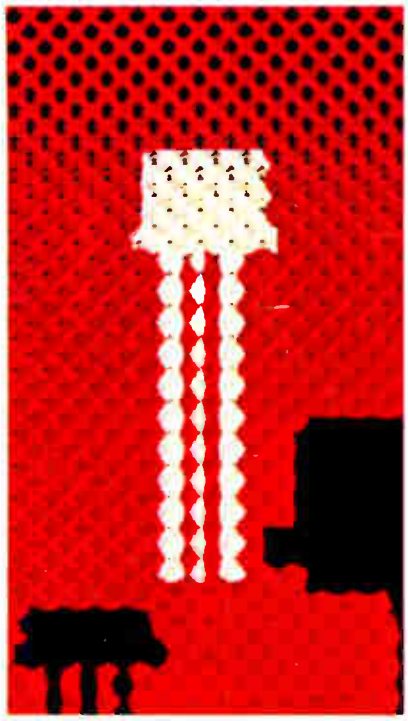
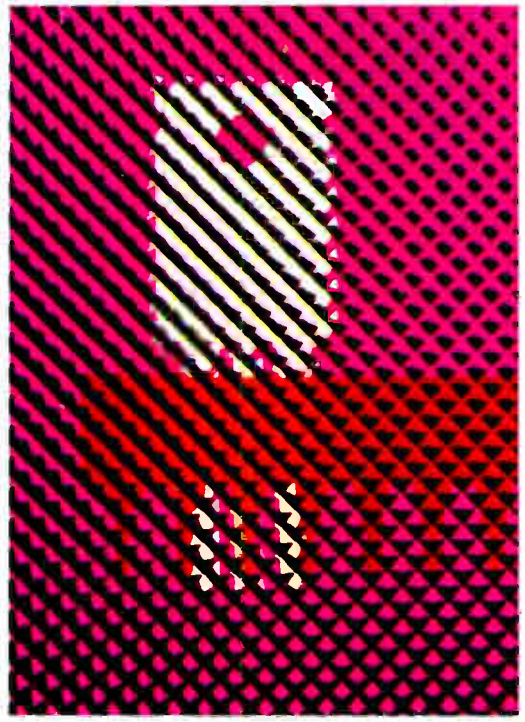
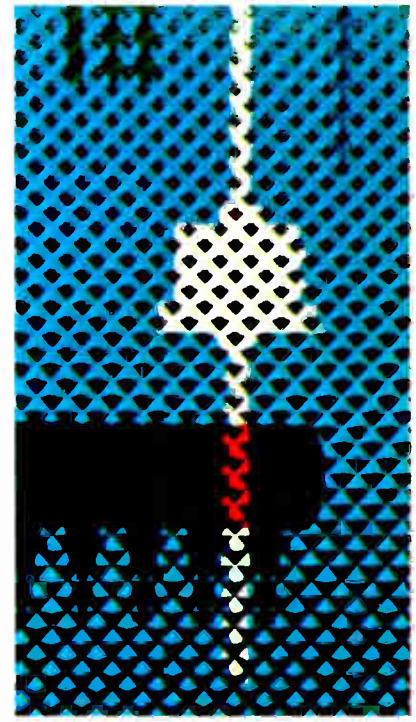
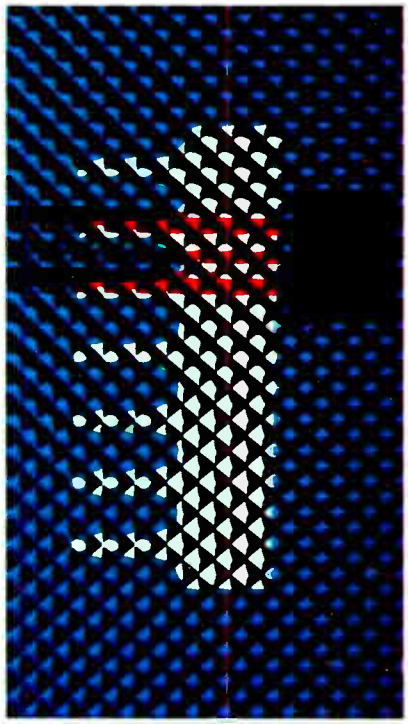
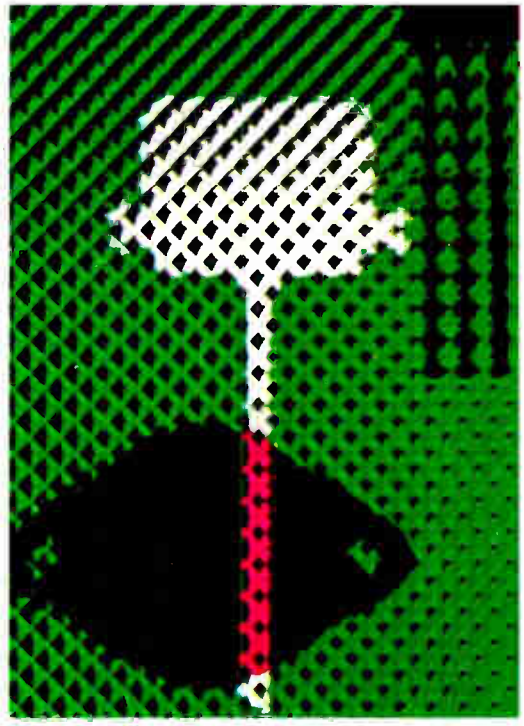
# MASTER SELECTION GUIDE
## and catalog

**MOTOROLA Semiconductors**

World Radio History

World Radio History

# MASTER SELECTION GUIDE and catalog

Selecting the best semiconductor for a given application can pose a significant challenge. To simplify the task, this book presents the full line of Motorola products, with selection tables highlighting the preferred devices for the various applications.

Keeping up to date on new products also poses a challenge. The following two pages outline Motorola's program for meeting that challenge.

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**INTEGRATED CIRCUITS .... Page 1**

**DISCRETE DEVICES ..... Page 109**

Second Printing

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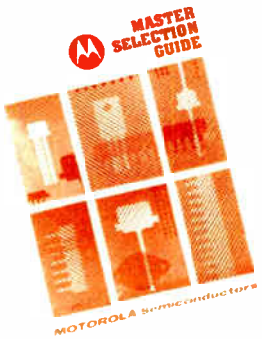
# THE MOTOROLA SEMICONDUCTOR UPDATING SYSTEM

*In an era when semiconductor devices are multiplying like the proverbial "rabbits", the task of providing an effective and up-to-date perspective of available components is beyond the means of any single document. Hence, a comprehensive Motorola UPDATING SYSTEM concept has been developed to keep semiconductor users totally informed of all aspects of our product lines — from new product introductions, to major changes in directions and applications. Utilization of the system, however, demands some involvement on the part of the user . . . involvement in terms of subscribing to the update method most appropriate for his own requirements and in properly filing the associated periodicals. Toward that objective, here is a description of the system and its options.*



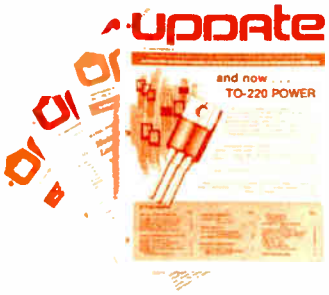

## The Master Selection Guide and Catalog (MSG)

This is the cornerstone of the Motorola Update System and, as such, it serves two purposes:

1. It lists, in alpha-numeric sequence, every standard product in the vast Motorola inventory, and . . .
2. It divides this total product offering into a variety of major-product categories, with sufficient technical information to permit an intelligent first-order evaluation as to the most suitable devices for a specific application.

The MSG is reprinted at least once a year but, as the months slip by between printings, it becomes more and more outdated. To bridge the gap between successive MSG issues, we have instituted a Periodical called...

## Semiconductor Data Update (SDU)*




Published bimonthly, this free* Periodical describes briefly the technical qualifications of all new products introduced between successive issues. Every third issue contains a categorized, cumulative index of all devices covered, to provide quick-scan insight into new-product introductions. The cumulative index in SDU will be started anew after each printing of a revised MSG since all products discussed in previous SDU issues will be integrated in any new issue of the MSG. Between issues of the MSG, however, the individual copies of the periodical should be kept on file as a quick and handy new-product reference. It works like this:

Need a power transistor for a new application? First check the MSG for basic specs on standard Motorola devices. Then, check the latest SDU index and any subsequent SDU issues for new introductions. This procedure should lead you quickly to the most suitable devices.

For detailed product evaluation, comparison, or analysis, only a data sheet will provide sufficient technical depth. For convenience to the user, Motorola supplies data sheets of its products in a collection of individual Data Books comprising the...



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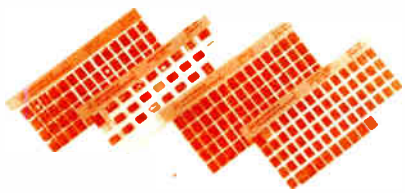
## Semiconductor Data Library

The Data Library is considered to be a reference library for design engineers. At least one complete set should be within easy access of any engineering group. It is particularly useful for comparative design analysis of one or more products. Once a particular design has begun, the designer may find separate data sheets for the selected products to be more convenient. Hence, Motorola field sales offices and distributors are supplied with such data sheets for localized distribution. Since Data Books represent a relatively large investment, they are updated less frequently than the MSG. For details on individual products that have not yet found their way into the Data Library, the user is again referred to the individual data sheets which can be obtained from regional Motorola Sales offices – or: He can subscribe to the free...



## Microfiche Literature Program**

For designers with access to a Microfiche *viewer*, the new Motorola Microfiche program represents the most convenient desk-top, new-product information system. Immediately after publication of an SDU issue, the data sheets (and other selected items of new literature) of products discussed in the issue will be made available on Microfiche. This provides for the user a complete file of new Motorola data literature that is easily stored and conveniently retrieved. If a Microfiche *copier* is available, it can quickly provide hard copy from the Microfiche file. Literature containing a great deal of textual material, such as application notes, handbooks, data books, etc., will not be made available on Microfiche at this time. These are available from regional Motorola sales offices and distributors.

For those requiring a timely and *automatic hard-copy update* of *all* new literature, Motorola has initiated a...

## Hard-Copy Subscription Service. Annual Fee, $12.00***

For subscription of $12/year, the user will receive a complete package of all data and literature described in each copy of SDU. This includes copies of application notes, data books and handbooks, as well as data sheets, and related brochures.

**In short . . .**

1. Through MSG and SDU you are acquainted with the major specifications of all our products.
2. Through our Data Library, plus subscription to our Microfiche (free) or hard-copy ($12/year), you can acquire a complete data-sheet file of all our products (plus additional literature).
3. If you're interested only in specific data sheets, application notes and related literature, a call to your regional Motorola sales office or distributor should get the required material to you free of charge within 24 to 48 hours.

It's all a part of a system to keep you fully informed of our products and their capabilities. But if the system still leaves some questions unresolved, a call to any of our regional sales offices or distributors will evoke quick response with competent answers.

**May we help you?**

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# 1 INTEGRATED CIRCUITS

## IC HIGHLIGHTS

The galloping integrated circuit technology produces important new design tools so rapidly that the presentation of a total overview of available products is an illusive objective. Moreover, Motorola's pervasiveness in the various categories of integrated circuits is so widespread that the mere cataloging of new products in such an overview tends to obscure their relative significance. Hence, the following highlights of the more important developments in each of the major IC product segments . . .

**MICROCOMPUTER FAMILIES** – Of major significance is Motorola's expansion into three different families for a variety of applications:

1. The M6800 MOS Family for control and communication applications;
2. The bipolar M2900 Family for general-purpose computer and minicomputer development;
3. The bipolar *superspeed* M10800 Family for critical, real-time computer systems.

While all families are slated for continual product expansion, one important new member of the M6800 line has been the MC6875 Monolithic Clock Generator (pages 8, 74) that provides a low-cost, highly efficient and simple replacement for the hybrid methods that had to be adopted for this function up to now. Other newly introduced additions to this family are a series of interface circuits that greatly simplify the expansion of the associated peripheral systems (page 10).

Supplementing the processor component families is a brand-new Motorola product offering – *Micromodules* (page 32). These new products offer MPU subsystems and systems of varying capabilities for those customers that want to speed-up their equipment development cycle.

**MEMORIES** – The past 12 months have seen Motorola memory production expand to virtually unlimited availability of the MCM6604 4K RAMs, as well as introduction of the MCM4027 4K RAM and the MCM6616 16K RAM, and

(continued on next page)

**MOTOROLA Semiconductors**



World Radio History

a selection of other MOS devices, page 36. Bipolar memory additions with major impact include the MCM10146 1K RAM, page 39.

In addition, Motorola now supplies *Memory Systems*, page 40, for those whose requirements go beyond the individual "chip" stage.

**LOGIC FAMILIES** — Most significant, for 1977, is Motorola's entry into low-power Schottky TTL competition, with up to a hundred devices slated for introduction during the year, page 53. New CMOS devices in both MSI and LSI categories, page 43, have been added to this explosive product line, with a major emphasis on B-series devices.

**INTERFACE CIRCUITS** — As IC technology spreads heavily into LSI, the need for the development of interface circuits with discrete components and SSI devices is a contradiction in scale. Motorola's large-scale effort on design of specialized single-chip interface circuits for computer and communications equipment has produced devices that satisfy a majority of requirements, page 71.

**LINEAR CIRCUITS** — No area of integrated circuits is as widely diversified as that of Linear Circuits. Motorola's Linear leadership has established itself in virtually every category. Some of the more interesting products newly added to this product line are:

One of the first Quad FET Operational Amplifiers, type MC3571/3471, which offers a low cost and wide bandwidth;

The MC3520/3420 Switching Regulator Control Unit which provides all the control circuitry for PWM push-pull, bridge and series type power supplies;

The MC3523/3423 Overvoltage Sensing Circuit, which quickly "crowbars" or short circuits the supply when an overvoltage condition is sensed;

For the automotive market, the MC3333 Vari-Dwell Ignition Circuit which offers externally adjustable overvoltage shutdown, dwell time, and spark energy.

**PHASE-LOCKED LOOP** — Expanding the choice of circuits designed for phase-locked loop applications are a number of CMOS Frequency Synthesizers for CB and FM transceivers (see page 106).


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Page No.


## MICROCOMPUTER FAMILIES

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105 ..... PHASE-LOCKED LOOP




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MOTOROLA

# MICROCOMPUTER FAMILIES

## M6800 — ALL YOU NEED FOR YOUR MICROCOMPUTER SYSTEM

The M6800 Family is a pervasive set of computer circuits designed to handle most data processing, control and communication functions with a high degree of efficiency. Its NMOS LSI architecture optimizes process cost reduction without stifling system design flexibility. Its powerful instruction set minimizes memory requirements and enhances system speed. And as backup for these components, Motorola offers an extensive system of support products, design aids and services that can significantly reduce your system development costs.


| | Page |
|---|---|
| M6800 Concept | 5 |
| The Components | 8 |
| Support Products | 13 |
| Support Software | 18 |
| Support Peripherals | 20 |
| Application Support | 22 |


## A FAMILY OF COMPUTER SLICES

For high performance computer systems, the "Slice" approach provides an excellent method for system design. With its "building block" expansion concept, it is possible to meet the end-use requirement of any computing system, from the simple to the most complex, while taking advantage of the cost and ease-of-design features of standard LSI components. The Motorola "Slice" family consists of two device lines. Both families have 4-bit architecture that is easily expandable to meet any system size and performance goal.


| | Page |
|---|---|
| M10800 Family — MECL Technology | 23 |
| M2900 Family — Schottky TTL Technology | 29 |


## MICROMODULES

A new capability at Motorola now offers the equipment designer an expanding line of microcomputer-oriented modules that permits entry into the equipment hardware design cycle at a level considerably higher than the LSI components level. Page 32



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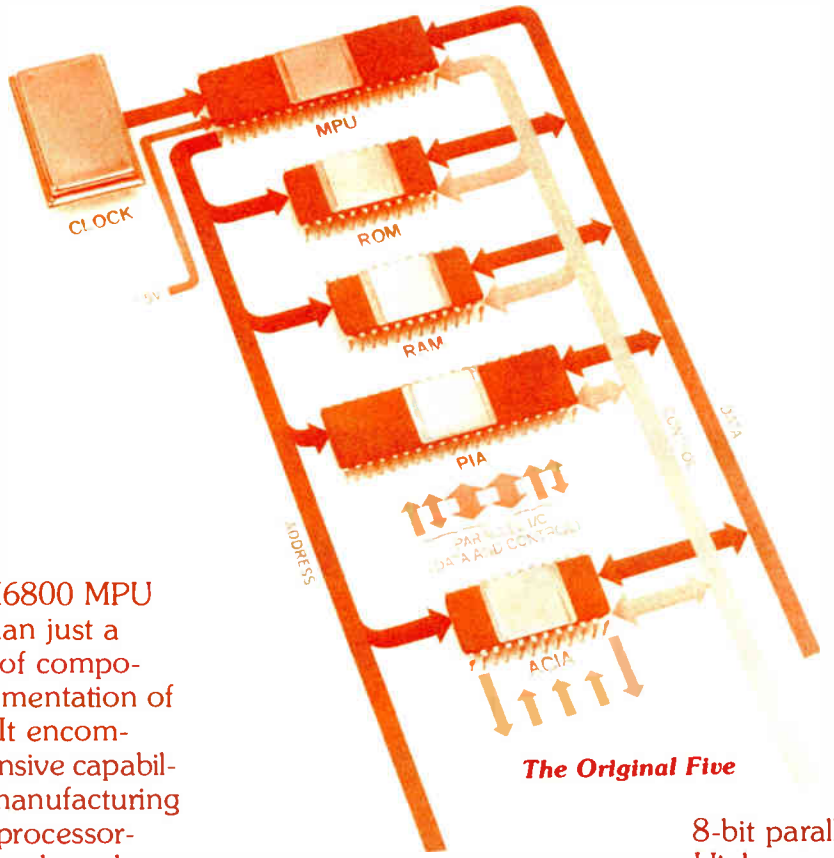
# The Motorola M6800 Concept




*The Original Five*

The Motorola M6800 MPU concept is more than just a compatible family of components for the implementation of a microcomputer. It encompasses a comprehensive capability for the design, manufacturing and upgrading of processor-based equipment and product lines. It consists of the following: ☐ An interactive family of NMOS LSI building blocks that combines cost-effective architecture with a high degree of design flexibility and operating efficiency. ☐ A pervasive complement of support equipment for system design, evaluation and analysis.

## The Components
page 8

The original M6800 microprocessor family consists of five LSI NMOS components that comprise a basic but powerful microcomputer. These basic components since have been supplemented with additional devices utilizing both NMOS and bipolar technologies. The additional parts, including a single-chip MODEM, a series of clock generators and an assortment of controllers, adapters and expanders, all interact to give the M6800 system ever-increasing versatility in expanding applications.

Special features of an M6800 MPU system include: ☐ 8-bit parallel orientation; ☐ High-speed operation, with clock rates up to 1.5 MHz; ☐ 72 powerful, variable-length instructions; ☐ 65,000-byte memory capacity; ☐ Single, 5-V power-supply requirement. ☐ An extensive repertoire of funcional and diagnostic software. ☐ A growing line of peripheral equipment to augment system design and operation.

This comprehensive product line is supported by an elaborate program of applications information, training and assistance that helps ensure the success of a user's project.



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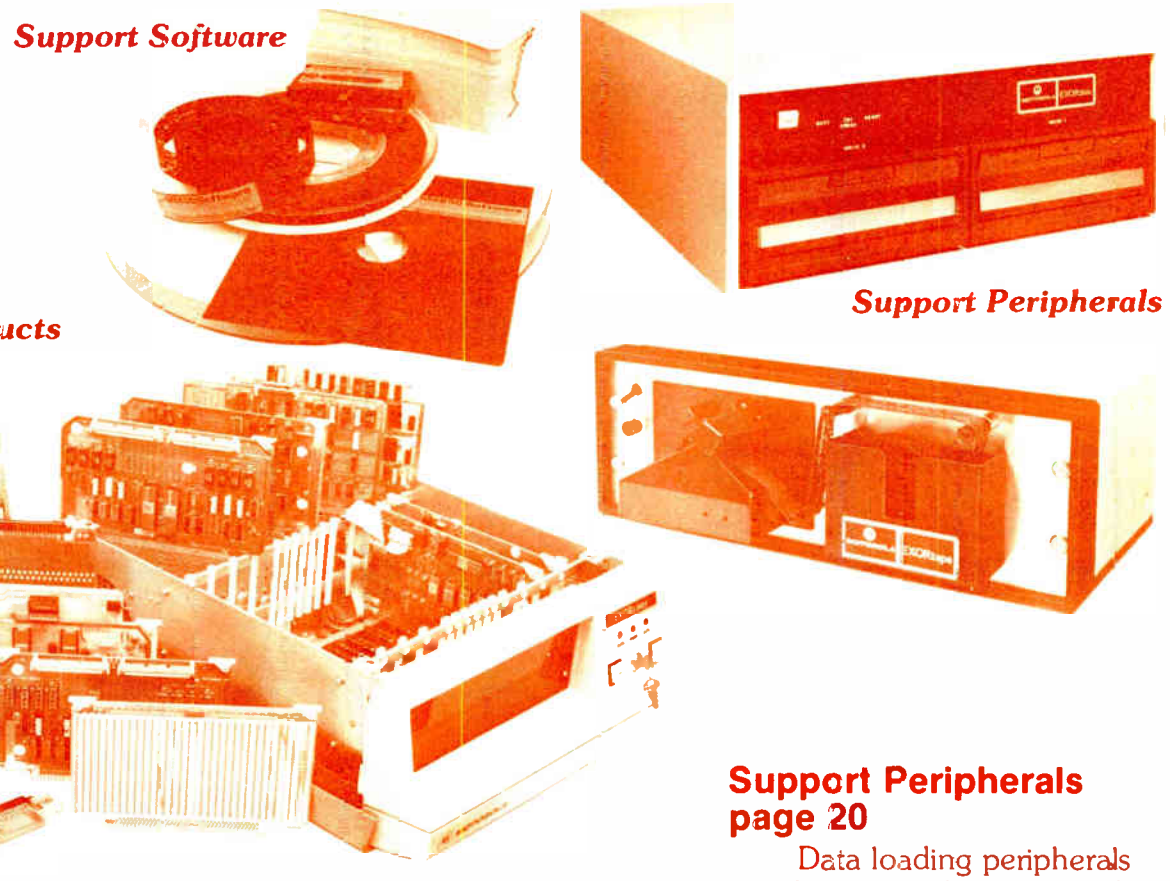


## Support Products page 13

Significant aspects of microprocessor design involve the development of programs that adapt the system to its eventual unique function. Motorola M6800 Support Products include powerful design, evaluation and diagnostic equipment that simplifies the system-design cycle. And to further increase M6800 functional utility, the rapidly expanding Support Product line encompasses go/no-go test equipment for rapid incoming inspection of complex LSI components, and dedicated instrumentation for field-testing of in-use systems.

## Support Software page 18

The development of the fixed programming routines that convert a microprocessor system into a dedicated control element can be accomplished by means of software that emulates or simulates the actual system. M6800 Software Support consists of tape, disk and card libraries that permit user-program development not only with a supportive EXORciser, but with large time-shared computer systems and other popular computers and minicomputers as well. These alternatives provide maximum versatility for program development.

## Support Peripherals page 20

Data loading peripherals aren't necessarily an integral part of an MPU line. But when designed specifically for use in conjunction with a particular MPU system it is often possible to effect cost savings by avoiding circuit redundancy. Motorola already supplies some dedicated peripherals for the M6800 system and has more under consideration.

## Applications Support page 22

The success of an MPU-based design project is directly related to the designer's familiarity with the technical details of the product line. The Motorola literature, training and technical assistance program is aimed at providing maximum assistance for M6800 users.



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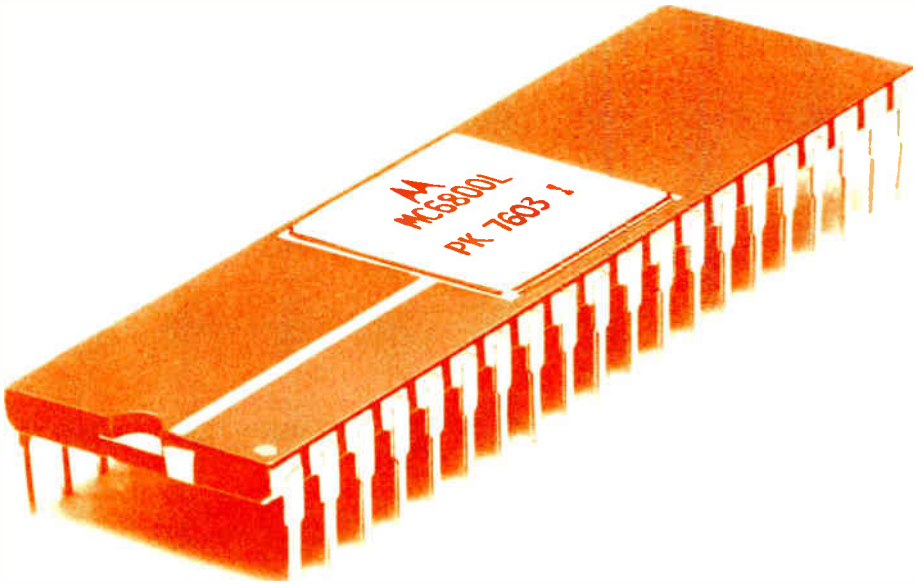
# The Components




## The MPU

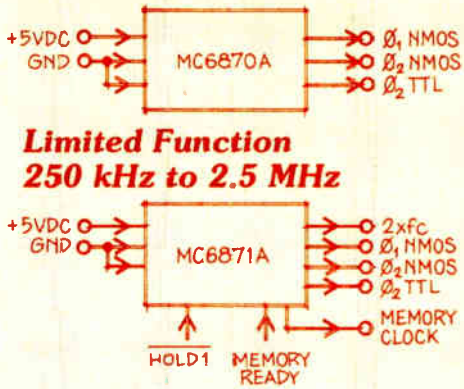
The microprocessing unit (MPU) performs the central control function of a microcomputer and its architecture determines the eventual applications for which the system is best suited. The MC6800 MPU is especially oriented toward the process control and data communications fields and offers maximum power and versatility for such applications.

Two objectives guided the designers of the M6800 family — maximum system throughput (operating speed), and system design ease. How well these objectives are achieved can be evaluated from the following inherent design features:

**Design Ease** — ☐ Bus organized system — reduces component count and simplifies interconnections. ☐ Single 5-V supply — reduces system complexity and cost. ☐ 16-bit address system — permits selective addressing in excess of 65,000 memory locations. ☐ 72 variable-length instruction set — actually performs 197 operational sequences.

**Optimized Throughput** — ☐ N-channel MOS processing — permits clock rates as high as 1.5 MHz and simplifies LSI implementation. ☐ Automatic data stacking during interrupts — saves contents of MPU registers. ☐ 3-state output — makes memory addressing and multiprocessing applications realizable. ☐ Vectored restart — automatically clears system during restart and saves programming steps.

## The Clock




The M6800 system operates on two non-overlapping clock phases, $\phi 1$ and $\phi 2$. Three versions of a suitable clock generator are currently available in hybrid module form. These modules contain the crystal, the oscillator circuit, the NMOS and TTL drivers, and the waveshaping and interface circuitry to operate in conjunction with the 5-V M6800 system. They are normally supplied with a 1 MHz crystal, but other frequencies between 250 kHz and 2.5 MHz can be ordered.

***Coming Soon***
***MC6875***

## Monolithic Clock Generator

Low-cost generator designed to enhance the M6800 system capability. Capable of operating at four times the highest MPU clock rate. Frequency is determined by external crystal or RC network.



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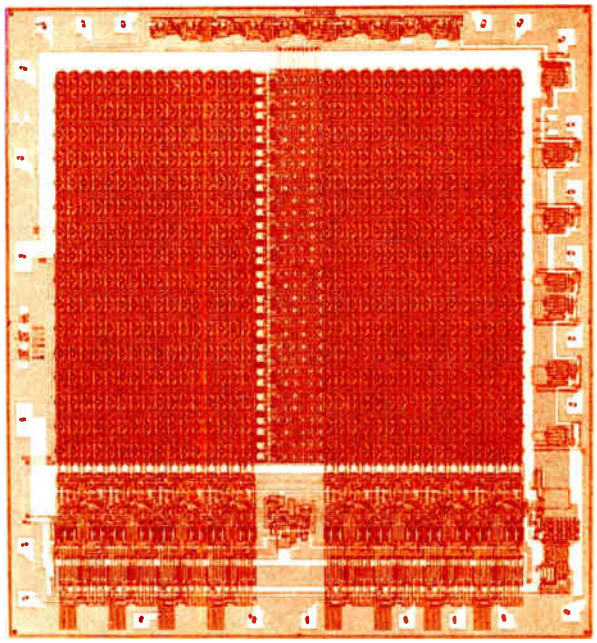
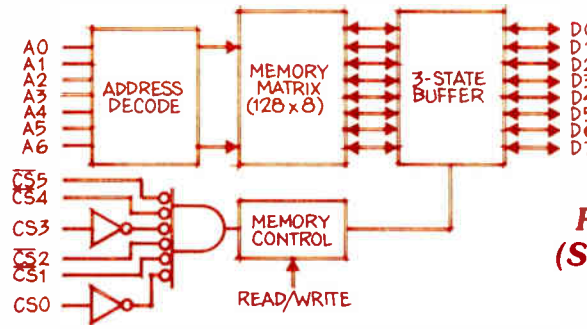
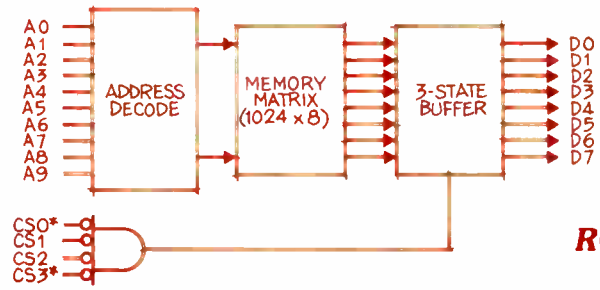
# Memories



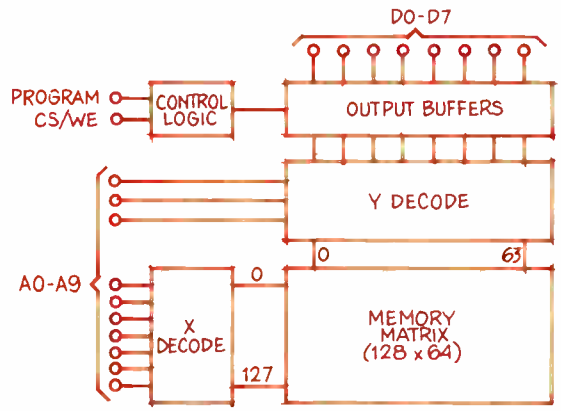



***RAM (Static)***




***ROM***

* These Chip Select inputs available on MCM6830A only.




***PROM (Alterable)***

M6800 implementation is enhanced by availability of bus oriented memories with 8-bit organization and 5-V operation to match the basic system philosophy. These N-channel, MOS memories, both RAMs and ROMs, operate directly from the bus system and require no additional components in most MPU applications.

## Random Access Memory (Static)

| 128 x 8-BIT | ACCESS TIME |
|---|---|
| MCM6810A1 | 350 ns |
| MCM6810A | 450 ns |

## Read-Only Memory

All are mask-programmable, with the active level of the Chip Select inputs and the memory content defined by the user. All have Access Time of 500 ns (max).

**1024 x 8-BIT** — MCM6830A
MCM68308

These two memories differ primarily in pinouts and number of Chip Select inputs available.

**2048 x 8-BIT** — MCM6832

## Programmable Read-Only Memory (Alterable)

**1024 X 8-BIT** — MCM68708

Electrically programmable in the field. May be erased with ultraviolet light and reprogrammed electrically. Contact your Motorola representative for availability information.



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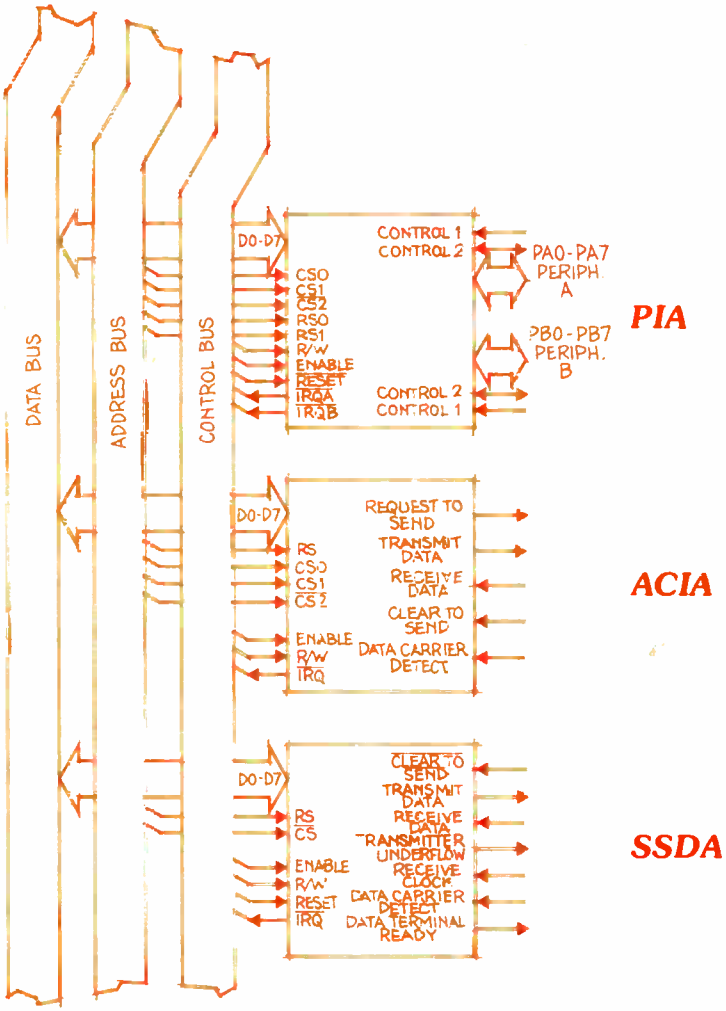


# Interface Circuits

## Peripheral Interface Adapter (PIA) MC6820

Parallel oriented peripheral(s) can be connected to the MC6800 MPU via the Peripheral Interface Adapter — usually without any additional circuit requirements. The PIA contains two I/O circuit blocks, each capable of controlling an independent 8-bit peripheral I/O bus.

Multiple PIAs can be used with a single system and selectively addressed by means of Chip Select Inputs.

## Asynchronous Communications Interface Adapter (ACIA) MC6850

Data transmission is accomplished in the serial mode; the M6800 bus system operates only in the parallel mode. By performing serial-to-parallel and parallel-to-serial conversions, the MC6850 ACIA provides the means for communication between the MPU and peripheral equipment such as modems, TTYs, CRT terminals, keyboard/printers and other equipment requiring an asynchronous serial data format. Communications can be accomplished at transmission rates up to 500 kbps.

## Synchronous Serial Data Adapter (SSDA) MC6852

Provides interface between the M6800 MPU system and synchronous data terminals such as floppy disk equipment, cassette or cartridge tape controllers, numerical control systems and other systems requiring movement of data blocks. Operates at speeds up to 600 kbps. Features: ☐ Programmable Interrupts. ☐ Character Sync on 1 or 2 Sync Codes. ☐ Peripheral Modem Control Functions. ☐ 7-, 8-, or 9-Bit Transmission. ☐ Optional Even and Odd Parity.


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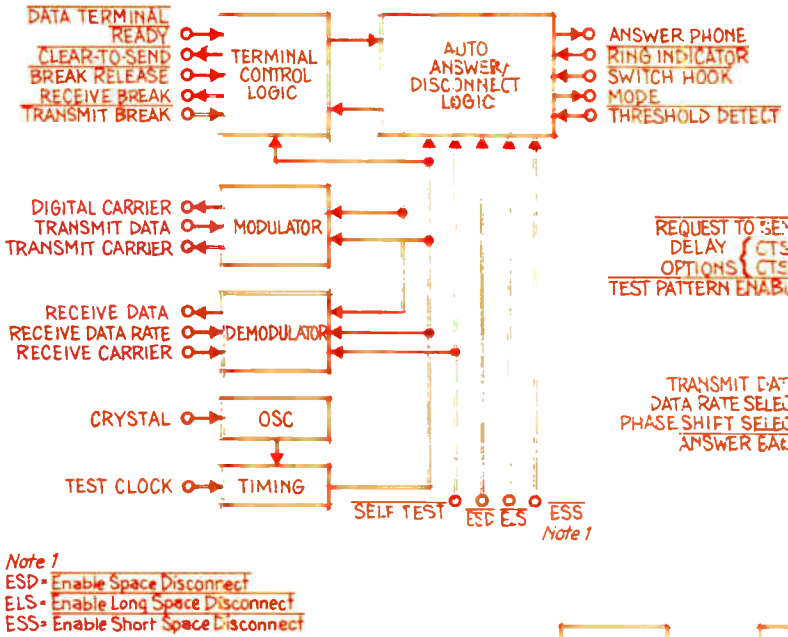
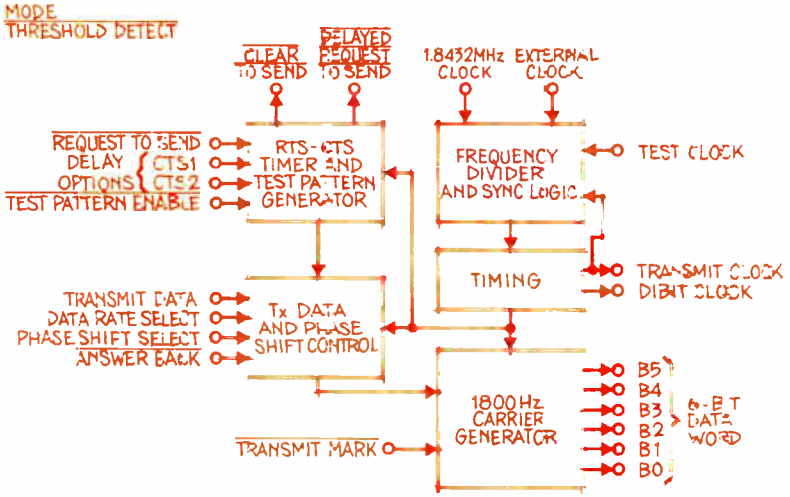



Note 1
ESD = Enable Space Disconnect
ELS = Enable Long Space Disconnect
ESS = Enable Short Space Disconnect

### Digital Modem

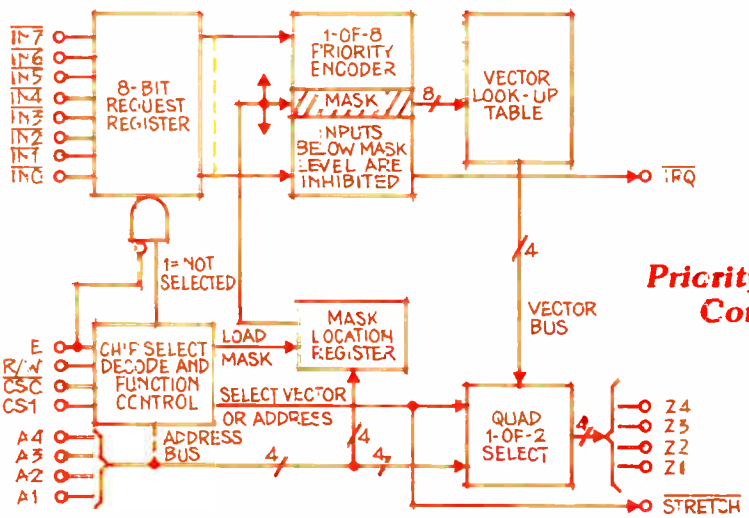



### Digital Modulator

# Auxiliary Circuits

## MC6860 0-600 bps Digital Modem

Operating from the same 5-V supply as other M6800 components, this low-speed modem is designed for implementation in a wide range of data handling systems — including stand-alone modems, data-storage devices, remote data-communications terminals and I/O interfaces for minicomputers. Interfaces with the MPU system through MC6850 ACIA over voice-grade channel. Features: ☐ Originate and Answer Capability. ☐ Automatic Answer and Disconnect. ☐ Full-Duplex or Half-Duplex Operation. ☐ Mod-Demod Self-Test.




### Priority Interrupt Controller

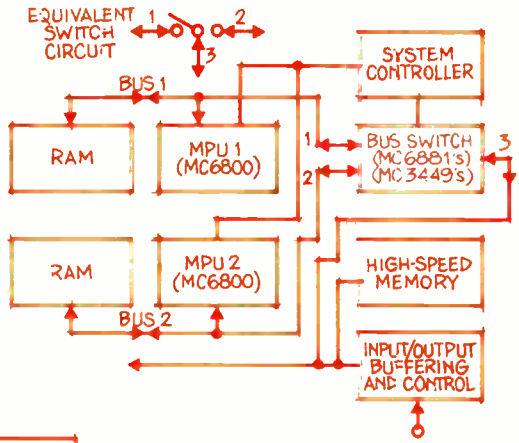
## MC6862 2400 bps Digital Modulator

Provides the necessary modulation and control functions to implement a serial data communications link over voice-grade channels at bit rates of 1200 and 2400 bps. Features: ☐ Clear-to-Send Options. ☐ CCITT and U.S. Phase Options. ☐ Answer Back Tone.

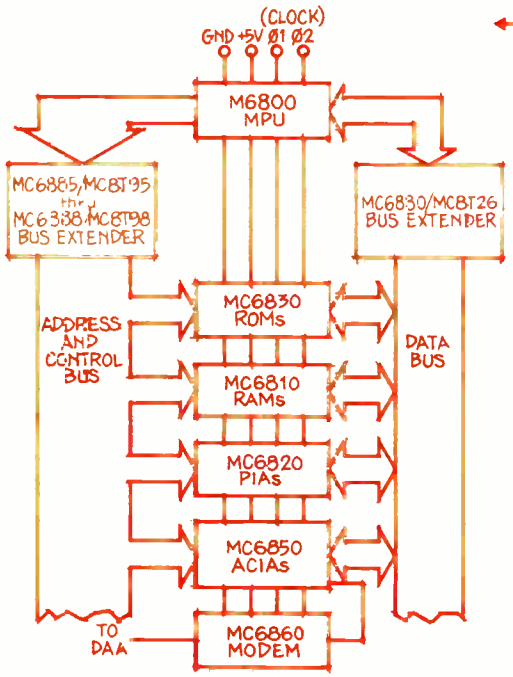
## MC8507/MC6828 Priority Interrupt Controller

This bipolar LSI circuit adds high-speed "priority interrupt" capability to the M6800 system as well as to other processor systems encompassing up to eight peripherals. It eliminates the necessity for the MPU to poll all its peripherals to determine their service requirements and priority ratings. The circuit is of particular importance in systems utilizing many peripherals with interrupt requirements.


World Radio History




***Microprocessor Bus Switch Application***




***Microprocessor Bus Extender Application***

# Expansion Components

The MC6800 Microprocessing Unit is capable of directly interfacing with eight of its peripheral components (memories, interface, etc.) and one TTL load on the same bus, at a 1-MHz clock rate. For systems requiring greater load capacity, and to increase the versatility of the system in general, a number of ancillary bipolar monolithic components have been designed. All of the parts described here will be in mass production by the end of 1976.

## Quad Bus Transceiver MC6880/MC8T26

This component consists of four separate receiver-transmitter combinations, designed for use with a bidirectional bus system such as the M6800 data bus. Driver and receiver output currents are −40 mA and −16 mA, respectively. Maximum input current requirement of 200 μA at any input pin ensures proper operation with MC6800 MPU. Employs Schottky technology for high-speed operation.

## Hex Buffer/Inverters MC6885/MC8T95 through MC6888/MC8T98

Designed as bus extender for unidirectional bus systems such as the M6800 Address and Control bus functions. The various devices in this product sequence differ in output (inverting and noninverting) and enable configurations. Schottky technology assures high-speed operation (8 ns typ). High impedance inputs prevent loading of bus system for output requirements up to 40 mA.

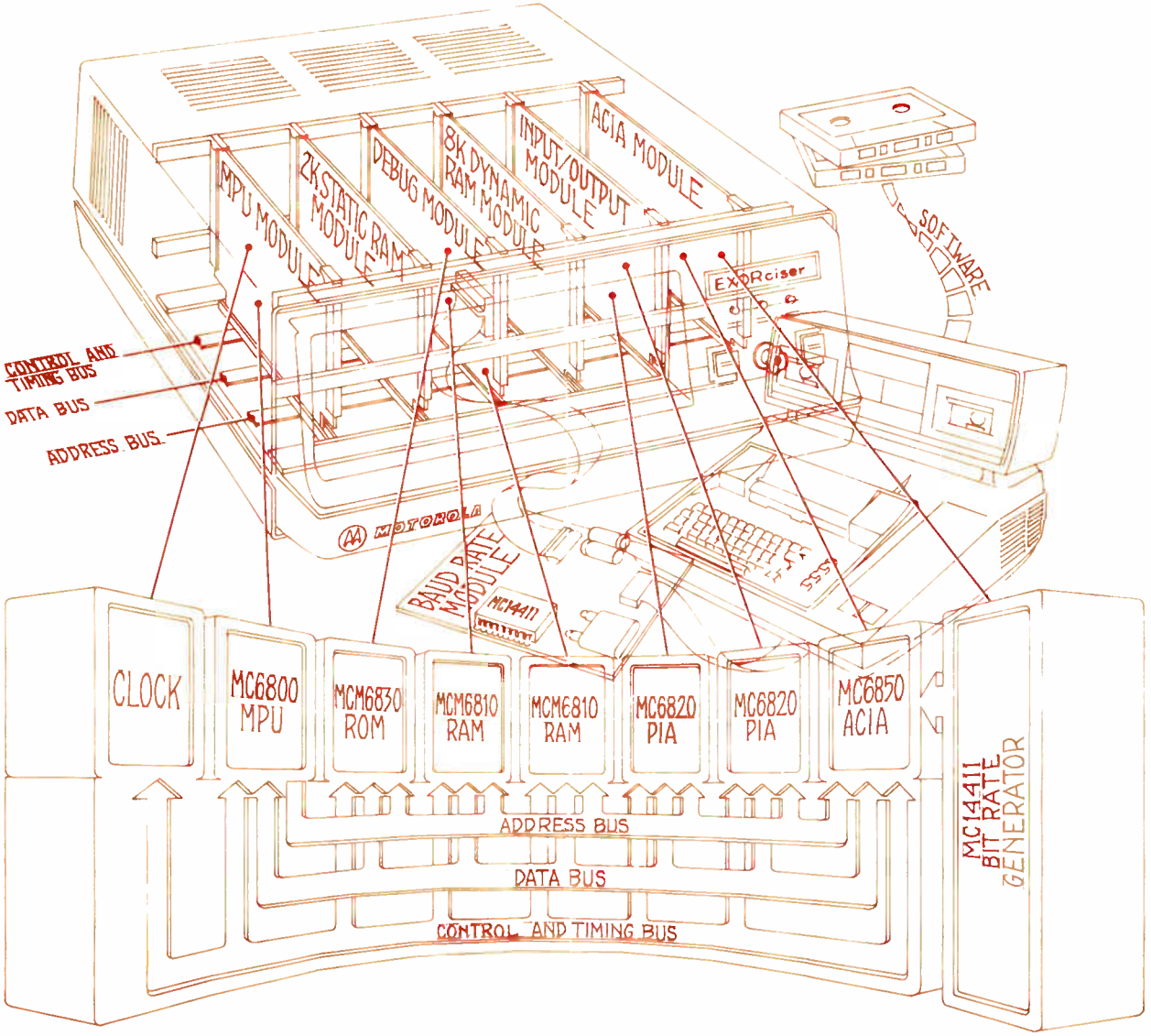
## Triple Bidirectional Bus Extender/Switch MC6881/MC3449

Permits bidirectional exchange of TTL level signals in multiprocessor installations, or multiplexing of signals to a single processor.



World Radio History

# M6800 Support Products




There are important differences in system-design with hardwired circuitry and designing with microprocessors. With hardwired, dedicated circuitry, once the necessary components have been functionally interconnected, the job is done; with microprocessors, when the hardware of the system has been emulated, that's when the real design starts — the job of designing the program that turns a basic uneducated computer into a functional system dedicated to a specific task.

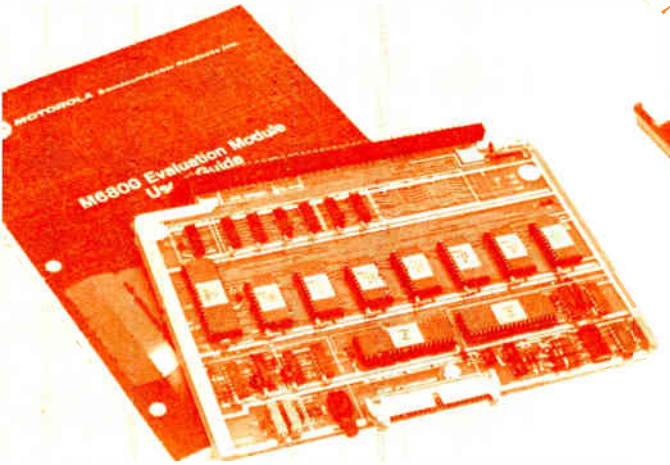
The key to developing a dedicated MPU system and, ultimately, to manufacture and service the system, requires an umbrella of support equipment ranging from development aids to manufacturing and service instruments. The M6800 product family is already complemented with an array of such user-oriented developments and test equipment, and additional items will be implemented as quickly as a need for them is demonstrated. It's part of a systematic plan to keep The Family foremost on the "preferred product" list of the system designer.

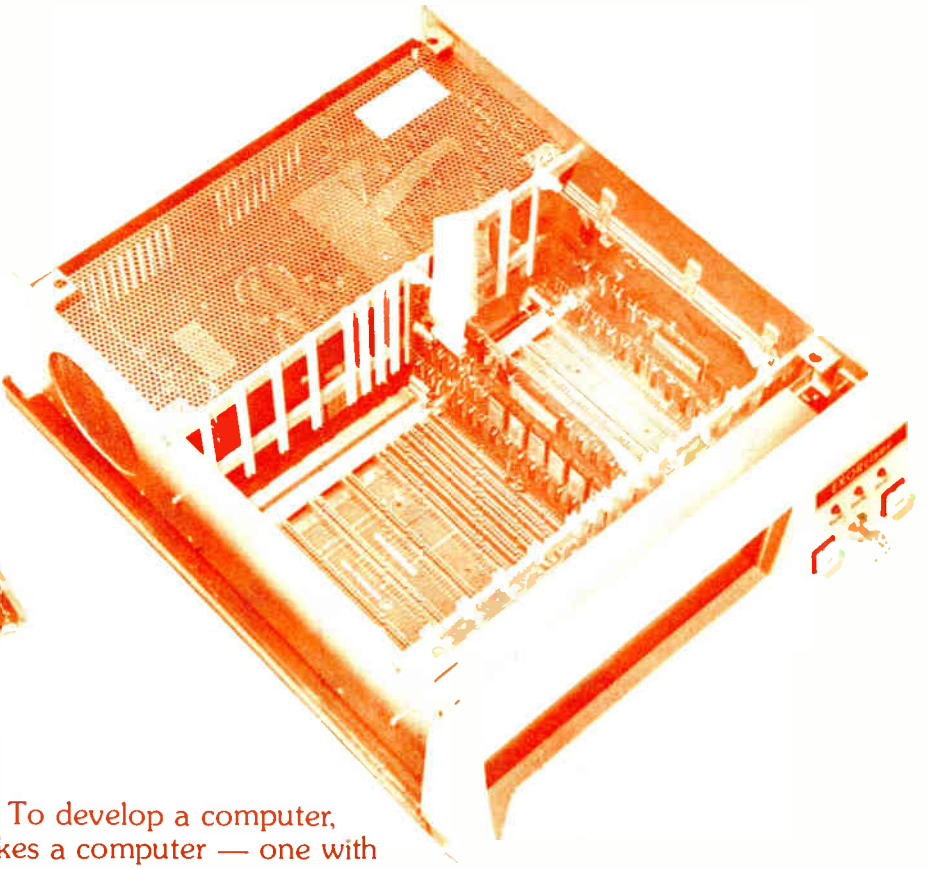


World Radio History

# The M68SDT EXORciser

## M6800B Evaluation Module II



This Module is, in effect, a microcomputer that provides an efficient and relatively economical off-the-shelf means to evaluate the operating characteristics of the M6800 component family in various applications. It interfaces with either a TTY (20 $\mu$A neutral current loop) or an RS-232C-compatible terminal and, through its inherent MINIBUG control program, provides the following functions: ☐ Load data. ☐ Analyze and, if required, change data in the module's RAM and MPU registers. ☐ Print out or record on tape the data stored in the memory. ☐ Set the number of stop bits for data communications. ☐ Run the user's program. Requires a separate power supply with 5 V/2 A and ±12 V/50 mA capability.

To develop a computer, it takes a computer — one with even greater capacity than the system under development. The EXORciser is such a computer, developed expressly as a design, evaluation and diagnostic instrument for M6800-based microcomputer systems.

Essentially, the EXORciser is an expandable "breadboarding" system that allows almost instantaneous emulation of any M6800 microcomputer configuration, from the simplest to the most elaborate. Built-in programming and diagnostic routines then facilitate the development and debugging of the dedicated programs for the system under design.

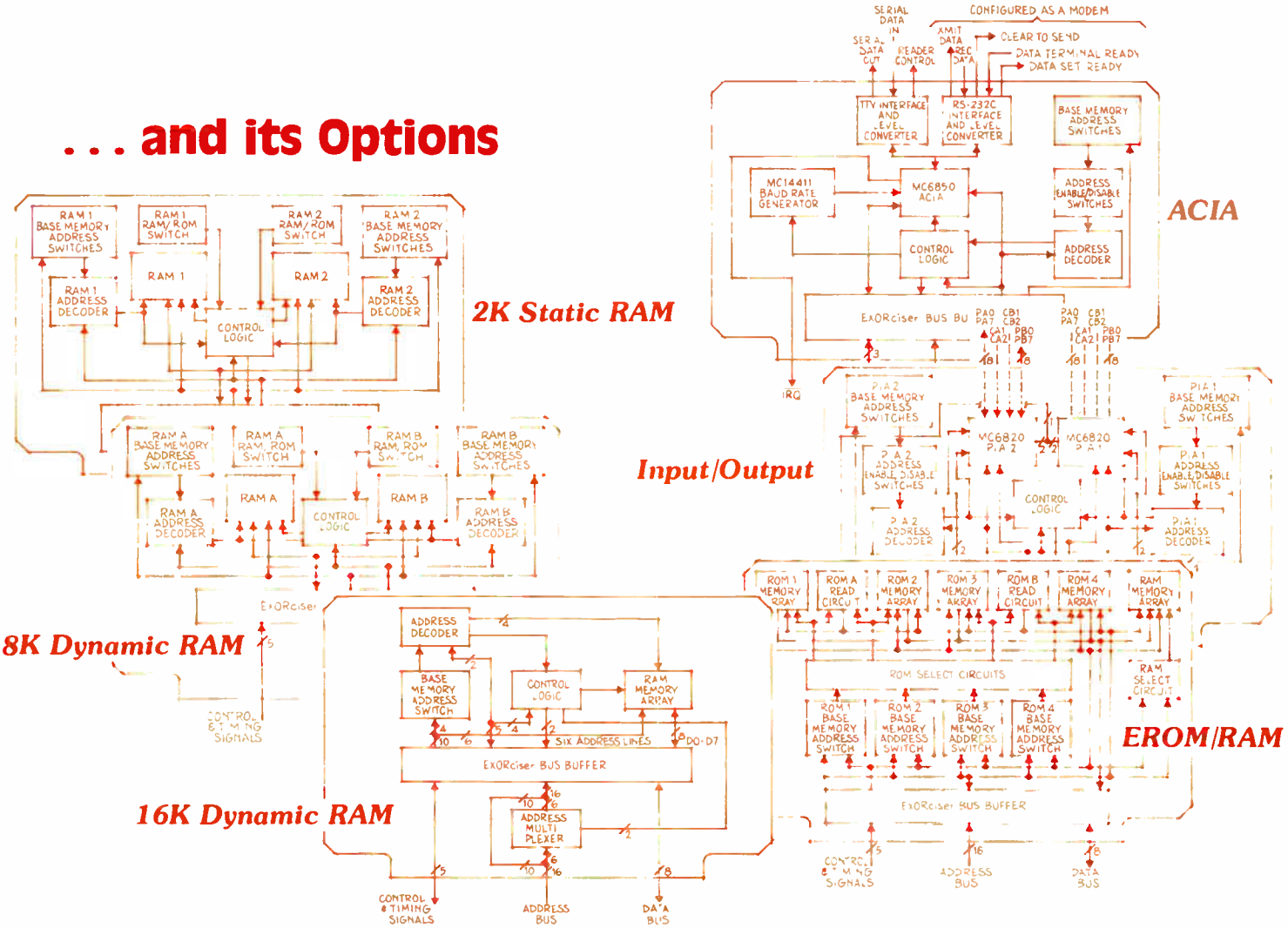
The basic EXORciser contains a power supply and three functional modules — an MPU Module, a Debug Module and a Baud-Rate Module. Together, these form a development microcomputer, requiring only additional memory capacity and appropriate interface circuitry for the peripherals. These additional requirements are available as add-on modules, permitting the designer to purchase a few or as many as required for the anticipated end-functions of the system(s) to be developed.

The chassis is capable of accommodating up to 12 additional plug-in modules to give the EXORciser increased versatility, with memory capacity of up to 65,536 bytes.



World Radio History

# . . . and its Options




## Memory Modules

All are bus compatible with the EXORciser and simply plug into the main chassis. These Modules extend the flexibility of the EXORciser as a microcomputer.

**A. 2K Static RAM Module — (MEX6812-1)** ☐ 2048 x 8-bit NMOS memory in two 1024-byte arrays. ☐ Each array is switch-selectable and can be used as ROM.

**B. 8K Dynamic RAM Module — (MEX6815-3)** ☐ 8192 x 8-bit NMOS memory in two 4096-byte arrays. ☐ Each array is switch-selectable and can be used as ROM. ☐ Cycle stealing refresh. ☐ Refresh capability during power failure.

**C. 16K Dynamic RAM Module — (MEX6816-1)** ☐ 16,384 x 8-bits NMOS array. ☐ Switch-selectable base address. ☐ Cycle stealing refresh.

**D. EROM/RAM Module — (MEX68RR)** ☐ Prewired memory card has provisions for mounting up to 16 MCM68708 EROM devices (or equivalent) for 16K x 8-bits of available PROM . . . plus four sockets for MCM6810 RAM devices (Memory devices not supplied).

## Interface Modules

**E. Input/Output Module — (MEX6820)** ☐ Four 8-bit input/output ports for parallel oriented peripheral interfacing. ☐ Eight controlled interrupt lines. ☐ Each I/O port individually selectable as a memory address. ☐ Three-state TTL compatible I/O lines.

**F. ACIA Module — (MEX6850)** ☐ Interfaces with TTY or RS-232C data terminal. ☐ 8 or 9-bit transmission. ☐ Program-selectable odd, even or no parity. ☐ 8 switch-selectable baud rates (110–9600 baud).

## Auxiliary Modules

**Universal Wirewrap Module — (MEX68WW)**

Space for mounting up to 75 14-pin wirewrap sockets for user designed accessory circuits.

**Extender Module — (MEX68XT)**

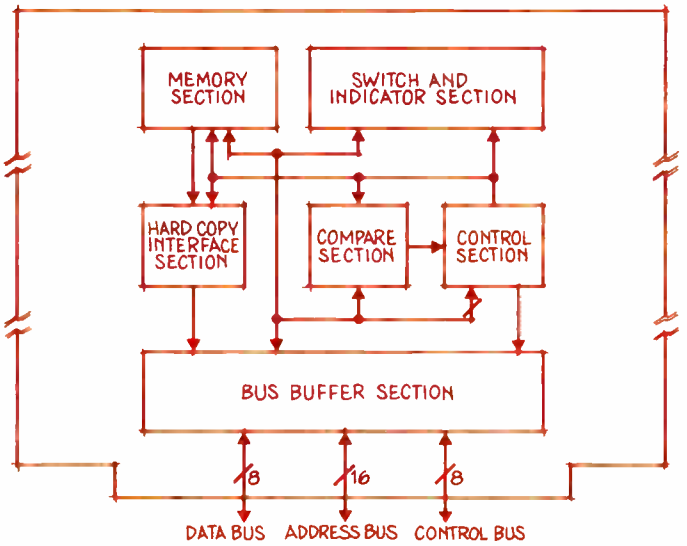
Permits access to any EXORciser module from outside the EXORciser chassis.



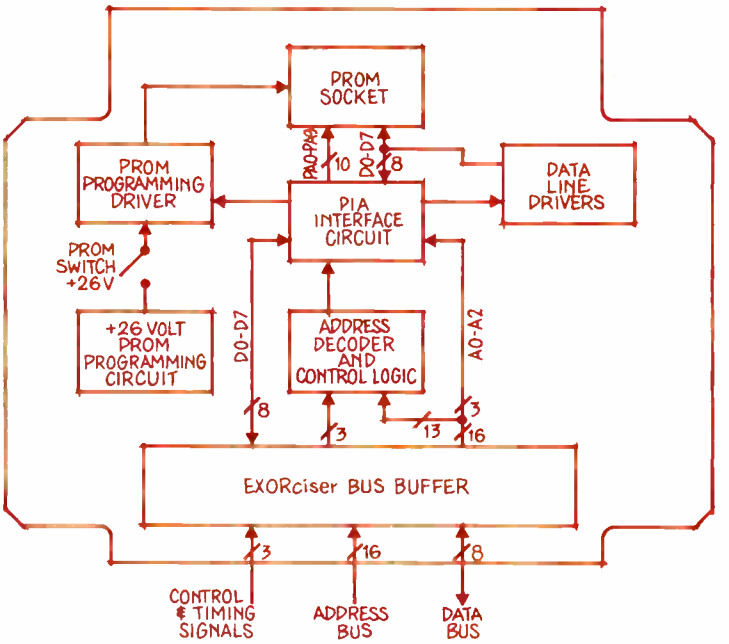
World Radio History

# . . . and more sophisticated aids for

***System Analyzer***




***PROM Programmer***




The basic EXORciser is the focal point not only for system design support, but also for the support of subsequent microprocessor manufacturing and testing procedures, as described here.

## System Analyzer (MEX68SA)

This unique instrument can be used as an independent, portable troubleshooting unit for field service of M6800-based equipment, or in conjunction with the EXORciser to enhance the capabilities of the latter as a design tool.

**In field service applications,** the System Analyzer derives operating power and I/O signals directly from the system under test. It stops the system at any point in its program, steps through the program, changes the contents of the system memory, monitors and records the MPU's operation during a selected portion of the program. It can even perform these functions without shutting down the operation of the system.

**In EXORciser applications,** it adds a variety of options to the system's inherent program development capabilities.

**In conjunction with the EXORciser and USE,** it offers the most powerful combination of development and diagnostic tools available for microcomputer work.

## PROM Programmer (MEX68PP1)

Once a program for a microprocessor system is designed and debugged, it is entered into a Read-Only Memory which becomes part of the dedicated MPU operated end system. When an end system is manufactured in large quantities, these programmed ROMs are often purchased in quantity from the component supplier. When only a few end systems are to be produced, the equipment manufacturer may elect to use an Electrically Alterable PROM (EPROM) and do the programming himself. The PROM Programmer, in conjunction with the EXORciser, will perform this function quickly, easily and inexpensively.

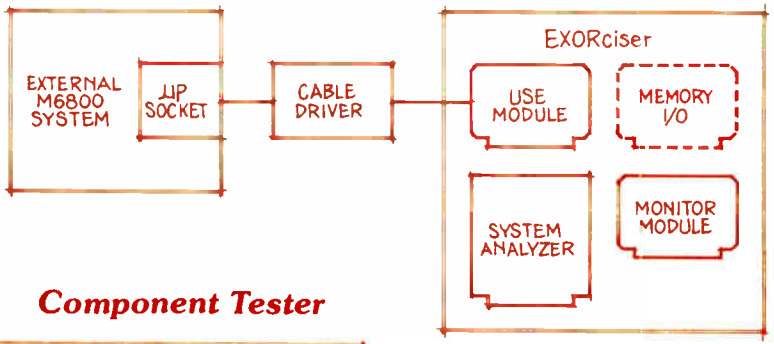
The PROM Programmer operates in conjunction with the EXORciser's EXbug firmware to program the EPROMs of the 2704 and 2708 type. It can verify

EXbug is a trademark of Motorola Inc.



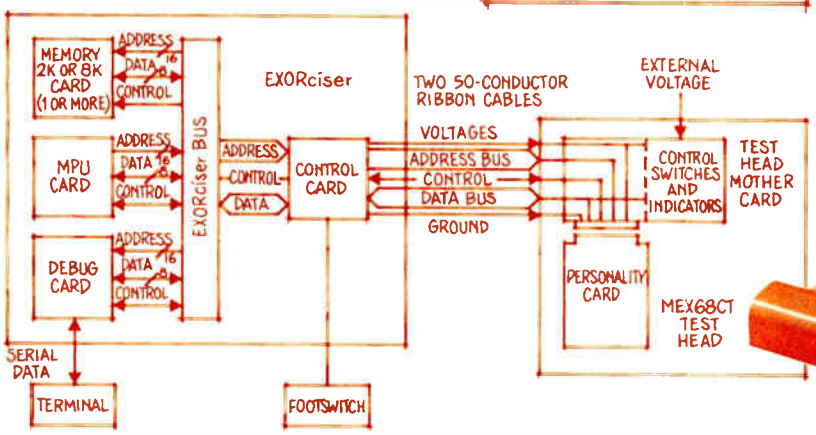
World Radio History

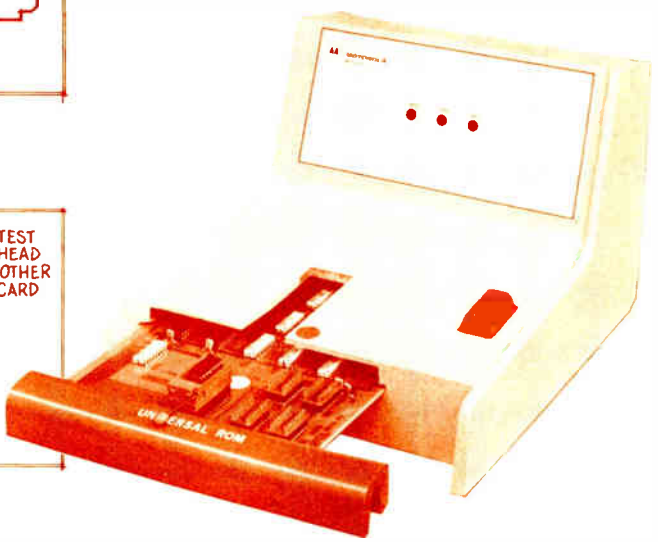
# System Design, Manufacturing and Service




***User System Evaluator (USE)***

***Component Tester***



the data in the EPROM, transfer data from the EPROM to the EXORciser RAM memory, and transfer blocks of data from one memory location to another. Programming time varies from 0.57 minutes for the 2704, to 1.54 minutes for the 2708.

## User System Evaluator (USE) (MEX68USE)

This module extends all the capabilities of the EXORciser to an existing user system. Whereas the basic EXORciser permits design of a processor system through emulation, the USE Module brings the diagnostic and evaluation capabilities of the EXORciser to bear on an existing system. In conjunction with the System Analyzer (and EXORciser), it provides a comprehensive system diagnostic center for all 6800-based equipment.

## Component Tester (MEX68CT)

The most practical way to test an LSI computer component is in an actual computer system in which the component under test is used to perform its actual intended function. For the M6800 system, this can be done quickly and easily with the Component Tester.

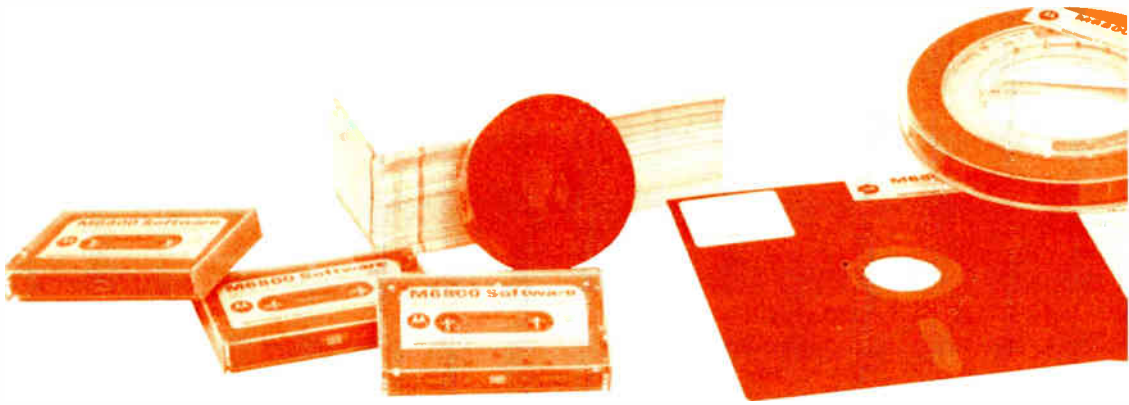
The Component Tester consists of a Test Head, an EXORciser Control Card, a series of Personality Cards (one for each component in the M6800 Family), and the associated Test Programs. In use, the Test Head is interconnected with the EXORciser, via the Control Card (and interface cables), and the appropriate Personality Card is inserted in the Test Head. Then, with the device under test plugged into the Personality Card, the appropriate Test Programs steps the component through its various functions, using the inherent firmware of the EXORciser. The entire test takes from .5 to 1.5 seconds, depending on the device under test, and indicator lamps on the Test Head give a Pass/Fail indication of the component status.

The Component Tester is an ideal instrument to be used for incoming inspection, or on the production line. A single EXORciser can handle as many as eight test heads simultaneously.



World Radio History

# M6800 Support Software




Human programmers speak one language; machines understand another. Hence, a number of programs (software) have been developed to automatically translate, via a computer, from the programmer's language (source language) to machine language. Such a translation program is called an *Assembler* or a *Compiler*.

The development of programs that convert an uneducated microcomputer into a dedicated machine can be accomplished directly on the machine to be programmed (as with an EXORciser), or on other types of computers. The Assembler for use with the EXORciser is called a Resident Assembler. Assemblers that translate the M6800 mnemonics instructions into unique languages of other computers are called Cross Assemblers. A number of Cross Assemblers for major computer systems have been developed.

Going hand-in-hand with the Assembler, for program development, is the Editor. This software routine permits the programmer to use a computer to make whatever changes are required to create, correct, or revise a program. Each computer has an edit program that is unique to that system.

Motorola provides a compatible family of software that permits M6800 microcomputer program development in one of three ways:

1. **Resident Software** — designed for the EXORciser and Evaluation Module to provide the lowest program-development cost where a number of M6800 microcomputer designs are contemplated over a period of time.
2. **Time-Sharing System** — provides a software package that permits immediate utilization of a number of national and international time-share computers for M6800 program development. Recommended where maximum capability at low initial cost is required.
3. **Non-Resident Computer System** — permits utilization of in-house computer (not a 6800 system) to simulate M6800 hardware in the development of microcomputer programs. Features lower cost than conventional time-sharing, as well as access to faster peripherals.

***A Resident Assembler and Editor is available for use with the Motorola EXORciser and Evaluation Module as follows:***

## M6800 Resident Software Options

| DESCRIPTION | MEDIA | PART NUMBER For EXORciser | PART NUMBER For Eval. Module II |
|---|---|---|---|
| Assembler/Editor | Cassette | M68XAE6812A | |
| | Paper Tape | M68XAE6812B | |
| | Diskette | M68XAE6812D | |
| Assembler Only | Cassette | M68ASMR012A | M68ASMR212A |
| | Paper Tape | M68ASMR012B | M68ASMR212B |
| | Diskette | M68ASMR012D | |
| Editor Only | Cassette | M68EDTR012A | M68EDTR212A |
| | Paper Tape | M68EDTR012B | M68EDTR212B |
| | Diskette | M68EDTR012D | |



World Radio History

To simplify the use of other computers in the development of programs for M6800 machines, additional software routines have been developed, as follows: ☐ **Simulator** — duplicates on a host machine the exact execution of machine language instructions for the M6800 microprocessor — including a count of the elapsed cycles of simulated execution. ☐

**Build Virtual Machine** — enables the programmer to manipulate machine files, and the object code which may be contained in machine files, independently of the Assember — assists the programmer on a host machine in the use of M6800 software and hardware. Provides up-to-date information on new developments in the M6800 Microcomputer family of components and software support.

## M6800 Non-Resident Computer Software Options

| | | COMPUTER | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | MEDIA | SIGMA | HP2100 | IBM360/370 | NOVA | HIS6000 | CDC6000 | PDP11 |
| Cross Assembler | Punch Card<br>Mag Tape<br>Disk Cartridge | M68SAM0213E<br>M68SAM0213F | M68SAM0413E<br>M68SAM0413F | M68SAM0713E<br>M68SAM0713F | M68SAM0812E<br>M68SAM0812F | M68SAM0912E<br>M68SAM0912F | M68SAM1013E<br>M68SAM1013F | M68SAM1113E<br>M68SAM1113F<br>M68SAM1113G |
| | | | (CUSTOMER SUPPLIES CARTRIDGE) | | | | | |
| Compiler | Funch Card<br>Mag Tape | | | | | M68MPL011E<br>M68MPL011F | | |
| Simulator | Funch Card<br>Mag Tape | | M68EML0411E<br>M68EML0411F | | M68EML0811E<br>M68EML0811F | | M68EML1011E<br>M68EML1011F | |

## M6800 Time-Sharing Systems

***Time-Share Package***

☐ **MPCASM Cross Assembler** — converts assembly language to machine language. ☐ **MPSSIM Simulator** — simulates M6800 MPU functions, including hardware timing, etc.

☐ **MPBVM Build Virtual Machine** — permits structuring of a "Virtual Machine" that duplicates configuration of actual programmable system. ☐ **HELP** — assists designer in use of M6800 software and hardware.

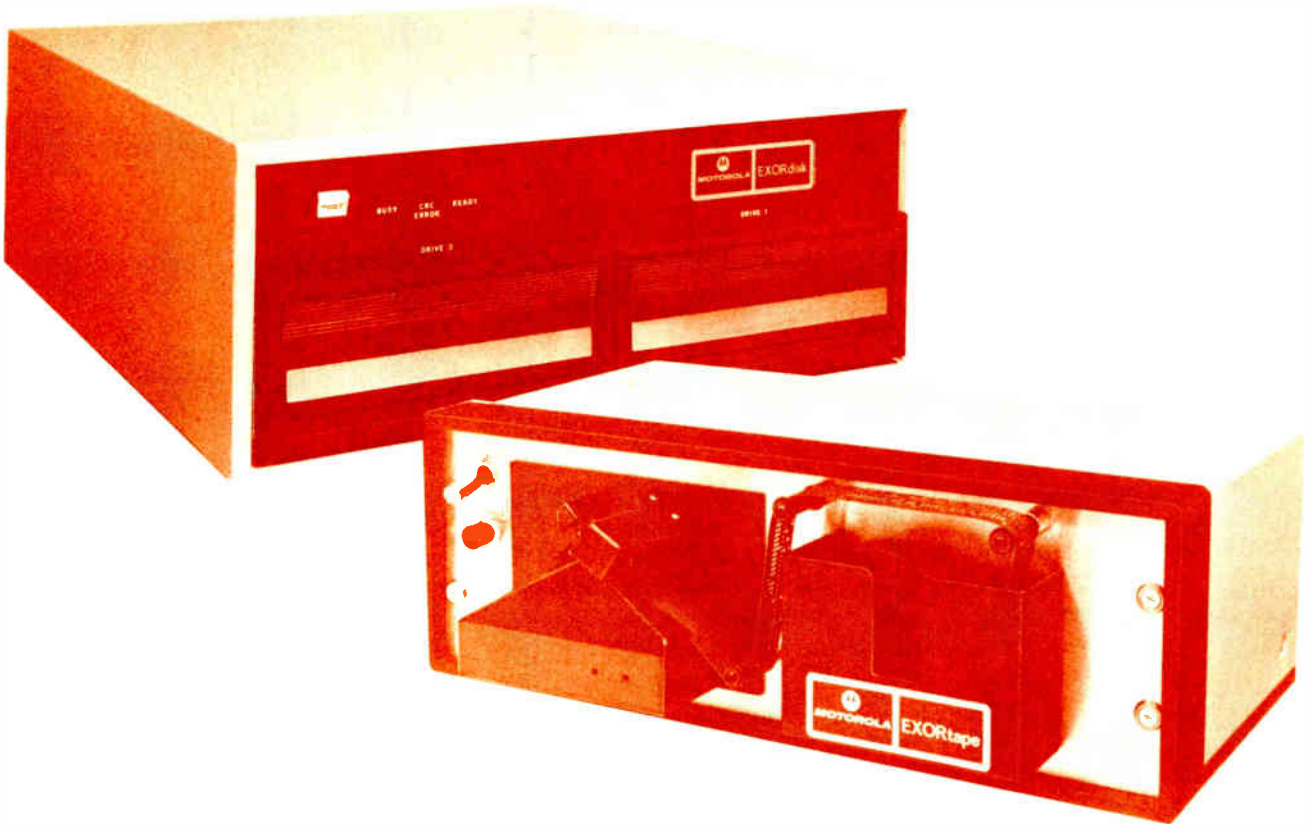
***M6800 Time-Share Sources***

☐ U.S.A. — United Computer Service/GE ☐ International — General Electric ☐ Europe — Honeywell-Bull ☐ Japan — Densta



World Radio History

# M6800 Support Peripherals




The EXORdisk is a "floppy disk" storage system that extends the capacity of the EXORciser by up to one-million bytes of memory. Together with the EXORciser, and an associated, separately available Interface Module, it provides a complete development system whose high-speed software-development capabilities can be matched only by much more expensive minicomputers. Special Features: ☐ Two and Four Disk-Drive Units with up to 256,256 8-Bit Bytes per Diskette. ☐ Software Operating System, Includes EDOS (EXORciser Floppy Disk Operating System). ☐ Build-In Controller Compatible with IBM 3740 Format and Media.

The EXORtape is a high-speed paper-tape reader capable of loading a program into a memory at a rate up to 250 characters per second. Designed to operate with the compatible flat ribbon cables and plugs. Special Features: ☐ Loads up to 250 Characters per Second ☐ Photo Electric Character Detector for more Reliable Loading ☐ Plug Compatible with EXORciser ☐ Ribbon Cables included for Easy Hookup ☐ Daisy Chaining of Cables Allows Use of the EXORdisk

### *EXORdisk Options and Ordering Information*

| PART NUMBER | DESCRIPTION |
|---|---|
| M68FD3712 | EXORdisk with two drives |
| M68FD3712-12 | EXORdisk for 220V, 50 Hz operation |
| M68FD3712-19 | 19-inch Rack Mounting Kit |
| M68IFC | M6800 EXORciser Interface Module |
| M68XAE6812D | EXORciser Diskette with EDOS, M6800 Resident Editor and M6800 Resident Assembler |

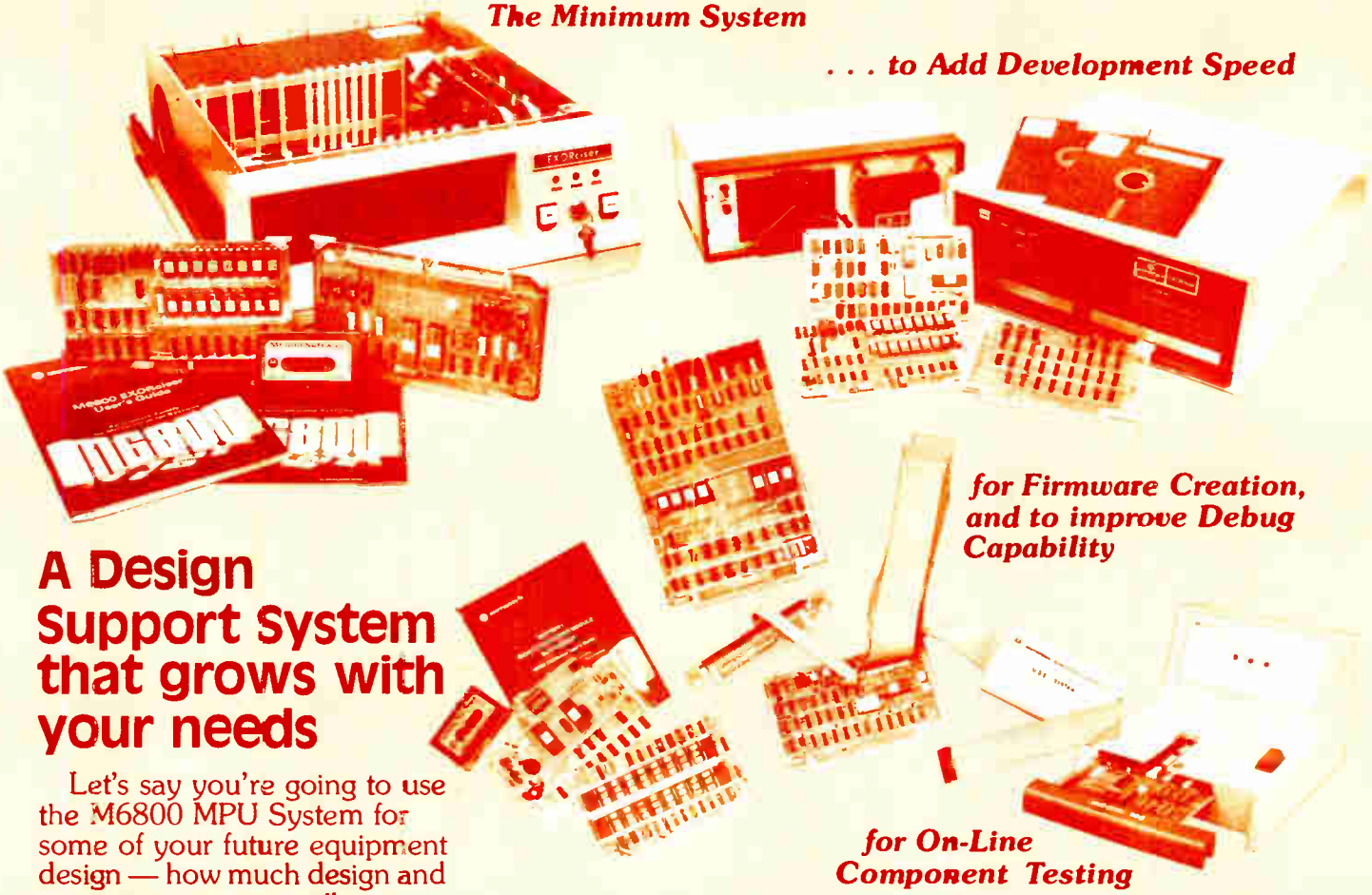
### *EXORtape Options and Ordering Information*

| PART NUMBER | DESCRIPTION |
|---|---|
| M68R680 | Table Top EXORtape |
| M68R680-12 | EXORtape with 220, 50/60 Hz Power Requirement |
| M68IFC | M6800 EXORciser Interface Module |

EXORdisk and EXORtape are trademarks of Motorola Inc.



World Radio History




# A Design Support System that grows with your needs

Let's say you're going to use the M6800 MPU System for some of your future equipment design — how much design and support equipment will you need, and when will you need it? The flexibility of Motorola's Support equipment lets you satisfy your requirements at the lowest cost.

At the outset, you may want a Minimum System that provides a basic, get-acquainted development capability. Then, as designs become more involved, you may want to augment the basic equipment with higher speed development tools and their accompanying software and, certainly, you will want to expand the system's memory capacity.

As you near the end of the design cycle, you will need a production capability in the form of an EROM/RAM Card and a PROM Programmer and you may want the additional Debug options that are available with the System Analyzer and the Use Modules.

Finally, to test the various components on a production, the MOTEST-I Component Tester is a valuable system addition.

These various groupings are itemized here.

***The Minimum System***

☐ The basic EXORciser — M68SDTT1 ☐ 8Kx8-Bit Dynamic RAM — MEX6815-3 ☐ Peripheral I/O Card — MEX6820, with cables (2 required) — MEX68IC ☐ Coresident Assembler-Editor — M68XAE6812() PLUS Terminal and auxiliary peripherals

***. . . to Add Development Speed***

☐ Dual Flexible-Disk System — M68FD3712-1, with Interface Module — M68IFC ☐ Disk Software — M68D0SR022D ☐ Macroassembler — M68ASMR0121A, 16Kx8-Bit RAM (dynamic) — MEX6816-1, 2Kx8-Bit RAM (static) — MEX6812-1, (buffer for fuller Editor/Assembler operation) ☐ Option — High-Speed Tape Reader

***for Firmware Creation, and***

☐ EROM/RAM Card — MEX68RR ☐ PROM Programmer — MEX68PP1

***. . . to improve Debug Capability***

☐ System Analyzer Module — MEX68SA ☐ User System Evaluator — MEX68USE

***for On-Line Component Testing***

☐ MOTEST-1 Component Tester — MEX68CT

***. . . and for Data Communications Designs***

☐ ACIA I/O Card — MEX6850


World Radio History

# M6800 Applications Support

The design of an operational MPU-based system is not particularly difficult. The LSI nature of the required components reduces the hardware complement to just a small number of the basic, easily compatible building blocks.

However, the development of the software that *efficiently* converts the basic computer into a dedicated machine is another matter. It demands a thorough knowledge of the interactive nature of the building block, as well as an in-depth understanding of the processor's unique instruction set and its capabilities.

Motorola's M6800 customer applications support ranges from an extensive literature library to personalized training and consultation.



World Radio History

# M10800

# A MECL High-Performance 4-Bit Slice Processor Family

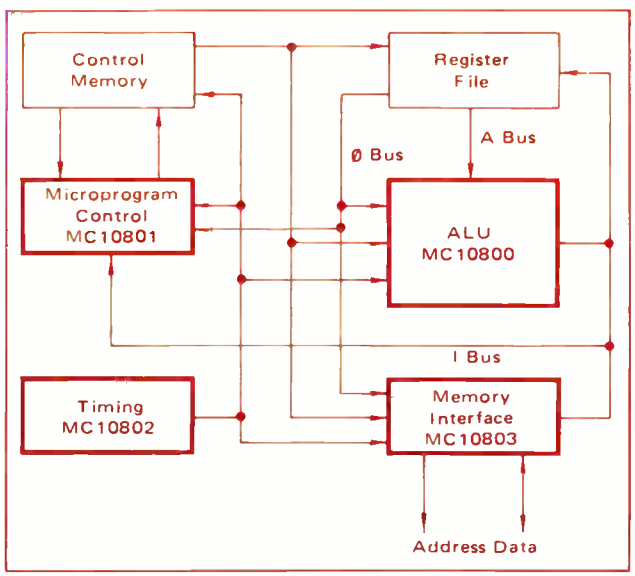
## THE FEATURES

High-Speed Performance—
Less than 100 ns per Microinstruction
Bidirection Bus Orientation
LSI Components
MECL 10,000 Compatibility
BCD/Binary ALU
Microprogrammable

## M10800-QUAD-IN-LINE PACKAGE

The Motorola M10800 LSI family brings a new integrated circuit package to the industry.

The 48 pin quad-in-line (QUIL) package is designed not to be different, but to be better. It requires only 1.0 square inch of circuit board space and results in a 30% density improvement over the standard 40 pin package.

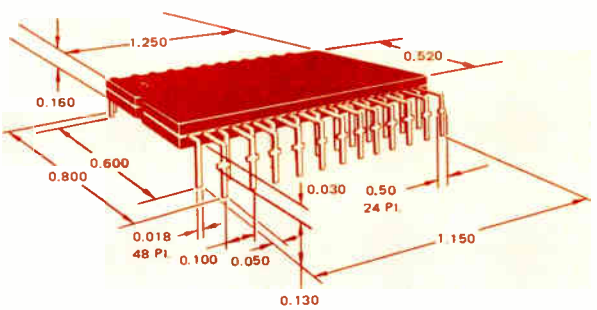



**Microprogrammed Processor**

## THE LSI FAMILY

| Part No. | Description | Availability |
|---|---|---|
| MC10800 | 4-Bit ALU Slice | Now |
| MC10801 | Microprogram Control | Now |
| MC10802 | Timing Function | 1977 |
| MC10803 | Memory Interface | Now |
| MC10804 | ALU Extender | 1977 |
| MC10805 | Bus Translator | 1977 |
| MC10806 | Dual Address Register | 1977 |
| MC10808 | Multibit Shifter | 1977 |

**QUAD-IN-LINE**
**QUIL PACKAGE**




**CASE 725-01**
**DIMENSIONS IN INCHES.**

The figure to the left shows how four of the basic M10800 devices may fit in a processor system. The M10800 building blocks when combined with MECL memories for control, memory storage and register files, results in a cost effective high performance system design. The flexibility, designed into the parts, allows numerous other configurations than that which is shown.



World Radio History

## M10800 (continued)

### SUMMARY OF MICROINSTRUCTIONS

### MC10800 4-Bit ALU Microinstructions

28 Logical Operations
21 Binary Arithmetic Functions
15 BCD Arithmetic Functions
Arithmetic and Logical Shift Right
Shift Left (Overflow Detected)
Carry, Zero, Overflow, Sign
Single Pass Add/Subtract and Shift
Single Pass Mask of One Operand with Another and Compare with a Third.

| LOGIC | BINARY | BCD |
|---|---|---|
| F = Logic 0 | F = A plus Ø | F = A plus Ø |
| F = A | F = A minus Ø | F = A minus Ø |
| F = Ø | F = Ø minus A | F = Ø minus A |
| F = $\overline{A}$ | F = A | F = A |
| F = $\overline{Ø}$ | F = Ø | F = Ø |
| F = A + Ø | F = $\overline{A}$ | F = 9's Comp. A |
| F = A + $\overline{Ø}$ | F = $\overline{Ø}$ | F = 9's Comp. Ø |
| F = $\overline{A}$ + Ø | F = A minus 1 | F = A plus 2 |
| F = A • Ø | F = Ø minus 1 | F = Ø plus 2 |
| F = A • $\overline{Ø}$ | F = A minus 2 | F = A plus A |
| F = $\overline{A}$ • Ø | F = Ø minus 2 | F = Ø plus Ø |
| F = A ⊕ Ø | F = A plus 2 | F = ACC plus A |
| F = A ⊕ $\overline{Ø}$ | F = Ø plus 2 | F = ACC plus Ø |
| F = $\overline{A}$ • Ø | F = A plus A | F = ACC minus A |
| F = $\overline{A}$ + Ø | F = Ø plus Ø | F = ACC minus Ø |
| F = Logic 1 | F = ACC plus A | F = ACC plus A • Ø |
| F = ACC • $\overline{A}$ | F = ACC minus A | F = ACC minus A • Ø |
| F = ACC • Ø | F = ACC plus Ø | F = ACC plus A + Ø |
| F = $\overline{ACC}$ + A | F = ACC minus Ø | F = ACC minus A + Ø |
| F = $\overline{ACC}$ + Ø | F = ACC plus A • Ø | |
| F = ACC ⊕ A | F = ACC minus A • Ø | |
| F = ACC ⊕ $\overline{A}$ | F = ACC plus A + Ø | |
| F = ACC ⊕ Ø | F = ACC minus A + Ø | |
| F = ACC ⊕ $\overline{Ø}$ | | |
| F = ACC ⊕ A • Ø | | |
| F = ACC ⊕ $\overline{A}$ • Ø | | |
| F = ACC ⊕ A + Ø | | |
| F = ACC ⊕ $\overline{A}$ + Ø | | |

### MC10801 Microprogram Control Microinstructions

Six Unconditional Jumps (Four Next Address Sources)
Two Conditional Jumps
Seven Subroutine Instructions
  Two Conditional
  Repeat Subroutine Hardware
Increment

| | |
|---|---|
| INC | Increment |
| JMP | Jump to NA Inputs |
| JIB | Jump to I Bus |
| JIN | Jump to I Bus and Load R2 |
| JPI | Jump to R2 |
| JEP | Jump to External Bus (Ø Bus) |
| JL2 | Jump to NA Inputs and Load R2 |
| JLA | Jump to NA Inputs and Load R1 |
| JSR | Jump to Subroutine |
| RTN | Return from Subroutine |
| RSR | Repeat Subroutine (Load R1 from NA Inputs) |
| RPI | Repeat Instruction (Jump to R1) |
| BRC | Branch to NA Inputs on Condition Otherwise Increment |
| BSR | Branch to Subroutine on Condition Otherwise Increment |
| ROC | Return from Subroutine on Condition or jump to NA inputs |
| BRM | Branch and Modify address with Branch inputs (multiway Branches) |

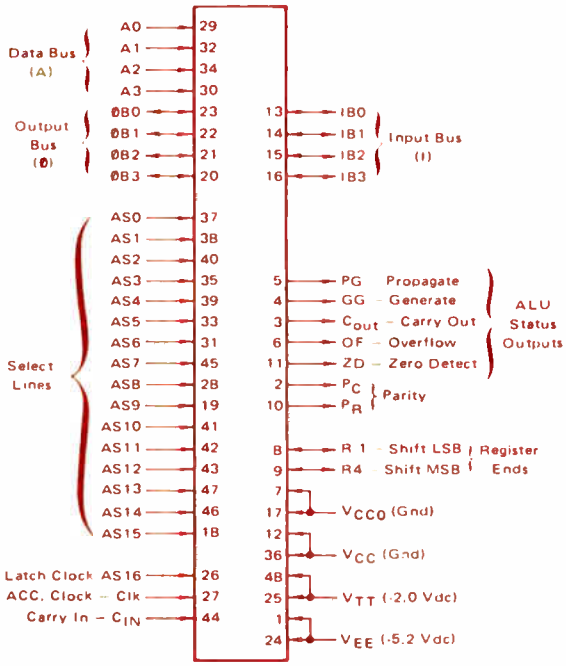
### MC10803 Memory Interface Microinstructions

Two's Complement Add/Subtract
Unsigned Data Instructions
  Push/Pop Pointer
  Add Displacement
  Increment/Decrement by any Constant
Shift Instructions
  Right/Left
  Arithmetic/Logical
Logical Instructions
  AND
  Inclusive OR
  Exclusive OR
  Bit Clear
  Bit Complement

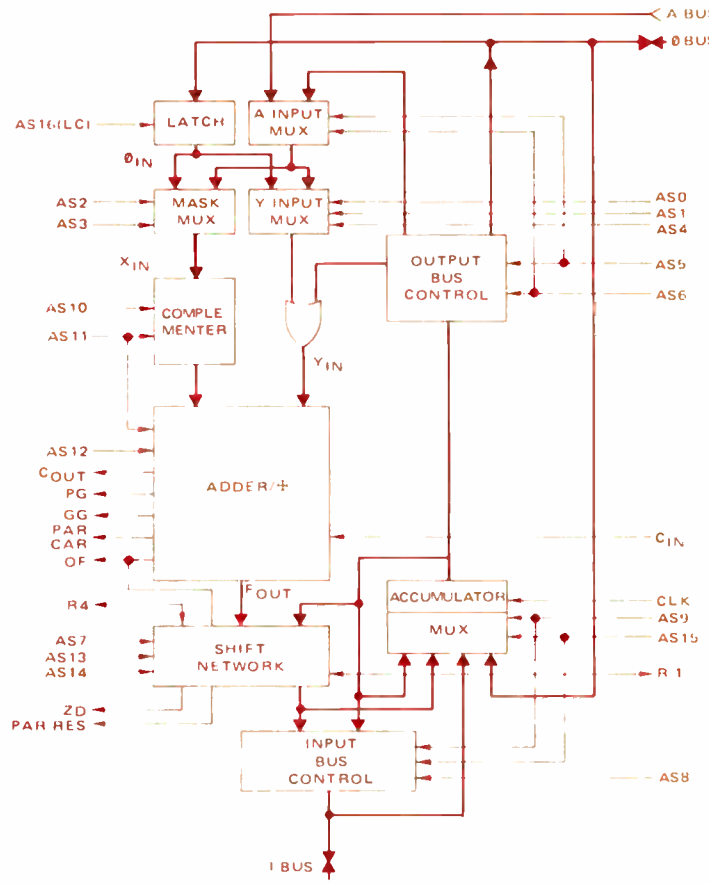
| | |
|---|---|
| FØB | – Register File to Ø Bus |
| RØB | – Data Register to Ø Bus |
| FDB | – Register File to Data Bus |
| ØDB | – Ø Bus to Data Bus |
| RDB | – Data Register to Data Bus |
| ADR | – ALU to Data Register |
| BDR | – Data Bus to Data Register |
| AIB | – ALU to I Bus |
| BIB | – Data Bus to I Bus |
| IDR | I Bus to Data Register |
| ØDR | – Ø Bus to Data Register |
| BRF | – Data Bus to Register File |
| BAR | – Data Bus to Address Register |
| PIØ | – Pipeline the I Bus to Ø Bus via the Data Register |
| PBØ | – Pipeline the Data Bus to Ø Bus via the Data Register |
| PIB | – Pipeline the I Bus to the Data Bus via the Data Register |
| NOP | – No operation (all busses go to $V_{OL}$ Level) |


World Radio History

## INPUT/OUTPUT DIAGRAM




## BLOCK DIAGRAM




Contained on this chip are the following functions:

- 4-Bit ALU
- Shift Network
- Accumulator
- I/O Structures

Provisions have been included for lateral expansion to any bit length in increments of 4 bits. Vertical expansion is also permissible—to permit pipelining for increased data throughput rates. The processor slice and associated circuits (MC10801—MC10803) are suitable for use in single or multi-bus systems.

Circuit inputs and outputs consist of the following:

a) Two bidirectional ports: "Ø", "I" (4-bit width each). One single direction port: "A".
b) Two bidirectional lines, one at either end of the shift network (R-1, R4).
c) Sixteen Select Lines (AS0-AS15), for controlling data flow and for determining operations on data.
d) Two clock input lines (latch clock AS-16; accumulator clock C.
e) Carry input line ($C_{in}$).
f) Five ALU-status output lines (propagate, generate, carry out, overflow, and zero detect).
g) Parity output lines.



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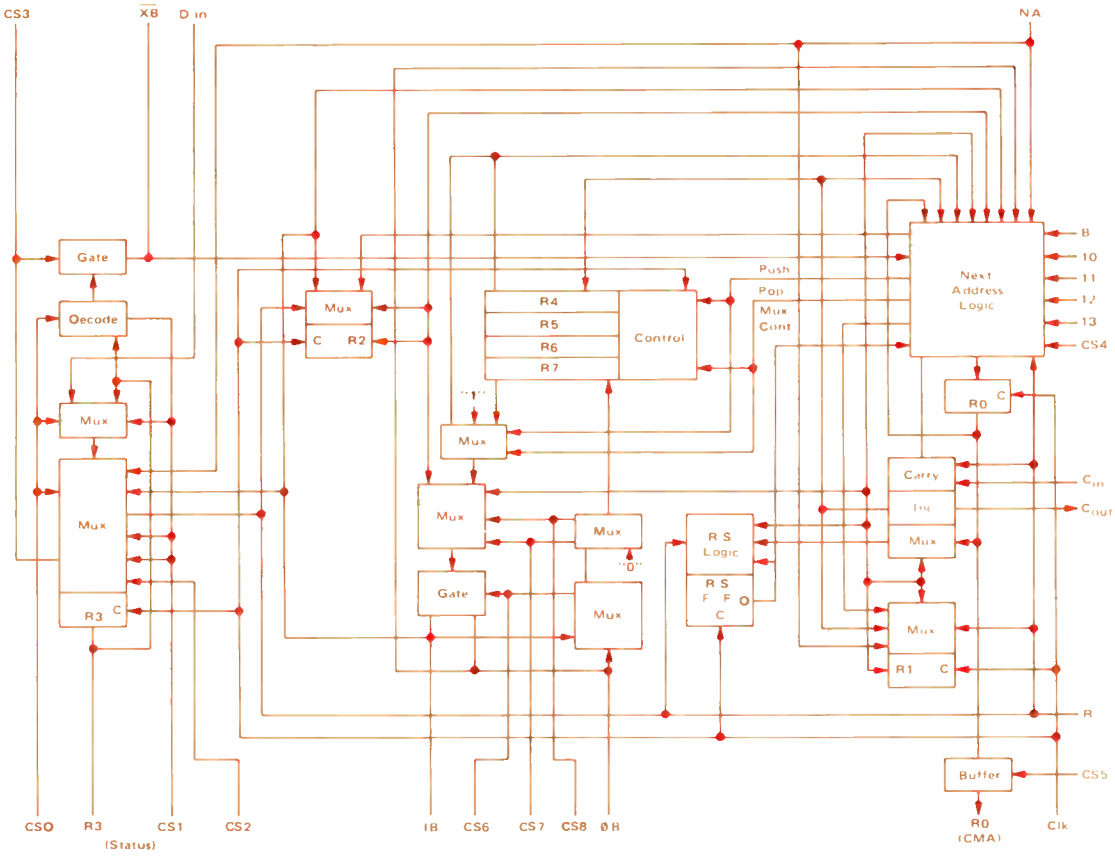
# THE MC10801 MICROPROGRAM CONTROL FUNCTION

## BLOCK DIAGRAM




The MC10801 is a component part of the M10800 high-speed microprocessor kit. In addition, this LSI circuit may be used as an independent component, for computer controllers, microprocessors and microcontrollers.

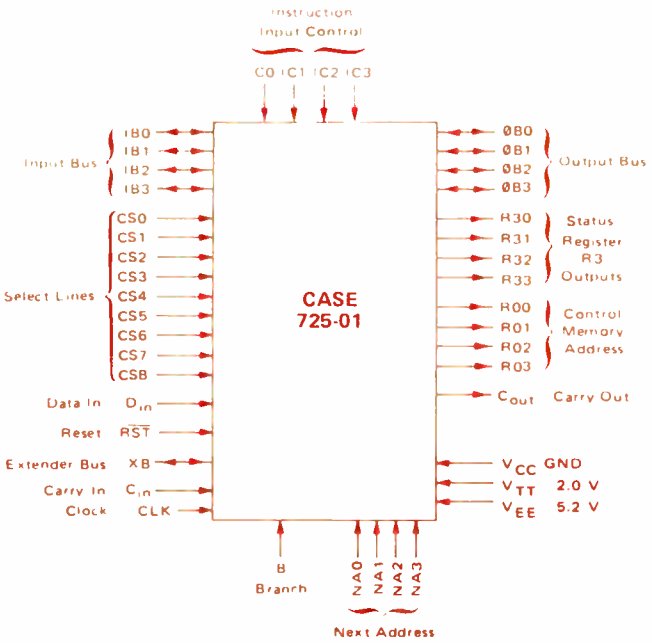
Contained on this chip are the following functions:

- Control Registers (4-bit, expandable)
- Control Memory address register
- 4 x 4 push/pop LIFO stack, for nesting subroutines.
- Sixteen address control functions for conditional and unconditional jumps, and for subroutines
- Internal instruction register, repeat register, and a cascadable 4-bit status register with conditional branch capability

Other features of the MC10801 include:

- Next Address mask capability on certain instructions
- 3 separate branch inputs for up to 8-way branch capability (2 chips required)
- Addressing of up to 256 words with a single MC10801 using row/column jumping (65K words with 2 chips)
- Fast increments for incrementing the micro program address register
- Extender Bus for multiple chip operation

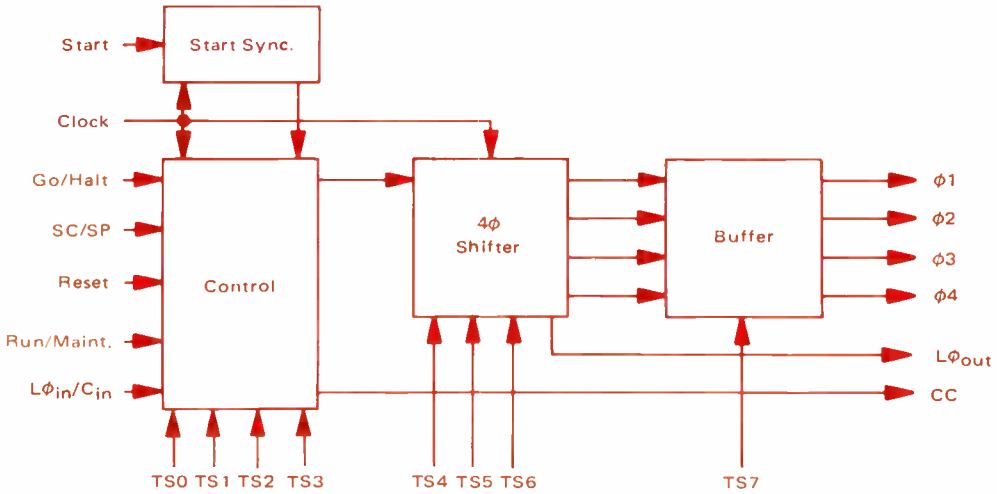
## INPUT/OUTPUT DIAGRAM






World Radio History

## BLOCK DIAGRAM

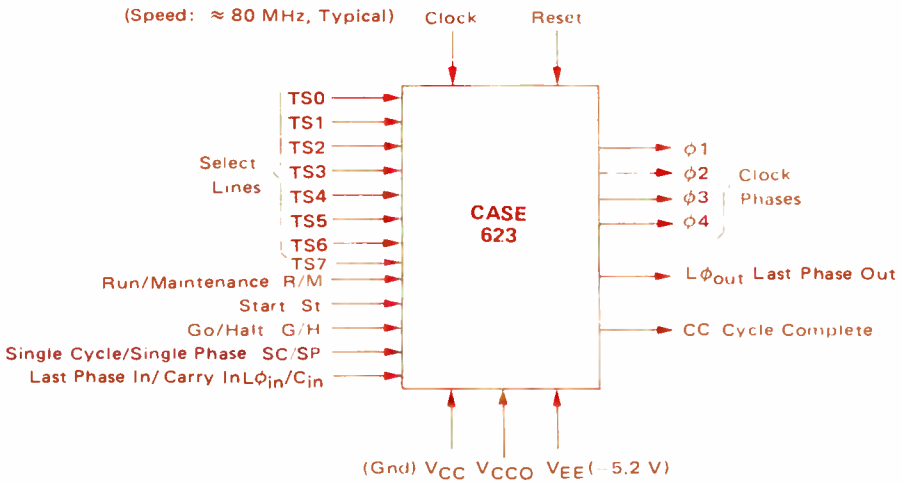



The MC10802 is a component part of the M10800 high-speed microprocessor kit. Contained on this chip are the following functions:

- 4-Phase Clock Counter
- MECL 10,000 Compatible Output
- Start Synchronizer
- Programmable Phases
- Programmable Double Phase Time

In addition to providing multiphase clock signals, the control inputs on this chip permit single-stepping a microprocessor for diagnostic or checkout purposes.

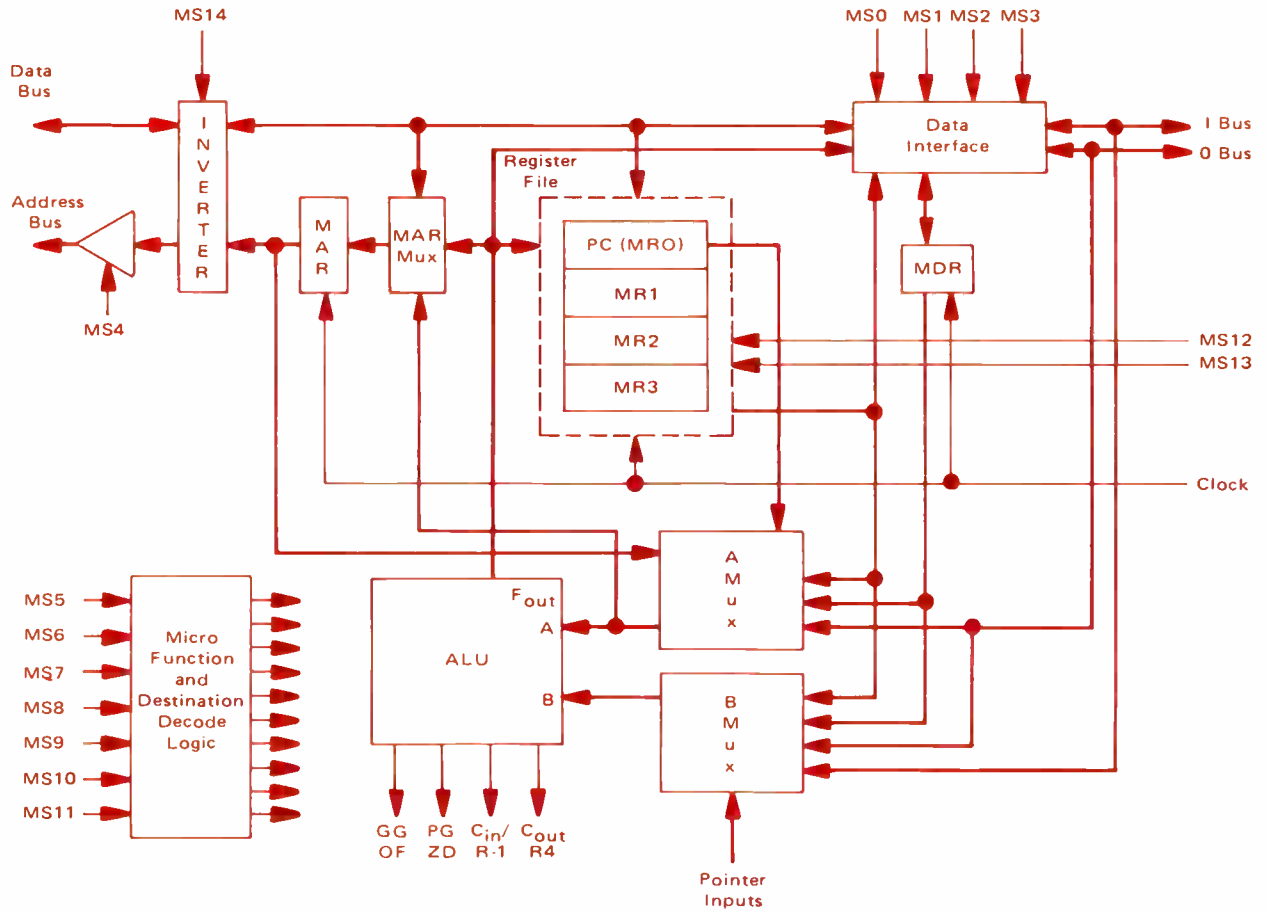
## INPUT/OUTPUT DIAGRAM



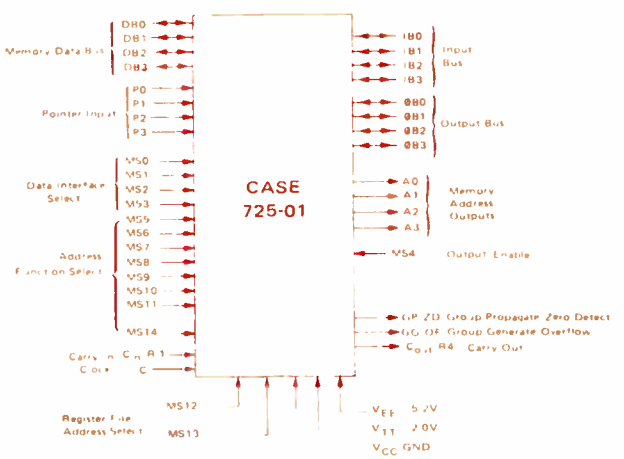



World Radio History

## BLOCK DIAGRAM




## INPUT/OUTPUT DIAGRAM




The MC10803 is a component part of the M10800 high-speed microprocessor kit. Contained on this chip are the following functions:

- Memory Address Register
- Memory Data Register
- ALU for Address Generation and Manipulation
- Four 4-Bit Register Files

This circuit is 4-bits wide and is fully expandable. It is intended to be a basic interface circuit between memory and a processor, for generating memory addresses and routing data. It can also assume ALU responsibility in minimum systems. The MC10803 is capable of twelve basic register/bus-ALU operations, and 17 transfer/storage operations (for data manipulation).



World Radio History

# A Schottky TTL High-Performance 4-Bit Slice Processor Family

## MC2901 FOUR-BIT BIPOLAR MICROPROCESSOR SLICE

### GENERAL DESCRIPTION

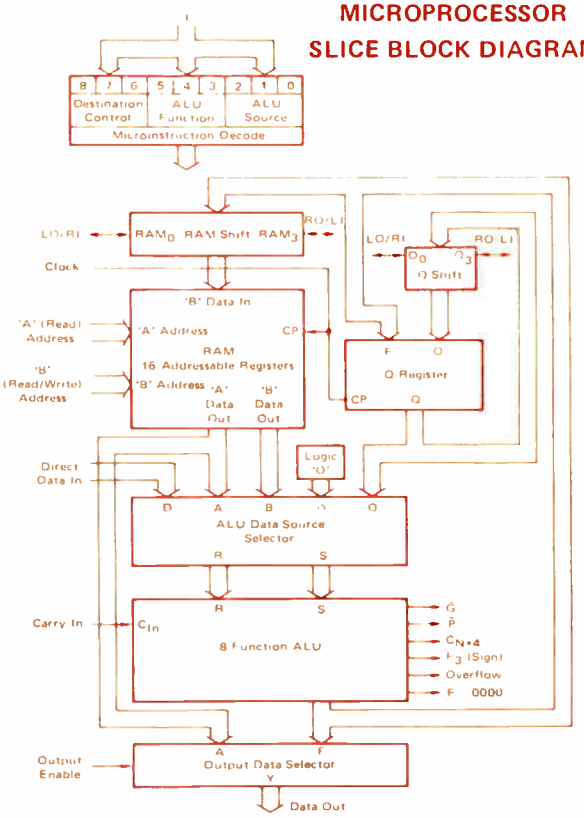
The four-bit bipolar microprocessor slice is designed as a high-speed cascadable element intended for use in CPU's, peripheral controllers, programmable microprocessors and numerous other applications. The microinstruction flexibility of the MC2901 will allow efficient emulation of almost any digital computing machine.

The device, as shown in the block diagram below, consists of a 16-word by 4-bit two-port RAM, a high-speed ALU, and the associated shifting, decoding and multiplexing circuitry. The nine-bit microinstruction word is organized into three groups of three bits each and selects the ALU source operands, the ALU function, and the ALU destination register. The microprocessor is cascadable with full look-ahead or with ripple carry, has three-state outputs, and provides various status flag outputs from the ALU. Advanced low-power Schottky processing is used to fabricate this 40-lead LSI chip.

### DISTINCTIVE CHARACTERISTICS

- Two-address architecture –
  Independent simultaneous access to two working registers saves machine cycles.
- Eight-function ALU –
  Performs addition, two subtraction operations, and five logic functions on two source operands.
- Flexible data source selection –
  ALU data is selected from five source ports for a total of 203 source operand pairs for every ALU function.
- Left/right shift independent of ALU –
  Add and shift operations take only one cycle.
- Four status flags –
  Carry, overflow, zero, and negative.
- Expandable –
  Connect any number of MC2901's together for longer word lengths.
- Microprogrammable –
  Three groups of three bits each for source operand, ALU function, and destination control.

### MICROPROCESSOR SLICE BLOCK DIAGRAM




| Package Type | Temperature Range | $V_{CC}$ | Device Type |
|---|---|---|---|
| Hermetic DIP | 0°C to +70°C | 4.75 V to 5.25 V | MC2901 LC |
| Hermetic DIP | -55°C to +125°C | 4.50 V to 5.50 V | MC2901 LM |
| Dice | 0°C to +70°C | | MCC2901 C |



World Radio History

## MC2909 MICROPROGRAM SEQUENCER

### DISTINCTIVE CHARACTERISTICS

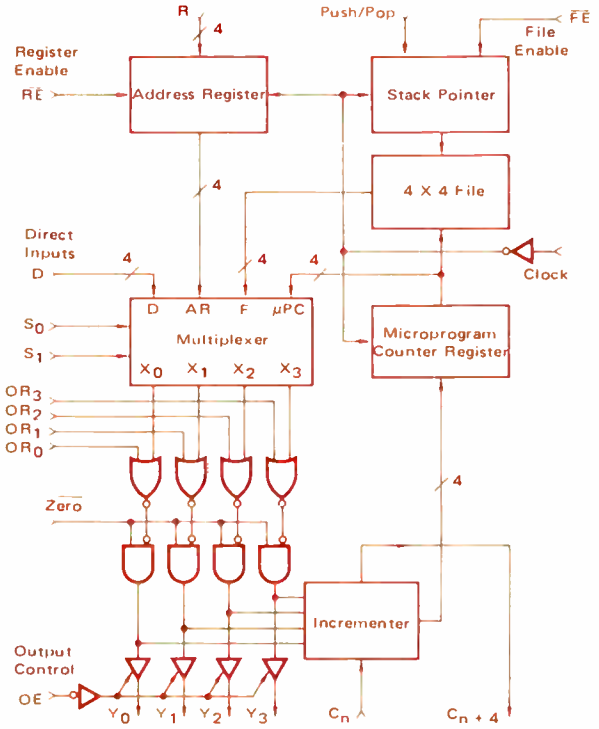
- 4-bit slice cascadable to any number of microwords
- Internal address register
- Branch input for N-way branches
- Cascadable 4-bit microprogram counter
- 4 x 4 file with stack pointer and push pop control for nesting microsubroutines.
- Zero input for returning to the zero microcode word
- Individual OR input for each bit for branching to higher microinstructions
- Three-state outputs
- All internal registers change state on the LOW-to-HIGH transition of the clock

### GENERAL DESCRIPTION

The MC2909 is a four-bit wide address controller intended for sequencing through a series of microinstructions contained in a ROM or PROM. Two MC2901's may be interconnected to generate an eight-bit address (256 words), and three may be used to generate a twelve-bit address (4K words).

The MC2909 can select an address from any of four sources. They are: 1) a set of external direct inputs (D); 2) external data from the R inputs, stored in an internal register; 3) a four-word deep push/pop stack; or 4) a program counter register (which usually contains the last address plus one). The push/pop stack includes certain control lines so that it can efficiently execute nested subroutine linkages. Each of the four outputs can be OR'ed with an external input for conditional skip or branch instructions, and a separate line forces the outputs to all zeroes. The outputs are three-state.

### MICROPROGRAM SEQUENCER BLOCK DIAGRAM




| Package Type | Temperature Range | $V_{CC}$ | Device Type |
|---|---|---|---|
| Hermetic DIP | 0°C to +70°C | 4.75 V to 5.25 V | MC2909 LC |
| Hermetic DIP | -55°C to +125°C | 4.50 V to 5.50 V | MC2909 LM |
| Dice | 0°C to +70°C | | MCC2909C |



World Radio History

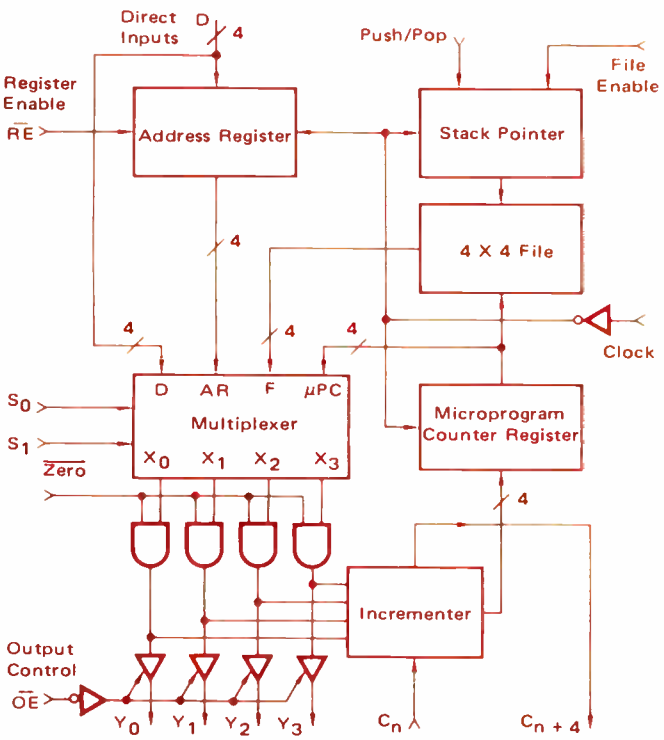
## PRODUCT PREVIEW

| Device No.* | Description |
|---|---|
| MC2902 | Carry Lookahead Chip |
| MC2905 | LSI Bus Transceivers |
| MC2906 | LSI Bus Transceivers |
| MC2907 | LSI Bus Transceivers |
| MC2911 | Minimicroprogram Sequencer |
| MC2915 | LSI Bus Transceivers |
| MC2916 | LSI Bus Transceivers |
| MC2917 | LSI Bus Transceivers |
| MC2918 | One-by-Two Port Register |

*Contact your nearest Sales Representative for Availability

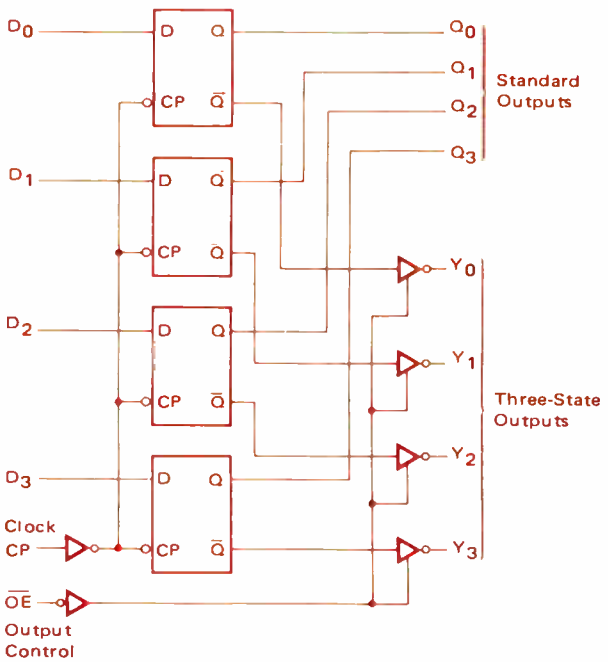
### MC2911 Minimicroprogram Sequencer

The MC2911 contains nearly all the power of the MC2909 in a space and cost saving 20-pin package. Delay from clock to output is typically 40 ns.




### MC2918 One-by-Two Port Register

A four-bit register, one set of inputs; two sets of outputs — three-state and regular Schottky TTL. Ideal for status registers, data bus interfaces.



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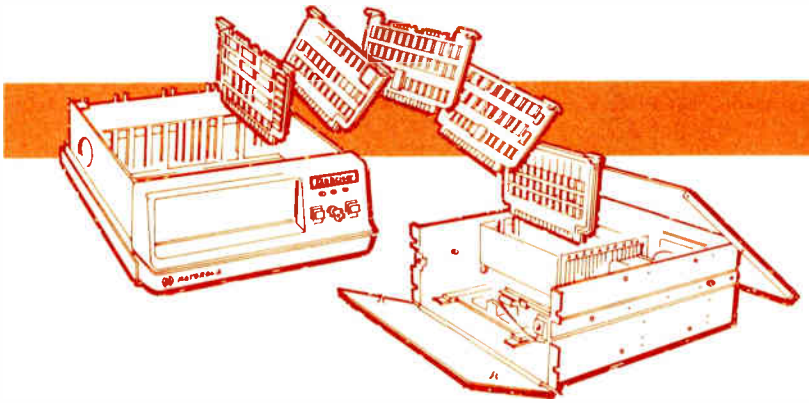


# Micromodules — A New Product Line from Motorola

Microprocessors are changing a lot of design and manufacturing concepts — as well as a lot of well-entrenched and dearly held marketing philosophies. At Motorola, we have always adhered to the charter of supplying the wide range of components needed for the manufacture of electronic equipment, leaving the manufacture of the equipment itself to our customers. While this charter still applies, the MPU has changed the definition of "equipment," raising it to a higher level of system sophistication and spawning new building blocks of ever-increasing complexity.

It started with Support Products for the M6800 microcomputer components — a series of development aids that permits the system designer to "exercise" the MPU components and to "exorcise" the user program that converts an uneducated computer into a dedicated, functional instrument. Called the EXORciser, this development tool is, in essence, an expandable microcomputer, designed to facilitate emulation and debugging of a systems designer's unique end product. Obviously, it is more than just a component, but it's an indispensable stimulant toward the implementation of a specific MPU family. So — If not we, — who?

## Expanding The Concept

But the microprocessor itself is more than just another component. It's a viable, working computer that needs only auxiliary memory and interface (and some dedicated software) to make it useful for an almost infinite variety of processing and control applications. How much memory? How much interface? About the only thing that prevents the manufacturer of a general purpose microprocessor from putting all this memory and interface on the same chip with the MPU is that he can't anticipate the eventual application. But wouldn't it be convenient to be able to buy a microcomputer with just the right amount of circuitry, ready for programming to your needs?

Well, we are not yet ready to build single-chip MPUs dedicated to every conceivable end use, but we can take a lot of the design time out of system hardware implementation. And so, a new Motorola department — *Microsystems* — was born.

*Microsystems* is an operations group that elevates microcomputer system design from the package level to the board level. Its charter includes the development of interactive modules ranging from complete, off-the-shelf microcomputers with fixed capabilities (ready for dedicated programming), to a variety of mix-and-match board assemblies that give the designer a wide latitude of system options.

The scope of the program is indicated by a family of Micromodules recently introduced. These include (see product descriptions for details):

A complete single-board Microcomputer
A CPU (Central Processing Unit) Module
A 32/32 I/O Module
An 8K/16K AROM/ROM Module

These are supplemented by the existing complementary EXORciser Modules which add five additional memory and interface options to the system. And the near-term introduction schedule is even more impressive, comprising a series of capabilities (A-D/D-A Modules, Timing and GPIB Modules, etc.) that extend modular simplicity to ever-widening applications.

The Micromodule approach to microcomputer design is offered as an adjunct to, not a substitute for, the more fundamental design with basic components. It is available to those with small volume or limited development and manufacturing resources, or where design and development time-savings is of significance. And it is backed by a custom design capability that could provide cost-effective solutions to complex problems. Your inquiries are invited.



World Radio History

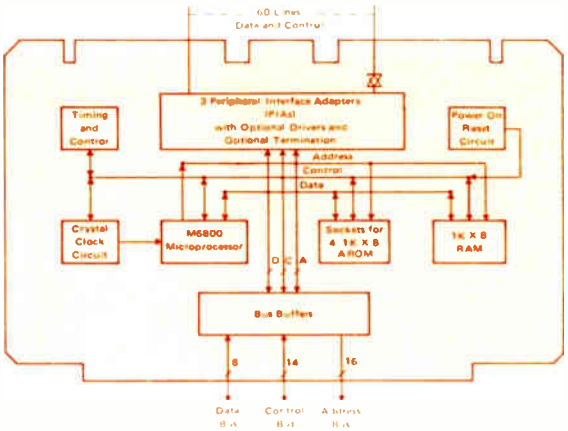
# MICROMODULES

## MONOBOARD MICROCOMPUTER
**(Micromodule 1)**

## M68MM01

Complete microcomputer on a board
M6800 Microprocessing unit (MPU)
1MHz crystal controlled clock
Reset circuitry
1K RAM
Sockets for four-1K AROM or ROM
Three MC6820 peripheral interface adapters
EXORciser and Micromodule Family bus compatible
36K bytes of unused memory addresses available
Dynamic memory refresh circuit

M68MM01

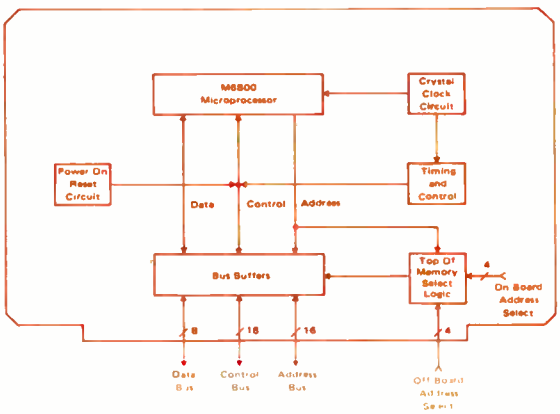



## CENTRAL PROCESSING UNIT MODULE
**(Micromodule 2)**

## M68MM02

M6800 Microprocessing unit (MPU)
1MHz crystal controlled clock
Reset circuitry
EXORciser and Micromodule Family bus compatible
Top of user memory address selectable
Timing and control for three-state, halt, DMA and refresh operations

M68MM02

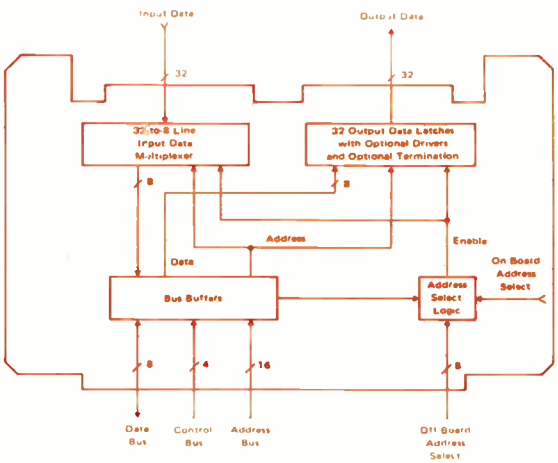



## 32/32 INPUT/OUTPUT MODULE
**(Micromodule 3)**

## M68MM03

32 bits of input in four contiguous 8-bit bytes
32 bits of latched output in four contiguous 8-bit bytes
EXORciser and Micromodule Family bus compatible
Selectable base memory address

M68MM03

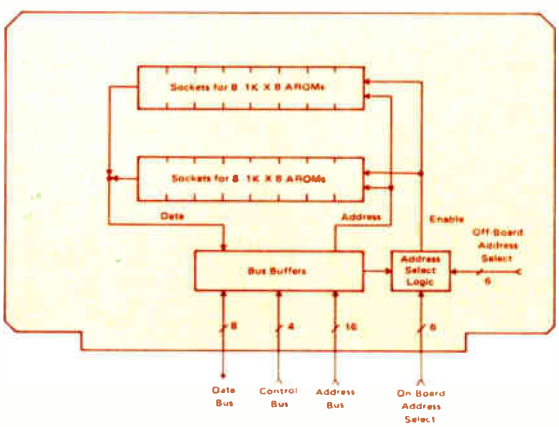



## 8K/16K AROM/ROM MODULE
**(Micromodule 4)**

## M68MM04

Sockets for from one to sixteen 1K x 8-bit AROM or ROM devices
EXORciser and Micromodule Family bus compatible
Selectable base memory address for each 8K memory block

M68MM04



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MOTOROLA

# MEMORIES

**Memories are among the most important parts used in digital data-processing systems. In addition to Read Only and Random Access Memory devices, Motorola also is supplying Memory Systems and Micromodules for those whose requirements go beyond the individual "chip" stage.**

Read Only Memories are available from Motorola in three ways:

1. In *Mask Programmable* (custom program) form; the customer defines the memory content before the final metallization step, permitting the devices to be designed for a specific application.
2. In *Programmable (PROM)* form; UV Erasable Memories provide flexibility in system development by permitting erasure of memory content and re-programming for current needs. Field-Programmable PROMs allow custom programs on a small-quantity basis through use of fusable nichrome links, bypassing the expense of a mask-program effort.
3. In *Pre-Programmed* form; these low-cost, off-the-shelf ROMs contain specific popular programs, particularly in code converter and character generator functions.

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NOTE: Memory Interface circuits are shown on pages 77 thru 81.



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# MOS READ ONLY MEMORIES

## NMOS ($T_A$ = 0 to 70°C unless otherwise noted.)

| Size (Organization) | OPTIONS | | No. of Chip Selects | Access Time (ns max) | Power Supplies (V) | No. of Pins |
|---|---|---|---|---|---|---|
| | Mask-Programmable* | Pre-Programmed | | | | |
| **FOR M6800 MICROPROCESSOR AND OTHER BUS-ORIENTED APPLICATIONS** | | | | | | |
| 16K Bits (2048 x 8) | MCM68316E | MCM68316E-91 – Code converter See MCM6591 data sheet for detail | 3 | 500 | +5 | 24 |
| | MCM68316E1 – $T_A$ = 40 to 85°C | – | | | | |
| | MCM6832 | MCM6832-91 – Code as above | 1 | 500 | +12, +5, -5 | 24 |
| | MCM65317 – Pin compatible with 2708 PROM | MCM65317-91 – Code as above | | | | |
| 8K Bits (1024 x 8) | MCM6830A | MCM6830-8 – Programs: MIKBUG, MINIBUG, Test Pattern | 4 | 500 | +5 | 24 |
| | MCM68308 | MCM68308-7 – Programs: Same as above | 2 | 500 | +5 | 24 |
| | MCM65308 | MCM65308-7 – Programs: Same as above | 2 | 350 | +12, +5, -5 | 24 |
| **FOR CHARACTER GENERATOR APPLICATIONS** | | | | | | |
| 8K Bits 128 Characters 9 x 7 Matrix Horizontal Scan | MCM6570 – Shift Capability | MCM6571,A – ASCII and Greek Characters, Shifted<br>MCM6572 – ASCII and Greek, Not Shifted<br>MCM6573 – Japanese Characters, Not Shifted<br>MCM6574 – Math Symbols and Pictures, Shifted<br>MCM6575 – Alphanumeric Control Characters, Shifted<br>MCM6576 – British Standard Characters, Shifted<br>MCM6577 – German Standard Characters, Shifted<br>MCM6578 – French Standard Characters, Shifted<br>MCM6579 – General European Standard Characters, Shifted | – | 500 | +12, +5, -3 | 24 |
| 8K Bits 128 Characters 7 x 9 Matrix Vertical Scan | MCM6580 – Shift Capability | MCM6581 – ASCII and Greek Characters, Shifted<br>MCM6583 – Japanese Characters, Not Shifted | – | 400 | +12, +5, -3 | 24 |
| 8K Bits 128 Characters 7 x 5 Matrix Horizontal Scan | MCM6670 | – | 1 | 500 | +5 | 18 |
| **CODE CONVERTERS** | | | | | | |
| 8K Bits 1024 x 8 or 2048 x 4 | MCM6560 | MCM6561,2 – 1024 x 8; Codes:<br>Selectric to ASCII<br>ASCII to Selectric<br>Modified 8-bit Hollerith to ASCII<br>ASCII to Modified 8-bit Hollerith<br>EBCDIC to ASCII<br>ASCII to EBCDIC | 2 | 350 | +12, +5, -3 | 24 |
| 16K Bits 2048 x 8 | MCM6590 | MCM6591 – Codes as above *plus* 128 USASCII Characters using mixed fonts | 1 | 800 | +12, +5, -3 | 24 |
| **RHYTHM GENERATOR for Electronic Organs** | | | | | | |
| 7168 Bits 16 Patterns of 24 or 32 Beats | MCM6550 – Requires no external counters | – | – | $t_{cyc}$ = 1 ms | +15, +5, -3 | 40 |

*Mask-programmable ROMs are manufactured according to a bit-pattern supplied by the customer. A special device number (SCMxxxx) is assigned to each individual pattern.

Selectric is a registered trademark of IBM.



World Radio History

## MOS READ ONLY MEMORIES (continued)

### CMOS

| Size (Organization) | Options (Mask-Programmable*) | Access Time (ns max) | Power Supplies (V) | No. of Pins |
|---|---|---|---|---|
| 1K Bits (256 x 4) | MCM14524A – $T_A$ = -55 to +125°C | 2650# | +3 to +18 | 16 |
| | MCM14524C – $T_A$ = -40 to +85°C | 4000# | | |

*Mask-Programmable ROMs are manufactured according to a bit-pattern supplied by the customer. A special device number (SCMxxxx) is assigned to each individual pattern.

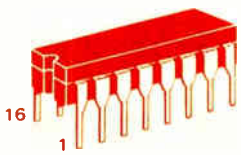
#Measured with $V_{DD}$ = +5 V, $T_A$ = 25°C.

# UV ERASABLE PROM

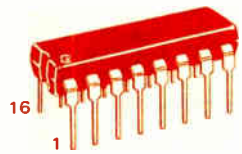
### NMOS ($T_A$ = 0 to 70°C)

| Size (Organization) | Description | No. of Chip Selects | Access Time (ns max) | Power Supplies (V) | No. of Pins |
|---|---|---|---|---|---|
| 8K Bits (1024 x 8) | MCM68708 – Pin equivalent to 2708; upward pin compatible with popular 16K ROMs | 1 | 500 | +12, +5, -5 | 24 |

**16-PIN PACKAGES**




L SUFFIX
CERAMIC PACKAGE
CASE 620

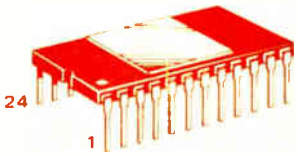



P SUFFIX
PLASTIC PACKAGE
CASE 648

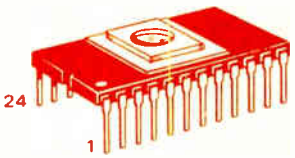
**18-PIN PACKAGES**

P SUFFIX
PLASTIC PACKAGE
CASE 707

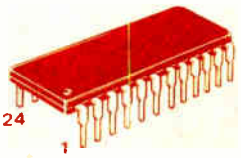
**24-PIN PACKAGES**




L SUFFIX
CERAMIC PACKAGE
CASE 716

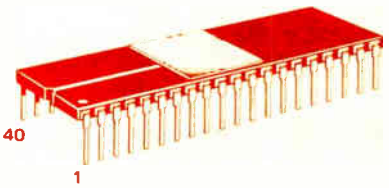



L SUFFIX
CERAMIC PACKAGE
CASE 716-03
UV ERASABLE PROM ONLY

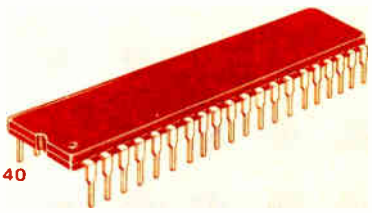



P SUFFIX
PLASTIC PACKAGE
CASE 709

**40-PIN PACKAGES**




L SUFFIX
CERAMIC PACKAGE
CASE 715




P SUFFIX
PLASTIC PACKAGE
CASE 711



World Radio History

# MOS RANDOM ACCESS MEMORIES

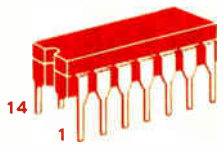
NMOS ($T_A$ = 0 to 70°C unless otherwise noted.)

| Size (Organization) | Description | Device No. | Access Time (ns max) | Power Supplies (V) | No. of Pins | Case |
|---|---|---|---|---|---|---|
| 16K Bits (16384 x 1) | Dynamic | MCM6616-3<br>MCM6616-4<br>MCM6616-5 | 200<br>250<br>300 | +12, +5, -5 | 16 | 690, 648 |
| 4K Bits (4096 x 1) | Dynamic | MCM4027-2<br>MCM4027-3<br>MCM4027-4 | 150<br>200<br>250 | +12, +5, -5 | 16 | 690, 648 |
| | | MCM6604<br>MCM6604-2<br>MCM6604-4 | 350<br>250<br>300 | +12, +5, -5 | 16 | 690, 648 |
| | | MCM6605A<br>MCM6605A1<br>MCM6605A2 | 300<br>150<br>200 | +12, +5, -5 | 22 | 677, 708 |
| | | MCM4096* | 350 | +12, +5, -5 | 16 | TBA |
| 4K Bits (1024 x 4) | Static | MCM6614* | 300 | +5 | 18 | 707, 726 |
| 1K Bits (128 x 8) | Static<br>$T_A$ = -40 to +85°C<br>$T_A$ = -40 to +85°C | MCM6810A<br>MCM6810A1<br>MCM6810AC<br>MCM6810AC1 | 450<br>350<br>450<br>350 | +5 | 24 | 716, 709 |

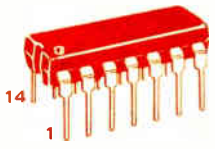
CMOS

| | | | | | | |
|---|---|---|---|---|---|---|
| 256 Bits (256 x 1) | Static — $T_A$ = -55 to +125°C<br>$T_A$ = -40 to +85°C | MCM14537A<br>MCM14537C | 4000≠<br>6000≠ | +3 to +18 | 16 | 690 |
| 256 Bits (64 x 4) | Static — $T_A$ = -55 to +125°C<br>$T_A$ = -40 to +85°C | MCM14552A<br>MCM14552C | 3000≠<br>6000≠ | +3 to +18 | 24 | 716<br>716, 709 |
| 64 Bits (64 x 1) | Static — $T_A$ = -55 to +125°C<br>$T_A$ = -40 to +85°C | MCM14505A<br>MCM14505C | 640≠<br>750≠ | +3 to +18 | 14 | 632<br>632, 646 |

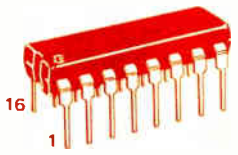
*To be announced. ≠Measured with $V_{DD}$ = +5 V, $T_A$ = 25°C.



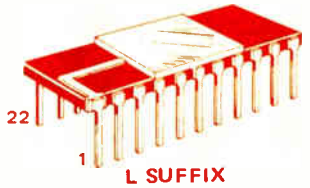

L SUFFIX
CERAMIC PACKAGE
CASE 632



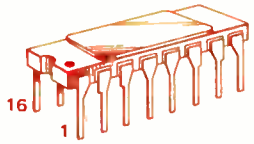

P SUFFIX
PLASTIC PACKAGE
CASE 646



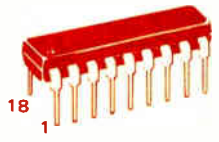

P SUFFIX
PLASTIC PACKAGE
CASE 648



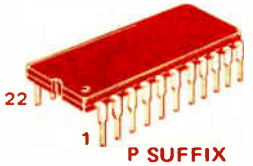

L SUFFIX
CERAMIC PACKAGE
CASE 677



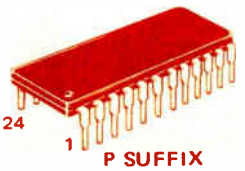

L SUFFIX
CERAMIC PACKAGE
CASE 690



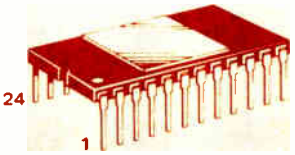

P SUFFIX
PLASTIC PACKAGE
CASE 707



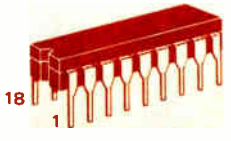

P SUFFIX
PLASTIC PACKAGE
CASE 708




P SUFFIX
PLASTIC PACKAGE
CASE 709




L SUFFIX
CERAMIC PACKAGE
CASE 716




L SUFFIX
CERAMIC PACKAGE
CASE 726



World Radio History

# BIPOLAR PROGRAMMABLE READ ONLY MEMORIES

These field Programmable Read Only Memories (PROMs) can be custom programmed to any pattern using a simple programming procedure fusing appropriate nichrome metallization links.

## TTL

| Size (Organization) | Device No. | Description | Access Time (ns typ) | $P_D$ (mW typ/pkg) | Temperature (°C) | No. of Pins | Case |
|---|---|---|---|---|---|---|---|
| 512 Bits (64 x 8) | MCM5003<br>MCM5303 | Open Collector | 75 = | 500 | 0 to +70<br>-55 to +125 | 24 | 623 |
| | MCM5004<br>MCM5304 | 2 kΩ Pullup Resistor | 75 = | 600 | 0 to +70<br>-55 to +125 | | |
| 4K Bits (512 x 8) | MCM7640*<br>MCM7641* | Open Collector<br>3-State Output | 40 | 500 | 0 to +70 | 24 | 623, 649 |
| 4K Bits (1024 x 4) | MCM7642*<br>MCM7643* | Open Collector<br>3-State Output | | | | 18 | 701, 726 |

## MECL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 256 Bits (32 x 8) | MCM10139A* | (32 x 8) | 10 | 500 | 0 to +70 | 16 | 620 |
| 1K Bits (256 x 4) | MCM10149 | | 25† | 540 | -30 to +85 | | |

*To be announced. =Max over temperature range. †Max at 25°C

# BIPOLAR RANDOM ACCESS MEMORIES

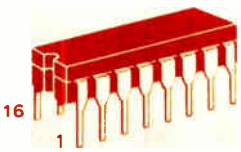
## TTL

| Size (Organization) | Device No. | Description | Access Time (ns max) | $P_D$ (mW typ/pkg) | Temperature (°C) | No. of Pins | Case |
|---|---|---|---|---|---|---|---|
| 1K Bits (1024 x 1) | MCM93415*<br>MCM93425* | Open Collector<br>3-State Output | 35 | 550 | 0 to +70 | 16 | 620, 648 |

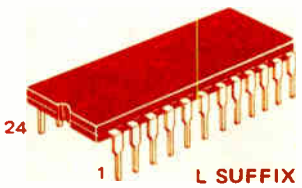
## MECL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1K Bits (1024 x 1) | MCM10146 | 10415A Replacement | 29 | 500 | 0 to +75 | 16 | 620 |
| 256 Bits (256 x 1) | MCM10144 | 10410 Replacement | 26 | 420 | | | |
| | MCM10152* | | 15 | 500 | | | |
| 128 Bits (128 x 1) | MCM10147 | 10405 Type | 12† | 420 | -30 to +85 | | |
| 64 Bits (16 x 4) | MCM10145 | Register File | 15 | 625 | 0 to +75 | | |
| 16 Bits (8 x 2) | MCM10143 | Multiport Register File | 14.5† | 610 | -30 to +85 | 24 | 623 |

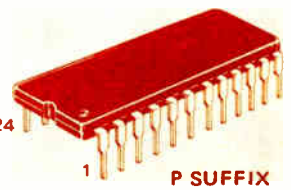
*To be announced. †Max at 25°C



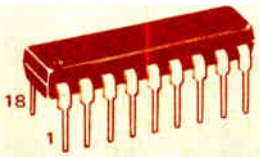

L SUFFIX
CERAMIC PACKAGE
CASE 620



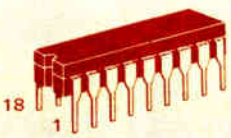

L SUFFIX
CERAMIC PACKAGE
CASE 623




P SUFFIX
PLASTIC PACKAGE
CASE 649




P SUFFIX
PLASTIC PACKAGE
CASE 701




L SUFFIX
CERAMIC PACKAGE
CASE 726



World Radio History

# MOS MEMORY SYSTEMS

| Organization | System | Description | Availability |
|---|---|---|---|
| 16K x 16 | MMS1116 | Add-in for PDP-11/05, 10, 15, 20, 35, 40, 45 | Now |
| 16K x 8 | MMS68100 | Hidden Refresh for M6800 Systems<br>Option 1 8K x 8<br>Option 2 4K x 8 | Now |
| 16K x 8 | MMS68102 | Battery Backup for M6800 and Other Synchronous Systems<br>Option 1 8K x 8<br>Option A 16K x 9<br>Option A-1 8K x 9 | Now |
| 16K x 8 | MMS68103 | Same as MMS68100<br>Option 1 8K x 8 | Now |
| 16K x 16 | MMS1110 | Add-in for 11/03G LSI 11 | Now |
| 32K x 18<br>64K x 9 | MMS3400 | For Large Systems | March 1977 |
| 32K x 8 | MMS80810 | For 8080 and Others<br>Option 1 16K x 8<br>Option A 32K x 9<br>Option A-1 16K x 9 | March 1977 |
| 16K x 16 | MMS1118 | Add-in for PDP-11/04, 34 | Now |

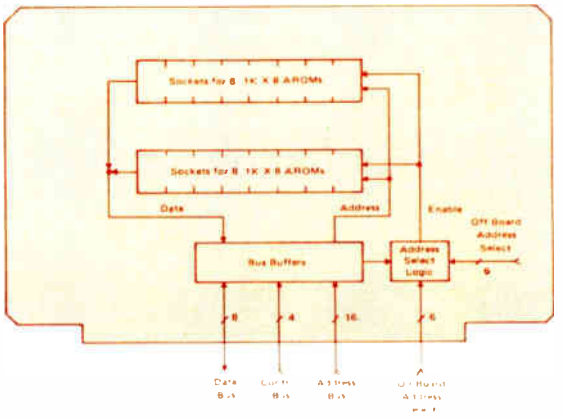
# MICROMODULES

## 8K/16K AROM/ROM MODULE
(Micromodule 4)

## M68MM04

Sockets for from one to sixteen 1K x 8-bit AROM or ROM devices
EXORciser and Micromodule Family bus compatible
Selectable base memory address for each 8K memory block

M68MM04





World Radio History

MOTOROLA

# LOGIC FAMILIES

**Motorola carries a comprehensive inventory of standard components encompassing all major digital logic families and technologies.**

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MECL III MC1600 Series – Highest-speed logic family available, with clock frequencies in excess of 500 MHz and propagation delays in the 1 ns range . . . . . 51

MEGALOGIC LSI

MC8500 Series – Low-cost LSI components designed for dedicated applications in computer and industrial equipment . . . . . 52

TRANSISTOR-TRANSISTOR LOGIC – MTTL

SN54LS00/SN74LS00 Series – Motorola has undertaken the task of becoming a major supplier for high-speed, low-power Schottky TTL product line represented by this series. Contact your Motorola representative for product availability . . . . . 53

MC5400/MC7400 Series – Medium-speed family with high noise immunity; designed for applications requiring clock frequencies to 30 MHz and switching speeds in the 12–15 ns range under moderate capacitive loading . . . . . 55

MC3100/MC3000 Series (MTTL III – MC74H00/MC54H00) – High-speed family for operation at clock frequencies in the 30–50 MHz range. Features good external-noise immunity, high fan-out and the capability to drive lines up to 600 pF capacitance . . . . . 58

MC2100/MC2000 Series (MTTL II – SUHL) – High-speed family with flip-flop clock frequencies as high as 70 MHz . . . . . 59

MC500/MC400 Series (MTTL I – SUHL) – Medium speed family with flip-flop clock frequencies up to 35 MHz . . . . . 60

MC4300/MC4000 Series, . . . . . 61

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Complex TTL functions designed for medium-to-high speed operating range.




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HIGH-THRESHOLD LOGIC – MHTL

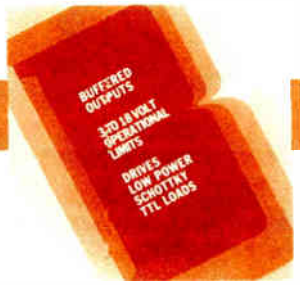
MC660 Series – Especially designed to meet the high-noise immunity requirements of industrial environments . . . . . 69

MONOLITHIC DIODE ARRAYS

MC1100 Series – Arrays designed for applications requiring high currents (to 400 mA continuous, in dual in-line package) and fast switching . . . . . 70



World Radio History




# Complementary MOS

**Motorola's Complementary MOS (CMOS) design and manufacturing facility offers the inherent advantages of CMOS—low power dissipation, flexible power supply requirements and high noise immunity—in three unique, system-oriented categories:**

- **A large complement of diversified MSI/SSI components, available off-the-shelf, for complete system designs.**
- **A group of standard LSI components, dedicated toward the most-effective designs for specifically designated systems.**
- **A custom capability for the development and production of proprietary customer-initiated circuits.**

## OFF-THE-SHELF MSI/SSI CIRCUITS

### Series MC14000/MC14500

These standard lines of MSI/SSI circuits contain a large complement of devices designed to the new JEDEC B-Series Specification with low-power Schottky-compatible buffered outputs. The B-Series line is broad enough (more than 100 device types are now available) to permit complete system design. Compatibility with Motorola non-buffered devices (with increased speed capabilities) and with Schottky TTL provides mix and match versatility for added performance potential. Devices are available in ceramic and top-reliability plastic packages.

## STANDARD LSI

### Series MC14400

This series of highly complex devices consists of single-chip subsystems tailored for specific applications. Designed to maximize efficiency in systems requiring large-scale timing, control, conversion and interface functions, these circuits find wide potential use in industrial/commercial electronic systems.

## CUSTOM CMOS

A new and modern facility in Austin, Texas is devoted exclusively to the design and production of MOS components. Motorola-developed design techniques now permit a combination of both digital and linear functions on the same chip, thereby extending the performance enhancement of customer-required special functions. For details regarding the custom capability, please consult your Motorola Sales Office.

Note: Ask your sales representative for copies of Reliability Reports:

CMOS LIFE STRESS TESTING

CMOS PLASTIC PACKAGING SYSTEM



World Radio History

## B-SERIES FAMILY DATA

The CMOS Devices which have a B suffix meet the minimum values for the industry-standardized* family specification for the B Series. Some of these standardized values are shown in the Maximum Ratings table.

The B-Series devices are compatible with the other devices in the CMOS product line. Features include:

- All buffered outputs
- 3–18 volt operational limits
- Capable of driving two low-power TTL loads, one low-power Schottky TTL load, or two HTL loads over the rated temperature range
- Maximum input current of ±1 μA at 15 volt power supply over the temperature range
- Parameters specified at 5.0, 10, and 15 volt supply
- Noise margins of 1.0 V min @ 5.0 V supply
  2.0 V min @ 10 V supply
  2.5 V min @ 15 V supply

For the industry-standardized B series, the maximum ratings and recommended operating range are shown at the bottom of this page. Additional specification values are shown on the individual data sheets.

Switching characteristics for the B-Series devices are specified under the following conditions:

- Load Capacitance, $C_L$, of 50 pF
- Input pulse voltage equal to $+V_{DD}$ supply voltage
- Input pulse rise and fall times of 20 ns
- Propagation Delay times measured from 50% point of input voltages to 50% point of output voltage
- Three different supply voltages: 5, 10, and 15 V

### Exceptions to the B-Series Family Specification

There are a number of devices which have a B suffix whose input and/or outputs vary somewhat from the B-Series family specification because of functional requirements. Some categories of notable exceptions are:

- Inverting buffers with only one stage of buffering do not meet the input voltage specification.
- Devices with specialized outputs on the chip, such as NPN emitter-follower drivers or transmission gates, do not meet output specifications.
- Devices with specialized inputs, such as oscillator inputs, have unique input specifications.

### Input Voltage

The input voltage specification is interpreted as the worst-case input voltage to produce an output level of "1" or "0". The "1" or "0" output level is defined as a deviation from the supply ($V_{DD}$) and ground ($V_{SS}$) levels. For a 5.0 V supply, this deviation is 0.5 V; for a 10 V supply, 1.0 V; and for 15 V, 1.5 V. As an example, in a device operating at a 5.0 V supply, the device with the input starting at ground is guaranteed to switch on or before 3.5 V and not to switch up to 1.5 V. Switching and not switching are defined as within 0.5 V of the ideal output level for the example with a 5.0 V supply. The actual switching level referred to the input is between 1.5 V and 3.5 V.

### Noise Margin

The values for input voltage and the given defined output deviation lead to minimum noise margins of 1.0 V, 2.0 V, and 2.5 V for a 5.0 V, 10 V, and 15 V supply, respectively.

### Output Device Current

Devices in the B Series are capable of sinking a minimum of 0.36 mA over the temperature range with a 5.0 V supply. This value guarantees that these CMOS devices will drive low-power Schottky TTL inputs which require 0.36 mA maximum over the temperature range.

### Compatibility

Other devices in the CMOS line not labeled with the B suffix also have 3.0 to 18 volt operating limits. These devices are fully compatible with B-Series devices over the full voltage range. Notable in this group is a series of eight gates available in nonbuffered (numbered without the B suffix) and buffered designs (B suffix on the part number).

**MAXIMUM RATINGS** (Voltages referenced to $V_{SS}$.)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| DC Supply Voltage | $V_{DD}$ | -0.5 to +18 | Vdc |
| Input Voltage, All Inputs | $V_{in}$ | -0.5 to $V_{DD}$ +0.5 | Vdc |
| DC Current Drain per Pin | I | 10 | mAdc |
| Operating Temperature Range — AL Device<br>CL/CP Device | $T_A$ | -55 to +125<br>-40 to +85 | °C |
| Storage Temperature Range | $T_{stg}$ | -65 to +150 | °C |
| **RECOMMENDED OPERATING RANGE** | | | |
| DC Supply Voltage | $V_{DD}$ | +3.0 to +15 | Vdc |

*Specifications coordinated by EIA/JEDEC Solid-State Products Council.



World Radio History

# THE MOTOROLA CMOS LINE — Listed in alpha-numeric sequence

| Device Type | Function | Suffix* | Pins | Second Sourced |
|---|---|---|---|---|
| MC14000 | Dual 3 Input NOR Gate plus Inverter | AL,CL,CP | 14 | ✓ |
| MC14001 | Quad 2 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14001B | Quad 2 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14002 | Dual 4 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14002B | Dual 4 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14006B | 18 Bit Static Shift Register | AL,CL,CP | 14 | ✓ |
| MC14007B | Dual Complementary Pair plus Inverter | AL,CL,CP | 14 | ✓ |
| MC14008B | 4 Bit Full Adder | AL,CL,CP | 16 | ✓ |
| MC14011 | Quad 2 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14011B | Quad 2 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14012 | Dual 4 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14012B | Dual 4 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14013B | Dual D Flip Flop | AL,CL,CP | 14 | ✓ |
| MC14014B | 8 Bit Static Shift Register | AL,CL,CP | 16 | ✓ |
| MC14015B | Dual 4 Bit Static Shift Register | AL,CL,CP | 16 | ✓ |
| MC14016B | Quad Analog Switch/Quad Multiplexer | AL,CL,CP | 14 | ✓ |
| MC14017B | Decade Counter/Divider | AL,CL,CP | 16 | ✓ |
| MC14018B | Presettable Divide by N Counter | AL,CL,CP | 16 | ✓ |
| MC14020B | 14 Bit Binary Counter | AL,CL,CP | 16 | ✓ |
| MC14021B | 8 Bit Static Shift Register | AL,CL,CP | 16 | ✓ |
| MC14022B | Octal Counter/Divider | AL,CL,CP | 16 | ✓ |
| MC14023 | Triple 3 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14023B | Triple 3 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14024B | Seven Stage Ripple Counter | AL,CL,CP | 14 | ✓ |
| MC14025 | Triple 3 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14025B | Triple 3 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14027B | Dual J K Flip Flop | AL,CL,CP | 16 | ✓ |
| MC14028B | BCD to Decimal Decoder | AL,CL,CP | 16 | ✓ |
| MC14032B | Triple Serial Adder (Positive Logic) | AL,CL,CP | 16 | ✓ |
| MC14034B | 8 Bit Universal Bus Register | AL,CL,CP | 24 | ✓ |
| MC14035B | 4 Bit Shift Register | AL,CL,CP | 16 | ✓ |
| MC14038B | Triple Serial Adder (Negative Logic) | AL,CL,CP | 16 | ✓ |
| MC14040B | 12 Bit Binary Counter | AL,CL,CP | 16 | ✓ |
| MC14042B | Quad Latch | AL,CL,CP | 16 | ✓ |
| MC14043B | Quad NOR R S Latch | AL,CL,CP | 16 | ✓ |
| MC14044B | Quad NAND R S Latch | AL,CL,CP | 16 | ✓ |
| MC14046B | Phase Locked Loop | AL,CL,CP | 16 | ✓ |
| MC14049B | Hex Inverter/Buffer | AL,CL,CP | 16 | ✓ |
| MC14050B | Hex Buffer | AL,CL,CP | 16 | ✓ |
| MC14051B | 8 Channel Analog Multiplexer | AL,CL,CP | 16 | ✓ |
| MC14052B | Dual 4 Channel Analog Multiplexer | AL,CL,CP | 16 | ✓ |
| MC14053B | Triple 2 Channel Analog Multiplexer | AL,CL,CP | 16 | ✓ |
| MC14066B | Quad Analog Switch | AL,CL,CP | 14 | ✓ |
| MC14068B | 8 Input NAND Gate | AL,CL,CP | 14 | ✓ |
| MC14069B | Hex Inverter | AL,CL,CP | 14 | ✓ |
| MC14070B | Quad Exclusive OR Gate | AL,CL,CP | 14 | ✓ |
| MC14071 | Quad 2 Input OR Gate | AL,CL,CP | 14 | ✓ |
| MC14071B | Quad 2 Input OR Gate | AL,CL,CP | 14 | ✓ |
| MC14072B | Dual 4 Input OR Gate | AL,CL,CP | 14 | ✓ |
| MC14073B | Triple 3 Input AND Gate | AL,CL,CP | 14 | ✓ |
| MC14075B | Triple 3 Input OR Gate | AL,CL,CP | 14 | ✓ |
| MC14076B | Quad D Type Register | AL,CL,CP | 16 | ✓ |
| MC14077B | Quad Exclusive NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14078B | 8 Input NOR Gate | AL,CL,CP | 14 | ✓ |
| MC14081 | Quad 2 Input AND Gate | AL,CL,CP | 14 | ✓ |
| MC14081B | Quad 2 Input AND Gate | AL,CL,CP | 14 | ✓ |
| MC14082B | Dual 4 Input AND Gate | AL,CL,CP | 14 | ✓ |
| MC14093B | Quad 2 Input NAND Schmitt Trigger | AL,CL,CP | 14 | ✓ |
| MC14160B | Decade Counter (Asynchronous Clear) | AL,CL,CP | 16 | ✓ |
| MC14161B | Binary Counter (Asynchronous Clear) | AL,CL,CP | 16 | ✓ |
| MC14162B | Decade Counter (Synchronous Clear) | AL,CL,CP | 16 | ✓ |
| MC14163B | Binary Counter (Synchronous Clear) | AL,CL,CP | 16 | ✓ |
| MC14174B | Hex D Flip Flop | AL,CL,CP | 16 | ✓ |
| MC14175B | Quad D Flip Flop | AL,CL,CP | 16 | ✓ |
| MC14194B | 4 Bit Universal Shift Register | AL,CL,CP | 16 | ✓ |
| MC14408 | Binary-to-Phone Pulse Converter | L,P | 16 | |
| MC14409 | Binary to Phone Pulse Converter | L,P | 16 | |
| MC14410 | 2 of 8 Tone Encoder | L,P | 16 | |
| MC14411 | Bit Rate Frequency Generator | L,P | 24 | |
| MC14412 | Universal Low Speed Modem | FP,VP | 16 | |
| MC14415 | Quad Precision Timer/Driver | EFL,FL,FP, EVL,VL,VP | 16 | |
| MC14419 | 2 of 8 Keypad to Binary Encoder | L,P | 16 | |
| MC14422 | Remote Control Transmitter | P | 16 | |
| MC14433 | 3½ Digit A/D Converter | L,P | 24 | |
| MC14435 | 3½ Digit A/D Logic Subsystem | EFL,FL,FP, EVL,VL,VP | 16 | |
| MC14440 | LCD Watch/Clock Circuit | L,Z | 40,36 | |
| MC14450 | Oscillator $2^{16}$ Divider/Buffer | L,P | 6 | |
| MC14451 | Oscillator Divider/Buffer | L,P | 16 | |
| MC14452 | Digitally Trimmed Frequency Divider | P | 14 | |
| MC14460 | Automotive Speed Control Processor | P | 16 | |
| MC14490 | Hex Contact Bounce Eliminator | EFL,FL,FP, EVL,VL,VP | 16 | |
| MC14501 | Triple Gate | AL,CL,CP | 16 | |
| MC14502B | Strobed Hex Inverter/Buffer | AL,CL,CP | 16 | ✓ |
| MC14503B | Hex 3 State Buffer | AL,CL,CP | 16 | ✓ |
| MCM14505 | 64 x 1 Bit Static RAM | AL,CL,CP | 14 | |

| Device Type | Function | Suffix* | Pins | Second Sourced |
|---|---|---|---|---|
| MC14506B | Dual Expandable AOI Gate | AL,CL,CP | 16 | |
| MC14507 | Quad Exclusive OR Gate | AL,CL,CP | 14 | ✓ |
| MC14508B | Dual 4-Bit Latch | AL,CL,CP | 24 | ✓ |
| MC14510B | BCD Up/Down Counter | AL,CL,CP | 16 | ✓ |
| MC14511B | BCD to 7 Segment Latch/Decoder/Driver | AL,CL,CP | 16 | ✓ |
| MC14512 | 8 Channel Data Selector | AL,CL,CP | 16 | ✓ |
| MC14513B | BCD to 7 Segment Latch/Decoder/Driver | AL,CL,CP | 18 | |
| MC14514B | 4 Bit Latch/4 to 16 Line Decoder (High) | AL,CL,CP | 24 | ✓ |
| MC14515B | 4 Bit Latch 4 to 16 Line Decoder (Low) | AL,CL,CP | 24 | ✓ |
| MC14516B | Binary Up/Down Counter | AL,CL,CP | 16 | ✓ |
| MC14517B | Dual 64 Bit Static Shift Register | AL,CL,CP | 16 | ✓ |
| MC14518B | Dual BCD Up Counter | AL,CL,CP | 16 | ✓ |
| MC14519B | 4 Bit AND/OR Selector | AL,CL,CP | 16 | ✓ |
| MC14520B | Dual Binary Up Counter | AL,CL,CP | 16 | ✓ |
| MC14521B | 24 Stage Frequency Divider | AL,CL,CP | 16 | |
| MC14522B | Programmable BCD Divide by N Counter | AL,CL,CP | 16 | ✓ |
| MCM14524 | 256 x 4 Bit Read Only Memory | AL,CL,CP | 16 | |
| MC14526B | Programmable Binary Divide by N Counter | AL,CL,CP | 16 | ✓ |
| MC14527B | BCD Rate Multiplier | AL,CL,CP | 16 | ✓ |
| MC14528B | Dual Monostable Multivibrator | AL,CL,CP | 16 | ✓ |
| MC14529B | Dual 4 Channel Analog Data Selector | AL,CL,CP | 16 | ✓ |
| MC14530B | Dual 5 Input Majority Logic Gate | AL,CL,CP | 16 | |
| MC14531B | 12 Bit Parity Tree | AL,CL,CP | 16 | ✓ |
| MC14532B | 8 Bit Priority Encoder | AL,CL,CP | 16 | ✓ |
| MC14534B | Real Time 5 Decade Counter | AL,CL,CP | 24 | |
| MC14536B | Programmable Timer | AL,CL,CP | 16 | |
| MCM14537 | 256 x 1 Bit Static RAM | AL,CL | 16 | |
| MC14538B | Dual Precision Retriggerable/Resettable Monostable Multivibrator | AL,CL,CP | 16 | |
| MC14539B | Dual 4 Channel Data Selector/Multiplexer | AL,CL,CP | 16 | |
| MC14541B | Programmable Oscillator Timer | AL,CL,CP | 14 | |
| MC14543B | BCD to 7 Segment Latch/Decoder/Driver | AL,CL,CP | 16 | ✓ |
| MC14549B | Successive Approximation Register | AL,CL,CP | 16 | |
| MCM14552 | 64 x 4 Bit Static RAM | AL,CL,CP | 24 | |
| MC14553B | 3 Digit BCD Counter | AL,CL,CP | 16 | |
| MC14554B | 2 x 2 Bit Parallel Binary Multiplier | AL,CL,CP | 16 | |
| MC14555B | Dual Binary to 1 of 4 Decoder | AL,CL,CP | 16 | ✓ |
| MC14556B | Dual Binary to 1 of 4 Decoder (Inverting) | AL,CL,CP | 16 | ✓ |
| MC14557B | 1 to 64 Bit Variable Length Shift Register | AL,CL,CP | 16 | |
| MC14558B | BCD to 7 Segment Decoder | AL,CL,CP | 16 | |
| MC14559B | Successive Approximation Register | AL,CL,CP | 16 | |
| MC14560B | NBCD Adder | AL,CL,CP | 16 | |
| MC14561B | 9's Complementer | AL,CL,CP | 14 | |
| MC14562B | 128 Bit Static Shift Register | AL,CL,CP | 14 | |
| MC14566B | Industrial Time Base Generator | AL,CL,CP | 16 | |
| MC14568B | Phase Comparator/Programmable Counter | AL,CL,CP | 16 | |
| MC14569B | Dual Programmable BCD/Binary Counter | AL,CL,CP | 16 | |
| MC14572 | Hex Gate | AL,CL,CP | 16 | |
| MC14580B | 4 x 4 Multiport Register | AL,CL,CP | 24 | ✓ |
| MC14581B | 4 Bit Arithmetic Logic Unit | AL,CL,CP | 24 | ✓ |
| MC14582B | Look-Ahead Carry Block | AL,CL,CP | 16 | ✓ |
| MC14583B | Dual Schmitt Trigger | AL,CL,CP | 16 | |
| MC14584B | Hex Schmitt Trigger | AL,CL,CP | 14 | |
| MC14585B | 4 Bit Magnitude Comparator | AL,CL,CP | 16 | ✓ |
| MCM14505 | 64 Bit Static Random Access Memory | AL,CL,CP | 14 | |
| MCM14524 | 1024 Bit Read Only Memory | AL,CL,CP | 16 | |
| MCM14537 | 256 Bit Static Random Access Memory | AL,CL | 16 | |
| MCM14552 | 256 Bit Static Random Access Memory | AL,CL,CP | 24 | |

NMOS Devices Designed to work with the MC14422 CMOS device

| | | | | |
|---|---|---|---|---|
| MC6525 | Remote Control Receiver | P | 28 | |
| MC6526 | Remote Control Receiver | P | 28 | |

*Add suffix to part number on all orders

| | |
|---|---|
| AL | 3 to 18 V, −55 to +125°C, ceramic package |
| CL | 3 to 18 V, −40 to +85°C, ceramic package |
| CP | 3 to 18 V, −40 to +85°C, plastic package |
| L | Limited voltage range, limited temperature range, ceramic package |
| P | Limited voltage range, limited temperature range, plastic package |
| EFL | 3 to 18 V, −55 to +125°C, ceramic package |
| FL | 3 to 18 V, −40 to +85°C, ceramic package |
| FP | 3 to 18 V, −40 to +85°C, plastic package |
| EVL | 3 to 6 V, −55 to +125°C, ceramic package |
| VL | 3 to 6 V, −40 to +85°C, ceramic package |
| VP | 3 to 6 V, −40 to +85°C, plastic package |
| Z | Limited voltage range, limited temperature range, leadless ceramic package |

Chips are available for all McMOS types
Consult your Motorola Sales Office or
Authorized Motorola Distributor



World Radio History

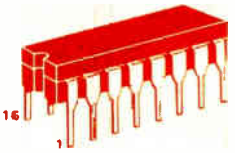
# SUMMARY OF CMOS DEVICES — By function

| Gates | | | | | | Flip-Flops/ Latches | Multi-vibrators |
|---|---|---|---|---|---|---|---|
| Single-Level | | | Multi-Level | | | | |
| NOR/NAND | OR/AND | Buffers & Inverters | Multifunction/ AOI | Decoders/ Encoders | Schmitt Triggers | | |
| MC14000 | MC14071 | MC14007B | MC14070B | MC14028B | MC14093B | MC14013B | MC14528B |
| MC14001 | MC14071B | MC14049B | MC14077B | MC14514B | MC14583B | MC14027B | MC14538B |
| MC14001B | MC14072B | MC14050B | MC14506B | MC14515B | MC14584B | MC14042B | |
| MC14002 | MC14073B | MC14069B | MC14507 | MC14532B | | MC14043B | |
| MC14002B | MC14075B | MC14502B | MC14519B | MC14555B | | MC14044B | |
| MC14011 | MC14081 | MC14503B | MC14530B | MC14556B | | MC14076B | |
| MC14011B | MC14081B | | | | | MC14174B | |
| MC14012 | MC14082B | | | | | MC14175B | |
| MC14012B | | | | | | MC14508B | |
| MC14023 | | | | | | | |
| MC14023B | | | | | | | |
| MC14025 | | | | | | | |
| MC14025B | | | | | | | |
| MC14068B | | | | | | | |
| MC14078B | | | | | | | |
| MC14501 | | | | | | | |
| MC14572 | | | | | | | |

| Shift Registers | Counters | | | Phase-Locked Loop | Memories | | |
|---|---|---|---|---|---|---|---|
| | Ripple | Synchronous | Oscillators & Timers | | Multiport Register | RAMs | ROMs |
| MC14006B | MC14020B | MC14017B | MC14450 | MC14046B | MC14580B | MCM14505 | MCM14524 |
| MC14014B | MC14024B | MC14018B | MC14451 | MC14568B | | MCM14537 | |
| MC14015B | MC14040B | MC14022B | MC14452 | | | MCM14552 | |
| MC14021B | MC14534B | MC14160B | MC14521B | | | | |
| MC14034B | MC14566B | MC14161B | MC14536B | | | | |
| MC14035B | | MC14162B | MC14541B | | | | |
| MC14194B | | MC14163B | | | | | |
| MC14517B | | MC14510B | | | | | |
| MC14557B | | MC14516B | | | | | |
| MC14562B | | MC14518B | | | | | |
| | | MC14520B | | | | | |
| | | MC14522B | | | | | |
| | | MC14526B | | | | | |
| | | MC14553B | | | | | |
| | | MC14569B | | | | | |

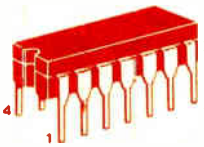
| Multiplexers/ Demultiplexers, Bilateral Switches | Display Drivers/ Encoders | Arithmetic Circuits | | | Communication/ Telephone | A/D Converters | Other Complex Functions |
|---|---|---|---|---|---|---|---|
| | | Adders/ Comparators | ALU/Rate Multipliers | Parity Generator/ Checker | | | |
| MC14016B | MC14511B | MC14008B | MC14527B | MC14531B | MC14408 | MC14433 | MC14415 |
| MC14051B | MC14513B | MC14032B | MC14554B | | MC14409 | MC14435 | MC14422 |
| MC14052B | MC14543B | MC14038B | MC14581B | | MC14410 | MC14549B | MC14440 |
| MC14053B | MC14558B | MC14560B | | | MC14411 | MC14559B | MC14460 |
| MC14066B | | MC14561B | | | MC14412 | | MC14490 |
| MC14512 | | MC14582B | | | MC14419 | | |
| MC14519B | | MC14585B | | | | | |
| MC14529B | | | | | | | |
| MC14539B | | | | | | | |

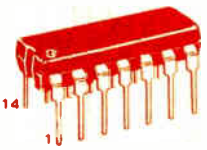
## CMOS PACKAGES




L SUFFIX
CERAMIC PACKAGE
CASE 620

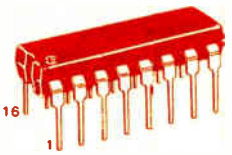
L SUFFIX
CERAMIC PACKAGE
CASE 632

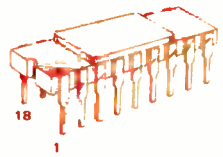



P SUFFIX
PLASTIC PACKAGE
CASE 646

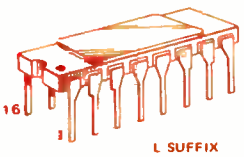
P SUFFIX
PLASTIC PACKAGE
CASE 648




L SUFFIX
CERAMIC PACKAGE
CASE 680

L SUFFIX
CERAMIC PACKAGE
CASE 688

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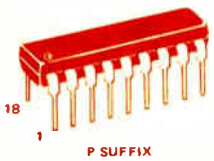
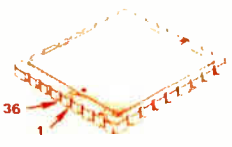
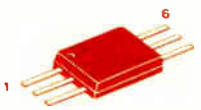
CERAMIC PACKAGE
CASE 690



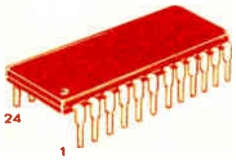

P SUFFIX
PLASTIC PACKAGE
CASE 707



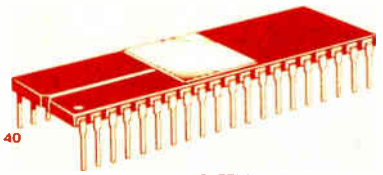

Z SUFFIX
LEADLESS CERAMIC PACKAGE
CASE 703



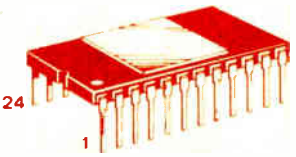

P SUFFIX
PLASTIC PACKAGE
CASE 704




P SUFFIX
PLASTIC PACKAGE
CASE 709




L SUFFIX
CERAMIC PACKAGE
CASE 715




L SUFFIX
CERAMIC PACKAGE
CASE 716



World Radio History

# CMOS SELECTION GUIDE BY FUNCTION

| Device Type | Function |
|---|---|
| **NAND Gates** | |
| MC14011<br>MC14011B | Quad 2-Input NAND Gate |
| MC14093B | Quad 2-Input NAND Schmitt Trigger |
| MC14023<br>MC14023B | Tr ple 3-Input NAND Gate |
| MC14012<br>MC14012B | Dual 4-Input NAND Gate |
| MC14068B | 8-Input NAND Gate |
| **NOR Gates** | |
| MC14001 | Quad 2-Input NOR Gate |
| MC14001B | Quad 2-Input NOR Gate |
| MC14025<br>MC14025B | Triple 3-Input NOR Gate |
| MC14000 | Dual 3-Input NOR Gate plus Inverter |
| MC14002<br>MC14002B | Dual 4-Input NOR Gate |
| MC14078B | 8-Input NOR Gate |
| **AND Gates** | |
| MC14081<br>MC14081B | Quad 2-Input AND Gate |
| MC14073B | Triple 3-Input AND Gate |
| MC14082B | Dual 4-Input AND Gate |
| **OR Gates** | |
| MC14071<br>MC14071B | Quad 2-Input OR Gate |
| MC14075B | Triple 3-Input OR Gate |
| MC14072B | Dual 4-Input OR Gate |
| **Complex Gates** | |
| MC14070B | Quad Exclusive OR Gate |
| MC14077B | Quad Exclusive NOR Gate |
| MC14501 | Triple Gate (Dual 4-Input NAND Gate and 2-Input NOR/OR Gate or 8-Input AND/NAND Gate) |
| MC14506B | Dual Expandable AND-OR-INVERT Gate |
| MC14507 | Quad Exclusive OR Gate |
| MC14519B | 4-Bit AND/OR Selector (Quad 2-Channel Data Selector or Quad Exclusive NOR Gate) |
| MC14530B | Dual 5-Input Majority Logic Gate |
| MC14572 | Hex Gate (Quad Inverter plus 2-Input NOR Gate plus 2-Input NAND Gate) |
| **Inverters/Buffers** | |
| MC14007B | Dual Complementary Pair plus Inverter |
| MC14049B | Hex Inverter/Buffer |
| MC14050B | Hex Buffer |
| MC14069B | Hex Inverter |
| MC14502B | Strobed Hex Inverter/Buffer |
| MC14503B | Hex 3-State Buffer |
| MC14584B | Hex Schmitt Trigger |

| Device Type | Function |
|---|---|
| **Decoders/Encoders** | |
| MC14028B | BCD-to-Decimal/Binary-to-Octal Decoder |
| MC14514B | 4-Bit Latch/4-to-16 Line Decoder (High) |
| MC14515B | 4-Bit Latch/4-to-16 Line Decoder (Low) |
| MC14532B | 8-Bit Priority Encoder |
| MC14555B | Dual Binary-to-1-of-4 Decoder/Demultiplexer |
| MC14556B | Dual Binary-to-1-of-4 Decoder/Demultiplexer (Inverting) |
| **Display Decoders** | |
| MC14511B | BCD-to-Seven Segment Latch/Decoder/Driver |
| MC14513B | BCD-to-Seven Segment Latch/Decoder/Driver |
| MC14543B | BCD-to-Seven Segment Latch/Decoder/Driver |
| MC14558B | BCD-to-Seven Segment Decoder |
| **Multiplexers/Demultiplexers/Bilateral Switches** | |
| MC14016B | Quad Analog Switch/Quad Multiplexer |
| MC14066B | Quad Analog Switch/Quad Multiplexer |
| MC14053B | Triple 2-Channel Analog Multiplexer/Demultiplexer |
| MC14052B | Dual 4-Channel Analog Multiplexer/Demultiplexer |
| MC14529B | Dual 4-Channel Analog Data Selector |
| MC14539B | Dual 4-Channel Data Selector/Multiplexer |
| MC14051B | 8-Channel Analog Multiplexer/Demultiplexer |
| MC14512 | 8-Channel Data Selector |
| MC14519B | 4-Bit AND/OR Selector |
| **Schmitt Triggers** | |
| MC14093B | Quad 2-Input NAND Schmitt Trigger |
| MC14583B | Dual Schmitt Trigger |
| MC14584B | Hex Schmitt Trigger |
| **Flip-Flops/Latches** | |
| MC14013B | Dual Type-D Flip-Flop |
| MC14027B | Dual J-K Flip-Flop |
| MC14042B | Quad Latch |
| MC14043B | Quad NOR R-S Latch |
| MC14044B | Quad NAND R-S Latch |
| MC14076B | Quad D-Type Register |
| MC14175B | Quad Type-D Flip-Flop |
| MC14508B | Quad 4-Bit Latch |
| MC14174B | Hex Type-D Flip-Flop |
| **Shift Registers** | |
| MC14035B | 4-Bit Parallel-In/Parallel-Out Shift Register |
| MC14194B | 4-Bit Bidirectional Universal Shift Register |
| MC14015B | Dual 4-Bit Static Shift Register |
| MC14014B | 8-Bit Static Shift Register (Synchronous) |
| MC14021B | 8-Bit Static Shift Register (Asynchronous) |
| MC14034B | 8-Bit Universal Bus Register |
| MC14006B | 18-Bit Static Shift Register |
| MC14557B | 1-to-64 Bit Variable Length Shift Register |
| MC14517B | Dual 64-Bit Static Shift Register |
| MC14562B | 128-Bit Static Shift Register |



World Radio History

## SELECTION GUIDE BY FUNCTION (continued)

| Device Type | Function |
|---|---|
| **Counters** | |
| MC14024B | Seven-Stage Ripple Counter |
| MC14017B | Decade Counter/Divider |
| MC14018B | Presettable Divide-by-N Counter |
| MC14160B | Decade Counter (Asynchronous Clear) |
| MC14162B | Decade Counter (Synchronous Clear) |
| MC14510B | BCD Up/Down Counter |
| MC14522B | Programmable Divide-by-N 4-Bit Counter (BCD) |
| MC14040B | 12-Bit Binary Counter |
| MC14020B | 14-Bit Binary Counter |
| MC14022B | Octal Counter/Divider |
| MC14161B | 4-Bit Binary Counter (Asynchronous Clear) |
| MC14163B | 4-Bit Binary Counter (Synchronous Clear) |
| MC14516B | Binary Up/Down Counter |
| MC14526B | Programmable Divide-by-N 4-Bit Counter (Binary) |
| MC14518B | Dual BCD Up Counter |
| MC14520B | Dual Binary Up Counter |
| MC14569B | Dual Programmable BCD/Binary Counter |
| MC14553B | Three-Digit BCD Counter |
| MC14534B | Real Time 5-Decade Counter |
| MC14566B | Industrial Time Base Generator |
| **Oscillators/Timers** | |
| MC14521B | 24-Stage Frequency Divider |
| MC14536B | Programmable Timer |
| MC14541B | Programmable Oscillator/Timer |
| MC14450 | Oscillator/$2^{16}$ Divider/Buffer |
| MC14451 | Oscillator/$2^{11}$ to $2^{19}$ Divider/Buffered Duty Cycle Control |
| MC14452 | Digitally Trimmed Frequency Divider |
| **Phase-Locked Loops** | |
| MC14046B | Phase-Locked Loop |
| MC14568B | Phase Comparator and Programmable Counter |
| **Multivibrators** | |
| MC14528B | Dual Retriggerable/Resettable Monostable Multivibrator |
| MC14538B | Dual Precision Retriggerable/Resettable Monostable Multivibrator |
| **Adders/Comparators** | |
| MC14008B | 4-Bit Full Adder |
| MC14032B | Triple Serial Adder (Positive Logic) |
| MC14038B | Triple Serial Adder (Negative Logic) |
| MC14560B | NBCD Adder |
| MC14561B | 9s Complementer |
| MC14582B | Look-Ahead Carry Block |
| MC14585B | 4-Bit Magnitude Comparator |

| Device Type | Function |
|---|---|
| **ALU Rate Multipliers** | |
| MC14527B | BCD Rate Multiplier |
| MC14554B | 2 x 2-Bit Parallel Binary Multiplier |
| MC14581B | 4-Bit Arithmetic Logic Unit |
| **Parity Checker** | |
| MC14531B | 12-Bit Parity Tree |
| **Memories** | |
| MC14580B | 4 x 4 Multiport Register |
| MCM14505 | 64-Bit Static Random Access Memory |
| MCM14537 | 256-Bit (256 x 1) Static Random Access Memory |
| MCM14552 | 256-Bit (64 x 4) Static Random Access Memory |
| MCM14524 | 1024-Bit Read Only Memory |
| **Communications/Telephone Functions** | |
| MC14408 | Binary to Phone Pulse Converter Subsystem |
| MC14409 | Binary to Phone Pulse Converter Subsystem |
| MC14410 | 2-of-8 Tone Encoder |
| MC14411 | Bit Rate Generator |
| MC14412 | Universal Low-Speed Modem |
| MC14419 | 2-of-8 Keypad-to-Binary Encoder |
| **A/D Converter/Logic Functions** | |
| MC14433 | 3-1/2-Digit A/D Converter |
| MC14435 | 3-1/2-Digit A/D Logic Subsystem |
| MC14549B | Successive Approximation Register |
| MC14559B | Successive Approximation Register |
| **Other Complex Functions** | |
| MC14415 | Quad Precision Timer/Driver |
| MC14422 | Remote Control Transmitter |
| MC14440 | LCD Watch/Clock Circuit |
| MC14460 | Automotive Speed Control Processor |
| MC14490 | Hex Contact Bounce Eliminator |



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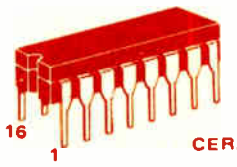
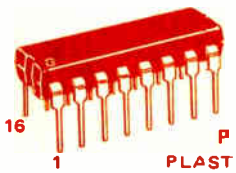
# MECL 10,000
## INTEGRATED CIRCUITS

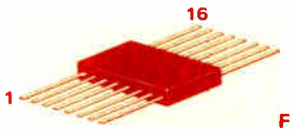
MC10,100/10,200 Series (–30 to +85°C)
MC10,500/10,600 Series (–55 to +125°C)




L SUFFIX
CERAMIC PACKAGE
CASE 620




P SUFFIX
PLASTIC PACKAGE
CASE 648




F SUFFIX
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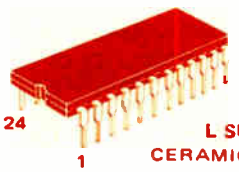
CASE 650

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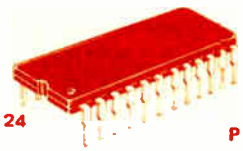


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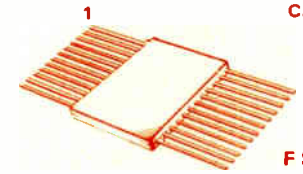
PLASTIC PACKAGE
CASE 649




F SUFFIX
CERAMIC PACKAGE
CASE 662

| Function | Device Type | | Case |
|---|---|---|---|
| | –30 to +85°C | –55 to +125°C | |
| **NOR GATES** | | | |
| Quad 2-Input with Strobe | MC10100 | MC10500 | 620, 648, 650 |
| Quad 2-Input | MC10102 | MC10502 | 620, 648, 650 |
| Triple 4-3-3-Input | MC10106 | MC10506 | 620, 648, 650 |
| Dual 3-Input 3-Output | MC10111 | – | 620, 648 |
| (High Speed) | MC10211 | MC10611 | 620, 648, 650 |
| **OR GATES** | | | |
| Quad 2-Input | MC10103 | MC10503 | 620, 648, 650 |
| Dual 3-Input 3-Output | MC10110 | – | 620, 648 |
| (High Speed) | MC10210 | MC10610 | 620, 648, 650 |
| **AND GATES** | | | |
| Quad 2-Input | MC10104 | MC10504 | 620, 648, 650 |
| Hex | MC10197 | MC10597 | 620, 648, 650 |
| **COMPLEX GATES** | | | |
| Quad OR/NOR | MC10101 | MC10501 | 620, 648, 650 |
| Triple 2-3-2-Input | MC10105 | MC10505 | 620, 648, 650 |
| Triple 2-Input Exclusive OR/Exclusive NOR | MC10107 | MC10507 | 620, 648, 650 |
| Dual 4-5-Input OR/NOR | MC10109 | MC10509 | 620, 648, 650 |
| Quad Exclusive OR | MC10113 | – | 620, 648 |
| Dual 2-Wide 2-3-Input OR-AND/OR-AND-Invert | MC10117 | MC10517 | 620, 648, 650 |
| Dual 2-Wide 3-Input OR-AND | MC10118 | MC10518 | 620, 648, 650 |
| 4-Wide 4-3-3-3 Input OR-AND Gate | MC10119 | MC10519 | 620, 648, 650 |
| OR-AND/OR-AND-INVERT Gate | MC10121 | MC10521 | 620, 648, 650 |
| Hex Inverter/Buffer | MC10195 | MC10595 | 620, 648, 650 |
| **TRANSLATORS** | | | |
| Quad MTTL to MECL | MC10124 | MC10524 | 620, 648, 650 |
| Quad MECL to MTTL | MC10125 | MC10525 | 620, 648, 650 |
| Triple MECL to NMOS | MC10177 | – | 620 |
| **RECEIVERS** | | | |
| Triple Line | MC10114 | MC10514 | 620, 648, 650 |
| Quad Line | MC10115 | MC10515 | 620, 648, 650 |
| Triple Line | MC10116 | MC10516 | 620, 648, 650 |
| (High Speed) | MC10216 | MC10616 | 620, 648, 650 |
| Quad Bus | MC10129 | – | 620 |
| **FLIP-FLOPS** | | | |
| Dual Type D Master-Slave | MC10131 | MC10531 | 620, 648, 650 |
| (High Speed) | MC10231 | MC10631 | 620, 648, 650 |
| Dual J-K Master-Slave | MC10135 | MC10535 | 620, 648, 650 |
| Hex D Master-Slave | MC10175 | MC10576 | 620, 648, 650 |



World Radio History

## MECL 10,000 INTEGRATED CIRCUITS (continued)

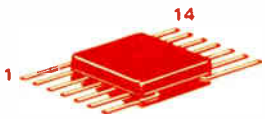
| Function | Device Type | | Case |
|---|---|---|---|
| | -30 to +85°C | -55 to +125°C | |
| **DRIVERS** | | | |
| Triple 4-3-3 Input Bus Driver | MC10123 | MC10523 | 620, 648, 650 |
| Bus Driver | MC10128 | – | 620 |
| **PARITY CHECKER** | | | |
| 12-Bit Parity Generator-Checker | MC10160 | MC10560 | 620, 648, 650 |
| **ENCODER** | | | |
| 8-Input Encoder | MC10165 | MC10565 | 620, 648, 650 |
| **DECODERS** | | | |
| Binary to 1-8 (low) | MC10161 | MC10561 | 620, 648, 650 |
| Binary to 1-8 (high) | MC10162 | MC10562 | 620, 648, 650 |
| Dual Binary to 1-4 (low) | MC10171 | MC10571 | 620, 648, 650 |
| Dual Binary to 1-4 (high) | MC10172 | MC10572 | 620, 648, 650 |
| **DATA SELECTORS/MULTIPLEXERS** | | | |
| Dual Multiplexer with Latch and Common Reset | MC10132 | MC10532 | 620, 648, 650 |
| Dual Multiplexer with Latch | MC10134 | MC10534 | 620, 648, 650 |
| Quad 2-Input Multiplexer (non-inverting) | MC10158 | MC10558 | 620, 648, 650 |
| Quad 2-Input Multiplexer (inverting) | MC10159 | MC10559 | 620, 648, 650 |
| 8-Line Multiplexer | MC10164 | MC10564 | 620, 648, 650 |
| Quad 2-Input Multiplexer/Latch | MC10173 | MC10573 | 620, 648, 650 |
| Dual 4 to 1 Multiplexer | MC10174 | MC10574 | 620, 648, 650 |
| **LATCHES** | | | |
| Quad (common clock) | MC10130 | MC10530 | 620, 648, 650 |
| Quad (negative transition) | MC10133 | MC10533 | 620, 648, 650 |
| Quad (positive transition) | MC10153 | MC10553 | 620, 648, 650 |
| Quad | MC10168 | MC10568 | 620, 648, 650 |
| Quint | MC10175 | MC10575 | 620, 648, 650 |
| **SHIFT REGISTERS** | | | |
| Four-Bit Universal | MC10141 | MC10541 | 620, 648, 650 |
| **ERROR DETECTION-CORRECTION** | | | |
| IBM Code | MC10163 | MC10563 | 620, 648, 650 |
| Motorola Code | MC10193 | MC10593 | 620, 648, 650 |
| **COUNTERS** | | | |
| Universal Hexadecimal | MC10136 | MC10536 | 620, 648, 650 |
| Universal Decade | MC10137 | MC10537 | 620, 648, 650 |
| Bi-Quinary | MC10138 | MC10538 | 620, 648, 650 |
| Binary | MC10178 | MC10578 | 620, 648, 650 |
| **GENERATOR-CHECKER** | | | |
| 9 + 2-Bit Parity | MC10170 | MC10570 | 620, 648, 650 |
| Hex "D" Master-Slave/with Reset | MC10186 | MC10586 | 620, 648, 650 |
| Quad MST-to-MECL 10,000 | MC10190 | MC10590 | 620, 648, 650 |
| Hex MECL 10,000-to-MST | MC10191 | MC10591 | 620, 648, 650 |
| **BUS TRANSCEIVER** | | | |
| Dual Simultaneous | MC10194 | MC10594 | 620, 648, 650 |
| **ARITHMETIC FUNCTIONS** | | | |
| Look-Ahead Carry Block | MC10179 | MC10579 | 620, 648, 650 |
| Dual High Speed Adder/Subtractor | MC10180 | MC10580 | 620, 648, 650 |
| 4-Bit Logic Unit/Function Generator | MC10181 | MC10581 | 623, 649, 652 |
| 2-Bit Logic Unit/Function Generator | MC10182 | MC10582 | 620, 648, 650 |
| 4 x 2 Multiplier | MC10183 | – | 623 |
| 2 x 1-Bit Array Multiplier (High Speed) | MC10287 | MC10687 | 620, 648, 650 |
| **COMPARATOR** | | | |
| 5-Bit Magnitude | MC10166 | – | 620 |
| **MEMORIES** | | | |
| 8 x 2 Multiport Register File (RAM) | MCM10143 | – | 623 |
| 64-Bit Register File (RAM) | MCM10145 | – | 620 |
| 256-Bit Random Access | MCM10144 | – | 620 |
| 128-Bit Random Access | MCM10147 | – | 620 |
| 1024-Bit Random Access | MCM10146 | – | 620 |
| 1024-Bit Programmable Read Only | MCM10149 | – | 620 |



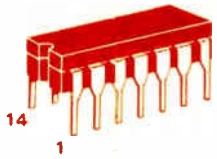
World Radio History

# MECL III
## INTEGRATED CIRCUITS

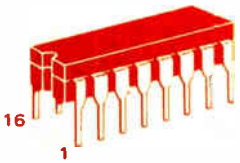
MC1600 Series (-30 to +85°C)



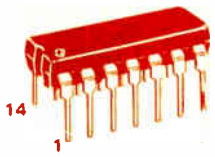

F SUFFIX
CERAMIC PACKAGE
CASE 607



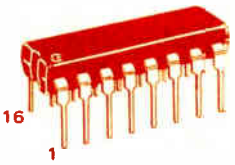

L SUFFIX
CERAMIC PACKAGE
CASE 632



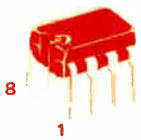

L SUFFIX
CERAMIC PACKAGE
CASE 620



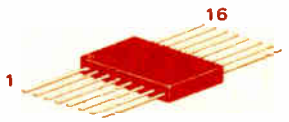

P SUFFIX
PLASTIC PACKAGE
CASE 646




P SUFFIX
PLASTIC PACKAGE
CASE 648




P SUFFIX
PLASTIC PACKAGE
CASE 626




F SUFFIX
CERAMIC PACKAGE
CASE 650

| Function | Device Type -30° to +85°C | Case |
|---|---|---|
| **GATES** | | |
| Dual 4-Input OR/NOR | MC1660 | 620, 650 |
| Dual 4-5-Input OR/NOR | MC1588 | 650 |
| Quad 2-Input NOR | MC1362 | 620, 650 |
| Triple 2-Input Exclusive NOR | MC1574 | 620, 650 |
| Quad 2-Input OR | MC1664 | 620, 650 |
| Triple 2-Input Exclusive OR | MC1572 | 620, 650 |
| **FLIP-FLOPS** | | |
| Dual Clocked R-S | MC1666 | 620, 650 |
| Dual Clocked Latch | MC1568 | 620, 650 |
| Master-Slave Type D | MC1570 | 620, 650 |
| UHF Prescaler Type D | MC1690 | 620, 650 |
| **COUNTERS** | | |
| Binary | MC1654 | 620 |
| Bi-Quinary | MC1678 | 620 |
| **SHIFT REGISTER** | | |
| 4-Bit Shift | MC1694 | 620 |
| **MULTIVIBRATOR** | | |
| Voltage-Controlled | MC1658 | 620, 648, 650 |
| **OSCILLATOR** | | |
| Emitter Coupled | MC1648 | 607, 632, 646 |
| **COMPARATOR** | | |
| Dual A/D | MC1650/MC1651 | 620, 650 |
| **RECEIVER** | | |
| Quad Line | MC1692 | 620, 650 |
| **PRESCALER** | | |
| 1 GHz Divide-by-Four | MC1697 | 626 |



World Radio History

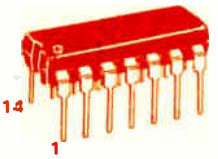
# LSI

# INTEGRATED CIRCUITS

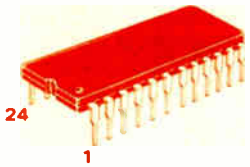
MC8500 Series (0 to +75°C)

## MEGALOGIC LSI

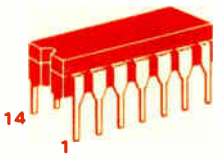
Designers can now implement highly complex systems with only a few basic off-the-shelf LSI components. Benefits include lower system costs, off-the-shelf availability, improved reliability, lower system power drain, fewer parts to assemble and inspect, and more compact system architecture.




**P SUFFIX**
**PLASTIC PACKAGE**
**CASE 646**

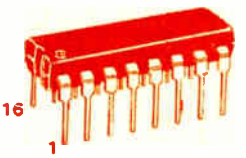


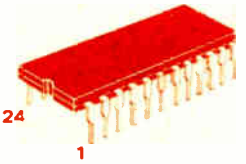

**L SUFFIX**
**CERAMIC PACKAGE**
**CASE 623**




**L SUFFIX**
**CERAMIC PACKAGE**
**CASE 632**

**P SUFFIX**
**PLASTIC PACKAGE**
**CASE 648**




**P SUFFIX**
**PLASTIC PACKAGE**
**CASE 649**

| Device | Function | Case | Applications |
|---|---|---|---|
| MC8500 | CRCC Generator | 623, 649 | Magnetic tape drive controllers using NRZI or GCR recordings, 7 or 9 channels. |
| MC8501 | Error Pattern Register | 620, 648 | |
| MC8502 | LRCC/Data Register | 623, 649 | |
| MC8503 | Universal Polynomial Generator (16-bit) | 632, 646 | Cassette, floppy disc, data communications |
| MC8504 | Universal Presettable Polynomial Generator (4-Bit, Cascadable) | 620, 648 | High-speed disc controllers, data filtering |
| MC8505 | MOS Dynamic Memory Refresh Logic Circuit | 620, 648 | Add-on memory, memory applications |
| MC8506 | Polynomial Generator (16-Bit) | 620, 648 | Floppy disc, SDLC terminals |
| MC8507<br>MC6828 | Priority Interrupt Controller | 623, 649 | PIC is used to add prioritized responses to inputs to microprocessor systems |
| MC8520 | Deskew/Queue Register | 623 | Magnetic tape drive controllers, phase encoded |



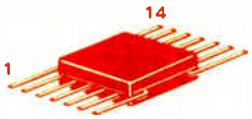
World Radio History

# MTTL 54LS00/74LS00

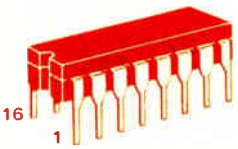
## INTEGRATED CIRCUITS

SN74LS00 Series (0 to +75°C)
SN54LS00 Series (-55 to +125°C)

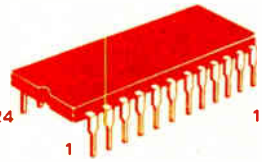
LS Low Power Schottky TTL family combines a current and power reduction by a factor 5 (compared to 7400 TTL) with anti-saturation Schottky diode clamping and advanced processing, using shallower diffusions and higher sheet resistivity to achieve circuit performance better than conventional TTL. A full complement of TTL functions will become available during 1977. Contact your Motorola representative for complete details.



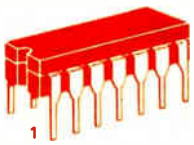

W SUFFIX
CERAMIC PACKAGE
CASE 607



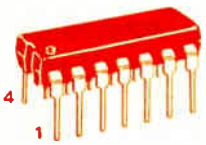

J SUFFIX
CERAMIC PACKAGE
CASE 620



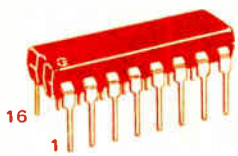

J SUFFIX
CERAMIC PACKAGE
CASE 623




J SUFFIX
CERAMIC PACKAGE
CASE 632

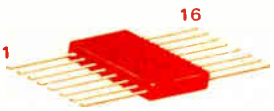



N SUFFIX
PLASTIC PACKAGE
CASE 646

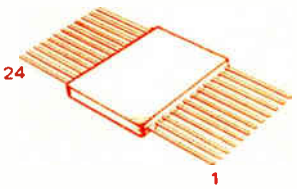



N SUFFIX
PLASTIC PACKAGE
CASE 648

N SUFFIX
PLASTIC PACKAGE
CASE 649




W SUFFIX
CERAMIC PACKAGE
CASE 650




W SUFFIX
CERAMIC PACKAGE
CASE 652

| Function | Operating Temperature Range -55°C to +125°C | Operating Temperature Range 0°C to +75°C | Packages Dual-in-Line Plastic | Packages Dual-in-Line Ceramic | Flat Ceramic |
|---|---|---|---|---|---|
| **AND Gates** | | | | | |
| Quad 2-Input | SN54LS08 | SN74SL08 | 646 | 632 | 607 |
| Quad 2-Input (O.C.) | SN54LS09 | SN74LS09 | 646 | 632 | 607 |
| Triple 3-Input | SN54LS11 | SN74LS11 | 646 | 632 | 607 |
| Triple 3-Input (O.C.) | SN54LS15 | SN74LS15 | 646 | 632 | 607 |
| Dual 4-Input | SN54LS21 | SN74LS21 | 646 | 632 | 607 |
| **OR Gates** | | | | | |
| Quad 2-Input | SN54LS32 | SN74LS32 | 646 | 632 | 607 |
| **Exclusive OR Gate** | | | | | |
| Quad 2-Input | SN54LS86 | SN74LS86 | 646 | 632 | 607 |
| Quad 2-Input (O.C.) | SN54LS136 | SN74LS136 | 646 | 632 | 607 |
| **Exclusive NOR Gate** | | | | | |
| Quad 2-Input (O.C.) | SN54LS266 | SN74LS266 | 646 | 632 | 607 |
| **AND-OR-INVERT Gates** | | | | | |
| Dual 2-2 Input | SN54LS51 | SN74LS51 | 646 | 632 | 607 |
| 2-2-3-3 Input | SN54LS54 | SN74LS54 | 646 | 632 | 607 |
| 4-4 Input | SN54LS55 | SN74LS55 | 646 | 632 | 607 |

| Function | Operating Temperature Range -55°C to +125°C | Operating Temperature Range 0°C to +75°C | Packages Dual-in-Line Plastic | Packages Dual-in-Line Ceramic | Flat Ceramic |
|---|---|---|---|---|---|
| **NAND Gates** | | | | | |
| Hex Inverters | SN54LS04 | SN74SL04 | 646 | 632 | 607 |
| Hex Inverters (O.C.) | SN54LS05 | SN74LS05 | 646 | 632 | 607 |
| Hex Schmitt Trigger | SN54LS14 | SN74LS14 | 646 | 632 | 607 |
| Quad 2-Input | SN54LS00 | SN74LS00 | 646 | 632 | 607 |
| Quad 2-Input (O.C.) | SN54LS03 | SN74LS03 | 646 | 632 | 607 |
| Quad 2-Input (48 mA) | SN54LS37 | SN74LS37 | 646 | 632 | 607 |
| Quad 2-Input (O.C., 48 mA) | SN54LS38 | SN74LS38 | 648 | 620 | 650 |
| Quad 2-Input Schmitt Trigger | SN54LS132 | SN74LS132 | 646 | 632 | 607 |
| 13-Input | SN54LS133 | SN74LS133 | 648 | 620 | 650 |
| Triple 3-Input | SN54LS10 | SN74LS10 | 646 | 632 | 607 |
| Dual 4-Input | SN54LS20 | SN74LS20 | 646 | 632 | 607 |
| Dual 4-Input (O.C.) | SN54LS22 | SN74LS22 | 646 | 632 | 607 |
| Dual 4-Input Buffer | SN54LS40 | SN74LS40 | 646 | 632 | 607 |



World Radio History

| Function | Operating Temperature Range -55°C to +125°C | Operating Temperature Range 0°C to +75°C | Packages Dual-in-Line Plastic | Packages Dual-in-Line Ceramic | Flat Ceramic |
|---|---|---|---|---|---|
| **NAND Gates (continued)** | | | | | |
| 8-Input | SN54LS30 | SN74LS30 | 646 | 632 | 607 |
| Quad Buffer w/Enable | SN54LS125 | SN74LS125 | 646 | 632 | 607 |
| Quad Buffer w/Enable | SN54LS126 | SN74LS126 | 646 | 632 | 607 |
| Hex Buffer w/Enable | SN54LS365 | SN74LS365 | 648 | 620 | 650 |
| Hex Buffer w/Enable | SN54LS367 | SN74LS367 | 648 | 620 | 650 |
| Hex Inverter w/Enable | SN54LS366 | SN74LS366 | 648 | 620 | 650 |
| Hex Inverter w/Enable | SN54LS368 | SN74LS368 | 648 | 620 | 650 |
| **NOR Gates** | | | | | |
| Quad 2-Input | SN54LS02 | SN74LS02 | 646 | 632 | 607 |
| Triple 3-Input | SN54LS27 | SN74LS27 | 646 | 632 | 607 |
| **Dual Flip-Flops** | | | | | |
| Dual J-K | SN54LS73 | SN74LS73 | 646 | 632 | 607 |
| Dual D | SN54LS74 | SN74LS74 | 646 | 632 | 607 |
| Dual J-$\overline{K}$ | SN54LS109 | SN74LS109 | 648 | 620 | 650 |
| Dual J-K | SN54LS112 | SN74LS112 | 648 | 620 | 650 |
| Dual J-K | SN54LS113 | SN74LS113 | 646 | 632 | 607 |
| Dual J-K | SN54LS114 | SN74LS114 | 646 | 632 | 607 |
| **Arithmetic Operators** | | | | | |
| Adder | SN54LS83 | SN74LS83 | 648 | 620 | 650 |
| Adder | SN54LS283 | SN74LS283 | 648 | 620 | 650 |
| Arithmetic Logic Unit | SN54LS181 | SN74LS181 | 649 | 623 | 652 |
| **Counters** | | | | | |
| Asynchronous | SN54LS90 | SN74LS90 | 646 | 632 | 607 |
| Asynchronous | SN54LS92 | SN74LS92 | 646 | 632 | 607 |
| Asynchronous | SN54LS93 | SN74LS93 | 646 | 632 | 607 |
| Asynchronous | SN54LS196 | SN74LS196 | 646 | 632 | 607 |
| Asynchronous | SN54LS197 | SN74LS197 | 646 | 632 | 607 |
| Synchronous | SN54LS160 | SN74LS160 | 648 | 620 | 650 |
| Synchronous | SN54LS161 | SN74LS161 | 648 | 620 | 650 |
| Synchronous | SN54LS162 | SN74LS162 | 648 | 620 | 650 |
| Synchronous | SN54LS163 | SN74LS163 | 648 | 620 | 650 |
| Up/Down | SN54LS192 | SN74LS192 | 648 | 620 | 650 |
| Up/Down | SN54LS193 | SN74LS193 | 648 | 620 | 650 |
| Up/Down | SN54LS190 | SN74LS190 | 648 | 620 | 650 |
| Up/Down | SN54LS191 | SN74LS191 | 648 | 620 | 650 |
| Up/Down | SN54LS290 | SN74LS290 | 646 | 632 | 607 |
| Up/Down | SN54LS293 | SN74LS293 | 646 | 632 | 607 |
| **Decoders/Demultiplexers** | | | | | |
| Dual 1-of-4 | SN54LS139 | SN74LS139 | 648 | 620 | 650 |
| Dual 1-of-4 | SN54LS155 | SN74LS155 | 648 | 620 | 650 |
| Dual 1-of-4 | SN54LS156 | SN74LS156 | 648 | 620 | 650 |
| 1-of-8 | SN54LS259 | SN74LS259 | 648 | 620 | 650 |
| 1-of-8 or 1-of-10 | SN54LS42 | SN74LS42 | 648 | 620 | 650 |
| 1-of-8 | SN54LS138 | SN74LS138 | 648 | 620 | 650 |

| Function | Operating Temperature Range -55°C to +125°C | Operating Temperature Range 0°C to +75°C | Packages Dual-in-Line Plastic | Packages Dual-in-Line Ceramic | Flat Ceramic |
|---|---|---|---|---|---|
| **Latches/Flip-Flops** | | | | | |
| 4-Bit R-S Latch | SN54LS279 | SN74LS279 | 648 | 620 | 650 |
| 4-Bit D Latch | SN54LS196 | SN74LS196 | 646 | 632 | 607 |
| 4-Bit D Latch | SN54LS197 | SN74LS197 | 646 | 632 | 607 |
| 4-Bit D Flip-Flop | SN54LS175 | SN74LS175 | 648 | 620 | 650 |
| 4-Bit D Flip-Flop | SN54LS298 | SN74LS298 | 648 | 620 | 650 |
| 6-Bit D Flip-Flop | SN54LS174 | SN74LS174 | 648 | 620 | 650 |
| 8-Bit Add. Latch | SN54LS259 | SN74LS259 | 648 | 620 | 650 |
| 4x4 Register File | SN54LS170 | SN74LS170 | 648 | 620 | 650 |
| 4x4 Register File (3-State) | SN54LS670 | SN74LS670 | 648 | 620 | 650 |
| **Multiplexers** | | | | | |
| Quad 2-Input | SN54LS157 | SN74LS157 | 648 | 620 | 650 |
| Quad 2-Input | SN54LS158 | SN74LS158 | 648 | 620 | 650 |
| Quad 2-Input | SN54LS257 | SN74LS257 | 648 | 620 | 650 |
| Quad 2-Input | SN54LS258 | SN74LS258 | 648 | 620 | 650 |
| Quad 2-Input | SN54LS298 | SN74LS298 | 648 | 620 | 650 |
| Dual 4-Input | SN54LS153 | SN74LS153 | 648 | 620 | 650 |
| Dual 4-Input | SN54LS253 | SN74LS253 | 648 | 620 | 650 |
| 8-Input | SN54LS151 | SN74LS151 | 648 | 620 | 650 |
| 8-Input | SN54LS251 | SN74LS251 | 648 | 620 | 650 |
| 8-Input | SN54LS152 | SN74LS152 | 646 | 632 | 607 |
| **Registers** | | | | | |
| Parallel-in/ Parallel-out Shift Right | SN54LS95 | SN74LS95 | 646 | 632 | 607 |
| Parallel-in/ Parallel-out Shift Right | SN54LS195 | SN74LS195 | 648 | 620 | 650 |
| Parallel-in/ Parallel-out Shift Right | SN54LS295 | SN74LS295 | 646 | 632 | 607 |
| Parallel-in/ Parallel-out Bidirectional | SN54LS194 | SN74LS194 | 648 | 620 | 650 |
| Serial-in/ Parallel-out | SN54LS164 | SN74LS164 | 646 | 632 | 607 |
| Parallel-in/ Parallel-out | SN54LS174 | SN74LS174 | 648 | 620 | 650 |
| Parallel-in/ Parallel-out | SN54LS175 | SN74LS175 | 648 | 620 | 650 |
| Parallel-in/ Parallel-out | SN54LS298 | SN74LS298 | 648 | 620 | 650 |
| Multiport Registers | SN54LS170 | SN74LS170 | 648 | 620 | 650 |
| Multiport Registers | SN54LS670 | SN74LS670 | 648 | 620 | 650 |



World Radio History

# MTTL 5400/7400

## INTEGRATED CIRCUITS SERIES

MC7400 Series (0 to +75°C)
MC5400 Series (-55 to +125°C)

MAXIMUM RATINGS

| Rating | | Value | Unit |
|---|---|---|---|
| Power Supply Voltage | | 7.0 | Vdc |
| Input Voltage | | 5.5 | Vdc |
| Operating Temperature Range | MC5400<br>MC7400 | -55 to +125<br>0 to +75 | °C |
| Storage Temperature Range — | Ceramic<br>Plastic | -65 to +150<br>-55 to +125 | °C |

| Function | Operating Temperature Range | | Packages Dual-In-Line | | Flat |
|---|---|---|---|---|---|
| NAND/NOR/AND/OR Gates | -55°C To +125°C | 0°C To +75°C | Plastic | Ceramic | Ceramic |
| Quad 2-Input Pos NAND Gates | MC5400 | MC7400 | 646 | 632 | 607 |
| Quad 2-Input Pos NAND Gate (w/O.C. Output) | MC5401 | MC7401 | 646 | 632 | 607 |
| Quad 2-Input Pos NOR Gates | MC5402 | MC7402 | 646 | 632 | 607 |
| Quad 2-Input Pos NAND Gate (w/O.C. Output) | MC5403 | MC7403 | 646 | 632 | 607 |
| Hex Inverters | MC5404 | MC7404 | 646 | 632 | 607 |
| Hex Inverters (w/O.C. Output) | MC5405 | MC7405 | 646 | 632 | 607 |
| Quad 2-Input Pos AND Gates | MC5408 | MC7408 | 646 | 632 | 607 |
| Quad 2-Input Pos AND Gate (w/O.C. Output) | MC5409 | MC7409 | 646 | 632 | 607 |
| Triple 3-Input Pos NAND Gates | MC5410 | MC7410 | 646 | 632 | 607 |
| Dual NAND Schmitt Triggers | MC5413 | MC7413 | 646 | 632 | 607 |
| Hex Schmitt Triggers | MC5414 | MC7414 | 646 | 632 | 607 |
| Quad 2-Input Pos NAND Schmitt | MC54132 | MC74132 | 646 | 632 | 607 |
| Dual 4-Input Positive NAND Gates | MC5420 | MC7420 | 646 | 632 | 607 |
| Expandable Dual 4-Input Pos NOR Gate (w/Strobe) | MC5423 | MC7423 | 648 | 620 | 650 |
| Dual 4-Input Pos NOR Gates | MC5425 | MC7425 | 646 | 632 | 607 |
| Quad 2-Input HV Interface NAND Gates | MC5426 | MC7426 | 646 | 632 | 607 |
| Triple 3-Input Positive NOR Gates | MC5427 | MC7427 | 646 | 632 | 607 |
| 8-Input Positive NAND Gates | MC5430 | MC7430 | 646 | 632 | 607 |
| **Buffers/Drivers** | | | | | |
| Hex Inverter Buffers/Drivers (w/O.C. HV Output) | MC5406 | MC7406 | 646 | 632 | 607 |
| Hex Buffers/Drivers (w/O.C. HV Output) | MC5407 | MC7407 | 646 | 632 | 607 |
| Hex, Inverter Buffer/Driver | MC5416 | MC7416 | 646 | 632 | 607 |
| Hex Buffer/Driver | MC5417 | MC7417 | 646 | 632 | 607 |
| Quad 2-Input Pos NAND Buffer | MC5437 | MC7437 | 646 | 632 | 607 |
| Quad 2-Input Pos NAND Buffer (open collector) | MC5438 | MC7438 | 646 | 632 | 607 |
| Dual 4-Input Pos NAND Buffer | MC5440 | MC7440 | 646 | 632 | 607 |
| **AND-OR-INVERT Gates** | | | | | |
| Expandable Dual 2-Wide 2-Input AOI Gate | MC5450 | MC7450 | 646 | 632 | 607 |
| Dual 2-Wide 2-Input AOI Gate | MC5451 | MC7451 | 646 | 632 | 607 |
| Expandable 4-Wide 2-Input AOI Gate | MC5453 | MC7453 | 646 | 632 | 607 |
| 4-Wide 2-Input AOI Gate | MC5454 | MC7454 | 646 | 632 | 607 |
| **Flip-Flops/Monostable Multivibrators** | | | | | |
| Pos Edge-Triggered J-K Flip-Flop | MC5470 | MC7470 | 646 | 632 | 607 |
| J-K Master-Slave Flip-Flop | MC5472 | MC7472 | 646 | 632 | 607 |
| Dual J-K Master-Slave Flip-Flop | MC5473 | MC7473 | 646 | 632 | 607 |
| Dual D-Type Edge-Triggered Flip-Flop | MC5474 | MC7474 | 646 | 632 | 607 |
| Dual J-K Master-Slave Flip-Flop (preset and clear) | MC5476 | MC7476 | 648 | 620 | 650 |
| Dual D-Type Edge-Triggered Flip-Flop | MC5479 | MC7479 | 646 | 632 | 607 |
| Dual J-K Master-Slave Flip-Flop ($V_{CC}$ 14, GND 7) | MC54107 | MC74107 | 646 | 632 | 607 |
| Monostable Multivibrator | MC54121 | MC74121 | 646 | 632 | 607 |
| Retriggerable Monostable Multivibrator w/Clear | MC54122 | MC74122 | 646 | 632 | 607 |
| Dual Retriggerable Monostable Multivibrator | MC54123 | MC74123 | 648 | 620 | 650 |



World Radio History

## MTTL 5400/7400 SERIES (continued)

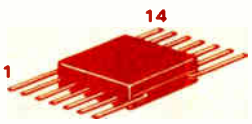
| Function | Operating Temperature Range | | Packages Dual-In-Line | | Flat |
|---|---|---|---|---|---|
| | −55°C To +125°C | 0°C To +75°C | Plastic | Ceramic | Ceramic |
| **Asynchronous Counters** | | | | | |
| Decade Counter | MC5490A | MC7490A | 646 | 632 | 607 |
| Divide by 12 Counter | MC5492A | MC7492A | 646 | 632 | 607 |
| 4-Bit Binary Counter | MC5493A | MC7493A | 646 | 632 | 607 |
| 35MHz Presettable Decade Counter/Latch | MC54176 | MC74176 | 646 | 632 | 607 |
| 35MHz Presettable 4-Bit Binary Counter/Latch | MC54177 | MC74177 | 646 | 632 | 607 |
| 50 MHz Presettable Decade Counter/Latch | MC54196 | MC74196 | 646 | 632 | 607 |
| 50 MHz Presettable 4-Bit Binary Counter/Latch | MC54197 | MC74197 | 646 | 632 | 607 |
| Decade Counter | MC54290 | MC74290 | 646 | 632 | 607 |
| 4-Bit Binary Counter | MC54293 | MC74293 | 646 | 632 | 607 |
| **Synchronous Counters** | | | | | |
| Synchronous 6-Bit Binary Rate Multiplier | MC5497 | MC7497 | 648 | 620 | 650 |
| Synchronous Decade Counter | MC54160 | MC74160 | 648 | 620 | 650 |
| Synchronous 4-Bit Binary Counter | MC54161 | MC74161 | 648 | 620 | 650 |
| Fully Synchronous Decade Counter | MC54162 | MC74162 | 648 | 620 | 650 |
| Fully Synchronous 4-Bit Binary Counter | MC54163 | MC74163 | 648 | 620 | 650 |
| Synchronous Decade Decimal Rate Multiplier | MC54167 | MC74167 | 648 | 620 | 650 |
| Synchronous Up/Down Decade Counter | MC54190 | MC74190 | 648 | 620 | 650 |
| Synchronous Up/Down 4-Bit Binary Counter | MC54191 | MC74191 | 648 | 620 | 650 |
| Synchronous Up/Down Decade Counter | MC54192 | MC74192 | 648 | 620 | 650 |
| Synchronous Up/Down 4-Bit Binary Counter | MC54193 | MC74193 | 648 | 620 | 650 |
| **4-Bit, 5-Bit Shift/Storage Resistors** | | | | | |
| 8-Bit Shift Register | MC5491A | MC7491A | 646 | 632 | 607 |
| 4-Bit Shift Register (Parallel-In, Serial-Out) | MC5494 | MC7494 | 648 | 620 | 650 |
| 4-Bit Shift Register (Parallel Access) | MC5495A | MC7495A | 646 | 632 | 607 |
| 5-Bit Shift Register (Paralled-In, Parallel-Out) | MC5496 | MC7496 | 648 | 620 | 650 |
| Parallel Load 8-Bit Shift Register | MC54165 | MC74165 | 648 | 620 | 650 |
| 4-Bit Parallel-In/Out Bidirectional Shift Register | MC54194 | MC74194 | 648 | 620 | 650 |
| 4-Bit Parallel-In/Out Shift Register | MC54195 | MC74195 | 648 | 620 | 650 |
| **Other Registers** | | | | | |
| Hex D-Type Flip-Flop with Clear | MC54174 | MC74174 | 648 | 620 | 650 |
| Quad D-Type Flip-Flop with Clear | MC54175 | MC74175 | 648 | 620 | 650 |
| Quad 2-Input Multiplexer with Storage | MC54298 | MC74298 | 648 | 620 | 650 |
| **Pulse Synchronizers** | | | | | |
| Dual Pulse Synchronizer/Driver | MC54120 | MC74120 | 648 | 620 | 650 |
| **Decoders/Demultiplexers** | | | | | |
| BCD-to-Decimal Decoder | MC5442 | MC7442 | 648 | 620 | 650 |
| Excess-3-To-Decimal Decoder | MC5443 | MC7443 | 648 | 620 | 650 |
| Excess 3 Gray To Decimal Decoder | MC5444 | MC7444 | 648 | 620 | 650 |
| 4-Line to 16-Line Decoder/Demultiplexers | MC54154 | MC74154 | 649 | 623 | 667 |
| Dual 2 Line To 4 Line Decoder/Demultiplexer | MC54155 | MC74155 | 648 | 620 | 650 |
| Dual 2 To 4 Line Decoder Demultiplexer (open collector) | MC54156 | MC74156 | 648 | 620 | 650 |
| **Decoders/Lamp Drivers/Buffers** | | | | | |
| BCD-to-Decimal Decoder/Driver (30 V Output) | MC5445 | MC7445 | 648 | 620 | 650 |
| BCD-to-7-Segment Decoder/Driver (30 V Output) | MC5446A | MC7446A | 648 | 620 | 650 |
| BCD-to-7-Segment Decoder/Driver (15 V Output) | MC5447A | MC7447A | 648 | 620 | 650 |
| BCD-to-7-Segment Decoder | MC5448 | MC7448 | 648 | 620 | 650 |
| BCD-to-7-Segment Decoder (14 Pin Function) | MC5449 | MC7449 | 646 | 632 | 607 |
| BCD-to-Decimal Decoder/Driver | MC54141 | MC74141 | 648 | 620 | 650 |



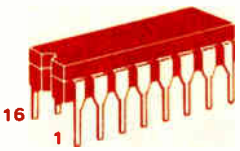
World Radio History

## MTTL 5400/7400 SERIES (continued)

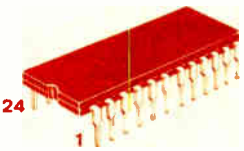
| Function | Operating Temperature Range | | Packages Dual-In-Line | | Flat |
|---|---|---|---|---|---|
| | −55°C To +125°C | 0° To +75°C | Plastic | Ceramic | Ceramic |
| **Latches** | | | | | |
| Quad Bistable Latch | MC5475 | MC7475 | 648 | 620 | 650 |
| Quad Bistable Latch | MC5477 | MC7477 | 646 | 632 | 607 |
| 8-Bit Bistable Latch | MC54100 | MC74100 | 649 | 623 | 667 |
| **Arithmetic Elements** | | | | | |
| Gated Full Adder | MC5480 | MC7480 | 646 | 632 | 607 |
| 2-Bit Binary Full Adder | MC5482 | MC7482 | 646 | 632 | 607 |
| 4-Bit Binary Full Adder | MC5483 | MC7483 | 648 | 620 | 650 |
| 4-Bit Magnitude Comparator | MC5485 | MC7485 | 648 | 620 | 650 |
| Quad 2-Input Exclusive OR Gate | MC5486 | MC7486 | 646 | 632 | 607 |
| 4-Bit True/Complement Zero-One Elements | MC54H87 | MC74H87 | 646 | 632 | 607 |
| Quad 2-Input Exclusive OR Gate (open collector) | MC54136 | MC74136 | 646 | 632 | 607 |
| 8-Bit Odd/Even Parity Generator/Checker | MC54180 | MC74180 | 646 | 632 | 607 |
| 4-Bit ALU And Function Generator | MC54181 | MC74181 | 649 | 623 | 667 |
| Look Ahead Carry Generator For ALU | MC54182 | MC74182 | 648 | 620 | 650 |
| **Data Selectors/Multiplexers** | | | | | |
| 16-Bit Data Selector/Multiplexer | MC54150 | MC74150 | 649 | 623 | 667 |
| 8-Bit Data Selector/Multiplexer with Strobe | MC54151 | MC74151 | 648 | 620 | 650 |
| 8-Bit Data Selector/Multiplexer | MC54152 | MC74152 | 646 | 632 | 607 |
| Dual 4-To-1 Line Data Selector/Multiplexer | MC54153 | MC74153 | 648 | 620 | 650 |



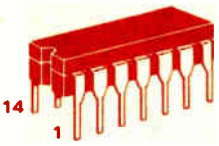

**F SUFFIX**
CERAMIC PACKAGE
CASE 607



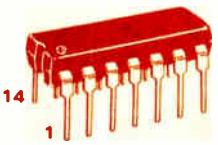

**L SUFFIX**
CERAMIC PACKAGE
CASE 620



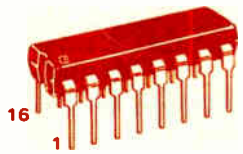

**L SUFFIX**
CERAMIC PACKAGE
CASE 623



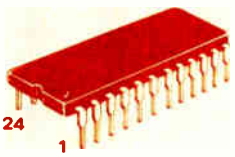

**L SUFFIX**
CERAMIC PACKAGE
CASE 632



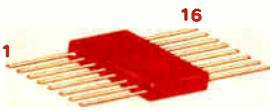

**P SUFFIX**
PLASTIC PACKAGE
CASE 646




**P SUFFIX**
PLASTIC PACKAGE
CASE 648




**P SUFFIX**
PLASTIC PACKAGE
CASE 649




**F SUFFIX**
CERAMIC PACKAGE
CASE 650

**F SUFFIX**
CERAMIC PACKAGE
CASE 667



World Radio History

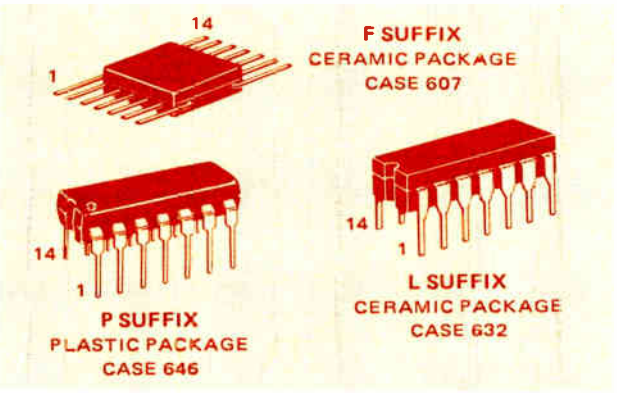
# MTTL III
# INTEGRATED CIRCUITS

**MC3000 Series /MC74H00 (0 to +75°C)**
**MC3100 Series /MC54H00 (–55 to +125°C)**

MTTL III integrated circuits comprise a family of transistor-transistor logic designed for general purpose digital applications. The family has a high operating speed (30–50 MHz clock rate), good external noise immunity, high fan-out, and the capability of driving lines up to 600 pF capacitance.

## MAXIMUM RATINGS

| Rating | | Value | Unit |
|---|---|---|---|
| Supply Voltage – Continuous | MC3100 series | +7.0 | Vdc |
| | MC3000 series | +7.0 | Vdc |
| Supply Operating Voltage Range | | 4.5 to 5.5 | Vdc |
| Input Voltage | | +5.5 | Vdc |
| Output Voltage | | +5.5 | Vdc |
| Operating Temperature Range | MC3100 series | –55 to +125 | °C |
| | MC3000 series | 0 to +75 | °C |
| Storage Temperature Range – Ceramic Package | | –65 to +175 | °C |
| Plastic Package | | –55 to +125 | °C |




## FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 5.0 V, $T_A$ = 25°C)

| Function | Type ① Case 607, 632, 646 0°C to +75°C | Type ① Case 607, 632 –55°C to +125°C | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg |
|---|---|---|---|---|---|
| Quad 2 Input NAND Gate | MC3000(74H00) | MC3100(54H00) | 10 | 6.0 | 88 |
| Quad 2 Input AND Gate | MC3001 | MC3101 | 10 | 9.0 | 112 |
| Quad 2 Input NOR Gate | MC3002 | MC3102 | 10 | 6.0 | 122 |
| Quad 2 Input OR Gate | MC3003 | MC3103 | 10 | 9.0 | 150 |
| Quad 2 Input NAND Gate (Open Collector) | MC3004(74H01) | MC3104(54H01) | 10 | 8.0 | 88 |
| Triple 3 Input NAND Gate | MC3005(74H10) | MC3105(54H10) | 10 | 6.0 | 66 |
| Triple 3 Input AND Gate | MC3006(74H11) | MC3106(54H11) | 10 | 9.0 | 84 |
| Triple 3 Input NAND Gate (Open Collector) | MC3007 | MC3107 | 10 | 8.0 | 66 |
| Hex Inverter | MC3008(74H04) | MC3108(54H04) | 10 | 6.0 | 140 |
| Hex Inverter | MC3009(74H05) | MC3109(54H05) | 10 | 8.0 | 90 |
| Dual 4 Input NAND Gate | MC3010(74H20) | MC3110(54H20) | 10 | 6.0 | 44 |
| Dual 4 Input AND Gate | MC3011(74H21) | MC3111(54H21) | 10 | 9.0 | 56 |
| Dual 4 Input NAND Gate (Open Collector) | MC3012(74H22) | MC3112(54H22) | 10 | 8.0 | 44 |
| 8 Input NAND Gate | MC3015 | MC3115 | 10 | 8.0 | 22 |
| 8 Input NAND Gate | MC3016(74H30) | MC3116(54H30) | 10 | 8.0 | 22 |
| Expandable Dual 2 Wide 2 Input AND OR INVERT Gate | MC3020(74H50) | MC3120(54H50) | 10 | 6.0 | 62.5 |
| Quad 2 Input Exclusive OR Gate | MC3021 | MC3121 | 8 | 14 | 100 |
| Quad 2 Input Exclusive NOR Gate | MC3022 | MC3122 | 8 | 14 | 85 |
| Dual 2 Wide 2 Input AND-OR INVERT Gate | MC3023(74H51) | MC3123(54H51) | 10 | 6.0 | 62.5 |
| Dual 4 Input NAND Buffer Gate | MC3024(74H40) | MC3124(54H40) | 30 | 6.0 | 90 |
| Dual 4 Input NAND Power Gate | MC3025 | MC3125 | 20 | 6.0 | 70 |
| Dual 4 Input AND Power Gate | MC3026 | MC3126 | 20 | 9.0 | 90 |
| Dual 3 Input 3 Output AND Series Terminated Line Driver | MC3028 | MC3128 | * | 9.0 | 56 |
| Dual 3 Input 3-Output NAND Series Terminated Line Driver | MC3029 | MC3129 | * | 6.0 | 44 |
| Expandable 4 Wide 2 2 2 3 Input AND OR Gate | MC3031(74H52) | MC3131(54H52) | 10 | 10 | 87.5 |
| Expandable 4-Wide 2-2-2-3 Input AND OR INVERT Gate | MC3032(74H53) | MC3132(54H53) | 10 | 7.0 | 40 |
| AND Input J-K Flip Flop | MC3051 | MC3151 | 10 | f = 50 MHz | 50 |
| AND Input JJ KK Flip-Flop | MC3052 | MC3152 | 10 | f = 40 MHz | 75 |
| Dual Type D Flip Flop | MC3060 | MC3160 | 10 | f = 30 MHz | 120 |
| Dual J-K Flip-Flop | MC3061 | MC3161 | 10 | f = 50 MHz | 100 |
| Dual J K Flip-Flop | MC3062 | MC3162 | 10 | f = 50 MHz | 100 |

① F suffix denotes Flat Package, L suffix denotes Dual In Line Ceramic Package, P suffix denotes Plastic Package, (i.e., MC3000F = Flat Package, MC3000L = Ceramic Package, MC3000P = Plastic Package).

*Direct Output = 10 minus the number of resistor terminated outputs being used.



World Radio History

# MTTL II

# INTEGRATED CIRCUITS

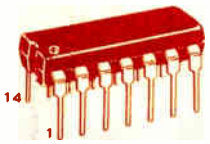
MC2000 Series (0 to +75°C)
MC2100 Series (-55 to +125°C)

MTTL II integrated circuits comprise a family of transistor-transistor logic designed for general purpose digital applications. The family has a high operating speed (30–50 MHz clock rate), good external noise immunity, high fan-out, and the capability of driving capacitive loads to 600 pF.

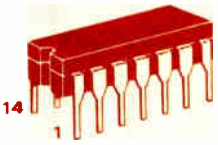
## MAXIMUM RATINGS

| Rating | Value | Unit |
|---|---|---|
| Supply Voltage-Continuous – MC2100 Series<br>MC2000 Series | +8.0<br>+7.0 | Vdc |
| Supply Operating Voltage Range | 4.5 to 6.0 | Vdc |
| Input Voltage | +5.5 | Vdc |
| Output Voltage | +5.5 | Vdc |
| Operating Temperature Range – MC2100 Series<br>MC2000 Series | -55 to +125<br>0 to +75 | °C |
| Storage Temperature Range – Ceramic Package<br>– Plastic Package | -65 to +150<br>-55 to +125 | °C |
| Maximum Junction Temperature – MC2100 Series<br>MC2000 Series | +175<br>+150 | °C |
| Thermal Resistance-Junction to Case ($\theta_{JC}$)<br>– Ceramic Package<br>– Plastic Package | <br>0.09<br>0.15 | °C/mW |
| Thermal Resistance-Junction to Ambient ($\theta_{JA}$)<br>– Ceramic Package<br>– Plastic Package | <br>0.26<br>0.30 | °C/mW |

F SUFFIX
CERAMIC PACKAGE
CASE 607




P SUFFIX
PLASTIC PACKAGE
CASE 646




L SUFFIX
CERAMIC PACKAGE
CASE 632

## FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 5.0 V, $T_A$ = 25°C)

| Function | Type ① Case 607,632,646 0 to +75°C | Type ① Case 607, 632 -55 to +125°C | Loading Factor Each Output MC2000 Series | Loading Factor Each Output MC2100 Series | Propagation Delay ns typ | Power Dissipation mW typ/pkg |
|---|---|---|---|---|---|---|
| Expandable 2-Wide 4-Input AND-OR-INVERT Gate | MC2000<br>MC2050 | MC2100<br>MC2150 | 9<br>5 | 11<br>6 | 7.0 | 27 |
| Quad 2-Input NAND Gate | MC2001<br>MC2051 | MC2101<br>MC2151 | 9<br>5 | 11<br>6 | 6.0 | 88 |
| 4-Wide 3-2-2-3 Input Expander for AND-OR-INVERT Gates | MC2002<br>MC2052 | MC2102<br>MC2152 | 9<br>5 | 11<br>6 | – | 28 |
| Dual 4-Input NAND Gate | MC2003<br>MC2053 | MC2103<br>MC2153 | 9<br>5 | 11<br>6 | 6.0 | 44 |
| Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate | MC2004<br>MC2054 | MC2104<br>MC2154 | 9<br>5 | 11<br>6 | 7.0 | 36 |
| 8-Input NAND Gate | MC2005<br>MC2055 | MC2105<br>MC2155 | 9<br>5 | 11<br>6 | 8.0 | 22 |
| Dual 4-Input Expander for AND-OR-INVERT Gates | MC2006<br>MC2056 | MC2106<br>MC2156 | 9<br>5 | 11<br>6 | – | 14 |
| Triple 3-Input NAND Gate | MC2007<br>MC2057 | MC2107<br>MC2157 | 9<br>5 | 11<br>6 | 6.0 | 66 |
| Expandable 8-Input NAND Gate | MC2011<br>MC2061 | MC2111<br>MC2161 | 9<br>9 | 11<br>6 | 11 | 22 |
| Expandable 3-Wide 3-Input AND-OR-INVERT Gate | MC2012<br>MC2062 | MC2112<br>MC2162 | 9<br>5 | 11<br>6 | 6.0 | 39 |
| Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate | MC2013<br>MC2063 | MC2113<br>MC2163 | 9<br>5 | 11<br>6 | 7.0 | 58 |
| Quad 2 Input Lamp/ Line Driver (open collector) | MC2065 | MC2165 | 24 | 30 | 20 | 105 |
| Hex Inverter | MC2016<br>MC2066 | MC2116<br>MC2166 | 5<br>5 | 9<br>9 | 6.0 | 132 |
| Quad 2-Input Lamp/Line Driver | MC2018<br>MC2068 | MC2118<br>MC2168 | 40MA<br>20MA | 40MA<br>20MA | 10.0 | 90 |
| Dual J-K Flip-Flop (separate clock) | MC2023<br>MC2073 | MC2123<br>MC2173 | 9<br>5 | 11<br>6 | f = 70 MHz | 110 |
| Dual J-K Flip-Flop (common clock) | MC2024<br>MC2074 | MC2124<br>MC2174 | 9<br>5 | 11<br>6 | f = 70 MHz | 110 |
| AND J-K Flip-Flop | MC2025<br>MC2075 | MC2125<br>MC2175 | 9<br>5 | 11<br>6 | f = 50 MHz | 50 |
| OR J-K Flip-Flop | MC2026<br>MC2076 | MC2126<br>MC2176 | 9<br>5 | 11<br>6 | f = 50 MHz | 60 |
| OR J-K Flip-Flop | MC2028<br>MC2078 | MC2128<br>MC2178 | 9<br>5 | 11<br>6 | f = 35 MHz | 60 |

① F suffix denotes Flat Package, L denotes Dual In-Line Ceramic Package, P denotes Plastic Package, (i.e., MC2000F = Flat Package, MC2100L = Dual In-Line Ceramic, MC2000P = Plastic Package.)



World Radio History

# MTTL I

# INTEGRATED CIRCUITS

MC400 Series (0 to +75°C)
MC500 Series (−55 to +125°C)

For equivalent Maximum Ratings and package drawings, see MTTL II, page 59.

## FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 5.0 V, $T_A$ = 25°C)

| Function | Type ① Case 607, 632, 646 0 to +75°C | Type ① Case 607, 632 −55 to +125°C | Output Loading Factor Each Output MC400 Series | Output Loading Factor Each Output MC500 Series | Propagation Delay $t_{pd}$ ns typ | Power Dissipation mW typ/pkg |
|---|---|---|---|---|---|---|
| **GATES** | | | | | | |
| Dual 4-Input NAND Gate | MC400<br>MC450 | MC500<br>MC550 | 12<br>6 | 15<br>7 | 10 | 30 |
| Expandable 4-Wide 2-2-2-3 Input AND-OR-INVERT Gate | MC401<br>MC451 | MC501<br>MC551 | 12<br>6 | 15<br>7 | 12 | 30 |
| 8-Input NAND Gate | MC402<br>MC452 | MC502<br>MC552 | 12<br>6 | 15<br>7 | 12 | 15 |
| 2-Wide 3-Input AND-OR-INVERT Gate with Gated Complement | MC403<br>MC453 | MC503<br>MC553 | 12<br>6 | 15<br>7 | 11 | 35 |
| Expandable 3-Wide 3-Input AND-OR-INVERT Gate | MC404<br>MC454 | MC504<br>MC554 | 12<br>6 | 15<br>7 | 12 | 25 |
| Expandable 2-Wide 4-Input AND-OR-INVERT Gate | MC405<br>MC455 | MC505<br>MC555 | 12<br>6 | 15<br>7 | 12 | 20 |
| Expandable 8-Input NAND Gate | MC406<br>MC456 | MC506<br>MC556 | 12<br>6 | 15<br>7 | 18 | 15 |
| Quad 2-Input NAND Gate | MC408<br>MC458 | MC508<br>MC558 | 12<br>6 | 15<br>7 | 10 | 60 |
| Triple 3-Input NAND Gate | MC412<br>MC462 | MC512<br>MC562 | 12<br>6 | 15<br>7 | 10 | 45 |
| Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate | MC420<br>MC470 | MC520<br>MC570 | 12<br>6 | 15<br>7 | 12 | 40 |
| Dual 3-Input Pulse Shaper/Delay AND Gate | MC426<br>MC476 | MC526<br>MC576 | 13<br>7 | 16<br>8 | 15 | 60 |
| OR Expandable Dual 4-Input AND Gate | MC427<br>MC477 | MC527<br>MC577 | 12<br>6 | 15<br>7 | 10 | 38 |
| **EXPANDERS** | | | | | | |
| 4-Wide 3-2-2-3 Input Expander for AND-OR-INVERT Gates | MC409<br>MC459 | MC509<br>MC559 | 12<br>6 | 15<br>7 | – | – |
| Dual 4-Input Expander for AND-OR-INVERT Gates | MC410<br>MC460 | MC510<br>MC560 | 12<br>6 | 15<br>7 | – | – |
| Dual 4-Input Expander for NAND Gate | MC411<br>MC461 | MC511<br>MC561 | 12<br>6 | 15<br>7 | – | – |
| Dual 2 Wide 2 3 Input "OR" Expander | MC428<br>MC478 | MC528<br>MC578 | – | – | | 15 |
| **INVERTERS** | | | | | | |
| Hex Inverter | MC425<br>MC475 | MC525<br>MC575 | 12<br>6 | 15<br>7 | 10 | 90 |
| Hex Inverter | MC429<br>MC479 | MC529<br>MC579 | 12<br>6 | 15<br>7 | 10 | 90 |
| **DRIVERS** | | | | | | |
| Line Driver | MC407<br>MC457 | MC507<br>MC557 | 12<br>6 | 15<br>7 | 25 @<br>1000 pF Load | 60 |
| Triple 2-Input Buss Driver | MC419<br>MC469 | MC519<br>MC569 | –<br>– | –<br>– | 50/15* | 54 |
| **FLIP-FLOPS** | | | | | | |
| R-S Flip-Flop | MC413<br>MC463 | MC513<br>MC563 | 12<br>6 | 15<br>7 | $t_{on}$ = 15<br>$t_{off}$ = 20 | 30 |
| Gated R-S Flip-Flop | MC414<br>MC464 | MC514<br>MC564 | 12<br>6 | 15<br>7 | $t_{on}$ = 7.5<br>$t_{off}$ = 20 | 30 |
| AND J-K Flip-Flop | MC415<br>MC465 | MC515<br>MC565 | 12<br>6 | 15<br>7 | $t_{on}$ = 25<br>$t_{off}$ = 13 | 40 |
| OR J-K Flip-Flop | MC416<br>MC466 | MC516<br>MC566 | 12<br>6 | 15<br>7 | $t_{on}$ = 25<br>$t_{off}$ = 13 | 50 |
| AC Coupled R-S Flip-Flop | MC421<br>MC471 | MC521<br>MC571 | 12<br>6 | 15<br>7 | 18 | 30 |
| Dual Type D Flip-Flop | MC422<br>MC472 | MC522<br>MC572 | 12<br>6 | 15<br>7 | 16 | 84 |
| Dual J-K Flip-Flop (separate clock) | MC423<br>MC473 | MC523<br>MC573 | 13<br>7 | 16<br>8 | $t_{on}$ = 12<br>$t_{off}$ = 10 | 110 |
| Dual J-K Flip-Flop (common clock) | MC424<br>MC474 | MC524<br>MC574 | 13<br>7 | 16<br>8 | $t_{on}$ = 12<br>$t_{off}$ = 10 | 110 |

① F suffix denotes Ceramic Flat Package, L suffix denoted dual in-line Ceramic Package, P suffix denotes dual in-line Plastic Package. (i.e., MC401F = Flat Package, MC401L = Ceramic Package, MC401P – Plastic Package.)

*$t_{pd+}/t_{pd-}$



World Radio History

# MTTL COMPLEX FUNCTIONS

## INTEGRATED CIRCUITS

MC4000 Series (0 to +75°C)
MC4300 Series (-55 to +125°C)

The MTTL complex functions are designed for digital applications in the medium to high-speed range.

These MTTL devices provide significant reduction in package count and increased logic per function over devices in the basic MTTL and MDTL families.

### FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 5.0 V, $T_A$ = 25°C)

All devices shown can be used with all MTTL and MDTL devices, however, the loading factors shown reflect use with other devices in the same MC number series unless otherwise noted

| Function | Operating Operating Range | | Case | Output Loading Factor Each Output | Propagation Delay $t_{pd}$ ns typ | Power Dissipation $P_D$ mW typ/pkg |
|---|---|---|---|---|---|---|
| | -55 to +125°C | 0 to +75°C | | | | |
| Dual 4-Channel Data Selector | MC4300F,L | MC4000F,L,P | 607,632,646 | 10 | Control Line = 18<br>Data Line = 11 | 150 |
| BCD to-Binary/Binary to-BCD Number Converter | | MC4001F,L,P | 650,620,648 | Open Collector $I_{OL}$ = 16 mA | Address Time <45 ns | 300 |
| Dual Data Distributor | MC4302F,L | MC4002F,L,P | 607,632,646 | 10 | 10.5 | 175 |
| 16 Bit Scratch Pad Memory Cell | MC4304F,L | MC4004F,L,P | 607,632,646 | $I_{OL}$ = 40 mA<br>Open Collector | Write mode 25<br>Sense mode 15 | 250 |
| 16 Bit scratch Pad Memory Cell | MC4305F'L | MC4005F,L,P | 607,632,646 | $I_{OL}$ = 20 mA | Write mode 25<br>Sense mode 15 | 250 |
| Binary to One-of Eight Line Decoder | MC4306F,L | MC4006F,L,P | 607,632,646 | 10 | 14 | 100 |
| Dual Binary to One-of-Four Line Decoder | MC4307F,L | MC4007F,L,P | 650,620,648 | 10 | 14 | 125 |
| 8-Bit Parity Tree | MC4308F,L | MC4008F,L,P | 607,632,646 | 10 | 15 to 30 | 150 |
| Dual 4 Bit Parity Tree | MC4310F,L | MC4010F,L,P | 607,632,646 | 10 | 9.5 to 22 | 125 |
| 4-Bit Shift Register | MC4312F,L | MC4012F,L,P | 607,632,646 | 10 | 22/bit | 180 |
| Quad Type D Flip Flop | MC4315F,L | MC4015F,L,P | 650,620,648 | 10 | 16 | 190 |
| Programmable Modulo-N Decade Counter | MC4316F,L | MC4016F,L,P | 650,620,648 | 8 | Clock to Q3 = 50<br>Clock to Bus = 35 | 250 |
| Programmable Modulo 2, Modulo 5 Counters | MC4317F,L | MC4017F,L,P | 650,620,648 | 8 | Clock to Q3 = 50<br>Clock to Bus = 35 | 250 |
| Programmable Modulo-N Hexadecimal Counter | MC4318F,L | MC4018F,L,P | 650,620,648 | 8 | Clock to Q3 = 50<br>Clock to Bus = 35 | 250 |
| Dual Programmable Modulo 4 Counters | MC4319F,L | MC4019F,L,P | 650,620,648 | 8 | Clock to Q3 = 50<br>Clock to Bus = 35 | 250 |
| Dual 4-Bit Comparator (Open Collector) | MC4321F,L | MC4021F,L,P | 650,620,648 | 10 | 20 | 250 |
| Dual 4-Bit Comparator | MC4322F,L | MC4022F,L,P | 650,620,648 | 10 | 20 | 250 |
| 4 Bit Universal Counter | MC4323F,L | MC4023F,L,P | 607,632,646 | 10 | 16/bit | 200 |
| Dual Voltage Controlled Multivibrator | MC4324F,L | MC4024F,L,P | 607,632,646 | 7 | $f_{max}$ = 30 MHz | 150 |
| Full Adder | MC4326F,L | MC4026F,L,P | 607,632,646 | 15/12•• | 25/13# | 90 |
| Full Adder | MC4327F,L | MC4027F,L,P | 607,632,646 | 7/6•• | 25/13# | 90 |
| Adder (Dependent Carry) | MC4328F,L | MC4028F,L,P | 607,632,646 | 15/12•• | 25/13# | 125 |
| Adder (Dependent Carry) | MC4329F,L | MC4029F,L,P | 607,632,646 | 7/6•• | 25/13# | 125 |
| Adder (Independent Carry) | MC4330F,L | MC4030F,L,P | 607,632,646 | 15/12•• | 25/13# | 125 |
| Adder (Independent Carry) | MC4331F,L | MC4031F,L,P | 607,632,646 | 7/6•• | 25/13# | 125 |
| Carry Decoder | MC4332F,L | MC4032F,L,P | 607,632,646 | – | $\Delta t_{pd}$ = 4 decoder | 20 |
| Quad Latch (Open Collector) | MC4335F,L | MC4035F,L,P | 607,632,646 | 7 | 25 | 140 |
| Quad Latch | MC4337F,L | MC4037F,L,P | 607,632,646 | 10 | 25 | 150 |

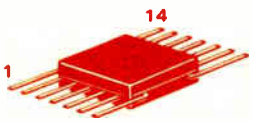


World Radio History

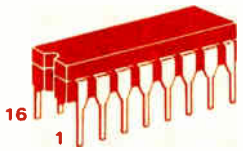
| Function | −55 to +125°C | 0 to +75°C | Case | Output Loading Factor Each Output | Propagation Delay $t_{pd}$ ns typ | Power Dissipation $P_D$ mW typ/pkg |
|---|---|---|---|---|---|---|
| Inverting/Non Inverting One of Eight Decoder | — | MC4038F,L,P | 650,620,648 | | | 240 |
| Seven Segment Character Generator | | MC4039F,L,P | 650,620,648 | Open Collector | Address | 240 |
| Binary to Two of Eight Decoder | — | MC4040F,L,P | 650,620,648 | $I_{OL}$ = 20 mA | Time | 200 |
| Single-Error Hamming Code Detector and Generator | | MC4041F,L,P | 650,620,648 | | <45 ns | 240 |
| Quad Predriver | MC4342F,L | MC4042F,L,P | 607,632,646 | $I_{OL}$ = 50 mA Open Collector | 15 | 120 |
| Dual Line Selector | MC4343F,L | MC4043F,L,P | 607,632,646 | $I_{OL}$ = 400 mA Pulsed | 20 | 70 |
| Phase Frequency Detector | MC4344F,L | MC4044F,L,P | 607,632,646 | 10 | 9.0 | 85 |
| Non Inverting One-of-Eight Decoder | | MC4048F,L,P | 650,620,648 | Open Collector $I_{OL}$ = 16 mA | Address Time <50 ns) | 240 |
| Counter Latch-Decoder | MC4350F,L | MC4050F L.P | 650,620,648 | Open Collector $I_{OL}$ = 40 mA | $f_{Tog}$ = 35 MHz | 450 |
| Counter Latch Decoder | MC4351F,L | MC4051F,L,P | 650,620,648 | Open Emitter 40 mA Sourcing Capability @ 10% Duty Cycle | $f_{Tog}$ = 35 MHz | 450 |
| Dual Decade Counter | MC4352F,L | MC4052F,L,P | 650,620,648 | 10 | $f_{Tog}$ = 40 MHz | 350 |
| Dual Hexadecimal Counter | MC4353F,L | MC4053F,L,P | 650,620,648 | 10 | $f_{Tog}$ = 40 MHz | 350 |
| Dual Decade Up/Down Counter | MC4354F,L | MC4054F,L,P | 667,623,649 | 10 | $f_{Tog}$ = 12 MHz | 600 |
| Dual Binary Up/Down Counter | MC4355F,L | MC4055F,L,P | 667,623,649 | 10 | $f_{Tog}$ = 12 MHz | 600 |
| NBCD Adder | MC4356F,L | MC4056F,L,P | 650,620,648 | 10 | 30 | 300 |
| Nines Complement/Zero Element | MC4358F,L | MC4058F,L,P | 607,632,646 | 10 | 30 | 200 |
| Bus Transfer Switch | MC4360F,L | MC4060F,L,P | 650,620,648 | 10 | 25 | 350 |
| Dual Majority Logic Gate | MC4362F,L | MC4062F,L,P | 607,632,646 | 10 | Z = 20 Z = 11 | 75 |
| 64-Bit Random Access Memory | | MC4064F,L,P | 650,620,648 | Open Collector $I_{OL}$ = 15 mA | Access Time <60 ns | 384 |
| Dual MOS-to-TTL Level Translator with Three-State Output | MC4368F,L | MC4068F,L,P | 607,632,646 | 10 | 20 | 150 |

**MC4300/MC400 Series loading specified for use with MTTL Devices

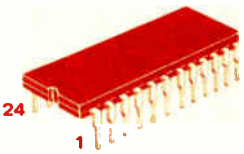
#Add delay, Carry delay



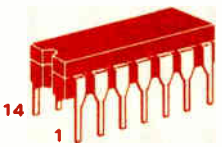

**F SUFFIX**
CERAMIC PACKAGE
CASE 607



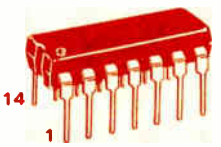

**L SUFFIX**
CERAMIC PACKAGE
CASE 620



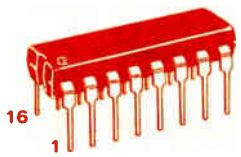

**L SUFFIX**
CERAMIC PACKAGE
CASE 623



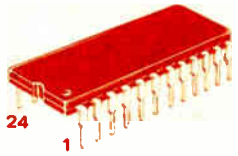

**L SUFFIX**
CERAMIC PACKAGE
CASE 632




**P SUFFIX**
PLASTIC PACKAGE
CASE 646




**P SUFFIX**
PLASTIC PACKAGE
CASE 648




**P SUFFIX**
PLASTIC PACKAGE
CASE 649

**F SUFFIX**
CERAMIC PACKAGE
CASE 650

**F SUFFIX**
CERAMIC PACKAGE
CASE 667



World Radio History

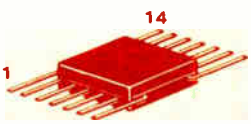
# MTTL COMPLEX FUNCTIONS

## INTEGRATED CIRCUITS

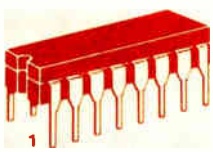
MC7200 Series (0 to +75°C)
MC8200 Series (-55 to +125°C)

These complex functions are designed for digital applications in the medium-to high-speed range, with significant reduction in package count and increased logic per function over devices in the basic MTTL and MDTL families. They are direct replacements for S7200/8200 Series devices.

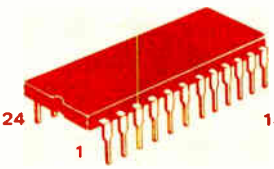
| Function | Operating Temperature Range | | Packages | | |
|---|---|---|---|---|---|
| | | | Dual-in-line | | Flat |
| | –55°C TO +125°C | 0°C TO +70°C | Plastic | Ceramic | Ceramic |
| Dual 5 Bit Buffer Register | MC8200 | MC7200 | 649 | 623 | 667 |
| Dual 5 Bit Buffer Register W/D Inputs | MC8201 | MC7201 | 649 | 623 | 667 |
| 10 Bit Buffer Register | MC8202 | MC7202 | 649 | 623 | 667 |
| 10 Bit Buffer Register W/D Inputs | MC8203 | MC7203 | 649 | 623 | 667 |
| 2 Input 4-Bit Digital Multiplexer | MC8233 | MC7233 | 648 | 620 | 650 |
| 2 Input 4-Bit Digital Multiplexer | MC8234 | MC7234 | 648 | 620 | 650 |
| 2 Input 4-Bit Digital Multiplexer | MC8235 | MC7235 | 648 | 620 | 650 |
| Quad Exclusive OR | MC8241 | MC7241 | 646 | 632 | 607 |
| Quad Exclusive NOR | MC8242 | MC7242 | 646 | 632 | 607 |
| Binary To Octal Decoder | MC8250 | MC7250 | 646 | 632 | 607 |
| BCD To Decimal Decoder | MC8251 | MC7251 | 648 | 620 | 650 |
| Arithmetic Logic Unit | MC8260 | MC7260 | 649 | 623 | 667 |
| Fast Carry Extender | MC8261 | MC7261 | 646 | 632 | 607 |
| 2 Input 4-Bit Digital Multiplexer | MC8266 | MC7266 | 648 | 620 | 650 |
| 2 Input 4-Bit Digital Multiplexer | MC8267 | MC7267 | 648 | 620 | 650 |
| 4 Bit Shift Register | MC8270 | MC7270 | 646 | 632 | 607 |
| 4 Bit Shift Register | MC8271 | MC7271 | 648 | 620 | 650 |
| Presettable Decode Counter | MC8280 | MC7280 | 646 | 632 | 607 |
| Presettable Binary Counter | MC8281 | MC7281 | 646 | 632 | 607 |
| Binary Up/Down Counter | MC8284 | MC7284 | 646 | 632 | 607 |
| Decade Up/Down Counter | MC8285 | MC7285 | 646 | 632 | 607 |
| Divide by Twelve Counter | MC8288 | MC7288 | 646 | 632 | 607 |
| Presettable High Speed Decade Counter | MC8290 | MC7290 | 646 | 632 | 607 |
| Presettable High Speed Binary Counter | MC8291 | MC7291 | 646 | 632 | 607 |



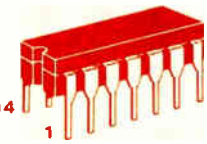

**F SUFFIX**
CERAMIC PACKAGE
CASE 607



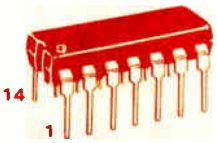

**L SUFFIX**
CERAMIC PACKAGE
CASE 620



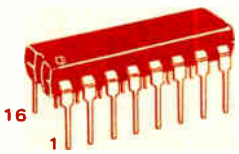

**L SUFFIX**
CERAMIC PACKAGE
CASE 623



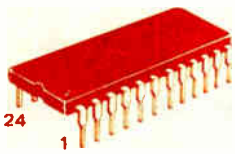

**L SUFFIX**
CERAMIC PACKAGE
CASE 632




**P SUFFIX**
PLASTIC PACKAGE
CASE 646

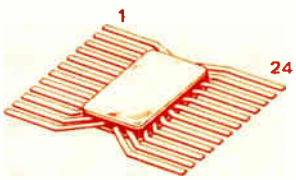



**P SUFFIX**
PLASTIC PACKAGE
CASE 648




**P SUFFIX**
PLASTIC PACKAGE
CASE 649

**F SUFFIX**
CERAMIC PACKAGE
CASE 650




**F SUFFIX**
CERAMIC PACKAGE
CASE 667



World Radio History

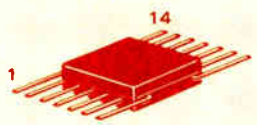
# MTTL COMPLEX FUNCTIONS

## INTEGRATED CIRCUITS

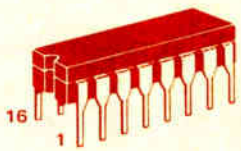
MC8300 Series (0 to +75°C)
MC9300 Series (−55 to +125°C)

These complex functions are designed for digital applications in the medium-to high-speed range, with significant reduction in package count and increased logic per function over devices in the basic MTTL and MDTL families. They are direct replacements for F8300/9300 Series devices.

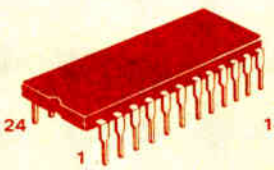
| Function | Operating Temperature Range | | Packages | | |
|---|---|---|---|---|---|
| | | | Dual-in-line | | Flat |
| | −55°C TO +125°C | 0°C TO +75°C | Plastic | Ceramic | Ceramic |
| Universal 4-Bit Shift Register | MC9300 | MC8300 | 648 | 620 | 650 |
| BCD to Decimal Decoder | MC9301 | MC8301 | 648 | 620 | 650 |
| Dual Full Adder | MC9304 | MC8304 | 648 | 620 | 650 |
| Presettable Decade Up/Down Counter | MC9306 | MC8306 | 649 | 623 | 667 |
| 7-Segment Decoder | MC9307 | MC8307 | 648 | 620 | 650 |
| Dual 4-Bit Latch | MC9308 | MC8308 | 649 | 623 | 667 |
| Dual 4-Channel Data Selector | MC9309 | MC8309 | 648 | 620 | 650 |
| Presetable Decade Counter | MC9310 | MC8310 | 648 | 620 | 650 |
| One of Sixteen Decoder | MC9311 | MC8311 | 649 | 623 | 667 |
| 8 Channel Data Selector | MC9312 | MC8312 | 648 | 620 | 650 |
| 4 Bit Latch | MC9314 | MC8314 | 648 | 620 | 650 |
| 4 Bit Binary Counter | MC9316 | MC8316 | 648 | 620 | 650 |
| 7 Segment Decider/Driver | MC9317 | MC8317 | 648 | 620 | 650 |
| 8 Input Priority Encoder | MC9318 | MC8318 | 648 | 620 | 650 |
| Quad 2 Input Multiplexer | MC9322 | MC8322 | 648 | 620 | 650 |
| 5 Bit Comparator | MC9324 | MC8324 | 648 | 620 | 650 |
| Dual 8 Bit Shift Register | MC9328 | MC8328 | 648 | 620 | 650 |
| One Shot Multivibrator | MC9601 | MC8601 | 646 | 632 | 607 |
| Dual One Shot Multivibrator | MC9602 | MC8602 | 648 | 620 | 650 |



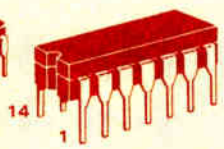

F SUFFIX
CERAMIC PACKAGE
CASE 607



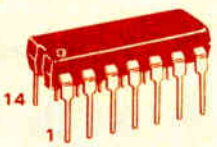

L SUFFIX
CERAMIC PACKAGE
CASE 620



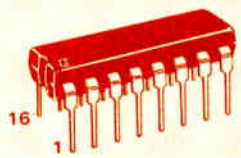

L SUFFIX
CERAMIC PACKAGE
CASE 623



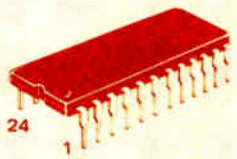

L SUFFIX
CERAMIC PACKAGE
CASE 632




P SUFFIX
PLASTIC PACKAGE
CASE 646

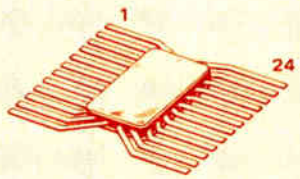



P SUFFIX
PLASTIC PACKAGE
CASE 648




P SUFFIX
PLASTIC PACKAGE
CASE 649

F SUFFIX
CERAMIC PACKAGE
CASE 650




F SUFFIX
CERAMIC PACKAGE
CASE 667



World Radio History

# MDTL

# INTEGRATED CIRCUITS

**MC830 Series (0 to +75°C)**
**MC930 Series (-55 to +125°C)**

MDTL integrated circuits provide an excellent balance of speed, power dissipation, and noise immunity for general purpose digital applications. The line includes many multifunction types. Additional logic power is provided by the "wired OR" capability of the basic MDTL gate.

## MAXIMUM RATINGS

| Rating | Value | Unit |
|---|---|---|
| Supply Voltage — | | Vdc |
| Operating | 4.5 to 5.5 | |
| Continuous | 8.0 | |
| Pulsed, < 1 second | 12 | |
| Output Current (Into Outputs with Outputs Low) | | mAdc |
| Buffers, Power Gates — Continuous | 100 | |
| Pulsed, < 30 ms | 300 | |
| All other types — Continuous | 30 | |
| Pulsed, < 30 ms | 90 | |
| Input Forward Current — | | mAdc |
| Continuous | -10 | |
| Pulsed, < 30 ms | -30 | |
| or | | |
| Negative Voltage at Input — | | Vdc |
| Continuous | -0.5 | |
| Pulsed, < 30 ms | -1.5 | |

| Rating | Value | Unit |
|---|---|---|
| Input Reverse Current | 1.0 | mAdc |
| or | | |
| Positive Voltage at Diode Input | 5.5 | Vdc |
| Operating Temperature Range | | °C |
| MC930 Series | -55 to +125 | |
| MC830 Series | 0 to +75 | |
| Storage Temperature Range | | °C |
| Metal Can, Ceramic Package | -65 to +150 | |
| Plastic Package | -55 to +125 | |
| Maximum Junction Temperature | | °C |
| MC930 Series | 175 | |
| MC830 Series | 150 | |

## FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 5.0 Vdc, $T_A$ = 25°C)

| Function | Type ① 0 to +75°C | Case | Type ① -55 to +125°C | Case | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg |
|---|---|---|---|---|---|---|---|
| Expandable Dual 4 Input NAND Gate | MC830 | 607,632,646 | MC930 | 607,632 | 8 | 30 | 22 |
| Expandable Dual 3 2 Input NAND Gate | MC830 | 603 | MC930 | 603 | 8 | 30 | 22 |
| Expandable Dual 4 Input Buffer | MC832 | 607,632,646 | MC932 | 607,632 | 25 | 35 | 85 |
| Expandable Dual 3 2 Input Buffer | MC832 | 603 | MC932 | 603 | 25 | 35 | 85 |
| Dual 4 Input Expander | MC833 | 607,632,646 | MC933 | 607,632 | – | – | – |
| Dual 4 3 Input Expander | MC833 | 603 | MC933 | 603 | – | – | – |
| Hex Inverter | MC834 | 607,632,646 | MC934 | 607,632 | 8 | 30 | 66 |
| Hex Inverter (without output resistors) | MC835 | 607,632,646 | MC935 | 607,632 | 8 | 30 | 42 |
| Hex Inverter | MC836 | 607,632,646 | MC936 | 607,632 | 8 | 30 | 66 |
| Hex Inverter | MC837 | 607,632,646 | MC937 | 607,632 | 7 | 25 | 90 |
| Decade Counter | MC838 | 607,632,646 | MC938 | 607,632 | 8 | 30 MHz ③ | 150 |
| Divide by Sixteen Counter | MC839 | 607,632,646 | MC939 | 607,632 | 8 | 30 MHz ③ | 150 |
| Hex Inverter (without input diodes) | MC840 | 607,632,646 | MC940 | 607,632 | 8 | 30 | 66 |
| Hex Inverter (without output resistors and input diodes) | MC841 | 607,632,646 | MC941 | 607,632 | 8 | 30 | 42 |
| Expandable Dual 4 Input Power Gate | MC844 | 607,632,646 | MC944 | 607,632 | 27 | 30 | 65 |
| Expandable Dual 3 2 Input Power Gate | MC844 | 603 | MC944 | 603 | 27 | 30 | 65 |
| Clocked Flip Flop | MC845 | 603,607,632,646 | MC945 | 603,607,632 | 12/10 ② | 40 | 60 |
| Quad 2 Input NAND Gate | MC846 | 607,632,646 | MC946 | 607,632 | 8 | 30 | 44 |
| Quad Inverter | MC846 | 603 | MC946 | 603 | 8 | 30 | 44 |
| Quad 2 Input Gate Expander | MC847 | 607,632,646 | MC947 | 607,632 | – | – | – |
| Clocked Flip Flop | MC848 | 603,607,632,646 | MC948 | 603,607,632 | 11/9 ② | 40 | 70 |
| Quad 2 Input NAND Gate (2 k pullup resistor) | MC849 | 607,632,646 | MC949 | 607,632 | 7 | 25 | 66 |
| Quad Inverter (2 k pullup resistor) | MC849 | 603 | MC949 | 603 | 7 | 25 | 60 |
| Pulse Triggered Binary | MC850 | 603,607,632,646 | MC950 | 603,607,632 | 10/8 ② | 15 | 50 |
| Monostable Multivibrator | MC851 | 603,607,632,646 | MC951 | 603,607,632 | 10 | 40 | 30 |
| Dual J K Flip Flop (common clock and $C_D$, separate $S_D$) | MC852 | 607,632,646 | MC952 | 607,632 | 12/10 ② | 40 | 120 |
| Dual J K Flip Flop (separate clock and $S_D$, no $C_D$) | MC853 | 607,632,646 | MC953 | 607,632 | 12/10 ② | 40 | 120 |

(continued)



World Radio History

## MDTL INTEGRATED CIRCUITS (continued)

| Function | Type ① 0 to +75°C | Case | Type ① -55 to +125°C | Case | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg |
|---|---|---|---|---|---|---|---|
| Dual J K Flip Flop (common clock and $C_D$, separate $S_D$, 2 k pullup resistor) | MC855 | 607,632,646 | MC955 | 607,632 | 11/9 ② | 40 | 140 |
| Dual J K Flip Flop (separate clock and $S_D$, no $C_D$, 2 k pullup resistor) | MC856 | 607,632,646 | MC956 | 607,632 | 11/9 ② | 40 | 140 |
| Quad 2 Input Buffer | MC857 | 607,632,646 | MC957 | 607,632 | 25 | 35 | 170 |
| Quad 2 Input NAND Power Gate | MC858 | 607,632,646 | MC958 | 607,632 | 27 | 30 | 130 |
| Expandable Dual 4 Input NAND Gate (2 k pullup resistor) | MC861 | 607,632,646 | MC961 | 607,632 | 7 | 25 | 33 |
| Expandable Dual 3 2 Input NAND Gate (2 k pullup resistor) | MC861 | 603 | MC961 | 603 | 7 | 25 | 33 |
| Triple 3 Input NAND Gate | MC862 | 607,632,646 | MC962 | 607,632 | 8 | 30 | 33 |
| Dual 2 Input NAND Gate plus Inverter | MC862 | 603 | MC962 | 603 | 8 | 30 | 30 |
| Triple 3 Input NAND Gate (2 k pullup resistor) | MC863 | 607,632,646 | MC963 | 607,632 | 7 | 25 | 50 |
| Dual 2 Input NAND Gate plus Inverter (2 k pullup resistor) | MC863 | 603 | MC963 | 603 | 7 | 25 | 45 |
| Dual 5 Input NAND Gate (6K pullup resistor) | MC1800 | 607,632,646 | MC1900 | 607,632 | 8 | 30 | 22 |
| Dual 5 Input NAND Gate (2k pullup resistor) | MC1801 | 607,632,646 | MC1901 | 607,632 | 7 | 25 | 33 |
| Expandable 8 Input NAND Gate | MC1802 | 607,632,646 | MC1902 | 607,632 | 8 | 30 | 11 |
| Expandable 8 Input NAND Gate (2 k pullup resistor) | MC1803 | 607,632,646 | MC1903 | 607,632 | 7 | 25 | 16.5 |
| 10 Input NAND Gate | MC1804 | 607,632,646 | MC1904 | 607,632 | 8 | 30 | 11 |
| 10 Input NAND Gate (2k pullup resistor) | MC1805 | 607,632,646 | MC1905 | 607,632 | 7 | 25 | 16.5 |
| Quad 2 Input AND Gate | MC1806 | 607,632,646 | MC1906 | 607,632 | 8 | 35 | 72 |
| Quad 2 Input AND Gate (2k pullup resistor) | MC1807 | 607,632,646 | MC1907 | 607,632 | 7 | 30 | 85 |
| Quad 2 Input OR Gate | MC1808 | 607,632,646 | MC1908 | 607,632 | 8 | 35 | 97 |
| Quad 2 Input OR Gate (2k pullup resistor) | MC1809 | 607,632,646 | MC1909 | 607,632 | 7 | 30 | 115 |
| Quad 2 Input NOR Gate | MC1810 | 607,632,646 | MC1910 | 607,632 | 8 | 30 | 60 |
| Quad 2 Input NOR Gate (2k pullup resistor) | MC1811 | 607,632,646 | MC1911 | 607,632 | 7 | 25 | 72 |
| Quad 2 Input Exclusive OR Gate | MC1812 | 607,632,646 | MC1912 | 607,632 | 8 | 40 | 120 |
| Quad Latch | MC1813 | 620,648 | – | – | 7 | 35 | 220 |
| Quad Latch | MC1814 | 607,632,646 | MC1914 | 607,632 | 7 | 35 | 220 |
| Parallel Gated Clocked Flip Flop | MC1815 | 607,632,646 | MC1915 | 607,632 | 12/10 ② | 40 | 65 |
| Parallel Gated Clocked Flip Flop | MC1816 | 607,632,646 | MC1916 | 607,632 | 11/9 ② | 40 | 75 |
| Quad 2 Input NAND Gate (without output resistor) | MC1818 | 607,632,646 | MC1918 | 607,632 | 8 | 30 | 32 |
| High Voltage Hex Inverter | MC1820 | 632,646 | – | – | 7 | 40 | 42 |

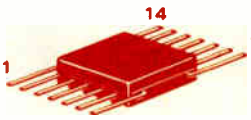
① F suffix denotes Ceramic Flat Package, G suffix denotes Metal Can, L suffix denotes Dual In Line Ceramic Package, P suffix denotes Dual In Line Plastic Package. (i.e., MC830G = Metal Can, MC830F = Flat Package, MC830L = Dual In Line Ceramic Package, MC830P = Plastic Package)

② Fan out for MC830 series type / Fan out for MC930 series type.

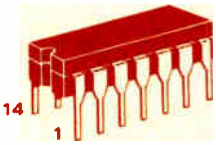
③ Counting frequency

10 LEADS

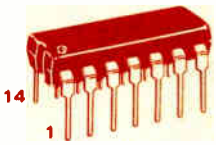
**G SUFFIX**
METAL PACKAGE
CASE 603
TO-100




**F SUFFIX**
CERAMIC PACKAGE
CASE 607




**L SUFFIX**
CERAMIC PACKAGE
CASE 632




**P SUFFIX**
PLASTIC PACKAGE
CASE 646



World Radio History

# MRTL/mW MRTL

## INTEGRATED CIRCUITS

MC800 Series (0 to 75°C)
MC900 Series (−55 to +125°C)

Medium-power MRTL integrated circuits provide a broad line of low-cost, multi-function, digital circuits. Typical gate speed is 12 ns, with power dissipation averages of 19 mW (input high) and 5.0 mW (inputs low) per logic node. Devices from the MC800 Series have loading factors normalized for compatibility with the low-power mW MRTL devices for ease in mixing the two power levels in a system.

Low-power mW MRTL integrated circuits are designed for use where minimal system power consumption is desired. Typical gate speed is 27 ns, with typical power dissipation of 6.5 mW (input high) and 0.5 mW (inputs low) per logic node. Devices from the mW MRTL Series can be mixed with devices from the medium-power MRTL Series which has loading factors normalized for compatibility.

## FUNCTIONS AND CHARACTERISTICS

($V_{CC}$ = 3.0 V ± 10% for MC900 Series devices.)
($V_{CC}$ = 3.6 V ± 10% for MC800 Series devices.)
(Power Dissipation and $t_p$ typicals at $T_A$ = 25°C.)

| Functions | MRTL | mW MRTL | Type (1) MC800 Series 0 to +75°C | MC800 Series Case | Type (1) MC900 Series −55 to +125°C | MC900 Series Case | Loading Factors Each Output: MRTL With mW MRTL | Loading Factors Each Output: MRTL With MRTL | Loading Factors Each Output: mW MRTL With mW MRTL | tp ns typ | Power Dissipation: MC800 P&L Series | Power Dissipation: MC900 F&G Series |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buffer | • | | | | MC900 | 601,606 | 80 | 25 | | 20 | | 16/45 (2) |
| Counter Adapter | • | | | | MC901 | 601,606 | 16 | 5 | – | 22 | | 55 |
| R.S. Flip Flop | • | | | | MC902 | 601,606 | 13 | 4 | – | 14 | | 22 |
| 3 Input NOR Gate | • | | | | MC903 | 601,606 | 16 | 5 | – | 12 | | 19/5 (2) |
| Half Adder | • | | | | MC904 | 601,606 | 16 | 5 | – | 14 | | 45 |
| Half-Shift Register | • | | | | MC905 | 601,606 | 13 | 4 | – | 22 | | 53 |
| Half Shift Register (w/o Inverter) | • | | | | MC906 | 601,606 | 13 | 4 | – | 22 | | 36 |
| 4 Input NOR Gate | • | | | | MC907 | 601,606 | 16 | 5 | – | 12 | | 19/5 (2) |
| Half Adder | | • | | | MC908 | 601,606 | – | – | 4 | 60 | | 14/8.5 (2) |
| 2 Input Buffer | | • | | | MC909 | 601,606 | – | – | 30 | 57 | | 5.5/16 (2) |
| Dual 3 Input (NOR Gate) | | • | | | MC910 | 601,606 | – | – | 4 | 27 | | 8.0/1.0 (2) |
| 4 Input OR/NOR Gate | | • | | | MC911 | 601,606 | – | – | 4 | 60 | | 6.0/3.5 (2) |
| Half-Adder | | • | | | MC912 | 601,606 | – | – | 4 | 66 | | 11.5/5.5 (2) |
| Type D Flip-Flop | | • | | | MC913 | 601,606 | – | – | 3 | 75 | | 17.5/13 (5) |
| Dual 2 Input NOR Gate | • | | | | MC914 | 601,606 | 16 | 5 | – | 12 | | 38/10 (2) |
| Dual 3 Input NOR Gate | • | | MC815 | 646,632 | MC915 | 603,606 | 16 | 5 | – | 12 | 55/15 (2) | 38/10 (2) |
| J.K. Flip Flop | • | | MC816 | 646,632 | MC916 | 601,606 | 10 | 3 | – | 30 | 91/79 (3) | 62/54 (3) |
| Quad 2 Input NOR Gate | | • | MC817 | 646,632 | MC917 | 607 | – | – | 4 | 27 | 20/5.0 (2) | 16/2.5 (2) |
| Dual 3 Input NOR Gate | | • | MC818 | 646,632 | MC918 | 603,606 | – | – | 4 | 27 | 12/2.5 (2) | 9.5/1.0 (2) |
| Dual 4 Input NOR Gate | | • | MC819 | 646,632 | MC919 | 607 | – | | 4 | 27 | 13/2.5 (2) | 11/1.0 (2) |
| J.K. Flip Flop | | • | | | MC920 | 601,606 | – | – | 2 | 50 | | 15.5/10 (3) |
| Dual 2 Input Gate Expander | | • | | | MC921 | 601,606 | – | – | – | 27 | | 3.0/– (2) |
| J.K. Flip Flop | | • | MC822 | 646,632 | MC922 | 603,606 | – | – | 4 | 70 | 24/20 (3) | 17.5/13 (3) |
| Quad 2 Input NOR Gate | • | | MC824,A | 646,632 | MC924 | 607 | 16 | 5 | – | 12 | 100/30 (2) | 76/20 (2) |
| Dual 4 Input NOR Gate | • | | MC825 | 646,632 | MC925 | 607 | 16 | 5 | | 12 | 60/15 (2) | 38/10 (2) |
| J.K. Flip Flop | • | | MC826 | 646,632 | MC926 | 603,606 | 16 | 5 | – | 35 | 100/86 (3) | 130/65 (3) |
| Wuad Inverter | • | | | | MC927 | 603,606 | 16 | 5 | – | 12 | | 76/20 (2) |
| 5 Input NOR Gate | | • | | | MC928 | 601,606 | – | – | 4 | 27 | | 6.5/0.5 (2) |
| 5 Input NOR Gate | • | | | | MC929 | 601,606 | 16 | 5 | – | 12 | | 19/5 (2) |
| Dual Exclusive (OR/NOR Gate) | | • | MC864 | 646,632 | – | – | – | – | 4 | – | 25 | |
| Quad Latch | | • | MC867,A | 648,620 | – | | – | – | 9 | 50 | 110 | |
| BCD to Decimal Decoder | | • | MC870 | 648,620 | – | | – | – | 7 | 36 | 100/ | |
| Quad Exclusive OR Gate | • | | MC871 | 646,632 | MC971 | 607 | 16 | 5 | – | 12 | 72 | 28 |
| J.K. Flip-Flop | • | | | | MC974 | 601,606 | 16 | 5 | – | 35 | | 130/65 (3) |
| Dual Half-Adder | • | | MC875 | 646,632 | MC975 | 607 | 16 | 5 | 2 | 20 | 120 | 90 |
| Dual J.K. Flip-Flop | | • | MC876 | 646,632 | MC976 | 607 | – | – | – | 50 | 41/29 (3) | 31/20 (3) |
| Binary Up Counter | • | | MC877 | 646,632 | – | | 10 | 3 | – | – | 180 | |
| Dual Type D Flip Flop | | • | MC878 | 646,632 | MC978 | 607 | – | – | 3 | 60 | 48/35 (5) | 35/26 (5) |
| 1 J.K. Flip-Flop, 1 (Expander, 2 Buffers) | • | | MC879 | 646,632 | | | – | – | – | – | 141/124 (4) | |
| Decade Up Counter | • | | MC880 | 646,632 | – | | 10 | 3 | – | | 250 | |
| Dual Buffer | | • | | | MC981 | 601,606 | – | – | 30 | 57 | | 11/32 (2) |
| J.K. Flip Flop | | • | | | MC982 | 601,606 | – | – | 2 | 80 | | 15/13 (3) |
| Dual Half-Shift Register | • | | MC883 | 646,632 | MC983 | 607 | 13 | 4 | – | 22 | 140 | 110 |
| Dual Half-Shift Register (w/Inverter) | • | | MC884 | 646,632 | MC984 | 607 | 13 | 4 | – | 22 | 100 | 75 |
| Quad 2-Input Expander | • | | MC885,A | 646,632 | MC985 | 607 | – | – | – | 12 | 20/– (2) | 17/– (2) |
| Dual 4-Input Expander | • | | MC886 | 646,632 | MC986 | 607 | – | – | – | 12 | 20/– (2) | 17/– (2) |
| 1 J.K. Flip-Flop, 1 Inverter (2, Buffers | • | | MC887 | 646,632 | – | | – | – | – | – | 138/132 (4) | |
| Dual 3 Input Buffer (Non-Inverting) | • | | MC888 | 646,632 | MC988 | 607 | 80 | 25 | – | 24 | 145/56 (2) | 128/42 (2) |
| Hex Inverter | • | | MC889,A | 646,632 | MC989 | 607 | 16 | 5 | – | 12 | 130/15 (2) | 76/20 (2) |

(continued)



World Radio History

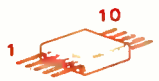
## MRTL/mW MRTL INTEGRATED CIRCUITS (continued)

| Functions | MRTL | mW MRTL | Type ① MC800 Series 0 to +75°C | MC800 Series Case | Type ① MC900 Series −55 to +125°C | MC900 Series Case | Loading Factors Each Output: MRTL With mW MRTL | Loading Factors Each Output: MRTL With MRTL | Loading Factors Each Output: mW MRTL With mW MRTL | tp ns typ | Power: MC800 P&L Series | Dissipation: MC900 F&G Series |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dual J.K. Flip Flop | • | | MC890 | 646,632 | MC990 | 607 | 10 | 3 | – | 35 | 182/158 ③ | 124/108 ③ |
| Dual J.K. Flip Flop | • | | MC891 | 646,632 | MC991 | 607 | 16 | 5 | – | 40 | 190/160 ③ | 155/130 ③ |
| Triple 3 Input NOR Gate | • | | MC892 | 646,632 | MC992 | 607 | 16 | 5 | – | 12 | 82/24 ② | 57/15 ② |
| Triple 3 Input NOR Gate | | • | MC893 | 646,632 | MC993 | 607 | – | – | 4 | 27 | 18/3.5 ② | 14/2.0 ② |
| Serial-Parallel Shift Register | • | | MC894 | 646,632 | – | | 16 | 5 | – | 55 | 225 | |
| Dual Full Adder | • | | MC896 | 646,632 | MC996 | 607 | 16 | 5 | – | 60 | 225 | 190 |
| Dual Full Subtractor | • | | MC897 | 646,632 | MC997 | 607 | 16 | 5 | – | 60 | 225 | 190 |
| Dual 2 Input Buffer | | • | MC898 | 646,632 | MC998 | 607 | – | – | 30 | 57 | 14/46 ② | 11/32 ② |
| Dual Buffer | • | | MC899 | 646,632 | MC999 | 603, 606 | 80 | 25 | – | 15 | 50/90 ② | 32/90 ② |
| Dual 4 Channel (Data Selector) | • | | MC9801 | 648,620 | – | | 16 | 5 | – | 25 | 100 | |
| Dual J.K. Flip Flop | • | | MC9802 | 646,632 | – | | 10 | 3 | – | 35 | 182/158 ③ | |
| 4 Bit Parallel Full Adder | • | | MC9804 | 648,620 | – | | 6 | 2 | – | 125 | 265 | |
| Dual 4 Channel (Data Distributor) | • | | MC9807 | 648,620 | – | | 16 | 5 | – | 25 | 150 | |
| Quad Schmitt Trigger | • | | MC9809 | 646,632 | – | | 16 | 5 | – | 30 | 95 | |
| Quad 2 Input AND Gate | • | | MC9813 | 646,632 | – | | 16 | 5 | – | 28 | 100 | |
| Quad 2 Input NAND Gate | • | | MC9814 | 646,632 | – | | 16 | 5 | – | 35 | 145 | |
| Quad 2 Input OR Gate | • | | MC9815 | 646,632 | – | | 16 | 5 | – | 40 | 28/100 ② | |
| Hex Inverter | | • | MC9818 | 646,632 | – | | – | – | 4 | 27 | 7.0/3.0 ② | |
| Hex Expander | • | | MC9819,A | 646,632 | – | | – | – | – | 12 | 13/– ② | |
| Hex Expander | | • | MC9820 | 646,632 | – | | – | – | – | 12 | 30/– ② | |
| Quad 2 Input Expander | | • | MC9821 | 646,632 | – | | – | – | – | 27 | 20/– ② | |
| Dual J.K. Flip Flop | | • | MC9822 | 646,632 | – | | – | – | 4 | 75 | 24/– ③ | |
| Quad 2 Input AND Gate | | • | MC9823 | 646,632 | – | | – | – | 4 | 50 | 12 ⑥ | |
| Quad 2 Input NAND Gate | | • | MC8924 | 646,632 | – | | – | – | 4 | 50 | 20/5.0 ② | |
| Quad 2 Input OR Gate | | • | MC9825 | 646,632 | – | | – | – | 4 | 50 | –/7.0 ② | |

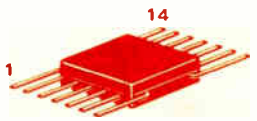
"A" Suffix devices have insured capability to drive at least one MTTL load or two MDTL loads.
① G suffix denotes Metal, F suffix Flat Package, P suffix denotes Plastic Package, L suffix denotes dual inline Ceramic Package.
② Inputs High/Inputs Low unless otherwise noted.
③ Only clock inputs High/Input Low.
④ Only clock inputs high on Flip-Flop, other elements High/Inputs Low.
⑤ Direct Set & Direct Clear Low, all other inputs high/all inputs low.
⑥ One input high/one input low.

**G SUFFIX**
METAL PACKAGE
CASE 601

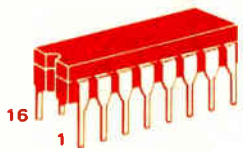
**G SUFFIX**
METAL PACKAGE
CASE 603
TO-100



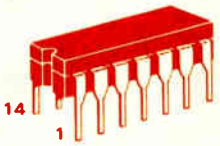

**F SUFFIX**
CERAMIC PACKAGE
CASE 606
TO-91



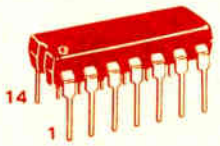

**F SUFFIX**
CERAMIC PACKAGE
CASE 607




**L SUFFIX**
CERAMIC PACKAGE
CASE 620



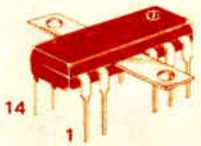

**L SUFFIX**
CERAMIC PACKAGE
CASE 632




**P SUFFIX**
PLASTIC PACKAGE
CASE 646

**P SUFFIX**
PLASTIC PACKAGE
CASE 648

MRTL/mW MRTL
and
MHTL Packages




**P SUFFIX**
PLASTIC PACKAGE
CASE 675

**PC SUFFIX**
PLASTIC PACKAGE
CASE 676



World Radio History

# MHTL

# INTEGRATED CIRCUITS

**MC660P, L Series (-30 to +75°C)**
***MC660TL Series (-55 to +125°C)**

Motorola's MHTL integrated circuits are especially designed to meet the requirements of industrial applications because of the outstanding noise immunity. MHTL circuits provide error-free operation in high noise environments far beyond the tolerance of other integrated circuit families. Multifunction packages and broad operating temperature range further tailor this device family to the industrial designer's requirements.

*MHTL ceramic dual in-line devices are available with specification over the -55°C to +125°C temperature range and/or with hi-rel processing on special order. See your Motorola representative for pricing.

Package drawings are shown on page 68.

## TYPICAL CHARACTERISTICS

| Rating | Value | Unit |
|---|---|---|
| Supply Voltage | 15 ± 1.0 | Vdc |
| Threshold Voltage | 7.5 | Vdc |
| Logic "0" Output Voltage @ $I_{OL}$ = 5 mA | | |
| (Active Pullup Output) | 1.0 | Vdc |
| (Passive Pullup) | 0.4 | Vdc |
| Logic "1" Output Voltage @ $V_{CC}$ = 15 V | | |
| (Active Pullup Output) | 14.4 | Vdc |
| (Passive Pullup) | 14.9 | Vdc |
| Noise Margin | 6.0 | Vdc |

## FUNCTIONS AND CHARACTERISTICS ($V_{CC}$ = 15 V ± 1.0 Vdc, $T_A$ = 25°C)

| Function | Type | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg | Case |
|---|---|---|---|---|---|
| Expandable Dual 4 Input NAND Gate (active pullup) | MC660 | 10 | 110 | 88/26 ② | 632,646 |
| Expandable Dual 4 Input NAND Gate (passive pullup) | MC661 | 10 | 125 | 88/26 ② | 632,646 |
| Expandable Dual 4 Input Line Driver (NAND) | MC662 | 30 | 140 | 180/26 ② | 632,646 |
| Dual J K Flip Flop | MC663 | 9 | 3.0 MHz ③ | 200 | 632,646 |
| Master Slave R S Flip Flop | MC664 | 8 | 3.0 MHz ③ | 160 | 632,646 |
| Triple Level Translator | MC665 | MDTL = 8<br>MTTL III = 5.5<br>MRTL = 5 | 40 | 83 (MDTL)<br>104 (MRTL) | 632,646 |
| Triple Level Translator | MC666 | 10 | 75 | 105 | 632,646 |
| Dual Monostable Multivibrator | MC667 | 10 | 140 | 240 | 632,646 |
| Quad 2 Input NAND Gate (passive pullup) | MC668 | 10 | 125 | 176/52 ② | 632,646 |
| Dual 4 Input Expander | MC669 | – | – | – | 632,646 |
| Triple 3 Input NAND Gate (passive pullup) | MC670 | 10 | 125 | 132/39 ② | 632,646 |
| Triple 3 Input NAND Gate (active pullup) | MC671 | 10 | 110 | 132/39 ② | 632,646 |
| Quad 2 Input NAND Gate (active pullup) | MC672 | 10 | 110 | 176/52 ② | 632,646 |
| Dual 2 Input AND OR INVERT Gate (active pullup) | MC673 | 10 | 110 | 160/50 ② | 632,646 |
| Dual 2 Input AND OR INVERT Gate (passive pullup) | MC674 | 10 | 125 | 160/50 ② | 632,646 |
| Dual Pulse Stretcher/Multivibrator | MC675 | 10 | 150 (pins 1,6)<br>110 (pins 5,6) | 180 | 632,646 |
| BCD To Decimal Decoder Driver | MC676 | – | 500 | 380 | 620,648 |
| Hex Inverter With Strobe (active pullup) | MC677 | 10 | 110 | 246/96 ② | 620,648 |
| Hex Inverter With Strobe (without output resistors) | MC678 | 10 | 125 | 192/96 ② | 620,648 |
| Dual Lamp/Line Driver | MC679,B | 125 | 0.5 µs typ | 250/30 ② | 632,646 |
| Hex Inverter (active pullup) | MC680 | 10 | 110 | 246/96 ② | 632,646 |
| Hex Inverter (open collector) | MC681 | 10 | 125 | 192/96 ② | 632,646 |
| Quad Latch | MC682 | 10 | 250 | 375 | 620,648 |
| Quad 2 Input Exclusive OR Gate | MC683 | 10 | – | 380 | 632,646 |
| Decade Counter | MC684 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| Binary Counter | MC685 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| 4 Bit Shift Register | MC686 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| Dual J K Flip Flop | MC688 | 10 | 2.5 MHz ③ | 375 | 620,648 |
| Hex Inverter (high voltage) | MC689 | 10 | 150 | 173/55 ② | 632,646 |
| Hex Inverter (active pullup) | MC690 | 10 | 150 | 173/55 ② | 632,646 |
| Hex Inverter/Interface Element | MC691 | 10 | 300 | 500/150 ② | 632,646 |
| 250 mA Quad 2-Input NAND Gate (Schmitt Trigger) | MC693 | 200 | 400 | 300 | 620,648 |
| Dual Interface Element, Line Driver/Receiver (Schmitt Trigger) | MC696 | 10 @ 10 V $V_{CC}$<br>15 @ 25 V $V_{CC}$ | 400 | 225/60 ② | 620,648 |
| Hex Inverter (Passive Pull-up) | MC697 | 10 | 125 | 246/96 ② | 632,646 |
| 500 mA Dual 2-Input AND Gate (Schmitt Trigger) | MC699 | 400 | 400 | 450 | 675,676 |

① L suffix denotes Dual In-Line Ceramic Package, P denotes Dual In-Line Plastic Package (i.e., MC660L = Dual In-Line Ceramic, MC660P = Dual In-Line Plastic Package)

② Inputs High/Input Low ③ $f_{Tog}$



World Radio History

# MONOLITHIC DIODE ARRAYS

## MC1100 Series (-55 to +150°C)

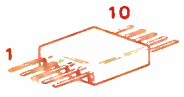
Motorola diode arrays are monolithic multiple junction-isolated diodes, fabricated using a standard integrated circuit planar process. The arrays can be used in any application requiring high current and fast switching.

**MAXIMUM RATINGS** (For each diode, $T_A$ = 25°C Free Air Temperature)

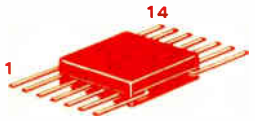
| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Peak Reverse Voltage | $V_R$ | 50 | Vdc |
| Steady-State Reverse Voltage | $V_R$ | 40 | Vdc |
| Peak Forward Surge Current @ $T_A$ = 25°C 1 second) | $I_F$ | 1.0 | Adc |
| Forward Current (1) (Continuous @ $T_A$ = 25°C) | $I_F$ | | mAdc |
| Ceramic Flat Package | | 300 | |
| Dual in line Package | | 400 | |
| Power Dissipation (Continuous @ $T_A$ = 25°C) | $P_D$ | | mW |
| Ceramic Flat Package | | 500 | |
| Dual in line Package | | 600 | |
| Operating Temperature Range (Free Air) | $T_A$ | | °C |
| Ceramic Flat and DIL Package | | -55 to +150 | |
| Plastic DIL Package | | -55 to +125 | |
| Storage Temperature Range | $T_{stg}$ | | °C |
| Ceramic Flat and DIL Package | | -65 to +175 | |
| Plastic DIL Package | | -65 to +125 | |

(1) Derate @ 2.4 mAdc/°C to 150°C (F package).
Derate @ 3.2 mAdc °C to 150°C (L package).
Derate @ 4.0 mAdc °C to 125°C (P package).

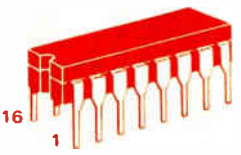
| FUNCTION | TYPE | CASE |
|---|---|---|
| 16 Diode Array | MC1103 | 646, 632, 606 |
| Dual 8 Diode Array | MC1104 | 646, 632, 607 |
| 8 Diode Common Cathode Array | MC1105 | 646, 632, 606 |
| 8 Diode Common Anode Array | MC1106 | 646, 632, 606 |
| Dual 8 Diode Array | MC1107 | 646, 632, 607 |
| 8 Single Monolithic Diodes | MC1108 | 648, 620, 650 |



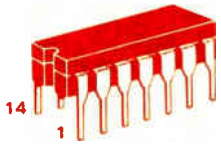

**F SUFFIX**
**CERAMIC PACKAGE**
**CASE 606**
**TO-91**



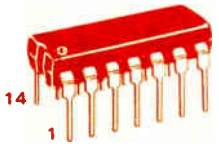

**F SUFFIX**
**CERAMIC PACKAGE**
**CASE 607**




**L SUFFIX**
**CERAMIC PACKAGE**
**CASE 620**




**L SUFFIX**
**CERAMIC PACKAGE**
**CASE 632**




**P SUFFIX**
**PLASTIC PACKAGE**
**CASE 646**

**F SUFFIX**
**CERAMIC PACKAGE**
**CASE 650**



World Radio History

MOTOROLA

# INTERFACE CIRCUITS

The economics of today's marketplace dictate that electronic systems be developed largely with semiconductor devices that are designed and manufactured on a large-volume basis. This requirement, in turn, demands that these semiconductor components be "generic" in design, so that they can be used for a variety of systems with widely diversified capabilities and characteristics.

To a significant degree, the above prerequisites prohibit the tailoring of integrated circuits—even MSI and LSI components—to a specifically designated end-product. While specific families are engineered to work together harmoniously, it is often advantageous to mix functions from a number of families in order to derive performance or economic benefits. And, often, such conglomerates require matching, level translation or driver enhancement.

Even within a single family, interfacing in terms of fan-out enhancement or power boosting is often required.

Motorola's broad line of products, encompassing all popular device families and technologies, has generated a comprehensive insight into interface requirements. It has spawned a large and continuously expanding repertoire of interface circuits to meet the needs of the system designer.

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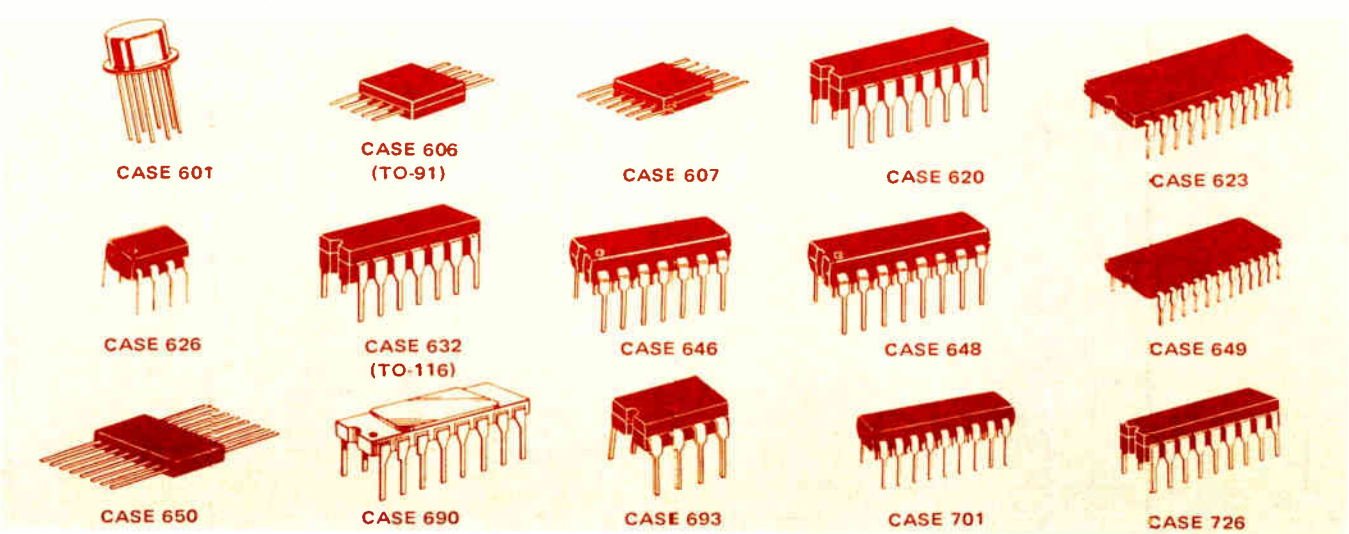
| Computer and Terminal Interface | 82 |
| Peripheral Interface | 84 |
| Numeric Display Interface | 85 |
| Voltage Comparators | 86 |
| Communications Interface (Telephony) | 88 |




World Radio History

# BUS INTERFACE

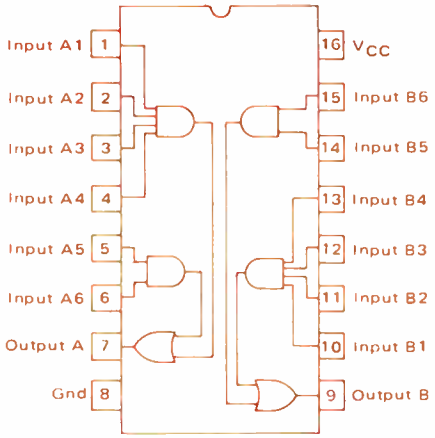
## Computer Bus

Line drivers and receivers designed to operate compatibly. The MC8T13/MC8T14 combination is specified for general TTL system applications. The MC8T23/MC8T24 combination is specifically oriented toward IBM 360/370 system requirements.

### DUAL LINE DRIVERS

MC8T13 – Open emitter driver; specified for general TTL systems.

MC8T23 – Open emitter driver; specified to meet IBM system requirements.




All four devices:
$T_A$ = 0 to 75°C

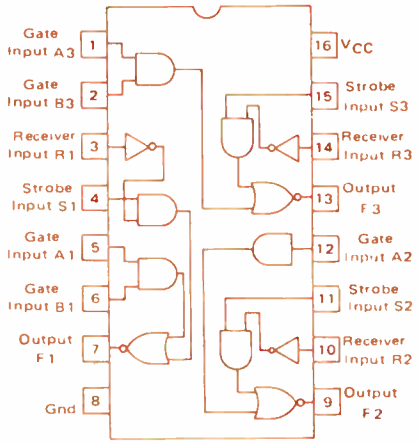
Packages:
L Suffix – Case 620
P Suffix – Case 648

| Device Number | $V_{OH}$ @ $I_{OH}$ = -75 mA @ $I_{OH}$ = -59.3 mA* Volts Max | $I_{OS}$ @ $V_O$ = 0 mA Max | $t_{PLH}$ @ $C_L$ = 15 pF ns Max |
|---|---|---|---|
| MC8T13 | 2.4 | 30 | 20 |
| MC8T23 | 3.11* | -30 | 20 |

### TRIPLE LINE RECEIVERS

MC8T14 – Hysteresis-equipped receiver; specified for general TTL systems.

MC8T24 – Hysteresis-equipped receiver; specified to meet IBM system requirements.



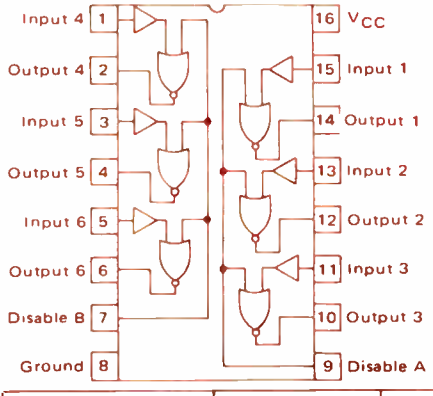

| Device Number | $V_{H(R)}$ Volts Min | $I_{IH(R)}$ @ $V_{IH(R)}$ = 3.8 V @ $V_{IH(R)}$ = 3.11 V* mA Max | $t_{PLH(R)}$ @ $C_L$ = 15 pF ns Max |
|---|---|---|---|
| MC8T14 | 0.3 | 0.17 | 30 |
| MC8T24 | 0.2 | 0.17* | 30 |

## Minicomputer Bus

Transceivers and receivers for bus organized minicomputers employing 120-ohm terminated lines.

### HEX RECEIVERS

MC3437 – Hysteresis-equipped for improved noise immunity. DS8837 equivalent.




All three devices:
$T_A$ = 0 to 70°C

Packages:

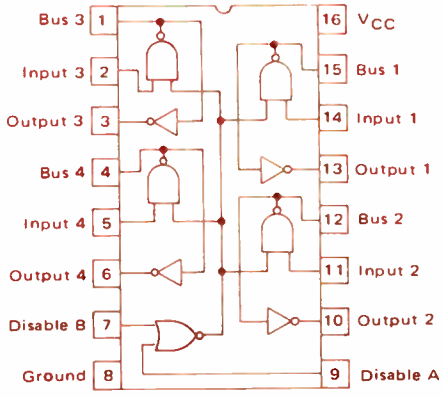
MC3437
MC3438
L Suffix – Case 620
P Suffix – Case 648

DS8641
J Suffix
N Suffix

| $I_{I(R)}$ @ $V_{I(R)}$ = 4.0 V µA Max | Hysteresis Volts Min | $t_{PLH(R)}$ @ $C_L$ = 15 pF ns Max |
|---|---|---|
| 50 | 0.5 | 30 |

### QUAD TRANSCEIVERS

MC3438
DS8641 – Open collector driver outputs allow wire-OR connection. MC3438 has hysteresis-equipped receiver for improved noise immunity (not available with DS8641). MC3438 is equivalent DS8838.




| Receiver Hysteresis Volts Min | $V_{L(BUS)}$ @ $I_{BUS}$ = 50 mA Volts Max | $I_{BUS}$ @ $V_{IH(BUS)}$ = 4.0 V µA Max | $t_{PLH(D)}$ @ $C_L$ = 15 pF ns Max | $t_{PLH(R)}$ @ $C_L$ = 15 pF ns Max |
|---|---|---|---|---|
| 0.25* | 0.7 | 100 | 25 | 30 |

*MC3438 only.



World Radio History

# Microcomputer Bus

This family of devices is designed to extend the limited drive capabilities of today's standard 6800 and 8080 type NMOS microprocessors. All devices are fabricated with Schottky TTL technology for high speed.

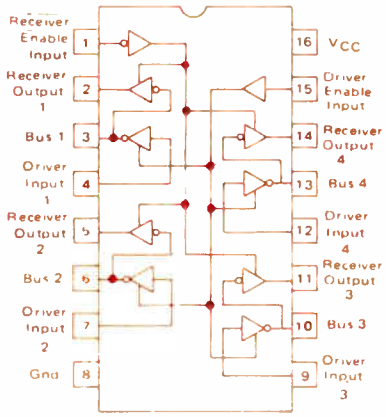
General features include:

- Single +5.0 V Power Supply Requirement
- Three-State Logic Output
- Low Input Loading – 200 μA Max.

## DATA BUS EXTENDERS

Quad, Bidirectional, with 3-State Outputs

MC6880A/MC8T26A# – Inverting

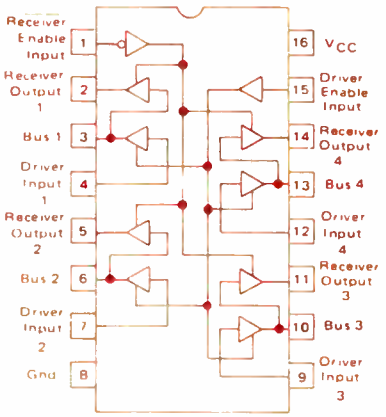



#These devices may be ordered by either of the paired numbers.

Both types:
$T_A$ = 0 to 75°C

Packages:
L Suffix – Case 620
P Suffix – Case 648

MC6889/MC8T28# – Non-inverting

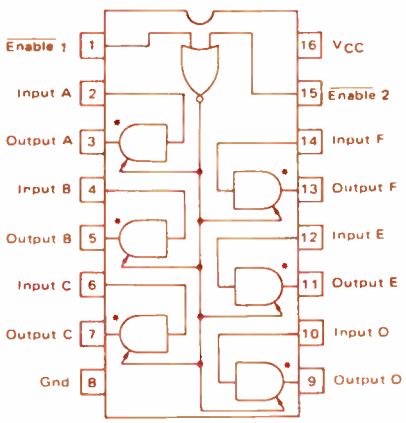



| Device Number | Input Current $I_{IH}$ μA Max | Input Current $I_{IL}$ μA Max | $I_{OHL}$ Output Disabled Leakage Current – High Logic State μA Max | $t_{PLH}$, $t_{PHL}$ Propagation Delay Time – High to Low or Low to High ns Max |
|---|---|---|---|---|
| MC6880A/MC8T26A | 25 | -200 | 100 | 14 |
| MC6889/MC8T28 | 25 | -200 | 100 | 17 |

## ADDRESS AND CONTROL BUS EXTENDERS

Hex, Unidirectional, with 3-State Outputs

MC6885/MC8T95# – Non-inverting
MC6886/MC8T96# – Inverting
Two-input Enable controls all six buffers.



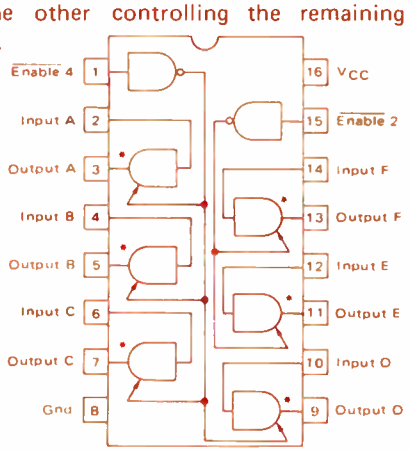

*Add inverter for MC6886/MC8T96.

#These devices may be ordered by either of the paired numbers.

All four types:
$T_A$ = 0 to 75°C

Packages:
L Suffix – Case 620
P Suffix – Case 648

MC6887/MC8T97# – Non-inverting
MC6888/MC8T98# – Inverting
Two Enable inputs, one controlling four buffers and the other controlling the remaining two buffers.




*Add inverter for MC6888/MC8T98.

| $V_{OL}$ @ $I_{OL}$ = 48 mA Volts Max | $V_{OH}$ @ $I_{OH}$ = -5.2 mA Volts Min | $I_{OS}$ mA Typ | $t_{PLH}$ ns Typ | $t_{P(Enable)}$ ns Typ |
|---|---|---|---|---|
| 0.5 | 2.4 | -80 | 6.0 | 11 |

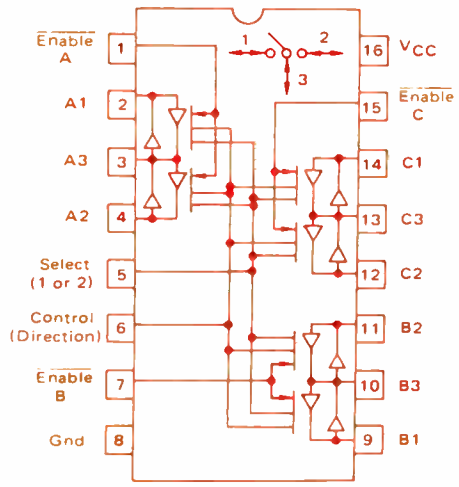


World Radio History

Microcomputer Bus (continued)

## BIDIRECTIONAL BUS SWITCH

MC6881/MC3449# — For exchanging TTL level digital information between selected pairs of ports in a 3-port network.




#This device may be ordered by either of the numbers.

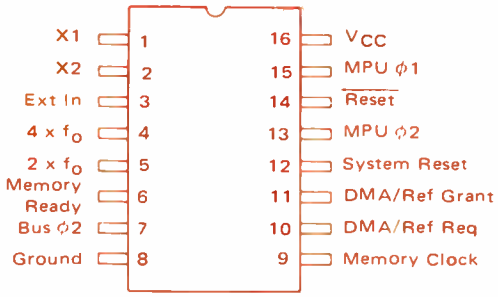
Both types:
$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 620
P Suffix — Case 648

| $V_{OL}$ @ $I_{OL}$ = 8.0 mA Volts Max | $I_{OD}$ @ $V_O$ = 2.7 V µA Max | $I_{IL}$ @ $V_{IL}$ = 0.4 V µA Max | $I_{IH}$ @ $V_{IH}$ = 2.7 V µA Max |
|---|---|---|---|
| 0.5 | 25 | -200 | 40 |

## M6800 CLOCK GENERATOR

MC6875 — Provides the non-overlapping two-phase clock signals for M6800 MPU systems.




$V_{OLC}$ = 0.3 V Max
$V_{OHC}$ = $V_{CC}$ − 0.3 V Min
$f_{op}$ = 2.0 MHz Typ

### MC6881/MC3449 TRUTH TABLE

| Enable | Select | Control | Data Flow |
|---|---|---|---|
| 0 | 0 | 0 | 2→3 |
| 0 | 0 | 1 | 3→2 |
| 0 | 1 | 0 | 1→3 |
| 0 | 1 | 1 | 3→1 |
| 1 | X | X | High Impedance |

X Don't Care

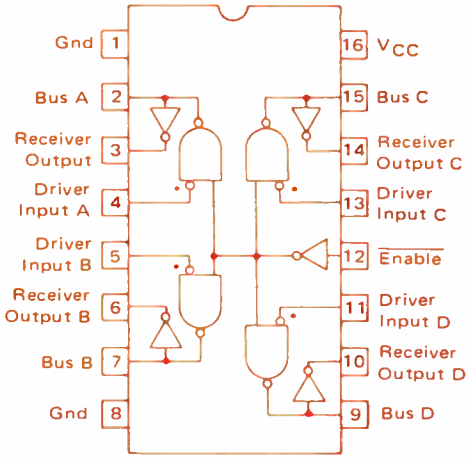
# Instrumentation Bus

## HIGH-CURRENT PARTY-LINE BUS TRANSCEIVERS

Devices for industrial control and data communication.

MC26S10 — Inverting
MC26S11 — Non-inverting

Quad transceivers with open-collector drivers and PNP-buffered inputs for MOS compatibility.




•Inverter on MC26S11 only.

Both types:
$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 620
P Suffix — Case 648

| Test | Condition | Limits |
|---|---|---|
| $V_{OL}$ (D) | $I_{OL}$ = 100 mA | 0.8 Volts Max |
| $I_O$ (D) | $V_{OH}$ = 4.5 V | 100 µA Max |
| $I_{O1}$(D) | $V_{CC}$ = 0 V, $V_{OH}$ = 4.5 V | 100 µA Max |
| $I_{IH}$ (D) | $V_{IH}$ = 2.7 V | 30 µA Max |
| $I_{IL}$ (D) | $V_{IL}$ = 0.4 V | -0.54 mA Max |
| $t_P$ (D) | MC26S10 | 15 ns Max |
| | MC26S11 | 19 ns Max |
| $t_P$ (R) | Both Types | 15 ns Max |



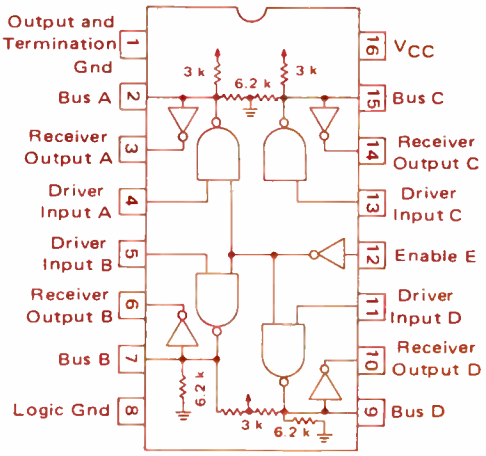
World Radio History

Instrumentation Bus (continued)

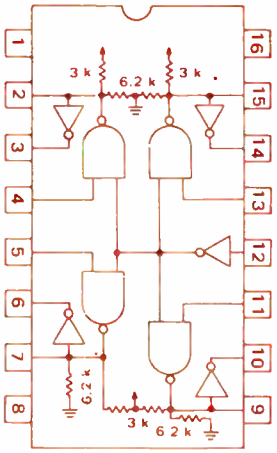
## QUAD INTERFACE TRANSCEIVERS

These devices are designed to meet the HP-IB bus specification of IEEE Standard 488-1975, for the interconnection of Measurement Apparatus.

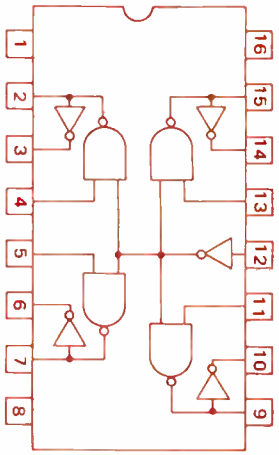
MC3440P – Three drivers with common Enable input; one driver without Enable.



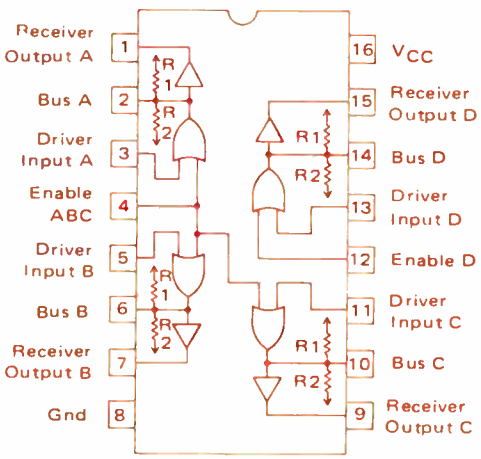

MC3441P – Four drivers with common Enable input.



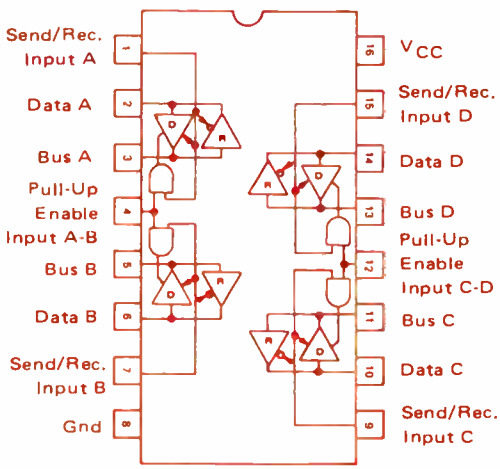

MC3443P – Four drivers with common Enable input; no termination resistors.



MC3446P – For low-power instruments, including MOS.




MC3448P – For common Send-Receive bus; bidirectional.




All types:
$T_A$ = 0 to 70°C
Package – Case 648

| Device Number | Receiver Input Hysteresis mV Min | Drive Output Voltage @ $I_{OL}$ = 48 mA; Volts Max | Bus Divider Voltage Volts | $t_{PHL}$ (Driver or Receiver) ns Max |
|---|---|---|---|---|
| MC3440P | 400 | 0.4 | 2.6 to 3.75 | 30 |
| MC3441P | 400 | 0.4 | 2.6 to 3.75 | 30 |
| MC3443P | 400 | 0.4 | – | 25(D) 22(R) |
| MC3446P | 400 | 0.4 | 2.5 to 3.7 | 50 |
| MC3448P | 400 | 0.4 | 2.5 to 3.7 | 35 |

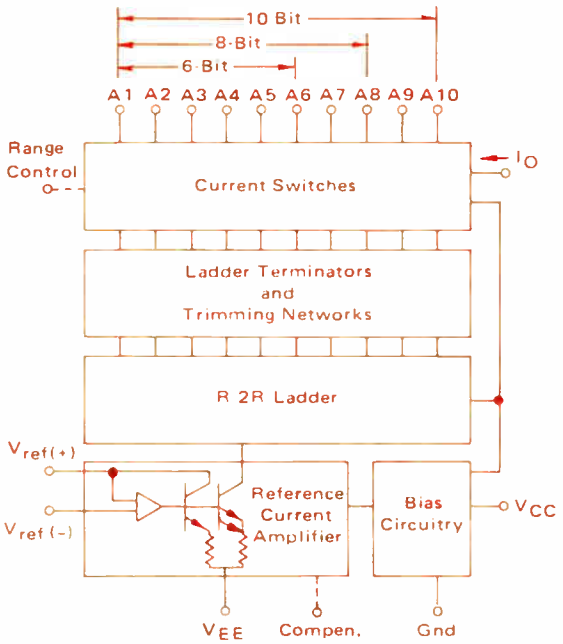


World Radio History

# A-D/D-A CONVERSION

Low-cost building blocks for construction of D-A/A-D systems. Involves use of advanced technologies such as ion implantation, laser trimming and CMOS processing where necessary to achieve the required functional capability, operating accuracy and production repeatability.

## D-A Converters




– – – Dotted terminals available on 6- and 8-bit units only.

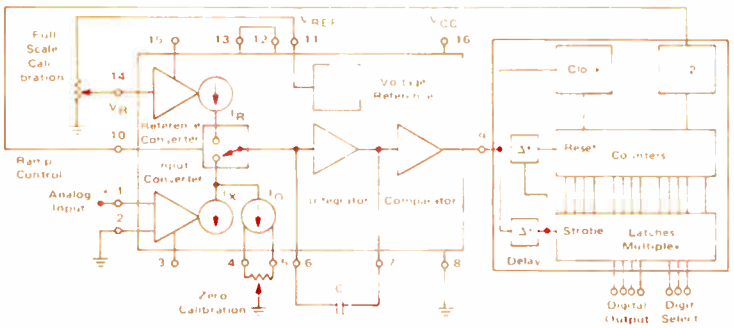
Multiplying D-A converters designed to supply an output current that is a linear product of an analog input reference voltage and a digital input word. Devices for 6-, 8- and 10-bit digital word inputs are available.

| Device Number | Error % Max | $P_D$ @ $V_{EE}$ = -5 V mW Max | $t_{Settling}$ ns Typ | $I_O$ @ $V_{Ref}$ = 2 V mA | Suffix | Case |
|---|---|---|---|---|---|---|
| 6 Bit | | | | | | |
| MC1506* | ±0.78 | 120 | 150 | 1.9 to 2.1 | L | 632 |
| MC1406 | | | | | | |
| 8 Bit | | | | | | |
| MC1508L8* | ±0.19 | 170 | 300 | 1.9 to 2.1 | L | 620 |
| MC1408L8 | | | | | | |
| MC1408L7 | ±0.39 | | | | L, P | 620, 648 |
| MC1408L6 | ±0.78 | | | | | |
| MC3408 | ±0.5 | | | | L | 620 |
| 10 Bit | | | | | | |
| MC3510* | ±0.05 | 220 | 250 | 3.8 to 4.2 | L | 690 |
| MC3410 | | | | | | |
| MC3410C | ±0.1 | | | | L, P | 690, 648 |

*$T_A$ = -55 to 125°C,
Devices without asterisk: $T_A$ = 0 to 70°C.

## A-D Subsystems

### 2-Chip A-D Converter System Functional Diagram




These devices are relatively complex subsystems. The bipolar, dual-ramp A-D converter has up to 4-1/2-digit conversion capability. The CMOS logic subsystem specifically adapts the A-D converter to a 3-1/2-digit DVM function.

MC1505/1405 – A-D Converter

MC14435 – Digital Logic
(See Semiconductor Data Library Vol. 5 for data.)

MC1505L – $T_A$ = -55 to 125°C – Case 620
MC1405L – $T_A$ = 0 to 70°C – Case 620

MC14435EFL/EVL* – $T_A$ = -55 to 125°C – Case 620
MC14435FL/VL* – $T_A$ = -40 to 85°C – Case 620
MC14435FP/VP* – $T_A$ = -40 to 85°C – Case 648

| Linearity Error % Max | Voltage Reference Volts | Temperature Coefficient of Reference %/°C | $I_{CC}$ @ $V_{CC}$ = 5.0 V mA Max |
|---|---|---|---|
| ±0.05 | 1.15 to 1.35 | 0.005 | 12 |

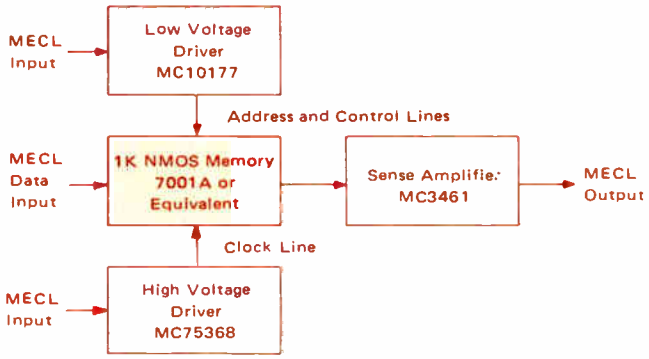
| $P_{C(quiescent)}$ @ $V_{DD}$ = 5.0 V mW Max | $I_{OL}$ @ $V_{DD}$ = 5.0 V (Digit Selects) mA Min | $I_{OL}$ @ $V_{DD}$ = 5.0 V (BCD Outputs) mA Min | $I_{OL}$ @ $V_{DD}$ = 5.0 V (All Outputs) mA Min |
|---|---|---|---|
| 1.75 | 1.6 | 1.6 | -0.2 |

*MC14435EFL/FL/FP: $V_{DD}$ = 3.0 to 18 Vdc
MC14435EVL/VL/VP: $V_{DD}$ = 3.0 to 6.0 Vdc


World Radio History

# NMOS Memories to MECL Systems

The high-speed capabilities of some NMOS memories (example: 7001A types) make them desirable for use in conjunction with MECL logic for some applications. Yet, the *positive* input requirements of NMOS memories are incompatible with the negative voltage levels characteristic of the MECL family. Hence, level conversion is required—for both input and output matching of the NMOS memory. The interface devices below include driver/translators to feed the memory inputs and a sense amplifier to match the output.

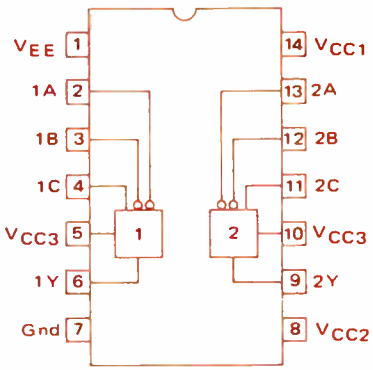



## DRIVER/TRANSLATORS

MECL-to-MOS driver/translators convert standard MECL 10,000 input signals to suitable levels for NMOS memory systems. The MC75358 and MC75368 may also be used as positive logic NOR or non-inverting gates.

MC75368, MC75358 — Dual Clock Line Drivers suitable for driving address, control, and timing inputs.

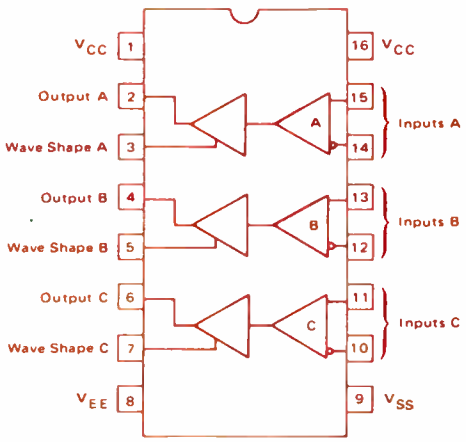
MC10177L — Triple Line Driver for driving address and control inputs.




Maximum Supply Voltage:
MC75368 = 18 V
MC75358 = 22 V

$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 632
P Suffix — Case 646




$T_A$ = -30 to 85°C
Package — Case 620

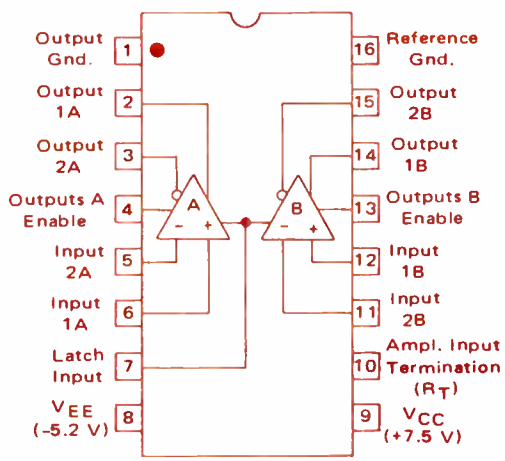
| Device Number | $V_{OH}$ Volts Min | @ $I_{OH}$ mA | $V_{OL}$ Volts Max | @ $I_{OL}$ mA | $t_{DHL}$ ns Max | @ $C_L$ pF |
|---|---|---|---|---|---|---|
| MC75368 | $V_{CC2}$ - 0.3 | 0.1 | 0.3 | 10 | 26 | 300 |
| MC75358 | $V_{CC2}$ - 0.3 | 0.1 | 0.3 | 10 | 24 | 390 |
| MC10177 | 4.0 | 15 | 0.5 | 1.0 | 6.0 | 350 |

## SENSE AMPLIFIER

MC3461L — Dual Sense Amplifier with MECL 10,000-compatible control inputs and complementary, open-emitter outputs. Designed for 7001 and 2105 type NMOS 1K RAMs.

| $I_{TH}$ µA Max | $t_{PD}$ (Amplifier) ns Max | $t_{PD}$ (Enable) ns Max |
|---|---|---|
| ±200 | 10 | 5.0 |

$T_A$ = 0 to 75°C
Package — Case 620

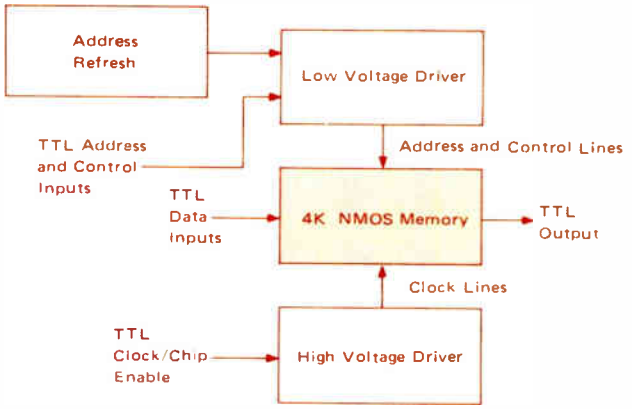





World Radio History

# NMOS Memories to TTL Systems

The highly capacitive loads represented by NMOS memories are, in themselves, incompatible with the drive capabilities of conventional TTL logic circuits. So, also, are some of the voltage levels. The devices shown are used to match TTL capabilities to various types of popular NMOS memories.

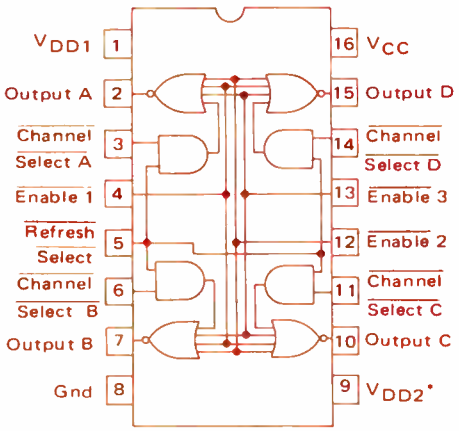



## CLOCK AND CHIP ENABLE LINE DRIVERS (High Level)

MC3460, MC3466, MC3245 — Quad Clock Drivers with Refresh Select Logic

MC75365 — Quad Clock Driver or High-Current NAND Gate

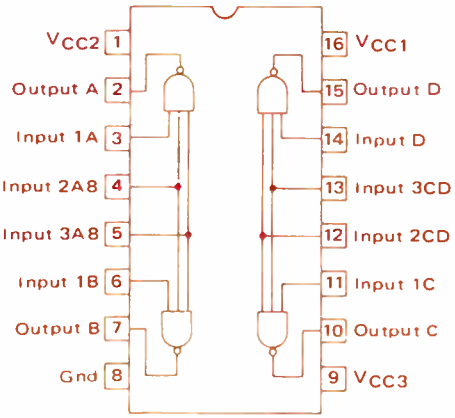
MMH0026, MMH0026C — Dual Clock Driver




*MC3245 — no connection; $V_{DD2}$ not required.

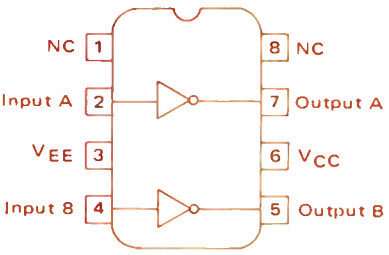
$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 620
P Suffix — Case 648




$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 620
P Suffix — Case 648




(Pin Connections for U or P1 Package)

$T_A$:
MMH0026 — -55 to 125°C
MMH0026C — 0 to 70°C

Packages
G Suffix — Case 601
L Suffix — Case 632
U Suffix — Case 693
P1 Suffix — Case 626 (For MMH0026C only)

| Device Number | $V_{OH}$ Volts Min | @ $I_{OH}$ mA | $V_{OL}$ Volts Max | @ $I_{OL}$ mA | $t_{DHL}$ ns Max | @ $C_L$ pF | Feature |
|---|---|---|---|---|---|---|---|
| MC3460 | $V_{DD1}$ - 1.0 | -2.0 | 0.55 | 40 | 23 | 480 | Specified for use with 4K NMOS dynamic memories. |
| MC3466 | $V_{DD1}$ - 1.3 | -40 | 0.55 | 40 | 24 | 480 | Specified for use with 1K NMOS dynamic memories (e.g., 7001A types). |
| MC3245 | $V_{DD}$ - 0.5 | -1.0 | 0.45 | 5.0 | 32 | 250 | Does not require second high voltage supply. Low input loading. |
| MC75365 | $V_{CC2}$ - 0.3 | -0.1 | 0.3 | 10 | 18 | 200 | Derives $V_{CC1}$ power from TTL 5-V supply, and $V_{CC2}$ and $V_{CC3}$ from $V_{SS}$ and $V_{BB}$ supplies from NMOS memories. |
| MMH0026 MMH0026C | $V_C$ - 1.0 | 0.4 V* | $V_{EE}$ + 1.0 | 2.4 V* | 12 | 1000 | For very high capacitance loads. |

*@ $V_I$ - $V_{EE}$

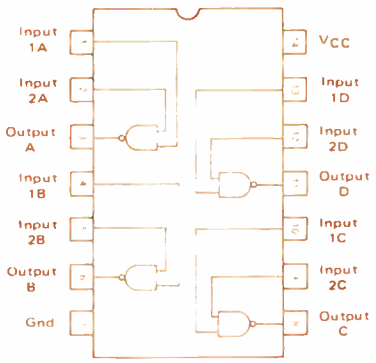


World Radio History

NMOS Memories to TTL Systems (continued)

## DATA AND ADDRESS LINE DRIVERS
## (Low Level)

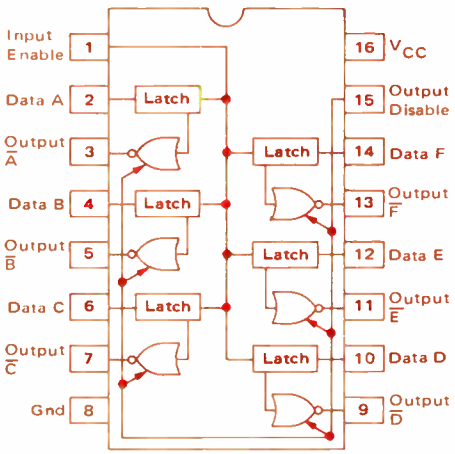
MC3459 — Quad Address Line Driver




$T_A$ = 0 to 70°C

Packages:
L Suffix — Case 632
P Suffix — Case 646

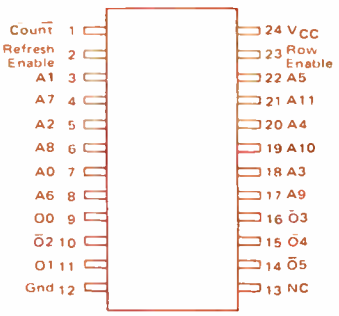
DS3645
DS3675 } — Hex 3-State Latch/Drivers. Output dumping resistor on DS3675




$T_A$ = 0 to 75°C

Packages:
J Suffix — Case 620
N Suffix — Case 648

MC3232A — Address Multiplexer and Refresh Counter




$T_A$ = 0 to 75°C

Packages
L Suffix — Case 649
P Suffix — Case 623

| Device Number | $V_{OH}$ Volts Min | @ $I_{OH}$ mA | $V_{OL}$ Volts Max | @ $I_{OL}$ mA | Propagation Delay ns Max | @ $C_L$ pF | Features |
|---|---|---|---|---|---|---|---|
| MC3459 | 2.4 | -2.0 | 0.7 | 80 | 26 | 360 | High fan-out capability. |
| DS3645 | 2.4 | -1.0 | 0.6 | 20 | 25 Typ | 500 | Extremely low input currents for MOS input compatibility. |
| DS3675 | 2.5 | -1.0 | 0.3 | 20 | | | |
| MC3232A | 2.8 | -1.0 | 0.4 | 50 | 25 | 250 | Multiplexes the 12 address bits to the 6 input address pins of 16-pin 4K RAMs. |

## MEMORY I/O REGISTERS
## (Hex)

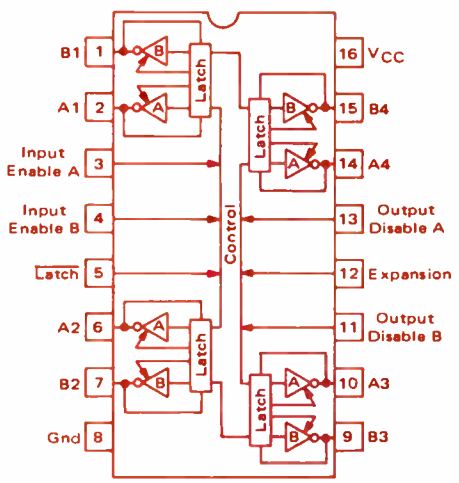
**B Output**

DS3647 — Inverting, 3-State
DS3677 — Non-inverting, 3-State
DS36147 — Inverting, Open Collector
DS36177 — Non-inverting, Open Collector

These registers, with two I/O ports per bit, can handle bidirectional data, with the direction of data controlled by Input Enables. An Expansion input disables both A and B outputs to permit multiplexing of other registers.

$T_A$ = 0 to 70°C

Packages:
J Suffix — Case 620
N Suffix — Case 648



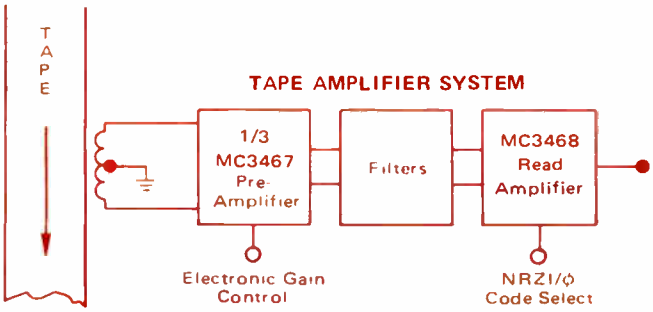



World Radio History

# Magnetic Memories to TTL Systems

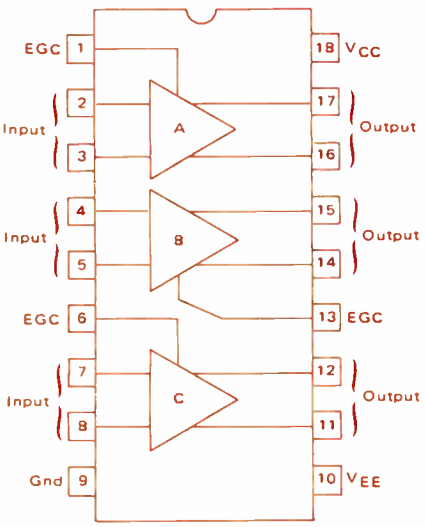
## SENSE AMPLIFIERS

### . . . for Magnetic Tape Memories



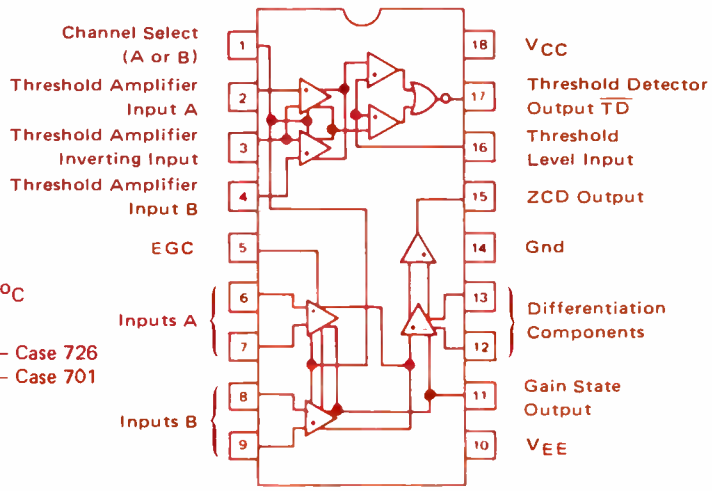

A two-component preamplifier/amplifier combination that provides the interface between magnetic tape heads and digital logic. Suitable for both open reel and cartridge tape systems. Triple preamp has individually adjustable gain controls. LSI Read Amplifier performs peak detection and threshold detection functions, as required for NRZI/phase encoded recording formats.

MC3467 – Triple Preamplifier




Both types:
$T_A$ = 0 to 70°C
Packages:
L Suffix – Case 726
P Suffix – Case 701

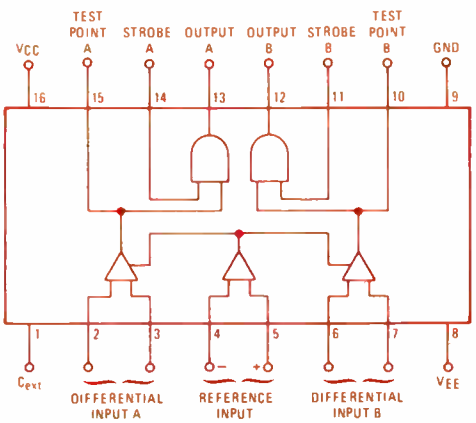
MC3468 – Read Amplifier




### . . . for Core Memories

Feature adjustable threshold, time and amplitude signal discrimination, dual inputs with independent outputs, and a range of options.

**Representative Diagram (MC5528/29)***




*Pin assignment slightly different for devices without test points.

| | $T_A$ = -55 to 125°C | | $T_A$ = 0 to 70°C | | Test Points |
|---|---|---|---|---|---|
| AND Output | MC5524 | MC5525 | MC7524 | MC7525 | No |
| | MC5528 | MC5529 | MC7528 | MC7529 | Yes |
| NAND Output | MC5534 | MC5535 | MC7534 | MC7535 | No |
| | MC5538 | MC5539 | MC7538 | MC7539 | Yes |
| $V_{TH}$ @ $V_{Ref}$ = 15 mV | 10 to 20 mV | 8 to 22 mV | 11 to 19 mV | 8 to 22 mV | |
| $V_{TH}$ @ $V_{Ref}$ = 40 mV | 35 to 45 mV | 33 to 47 mV | 36 to 44 mV | 33 to 47 mV | |
| Max $I_{IB}$ | 100 µA | 100 µA | 75 µA | 75 µA | |
| Max $t_{PLH}$ @ $C_L$ = 15 pF | 40 ns | 40 ns | 40 ns | 40 ns | |
| Packages | L Suffix – Case 620 | | L Suffix – Case 620<br>P Suffix – Case 648 | | |



World Radio History

## Magnetic Memories to TTL Systems (continued)

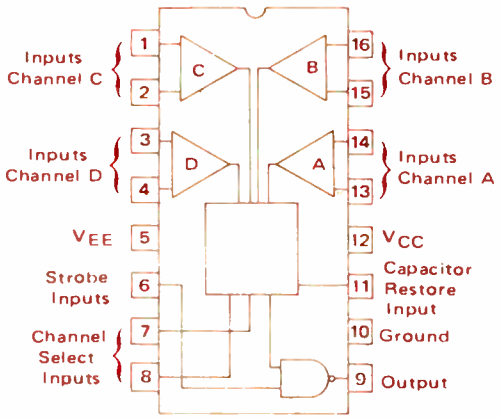
### SENSE AMPLIFIERS (continued)

**. . . for Plated Wire and Thin-Film Memories** and other low-level sensing applications.

MC1544 – $T_A$ = -55 to 125°C
MC1444 – $T_A$ = 0 to 70°C

Features 4-channel input with decoded channel selection and strobed output capability.

Packages:
- MC1544
  - L Suffix – Case 620
  - F Suffix – Case 650
- MC1444
  - L Suffix – Case 620



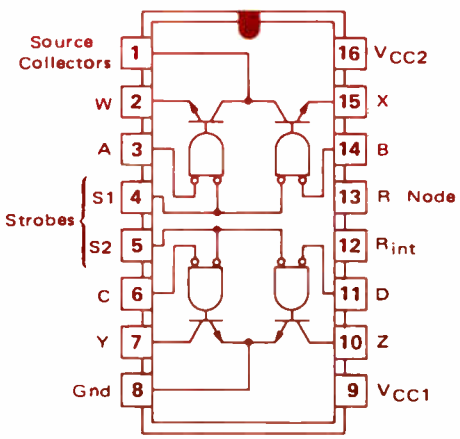

| Device Number | $V_{TH}$ mV | $V_{OH}$ @ $I_{OH}$ = -400 µA Volts Min | $V_{OL}$ @ $I_{OL}$ = 10 mA Volts Max | $t_{PD}$ ns Max |
|---|---|---|---|---|
| MC1544 | 0.5 to 1.5 | 2.4 | 0.5 | 25 |
| MC1444 | 0.3 to 2.3 | 2.4 | 0.5 | 25 |

## CORE DRIVER

MC55325 – $T_A$ = -55 to 125°C
MC75325 – $T_A$ = 0 to 70°C

Contains two source switches and two sink switches. Source and sink selection is determined by one of two logic inputs, and turn-on is determined by the appropriate strobe.

Packages:
- L Suffix – Case 620
- F Suffix – Case 650
- P Suffix – Case 648 (MC75325 only)




| Device Number | $V_{sat}$ @ $I_{sink}$ or $I_{source}$ = 600 mA Volts Max | $I_{off}$ @ $V_{CC2}$ = 24 V µA Max | $t_{PLH}$ (Source) ns Max | $t_{PLH}$ (Sink) ns Max |
|---|---|---|---|---|
| MC55325 | 0.70 | 150 | 50 | 45 |
| MC75325 | 0.75 | 200 | 50 | 45 |



World Radio History

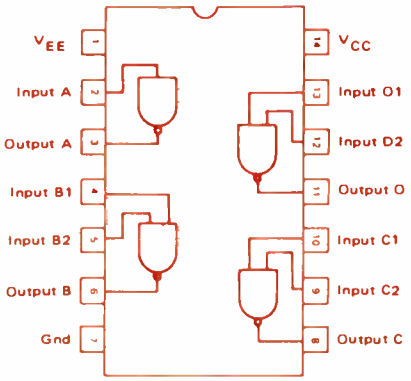
## LINE DRIVERS AND RECEIVERS
for Modem/Terminal Applications

# Voltage Mode

### RS-232C SPECIFICATION

#### DRIVER

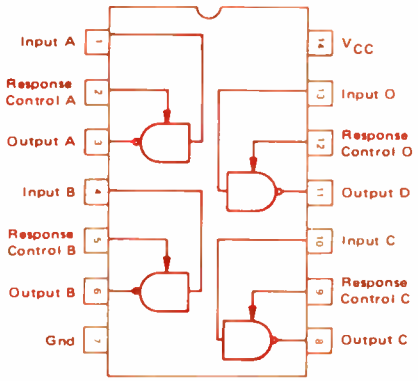
MC1488 – Quad; output current limiting.




All devices:
$T_A$ = 0 to 70°C
Package:
L Suffix – Case 632

#### RECEIVERS

MC1489 – Quad; 0.25 V input hysteresis.
MC1489A – Quad; 1.1 V input hysteresis.



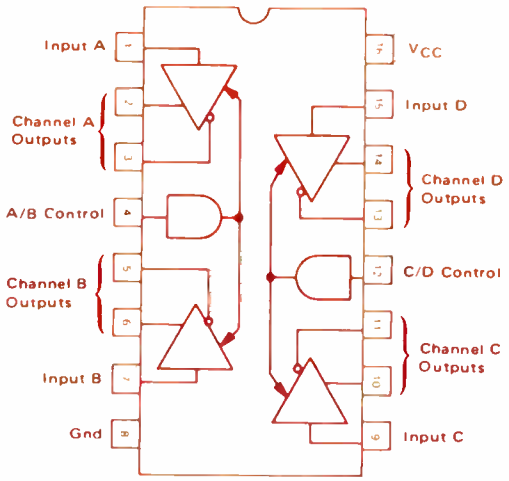

| $V_{OH}$ @ $V_{CC}/V_{EE}$ = +9.0 V Volts Min | $V_{OL}$ @ $V_{CC}/V_{EE}$ = +9.0 V Volts Max | $I_{OS}$ mA | $t_{PHL}$ @ $C_L$ = 15 pF ns Max |
|---|---|---|---|
| 6.0 | -6.0 | ±6.0 to 12 | 175 |

| Device Number | Input $V_{IHL}$ Volts | Input $V_{ILH}$ Volts | $t_{PHL}$ @ $R_L$ = 390 Ω ns Max |
|---|---|---|---|
| MC1489 | 1.0 to 1.5 | 0.75 to 1.25 | 50 |
| MC1489A | 1.75 to 2.25 | 0.75 to 1.25 | 50 |

### RS-422/423 SPECIFICATION

#### DRIVER

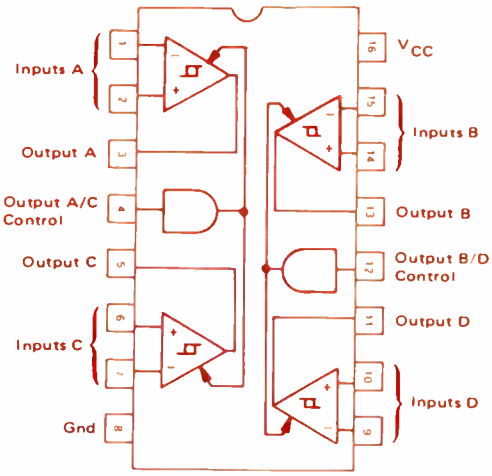
MC3487 – Quad; three-state outputs.




Both devices:
$T_A$ = 0 to 70°C
Packages:
L Suffix – Case 620
P Suffix – Case 648

#### RECEIVER

MC3486 – Quad; three-state outputs and input hysteresis.




| $V_{OH}$ @ $I_{OH}$ = 50 mA Volts Min | $V_{OL}$ @ $I_{OL}$ = 48 mA Volts Max | $V_{OD}$(Differential) @ $R_L$ = 100 Ω Volts Min | $t_{PLH}/t_{PHL}$ ns Typ |
|---|---|---|---|
| 2.0 | 0.5 | 2.0 | 15 |

| $V_{TH(D)}$ @ $V_{ICM}$ = ±7.0 V Volts Max | $I_{ID}$ @ $V_{ID}$ = ±10 V $V_{CC}$ = 0 to 5.25 V mA Max | $t_{PHL}/t_{PLH}$ ns Typ | $t_{P(Control)}$ ns Typ |
|---|---|---|---|
| ±0.2 | +3.25 | 20/25 | 25 |



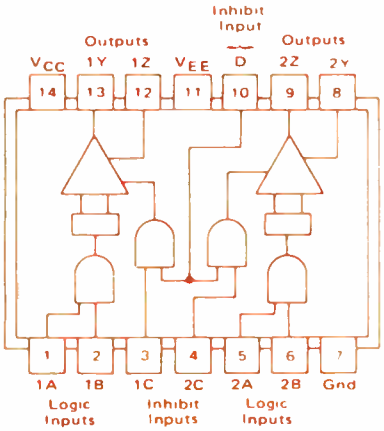
World Radio History

Line Drivers and Receivers for Modem/Terminal Applications (continued)

# Differential Current Mode

## DRIVERS

MC75110 – Dual; industry standard.

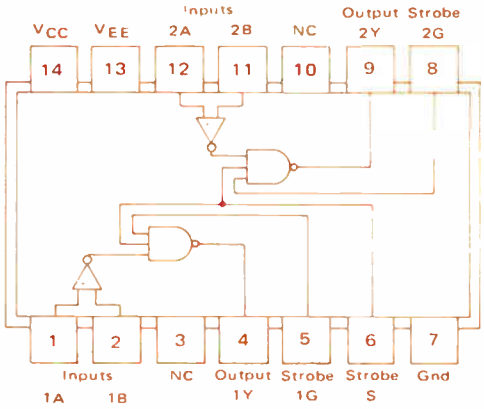



$T_A$ = 0 to 70°C
(MC75xxx)
-55 to 125°C
(MC55xxx)

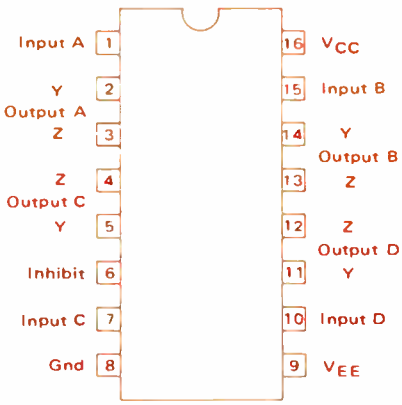
Packages:
L Suffix – Case 632
P Suffix – Case 646
(MC75xxx only)

## RECEIVERS

MC75107/MC55107 – Dual; active pullup output.
MC75108/MC55108 – Dual; open collector output.




MC3453 – Quad; common inhibit input; current sink approximately 12 mA.

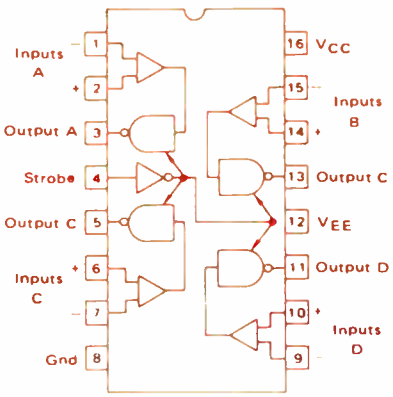



All three devices:
$T_A$ = 0 to 70°C

Packages:
L Suffix – Case 620
P Suffix – Case 648

MC3450 – Quad; active pullup outputs; common three-state enable.

MC3452 – Quad; open collector outputs.




### BOTH DRIVERS

| $I_O$ (on) mA Min | $I_O$ (off) µA Max | $t_{PHL}$ ns Max |
|---|---|---|
| 6.5 | 100 | 15 |

### ALL RECEIVERS

| Input $V_{TH}$ mV Max | $I_{IH}$ @ $V_{ID}$ = 0.5 V µA Max | $I_{IL}$ @ $V_{ID}$ = -2.0 V µA Max | $t_{PLH}$ ns Max |
|---|---|---|---|
| ±25 | 75 | -10 | 25 |



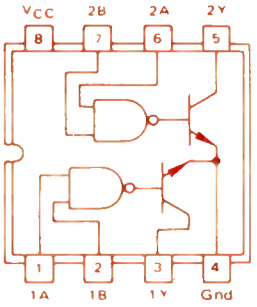
World Radio History

# Dual Drivers

. . . for relays, lamps, and other peripherals requiring more power than generally available from logic gates.

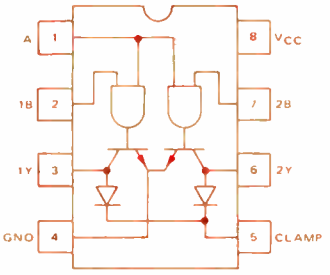
**Representative Diagrams**

**MC754xx Series**




(MC75451/MC75461)

**MC147x Series**



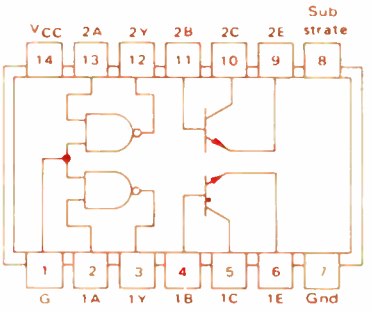

(MC1472)

Logic gates vary to provide output shown

| Logic Output (Including Transistor Inversion) | $BV_{CER}$ | | | |
|---|---|---|---|---|
| | 30 V | 30 V | 35 V | 70 V Hi-Z Input |
| AND | MC75451 | SN75451B* | MC75461 | MC1471 # |
| NAND | MC75452 | SN75452B* | MC75462 | MC1472 |
| OR | MC75453 | SN75453B* | MC75463 | MC1473 # |
| NOR | MC75454 | SN75454B* | MC75464 | MC1474 # |

*Same as equivalent MC types, but with guaranteed switching limits.
#To be introduced.

MC75450 – Similar to MC75451, but with uncommitted output transistors.




All Devices
$T_A$ = 0 to 70°C

Packaging:
MC75450
L Suffix – Case 632
P Suffix – Case 646
MC75451–54/MC75461–64
P Suffix – Case 626
U Suffix – Case 693
MC1471–74
P1 Suffix – Case 626
U Suffix – Case 693

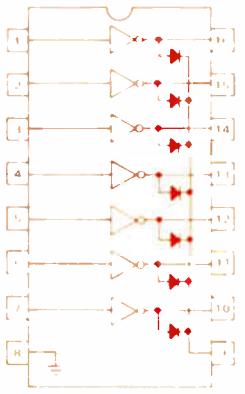
# Driver Arrays

. . . Seven Darlington transistors with output clamp diodes.

| Device Number | Application | Input Element |
|---|---|---|
| MC1411 | General Purpose | Basic |
| MC1412 | 14–25 V PMOS | Zener and Series 10.5 kΩ resistor |
| MC1413 | 5 V CMOS or TTL | Series 2.7 kΩ resistor |
| MC1416 | 8–18 V MOS | Series 10.5 kΩ resistor |

All Types:
$V_{Max}$ = 50 V
$I_{Max}$ = 500 mA
$T_A$ = 0 to 85°C

Packages:
L Suffix – Case 620
P Suffix – Case 648

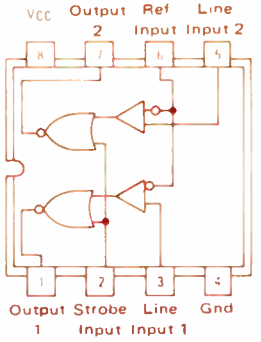


# Dual Receiver

MC75140P1 – Dual single-ended receiver with common strobe and reference inputs for maximizing noise immunity. Useful for bus-organized (party line) TTL systems.

| $V_{TH}$ | $V_{Ref}$ | $t_{PLH(L)}$ |
|---|---|---|
| ±100 V | 1.5 to 3.5 V | 35 ns |

$T_A$ = 0 to 70°C
Package – Case 626





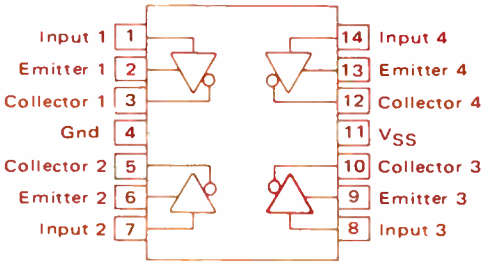

World Radio History

# NUMERIC DISPLAY INTERFACE

. . . for mating multiplexed LED or gas discharge numeric displays to MOS or TTL logic systems.

## LED Drivers for Common-Cathode Displays

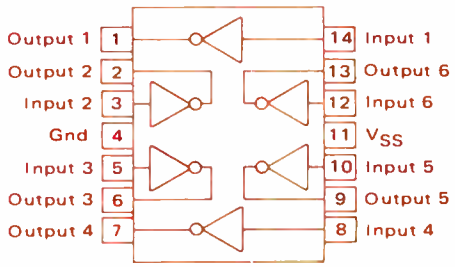
MC75491 – Quad segment driver




Both Devices:
$T_A$ = 0 to 70°C

Packages:
L Suffix – Case 632
P Suffix – Case 646

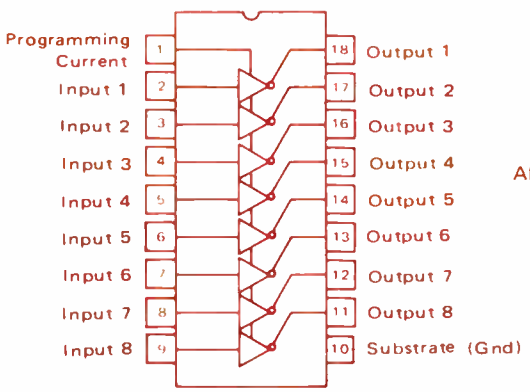
MC75492 – Hex digit driver




| Device Number | $I_I$ @ $V_I$ = 10 V mA Max | $V_{OL}$ Volts Max | @ $I_{OL}$ mA | $V_{SS}$ Volts Max |
|---|---|---|---|---|
| MC75491 | 3.3 | 1.2 | 250 | 10 |
| MC75492 | 3.3 | 1.2 | 50 | 10 |

## Gas Discharge Drivers

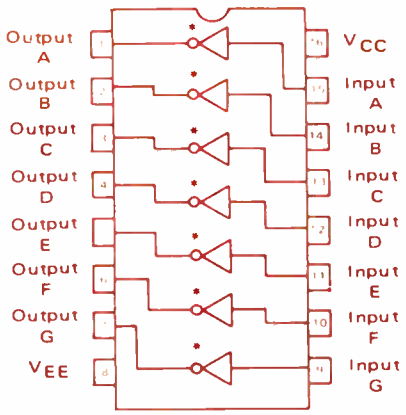
MC3491
MC3492 – Eight segment cathode drivers with programmable current.




All Devices:
$T_A$ = 0 to 70°C

Package: P Suffix – Case 701

MC3490 – High Level
MC3494 – Low Level
Seven digit anode drivers




*Inverter on MC3494 only.
Package: P Suffix – Case 648

| Device Number | Output ON Current mA Max | Breakdown Voltage Volts Min | Current Deviation (All 8 Outputs) % Max | Output Voltage Compliance Range Volts |
|---|---|---|---|---|
| MC3491 | 1.85 | 80 | 10 | 5.0 to 50 |
| MC3492 | 5.25 | 80 | 10 | 5.0 to 50 |

| Device Number | Breakdown Voltage Volts Min | Input Voltage (OFF-State) Volts | Input Voltage (ON-State) Volts | Input Current µA Max |
|---|---|---|---|---|
| MC3490 | 48 | -5.0 Min | -2.0 Max | 450 |
| MC3494 | 48 | -2.0 Max | -5.0 Min | -350 |

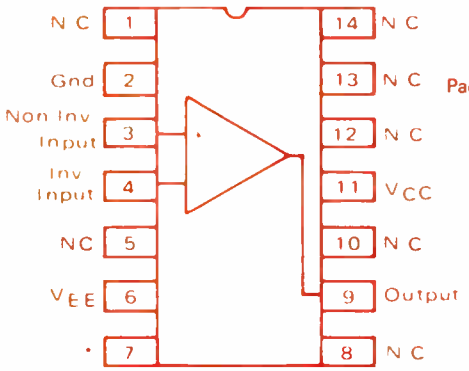


World Radio History

# General Purpose Comparators

. . . for detecting the polarity relationship between two analog levels and giving a corresponding TTL output.

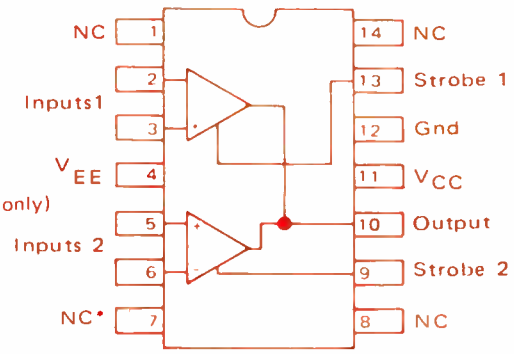
MC1710 – $T_A$ = -55 to 125°C
MC1710C – $T_A$ = 0 to 70°C
Single comparators




*Connected to pin 6 via the substrate on some plastic units.

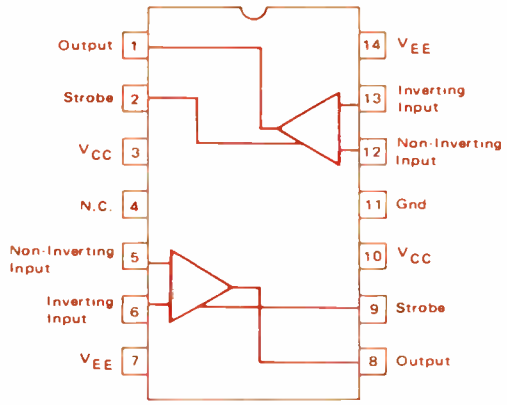
Packages:
G Suffix – Case 601
F Suffix – Case 606
L Suffix – Case 632
P Suffix – Case 646 (for MC1710C, MC1711C only)

MC1711 – $T_A$ = -55 to 125°C
MC1711C – $T_A$ = 0 to 70°C
Dual comparators with strobes and wire-ORed outputs




*Connected to pin 4 via the substrate on some plastic units.

MC1514 – $T_A$ = -55 to 125°C
MC1414 – $T_A$ = 0 to 70°C
Dual comparators with strobes.




Packages:
F Suffix – Case 607
L Suffix – Case 632
P Suffix – Case 646 (MC1414 only)

| Device Number | $V_{IO}$ mV Max | $I_{IB}$ µA Max | $A_{VOL}$ V/V Min |
|---|---|---|---|
| MC1710C | 5.0 | 25 | 1000 |
| MC1710 | 2.0 | 20 | 1250 |
| MC1711C | 5.0 | 100 | 700 |
| MC1711 | 3.5 | 75 | 700 |
| MC1514 | 2.0 | 20 | 1250 |
| MC1414 | 5.0 | 25 | 1000 |



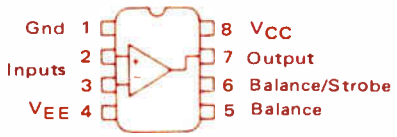
World Radio History

# Precision Comparators

. . . featuring low input loading, high voltage gain, and a choice of either dual or single positive power supply operation.

MLM111 – $T_A$ = -55 to 125°C
MLM211 – $T_A$ = -25 to 85°C
MLM311 – $T_A$ = 0 to 70°C

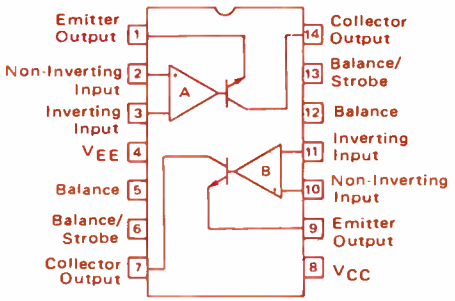
Single comparators; high gain, high input impedance; strobe and balance inputs provided.




Packages:
G Suffix – Case 601
F Suffix – Case 606
L Suffix – Case 632
P1 Suffix – Case 626 (MLM311 only)

MC3411 – $T_A$ = 0 to 70°C
Dual 311-type comparator.

Packages:
L Suffix – Case 632
P Suffix – Case 646




| Device Number | $V_{IO}$ mV Max | $I_{IB}$ nA Max | $V_{OL}$ @ $I_{OL}$ = 50 mA Volts Max |
|---|---|---|---|
| MLM111 | 3.0 | 100 | 1.5 |
| MLM211 | 3.0 | 100 | 1.5 |
| MLM311 | 7.5 | 250 | 1.5 |
| MC3411 | 7.5 | 250 | 1.5 |

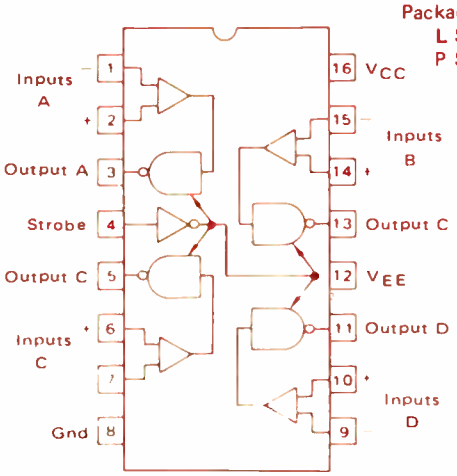
# Quad Comparators

. . . for applications requiring multiple comparators.

MC3430
MC3431
} – High-speed quad comparators with three-state Enable common to all four devices; ±5 volt supply; $T_A$ = 0 to 70°C.

MC3432
MC3433
} – Quad comparators with open collector outputs, common strobe input; ±5 volt supply; $T_A$ = 0 to 70°C.

Packages:
L Suffix – Case 620
P Suffix – Case 648



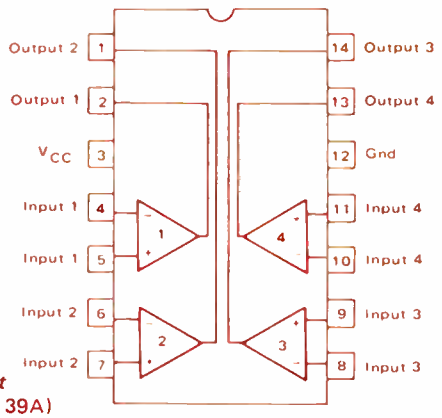

| Device Number | $V_{IS}$ mV Max | $I_{IB}$ µA Max | $t_{PHL}$ ns Max |
|---|---|---|---|
| MC3430 | ±6.0 | 20 | 45 |
| MC3431 | ±10 | 20 | 45 |
| MC3432 | ±6.0 | 20 | 50 |
| MC3433 | ±10 | 20 | 50 |

MLM139
MLM139A
} – $T_A$ = -55 to 125°C

MC3302
MLM239
MLM239A
} – $T_A$ = -40 to 85°C

MLM339
MLM339A
} – $T_A$ = 0 to 70°C

Single supply voltage comparators.




Packages:
L Suffix – Case 632
P Suffix – Case 646 (For all devices *except* MLM139, MLM139A)

| Device Number | $V_{IO}$ @ 25°C mV Max | $I_{IB}$ @ 25°C nA Max | $I_{sink}$ @ $V_{OL}$ = 500 mV mA Min | $V_{OL}$ @ $I_{OL}$ = 2.0 mA* @ $I_{OL}$ = 4.0 mA mV Max |
|---|---|---|---|---|
| MC3302 | 20 | 1000 | – | 400* |
| MLM139 | 5.0 | 100 | 6.0 | 500 |
| MLM139A | 2.0 | 100 | 6.0 | 500 |
| MLM239 | 5.0 | 250 | 6.0 | 500 |
| MLM239A | 2.0 | 250 | 6.0 | 500 |
| MLM339 | 5.0 | 250 | 6.0 | 500 |
| MLM339A | 2.0 | 250 | 6.0 | 500 |



World Radio History

# Crosspoint Switch

MC3416 — Low-cost solid-state crosspoint switch offers important advantages in modern telephone exchanges employing space-division switching. Features 4 x 4 two-wire monolithic structure for PABX applications. Select inputs are both CMOS and TTL compatible.

$T_A$ = 0 to 70°C

Packages:
P Suffix — Case 649
L Suffix — Case 623

| $r_{off}$ @ $V_{AK}$ = 10 V MΩ Min | $r_{on}$ @ $I_{AK}$ = 20 mA Ohms Max | $BV_{AK}$ $BV_{KA}$ Volts Min | $V_{AK}$ @ $I_{AK}$ = 20 mA Volts Max |
|---|---|---|---|
| 100 | 10 | 25 | 1.1 |

# Voice Encoding/ Decoding

Simplified voice encoding/decoding using continuous Variable Slope Delta Modulator (CVSD) technique.

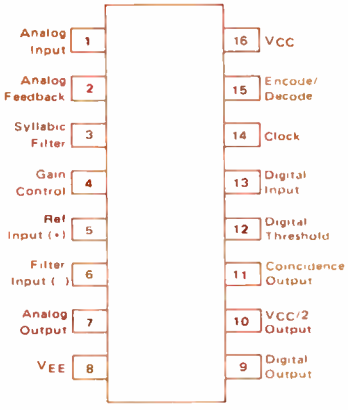
MC3417 — 3-bit algorithm; for military secure communication applications.

MC3418 — 4-bit algorithm; telephone quality.

$T_A$ = 0 to 70°C*

Packages:
L Suffix — Case 620
P Suffix — Case 648

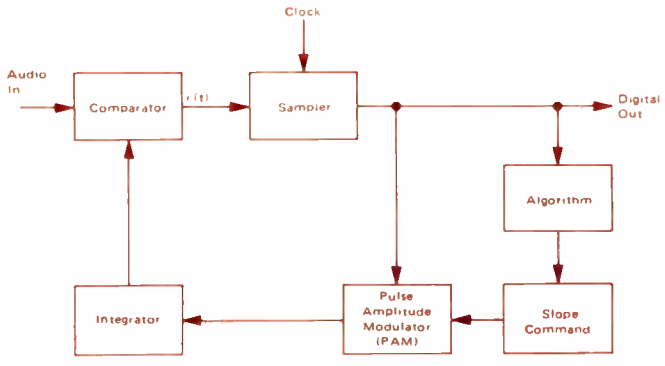
*Military temperature range devices (MC3517/18) to be offered in early 1977.



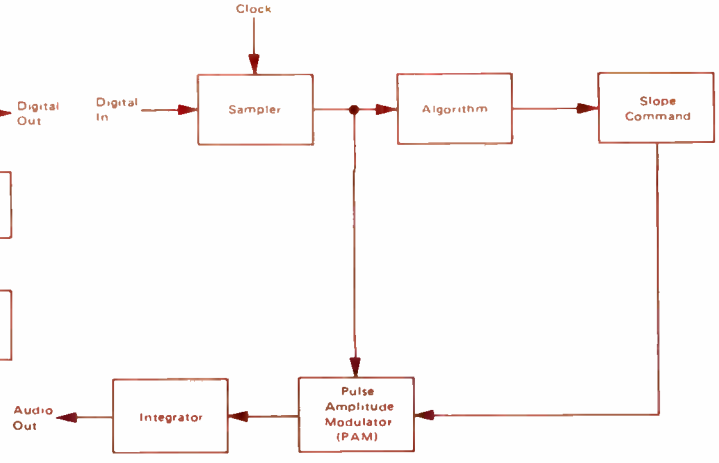

| Device Number | Sample Rate Samples/s Typ | Total Loop Offset Voltage mV Max | $t_{PD}$, Clock Trigger to Output µs Max |
|---|---|---|---|
| MC3417 | 16 k | ±5.0 | 2.5 |
| MC3418 | 38 k | ±2.0 | 2.5 |

## Block Diagrams

### CVSD Encoder




### CVSD Decoder






World Radio History

MOTOROLA

# LINEAR INTEGRATED CIRCUITS

Starting with the now all pervasive operational amplifier, linear integrated circuit technology currently influences the design and architecture of equipment for all major markets. Amplifiers? Of course! But that's only a starting point. Linear circuits have taken the erstwhile expensive and exclusive voltage regulator and turned it into a commodity item for all electronic equipment. They have reduced the myriad of discrete parts formerly involved in consumer products to just a handful of IC packages and they've brought electronic capabilities a giant step closer to widespread use by mass markets.

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World Radio History

# OPERATIONAL AMPLIFIERS

Motorola offers a broad line of operational amplifiers to meet a wide range of usages. From low-cost industry-standard types to high precision circuits, the span encompasses a large range of performance capabilities. These linear integrated circuits are available as single, dual, and quad monolithic devices in a variety of package styles as well as standard chips.

The following tables provide the major technical specifications normally associated with Operational Amplifiers. In addition, the Description column highlights any unique feature or application for each particular device. To simplify initial selection further, the devices in each table are listed in ascending order of price. This permits basic selection from among several devices whose specifications may be suitable for the intended applications.

## Single Operational Amplifiers

### NONCOMPENSATED

Devices listed in ascending order of price

| $I_{IB}$ uA max | $V_{IO}$ mV max | $TC_{VIO}$ uV/°C typ | $I_{IO}$ nA max | $A_{vol}$ V/V min | BW(Av=1) MHz typ | SR(Av=1) V/us typ | Supply Voltage V min | Supply Voltage V max | Description | Device | Packages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Military Temperature Range (-55°C to +125°C)** | | | | | | | | | | | |
| .5 | 5 | 15 | 200 | 25K | 1 | .3 | ±3 | ±18 | General Purpose | MC1709 | 601, 606, 632, 693 |
| .5 | 5 | 15 | 200 | 50K | 1 | .5 | ±3 | ±22 | General Purpose | MC1748 | 601, 693 |
| .075 | 2 | 10 | 10 | 50K | 1 | .5 | ±3 | ±22 | General Purpose | MLM101A | 601, 693 |
| .5 | 3 | 15 | 60 | 50K | 2 | 4.2 | ±4 | ±18 | High Slew Rate | MC1539 | 601, 632 |
| 5 | 2 | 15 | 500 | 2.5K | 7 | 1.5 | +12 -6 | +12 -6 | Wideband DC Amplifier | MC1712 | 601, 606, 632 |
| 1 | 5 | 15 | 150 | 40K | .8 | 2.0 | ±4 | ±20 | General Purpose | MC1533 | 603B, 606, 632 |
| 2 | 10 | 15 | 100 | 1K | 10 | 5.0 | ±4 | ±8 | Differential Output | MC1520 | 603, 606 |
| .6 | 3 | 5 | 100 | 25K | 1 | .5 | ±3 | ±18 | High Performance MC1709 | MC1709A | 601, 606, 632 |
| .002 | 2 | 3 | .2 | 50K | 1 | .3 | ±3 | ±20 | Precision | MLM108 | 601, 606, 693 |
| 10 | 5 | 15 | 2000 | 4.5K | 3 | 1.0 | ±4 | ±9 | General Purpose | MC1530 | 603B, 606, 632 |
| 15 | 10 | 15 | 25 | 2.5K | 2 | 1.0 | ±4 | ±9 | General Purpose (Darlington Input) | MC1531 | 603B, 606, 632 |
| .002 | 5 | 1 | .2 | 80K | 1 | .3 | ±3 | ±20 | Precision | MLM108A | 601, 606, 693 |
| **Industrial Temperature Range (0°C to +70°C)** | | | | | | | | | | | |
| .25 | 7.5 | 10 | 50 | 25K | 1 | .5 | ±3 | ±18 | General Purpose | LM301A | 601, 626 693 |
| .5 | 6 | 15 | 200 | 20K | 1 | .5 | ±3 | ±18 | General Purpose | MC1748C | 601, 626 693 |
| 1.5 | 7.5 | 15 | 500 | 15K | 1 | .3 | ±3 | ±18 | General Purpose | MC1709C | 601, 606, 626, 632, 646, 693 |
| 7 | 7.5 | 15 | 1 | 25K | 1 | .3 | ±3 | ±18 | Precision | LM308 | 601, 606, 626, 693 |
| 7.5 | 5 | 15 | 2000 | 2K | 7 | 1.5 | +12 -6 | +12 -6 | Wideband DC Amplifier | MC1712C | 601, 606, 632 |
| 4 | 15 | 15 | 200 | 750 | 10 | 5.0 | ±4 | ±8 | Differential Output | MC1420 | 603, 606 |
| 1 | 7.5 | 15 | 100 | 15K | 2 | 4.2 | ±6 | ±18 | High Slew Rate | MC1439 | 601, 626, 632, 646 |
| 2 | 7.5 | 15 | 50 | 30K | .8 | 2.0 | ±4 | ±18 | General Purpose | MC1433 | 603B, 606, 632, 646 |
| 7 | .5 | 5 | 1 | 80K | 1 | .3 | ±3 | ±18 | Precision | LM308A | 601, 606, 626, 693 |
| 15 | 10 | 15 | 4000 | 3K | 3 | 1.0 | ±4 | ±8 | General Purpose | MC1430 | 603B, 606, 632, 646 |
| .3 | 15 | 15 | 100 | 1.5K | 2 | 1.0 | ±4 | ±8 | General Purpose (Darlington Input) | MC1431 | 603B, 606, 632, 646 |



World Radio History

# Single Operational Amplifiers

## INTERNALLY COMPENSATED

Devices listed in ascending order of price

| $I_{IB}$ uA max | $V_{IO}$ mV max | $TC_{VIO}$ uV/°C typ | $I_{IO}$ nA max | $A_{vol}$ V/V min | BW(Av=1) MHz typ | SR(Av=1) V/us typ | Supply Voltage V min | Supply Voltage V max | Description | Device | Packages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Military Temperature Range (-55°C to +125°C)** | | | | | | | | | | | |
| .5 | 5 | 15 | 200 | 50K | 1 | .5 | ±3 | ±22 | General Purpose | MC1741 | 601, 606, 632, 693 |
| .20 | - | - | 3000 | 90 | 90 | - | ±4 | ±8 | Differential Wide-band Video Amp | MC1733 | 603, 632 |
| .5 | 5 | 15 | 200 | 50K | 1 | .5 | ±3 | ±22 | Low Noise | MC1741N | 601, 606 632, 693 |
| .5 | 5 | 15 | 200 | 50K | 1 | 10 | ±3 | ±22 | High Slew Rate | MC1741S | 601, 632, 693 |
| .075 | 2 | 10 | 10 | 50K | 1 | .5 | ±3 | ±22 | General Purpose | MLM107 | 601, 693 |
| .003 | 4 | 12 | - | Unity | 20 | 30 | ±3 | ±18 | Unity Gain | MLM110 | 601 |
| .015 | 4 | 10 | 2 | 100K | 1 | 2.5 | ±3 | ±22 | High Performance | MC1556 | 601, 632 |
| .0075 | 5 | 15 | 3 | 200K | 1 | .2 | ±1.5 | ±18 | uPower Programmable | MC1776 | 601, 632 |
| .02 | 5 | 10 | 3 | 100K | 1 | 2.0 | ±15 | ±40 | High Voltage | MC1536 | 601 |
| 100pA | 5 | 5 | 20pA | 50K | 1 | 5 | ±5 | ±22 | FET Input | LF155 | 601 |
| 100pA | 5 | 5 | 20pA | 50K | 2 | 15 | ±5 | ±22 | FET Input | LF156 | 601 |
| 100pA | 5 | 5 | 20pA | 50K | 3 | 75 | ±5 | ±22 | Wideband FET Input | LF157 | 601 |
| 50pA | 2 | 3 | 10pA | 50K | 1 | 5 | ±5 | ±22 | FET Input | LF155A | 601 |
| 50pA | 2 | 3 | 10pA | 50K | 2 | 15 | ±5 | ±22 | FET Input | LF156A | 601 |
| 50pA | 2 | 3 | 10pA | 50K | 3 | 75 | ±5 | ±22 | Wideband FET Input | LF157A | 601 |
| **Industrial Temperature Range (0°C to +70°C)** | | | | | | | | | | | |
| .5 | 6 | 15 | 200 | 20K | 1.0 | .5 | ±3 | ±18 | General Purpose | MC1741C | 601, 632, 626, 646, 693 |
| .25 | 7.5 | 10 | 50 | 25K | 1.0 | .5 | ±3 | ±18 | General Purpose | MLM307 | 601, 626, 693 |
| 30 | - | - | 5000 | 80 | 90 | - | ±4 | ±8 | Differential Wide-band Video Amp | MC1733C | 601, 632, 646 |
| .05 | 6 | 15 | 25 | 50K | 1.0 | .2 | ±1.5 | ±18 | Low Cost uPower, Programmable | MC3476 | 601, 626 |
| .5 | 6 | 15 | 200 | 20K | 1.0 | .5 | ±3 | ±18 | Low Noise | MC1741NC | 601, 632, 626, 646, 693 |
| .5 | 6 | 15 | 200 | 20K | 1.0 | 10 | ±3 | ±18 | High Slew Rate | MC1741SC | 601, 632, 626, 646, 693 |
| .007 | 7.5 | 12 | - | Unity | 20.0 | 30 | ±3 | ±18 | Unity Gain | MLM310 | 601 |
| .003 | 6 | 15 | 3 | 100K | 1.0 | .2 | ±1.5 | ±18 | uPower, Programmable | MC1776C | 601 |
| .03 | 10 | 12 | 10 | 70K | 1.0 | 2.5 | ±3 | ±18 | High Performance | MC1456 | 601, 632 |
| .04 | 10 | 12 | 10 | 70K | 1.0 | 2.0 | ±15 | ±34 | High Voltage | MC1436 | 601 |
| 200pA | 10 | 5 | 50pA | 50K | 1.0 | 5 | ±5 | ±18 | FET Input | LF355 | 601 |
| 200pA | 10 | 5 | 50pA | 50K | 2.0 | 15 | ±5 | ±18 | FET Input | LF356 | 601 |
| 200pA | 10 | 5 | 50pA | 50K | 3.0 | 75 | ±5 | ±18 | Wideband FET Input | LF357 | 601 |
| 50pA | 2 | 1 | 10pA | 50K | 1.0 | 5 | ±5 | ±18 | FET Input | LF355A | 601 |
| 50pA | 2 | 1 | 10pA | 50K | 2.0 | 15 | ±5 | ±18 | FET Input | LF356A | 601 |
| 50pA | 2 | 1 | 10pA | 50K | 3.0 | 75 | ±5 | ±18 | Wideband FET Input | LF357A | 601 |



World Radio History

# Dual Operational Amplifiers

## INTERNALLY COMPENSATED

Devices listed in ascending order of price

| $I_{IB}$ uA max | $V_{IO}$ mV max | $TC_{VIO}$ uV/°C typ | $I_{IO}$ nA max | $A_{vol}$ V/V min | BW(Av=1) MHz typ | SR(Av=1) V/us typ | Supply Voltage V min | Supply Voltage V max | Description | Device | Packages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Military Temperature Range (-55°C to +125°C)** | | | | | | | | | | | |
| .5 | 5 | 10 | 200 | 50K | 1.1 | .8 | ±3 | ±22 | Dual MC1741 | MC1558 | 601, 632 693 |
| .5 | 5 | 10 | 200 | 50K | 1 | .5 | ±3 | ±22 | Dual MC1741 | MC1747 | 601, 632 |
| .5 | 5 | 10 | 200 | 50K | 1.1 | .8 | ±3 | ±22 | Dual Low Noise | MC1558N | 601, 632, 693 |
| 5 | 5 | 10 | 200 | 50K | 4 | 1.5 | ±3 | ±22 | High Frequency Dual | MC4558 | 601, 632 693 |
| .15 | 5 | 10 | 30 | 50K | 1 | .6 | ±1.5 +3 | ±18 +36 | Single Supply Dual (Low Power Consumption) | MLM158 | 601, 632, 693 |
| .5 | 5 | 10 | 200 | 50K | 1 | 10 | ±3 | ±22 | High Slew Rate Dual | MC1558S | 601, 632, 693 |
| .5 | 5 | 10 | 50 | 50K | 1 | .6 | ±1.5 +3 | ±18 +36 | Single Supply Dual | MC3558 | 601, 632, 693 |
| **Industrial Temperature Range (0°C to +70°C)** | | | | | | | | | | | |
| .5 | 6 | 10 | 200 | 20K | 1.1 | .8 | ±3 | ±18 | Dual MC1741 | MC1458 | 601, 626, 632, 646, 693 |
| 5 | 6 | 10 | 200 | 25K | 1 | .5 | ±3 | ±18 | Dual MC1741 | MC1747C | 603, 632, 646 |
| 25 | 6 | 7 | 50 | 25K | 1 | .6 | ±1.5 +3.0 | ±18 +36 | Single Supply Dual (Low Power Consumption) | MLM358 | 601, 626, 693 |
| .5 | 6 | 10 | 200 | 20K | 3 | 1.5 | ±3 | ±18 | Dual High Frequency | MC4558C | 601, 626 693 |
| .5 | 10 | 7 | 50 | 20K | 1 | .6 | ±1.5 +3.0 | ±18 +36 | Single Supply Dual (Low Crossover Distortion) | MC3458 | 601, 626 693 |
| 5 | 6 | 10 | 200 | 20K | 1 | 10 | ±3 | ±18 | High Slew Rate Dual | MC1458S | 601, 626, 632, 646, 693 |
| .5 | 6 | 10 | 200 | 20K | 1.1 | .8 | ±3 | ±18 | Dual Low Noise | MC1458N | 601, 626, 632, 646, 693 |
| **Automotive Temperature Range (-40°C to +85°C)** | | | | | | | | | | | |
| 5 | 8 | 10 | 75 | 20K | 1 | .6 | ±1.5 +3 | ±18 +36 | Single Supply Dual | MC3358 | 626 |

## NONCOMPENSATED

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Military Temperature Range (-55°C to +125°C)** | | | | | | | | | | | |
| .5<br>3 | 5<br>3 | 10<br>10 | 200<br>300 | 25K<br>4K | 1<br>1 | .25<br>.01 | ±3<br>±2 | ±18<br>±10 | Dual MC1709 Dual General Purpose | MC1537<br>MC1535 | 632<br>603B, 606, 632 |
| **Industrial Temperature Range (0°C to +70°C)** | | | | | | | | | | | |
| 1.5<br>5 | 7.5<br>5 | 10<br>10 | 500<br>500 | 15K<br>3.5K | 1<br>1 | .25<br>.01 | ±3<br>±2 | ±18<br>±9 | Dual MC1709 Dual General Purpose | MC1437<br>MC1435 | 632, 646<br>603B, 607, 632 |



World Radio History

# Quad Operational Amplifiers

## INTERNALLY COMPENSATED

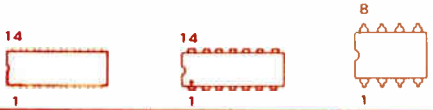
Devices listed in ascending order of price

| $I_{IB}$ uA max | $V_{IO}$ mV max | $TC_{VIO}$ uV/°C typ | $I_{IO}$ nA max | $A_{vol}$ V/V min | BW(Av=1) MHz typ | SR(Av=1) V/us typ | Supply Voltage V min | Supply Voltage V max | Description | Device | Packages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Military Temperature Range (-55°C to +125°C)** | | | | | | | | | | | |
| .5 | 5 | 15 | 200 | 50K | 1 | .5 | ±3 | ±22 | Quad MC1741 | MC4741 | 632, 646 |
| .15 | 5 | 7 | 30 | 50K | 1 | .6 | ±1.5<br>+3.0 | ±16<br>+32 | Quad (Lower Power Consumption) | MLM124 | 632, 646 |
| .5 | 5 | 7 | 50 | 50K | 1 | .6 | ±1.5<br>+3.0 | ±18<br>+36 | Quad General Purpose | MC3503 | 632, 646 |
| 200pA | 5 | 10 | 20pA | 50K | 10 | 20 | ±3.0 | ±18 | Low Power Quad Active Filter FET Input, High Frequency | MC3571 | 632, 646 |
| **Industrial Temperature Range (0°C to 70°C)** | | | | | | | | | | | |
| .3 | - | - | - | 1K | 5 | .6 | ±1.5<br>+3.0 | ±18<br>+36 | Low Cost Quad | MC3401 | 632, 646 |
| .25 | 6 | 7 | 50 | 25K | 1 | .6 | ±1.5<br>+3.0 | ±16<br>+32 | Quad (Low Power Consumption) | MLM324 | 632, 646 |
| .5 | 10 | 7 | 50 | 20K | 1 | .6 | ±1.5<br>+3.0 | ±18<br>+36 | Quad (No Crossover Distortion) | MC3403 | 632, 646 |
| .5 | 6 | 15 | 200 | 20K | 1 | .5 | ±3 | ±18 | Quad MC1741 | MC4741C | 632, 646 |
| 200pA | 6 | 10 | 20pA | 25K | 10 | 20 | ±3.0 | ±18 | Quad Active Filter FET Input, High Frequency | MC3471 | 632, 646 |
| **Automotive Temperature Range (-40°C to +85°C)** | | | | | | | | | | | |
| .3 | - | - | - | 1K | 4 | .6 | ±2<br>+4 | ±15<br>+28 | Quad Mirror Gain | MC3301 | 646 |
| .5 | 10 | - | 50 | - | 1 | .6 | ±1.5<br>+3 | ±13<br>+26 | Quad Diff. (Low Power) | MLM2902 | 646 |
| .5 | 8 | 10 | 75 | 20K | 1 | .6 | ±1.5<br>+3 | ±18<br>+36 | Quad Diff. General Purpose | MC3303 | 646 |

# Package Styles

LEAD CONFIGURATION

| CASE | 601 | 603 | 603B | 606 | 626 |
|---|---|---|---|---|---|
| MATERIAL | Metal | Metal | Metal | Ceramic | Plastic |
| SUFFIX after type number | G | G | G | F | P,P1,N |




| CASE | 632 | 646 | 693 |
|---|---|---|---|
| MATERIAL | Ceramic | Plastic | Ceramic |
| SUFFIX after type number | L | P | U |



World Radio History

# VOLTAGE REGULATORS

## Fixed Output Voltage Regulators

*Low cost, monolithic circuits for positive and/or negative regulation at currents from 100 mA to 3 A. These circuits require no external add-on component, although an input capacitor should be used if the regulator is located an appreciable distance from the power supply filter, and an output capacitor could improve transient response. They are ideal for on-card regulation of subsystems, affording possible economic advantages and performance improvement in applications where total system regulation is not required.*

*Most devices are available in metal and plastic packages. All employ internal current limiting, thermal shutdown and safe-area compensation — making them essentially blow-out proof. All are designed to operate over a 0°C to 150°C junction temperature range, except *$T_J$ = -55°C to +150°C.*

### FIXED VOLTAGE, 3-TERMINAL REGULATORS FOR POSITIVE OR NEGATIVE POLARITY POWER SUPPLIES.

| $V_{out}$ Volts | Tol.† Volts | $I_O$ mA Max | Device Type Positive Output | Device Type Negative Output | $V_{in}$ Min/Max | $Reg_{line}$ mV | $Reg_{load}$ mV | $\Delta V_O/\Delta T$ mV/°C | Case |
|---|---|---|---|---|---|---|---|---|---|
| 2 | ± 0.1 | 1500 | — | MC7902C | 5.5/35 | 40 | 120 | 1.0 | 11, 313 |
| 3 | ± 0.15 | 100 | — | MC79L03AC | 4.7/30 | 60 | 72 | 0.6 | |
| 3 | ± 0.3 | 100 | — | MC79L03C | 4.7/30 | 80 | 72 | 0.6 | 29, 79 |
| 5 | ±0.5 | 100 | MC78L05C | MC79L05C | 6.7/30 | 200 | 60 | 0.1 | 29, 79 |
| | ±0.25 | | MC78L05AC | MC79L05AC | | 150 | | | |
| | | 500 | MC78M05C | — | 7/35 | 100 | 100 | 1.0 | 79, 313 |
| | | 750 | MC7705C | — | | | | | 79, 313 |
| | | 1500 | MC7805C | MC7905C | | | | | 11, 313 |
| | ± 0.4 | | LM109 | — | | | | | 11, 79 |
| | | | LM209 | — | | | | | |
| | ± 0.25 | | LM309 | — | | 50 | | | 11 |
| | ± 0.3 | 3000 | **LM123* | — | 7.5/20 | 25 | | | |
| | ± 0.2 | | **LM323 | — | | | | | |
| 5.2 | ± 0.26 | 1500 | — | MC7905.2C | 7.2/35 | 105 | 105 | 1.0 | 11, 313 |
| 6 | ± 0.3 | 500 | MC78M06C | — | 8/35 | 100 | 120 | 1.0 | 79, 313 |
| | | 750 | MC7706C | — | | 120 | | | 79, 313 |
| | | 1500 | MC7806C | MC7906C | | | | | 11, 313 |
| 8 | ± 0.8 | 100 | MC78L08C | — | 9.7/30 | 200 | 80 | 0.16 | 29, 79 |
| | ± 0.4 | | MC78L08AC | — | | 175 | | | |
| | | 500 | MC78M08C | — | 10/35 | 100 | 160 | 1.0 | 79, 313 |
| | | 750 | MC7708C | — | | 160 | | | 79, 313 |
| | | 1500 | MC7808C | MC7908C | | | | | 11, 313 |
| 12 | ± 1.2 | 100 | MC78L12C | MC79L12C | 13.7/35 | 250 | 100 | 0.24 | 29, 79 |
| | ± 0.6 | | MC78L12AC | MC79L12AC | | | | | |
| | | 500 | MC78M12C | — | 14/35 | 100 | 240 | 1.0 | 79,313 |
| | | 750 | MC7712C | — | | 240 | | | 79, 313 |
| | | 1500 | MC7812C | MC7912C | | | | | 11, 313 |
| 15 | ± 1.5 | 100 | MC78L15C | MC79L15C | 16.7/35 | 300 | 150 | 0.3 | 29, 79 |
| | ± 0.75 | | MC78L15AC | MC79L15A | | | | | |
| | | 500 | MC78M15C | — | 17/35 | 100 | 300 | 1.0 | 79, 313 |
| | | 750 | MC7715C | — | | 300 | | | 79, 313 |
| | | 1500 | MC7815C | MC7915C | | | | | 11, 313 |
| 18 | ± 1.8 | 100 | MC78L18C | MC79L18C | 19.7/35 | 325 | 170 | 0.36 | 29, 79 |
| | ± 0.9 | | MC78L18AC | MC79L18AC | | | | | |
| | | 500 | MC78M18C | — | 20/35 | 100 | 360 | 1.0 | 79, 313 |
| | | 750 | MC7718C | — | | 360 | | | 79, 313 |
| | | 1500 | MC7818C | MC7918C | | | | | 11, 313 |
| 20 | ±1.0 | 500 | MC78M20C | — | 22/40 | 10 | 400 | 1.0 | 79, 313 |
| | | 750 | MC7720C | — | | 400 | | | |
| 24 | ± 2.4 | 100 | MC78L24C | MC79L24C | 25.7/40 | 350 | 200 | 0.48 | 29, 79 |
| | ± 1.2 | | MC78L24AC | MC79L24AC | | 300 | | | 29, 79 |
| | | 500 | MC78M24C | — | 26/40 | 100 | 480 | 1.2 | 79, 313 |
| | | 750 | MC7724C | — | | 480 | | 1.0 | 79, 313 |
| | | 1500 | MC7824C | MC7924C | | | | | 11, 313 |

*$T_J$ = -55 to +150°C
**To be introduced
†Output Voltage Tolerance for Worst Case


World Radio History

# Variable Output Voltage Regulators

*The regulators in the following tables can be tailored for any specific output voltage within the indicated ranges through the use of external resistors. The indicated output current is available directly from the device. Increased output current can usually be obtained through the use of external current – boosting circuits. All have internal provisions for current limiting, or are internally protected against excessive thermal or SOA overloads.*

## POSITIVE OUTPUT REGULATORS

| $I_O$ mA Max | Device Type | SUFFIX | $V_{out}$ Volts Min | $V_{out}$ Volts Max | $V_{in}$ Volts Min | $V_{in}$ Volts Max | $V_{in} - V_{out}$ Differential Volts Max | $P_D$ Watts Max $T_A$ = 25°C | $P_D$ Watts Max $T_C$ = 25°C | Regulation % $V_{out}$ @ $T_A$ = 25°C Typ Line | Regulation % $V_{out}$ @ $T_A$ = 25°C Typ Load | TC $V_{out}$ Typ % / °C | $T_J$ = °C Max | Case |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | MLM305 | G | 4.5 | 40 | 8.5 | 50 | 3.0 | 0.4 | 1.3 | 0.06 | 0.1 | 0.007 | 85 | 601 |
| | MLM205 | | | | | | | 0.68 | 1.6 | | | | 100 | |
| | MLM105 | | | 30 | | | | | 2.7 | | | | 150 | |
| 150 | MC1723 | CP | 2.0 | 37 | 9.5 | 40 | 3.0 | 0.65 | – | 0.1 | 0.3 | 0.003 | 150 | 646 |
| | | CG | | | | | | 0.8 | 2.1 | 0.1 | | 0.003 | | 603C |
| | | G | | | | | | | | 0.2 | | 0.002 | | |
| | | CL | | | | | | 1.0 | – | 0.1 | | 0.003 | 175 | 632 |
| | | L | | | | | | | – | 0.2 | | 0.002 | | |
| 250 | MC1469 | G | 2.5 | 32 | 9 | 35 | 3.0 | 0.68 | 1.8 | 0.03 | 0.13 | 0.002 | 150 | 603 |
| | MC1569 | | | 37 | 8.5 | 40 | 2.7 | | | 0.015 | | | | |
| 600 | MC1469 | R | 2.5 | 32 | 9.0 | 35 | 3.0 | 3.0 | 14.0 | 0.03 | 0.05 | 0.002 | 150 | 614 |
| | MC1569 | | | 37 | 8.5 | 40 | 2.7 | | | 0.015 | | | | |
| 1500 | LM317* | T | 1.2 | 37 | 5.0 | 40 | 3.0 | Internally Limited | | 0.07 | 1.5 | 0.5 | 125 | 313 |
| | LM317* | K | | | | | | | | | | | | 11 |
| | LM117* | | | | | | | | | 0.05 | 1.0 | | 150 | |

*To be introduced

## NEGATIVE OUTPUT REGULATORS

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | LM304 | G | 0.035 | 30 | 8.0 | 40 | 2.0 | 0.4 | 1.3 | 0.1 | 0.05 | 0.007 | 80 | 603 |
| | LM204 | | 0.015 | 40 | | 50 | | 0.68 | 1.6 | | | | 100 | |
| | LM104 | | | | | | | | 2.7 | | | | 150 | |
| 250 | MC1463 | G | 3.8 | 32 | 9.0 | 35 | 3.0 | 0.68 | 1.8 | 0.03 | 0.05 | 0.002 | 150 | 603 |
| | MC1563 | | 3.6 | 33 | 8.5 | 40 | 2.7 | | | 0.015 | 0.13 | | | |
| 600 | MC1463 | R | 3.8 | 34 | 9.0 | 35 | 3.0 | 2.4 | 9.0 | 0.03 | 0.05 | 0.002 | 175 | 614 |
| | MC1463 | | 3.6 | 37 | 8.5 | 40 | 2.7 | | | 0.015 | | | | |

# Switching Regulators

*Used as the control circuit in PWM, push-pull, bridge and series type switchmode supplies. The device includes the reference, oscillator, pulse-width modulator, phase splitter and output sections. Frequency and duty cycle are independently adjustable.*

| $I_O$ ± mA Max | $V_{CC}$ Volts Min | $V_{CC}$ Volts Max | $f_o$ kHz Min | $f_o$ kHz Max | Device Number | SUFFIX | $T_A$ °C | Case |
|---|---|---|---|---|---|---|---|---|
| 40 | 10 | 30 | 2.0 | 100 | MC3420 | P | 0 to +70 | 648 |
| | | | | | | L | | 620 |
| | | | | | MC3520 | L | -55 to +125 | 620 |


World Radio History

# Special Regulators

**FLOATING VOLTAGE AND CURRENT REGULATORS.** *Designed for laboratory type power supplies, these unique regulators can deliver hundreds of volts — limited only by the breakdown voltage of associated, external, series-pass transistors.*

| $V_{out}$ Volts Min | $V_{out}$ Volts Max | $I_O$ mA Max | Device Type | SUFFIX | $V_{aux}$ Volts Min | $V_{aux}$ Volts Max | $P_D$ Watts Max | $\Delta V_{ref}/V_{ref}$ % Line | $\Delta V_{ref}/V_{ref}$ % Load | $\Delta I_L/I_L$ % Max | $TCV_{out}$ %/°C Typ | Case |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | * | * | MC1466 | L | 21 | 30 | 0.75 | 0.015 | 0.015 | 0.2 | 0.01 | 632 |
| | | | MC1566 | L | 20 | 35 | | 0.004 | 0.004 | 0.1 | 0.006 | |

*Dependent on characteristics of external series-pass elements.

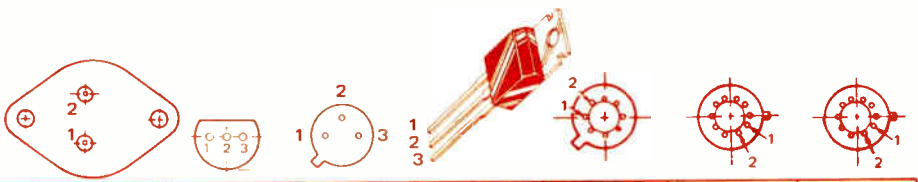
**DUAL ±15 V TRACKING REGULATORS.** *Dual polarity regulator designed to provide balanced positive and negative output voltages. Internally, the device is set for ±15 V, but an external adjustment can change both outputs simultaneously, from 8.0 V to 20 V.*

| $V_{out}$ Volts Min | $V_{out}$ Volts Max | $I_O$ mA Max | $V_{in}$ Volts Min | $V_{in}$ Volts Max | Device Type | SUFFIX | $P_D$ Watts Max | Regline mV | Regload mV | TC %/°C ($T_{low}$ to $T_{high}$ Typ | $T_A$ °C | Case |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.8 | 15.2 | ±100 | 17 | 30 | MC1468 | G | 0.8 | 10 | 10 | 3.0 | 0 to +75 | 603C |
| | | | | | | L | 1.0 | | | | | 632 |
| | | | | | | R | 2.4 | | | | | 614 |
| | | | | | MC1568 | G | 0.8 | | | | -55 to +125 | 603C |
| | | | | | | L | 1.0 | | | | | 632 |
| | | | | | | R | 2.4 | | | | | 614 |

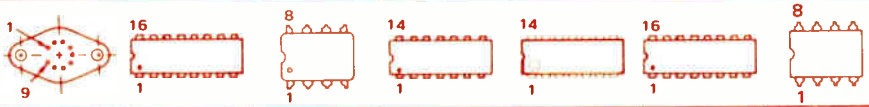
**LOW TEMPERATURE DRIFT, LOW VOLTAGE REFERENCE**

| $V_{out}$ Volts Typ | $I_O$ mA Max | $\Delta V_{out}/\Delta T$ ppm/°C Max | Device Type | SUFFIX | Regline (7.0 V ≤ $V_I$ ≤ 30 V) Max | Regline (4.5 V ≤ $V_{in}$ ≤ 7.0 V Max | Regload (1.0 mA < $I_O$ < 11mA) mA Max | $T_A$ °C | Case |
|---|---|---|---|---|---|---|---|---|---|
| 2.5 ± 25 mV | 10 | 40 | MC1403 | P1, U | 6.0 | 3.0 | 10 | 0 to +70 | 626,693 |
| | | 25 | MC1403A | | | | | | |
| | | 55 | MC1503 | U | | | | -55 to +125 | 693 |
| | | 25 | MC1503A | | | | | | |

# Package Styles



| CASE | 11 | 29 | 79 | 313 | 601 | 603 | 603C |
|---|---|---|---|---|---|---|---|
| MATERIAL | Metal | Plastic | Metal | Plastic | Metal | Metal | Metal |
| SUFFIX after type number | K | P | G | T | G | G | G |



| CASE | 614 | 620 | 626 | 632 | 646 | 648 | 693 |
|---|---|---|---|---|---|---|---|
| MATERIAL | Metal | Ceramic | Plastic | Ceramic | Plastic | Plastic | Ceramic |
| SUFFIX after type number | R | L | P or P1 | L | P | P | U |


World Radio History

# HIGH FREQUENCY AMPLIFIERS

*A variety of high-frequency circuits with features ranging from low-cost simplicity to multi-function versatility marks Motorola's line of integrated RF/IF amplifiers. Devices described here are intended for industrial and cummunications applications. For devices especially dedicated to consumer products, i.e., TV and entertainment radio, see page 100.*

## NON-AGC Amplifiers

**SE/NE592 — Differential Two Stage Video Amplifier**

A monolithic, two state differential output, wide-band video amplifier. It offers fixed gains of 100 and 400 without external components and adjustable gains from 400 to 0 with one external resistor. The input stage has been designed so that with the addition of a few external reactive elements between the gain select terminals, the circuit can function as a high pass, low pass, or band pass filter. This feature makes the circuit ideal for use as a video or pulse amplifier in communications, magnetic memories, display and video recorder systems.

**MC1733/MC1733C — Video Amplifier**

Differential input and output amplifier provides three fixed gain options with bandwidth to 120 MHz. External resistor permits any gain setting from 10 to 400 v/v. Extremely fast rise time (2.5 ns typ) and propagation delay time (3.6 ns typ) makes this unit particularly useful as pulse amplifier in tape, drum, or disc memory read applications.

**MC1552/MC1553 — Low Distortion Amplifier**

A high performance amplifier with internal series feedback for stable voltage gain and low distortion. Temperature compensation stabilizes operating point. Has selectable gain option and well characterized data that permits accurate response shaping. Useful for critical applications such as wideband linear amplifiers or fast-rise pulse amplifiers.

**MC1510/MC1410 — General-Purpose Differential Amplifier**

Differential amplifier with flat response to 40 MHz. Provides excellent performance and simple design for most video and communications purposes.

## AGC Amplifiers

**MC1550 — Low Cost Building Block**

Single-stage cascade connected amplifier with delayed AGC characteristics, for operation at frequencies to 100 MHz. Has typical power gain of 25 dB @ 60 MHz.

**MC1545/MC1445 — Gated 2-Channel Input**

Differential input and output amplifier with gated 2-channel input for a wide variety of switching purposes. Typical 75 MHz bandwidth makes it suitable for high-frequency applications such as video switching, FSK circuits, multiplexers, etc. Gating circuit is useful for AGC control.

**MC1590 — Wide-Band General Purpose**

Has differential inputs and outputs with unneutralized power gain as high as 35 dB typical at 100 MHz in tuned amplifier service. Effective AGC voltage range from 5 to 7 volts for a 30 dB gain reduction.

## Electrical Specifications

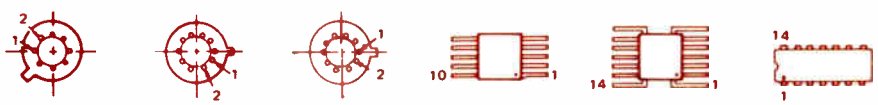
### AGC AMPLIFIERS

| Operating Temperature Range | | $A_V$ dB | Band width MHz | $V_{CC}/V_{EE}$ Vdc | Case |
|---|---|---|---|---|---|
| -55 to +125°C | 0 to +75°C | | | | |
| MC1550 | — | 22 Min | 22 | +6/- | 603B,606 |
| MC1590 | — | 44 Typ @<br>4 Typ @ | 10<br>100 | +12/- | 601 |
| MC1545 | MC1445 | 19 Typ @ | 75 | +5/-5 | 603,607<br>632 |

### NON AGC AMPLIFIERS

| | | | | |
|---|---|---|---|---|
| MC1733 | MC1733C | 52 @ 40<br>40 90<br>20 120 | +6/-6 | 603,632 |
| MC1510 | MC1410 | 40 40 | +6/-6 | 601 |
| MC1553 | — | 46 @ 35<br>52 15 | +6/-6 | 603B |
| MC1552 | — | 34 @ 40<br>40 @ 35 | +6/-6 | 603B |
| SE592 | NE592 | 55 @ 40<br>45 @ 90 | +6/-6 | 603,632 |

## Package Styles




| CASE | 601 | 603 | 603B | 606 | 607 | 632 |
|---|---|---|---|---|---|---|
| MATERIAL | Metal | Metal | Metal | Ceramic | Ceramic | Ceramic |
| SUFFIX after type number | G | G | G | F | F | L |



World Radio History

# SPECIAL PURPOSE CIRCUITS

*The linear-integrated-circuits listed in this section were developed by Motorola for the system design engineer to fill special-purpose requirements. Temperature ranges and package availability are tailored to provide price/performance versatility.*

## Linear Four-Quadrant Multipliers

**MC1594/1494**

This device is designed for use where the output voltage is a linear product of two input voltages. Typical applications include: multiply, divide, square root, mean square, phase detector, frequency doubler, balanced modulator/demodulator, electronic gain control.

The MC1594/MC1494 is a variable transconductance multiplier with internal level-shift circuitry and voltage regulator. Scale factor, input offsets and output offset are completely adjustable with the use of four external potentiometers. Two complementary regulated voltages are provided to simplify offset adjustment and improve power-supply rejection.

**MC1595/MC1495**

Similar to the MC1594/1494, but without internal level shift and voltage regulator circuits.

## Balanced Modulator-Demodulator

**MC1596/MC1496**

Designed for use where the output voltage is a product of an input voltage (signal) and a switching function (carrier). Typical applications include suppressed carrier and amplitude modulation, synchronous detection, FM detection, phase detection and chopper applications.

## Ground Fault Interrupter Circuit

**MC3426**
(Latching)

This circuit provides ground fault and grounded neutral protection for 120 VAC, 15 and 20 Amp. lines. Useful in wall socket and circuit breaker applications.

- Trip Times in Accordance with U.L.
- High Noise Immunity
- Resistance to False Tripping
- Minimum Trip Leakage Current-5 ± mA
- Trips for Neutral Gnd. Resistance > 2

## Timing Circuits

**MC1555/MC1455/MC1422**

These devices are highly stable timing circuits capable of producing accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive MTTL circuits. Timing from Microseconds through Hours. The MC1422 has variable threshold level, adjustable externally.

| | Timing Error (typ) |
|---|---|
| MC1555 | 0.5% |
| MC1455 | 1.0% |
| MC1422 | 1.0% |

**MC3556/MC3456**

Dual Version of the MC1555/MC1455

## Overvoltage Protection Circuit

**MC3523/MC3423**

Protects sensitive electronic circuitry from over voltage conditions by short circuiting the supply current when an overvoltage occurs. This causes circuit breaker to trip or fuse to open.

- Adjustable Threshold Voltage
- Adjustable Energy Threshold
- Remote Activation
- Activation Indication

## Power Control Circuits

**MC3370**

Electronic switch for triac triggering applications. Features zero-crossing detector to eliminate RFI, differential input with dual sensor inputs, input open and short protection, and built-in regulator permitting AC line operation.



World Radio History

# Low Frequency Power Amplifier

**MC1554/MC1454**

One-watt power amplifier for single or split supply operation. Typical voltage gain of 10, 18, or 36 V/V with 0.4% THD.

# Monolithic Dual OP Amp and Dual Comparator

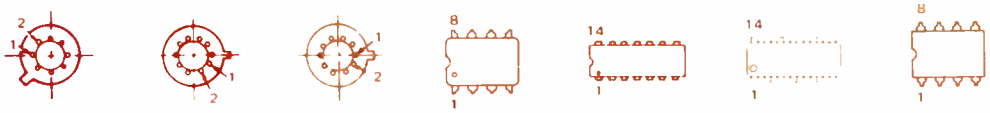
**MC3505/MC3405**

This device contains two differential input operational amplifiers and two comparators each set capable of single supply operation. This operational amplifier-comparator circuit will find its applications as a general purpose product for automotive circuits and as an industrial "building block".

- Op Amp Equivalent in Performance to MC3403
- Comparator Similar in Performance to MLM339
- Op Amps are Internally Frequency Compensated
- Supply Operation 3.0 Volts to 36.0 Volts
- Dual Supply Operation also Available

# Package Styles

| Operating Temperature Range | | Case |
|---|---|---|
| -55 to +125°C | 0 to +70°C | |
| MC1554 | MC1454 | 603B |
| MC1555 | | 601, 693 |
| | MC1455 | 601, 626, 693 |
| MC1594 | MC1494 | 620 |
| MC1595 | MC1495 | 632 |
| MC1596 | | 603, 632 |
| | MC1496 | 603, 632, 646 |
| | MC1422 | 601, 626 |
| MC3505 | | 632 |
| | MC3405 | 632, 646 |
| MC3556 | | 632 |
| | MC3456 | 632, 646 |
| MC3523 | | 693 |
| | MC3423 | 626, 693 |
| | MC3426 | 632 |
| | MC3370 | 626 |



| CASE | 601 | 603 | 603B | 626 | 632 | 646 | 693 |
|---|---|---|---|---|---|---|---|
| MATERIAL | Metal | Metal | Metal | Plastic | Ceramic | Plastic | Ceramic |
| SUFFIX after type number | G | G | G | P or P1 | L | P | U |



World Radio History

# CIRCUITS FOR CONSUMER APPLICATIONS

. . . reflecting Motorola's continuing commitment to semiconductor products necessary for consumer system designs. This tabulation is arranged to simplify first-order selection of consumer integrated circuit devices that satisfy the primary functions for Television, Audio, Radio, Citizens Band, Automotive and Organ applications.

## Television Circuits

### SOUND

| Function | Features | Case | Type |
|---|---|---|---|
| Sound IF, Detector, Limiter, Audio Preamplifier | 80 μV, 3 dB Limiting Sensitivity, 3.5 V (RMS) Output, Sufficient for Single Transistor Output Stage | 646, 647 | MC1351 |
| Sound IF Detector | Interchangeable with ULN2111A | 646, 647 | MC1357 |
| Sound IF Detector, dc Volume Control, Preamplifier | Excellent AMR, Interchangeable with CA3065 | 646, 647 | MC1358 |
| Sound IF, Low Pass Filter, Detector, dc Volume Control, Preamplifier, Power Amplifier | Complete TV Sound System; 100 μV, 3 dB Limiting Sensitivity; 4 Watts Output; $V_{CC}$ = 24 V; $R_L$ = 16 Ω | 722A | TDA1190Z |

### VIDEO

| | | | |
|---|---|---|---|
| 1st and 2nd Video IF Amplifier | IF Gain @ 45 MHz = 60 dB typ, AGC Range = 70 dB min | 626 | MC1349 |
| | IF Gain @ 45 MHz = 46 dB typ, AGC Range = 60 dB min | 626 | MC1350 |
| 1st and 2nd Video IF, AGC Keyer and Amplifier | IF Gain @ 45 MHz = 53 dB typ, AGC Range = 65 dB min, "Forward AGC" Provided for Tuner | 646, 647 | MC1352 |
| 3rd IF, Video Detector, Video Buffer, and | Low-Level Detection, Low Harmonic Generation, Zero Signal dc Output Voltage of 7.0 to 8.2 V | 626 | MC1330A1 |
| AFC Buffer | Same as MC1330A1 except zero signal dc output voltage of 7.8 to 9.0 V | 626 | MC1330A2 |
| 3rd IF, Video Detector, Sound IF Detector, and Sync Separator | Low-Level Detection, Separate Sound Detector, Differential Inputs | 646 | MC1331 |
| AGC Keyer, AGC Amplifier, Noise Gate, Sync Separator | High-Quality Noise Gate, One IF AGC Output and Two Tuner AGC Outputs, Adjustable AGC Delay | 646 | MC1344 |
| Automatic Fine Tuning | High Gain AFT System, Interchangeable with CA3064 | 646 | MC1364 |

### CHROMA

| | | | |
|---|---|---|---|
| Chroma IF Amplifier and Subcarrier System | Includes Complete Chroma IF, AGC, dc Gain and Tint Controls Injection Locked Oscillator. Low Peripheral Parts Count | 646 | MC1398 |
| Chroma IF Amplifier and Subcarrier System (PLL) | Includes Complete Chroma IF, AGC, dc Chroma and Hue Controls, Phase-Locked Loop (PLL) Oscillator, Color Killer Threshold Adjustment | 648 | MC1399 |
| Dual Chroma Demodulators | Dual Doubly Balanced Demodulator with RGB Matrix and Chroma Driver Stages | 646 | MC1324 |
| | Dual Doubly Balanced Demodulator with RGB Matrix and PAL Switch | 646, 647 | MC1327 |
| Triple Chroma Demodulator | Triple Doubly Balanced Demodulator with Adjustable Output Matrix, Contains Three Independent Demodulators | 648 | MC1323 |

### DEFLECTION

| | | | |
|---|---|---|---|
| Horizontal Processor | Includes Linear Balanced Phase Detector, Oscillator and Predriver. Adjustable dc Loop Gain | 626 | MC1391 |
| | Same as MC1391 except designed to accept negative sawtooth sync pulse | 626 | MC1394 |
| Vertical Processor | Includes Oscillator and Complementary Driver, Low Thermal Drift, Retrace Pulse for Effective Blanking | 648 | MC1393 |



World Radio History

# Audio Circuits

## PREAMPLIFIERS

| Function | $V_{CC}$ Vdc Max | $A_{vol}$ dB Min | THD % Typ | $z_o$ Ohms Typ | Case | Type |
|---|---|---|---|---|---|---|
| Dual Preamplifier | ±15 | 80 | 0.1 | 100 | 646 | MC1303 |

## DRIVERS

| Function | $V_{CC}$ Vdc Max | Drive Current mA | $A_{vol}$ dB | Case | Type |
|---|---|---|---|---|---|
| Class B Audio Drivers | 35 | 150 peak | 89 typ | 626 | MC3320 |
| | 20 | 150 peak | 87 typ | 626 | MC3321 |
| | 25 | 50 max | — | 646 | MC1385 |

## POWER AMPLIFIERS

| Features | $P_O$ Watts | $V_{CC}$ Vdc Max | $V_{in}$ @ rated $P_O$ mV Typ | $I_D$ mA Typ | $R_L$ Ohms | Case | Type |
|---|---|---|---|---|---|---|---|
| Audio Power Amplifiers | 0.5 | 12 | 3.0 | 4.0 | 8.0 | 626 | MC1306 |
| | 0.25 | 12 | 3.0 | 3.0 | 16 | 626 | MC3360 |

# Radio Circuits

## IF AMPLIFIERS

| Function | Gain @ 10.7 MHz dB Typ | 3 dB Limiting @ 10.7 MHz mV (RMS) typ | AMR dB Typ | Recovered Audio Output f = ±75 kHz mV (RMS) | Power Supply Volts Max | Case | Type |
|---|---|---|---|---|---|---|---|
| IF Amplifier | 58 | 0.175 | 60 | 690 | 18 | 626 | MC1350 |
| Limiting FM-IF Amplifier | - | 0.600 | 45 | 480 | 18 | 646, 647 | MC1355 |
| Limiting IF Ampl/Quadrature Detector with Built-In Regulator | - | 0.4 | 42 | 450 | 16 | 646 | MC1356 |
| Limiting IF Ampl/Quad Detector | 53 | 0.4 | 45 | 480 | 16 | 646, 647 | MC1357 |
| IF Amplifier, Limiter, Detector, Audio Preamplifier | 21 | 0.25 | 55 | 625 | 16 | 646 | MC1375 |
| IF Amplifier | 42 | 60 | 50 | 500 | 18 | 626 | MC3310 |

## DECODERS

| Function | Channel Separation dB Typ | THD % Typ | Stereo—Indicator Lamp Driver mA Max | Features | Case | Type |
|---|---|---|---|---|---|---|
| FM Multiplex Stereo Decoder | 40 | 0.3 | 75 | Coilless Operation | 646 | MC1310 |
| Four Channel SQ† Decoders | 45 | 0.1 | - | $V_{CC}$ = 20 Vdc nom | 646 | MC1312 |
| Four Channel SQ† Gain and Balance Control | - | - | - | Master Volume Control and LF/RF, LB/RB, E/B Balance Control | 648 | MC1314 |
| Four Channel SQ† Logic Circuit | - | - | - | Interface with MC1314 and MC1312 to increase F/B Separation and Supply Gain and Balance Control to MC1314 | 648 | MC1315 |

†Trademark of CBS Inc.



World Radio History

# Organ Circuits

## FREQUENCY DIVIDER

| Function | $V_{CC}$ Range Vdc | $f_{Tog}$ MHz Typ | $V_{OH}$ Vdc Min | Case | Type |
|---|---|---|---|---|---|
| 7-Stage Divider | 6-16 | 1.0 | 12.0/15.0 | 646 | MC1302 |

## ATTENUATOR

| Function | $V_{CC}$ Range Vdc | THD % Typ | $A_V$ dB Typ | Attenuation Range dB Typ | Case | Type |
|---|---|---|---|---|---|---|
| Electronic Attenuator | 9.0 to 18 | 0.6 | 13 | 90 | 626 | MC3340 |

# Automotive Circuits

## OPERATIONAL AMPLIFIER

| Function | $V_{CC}$ Range Vdc | $A_{VOl}$ V/V Min | $I_{IB}$ A Max | Unity Gain Bandwidth MHz Typ | Case | Type |
|---|---|---|---|---|---|---|
| Quad Operational Amplifier | 4.0—28 | 1000 | 0.3 | 4.0 | 646 | MC3301 |

## COMPARATORS

| Function | $V_{CC}$ Range Vdc | $V_{IO}$ mV Max | $I_{IO}$ nA Max | $I_{IB}$ na Max | Sink Current mA Typ | Case | Type |
|---|---|---|---|---|---|---|---|
| Quad Comparators | 2.0—28 | ±20 | | 500 | 6.0 | 646, 632 | MC3302 |
| | 2.0—36 | ±7.0 | ±50 | 250 | 16.0 | 646 | MLM2901 |
| | | ±5.0 | | | | 646, 632 | MLM239 |
| | | ±2.0 | | | | 646, 632 | MLM239A |

## VOLTAGE REGULATOR

| Function | Features | Case | Type |
|---|---|---|---|
| Automotive Voltage Regulator | Designed for use with NPN Darlington; Overvoltage Protection; "Open Sense" Shut Down; Selectable Temperature Coefficient | 646 | MC3325 |

## ELECTRONIC IGNITION

| Function | Features | Case | Type |
|---|---|---|---|
| Electronic Ignition Circuit | Designed for use in High Energy-Variable Dwell Electronic Ignition Systems with Variable Reluctance Sensors. Dwell and Spark Energy Are Externally Adjustable. | 646 | MC3333 |



World Radio History

# Transistor Arrays

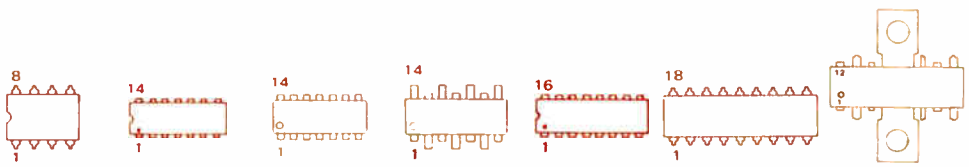
## GENERAL PURPOSE

| Function | $I_C$ (max) mA | $V_{CEO}$ Volts Max | $V_{CBO}$ Volts Max | $V_{EBO}$ Volts Max | Case | Type |
|---|---|---|---|---|---|---|
| One Differentially Connected Pair and Three Isolated Transistors | 50 | 15 | 20 | 5.0 | 646 | MC3346<br>MC3386 |
| One Differentially Connected Pair with Associated Constant Current Transistor | 50 | 20 | 20 | 5.0 | 626 | MC3330 |

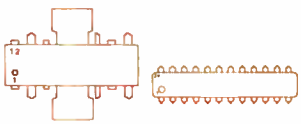
# Special Functions

| Function | Features | Case | Type |
|---|---|---|---|
| Emitter-Coupled Astable Multivibrator | Useful as DC-DC Converter, Power Regulator or Multivibrator. Toggle Freq = 100 kHz (typ). | 626 | MC3380 |
| Phase-Locked Loop | Contains Voltage Controlled Oscillator and Double Balanced Phase Detector | 646 | MLM565C |
| Programmable Frequency Switch | Wide Input Frequency Range (10 Hz to 100 kHz)<br>Adjustable Hysteresis<br>Wide Supply Operating Range (7 to 24 V) | 646, 632 | MC3344 |

# Package Styles




| LEAD CONFIGURATION | | | | | | | |
|---|---|---|---|---|---|---|---|
| CASE | 626 | 632 | 646 | 647 | 648 | 701 | 722 |
| MATERIAL | Plastic | Ceramic | Plastic | Plastic | Plastic | Plastic | Plastic |
| SUFFIX after type number | P or PL | L | P | PQ | P | P | P |




| LEAD CONFIGURATION | | |
|---|---|---|
| CASE | 722A | 724 |
| MATERIAL | Plastic | Plastic |
| SUFFIX after type number | P | P |



World Radio History

World Radio History

MOTOROLA

# COMPONENTS FOR PHASE-LOCKED LOOP APPLICATIONS

Motorola offers the designer a choice of specially designed integrated circuits for performing phase-locked loop functions: phase detection, frequency division, filtering, and voltage-controlled signal generation. In addition, the choice of circuits permits the designer to select CMOS circuits for low-power applications, TTL circuits for intermediate speed, or ECL circuits where high speed is required. The MC12000 ECL series circuits will operate at either +5.0 V or -5.2 V, and translators are included where needed so that all functions are TTL compatible.

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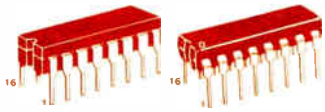
World Radio History

# CONSOLIDATED FUNCTIONS

## CMOS Components . . . for very low power consumption

ORDERING INFORMATION

MC14XXXB — Suffix Denotes
- L Ceramic Package
- P Plastic Package
- A Extended Operating Temperature Range
- C Limited Operating Temperature Range

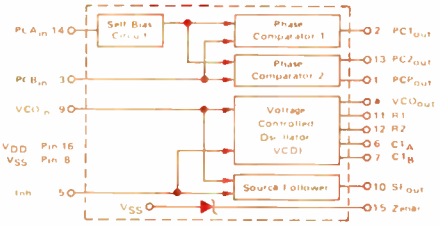


L SUFFIX
CERAMIC PACKAGE
CASE 620

P SUFFIX
PLASTIC PACKAGE
CASE 648

### PHASE COMPARATORS/VCO

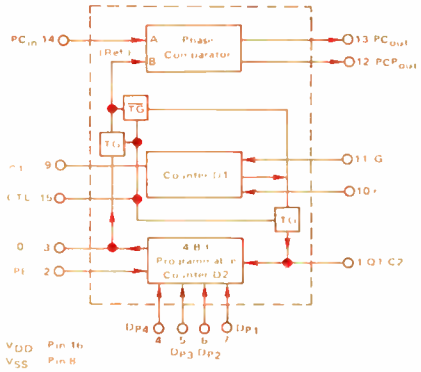
**MC14046B** — for general-purpose, digital applications at frequencies to 1.4 MHz.




- VCO Frequency = 1.4 MHz typ @ 10 V
- VCO Frequency Drift with Temperature = 0.04%/°C typ @ 10 V
- VCO Linearity = 1% typ
- Quiescent Current = 5 nA/pkg @ 5 V
- Low Dynamic Power Dissipation — 70 μW typ @ $f_0$ = 10 kHz, $V_{DD}$ = 5 V, R1 = 1 MΩ, R2 = ∞, $R_{SF}$ = ∞
- Buffered Outputs Compatible with MHTL and Low-Power TTL

### PHASE COMPARATOR/PROGRAMMABLE COUNTERS

**MC14568B** — for use with external VCO for PLL applications.

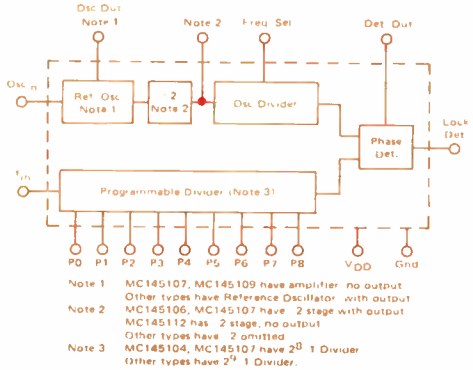



ORDERING INFORMATION — Same as above

- Two Internal Programmable Counters
  - Divide-by-4, 16, 64 or 100
  - Divide-by-N 4-bit binary
- Pulse Repetition Frequency to 10 MHz
- Quiescent Current = 5 nA/pkg @ 5 V
- Counters Internally Cascadable, or May Be Cascaded with External Counters for Greater Range

### FREQUENCY SYNTHESIZERS

**MC145104**
**MC145106**
**MC145107**
**MC145109**
**MC145112**
— for CB and FM transceivers




Note 1 MC145107, MC145109 have amplifier, no output. Other types have Reference Oscillator with output.
Note 2 MC145106, MC145107 have ÷2 stage with output. MC145112 has ÷2 stage, no output. Other types have ÷2 omitted.
Note 3 MC145104, MC145107 have $2^8$ ÷1 Divider. Other types have $2^9$ ÷1 Divider.

ORDERING INFORMATION —
16 or 18 Pin Plastic Package
(P Suffix)

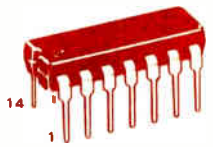
- Voltage Range = 4.5 to 12 V
- 10.24 MHz Oscillator On-Chip (Except MC145107 and MC145109 Require External Reference)
- 5.12 MHz Output
- Programmable Binary Inputs with On-Chip Pulldown Resistors
- Selectable Reference Divider with On-Chip Pullup Resistor
  $2^{10}$ or $2^{11}$ for MC145104, 5109
  $2^9$ or $2^{10}$ for MC145106, 5112



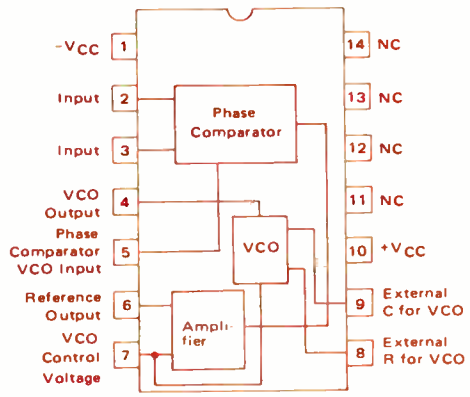
World Radio History

# Linear PLL

**MLM565C** – for general-purpose analog applications at frequencies to 500 kHz.




**P SUFFIX**
PLASTIC PACKAGE
CASE 646




- Stable Center Frequency – 200 ppm/°C typ
- Flexible Power Supply Range – ±5 to ±12 Volts with Small Frequency Drift – 100 ppm/% typ
- Low Total Harmonic Distortion of Demodulator Output – 1.5% max
- Linear Triangle Wave Output – 0.5% typ
- TTL, DTL Compatible Inputs and Outputs
- Adjustable Hold In Range – ±1% to >±60%.

# BASIC FUNCTIONS

The following functions are given in order of decreasing frequency within each category.

| Function | Family | Frequency MHz typ | Power Dissipation mW typ/pkg | Type –55 to +125°C | Type 0 to +75°C | Case ① |
|---|---|---|---|---|---|---|
| **OSCILLATORS** | | | | | | |
| Crystal Oscillator | MECL | 2.0 to 20 | 210 | MC12561 | MC12061 | 620, 648 |
| Crystal Oscillator | MECL | 0.1 to 2.0 | 175 | MC12560 | MC12060 | 620, 648 |
| Voltage-Controlled Oscillator | MECL | 225 | 150 | MC1648M | MC1648# | 607, 632, 646 |
| Voltage-Controlled Multivibrator | MECL | 150 | 150 | – | MC1658# | 620, 648 |
| Dual Voltage-Controlled Multivibrator | MTTL | 30 | 150 | MC4324 | MC4024 | 607, 632, 646 |
| **PHASE DETECTORS** | | | | | | |
| Digital | | | | | | |
| Phase-Frequency Detector | MECL | 70 | 520 | MC12540 | MC12040 | 607, 632, 646 |
| Phase-Frequency Detector | MTTL | 8.0 | 85 | MC4344 | MC4044 | 607, 632, 646 |
| Analog | | | | | | |
| Analog Mixer – Double Balanced | MECL | 300 | 60 | MC12502 | MC12002# | 632, 646 |
| Modulator/Demodulator | LINEAR | 10 | 575 | MC1596 | MC1496 | 603, 632, 646 |
| **CONTROL FUNCTIONS** | | | | | | |
| Counter Control Logic | MECL | 25 | 150 | MC12514 | MC12014 | 620, 648 |
| Offset Control | MECL | – | 35 | MC12520 | MC12020# | 632, 646 |
| Offset Programmer | MECL | – | 35 | MC12521 | MC12021# | 620, 648 |
| **PRESCALERS** | | | | | | |
| ÷4 Counter | MECL | 1200 | 322 (no load) | – | MC1697 | 626 |
| ÷4 Counter | MECL | 1200 | 322 (no load) | – | MC1699# | 620, 650 |
| Two-Modulus Prescaler (÷8/9) | MECL | 600 | 310 | MC12511* | MC12011*# | 620, 648 |
| Two-Modulus Prescaler (÷10/11) | MECL | 600 | 310 | MC12513 | MC12013# | 620, 648, 650 |
| Two-Modulus Prescaler (÷5/6) | MECL | 500 | 310 | MC12509* | MC12009*# | 620, 648 |
| UHF Type D Prescaler (÷2) | MECL | 500 | | – | MC1690# | 620, 650 |
| Two-Modulus Prescaler (÷2, ÷5/6, ÷10/11, ÷10/12) | MECL | 200 | 500 | – | MC12012 | 620, 648 |
| Dual Type D | LS TTL | 45 | 20 | SN54LS74 | SN74LS74 | 607, 632, 646 |

①Plastic package available for commercial-temperature devices only.
# $T_A$ = -30 to +85°C
*To be announced.



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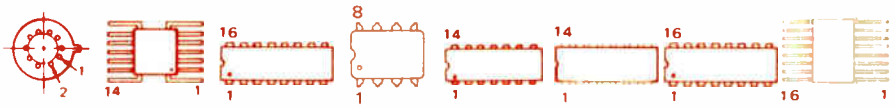
## BASIC PLL FUNCTIONS (continued)

(In order of decreasing frequency within each category.)

| Function | Family | Frequency MHz typ | Power Dissipation mW typ/pkg | Type | | Case ① |
|---|---|---|---|---|---|---|
| | | | | –55 to +125°C | 0 to +75°C | |
| **COUNTERS** | | | | | | |
| Binary | MECL | 325 | 750 | – | MC1654# | 620 |
| Bi-Quinary (÷2, ÷5, ÷10) | MECL | 325 | 750 | – | MC1678# | 620 |
| Universal Hexadecimal (÷0-15) | MECL | 150 | 625 | MC10536 | MC10136# | 620, 648, 650 |
| Universal Decade | MECL | 150 | 625 | MC10537 | MC10137# | 620, 648, 650 |
| Bi-Quinary | MECL | 150 | 370 | MC10538 | MC10138# | 620, 648 |
| Binary | MECL | 150 | 370 | MC10578 | MC10178# | 620, 648 |
| Presettable Binary (÷2, ÷8) | LS TTL | 60 | 60 | SN54LS197 | SN74LS197 | 607, 632, 646 |
| Presettable Decade (÷2, ÷5) | LS TTL | 60 | 60 | SN54LS196 | SN74LS196 | 607, 632, 646 |
| Presettable Up/Down Decade | LS TTL | 40 | 95 | SN54LS192 | SN74LS192 | 620, 648, 650 |
| Presettable Up/Down Binary | LS TTL | 40 | 95 | SN54LS193 | SN74LS193 | 620, 648, 650 |
| Presettable Decade | LS TTL | 35 | 95 | SN54LS160 | SN74LS160 | 620, 648, 650 |
| Presettable Binary | LS TTL | 35 | 95 | SN54LS161 | SN74LS161 | 620, 648, 650 |
| Presettable Decade | LS TTL | 35 | 95 | SN54LS162 | SN74LS162 | 620, 648, 650 |
| Presettable Binary | LS TTL | 35 | 95 | SN54LS163 | SN74LS163 | 620, 648, 650 |
| Presettable Up/Down Decade | LS TTL | 35 | 95 | SN54LS190 | SN74LS190 | 620, 648, 650 |
| Presettable Up/Down Binary | LS TTL | 35 | 95 | SN54LS191 | SN74LS191 | 620, 648, 650 |
| Decade (÷2, ÷5) | LS TTL | 32** | 45 | SN54LS90 | SN74LS90 | 607, 632, 646 |
| Binary (÷2, ÷8) | LS TTL | 32** | 45 | SN54LS93 | SN74LS93 | 607, 632, 646 |
| Universal (÷2-12 except 7 and 11) | MTTL | 30 | 200 | MC4323 | MC4023 | 607, 632, 646 |
| Decade (÷2, ÷5, ÷10) | MTTL | 20 | 160 | MC5490A | MC7490A | 607, 632, 646 |
| Decade (÷10) | CMOS | 12 ## | 10 nA † | MC14017B ‡ | MC14017B ‡ | 620, 648 |
| Programmable ÷N Decade (÷0-9) | MTTL | 10 | 250 | MC4316 | MC4016 | 620, 648, 650 |
| Two Programmable ÷N (÷0-1, ÷0-4) | MTTL | 10 | 250 | MC4317 | MC4017 | 620, 648, 650 |
| Programmable ÷N Hexadecimal (÷0-15) | MTTL | 10 | 250 | MC4318 | MC4018 | 620, 648, 650 |
| Two Programmable ÷N (÷0-3, ÷0-3) | MTTL | 10 | 250 | MC4319 | MC4019 | 620, 648, 650 |
| Binary ($\div 2^{14}$) | CMOS | 9 ## | 10 nA † | MC14020B ‡ | MC14020B ‡ | 620, 648 |
| Binary ($\div 2^{12}$) | CMOS | 9 ## | 10 nA † | MC14040B ‡ | MC14040B ‡ | 620, 648 |
| Dual Programmable BCD/Binary Down | CMOS | 8 ## | 10 nA † | MC14569B ‡ | MC14569B ‡ | 620, 648 |
| BCD Up/Down | CMOS | 6 ## | 10 nA † | MC14510B ‡ | MC14510B ‡ | 620, 648 |
| Binary Up/Down | CMOS | 6 ## | 10 nA † | MC14516B ‡ | MC14516B ‡ | 620, 648 |
| Dual BCD Up | CMOS | 6 ## | 10 nA † | MC14518B ‡ | MC14518B ‡ | 620, 648 |
| Dual Binary Up | CMOS | 6 ## | 10 nA † | MC14520B ‡ | MC14520B ‡ | 620, 648 |
| Programmable ÷N BCD (÷0-9) | CMOS | 5 ## | 10 nA † | MC14522B ‡ | MC14522B ‡ | 620, 648 |
| Programmable ÷ Binary (÷0-15) | CMOS | 5 ## | 10 nA † | MC14526B ‡ | MC14526B ‡ | 620, 648 |

①Plastic package available for commercial-temperature devices only.
* To be announced
# $T_A$ = –30 to +85°C
** When using $\overline{CP}_0$
## @ $V_{DD}$ = 10 V
† Quiescent Current @ $V_{DD}$ = 10 V
‡ For CMOS devices, add suffix for temperature range: A for –55 to +125°C,
C for –40 to +85°C,
followed by package suffix (see Ordering Information, page 106).

# Package Styles

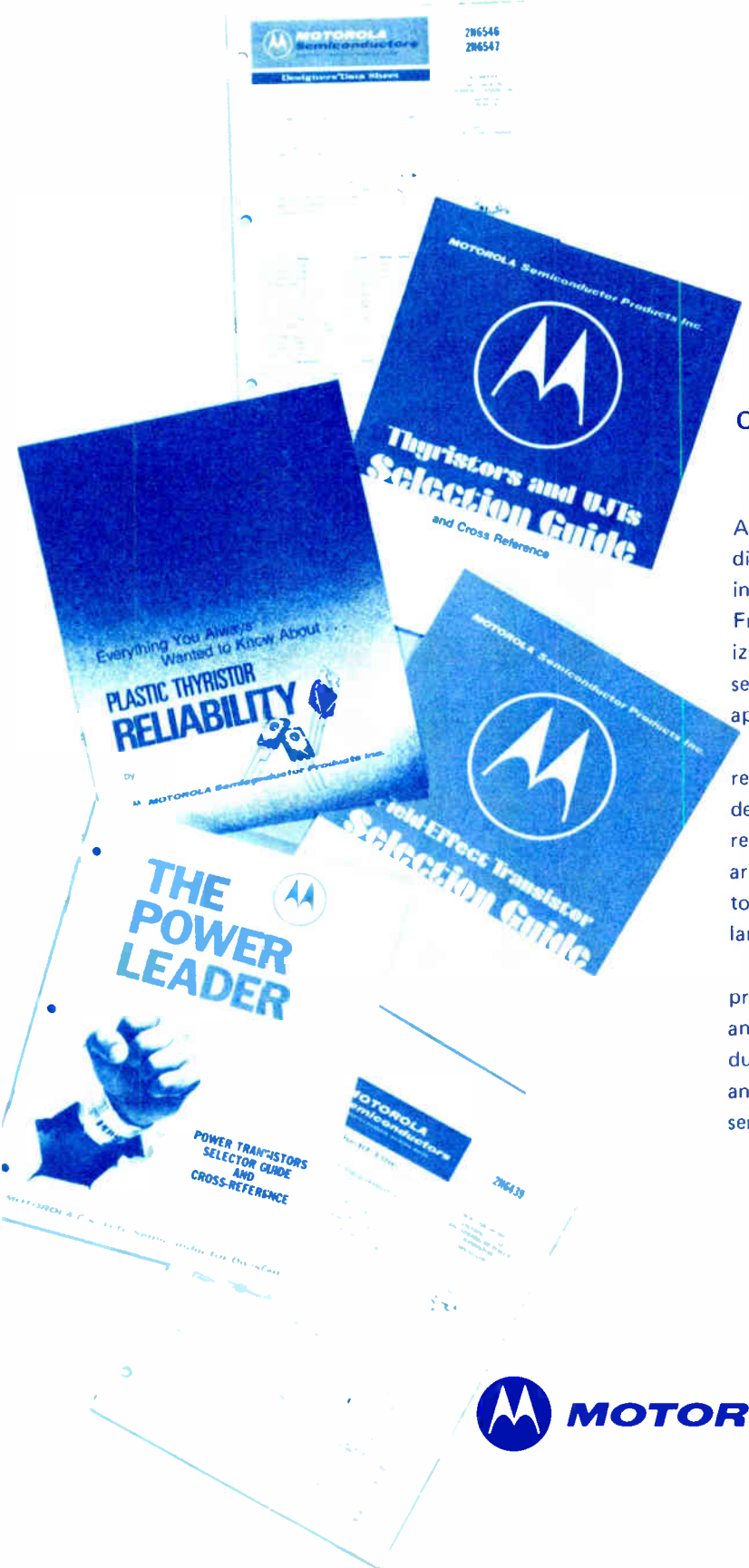



| CASE | | 603 | 607 | 620 | 626 | 632 | 646 | 648 | 650 |
|---|---|---|---|---|---|---|---|---|---|
| MATERIAL | | Metal | Ceramic | Ceramic | Plastic | Ceramic | Plastic | Plastic | Ceramic |
| SUFFIX after type number | LS TTL | – | W | J | – | J | N | N | W |
| | Others | G | F | L | P | L | P | P | F |



World Radio History

# 2 DISCRETE DEVICES




## ONE-STOP SHOPPING FOR SEMICONDUCTORS

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But don't be misled by the limited listings. They represent only the most popular off-the-shelf types—devices that meet the general cost and performance requirements for the majority of circuits. Beyond these are the hosts of "specials" that are computer-selectable to a customer's unique electrical requirements from the large production runs of the standard products.

Between standards and specials, there's hardly any product application that can't be satisfied—expeditiously and economically—with Motorola discrete semiconductors, and a pervasive network of factory sales offices and distributors are staffed to provide efficient customer service.

May we help you?

MOTOROLA Semiconductors



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# SILICON POWER TRANSISTORS

Motorola's extensive power transistor manufacturing facility encompasses a wide variety of technologies (epi-base, single-, double-, and triple-diffusion, etc.), packages, and geometric configurations to best meet the selective needs of the expanding applications. Devices with several thousand different specifications tables are being manufactured to specific order. Of these, some four hundred (+) devices have been selected as standard products for off-the-shelf delivery. These "standards", representing the most cost-effective devices for the vast majority of end uses, are described on the following pages.

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# Motorola Power Transistor Packages

Motorola provides Silicon Power Transistors encased in several packages. Each package has advantages and trade-offs; the choice is left to the user.

Metal cases are hermetic and capable of operating at 200°C junction. These include the TO-5 and TO-39, intended for lead mounting with power dissipation less than 5 watts at 25°C ambient. Press-on heat sinks will allow higher power dissipation.

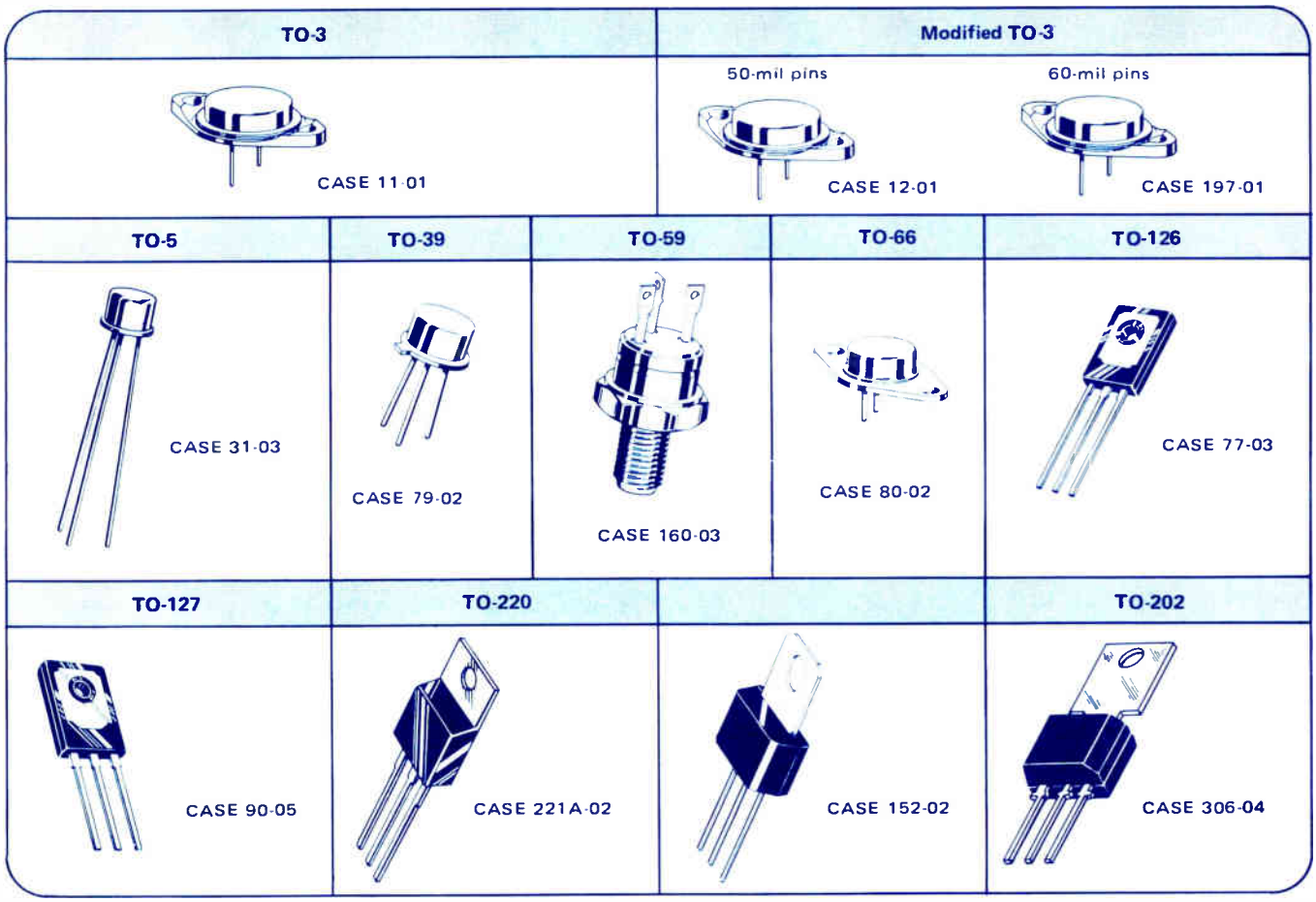
For high power dissipation, packages designed expressly for use with heat sinks are available. These include the TO-66 for 20 to 100 watts and the TO-3 for 100 to 300 watts. Both of these are easily mounted on a heat sink and may be used with sockets, wire soldered, or PC board connection. Metal stud devices need only a single hole for mounting to a heat sink but must be solder wired to make connection at the terminals. Various stud packages are used in the industry with power dissipation ranging from 10 to greater than 300 watts. Motorola provides the TO-59 at 60 watts for standard devices but has capability in TO-61 and TO-63.

Note: Mounting Hardware is available for all packages.

Plastic encapsulated power transistors offer extremely high package density per watt of power dissipation despite the restriction of 150°C maximum junction temperature. In addition to compactness, these have a low silhouette and all three terminals are brought out in leads so that electrical connection is easily made via a PC board or socket. Present day Plastic Power Transistors use silicon dioxide or special glass passivation on the die so these meet most of the "metal can" hermeticity tests.

Motorola produces several plastic encapsulated power transistor lines. Included in this selector guide are the Case 152 and TO-202 (Case 306) for up to 2 watts free air dissipation or 10 watts dissipation with heat sinking; TO-126* (Case 77) which ranges from 15 to 49 watts $P_D$; the TO-127 (Case 90) for 75 to 100 watts; the TO-220 for 40 to 100 watts. Motorola also has a "Case 199" which is similar to the TO-220 and has the same power handling range; this package eventually will be phased out, and is not included in this guide.

*There are two lead options with this case. The base and emitter leads on some lines are reversed from the majority of lines. These so called "reverse" leads are compatible with the TO-220.



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# Motorola Standard Silicon Power Transistors

Comprehensive listing of over 500 Motorola standard silicon power transistors arranged in ascending order of maximum continuous collector current, $I_C$ Cont, and open base sustaining voltage, $V_{CEO(sus)}$. Also listed are current gain ($h_{FE}$), turn off switching times ($t_f$, $t_s$ or $t_{off}$), $f_T$, power dissipation, and package type (both JEDEC and Motorola). Complementary pairs are grouped together.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | $I_C$ @ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | 120 | D40P1 | | 40 min | .080 | | | | 50 | 10 | TO-202/306 |
| | 250 | MJE3440 | | 40/160 | 0.02 | | | | 15 | 15 | TO-126/77 |
| | 350 | MJE3439 | | 40/160 | 0.02 | | | | 15 | 15 | TO-126/77 |
| 0.5 | 150 | MJE341 | | 25/200 | 0.05 | | | | 15 | 20.8 | TO-126/77 |
| | | 2N6591 | | 40/200 | 0.1 | | | | 35 | 10 | TO-202/306 |
| | 180 | D40P3 | | 40 min | .080 | | | | 50 | 10 | TO-202/306 |
| | 200 | MJE344 | | 30/300 | 0.05 | | | | 15 | 20.8 | TO-126/77 |
| | | 2N6592 | | 30/200 | 0.1 | | | | 35 | 10 | TO-202/306 |
| | | | MJ4645 | 20 min | 0.5 | 0.72* | | 0.05 | 40 | 5 | TO-39/79 |
| | 225 | D40P5 | | 40 min | .080 | | | | 50 | 10 | TO-202/306 |
| | | 2N5655 | | 30/250 | 0.1 | 3.5 typ | 0.24 typ | 0.1 | 10 | 20 | TO-126/77 |
| | 250 | 2N6557 | | 40/180 | .030 | | | | 45 | 10 | TO-202/306 |
| | | D40N1 | | 20 min | .040 | | | | 50 | 10 | TO-202/306 |
| | | D40N2 | | 30 min | .040 | | | | 50 | 10 | TO-202/306 |
| | | 2N6593 | | 30/200 | 0.1 | | | | 35 | 10 | TO-202/306 |
| | 300 | MPS-U10 | MPS-U60 | 30 min | .030 | | | | 60 | 10 | /152 |
| | | | MDS-60 | 30 min | .030 | | | | 60 | 10 | TO-202/306 |
| | | 2N6558 | | 40/180 | .030 | | | | 45 | 10 | TO-202/306 |
| | | D40N3 | | 20 min | .040 | | | | 50 | 10 | TO-202/306 |
| | | D40N4 | | 30 min | .040 | | | | 50 | 10 | TO-202/306 |
| | | MJE340 | MJE350 | 30/240 | 0.05 | | | | 50 | 20.8 | TO-126/77 |
| | | 2N5656 | | 30/250 | 0.1 | 3.5 typ | 0.24 typ | 0.1 | 10 | 20 | TO-126/77 |
| | | | MJ4646 | 20 min | 0.5 | 0.72* | | 0.05 | 40 | 5 | TO-39/79 |
| | 350 | 2N6559 | | 40/180 | .030 | | | | 45 | 10 | TO-202/306 |
| | | 2N5657 | | 30/250 | 0.1 | 3.5 typ | 0.24 typ | 0.1 | 10 | 20 | TO-126/77 |
| | 400 | | MJ4647 | 20 min | 0.5 | 0.72* | | 0.05 | 30 | 5 | TO-39/79 |
| 0.8 | 40 | MPS-U02 | MPS-U52 | 30 min | 0.5 | | | | 150 | 10 | /152 |
| 1 | 30 | MJE520 | MJE370 | 20/100 | 0.5 | | | | | | TO-126/77 |
| | | D40D1 | D41D1 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D2 | D41D2 | 20 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D3 | | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40E1 | D41E1 | 10 min | 1 | 0.4 typ | 0.17 typ | 1 | 230 typ | 10 | TO-202/306 |
| | 40 | MJE29 | MJE30 | 40 min | 0.2 | | | | 3 | 30 | TO-126/77R |
| | | 2N4921 | 2N4918 | 20/100 | 0.5 | 0.6 typ | 0.3 typ | 0.5 | 3 | 30 | TO-126/77 |
| | 45 | D40D4 | D41D4 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D5 | D41D5 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | 60 | MJE29A | MJE30A | 40 min | 0.2 | | | | 3 | 30 | TO-126/77R |
| | | 2N4922 | 2N4919 | 20/100 | 0.5 | 0.6 typ | 0.3 typ | 0.5 | 3 | 30 | TO-126/77 |
| | | 2N6551 | 2N6554 | 25 min | 0.5 | | | | 75 | 10 | TO-202/306 |
| | | D40D7 | D41D7 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D8 | D41D8 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40E5 | D41E5 | 10 min | 1 | 0.4 typ | 0.17 typ | 1 | 230 typ | 10 | TO-202/306 |

*$t_{off}$



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| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | $I_C$ @ Amp | Resistive Switching $t_s$ us Max | Resistive Switching $t_f$ us Max | Resistive Switching @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 75 | D40D13 | D41D13 | 50/150 | 0.1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D14 | D41D14 | 50/150 | 0.1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D10 | D41D10 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | | D40D11 | D41D11 | 10 min | 1 | 0.2 typ | 0.05 typ | 1 | 200 typ | 10 | TO-202/306 |
| | 80 | MJE29B | MJE30B | 40 min | 0.2 | | | | 3 | 30 | TO-126/77R |
| | | 2N4923 | 2N4920 | 20/100 | 0.5 | 0.6 typ | 0.3 typ | 0.5 | 3 | 30 | TO-126/77 |
| | | 2N6552 | 2N6555 | 25 min | 0.5 | | | | 75 | 10 | TO-202/306 |
| | | D40E7 | D41E7 | 10 min | 1 | 0.4 typ | 0.17 typ | 1 | 220 typ | 10 | TO-202/306 |
| | 100 | MJE29C | MJE30C | 40 min | 0.2 | | | | 3 | 30 | TO-126/77R |
| | | 2N6553 | 2N6556 | 25 min | 0.5 | | | | 75 | 10 | TO-202/306 |
| | 120 | MPS-U03 | | 40 min | .010 | | | | 100 | 10 | /152 |
| | 175 | 2N3583 | 2N6420 | 40/200 | 0.5 | 2 typ | 0.23 typ | 0.5 | 10 | 35 | TO-66/80 |
| | 180 | MPS-U04 | | 40 min | .010 | | | | 100 | 10 | /152 |
| | 225 | 2N3738 | 2N6424 | 40/200 | 0.1 | 3 typ | 0.3 typ | 0.1 | 10 | 20 | TO-66/80 |
| | 250 | | 2N5344 | 25/100 | 0.5 | 0.6 | 0.1 | 0.5 | 60 | 40 | TO-66/80 |
| | 300 | 2N3739 | 2N6425 | 40/200 | 0.1 | 3 typ | 0.3 typ | 0.1 | 10 | 20 | TO-66/80 |
| | | | 2N5345 | 25/100 | 0.5 | 0.6 | 0.1 | 0.5 | 60 | 40 | TO-66/80 |
| 1.5 | 300 | MJE13002 | | 5/25 | 1 | 4 | 0.7 | 1 | 5 | 40 | TO-126/77R |
| | 400 | MJE13003 | | 5/25 | 1 | 4 | 0.7 | 1 | 5 | 40 | TO-126/77R |
| | 30 | D40C1 | | 10K-60K | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | D40C2 | | 40K min | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | | D41K3 | 1K min | 1 | | | | 75 typ | 10 | TO-202/306 |
| | | MDS-01 | MDS-51 | 50 min | 1 | | | | 50 | 10 | TO-202/306 |
| | | MPS-U01 | MPS-U51 | 50 min | 1 | | | | 50 | 10 | /152 |
| | | D40K1 | D41K1 | 1K min | 1.5 | | | | 75 typ | 10 | TO-202/306 |
| | 40 | D40C4 | | 10K-60K | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| 2 | 40 | D40C5 | | 40K min | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | 2N6548 | | 5K min | 1 | | | | 100 | 10 | TO-202/306 |
| | | 2N6549 | | 3K min | 1 | | | | 100 | 10 | TO-202/306 |
| | | MDS-01A | MDS-51A | 50 min | 1 | | | | 50 | 10 | TO-202/306 |
| | | MDS-45 | MDS-95 | 50 min | 1 | | | | 100 | 10 | /152 |
| | | MPS-U01A | MPS-U51A | 50 min | 1 | | | | 50 | 10 | /152 |
| | 60 | MPS-U05 | MPS-U55 | 60 min | 0.25 | | | | 50 | 10 | /152 |
| | 80 | MPS-U06 | MPS-U56 | 60 min | 0.25 | | | | 50 | 10 | /152 |
| | 100 | MPS-U07 | MPS-U57 | 30 min | 0.25 | | | | 50 | 10 | /152 |
| | 120 | 2N5050 | | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | 40 | TO-66/80 |
| | 150 | 2N5051 | | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | 40 | TO-66/80 |
| | 200 | 2N5052 | | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | 40 | TO-66/80 |
| | 250 | 2N3584 | 2N6421 | 25/100 | 1 | 4 | 3 | 1 | 10 | 35 | TO-66/80 |
| | 300 | 2N4240 | 2N6423 | 30/150 | 0.75 | 6 | 3 | 0.75 | 10 | 35 | TO-66/80 |
| | | 2N3585 | 2N6422 | 25/100 | 1 | 4 | 3 | 1 | 10 | 35 | TO-66/80 |
| 3 | 40 | MJE180 | MJE170 | 50/250 | 0.1 | 0.6 typ | 0.12 typ | 0.1 | 50 | 12.5 | TO-126/77 |
| | | MJE31 | MJE32 | 25 min | 1 | | | | 3 | 40 | TO-126/77R |
| | | TIP31 | TIP32 | 25 min | 1 | 1 typ* | | 1 | 3 | 40 | TO-220/221A |
| | | | 2N3719 | 25/180 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | | | 2N3867 | 40/200 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | 60 | MJE181 | MJE171 | 50/250 | 0.1 | 0.6 typ | 0.12 typ | 0.1 | 50 | 12.5 | TO-126/77 |
| | | MJE31A | MJE32A | 25 min | 1 | | | | 3 | 40 | TO-126/77R |
| | | TIP31A | TIP32A | 25 min | 1 | 1 typ* | | 1 | 3 | 40 | TO-220/221A |
| | | | 2N3720 | 25/180 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | | | 2N3868 | 30/150 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| 3 | 65 | MDS1678 | | 10 min | 1.5 | | | | | 10 | TO-202/306 |
| | 80 | MJE182 | MJE172 | 50/250 | 0.1 | 0.6 typ | 0.12 typ | 0.1 | 50 | 12.5 | TO-126/77 |
| | | MJE31B | MJE32B | 25 min | 1 | | | | 3 | 40 | TO-126/77R |
| | | TIP31B | TIP32B | 25 min | 1 | 1 typ* | | 1 | 3 | 40 | TO-220/221A |
| | | | 2N6303 | 30/150 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | 100 | MJE31C | MJE32C | 25 min | 1 | | | | 3 | 40 | TO-126/77R |
| | | TIP31C | TIP32C | 25 min | 1 | 1 typ* | | 1 | 3 | 40 | TO-220/221A |

*$t_{off}$



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## STANDARD SILICON POWER TRANSISTORS (continued)

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max @ Amp | $I_C$ | Resistive Switching $t_s$ µs Max | Resistive Switching $t_f$ µs Max | Resistive Switching @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.5 | 325 | 2N3902 | | 30 90 | 1 | 1 2 typ | 0 1 typ | 1 | 2 8 | 100 | TO 3 11 |
| | 400 | 2N5157 | | 30 90 | 1 | 1 2 typ | 0 1 typ | 1 | 2 8 | 100 | TO 3 11 |
| 4 | 40 | 2N4910 | 2N4898 | 20 100 | 0 5 | 0 6 typ | 0 3 typ | 0 5 | 3 | 25 | TO 66 80 |
| | | MJE3300 | MJE3310 | 1k min | 1 | | | | 20 # | 15 | TO 126 77R |
| | | 2N5190 | 2N5193 | 25 100 | 1 5 | 0 4 typ | 0 4 typ | 1 5 | 2 | 40 | TO 126 77 |
| | 45 | 2N6121 | 2N6124 | 25 100 | 1 5 | | | | 2 5 | 40 | TO 220 221A |
| | 60 | | 2N3740 | 30 100 | 0.25 | 1 3 typ | 0.27 typ | 0.25 | 4 | 25 | TO 66 80 |
| | | 2N4911 | 2N4899 | 20 100 | 0 5 | 0 6 typ | 0 3 typ | 0 5 | 3 | 25 | TO 66 80 |
| | | 2N3054,A | 2N6049 | 25 100 | 0 5 | 1 typ | 0 3 typ | 0.5 | 3 | 75 | TO 66 80 |
| | | 2N3766 | | 40 160 | 0 5 | 0 9 typ | 0.09 typ | 0 5 | 10 | 20 | TO 66 80 |
| | | MJE3301 | MJE3311 | 1k min | 1 | | | | 20# | 15 | TO 126 77R |
| | | 2N5191 | 2N5194 | 25 100 | 1 5 | 0 4 typ | 0 4 typ | 1 5 | 2 | 40 | TO 126 77 |
| | | MJE800 | MJE700 | 750 min | 1 5 | | | | 1# | 40 | TO 126 77 |
| | | 2N6122 | 2N6125 | 25 100 | 1 5 | | | | 2 5 | 40 | TO 220 221A |
| | | 2N6294 | 2N6296 | 750 18k | 2 | 0 9 typ | 0 7 typ | 2 | 4# | 50 | TO 66 80 |
| | | 2N6037 | 2N6034 | 750 18k | 2 | 1 7 typ | 1 2 typ | 2 | 25# | 40 | TO 126 77 |
| | | 2N4877 | | 20 100 | 4 | 1 5 | 0 5 | 4 | 30 | 10 | TO 39 79 |
| | 80 | MJE241 | MJE251 | 40 120 | 0 2 | 0 7 typ | 0.08 typ | 0 2 | 40 | 15 | TO 126 77 |
| | | | 2N3741 | 30 100 | 0 25 | 1 3 typ | 0.27 typ | 0 25 | 4 | 25 | TO 66 80 |
| | | 2N4912 | 2N4900 | 20 100 | 0 5 | 0 6 typ | 0 3 typ | 0 5 | 3 | 25 | TO 66 80 |
| | | 2N3767 | | 40 160 | 0 5 | 0 9 typ | 0.09 typ | 0 5 | 10 | 20 | TO 66 80 |
| | | MJE3302 | MJE3312 | 1k min | 1 | | | | 20# | 15 | TO 126 77R |
| | | 2N5192 | 2N5195 | 25 100 | 1 5 | 0 4 typ | 0 4 typ | 1 5 | 2 | 40 | TO 126 77 |
| | | MJE802 | MJE702 | 750 min | 1 5 | | | | 1 # | 40 | TO 126 77 |
| | | 2N6123 | 2N6126 | 20 80 | 1 5 | | | | 2 5 | 40 | TO 220 221A |
| | | 2N6038 | 2N6035 | 750 18k | 2 | 1 7 typ | 1 2 typ | 2 | 25 # | 40 | TO 126 77 |
| | | 2N6295 | 2N6297 | 750 10k | 2 | 0 9 typ | 0 7 typ | 2 | 4 # | 50 | TO 66 80 |
| | 100 | MJE243 | MJE253 | 40 120 | 0 2 | 0 7 typ | 0 08 typ | 0 2 | 40 | 15 | TO 126 77 |
| | | 2N6039 | 2N6036 | 750 18k | 2 | 1 7 typ | 1 2 typ | 2 | 25# | 40 | TO 126 77 |
| | 300 | MJE13004 | | 6 30 | 3 | 3 | 0 7 | 3 | 4 | 60 | TO 220 221A |
| | 400 | MJE13005 | | 6 30 | 3 | 3 | 0 7 | 3 | 4 | 60 | TO 220 221A |
| 5 | 25 | MJE200 | MJE210 | 45 180 | 2 | 0 13 typ | 0.035 typ | 2 | 65 | 15 | TO 126 77R |
| | 40 | 2N5067 | 2N4901 | 20 180 | 1 | 0 4 typ | 0 15 typ | 1 | 4 | 87 5 | TO 3 11 |
| | | 2N4231A | 2N6312 | 25 100 | 1 5 | 0 5 typ | 0 2 typ | 1 5 | 4 | 75 | TO 66 80 |
| | | 2N5977 | 2N5974 | 20 120 | 2 5 | 0 45 typ | 0 18 typ | 2 5 | 2 | 75 | TO 127 90 |
| | | 2N4904 | 2N4913 | 25 100 | 2 5 | 0 3 typ | 0 2 typ | 2 5 | 4 | 87 5 | TO 3 11 |
| | 50 | MJE205 | MJE105 | 25 100 | 2 | | | | | 65 | TO 127 90 |
| | 60 | 2N5068 | 2N4902 | 20 180 | 1 | 0 4 typ | 0 15 typ | 1 | 4 | 87 5 | TO 3 11 |
| | | 2N4232A | 2N6313 | 25 100 | 1 5 | 0 5 typ | 0 2 typ | 1 5 | 4 | 75 | TO 66 80 |
| | | | MJ8100 | 25 180 | 2 | 1 | 0 15 | 2 | 30 | 10 | TO 39 79 |
| | | 2N5978 | 2N5975 | 25 100 | 2 5 | 0 45 typ | 0 18 typ | 2 5 | 2 | 75 | TO 127 90 |
| | | 2N4914 | 2N4905 | 25 100 | 2 5 | 0 3 typ | 0 2 typ | 2 5 | 4 | 87 5 | TO 3 11 |
| | | MJE1100 | MJE1090 | 750 min | 3 | | | | 1# | 70 | TO 127 90 |
| | | MJE1101 | MJE1091 | 750 min | 4 | | | | 1# | 70 | TO 127 90 |
| | 80 | 2N5069 | 2N4903 | 20 180 | 1 | 0 4 typ | 0 15 typ | 1 | 4 | 87 5 | TO 3 11 |
| | | 2N4233A | 2N6314 | 25 100 | 1 5 | 0 5 typ | 0 2 typ | 1 5 | 4 | 75 | TO 66 80 |
| | | 2N5336 | 2N6190 | 30 120 | 2 | 2 | 0 2 | 2 | 30 | 10 | TO 39 79 |
| | | 2N5337 | 2N6191 | 60 240 | 2 | 2 | 0 2 | 2 | 30 | 10 | TO 39 79 |
| | | 2N5979 | 2N5976 | 20 120 | 2 5 | 0 45 typ | 0 18 typ | 2 5 | 2 | 75 | TO 127 90 |
| | | 2N4915 | 2N4906 | 25 100 | 2 5 | 0 3 typ | 0 2 typ | 2 5 | 4 | 87 5 | TO 3 11 |
| | | MJE1102 | MJE1092 | 750 min | 3 | | | | 1# | 70 | TO 127 90 |
| | | MJE1103 | MJE1093 | 750 min | 4 | | | | 1# | 70 | TO 127 90 |
| | 100 | 2N5338 | 2N6192 | 30 120 | 2 | 2 | 0 2 | 2 | 30 | 10 | TO 39 79 |
| | | 2N5339 | 2N6193 | 60 240 | 2 | 2 | 0 2 | 2 | 30 | 10 | TO 39 79 |
| | 200 | MJ410 | | 30 90 | 1 | | | | 2 5 | 100 | TO 3 11 |
| | 225 | 2N6233 | | 25 125 | 1 | 3 5 | 0 5 | 1 | 20 | 50 | TO 66 80 |
| | 250 | 2N6234 | | 25 125 | 1 | 3 5 | 0.5 | 1 | 20 | 50 | TO 66 80 |
| | | MJ3029 | | 30 min | 0 4 | | 1 | 3 | | 125 | TO 3 11 |
| | | MJ1800 | | 40 120 | 0 4 | | | | | 100 | TO 3 11 |
| | | 2N5838 | | 8 40 | 3 | 1 typ | 0 4 typ | 3 | 5 | 100 | TO 3 11 |
| | 275 | 2N5839 | | 10 50 | 2 | 1 typ | 0 4 typ | 3 | 5 | 100 | TO 3 11 |
| | 300 | MJ411 | | 30 90 | 1 | | | | 2 5 | 100 | TO 3 11 |
| | | 2N6542 | | 7 35 | 3 | 4 | 0 8 | 3 | 6 | 100 | TO 3 11 |
| | 325 | 2N6235 | | 25 125 | 1 | 3 5 | 0.5 | 1 | 20 | 50 | TO 66 80 |
| | | MJ3030 | | 3 75 min | 3 | | 1 | 3 | | 125 | TO 3 11 |
| | | 2N5241 | | 15 35 | 2 5 | 1 typ | 0 2 typ | 2 5 | 2 5 | 125 | TO 3 11 |
| | 350 | 2N5840 | | 10 50 | 2 | 1 typ | 0 4 typ | 3 | 5 | 100 | TO 3 11 |
| | 400 | 2N6543 | | 7 35 | 3 | 4 | 0 8 | 3 | 6 | 100 | TO 3 11 |
| | 600 | BU207 | | 2 25 min | 4 5 | | 1 | 4 5 | 7 5 | 125 | TO 3 11 |
| | 700 | BU208 | | 2 25 min | 4 5 | | 1 | 4 5 | 7 5 | 125 | TO 3 11 |

# $h_{fe}$ @ 1 MHz



World Radio History

## STANDARD SILICON POWER TRANSISTORS (continued)

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max @ Amp | $I_C$ | Resistive Switching $t_s$ us Max | Resistive Switching $t_f$ us Max | Resistive Switching @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 40 | TIP41 | TIP42 | 15/75 | 3 | 0.7 typ* | | 6 | 3 | 65 | TO-220/221A |
| | 60 | TIP41A | TIP42A | 15/75 | 3 | 0.7 typ* | | 6 | 3 | 65 | TO-220/221A |
| | 80 | TIP418 | TIP428 | 15/75 | 3 | 0.7 typ* | | 6 | 3 | 65 | TO-220/221A |
| | 100 | TIP41C | TIP42C | 15/75 | 3 | 0.7 typ* | | 6 | 3 | 65 | TO-220/221A |
| | | 2N5758 | 2N6226 | 25/100 | 3 | 0.7 typ | 0.5 typ | 3 | 1 | 150 | TO-3/11 |
| | 120 | 2N5759 | 2N6227 | 20/80 | 3 | 0.7 typ | 0.5 typ | 3 | 1 | 150 | TO-3/11 |
| | 140 | 2N5760 | 2N6228 | 15/60 | 3 | 0.7 typ | 0.5 typ | 3 | 1 | 150 | TO-3/11 |
| 7 | 30 | 2N6288 | 2N6111 | 30/150 | 3 | 0.4 typ | 0.15 typ | 3 | 4 | 65 | TO-220/221A |
| | 50 | 2N6290 | 2N6109 | 30/150 | 2.5 | 0.4 typ | 0.15 typ | 3 | 4 | 65 | TO-220/221A |
| | 60 | 2N6315 | 2N6317 | 20/100 | 2.5 | 1 | 0.8 | 2.5 | 4 | 90 | TO-66/80 |
| | 70 | 2N6292 | 2N6107 | 30/150 | 2 | 0.4 typ | 0.15 typ | 3 | 4 | 65 | TO-220/221A |
| | 80 | 2N5427 | | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5346 | 2N6186 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N5428 | | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5347 | 2N6187 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N6316 | 2N6318 | 20/100 | 2.5 | 1 | 0.8 | 2.5 | 4 | 90 | TO-66/80 |
| | 100 | 2N5429 | | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5348 | 2N6188 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N5430 | | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5349 | 2N6189 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | 300 | MJ3040 | | 100 min | 2.5 | | | | | 100 | TO-3/11 |
| | | MJ3041 | | 250 min | 2.5 | | | | | 100 | TO-3/11 |
| | 350 | MJ3042 | | 250 min | 2.5 | | | | | 100 | TO-3/11 |
| 7.5 | 60 | 2N3445 | | 20/60 | 3 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | | 2N3447 | | 40/120 | 5 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | 80 | 2N3446 | | 20/60 | 3 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | | 2N3448 | | 40/120 | 5 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| 8 | 40 | 2N5983 | 2N5980 | 20/120 | 4 | 0.7 typ | 0.4 typ | 4 | 2 | 90 | TO-127/90 |
| | 60 | MJ1000 | MJ900 | 1k min | 3 | | | | | 90 | TO-3/11 |
| | | TIP120 | TIP125 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 65 | TO-220/221A |
| | | 2N5984 | 2N5981 | 20/120 | 4 | 0.7 typ | 0.4 typ | 4 | 2 | 90 | TO-127/90 |
| | | 2N6300 | 2N6298 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-66/80 |
| | | 2N6055 | 2N6053 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 100 | TO-3/11 |
| | | MJE6043 | MJE6040 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-127/90 |
| | 80 | MJ1001 | MJ901 | 1k min | 3 | | | | | 90 | TO-3/11 |
| | | TIP121 | TIP126 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 65 | TO-220/221A |
| | | 2N5985 | 2N5982 | 20/120 | 4 | 0.7 typ | 0.4 typ | 4 | 2 | 90 | TO-127/90 |
| | | 2N6301 | 2N6299 | 750/1k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-66/80 |
| | | 2N6056 | 2N6054 | 750/1k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 100 | TO-3/11 |
| | | MJE6044 | MJE6041 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-127/90 |
| | 100 | MJE6045 | MJE6042 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-127/90 |
| | | TIP122 | TIP127 | 1k min | 3 | 1.5 typ | 1.5 typ | 4 | 4# | 75 | TO-220/221A |
| | 250 | 2N6306 | | 15/75 | 3 | 1.6 | 0.4 | 3 | 5 | 125 | TO-3/11 |
| | 300 | 2N6307 | | 15/75 | 3 | 1.6 | 0.4 | 3 | 5 | 125 | TO-3/11 |
| | | 2N6544 | | 7/35 | 5 | 4 | 1 | 5 | 6 | 125 | TO-3/11 |
| | | MJ7160 | | 25/100 | 3 | 2 | 0.3 | 3 | 30 | 140 | TO-3/11 |
| | | MJE13006 | | 6/30 | 5 | 3 | 0.7 | 5 | 4 | 80 | TO-220/221A |
| | 350 | 2N6308 | | 12/60 | 3 | 1.6 | 0.4 | 5 | 5 | 125 | TO-3/11 |
| | 400 | MJE13007 | | 6/30 | 5 | 3 | 0.7 | 5 | 4 | 80 | TO-220/221A |
| | | 2N6545 | | 7/35 | 5 | 4 | 1 | 5 | 6 | 125 | TO-3/11 |
| | | MJ7161 | | 25/100 | 3 | 2 | 0.3 | 3 | 30 | 140 | TO-3/11 |
| 10 | 60 | | MJ6700 | 25/180 | 2 | 1 | 0.15 | 2 | 30 | 60 | TO-59/160 |
| | | MJE2801 | MJE2901 | 25/100 | 3 | | | | | 90 | TO-127/90 |
| | | 2N3713 | 2N3789 | 15 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| | | 2N3715 | 2N3791 | 30 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| | | MJE3055 | MJE2955 | 20/70 | 4 | | | | 2 | 90 | TO-127/90 |
| | | 2N5877 | 2N5875 | 20/100 | 4 | 1 | 0.8 | 4 | 4 | 150 | TO-3/11 |
| | | MJ3000 | MJ2500 | 1k min | 5 | | | | | 150 | TO-3/11 |
| | 80 | 2N3714 | 2N3790 | 15 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| | | 2N3716 | 2N3792 | 30 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| | | 2N5878 | 2N5876 | 20/100 | 4 | 1 | 0.8 | 4 | 4 | 150 | TO-3/11 |
| | | MJ3001 | MJ2501 | 1k min | 5 | | | | | 150 | TO-3/11 |
| | | 2N6495 | | 10/60 | 10 | 0.15 typ | 0.05 typ | 10 | 25 | 70 | TO-66/80 |
| | 100 | 2N5632 | 2N6229 | 25/100 | 5 | 0.9 typ | 0.9 typ | 5 | 1 | 150 | TO-3/11 |
| | 120 | 2N5633 | 2N6230 | 20/80 | 5 | 0.9 typ | 0.9 typ | 5 | 1 | 150 | TO-3/11 |
| | 140 | 2N5634 | 2N6231 | 15/60 | 5 | 0.9 typ | 0.9 typ | 5 | 1 | 150 | TO-3/11 |
| | 325 | MJ413 | | 20/80 | 0.5 | | | | 2.5 | 125 | TO-3/11 |
| | | MJ423 | | 30/90 | 1 | | | | 2.5 | 125 | TO-3/11 |
| | | MJ431 | | 15/35 | 2.5 | | | | 2.5 | 125 | TO-3/11 |
| | | MJ9000 | | 3.75 min | 6 | | 1.1 | 6 | | 125 | TO-3/11 |

* $t_{off}$

\# $h_{fe}$ @ 1 MHz



World Radio History

## STANDARD SILICON POWER TRANSISTORS (continued)

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | @ $I_C$ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 350 | MJ10002 | | 30 300 | 5 | 2 5 | 1 | 5 | 10 # | 150 | TO-3 11 |
| | | MJ10006 | | 30 300 | 5 | 1 1 | 0 25 | 5 | 10 # | 150 | TO-3 11 |
| | 400 | MJ10003 | | 30 300 | 5 | 2 5 | 1 | 5 | 10 # | 150 | TO-3 11 |
| | | MJ10007 | | 30 300 | 5 | 1 1 | 0 25 | 5 | 10 # | 150 | TO-3 11 |
| 12 | 40 | 2N6569 | 2N6594 | 15 200 | 4 | 5 | 1 5 | 2 | 1 5 to 15 | 100 | TO-3 11 |
| | | 2N5989 | 2N5986 | 20 120 | 6 | 0 5 typ | 0 25 typ | 6 | 2 | 100 | TO-127/90 |
| | 60 | 2N5990 | 2N5987 | 20 120 | 6 | 0 5 typ | 0 25 typ | 6 | 2 | 100 | TO-127/90 |
| | | 2N6057 | 2N6050 | 750 18k | 6 | 1 6 typ | 1 5 typ | 6 | 4# | 150 | TO-3 11 |
| | 80 | 2N5991 | 2N5988 | 20 120 | 6 | 0 5 typ | 0 25 typ | 6 | 2 | 100 | TO-127 90 |
| | | 2N6058 | 2N6051 | 750 18k | 6 | 1 6 typ | 1 5 typ | 6 | 4# | 150 | TO-3 11 |
| | 100 | 2N6059 | 2N6052 | 750 18k | 6 | 1 6 typ | 1 5 typ | 6 | 4# | 150 | TO-3 11 |
| | 300 | MJE13008 | | 6 30 | 8 | 3 | 0 7 | 8 | 4 | 100 | TO-220 221A |
| | 400 | MJE13009 | | 6 30 | 8 | 3 | 0 7 | 8 | 4 | 100 | TO-220 221A |
| 15 | 40 | MJE1660 | MJE1290 | 20 100 | 5 | | | | 3 | 90 | TO-127 90 |
| | 60 | 2N3055 | MJ2955 | 20 70 | 4 | 0 7 typ | 0 3 typ | 4 | 2 5 | 115 | TO-3 11 |
| | | 2N6576 | | 2k 20k | 4 | 2 | 7 | 10 | 10 to 200# | 120 | TO-3 11 |
| | | MJE1661 | MJE1291 | 20 100 | 5 | | | | 3 | 90 | TO-127 90 |
| | | 2N5881 | 2N5879 | 20 100 | 6 | 1 | 0 8 | 6 | 4 | 160 | TO-3 11 |
| | 80 | 2N5882 | 2N5880 | 20 100 | 6 | 1 | 0 8 | 6 | 4 | 160 | TO-3 11 |
| | 90 | 2N6577 | | 2k 20k | 4 | 2 | 7 | 10 | 10 to 200# | 120 | TO-3 11 |
| | 120 | 2N6578 | | 2k 20k | 4 | 2 | 7 | 10 | 10 to 200# | 120 | TO-3 11 |
| | 140 | MJ15001 | MJ15002 | 25 150 | 4 | | | | 2 | 200 | TO-3 11 |
| | 200 | 2N6249 | | 10 50 | 10 | 3 5 | 1 | 10 | 2 5 | 175 | TO-3 11 |
| | 275 | 2N6250 | | 8 50 | 10 | 3 5 | 1 | 10 | 2 5 | 175 | TO-3 11 |
| | 300 | MJ7260 | | 25 100 | 5 | 2 | 0 3 | 5 | 30 | 175 | TO-3 11 |
| | | 2N6546 | | 6 30 | 10 | 4 | 0 7 | 10 | 6 to 24 | 175 | TO-3 11 |
| | 350 | 2N6251 | | 6 50 | 10 | 3 5 | 1 | 10 | 2 5 | 175 | TO-3 11 |
| | 400 | 2N6547 | | 6 30 | 10 | 4 | 0 7 | 10 | 6 to 24 | 175 | TO-3 11 |
| | | MJ7261 | | 25 100 | 5 | 2 | 0 3 | 5 | 30 | 175 | TO-3 11 |
| 16 | 60 | MJ4033 | MJ4030 | 1k min | 10 | | | | | 150 | TO-3 11 |
| | 80 | MJ4034 | MJ4031 | 1k min | 10 | | | | | 150 | TO-3 11 |
| | 100 | 2N5629 | 2N6029 | 25 100 | 8 | 1 2 typ | 1 2 typ | 8 | 1 | 200 | TO-3 11 |
| | | MJ4035 | MJ4032 | 1k min | 10 | | | | | 150 | TO-3 11 |
| | 120 | 2N5630 | 2N6030 | 20 80 | 8 | 1 2 typ | 1 2 typ | 8 | 1 | 200 | TO-3 11 |
| | 140 | 2N3773 | 2N6609 | 15 60 | 8 | 1 1 typ | 0.9 typ | 8 | 4 | 150 | TO-3 11 |
| | | 2N5631 | 2N6031 | 15 60 | 8 | 1 2 typ | 1 2 typ | 8 | 1 | 200 | TO-3 11 |
| 20 | 60 | 2N6282 | 2N6285 | 750 18k | 10 | 2 5 typ | 2 5 typ | 10 | 4# | 160 | TO-3 11 |
| | 75 | MJ5039 | | 20 100 | 10 | 1 5 | 0 5 | 10 | 60 | 115 | TO-3 11 |
| | 80 | 2N5303 | 2N5745 | 15 60 | 10 | 2 | 1 | 10 | 2 | 200 | TO-3 11 |
| | | 2N6283 | 2N6286 | 750 18k | 10 | 2 5 typ | 2 5 typ | 10 | 4# | 160 | TO-3 11 |
| | 90 | MJ5038 | | 20 100 | 12 | 1 5 | 0 5 | 12 | 60 | 115 | TO-3 11 |
| | 100 | 2N6284 | 2N6287 | 750 18k | 10 | 2 5 typ | 2 5 typ | 10 | 4# | 160 | TO-3 11 |
| | 140 | MJ15003 | MJ15004 | 25 150 | 5 | | | | 2 | 250 | TO-3 11 |
| | 350 | MJ10000 | | 40 400 | 10 | 3 | 1 8 | 10 | 10# | 175 | TO-3 11 |
| | | MJ10004 | | 40 400 | 10 | 1 25 | 0 35 | 10 | 10# | 175 | TO-3 11 |
| | 400 | MJ10001 | | 40 400 | 10 | 3 | 1 8 | 10 | 10# | 175 | TO-3 11 |
| | | MJ10005 | | 40 400 | 10 | 1 25 | 0 35 | 10 | 10# | 175 | TO-3 11 |
| 25 | 60 | 2N5885 | 2N5883 | 20 100 | 10 | 1 | 0 8 | 10 | 4 | 200 | TO-3 11 |
| | 80 | 2N5886 | 2N5884 | 20 100 | 10 | 1 | 0 8 | 10 | 4 | 200 | TO-3 11 |
| | 100 | | 2N6436 | 20 80 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | | 2N6338 | | 30 120 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | 120 | | 2N6437 | 20 80 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | | 2N6339 | | 30 120 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | | | 2N6438 | 20 80 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | 140 | 2N6340 | | 30 120 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| | 150 | 2N6341 | | 30 120 | 10 | 1 | 0 25 | 10 | 40 | 200 | TO-3 11 |
| 30 | 40 | 2N5301 | 2N4398 | 15 60 | 15 | 2 | 1 | 10 | 2 | 200 | TO-3 11 |
| | 60 | 2N5302 | 2N4399 | 15 60 | 15 | 2 | 1 | 10 | 2 | 200 | TO-3 11 |
| | | MJ11012 | MJ11011 | 1k min | 20 | | | | 4# | 200 | TO-3 11 |
| | 90 | MJ11014 | MJ11013 | 1k min | 20 | | | | 4# | 200 | TO-3 11 |
| | 100 | MJ802 | MJ4502 | 25 100 | 7 5 | | | | 2 | 200 | TO-3 11 |
| | 120 | MJ11016 | MJ11015 | 1k min | 20 | | | | 4# | 200 | TO-3 11 |
| 50 | 60 | 2N5685 | 2N5683 | 15 60 | 25 | 0 5 typ | 0 3 typ | 25 | 2 | 300 | TO-3 Mod 197 |
| | 80 | 2N5686 | 2N5684 | 15 60 | 25 | 0 5 typ | 0 3 typ | 25 | 2 | 300 | TO-3 Mod 197 |
| | | | 2N6377 | 30 120 | 20 | 0 8 | 0 25 | 20 | 30 | 250 | TO-3 Mod 197 |
| | 100 | 2N6274 | 2N6378 | 30 120 | 20 | 0 8 | 0 25 | 20 | 30 | 250 | TO-3 Mod 197 |
| | 120 | 2N6275 | 2N6379 | 30 120 | 20 | 0 8 | 0 25 | 20 | 30 | 250 | TO-3 Mod 197 |
| | 140 | 2N6276 | | 30 120 | 20 | 0 8 | 0 25 | 20 | 30 | 250 | TO-3 Mod 197 |
| | 150 | 2N6277 | | 30 120 | 20 | 0 8 | 0 25 | 20 | 30 | 250 | TO-3 Mod 197 |

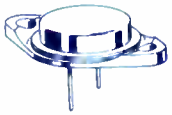
# $h_{fe}$ @ 1 MHz



World Radio History

# Motorola Standard Silicon Power Transistors Arranged by Package

## TO-3



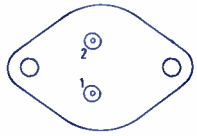
CASE 11-01 – 40-mil pins

**MODIFIED TO-3**

CASE 197-01 – 60-mil pins

For single side mounting in power range of 87.5 to 300 watts, at 25°C.

Devices shown have 40-mil pins unless otherwise noted.




STYLE 1:
PIN 1. BASE
2. EMITTER
CASE. COLLECTOR

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 3.5 | 325 | 2N3902 | |
| | 400 | 2N5157 | |
| 5 | 40 | 2N5067<br>2N4904 | 2N4901<br>2N4913 |
| | 60 | 2N5068<br>2N4914 | 2N4902<br>2N4905 |
| | 80 | 2N5069<br>2N4915 | 2N4903<br>2N4906 |
| | 200 | MJ410 | |
| | 250 | MJ3029<br>MJ1800<br>2N5838 | |
| | 275 | 2N5839 | |
| | 300 | MJ411<br>2N6542 | |
| | 325 | MJ3030<br>2N5241 | |
| | 350 | 2N5840 | |
| | 400 | 2N6543 | |
| | 600 | BU207 | |
| | 700 | BU208 | |
| 6 | 100 | 2N5758 | 2N6226 |
| | 120 | 2N5759 | 2N6227 |
| | 140 | 2N5760 | 2N6228 |
| | 250 | MJ3260 | |
| 7 | 300 | MJ3040<br>MJ3041 | |
| | 350 | MJ3042 | |
| 7.5 | 60 | 2N3445<br>2N3447 | |
| | 80 | 2N3446<br>2N3448 | |
| 8 | 60 | MJ1000<br>2N6055 | MJ900<br>2N6053 |
| | 80 | MJ1001<br>2N6056 | MJ901<br>2N6054 |
| | 250 | 2N6306 | |
| | 300 | 2N6307<br>2N6544<br>MJ7160 | |

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 8 | 350 | 2N6308 | |
| | 400 | 2N6545<br>MJ7161 | |
| 10 | 60 | 2N3713<br>2N3715<br>2N5877<br>MJ3000 | 2N3789<br>2N3791<br>2N5875<br>MJ2500 |
| | 80 | 2N3714<br>2N3716<br>2N5878<br>MJ3001 | 2N3790<br>2N3792<br>2N5876<br>MJ2501 |
| | 100 | 2N5632 | 2N6229 |
| | 120 | 2N5633 | 2N6230 |
| | 140 | 2N5634 | 2N6231 |
| | 325 | MJ413<br>MJ423<br>MJ431<br>MJ9000 | |
| | 350 | MJ10002<br>MJ10006 | |
| | 400 | MJ10003<br>MJ10007 | |
| 12 | 40 | 2N6569 | 2N6594 |
| | 60 | 2N6057 | 2N6050 |
| | 80 | 2N6058 | 2N6051 |
| | 100 | 2N6059 | 2N6052 |
| 15 | 60 | 2N3055<br>2N6576<br>2N5881 | MJ2955<br>2N5879 |
| | 80 | 2N5882 | 2N5880 |
| | 90 | 2N6577 | |
| | 120 | 2N6578 | |
| | 140 | MJ15001 | MJ15002 |
| | 200 | 2N6249 | |
| | 275 | 2N6250 | |
| | 300 | 2N6546<br>MJ7260 | |
| | 350 | 2N6251 | |
| | 400 | 2N6547<br>MJ7261 | |

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 16 | 60 | MJ4033 | MJ4030 |
| | 80 | MJ4034 | MJ4031 |
| | 100 | 2N5629<br>MJ4035 | 2N6029<br>MJ4032 |
| | 120 | 2N5630 | 2N6030 |
| | 140 | 2N3773<br>2N5631 | 2N6609<br>2N6031 |
| 20 | 60 | 2N6282 | 2N6285 |
| | 75 | MJ5039 | |
| | 80 | 2N5303<br>2N6283 | 2N5745<br>2N6286 |
| | 90 | MJ5038 | |
| | 100 | 2N6284 | 2N6287 |
| | 140 | MJ15003 | MJ15004 |
| | 350 | MJ10000<br>MJ10004 | |
| | 400 | MJ10001<br>MJ10005 | |
| 25 | 60 | 2N5885 | 2N5883 |
| | 80 | 2N5886 | 2N5884<br>2N6436 |
| | 100 | 2N6338 | 2N6437 |
| | 120 | 2N6339 | 2N6438 |
| | 140 | 2N6340 | |
| | 150 | 2N6341 | |
| 30 | 40 | 2N5301 | 2N4398 |
| | 60 | 2N5302<br>MJ11012 | 2N4399<br>MJ11011 |
| | 90 | MJ11014 | MJ11013 |
| | 100 | MJ802 | MJ4502 |
| | 120 | MJ11016 | MJ11015 |
| 50 | 60 | 2N5685* | 2N5683* |
| | 80 | 2N5686* | 2N5684*<br>2N6377* |
| | 100 | 2N6274* | 2N6378* |
| | 120 | 2N6275* | 2N6379* |
| | 140 | 2N6276* | |
| | 150 | 2N6277* | |

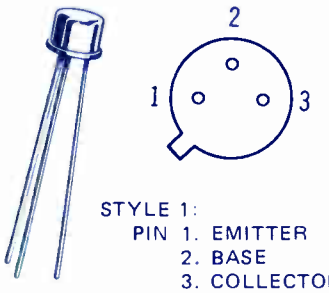
*Modified TO-3 (Case 197); 60-mil pins.



World Radio History

## TO-5

CASE 31-03



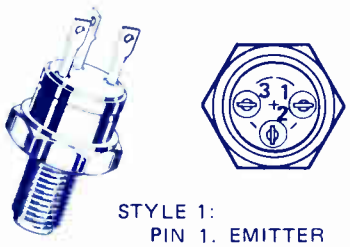

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

Lead mounted devices; power dissipation of 6 watts at 25°C ambient.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 3 | 40 | | 2N3719<br>2N3867 |
| | 60 | | 2N3720<br>2N3868 |
| | 80 | | 2N6303 |

## TO-59

CASE 160-03



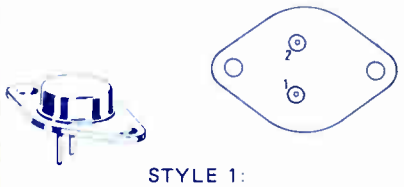

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

Stud mounted devices; power dissipation 60 watts at 25°C case.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 7 | 80 | 2N5346<br>2N5347 | |
| | 100 | 2N5348<br>2N5349 | |
| 10 | 60 | | MJ6700 |
| | 80 | | 2N6186<br>2N6187 |
| | 100 | | 2N6188<br>2N6189 |

## TO-66

CASE 80-02



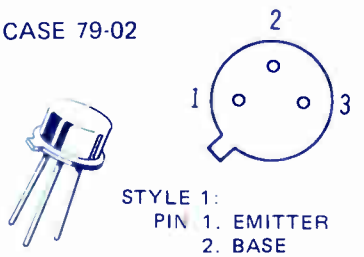

STYLE 1:
PIN 1. BASE
2. EMITTER
CASE. COLLECTOR

For single side mounting; power dissipation of 20 to 90 watts at 25°C case.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 1 | 175 | 2N3583 | 2N6420 |
| | 225 | 2N3738 | 2N6424 |
| | 250 | | 2N5344 |
| | 300 | 2N3739 | 2N5345<br>2N6425 |
| 2 | 120 | 2N5050 | |
| | 150 | 2N5051 | |
| | 200 | 2N5052 | |
| | 250 | 2N3584 | 2N6421 |
| | 300 | 2N3585<br>2N4240 | 2N6422<br>2N6423 |
| 4 | 40 | 2N4910 | 2N4898 |
| | 60 | 2N4911<br>2N3054<br>2N3766<br>2N6294 | 2N3740<br>2N4899<br>2N6049<br>2N6296 |
| | 80 | 2N4912<br>2N3767<br>2N6295 | 2N3741<br>2N4900<br>2N6297 |
| 5 | 40 | 2N4231A | 2N6312 |
| | 60 | 2N4232A | 2N6313 |
| | 80 | 2N4233A | 2N6314 |
| | 225 | 2N6233 | |
| | 250 | 2N6234 | |
| | 325 | 2N6235 | |
| 7 | 60 | 2N6315 | 2N6317 |
| | 80 | 2N5427<br>2N5428<br>2N6316 | 2N6318 |
| | 100 | 2N5429<br>2N5430 | |
| 8 | 60 | 2N6300 | 2N6298 |
| | 80 | 2N6301 | 2N6299 |
| 10 | 80 | 2N6495 | |

## TO-39

CASE 79-02




STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

Lead mounted devices; power dissipation of 5 to 10 watts at 25°C ambient.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 0.5 | 200 | | MJ4645 |
| | 300 | | MJ4646 |
| | 400 | | MJ4647 |
| 4 | 60 | 2N4877 | |
| 5 | 60 | | MJ8100 |
| | 80 | 2N5336<br>2N5337 | 2N6190<br>2N6191 |
| | 100 | 2N5338<br>2N5339 | 2N6192<br>2N6193 |


World Radio History

## TO-126

CASE 77-03
PLASTIC

STYLE 1 (Case 77 on Tables):
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 3 (Case 77R on Tables)
PIN 1. BASE
2. COLLECTOR
3. EMITTER

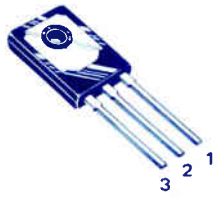
For lead mounted applications or use with heat sinks; power dissipation of 15 to 40 watts at 25°C case.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 0.3 | 250 | MJE3440 | |
| | 350 | MJE3439 | |
| 0.5 | 150 | MJE341 | |
| | 200 | MJE344 | |
| | 225 | 2N5655 | |
| | 300 | MJE340<br>2N5656 | MJE350 |
| | 350 | 2N5657 | |
| 1 | 30 | MJE520 | MJE370 |
| | 40 | MJE29*<br>2N4921 | MJE30*<br>2N4918 |
| | 60 | MJE29A*<br>2N4922 | MJE30A*<br>2N4919 |
| | 80 | MJE29B*<br>2N4923 | MJE30B*<br>2N4920 |
| | 100 | MJE29C* | MJE30C* |
| 1.5 | 300 | MJE13002* | |
| | 400 | MJE13003* | |
| 3 | 40 | MJE180<br>MJE31* | MJE170<br>MJE32* |
| | 60 | MJE181<br>MJE31A* | MJE171<br>MJE32A* |
| | 80 | MJE182<br>MJE31B* | MJE172<br>MJE32B* |
| | 100 | MJE31C* | MJE32C* |
| 4 | 40 | MJE3300*<br>2N5190 | MJE3310*<br>2N5193 |
| | 60 | MJE3301*<br>2N5191<br>MJE800<br>2N6037* | MJE3311*<br>2N5194<br>MJE700<br>2N6034* |
| | 80 | MJE241<br>MJE3302*<br>2N5192<br>MJE802<br>2N6038 | MJE251<br>MJE3312*<br>2N5195<br>MJE702<br>2N6035 |
| | 100 | MJE243<br>2N6039 | MJE253<br>2N6036 |
| 5 | 25 | MJE200* | MJE210* |

*Case 77R (Style 3)

## TO-127

CASE 90-05
PLASTIC

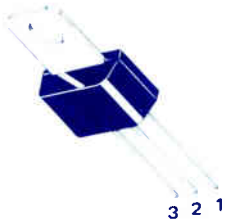



STYLE 2:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

Same as Case 77 except power dissipation is 65 to 100 watts at 25°C case.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 5 | 40 | 2N5977 | 2N5974 |
| | 50 | MJE205 | MJE105 |
| | 60 | 2N5978<br>MJE1100<br>MJE1101 | 2N5975<br>MJE1090<br>MJE1091 |
| | 80 | 2N5979<br>MJE1102<br>MJE1103 | 2N5976<br>MJE1092<br>MJE1093 |
| 8 | 40 | 2N5983 | 2N5980 |
| | 60 | 2N5984<br>MJE6043 | 2N5981<br>MJE6040 |
| | 80 | 2N5985<br>MJE6044 | 2N5982<br>MJE6041 |
| | 100 | MJE6045 | MJE6042 |
| 10 | 60 | MJE2801<br>MJE3055 | MJE2901<br>MJE2955 |
| 12 | 40 | 2N5989 | 2N5986 |
| | 60 | 2N5990 | 2N5987 |
| | 80 | 2N5991 | 2N5988 |
| 15 | 40 | MJE1660 | MJE1290 |
| | 60 | MJE1661 | MJE1291 |

## CASE 152




STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

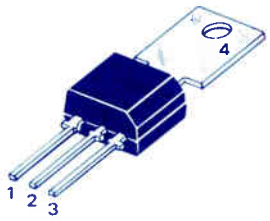
For lead or chassis mounted application or use with heat sink; power dissipation of 1 to 10 watts.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP |
|---|---|---|---|
| 0.5 | 300 | MPS-U10 | MPS-U60 |
| 0.8 | 40 | MPS-U02 | MPS-U52 |
| 1 | 120 | MPS-U03 | |
| | 180 | MPS-U04 | |
| 2A | 30 | MPS-U01 | MPS-U51 |
| | 40 | MPS-U01A<br>MPS-U45 | MPS-U51A<br>MPS-U95 |
| | 60 | MPS-U05 | MPS-U55 |
| | 80 | MPS-U06 | MPS-U56 |
| | 100 | MPS-U07 | MPS-U57 |


World Radio History

## TO-202

CASE 306




STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. COLLECTOR

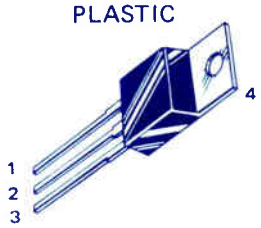
For lead or chassis mounted applications or use with heat sink; power dissipation of 2 to 10 watts.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 0.5 | 120 | D40P1 | |
| | 150 | 2N6591 | |
| | 180 | D40P3 | |
| | 200 | 2N6592 | |
| | 225 | D40P5 | |
| | 250 | 2N6593<br>D40N1<br>D40N2<br>2N6557 | |
| | 300 | D40N3<br>D40N4<br>2N6558 | MDS-60 |
| | 350 | 2N6559 | |
| 1 | 30 | D40D1<br>D40D2<br>D40D3<br>D40E1 | D41D1<br>D41D2<br><br>D41E1 |
| | 45 | D40D4<br>D40D5 | D41D4<br>D41D5 |
| | 60 | 2N6551<br>D40D7<br>D40D8<br>D40E5 | 2N6554<br>D41D7<br>D41D8<br>D41E5 |
| | 75 | D40D10<br>D40D11<br>D40D13<br>D40D14 | D41D10<br>D41D11<br>D41D13<br>D41D14 |
| | 80 | 2N6552<br>D40E7 | 2N6555<br>D41E7 |
| | 100 | 2N6553 | 2N6556 |
| 2 | 30 | D40C1<br>D40C2<br>D40K1<br><br>MDS-01 | <br><br>D41K1<br>D41K3<br>MDS-51 |
| | 40 | 2N6548<br>2N6549<br>D40C4<br>D40C5<br>MDS-01A | MDS-51A |
| 3 | 65* | MDS-1678 | |

*$V_{CBO}$

## TO-220

CASE 221A-02
PLASTIC




STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

Same as Case 77 except power dissipation is 40 to 100 watts at 25°C case.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | |
|---|---|---|---|
| | | NPN | PNP |
| 3 | 40 | TIP31 | TIP32 |
| | 60 | TIP31A | TIP32A |
| | 80 | TIP31B | TIP32B |
| | 100 | TIP31C | TIP32C |
| 4 | 45 | 2N6121 | 2N6124 |
| | 60 | 2N6122 | 2N6125 |
| | 80 | 2N6123 | 2N6126 |
| | 300 | MJE13004 | |
| | 400 | MJE13005 | |
| 6 | 40 | TIP41 | TIP42 |
| | 60 | TIP41A | TIP42A |
| | 80 | TIP41B | TIP42B |
| | 100 | TIP41C | TIP42C |
| 7 | 30 | 2N6288 | 2N6111 |
| | 50 | 2N6290 | 2N6109 |
| | 70 | 2N6292 | 2N6107 |
| 8 | 60 | TIP120 | TIP125 |
| | 80 | TIP121 | TIP126 |
| | 100 | TIP122 | TIP127 |
| | 300 | MJE13006 | |
| | 400 | MJE13007 | |
| 12 | 300 | MJE13008 | |
| | 400 | MJE13009 | |



World Radio History

# Motorola Power Darlingtons

Power Darlingtons provide high gain, high input impedance and reduced component count, with subsequent space savings. Devices are listed in ascending order of maximum continuous collector current, $I_C$ Cont, and open base sustaining voltage, $V_{CEO(sus)}$. Complementary types are grouped together.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | @ $I_C$ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching @ $I_C$ Amp | $\lvert h_{fe} \rvert$ @ 1 MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 30 | D40C1 | | 10k/60K | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | D40C2 | | 40k min | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | D40C4 | | 10k/60K | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | | D40C5 | | 40k min | 0.2 | 0.35 typ | 0.8 typ | 1 | 75 typ | 10 | TO-202/306 |
| | 40 | 2N6548 | | 5k min | 1 | | | | 100 | 10 | TO-202/306 |
| | | 2N6549 | | 3k min | 1 | | | | 100 | 10 | TO-202/306 |
| | | | D41K3 | 1k min | 1 | | | | 75 typ | 10 | TO-202/306 |
| | | MPS-U45 | MPS-U95 | 4k min | 1 | | | | 100 | 10 | /152 |
| | | D40K1 | D41K1 | 1k min | 1.5 | | | | 75 typ | 10 | TO-202/306 |
| 4 | 40 | MJE3300 | MJE3310 | 1k min | 1 | | | | 20 | 15 | TO-126/77R |
| | | 2N6037 | 2N6034 | 750/1k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-126/77 |
| | 60 | MJE3301 | MJE3311 | 1k min | 1 | | | | 20 | 15 | TO-126/77R |
| | | MJE800 | MJE700 | 750 min | 1.5 | | | | 1 | 40 | TO-126/77 |
| | | 2N6038 | 2N6035 | 750/18k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-126/77 |
| | | 2N6294 | 2N6296 | 750/18k | 2 | 0.9 typ | 0.7 typ | 2 | 4 | 50 | TO-66/80 |
| | 80 | MJE3302 | MJE3312 | 1k min | 1 | | | | 20 | 15 | TO-126/77R |
| | | MJE802 | MJE702 | 750 min | 1.5 | | | | 1 | 40 | TO-126/77 |
| | | 2N6039 | 2N6036 | 750/18k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-126/77 |
| | | 2N6295 | 2N6297 | 750/18k | 2 | 0.9 typ | 0.7 typ | 2 | 4 | 50 | TO-66/80 |
| 5 | 60 | MJE1100 | MJE1090 | 750 min | 3 | | | | 1 | 70 | TO-127/90 |
| | | MJE1101 | MJE1091 | 750 min | 4 | | | | 1 | 70 | TO-127/90 |
| | 80 | MJE1102 | MJE1092 | 750 min | 3 | | | | 1 | 70 | TO-127/90 |
| | | MJE1103 | MJE1093 | 750 min | 4 | | | | 1 | 70 | TO-127/90 |
| 8 | 60 | MJ1000 | MJ900 | 1k min | 3 | | | | | 90 | TO-3/11 |
| | | TIP120 | TIP125 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| | | 2N6300 | 2N6298 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 75 | TO-66/80 |
| | | 2N6055 | 2N6053 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 100 | TO-3/11 |
| | | MJE6043 | MJE6040 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 2 | 90 | TO-127/90 |
| | 80 | MJ1001 | MJ901 | 1k min | 3 | | | | | 90 | TO-3/11 |
| | | TIP121 | TIP126 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| | | 2N6301 | 2N6299 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 75 | TO-66/80 |
| | | 2N6056 | 2N6054 | 750/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 100 | TO-3/11 |
| | | MJE6044 | MJE6041 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 2 | 90 | TO-127/90 |
| | 100 | MJE6045 | MJE6042 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 2 | 90 | TO-127/90 |
| | | TIP122 | TIP127 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| 10 | 60 | MJ3000 | MJ2500 | 1k min | 5 | | | | | 150 | TO-3/11 |
| | 80 | MJ3001 | MJ2501 | 1k min | 5 | | | | | 150 | TO-3/11 |
| | 350 | MJ10002 | | 30/300 | 5 | 2.5 | 1 | 5 | 10 | 150 | TO-3/11 |
| | | MJ10006 | | 30/300 | 5 | 1.1 | 0.25 | 5 | 10 | 150 | TO-3/11 |
| | 400 | MJ10003 | | 30/300 | 5 | 2.5 | 1 | 5 | 10 | 150 | TO-3/11 |
| | | MJ10007 | | 30/300 | 5 | 1.1 | 0.25 | 5 | 10 | 150 | TO-3/11 |
| 12 | 60 | 2N6057 | 2N6050 | 750/18k | 6 | 1.6 typ | 1.5 typ | 6 | 4 | 150 | TO-3/11 |
| | 80 | 2N6058 | 2N6051 | 750/18k | 6 | 1.6 typ | 1.5 typ | 6 | 4 | 150 | TO-3/11 |
| | 100 | 2N6059 | 2N6052 | 750/18k | 6 | 1.6 typ | 1.5 typ | 6 | 4 | 150 | TO-3/11 |
| 15 | 60 | 2N6576 | | 2k/20k | 4 | 2 | 7 | 10 | 10/200 | 120 | TO-3/11 |
| | 90 | 2N6577 | | 2k/20k | 4 | 2 | 7 | 10 | 10/200 | 120 | TO-3/11 |
| | 120 | 2N6578 | | 2k/20k | 4 | 2 | 7 | 10 | 10/200 | 120 | TO-3/11 |
| 16 | 60 | MJ4033 | MJ4030 | 1k min | 10 | | | | | 150 | TO-3/11 |
| | 80 | MJ4034 | MJ4031 | 1k min | 10 | | | | | 150 | TO-3/11 |
| | 100 | MJ4035 | MJ4032 | 1k min | 10 | | | | | 150 | TO-3/11 |
| 20 | 60 | 2N6282 | 2N6285 | 750/18k | 10 | 2.5 typ | 2.5 typ | 10 | 4 | 160 | TO-3/11 |
| | 80 | 2N6283 | 2N6286 | 750/18k | 10 | 2.5 typ | 2.5 typ | 10 | 4 | 160 | TO-3/11 |
| | 100 | 2N6284 | 2N6287 | 750/18k | 10 | 2.5 typ | 2.5 typ | 10 | 4 | 160 | TO-3/11 |
| | 350 | MJ10000 | | 40/400 | 10 | 3 | 1.8 | 10 | 10 | 175 | TO-3/11 |
| | | MJ10004 | | 40/400 | 10 | 1.25 | 0.35 | 10 | 10 | 175 | TO-3/11 |
| | 400 | MJ10001 | | 40/400 | 10 | 3 | 1.8 | 10 | 10 | 175 | TO-3/11 |
| | | MJ10005 | | 40/400 | 10 | 1.25 | 0.35 | 10 | 10 | 175 | TO-3/11 |
| 30 | 60 | MJ11012 | MJ11011 | 1k min | 20 | | | | 4 | 200 | TO-3/11 |
| | 90 | MJ11014 | MJ11013 | 1k min | 20 | | | | 4 | 200 | TO-3/11 |
| | 120 | MJ11016 | MJ11015 | 1k min | 20 | | | | 4 | 200 | TO-3/11 |



World Radio History

# Motorola Power Switching Transistors

(See page 126 for devices with $BV_{CEO}$ = 200 Volts and greater.)

Devices are listed in ascending order of maximum continuous collector current, $I_C$ Cont, and open base sustaining voltage, $V_{CEO(sus)}$. Complementary types are grouped together.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type | | $h_{FE}$ | $I_C$ | Resistive Switching $t_s$ us | $t_f$ us | $I_C$ | $f_T$ MHz | $P_D$ (Case) Watts | Case |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NPN | PNP | Min/Max @ | Amp | Max | Max | @ Amp | Min | @ 25°C | JEDEC/MOT |
| 2 | 120 | 2N5050 | | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | 40 | TO-66/80 |
| | 150 | 2N5051 | | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | 40 | TO-66/80 |
| 3 | 40 | | 2N3719 | 25/180 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | | | 2N3867 | 40/200 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | 60 | | 2N3720 | 25/180 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | | | 2N3868 | 30/150 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | 80 | | 2N6303 | 30/150 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| 4 | 60 | 2N4877 | | 20/100 | 4 | 1.5 | 0.5 | 4 | 30 | 10 | TO-39/79 |
| 5 | 60 | | MJ8100 | 25/180 | 2 | 1 | 0.15 | 2 | 30 | 10 | TO-39/79 |
| | 80 | 2N5336 | 2N6190 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 10 | TO-39/79 |
| | | 2N5337 | 2N6191 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 10 | TO-39/79 |
| | 100 | 2N5338 | 2N6192 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 10 | TO-39/79 |
| | | 2N5339 | 2N6193 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 10 | TO-39/79 |
| 7 | 60 | 2N6315 | 2N6317 | 20/100 | 2.5 | 1 | 0.8 | 2.5 | 4 | 90 | TO-66/80 |
| | 80 | 2N5427 | | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5346 | 2N6186 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N5428 | | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-66/80 |
| | | 2N5347 | 2N6187 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N6316 | 2N6318 | 20/100 | 2.5 | 1 | 0.8 | 2.5 | 4 | 90 | TO-66/80 |
| | 100 | 2N5429 | | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 40 | TO-66/80 |
| | | 2N5348 | 2N6188 | 30/120 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| | | 2N5430 | | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-66/80 |
| | | 2N5349 | 2N6189 | 60/240 | 2 | 2 | 0.2 | 2 | 30 | 60 | TO-59/160 |
| 7.5 | 60 | 2N3445 | | 20/60 | 3 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | | 2N3447 | | 40/120 | 5 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | 80 | 2N3446 | | 20/60 | 3 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| | | 2N3448 | | 40/120 | 5 | 2 | 0.35 | 5 | 10 | 115 | TO-3/11 |
| 10 | 60 | | MJ6700 | 25/180 | 2 | 1 | 0.15 | 2 | 30 | 60 | TO-59/160 |
| | | 2N5877 | 2N5875 | 20/100 | 4 | 1 | 0.8 | 4 | 4 | 150 | TO-3/11 |
| | 80 | 2N5878 | 2N5876 | 20/100 | 4 | 1 | 0.8 | 4 | 4 | 15 | TO-3/11 |
| 15 | 60 | 2N5881 | 2N5879 | 20/100 | 6 | 1 | 0.8 | 6 | 4 | 160 | TO-3/11 |
| | 80 | 2N5882 | 2N5880 | 20/100 | 6 | 1 | 0.8 | 6 | 4 | 160 | TO-3/11 |
| 20 | 75 | MJ5039 | | 20/100 | 10 | 1.5 | 0.5 | 10 | 60 | 115 | TO-3/11 |
| | 80 | 2N5303 | 2N5745 | 15/60 | 10 | 2 | 1 | 10 | 2 | 200 | TO-3/11 |
| | 90 | MJ5038 | | 20/100 | 12 | 1.5 | 0.5 | 12 | 60 | 115 | TO-3/11 |
| 25 | 60 | 2N5885 | 2N5883 | 20/100 | 10 | 1 | 0.8 | 10 | 4 | 200 | TO-3/11 |
| | 80 | 2N5886 | 2N5884 | 20/100 | 10 | 1 | 0.8 | 10 | 4 | 200 | TO-3/11 |
| | | | 2N6436 | 20/80 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | 100 | 2N6338 | | 30/120 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | | | 2N6437 | 20/80 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | 120 | 2N6339 | | 30/120 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | | | 2N6438 | 20/80 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | 140 | 2N6340 | | 30/120 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| | 150 | 2N6341 | | 30/120 | 10 | 1 | 0.25 | 10 | 40 | 200 | TO-3/11 |
| 30 | 40 | 2N5301 | 2N4398 | 15/60 | 15 | 2 | 1 | 10 | 2 | 200 | TO-3/11 |
| | 60 | 2N5302 | 2N4399 | 15/60 | 15 | 2 | 1 | 10 | 2 | 200 | TO-3/11 |
| 50 | 80 | | 2N6377 | 30/120 | 20 | 0.8 | | | | | TO-3 Mod/197 |
| | 100 | 2N6274 | 2N6378 | 30/120 | 20 | 0.8 | 0.25 | 20 | 30 | 250 | TO-3 Mod/197 |
| | 120 | 2N6275 | 2N6379 | 30/120 | 20 | 0.8 | 0.25 | 20 | 30 | 250 | TO-3 Mod/197 |
| | 140 | 2N6276 | | 30/120 | 20 | 0.8 | 0.25 | 20 | 30 | 250 | TO-3 Mod/197 |
| | 150 | 2N6277 | | 30/120 | 20 | 0.8 | 0.25 | 20 | 30 | 250 | TO-3 Mod/197 |

*$t_{off}$



World Radio History

# Motorola SWITCHMODE Power Transistors

## $BV_{CEO} \geq 200$ V

SWITCHMODE power transistors are useful for "off line" converters, switching regulators, deflection circuits, solenoid drivers, and motor control. SWITCHMODE devices, both regular transistor structures and Darlingtons with and without "speed-up" diodes, are completely characterized in a Designers Data Sheet format. This format includes switching information at 25°C and 100°C for both resistive and inductive loads, as well as clamped inductive reverse-bias SOA.

Other power switching devices with $BV_{CEO} \geq 200$ V, but without the SWITCHMODE label or Designers Data Sheet, are included in this table.

Devices are listed in descending order of $V_{CEO(sus)}$, $I_C$ Cont, and $V_{CEX(sus)}$.

| $V_{CEO(sus)}$ Volts Min | $I_C$ Cont Amps Max | $V_{CEX(sus)}$ Volts Min | Device Type NPN unless otherwise noted | $h_{FE}$ Min/Max | $I_C$ @ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching $I_C$ @ Amp | $f_T$ MHz Min | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|
| 700 | 5 | 1500 | BU208 | 2.25 min | 4.5 | | 1 | 4.5 | 7.5 | TO-3/11 |
| 600 | 5 | 1300 | BU207 | 2.25 min | 4.5 | | 1 | 4.5 | 7.5 | TO-3/11 |
| 400 | 20 | 500 | MJ10001# | 40/400 | 10 | 3 | 1.8 | 10 | 10** | TO-3/11 |
| | | | MJ10005## | 40/400 | 10 | 1.25 | 0.35 | 10 | 10** | TO-3/11 |
| | 15 | 850 | 2N6547 | 6/30 | 10 | 4 | 0.7 | 10 | 6 to 24 | TO-3/11 |
| | | 425 | MJ7261 | 25/100 | 5 | 2 | 0.3 | 5 | 30 | TO-3/11 |
| | 12 | 700 | MJE13009 | 6/30 | 8 | 3 | 0.7 | 8 | 4** | TO-220/221A |
| | 10 | 500 | MJ10003# | 30/300 | 5 | 2.5 | 1 | 5 | 10** | TO-3/11 |
| | | | MJ10007## | 30/300 | 5 | 1.1 | 0.25 | 5 | 10** | TO-3/11 |
| | 8 | 850 | 2N6545 | 7/35 | 5 | 4 | 1 | 5 | 6 | TO-3/11 |
| | | 700 | MJE13007 | 6/30 | 5 | 3 | 0.7 | 5 | 4 | TO-220/221A |
| | | 425 | MJ7161 | 25/100 | 3 | 2 | 0.3 | 3 | 30 | TO-3/11 |
| | 5 | 850 | 2N6543 | 7/35 | 3 | 4 | 0.8 | 3 | 6 | TO-3/11 |
| | 4 | 700 | MJE13005 | 6/30 | 3 | 3 | 0.7 | 3 | 4 | TO-220/221A |
| | 1.5 | 700 | MJE13003 | 5/25 | 1 | 4 | 0.7 | 1 | 5 | TO-126/77R |
| | 0.5 | 400 | MJ4647 | 20 min | 0.5 | 0.72* | | 0.05 | 40 | TO-39/79 |
| 350 | 20 | 450 | MJ10000# | 40/400 | 10 | 3 | 1.8 | 10 | 10** | TO-3/11 |
| | | | MJ10004## | 40/400 | 10 | 1.25 | 0.35 | 10 | 10** | TO-3/11 |
| | 15 | 375 | 2N6251 | 6/50 | 10 | 3.5 | 1 | 10 | 2.5 | TO-3/11 |
| | 8 | 700 | 2N6308 | 12/60 | 3 | 1.6 | 0.4 | 5 | 5 | TO-3/11 |
| | | 450 | MJ10002# | 30/300 | 5 | 2.5 | 1 | 5 | 10** | TO-3/11 |
| | | | MJ10006## | 30/300 | 5 | 1.1 | 0.25 | 5 | 10** | TO-3/11 |
| 325 | 8 | 700 | MJ9000 | 3.75 min | 6 | | 1.1 | 6 | | TO-3/11 |
| | 5 | 700 | MJ3030 | 3.75 min | 3 | | 1 | 3 | | TO-3/11 |
| | | 350 | 2N6235 | 25/125 | 1 | 3.5 | 0.5 | 1 | 20 | TO-66/80 |
| 300 | 15 | 650 | 2N6546 | 6/30 | 10 | 4 | 0.7 | 10 | 6 to 24 | TO-3/11 |
| | | 325 | MJ7260 | 25/100 | 5 | 2 | 0.3 | 5 | 30 | TO-3/11 |
| | 12 | 600 | MJE13008 | 6/30 | 8 | 3 | 0.7 | 8 | 4** | TO-220/221A |
| | 8 | 650 | 2N6544 | 7/35 | 5 | 4 | 1 | 5 | 6 | TO-3/11 |
| | | 600 | 2N6307 | 15/75 | 3 | 1.6 | 0.4 | 3 | 5 | TO-3/11 |
| | | | MJE13006 | 6/30 | 5 | 3 | 0.7 | 5 | 4 | TO-220/221A |
| | | 325 | MJ7160 | 25/100 | 3 | 2 | 0.3 | 3 | 30 | TO-3/11 |
| | 5 | 650 | 2N6542 | 7/35 | 3 | 4 | 0.8 | 3 | 6 | TO-3/11 |
| | 4 | 600 | MJE13004 | 6/30 | 3 | 3 | 0.7 | 3 | 4 | TO-220/221A |
| | 2 | 500 | 2N3585 | 25/100 | 1 | 4 | 3 | 1 | 10 | TO-66/80 |
| | | | 2N6422-PNP | 25/100 | 1 | 4 | 3 | 1 | 10 | TO-66/80 |
| | | | 2N4240 | 30/150 | 0.75 | 4 | 3 | 1 | 10 | TO-66/80 |
| | | | 2N6423-PNP | 30/150 | 0.75 | 4 | 3 | 1 | 10 | TO-66/80 |
| | 1.5 | 600 | MJE13002 | 5/25 | 1 | 4 | 0.7 | 1 | 5 | TO-126/77R |
| | 1 | 300 | 2N5345 | 25/100 | 0.5 | 0.6 | 0.1 | 0.5 | 60 | TO-66/80 |
| | 0.5 | 300 | MJ4646 | 20 min | 0.5 | 0.72* | | 0.05 | 40 | TO-39/79 |

Designers Data Sheet characterization

#Darlington ##Darlington with speed-up diode

*$t_{off}$

**$|h_{fe}|$ @ 1 MHz



World Radio History

| $V_{CEO}$ (sus) Volts Min | $I_C$ Cont Amps Max | $V_{CEX}$ (sus) Volts Min | Device Type NPN unless otherwise noted | $h_{FE}$ Min/Max | $I_C$ @ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching $I_C$ @ Amp | $f_T$ MHz Min | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|
| 275 | 15 | 300 | 2N6250 | 8/50 | 10 | 3.5 | 1 | 10 | 2.5 | TO-3/11 |
| | 8 | 500 | 2N6306 | 15/75 | 3 | 1.6 | 0.4 | 3 | 5 | TO-3/11 |
| | 5 | 500 | MJ3029 | 30 min | 0.4 | | 1 | 3 | | TO-3/11 |
| | | 275 | 2N6234 | 25/125 | 1 | 3.5 | 0.5 | 1 | 20 | TO-66/80 |
| | 2 | 375 | 2N3584 | 25/100 | 1 | 4 | 3 | 1 | 10 | TO-66/80 |
| | | | 2N6421-PNP | 25/100 | 1 | 4 | 3 | 1 | 10 | TO-66/80 |
| | 1 | 250 | 2N5344 | 25/100 | 0.5 | 0.6 | 0.1 | 0.5 | 60 | TO-66/80 |
| 225 | 5 | 250 | 2N6233 | 25/125 | 1 | 3.5 | 0.5 | 1 | 20 | TO-66/80 |
| 200 | 15 | 225 | 2N6249 | 10/50 | 10 | 3.5 | 1 | 10 | 2.5 | TO-3/11 |
| | 2 | 200 | 2N5052 | 25/100 | 0.75 | 3.5 | 1.2 | 0.75 | 10 | TO-66/80 |
| | 0.5 | 200 | MJ4645 | 20 min | 0.5 | 0.72* | | 0.05 | 40 | TO-39/79 |

# Motorola Military Specified Power Transistors

The listed devices are active per QPL-19500 (Qualified Products List) as of September 16, 1976. Check with your local Motorola Sales Office or franchised Distributor for current qualification status and additions.

| $I_C$ Cont Amps Max | $V_{CEO}$ (sus) Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | $I_C$ @ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching $I_C$ @ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 300 | 2N3739J, TX | | 40/200 | 0.1 | 3 typ | 0.3 typ | 0.1 | 10 | 20 | TO-66/80 |
| 3 | 40 | 2N3506J, TX, TXV | 2N3867J, TX, TXV | 40/200 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| | 60 | 2N3507J, TX, TXV | 2N3868J, TX, TXV | 30/150 | 2 | 0.4* | | 1 | 60 | 6 | TO-5/31 |
| 4 | 60 | | 2N3740J, TX, TXV | 30/100 | 0.25 | 1.3 typ | 0.27 typ | 0.25 | 4 | 25 | TO-66/80 |
| | 80 | | 2N3741J, TX, TXV | 3/100 | 0.25 | 1.3 typ | 0.27 typ | 0.25 | 4 | 25 | TO-66/80 |
| 8 | 250 | 2N6306J, TX, TXV | | 15/75 | 3 | 1.6 | 0.4 | 3 | 5 | 125 | TO-3/11 |
| | 350 | 2N6308J, TX, TXV | | 12/60 | 3 | 1.6 | 0.4 | 3 | 5 | 125 | TO-3/11 |
| 10 | 60 | 2N3715J, TX, TXV | 2N3791J, TX, TXV | 30 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| | 80 | 2N3716J, TX, TXV | 2N3792J, TX, TXV | 30 min | 3 | 0.3 typ | 0.4 typ | 5 | 4 | 150 | TO-3/11 |
| 20 | 80 | 2N5303J, TX | 2N5745J, TX, TXV | 15/60 | 10 | 2 | 1 | 10 | 2 | 200 | TO-3 Mod/12 |
| 30 | 60 | 2N5302J, TX | 2N4399J, TX, TXV | 15/60 | 15 | 2 | 1 | 10 | 2 | 200 | TO-3 Mod/12 |
| 50 | 60 | 2N5685J, TX, TXV | 2N5683J, TX, TXV | 15/60 | 25 | 0.5 typ | 0.3 typ | 25 | 2 | 300 | TO-3 Mod/197 |
| | 80 | 2N5686J, TX, TXV | 2N5684J, TX, TXV | 15/60 | 25 | 0.5 typ | 0.3 typ | 25 | 2 | 300 | TO-3 Mod/197 |

* $t_{off}$



World Radio History

World Radio History

MOTOROLA

# METAL-PACKAGED SMALL-SIGNAL TRANSISTORS

500 AND GROWING! That phrase aptly describes the number of different classifications in Motorola's line of small-signal transistors. And with this many device type numbers covering the small-signal transistor spectrum, it is apparent that the actual differences between some devices becomes quite small. Even when the line is divided into its two natural categories — plastic for lowest cost, and metal for hermeticity — the sheer number of devices in each category makes selection by spec-for-spec comparison a significant task. This selector guide, therefore, ignores the large bulk of general-purpose, small-signal type numbers and concentrates on those transistors that have emerged as the best values in various applications categories.

Since the devices highlighted here are the most popular in each category, it follows that they are among the most widely available, at the lowest cost. They are particularly well-suited for new designs where a continuous, off-the-shelf supply of product is required.

The reader is reminded, however, that semiconductors are manufactured by "batch" processes, and that each "batch" may yield devices with widely varying parameters. This creates device "families". While the various specifications limits assigned to "family members" have been selected on the basis of demonstrated industry need, modern testing methods have made the selection of devices with special characteristics simple and inexpensive. Where the specified characteristics of the devices listed in the following selector guides do not meet a particular design requirement the designer is requested to contact his nearest Motorola sales representative for price quotations on special devices to fit his needs.

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World Radio History

# Switching Transistors

The following devices are intended for use in general-purpose switching and amplifier applications. Within each family and package group shown, the devices are listed in order of decreasing turn-on time ($t_{on}$).

| Package | Family | Device Type | $t_{on}$ ns Max | $t_{off}$ ns Max | @ $I_C$ mA | $BV_{CEO}$ Volts Min | $I_C$ mA Max | $h_{FE}$ Min | @ $I_C$ mA | $V_{CE(sat)}$ Volts Max | @ $I_C$ mA | & $I_B$ mA | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | | | | | |
| TO-18 | 5 | 2N2845 | 40 | 40 | 150 | 30 | | 30 | 150 | 0.4 | 150 | 15 | 250 | 50 |
| | | 2N2540 | 40 | 40 | 150 | 30 | | 100 | 150 | 0.45 | 150 | 15 | 250 | 20 |
| | | 2N2539 | 40 | 40 | 150 | 30 | | 50 | 150 | 0.45 | 150 | 15 | 250 | 20 |
| TO-39 | 22 | 2N3507 | 45 | 90 | 1500 | 50 | 3000 | 30 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| | | 2N3506 | 45 | 90 | 1500 | 40 | 3000 | 40 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| TO-39 | 27 | 2N3444 | 50 | 70 | 500 | 50 | | 20 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| | | 2N3253 | 50 | 70 | 500 | 40 | | 25 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| | | 2N3735 | 48 | 60 | 1000 | 75 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | 2N3734 | 48 | 60 | 1000 | 50 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | 2N3252 | 45 | 70 | 500 | 30 | | 30 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | | 2N3725 | 35 | 60 | 500 | 50 | 2000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | | 2N3724 | 35 | 60 | 500 | 30 | 2000 | 35 | 500 | 0.42 | 500 | 50 | 300 | 50 |
| | | 2N5859 | 35 | 60 | 1000 | 40 | 2000 | 15 | 1000 | 0.4 | 500 | 50 | 250 | 50 |
| | | MM5262 | 30 | 60 | 1000 | 50 | 2000 | 25 | 1000 | 0.8 | 1000 | 100 | 350 (typ) | 50 |
| | | 2N5861 | 25 | 60 | 500 | 50 | 2000 | 25 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| TO-18 | | 2N4014 | 35 | 60 | 500 | 50 | 1000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | | 2N4013 | 35 | 60 | 500 | 30 | 1000 | 35 | 500 | 0.42 | 500 | 50 | 300 | 50 |
| TO-18 | 73 | 2N3227 | 12 | 18 | 100 | 20 | 500 | 30 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N2369 | 12 | 18 | 100 | 15 | 500 | 20 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N2369A | 12 | 18 | 10 | 15 | 200 | 40 | 10 | 0.2 | 10 | 1.0 | 500 | 10 |
| TO-46 | | 2N2206 | 40 | 75 | 10 | 12 | 200 | 40 | 10 | 220 | 10 | 1.0 | 200 | 10 |
| | | 2N3508 | 12 | 18 | 10 | 20 | 500 | 40 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N3509 | 12 | 18 | 10 | 20 | 500 | 100 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| TO-46 | 81 | 2N3647 | 20 | 25 | 150 | 10 | 500 | 25 | 150 | 0.4 | 150 | 15 | 350 | 15 |
| | | 2N3648 | 16 | 18 | 150 | 15 | 500 | 30 | 150 | 0.4 | 150 | 15 | 450 | 15 |
| TO-46 | 99 | 2N3737 | 48 | 60 | 1000 | 50 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | 2N3736 | 48 | 60 | 1000 | 30 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| **PNP** | | | | | | | | | | | | | | |
| TO-18 | 44 | 2N2894 | 60 | 90 | 30 | 12 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 30 |
| | | 2N3012 | 60 | 75 | 30 | 12 | 200 | 30 | 30 | 0.2 | 30 | 3.0 | 400 | 30 |
| | | 2N869A | 50 | 80 | 30 | 18 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 10 |
| TO-18 | 45 | 2N3546 | 40 | 30 | 50 | 12 | | 25 | 50 | 0.25 | 50 | 5.0 | 700 | 10 |
| TO-39 | 50 | MM4036 | 75 | 175 | 150 | 65 | 1000 | 40 | 150 | 0.65 | 150 | 15 | 60 | 50 |
| | | MM4037 | 75 | 175 | 150 | 40 | 1000 | 50 | 150 | 1.4 | 150 | 15 | 60 | 50 |
| | | 2N4405 | 40 | 210 | 500 | 80 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | | 2N4404 | 40 | 210 | 500 | 80 | 1000 | 15 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| TO-39 | 56 | MM4031 | 100 | 240 typ | 500 | 80 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 100 | 50 |
| | | MM4033 | 100 | 240 typ | 500 | 80 | 1000 | 70 | 500 | 0.5 | 500 | 50 | 150 | 50 |
| | | MM4032 | 100 | 240 typ | 500 | 60 | 1000 | 70 | 500 | 0.5 | 500 | 50 | 150 | 50 |
| | | MM4030 | 100 | 240 typ | 500 | 60 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 100 | 50 |
| | | 2N4407 | 75 | 225 | 1000 | 80 | 2000 | 15 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| | | 2N4406 | 75 | 225 | 1000 | 80 | 2000 | 10 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| TO-39 | 60 | 2N3763 | 43 | 115 | 1000 | 60 | 1500 | 20 | 1000 | 0.9 | 1000 | 100 | 150 | 50 |
| | | 2N3762 | 43 | 115 | 1000 | 40 | 1500 | 30 | 1000 | 0.9 | 1000 | 100 | 180 | 50 |
| TO-39 | 337 | 2N3245 | 55 | 165 | 500 | 50 | 1000 | 30 | 500 | 0.6 | 500 | 50 | 150 | 50 |
| | | 2N3244 | 50 | 185 | 500 | 40 | 1000 | 50 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | | 2N3468 | 40 | 90 | 500 | 50 | 1000 | 25 | 500 | 0.6 | 500 | 50 | 150 | 50 |
| | | 2N3467 | 40 | 90 | 500 | 40 | 100 | 40 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | | MM3726 | 35 | 60 | 1000 | 50 | 1500 | 15 | 1000 | 1.2 | 1000 | 100 | 200 | 50 |
| TO-18 | 345 | 2N4208 | 15 | 20 | 10 | 12 | 200 | 30 | 10 | 0.15 | 10 | 1.0 | 700 | 10 |
| | | MM4258 | 15 | 20 | 10 | 12 | 80 | 30 | 10 | 0.15 | 10 | 1.0 | 700 | 10 |
| | | MM4257 | 15 | 15 | 10 | 6.0 | 80 | 30 | 10 | 0.15 | 10 | 1.0 | 500 | 10 |
| TO-39 | 454 | 2N3636 | 400 | 600 | 50 | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | | 2N3635 | 400 | 600 | 50 | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3634 | 400 | 600 | 50 | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |



World Radio History

# High-Gain Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

| Package | Family | Device Type | NF Wideband Typ* Max dB | $BV_{CEO}$ Volts Min | $I_C$ mA Max | $h_{FE}$ Min | $h_{FE}$ Max | $I_C$ uA mA* | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | |
| TO-18 | 18 | 2N2483 | 8.0* | 60 | 50 | 40 | 120 | 10 | 12 | 0.05 |
| | | 2N2484 | 8.0* | 60 | 50 | 100 | 500 | 10 | 15 | 0.05 |
| | | 2N929 | 4.0 | 45 | 30 | 40 | 120 | 10 | 30 | 0.5 |
| | | 2N930A | 3.0 | 45 | 30 | 100 | 300 | 10 | 45 | 0.5 |
| | | 2N930 | 3.0 | 45 | 30 | 100 | 300 | 10 | 30 | 0.5 |
| **NPN DARLINGTON** | | | | | | | | | | |
| TO-18 | | MM6427 | | 40 | 300 | 5000 | | 10* | 125 | 100 |
| **PNP** | | | | | | | | | | |
| TO-18 | 55 | 2N3798 | 3.5 | 60 | 50 | 150 | 450 | 500 | 30 | 0.5 |
| | | 2N3799 | 2.5 | 60 | 50 | 300 | 900 | 500 | 30 | 0.5 |

# High-Voltage/High-Current Amplifiers

The following table lists Motorola standard devices that have high Collector-Emitter Breakdown Voltage. Devices are listed in decreasing order of $BV_{CEO}$ within each family.

| Package | Family | Device Type | $BV_{CEO}$ Volts Min | $I_C$ mA Max | $h_{FE}$ Min | @ $I_C$ mA | $V_{CE(sat)}$ Volts Max | @ $I_C$ mA | & $I_B$ mA | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | | |
| TO-39 | 6 | MM3009 | 180 | 400 | 40 | 10 | | | | 50 | 20 |
| | | MM3008 | 120 | 400 | 40 | 10 | | | | 50 | 20 |
| TO-39 | 26R | MM2259 | 175 | 300 | 35 | 10 | 0.4 | 25 | 2.5 | 150 | 20 |
| | | 2N3501 | 150 | 300 | 100 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | | 2N3500 | 150 | 300 | 40 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | | 2N3114 | 150 | 200 | 30 | 30 | 1.0 | 50 | 5.0 | 40 | 30 |
| | | 2N3712 | 150 | 200 | 30 | 30 | 2.0 | 50 | 5.0 | 40 | 30 |
| | | MM3001 | 150 | 200 | 20 | 10 | | | | 150 | 10 |
| | | MM2258 | 120 | 500 | 50 | 10 | 0.4 | 25 | 2.5 | 150 | 20 |
| | | 2N3499 | 100 | 500 | 100 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | | 2N3498 | 100 | 500 | 40 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | | 2N4924 | 100 | 200 | 40 | 150 | 0.4 | 50 | 5.0 | 100 | 20 |
| | | 2N657 | 100 | | 30 | 200 | 4.0 | 200 | 40 | | |
| | | 2N1990 | | 1000 | 20 | 30 | 0.5 | 2.0 | 0.2 | | |
| TO-39 | 88 | MM3007 | 100 | 2500 | 50 | 250 | 0.35 | 150 | 15 | 50 | 50 |
| | | MM3006 | 80 | 2500 | 50 | 200 | 0.35 | 150 | 15 | 50 | 50 |
| | | MM3005 | 60 | 2500 | 50 | 150 | 0.35 | 150 | 15 | 50 | 50 |
| TO-39 | 210R | 2N5058 | 300 | 150 | 35 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N3742 | 300 | 50 | 20 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N5059 | 250 | 150 | 30 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N4927 | 250 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | | MM3003 | 250 | 50 | 20 | 10 | | | | 150 | 10 |
| | | 2N4926 | 200 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | | MM3002 | 200 | 50 | 20 | 10 | | | | 150 | 10 |
| TO-39 | 212 | 2N5682 | 120 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | | 2N5681 | 100 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| TO-39 | 242 | 2N3439 | 350 | 1000 | 40 | 20 | 0.5 | 50 | 4 | 15 | 10 |
| | | MM421 | 325 | 1000 | 25 | 30 | 5.0 | 30 | 3 | 15 | 10 |
| | | 2N3440 | 250 | 1000 | 40 | 20 | 0.5 | 50 | 4 | 15 | 10 |
| | | MM420 | 250 | 1000 | 25 | 30 | 5.0 | 30 | 3 | 15 | 10 |
| TO-39 | 244 | 2N4239 | 80 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |
| | | 2N4238 | 60 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |
| | | 2N4237 | 40 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |



World Radio History

### High-Voltage/High-Current Amplifiers (continued)

| Package | Family | Device Type | $BV_{CEO}$ Volts Min | $I_C$ mA Max | $h_{FE}$ Min | @ $I_C$ mA | $V_{CE(sat)}$ Volts Max | @ $I_C$ mA | & $I_B$ mA | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PNP** | | | | | | | | | | | |
| TO-39 | 46 | 2N3495 | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | | 2N4928 | 100 | 100 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | | MM4000 | 100 | 100 | 20 | 10 | 0.6 | 10 | 1.0 | — | — |
| | | 2N3494 | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| TO-18 | 47 | 2N3497 | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | | 2N3496 | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| TO-39 | 211 | 2N5680 | 120 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | | 2N5679 | 100 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| TO-39 | 243 | 2N4236 | 80 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |
| | | 2N4235 | 60 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |
| | | 2N4234 | 40 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |
| TO-39 | 247 | *2N5416 | 300 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| | | MM5416 | 300 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| | | *2N5415 | 200 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| | | MM5415 | 200 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| TO-39 | 452R | 2N3743 | 300 | 50 | 25 | 30 | 8.0 | 30 | 3.0 | 30 | 10 |
| | | 2N4931 | 250 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | | MM4003 | 250 | 500 | 20 | 10 | 5.0 | 10 | 1.0 | — | — |
| | | 2N4930 | 200 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | | MM4002 | 200 | 500 | 20 | 10 | 5.0 | 10 | 1.0 | — | — |
| TO-39 | 454R | 2N3637 | 175 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3636 | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | | 2N4929 | 150 | 500 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | | MM4001 | 150 | 500 | 20 | 10 | 0.6 | 10 | 1.0 | — | — |
| | | 2N3635 | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3634 | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |

*These devices are rated at 50 mA $I_{CEO(sus)}$ and $C_{IB}$ pF.

# High-Frequency Amplifiers/ Oscillators

The transistors shown are designed for use as both oscillators and amplifiers at UHF and VHF frequencies. Devices are listed in decreasing order of $BV_{CEO}$ within each family.

| Package | Family | Device Type | $BV_{CEO}$ Volts Min | $h_{FE}$ Min | @ $I_C$ mA | $G_{pe}$ dB Min | NF dB Max | @ f MHz | $f_T$ MHz Min | @ $I_C$ mA | $C_{ob}$ pF Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | | |
| TO-72 | 72 | 2N917 | 15 | 20 | 3.0 | 9.0 | 6.0 | 60 | 500 | 4.0 | 1.7 |
| | | 2N918 | 15 | 20 | 3.0 | 15 | 6.0 | 60 | 600 | 4.0 | 1.7 |
| TO-18 | 75 | 2N3544 | 25 | 25 | 10 | — | — | — | 600 | 10 | 2.5 |
| | | MM1941 | 20 | 25 | 10 | 7.0 | — | — | 600 | 10 | 2.5 |
| **PNP** | | | | | | | | | | | |
| TO-18 | 63 | 2N3307 | 35 | 40 | 2.0 | 17 | 4.5 | 200 | 300 | 2.0 | 1.3 |
| | | 2N3308 | 25 | 25 | 2.0 | 17 | 6.0 | 200 | 300 | 2.0 | 1.6 |
| TO-72 | 65 | 2N4261 | 15 | 30 | 10 | — | — | — | 1600 | 10 | 2.5 |
| | | 2N4260 | 15 | 30 | 10 | — | — | — | 2000 | 10 | 2.5 |



World Radio History

# General-Purpose Amplifiers

These transistors are designed for dc to VHF amplifier applications, general-purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of $BV_{CEO}$ within each family.

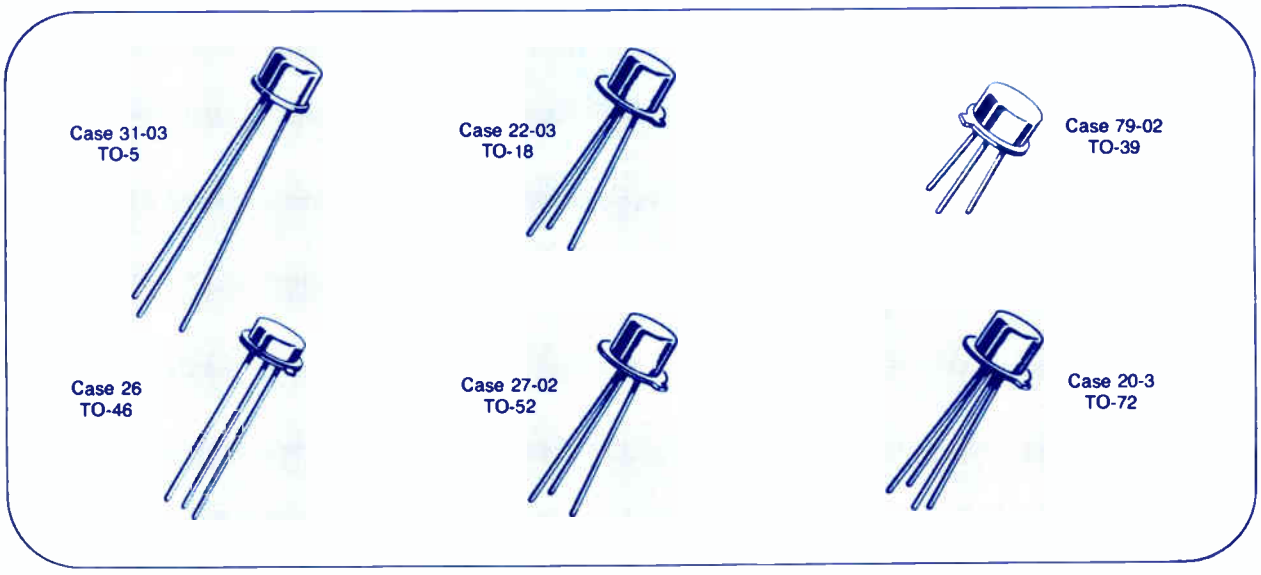
| Package | Family | Device Type | $BV_{CEO}$ Volts Min | $f_T$ MHz Min | @ $I_C$ mA | $I_C$ mA Max | $h_{FE}$ Min | $h_{FE}$ Max | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | |
| TO-39 | 2R | 2N1711 | 80 | 70 | 50 | | 100 | 300 | 150 |
| | | 2N1613 | 50 | 60 | 50 | 500 | 40 | 120 | 150 |
| | | 2N2219A | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| | | 2N2218A | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | | 2N697 | 40 | 50 | 50 | | 40 | 120 | 150 |
| | | 2N3300 | 30 | 250 | 50 | 500 | 100 | 300 | 150 |
| | | 2N2218 | 30 | 250 | 20 | 800 | 40 | 120 | 150 |
| | | 2N2219 | 30 | 250 | 20 | 800 | 100 | 300 | 150 |
| TO-46 | 2S | 2N5582 | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| | | 2N5581 | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | | 2N4450 | 30 | 250 | 50 | 500 | 100 | 300 | 150 |
| TO-18 | 3 | 2N956 | 50 | 70 | 50 | | 40 | 120 | 150 |
| | | 2N2222A | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| | | 2N2221A | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | | 2N718 | 40 | 50 | 50 | | 40 | 120 | 150 |
| | | 2N3302 | 30 | 250 | 50 | 500 | 100 | 300 | 150 |
| | | 2N2222 | 30 | 250 | 20 | 800 | 100 | 300 | 150 |
| TO-39 | 14R | 2N3019 | 80 | 100 | 50 | 1000 | 100 | 300 | 150 |
| | | 2N3020 | 80 | 80 | 50 | 1000 | 40 | 120 | 150 |
| | | 2N656 | 60 | | | | 30 | 90 | 200 |
| | | 2N2193A | 50 | 50 | 50 | 1000 | 40 | 120 | 150 |
| | | 2N2270 | 45 | 100 | 50 | 1000 | 50 | 200 | 150 |
| | | 2N3110 | 40 | 600 | 10 | 1000 | 40 | 120 | 150 |
| | | 2N3053 | 40 | 100 | 50 | 700 | 50 | 250 | 150 |
| TO-18 | 23 | 2N915 | 50 | 250 | 10 | | 50 | 200 | 10 |
| | | 2N3946 | 40 | 300 | 10 | 200 | 50 | 150 | 10 |
| | | 2N3947 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | 2N916 | 25 | 300 | 10 | | 50 | 200 | 10 |
| TO-52 | 221 | MM3904 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | MM3903 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |



World Radio History

## General-Purpose Amplifiers (continued)

| Package | Family | Device Type | $BV_{CEO}$ Volts Min | $f_T$ MHz Min | @ $I_C$ mA | $I_C$ mA Max | $h_{FE}$ Min | $h_{FE}$ Max | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|
| **PNP** | | | | | | | | | |
| TO-18 | 35 | 2N3251A | 60 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | 2N3250A | 60 | 250 | 10 | 200 | 50 | 150 | 10 |
| | | 2N3251 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | 2N3250 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| TO-46 | 48 | 2N3485A | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N3486A | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N3673 | 50 | 200 | 50 | 600 | 75 | 225 | 150 |
| | | 2N3486 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| TO-39 | 49 | MM5007 | 100 | 30 | 50 | 2000 | 50 | 250 | 250 |
| | | MM5006 | 80 | 30 | 50 | 2000 | 50 | 250 | 200 |
| | | MM5005 | 60 | 30 | 50 | 2000 | 50 | 250 | 150 |
| TO-39 | 50 | 2N4405 | 80 | 200 | 50 | 1000 | 100 | 300 | 150 |
| | | 2N4404 | 80 | 200 | 50 | 1000 | 40 | 120 | 150 |
| | | MM4036 | 65 | 60 | 50 | 1000 | 20 | 140 | 150 |
| | | MM4037 | 40 | 60 | 50 | 1000 | 50 | 250 | 150 |
| TO-18 | 333 | 2N2906A | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2907A | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N2906 | 40 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2907 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| TO-39 | | 2N2904A | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2905A | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N2904 | 40 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2905 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N1132A | 40 | 60 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1131A | 40 | 50 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1132 | 35 | 60 | 50 | 600 | 30 | 90 | 150 |
| TO-52 | 271 | MM3906 | 40 | 250 | 10 | 200 | 100 | 300 | 10 |
| | | MM3905 | 40 | 200 | 10 | 200 | 50 | 150 | 10 |






World Radio History

MOTOROLA

# PLASTIC-ENCAPSULATED SMALL-SIGNAL TRANSISTORS

The Small-Signal Plastic Transistors represent Motorola's broadest product line. From RF/VHF/UHF amplifiers, mixers, oscillators and switches to general-purpose amplifiers and switches, all are available as standard product or custom specials. Specialty devices for the industrial, computer or consumer market as well as a specialty package—the MiniBloc—are all available for unique high technology applications. The following list demonstrates the many applications possible with plastic transistors. If specific applications are not listed, consult your factory representative for assistance.

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World Radio History

# RF/ UHF/ VHF Amplifiers and CATV Transistors

The transistors listed below are high performance, high frequency standard transistors. Devices are in the TO-92 plastic package unless otherwise noted. The transistors are listed in order of decreasing $f_T$ min.

| Device Type | $f_T$ MHz Min | $f_T$ MHz Typ | @ $I_C$ mA | $C_{cb}$ $C_{ce}$* pF Typ# Max | $BV_{CEO}$ Volts Min | $G_{pe}$ $G_{pb}$ dB Typ# Min | NF dB Typ* Max | @ f MHz | $V_{AGC}$ @ $I_{AGC}$* Typ# Min | Gain Reduction dB |
|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | |
| FMT1091 | 1300 | 1600 | 20 | 1.2 | 14 | | 3.5 | 450 | | |
| MPS3571 | 1200 | 1600 | 5 | 0.9 | 25 | | 4 | 450 | | |
| MPS3572 | 1000 | 1600 | 5 | 0.9 | 25 | | 6 | 450 | | |
| FMT1092 | 1000 | 1600 | 20 | 1.2 | 14 | | 4 | 450 | | |
| BF363(1) | 800 | | 3 | | 20 | 11 | 5* | 800 | | |
| MPS-H17 | 800 | 1600 | 5 | 0.9 | 15 | 24# | 6 | 200 | | |
| FMT1190 | 800 | 1600 | 20 | 1.2 | 12 | | 5 | 450 | | |
| MPS6543 | 750 | 1100 | 4 | 1.0 | 25 | | | | | |
| MPS-H10 | 650 | 1500 | 4 | 0.65* | 25 | | | | | |
| MPS-H11 | 650 | 1400 | 4 | 0.7 | 25 | | | | | |
| MPS-H33 | 600 | 800 | 2.5 | 0.3* | 30 | 10 | 6.5 | 850 | 8.6* | 30 |
| MPS6546 | 600 | 1100 | 2 | 0.35# | 25 | | | | | |
| MPS6547 | 600 | 1100 | 2 | 0.35# | 25 | | | | | |
| MPS918 | 600 | 800 | 4 | 1.7 | 15 | 15 | 6 | 60 | | |
| MPS3563 | 600 | 800 | 8 | 1.7 | 12 | | | | | |
| MPS-H08 | 500 | 700 | 3 | 0.3* | 30 | 14 | 3.5 | 200 | 5* | 30 |
| MPS-H34 | 500 | 700 | 15 | 0.32 | 45 | | | | | |
| MPS6539 | 500 | 1000 | 4 | 0.7 | 20 | | 4.5 | 100 | | |
| 2N5222 | 450 | 1000 | 4 | 1.3 | 15 | | | | | |
| MPS-H07 | 400 | 700 | 3 | 0.3* | 30 | 18 | 3.2 | 100 | 5 | 30 |
| MPS-H24 | 400 | 800 | 8 | 0.36 | 30 | | | | | |
| MPS-H20 | 400 | 750 | 4 | 0.65 | 30 | | | | | |
| MPS-H6540 | 350 | 700 | 2 | 0.65 | 30 | | | | | |
| MPS-H32 | 300 | 450 | 4 | 0.22 | 30 | 22.5 | 3.3* | 45 | 5.5# | 30 |
| BF367 | 300 | 450 | 4 | 0.3* | 30 | 20 | | | | |
| MPS-H19 | 300 | 1400 | 4 | 0.65 | 25 | | | | | |
| MPS-H30 | 300 | 450 | 4 | 0.65 | 20 | 22.5 | 6 | 45 | 4.4 | 30 |
| MPS-H31 | 300 | 450 | 4 | 0.65 | 20 | 22.5 | 6 | 45 | 5.2 | 30 |
| MPS-H37 | 300 | 750 | 5 | 0.7# | 40 | | | | | |
| MPS3693 | 200 | 400 | 10 | 0.2# | 45 | | | | | |
| MPS3694 | 200 | 400 | 10 | 0.2# | 45 | | 4 | 1 | | |
| MPS8001 | 100 | 800 | 4 | 0.65# | 25 | | | | | |
| MPS-H04 | 80 | 120 | 1.5 | 1.6 | 80 | | 2 | 1 | | |
| MPS-H05 | 80 | 120 | 1.5 | 1.6 | 80 | | 2 | 1 | | |
| **PNP** | | | | | | | | | | |
| BF479(1) | 1400 | | 10 | 0.7# | 25 | 15 | 5.5 | 800 | | |
| BF679(1) | 850 | | 3 | 0.6# | 35 | 12 | 5 | 800 | 6.6* | 30 |
| BF509(1) | 800 | | 3 | 0.2# | 35 | 12 | 2.5* | 200 | 10*# | 30 |
| BF680(1) | 650 | | 3 | 0.6 | 35 | 11 | 5.5* | 800 | | |
| MPS-H83 | 600 | 1000 | 2.5 | 0.3* | 30 | 10 | 6.5 | 850 | 4.5# | 30 |
| MPS-H81 | 600 | 700 | 5 | 0.65* | 20 | | | | | |
| MPS-H85 | 350 | 1000 | 2.5 | 0.2* | 30 | 14 | 6.5 | 200 | | |
| 2N5208 | 300 | 600 | 2 | 1.0 | 25 | 22 | 3 | 100 | | |
| MPS-H54 | 80 | 130 | 1.5 | 1.6 | 80 | | 2 | 1 | | |
| MPS-H55 | 80 | 130 | 1.5 | 1.6 | 80 | | | | | |

(1) Packaged in Case 317A.



World Radio History

# High-Speed Saturated Switching Transistors

The transistors listed in this table are specially optimized for high-speed saturated switches. They are heavily gold doped and processed to provide very short switching times and low output capacitance (below 6 pF). The transistors are listed in order of decreasing turn-on time ($t_{on}$).

| Device Type | $t_{on}$ & $t_{off}$ ns Max | @ $I_C$ mA | $BV_{CEO}$ Volts Min | $h_{FE}$ Min | @ $I_C$ mA | $V_{CE(sat)}$ Volts Max | @ $I_C$ mA | & $I_B$ mA | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | | |
| MPS706,A | 40 | 75 | 10 | 15 | 20 | 10 | 0.6 | 10 | 1.0 | 200 | 10 |
| 2N4264 | 25 | 35 | 10 | 15 | 40 | 10 | 0.22 | 10 | 1.0 | 300 | 10 |
| 2N4265 | 25 | 35 | 10 | 12 | 100 | 10 | 0.22 | 10 | 1.0 | 300 | 10 |
| MPS835 | 20 | 35 | 10 | | 20 | 10 | 0.3 | 10 | 1.0 | 300 | 10 |
| MPS3646 | 18 | 28 | 300 | 15 | 30 | 30 | 0.2 | 30 | 3.0 | 350 | 30 |
| MPS834 | 16 | 30 | 10 | | 25 | 10 | 0.25 | 10 | 1.0 | 350 | 10 |
| MPS3013 | 15 | 25 | 300 | 15 | 15 | 300 | 0.5 | 300 | 30 | 350 | 30 |
| MPS2369 | 12 | 18 | 10 | 15 | 40 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| **PNP** | | | | | | | | | | |
| 2N5228 | 75 | 140 | 10 | 5 | 30 | 10 | 0.4 | 10 | 3 | 300 | 10 |
| MPS3640 | 25 | 35 | 50 | 12 | 30 | 10 | 0.2 | 10 | 1 | 500 | 10 |
| MPS3639 | 25 | 25 | 50 | 6 | 30 | 10 | 0.16 | 10 | 1 | 500 | 10 |
| MPS4258 | 15 | 20 | 10 | 12 | 30 | 50 | 0.15 | 10 | 1 | 700 | 10 |
| 2N5771 | 15 | 20 | 10 | 15 | 50 | 10 | 0.18 | 10 | 1 | 850 | 10 |
| MPS4257 | 15 | 15 | 10 | 6 | 30 | 50 | 0.15 | 10 | 1 | 500 | 10 |

# General-Purpose Transistors

These general-purpose transistors are designed for small-signal amplification from dc to low radio frequencies. They are also useful as oscillators and general-purpose switches. The transistors are listed in order of decreasing breakdown voltage ($BV_{CEO}$).

| Device and Polarity NPN | PNP | $BV_{CEO}$ Volts Min | $f_T$ @ MHz Min | @ $I_C$ mA | $I_C$ mA Max | $h_{FE}$ @ $I_C$ Min | Max | mA |
|---|---|---|---|---|---|---|---|---|
| MPS8099 | MPS8599 | 80 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A06 | MPS-A56 | 80 | 100 | 10 | 500 | 50 | | 100 |
| MPS8098 | MPS8598 | 60 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A05 | MPS-A55 | 60 | 100 | 10 | 500 | 50 | | 100 |
| 2N3904 | 2N3906 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| 2N4401 | 2N4403 | 40 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N3903 | 2N3905 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| 2N4400 | 2N4402 | 40 | 200 | 20 | 600 | 50 | 150 | 150 |
| MPS-A20 | MPS-A70 | 40 | 125 | 5.0 | 100 | 40 | 400 | 5.0 |
| MPS6531 | MPS6534 | 40 | | 50 | 600 | 100 | 300 | 150 |
| MPS2222 | MPS2907 | 30 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N4123 | 2N4125 | 30 | 250 | 10 | 200 | 50 | 150 | 2.0 |
| MPS3704 | MPS3702 | 30 | 100 | 50 | 600 | 100 | 300 | 50 |
| MPS6513 | MPS6517 | 30 | 330 | 10 | 100 | 90 | 180 | 2.0 |
| 2N4124 | 2N4126 | 25 | 300 | 10 | 300 | 120 | 360 | 2.0 |
| MPS6514 | MPS6518 | 25 | 200 | 10 | 200 | 50 | 300 | 10 |
| MPS6515 | MPS6519 | 25 | 480 | 10 | 100 | 250 | 500 | 2.0 |
| MPS5172 | | 25 | | | 100 | 100 | 500 | 10 |
| MPS6560 | MPS6562 | 25 | 60 | 10 | 500 | 50 | 200 | 500 |



World Radio History

# TO-92 Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high gain and input impedance. These devices have monolithic construction and are listed in order of decreasing voltage ($BV_{CEO}$).

| Device and Polarity | | $BV_{CEO}$ Volts | $h_{FE}$ @ $I_C$ | | $I_C$ mA | $f_T$ @ | | NF | $V_{CE(sat)}$ Volts @ $I_C$ & $I_B$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NPN | PNP | Min | Min | mA | Max | MHz Min | mA | dB | Max | mA | mA |
| MPS-A24 | | 100 | 5000 | 1000 | 2000 | 100 | 100 | | 1.5 | 500 | 0.5 |
| MPS-A23 | | 80 | 5000 | 1000 | 2000 | 100 | 100 | | 1.5 | 500 | 0.5 |
| 2N6426 | | 40 | 30000 | 100 | 500 | 150 | 10 | 10 | 1.5 | 500 | 0.5 |
| 2N6427 | | 40 | 20000 | 100 | 500 | 130 | 10 | 10 | 1.5 | 500 | 0.5 |
| | MPS-A65 | 30 | 50000 | 10 | 300 | 100 | 10 | 20 | 1.5 | 100 | 0.1 |
| MPS-A14 | MPS-A64 | 30 | 20000 | 100 | 500 | 125 | 10 | | 1.5 | 100 | 0.1 |
| MPS-A13 | MPS-A63 | 30 | 10000 | 100 | 500 | 125 | 10 | | 1.5 | 100 | 0.1 |
| **MPS-D04** | MPS-D54 | 25 | 1000 | 100 | 300 | 100 | 10 | | 1.0 | 100 | 0.1 |
| **MPS-A12** | MPS-A62 | 20 | 20000 | 10 | 500 | | | | 1.0 | 10 | 0.01 |

# Low-Noise Amplifier Transistors

The small-signal transistors listed in this table are characterized for low-noise amplification at low frequencies. The transistors are listed in decreasing order of noise figure (NF).

| Device Type | NF @ dB Typ | f* | $BV_{CEO}$ Volts Min | $h_{FE}$ Min | @ $I_C$ mA | $f_T$ MHz Min | @ $I_C$ mA |
|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | |
| 2N4123 | 6.0 | Audio | 30 | 50 | 2.0 | 250 | 10 |
| 2N4124 | 5.0 | Audio | 25 | 120 | 2.0 | 300 | 10 |
| 2N5209 | 3.0 | Audio | 50 | 150 | 10 | 30 | 500 |
| 2N5088 | 3.0 | Audio | 30 | 100 | 300 | 50 | 500 |
| MPS6520 | 3.0 | Audio | 25 | 200 | 2.0 | 390 | 2.0 |
| MPS6521 | 3.0 | Audio | 25 | 300 | 2.0 | 390 | 2.0 |
| 2N5210 | 2.0 | Audio | 5.0 | 250 | 10 | 30 | 500 |
| MPS8097 | 2.0 | 100Hz | 40 | 250 | 0.1 | 200 | 10 |
| 2N5089 | 2.0 | Audio | 25 | 400 | 10 | 50 | 500 |
| MPS-A18 | 1.5 | Audio | 45 | 500 | 10 | 100 | 1.0 |
| MPS-A09 | 1.4 | 1.0kHz | 50 | 100 | 0.1 | 30 | 0.5 |
| **PNP** | | | | | | | |
| 2N4125 | 5.0 | Audio | 30 | 50 | 2.0 | 200 | 10 |
| 2N4126 | 4.0 | Audio | 25 | 120 | 2.0 | 250 | 10 |
| 2N5086 | 3.0 | Audio | 50 | 100 | 150 | 40 | 0.5 |
| MPS6522 | 3.0 | Audio | 25 | 200 | 2.0 | 340 | 2.0 |
| MPS6523 | 3.0 | Audio | 25 | 300 | 2.0 | 340 | 2.0 |
| MPS4249 | 3.0 | Audio | 60 | 100 | 10 | 100 | 1.0 |
| 2N5087 | 2.0 | Audio | 50 | 250 | 10 | 40 | 500 |
| MPS4250 | 2.0 | Audio | 40 | 250 | 10 | 250 | 1.0 |
| MPS4250A | 2.0 | Audio | 60 | 250 | 0.1 | 250 | 1.0 |

* Audio = 10 Hz to 15.7 kHz.



World Radio History

# High-Voltage Transistors

These high-voltage transistors are designed for driving neon bulbs and Nixie® indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage ($BV_{CEO}$).

| Device Type | $BV_{CEO}$ Volts Min | $I_C$ Amp Max | $h_{FE}$ @ $I_C$ Min | mA | $V_{CE(sat)}$ Volts @ $I_C$ & $I_B$ Max | mA | mA | $f_T$ MHz @ $I_C$ Min | mA |
|---|---|---|---|---|---|---|---|---|---|
| **NPN** | | | | | | | | | |
| 2N6517 | 350 | 0.5 | 40 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| 2N6516 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A42 | 300 | 0.5 | 40 | 10 | 0.5 | 20 | 2.0 | 50 | 10 |
| 2N6515 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A43 | 200 | 0.5 | 40 | 10 | 0.4 | 20 | 2.0 | 50 | 10 |
| MPS-D01 | 200 | 0.1 | 20 | 30 | | | | 40 | 10 |
| 2N5551 | 160 | 0.6 | 80 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| 2N5550 | 140 | 0.6 | 60 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| MPS-D02 | 140 | 0.05 | 20 | 30 | | | | 40 | 10 |
| MPS-D03 | 100 | 0.05 | 50 | 10 | 0.2 | 10 | 1.0 | 60 | 10 |
| MPS-L01 | 100 | 0.05 | 20 | 30 | | | | 40 | 10 |
| **PNP** | | | | | | | | | |
| 2N6520 | 350 | 0.5 | 30 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| 2N6519 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A92 | 300 | 0.5 | 40 | 10 | 0.8 | 20 | 2.0 | 50 | 10 |
| 2N6518 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A93 | 200 | 0.5 | 40 | 10 | 0.7 | 20 | 2.0 | 50 | 10 |
| MPS-D51 | 200 | 0.1 | 20 | 30 | | | | 40 | 10 |
| 2N5401 | 150 | 0.6 | 60 | 10 | 0.2 | 10 | 1.0 | 100 | 10 |
| MPS-D52 | 140 | 0.05 | 20 | 30 | | | | 40 | 10 |
| 2N5400 | 120 | 0.6 | 40 | 10 | 0.2 | 10 | 1.0 | 100 | 10 |
| MPS-D53 | 100 | 0.05 | 20 | 30 | | | | 40 | 10 |
| MPS-L51 | 100 | 0.6 | 40 | 50 | 0.25 | 10 | 1.0 | 60 | 10 |

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# Dual Diodes

Dual diodes designed for use in low cost biasing, steering and voltage doubler applications including series, common cathode and common anode diodes.

| $V_{(BR)}$ @ $I_{(BR)}$ Volts Min | μA | $I_R$ @ $V_R$ μA Max | Volts | $V_F$ @ Volts Min/Max | $I_F$ mA | $C_{VR}=0$ pF Max | $t_{rr}$ ns Max | Device Type | Description | |
|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 0.1 | 50 | 0.67/0.82 | 10 | 1.5 | 4.0 | MSD6100 | Switching | TO-92 |
| 50 | 100 | 0.1 | 40 | 0.67/0.82 | 10 | 2.0 | 10 | MSD6101 | Discrimmator | |
| 70 | 100 | 0.1 | 50 | 0.67/1.0 | 10 | 3.0 | 100 | MSD6102 | Common Cathode | |
| 70 | 100 | 0.1 | 50 | —/1.0 | 10 | 8.0 | 100 | MSD6150 | Common Cathode | |
| 100 | 100 | 0.2 | 50 | 0.67/0.82 | 10 | 1.5 | 15 | MSD7000 | Series | |



World Radio History

# MiniBloc

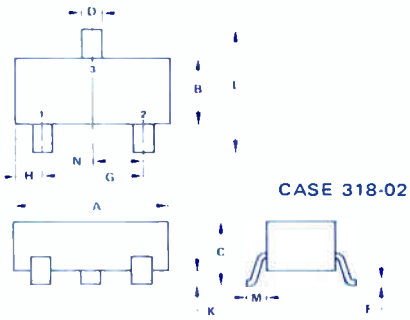
Unencapsulated semiconductors, used extensively in hybrid circuits, require careful handling and interconnection techniques to ensure a high level of product reliability. To minimize problems during hybrid circuit assembly, Motorola will be offering small-signal semiconductors in a miniature plastic package called the MiniBloc. This small, rectangular package (referred to as the SOT-23 by European manufacturers) is ideally-suited for use in thick-film and thin-film hybrid circuits. The MiniBloc is also used in certain PC board applications.

The new MiniBloc package and Motorola's existing wide array of products, chips, flip-chips, etc. will satisfy most of your hybrid semiconductor requirements. Contact the Small-Signal Marketing group for more information.

The following devices will be the first ones offered in the MiniBloc package:

## Available 2nd Half 1977.

| Device | Polarity | Similar to |
|---|---|---|
| **RF Transistors** | | |
| MMBR901 | NPN | MRF901 |
| MMBR930 | NPN | BFR91 |
| MMBR2060 | NPN | FMT2060 |
| MMBR6304 | NPN | 2N6304 |
| MMBR4957 | PNP | 2N4957 |
| **Small-Signal Transistors** | | |
| MMBT918 | NPN | MPS918 |
| MMBT2222 | NPN | MPS2222 |
| MMBT2907 | PNP | MPS2907 |
| MMBT3904 | NPN | MPS3904 |
| MMBT3906 | PNP | MPS3906 |
| MMBT6543 | NPN | MPS6543 |
| MMBT-A06 | NPN | MPS-A06 |
| MMBT-A20 | NPN | MPS-A20 |
| MMBT-A70 | PNP | MPS-A70 |
| **Varactor Diode** | | |
| MMBV3102 | – | MV3102 |




| DIM | MILLIMETERS MIN | MILLIMETERS MAX | INCHES MIN | INCHES MAX |
|---|---|---|---|---|
| A | 2.80 | 3.05 | 0.110 | 0.120 |
| B | 1.20 | 1.40 | 0.047 | 0.055 |
| C | 0.85 | 1.20 | 0.034 | 0.047 |
| D | 0.37 | 0.43 | 0.015 | 0.017 |
| F | 0.085 | 0.115 | 0.003 | 0.005 |
| G | 1.78 | 2.04 | 0.070 | 0.080 |
| H | 0.51 | 0.61 | 0.020 | 0.024 |
| K | 0.10 | 0.25 | 0.004 | 0.010 |
| L | 2.10 | 2.50 | 0.083 | 0.098 |
| M | 0.45 | 0.60 | 0.018 | 0.024 |
| N | 0.89 | 1.02 | 0.035 | 0.040 |



World Radio History

MOTOROLA

# MICRO-T TRANSISTORS and DIODES

**Micro-T devices combine high performance with extremely small physical size. The devices shown in these tables are available from stock; all other Motorola small-signal transistors may be obtained in Micro-T packages on special order.**

### How to Use These Selection Tables

The tables in this section divide the off-the-shelf Micro-T transistors and diodes into major applications categories. In each category, the first delineation is by NPN/PNP (or anode/cathode) device types. Under each of these classifications, the prime devices—those devices designed to a particular set of electrical parameters—are highlighted. Associated with each of the prime devices is a listing of the basic design parameters. Most categories also provide tabulation of other device types utilizing the same basic chip but having relaxed specifications.

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Single and dual diodes with common anode or cathode

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J-FET and MOSFET




World Radio History

## RF AMPLIFIER/HIGH SPEED SWITCHING TRANSISTORS

Standard RF devices in Micro-T packages are designed for applications where limited space is critical. This package is particularly attractive from a pre-testing and cost point of view as the RF parameters can be 100% tested for high performance. For complete design data, consult the prime device data sheet. For other RF devices not listed, contact your nearest Motorola sales representative or distributor. Ceramic pacakges with a cold sealing process are also available.

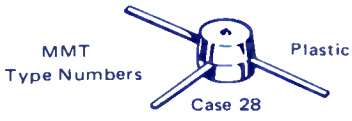
| | NPN Types | | | |
|---|---|---|---|---|
| **Prime Devices** | **MMT2857, A** | **MMT8006, 07, 08** | **MMT3960** | **MMT5031, A** |
| Design Parameters | | | | |
| $BV_{CEO}$ | 15 V | To 8.0 V | 3.0 V | To 14 V |
| Operating $h_{FE}$ Range | 1.0 to 20 mA | 0.010 to 10 mA | 1.0 to 30 mA | 1.0 to 5.0 mA |
| $f_T$ (Typ) | 1400 MHz @ 5.0 mA | 2200 MHz @ 2.0 mA | 2250 MHz @ 10 mA | 2.0 GHz @ 5.0 mA |
| NF (Typ) | 4.0 dB @ 1.5 mA | 2.5 dB @ 1.0 mA | – | 2.0 dB @ 1.0 mA |
| $G_{pe}$ (Typ) | 12 dB @ 450 MHz | 25 dB @ 200 MHz | – | 20 dB @ 450 MHz |
| $t_{on}$ (Typ) | – | – | 3.0 ns @ 10 mA | – |

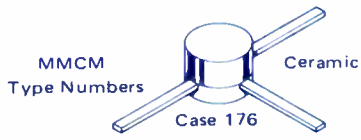
Case 28

| | PNP Types | |
|---|---|---|
| **Prime Devices** | **MMT918** | **MMT4261** |
| Design Parameters | | |
| $BV_{CEO}$ | 15 V | 15 V |
| Operating $h_{FE}$ Range | 3.0 mA | 10 mA |
| $f_T$ (Typ) | 600 MHz @ 4.0 mA | 1000 MHz @ 10 mA |
| NF (Typ) | 6.0 dB @ 1.0 mA | – |
| $G_{pe}$ (Typ) | 15 dB @ 200 MHz | – |
| $t_{on}$ (Typ) | – | – |

## GENERAL-PURPOSE AND SWITCHING TRANSISTORS

For general-purpose applications and for designs requiring fast switching, the Micro-T packaged transistors are available in either economy plastic or hermetically sealed ceramic. Complete data sheets are available for prime devices; equivalent data sheets may be obtained when the same die is used in other 2N – standard devices. For devices not listed, contact your nearest Motorola representative or distributor.



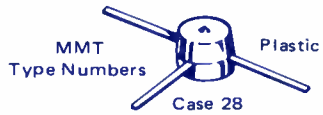

| | NPN Types | | PNP Types | |
|---|---|---|---|---|
| **Prime Devices** | **MMT2222 MMCM2222** | **MMT3904 MMCM3904** | **MMT2907 MMCM2907** | **MMT3906 MMCM3906** |
| Design Parameters | | | | |
| $BV_{CEO}$ | To 60 V | To 40 V | To 60 V | To 40 V |
| Operating $h_{FE}$ Range | 100 µA to 500 mA | 100 µA to 100 mA | 100 µA to 500 mA | 100 µA to 100 mA |
| $f_T$ (Typ) | 300 MHz @ 20 mA | 300 MHz @ 10 mA | 350 MHz @ 50 mA | 350 MHz @ 10 mA |
| $t_{on}$ (Typ) | 25 ns @ 150 mA | 40 ns @ 10 mA | 30 ns @ 150 mA | 45 ns @ 10 mA |
| $t_{off}$ (Typ) | 250 ns | 140 ns | 100 ns | 160 ns |
| | Ceramic Package | Plastic Package | | Plastic Package |
| Derivatives from Prime Devices | MMCM2221 | MMT3903<br>MMT76<br>Ceramic Package<br>MMCM3903 | | MMT3905<br>MMT75<br>Ceramic Package<br>MMCM3905 |

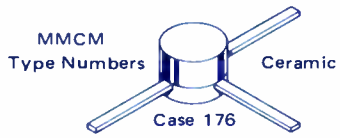


World Radio History

## LOW NOISE/HIGH GAIN AMPLIFIER TRANSISTORS

Two types of specialty transistors complement Motorola's micro-transistor amplifier selection. The combination of high-gain and low-noise have made these standards popular for many years. The Micro-T package coupled with performance permits space premium designs to become a reality. Other high voltage and Darlington transistors are also available as specials.

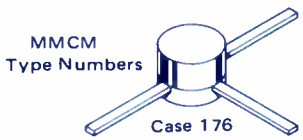



| | NPN Types | | PNP Types | |
|---|---|---|---|---|
| **Prime Devices** | **MMT2484 MMCM2484** | | **MMT3799 MMCM3799** | |
| Design Parameters<br>$BV_{CEO}$<br>Operating $h_{FE}$ Range<br>$f_T$ (Typ)<br>NF (Typ) | To 60 V<br>100 μA to 10 mA<br>90 MHz @ 500 μA<br>2.0 dB @ 10 μA | | To 60 V<br>10 μA to 10 mA<br>140 MHz @ 1.0 mA<br>1.5 dB @ 100 μA | |
| Derivatives from Prime Devices | Ceramic Package MMCM930 | Plastic Package MMT930 MMT70 | Ceramic Package MMCM3798 | Plastic Package MMT3798 MMT71 |

## LOW CURRENT SWITCHING TRANSISTORS

These high speed switching transistors can be used in circuits where space limitations are critical. For design data, consult prime device data sheet or the 2N JEDEC equivalent. For devices not listed, consult your nearest Motorola sales representative or distributor.




| | NPN Types | | PNP Types |
|---|---|---|---|
| **Prime Devices** | **MMT2369 MMCM2369** | **MMT3014** | **MMT3546** |
| Design Parameters<br>$BV_{CEO}$<br>Operating $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ) | To 15 V<br>10 mA to 100 mA<br>650 MHz @ 10 mA<br>2.0 ns<br>15 ns @ 10 mA | To 20 V<br>10 mA to 100 mA<br>400 MHz @ 30 mA<br>12 ns<br>13 ns @ 300 mA | To 12 V<br>10 mA to 100 mA<br>850 MHz @ 10 mA<br>15 ns<br>25 ns @ 50 mA |
| Derivatives from Prime Devices | | Plastic Package MMT72 | |



World Radio History

## SWITCHING DIODES

The Micro-T product line includes single and double diodes for voltage doubling or bias control functions. Zener diodes are also available as specials. For lead times and availability, contact your nearest distributor or Motorola's sales representative.

Case 166

Case 28

| | Single | Common Cathode | Common Anode | Series |
|---|---|---|---|---|
| **Prime Devices** | **MMD6050** | **MMD6100** | **MMD6150** | **MMD7000** |
| Design Paremeters | | | | |
| $V_{BR}$ | To 100 V | To 100 V | To 100 V | To 100 V |
| $I_R$ (Typ) | 10 mA | 10 mA | 10 mA | 10 mA |
| $V_F$ (Typ) | 0.6 V @ 1.0 mA | 0.6 V @ 1.0 mA | 0.6 V @1.0 mA | 0.6 V @ 1.0 mA |
| $t_{rr}$ (Typ) | 10 ns | 20 ns | 20 ns | 20 ns |
| Derivatives from Prime Devices | MMD70 | | | MMD7001 |

## FIELD-EFFECT TRANSISTORS

Technologies other than bipolar transistors are available in the Micro-T package. One example is the popular J-FET. Also available are other J-FET and MOSFET devices requiring up to four leads and having a chip size less than 25 mils per side. For lead time and availability, contact your nearest Motorola sales representative.

Case 28

| | N-Channel J-FET |
|---|---|
| **Prime Device** | **MMT3823** |
| Design Parameters | |
| $BV_{GSS}$ | To 35 V |
| $I_{DSS}$ (surge) | 5.0 mA to 20 mA |
| $C_{iss}$ (Typ) | 4.0 pF |
| NF (Typ) | 2.0 dB @ 100 MHz, $R_S$ = 1000 Ohms |

Note: Other FETs are available as specials.



World Radio History

MOTOROLA

# MULTIPLE DEVICES

## SMALL-SIGNAL MULTIPLE TRANSISTORS AND DARLINGTON TRANSISTORS

**Motorola offers a large selection of Quad, Dual and Darlington transistors for off-the-shelf delivery. The chips used in the Quad and Dual transistors are those that have emerged as the most popular ones for discrete transistor applications. But even beyond that, Motorola offers its entire vast repertoire of discrete small-signal transistors for multiple-device packaging. For special applications where the devices listed may not quite fit the design requirements, special configurations can be supplied with quick turnaround time and low premiums.**

### How to Use These Selection Tables

The tables in this section divide the off-the-shelf multiple transistors into major applications categories. In each category, the first delineation is by NPN/PNP device types. Under each of these classifications, the prime devices—those devices designed to a particular set of electrical parameters—are highlighted, and the basic (discrete) chip from which these prime devices are formed is indicated. (More characteristic information for these basic chips is given elsewhere in this Master Selection Guide; refer to the Device Catalog for page reference.)

Associated with each of the prime devices is a listing of the basic design parameters, and a tabulation of other device types utilizing the same basic chip but having relaxed specifications. These derivatives are listed in order of decreasing price.

Each device number printed in italics indicates that the associated data sheet contains a set of design curves. These curves are typical for that entire device line.

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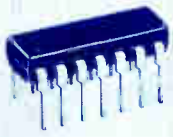
# Motorola Quad Transistors

## General-Purpose Amplifier and Switching Transistors

The multiple transistors included in this category have been implemented with discrete transistor chips that have proved to be the most popular for high all around performance at low cost. The line is characterized by a relatively high-current gain over an extremely wide range of dc collector current, a high-frequency response and medium-speed switching capability.

CASE 607-04
(Ceramic Flat Package)
MQ Devices

CASE 632
TO-116
(Ceramic Package)
MHQ Devices



CASE 646
(Plastic Package)
MPQ Devices

| | NPN TYPES | | | | PNP TYPES | | | |
|---|---|---|---|---|---|---|---|---|
| Prime Devices | MPQ2222<br>MHQ2222<br>MQ2219A<br>*(Basic Device Design — 2N2222)* | | | MPQ3904<br>*(Basic Device Design 2N3904)* | MPQ2907<br>MHQ2907<br>MQ2905A<br>*(Basic Device Design — 2N2907)* | | | MPQ3906<br>*(Basic Device Design 2N3906)* |
| Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ) | To 60 Vdc<br>100 μA to 500 mA<br>300 MHz @ 20 mA<br>25 ns<br>250 ns @ 150 mA | | | To 40 Vdc<br>100 μA to 100 mA<br>300 MHz @ 10 mA<br>40 ns<br>136 ns @ 10 mA | To 60 Vdc<br>100 μA to 500 mA<br>350 MHz @ 50 mA<br>30 ns<br>100 ns @ 150 mA | | | To 40 Vdc<br>100 μA to 100 mA<br>350 MHz @ 10 mA<br>43 ns<br>155 ns @ 10 mA |
| Derivatives From Prime Devices (In decreasing order of price) | Ceramic Package | Plastic Package | Ceramic Flat Package | — | Ceramic Package | Plastic Package | Ceramic Flat Package | — |
| | MHQ2221 | MPQ2221<br>MPQ1000 | *MQ2218,A*<br>*MQ2219*<br>MQ1120<br>MQ1129 | | MHQ2906 | MPQ2906<br>MPQ1500 | *MQ2904*<br>MQ7001<br>MQ982<br>MQ3251 (1)<br>MQ7007 (1)<br>(1)<br>See 2N3250 data sheet for basic design parameters. | |

| Complementary Pairs (2 Pairs Per Package) | Ceramic Package | Plastic Package | Ceramic Flat Package | Description |
|---|---|---|---|---|
| | MHQ6002<br>MHQ6001 | MPQ6002<br>MPQ6001 | MQ6002<br>MQ6001 | Two Chips from Basic Device Design 2N2222 and 2N2907. Devices differ principally in $h_{FE}$. |
| | | MPQ6502<br>MPQ6501 | | Same as above, but with a different pin arrangement. |
| | | *MPQ6700* | | Two Chips from Basic Device Design 2N3904 and 2N3906. |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

QUAD TRANSISTORS (continued)

## Low-Noise, High-Gain Amplifier Transistors

| NPN TYPES | | | PNP TYPES | | | |
|---|---|---|---|---|---|---|
| MQ2484<br>MPQ2484<br>MHQ2484<br>*(Basic Device Design – 2N2484)* | | | MQ3799A (Matched)<br>MPQ3799<br>MHQ3799<br>*(Basic Device Design – 2N3799)* | | | Prime Devices |
| To 60 Vdc<br>100 μA to 10 mA<br>90 MHz @ 500 μA<br>2.0 dB @ 10 μA | | | To 60 Vdc<br>10 μA to 10 mA<br>140 MHz @ 1.0 mA<br>1.5 dB @ 100 μA | | | Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>NF (Typ) |
| Ceramic Package | Plastic Package | Ceramic Flat Package | Ceramic Package | Plastic Package | Ceramic Flat Package | Derivatives From Prime Devices (In decreasing order of price) |
| MHQ2483 | MPQ2483 | MQ930 | MHQ3798 | MPQ3798 | MQ3799<br>*MQ3798*<br>MQ7003 | |
| Ceramic Package | Plastic Package | Ceramic Flat Package | Description | | | Complementary Pairs |
| MHQ6100,A | MPQ6100,A<br>MPQ6600,A | MQ6100<br>MQ7021 | Two Chips from Basic Device Design 2N2484 and 2N3799. The A version has higher gain. | | | |

## High-Current Switching and Core Driver Transistors

| NPN TYPES | | | | PNP TYPES | | | |
|---|---|---|---|---|---|---|---|
| MPQ3725A<br>*(Basic Device Design – 2N3725)* | MHQ4014<br>*(Basic Device Design – 2N4014)* | MPQ3303<br>*(Basic Device Design 2N3303)* | | MPQ3762<br>2N5146<br>*(Basic Device Design – 2N3762)* | | | Prime Devices |
| To 50 Vdc<br>100 mA to 500 mA<br>300 MHz @ 50 mA<br>20 ns<br>50 ns @ 500 mA | To 45 Vdc<br>10 mA to 1.0 A<br>300 MHz @ 50 mA<br>20 ns<br>50 ns @ 500 mA | To 12 Vdc<br>100 mA to 1.0 A<br>500 MHz @ 100 mA<br>12 ns<br>20 ns @ 1.0 A | | To 40 Vdc<br>100 mA to 1.0 A<br>200 MHz @ 50 mA<br>30 ns<br>75 ns @ 500 mA | | | Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ) |
| Plastic Package | Ceramic Package | Ceramic Flat Package | – | Ceramic Package | Plastic Package | Ceramic Flat Package | Derivatives From Prime Devices (In decreasing order of price) |
| *MPQ3725*<br>MPQ4004<br>MPQ4003<br>MPQ1050 | MHQ4013<br>MHQ4002A<br>MHQ4001A | MQ3725<br>2N6501 | | MHQ3467 | MPQ3467 | MQ3467<br>MQ3762 | |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

QUAD TRANSISTORS (continued)

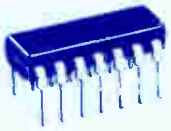
## Low-Current Switching Transistors

| | NPN TYPES | PNP TYPES |
|---|---|---|
| Prime Devices | MPQ2369<br>MQ2369<br>MHQ2369<br>*(Basic Device Design – 2N2369)* | MPQ3546<br>MHQ3546<br>*(Basic Device Design – 2N3546)* |
| Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ) | To 15 Vdc<br>10 mA to 100 mA<br>650 MHz @ 10 mA<br>9.0 ns<br>15 ns @ 10 mA | To 12 Vdc<br>10 mA to 100 mA<br>850 MHz @ 10 mA<br>15 ns<br>25 ns @ 50 mA |
| Derivative From Prime Devices | Flat Package<br>MQ7004 | – |

CASE 607-04 (Ceramic Flat Package) MQ Devices

CASE 632 TO-116 (Ceramic Package) MHQ Devices

CASE 646 (Plastic Package) MPQ Devices



## RF Amplifiers and Oscillators, High-Voltage (HV) Drivers, and J-FET-Bipolar Quad Transistors

| | RF NPN TYPES | HV NPN TYPES | HV PNP TYPES |
|---|---|---|---|
| Prime Devices | MPQ918<br>MQ918<br>MHQ918<br>*(Basic Device Design 2N918)* | MPQ7043<br>*(Basic Device Design – 2N6515)* | MPQ7093<br>*(Basic Device Design – 2N6518)* |
| Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>NF (Typ) | To 15 Vdc<br>100 µA to 10 mA<br>850 MHz @ 4.0 mA<br>4.0 dB @ 1.0 mA | To 400 Vdc**<br>1.0 mA to 30 mA<br>70 MHz @ 10 mA | To 400 Vdc**<br>1.0 mA to 30 mA<br>70 MHz @ 10 mA |
| Derivatives From Prime Devices (In decreasing order of price) | Ceramic Flat Package<br>MQ7005 | Plastic Package<br>MPQ7042<br>MPQ7041 | Plastic Package<br>MPQ7092<br>MPQ7091 |
| Complementary Pairs (2 Pairs Per Package) | –<br>– | Plastic Package<br>MPQ7051<br>MPQ7052<br>MPQ7053 | Description<br>Two Chips from Basic Device Design 2N6515 and 2N6518. Devices differ principally in $BV_{CEO}$. |
| NPN-Bipolar, N-Channel, J-FET Quad Transistor Combination | – | MPQ2001 | Two Chips from Basic Device Design 2N2222 & 2N5358 (J-FET) lines. $BV_{GSS}$ to 25 Vdc, $I_{DSS}$ from 2.0 mA-16 mA |

**Supplied as Specials.

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

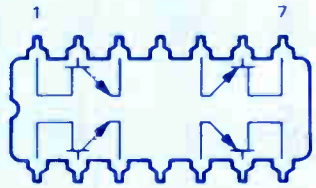
# Motorola MPU Clock Buffer

## MPQ6842

Quad dual in-line silicon annular complementary pair transistors.

The MPQ6842 is designed to provide the switching speed and saturation voltages necessary to design the clock circuit to meet the MPU clock requirements.

CASE 646
Plastic




CONNECTION DIAGRAM

| Design Parameters | Limits |
|---|---|
| $BV_{CEO}$ | To 40 Vdc |
| Specified $h_{FE}$ Range | 100 $\mu$A to 100 mA |
| $f_T$ (Typ) | 300 MHz @ 10 mA |
| $t_{on}$ (Typ) | 45 ns @ 10 mA |
| $t_{off}$ (Typ) | 150 ns @ 10 mA |



World Radio History

# Motorola Dual Transistors

## Low-Noise, High-Gain Amplifier Transistors

CASE
610A-03
(Ceramic Package)

CASE
654-07
(Metal Package)

| | NPN TYPE | | PNP TYPE | |
|---|---|---|---|---|
| Prime Devices | 2N2920<br>*(Basic Device Design – 2N2484)* | | 2N3811A<br>*(Basic Device Design – 2N3799)* | |
| Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>NF (Typ)<br>$h_{FE}$ Matching Avail. | To 60 Vdc<br>10 μA to 10 mA<br>90 MHz @ 500 μA<br>2.0 dB @ 10 μA | | To 60 Vdc<br>1.0 μA to 10 mA<br>140 MHz @ 1.0 mA<br>1.5 dB @ 100 μA | |
| Derivatives From Prime Devices (In decreasing order of price) | **Metal Package** | **Ceramic Package** | **Metal Package** | **Ceramic Package** |
| | 2N2543,A<br>2N2639<br>thru<br>2N2644<br>2N2722<br>2N2903,A<br>2N2913<br>thru<br>2N2919<br>MD7002,A,B<br>MD8001<br>MD8003 | 2N3043<br>thru<br>2N3048 | 2N3806<br>thru<br>2N3811<br>MD7003,A,B | 2N3812<br>thru<br>2N3817A<br>MD7003F,AF |
| Complementary Pairs (Basic Device Design 2N2484 and 2N3799) | **Metal Package** | | **Ceramic Package** | |
| | MD6100<br>MD7021 | | MD6100F<br>MD7021F | |
| Matched Pairs (Monolithic Devices) | **Metal Package** | | **Description** | |
| | *2N6441*<br>thru<br>2N6448 | | Devices differ principally in gain and matching characteristics. | |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

DUAL TRANSISTORS (continued)

# General-Purpose Amplifier and Switching Transistors

The multiple transistors included in this category have been implemented with discrete transistor chips that have proved to be the most popular for high all around performance at low cost. The line is characterized by a relatively high-current gain over an extremely wide range of dc collector current, a high-frequency response and medium-speed switching capability.

CASE
610A-03
(Ceramic Package)

CASE
654-07
(Metal Package)

| NPN TYPE | | PNP TYPE | | |
|---|---|---|---|---|
| MD2219A,AF<br>*(Basic Device Design – 2N2222)* | | MD2905A,AF<br>*(Basic Device Design – 2N2907)* | | Prime Devices |
| To 60 Vdc<br>10 μA to 500 mA<br>300 MHz @ 20 mA<br>40 ns<br>110 ns @ 150 mA | | To 60 Vdc<br>100 μA to 500 mA<br>350 MHz @ 50 mA<br>30 ns<br>100 ns @ 150 mA | | Design Parameters<br>$BV_{CED}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ)<br>$h_{FE}$ Matching Avail. |
| Metal Package | Ceramic Package | Metal Package | Ceramic Package | |
| 2N2060,A *MD2218,A*<br>2N2223,A *MD2219*<br>2N2480,A MD3409<br>2N2652,A MD3410<br>MD1120<br>2N2720 MD1121<br>2N2721 MD1122<br>2N5793 MD1129<br>2N5794 MD7000 | *MD2218F,AF*<br>*MD2219F*<br>MD1120F<br>MD1129F | 2N4015<br>2N4016<br>2N5795<br>2N5796<br>*MD2904,A*<br>*MD2905*<br>MD7001<br>MD982 | *MD2904F,AF*<br>*MD2905F*<br>MD7001F<br>MD982F | Derivatives From Prime Devices (In decreasing order of price) |
| Metal Package | | Ceramic Flat Package | | Complemenatry Pairs (Basic Device Design 2N2222 and 2N2907) |
| 2N4854 MD6001<br>2N4855 MD6002<br>MD985 MD6003 | | 2N3838<br>MD985F<br>MD6001F<br>MD6002F<br>MD6003F | | |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

DUAL TRANSISTORS (continued)

# RF Amplifiers and Oscillators

CASE
610A-03
(Ceramic Package)

CASE
654-07
(Metal Package)

CASE
654-01
(Metal Package)

| | NPN TYPE | | PNP TYPE | |
|---|---|---|---|---|
| Prime Devices | MD918A<br>MD918AF<br>*(Basic Device Design – 2N918)* | | MD5000A<br>*(Basic Device Design – 2N3307)* | |
| Design Parameters<br>$BV_{CEO}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>NF (Typ)<br>Gpe<br>$h_{FE}$ Matching Avail. | To 15 Vdc<br>100 μA to 10 mA<br>850 MHz @ 4.0 mA<br>4.0 dB @ 1.0 mA<br>15 dB @ 4.0 mA | | To 15 Vdc<br>100 μA to 10 mA<br>900 MHz @ 4.0 mA<br>3.0 dB @ 1.0 mA<br>18 dB @ 4.0 mA | |
| Derivatives From Prime Devices (In decreasing order of price) | Metal Package | Ceramic Package | Metal Package | – |
| | *MD918,B*<br>MD1131<br>MD1132<br>MD7005 | *MD918F,BF*<br>MD1131F<br>MD1132F<br>MD7005F | MD5000<br>MD5000B | |

## NEW INTRODUCTIONS

| | |
|---|---|
| MD4260<br>MD4261 | PNP silicon transistors designed for use as wideband or high-frequency differential amplifiers and dual RF amplifiers. |
| MD6900 | NPN/PNP silicon transistor designed for use as complementary wideband RF amplifiers. |

## TO BE INTRODUCED

| | |
|---|---|
| MD5500,F | 450 MHz NPN Amplifier |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

DUAL TRANSISTORS (continued)

## High-Current Switching and Core Driver Transistors

| NPN TYPE | | PNP TYPE | | |
|---|---|---|---|---|
| MD3725,F<br>*(Basic Device Design – 2N3725)* | | MD3762,F<br>*(Basic Device Design – 2N3762)* | | Prime Devices |
| To 45 Vdc<br>10 mA to 1.0 A<br>300 MHz @ 50 mA<br>20 ns<br>25 ns @ 500 mA | | To 40 Vdc<br>100 mA to 1.0 A<br>200 MHz @ 50 mA<br>30 ns<br>75 ns @ 500 mA | | Design Parameters<br>$BV_{CED}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ)<br>$h_{FE}$ Matching Avail. |
| **Metal Package** | **Ceramic Package** | **Metal Package** | **Ceramic Package** | Derivatives From Prime Devices |
| 2N6502 | 2N6503 | *MD3467* | MD3467F | |

## Low Current Switching Transistors

| NPN TYPE | | PNP TYPE | | |
|---|---|---|---|---|
| MD2369A,AF<br>*(Basic Device Design – 2N2369)* | | MD3251A,AF<br>*(Basic Device Design – 2N3250)* | | Prime Devices |
| To 15 Vdc<br>10 mA to 100 mA<br>650 MHz @ 10 mA<br>15 ns<br>15 ns @ 10 mA | | To 40 Vdc<br>10 μA to 50 mA<br>300 MHz @ 10 mA<br>50 ns<br>200 ns @ 10 mA | | Design Parameters<br>$BV_{CED}$<br>Specified $h_{FE}$ Range<br>$f_T$ (Typ)<br>$t_{on}$ (Typ)<br>$t_{off}$ (Typ)<br>$h_{FE}$ Matching Avail. |
| **Metal Package** | **Ceramic Package** | **Metal Package** | **Ceramic Package** | |
| 2N3425<br>MD708,A,B<br>*MD2369,B*<br>MD7004 | MD708,AF,BF,F<br>MD2369F,BF<br>MD7004F | 2N4937<br>2N4938<br>2N4939<br>*MD3250,A*<br>*MD3251,A*<br>MD1123<br>MD1130<br>MD7007,A,B<br>MD984 | 2N4940<br>2N4941<br>2N4942<br>*MD3250F,AF*<br>*MD3251F,AF*<br>MD1130F<br>MD7007F,BF | Derivatives From Prime Devices (In decreasing order of price) |
| **Metal Package** | | **Ceramic Package** | | Complementary Pairs (Basic Device Design 2N2369 and 2N3250) |
| MD986 | | MD986F | | |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

# Motorola Darlington Transistors

## Small-Signal Darlington Amplifier Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high-current gain and input impedance. The plastic transistors have monolithic construction and the metal package transistors are two chip construction. The transistors are listed in order of increasing breakdown voltage ($BV_{CEO}$).

| $BV_{CES}$* $V_{CEO(sus)}$ # $BV_{CEO}$ Volts Min | $I_C$ mA Max | $h_{FE}$ @ $I_C$ Min | Max | mA | $V_{CE(sat)}$ @ $I_C$ Volts Max | mA* Amp | $P_D$ Watts | $f_T$ MHz Min | NF dB Typ | Device Type NPN | PNP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20* | 500 | 20,000 | – | 10 | 1.0 | 10* | 0.625 | 0.035 | – | *MPS-A12* | – |
| 25* | 300 | 1000 | – | 10 | 1.0 | 0.1 | 0.625 | 100 | – | *MPS-D04* | MPS-D54 |
| 30* | 500 | 5000 | – | 10 | 1.5 | 0.1 | 0.625 | 125 | 2.0 | *MPS-A13* | – |
| 30* | 500 | 10,000 | – | 10 | 1.5 | 0.1 | 0.625 | 125 | 2.0 | *MPS-A14* | – |
| 30* | 300 | 50,000 | – | 10 | 1.5 | 0.1 | 0.625 | 100 | 2.0 | – | *MPS-A65* |
| 30* | 300 | 75,000 | – | 10 | 1.5 | 0.1 | 0.625 | 100 | 2.0 | – | *MPS-A66* |
| 40 | 200 | 1200 | – | 10 | 1.0 | 15* | 0.5 | 10 | – | 2N2785 | – |
| 40 | 300 | 5000 | – | 10 | 1.5 | 0.1 | 0.375 | – | – | *MM6427* | – |
| 40 | 500 | 5000 | – | 10 | 1.5 | 0.1 | 0.75 | – | – | *MPQ6426* | – |
| 40 | 500 | 10,000 | 200,000 | 10 | 1.2 | 50* | 0.625 | – | 3.0 | *2N6427* | – |
| 40 | 500 | 20,000 | 200,000 | 10 | 1.2 | 50* | 0.625 | – | 3.0 | *2N6426* | – |
| 60# | 500 | 1600 | 8,000 | 10 | – | – | 0.5 | – | 6.0 | 2N998 | – |
| 60 | 40 | 2000 | 10,000 | 10 | 1.0 | 10* | 0.5 | 100 | 10 | 2N2723 | – |

| Case 20 TO-72 | Case 22-03 TO-18 | Case 29-02 TO-92 | Case 646 |
|---|---|---|---|
| 2N998<br>2N2723<br>2N2785 | MM6427 | 2N6426<br>2N6427<br>MPS-A12<br>MPS-A13<br>MPS-A14<br>MPS-A65<br>MPS-A66<br>MPS-D04<br>MPS-D54 | MPQ6426<br>MPQ6427 |

*Numbers in italic type denote data sheet that shows design curves.*



World Radio History

MOTOROLA

# FIELD-EFFECT TRANSISTORS

**Motorola offers a line of field-effect transistors that encompasses the latest technology and covers the full range of FET applications. Included is a wide variety of junction FETs and MOSFETs, with N- or P-channel polarity with both single and dual gates. These FETs include devices developed for operation across the frequency range from dc to UHF in switching and amplifying applications. Package options from low-cost plastic to metal TO-72 packages are available.**

## How to Use These Selection Tables

The selector guides on the following pages are designed to emphasize the preferred FET devices—those whose specifications groupings have proved to be the most popular, resulting in a combination of good performance and low cost. The major specifications of these devices are given for easy comparison.

Also given in each table are the family characteristics from which the individual member characteristics have been derived. This makes it easy to determine the portion of the total specifications spectrum covered by each preferred type number. In the event that the preferred-device specifications do not encompass a particular design requirement, it is normally possible to obtain the desired specifications on special order, using the family specification limits as a guide.

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Devices designed for chopper and high-speed switching applications.

RF Amplifiers . . . . . 159
Devices characterized for operation at frequencies as high as 500 MHz.

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TO-72

Case 22
TO-18

Case 27
TO-52

Case 29
TO-92



World Radio History

# General-Purpose Devices

Using the same transistor for both switching and amplifier applications can reduce inventories and increase purchase quantities to take advantage of quantity price reductions. Transistors listed here represent good, all-around amplifiers in the audio frequency range, and provide satisfactory medium-speed switching capabilities. MOSFETs listed are characterized primarily as switches but can be used as satisfactory general-purpose amplifiers.

## JFETs – N-CHANNEL

| Package | Family | Preferred Types | Features | $\|Y_{fs}\|$ mmhos Min/Max | $I_{DSS}$ mA Min/Max | $V_{(BR)GSS}$ $V_{(BR)DSS}$* Volts Min | $V_{GS(off)}$ $V_{GS(TH)}$* Volts Min/Max | NF dB $nV/\sqrt{Hz}$* |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 131 | **Standard Family Limits** | | 0.5/6.5 | 0.5/24 | to -50 | -0.2/-8.0 | to 2.5 |
| | | 2N5457 | Good overall performance. Low Cost. | 1.0/5.0 | 1.0/5.0 | -25 | -0.5/-6.0 | – |
| | | 2N5458 | | 1.5/5.5 | 2.0/9.0 | -25 | -1.0/-7.0 | – |
| | | 2N5459 | | 2.0/6.0 | 4.0/16 | -25 | -2.0/-8.0 | – |
| TO-72 | | 2N4220 | Somewhat improved specifications; slightly higher cost. | 1.0/4.0 | 0.5/3.0 | -30 | -/-4.0 | 2.5 |
| | | 2N4221 | | 2.0/5.0 | 2.0/6.0 | -30 | -/-6.0 | 2.5 |
| | | 2N4222 | | 2.5/6.0 | 5.0/15 | -30 | -/-8.0 | 2.5 |
| | | 2N3823 | | 3.5/6.5 | 4.0/20 | -30 | -/-8.0 | 2.5 |
| | | 2N3824 | | – | – | -50 | – | – |

## JFETs – P-CHANNEL

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 125 | **Standard Family Limits** | | 0.8/8.0 | 0.3/30 | to 60 | 0.2/9.0 | 115* |
| | | 2N5460 | Good performance, low cost. | 1.0/4.0 | 1.0/5.0 | 40 | 0.75/6.0 | 115* |
| | | 2N5461 | | 1.5/5.0 | 2.0/9.0 | 40 | 1.0/7.5 | 115* |
| | | 2N5462 | | 2.0/6.0 | 4.0/16 | 40 | 1.8/9.0 | 115* |

## MOSFET – N-CHANNEL (Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-72 | 122 | **Standard Family Limits** | | 1.0/- | 10/- | 25* | 0.5/5.0* | – |
| | | 2N4351 | Relatively low-cost, complement to 2N4352 | 1.0/- | 10/- | 25* | 0.5/5.0* | – |

## MOSFET – P-CHANNEL (Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-72 | 123 | **Standard Family Limits** | | 1.0/4.0 | -1.0/-10 | to -50* | -1.0/-5.0* | – |
| | | 2N4352 | Relatively low-cost, complement to 2N4351 | 1.0/- | -10/- | -25* | -1.0/-5.0* | – |



World Radio History

# General-Purpose Amplifiers

The following transistors are designed for amplification in the audio-frequency range. The devices characterized represent the best values and should receive primary consideration. Other family members are also indicated, together with any specific features they may have.

## JFET – N-CHANNEL

| Package | Family | Preferred Types | Features | $Y_{fs}$ mmhos Min/Max | $I_{DSS}$ mA Min/Max | $V_{(BR)GSS}$ $V_{(BR)DSS}$* V Min | $V_{GS(off)}$ V Min/Max | NF dB $nV/\sqrt{Hz}$* |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 131 | **Standard Family Limits** | | 0.5/6.5 | 0.5/24 | to -50 | -0.2/-0.8 | to 75* |
| | | 2N5457 | Lowest Cost Family. | 1.0/5.0 | 1.0/5.0 | -25 | -0.5/-6.0 | – |
| | | 2N5458 | General-purpose application. | 1.5/5.5 | 2.0/9.0 | -25 | -1.0/-7.0 | – |
| | | 2N5459 | | 2.0/6.0 | 4.0/16 | -25 | -2.0/-8.0 | – |
| TO-72 | | 2N4220A | Similar to above series, but | 1.0/4.0 | 0.5/3.0 | -30 | -/-4.0 | 2.5 |
| | | 2N4221A | with specified NF and | 2.0/5.0 | 2.0/6.0 | -30 | -/-6.0 | 2.5 |
| | | 2N4222A | slightly improved specifications. Somewhat higher cost. | 2.5/6.0 | 5.0/15 | -30 | -/-8.0 | 2.5 |
| | | | Very low noise. | | | | | |

**Other Family Members**

| | | |
|---|---|---|
| | | (All comparisons are referenced to similarly packaged preferred device types in the tables above.) |
| TO-18 | 124 | MFE2093, 4, 5 – Higher $V_{(BR)GSS}$, higher cost. |
| TO-72 | 131 | 2N3822, 3 – Higher $V_{(BR)GSS}$, higher cost. |
| | | 2N5358, 59, 60, 61, 62, 63, 64 – Tighter specifications, higher cost. |
| TO-92 | 131 | MPF109, MPF111 – Lowest Cost. Loose specifications. |

## JFET – P-CHANNEL

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 125 | **Standard Family Limits** | | 0.8/8.0 | 0.3/30 | to 60 | 0.2/9.0 | to 3.0 |
| | | 2N5460 | Good performance, Low cost. | 1.0/4.0 | 1.0/5.0 | 40 | 0.75/6.0 | 2.5 |
| | | 2N5461 | | 1.5/5.0 | 2.0/9.0 | 40 | 1.0/7.5 | 2.5 |
| | | 2N5462 | | 2.0/6.0 | 4.0/16 | 40 | 1.8/9.0 | 2.5 |
| TO-72 | | 2N3330 | Tighter specifications, metal package, higher cost. | 1.5/3.0 | 2.0/6.0 | 20 | -/6.0 | 3.0 |

**Other Family Members**

| | | |
|---|---|---|
| TO-72 | 125 | 2N3909,A<br>2N5265, 66, 67, 68, 69, 70 –<br>MFE4007, 08, 09, 10, 11, 12 – Very tight specifications. Higher cost. |
| TO-92 | 125 | 2N5463, 64, 65 – Higher $V_{(BR)GSS}$. Higher cost.<br>2N4342, MPF161 – Low cost.<br>2N4360 – Lowest cost. Very loose specifications. |

## MOSFET – N-CHANNEL (Depletion-Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-18 | 110 | **Standard Family Limits** | | 0.7/4.0 | 0.5/15 | to 25* | $V_{GS(TH)}$ -/-8.0 | to 3.8 |
| | | MFE824 | Especially suited for smoke detector applications. | 1.0/- | 1.0/15 | 20* | -/-6.0 | – |
| TO-72 | | MFE3001 | $I_{GSS}$ = ±1.0 pAdc Max | 0.7/3.5 | 0.5/6.0 | 20* | -/-8.0 | – |
| | | 2N3796 | | 0.9/1.8 | 0.5/3.0 | 25 | -/-4.0 | 3.8 Typ |
| | | 2N3797 | | 1.5/3.0 | 2.0/6.0 | 20 | -/-7.0 | 3.8 Typ |

## MOSFET – P-CHANNEL (Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-18 | | MFE823 | Especially suited for smoke detector applications. $I_{GSS}$ = ±1.0 pAdc Max | 1.0/- | -/-20 | -25* | -2.0/-6.0 | – |



World Radio History

# Choppers and Switches

FETs have no offset voltages and low "on" resistance. As a result they are especially well suited for chopper/switch applications. The following characterized devices represent the best values and should receive primary consideration.

## JFETs – N CHANNEL

| Package | Family | Preferred Types | Features | $r_{ds(on)}$ Ohms Max | $I_{D(off)}$ / $I_{DSS}$* nA Max | $C_{rss}$ pF Max | $V_{(BR)GSS}$ / $V_{(BR)DSS}$* V Min | $V_{GS(off)}$ / $V_{GS(TH)}$* V Min/Max |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 140 | **Standard Family Limits** | | 25 to 100 | 0.25 to 1 | 3.5 to 8.0 | to -40 | -0.5/-10 |
| | | 2N5638 | Good Performance, low-cost. | 30 | 1.0 | 4.0 | -30 | – |
| | | 2N5639 | | 60 | 1.0 | 4.0 | -30 | – |
| | | 2N5640 | | 100 | 1.0 | 4.0 | -30 | – |
| TO-18 | | 2N4856 | Somewhat improved specifi | 25 | 0.25 | 8.0 | -40 | -4.0/-10 |
| | | 2N4857 | cations. Metal Package. | 40 | 0.25 | 8.0 | -40 | -2.0/-6.0 |
| | | 2N4858 | Higher cost. | 60 | 0.25 | 8.0 | -40 | -0.8/-4.0 |

**Other Family Members**

| | | |
|---|---|---|
| TO-92 | 140 | MPF4391,2,3 – Similar to 2N5638 Series, slightly higher cost. |
| TO-18 | | 2N4091, 2, 3 – Slower than 2N4856 Series, slightly lower cost. 2N4391, 2, 3 – Slightly improved performance, but higher cost. 2N4859, 60, 61 – Same as 2N4856, 57, 58 except for -30 V $V_{(BR)GSS}$ 2N4856A, 57A, 58A, 59A, 60A, 61A – Tighter $C_{rss}$ than non-A version. 2N3970, 71, 72 – MFE2004, 5, 6. |

**Other Family Members**

| | | |
|---|---|---|
| TO-72 | 136 | MFE2010, 11, 12 – Lower $r_{ds(on)}$, significantly higher cost. |

## JFETs – P-CHANNEL

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-92 | 128 | **Standard Family Limits** | | 100 to 250 | 10 | 5.0 | 30 | 1.0/12 |
| | | MPF970 | Good Performance, low cost. | 100 | 10 | 5.0 | 30 | 5.0/12 |
| | | MPF971 | | 250 | 10 | 5.0 | 30 | 1.0/7.0 |
| TO-72 | 129 | **Standard Family Limits** | | 150 to 300 | 1.2 | 3.5 to 5.0 | 25 | 1.0/9.5 |
| | | 2N3993 | Higher cost than above | 150 | 1.2 | 4.5 | 25 | 4.0/9.5 |
| | | 2N3994 | plastic series. | 300 | 1.2 | 5.0 | 25 | 1.0/5.5 |

## MOSFET – N-CHANNEL (Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-72 | 122 | **Standard Family Limits** | | 100 to 300 | 10* | 1.3 | 25* | 0.5/5.0* |
| | | 2N4351 | Relatively low cost. Complementary with 2N4352 P-Channel device. | 300 | 10* | 1.3 | 25* | 1.0/5.0* |

**Other Family Members**

| | | |
|---|---|---|
| TO-72 | 122 | 3N169, 170, 171 – Tighter $V_{GS(TH)}$, higher cost. |

## MOSFET – P-CHANNEL (Enhancement)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TO-72 | 123 | **Standard Family Limits** | | 200 to 600 | 0.25 to 10* | to 1.3 | to -50* | -1.0/-5.0* |
| | | 2N4352 | Relatively Low cost | 600 | -10* | 1.3 | 25* | -1.0/-5.0* |

**Other Family Members**

| | | |
|---|---|---|
| TO-72 | 123 | 3N155, 55A, 56, 56A, 57, 57A, 58, 58A – Tighter parameter limits, higher costs. |



World Radio History

# RF Amplifiers

Devices listed here are characterized for operation at frequencies as high as 500 MHz. Both amplifier and mixer devices are included. In general, amplifier transistors have a small-signal power gain ($G_{ps}$) specification and a noise figure (NF), while mixer devices are characterized by a conversion gain ($G_c$) specification and may or may not have an assigned noise figure.

## JFET – N-CHANNEL

| Package | Family | Preferred Types | Features | Test Frequency MHz | $G_{ps}$ $G_c$* dB Min/Max | $Y_{fs}$ mmhos Min/Max | $C_{rss}$ $C_{gd}$* pF Min/Max | NF dB Max | $V_{(BR)DSS}$ $V_{(BR)GSS}$* V Min |
|---|---|---|---|---|---|---|---|---|---|
| TO-92 | 130 | **Standard Family Limits** | | to 200 | 10/20 | 2.0/7.5 | -/3.0 | 4.0 | to 25 |
| | | MPF102 | Very low cost. Limited specifications | 100 | – | 2.0/7.5 | -/3.0 | – | 25* |
| | 146 | **Standard Family Limits** | | to 400 | 10/30 | 3.0/8.0 | 1.0/3.0 | – | to 30 |
| | | 2N5484 | Moderate cost. Low noise figure. | 100 | 16/25 | 3.0/6.0 | -/3.0 | 3.0 | 25* |
| | | MPF256 | Slightly higher cost. Improved performance. | 400 | 12/- | 6.0/- | 1.2 Typ | 4.0 | 25* |
| | | 2N5485 | Somewhat higher cost. | 400 | 10/20 | 3.5/7.0 | -/1.0 | 4.0 | 25* |
| | | 2N5486 | | 400 | 10/20 | 4.0/8.0 | -/1.0 | 4.0 | 25* |
| TO-72 | | 2N4416 | Best value in metal. | 400 | 10/- | 4.5/7.5 | -/0.8 | 4.0 | 30* |
| | | 2N4416A | As above, but higher breakdown voltage and tighter $V_{GS(off)}$ | | | | | | |
| | 145 | **Standard Family Limits** | | to 450 | 12 Typ | 8.0/20 | -/2.5* | 3.0 Typ | 25* |
| TO-52 | | U310 | | 450 | 11 Typ | 10/20 | -/2.5 | 3.0 Typ | 25* |
| TO-92 | | J310 | | 100 | 16 Typ | 13 Typ | -/2.5 | 1.5 Typ | 25* |

**Other Family Members**

| | | |
|---|---|---|
| | | (All comparisons are referenced to similarly packaged preferred device types in the table above.) |
| TO 92 | 130 | 2N5668, 69, 70 – Somewhat improved specifications. Higher cost.<br>MPF108, MPF112 – Lowest cost. Very limited specifications. |
| TO-72 | | 2N4223, 24; 2N3823 |
| | 146 | MFE2000, 1 |
| | 120 | 3N124, 25, 26 – This family is tetrode connected, and is tested at 100 MHz. Has higher breakdown voltage (50 V) and higher cost than other metal packaged devices. |

## MOSFET – N-CHANNEL

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **AMPLIFIERS** | | | | | | |
| TO-72 | 877 | **Standard Family Limits** | to 500 | 10/30 | 7.0/20 | -/0.05 | 6.0 | to 25 |
| | | 3N203 VHF amplifiers listed in | 45 | 20/30 | 7.0/15 | -/0.03 | 6.0 | 6.0 |
| | | MFE130 order of increasing test. | 105 | 17/- | 8.0/20 | -/0.05 | 5.0 | 25 |
| | | 3N201 frequency. Cost variations | 200 | 15/25 | 8.0/20 | -0.03 | 4.5 | 6.0 |
| | | MFE131 are relatively small. | 200 | 17/- | 8.0/20 | -/0.05 | 5.0 | 25 |
| | | 3N209 | 500 | 10/20 | 10/20 | -/0.05 | 6.0 | 25 |
| | 881 | **Standard Family Limits** | to 500 | 10/- | 8.0/40 | -/0.025 | 3.5 | 25 |
| | | 3N213 VHF/UHF amplifiers | 45 | 27/35 | 15/35 | -/0.025 | 4.0 | 6.0 |
| | | 3N211 characterized to 500 MHz. | 200 | 29/37 | 17/40 | -/0.05 | 3.5 | 6.0 |
| | 890 | MFE521 | 500 | 21/- | 10/20 | -/0.02 | 3.5 | 25 |
| | | **MIXERS** | | | | | | |
| TO-72 | | **Standard Family Limits** | to 200 | 10/28 | 8.0/40 | -/0.05 | – | to 6.0 |
| | 877 | 3N202 | 200 | 15/25* | 8.0/20 | -/0.03 | – | 6.0 |
| | 881 | 3N212 | 200 | 21/28* | 17/40 | -/0.05 | – | 6.0 |

**Other Family Members**

| | | |
|---|---|---|
| TO-72 | 112 | MFE3004, 5 – Amplifier |
| | | 3N128 – Amplifier |
| | 816 | 3N140 – Amplifier/Mixer |



World Radio History

World Radio History

MOTOROLA

# RF TRANSISTORS AND MODULES

**This selection guide contains the preferred registered and non-registered RF parts available. From more than 500 total individual available devices, Motorola has selected 19 transistor/module chains from 1.5 to 300 W (PEP) output. All devices are designed, tested and optimized for frequency ranges from 2.0 to 900 MHz. These devices are designed for your advanced RF engineering concepts.**

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World Radio History

# High Frequency, Low Voltage Amplifier Transistors/ Modules

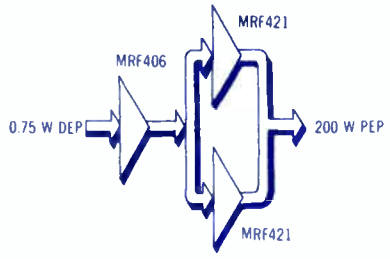
The transistors listed in this table are specified for operation in RF Power amplifiers and are listed by specific application at a given test frequency. Arrangement within each application group is in the order of increasing output power. Modulation type is given in each application heading.

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| **2-30 MHz, SSB TRANSISTORS** | | | | |
| 2N6367 | 9.0 PEP | 14 | 12.5 | 211-07 |
| MRF475 | 12 PEP | 10 | 13.6 | TO-220 |
| MRF432* | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF433* | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF406 | 20 PEP | 12 | 12.5 | 211-07 |
| MRF425 | 30 PEP | 12 | 12.5 | 145A-08 |
| MRF460 | 40 PEP | 12 | 12.5 | 211-10 |
| MRF454 | 80 PEP | 12 | 12.5 | 211-11 |
| MRF454A | 80 PEP | 12 | 12.5 | 145A-08 |
| MRF421 | 100 PEP | 10 | 12.5 | 211-04 |

*PNP/NPN Complements for Complementary Symmetry Driver, See EB-32.
For Matched Pairs Order MK433.

**Chain 1 — 12.5 V, 2-30 MHz**

Off-road vehicles/Oil tankers/Fishing fleets




| | | | | |
|---|---|---|---|---|
| **14-30 MHz, CB/AMATEUR TRANSISTORS** | | | | |
| MRF8003 | 0.5 | 13 | 12.5 | TO-39 |
| MRF8004 | 3.5 | 10 | 12.5 | TO-39 |
| MRF472 | 4.0 | 10 | 12.5 | 77-03 |
| MRF474 | 4.0 | 10 | 6.0 | 77-03 |
| MRF482 | 4.0 | 10 | 12.5 | 77-03 |
| MRF449 | 30 | 10 | 13.6 | 211-07 |
| MRF449A | 30 | 10 | 13.6 | 145A-07 |
| MRF450 | 50 | 11 | 13.6 | 211-07 |
| MRF450A | 50 | 11 | 13.6 | 145A-07 |
| MRF453 | 60 | 11 | 13.6 | 211-10 |
| MRF453A | 60 | 11 | 13.6 | 145A-04 |
| MRF455 | 60 | 11 | 13.6 | 211-07 |
| MRF455A | 60 | 11 | 13.6 | 145A-07 |
| **27-50 MHz, LOW-BAND FM TRANSISTORS** | | | | |
| MRF402 | 1.0 | 10 | 12.5 | TO-39 |
| 2N5847 | 8.0 | 10 | 12.5 | 145A-07 |
| 2N5848 | 20 | 8.0 | 12.5 | 145A-07 |
| 2N5849 | 40 | 7.5 | 12.5 | 145A-08 |


World Radio History

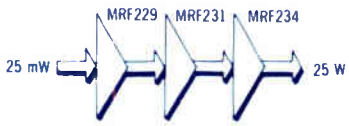
## HIGH FREQUENCY, LOW VOLTAGE AMPLIFIER TRANSISTORS/MODULES (Continued)

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| **40-100 MHz, MIDBAND FM TRANSISTORS** | | | | |
| MRF229** | 1.5 | 10 | 12.5 | TO-39 |
| MRF230 | 1.5 | 10 | 12.5 | TO-39 |
| MRF231 | 3.5 | 10 | 12.5 | 145A-07 |
| MRF232 | 7.5 | 9.0 | 12.5 | 145A-07 |
| MRF233 | 15 | 9.5 | 12.5 | 145A-07 |
| MRF234 | 25 | 10 | 12.5 | 145A-07 |

**Grounded emitter TO-39 package.

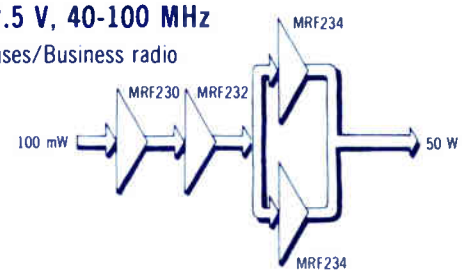
### Chain 2 — 12.5 V, 40-100 MHz

European taxis/Off-shore oil rigs




### Chain 3 — 12.5 V, 40-100 MHz

European buses/Business radio

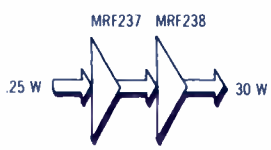



| | | | | |
|---|---|---|---|---|
| **156-162 MHz, VHF MARINE RADIO FM TRANSISTORS/MODULE** | | | | |
| MRF237** | 4.0 | 12 | 12.5 | TO-39 |
| MRF238 | 30 | 9.0 | 13.6 | 145A-07 |
| MHW603 | 30 | 21.7 | 13.6 | 297-02 |

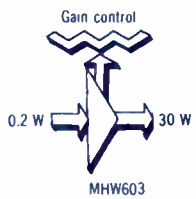
**Grounded emitter TO-39 package. See EB-29

### Chain 4 — 13.6 V, 160 MHz

Marine radio/Pleasure craft/Fishing boats/2 meter "ham band"




### Chain 5 — 13.6 V, 160 MHz






World Radio History

## HIGH FREQUENCY, LOW VOLTAGE AMPLIFIER TRANSISTORS/MODULES (Continued)

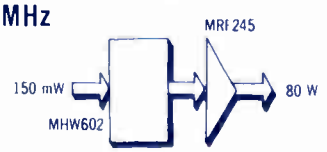
| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| **130-175 MHz, HIGH BAND/VHF FM TRANSISTORS** | | | | |
| MRF604 | 1.0 | 10 | 12.5 | TO-46 |
| 2N4427 | 1.0 | 10 | 12 | TO-39 |
| MRF607 | 1.75 | 12.5 | 12.5 | TO-39 |
| 2N6255 | 3.0 | 7.8 | 12.5 | TO-39 |
| 2N5589 | 3.0 | 8.2 | 13.6 | 144B-06 |
| MRF237** | 4.0 | 12 | 12.5 | TO-39 |
| 2N6080 | 4.0 | 12 | 12.5 | 145A-07 |
| 2N5590 | 10 | 5.2 | 13.6 | 145A-07 |
| MRF212 | 10 | 9.0 | 12.5 | 145A-07 |
| 2N6081 | 15 | 6.3 | 12.5 | 145A-07 |
| MRF221 | 15 | 6.3 | 12.5 | 211-07 |
| MRF215* | 20 | 8.2 | 12.5 | 278-06 |
| 2N5591 | 25 | 4.4 | 13.6 | 145A-07 |
| 2N6082 | 25 | 6.2 | 12.5 | 145A-07 |
| MRF222 | 25 | 6.2 | 12.5 | 211-07 |
| 2N6083 | 30 | 5.7 | 12.5 | 145A-07 |
| MRF223 | 30 | 5.7 | 12.5 | 211-07 |
| 2N6084 | 40 | 4.5 | 12.5 | 145A-07 |
| MRF224 | 40 | 4.5 | 12.5 | 211-07 |
| MRF216* | 40 | 6.7 | 12.5 | 278-06 |
| MRF243* | 60 | 7.0 | 12.5 | 278-06 |
| MRF245* | 80 | 6.4 | 12.5 | 278-06 |

*Controlled "Q" transistor. See EB-19. **Grounded emitter TO-39 package. See EB-29.

| | | | | |
|---|---|---|---|---|
| **146-175 MHz, HIGH BAND/VHF FM MODULES** | | | | |
| MHW601 | 13 | 21 | 12.5 | 297-02 |
| MHW602 | 20 | 21 | 12.5 | 297-02 |
| MHW603 | 30 | 21.7 | 13.6 | 297-02 |

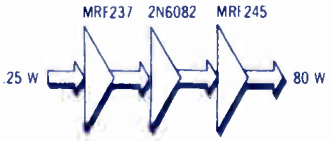
See EB-23 for applications information.

**Chain 6 — 12.5 V, 175 MHz**



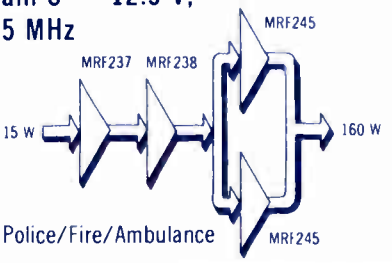

Construction vehicles/
Oil fields/
Business band

**Chain 7 — 12.5 V, 175 MHz**




Business band/Truck dispatch

**Chain 8 — 12.5 V, 175 MHz**



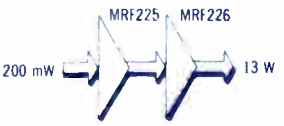

Police/Fire/Ambulance

| | | | | |
|---|---|---|---|---|
| **220 MHz, CITIZENS BAND FM TRANSISTORS** | | | | |
| MRF207 | 1.0 | 8.2 | 12.5 | TO-39 |
| MRF225 | 1.5 | 9.0 | 12.5 | TO-39 |
| MRF227* | 3.0 | 13.5 | 12.5 | TO-39 |
| MRF208 | 10 | 10 | 12.5 | 145A-07 |
| MRF226 | 13 | 9.0 | 12.5 | 145A-07 |
| MRF209 | 25 | 4.4 | 12.5 | 145A-07 |

*Grounded emitter TO-39 package. See EB-29.

**Chain 9 — 12.5 V, 225 MHz**

1¼ meter "ham band"/225 MHz






World Radio History

## HIGH FREQUENCY, LOW VOLTAGE AMPLIFIER TRANSISTORS/MODULES (Continued)

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage | Package |
|---|---|---|---|---|
| **407-512 MHz, UHF FM TRANSISTORS** | | | | |
| 2N6256 | 0.5 | 10 | 12.5 | 249.05 |
| MRF626 | 0.5 | 10 | 12.5 | 305-01 |
| MRF627 | 0.5 | 10 | 12.5 | 305A-01 |
| MRF628 | 0.5 | 10 | 12.5 | 249-05 |
| MRF515 | 0.75 | 8.0 | 12.5 | TO-39 |
| 2N3948 | 1.0 | 6.0 | 13.6 | TO-39 |
| 2N5644 | 1.0 | 7.0 | 12.5 | 145A-07 |
| MRF629** | 2.0 | 8.0 | 12.5 | TO-39 |
| 2N5944 | 2.0 | 9.0 | 12.5 | 244-04 |
| 2N5945 | 4.0 | 8.0 | 12.5 | 244-04 |
| 2N5946 | 10 | 6.0 | 12.5 | 244-04 |
| MRF641* | 15 | 6.0 | 12.5 | 278-06 |
| MRF644* | 25 | 6.2 | 12.5 | 278-06 |
| MRF646* | 40 | 4.8 | 12.5 | 278-06 |
| MRF648* | 60 | 4.8 | 12.5 | 278-06 |

*Controlled "Q" transistor. See EB-19.
**Grounded emitter TO-39 package.

| Device Type | $P_{out}$ Output Power Watts | f MHz | $G_{PE}$ Power Gain dB Min | $V_{DC}$ Supply Voltage | Package |
|---|---|---|---|---|---|
| **407-512 MHz, UHF FM MODULES** | | | | | |
| MHW401-1 | 1.5 | 400-440 | 15 | 7.5 | 301-01 |
| MHW401-2 | 1.5 | 440-470 | 15 | 7.5 | 301-01 |
| MHW401-3 | 1.5 | 470-512 | 15 | 7.5 | 301-01 |
| MHW709-1 | 7.5 | 400-440 | 18.8 | 12.5 | 700-01 |
| MHW709-2 | 7.5 | 440-470 | 18.8 | 12.5 | 700-01 |
| MHW709-3 | 7.5 | 470-512 | 18.8 | 12.5 | 700-01 |
| MHW710-1 | 13 | 400-440 | 19.4 | 12.5 | 700-01 |
| MHW710-2 | 13 | 440-470 | 19.4 | 12.5 | 700-01 |
| MHW710-3 | 13 | 470-512 | 19.4 | 12.5 | 700-01 |

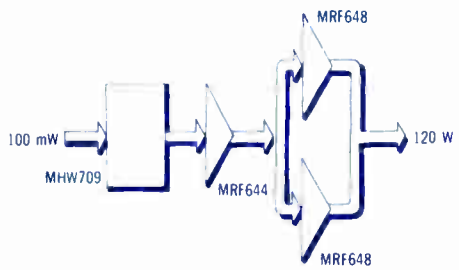
See EB-8 for applications information.

### Chain 10 — 12.5 V, 512 MHz

Agricultural communications/Base stations/Repeaters

### Chain 11 — 12.5 V, 470 MHz

Public safety/Industrial dispatch






World Radio History

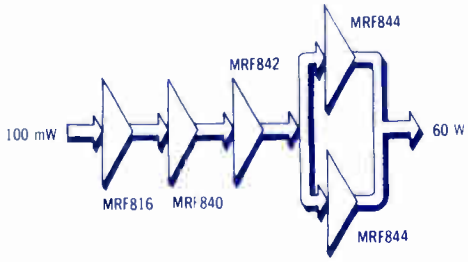
## HIGH FREQUENCY, LOW VOLTAGE AMPLIFIER TRANSISTORS/MODULES (Continued)

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| 806-947 MHz, UHF FM TRANSISTORS | | | | |
| MRF816 | 0.75 | 10 | 12.5 | 249-05 |
| MRF817 | 2.5 | 6.2 | 13.6 | 244-04 |
| MRF840* | 8.0 | 7.0 | 12.5 | 319-01 |
| MRF842* | 20 | 6.5 | 12.5 | 319-01 |
| MRF844* | 30 | 5.7 | 12.5 | 319-01 |
| MRF846* | 40 | 6.0 | 12.5 | 319-01 |

*To be introduced

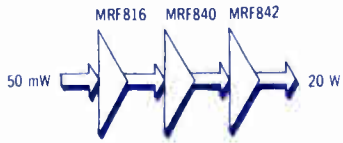
### Chain 12 — 12.5 V, 870 MHz

Base station/Industrial dispatch




### Chain 13 — 12.5 V, 850 MHz

Cellular radio telephone






World Radio History

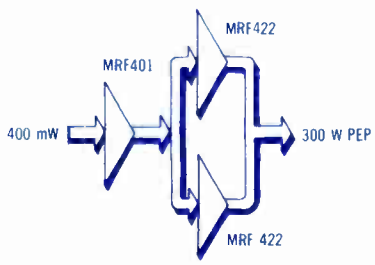
# High Frequency, High Voltage, Power Amplifier Transistors

The transistors listed in this table are specified for operation in RF Power amplifiers and are listed by specific application at a given test frequency. Arrangement within each application group is in the order of increasing output power. Modulation type is given in each application heading.

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| **2-30 MHz, SSB TRANSISTORS** | | | | |
| 2N6370 | 10 PEP | 12 | 28 | 211-07 |
| MRF432 | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF433 | 12.5 PEP | 20 | 12.5 | 211-07 |
| 2N5070 | 25 PEP | 13 | 28 | TO-60 |
| MRF401 | 25 PEP | 13 | 28 | 145A-07 |
| MRF427A | 25 PEP | 12 | 50 | 145A-08 |
| 2N5941 | 40 PEP | 13 | 28 | 211-07 |
| MRF463 | 80 PEP | 15 | 28 | 211-04 |
| MRF464 | 80 PEP | 15 | 28 | 211-11 |
| MRF464A | 80 PEP | 15 | 28 | 145A-08 |
| MRF422 | 150 PEP | 10 | 28 | 211-04 |
| MRF428A | 150 PEP | 13 | 50 | 307-01 |

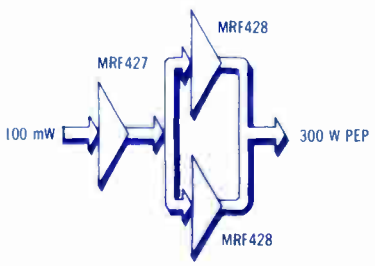
### Chain 14 — 28 V, 2-30 MHz

Merchant ships/Land-base stations/Government vehicles/ Marine base stations




### Chain 15 — 50 V, 2-30 MHz

Commercial ships/Military base stations






World Radio History

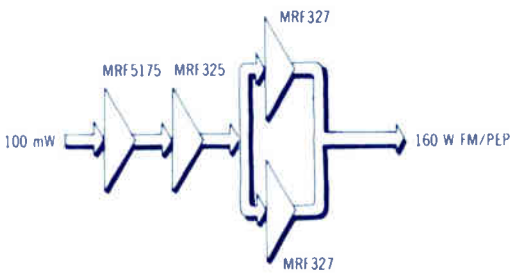
## HIGH FREQUENCY, HIGH VOLTAGE POWER AMPLIFIER TRANSISTORS (Continued)

| Device Type | $P_{out}$ Output Power Watts | $G_{PE}$ Power Gain dB Min | $V_{CC}$ Supply Voltage Volts | Package |
|---|---|---|---|---|
| **106-175 MHz, VHF AM TRANSISTORS** | | | | |
| 2N3866 | 1.0 | 10 | 28 | TO-39 |
| 2N3553 | 2.5 | 10 | 28 | TO-39 |
| 2N5641 | 7.0 | 8.4 | 28 | 144B-04 |
| 2N5642 | 20 | 8.2 | 28 | 145A-07 |
| 2N5643 | 40 | 7.6 | 28 | 145A-07 |
| MRF317 | 100 | 9.0 | 28 | 278-06 |
| **225-400 MHz, UHF AM TRANSISTORS** | | | | |
| 2N3866 | 1.0 | 10 | 28 | TO-39 |
| MRF313 | 1.0 | 16 (typ) | 28 | 305-01 |
| MRF313A | 1.0 | 16 (typ) | 28 | 305A-01 |
| MRF5174 | 2.0 | 12 | 28 | 244-04 |
| 2N5635 | 2.5 | 6.2 | 28 | 144B-04 |
| MRF5175 | 5.0 | 11 | 28 | 244-04 |
| 2N5636 | 7.5 | 5.7 | 28 | 144B-04 |
| MRF321** | 10 | 12 | 28 | 244-04 |
| MRF5176 | 15 | 10 | 28 | 244-04 |
| MRF323** | 20 | 10 | 28 | 244-04 |
| 2N5637 | 20 | 4.6 | 28 | 145A-07 |
| MRF5177 | 30 | 6.0 | 28 | 215-01 |
| MRF5177A | 30 | 6.0 | 28 | 145A-07 |
| MRF325* | 30 | 8.5 | 28 | 278-06 |
| 2N6439** | 60 | 8.0 | 28 | 278-06 |
| MRF327** | 80 | 7.3 | 28 | 278-06 |

*Controlled "Q" transistor. See EB-19 **Gold metallization, double matched controlled "Q" transistor. See EB-26, EB-19.

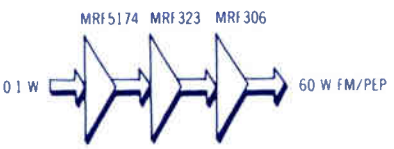
### Chain 16 — 28 V, 400 MHz

Fixed/Mobile/Aircraft radio




### Chain 17 — 28 V, 400 MHz

Aircraft radio






World Radio History

# UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing test frequency.

| Device Type | Test Conditions f MHz | Test Conditions $V_{CC}$ Volts | $P_{out}$ mW Typ* Min | $f_T$ MHz Typ* Min | Package |
|---|---|---|---|---|---|
| 2N3866 | 400 | 15 | 1000 | 500 | TO-39 |
| 2N5179 | 500 | 10 | 20 | 900 | TO-72 |
| 2N2857 | 500 | 10 | 30 | 1000 | TO-72 |
| 2N3839 | 500 | 6.0 | 30 | 1000 | TO-72 |
| MM8009 | 1680 | 20 | 200 | 1000 | TO-39 |
| 2N5108 | 1680 | 20 | 300 | 1200 | TO-39 |
| MRF905 | 1680 | 20 | 500* | 2200* | TO-46 |

# Low-Noise Transistors

The low-noise devices listed are produced with carefully controlled $r_b'$ and $f_T$ to optimize device noise performance. Devices listed in the matrix are classified according to noise figure performance versus frequency.

| NF dB | FREQUENCY MHz 60 | 100 | 200 | 450 | 1000 | 2000 | Polarity |
|---|---|---|---|---|---|---|---|
| 1.5 | 2N5829 | 2N5829 | | | | | PNP |
| | 2N5031 | 2N5031 | MRF904 | | | | NPN |
| 2.0 | 2N4957 | 2N4957 | 2N5829 | | | | PNP |
| | 2N5032 | 2N5032 | 2N5031 | MRF904 | MRF901 | | NPN |
| 2.5 | 2N4958 | 2N4958 | 2N4957 | 2N5829 | | | PNP |
| | 2N5032 | 2N5032 | 2N5032 | 2N5031 | MRF901 | | NPN |
| 3.0 | 2N4959 | 2N4959 | 2N4958 | 2N4957 | 2N5829 | | PNP |
| | 2N2857 | 2N2857 | 2N5032 | 2N5032 | MRF901 | MRF902 | NPN |
| 3.5 | 2N4959 | 2N4959 | 2N4959 | 2N4958 | 2N4957 | | PNP |
| | 2N5179 | 2N5179 | 2N2857 | 2N5032 | 2N5031 | MRF901 | NPN |
| 4.0 | 2N4959 | 2N4959 | 2N4959 | 2N4959 | 2N4958 | | PNP |
| | 2N5179 | 2N5179 | 2N5179 | 2N2857 | 2N5031 | | NPN |
| 4.5 | 2N4959 | 2N4959 | 2N4959 | 2N4959 | 2N4959 | | PNP |
| | 2N5179 | 2N5179 | 2N5179 | 2N2857 | 2N5032 | | NPN |



World Radio History

# General-Purpose Amplifier Transistors

The behavior of $f_T$ as a function of $I_C$ is critical in most Class A amplifier applications. The devices listed in the matrix form below are classified according to $F_T$ versus $I_C$.

| $f_T$ GHz Min | COLLECTOR CURRENT mA | | | | | | | Polarity |
|---|---|---|---|---|---|---|---|---|
| | 0.10 | 1.0 | 5.0 | 10 | 20 | 50 | 100 | |
| 6.0 | | | | BFR90 | BFR91 | | | NPN |
| 5.5 | | | | | BFR91 | BFR96 | | NPN |
| 5.0 | | | | | BFR91 | BFR96 | BFR96 | NPN |
| 4.5 | | | | | MM4049 | | | PNP |
| | | | BFR90 | MRF901 | MRF901 | BFR96 | BFR96 | NPN |
| 4.0 | | | | | MM4049 | | | PNP |
| | | MRF931 | MRF901 | | MRF901 | BFR96 | BFR96 | NPN |
| 3.5 | | | | MM4049 | MM4049 | | | PNP |
| | | MRF931 | MRF901 | MRF901 | MRF901 | BRF96 | BRF96 | NPN |
| 3.0 | | MRF931 | MRF901 | MRF904 | MRF904 | BRF96 | MRF515 | NPN |
| 2.5 | | MRF931 | MRF901 | 2N5835 | 2N5835 | 2N5836 | MRF515 | NPN |
| 2.0 | | | 2N4957 | 2N4957 | | | 2N5583 | PNP |
| | | MRF901 | 2N5031 | FMT1061 | FMT1061 | MRF515 | 2N5837 | NPN |
| 1.5 | | | | | 2N5583 | 2N5583 | 2N5583 | PNP |
| | | 2N5031 | 2N2857 | 2N6304 | 2N6304 | 2N5943 | 2N5109 | NPN |
| 1.0 | | 2N4957 | | | 2N5160 | 2N5160 | 2N5160 | PNP |
| | MRF931 | 2N5179 | 2N5179 | 2N2857 | 2N3866 | MM8001 | 2N5108 | NPN |
| | 2N4957 | | | | MRF532* | MRF532* | MM4019 | PNP |
| 0.5 | MRF931 | MRF501 | MRF501 | MRF501 | MRF531** | MRF531** | 2N3553 | NPN |

*BVceo = 80 Vdc **BVceo = 100 Vdc

# CATV, MATV, and Class A Linear Transistors

The devices listed below are excellent for Class A linear CATV/MATV applications. The new MRF511 is gaining wide industry acceptance. The devices are listed according to increasing Current-Gain ($f_T$). More information concerning the device for your specific linear design needs can be obtained through your local Motorola Sales Office or Motorola distributor.

| Device Type | Nominal Test Conditions $V_{CE}/I_C$ Volts/mA | $f_T$ MHz Min | Noise Figure | Distortion Specifications | | | | Package |
|---|---|---|---|---|---|---|---|---|
| | | Typ* | Max or Typ* / Freq. MHz | 2nd Order IMD | 3rd Order IMD | 12 ch. Cross-Mod. | Output Level dbMV | |
| MRF501 | 6/2-5 | 600 | 4.5*/200 | | | | | TO72 |
| MRF502 | 6/2-5 | 800 | 4.0*/200 | | | | | TO72 |
| 2N5179 | 6/1.5-2 | 900 | 4.5/200 | | | | | TO72 |
| BFY90 | 5/2 | 1000 | 5.0/500 | | | | | TO72 |
| 2N6305 | 5/2-10 | 1200 | 5.5/450 | | | | | TO72 |
| BFX89 | | 1200 | 6.5/500 | | | | | TO72 |
| 2N5109 | 15/10-50 | 1200 | 3.0*/200 | | | | | TO39 |
| 2N5943 | 15/30-50 | 1200 | 6.8*/200 | -50 | | -42 | +50 | TO39 |
| 2N6304 | 5/2-10 | 1400 | 4.5/450 | | | | | TO72 |
| MRF511 | 20/50-80 | 1500 | 7.3*/200 | -50 | -65 | -57 | +50 | 144D-04 |
| MRF517 | 15/25-60 | 2200 | 7.5/300 | -60 | -72 | -57 | +45 | TO39 |
| MRF525 | 20/50-80 | 2200 | 8.0/300 | -50 | -68 | -57 | +50 | TO39(1) |
| BFR90 | 10/14 | 5000* | 2.4*/500 | | | | | 302 |
| BFR91 | 5/35 | 5000* | 1.9*/500 | | | | | 302 |
| BFR96 | 10/50 | 5000* | 3.3*/500 | | | | | 302 |

(1) Grounded Emitter TO39 (Case 79-05)



World Radio History

# Hybrid Amplifier Modules

The Hybrid Modules listed are specified for amplifier applications in CATV distribution equipment but are applicable wherever broadband (HF/VHF) low distortion, low-noise amplification is required. These modules are also specified as wideband amplifiers for use in communications/instrumentation equipment operating in bands from 1 MHz to 400 MHz.

## CATV HYBRID MODULES

| Device Type | Gain 40-300 MHz dB Min/Typ | Maximum Distortion Specifications | | | | Noise Figure @ 300 MHz dB |
|---|---|---|---|---|---|---|
| | | Output Level dBmV | 2nd Order Test Note 1 dB | 35 Channel Triple Beat dB | 35 Channel Cross Modulation dB | |
| MHW1171 | 16.6/17 | +50 | -68 | -51 | -51 | 7.0 |
| MHW1172 | 16.6/17 | +50 | -70 | -56 | -56 | 8.0 |
| MHW1182* | 18.0/18.5 | +50 | -72 | -80# | -57## | 7.0 |
| MHW1221 | 21.4/22 | +50 | -64 | -51 | -51 | 6.0 |
| MHW1222 | 21.4/22 | +50 | -66 | -55 | -56 | 7.0 |
| MHW1341 | 33/34 | +48 | -68 | -55 | -55 | 7.0 |
| MHW1342 | 33/34 | +48 | -70 | -57 | -57 | 7.0 |
| MHW1391** | 38/39 | +48 | -68 | -55 | -55 | 7.0 |
| MHW1392** | 38/39 | +48 | -70 | -57 | -57 | 7.0 |

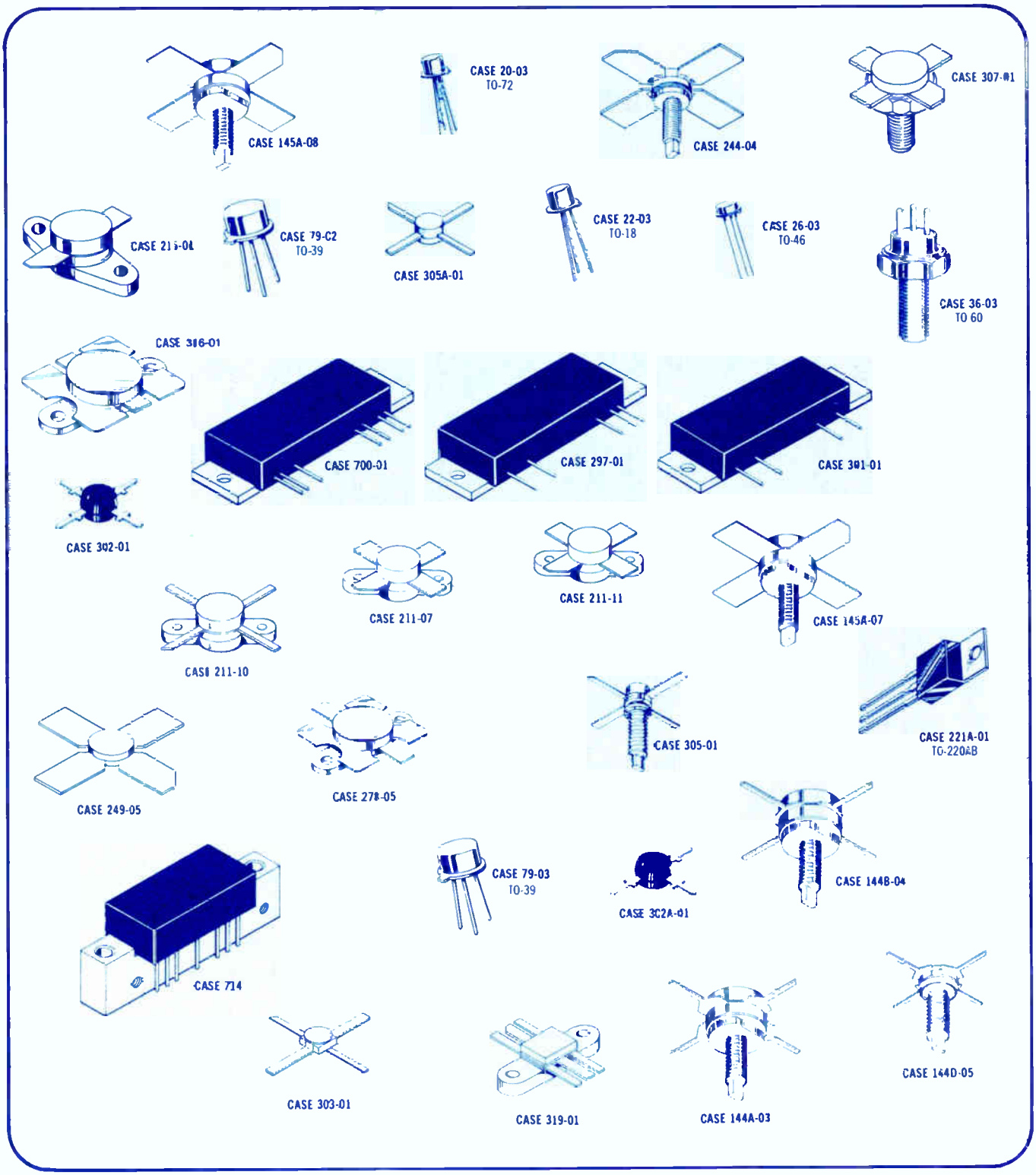
Note 1. Channels (2+13) @ R
* Operating frequency range = 5 to 120 MHz
** To be introduced
# 3 Channel triple beat
## 12 Channels @ $P_{out}$ = +54 dBmV

## GENERAL PURPOSE 50 Ω–100Ω WIDEBAND MODULES

| Device Type | Frequency Range MHz | Gain dB Min/Typ | Supply Voltage Vdc | Output Level 1 dB Compression mW/f (MHz) | Noise Figure @ 250 MHz dB |
|---|---|---|---|---|---|
| MHW590 | 10-400 | 32.5/34 | 24 | 800/200 | 5.0 |
| MHW591 | 1.0-250 | 35/36.5 | 13.6 | 700/100 | 5.0 |
| MHW592 | 1.0-250 | 34.5/36 | 24 | 900/100 | 5.0 |
| MHW593 | 10-400 | 34/35.5 | 13.6 | 600/200 | 4.5 |



World Radio History




## PACKAGE INFORMATION

Silicon High Frequency products are available in a variety of packages for many applications. Information on devices in non-standard packaging may be obtained through your local Motorola Sales Office or Motorola distributor.



World Radio History

MOTOROLA

# TUNING DIODES
# HOT-CARRIER DIODES
# PIN DIODES

The age of electronic tuning and frequency control is here! Mechanical tuning systems are being outdated by the following advantages of electronic tuning systems:

- Mechanical linkage and contacts are eliminated.
- Channel or station changes can easily be made by push button, continuous tuning, signal search or sweep methods.
- Faster response time.
- Remote tuning is simplified.
- Tuning components are much smaller than mechanical components.
- The designer is released from the mechanical and size restrictions dictated by mechanical tuning methods.

Three parameters are of prime consideration in choosing the proper tuning diode.

CT — Nominal capacitance — Measure of the capacitance at one specified voltage.

CR — Capacitance ratio — Ratio of the capacitance at two separate voltages usually at the operating ends of the CV curve. Measure of the magnitude of capacitance change as the reverse voltage is varied across the operating range.

Q — Figure of Merit — The same figure of merit that is widely used for capacitance and coils and is an indicator of how "good" a capacitor the tuning diode is.

These parameters are highlighted in the following selector guide and organized by package style to permit selection of the required specifications and package.

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AM Tuning Diodes . . . designed for electronic tuning of AM radios, receivers, and general AM frequency control . . . . . 179

Hot-Carrier Diodes . . . ideal for VHF and UHF mixer and detector applications as well as many higher microwave frequency applications . . . . . 180

PIN Switching Diodes . . . designed for VHF band switching and general-purpose switching . . . . . 180




World Radio History

# EPICAP TUNING DIODES

. . . designed for electronic tuning and control applications

## HERMETIC-PACKAGE DEVICES

**LINE HIGHLIGHTS**

| | | |
|---|---|---|
| • LOW CAPACITANCE<br>• MICROWAVE OPERATION<br>• MICROWAVE PACKAGE<br>• HIGH Q | • HIGH Q<br>• CAPACITANCE TOLERANCE 10% and 5.0% | • HIGH Q GUARANTEED @ 4.0 V<br>• CONTROLLED TR |

**MAXIMUM WORKING VOLTAGE 60 VOLTS**

Case 45

Case 51
DO 7

Case 51
DO 7

| $C_T$ NOMINAL CAPACITANCE pF ±10% @ $V_R$ = 4.0 V f = 1.0 MHz | Cap Ratio 4–60 V Min | Q @ 4.0 V 100 MHz Min | Device Type | Cap Ratio 4–60 V Min | Q @ 4.0 V 50 MHz Min | (1) Device Type | Cap Ratio 4–60 V Min | Q @ 4.0 V 50 MHz Min | Device Type |
|---|---|---|---|---|---|---|---|---|---|
| 1.0 | 2.1 | 350 | MV1858D | | | | | | |
| 2.2 | 2.5 | 350 | MV1860D | | | | | | |
| 3.3 | 2.6 | 300 | MV1862D | | | | | | |
| 4.7 | 2.6 | 300 | MV1863D | | | | | | |
| 6.8 | 2.7 | 300 | MV1864D | 2.7 | 350 | 1N5139,A (2) | | | |
| 8.2 | 2.7 | 300 | MV1865D | | | | | | |
| 10 | 2.8 | 250 | MV1866D | 2.8 | 300 | 1N5140,A | 3.0 | 500 | MV1866 |
| 12 | 2.8 | 200 | MV1868D | 2.8 | 300 | 1N5141,A | 3.0 | 500 | MV1868 |
| 15 | 2.8 | 200 | MV1870D | 2.8 | 250 | 1N5142,A | 3.0 | 400 | MV1870 |
| 18 | | | | 2.8 | 250 | 1N5143,A | 3.0 | 400 | MV1871 |
| 22 | | | | 3.2 | 200 | 1N5144,A | 3.2 | 400 | MV1872 |
| 27 | | | | 3.2 | 200 | 1N5145,A | 3.2 | 300 | MV1874 |
| 33 | | | | 3.2 | 200 | 1N5146,A | 3.2 | 300 | MV1876 |
| 39 | | | | 3.2 | 200 | 1N5147,A | 3.2 | 300 | MV1877 |
| 47 | | | | 3.2 | 200 | 1N5148,A | 3.2 | 300 | MV1878 |

(1) Add Suffix "A" for ±5.0% $C_T$ tolerance.
(2) "A" versions of 1N5139–1N5148 series have tighter capacitance min/max windows.



World Radio History

## HERMETIC-PACKAGE DEVICES (continued)

**LINE HIGHLIGHTS**

| • THE PREMIUM GLASS LINE<br>• VERY HIGH Q<br>• GUARANTEED HIGH TR<br>• CAPACITANCE TOLERANCE 10%, 5.0% and 2.0% | • HIGH Q<br>• CAPACITANCE TOLERANCE 10%, 5.0% and 2.0%<br>• CONTROLLED | • GENERAL PURPOSE |
|---|---|---|

**MAXIMUM WORKING VOLTAGE 30 VOLTS**

Case 51
DO-7

Case 51
DO-7

Case 51
DO-7

| $C_T$ NOMINAL CAPACITANCE pF ±10% @ $V_R$ = 4.0 V f = 1.0 MHz | Cap Ratio 2–30 V Min | Q @ 4.0 V 50 MHz Min | (3) Device Type | Cap Ratio 2–30 V Min | Q @ 4.0 V 50 MHz Min | Device Type | Cap Ratio 4–25 V Min | Q @ 4.0 V 50 MHz Min | Device Type |
|---|---|---|---|---|---|---|---|---|---|
| 6.8 | 2.7 | 600 | 1N5461A | 2.5 | 450 | 1N5441A | | | |
| 8.2 | 2.8 | 600 | 1N5462A | 2.5 | 450 | 1N5442A | | | |
| 10 | 2.8 | 550 | 1N5463A | 2.6 | 400 | 1N5443A | | | |
| 12 | 2.8 | 550 | 1N5464A | 2.6 | 400 | 1N5444A | | | |
| 15 | 2.8 | 550 | 1N5465A | 2.6 | 400 | 1N5445A | 1.8 | 30 | MV830 |
| 18 | 2.9 | 500 | 1N5466A | 2.6 | 350 | 1N5446A | 1.8 | 25 | MV831 |
| 20 | 2.9 | 500 | 1N5467A | 2.6 | 350 | 1N5447A | | | |
| 22 | 2.9 | 500 | 1N5468A | 2.6 | 350 | 1N5448A | 1.8 | 25 | MV832 |
| 27 | 2.9 | 500 | 1N5469A | 2.6 | 350 | 1N5449A | 1.8 | 25 | MV833 |
| 33 | 2.9 | 500 | 1N5470A | 2.6 | 350 | 1N5450A | 1.9 | 20 | MV834 |
| 39 | 2.9 | 450 | 1N5471A | 2.6 | 300 | 1N5451A | 1.9 | 20 | MV835 |
| 47 | 2.9 | 400 | 1N5472A | 2.6 | 250 | 1N5452A | 1.9 | 15 | MV836 |
| 56 | 2.9 | 300 | 1N5473A | 2.6 | 200 | 1N5453A | 1.9 | 15 | MV837 |
| 68 | 2.9 | 250 | 1N5474A | 2.7 | 175 | 1N5454A | 2.0 | 15 | MV838 |
| 82 | 2.9 | 225 | 1N5475A | 2.7 | 175 | 1N5455A | 2.0 | 10 | MV839 |
| 100 | 2.9 | 200 | 1N5476A | 2.7 | 175 | 1N5456A | 2.0 | 10 | MV840 |

(3) Substitute "B" Suffix for ±5.0% $C_T$, "C" Suffix for 2.0% $C_T$.



World Radio History

## HERMETIC-PACKAGE DEVICES (continued)

**LINE HIGHLIGHTS**

| | • GENERAL PURPOSE | • HIGH CAPACITANCE<br>• GENERAL PURPOSE | • HYPER-ABRUPT<br>• GLASS DIODES |
|---|---|---|---|
| | 20 VOLTS | | 12 VOLTS |
| | <br>Case 51<br>DO 7 | <br>Case 146<br>DO-14 | <br>Case 51<br>DO 7 |

| $C_T$ NOMINAL CAPACITANCE pF ± 10% @ $V_R$ = 4.0 V = 2.0 V‡ = 1.0 V• f = 1.0 MHz | Cap Ratio 2–20 V Min | Q @ 4.0 V 50 MHz Min | Device Type | Cap Ratio 2–20 V Min | Q @ 4.0 V 20 MHz Min | Device Type | Cap Ratio 2–10 V =1–10 V Min | Q @ 2.0 V 1.0 MHz Min | Device Type |
|---|---|---|---|---|---|---|---|---|---|
| 6.8 | 2.0 | 300 | MV1620 | | | | | | |
| 8.2 | 2.0 | 300 | MV1622 | | | | | | |
| 10 | 2.0 | 300 | MV1624 | | | | | | |
| 12 | 2.0 | 300 | MV1626 | | | | | | |
| 15 | 2.0 | 250 | MV1628 | | | | | | |
| 18 | 2.0 | 250 | MV1630 | | | | | | |
| 20 | 2.0 | 250 | MV1632 | | | | | | |
| 22 | 2.0 | 250 | MV1634 | | | | | | |
| 27 | 2.0 | 200 | MV1636 | | | | | | |
| 33 | 2.0 | 200 | MV1638 | | | | | | |
| 39 | 2.0 | 200 | MV1640 | | | | | | |
| 47 | 2.0 | 200 | MV1642 | | | | | | |
| 56 | 2.0 | 150 | MV1644 | | | | | | |
| 68 | 2.0 | 150 | MV1646 | | | | | | |
| 82 | 2.0 | 150 | MV1648 | | | | | | |
| 100 | 2.0 | 150 | MV1650 | | | | | | |
| 120 | | | | 2.6 | 250 | MV1652 | 10 | 200 | MV1404‡ |
| 150 | | | | 2.6 | 250 | MV1654 | 10 | 200 | MV1403‡ |
| 180 | | | | 2.6 | 200 | MV1656 | | | |
| 200 | | | | 2.6 | 200 | MV1658 | | | |
| 220 | | | | 2.6 | 150 | MV1660 | | | |
| 250 | | | | 2.3 | 150 | MV1662 | 10 | 200 | MV1405‡ |
| 270 | | | | 2.3 | 100 | MV1664 | | | |
| 330 | | | | 2.3 | 100 | MV1666 | | | |
| 550 | | | | | | | 14 ¤ | 200 | MV1401• |



World Radio History

## PLASTIC-PACKAGE DEVICES

| LINE HIGHLIGHTS | • LOW-COST, HIGH VOLUME | • CONTROLLED AND UNIFORM TUNING RATIO<br>CAPACITANCE TOLERANCE 10%<br>• MICRO-MINIATURE PACKAGE |
|---|---|---|
| MAXIMUM WORKING VOLTAGE | | 30 VOLTS |
| | <br>CASE 182 | <br>CASE 166-02 |

| $C_T$ NOMINAL CAPACITANCE pF ±10% @ $V_R$ = 4.0 V f = 1.0 MHz | Cap Ratio 2–30 V Min | Q @ 4.0 V 50 MHz Min | Device Type | Cap Ratio 2–30 V Min | Q @ 4.0 V 100 MHz Min | Device Type |
|---|---|---|---|---|---|---|
| 1.0 | | | | 2.0 | 325 | MVI-2097 |
| 2.2 | | | | 2.0 | 325 | MVI-2908 |
| 3.3 | | | | 2.2 | 300 | MVI-2909 |
| 4.7 | | | | 2.4 | 300 | MVI-2100 |
| 6.8 | 2.5 | 450 | MV2101 | 2.7 | 275 | MVI-2101 |
| 8.2 | 2.5 | 450 | MV2102 | 2.8 | 275 | MVI-2102 |
| 10 | 2.5 | 400 | MV2103 | 2.8 | 275 | MVI-2103 |
| 12 | 2.5 | 400 | MV2104 | 2.8 | 275 | MVI-2104 |
| 15 | 2.5 | 400 | MV2105 | 2.9 | 275 | MVI-2105 |
| 15 | 3.4 (1) | 100 (2) | MV210 | | | |
| 18 | 2.5 | 350 | MV2106 | 2.9 | 250 | MVI-2106 |
| 20 | | | | | | |
| 22 | 2.5 | 350 | MV2107 | 2.9 | 200 | MVI-2107 |
| 27 | 2.5 | 300 | MV2108 | 2.7 | 200 | MVI-2108 |
| 33 | 2.5 | 200 | MV2109 | 2.7 | 200 | MVI-2109 |
| 39 | 2.5 | 150 | MV2110 | | | |
| 47 | 2.5 | 150 | MV2111 | | | |
| 56 | 2.6 | 150 | MV2112 | | | |
| 68 | 2.6 | 150 | MV2113 | | | |
| 82 | 2.6 | 100 | MV2114 | | | |
| 100 | 2.6 | 100 | MV2115 | | | |

(1) Cap Ratio 1–25 V Min

(2) Q @ 4.0 V 100 MHz Min



World Radio History

# FM Radio and TV Hyper-Abrupt Tuning Diodes

. . . designed for use in VHF and UHF tuners and FM radio, providing solid-state reliability in replacement of mechanical tuning methods.

| LINE HIGHLIGHTS | | • HIGH Q<br>• GUARANTEED CAPACITANCE RANGE | | | • LOW INDUCTANCE<br>• MINI-L PACKAGE | | |
|---|---|---|---|---|---|---|---|
| | | MAXIMUM WORKING VOLTAGE 32 VOLTS | | | 30 VOLTS | | |
| | | <br>Case 29-02<br>TO-92 | | | <br>Case 226 | | |
| | | Cap Ratio 3-30 V Min | Q @ 3.0 V 100 MHz Min | Device Type | Cap Ratio 3-25 V Min | Q @ 3.0 V 100 MHz Min | Device Type |
| $C_T$ NOMINAL CAPACITANCE pF ±10% $V_R$ = 3.0 Vdc f = 1.0 MHz | 2.2* | | | | 4.5 | 225 | BB105B |
| | 2.3* | | | | 4.0 | 150 | BB105G |
| | 2.6* | | | | 4.0 | 225 | BB105A |
| | 29 | | | | 5.0 | 280† | MV109 |
| | 29 | | | | 5.0 | 200† | MV209 |
| | 36 | 2.5 | 100 | MV104G | | | |
| | 40 | 2.5 | 100 | MV104 | | | |

*$V_R$ = 25 V for $C_T$

†Q @ 3.0 V 50 MHz Min



World Radio History

# AM Tuning Diodes

. . . designed for electronic tuning of AM radios, receivers, and general AM frequency control.

**LINE HIGHLIGHTS**

| | | • HIGH CAPACITANCE RATIO<br>• GUARANTEED DIODE CAPACITANCE | | | • HIGH CAPACITANCE RATIO<br>• GUARANTEED DIODE CAPACITANCE | | | |
|---|---|---|---|---|---|---|---|---|
| | | MAXIMUM WORKING VOLTAGE | | | 28 VOLTS | | | |
| | | <br>CASE 29-02<br>TO-92 | | | <br>CASE 182-03 | | | |
| | | Cap Ratio 1–25 V Min | Q @ 1.0 V 1.0 MHz Min | Device Type | Cap Ratio 1–15 V Min | Cap Ratio 1–25 V Min | Q @ 1.0 V 1.0 MHz Min | Device Type |
| $C_T$ NOMINAL CAPACITANCE pF ± 10% $V_R$ = 1.0 V f = 1.0 MHz | 300 | 15 | 150 | MVAM-2 (Dual AM Diode) | | | | |
| | 500 | | | | | 15 | 150 | MVAM-125 (Single AM Diode) |
| | | | | | 15 | | 150 | MVAM-115 (Single AM Diode) |



World Radio History

# Hot-Carrier Diodes

Hot-Carrier diodes are ideal for VHF and UHF mixer and detector applications as well as many higher microwave frequency applications. They provide stable electrical characteristics by eliminating the point-contact diode presently used in many applications. Motorola has the capability of supplying these devices in a variety of packages.

| $V_{(BR)R}$ $I_R$ = 10 A Volts Min | $C_T$ $V_R$ = 0 V, f = 1.0 MHz (1) $V_R$ = 15 V, f = 1.0 MHz (2) $V_R$ = 20 V, f = 1.0 MHz (3) pF Max | $V_F$ $I_F$ = 10 mA Volts Max | $I_R$ $V_R$ = 3.0 V (4) $V_R$ = 15 V (5) $V_R$ = 25 V (6) $V_R$ = 35 V (7) μA Max | NF dB Max | Device Type | Case |
|---|---|---|---|---|---|---|
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD101 | 182-02 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD102 | 226 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD103 | 45-01 |
| 20 | 1.5 (2) | 0.6 | 200 (5) | | MBD201 | 182-03 |
| 30 | 1.5 (2) | 0.6 | 200 (6) | | MBD301 | 182-03 |
| 50 | 1.0 (3) | 1.2 | 200 (6) | | MBD501 | 182-02 |
| 50 | 1.0 (3) | 1.2 | 200 (6) | | MBD502 | 226 |
| 70 | 1.0 (3) | 1.2 | 200 (7) | | MBD701 | 182-02 |
| 70 | 1.0 (3) | 1.2 | 200 (7) | | MBD702 | 226 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBI-101 | 166-02 |

CASE 45

CASE 166-02

CASE 182

CASE 226

# PIN Switching Diodes

. . . designed for VHF band switching and general purpose switching.

CASE 166-02

CASE 226

| $V_{(BR)R}$ $I_R$ = 10 μAdc Volts Min | $R_S$ $I_F$ = 10 mAdc Ohms Min | $C_T$ $V_R$ = 20 V f = 1.0 MHz f = 100 MHz* pF Max | $L_S$ f = 250 MHz nH Typ | $C_C$ f = 1.0 MHz pF Typ | Device Type | Case |
|---|---|---|---|---|---|---|
| 35 | 0.7 | 1.0 | 3.0 | 0.15 | MPI-3401 | 166-02 |
| 35 | 0.7 | 1.0 | 3.0 | 0.1 | MPN3401 | 226 |
| 35 | 0.6 | 2.0 | 3.0 | 0.1 | MPN3402 | 226 |



World Radio History

MOTOROLA

# ZENER DIODES

**Voltage Regulator and Reference Devices**

**In every language under the sun, the name most commonly associated with solid-state regulator and reference devices is Motorola. A pioneer in Zener diode development, Motorola has consistently led the industry in parameter improvements, packaging proliferation and specifications innovation. Today, Motorola serves the industry with an incomparable line of zener and avalanche regulator diodes, temperature compensated reference devices, and a host of integrated circuits, designed to provide the exact degree of regulation required, at the point in the circuit or system where it can be used most conveniently at the lowest cost.**

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Zener and Avalanche Regulator Diodes

Silicon-oxide passivation to provide low leakage, sharp breakover "knee" and long-term stability . . . . . 182

Zener Reference Devices (Temperature Compensated)

Consist of forward-biased silicon diode junctions in series with zener-breakdown diode to provide precise degree of temperature compensation. Though not specified, voltage-time stability normally better than 100 parts per million change per 1000 hours of operation. . . . . 185

Special Devices

Precision Reference Diodes

Ultra precision voltage standards with certified voltage-time variations as low as 5 ppm per 1000 hours of operation. . . . . 187

Amplifying Regulator Diodes

Designed for use in regulated power supplies as a combination voltage reference element and error voltage amplifier, providing temperature compensation for excellent reference voltage stability. . . . . 187

Field-Effect Current Regulator Diodes

Provide constant-current output over wider range of terminal voltage. Used in instrumentation (ramp and stair-step generators), over-current protection and other applications requiring a constant current between 0.22 and 4 mA (nom). . . . . 187

Low Voltage Regulators

High-conductance silicon diodes designed as a stable forward reference source for biasing transistor amplifiers and similar applications. . . . . 188

Current Limited Reference Devices (Temperature Compensated)

Designed specifically for precision instrumentation applications, this series of devices offers a 6.40 volt (nominal) output over a wide range of input voltages and temperature. . . . . 188

Tuning Diode Regulator

For use in television and FM radios that use variable capacitance diode tuners. . . . . 188

Transient Suppressors

For applications requiring protection of voltage sensitive equipment against high-energy voltage pulses. . . . . 189




World Radio History

# ZENER and AVALANCHE REGULATOR DIODES

The devices depicted in the accompanying matrix represent a basic profile of the largest inventoried zener-diode line in the industry. Check the following features for application to your specific requirements.

- Wide selection of package materials and styles:
  - Plastic (surmetic), for lowest cost
  - Glass for highest reliability
  - Metal for highest power
  - Unencapsulated (chips), for hybrid circuit applications
- Power ratings from 0.25 to 50 Watts
- Breakover voltages from 1.8 to 200 V in approximately 10% steps
- Available tolerances from 20% (low cost) to as tight as 1% (critical applications) with off-the-shelf-delivery

| Nominal Zener Voltage | CHIPS (20 Mils Square) Cathode = Bottom Surface<br>A denotes $I_{ZT}$ in mA range<br>B denotes $I_{ZT}$ in 250 μA | | 250 MILLIWATT (400 mW Package) Cathode = Polarity Mark<br>Glass Case 51 (DO-7) | 400 MILLIWATT Cathode = Polarity Mark<br>Glass Case 299 DO-35 | <br>Glass Case 51 DO-7 | 500 MILLIWATT Cathode = Polarity Mark<br>Surmetic 20 Case 51 (DO-7) | <br>Glass Case 299-01 (DO-35) |
|---|---|---|---|---|---|---|---|
| 1.8 | | MZC1.8B10 | MZ4614 | | | | |
| 2.0 | | MCZ2.0B10 | MZ4615 | | | | |
| 2.2 | | MCZ2.2B10 | MZ4616 | | | | |
| 2.4 | MZC2.4A10 | MCZ2.4B10 | MZ4617 | 1N4370 | | 1N5221 | 1N59B5 |
| 2.7 | MZC2.7A10 | MCZ2.7B10 | MZ4618 | 1N4371 | | 1N5223 | 1N59B6 |
| 3.0 | MZC3.0A10 | MCZ3.0B10 | MZ4619 | 1N4372 | | 1N5225 | 1N59B7 |
| 3.3 | MZC3.3A10 | MZC3.3B10 | MZ4620 | 1N746 | 1N551B | 1N5226 | 1N59B8 |
| 3.6 | MZC3.6A10 | MZC3.6B10 | MZ4621 | 1N747 | 1N5519 | 1N5227 | 1N59B9 |
| 3.9 | MZC3.9A10 | MZC3.9B10 | MZ4622 | 1N748 | 1N5520 | 1N522B | 1N5990 |
| 4.3 | MZC4.3A10 | MZC4.3B10 | MZ4623 | 1N749 | 1N5521 | 1N5229 | 1N5991 |
| 4.7 | MZC4.7A10 | MZC4.7B10 | MZ4624 | 1N750 | 1N5522 | 1N5230 | 1N5992 |
| 5.1 | MZC5.1A10 | MZC5.1B10 | MZ4625 | 1N751 | 1N5523 | 1N5231 | 1N5993 |
| 5.6 | MZC5.6A10 | MZC5.6B10 | MZ4626 | 1N752 | 1N5524 | 1N5232 | 1N5994 |
| 6.2 | MZC6.2A10 | MZC6.2B10 | MZ4627 | 1N753 | 1N5525 | 1N5234 | 1N5995 |
| 6.8 | MZC6.8A10 | MZC6.8B10 | 1N4099 | 1N754<br>1N957 | 1N5526 | 1N5235 | 1N5996 |
| 7.5 | MZC7.5A10 | MZC7.5B10 | 1N4100 | 1N756<br>1N958 | 1N5527 | 1N5236 | 1N5997 |
| 8.2 | MZC8.2A10 | MZC8.2B10 | 1N4101 | 1N756<br>1N959 | 1N5528 | 1N5237 | 1N599B |
| 9.1 | MZC9.1A10 | MZC9.1B10 | 1N4103 | 1N757<br>1N960 | 1N5529 | 1N5239 | 1N5999 |
| 10 | MZC10A10 | MZC10B10 | 1N4104 | 1N758<br>1N961 | 1N5530 | 1N5240 | 1N6000 |
| 11 | MZC11A10 | MZC11B10 | 1N4105 | 1N962 | 1N5531 | 1N5241 | 1N6001 |
| 12 | MZC12A10 | MZC12B10 | 1N4106 | 1N759<br>1N963 | 1N5532 | 1N5242 | 1N6002 |
| 13 | MZC13A10 | MZC13B10 | 1N4107 | 1N964 | 1N5533 | 1N5243 | 1N6003 |
| 15 | MZC15A10 | MZC15B10 | 1N4109 | 1N965 | 1N5535 | 1N5245 | 1N6004 |
| 16 | MZC16A10 | MZC16B10 | 1N4110 | 1N966 | 1N5536 | 1N5246 | 1N6005 |
| 18 | MZC1BA10 | MZC1BB10 | 1N4112 | 1N967 | 1N5538 | 1N524B | 1N6006 |
| 20 | MZC20A10 | MZC20B10 | 1N4114 | 1N968 | 1N5540 | 1N5250 | 1N6007 |
| 22 | MZC22A10 | MZC22B10 | 1N4115 | 1N969 | 1N5541 | 1N5251 | 1N600B |
| 24 | MZC24A10 | MZC24B10 | 1N4116 | 1N970 | 1N5542 | 1N5252 | 1N6009 |
| 27 | MZC27A10 | MZC27B10 | 1N4118 | 1N971 | | 1N5254 | 1N6010 |
| 30 | MZC30A10 | MZC30B10 | 1N4120 | 1N972 | 1N5545 | 1N5256 | 1N6011 |
| 33 | MZC33A10 | MZC33B10 | 1N4121 | 1N973 | 1N5546 | 1N5257 | 1N6012 |
| 36 | MZC36A10 | MZC36B10 | 1N4122 | 1N974 | | 1N525B | 1N6013 |
| 39 | MZC39A10 | MZC39B10 | 1N4123 | 1N975 | | 1N5259 | 1N6014 |
| 43 | MZC43A10 | MZC43B10 | 1N4124 | 1N976 | | 1N5260 | 1N6015 |
| 47 | MZC47A10 | MZC47B10 | 1N4125 | 1N977 | | 1N5261 | 1N6016 |
| 51 | MZC51A10 | MZC51B10 | 1N4126 | 1N978 | | 1N5262 | 1N6017 |
| 56 | MZC56A10 | MZC56B10 | 1N4127 | 1N979 | | 1N5263 | 1N601B |
| 62 | MZC62A10 | MZC62B10 | 1N4129 | 1N980 | | 1N5265 | 1N6019 |
| 68 | MZC6BA10 | MZC6BB10 | 1N4130 | 1N981 | | 1N5266 | 1N6020 |
| 75 | MZC75A10 | MZC75B10 | 1N4131 | 1N982 | | 1N5267 | 1N6021 |
| 82 | MZC82A10 | MZC82B10 | 1N4132 | 1N983 | | 1N526B | 1N6022 |
| 91 | MZC91A10 | MZC91B10 | 1N4134 | 1N984 | | 1N5270 | 1N6023 |
| 100 | MZC100A10 | MZC100B10 | 1N4135 | 1N985 | | 1N5271 | 1N6024 |
| 110 | MZC110A10 | MZC110B10 | | 1N986 | | 1N5272 | 1N6025 |
| 120 | MZC120A10 | MZC120B10 | | 1N987 | | 1N5273 | 1N6026 |
| 130 | MZC130A10 | MZC130B10 | | 1N988 | | 1N5274 | 1N6027 |
| 140 | MZC140A10 | MZC140B10 | | 1N989 | | 1N5275 | |
| 150 | MZC150A10 | MZC150B10 | | 1N990 | | 1N5276 | 1N602B |
| 160 | MZC160A10 | MZC160B10 | | 1N991 | | 1N5277 | 1N6029 |
| 170 | MZC170A10 | MZC170B10 | | 1N992 | | 1N527B | |
| 180 | MZC1B0A10 | MZC1B0B10 | | | | 1N5279 | 1N6030 |
| 200 | MZC200A10 | MZC200B10 | | | | 1N5281 | 1N6031 |

JAN/JANTX available ±5% only



World Radio History

## ZENER AND AVALANCHE REGULATOR DIODES (continued)

- Special selection of electrical characteristics available at low cost due to high-volume lines (check your Motorola sales representative for special quotations)
- JAN/JANTX (V) availability

| Nominal Zener Voltage | 1 WATT Cathode Polarity Mark | 1 WATT Cathode to Case | 1 WATT Cathode Polarity Mark | 5 WATT Cathode Polarity Mark | 10 WATT Cathode to Case = 1N3993 Series Anode to Case = 1N2970 Series | 50 WATT Anode to Case | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | Surmetic 30 Case 59 (DO-41) | Metal Case 52 (DO-13) | Glass Case 59 (DO-41) | Surmetic 40 Case 17 | Metal Case 56 (DO-4) | Metal Case 54 (TO-3) | Metal Case 58 (DO-5) |
| 1.8 | | | | | | | |
| 2.0 | | | | | | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.7 | | | | | | | |
| 3.0 | | | | | | | |
| 3.3 | 1N4728 | 1N3821 | 1N5913 | 1N5333 | | | |
| 3.6 | 1N4729 | 1N3822 | 1N5914 | 1N5334 | | | |
| 3.9 | 1N4730 | 1N3823 | 1N5915 | 1N5335 | 1N3993&R | 1N4557&R | 1N4549&R |
| 4.3 | 1N4731 | 1N3824 | 1N5916 | 1N5336 | 1N3994&R | 1N4558&R | 1N4550&R |
| 4.7 | 1N4732 | 1N3825 | 1N5917 | 1N5337 | 1N3995&R | 1N4559&R | 1N4551&R |
| 5.1 | 1N4733 | 1N3826 | 1N5918 | 1N5338 | 1N3996&R | 1N4560&R | 1N4552&R |
| 5.6 | 1N4734 | 1N3827 | 1N5919 | 1N5339 | 1N3997&R | 1N4561&R | 1N4553&R |
| 6.2 | 1N4735 | 1N3828 | 1N5920 | 1N5341 | 1N3998&R | 1N4562&R | 1N4554&R |
| 6.8 | 1N4736 | 1N3829 | 1N5921 | 1N5342 | 1N3999&R | 1N4563&R | 1N4555&R |
| | | 1N3016 | | | 1N2970&R | 1N2804&R | 1N3305&R |
| 7.5 | 1N4737 | 1N3830 | 1N5922 | 1N5343 | 1N4000&R | 1N4564&R | 1N4556&R |
| | | 1N3017 | | | 1N2971&R | 1N2805&R | 1N3306&R |
| 8.2 | 1N4738 | 1N3018 | 1N5923 | 1N5344 | 1N2972&R | 1N2806&R | 1N3307&R |
| 9.1 | 1N4739 | 1N3019 | 1N5924 | 1N5346 | 1N2973&R | 1N2807&R | 1N3308&R |
| 10 | 1N4740 | 1N3020 | 1N5925 | 1N5347 | 1N2974&R | 1N2808&R | 1N3309&R |
| 11 | 1N4741 | 1N3021 | 1N5926 | 1N5348 | 1N2975&R | 1N2809&R | 1N3310&R |
| 12 | 1N4742 | 1N3022 | 1N5927 | 1N5349 | 1N2976&R | 1N2810&R | 1N3311&R |
| 13 | 1N4743 | 1N3023 | 1N5928 | 1N5350 | 1N2977&R | 1N2811&R | 1N3312&R |
| 15 | 1N4744 | 1N3024 | 1N5929 | 1N5352 | 1N2979&R | 1N2813&R | 1N3314&R |
| 16 | 1N4745 | 1N3025 | 1N5930 | 1N5353 | 1N2980&R | 1N2814&R | 1N3315&R |
| 18 | 1N4746 | 1N3026 | 1N5931 | 1N5355 | 1N2982&R | 1N2816&R | 1N3317&R |
| 20 | 1N4747 | 1N3027 | 1N5932 | 1N5357 | 1N2984&R | 1N2818&R | 1N3319&R |
| 22 | 1N4748 | 1N3028 | 1N5933 | 1N5358 | 1N2985&R | 1N2819&R | 1N3320&R |
| 24 | 1N4749 | 1N3029 | 1N5934 | 1N5359 | 1N2986&R | 1N2820&R | 1N3321&R |
| 27 | 1N4750 | 1N3030 | 1N5935 | 1N5361 | 1N2988&R | 1N2822&R | 1N3322&R |
| 30 | 1N4751 | 1N3031 | 1N5936 | 1N5363 | 1N2989&R | 1N2823&R | 1N3324&R |
| 33 | 1N4752 | 1N3032 | 1N5937 | 1N5364 | 1N2990&R | 1N2824&R | 1N3325&R |
| 36 | 1N4753 | 1N3033 | 1N5938 | 1N5365 | 1N2991&R | 1N2825&R | 1N3326&R |
| 39 | 1N4754 | 1N3034 | 1N5939 | 1N5366 | 1N2992&R | 1N2826&R | 1N3327&R |
| 43 | 1N4755 | 1N3035 | 1N5940 | 1N5367 | 1N2993&R | 1N2827&R | 1N3328&R |
| 47 | 1N4756 | 1N3036 | 1N5941 | 1N5368 | 1N2996&R | 1N2829&R | 1N3330&R |
| 51 | 1N4757 | 1N3037 | 1N5942 | 1N5369 | 1N2997&R | 1N2831&R | 1N3332&R |
| 56 | 1N4758 | 1N3038 | 1N5943 | 1N5370 | 1N2999&R | 1N2832&R | 1N3334&R |
| 62 | 1N4759 | 1N3039 | 1N5944 | 1N5372 | 1N3000&R | 1N2833&R | 1N3335&R |
| 68 | 1N4760 | 1N3040 | 1N5945 | 1N5373 | 1N3001&R | 1N2834&R | 1N3336&R |
| 75 | 1N4761 | 1N3041 | 1N5946 | 1N5374 | 1N3002&R | 1N2835&R | 1N3337&R |
| 82 | 1N4762 | 1N3042 | 1N5947 | 1N5375 | 1N3003&R | 1N2836&R | 1N3338&R |
| 91 | 1N4763 | 1N3043 | 1N5948 | 1N5377 | 1N3004&R | 1N2837&R | 1N3339&R |
| 100 | 1N4764 | 1N3044 | 1N5949 | 1N5378 | 1N3005&R | 1N2838&R | 1N3340&R |
| 110 | 1M110ZS10 | 1N3045 | 1N5950 | 1N5379 | 1N3007&R | 1N2840&R | 1N3342&R |
| 120 | 1M120ZS10 | 1N3046 | 1N5951 | 1N5380 | 1N3008&R | 1N2841&R | 1N3343&R |
| 130 | 1M130ZS10 | 1N3047 | 1N5952 | 1N5381 | 1N3009&R | 1N2842&R | 1N3344&R |
| 150 | 1M140ZS10 | 1N3048 | 1N5953 | 1N5383 | 1N3011&R | 1N2843&R | 1N3346&R |
| 160 | 1M160ZS10 | 1N3049 | 1N5954 | 1N5384 | 1N3012&R | 1N2844&R | 1N3347&R |
| 180 | 1M180ZS10 | 1N3050 | 1N5955 | 1N5386 | 1N3014&R | 1N2845&R | 1N3349&R |
| 200 | 1M200ZS10 | 1N3051 | 1N5956 | 1N5388 | 1N3015&R | 1N2846&R | 1N3350&R |

R, RA, & RB = Reverse Polarity Types Available



World Radio History

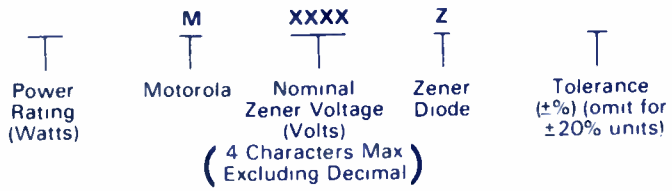
# Zener Diode Options

**In cases where standard specifications do not meet application requirements, an appropriate device can be selected and ordered from the following options.**

## NON-STANDARD ZENER DIODES SPECIAL VOLTAGE AND TOLERANCE RATINGS

JEDEC "1N" type numbers denote a specific Zener voltage, power rating, and tolerance. For example, JEDEC type 1N4728 is a standard 1 watt diode, rated at 3.3 volts ± 10%. A suffix "A" on this type number indicates a ± 5% voltage tolerance.

Special Motorola devices, with a choice of voltages and tolerances, are also available. The following diagram explains the Motorola coding system:




For example, the code for a special 10 watt Zener diode with a voltage of 41 volts and a tolerance of ± 1% would be 10M41Z1

Following is a list of other standard Motorola symbols for special Zener device orders (X's indicate nominal Zener voltage)

| BASIC MOTOROLA TYPE | DEVICE DESCRIPTION |
|---|---|
| ¼MXXXAZ5 | 250 mW Alloy Glass, ±5% |
| ¼MXXXZ5 | 250 mW Glass, ±5% |
| 4MXXXAZ5 | 400 mW Alloy Glass, ±5% |
| 4MXXXZ10 | 400 mW Glass, ±10% |
| 5MXXXZS10 | 500 mW Surmetic, ±10% |
| 1MXXXZ5 | 1 Watt Flangeless, ±5% |
| 1MXXXAZ10 | 1 Watt Alloy Flangless, ±10% |
| 1MXXXZ10 | 1 Watt Flangeless, ±10% |
| 1MXXXZS5 | 1 Watt Surmetic, ±5% |
| 1.5MXXXZ | 1.5 Watt, ±20% |
| 5MXXXZS5 | 5 Watt Surmetic, ±5% |
| 10MXXXAZ5 | 10 Watt Alloy Stud, ±5% |
| 10MXXXZ10 | 10 Watt Stud, ±10% |
| 50MXXXAZ10 | 50 Watt Alloy TO-3, ±10% |
| 50MXXXASZ5 | 50 Watt Alloy Stud, ±5% |
| 50MXXXZ | 50 Watt TO-3, ±20% |
| 50MXXXSZ5 | 50 Watt Stud, ±5% |

For reverse polarities (10 W and 50 W), insert "R" before tolerance, i.e., 50M110SZR5

1N5518 thru 1N5546 — This series may be ordered in ±2% and ±1% tolerance by adding the following suffix.

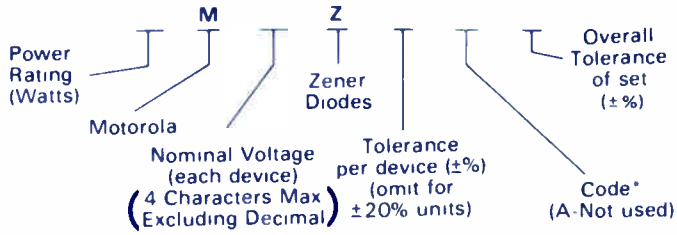
C = ±2% D = ±1%

For example the 1N5518D would be the same as the 1N5518B except $V_Z$ = 3.3 ±1%

## MATCHED SETS OF ZENER DIODES

Zener diodes can also be obtained in sets consisting of two or more matched devices. The method for specifying such matched sets is similar to the one described for specifying units with a special voltage and/or tolerance except that two extra suffixes are added to the code number described above.

These units are marked with code letters to identify the matched sets and in addition, each unit in a set is marked with the same serial number which is different for each set being ordered




*Code

B — Two devices in series
C — Three devices in series
D — Four devices in series
E — Five devices in series
F — Six devices in series
G — Seven devices in series
H — Eight devices in series
P — Two devices in parallel (not recommended)
X — Two devices, one standard polarity, the other reverse polarity (10 and 50 watts only)

i.e., 10M51Z5B1 is for two 10 watt zeners, each of 51 volts, ±5%, matched to a total voltage of 102 volts ±1%

## ZENER CHIPS (MZC)

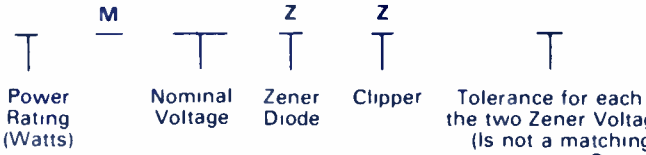
1. The nomenclature for Zener Chips is as follows:

| BASIC TYPE MOTOROLA NOMENCLATURE | DEVICE DESCRIPTION |
|---|---|
| MZCXXAX | Zener Chip—"A" Series, High Level |
| MZCXXBX | Zener Chip—"B" Series, Low Level |

2. Chips are sold in increments of ten (10) only.
3. The pricing formula for between nominal voltages and tight tolerance zeners shall apply.
4. Chips are **not** sold as matched sets or clippers.
5. A "-1" suffix will cause all chips ordered to be supplied in Deka-Pak.

## ZENER CLIPPERS

Special clipper diodes with opposing Zener junctions built into the device are available by using the following nomenclature:




i.e. 10M20ZZ10

This nomenclature is applicable to all packages and power ratings as restricted in the above paragraphs.

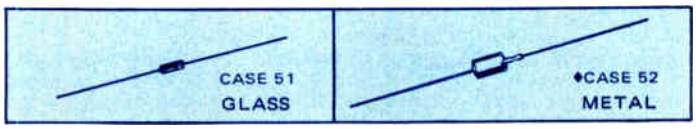


World Radio History

# ZENER REFERENCE DEVICES

For applications where output voltage must remain within narrow limits during changes in input voltage, load resistance and temperature. Motorola guarantees all Reference Devices to fall within the specified maximum voltage variations, $\Delta V_Z$, at the specifically indicated test temperatures and test current (JEDEC Standard #5). Temperature Coefficient is also specified but should be considered as a reference only — not a maximum rating.

Devices in this table are hermetically sealed structures. Includes JAN, JANTX and radiation hardened device types. These temperature compensated Zener Reference Diodes have low dynamic impedance and silicon-oxide-passivated junctions for long-term stability.




All devices Case 51 (DO-7) except as noted:♦

| $V_Z$ Volts | Test Current mAdc | Test Temp Points | AVERAGE TEMPERATURE COEFFICIENT OVER THE OPERATING RANGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0.01 %/°C | | 0.005 %/°C | | 0.002 %/°C | | 0.001 %/°C | | 0.0005 %/°C | |
| | | | Device Type | $\Delta V_Z$ Max Volts | Device Type | $\Delta V_Z$ Max Volts | Device Type | $\Delta V_Z$ Max Volts | Device Type | $\Delta V_Z$ Max Volts | Device Type | $\Delta V_Z$ Max Volts |
| 6.2⚠ | 7.5 | A | *1N821, J,TX | 0.096 | *1N823, J,TX | 0.048 | *1N825, J,TX | 0.019 | *1N827, J,TX | 0.009 | *1N829, J,TX | 0.005 |
| 6.2⚠ | 7.5 | A | *1N821A | 0.096 | *1N823A | 0.048 | *1N825A | 0.019 | *1N827A | 0.009 | *1N829A | 0.005 |
| 6.4 | 0.5 | B | 1N4565 | 0.018 | 1N4566 | 0.024 | 1N4567 | 0.010 | 1N4568 | 0.005 | 1N4569 | 0.002 |
| | 0.5 | A | 1N4565A | 0.099 | 1N4566A | 0.050 | 1N4567A | 0.020 | 1N4568A | 0.010 | 1N4569A | 0.005 |
| | 1.0 | B | 1N4570 | 0.048 | 1N4571 | 0.024 | 1N4572 | 0.010 | 1N4573 | 0.005 | 1N4574 | 0.002 |
| | 1.0 | A | 1N4570A | 0.099 | 1N4571A | 0.050 | 1N4572A | 0.020 | 1N4573A | 0.010 | 1N4574A | 0.005 |
| | 2.0 | B | 1N4575 | 0.048 | 1N4576 | 0.024 | 1N4577 | 0.010 | 1N4578 | 0.005 | 1N4579 | 0.002 |
| | 2.0 | A | 1N4575A | 0.099 | 1N4576A | 0.025 | 1N4577A | 0.020 | 1N4578A | 0.010 | 1N4579A | 0.005 |
| | 4.0 | B | 1N4580 | 0.048 | 1N4581 | 0.024 | 1N4582 | 0.010 | 1N4583 | 0.005 | 1N4584 | 0.002 |
| | 4.0 | A | 1N4580A | 0.099 | 1N4581A | 0.050 | 1N4582A | 0.020 | 1N4583A | 0.010 | 1N4584A | 0.005 |
| 8.4 | 10 | A | *1N3154, J,TX | 0.130 | *1N3155, J,TX | 0.065 | *1N3156, J,TX | 0.026 | *1N3157, J,TX | 0.013 | | |
| | 10 | C | *1N3154A | 0.072 | *1N3155A | 0.085 | *1N3156A | 0.034 | *1N3157A | 0.017 | | |
| 8.5 | 0.5 | B | 1N4775 | 0.064 | 1N4776 | 0.032 | 1N4777 | 0.013 | 1N4778 | 0.006 | 1N4779 | 0.003 |
| | 0.5 | A | 1N4775A | 0.132 | 1N4776A | 0.066 | 1N4777A | 0.026 | 1N4778A | 0.013 | 1N4779A | 0.007 |
| | 1.0 | B | 1N4780 | 0.064 | 1N4781 | 0.032 | 1N4782 | 0.013 | 1N4783 | 0.006 | 1N4784 | 0.003 |
| | 1.0 | A | 1N4780A | 0.132 | 1N4781A | 0.066 | 1N4782A | 0.026 | 1N4783A | 0.013 | 1N4784A | 0.007 |
| 9.0 | 7.5 | B | *1N935 | 0.067 | *1N936 | 0.033 | *1N937 | 0.013 | *1N938 | 0.006 | *1N939 | 0.003 |
| | 7.5 | A | *1N935A | 0.139 | *1N936A | 0.069 | *1N937A | 0.027 | *1N938A | 0.013 | *1N939A | 0.007 |
| | 7.5 | C | *1N935B, J,TX | 0.184 | *1N936B | 0.092 | *1N937B, J,TX | 0.037 | *1N938B, J,TX | 0.018 | *1N939B, J,TX | 0.009 |
| 9.4 ±0.4 (Suffix "A" ±0.2 V) | 10 | D | | | ♦1N2163,A | 0.033 | | | ♦1N2166,A | 0.007 | ♦1N2169,A | 0.004 |
| | | E | | | ♦1N2164,A | 0.086 | | | ♦1N2167,A | 0.017 | ♦1N2170,A | 0.009 |
| | | F | | | ♦1N2165,A | 0.110 | | | ♦1N2168,A | 0.023 | ♦1N2171,A | 0.012 |
| 11.7 | 7.5 | B | *1N941 | 0.088 | *1N942 | 0.044 | *1N943 | 0.018 | *1N944 | 0.009 | *1N945 | 0.004 |
| | 7.5 | A | *1N941A | 0.081 | *1N942A | 0.090 | *1N943A | 0.036 | *1N944A | 0.018 | *1N945A | 0.009 |
| | 7.5 | C | *1N941,B, J,TX | 0.239 | *1N942B | 0.120 | *1N943B, J,TX | 0.047 | *1N944B J,TX | 0.024 | *1N945B, J,TX | 0.012 |
| 12.8 | 0.5 | G | 1N4896 | 0.086 | 1N4897 | 0.048 | 1N4898 | 0.019 | 1N4899 | 0.010 | | |
| | 0.5 | A | 1N4896A | 0.198 | 1N4897A | 0.099 | 1N4898A | 0.040 | 1N4899A | 0.020 | | |
| | 1.0 | G | 1N4900 | 0.096 | 1N4901 | 0.048 | 1N4902 | 0.019 | 1N4903 | 0.010 | | |
| | 1.0 | A | 1N4900A | 0.198 | 1N4901A | 0.099 | 1N4902A | 0.040 | 1N4903A | 0.020 | | |
| | 2.0 | G | 1N4904 | 0.096 | 1N4905 | 0.048 | 1N4906 | 0.019 | 1N4907 | 0.010 | | |
| | 2.0 | A | 1N4904A | 0.198 | 1N4905A | 0.099 | 1N4906A | 0.040 | 1N4907A | 0.020 | | |
| | 4.0 | G | 1N4908 | 0.096 | 1N4909 | 0.048 | 1N4910 | 0.019 | 1N4911 | 0.010 | | |
| | 4.0 | A | 1N4908A | 0.198 | 1N4909A | 0.099 | 1N4910A | 0.040 | 1N4911A | 0.020 | | |
| | 7.5 | G | 1N4912 | 0.096 | 1N4913 | 0.048 | 1N4914 | 0.019 | 1N4915 | 0.010 | | |
| | 7.5 | A | 1N4912A | 0.198 | 1N4913A | 0.099 | 1N4914A | 0.040 | 1N4915A | 0.020 | | |
| 19.2 | 0.5 | G | 1N4916 | 0.144 | 1N4917 | 0.072 | 1N4918 | 0.029 | | | | |
| | 0.5 | A | 1N4916A | 0.298 | 1N4917A | 0.149 | 1N4918A | 0.060 | | | | |
| | 1.0 | G | 1N4919 | 0.144 | 1N4920 | 0.072 | 1N4921 | 0.029 | | | | |
| | 1.0 | A | 1N4919A | 0.298 | 1N4920A | 0.149 | 1N4921A | 0.060 | | | | |
| | 2.0 | G | 1N4922 | 0.144 | 1N4923 | 0.072 | 1N4924 | 0.029 | | | | |
| | 2.0 | A | 1N4922A | 0.298 | 1N4923A | 0.149 | 1N4924A | 0.060 | | | | |
| | 4.0 | G | 1N4925 | 0.144 | 1N4926 | 0.072 | 1N4927 | 0.029 | 1N4928 | 0.014 | | |
| | 4.0 | A | 1N4925A | 0.298 | 1N4926A | 0.149 | 1N4927A | 0.060 | 1N4928A | 0.030 | | |
| | 7.5 | G | 1N4929 | 0.144 | 1N4930 | 0.072 | 1N4931 | 0.029 | 1N4932 | 0.014 | | |
| | 7.5 | A | 1N4929A | 0.298 | 1N4930A | 0.149 | 1N4931A | 0.060 | 1N4932A | 0.030 | | |

| Test Temperature Points | |
|---|---|
| A | -55, 0, +25, +75, +100 |
| B | 0, +25, +75 |
| C | -55, 0, +25, +75, +100, +150 |
| D | 0, +25, +70 |
| E | -55, 0, +25, +75, +125 |
| F | -55, 0, +75, +125, +185 |
| G | +25, +75, +100 |

⚠ Non-suffix — $Z_{ZT}$ = 15, "A" Suffix — $Z_{ZT}$ = 10

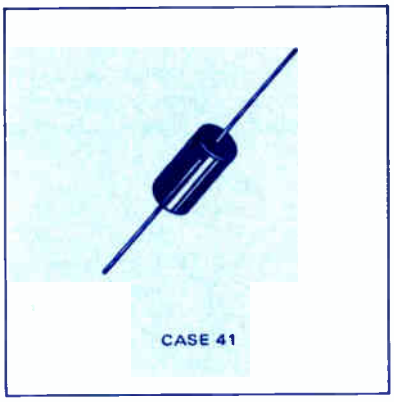
*Radiation Resistant Devices Available; to order, specify MZ821, A or B in lieu of "1N" prefix. Not applicable to J or TX devices.



World Radio History

## Molded Assemblies

Multiple-diode structures for higher voltages. Devices consist of hermetically sealed discrete glass-packaged devices, properly interconnected to yield higher voltages and encapsulated in a transfer-molded plastic package. All devices encapsulated in Case 41.




| Reference Voltage $V_Z$ Volts | Test Current $I_{ZT}$ mA | Max Voltage Change $\Delta V_Z$ (Volts) @ Test Temperatures (°C) -55 to 25 | Max Voltage Change $\Delta V_Z$ (Volts) @ Test Temperatures (°C) 25 to 100 | Average Temp. Coeff. %/°C | Device Type |
|---|---|---|---|---|---|
| 6.2 | 7.5 | 0.050 (1) | | 0.01 | 1N1735 |
| 12.4 | 7.5 | 0.100 (1) | 0.050 (1) | 0.01<br>0.005 | 1N1736<br>1N1736A |
| 12.4 | 10 | 0.050<br>0.020 | 0.047<br>0.010 | 0.005<br>0.002 | 1N4057<br>1N4057A |
| 14.6 | | 0.058<br>0.023 | 0.055<br>0.022 | 0.005<br>0.002 | 1N4058<br>1N4058A |
| 16.8 | | 0.067<br>0.027 | 0.063<br>0.025 | 0.005<br>0.002 | 1N4059<br>1N4059A |
| 18.5 | | 0.074<br>0.030 | 0.069<br>0.028 | 0.005<br>0.002 | 1N4060<br>1N4060A |
| 18.6 | 7.5 | 0.150 (1) | 0.075 (1) | 0.01<br>0.005 | 1N1737<br>1N1737A |
| 21 | 10 | 0.084<br>0.034 | 0.079<br>0.032 | 0.005<br>0.002 | 1N4061<br>1N4061A |
| 23 | 10 | 0.092<br>0.037 | 0.086<br>0.035 | 0.005<br>0.002 | 1N4062<br>1N4062A |
| 24.8 | 7.5 | 0.200 (1) | 0.100 (1) | 0.01<br>0.005 | 1N1738<br>1N1738A |
| 27 | 10 | 0.108<br>0.043 | 0.101<br>0.041 | 0.005<br>0.002 | 1N4063<br>1N4063A |
| 30 | 10 | 0.120<br>0.048 | 0.113<br>0.045 | 0.005<br>0.002 | 1N4064<br>1N4064A |
| 31.0 | 7.5 | 0.250 (1) | 0.125 (1) | 0.01<br>0.005 | 1N1739<br>1N1739A |
| 33 | 10 | 0.132<br>0.053 | 0.124<br>0.050 | 0.005<br>0.002 | 1N4065<br>1N4065A |
| 37 | 7.5 | 0.148<br>0.059 | 0.139<br>0.056 | 0.005<br>0.002 | 1N4066<br>1N4066A |
| 37.2 | | 0.300 (1) | 0.150 (1) | 0.01<br>0.005 | 1N1740<br>1N1740A |
| 43 | | 0.172<br>0.069 | 0.161<br>0.065 | 0.005<br>0.002 | 1N4067<br>1N4067A |
| 43.4 | | 0.350 (1) | 0.175 (1) | 0.01<br>0.005 | 1N1741<br>1N1741A |

| Reference Voltage $V_Z$ Volts | Test Current $I_{ZT}$ mA | Max Voltage Change $\Delta V_Z$ (Volts) @ Test Temperatures (°C) -55 to 25 | Max Voltage Change $\Delta V_Z$ (Volts) @ Test Temperatures (°C) 25 to 100 | Average Temp. Coeff. %/°C | Device Type |
|---|---|---|---|---|---|
| 47 | 7.5 | 0.188<br>0.075 | 0.176<br>0.071 | 0.005<br>0.002 | 1N4068<br>1N4068A |
| 51 | | 0.204<br>0.082 | 0.191<br>0.077 | 0.005<br>0.002 | 1N4069<br>1N4069A |
| 56 | | 0.224<br>0.090 | 0.210<br>0.084 | 0.005<br>0.002 | 1N4070<br>1N4070A |
| 62 | | 0.248<br>0.099 | 0.232<br>0.093 | 0.005<br>0.002 | 1N4071<br>1N4071A |
| 68 | 5.0 | 0.272<br>0.109 | 0.255<br>0.102 | 0.005<br>0.002 | 1N4072<br>1N4072A |
| 75 | | 0.300<br>0.120 | 0.281<br>0.113 | 0.005<br>0.002 | 1N4073<br>1N4073A |
| 82 | | 0.328<br>0.131 | 0.307<br>0.123 | 0.005<br>0.002 | 1N4074<br>1N4074A |
| 87 | | 0.348<br>0.139 | 0.326<br>0.131 | 0.005<br>0.002 | 1N4075<br>1N4075A |
| 91 | | 0.364<br>0.146 | 0.341<br>0.137 | 0.005<br>0.002 | 1N4076<br>1N4076A |
| 100 | | 0.400<br>0.160 | 0.375<br>0.150 | 0.005<br>0.002 | 1N4077<br>1N4077A |
| 105 | 2.5 | 0.420<br>0.168 | 0.394<br>0.158 | 0.005<br>0.002 | 1N4078<br>1N4078A |
| 110 | | 0.440<br>0.176 | 0.413<br>0.165 | 0.005<br>0.002 | 1N4079<br>1N4079A |
| 120 | | 0.480<br>0.192 | 0.450<br>0.180 | 0.005<br>0.002 | 1N4080<br>1N4080A |
| 130 | | 0.520<br>0.208 | 0.488<br>0.195 | 0.005<br>0.002 | 1N4081<br>1N4081A |
| 140 | | 0.560<br>0.224 | 0.525<br>0.210 | 0.005<br>0.002 | 1N4082<br>1N4082A |
| 150 | | 0.600<br>0.240 | 0.563<br>0.225 | 0.005<br>0.002 | 1N4083<br>1N4083A |
| 175 | | 0.700<br>0.280 | 0.656<br>0.263 | 0.005<br>0.002 | 1N4084<br>1N4084A |
| 200 | | 0.800<br>0.320 | 0.750<br>0.300 | 0.005<br>0.002 | 1N4085<br>1N4085A |

(1) These devices are tested at the following temperatures: -55°, +25°, and +100°C.



World Radio History

# SPECIAL DEVICES

## Precision Reference Diodes

Designed, manufactured and tested for ultra-high stability of voltage with time and temperature change. Use of special measurement equipment and voltage standards provide calibration directly traceable to the National Bureau of Standards.

CASE 51

| Reference Voltage Volts | Test Current mA | Temperature Stability $\Delta V_Z$ (mV) | Temperature Stability OP Temp Range °C | CERTIFIED VOLTAGE TIME STABILITY OVER 1000 HOURS OF OPERATION (Parts/Million Change) <5 PPM/1000 HR Device Type | <5 PPM/1000 HR Change µV Max | <10 PPM/1000 HR Device Type | <10 PPM/1000 HR Change µV Max | <20 PPM/1000 HR Device Type | <20 PPM/1000 HR Change µV Max | <40 PPM/1000 HR Device Type | <40 PPM/1000 HR Change µV Max | <100 PPM/1000 HR Device Type | <100 PPM/1000 HR Change µV Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.2 ± 5% | 7.5 | 2.5 | 25,75,100 | MZ605 | 30 | MZ610 | 60 | MZ620 | 120 | MZ640 | 240 | | |
| 8.4 ± 5% | 7.5 | 3.5 | 25,75,100 | MZ805 | 45 | MZ810 | 90 | MZ820 | 180 | MZ840 | 360 | | |
| 6.35 ± 5% | 7.5 | 2.5 | 25 to 100 | | | 1N4895 | 64 | 1N4893 | 127 | | | 1N4891* | 318 |
| 6.35 ± 5% | 7.5 | 5.0 | -65 to 100 | | | 1N4895A | 64 | 1N4893A | 127 | | | 1N4891A* | 318 |
| 6.35 ± 5% | 7.5 | 5.0 | 25 to 100 | | | 1N4894 | 64 | 1N4892 | 127 | | | 1N4890* | 318 |
| 6.35 ± 5% | 7.5 | 10 | -55 to 100 | | | 1N4894A | 64 | 1N4892A | 127 | | | 1N4890A* | 318 |
| 6.2 - 6.5 | 7.5 | 3.0 | 25 to 100 | | | | | | | | | 1N3502 | 636 |
| 6.2 - 6.5 | 7.5 | 6.0 | 25 to 100 | | | | | 1N3504 | 127 | 1N3503 | 318 | 1N3501 | 636 |

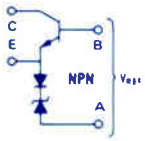
*< 50 PPM time stability on these devices.

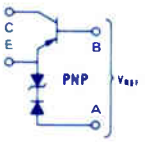
## Amplifying Regulator Diodes

Designed for use in regulated power supplies as a combination voltage reference element and error voltage amplifier, providing temperature compensation for excellent reference voltage stability. Available with either PNP or NPN transistors by adding either P or N suffix to part number.

ELECTRICAL CHARACTERISTICS ($I_{ZT}$ = 5.0 mA, $V_{CEO}$ = 30 V)

CASE 212-01




| $V_{REF}$ Volts | Tolerance ±% | Test Temperature °C | $V_{REF}$ Volts | Device Type |
|---|---|---|---|---|
| 6.8 | 10 | 0, +25, +75 | 0.05* | MCA1911 |
| | | | 0.025 | MCA1912 |
| | | | 0.010 | MCA1913 |
| | | | 0.005 | MCA1914 |
| 6.8 | 5.0 | -55, 0, +25, -55, +100 | 0.105 | MCA1921 |
| | | | 0.052 | MCA1922 |
| | | | 0.020 | MCA1923 |
| | | | 0.010 | MCA1924 |
| 6.8 | 5.0 | -55, 0, +25 +75,+100,+150 | 0.139 | MCA1931 |
| | | | 0.069 | MCA1932 |
| | | | 0.026 | MCA1933 |
| | | | 0.013 | MCA1934 |
| 8.6 | 10 | 0, +25, +75 | 0.060 | MCA2011 |
| | | | 0.030 | MCA2012 |
| | | | 0.012 | MCA2014 |
| | | | 0.006 | MCA2014 |
| 8.6 | 5.0 | -55, 0, +25 +75, +100 | 0.124 | MCA2021 |
| | | | 0.062 | MCA2022 |
| | | | 0.024 | MCA2023 |
| | | | 0.012 | MCA2024 |
| 8.6 | 5.0 | -55, 0, +25 +75,+100,+150 | 0.164 | MCA2031 |
| | | | 0.082 | MCA2032 |
| | | | 0.032 | MCA2033 |
| | | | 0.016 | MCA2034 |
| 9.5 | 10 | 0, +25, +75 | 0.071 | MCA2111 |
| | | | 0.035 | MCA2112 |
| | | | 0.014 | MCA2113 |
| | | | 0.007 | MCA2114 |
| 9.5 | 5.0 | -55, 0, +25 -75, +100 | 0.147 | MCA2121 |
| | | | 0.073 | MCA2122 |
| | | | 0.028 | MCA2123 |
| | | | 0.014 | MCA2124 |
| 9.5 | 5.0 | -55, 0, +25 +75,-100,+150 | 0.194 | MCA2131 |
| | | | 0.097 | MCA2132 |
| | | | 0.038 | MCA2133 |
| | | | 0.019 | MCA2134 |
| 11 | 10 | 0, +25, +75 | 0.082 | MCA2211 |
| | | | 0.04* | MCA2212 |
| | | | 0.016 | MCA2213 |
| | | | 0.008 | MCA2214 |
| 11 | 5.0 | -55, 0, +25 +75, +100 | 0.170 | MCA2221 |
| | | | 0.085 | MCA2222 |
| | | | 0.034 | MCA2223 |
| | | | 0.017 | MCA2224 |
| 11 | 5.0 | -55, 0, +25 +75,+100,+150 | 0.225 | MCA2231 |
| | | | 0.112 | MCA2232 |
| | | | 0.044 | MCA2233 |
| | | | 0.022 | MCA2234 |

## Field-Effect Current Regulator Diodes

High impedance diodes providing a constant current output over a wide range of applied voltages. For applications in instrumentation and protective circuitry.

Glass Case 51 DO-7

| Reg. Current Ip @$V_T$ = 25 V mA Nom | Device Type | Knee Imp $Z_K$ @$V_K$ = 6.0 V MΩ Max | Limiting Voltage @$I_L$ = 0.8 Ip Volts Max |
|---|---|---|---|
| 0.22 | 1N5283 | 2.75 | 1.00 |
| 0.24 | 1N5284 | 2.35 | 1.00 |
| 0.27 | 1N5285 | 1.95 | 1.00 |
| 0.30 | 1N5286 | 1.60 | 1.00 |
| 0.33 | 1N5287 | 1.35 | 1.00 |
| 0.39 | 1N5288 | 1.00 | 1.05 |
| 0.43 | 1N5289 | 0.870 | 1.05 |
| 0.47 | 1N5290 | 0.750 | 1.05 |
| 0.56 | 1N5291 | 0.560 | 1.10 |
| 0.62 | 1N5292 | 0.470 | 1.13 |
| 0.68 | 1N5293 | 0.400 | 1.15 |
| 0.75 | 1N5294 | 0.335 | 1.20 |
| 0.82 | 1N5295 | 0.290 | 1.25 |
| 0.91 | 1N5296 | 0.240 | 1.29 |
| 1.00 | 1N5297 | 0.205 | 1.35 |
| 1.10 | 1N5298 | 0.180 | 1.40 |
| 1.20 | 1N5299 | 0.155 | 1.45 |
| 1.30 | 1N5300 | 0.135 | 1.50 |
| 1.40 | 1N5301 | 0.115 | 1.55 |
| 1.50 | 1N5302 | 0.105 | 1.60 |
| 1.60 | 1N5303 | 0.092 | 1.65 |
| 1.80 | 1N5304 | 0.074 | 1.75 |
| 2.00 | 1N5305 | 0.061 | 1.85 |
| 2.20 | 1N5306 | 0.052 | 1.95 |
| 2.40 | 1N5307 | 0.044 | 2.00 |
| 2.70 | 1N5308 | 0.035 | 2.15 |
| 3.00 | 1N5309 | 0.029 | 2.25 |
| 3.30 | 1N5310 | 0.024 | 3.35 |
| 3.60 | 1N5311 | 0.020 | 2.50 |
| 3.90 | 1N5312 | 0.017 | 2.60 |
| 4.30 | 1N5313 | 0.014 | 2.75 |
| 4.70 | 1N5314 | 0.012 | 2.90 |
| 0.5±0.3 | MCL1300 | 0.500 | 1.00 |
| 1.0±0.6 | MCL1301 | 0.200 | 1.50 |
| 2.0±0.6 | MCL1302 | 0.100 | 2.00 |
| 3.0±0.6 | MCL1303 | 0.050 | 2.00 |
| 4.0±0.6 | MCL1304 | 0.025 | 2.50 |

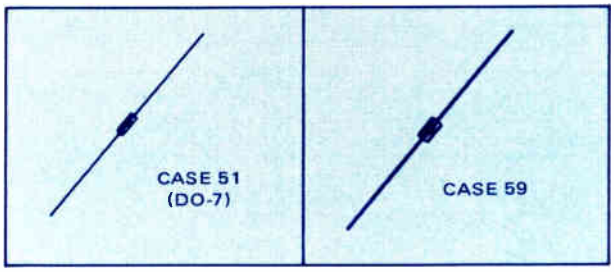
JAN/JANTX (V) availability



World Radio History

## Low Voltage Regulators

High-conductance silicon diodes designed as stable forward-reference sources for transistor amplifier biasing and similar applications. Available in high reliability glass construction or economic plastic packaging.




### ELECTRICAL CHARACTERISTICS

($T_A$ = 25°C unless otherwise noted).

| Forward Reference Voltage | | Test Current | Leakage Current $I_R$ @ $V_R$ | | Device Type | Case |
|---|---|---|---|---|---|---|
| Min | Max | $I_F$ mA | μA | Volts | | |
| 0.63 | 0.71 | 10 | 10 | 5.0 | MZ2360 | 59 Surmetic |
| 1.24 | 1.38 | 10 | 10 | 5.0 | MZ2361 | 51 Surmetic |
| 1.90 | 2.10 | 10 | 10 | 5.0 | MZ2362 | 51 |
| 0.58 | 0.70 | 1.0 | 0.1 | 4.0 | .4M.64FR10 | Glass |
| 1.29 | 1.43 | 10 | ↓ | ↓ | .4M1.36FR5 | ↓ |
| 1.33 | 1.39 | 10 | | | .4M1.36FR2 | |
| 1.94 | 2.14 | 10 | | | .4M2.04FR5 | |
| 2.00 | 2.08 | 10 | | | .4M2.04FR2 | |
| 0.58 | 0.70 | 1.0 | | | 1N816 | |

## Current Limited Temperature Compensated Voltage Reference Diodes

Voltage reference element with inherent temperature compensation and current regulation resulting in excellent reference stability over temperature excursions and wide variations of input voltage.

Specifications in the following table are given for an input of 31 volts. Devices differ specifically in temperature as shown in $\triangle V_{REF}$.

| $V_{REF}$ @ $V_{in}$ = 31 Volts | | $V_{in}$ Volts | | $I_{in}$ @ $V_{in}$ = 31 Volts | | Input Impedance MΩ | $Z_{REF}$ @ $I_{in}$ = 4.0 mA | $\triangle V_{REF}$ @$V_{in}$ = 31 Volts -55°C,+25°C,+100°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Min | Max | Min | Max | Min | Max | Min | Ohms Max | Volts Max | Device Type | |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.010 | MCLTC6010 | CASE 181-02 |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.025 | MCLTC6025 | |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.050 | MCLTC6050 | |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.100 | MCLTC6100 | |

## Tuning Diode Regulator

Highly reliable temperature compensated monolithic integrated circuit voltage stabilizer designed for use in television and FM radios that use variable capacitance diode tuners.

| $V_Z$ Volts Min/Max | $I_Z$ mA | $\frac{\triangle V_Z}{\triangle T}$ Mv/°C Min/Max | $Z_Z$ Ohms Max | $P_D$ mW | Device Type | |
|---|---|---|---|---|---|---|
| 31/35 | 18 | -31/+1.55 | 25 | 625 | MVS460 | CASE 182-01 |

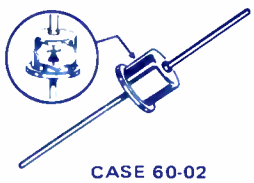


World Radio History

# TRANSIENT SUPPRESSORS

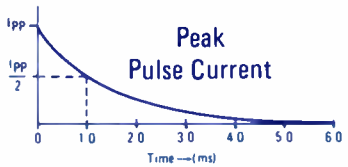
## Power Transient Suppressors

Transient suppressors designed for applications requiring protection of voltage sensitive electronic devices in danger of destruction by high energy voltage transients. Select from standard factory available types or design the suppressor to meet specific needs by paralleling cells. For specific options, i.e., non-standard voltages, higher power capacity, and package configurations, consult factory.



CASE 60-02

CASE 119




| $V_R$ Operating Voltage | | $I_R$ Reverse Current | $\Delta V_Z$ Breakdown Voltage | | $V_C$ Clamping Voltage | | $V_F$ Forward Voltage | | Device Type | Case |
|---|---|---|---|---|---|---|---|---|---|---|
| Nom Vdc | V(RMS) | μA | Min Volts @ | $I_{ZT}$ mA | Max Volts @ | $I_{pp}$ Amp | Volts @ | $I_F$ Amp | | |
| 14 | 10 | 50 | 16 | 0.4 | 1.25 | | 1.5 | 10 | MPZ5-16A | 119 |
| 14 | 10 | ↓ | 16 | 0.4 | 1.25 | | ↓ | ↓ | MPZ5-16B | ↓ |
| 28 | 20 | ↓ | 32 | 0.2 | 1.25 | | ↓ | ↓ | MPZ5-32A | ↓ |
| 28 | 20 | ↓ | 32 | 0.2 | 1.25 | | ↓ | ↓ | MPZ5-32B | ↓ |
| 28 | 20 | ↓ | 32 | 0.2 | 1.25 | | ↓ | ↓ | MPZ5-32C | ↓ |
| 165 | 117 | ↓ | 180 | 0.03 | 1.14 | | ↓ | ↓ | MPZ5-180A | ↓ |
| 165 | 117 | ↓ | 180 | 0.03 | 1.14 | | ↓ | ↓ | MPZ5-180B | ↓ |
| 165 | 117 | ↓ | 180 | 0.03 | 1.14 | | ↓ | ↓ | MPZ5-180C | ↓ |
| 30.5 | 21.5 | 5.0 | 33 | 1.0 | 47.5 | 32 | 2.0 | 100 | MZ5555 | 60-02 |
| 40.3 | 28.5 | ↓ | 43.7 | ↓ | 63.5 | 24 | 2.5 | ↓ | MZ5556 | ↓ |
| 49 | 34.5 | ↓ | 54 | ↓ | 78.5 | 19 | 2.8 | ↓ | MZ5557 | ↓ |
| 175 | 124 | ↓ | 191 | ↓ | 265 | 5.7 | 3.5 | ↓ | MZ5558 | ↓ |

## Power Rectifier/Power Surge Suppressor

. . . designed for applications requiring a low voltage rectifier with reverse avalanche characteristics or for use as a reverse power transient suppressor. Developed to suppress transients in the automotive system, this device operates in the forward mode as a standard rectifier or reverse mode as a power zener diode and will protect expensive mobile transceivers, radios and tape decks from over-voltage conditions.

CASE 296-03

| $B_V$ Breakdown Voltage @$I_R$ = 100 mA Volts | $I_R$ Reverse Current @$V_R$ = 20 V Max μA | $V_F$ Instantaneous Forward Voltage @$i_F$ = 79A Volts | $I_{(RMS)}$ Forward Current Max Amp | Device Type |
|---|---|---|---|---|
| 32 | 50 | 1.1 | 94 | MR2525,R |

Polarity: Standard polarity is cathode to case — MR2525
Reverse polarity is anode to case and is designated by an "R" suffix — MR2525R



World Radio History

World Radio History

MOTOROLA

# RECTIFIERS

**From tiny, lead-mounted, low-current rectifiers to powerful multi-cell units with near-thousand-amp capacity; from single-phase, half-wave devices to three-phase circuits; from conventional diode junctions to special-purpose units for specific applications, Motorola's extensive line of rectifiers satisfies every possible requirement for electronic equipment. Moreover, volume production unmatched in the industry offers low-cost selection potential.**

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**General Purpose Rectifiers**

Low and Medium Current 192

Single-cell rectifiers with forward current ranging from 1A to 50A and reverse voltage ratings up to 1000 volts.

High Current 194

Multi-cell devices with up to 700 A/600 V off-the-shelf ratings and even greater current and voltage capability on a custom basis.

**Rectifier Bridges and Circuits**

Low-to-Medium Current 195

A variety of packaging methods yields current ratings up to 35 A and reverse-voltage ratings to 1000 V.

High Current 196

Single-phase and three-phase bridges and circuits with current ratings up to 650 A.

**Special Purpose Rectifiers**

Fast Recovery Devices 197

For circuit applications requiring switching times from 200 to 1000 nanoseconds. Current rating up to 50 A.

Hot Carrier Devices 198

For high-frequency power supplies demanding switching times of less than 10 nanoseconds

High-Voltage Diodes and Stacks 199




World Radio History

# GENERAL PURPOSE RECTIFIERS

## Low and Medium Current

*Wide variety of low-cost devices to fit any mounting requirements. These lines are also available with anode-to-case connection by adding "R" suffix to the standard part number.*

| $I_O$ AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Case | 1.0 | 1.5 | 3.0 | | | 6.0 | 12 |
| | 59-04 Plastic | 59-04 (DO-15) Plastic | 60 Metal | 70 Metal | 267 Plastic | 194 Plastic | 245 (DO-4) Metal |
| | | | | | | | |
| $V_{RRM}$ Volts | | | | | | | |
| 50 | 1N4001‡ | 1N5391 | 1N4719 | 1N4997 | MR500 | MR750 | MR1120<br>1N1199,A |
| 100 | 1N4002‡ | 1N5392 | 1N4720 | 1N4998 | MR501 | MR751 | MR1121<br>1N1200,A |
| 200 | 1N4003‡ | 1N5393 | 1N4721 | 1N4999 | MR502 | MR752 | MR1122<br>1N1202,A |
| 400 | 1N4004‡ | 1N5395 | 1N4722 | 1N5000 | MR504 | MR754 | MR1124<br>1N1204,A |
| 600 | 1N4005‡ | 1N5397 | 1N4723 | 1N5001 | MR506 | MR756 | MR1126<br>1N1206A |
| 800 | 1N4006‡ | 1N5398 | 1N4724 | 1N5002 | MR508 | CF | MR1128<br>1N3988 |
| 1000 | 1N4007‡ | 1N5399 | 1N4725 | 1N5003 | MR510 | CF | MR1130<br>1N3990 |
| $I_{FSM}$ (Amps) | 30 | 50 | 300 | 300 | 100 | 400 | 300 |
| $T_A$ @ Rated $I_O$ (°C) | 75 | $T_L$ = 70 | 75 | 75 | 95 | 60 | |
| $T_C$ @ Rated $I_O$ (°C) | | | | | | | 150 |
| $T_J$ (Max) (°C) | 175 | 175 | 175 | 175 | 175 | 175 | 190 |

‡ Package Size 0.120" Max Diameter by 0.260" Max. Length

CF: Consult Factory



World Radio History

## GENERAL PURPOSE RECTIFIERS (continued)

### Low and Medium Current (continued)

| $I_O$ AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 20 | | 25 | | | 30 | 35 | 40 | 50 |
| 42A (DO-5) Metal | 42A (DO-5) Metal | 283-01 (DO-4) Low-Cost Plastic | 283-01 (DO-4) Low-Cost Plastic | 193-03 Low-Cost Plastic ▲ | 43 (DO-21) Metal | 43 (DO-21) Metal | 42A (DO-5) Metal | 42A (DO-5) Metal | 43-04 Metal |
| 1N3208 | 1N248B 1N1191 | MR2000S | MR2500S | MR2500 | 1N3491 | 1N3659 | 1N1183 | 1N1183A | MR5005 |
| 1N3209 | 1N249B 1N1192 | MR2001S | MR2501S | MR2501 | 1N3492 | 1N3660 | 1N1184 | 1N1184A | MR5010 |
| 1N3210 | 1N250B 1N1194 | MR2002S | MR2502S | MR2502 | 1N3493 | 1N3661 | 1N1186 | 1N1186A | MR5020 |
| 1N3212 | 1N1196 1N1196A | MR2004S | MR2504S | MR2504 | 1N3495 | 1N3663 | 1N1188 | 1N1188A | MR5040 |
| 1N3214 | 1N1198A 1N3214 | MR2006S | MR2506S | MR2506 | MR328 | CF | 1N1190 | 1N1190A | CF |
| CF | CF | MR2008S | MR2508S | MR2508 | MR330 | CF | 1N3766 | CF | CF |
| CF | CF | MR2010S | MR2510S | MR2510 | MR331 | CF | 1N3768 | CF | CF |
| 250 | 350 | 400 | 600 | 400 | 300 | 400 | 400 | 800 | 600 |
| | | | | | | | | | |
| 150 | 150 | 150 | 150 | 150 | 130 | 100 | 140 | 150 | 150 |
| 175 | | | | | 175 | 175 | 190 | 190 | 195 |

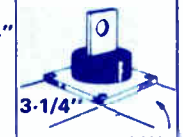
▲ Request Data Sheet for Mounting Information



World Radio History

# High-Current Multi-Cell Rectifier Diodes

*Multi-Cell construction, with matched cells, for excellent thermal management and highest reliability. Normally available with cathode connected to case. Add "R" suffix to type number for reverse polarity.*

| | $I_O$, AVERAGE RECTIFIED FORWARD CURRENT | | | | |
|---|---|---|---|---|---|
| | 50A | 100A | | 450A | 700A |
| $V_{RRM}$ (Volts) | Case 100 | 10-32 Stud 1-1/4" Hex Case 167 | 3/8" Stud 1-1/4" Hex Case 189 | Case 128 Case 135 |   Case 136 |
| 300 | MR1205FL | MR1215FL | MR1815SL | MR1245SL,FL | MR1265FL |
| 600 | MR1209FL | MR1219SL | MR1819SL | MR1249SL,FL | MR1269FL |
| $I_{FSM}$ (Amp) | 800 | 2000 | 2000 | 8000 | 12000 |
| $T_C$ @ Rated $I_O$ (°C) | 150 | 135 | 135 | 150 | 150 |
| $T_J$ (Max) (°C) | 190 | 190 | 190 | 190 | 190 |



World Radio History

# RECTIFIER BRIDGES and CIRCUITS

## Low-To-Medium Current

*Single-phase rectifier bridges with a wide variety of packaging options. Standard devices are made with general-purpose rectifiers, but similar configurations can be made with special rectifier-cells (i.e., fast recovery cells) on special order.*

| $I_O$, DC OUTPUT CURRENT (Amperes) | | | | | | |
|---|---|---|---|---|---|---|
| | 1.0 | 1.0 | 2.0 | 4.0/8.0* | 12 | 35 |
| Case / $V_{RRM}$ Volts | 109-03 | 312-02 | 312-02 | 117 | 309A-02 | 309A-02 |
| | | | | | | |
| 50 | MDA920A2 | 3N246<br>MDA100A | 3N253<br>MDA200 | MDA970-1 | MDA980-1 | MDA3500<br>BYW60 |
| 100 | MDA920A3 | 3N247<br>MDA101A | 3N254<br>MDA201 | MDA970-2 | MDA980-2 | MDA3501<br>BYW61 |
| 200 | MDA920A4 | 3N248<br>MDA102A | 3N255<br>MDA202 | MDA970-3 | MDA980-3 | MDA3502<br>BYW62 |
| 400 | MDA920A6 | 3N249<br>MDA104A | 3N256<br>MDA204 | MDA970-5 | MDA980-5 | MDA3504<br>BYW64 |
| 600 | MDA920A7 | 3N250<br>MDA106A | 3N257<br>MDA206 | CF | MDA980-6 | MDA3506<br>BYW66 |
| 800 | CF | 3N251<br>MDA108A | 3N258<br>MDA208 | | | MDA3508<br>BYW68 |
| 1000 | CF | 3N252<br>MDA110A | 3N259<br>MDA210 | | | MDA3510 |
| $I_{FSM}$ Amp | 32 | 45 | 60 | 100 | 300 | 400 |
| $T_A$ @ Rated $I_O$ (°C) | 75 | 75 | 55 | • | | |
| $T_C$ @ Rated $I_O$ (°C) | | | | • | 55 | 55 |
| $T_J$ (Max) (°C) | 175 | 150 | 175 | 150 | 175 | 175 |

CF: Consult Factory

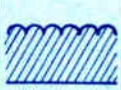
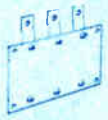
*4.0 A @ $T_A$ = 25°C
8.0 A @ $T_C$ = 55°C



World Radio History

# High-Current Multi-Cell Rectifier Circuits

*Multi-cell full-wave rectifier circuits and bridges with up to 650 A current carrying capacity.*

| | $I_O$, AVERAGE RECTIFIER FORWARD CURRENT (Forced Convection at 1500 LFM) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 300 A | | | | 600 A | | 650 A | |
| Circuit | Single-Phase Full-Wave Center Tap | Single-Phase Full-Wave Bridge | Three-Phase Full-Wave Center Tap | Three-Phase Full-Wave Bridge | Single-Phase Full-Wave Center Tap | Single-Phase Full-Wave Bridge | Three-Phase Full-Wave Center Tap | Three-Phase Full-Wave Bridge |
| Waveforms | | | |  | | | | |
| Case / $V_{RRM}$ (Volts) | 154A | 155A | 154 | 155 | 156A | 157A | 156 | 157 |
| | | |  | | | | | |
| 300 | MRA133 | MRA133B | MRA333 | MRA333B | MRA163 | MRA163B | MRA363 | MRA363B |
| $I_{FSM}$ (Amps) | 3000 | 3000 | 2000 | 2000 | 6000 | 6000 | 5000 | 5000 |
| $I_O$ Free Convection (Amps) | 75 | 75 | 75 | 75 | 125 | 125 | 150 | 150 |
| $T_A$ @ Rated $I_O$ (1500 FLM or Free Convection ($^oC$) | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 |
| $T_J$(Max) ($^oC$) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |



World Radio History

# Fast Recovery Rectifiers

*. . . available for designs requiring a power rectifier having maximum switching times ranging from 200 ns to 750 ns. These devices are offered in current ranges of 1.0 to 50 amperes and in voltages to 600 volts. Higher voltages are available upon request, but a necessary trade-off against switching speeds results. Reverse polarity (anode to case) obtained by adding an "R" suffix.*

| $I_O$, AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | | | 3.0 | | | 5.0 | 6.0 | 12 | 20 | 30 | 40 | 50 |
| Case | 59-04 Plastic | | 60 Metal | 70 Metal | 267-01 Plastic | | 194 Plastic | 56-02 (DO-4) Metal | | 257 (DO-5) Metal | | 42A (DO-5) Metal | |
| $V_{RRM}$ (Volts) | | | | | | | | | | | | | |
| 50 | 1N4933‡ | MR810 | MR830 | MR800 | MR850 | MR910 | MR820 | 1N3879 | 1N3889 | 1N3899 | 1N3909 | MR860 | MR870 |
| 100 | 1N4934‡ | MR811 | MR831 | MR801 | MR851 | MR911 | MR821 | 1N3880 | 1N3890 JAN,JTX | 1N3900 | 1N3910, JAN,JTX | MR861 | MR871 |
| 200 | 1N4935‡ | MR812 | MR832 | MR802 | MR852 | MR912 | MR822 | 1N3881 | 1N3891 JAN,JTX | 1N3901 | 1N3911, JAN,JTX | MR862 | MR872 |
| 400 | 1N4936‡ | MR814 | MR834 | MR804 | MR854 | MR914 | MR824 | 1N3883 | 1N3893, JAN,JTX | 1N3903 | 1N3913, JAN,JTX | MR864 | MR874 |
| 600 | 1N4937‡ | MR816 | MR836 | MR806 | MR856 | MR916 | MR826 | MR1366 | MR1376 | MR1386 | MR1396 | MR866 | MR876 |
| 800 | | MR817 | | | | MR917 | | | | | | | |
| 1000 | | MR818 | | | | MR918 | | | | | | | |
| $I_{FSM}$ (Amps) | 30 | 30 | 100 | 100 | 100 | 100 | 300 | 150 | 200 | 250 | 300 | 350 | 400 |
| $T_A$@Rated $I_O$ (°C) | 75 | 75 | | | 90* | 90* | 55* | | | | | | |
| $T_C$@Rated $I_O$ (°C) | | | 100 | 100 | | | | 100 | 100 | 100 | 100 | 100 | 100 |
| $T_J$(Max) (°C) | 150 | 150 | 150 | 150 | 175 | 175 | 175 | 150 | 150 | 150 | 150 | 160 | 160 |
| $t_{rr}$ (μs) | 0.2 | 0.75 | 0.2 | 0.2 | 0.2 | 0.75 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

*Must be derated for reverse power dissipation. See Data Sheet.
‡Package Size: 0.120" Max Diameter by 0.260" Max Length.



World Radio History

# Hot Carrier Rectifiers

*. . . Schottky barrier devices, ideal for use in low voltage, high frequency power supplies and as free-wheeling diodes. These units feature very low forward voltages and switching times estimated at less than 10 ns. They are offered in current ranges of 0.5 to 5.0 amperes and in voltages to 40. Reverse polarity (anode to case) is* **not** *available.*

| $I_O$, AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case / $V_{RRM}$ (Volts) | 0.5 | 1.0 | | 3.0 | | 3.0 | 5.0 | 15 | | 25 | | 40 | | |
| | 51-02 (DO-7) Glass | 59-04 Plastic | | 267 Plastic | | 60 Metal | | 245 (DO-4) Metal | | | | 257 (DO-5) Metal | | 430-2 (DO-21) Metal |
| 20 | MBR020 | 1N5817 | MBR120P | 1N5820 | MBR320P | MBR320M | 1N5823 | 1N5826 | MBR1520 | 1N5829 | MBR2520 | 1N5832 | MBR4020 | MBR4020PF |
| 30 | MBR030 | 1N5818 | MBR130P | 1N5821 | MBR330P | MBR330M | 1N5824 | 1N5827 | MBR1530 | 1N5830 | MBR2530 | 1N5833 | MBR4030 | MBR4030PF |
| 35 | | | MBR135P | | MBR335P | MBR335M | | | MBR1535 | | MBR2535 | | MBR4035 | MBR4035PF |
| 40 | | 1N5819 | MBR140P | 1N5822 | MBR340P | MBR340M | 1N5825 | 1N5828 | MBR1540 | 1N5831 | MBR2540 | 1N5834 | MBR4040 | |
| $I_{FSM}$ (Amps) | 5.0 | 100 | 50 | 250 | 200 | 500 | 500 | 500 | 500 | 800 | 800 | 800 | 800 | 800 |
| ‡$T_C$ @ Rated $I_O$ (°C) | | | | | | | | 85 | 80 | 85 | 80 | 75 | 70 | 50 |
| $T_A$ @ Rated $I_O$ PC Board Mount (°C) | 50 | | | | | | | | | | | | | |
| ‡$T_L$ @ Rated $I_O$ (°C) | | 90 | 80 | 95 | 85 | 90 | 80 | | | | | | | |
| $T_J$ Max (°C) | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 |
| Max $V_F$ @ $I_{FM} = I_O$ | 0.50 | *0.60 | 0.65 | *0.525 | 0.60 | 0.45 @ 5 A | *0.38 | *0.50 | 0.55 | *0.48 | 0.55 | *0.59 | 0.63 | 0.63 |

*Values are for the 40-Volt units. The lower voltage parts provide lower limits.

‡Must be derated for reverse power dissipation. See Data Sheet.



World Radio History

# High Voltage Diodes and Stacks

*. . . low-current, high-voltage diodes and stacks in current ranges of 250 mA to 1.0 ampere and in voltages from 1000 to 5000 volts.*

**250 mA High Voltage Diodes**

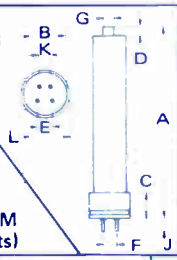
| Case / $V_{RRM}$ (Volts) | 169-02 Plastic |
|---|---|
| 1000 | MR250-1 |
| 2000 | MR250-2 |
| 3000 | MR250-3 |
| 4000 | MR250-4 |
| 5000 | MR250-5 |
| $I_{FSM}$ (Amps) | 15 |
| $T_A$ @ Rated $I_O$ (°C) | 75 |
| $T_J$ (Max) (°C) | 150 |

**1.0 Ampere Television Damper Diode**

| Case / $V_{RRM}$ (Volts) | 59-04 Plastic |
|---|---|
| 1000 | MR1-1000 |
| 1200 | MR1-1200 |
| 1400 | MR1-1400 |
| 1600 | MR1-1600 |
| $I_{FSM}$ (Amps) | 30 |
| $T_A$ @ Rated $I_O$ (°C) | 75* |
| $T_J$ (Max) (°C) | 175 |
| $t_{rr}$ (μs) | 25 |

*Must be derated for reverse power dissipation. See Data Sheet.

**Solid-State Mercury Vapor Tube Replacements**

Case 286-03 / $V_{RRM}$ (Volts) 


| DIM | INCHES MIN | MAX |
|---|---|---|
| A | 10.505 | 10.625 |
| B | 2.185 | 2.225 |
| C | 1.405 | 1.470 |
| D | 0.490 | 0.510 |
| E | 0.750 BSC | |
| F | 0.744 BSC | |
| G | 0.559 | 0.569 |
| J | 0.658 | 0.698 |
| K | 0.562 BSC | |
| L | 2.480 | 2.520 |

| | |
|---|---|
| 30,000 | MDA6693 |
| $I_O$ (Amps) | 5.0 |
| $I_{FSM}$ (Amps) | 400 |
| $T_A$ @ Rated $I_O$ (°C) | 75 |
| $T_J$ (Max) (°C) | 175 |
| $v_F$ @ $i_F$ = 20 A (Volts) (Pulse Width 10 ms, ≤ 1% Duty Cycle) | 38 |

MDA872A, MDA575A, Mercury Vapor Tube Replacements Available. Consult Factory.



World Radio History

World Radio History

MOTOROLA

# THYRISTORS and TRIGGERS

**Motorola's extensive line of thyristors consists of two generic component categories — SCRs and Triacs. Within each of these categories are two basic packaging divisions, plastic and metal — plastic for lowest cost and metal hermetically sealed packages for applications requiring highest reliability. Combined, these divisions include a large number of individual devices covering a forward-current range from 0.5 to 80 Amperes and a blocking voltage range from 15 to 800 Volts.**

**But the availability of devices for a wide range of current and voltage requirements doesn't begin to tell the whole story. For within the large selection of different series numbers are device families with characteristics designed for specifically designated applications. Here are some examples of preferred device families for the more high-volume applications, and for special unique purposes.**

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# THYRISTORS in PLASTIC PACKAGES

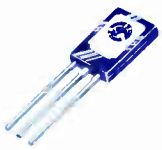
Excellent reliability and low cost make Motorola plastic-packaged thyristors the preferred devices for high-volume, low and medium current applications. Batch-processed, high-impact plastic provides outstanding mechanical ruggedness while oxide or glass surface passivation protects each die against impurity contamination and moisture penetration for long-term electrical stability.

## SCRs

| | | ON-STATE (RMS) CURRENT | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 AMP | 4.0 AMP | | 8.0 AMP | | 12 AMP | 16 AMP | 25 AMP |
| | | | | | | | | | |
| | | Case 29-02 TO-92 Style 10 | Case 77-03 TO-126 Style 2 | | Case 90-05 Style 1 | Case 221-02 TO-220AB Style 2 | Case 221-02 TO-220AB Style 1 | | |
| $V_{DRM}$ $V_{RRM}$ Blocking Voltage (DC or peak) Volts | 15 V | MCR101 | – | – | – | – | – | – | – |
| | 25 V | – | – | – | MCR3000-1 | – | – | – | – |
| | 30 V | MCR102 2N5060 | 2N6236 | MCR106-1 | – | – | – | – | – |
| | 50 V | – | 2N6237 | – | 2N4441 MCR3000-2 | C122F1 S2800F | 2N6394 | 2N6400 | 2N6504 |
| | 60 V | MCR103 2N5061 | – | MCR106-2 | – | – | – | – | – |
| | 100 V | MCR104 2N5062 | 2N6238 | MCR106-3 | MCR3000-3 | C122A1 S2800A | 2N6395 | 2N6401 | 2N6505 |
| | 150 V | MCR115 2N5063 | – | – | – | – | – | – | – |
| | 200 V | MCR120 2N5064 | 2N6239 | MCR106-4 | 2N4442 MCR3000-4 | C122B1 S2800B | 2N6396 | 2N6402 | 2N6505 |
| | 300 V | MCR100-5 | – | MCR106-5 | MCR3000-5 | C122C1 S2800C | MCR220-5 | MCR221-5 | – |
| | 400 V | MCR100-6 | 2N6240 | MCR106-6 | 2N4443 MCR3000-6 | C122D1 S2800D | 2N6397 | 2N6403 | 2N6507 |
| | 500 V | MCR100-7 | – | MCR106-7 | MCR3000-7 | C122E1 S2800E | MCR220-7 | MCR221-7 | – |
| | 600 V | MCR100-8 | 2N6241 | MCR106-8 | 2N4444 MCR3000-8 | C122M1 S2800M | 2N6398 | 2N6404 | 2N6508 |
| | 700 V | – | – | MCR106-9 | MCR3000-9 | C122S1 S2800S | MCR220-9 | MCR221-9 | – |
| | 800 V | – | – | MCR106-10 | MCR3000-10 | C122N1 S2800N | 2N6399 | 2N6405 | 2N6509 |
| ELECTRICAL CHARACTERISTICS | $I_{TSM}$ (Amp) | 6.0 | 25 | 25 | 80 | 90 | 100 | 160 | 300 |
| | $I_{GT}$ @ 25°C (mA) Max | 0.2 | 0.2 | 0.2 | 30 | 25 | 30 | 30 | 40 |
| | $V_{GT}$ @ 25°C (V) Max | 0.8 | 0.8 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | $I_H$ @ 25°C (mA) Max | 5.0 | 3.0 | 5.0 | 40 | 30 | 40 | 40 | 40 |


World Radio History

# triacs

| | | ON-STATE (RMS) CURRENT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.6 AMP | 4.0 AMP | | | 6.0 AMP | 8.0 AMP | 12 AMP | | 15 AMP | |
| | | |  | | | | | | | | |
| | | Case 29-02<br>TO-92<br>Style 12 | Case 77-03<br>Style 5 | | | Case 221-02<br>TO-220AB<br>Style 2 | | Case 221-02<br>TO-220AB<br>Style 2 | | | |
| $V_{DRM}$ Blocking Voltage (DC or Peak) Volts | 25 V | – | 2N6068 | 2N6068A | – | – | – | – | – | – | – |
| | 30 V | MAC92-1 | – | – | – | – | – | – | – | – | – |
| | 50 V | – | 2N6069 | 2N6069A | 2N6069B | – | MAC220-2<br>MAC221-2 | – | – | – | – |
| | 60 V | MAC92-2 | – | – | – | – | – | – | – | – | – |
| | 100 V | MAC92-3 | 2N6070 | 2N6070A | 2N6070B | SC141A<br>T2500A | MAC220-3<br>MAC221-3 | – | – | – | – |
| | 200 V | MAC92-4 | 2N6071 | 2N6071A | 2N6071B | SC141B<br>T2500B | 2N6342<br>2N6346 | 2N6342A | 2N6346A | MAC15-4 | MAC15A-4 |
| | 300 V | MAC92-5 | 2N6072 | 2N6072A | 2N6072B | SC141C<br>T2500C | MAC220-5<br>MAC221-5 | – | – | MAC15-5 | MAC15A-5 |
| | 400 V | MAC92-6 | 2N6073 | 2N6073A | 2N6073B | SC141D<br>T2500D | 2N6343<br>2N6347 | 2N6343A | 2N6347A | MAC15-6 | MAC15A-6 |
| | 500 V | MAC92-7 | 2N6074 | 2N6074A | 2N6074B | SC141E<br>T2500E | MAC220-7<br>MAC221-7 | – | – | MAC15-7 | MAC15A-7 |
| | 600 V | MAC92-8 | 2N6075 | 2N6075A | 2N6075B | SC141M<br>T2500M | 2N6344<br>2N6348 | 2N6344A | 2N6348A | MAC15-8 | MAC15A-8 |
| | 700 V | – | – | – | – | SC141S<br>T2500S | MAC220-9<br>MAC221-9 | – | – | MAC15-9 | MAC15A-9 |
| | 800 V | – | – | – | – | SC141N<br>T2500N | 2N6345<br>2N6349 | 2N6345A | 2N6349A | MAC15-10 | MAC15A-10 |
| ELECTRICAL CHARACTERISTICS | $I_{GT}$ @ 25°C (mA) | | | | | | | | | | |
| | MT2(+), G(+) (Maximum) | 5.0 | 30 | 5.0 | 3.0 | 50 | 50 | 50 | 50 | 50 | 50 |
| | MT2(+), G(–) (Maximum) | – | – | 5.0 | 3.0 | 50 | 75# | – | 75 | – | 75 |
| | MT2(–), G(–) (Maximum) | 5.0 | 30 | 5.0 | 3.0 | 50 | 50 | 50 | 50 | 50 | 50 |
| | MT2(–), G(+) (Maximum) | – | – | 10 | 5.0 | 50 | 75# | – | 75 | – | 75 |
| | $V_{GT}$ @ 25°C (V) | | @-40°C | @-40°C | @ -40°C | | | | | | |
| | MT2(+), G(+) (Maximum) | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | MT2(+), G(–) (Maximum) | – | – | 2.5 | 2.5 | 2.5 | 2.5# | – | 2.5 | – | 2.5 |
| | MT2(–), G(–) (Maximum) | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 | 2.0 |
| | MT2(–), G(+) (Maximum) | – | – | 2.5 | 2.5 | 2.5 | 2.5# | – | 2.5 | – | 2.5 |
| | $I_{TSM}$ (Amp) | 6.0 | 30 | 30 | 30 | 60/80 | 100 | 120 | 120 | 150 | 150 |

#Denotes 2N6346 thru 2N6349 and MAC221 Series only.



World Radio History

# SCRs in METAL PACKAGES

For current handling requirements up to 35 Amperes, with up to 800-Volt blocking potential, Motorola metal packaged SCRs combine highest reliability with the design flexibility offered by a wide variety of package options. Pulse modulator SCRs provide pulse current capacity to 1000 Amperes for radar and similar applications.

| | | ON-STATE (RMS) CURRENT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.5 AMP | 1.6 AMP | | | | 8.0 AMP | | 12.5 AMP | 16 AMP |
| | | | | | | | | | | Note 1 |
| | | Case 22-03 TO-18 Style 6 | Case 79-02 TO-39 Style 3 | | | | Case 86 Style 1 | Case 87L Style 1 | Case 54 Style 2 | Case 263-03 Style 1 |
| $V_{DRM}$ $V_{RRM}$ Blocking Voltage (DC or Peak) Volts | 15 V | MCR201 | – | – | – | – | – | – | – | – |
| | 25 V | – | – | 2N2322 | 2N4212 | MCR1906-1 | 2N4167 | 2N4183 | – | 2N1842 2N1842A |
| | 30 V | MCR202 | – | – | – | – | – | – | – | – |
| | 50 V | – | 2N1595 | 2N2323 | 2N4213 | MCR1906-2 | 2N4168 | 2N4184 | – | 2N1843 2N1843A |
| | 60 V | MCR203 | – | – | – | – | – | – | – | – |
| | 100 V | MCR204 | 2N1596 | 2N2324 | 2N4214 | MCR1906-3 | 2N4169 | 2N4185 | 2N3668 | 2N1844 2N1844A |
| | 150 V | MCR205 | – | 2N2325 | 2N4215 | – | – | – | – | 2N1845 2N1845A |
| | 200 V | MCR206 | 2N1597 | 2N2326 | 2N4216 | MCR1906-4 | 2N4170 | 2N4186 | 2N3669 | 2N1846 2N1846A |
| | 250 V | – | – | 2N2327 | 2N4217 | – | – | – | – | 2N1847 2N1847A |
| | 300 V | – | 2N1598 | 2N2328 | 2N4218 | MCR1906-5 | 2N4171 | 2N4187 | – | 2N1848 2N1848A |
| | 400 V | – | 2N1599 | 2N2329 | 2N4219 | MCR1906-6 | 2N4172 | 2N4188 | 2N3670 | 2N1849 2N1849A |
| | 500 V | – | – | – | – | MCR1906-7 | 2N4173 | 2N4189 | – | 2N1850 2N1850A |
| | 600 V | – | – | – | – | MCR1906-8 | 2N4174 | 2N4190 | 2N4103 | – |
| | 700 V | – | – | – | – | – | – | – | – | – |
| | 800 V | – | – | – | – | – | – | – | – | – |
| ELECTRICAL CHARACTERISTICS | $I_{TSM}$ (Amp) | 6.0 | 15 | 15 | 15 | 15 | ← 100 → | | 200 | 125 |
| | $I_{GT}$ @ 25°C (mA) Max | 0.2 | 10 | 0.2 | 0.1 | 1.0 | ← 30 → | | 40 | 80 |
| | $V_{GT}$ @ 25°C (V) Max | 1.0 | 3.0 | 0.8 | 0.8 | 1.0 | ← 1.5 → | | 2.0 | 2.0 |
| | $I_H$ @ 25°C (mA) Max | 2.0 | 5.0 Typ | 2.0 | 3.0 | 5.0 | ← 30 → | | 20 Typ | – |

NOTES:

1. Also available with flattened and pierced terminations.
2. Also available with solder lug terminations.



World Radio History

## SCRs in METAL PACKAGES (continued)

| ON-STATE (RMS) CURRENT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 AMP | | | | | | 25 AMP | | 35 AMP | | |
| Note 1 | Note 2 | Note 1 | | Note 2 | Note 2 | | Note 2 | Note 2 | Note 2 | Note 1 |
| | | Isolated | | | | | | | | Isolated |
| Case 310-01 Style 1 | Case 263-03 Style 1 | Case 311-01 Style 1 | Case 54 Style 2 | Case 174-03 Style 3 | Case 175-02 Style 1 | Case 61 TO-41 Style 1 | Case 263-03 Style 1 | Case 174-03 Style 3 | Case 175-02 Style 1 | Case 311-01 Style 1 |
| – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | MCR649AP-1 | MCR3818-1 | MCR3918-1 | 2N2573 | 2N681 | MCR3835-1 | MCR3935-1 | C228U3 |
| – | – | – | – | – | – | – | – | – | – | – |
| 2N5164 | 2N5168 | S6220F | MCR649AP-2 | MCR3818-2 | MCR3918-2 | 2N2574 | 2N682 | MCR3835-2 | MCR3935-2 | C228F3 |
| – | – | – | – | – | – | – | – | – | – | – |
| – | – | 2N6167 | MCR649AP-3 | MCR3818-3 | MCR3918-3 | 2N2575 | 2N683 | 2N3870 | 2N3896 | 2N6171 |
| – | – | – | – | – | – | – | 2N684 | – | – | – |
| 2N5165 | 2N5169 | 2N6168 | MCR649AP-4 | MCR3818-4 | MCR3918-4 | 2N2576 | 2N685 | 2N3871 | 2N3897 | 2N6172 |
| – | – | – | – | – | – | – | 2N686 | – | – | – |
| – | – | S6220C | MCR649AP-5 | MCR3818-5 | MCR3918-5 | 2N2577 | 2N687 | MCR3835-5 | MCR3935-5 | C228C3 |
| 2N5166 | 2N5170 | 2N6169 | MCR649AP-6 | MCR3818-6 | MCR3918-6 | 2N2578 | 2N688 | 2N3872 | 2N3898 | 2N6173 |
| – | – | S6220E | MCR649AP-7 | MCR3818-7 | MCR3918-7 | 2N2579 | 2N689 | MCR3835-7 | MCR3935-7 | C228E3 |
| 2N5167 | 2N5171 | 2N6170 | MCR649AP-8 | MCR3818-8 | MCR3918-8 | MCR649-8 | 2N690 | 2N3873 MCR3835-8 | 2N3899 MCR3935-8 | 2N6174 |
| – | – | S6220S | MCR649AP-9 | MCR3818-9 | MCR3918-9 | MCR649-9 | 2N691 | MCR3835-9 | MCR3935-9 | C228S3 |
| – | – | S6220N | MCR649AP-10 | MCR3818-10 | MCR3918-10 | MCR649-10 | 2N692 | MCR3835-10 | MCR3935-10 | C228N3 |
| ← 240 → | | | 260 | 240 | 240 | 260 | 200 | ← 350 → | | |
| ← 40 → | | | 40 | 40 | 40 | 40 | 40 | ← 40 → | | |
| ← 1.5 → | | | 3.5 | 1.5 | 1.5 | 3.5 | 3.0 | ← 1.6 → | | |
| ← 50 → | | | 20 Typ | 50 | 50 | 20 Typ | 20 Typ | ← 50 → | | |

NOTES:

1. Also available with flattened and pierced terminations.
2. Also available with solder lug terminations.



World Radio History

# TRIACs in METAL PACKAGES

Hermetically sealed for highest reliability in control applications to 40 Amperes and voltage to 800 Volts. Wide variety of package options simplifies mechanical design.

| | | ON-STATE (RMS) CURRENT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 AMP | | | 15 AMP | | | 30 AMP | | |
| | | Note 2 | Note 2 | Note 2 | Note 2 | Note 2 | Note 1 | Note 1 | Note 2 | Note 1 |
| | | | | | | | | | | |
| | | | | Isolated | | | Isolated | | | Isolated |
| | | Case 174-03 Style 3 | Case 175-02 Style 3 | Case 235-02 Style 2 | Case 174-03 Style 3 | Case 175-02 Style 3 | Case 311-01 Style 1 | Case 310-01 Style 1 | Case 263-03 Style 1 | Case 311-01 Style 1 |
| $V_{DRM}$ Blocking Voltage (DC or Peak) Volts | 200 V | 2N5567 | 2N5569 | T4121B | 2N5571 | 2N5573 | 2N6145 | 2N6157 | 2N6160 | 2N6163 |
| | 400 V | 2N5568 | 2N5570 | T4121D | 2N5572 | 2N5574 | 2N6146 | 2N6158 | 2N6161 | 2N6164 |
| | 600 V | SC246M | SC245M | T4121M | SC251M | SC250M | 2N6147 | 2N6159 | 2N6162 | 2N6165 |
| | 800 V | SC246N | SC245N | T4121N | SC251N | SC250N | T4120N* | T6401N | T6411N | T6421N |
| ELECTRICAL CHARACTERISTICS | $I_{GT}$@25°C (mA) | | | | | | | | | |
| Maximum | MT2(+),G(+) | 25 | 25 | 25 | 50 | 50 | 50 | 60 | 60 | 60 |
| Maximum | MT2(+),G(-) | 40 | 40 | 40 | 80 | 80 | 80 | 70 | 70 | 70 |
| Maximum | MT2(-),G(-) | 25 | 25 | 25 | 50 | 50 | 50 | 70 | 70 | 70 |
| Maximum | MT2(-),G(+) | 40 | 40 | 40 | 80 | 80 | 80 | 100 | 100 | 100 |
| | $V_{GT}$@25°C (V) | | | | | | | | | |
| Maximum | MT2(+),G(+) | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 |
| Maximum | MT2(+),G(-) | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.1 | 2.1 | 2.1 |
| Maximum | MT2(-),G(-) | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.1 | 2.1 | 2.1 |
| Maximum | MT2(-),G(+) | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| | $I_{TSM}$(Amp) | 100 | 100 | 100 | 150 | 150 | 150 | 250 | 250 | 250 |

NOTES:

1. Also available with flattened and pierced terminations.
2. Also available with solder lug terminations.

* In Case 235-02, Style 2; (with flattened and pierced terminations, also available with solder lug terminations).



World Radio History

## TRIACs in METAL PACKAGES (continued)

| ON-STATE (RMS) CURRENT | | |
|---|---|---|
| 40 AMP | | |
| Note 1 | Note 2 | Note 1 |
| | | Isolated |
| Case 310-01 Style 1 | Case 263-03 Style 1 | Case 311-01 Style 1 |
| 2N5441 | 2N5444 | T6420B |
| 2N5442 | 2N5445 | T6420D |
| 2N5443 | 2N5446 | T6420M |
| T6400N | T6410N | T6420N |
| 70 | 70 | 70 |
| 70 | 70 | 70 |
| 70 | 70 | 70 |
| 100 | 100 | 100 |
| 2.0 | 2.0 | 2.0 |
| 2.0 | 2.0 | 2.0 |
| 2.0 | 2.0 | 2.0 |
| 2.5 | 2.5 | 2.5 |
| 300 | 300 | 300 |

1. Also available with flattened and pierced terminations.
2. Also available with lug terminations.

# PULSE MODULATOR SCRs

These devices are especially designed for pulse modulator applications in radar and similar equipment.

| | | ON-STATE PULSE CURRENT | | |
|---|---|---|---|---|
| | | 100 AMP | | 1000 AMP |
| | | | | |
| | | Case 63-03 Style 1 TO-64 | | Case 263-03 Style 1 |
| $V_{DRM}$ $V_{RRM}$ Blocking Voltage (Volts) | 300 V | 2N4199 2N4199JAN | MCR729-5 | MCR1718 5 |
| | 400 V | 2N4200 2N4200JAN | MCR729-6 | MCR1718 6 |
| | 500 V | 2N4201 2N4201JAN | MCR729-7 | MCR1718 7 |
| | 600 V | 2N4202 2N4202JAN | MCR729-8 | MCR1718-8 |
| | 700 V | 2N4203 2N4203JAN | MCR729-9 | – |
| | 800 V | 2N4204 2N4204JAN | MCR729-10 | – |
| ELECTRICAL CHARACTERISTICS: $I_{GT}$ @ 25°C (mA) Max | | 50 | 50 | 50 |
| ELECTRICAL CHARACTERISTICS: $V_{GT}$ @ 25°C (V) Max | | 1.5 | 1.5 | 1.5 |
| ELECTRICAL CHARACTERISTICS: $I_H$ @ 25°C (mA) Typ | | 3.0 Min | 25 | 15 |
| ELECTRICAL CHARACTERISTICS: $t_{gt}$ (μs) Typ | | 0.4 | 0.5<br>0.4 Max | – |
| ELECTRICAL CHARACTERISTICS: $t_{off}$ (μs) Typ | | 20 Max | 6<br>15 | 20 |
| ELECTRICAL CHARACTERISTICS: dv/dt (V/μs) Max | | 250 | 50 | 100 Typ |



World Radio History

# TRIGGER DEVICES

UJT

PUT

SBS

SUS

DIAC

Trigger devices come under a variety of different classifications, with somewhat differing characteristics –

Unijunction Transistors
Unidirectional Switches
Bidirectional Switches
Bilateral Triggers

The principal function of all of these is to act as trigger devices for SCR and Triac circuits. Motorola makes them all, and with sufficient breadth of specifications to meet any circuit requirement.

The variety of different trigger devices available complicates device selection. No specific type of trigger has a clear-cut advantage over all others. Hence, trigger selection is often very subjective, based on the designer's experience and familiarity. Nevertheless, some basic comparisons can be drawn that might simplify the job of trigger selection for designers who have not already formed specific preferences. The matrix below compares various trigger devices in terms of design-oriented characteristics, thus providing a first-order evaluation for trigger and timer applications.

## GENERAL COMPARISON OF DEVICE PROPERTIES AND CHARACTERISTICS *

| | UJT | PUT | DIAC | SBS | SUS |
|---|---|---|---|---|---|
| Bidirectional | No | No | Yes | Yes | No |
| Device Cost | 1 | 1 | 1 | 3 | 2 |
| Circuit Complexity | 3 | 4 | 1 | 2 | 2 |
| Device Interchangeability | 3 | 1 | 4 | 2 | 2 |
| Pulse Height | 3 | 1 | 3 | 3 | 3 |
| Sensitivity | 2 | 1 | 2 | 4 | 4 |
| Upper Frequency Limit | 1 MHz | 100 kHz | 500 kHz | 10 kHz | 10 kHz |
| Lower Frequency Limit | 1 Hz | 0.01 Hz | 1 Hz | 30 Hz | 30 Hz |
| Synchronization | Yes | Yes | No | Yes | Yes |

*Where ratings 1 thru 4 are used, the 1 rating is most desirable.

## UNIJUNCTION TRANSISTORS – UJT

Highly stable devices for general-purpose trigger applications and as pulse generators (oscillators) and timing circuits. Useful at frequencies ranging (generally) from 1 Hz to 1 MHz. Available in low-cost plastic package (TO-92) and in hermetically sealed metal package (Case 22A).

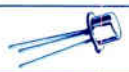
### UNIJUNCTION TRANSISTORS – (UJT)

| Package | Device Type | η Min | η Max | $I_P$ μA Max | $I_{EB20}$ μA Max | $I_V$ mA Min |
|---|---|---|---|---|---|---|
| Plastic Case 29 02 (TO 92) | MU10 | 0.50 | 0.85 | 5.0 | 1.0 | 1.0 |
| | 2N4870 | 0.56 | 0.75 | 5.0 | 1.0 | 2.0 |
| | 2N4871 | 0.70 | 0.85 | 5.0 | 1.0 | 4.0 |
| | MU2646 | 0.56 | 0.75 | 5.0 | 12 | 4.0 |
| | MU4891 | 0.55 | 0.82 | 5.0 | 0.01 | 2.0 |
| | MU4892 | 0.51 | 0.69 | 2.0 | ↓ | ↓ |
| | MU4893 | 0.55 | 0.82 | 2.0 | | |
| | MU4894 | 0.74 | 0.86 | 1.0 | | |
| Metal Case 22A 01 | MU20 | 0.56 | 0.85 | 2.0 | 0.2 | 1.0 |
| | 2N2646 | 0.56 | 0.75 | 5.0 | 12 | 4.0 |
| | 2N2647 | 0.68 | 0.82 | 2.0 | 0.2 | 8.0 |
| | 2N3980 | 0.68 | 0.82 | 2.0 | 0.01 | 1.0 |
| | 2N4851 | 0.56 | 0.75 | 2.0 | 0.1 | 2.0 |
| | 2N4852 | 0.70 | 0.85 | 2.0 | 0.1 | 4.0 |
| | 2N4853 | 0.70 | 0.85 | 0.4 | 0.05 | 6.0 |
| | 2N4948* | 0.55 | 0.82 | 2.0 | 0.01 | 2.0 |
| | 2N4949* | 0.74 | 0.86 | 1.0 | 0.01 | 2.0 |
| | 2N5431* | 0.72 | 0.80 | 0.4 | 0.01 | 2.0 |

*Also available as JAN and JANTX devices


World Radio History

### PROGRAMMABLE UNIJUNCTION TRANSISTORS – (PUT)

| Package | Device Type | $I_P$ $R_G$ = 10 kΩ μA Max | $I_P$ $R_G$ = 1.0 MΩ μA Max | $I_{GAO}$ @40 V nA Max | $I_V$ $R_G$ = 10 kΩ μA Min | $I_V$ $R_G$ = 1.0 MΩ μA Max |
|---|---|---|---|---|---|---|
| Plastic Case 29-02 TO-92 | 2N6027 | 5.0 | 2.0 | 10 | 70 | 50 |
| | 2N6028 | 1.0 | 0.15 | 10 | 25 | 25 |
| | MPU131 | 5.0 | 2.0 | 5.0 | 70 | 50 |
| | MPU132 | 2.0 | 0.3 | 5.0 | 50 | 50 |
| | MPU133 | 1.0 | 0.15 | 5.0 | 50 | 25 |
| Metal Case 22 03 TO 18  | 2N6116* | 5.0 | 2.0 | 5.0 | 70 | 50 |
| | 2N6117* | 2.0 | 0.3 | 5.0 | 50 | 50 |
| | 2N6118* | 1.0 | 0.15 | 5.0 | 50 | 25 |

*Also available as JAN and JANTX devices

## PROGRAMMABLE UNIJUNCTION TRANSISTORS – PUT

Similar to UJTs, except that $I_V$, $I_P$ and intrinsic standoff voltage are programmable (adjustable) by means of external voltage divider. This stabilizes circuit performance for variations in device parameters. General operating frequency range is from 0.01 Hz to 10 kHz, making them suitable for long-duration timer circuits. Two-package availability provides cost option.

| Package | Device Type | $V_S$ Volts Nom* Min | $V_S$ Volts Nom* Max | $I_S$ μA Max | $I_H$ mA Max |
|---|---|---|---|---|---|
| **BILATERAL TRIGGERS – (DIACs)** | | | | | |
| Plastic Case 182-02 TO-92 | 1N5758/MPT20 | 20 ± 4.0* | | 100 | |
| | 1N5759 | 24 ± 4.0* | | 100 | |
| | 1N5760/MPT28 | 28 ± 4.0* | | 100 | |
| | 1N5761/MPT32 | 32 ± 4.0* | | 100 | |
| | 1N5762 | 36 ± 4.0* | | 100 | |
| | 1N5758A | 20 ± 2.0* | | 25 | |
| | 1N5759A | 24 ± 2.0* | | 25 | |
| | 1N5760A | 28 ± 2.0* | | 25 | |
| | 1N5761A | 32 ± 2.0* | | 25 | |
| | 1N5762A | 36 ± 2.0* | | 25 | |
| **SILICON BIDIRECTIONAL SWITCH – (SBS)** | | | | | |
| Plastic Case 29 02 TO-92 | MBS4991 | 6.0 | 10 | 500 | 1.5 |
| | MBS4992 | 7.5 | 9.0 | 120 | 0.5 |
| **SILICON UNIDIRECTIONAL SWITCH – (SUS)** | | | | | |
| Plastic Case 29-02 TO-92 | MUS4987 | 6.0 | 10 | 500 | 1.5 |
| | MUS4988 | 7.5 | 9.0 | 150 | 0.5 |

## BILATERAL TRIGGERS – DIACs

Specifically designed as low-cost bidirectional triggers in line-operated Triac control circuits such as light dimmers, motor controls and temperature controls.

## SILICON BIDIRECTIONAL SWITCH – SBS

Applications similar to Diac, but has gate electrode that permits synchronization.

## SILICON UNIDIRECTIONAL SWITCH – SUS

Has gate electrode to permit synchronization.



World Radio History

World Radio History

MOTOROLA

# OPTOELECTRONICS

**Optoelectronic devices are designed for use in computer, industrial and consumer equipment. Motorola's standard line of optoelectronic products include optical couplers, infrared light emitters and light detectors. Compactness, reliability and compatibility with integrated circuits keynote advantages.**

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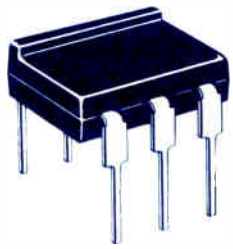
# OPTICAL COUPLERS/ISOLATORS



CASE 673-04

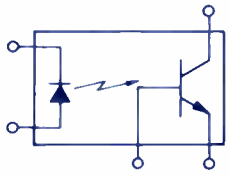
Actual Size

Couplers are designed to provide isolation protection from high-voltage transients, surge voltage or low level noise that would otherwise damage the input or generate erroneous information. They allow interfacing systems of different logic levels, different grounds, etc., that would otherwise be incompatible. Motorola offers a variety of standard isolation voltages from transients protection of 500 to 5000 Volts minimum.

Motorola also offers a wide array of standard devices that have a wide range of specifications (including the first series of DIP transistors and darlington couplers to achieve JEDEC registration: transistors – 4N25 thru 4N28, and Darlingtons – 4N29 thru 4N33).

**The Transistor Coupler** is probably the most popular form of isolator since it offers moderate speed (approximately 300 kHz), sensitivity and economy. In addition, the collector-base junction can be used as a photo diode to achieve higher speeds. The output in the diode mode is lower, requiring amplification for more usable output levels.

For High Speed, Moderate Efficiency



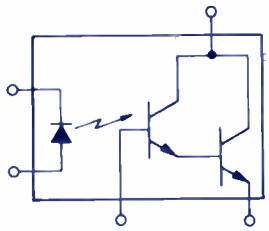
Transistor Output

| Device Type | Isolation* Voltage Volts Min | DC Current Transfer Ratio % Min | $BV_{CEO}$ Volts Min | Collector Output Current @$I_F$ = 10 mA Typ mA |
|---|---|---|---|---|
| 4N28 | 500 | 10 | 30 | 2.0 |
| 4N26 | 1500 | 20 | 30 | 3.5 |
| 4N27 | 1500 | 10 | 30 | 2.0 |
| 4N38 | 1500 | 20 | 80 | 3.5 |
| 4N37 | 1500 | 100 | 30 | 2.0 |
| 4N36 | 2500 | 100 | 30 | 2.0 |
| 4N25 | 2500 | 20 | 30 | 3.5 |
| 4N25A** | 2500 | 20 | 30 | 3.5 |
| 4N38A** | 2500 | 20 | 80 | 3.5 |
| 4N35 | 3550 | 100 | 30 | 2.0 |
| MOC1005 | 5000 | 20 | 30 | 5.0 |
| MOC1006 | 5000 | 10 | 30 | 3.0 |

*AC peak voltage – one full sine wave 60 Hz.
**Underwriter Laboratory Recognition

**The Darlington Transistor Coupler** is used when high transfer ratios and increased output current capability are needed. The speed, approximately 30 kHz, is slower than the transistor type but the transfer ratio can be as much as twenty times as high as the single transistor type.

For High Efficiency, Moderate Speed



Darlington Output

| Device Type | Isolation* Voltage Volts Min | DC Current Transfer Ratio % Min | $BV_{CEO}$ Volts Min | Collector Output Current @$I_F$ = 10 mA Typ mA |
|---|---|---|---|---|
| 4N30 (MOC1200) | 1500 | 100 | | 30 |
| 4N31 | 1500 | 50 | 30 | 10 |
| 4N33 | 1500 | 500 | 30 | 60 |
| MOC119 | 1500 | 300 | 30 | 45 |
| MOC8030 | 1500 | 300 | 80 | 45 |
| MOC8050 | 1500 | 500 | 80 | 60 |
| 4N29 | 2500 | 100 | 30 | 30 |
| 4N29A** | 2500 | 100 | 30 | 30 |
| 4N32 | 2500 | 500 | 30 | 60 |
| 4N32A** | 2500 | 500 | 30 | 60 |

*AC peak voltage – one full sine wave 60 Hz.
**Underwriter Laboratory Recognition.

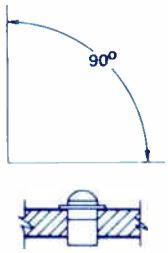


World Radio History

# INFRARED-EMITTING DIODES

Infrared (900 nm) gallium arsenide emitters are available from Motorola for use in light modulators, shaft or position encoders, punched card and tape readers, optical switching and logic circuits. They are spectrally matched for use with silicon detectors.

Peak Emission Wavelength = 900 nm (Typ)
Forward Voltage @ 50 mA = 1.2 (Typ)




Emission Angle – Angle at which $I_R$ emission is 50% of maximum intensity.

| Package | Device Type | Emission Angle α | Instantaneous Power Output Typ μW |
|---|---|---|---|
| Case 81A-01 Metal Actual Size | MLED910 | 30° | 150 @ 50 mA |
| Case 209-01 Metal Actual Size | MLED930 | 30° | 650 @ 100 mA |
| Case 234-02 Clear Plastic  Actual Size | MLED60<br>MLED90 | 65°<br>65° | 550 @ 50 mA<br>350 @ 50 mA |
| Case 29-02 Plastic Actual Size | MLED92 | 110° | 650 @ 100 mA |

# PHOTO DETECTORS

A variety of silicon photo detectors are available for a wide range of light detecting applications. Devices are available in packages offering choices of viewing angle and size in either low cost, economical, plastic cases or rugged, hermetic, metal cans. Advantages over photo tubes are high sensitivity, good temperature stability, and proven silicon reliability. Applications include card and tape readers, pattern and character recognition, shaft encoders, position sensors, counters, and others. Maximum sensitivity occurs at approximately 800 nm.

## Photodiodes

Photodiodes are used where high speed is required (1.0 ns).

| Package | Type Number | Light Current @ H | | $BV_R$ Volts Min | Dark Current | |
|---|---|---|---|---|---|---|
| | | Typ μA | mW/cm² | | nA Max @ | Volts |
| Case 209-01 Metal Convex Lens Actual Size | MRD500 | 9.0 | 5.0 | 100 | 2.0 | 20 |
| Case 210-01 Metal Flat Lens Actual Size | MRD510 | 2.0 | 5.0 | 100 | 2.0 | 20 |



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# Phototransistors

Phototransistors are used where moderate sensitivity and medium speed (2.0 μs) are required.

| Package | Type Number | Light Current Typ mA @ H mW/cm² | $BV_{CEO}$ Volts Min | Dark Current nA Max @ $V_{CE}$ Volts |
|---|---|---|---|---|
| Actual Size Case 81A-01 Metal | MRD604 | 8.5 @ 20 | 50 | 25 @ 30 |
| | MRD603 | 6.0 @ 20 | 50 | 25 @ 30 |
| | MRD602 | 3.5 @ 20 | 50 | 25 @ 30 |
| | MRD601 | 1.5 @ 20 | 50 | 25 @ 30 |
| Actual Size Case 82-01 Metal | MRD310 | 2.5 @ 5.0 | 50 | 25 @ 20 |
| | MRD300 | 7.5 @ 5.0 | 50 | 25 @ 20 |
| Actual Size Case 29-02 | L14H4 | 0.5 @ 10 | 30 | 100 @ 10 |
| | L14H1 | 0.5 @ 10 | 60 | 100 @ 10 |
| | L14H2 | 2.0 @ 10 | 30 | 100 @ 10 |
| | L14H3 | 2.0 @ 10 | 60 | 100 @ 10 |
| Actual Size Case 82-01 Metal | MRD3054 | 1.2 @ 5.0 | 30 | 100 @ 20 |
| | MRD3056 | 2.5 @ 5.0 | 30 | 100 @ 20 |
| | MRD3055 | 1.8 @ 5.0 | 30 | 100 @ 20 |
| | MRD3051 | 0.2 @ 5.0 | 30 | 100 @ 20 |
| | MRD3050 | 0.2 @ 5.0 | 30 | 100 @ 20 |
| Actual Size Case 234-02 Plastic | MRD160 | 1.5 @ 5.0 | 40 | 100 @ 20 |

# Photodarlingtons

Photodarlingtons are used where maximum sensitivity is required with typical rise and fall times of 50 μs.

| Package | Type Number | Light Current Typ mA @ H mW/cm² | $BV_{CEO}$ Volts Min | Dark Current nA Max @ Volts |
|---|---|---|---|---|
| Actual Size Case 82-01 Metal | MRD360 | 20 @ 0.5 | 40 | 100 @ 10 |
| | MRD370 | 10 @ 0.5 | 40 | 100 @ 10 |
| Actual Size Case 29-01 Plastic | 2N5780 | 8.0 @ 2.0 | 40 | 100 @ 12 |
| | 2N5779 | 8.0 @ 2.0 | 25 | 100 @ 12 |
| | 2N5778 | 4.0 @ 2.0 | 40 | 100 @ 12 |
| | 2N5777 | 4.0 @ 2.0 | 25 | 100 @ 12 |
| | MRD14B | 2.0 @ 2.0 | 12 | 100 @ 12 |



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MBR335P ..... 198
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3 CATALOG

The following pages contain a listing of devices which are available for military applications, and a complete alphanumeric listing of all standard Motorola semiconductors. This listing serves three specific purposes:

1. It serves as a quick guide to all product type numbers available from Motorola;
2. It provides a product-category identification for all Motorola-manufactured devices;
3. It indicates the "preferred" status of various Motorola products by referencing a page number in the Selector Guide portion of this document on which more information about the product is given. Device types with an accompanying page reference are considered prime device candidates for new designs. Device type numbers not referenced to the Selector Guides are available for replacement purposes but are not considered to be cost-effective in new designs.


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MOTOROLA

# DEVICES FOR MILITARY APPLICATIONS

The following tables list devices that appear in QPL-19500 (Qualified Products List) as of 21 December 1976 and are available in the JAN, JANTX, and JANTXV versions as specified. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

1N. . .Device Numbers
ASSEMBLIES
DIODES
Reference
Zener
Current Regulator
Voltage Regulator
RECTIFIERS

## Silicon Zener Diodes +5% Series

MIL-S-19500/127

1N746A JAN,JTX,JTXV thru 1N759A JAN,JTX,JTXV

MIL-S-19500/117

1N962B JAN,JTX,JTXV thru 1N992B JAN,JTX,JTXV

MIL-S-19500/114

1N2804B,RB JAN,JTX thru 1N2811B,RB JAN,JTX
1N2813B,RB JAN,JTX
1N2814B,RB JAN,JTX
1N2816B,RB JAN,JTX
1N2818B,RB JAN,JTX thru 1N2820B,RB JAN,JTX
1N2822B,RB JAN,JTX thru 1N2827B,RB JAN,JTX
1N2829B,RB JAN,JTX
1N2831B,RB JAN,JTX thru 1N2838B,RB JAN,JTX
1N2840B,RB JAN,JTX thru 1N2846B,RB JAN,JTX

MIL-S-19500/124

1N2970B,RB JAN,JTX thru 1N2977B,RB JAN,JTX
1N2979B,RB JAN,JTX
1N2980B,RB JAN,JTX
1N2982B,RB JAN,JTX
1N2984B,RB JAN,JTX thru 1N2986B,RB JAN,JTX
1N2988B,RB JAN,JTX thru 1N2993B,RB JAN,JTX
1N2995B,RB JAN,JTX
1N2997B,RB JAN,JTX
1N2999B,RB JAN,JTX thru 1N3005B,RB JAN,JTX
1N3007B,RB JAN,JTX thru 1N3009B,RB JAN,JTX
1N3011B,RB JAN,JTX
1N3012B,RB JAN,JTX
1N3014B,RB JAN,JTX
1N3015B,RB JAN,JTX

MIL-S-19500/115

1N3016B,RB JAN,JTX,JTXV thru 1N3051B,RB JAN,JTX,JTXV

## SILICON ZENER DIODES ±5% SERIES (continued)

MIL-S-19500/358

1N3305B,RB JAN,JTX thru 1N3312B,RB JAN,JTX
1N3314B,RB JAN,JTX
1N3315B,RB JAN,JTX
1N3317B,RB JAN,JTX
1N3319B,RB JAN,JTX thru 1N3321B,RB JAN,JTX
1N3323B,RB JAN,JTX thru 1N3328B,RB JAN,JTX
1N3330B,RB JAN,JTX
1N3332B,RB JAN,JTX
1N3334B,RB JAN,JTX thru 1N3340B,RB JAN,JTX
1N3342B,RB JAN,JTX thru 1N3344B,RB JAN,JTX
1N3346B,RB JAN,JTX
1N3347B,RB JAN,JTX
1N3349B,RB JAN,JTX
1N3350B,RB JAN,JTX

MIL-S-19500/115

1N3821A JAN,JTX,JTXV thru 1N3828A JAN,JTX,JTXV

MIL-S-19500/272

1N3993A,RA JAN,JTX thru 1N4000A,RA JAN,JTX

MIL-S-19500/435

1N4099 JAN,JTX,JTXV thru 1N4135 JAN,JTX,JTXV

MIL-S-19500/127

1N4370A JAN,JTX,JTXV thru 1N4372A JAN,JTX,JTXV

MIL-S-19500/358

1N4549B,RB JAN,JTX thru 1N4554B,RB JAN,JTX

MIL-S-19500/435

1N4614 JAN,JTX,JTXV thru 1N4627 JAN,JTX,JTXV

MIL-S-19500/114

1N4557B,RB JAN,JTX thru 1N4562B,RB JAN,JTX

## VOLTAGE REGULATORS

MIL-S 19500/437

1N5519B JAN,JANTX thru 1N5545B JAN,JANTX



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## Current Regulators

**MIL-S-19500/463**

| | |
|---|---|
| 1N5285 JAN,JTX,JTXV | 1N5300 JAN,JTX,JTXV |
| 1N5286 JAN,JTX,JTXV | 1N5301 JAN,JTX,JTXV |
| 1N5287 JAN,JTX,JTXV | 1N5302 JAN,JTX,JTXV |
| 1N5288 JAN,JTX,JTXV | 1N5303 JAN,JTX,JTXV |
| 1N5289 JAN,JTX,JTXV | 1N5304 JAN,JTX,JTXV |
| 1N5290 JAN,JTX,JTXV | 1N5305 JAN,JTX,JTXV |
| 1N5291 JAN,JTX,JTXV | 1N5306 JAN,JTX,JTXV |
| 1N5292 JAN,JTX,JTXV | 1N5307 JAN,JTX,JTXV |
| 1N5293 JAN,JTX,JTXV | 1N5308 JAN,JTX,JTXV |
| 1N5294 JAN,JTX,JTXV | 1N5309 JAN,JTX,JTXV |
| 1N5295 JAN,JTX,JTXV | 1N5310 JAN,JTX,JTXV |
| 1N5296 JAN,JTX,JTXV | 1N5311 JAN,JTX,JTXV |
| 1N5297 JAN,JTX,JTXV | 1N5312 JAN,JTX,JTXV |
| 1N5298 JAN,JTX,JTXV | 1N5313 JAN,JTX,JTXV |
| 1N5299 JAN,JTX,JTXV | 1N5314 JAN,JTX,JTXV |

## TC Reference Diodes

**MIL-S-19500**

| | |
|---|---|
| 1N429 JAN | /299 |
| 1N821 JAN,JTX,JTXV | /159 |
| 1N823 JAN,JTX,JTXV | /159 |
| 1N825 JAN,JTX,JTXV | /159 |
| 1N827 JAN,JTX,JTXV | /159 |
| 1N829 JAN,JTX,JTXV | /159 |
| 1N935B JAN,JTX,JTXV | /156 |
| 1N937B JAN,JTX,JTXV | /156 |
| 1N938B JAN,JTX,JTXV | /156 |
| 1N939B JAN,JTX,JTXV | /156 |
| 1N941B JAN,JTX | /157 |
| 1N943B JAN,JTX | /157 |
| 1N944B JAN,JTX | /157 |
| 1N945B JAN,JTX | /157 |
| 1N3154 JAN,JTX | /158 |
| 1N3155 JAN,JTX | /158 |
| 1N3156 JAN,JTX | /158 |
| 1N3157 JAN,JTX | /158 |
| 1N4565A JAN,JTX,JTXV thru 1N4574A JAN,JTX,JTXV | /452 |

## Diode Assemblies

**MIL-S-19500**

| | |
|---|---|
| 1N1530A JAN | /320 |
| 1N1742A JAN | /298 |

## Rectifiers

**MIL-S-19500/304**

1N3890 JAN,JTX,JTXV
1N3890R JAN,JTX,JTXV
1N3891 JAN,JTX,JTXV
1N3891R JAN,JTX,JTXV
1N3893 JAN,JTX,JTXV
1N3893R JAN,JTX,JTXV

**MIL-S-19500/308**

1N3910R JAN,JTX
1N3911R JAN,JTX
1N3912R JAN,JTX
1N3913R JAN,JTX



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2N. . . Device Numbers
TRANSISTORS
Field Effect, High Frequency,
Multiple Device, Power, RF Power,
Switching and Unijunction
THYRISTORS

The following tables list devices that appear in QPL-19500 (Qualified Products List) as of 21 December 1976 and are available in the JAN, JANTX, and JANTXV versions as specified. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

## Switching and High-Frequency Transistors

| MIL-S-19500 | | | |
|---|---|---|---|
| 2N499 JAN | /72 | 2N3253 JAN | /347 |
| 2N499A JAN | /72 | 2N3253S JAN | /347 |
| 2N502A JAN | /112 | 2N3444 JAN | /347 |
| 2N502B JAN | /112 | 2N3444S JAN | /347 |
| 2N703 JAN | /153 | 2N3449 JAN | /338 |
| 2N705 JAN | /86 | 2N3467 JAN,JTX,JTXV | /348 |
| 2N706 JAN | /120 | 2N3468 JAN,JTX,JTXV | /348 |
| 2N708 JAN,JTX | /312 | 2N3485A JAN,JTX | /392 |
| 2N718A JAN,JTX,JTXV | /181 | 2N3486A JAN,JTX | /392 |
| 2N869A JAN,JTX | /283 | 2N3498 JAN,JTX,JTXV | /366 |
| 2N914 JAN,JTX | /373 | 2N3499 JAN,JTX,JTXV | /366 |
| 2N916 JAN | /271 | 2N3500 JAN,JTX,JTXV | /366 |
| 2N918 JAN,JTX,JTXV | /301 | 2N3501 JAN,JTX,JTXV | /366 |
| 2N929 JAN,JTX | /253 | 2N3506 JAN,JTX,JTXV | /349 |
| 2N930 JAN,JTX | /253 | 2N3507 JAN,JTX,JTXV | /349 |
| 2N962 JAN | /258 | 2N3634 JAN,JTX,JTXV | /357 |
| 2N964 JAN | /258 | 2N3635 JAN,JTX,JTXV | /357 |
| 2N1132 JAN | /177 | 2N3636 JAN,JTX,JTXV | /357 |
| 2N1613 JAN,JTX,JTXV | /181 | 2N3637 JAN,JTX,JTXV | /357 |
| 2N2218 JAN,JTX,JTXV | /251 | 2N3700 JAN,JTX,JTXV | /391 |
| 2N2218A JAN,JTX,JTXV | /251 | 2N3735 JAN,JTX,JTXV | /395 |
| 2N2219 JAN,JTX,JTXV | /251 | 2N3737 JAN,JTX,JTXV | /395 |
| 2N2219A JAN,JTX,JTXV | /251 | 2N3743 JAN,JTX,JTXV | /397 |
| 2N2221 JAN,JTX,JTXV | /255 | 2N3762 JAN,JTX,JTXV | /396 |
| 2N2221A JAN,JTX,JTXV | /255 | 2N3763 JAN,JTX,JTXV | /396 |
| 2N2222 JAN,JTX,JTXV | /255 | 2N3764 JAN,JTX,JTXV | /396 |
| 2N2222A JAN,JTX,JTXV | /255 | 2N3765 JAN,JTX,JTXV | /396 |
| 2N2369A JAN,JTX,JTXV | /317 | 2N3959 JAN,JTX | /399 |
| 2N2481 JAN,JTX | /268 | 2N3960 JAN,JTX | /399 |
| 2N2905 JAN,JTX,JTXV | /290 | 2N4033 JAN,JTX,JTXV | /511 |
| 2N2905A JAN,JTX,JTXV | /290 | 2N4405 JAN,JTX | /488 |
| 2N2906 JAN,JTX,JTXV | /291 | 2N4449 JAN,JTX,JTXV | /317 |
| 2N2906A JAN,JTX,JTXV | /291 | 2N4453 JAN,JTX | /283 |
| 2N2907 JAN,JTX,JTXV | /291 | 2N4930 JAN,JTX,JTXV | /397 |
| 2N2907A JAN,JTX,JTXV | /291 | 2N4931 JAN,JTX,JTXV | /397 |
| 2N3013 JAN,JTX | /287 | 2N5581 JAN,JTX | /423 |
| 2N3019 JAN,JTX,JTXV | /391 | 2N5582 JAN,JTX | /423 |
| 2N3250A JAN,JTX,JTXV | /323 | 2N6365 JAN | /471 |
| 2N3251A JAN,JTX,JTXV | /323 | 2N6365A JAN | /471 |

## Power Transistors

| MIL-S-19500 | | | |
|---|---|---|---|
| 2N3715 JAN,JTX,JTXV | /408 | 2N4399 JAN,JTX,JTXV | /433 |
| 2N3716 JAN,JTX,JTXV | /408 | 2N5302 JAN,JTX | /456 |
| 2N3739 JAN,JTX,JTXV | /402 | 2N5303 JAN,JTX | /456 |
| 2N3740 JAN,JTX,JTXV | /441 | 2N5683 JAN,JTX,JTXV | /466 |
| 2N3741 JAN,JTX,JTXV | /441 | 2N5684 JAN,JTX,JTXV | /466 |
| 2N3791 JAN,JTX,JTXV | /379 | 2N5685 JAN,JTX,JTXV | /464 |
| 2N3792 JAN,JTX,JTXV | /379 | 2N5686 JAN,JTX,JTXV | /464 |
| 2N3867 JAN,JTX,JTXV | /350 | 2N5745 JAN,JTX,JTXV | /433 |
| 2N3868 JAN,JTX,JTXV | /350 | 2N6306 JAN,JTX,JTXV | /498 |
| 2N3902 JAN,JTX | /371 | 2N6308 JAN,JTX,JTXV | /498 |



World Radio History

## Silicon-Controlled Rectifiers

| MIL-S-19500 | |
|---|---|
| 2N4199 JAN | /372 |
| 2N4200 JAN | /372 |
| 2N4201 JAN | /372 |
| 2N4202 JAN | /372 |
| 2N4203 JAN | /372 |
| 2N4204 JAN | /372 |

## Unijunction

| MIL-S-19500 | |
|---|---|
| 2N4948 JAN,JTX | /388 |
| 2N4949 JAN,JTX | /388 |
| 2N5431 JAN,JTX | /425 |

## RF Transistors

| MIL-S-19500 | |
|---|---|
| 2N918 JAN,JTX,JTXV | /301 |
| 2N1142 JAN | /87 |
| 2N1195 JAN | /71 |
| 2N2273 JAN | /244 |
| 2N2857 JAN,JTX,JTXV | /343 |
| 2N3127 JAN | /346 |
| 2N3375 JAN,JTX,JTXV | /341 |
| 2N3553 JAN,JTX,JTXV | /341 |
| 2N3866 JAN,JTX,JTXV | /398 |
| 2N3866A JAN,JTX,JTXV | /398 |
| 2N4957 JAN,JTX,JTXV | /426 |
| 2N5109 JAN,JTX,JTXV | /453 |

## Multiple Devices

| MIL-S-19500 | |
|---|---|
| 2N2060 JAN,JTX,JTXV | /270 |
| 2N3810 JAN,JTX,JTXV | /336 |
| 2N3811 JAN,JTX,JTXV | /336 |
| 2N4854 JAN,JTX,JTXV | /421 |
| 2N5793,94 JAN,JTX,JTXV | 495 |
| 2N5795 JAN,JTX,JTXV | /496 |
| 2N5796 JAN,JTX,JTXV | /496 |

## Field-Effect Transistors

| MIL-S-19500 | |
|---|---|
| 2N2608 JAN,JTX | /295 |
| 2N2609 JAN,JTX | /296 |
| 2N3330 JAN,JTX | /378 |
| 2N3821 JAN,JTX | /375 |
| 2N3822 JAN,JTX | /375 |
| 2N3823 JAN,JTX | /375 |
| 2N4856,59 JAN,JTX | /385 |
| 2N4857,58,60,61 JAN,JTX | /385 |

## Programmable Unijunction

| MIL-S-19500 | |
|---|---|
| 2N6116 JAN,JTX | /493 |
| 2N6117 JAN,JTX | /493 |
| 2N6118 JAN,JTX | /493 |

The following tables list devices which are in the process of qualification for listing in QPL-19500 as of 21 December 1976. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

## Power Transistors

| MIL-S-19500 | |
|---|---|
| 2N3439,40 JAN,JTX | /368 |
| 2N3766,67 JAN,JTX,JTXV | /518 |
| 2N6051,52 JAN,JTX,JTXV | /501 |
| 2N6058,59 JAN,JTX,JTXV | /502 |
| 2N6274,77 JAN,JTX,JTXV | /514 |

## Switching and High Frequency Transistors

| MIL-S-19500 | |
|---|---|
| 2N4261 JAN,JTX,JTXV | /511 |

## RF Transistors

| MIL-S-19500 | |
|---|---|
| 2N6603,04 JAN,JTXV | /522 |

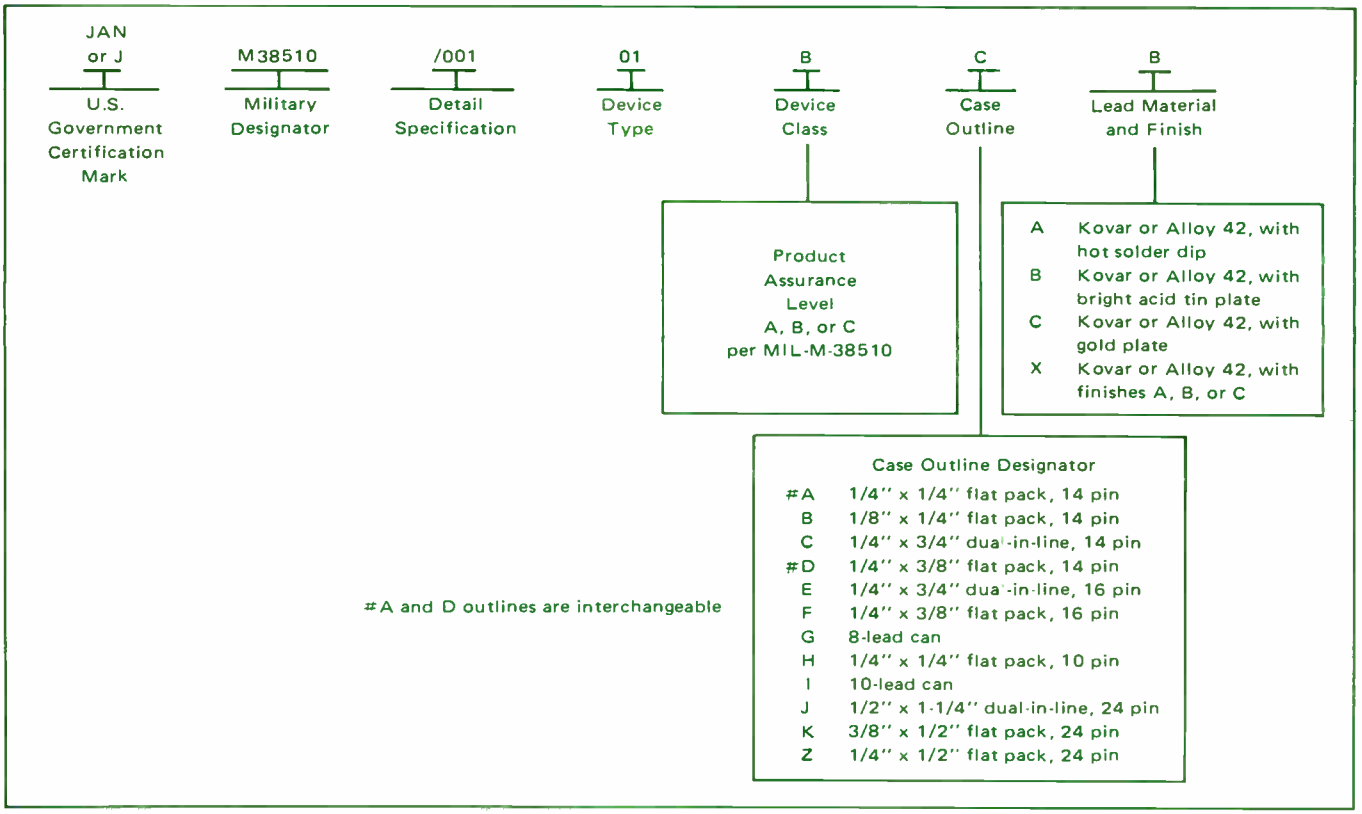


World Radio History

# INTEGRATED CIRCUITS

A typical military part number consists of the JAN prefix, the general specification number, the detail specification number, and a coded part number.

## PART NUMBER DESCRIPTION




## TABLE I – JAN PART NUMBER TO MOTOROLA PART NUMBER CROSS-REFERENCE

Contact your local Motorola sales office or franchised distributor for current qualification status and availability.

### MTTL INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/001 NAND Gates** | |
| 01 | MC5430 |
| 02 | MC5420 |
| 03 | MC5410 |
| 04 | MC5400 |
| 05 | MC5404 |
| 06 | MC5412 |
| 07 | MC5401 |
| 08 | MC5405 |
| 09 | MC5403 |
| **MIL-M-38510/002 Flip-Flops** | |
| 01 | MC5472 |
| 02 | MC5473 |
| 03 | MC54107 |
| 04 | MC5476 |
| 05 | MC5474 |
| 06 | MC5470 |
| 07 | MC5479 |
| **MIL-M-38510/003 NAND Buffers** | |
| 01 | MC5440 |
| 02 | MC5437 |
| 03 | MC5438 |
| **MIL-M-38510/004 NOR Gates** | |
| 01 | MC5402 |
| 02 | MC5423 |
| 03 | MC5425 |
| 04 | MC5427 |
| **MIL-M-38510/005 AND-OR-INVERT Gates** | |
| 01 | MC5450 |
| 02 | MC5451 |
| 03 | MC5453 |
| 04 | MC5454 |
| **MIL-M-38510/006 Binary Full Adders** | |
| 01 | MC15482 |
| 02 | MC5483 |
| 03 | MC9304 |
| 04 | MC5480 |
| **MIL-M-38510/007 Exclusive OR Gate** | |
| 01 | MC5486 |
| **MIL-M-38510/008 Hex Buffers/Drivers** | |
| 01 | MC5406 |
| 02 | MC5416 |
| 03 | MC5407 |
| 04 | MC5417 |
| 05 | MC5426 |
| **MIL-M-38510/009 Shift Registers** | |
| 01 | MC5495 |
| 02 | MC5496 |
| 03 | MC54164A |
| 04 | MC54165 |
| 05 | MC54194 |
| 06 | MC54195 |
| **MIL-M-38510/010 Decoders** | |
| 01 | MC5442 |
| 02 | MC5443 |
| 03 | MC5444 |
| 04 | MC5445 |
| 05 | MC54145 |
| 06 | MC5446 |
| 07 | MC5447 |
| 08 | MC5448 |
| 09 | MC5449 |

**JAN type number must be completed as shown in the Part Number Description.



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## TABLE I – JAN PART NUMBER TO MOTOROLA PART NUMBER CROSS-REFERENCE (continued)

### MTTL INTEGRATED CIRCUITS (continued)

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/011 Arithmetic Logic Unit** | |
| 01 | MC54181 |
| 02 | MC54182 |
| **MIL-M-38510/012 Monostable Multivibrators** | |
| 01 | MC54121 |
| 02 | MC54122 |
| 03 | MC54123 |
| 04 | MC9601 |
| 05 | MC9602 |
| **MIL-M-38510/013 Counters** | |
| 01 | MC5492 |
| 02 | MC5493 |
| 03 | MC54160 |
| 04 | MC54163 |
| 05 | MC54162 |
| 06 | MC54161 |
| 07 | MC5490 |
| 08 | MC54192 |
| 09 | MC54193 |
| **MIL-M-38510/014 Data Selectors/Multiplexers** | |
| 01 | MC54150 |
| 02 | MC9312 |
| 03 | MC54153 |
| 04 | MC9303 |
| 05 | MC9322 |
| 06 | MC54151 |
| **MIL-M-38510/015 Bistable Latches** | |
| 01 | MC5475 |
| 02 | MC5477 |
| 03 | MC9308 |
| 04 | MC9314 |
| **MIL-M-38510/016 AND Gates** | |
| 01 | MC5408 |
| 02 | MC5409 |
| **MIL-M-38510/017 Low-Power Flip-Flops** | |
| 01 | MC54174 |
| 02 | MC54175 |
| **MIL-M-38510/018 Register File** | |
| 01 | MC54120* |
| **MIL-M-38510/019 Parity Generators/Checkers** | |
| 01 | MC54180 |
| **MIL-M-38510/020 Low-Power NAND Gates** | |
| 01 | MC54L30* |
| 02 | MC54L20* |
| 03 | MC54L10* |
| 04 | MC54L00* |
| 05 | MC54L04* |
| 06 | MC54L03* |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/021 Low-Power Flip-Flops** | |
| 01 | MC54L71* |
| 02 | MC54L72* |
| 03 | MC54L73* |
| 04 | MC54L78* |
| 05 | MC54L74* |
| **MIL-M-38510/022 High-Speed Flip-Flops** | |
| 01 | MC54H72 |
| 02 | MC54H73 |
| 03 | MC54H74A |
| 04 | MC54H76 |
| 05 | MC54H101 |
| 06 | MC54H103 |
| **MIL-M-38510/023 High-Speed NAND Gates** | |
| 01 | MC54H30 |
| 02 | MC54H20 |
| 03 | MC54H10 |
| 04 | MC54H00 |
| 05 | MC54H04 |
| 06 | MC54H01 |
| 07 | MC54H22 |
| **MIL-M-38510/024 High-Speed NAND Buffer** | |
| 01 | MC54H40 |
| **MIL-M-38510/025 Low-Power Counters** | |
| 01 | MC54L90* |
| 02 | MC54L93* |
| **MIL-M-38510/026 Low-Power Exclusive OR Gate** | |
| 01 | MC54L86* |
| **MIL-M-38510/027 Low-Power NOR Gate** | |
| 01 | MC54L02* |
| **MIL-M-38510/028 Low-Power Shift Registers** | |
| 01 | MC54L95* |
| 02 | MC54L164* |
| 03 | MC93L28* |
| 04 | MC93L00* |
| 05 | MC76L70* |
| **MIL-M-38510/029 Low-Power Decoders** | |
| 01 | MC54L42* |
| 02 | MC54L43* |
| 03 | MC54L44* |
| 04 | MC54L46* |
| 05 | MC54L47* |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/040 High-Speed AND-OR-INVERT Gates** | |
| 01 | MC54H50 |
| 02 | MC54H51 |
| 03 | MC54H53 |
| 04 | MC54H54 |
| 05 | MC54H55 |
| **MIL-M-38510/041 Low-Power AND-OR-INVERT Gates** | |
| 01 | MC54L51* |
| 02 | MC54L54* |
| 03 | MC54L55* |
| **MIL-M-38510/042 Low-Power Monostable Multivibrator** | |
| 01 | MC54L121* |
| 02 | MC54L122* |
| **MIL-M-38510/043 Low-Power Priority Encoders** | |
| 01 | MC93L18* |
| **MIL-M-38510/044 Low-Power Comparators** | |
| 01 | MC93L24* |
| **MIL-M-38510/045 Low-Power Bistable Latches** | |
| 01 | MC93L14* |
| 02 | MC93L08* |
| **MIL-M-38510/046 Low-Power Data Selectors/Multiplexers** | |
| 01 | MC93L09* |
| 02 | MC93L12* |
| 03 | MC93L22* |
| **MIL-M-38510/070–082 Schottky Series** | |
| Not planned for immediate production | |
| **MIL-M-38510/150 Magnitude Comparators** | |
| 01 | MC5485 |
| 02 | MC9324 |
| **MIL-M-38510/151 Schmitt Triggers** | |
| 01 | MC5413 |
| 02 | MC5414 |
| 03 | MC54132 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/152 Data Decoders/Demultiplexers** | |
| 01 | MC54154 |
| 02 | MC54155 |
| 03 | MC54156 |
| 04 | MC8250* |
| 05 | MC8251* |
| 06 | MC9301 |
| **MIL-M-38510/153 Quadruple Bus Buffer Gates with 3-State Outputs** | |
| 01 | MC54125* |
| 02 | MC54126* |
| **MIL-M-38510/155 High-Speed AND Gates** | |
| 01 | MC54H08 |
| 02 | MC54H11 |
| 03 | MC54H21 |
| **MIL-M-38510/156 Data Encoders** | |
| 01 | MC54147* |
| 02 | MC54148* |
| 03 | MC9318 |
| **MIL-M-38510/157 Multiple Port Registers** | |
| 01 | MC9338* |
| **MIL-M-38510/158 Decoders** | |
| 01 | MC9321* |
| 02 | MC9317 |
| **MIL-M-38510/159 Shift Registers** | |
| 01 | MC9300 |
| 02 | MC9328 |
| **MIL-M-38510/160 Addressable Latches** | |
| 01 | MC9334* |
| **MIL-M-38510/161 Common OR Gates** | |
| 01 | MC5432* |
| **MIL-M-38510/162 NOR Buffers** | |
| 01 | MC5428* |
| **MIL-M-38510/163 Hex Bus Drivers 3-State Outputs** | |
| 01 | MC54365* |
| 02 | MC54366* |
| 03 | MC54367* |
| 04 | MC54368* |

*Not presently being manufactured or planned for immediate introduction.
**JAN type number must be completed as shown in the Part Number description.



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## TABLE I – JAN PART NUMBER TO MOTOROLA PART NUMBER CROSS-REFERENCE (continued)

### MTTL INTEGRATED CIRCUITS (continued)

| MIL-M-38510/300 Low-Power Schottky NAND Gates | |
|---|---|
| 01 | SN54LS00 |
| 02 | SN54LS03 |
| 03 | SN54LS04 |
| 04 | SN54LS05 |
| 05 | SN54LS10 |
| 06 | SN54LS12 |
| 07 | SN54LS20 |
| 08 | SN54LS22 |
| 09 | SN54LS30 |

| MIL-M-38510/301 Low-Power Schottky Flip-Flops | |
|---|---|
| 01 | SN54LS73 |
| 02 | SN54LS74 |
| 03 | SN54LS112 |
| 04 | SN54LS113 |
| 05 | SN54LS114 |
| 06 | SN54LS174 |
| 07 | SN54LS175 |
| 08 | SN54LS107 |
| 09 | SN54LS109 |
| 10 | SN54LS76 |

| MIL-M-38510/302 Low-Power NAND Buffers | |
|---|---|
| 01 | SN54LS40 |
| 02 | SN54LS37 |
| 03 | SN54LS38 |
| 04 | SN54LS28 |

| MIL-M-38510/303 Low-Power Schottky NOR Gates | |
|---|---|
| 01 | SN54LS02 |
| 02 | SN54LS27 |
| 03 | SN54LS266 |

| MIL-M-38510/304 Low-Power Schottky AND-OR-INVERT Gates | |
|---|---|
| 01 | SN54LS51 |
| 02 | SN54LS54 |

| MIL-M-38510/305 Low-Power Schottky OR Gates | |
|---|---|
| 01 | SN54LS32 |
| 02 | SN54LS86 |

| MIL-M-38510/306 Low-Power Schottky Shift Registers | |
|---|---|
| 01 | SN54LS194 |
| 02 | SN54LS195 |
| 03 | SN54LS95 |
| 04 | SN54LS96 |
| 05 | SN54LS164 |
| 06 | SN54LS295 |
| 07 | SN54LS395 |

| MIL-M-38510/307 Low-Power Schottky Decoders | |
|---|---|
| 01 | SN54LS138 |
| 02 | SN54LS139 |
| 03 | SN54LS42 |
| 04 | SN54LS47 |

| MIL-M-38510/308 Low-Power Schottky ALU/Function Gen. | |
|---|---|
| 01 | SN54LS181 |

| MIL-M-38510/309 Low-Power Schottky Data Selector/Multipliers | |
|---|---|
| 01 | SN54LS151 |
| 02 | SN54LS153 |
| 03 | SN54LS157 |
| 04 | SN54LS158 |
| 05 | SN54LS251 |
| 06 | SN54LS257 |
| 07 | SN54LS258 |
| 08 | SN54LS253 |

| MIL-M-38510/310 Low-Power Schottky AND Gates | |
|---|---|
| 01 | SN54LS11 |
| 02 | SN54LS15 |
| 03 | SN54LS21 |
| 04 | SN54LS08 |

| MIL-M-38510/311 Low-Power Schottky Magnitude Comparators | |
|---|---|
| 01 | SN54LS85 |

| MIL-M-38510/312 Low-Power Schottky 4-Bit Binary Full Adders with Fast Carry | |
|---|---|
| 01 | SN54LS83 |
| 02 | SN54LS283 |

| MIL-M-38510/313 Low-Power Schottky Schmitt-Trigger Positive NAND Gates and Inverters | |
|---|---|
| 01 | SN54LS13 |
| 02 | SN54LS14 |
| 03 | SN54LS132 |

| MIL-M-38510/314 Low-Power Schottky Monostable Multivibrator | |
|---|---|
| 01 | SN54LS123 |
| 02 | SN54LS221 |
| 03 | SN54LS122 |

| MIL-M-38510/315 Low-Power Schottky Counter | |
|---|---|
| 01 | SN54LS90 |
| 02 | SN54LS93 |
| 03 | SN54LS160 |
| 04 | SN54LS161 |
| 05 | SN54LS168 |
| 06 | SN54LS169 |
| 07 | SN54LS192 |
| 08 | SN54LS193 |
| 09 | SN54LS191 |
| 10 | SN54LS92 |
| 11 | SN54LS162 |
| 12 | SN54LS163 |
| 13 | SN54LS190 |

| MIL-M-38510/320 Low-Power Schottky Counters | |
|---|---|
| 01 | SN54LS290 |
| 02 | SN54LS293 |

| MIL-M-38510/321 Low-Power Schottky NAND Buffers | |
|---|---|
| 02 | SN54LS26 |

| MIL-M-38510/322 Low-Power Schottky Bus Drivers | |
|---|---|
| 01 | SN54LS365 |
| 02 | SN54LS366 |
| 03 | SN54LS367 |
| 04 | SN54LS368 |

| MIL-M-38510/323 Low-Power Schottky Quad Buffer Gates | |
|---|---|
| 01 | SN54LS125 |
| 02 | SN54LS126 |

### MDTL INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| MIL-M-38510/030 NAND Gates | |
| 01 | MC930 |
| 02 | MC935 |
| 03 | MC936 |
| 04 | MC946 |
| 05 | MC962 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| MIL-M-38510/031 NAND Buffer/Expander | |
| 01 | MC932 |
| 02 | MC944 |
| 03 | MC957 |
| 04 | MC958 |
| 05 | MC933 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| MIL-M-38510/032 Monostable Multivibrator | |
| 01 | MC951 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| MIL-M-38510/033 Flip-Flops | |
| 01 | MC945 |
| 02 | MC948 |
| 03 | MC950 |
| 04 | MC9093** |

*Not presently being manufactured or planned for immediate introduction.
**JAN type number must be completed as shown in the Part Number Description.



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## TABLE I – JAN PART NUMBER TO MOTOROLA PART NUMBER CROSS-REFERENCE (continued)

### McMOS INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/050 NAND Gates** | |
| 01 | MC14011A |
| 02 | MC14012A |
| 03 | MC14023A |
| **MIL-M-38510/051 Flip-Flops** | |
| 01 | MC14013B |
| 02 | MC14027B |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/052 NOR Gates** | |
| 01 | MC14000A |
| 02 | MC14001A |
| 03 | MC14002A |
| 04 | MC14025A |
| **MIL-M-38510/053 AND-OR-INVERT Gates** | |
| 01 | MC14007B |
| 02 | MC14019A* |
| 03 | MC14070B |
| **MIL-M-38510/054 4-Bit Full Adder** | |
| 01 | MC14008B |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/055 Buffers/Converters** | |
| 01 | MC1409A* |
| 02 | MC14010A* |
| 03 | MC14049B |
| 04 | MC14050B |
| 05 | MC14041A* |
| **MIL-M-38510/056 Counters/Dividers** | |
| 01 | MC14017B |
| 02 | MC14018B |
| 03 | MC14020B |
| 04 | MC14022B |
| 05 | MC14024B |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/057 Static Shift Registers** | |
| 01 | MC14006B |
| 02 | MC14014B |
| 03 | MC14015B |
| 04 | MC14021B |
| 05 | MC14031A* |
| 06 | MC14034B |

### MECL 10,000 INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/060 OR/NOR Gates** | |
| 01 | MC10501 |
| 02 | MC10502 |
| 03 | MC10505 |
| 04 | MC10506 |
| 05 | MC10507 |
| 06 | MC10509 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/061 Flip-Flops** | |
| 01 | MC10531 |
| 02 | MC10631 |
| 03 | MC10576 |
| 04 | MC10535 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/062 AND/NAND Gates** | |
| 01 | MC10504 |
| 02 | MC10597 |

### LINEAR INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/101 Operational Amplifiers** | |
| 01 | MC1741 |
| 02 | MC1747 |
| 03 | MLM101A |
| 04 | MLM108A |
| 05 | MLH2101A* |
| 06 | MLH2108A* |
| 07 | MLM118* |
| **MIL-M-38510/102 Voltage Regulator** | |
| 01 | MC1723 |
| **MIL-M-38510/103 Voltage Comparators** | |
| 01 | MC1710 |
| 02 | MC1711 |
| 03 | MLM106* |
| 04 | MLM111* |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/104 Line Drivers and Receivers** | |
| 01 | MC55107 |
| 02 | MC55108 |
| 03 | MC9614* |
| 04 | MC9615* |
| 05 | MC55113* |
| 06 | MC7831* |
| 07 | MC7832* |
| **MIL-M-38510/106 Voltage Follower Operational Amplifiers** | |
| 01 | MLM102* |
| 02 | MLM110 |
| **MIL-M-38510/107 Voltage Regulator** | |
| 01 | MLM109 |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/108 Transistor Array** | |
| 01 | MC3018A* |
| 02 | MC3045* |

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/035 Clock Driver** | |
| 01 | MMH0026 |

### MEMORIES

| JAN Part No.** | Motorola Standard Part No. |
|---|---|
| **MIL-M-38510/201 Programmable Read Only Memories** | |
| 01 | MCM5303 |
| 02 | MCM5304 |

*Not presently being manufactured or planned for immediate introduction.
**JAN type number must be completed as shown in the Part Number description.



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MOTOROLA

# CATALOG INDEX

A complete index of type numbers in alphanumerical order for instant device identification. Many of the devices are referred by page number to more comprehensive tables in this book. Device types that are not referenced are, nevertheless, manufactured and inventoried by Motorola, but are suggested principally for replacement purposes.


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