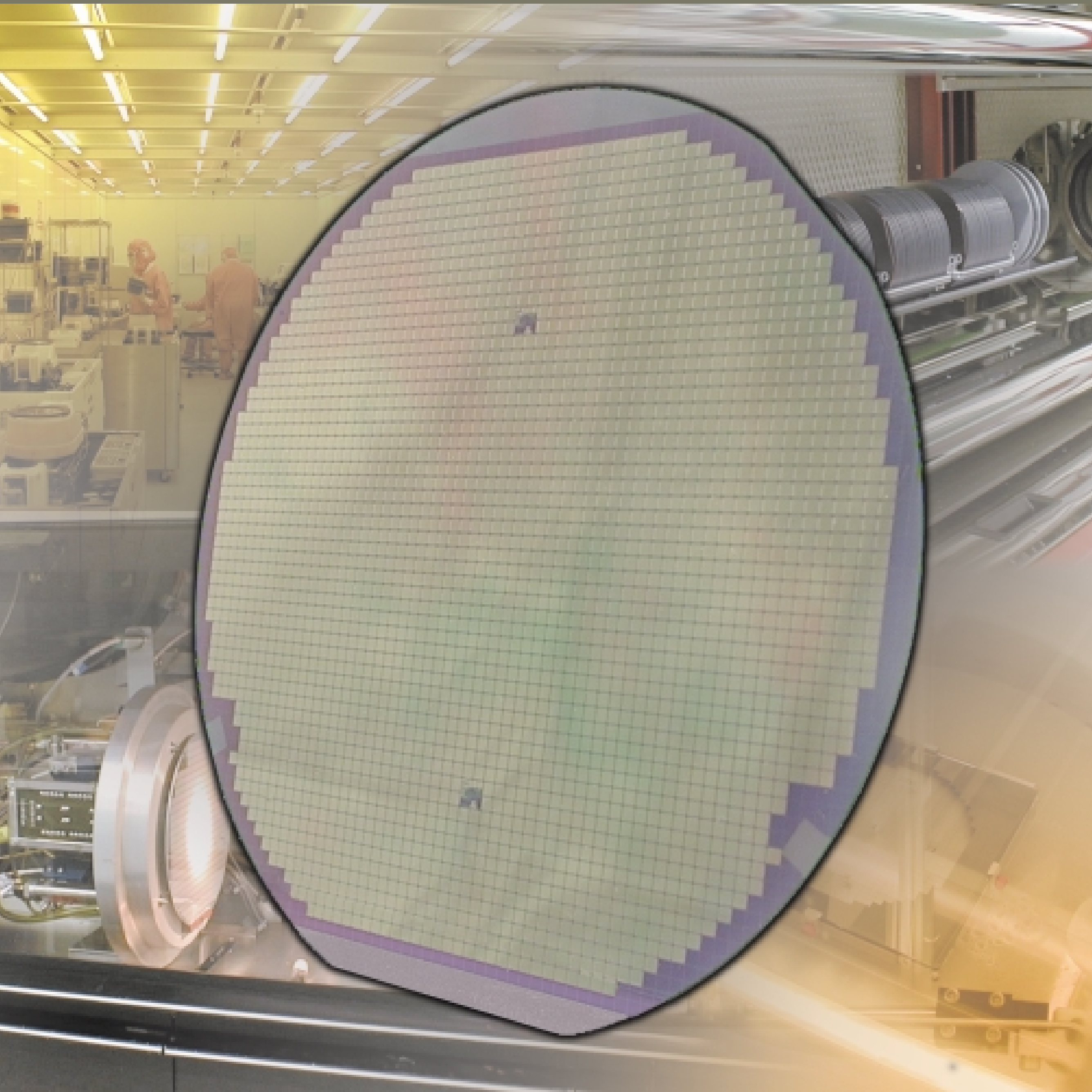
SG388/D
Rev. 1, Aug-1999

Master Components Selector Guide

ON Semiconductor
Formerly a Division of Motorola



ON Semiconductor Components Selector Guide

Analog, Logic and Discretes Products

SG388/D
Rev. 1, Aug–1999

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Analog Integrated Circuits

In Brief . . .

ON Semiconductor Analog Integrated Circuits cover a much broader range of products than the traditional op amps/regulators/consumer–image associated with Analog suppliers. Analog circuit technology currently influences the design and architecture of equipment for all major markets. As with other integrated circuit technologies, Analog circuit design techniques and processes have been continually refined and updated to meet the needs of these diversified markets.

Operational amplifiers have utilized *SMARTMOS*™ technology for improved performance, plus innovative design and trimming concepts have evolved for improved high performance and precision characteristics. In analog power ICs, basic voltage regulators have been refined to include higher current and voltage levels, low dropout regulators, CMOS technology, and more precise three–terminal fixed and adjustable voltages. The power area continues to expand into switching regulators, power supply control and supervisory circuits, motor controllers, and battery charging controllers and protection circuits.

The table of contents provides a perspective of the many markets served by Analog ICs and of ON Semiconductor's involvement in these areas.

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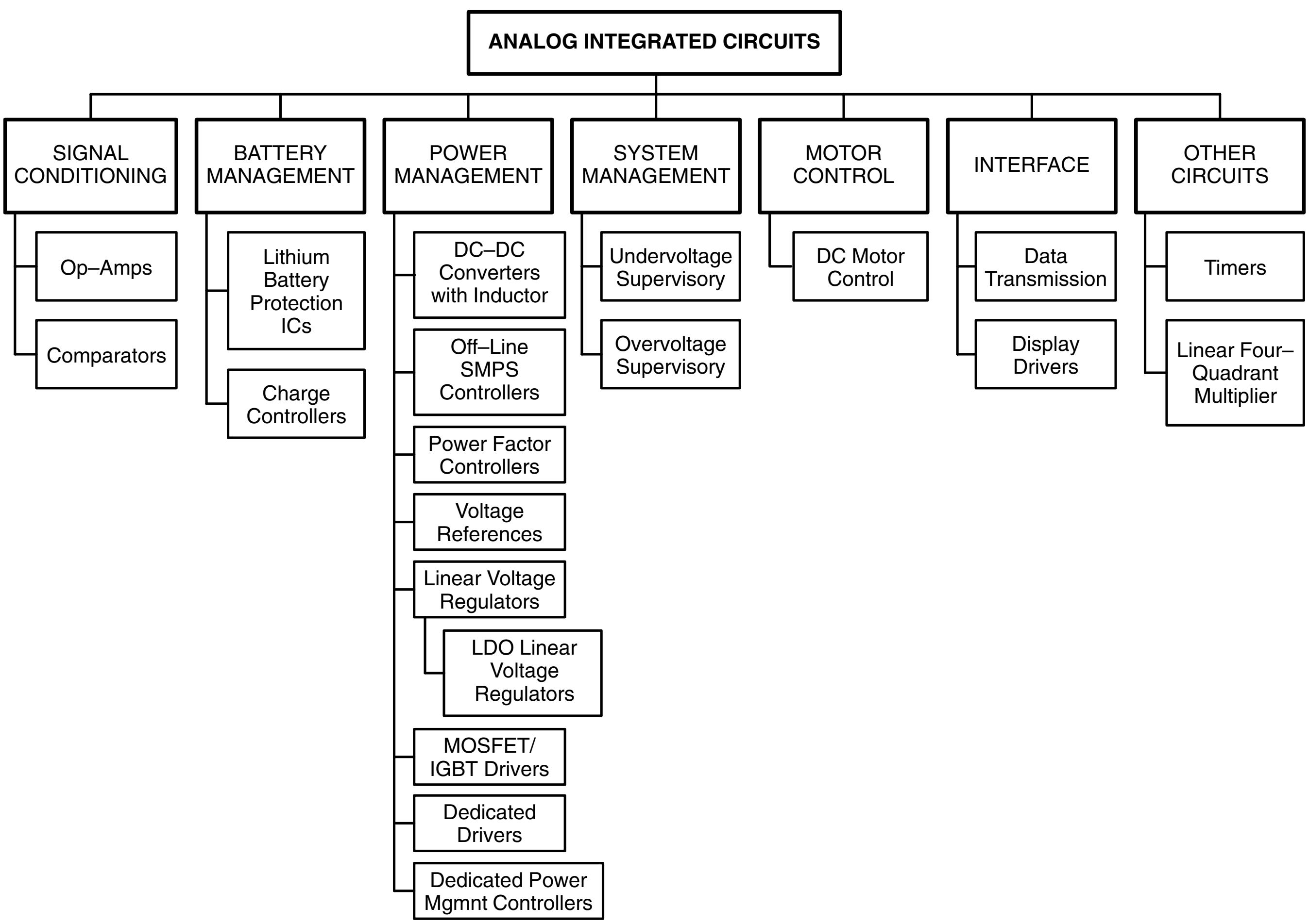

Signal Conditioning

In Brief . . .

For over two decades, ON Semiconductor has continually refined and updated integrated circuit technologies, analog circuit design techniques and processes in response to the needs of the marketplace. The enhanced performance of newer operational amplifiers and comparators has come through innovative application of these technologies, designs and processes. Some early designs are still available but are giving way to the new, higher performance operational amplifier and comparator circuits. ON Semiconductor has pioneered in JFET inputs, low temperature coefficient input stages, Miller loop compensation, all NPN output stages, dual–doublet frequency compensation and analog "in–the–package" trimming of resistors to produce superior high performance operational amplifiers and comparators, operating in many cases from a single supply with low input offset, low noise, low power, high output swing, high slew rate and high gain–bandwidth product at reasonable cost to the customer.

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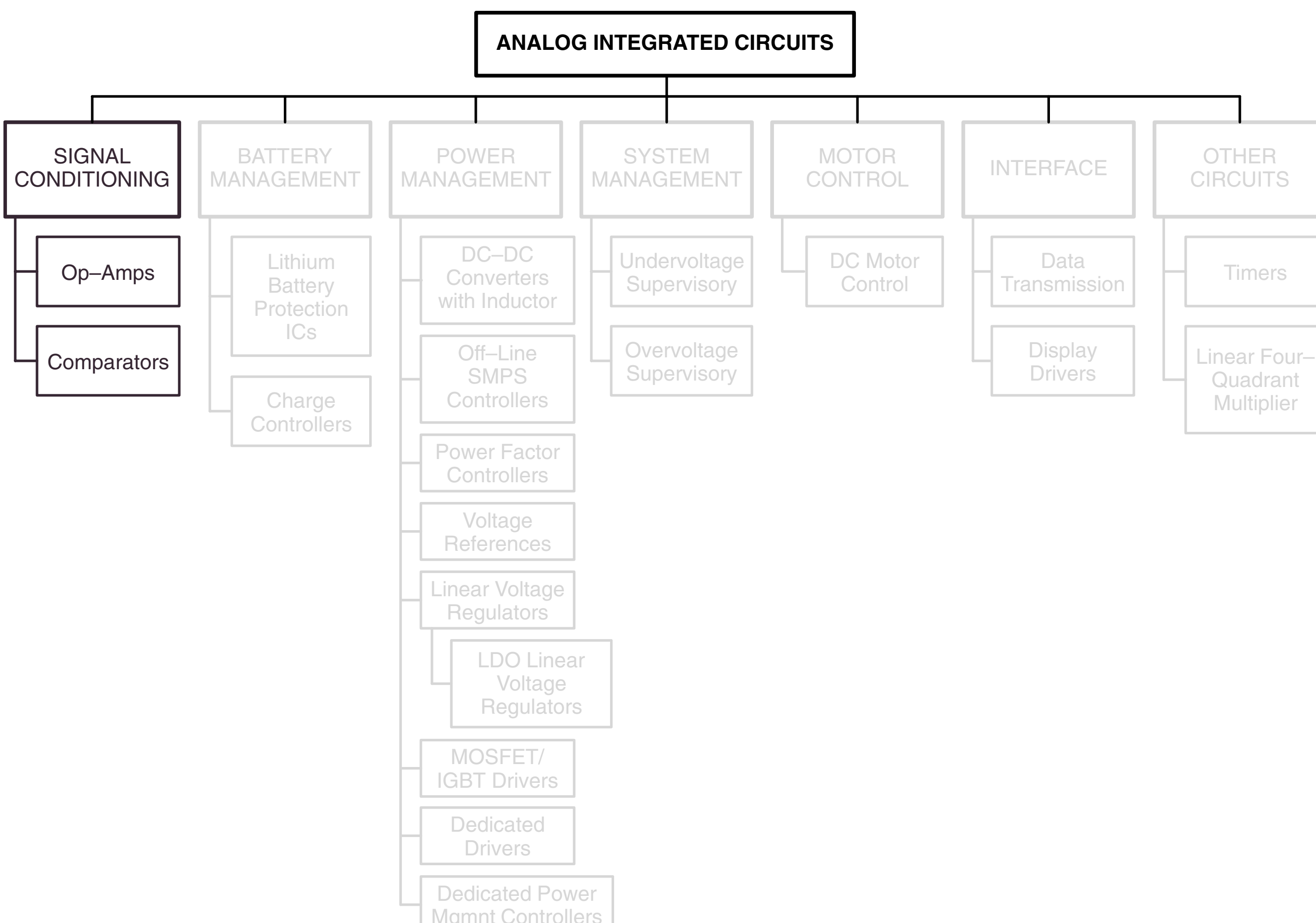
Present day operational amplifiers and comparator find applications in all market segments including motor controls, instrumentation, aerospace, automotive, telecommunications, medical, and consumer products.



Operational Amplifiers

ON Semiconductor offers a broad line of bipolar operational amplifiers to meet a wide range of applications. From low–cost industry–standard types to high precision circuits, the span encompasses a large range of performance capabilities. These Analog integrated circuits are available as single, dual and quad monolithic devices in a variety of temperature ranges and package styles. Most devices may be obtained in unencapsulated "chip" form as well. For price and delivery information on chips, please contact your ON Semiconductor Sales Representative or Distributor.

Table 1. Single Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Package
Noncompensated											
Commercial Temperature Range (0°C to +70°C)											
LM301A	0.25	7.5	10	50	25	1.0	0.5	±3.0	±18	General Purpose	DIP–8, SO–8
LM308A	7.0	0.5	5.0	1.0	80	1.0	0.3	±3.0	±18	Precision	DIP–8, SO–8
Industrial Temperature Range (–25°C to +85°C)											
LM201A	0.075	2.0	10	10	50	1.0	0.5	±3.0	±22	General Purpose	DIP–8, SO–8
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF351	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
LF411C	200 pA	2.0	10	100 pA	25	8.0	25	+5.0	±22	JFET Input, Low Offset, Low Drift	DIP–8, SO–8
MC1436, C	0.04	10	12	10	70	1.0	2.0	±15	±34	High Voltage	DIP–8, SO–8
MC1741C	0.5	6.0	15	200	20	1.0	0.5	±3.0	±18	General Purpose	DIP–8, SO–8
MC1776C	0.003	6.0	15	3.0	100	1.0	0.2	±1.2	±18	µPower, Programmable	DIP–8, SO–8
MC34001	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
MC34071	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	DIP–8, SO–8
MC34071A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	DIP–8, SO–8
MC34080B	200 pA	1.0	10	100 pA	25	16	55	±5.0	±22	Decompensated	DIP–8, SO–8
MC34081B	200 pA	1.0	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	DIP–8, SO–8
MC34181	0.1 nA	2.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
TL081AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
TL081C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
Automotive Temperature Range (–40°C to +85°C)											
MC33071	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	DIP–8, SO–8
MC33071A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	DIP–8, SO–8
MC33171	0.1	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	DIP–8, SO–8
MC33181	0.1 nA	2.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8

Table 1. Single Operational Amplifiers (continued)

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/μs) Typ	Supply Voltage (V) Min	Max	Description	Package
Extended Temperature Range (–40°C to +105°C)											
MC33201	250 nA	9.0	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	DIP–8, SO–8
Military Temperature Range (–55°C to +125°C)											
MC33201	400 nA	9.0	2.0	200	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	DIP–8, SO–8

Table 2. Dual Operational Amplifiers

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/μs) Typ	Supply Voltage (V) Min	Max	Description	Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF353	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
LF412C	200 pA	3.0	10	100 pA	25	4.0	13	+5.0	±18	JFET Input, Low Offset, Low Drift	DIP–8, SO–8
LF442C	100 pA	5.0	10	50 pA	25	2.0	6.0	±5.0	±18	Low Power, JFET Input	DIP–8, SO–8
LM358	0.25	6.0	7.0	50	25	1.0	0.6	±1.5 +3.0	±18 +36	Single Supply, Low Power Consumption	DIP–8, SO–8
LM833	1.0	5.0	2.0	200	31.6	15	7.0	+2.5	±18	Low Noise, Audio	DIP–8, SO–8
MC1458	0.5	6.0	10	200	20	1.1	0.8	±3.0	±18	Dual MC1741	DIP–8, SO–8
MC1458C	0.7	10	10	300	20	1.1	0.8	±3.0	±18	General Purpose	DIP–8, SO–8
MC3458	0.5	10	7.0	50	20	1.0	0.6	±1.5 +3.0	±18 +36	Split Supplies, Single Supply, Low Crossover Distortion	DIP–8, SO–8
MC4558C	0.5	6.0	10	200	20	2.8	1.6	±3.0	±18	High Frequency	DIP–8, SO–8
MC34002	100 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
MC34002B	100 pA	5.0	10	70 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
MC34072	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	DIP–8, SO–8
MC34072A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	DIP–8, SO–8
MC34082	200 pA	3.0	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	DIP–8
MC34083B	200 pA	3.0	10	100 pA	25	16	55	±5.0	±22	Decompensated	DIP–8
MC34182	0.1 nA	3.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
TL062AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
TL062C	200 pA	15	10	200 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
TL072AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	DIP–8, SO–8
TL072C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	DIP–8, SO–8
TL082AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8
TL082C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–8, SO–8

Table 2. Dual Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Package
Internally Compensated											
Industrial Temperature Range (–25°C to +85°C)											
LM258	0.15	5.0	10	30	50	1.0	0.6	±1.5 +3.0	±18 +36	Split or Single Supply Op Amp	DIP–8, SO–8
Automotive Temperature Range (–40°C to +85°C) (continued)											
MC3358	5.0	8.0	10	75	20	1.0	0.6	±1.5 +3.0	±18 +36	Split or Single Supply	DIP–8, SO–8
MC33072	0.50	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	DIP–8, SO–8
MC33072A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	DIP–8, SO–8
MC33076	0.5	4.0	2.0	70	25	7.4	2.6	±2.0	±18	High Output Current	DIP–8, SO–8
MC33077	1.0	1.0	2.0	180	150	37	11	±2.5	±18	Low Noise	DIP–8, SO–8
MC33078	750 nA	2.0	2.0	150	31.6	16	7.0	±5.0	±18	Low Noise	DIP–8, SO–8
MC33102											DIP–8, SO–8
(Awake)	600 nA	3.0	1.0	60	25	4.6	1.7	±2.5	±18	Sleep–Mode™	
(Sleep)	60 nA	3.0	1.0	6.0	15	0.3	0.1	±2.5	±18	Micropower	
MC33172	0.10	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	DIP–8, SO–8
MC33178	0.5	3.0	2.0	50	50	5.0	2.0	±2.0	±18	High Output Current	DIP–8, SO–8
MC33182	0.1 nA	3.0	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
MC33272A	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	±1.5	±18	High Performance	DIP–8, SO–8
MC33282	100 pA	200 µV	5.0	50 pA	50	30	12	±2.5	±18	Low Input, Offset JFET	DIP–8, SO–8
TL062V	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–8, SO–8
Extended Temperature Range (–40°C to +105°C)											
MC33202	250 nA	11	2.0	100	50	2.2	1.0	±0.9	±6.0	Low Voltage Rail–to–Rail	DIP–8, SO–8 Micro–8
MC33206										Rail–to–Rail with Enable	DIP–8, SO–8
MC33502	40 fA typ	0.5 typ	2.0 typ	–	100 typ	4.0 typ	4.0 typ	+0.9	+7.0	1.0 V Rail–to–Rail	DIP–8, SO–8
LM2904	0.25	10	7.0	50	100 typ	1.0	0.6	±1.5 +3.0	±13 +26	Split or Single Supply	DIP–8, SO–8

Table 2. Dual Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Package
Internally Compensated											
Extended Automotive Temperature Range (–40°C to +125°C)											
TCA0372	500 nA	15	20	50	30	1.1	1.4	+5.0	+36	Power Op Amp, Single Supply	DIP–8, DIP–16, SO–16L
LM2904V	0.25	13	7.0	50	100 typ	1.0	0.6	±1.5 +3.0	±13 +26	Split or Single Supply	DIP–8, SO–8
Military Temperature Range (–55°C to +125°C)											
MC33202	400 pA	11	2.0	200 pA	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	DIP–8, SO–8

Table 3. Quad Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF347	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–14
LF347B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	DIP–14
LF444C	100 pA	10	10	50 pA	25	2.0	6.0	±5.0	±18	Low Power, JFET Input	DIP–14, SO–14
LM324, A	0.25	6.0	7.0	50	25	1.0	0.6	±1.5 +3.0	±16 +32	Low Power Consumption	DIP–14, SO–14
MC3403	0.5	10	7.0	50	20	1.0	0.6	±1.5 +3.0	±18 +36	No Crossover Distortion	DIP–14, SO–14
MC4741C	0.5	6.0	15	200	20	1.0	0.5	±3.0	±18	Quad MC1741	DIP–14, SO–14
MC34004	200 pA	10	10	100 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–14
MC34004B	200 pA	5.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	DIP–14
MC34074	0.5	5.0	10	75	25	4.5	10	+3.0	+44	High Performance	DIP–14, SO–14
MC34074A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	Single Supply	DIP–14, SO–14
MC34084	200 pA	12	10	100 pA	25	8.0	30	±5.0	±22	High Speed, JFET Input	DIP–14, SO–16L
MC34184	0.1 nA	10	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–14, SO–14
TL064AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–14, SO–14
TL064C	200 pA	15	10	200 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–14, SO–14
TL074AC	200 pA	6.0	10	50 pA	50	4.0	13	±5.0	±18	Low Noise, JFET Input	DIP–14
TL074C	200 pA	10	10	50 pA	25	4.0	13	±5.0	±18	Low Noise, JFET Input	DIP–14
TL084AC	200 pA	6.0	10	100 pA	50	4.0	13	±5.0	±18	JFET Input	DIP–14
TL084C	400 pA	15	10	200 pA	25	4.0	13	±5.0	±18	JFET Input	DIP–14

Table 3. Quad Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Package
Industrial Temperature Range (–25°C to +85°C)											
LM224	0.15	5.0	7.0	30	50	1.0	0.6	±1.5 +3.0	±16 +32	Split Supplies or Single Supply	DIP–14, SO–14
Automotive Temperature Range (–40°C to +85°C)											
MC3303	0.5	8.0	10	75	20	1.0	0.6	±1.5 +3.0	±18 +36	Differential General Purpose	DIP–14, SO–14
MC33074	0.5	4.5	10	75	25	4.5	10	+3.0	+44	High Performance, Single Supply	DIP–14, SO–14
MC33074A	500 nA	3.0	10	50	50	4.5	10	+3.0	+44	High Performance	DIP–14, SO–14
MC33079	750 nA	2.5	2.0	150	31.6	9.0	7.0	±5.0	±18	Low Noise	DIP–14, SO–14
MC33174	0.1	4.5	10	20	50	1.8	2.1	+3.0	+44	Low Power, Single Supply	DIP–14, SO–14
MC33179	0.5	3.0	2.0	50	50	5.0	2.0	±2.0	±18	High Output Current	DIP–14, SO–14
MC33184	0.1 nA	10	10	0.05	25	4.0	10	±2.5	±18	Low Power, JFET Input	DIP–14, SO–14
MC33274A	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	±1.5	±18	High Performance	DIP–14, SO–14
MC33284	100 pA	2.0	5.0	50 pA	50	30	12	±2.5	±18	Low Input, Offset JFET	DIP–14, SO–14
TL064V	200 pA	9.0	10	100 pA	4.0	2.0	6.0	±2.5	±18	Low Power, JFET Input	DIP–14, SO–14
Extended Temperature Range (–40°C to +105°C)											
MC33204	250 nA	13	2.0	100	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	DIP–14, SO–14
MC33207					50	2.2		±0.9	±6.0	Rail–to–Rail with Enable	DIP–14, SO–14
MC33304					25	3.0		+1.8	+12	Sleepmode, Rail–to–Rail	DIP–14, SO–14
LM2902	0.5	10	–	50	15	1.0	0.6	±1.5 +3.0	±13 +26	Differential Low Power	DIP–14, SO–14
Extended Automotive Temperature Range (–40°C to +125°C)											
LM2902V	0.5	13	–	50	15	1.0	0.6	±1.5 +3.0	±13 +26	Differential Low Power	DIP–14, SO–14
Military Temperature Range (–55°C to +125°C)											
MC33204	400 pA	13	2.0	200 pA	50	2.2	1.0	±0.9	±6.0	Low V Rail–to–Rail	DIP–14, SO–14

One Volt SMARTMOS™ Rail–to–Rail Dual Operational Amplifier

MC33502D, P

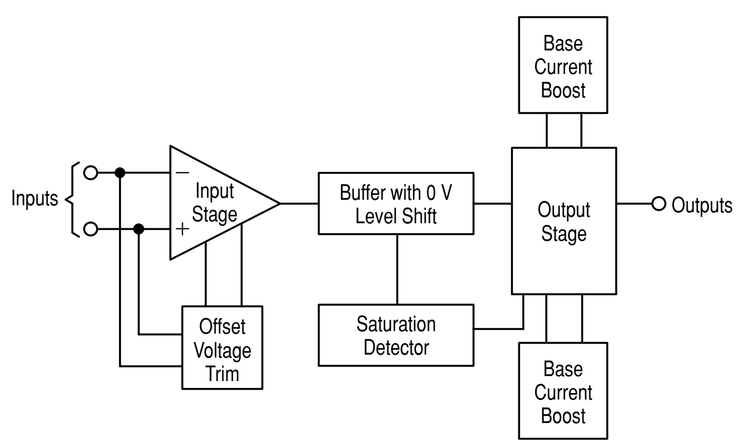
T_A = –40° to +105°C, DIP–8, SO–8 Packages

The MC33502 operational amplifier provides rail–to–rail operation on both the input and output. The output can swing within 50 mV of each rail. This rail–to–rail operation enables the user to make full use of the entire supply voltage range available. It is designed to work at very low supply voltages (1.0 V and ground), yet can operate with a supply of up to 7.0 V and ground. Output current boosting techniques provide high output current capability while keeping the drain current of the amplifier to a minimum.

- Low Voltage, Single Supply Operation (1.0 V and Ground to 7.0 V and Ground)
- High Input Impedance: Less than 40 fA Input Current
- Typical Unity Gain Bandwidth @ 5.0 V = 5.0 MHz, @ 1.0 V = 4.0 MHz
- High Output Current (I_{SC} = 50 mA @ 5.0 V, 10 mA @ 1.0 V)
- Output Voltage Swings within 50 mV of Both Rails
- Input Voltage Range Includes Both Supply Rails
- High Voltage Gain: 100 dB
- No Phase Reversal on the Output for Over–Driven Input Signals
- Input Offset Trimmed to <500 µV Typical
- Low Supply Current (I_D = 1.2 mA, Typical)
- 600 Ω Drive Capability
- Extended Operating Temperature Range (–40° to 105°C)

APPLICATIONS

- Single Cell NiCd/Ni MH Powered Systems
- Single Cell Lithium Powered Systems
- Portable Communication Devices
- Low Voltage Active Filters
- General Systems Requiring Battery Power



Miscellaneous Amplifiers

ON Semiconductor provides several Bipolar and CMOS special purpose amplifiers which fill specific needs. These devices range from low power CMOS programmable amplifiers and comparators to variable–gain bipolar power amplifiers.

MC3405
Dual Operational Amplifier and Dual Voltage Comparator

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."

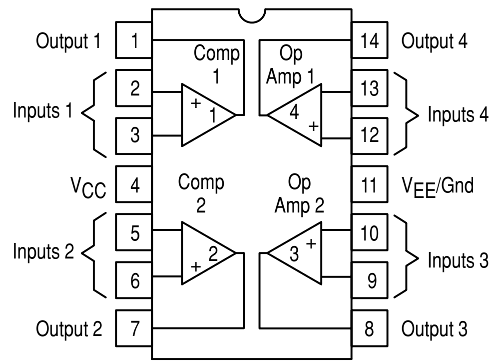


Table 4. Bipolar

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (nA) Max	A_{vol} (V/mV) Min	Response (µs) Typ	Supply Voltage Single	Supply Voltage Dual	Package
MC3405	0.5	10	50	20	1.3	3.0 to 36	±1.5 to ±18	DIP–14

MC14573
Quad Programmable Operational Amplifier
MC14575
Dual Programmable Operational Amplifier and Dual Programmable Comparator

Table 5. CMOS

Function	Quantity Per Package	Single Supply Voltage Range	Dual Supply Voltage Range	Frequency Range	Device	Package
Operational Amplifiers	4	3.0 to 15 V	±1.5 to ±7.5 V	DC to 1.0 MHz	MC14573	DIP–16, SO–16
Operational Amplifiers and Comparators	2 and 2	3.0 to 15 V	±1.5 to ±7.5 V	DC to 1.0 MHz	MC14575	DIP–16, SO–16

(1) 5.0 to 10 V for surface mount package.
(2) ±2.5 to ±5.0 V for surface mount package.

Comparators

Table 6. Single Comparators

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	I_{IO} (μA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Package
Bipolar										
LM211 LM311	0.1 0.25	3.0 7.5	0.01 0.05	200 k	8.0	200	+15, –15	With strobe, will operate from single supply	–25 to +85 0 to +70	SO–8 SO–8, DIP–8

Table 7. Dual Comparators

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	I_{IO} (μA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Package
Bipolar										
LM393 LM393A LM2903 LM2903V	0.25	5.0 2.0 7.0 7.0	0.05	200 k	6.0	1300 1300 1500 1500	±1.5 to ±18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	0 to +70 0 to +70 –40 to +105 –40 to +125	SO–8, DIP–8
MC3405	0.5	10	0.05	200 k	6.0	1300	±1.5 to ±7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	0 to +70	DIP–14
CMOS										
MC14575	0.001	30	0.0001	2.0 k	3.0	1000	±1.5 to ±7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	–40 to +85	DIP–16, SO–16

Table 8. Quad Comparators

Device	I_{IB} (μA) Max	V_{IO} (mV) Max	I_{IO} (μA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Package
Bipolar										
LM239 LM239A LM339 LM339A LM2901 LM2901V MC3302	0.25 0.5	5.0 2.0 5.0 2.0 7.0 7.0 20	0.05 0.5	200 k 200 k 200 k 200 k 100 k 100 k 100 k	6.0	1300	±1.5 to ±18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	–25 to +85 –25 to +85 0 to +70 0 to +70 –40 to +85 –40 to +125 –40 to +85	DIP–14, SO–14 DIP–14, SO–14
CMOS										
MC14574	0.001	30	0.0001	2.0 k	3.0	1000	±1.5 to ±7.5 or 3.0 to 15	Externally programmable power dissipation with 1 or 2 resistors	–40 to +85	DIP–16, SO–16

Battery Management

In Brief . . .

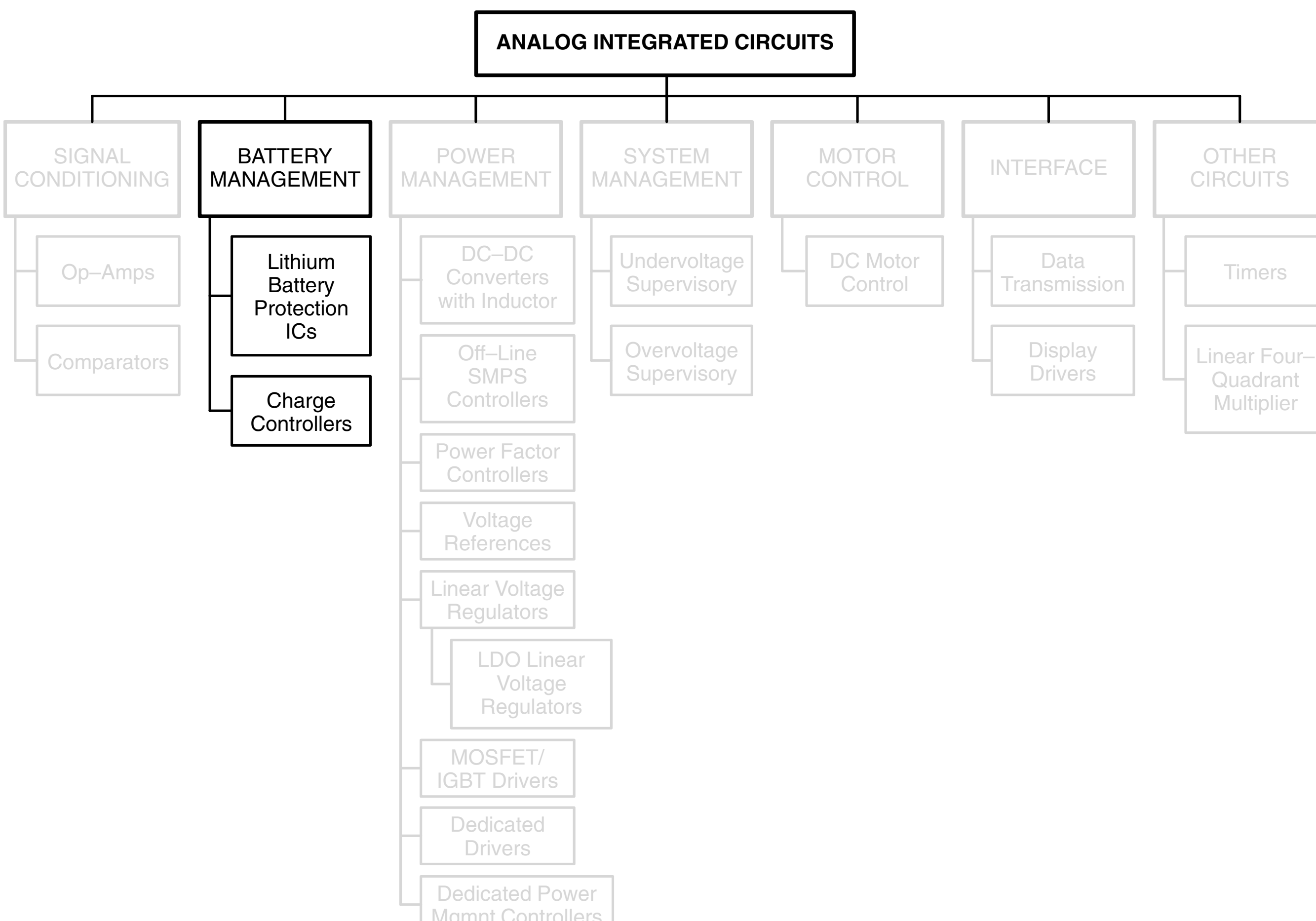
Battery management encompasses many functions and features for power conversion in portable electronics and ON Semiconductor offers charge control and battery pack protection IC's for these critical applications.

Battery charging requires that both safety and performance issues be addressed. It is important to know when to start and stop the charging activity so the battery is not overcharged or subjected to conditions that might damage the battery or degrade its performance.

The charging IC maintains precise control of output voltage and current in order to prevent damage to the battery. Instead of using a myriad of discrete devices, ON Semiconductor offers integrated charging IC solutions to close the voltage and current feedback loop circuit that incorporates a voltage and current amplifier, level shifting circuitry, summing circuitry, and a reference. ON Semiconductor's charge controllers are targeted for Nickel–based batteries, NiCd and/or NiMH.

Battery protection IC's perform critical charge and discharge control within the battery pack as well as overcurrent and undervoltage protection. When a battery cell is either overcharged or overdischarged its performance can be degraded and, in the case of Li–Ion cells, the battery pack safety can be compromised. ON Semiconductor has patented a technique of balancing the individual cell voltage to enhance battery pack life instead of managing the pack by the worst–case cell. Sleep or standby mode operation must also be kept to a minimum to reduce battery pack drain during operation or storage. Finally, short circuit protection is required of these IC's and they must be able to handle "hard" or "soft" short situations equally well.

ON Semiconductor's line of protection circuits is designed for lithium–based battery packs (Li–ion or Li–polymer) that contains one or two cells in series.



Lithium Battery Protection ICs

Lithium Battery Protection Circuit for One or Two Cell Battery Packs

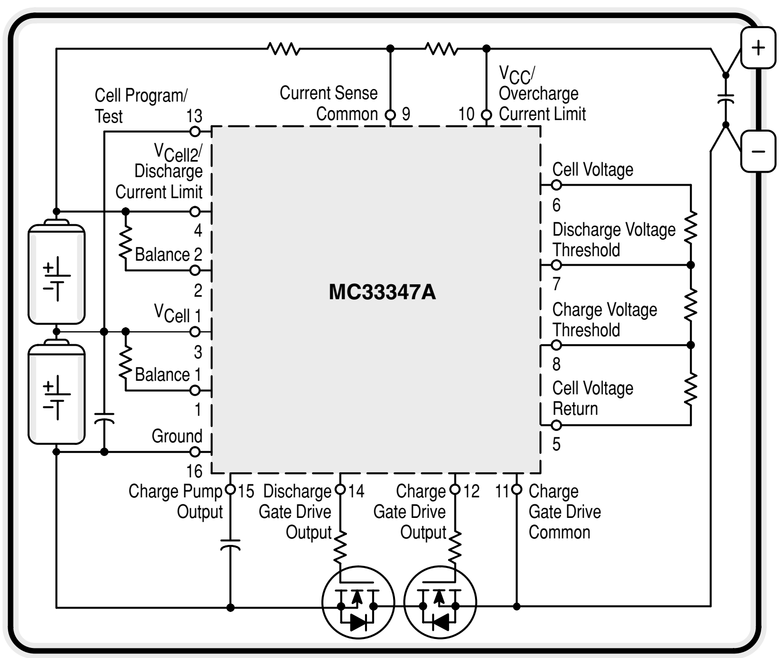
MC33347AD, ADTB

T_A = –25° to +85°C, SO–16, TSSOP–16 Packages

The MC33347A is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of one or two cell rechargeable battery packs. Cell protection features consist of independently programmable charge and discharge limits for both voltage and current with a delayed current shutdown, continuous cell voltage balancing with the choice of on–chip or external balancing resistors, and a virtually zero current sleepmode state when the cells are discharged. Additional features include an on–chip charge pump for reduced MOSFET losses while charging or discharging a low cell voltage battery pack, and the programmability for one or two cell battery pack. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. This MC33347A is available in standard and low profile 16 lead surface mount packages.

- Independently Programmable Charge and Discharge Limits for Both Voltage and Current
- Charge and Discharge Current Limit Detection with Delayed Shutdown
- Continuous Cell Voltage Balancing
- On–Chip or External Balancing Resistors
- Virtually Zero Current Sleepmode State when Cells are Discharged
- Charge Pump for Reduced Losses with a Low Cell Voltage Battery Pack
- Programmable for One or Two Cell Applications
- Minimum External Components for Inclusion within the Battery Pack
- Available in Low Profile Surface Mount Packages

Typical Two Cell Smart Battery Pack



Lithium Battery Protection ICs (continued)

Lithium Battery Protection Circuit for One Cell Battery Packs

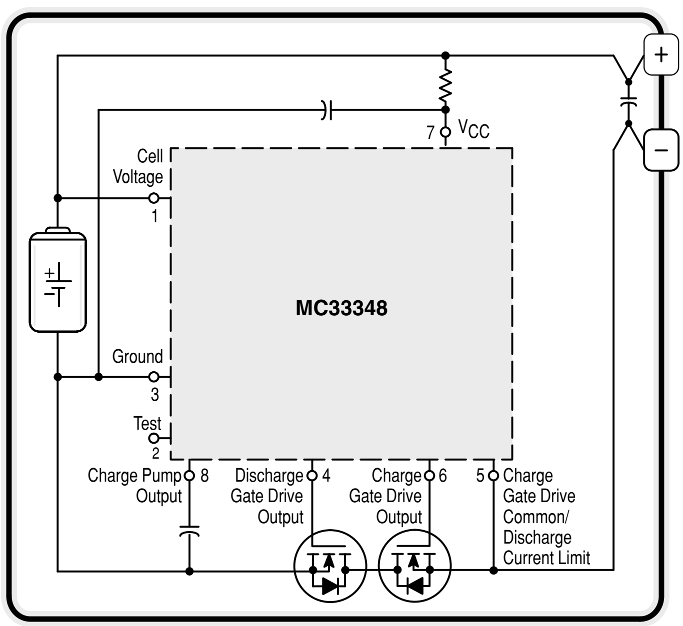
MC33348D

T_A = –25° to +85°C, SO–8 Package

The MC33348 is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of a one cell rechargeable battery pack. Cell protection features a consist of internally trimmed charge and discharge voltage limits, discharge current limit detection with a delayed shutdown, and a virtually zero current sleepmode state when the cell is discharged. An additional feature includes an on–chip charge pump for reduced MOSFET losses while charging or discharging a low cell voltage battery pack. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. This MC33348 is available in a standard 8 lead surface mount package.

- Internally Trimmed Charge and Discharge Voltage Limits
- Discharge Current Limit Detection with Delayed Shutdown
- Virtually Zero Current Sleepmode State when Cells are Discharged
- Charge Pump for Reduced Losses with a Low Cell Voltage Battery Pack
- Dedicated for One Cell Applications
- Minimum Components for Inclusion within the Battery Pack
- Available in Standard 8 Lead Surface Mount Package

Typical One Cell Smart Battery Pack



ORDERING INFORMATION

Device	Charge Overvoltage Threshold (V)	Charge Overvoltage Hysteresis (mV)	Discharge Undervoltage Threshold (V)	Discharge Current Limit Threshold (mV)	Operating Temperature Range	Package
MC33348D–1	4.20	300	2.25	400	T_A = –25° to +85°C	SO–8
MC33348D–2				200		
MC33348D–3	4.25		2.28	400		
MC33348D–4				200		
MC33348D–5	4.35		2.30	400		
MC33348D–6				200		

Lithium Battery Protection ICs (continued)

Lithium Battery Protection Circuit for One Cell Battery Packs

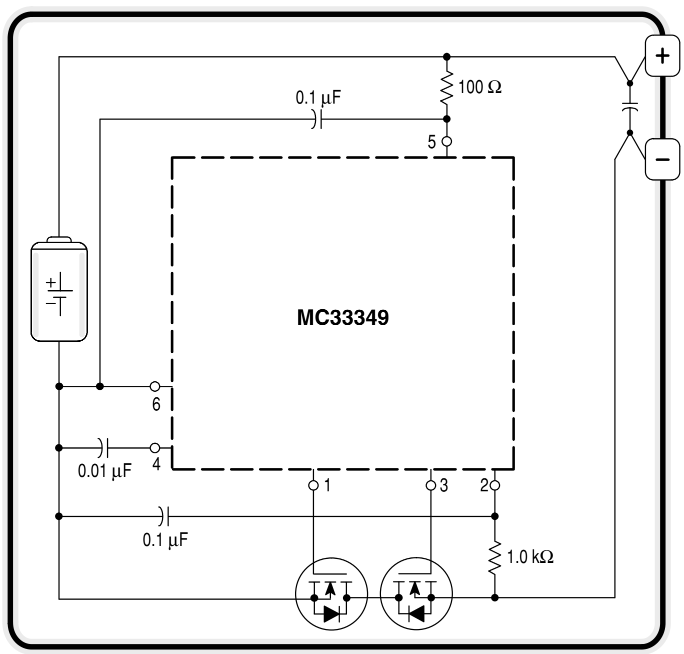
MC33349

T_A = –40° to 85°C, SOT–23 6 Lead Package

The MC33349 is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of a one cell rechargeable battery pack. Cell protection features consist of internally trimmed charge and discharge voltage limits, charge and discharge current limit detection, and a virtually zero current sleepmode state when the cell is discharged. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. This MC33349 is available in SOT–23 6 lead surface mount package.

- Internally Trimmed Charge and Discharge Voltage Limits
- Charge and Discharge Current Limit Detection
- Virtually Zero Current Sleepmode State when Cells are Discharged
- Dedicated for One Cell Applications
- Minimum Components for Inclusion within the Battery Pack
- Available in a Low Profile Surface Mount Package

Typical One Cell Smart Battery Pack



This device contains 264 active transistors.

ORDERING INFORMATION

Device	Charge Overvoltage Threshold (V)	Charge Overvoltage Hysteresis (mV)	Discharge Undervoltage Threshold (V)	Current Limit Threshold (mV)	Operating Temperature Range	Package
MC33349N–3	4.25	200	2.5	200	T_A = –40° to 85°C	SOT–23 (6 Lead)
MC33349N–4	4.25			75		
MC33349N–7	4.35			200		

Charge Controller

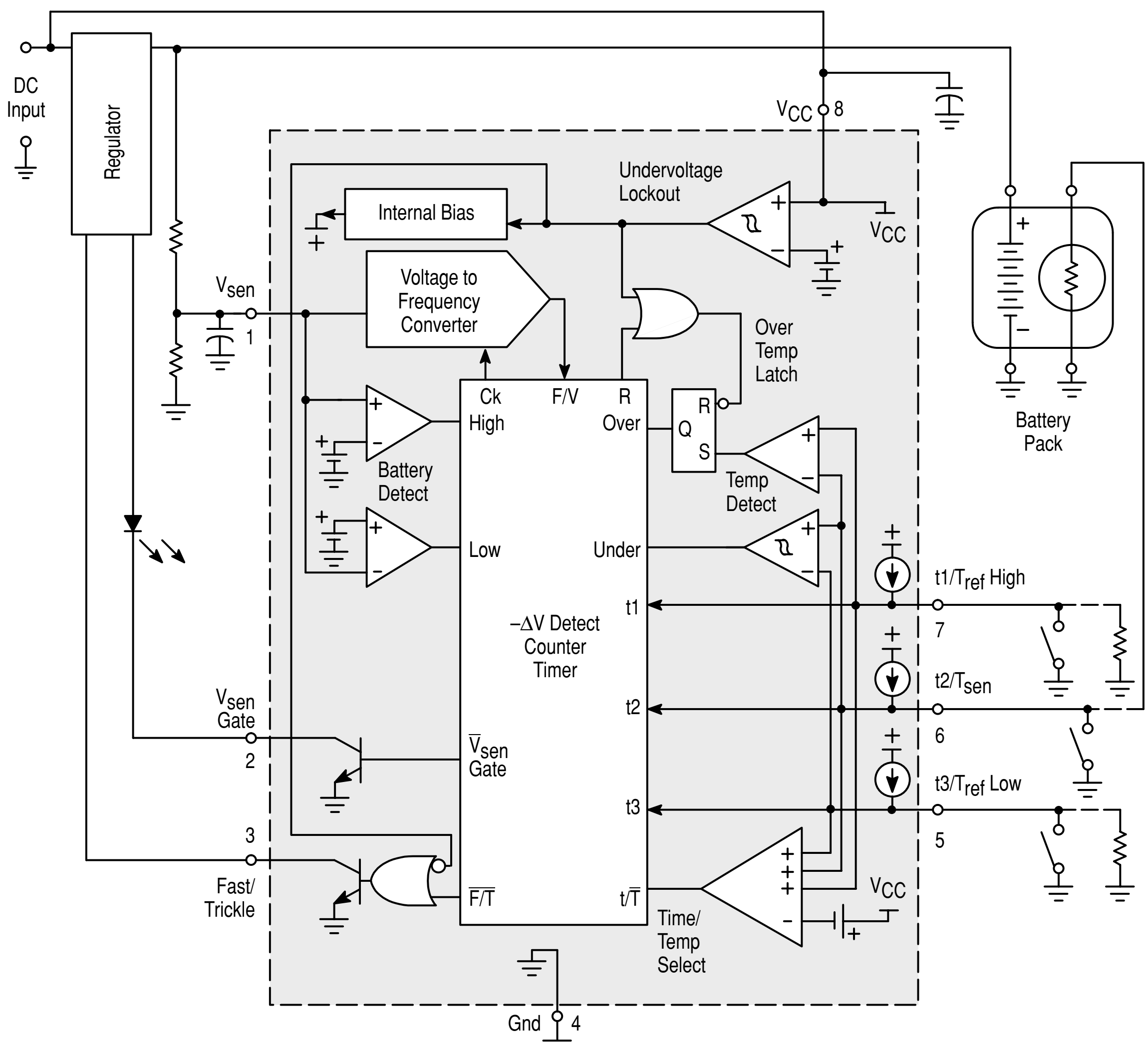
Battery Fast Charge Controller

MC33340P, D

T_A = –25° to +85°C, SO–8, DIP–8 Packages

The MC33340 is a monolithic control IC that is specifically designed as a fast charge controller for Nickel Cadmium (NiCd) and Nickel Metal Hydride (NiMH) batteries. This device features negative slope voltage detection as the primary means for fast charge termination. Accurate detection is ensured by an output that momentarily interrupts the charge current for precise voltage sampling. An additional secondary backup termination method can be selected that consists of either a programmable time or temperature limit. Protective features include battery over and undervoltage detection, latched over temperature detection, and power supply input undervoltage lockout with hysteresis. Provisions for entering a rapid test mode are available to enhance end product testing. This device is available in an economical 8–lead surface mount package.

- Negative Slope Voltage Detection with 4.0 mV Sensitivity
- Accurate Zero Current Battery Voltage Sensing
- High Noise Immunity with Synchronous VFC/Logic
- Programmable 1 to 4 Hour Fast Charge Time Limit
- Programmable Over/Under Temperature Detection
- Battery Over and Undervoltage Fast Charge Protection
- Rapid System Test Mode
- Power Supply Input Undervoltage Lockout with Hysteresis
- Operating Voltage Range of 3.0 V to 18 V



Charge Controller (continued)

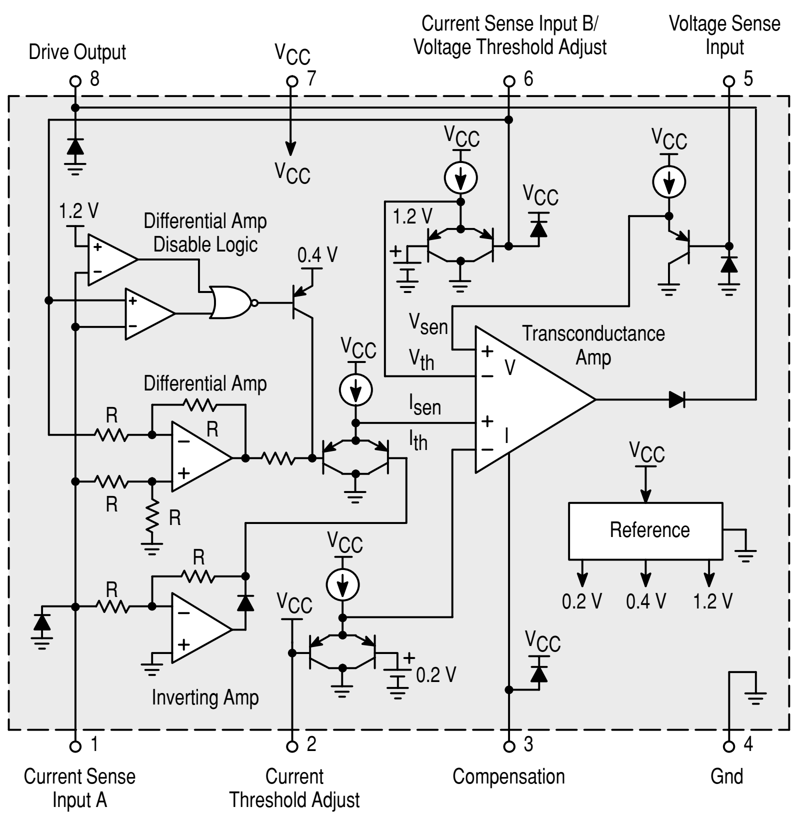
Power Supply Battery Charger Regulation Control Circuit

MC33341P, D

T_A = –25° to +85°C, SO–8, DIP–8 Packages

The MC33341 is a monolithic regulation control circuit that is specifically designed to close the voltage and current feedback loops in power supply and battery charger applications. This device features the unique ability to perform source high–side, load high–side, source low–side, and load low–side current sensing, each with either an internally fixed or externally adjustable threshold. The various current sensing modes are accomplished by a means of selectively using the internal differential amplifier, inverting amplifier, or a direct input path. Positive voltage sensing is performed by an internal voltage amplifier. The voltage amplifier threshold is internally fixed and can be externally adjusted in all low–side current sensing applications. An active high drive output is provided to directly interface with economical optoisolators for isolated output power systems. This device is available in8–lead dual–in–line and surface mount packages.

- Differential Amplifier for High–Side Source and Load Current Sensing
- Inverting Amplifier for Source Return Low–Side Current Sensing
- Noninverting Input Path for Load Low–Side Current Sensing
- Fixed or Adjustable Current Threshold in all Current Sensing Modes
- Positive Voltage Sensing in all Current Sensing Modes
- Fixed Voltage Threshold in all Current Sensing Modes
- Adjustable Voltage Threshold in all Low–Side Current Sensing Modes
- Output Driver Directly Interfaces with Economical Optoisolators
- Operating Voltage Range of 2.3 V to 16 V



Power Management Circuits

In Brief . . .

In most electronic systems, some form of voltage regulation is required. In the past, the task of voltage regulator design was tediously accomplished with discrete devices, and the results were quite often complex and costly. Today, with bipolar monolithic regulators, this task has been significantly simplified. The designer now has a wide choice of fixed, low dropout and adjustable type voltage regulators. These devices incorporate many built–in protection features, making them virtually immune to the catastrophic failures encountered in older discrete designs.

The switching power supply continues to increase in popularity and is one of the fastest growing markets in the world of power conversion. They offer the designer several important advantages over linear series–pass regulators. These advantages include significant advancements in the areas of size and weight reduction, improved efficiency, and the ability to perform voltage step–up, step–down, and voltage–inverting functions. ON Semiconductor offers a diverse portfolio of full featured switching regulator control circuits which meet the needs of today’s modern compact electronic equipment.

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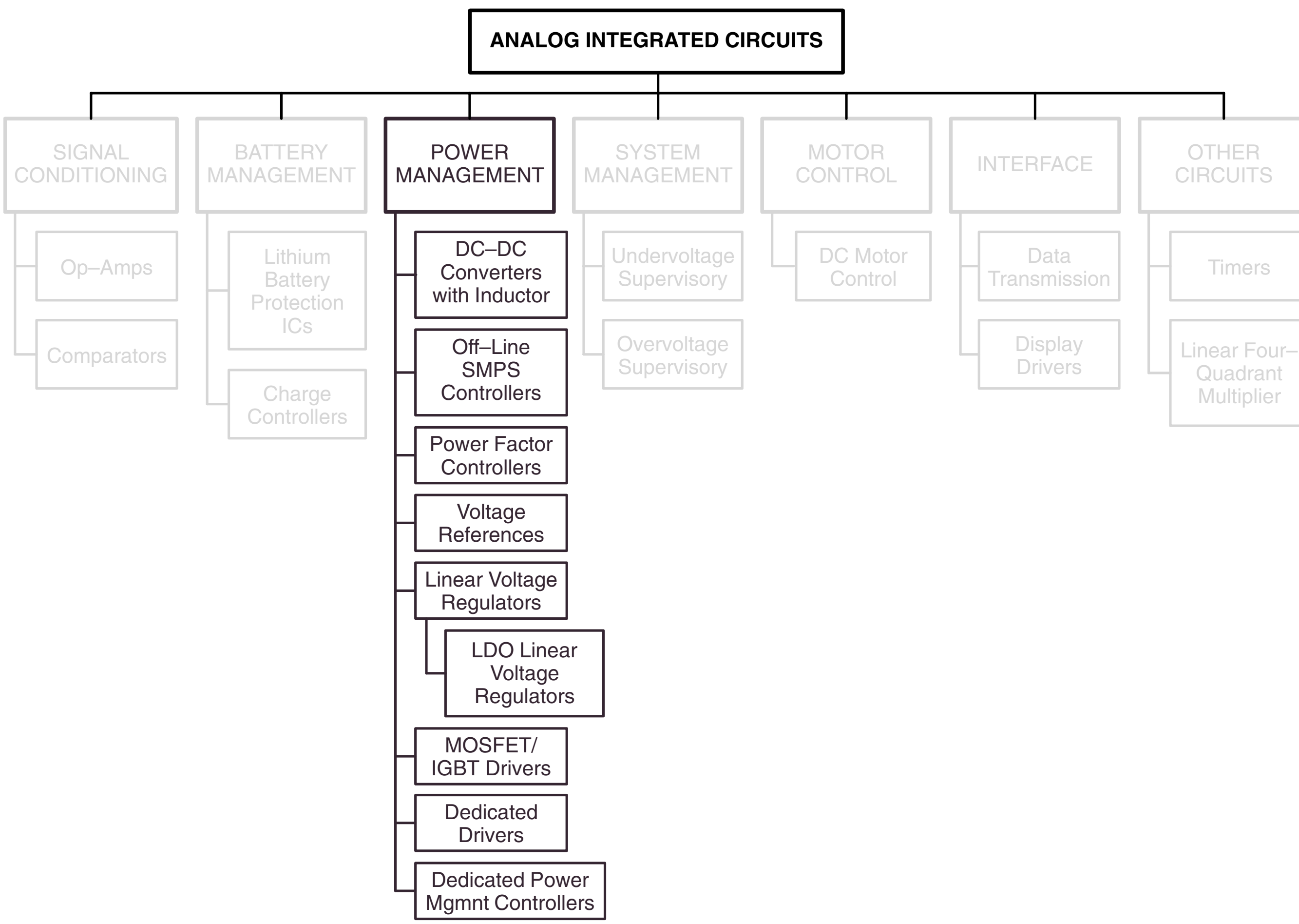

DC–DC Converters with Inductor

In Brief . . .

Available in multiple DIP and surface mount packages, DC–DC converters from ON Semiconductor cover a very wide range of output current levels from 50 mA up to 5 A and can be used in any topology, step–up, step–down, inverting and step–up and down.

These products are ideally suited to provide on–board conversion in systems where the power is distributed to various elements or electronic boards.

Recent developments have used synchronous rectification and CMOS technology for better efficiency and lower current consumption.

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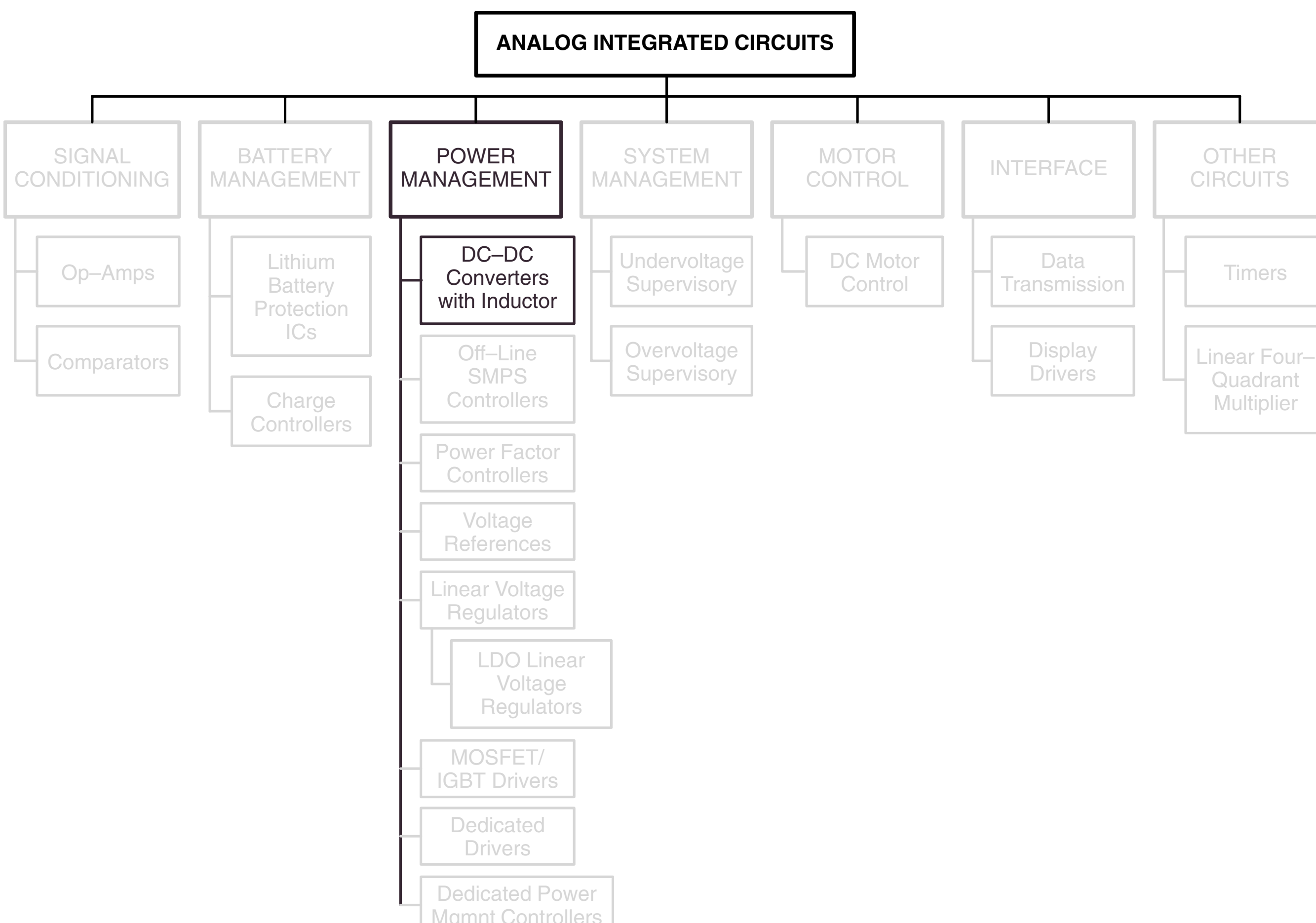


ON Semiconductor Selector Guide – Analog Integrated Circuits

Device	Input Voltage Range (V)	Output Voltage (V)	Output Switch Current (A)	Control Scheme	Topology	Package	Temp. Range (°C)	Features
MC34060A	4 to 42	Adjustable	0.5	PWM	Step–Up/Down & Inverting	DIP–14/SO–14	0 to 70, –40 to +85	External Switch Transistor
TL494/TL594	7 to 40	Adjustable	0.2	PWM	Step–Up/Down & Inverting	DIP–16/SO–16	0 to 70, –25 to +85	External Switch Transistor
μA78S40	2.5 to 40	Adjustable	1.5	PFM	Step–Up/Down & Inverting	DIP–16	0 to 70, –40 to +85	Internal Switch Transistor
MC34063A	3.0 to 40	Adjustable	1.5	PFM	Step–Up/Down & Inverting	DIP–8/SO–8	0 to 70, –40 to +85	Internal Switch Transistor
MC34163	2.5 to 40	Adjustable	3.0	PFM	Step–Up/Down & Inverting	DIP–16/SO–16	0 to 70, –40 to +85	Internal Switch Transistor
MC34165	3.0 to 65	Adjustable	1.5	PFM	Step–Up/Down & Inverting	DIP–16/SO–16	0 to 70, –40 to +85	Internal Switch Transistor
MC34166	7.5 to 40	Adjustable	3.0	PWM	Step–Up/Down & Inverting	5 Pin TO–220, 5 Pin D2PAK	0 to 70, –40 to +85	Internal Switch Transistor
MC34167	7.5 to 40	Adjustable	5.0	PWM	Step–Up/Down & Inverting	5 Pin TO–220, 5 Pin D2PAK	0 to 70, –40 to +85	Internal Switch Transistor
LM2574	4.75 to 45	3.3, 5, 12, 15 & Adjust.	0.5	PWM	Step–Down	DIP–8, SO–16WB	–40 to +125	Internal Switch Transistor, On/Off Control
LM2575	4.75 to 45	3.3, 5, 12, 15 & Adjust.	1.0	PWM	Step–Down	5 Pin TO–220, 5 Pin D2PAK	–40 to +125	Internal Switch Transistor, On/Off Control
LM2576	4.75 to 45	3.3, 5, 12, 15 & Adjust.	3.0	PWM	Step–Down	5 Pin TO–220, 5 Pin D2PAK	–40 to +125	Internal Switch Transistor, On/Off Control
MC33463–K	0.9 to Vout	3, 3.3, 5	0.250	VFM	Step–Up	SOT–89	–30 to +80	Internal Switch Transistor
MC33463–L	0.9 to Vout	3, 3.3, 5	0.050	VFM	Step–Up	SOT–89	–30 to +80	External Switch Transistor
MC33466–J	0.9 to Vout	3, 3.3, 5	0.250	PWM	Step–Up	SOT–89	–30 to +80	Internal Switch Transistor
MC33466–L	0.9 to Vout	3, 3.3, 5	0.050	PWM	Step–Up	SOT–89	–30 to +80	External Switch Transistor

PWM: Pulse Width Modulation   PFM: Pulse Frequency Modulation   VFM: Variable Frequency Modulation

Table 1. Single–Ended Controllers with On–Chip Power Switch

These monolithic power switching regulators contain all the active functions required to implement standard dc–to–dc converter configurations with a minimum number of external components.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_A (°C)	Package
1500 (Uncommitted Power Switch)	2.5 to 40	Voltage	1.25 ± 5.2%(1)	100	µA78S40	0 to +70	DIP–16
						–40 to +85	
			1.25 ± 2.0%		MC34063A	0 to +70	DIP–8
							SO–8
					MC33063A	–40 to +85	DIP–8
							SO–8
						–40 to +125	SO–8
3400 (Uncommitted Power Switch)	2.5 to 40	Voltage	1.25 ± 2.0% and 5.05 ± 3.0%	100	MC34163	0 to +70	DIP–16, SO–16L
					MC33163	–40 to +85	
3400(2) (Dedicated Emitter Power Switch)	7.5 to 40		5.05 ± 2.0%	72 ± 12% Internally Fixed	MC34166	0 to +70	5–Pin D^2PAK, 5–Pin TO–220
					MC33166	–40 to +85	
5500(3) (Dedicated Emitter Power Switch)					MC34167	0 to +70	
					MC33167	–40 to +85	

(1) Tolerance applies over the specified operating temperature range.
(2) Guaranteed minimum, typically 4300 mA.
(3) Guaranteed minimum, typically 6500 mA.

Table 2. Easy Switcher™ Single–Ended Controllers with On–Chip Power Switch

The Easy Switcher™ series is ideally suited for easy, convenient design of a step–down switching regulator (buck converter), with a minimum number of external components.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Oscillator Frequency (kHz)	Output Voltage (V)	Device	T_J (°C)	Package
500	4.75 to 40 8.0 to 40 15 to 40 18 to 40 8.0 to 40	Voltage	52 Fixed Internal	3.3 5.0 12 15 1.23 to 37	LM2574N–3.3 LM2574N–5 LM2574N–12 LM2574N–15 LM2574N–ADJ	–40 to +125	DIP–8

Table 2. Easy Switcher™ Single–Ended Controllers with On–Chip Power Switch(continued)

The Easy Switcher™ series is ideally suited for easy, convenient design of a step–down switching regulator (buck converter), with a minimum number of external components.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Oscillator Frequency (kHz)	Output Voltage (V)	Device	T_J (°C)	Package
1000	4.75 to 40	Voltage	52 Fixed Internal	3.3	LM2575T–3.3	–40 to +125	5–Pin TO–220
	8.0 to 40			5.0	LM2575T–5		
	15 to 40			12	LM2575T–12		
	18 to 40			15	LM2575T–15		
	8.0 to 40			1.23 to 37	LM2575T–ADJ		
	4.75 to 40			3.3	LM2575TV–3.3		5–Pin TO–220
	8.0 to 40			5.0	LM2575TV–5		
	15 to 40			12	LM2575TV–12		
	18 to 40			15	LM2575TV–15		
	8.0 to 40			1.23 to 37	LM2575TV–ADJ		
	4.75 to 40			3.3	LM2575D2T–3.3		5–Pin D^2PAK
	8.0 to 40			5.0	LM2575D2T–5		
	15 to 40			12	LM2575D2T–12		
	18 to 40			15	LM2575D2T–15		
	8.0 to 40			1.23 to 37	LM2575D2T–ADJ		
3000	4.75 to 40	Voltage	52 Fixed Internal	3.3	LM2576T–3.3	–40 to +125	5–Pin TO–220
	8.0 to 40			5.0	LM2576T–5		
	15 to 40			12	LM2576T–12		
	18 to 40			15	LM2576T–15		
	8.0 to 40			1.23 to 37	LM2576T–ADJ		
	4.75 to 40			3.3	LM2576TV–3.3		5–Pin TO–220
	8.0 to 40			5.0	LM2576TV–5		
	15 to 40			12	LM2576TV–12		
	18 to 40			15	LM2576TV–15		
	8.0 to 40			1.23 to 37	LM2576TV–ADJ		
	4.75 to 40			3.3	LM2576D2T–3.3		5–Pin D^2PAK
	8.0 to 40			5.0	LM2576D2T–5		
	15 to 40			12	LM2576D2T–12		
	18 to 40			15	LM2576D2T–15		
	8.0 to 40			1.23 to 37	LM2576D2T–ADJ		

Switching Regulator Control Circuits (continued)

CMOS Micropower DC–to–DC Converters

Variable Frequency Micropower DC–to–DC Converter

MC33463H

T_A = –30° to +80°C, SOT–89

The MC33463 series are micropower step–up switching voltage regulators, specifically designed for handheld and laptop applications, to provide regulated output voltages using a minimum of external parts. A wide choice of output voltages are available. These devices feature a very low quiescent bias current of 4.0 μA typical.

The MC33463H–XXKT1 series features a highly accurate voltage reference, an oscillator, a variable frequency modulation (VFM) controller, a driver transistor (Lx), a comparator and feedback resistive divider.

The MC33463H–XXLT1 is identical to the MC33463H–XXKT1, except that a drive pin (EXT) for an external transistor is provided.

Due to the low bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

MC33463 Series Features:

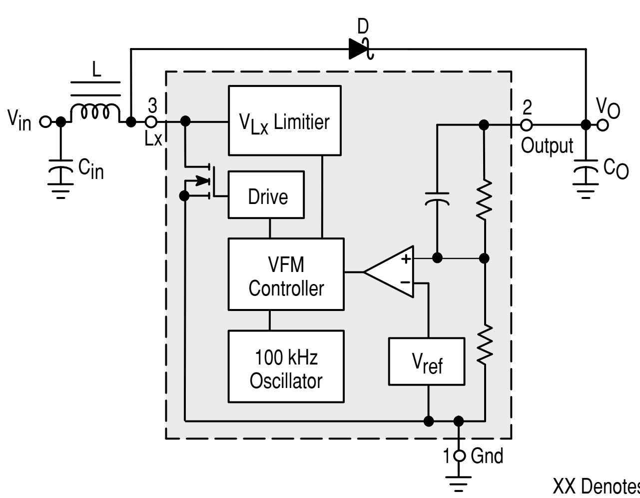
- Low Quiescent Bias Current of 4.0 μA
- High Output Voltage Accuracy of ±2.5%
- Low Startup Voltage of 0.9 V at 1.0 mA
- Wide Output Voltage Range of 2.5 V to 7.5 V Available
- High Efficiency of 80% Typical
- Surface Mount Package

ORDERING INFORMATION

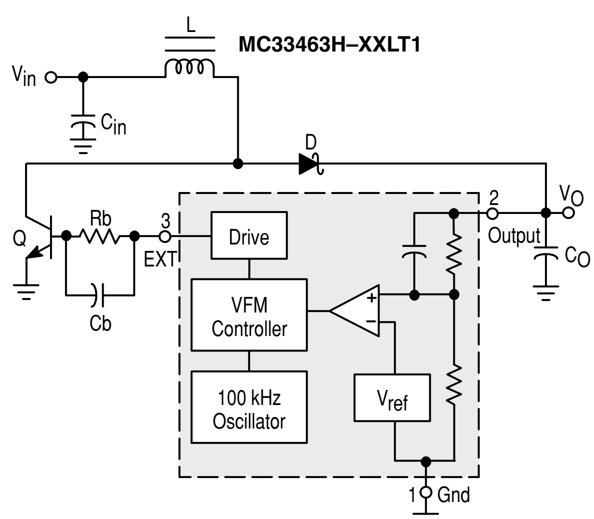
Device	Output Voltage	Type	Operating Temperature Range	Package (Tape/Reel)
MC33463H–30KT1 MC33463H–33KT1 MC33463H–50KT1	3.0 3.3 5.0	Int. Switch	T_A = –30° to +80°C	SOT–89 (Tape)
MC33463H–30LT1 MC33463H–33LT1 MC33463H–50LT1	3.0 3.3 5.0	Ext. Switch Drive		SOT–89 (Tape)

Other voltages from 2.5 V to 7.5 V, in 0.1 V increments are available. Consult factory for information.

MC33463H–XXKT1



MC33463H–XXLT1



XX Denotes Output Voltage

CMOS Micropower DC–to–DC Converters (continued)

Fixed Frequency PWM Micropower DC–to–DC Converter

MC33466H

T_A = –30° to +80°C, SOT–89

The MC33466 series are micropower switching voltage regulators, specifically designed for handheld and laptop applications, to provide regulated output voltages using a minimum of external parts. A wide choice of output voltages are available. These devices feature a very low quiescent bias current of 15 µA typical.

The MC33466H–XXJT1 series features a highly accurate voltage reference, an oscillator, a pulse width modulation (PWM) controller, a driver transistor (Lx), an error amplifier and feedback resistive divider.

The MC33466H–XXLT1 is identical to the MC33466H–XXJT1, except that a drive pin (EXT) for an external transistor is provided.

Due to the low bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

MC33466 Series Features:

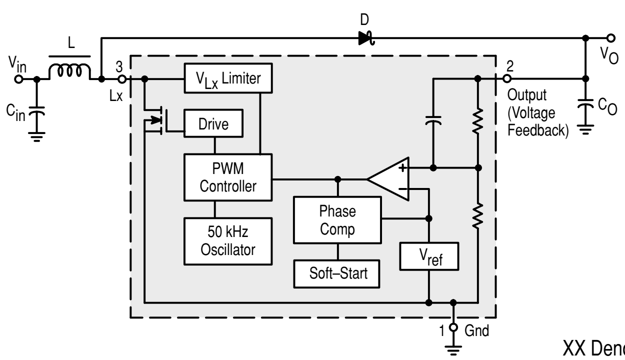
- Low Quiescent Bias Current of 15 µA
- High Output Voltage Accuracy of ±2.5%
- Low Startup Voltage of 0.9 V at 1.0 mA
- Soft–Start = 500 µs
- Surface Mount Package

ORDERING INFORMATION

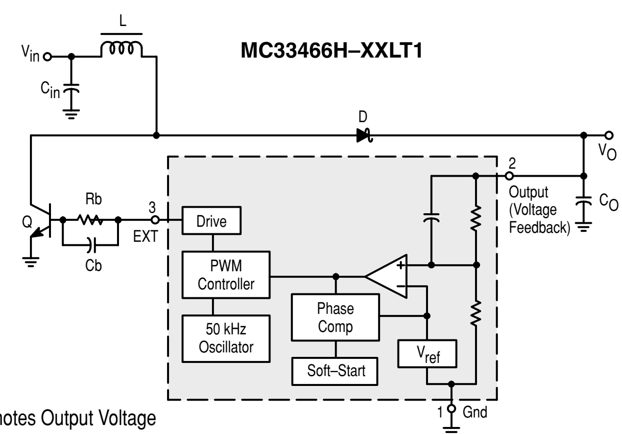
Device	Output Voltage	Type	Operating Temperature Range	Package (Tape/Reel)
MC33466H–30JT1 MC33466H–33JT1 MC33466H–50JT1	3.0 3.3 5.0	Int. Switch	T_A = –30° to +80°C	SOT–89 (Tape)
MC33466H–30LT1 MC33466H–33LT1 MC33466H–50LT1	3.0 3.3 5.0	Ext. Switch Drive		SOT–89 (Tape)

Other voltages from 2.5 V to 7.5 V, in 0.1 V increments are available. Consult factory for information.

MC33466H–XXJT1



MC33466H–XXLT1



XX Denotes Output Voltage

Switching Regulator Control Circuits (continued)

Synchronous Rectification DC/DC Converter Programmable Integrated Controller

MC33470

T_A = 0° to +75°C, SO–20L Package

The MC33470 is a digitally programmable switching voltage regulator, specifically designed for Microprocessor supply, Voltage Regulator Module and general purpose applications, to provide a high power regulated output voltage using a minimum of external parts. A 5–bit digital–to–analog converter defines the dc output voltage.

This product has three additional features. The first is a pair of high speed comparators which monitor the output voltage and expedite the circuit response to load current changes. The second feature is a soft start circuit which establishes a controlled response when input power is applied and when recovering from external circuit fault conditions. The third feature is two output drivers which provide synchronous rectification for optimum efficiency.

This product is ideally suited for computer, consumer, and industrial equipment where accuracy, efficiency and optimum regulation performance is desirable.

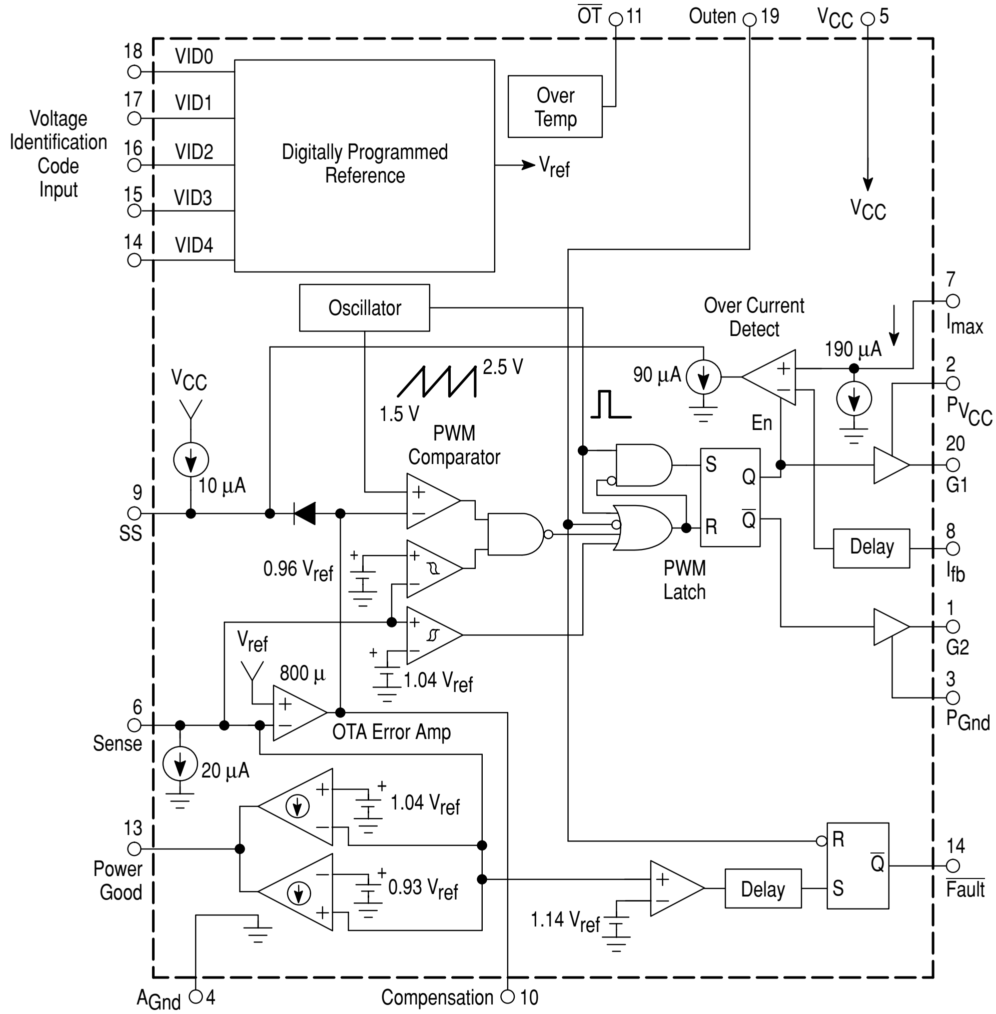
MC33470 Features:

- 5–Bit Digital–to–Analog Converter Allows Digital Control of Output Voltage
- High Speed Response to Transient Load Conditions
- Output Enable Pin Provides On/Off Control
- Programmable Soft Start Control
- High Current Output Drives for Synchronous Rectification
- Internally Trimmed Reference with Low Temperature Coefficient
- Programmable Overcurrent Protection
- Overvoltage Fault Indication
- Functionally Similar to the LTC1553

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33470DW	T_A = 0° to +75°C	SO–20L

Simplified Block Diagram



Switching Regulator Control Circuits (continued)

Easy Switcher™ Single–Ended Controllers with On–Chip Power Switch

Step–Down Voltage Regulators

LM2574N–XX

T_J = –40° to +125°C, DIP–8

The LM2574 series of regulators are monolithic integrated circuits ideally suited for easy and convenient design of a step–down switching regulator (buck converter). All circuits of this series are capable of driving a **0.5 A** load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5.0 V, 12 V, 15 V, and an adjustable output version.

These regulators were designed to minimize the number of external components to simplify the power supply design. Standard series of inductors optimized for use with the LM2574 are offered by several different inductor manufacturers.

Since the LM2574 converter is a switch–mode power supply, its efficiency is significantly higher in comparison with popular three–terminal linear regulators, especially with higher input voltages. In most cases, the power dissipated by the LM2574 regulator is so low, that the copper traces on the printed circuit board are normally the only heatsink needed and no additional heatsinking is required.

The LM2574 features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency (±2% over 0°C to +125°C). External shutdown is included, featuring 60 µA (typical) standby current. The output switch includes cycle–by–cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

Features

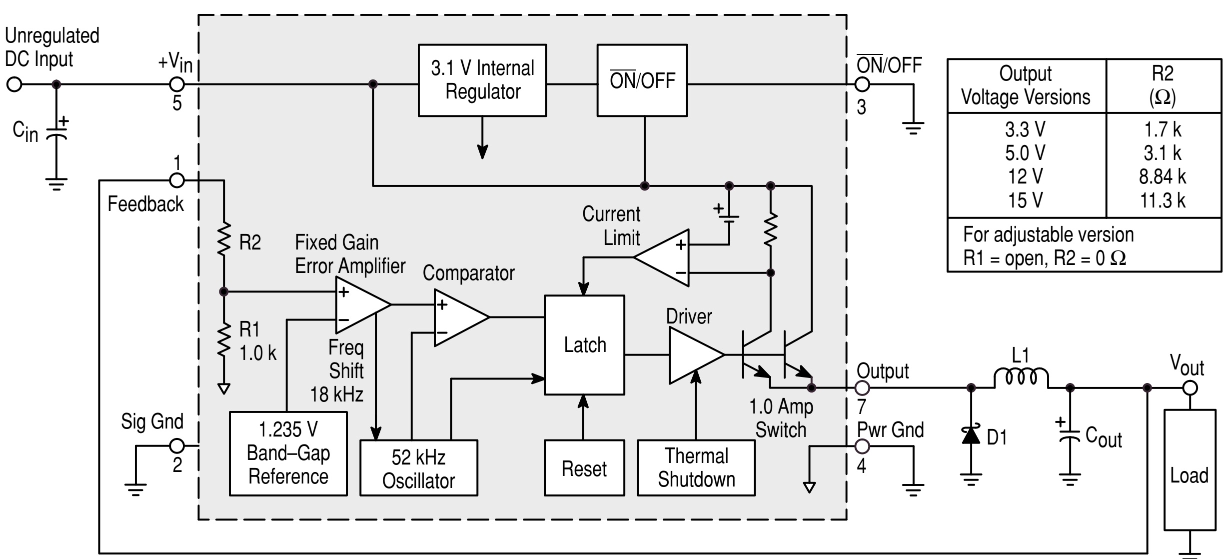
- 3.3 V, 5.0 V, 12 V, 15 V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range, 1.23 to 37 V ±4% max over Line and Load Conditions
- Guaranteed **0.5 A** Output Current
- Wide Input Voltage Range: 4.75 to 40 V
- Requires Only 4 External Components
- 52 kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability, Low Power Standby Mode
- High Efficiency
- Uses Readily Available Standard Inductors
- Thermal Shutdown and Current Limit Protection

Applications

- Simple and High–Efficiency Step–Down (Buck) Regulators
- Efficient Pre–Regulator for Linear Regulators
- On–Card Switching Regulators
- Positive to Negative Converters (Buck–Boost)
- Negative Step–Up Converters
- Power Supply for Battery Chargers

XX = Voltage Option, i.e., 3.3, 5, 12, 15 V; and ADJ for Adjustable Output

Representative Block Diagram and Typical Application



Output Voltage Versions	R2 (Ω)
3.3 V	1.7 k
5.0 V	3.1 k
12 V	8.84 k
15 V	11.3 k
For adjustable version R1 = open, R2 = 0 Ω	

Step–Down Voltage Regulators (continued)

LM2575T–XX, TV, D2T, LM2576T–XX, TV, D2T

T_J = –40° to +125°C, TO–220 5 Leads, D^2PAK 5 Leads

The LM2575/6 series of regulators are monolithic integrated circuits ideally suited for easy and convenient design of a step–down switching regulator (buck converter). All circuits of this series are capable of driving a **1.0 A** (LM2575) or **3.0 A** (LM2576) load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5.0 V, 12 V, 15 V, and an adjustable output version.

These regulators were designed to minimize the number of external components to simplify the power supply design. Standard series of inductors optimised for use with the LM2575/6 are offered by several different inductor manufacturers.

Since the LM2575/6 converter is a switch–mode power supply, its efficiency is significantly higher in comparison with popular three–terminal linear regulators, especially with higher input voltages. In many cases, the power dissipated by the LM2575/6 regulator is so low, that no heatsink is required or its size could be reduced dramatically.

The LM2575/6 features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency (±2% over 0°C to 125°C). External shutdown is included, featuring 80 µA typical standby current. The output switch includes cycle–by–cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

Features

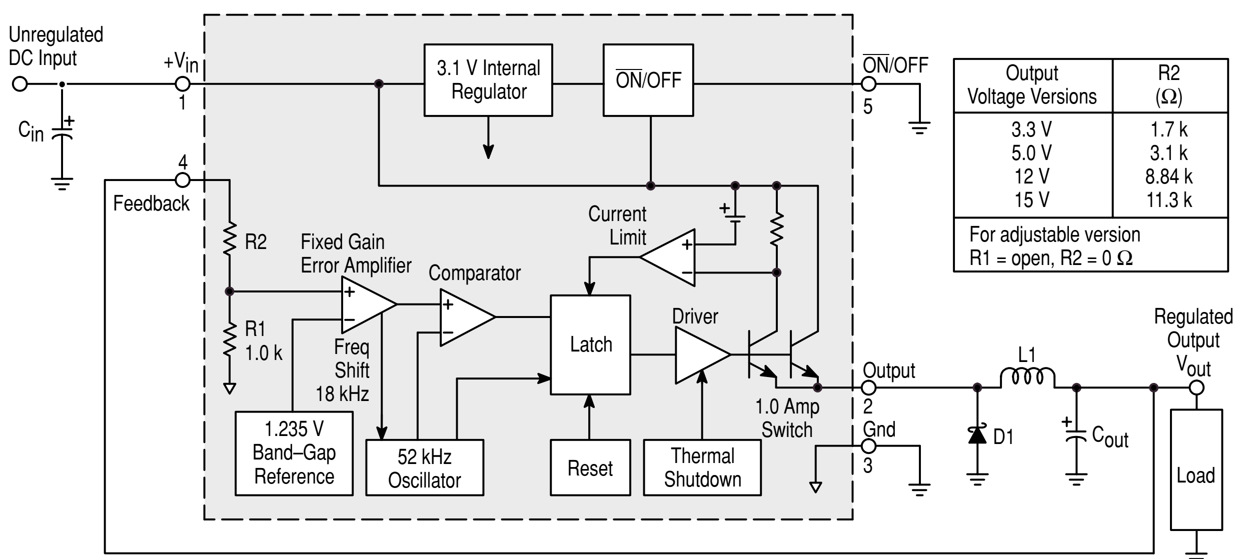
- 3.3 V, 5.0 V, 12 V, 15 V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range of 1.23 V to 37 V ±4% Maximum Over Line and Load Conditions
- Guaranteed **1.0 A** (LM2575) **3.0 A** (LM2576) Output Current
- Wide Input Voltage Range: 4.75 V to 40 V
- Requires Only 4 External Components
- 52 kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability, Low Power Standby Mode
- High Efficiency
- Uses Readily Available Standard Inductors
- Thermal Shutdown and Current Limit Protection

Applications

- Simple and High–Efficiency Step–Down (Buck) Regulators
- Efficient Pre–Regulator for Linear Regulators
- On–Card Switching Regulators
- Positive to Negative Converters (Buck–Boost)
- Negative Step–Up Converters
- Power Supply for Battery Chargers

XX = Voltage Option, i.e., 3.3, 5, 12, 15 V; and ADJ for Adjustable Output

Representative Block Diagram and Typical Application



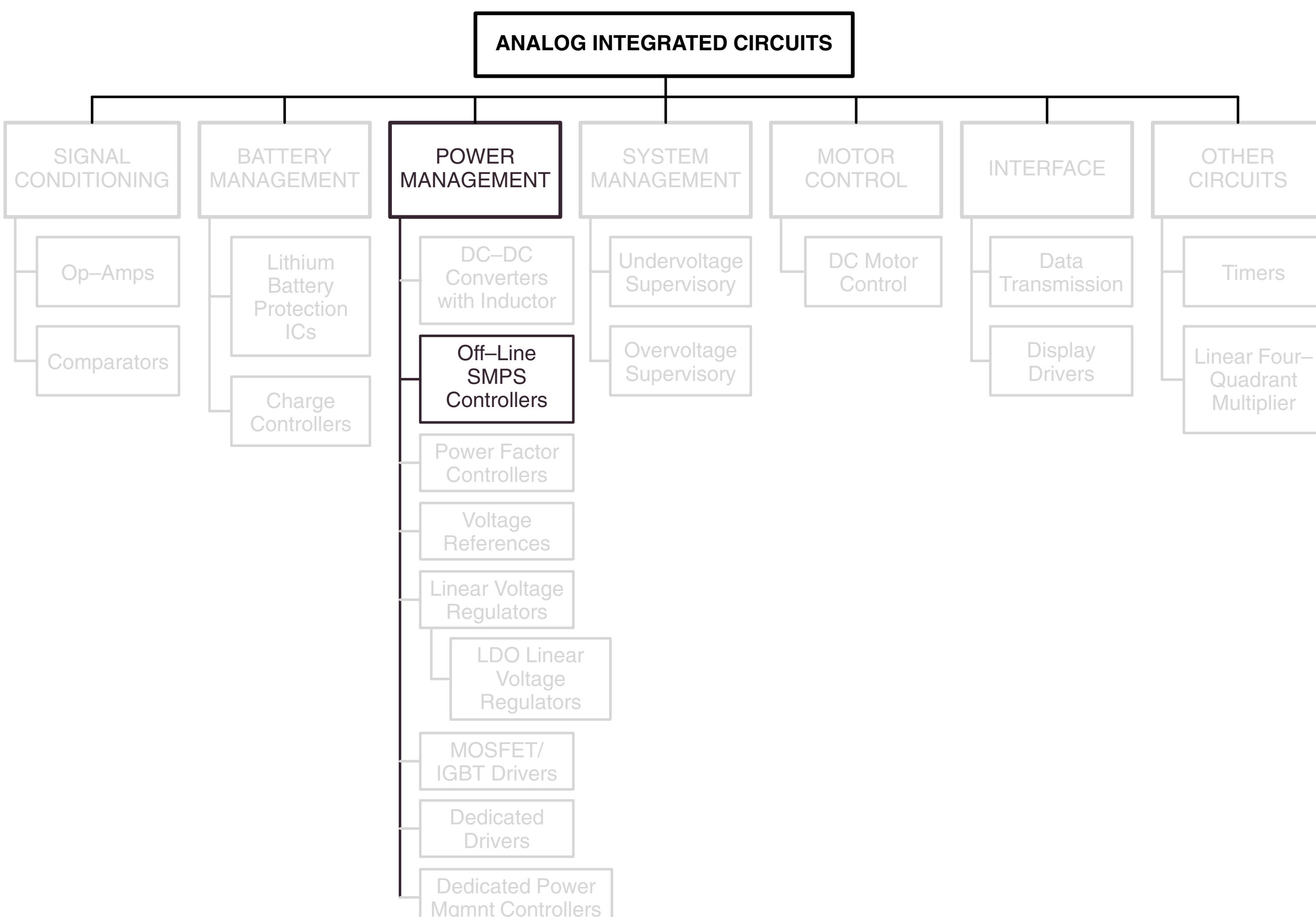
This device contains 162 active transistors.

Off–line SMPS Controllers

In Brief . . .

These high performance controllers are optimized for off–line, ac–to–dc power supplies and dc–to–dc converters in the flyback topology. They also have undervoltage lockout voltages which are optimized for off–line and lower voltage dc–to–dc converters, respectively. Applications include desktop computers, peripherals, televisions, games, and various consumer appliances.

Page



Off–line SMPS Controllers

These devices contain the primary building blocks which are required to implement a variety of switching power supplies. The product offerings fall into three major categories consisting of single–ended and double–ended controllers, plus single–ended ICs with on–chip power switch transistors. These circuits operate in voltage, current or resonant modes and are designed to drive many of the standard switching topologies. The single–ended configurations include buck, boost, flyback and forward converters. The double–ended devices control push–pull, half bridge and full bridge configurations.

Table 3. Single–Ended Controllers

These single–ended voltage and current mode controllers are designed for use in buck, boost, flyback, and forward converters. They are cost effective in applications that range from 0.1 to 200 W power output.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_A (°C)	Package
500 (Uncommitted Drive Output)	7.0 to 40	Voltage	5.0 ± 1.5%	200	MC34060A	0 to +70	SO–14
							DIP–14
					MC33060A	–40 to +85	SO–14
							DIP–14
1000 (Totem Pole MOSFET Drive Output)		Current					
	11.5 to 30		5.0 ± 2.0%	500	UC3842A	0 to +70	SO–14
							DIP–8
	11 to 30		5.0 ± 1.0%		UC2842A	–25 to +85	SO–14
							DIP–8
	8.2 to 30		5.0 ± 2.0%		UC3843A	0 to +70	SO–14
							DIP–8
			5.0 ± 1.0%		UC2843A	–25 to +85	SO–14
							DIP–8
	11.5 to 30		5.0 ± 2.0%	500 (50% Duty Cycle Limit)	UC3844	0 to +70	SO–14
							DIP–8
	11 to 30		5.0 ± 1.0%		UC2844	–25 to +85	SO–14
							DIP–8
	8.2 to 30		5.0 ± 2.0%		UC3845	0 to +70	SO–14
							DIP–8
			5.0 ± 1.0%		UC2845	–25 to +85	SO–14
							DIP–8
	11.5 to 30		5.0 ± 2.0%	500 (Improved Oscillator Specifications with Frequency Guaranteed at 250 kHz)	UC3842B	0 to +70	SO–14
							SO–8
							DIP–8
					UC3842BV	–40 to +105	SO–14
							SO–8
							DIP–8

Table 3. Single–Ended Controllers (continued)

These single–ended voltage and current mode controllers are designed for use in buck, boost, flyback, and forward converters. They are cost effective in applications that range from 0.1 to 200 W power output.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_A (°C)	Package
1000 (Totem Pole MOSFET Drive Output)	11 to 30	Current	5.0 ± 1.0%	500 (Improved Oscillator Specifications with Frequency Guaranteed at 250 kHz)	UC2842B	–25 to +85	SO–14
							SO–8
							DIP–8
	8.2 to 30		5.0 ± 2.0%		UC3843B	0 to +70	SO–14
							SO–8
							DIP–8
					UC3843BV	–40 to +105	SO–14
							SO–8
							DIP–8
			5.0 ± 1.0%		UC2843B	–25 to +85	SO–14
							SO–8
							DIP–8
	11.5 to 30		5.0 ± 2.0%	500 (50% Duty Cycle Limit)	UC3844B	0 to +70	SO–14
							SO–8
							DIP–8
					UC3844BV	–40 to +105	SO–14
							SO–8
							DIP–8
	11 to 30		5.0 ± 1.0%		UC2844B	–25 to +85	SO–14
							SO–8
							DIP–8
	8.2 to 30		5.0 ± 2.0%		UC3845B	0 to +70	SO–14
							SO–8
							DIP–8
					UC3845BV	–40 to +105	SO–14
							SO–8
							DIP–8
			5.0 ± 1.0%		UC2845B	–25 to +85	SO–14
							SO–8
							DIP–8
1000 Source 1500 Sink (Split Totem Pole Bipolar Drive Output)	11 to 18		5.0 ± 6.0%		MC44602		DIP–16
2000 (Totem Pole MOSFET Drive Output)	9.2 to 30	Current or Voltage	5.1 ± 1.0%	1000	MC34023P	0 to +70	DIP–16
					MC33023DW	–40 to +105	SO–16L

Table 4. Double–Ended Controllers

These double–ended voltage, current and resonant mode controllers are designed for use in push–pull, half–bridge, and full–bridge converters. They are cost effective in applications that range from 100 to 2000 watts power output.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_A (°C)	Package
500 (Uncommitted Drive Outputs)	7.0 to 40	Voltage	5.0 ± 5.0%(1)	200	TL494	0 to +70	DIP–16
						–25 to +85	DIP–16
			5.0 ± 1.5%	300	TL594	0 to +70	DIP–16
						–25 to +85	DIP–16
± 500 (Totem Pole MOSFET Drive Outputs)	8.0 to 40		5.1 ± 2.0%	400	SG3525A	0 to +70	DIP–16
± 200 (Totem Pole MOSFET Drive Outputs)			5.0 ± 2.0%		SG3526	0 to +125(2)	DIP–18
±1500 (Totem Pole MOSFET Drive Outputs)	9.6 to 20	Resonant (Zero Current)	5.1 ± 2.0%	1000	MC34066	0 to +70	DIP–16
					MC33066	–40 to +85	SO–16L
							DIP–16
		Resonant (Zero Voltage)		2000	MC34067	0 to +70	SO–16L
							DIP–16
					MC33067	–40 to +85	SO–16L
							DIP–16
2000 (Totem Pole MOSFET Drive Outputs)	9.2 to 30	Current or Voltage	5.1 ± 1.0%	1000	MC34025	0 to +70	SO–16L
							DIP–16
					MC33025	–40 to +105	SO–16L

(1) Tolerance applies over the specified operating temperature range.
(2) Junction Temperature Range.

Special Switching Regulator Controllers

These high performance dual channel controllers are optimized for off–line, ac–to–dc power supplies and dc–to–dc converters in the flyback topology. They also have undervoltage lockout voltages which are optimized for off–line and lower voltage dc–to–dc converters, respectively. Applications include desktop computers, peripherals, televisions, games, and various consumer appliances.

Table 5. Dual Channel Controllers

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_A (°C)	Package
±1000 (Totem Pole MOSFET Drive Outputs)	11 to 20	Current	5.0 ± 2.6%	500	MC33065	–40 to +85	SO–16L
							DIP–16
	8.4 to 20				MC33065	–40 to +85	SO–16L
							DIP–16

Table 6. Very High Voltage Single–Ended Controller with On–Chip Power Switch

This monolithic high voltage switching regulator is specifically designed to operate from a rectified ac line voltage source. Included are an on–chip high voltage power switch, active off–line startup circuitry and a full featured PWM controller with fault protection.

Device	Rectified 85 to 276 VAC Line	Power Switch MOSFET Integrated	Max Drain Voltage	Peak Current	$R_{DS(on)}$ (typ. @ T_J = 25 °C)	Max Output Power @ V_{in} = 92V to 265 VAC	Start–Up	Control Scheme	Oscillator Frequency	Package	Temperature Range	Additional Features
MC33362	ONLY 110 V Opera–tion	Yes	500 V	2A	4.4 Ω	20W	Active On–Chip 250 V FET	• PWM, Fixed Frequency • Voltage Mode	Adjustable up to 300 kHz	DIP–16 SO–16WB	– 25 to +125°C	
MC33363A	Yes	Yes	700 V	1A	7.5 Ω	14W	Active On–Chip 500 V FET	• PWM, Fixed Frequency • Voltage Mode	Adjustable up to 300 kHz	DIP–16 SO–16WB	– 25 to +125°C	
MC33363B	Yes	Yes	700 V	1A	15 Ω	8W	Active On–Chip 450 V FET	• PWM, Fixed Frequency • Voltage Mode	Adjustable up to 300 kHz	DIP–16 SO–16WB	– 25 to +125°C	
MC33365	Yes	Yes	700 V	1A	15 Ω	8W	Active On–Chip 450 V FET	• PWM, Fixed Frequency • Voltage Mode	Adjustable up to 300 kHz	DIP–16	– 25 to +125°C	Bulk Capacitor Voltage Sensing Capability to Sense an AC Line Brown–Out
MC33369	Yes	Yes	700 V	0.5A	12 Ω	12W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter

Device	Rectified 85 to 276 VAC Line	Power Switch MOSFET Integrated	Max Drain Voltage	Peak Current	$R_{DS(on)}$ (typ. @ $T_J = 25\,°C$)	Max Output Power @ V_{in} = 92V to 265 VAC	Start–Up	Control Scheme	Oscillator Frequency	Package	Temperature Range	Additional Features
MC33370	Yes	Yes	700 V	0.9A	12 Ω	25W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter
MC33371	Yes	Yes	700 V	1.5A	6.8 Ω	45W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter
MC33372	Yes	Yes	700 V	2A	4.8 Ω	60W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter
MC33373	Yes	Yes	700 V	2.7A	3.8 Ω	75W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter
MC33374	Yes	Yes	700 V	3.3A	3.0 Ω	90W	Active On–Chip 700 V FET	• PWM, Fixed Frequency	Fixed @ 100 kHz	DIP–8 TO–220 5	– 25 to +125°C	Programmable State Controller for Converter

Switching Regulator Control Circuits (continued)

Single–Ended GreenLine™ Controllers

Enhanced Mixed Frequency Mode GreenLine™ PWM Controller:

Fixed Frequency, Variable Frequency, Standby Mode

MC44603AP, DW

T_A = –25° to +85°C, DIP–16, SO–16L

The MC44603A is an enhanced high performance controller that is specifically designed for off–line and dc–to–dc converter applications. This device has the unique ability of automatically changing operating modes if the converter output is overloaded, unloaded, or shorted, offering the designer additional protection for increased system reliability. The MC44603A has several distinguishing features when compared to conventional SMPS controllers. These features consist of a foldback facility for overload protection, a standby mode when the converter output is slightly loaded, a demagnetization detection for reduced switching stresses on transistor and diodes, and a high current totem pole output ideally suited for driving a power MOSFET. It can also be used for driving a bipolar transistor in low power converters (< 150 W). It is optimized to operate in discontinuous mode but can also operate in continuous mode. Its advanced design allows use in current mode or voltage mode control applications.

Current or Voltage Mode Controller

- Operation up to 250 kHz Output Switching Frequency
- Inherent Feed Forward Compensation
- Latching PWM for Cycle–by–Cycle Current Limiting
- Oscillator with Precise Frequency Control

High Flexibility

- Externally Programmable Reference Current
- Secondary or Primary Sensing
- Synchronization Facility
- High Current Totem Pole Output
- Undervoltage Lockout with Hysteresis

Safety/Protection Features

- Overvoltage Protection Against Open Current and Open Voltage Loop
- Protection Against Short Circuit on Oscillator Pin
- Fully Programmable Foldback
- Soft–Start Feature
- Accurate Maximum Duty Cycle Setting
- Demagnetization (Zero Current Detection) Protection
- Internally Trimmed Reference
- Enhanced Output Drive

GreenLine Controller: Low Power Consumption in Standby Mode

- Low Startup and Operating Current
- Fully Programmable Standby Mode
- Controlled Frequency Reduction in Standby Mode
- Low dV/dT for Low EMI Radiations

High Safety Standby Ladder Mode GreenLine™ PWM Controller

MC44604P

T_A = –25° to +85°C, DIP–16

The MC44604 is an enhanced high performance controller that is specifically designed for off–line and dc–to–dc converter applications.

The MC44604 is a modification of the MC44603. The MC44604 offers enhanced safety and reliable power management in its protection features (foldback, overvoltage detection, soft–start, accurate demagnetization detection). Its high current totem pole output is also ideally suited for driving a power MOSFET but can also be used for driving a bipolar transistor in low power converters (< 150 W).

In addition, the MC44604 offers a new efficient way to reduce the standby operating power by means of a patented standby ladder mode operation of the converter significantly reducing the converter consumption in standby mode.

Current or Voltage Mode Controller

- Operation Up to 250 kHz Output Switching Frequency
- Inherent Feed Forward Compensation
- Latching PWM for Cycle–by–Cycle Current Limiting
- Oscillator with Precise Frequency Control

High Flexibility

- Externally Programmable Reference Current
- Secondary or Primary Sensing
- High Current Totem Pole Output
- Undervoltage Lockout with Hysteresis

Single–Ended GreenLine™ Controllers (continued)

High Safety Standby Ladder Mode GreenLine™ PWM Controller (continued)

Safety/Protection Features

- Overvoltage Protection Facility Against Open Loop
- Protection Against Short Circuit on Oscillator Pin
- Fully Programmable Foldback
- Soft–Start Feature
- Accurate Maximum Duty Cycle Setting
- Demagnetization (Zero Current Detection) Protection
- Internally Trimmed Reference

GreenLine™ Controller:

- Low Startup and Operating Current
- Patented Standby Ladder Mode for Low Standby Losses
- Low dV/dT for Low EMI

High Safety Latched Mode GreenLine™ PWM Controller for (Multi)Synchronized Applications

MC44605P

T_A = –25° to +85°C, DIP–16

The MC44605 is a high performance current mode controller that is specifically designed for off–line converters. The MC44605 has several distinguishing features that make it particularly suitable for multisynchronized monitor applications.

The MC44605 synchronization arrangement enables operation from 16 kHz up to 130 kHz. This product was optimized to operate with universal ac mains voltage from 80 V to 280 V, and its high current totem pole output makes it ideally suited for driving a power MOSFET.

The MC44605 protections provide well controlled, safe power management. Safety enhancements detect four different fault conditions and provide protection through a disabling latch.

Current or Voltage Mode Controller

- Current Mode Operation Up to 250 kHz Output Switching Frequency
- Inherent Feed Forward Compensation
- Latching PWM for Cycle–by–Cycle Current Limiting
- Oscillator with Precise Frequency Control
- Externally Programmable Reference Current
- Secondary or Primary Sensing (Availability of Error Amplifier Output)
- Synchronization Facility
- High Current Totem Pole Output
- Undervoltage Lockout with Hysteresis
- Low Output dV/dT for Low EMI
- Low Startup and Operating Current

Safety/Protection Features

- Soft–Start Feature
- Demagnetization (Zero Current Detection) Protection
- Overvoltage Protection Facility Against Open Loop
- EHT Overvoltage Protection (E.H.T.OVP): Protection Against Excessive Amplitude Synchronization Pulses
- Winding Short Circuit Detection (W.S.C.D.)
- Limitation of the Maximum Input Power (M.P.L.): Calculation of Input Power for Overload Protection
- Over Heating Detection (O.H.D.): to Prevent the Power Switch from Excessive Heating

Latched Disabling Mode

- When one of the following faults is detected: EHT overvoltage, Winding Short Circuit (WSCD), excessive input power (M.P.L.), power switch over heating (O.H.D.), a counter is activated
- If the counter is activated for a time that is long enough, the circuit gets definitively disabled. The latch can only be reset by removing and then re–applying power

Few External Components Reliable and Flexible GreenLine™ Very High Voltage PWM Controller

MC44608

T_A = –25° to +85°C, DIP–8

The MC44608 is a high performance voltage mode controller designed for off–line converters. This high voltage circuit that integrates the start–up current source and the oscillator capacitor, requires few external components while offering a high flexibility and reliability.

The device also features a very high efficiency stand–by management consisting of an effective Pulsed Mode operation. This technique enables the reduction of the stand–by power consumption to approximately 1W while delivering 300mW in a 150W SMPS.

- Integrated Start–Up Current Source
- Lossless Off–Line Start–Up
- Direct Off–Line Operation
- Fast Start–Up

General Features

- Flexibility
- Duty Cycle Control
- Undervoltage Lockout with Hysteresis
- On Chip Oscillator Switching Frequency 40, 75, or 100kHz
- Secondary control with Few External Components

Protections

- Maximum Duty Cycle Limitation
- Cycle by Cycle Current Limitation
- Demagnetization (Zero Current Detection) Protection
- "Over V_{CC} Protection" Against Open Loop
- Programmable Low Inertia Over Voltage Protection against open loop
- Internal Thermal Protection

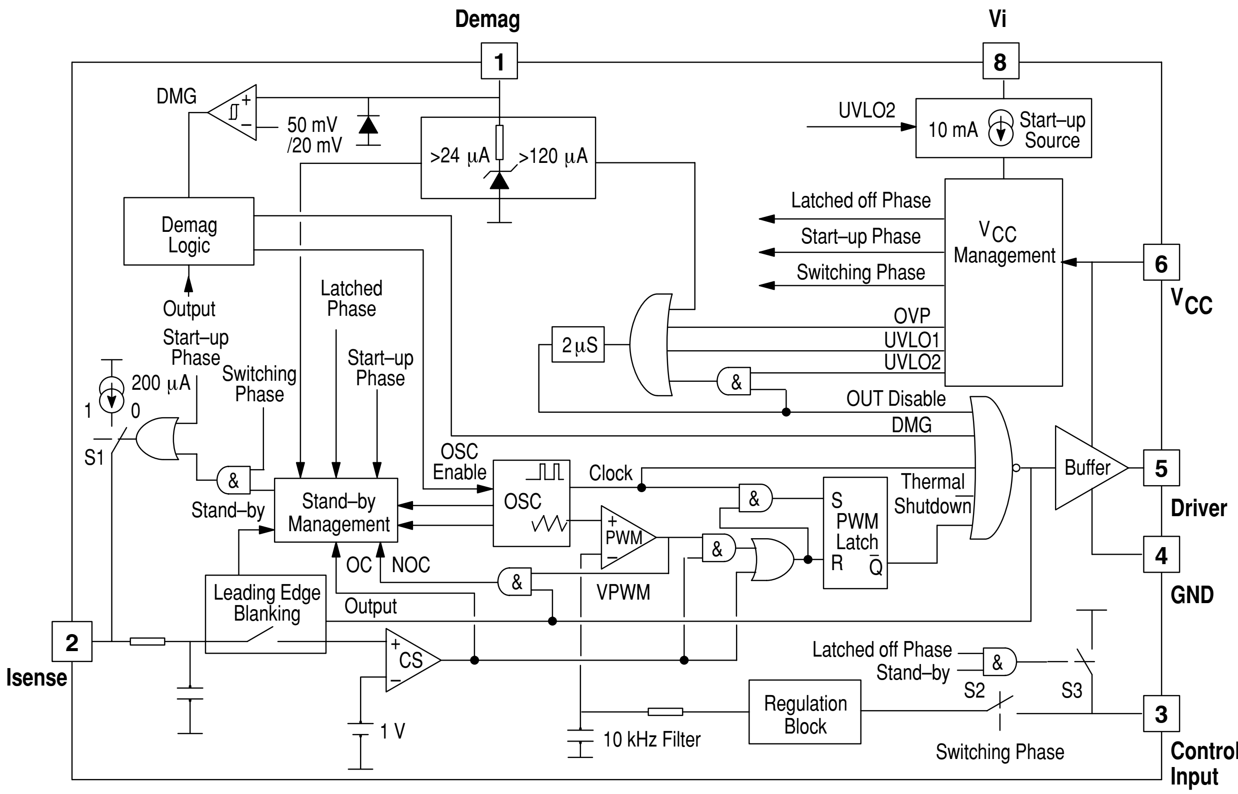
GreenLine™ Controller

- Pulsed Mode Techniques for a Very High Efficiency Low Power Mode
- Lossless Startup
- Low dV/dT for Low EMI Radiations

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC44608P40	T_J = –25° to +85°C	Plastic DIP–8
MC44608P75		
MC44608P100		

Representative Block Diagram



Switching Regulator Control Circuits (continued)

Very High Voltage Switching Regulator

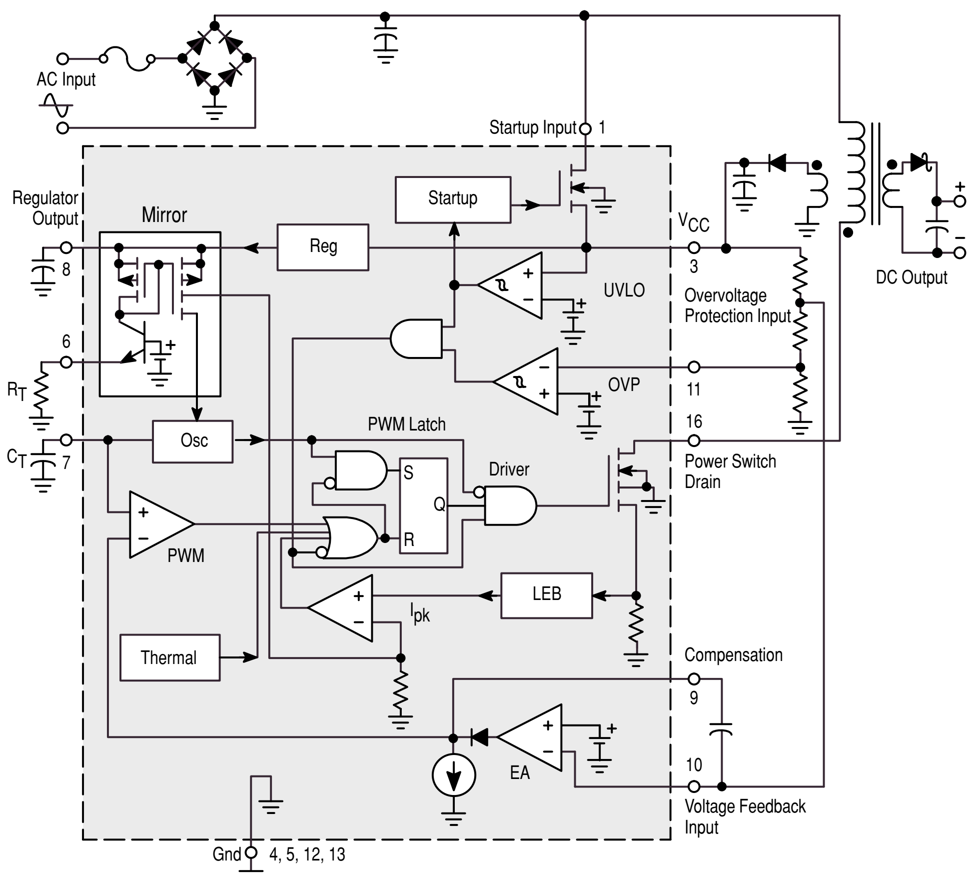
MC33362DW, P

T_J = –25° to +125°C, DIP–16, SOP–16L

The MC33362 is a monolithic high voltage switching regulator that is specifically designed to operate from a rectified 120 VAC line source. This integrated circuit features an on–chip 500 V/2.0 A SenseFET power switch, 250 V active off–line startup FET, duty cycle controlled oscillator, current limiting comparator with a programmable threshold and leading edge blanking, latching pulse width modulator for double pulse suppression, high gain error amplifier, and a trimmed internal bandgap reference. Protective features include cycle–by–cycle current limiting, input undervoltage lockout with hysteresis, output overvoltage protection, and thermal shutdown. This device is available in a 16–lead dual–in–line and wide body surface mount packages.

- On–Chip 500 V, 2.0 A SenseFET Power Switch
- Rectified 120 VAC Line Source Operation
- On–Chip 250 V Active Off–Line Startup FET
- Latching PWM for Double Pulse Suppression
- Cycle–By–Cycle Current Limiting
- Input Undervoltage Lockout with Hysteresis
- Output Overvoltage Protection Comparator
- Trimmed Internal Bandgap Reference
- Internal Thermal Shutdown

20 W Off–Line Converter



Switching Regulator Control Circuits (continued)

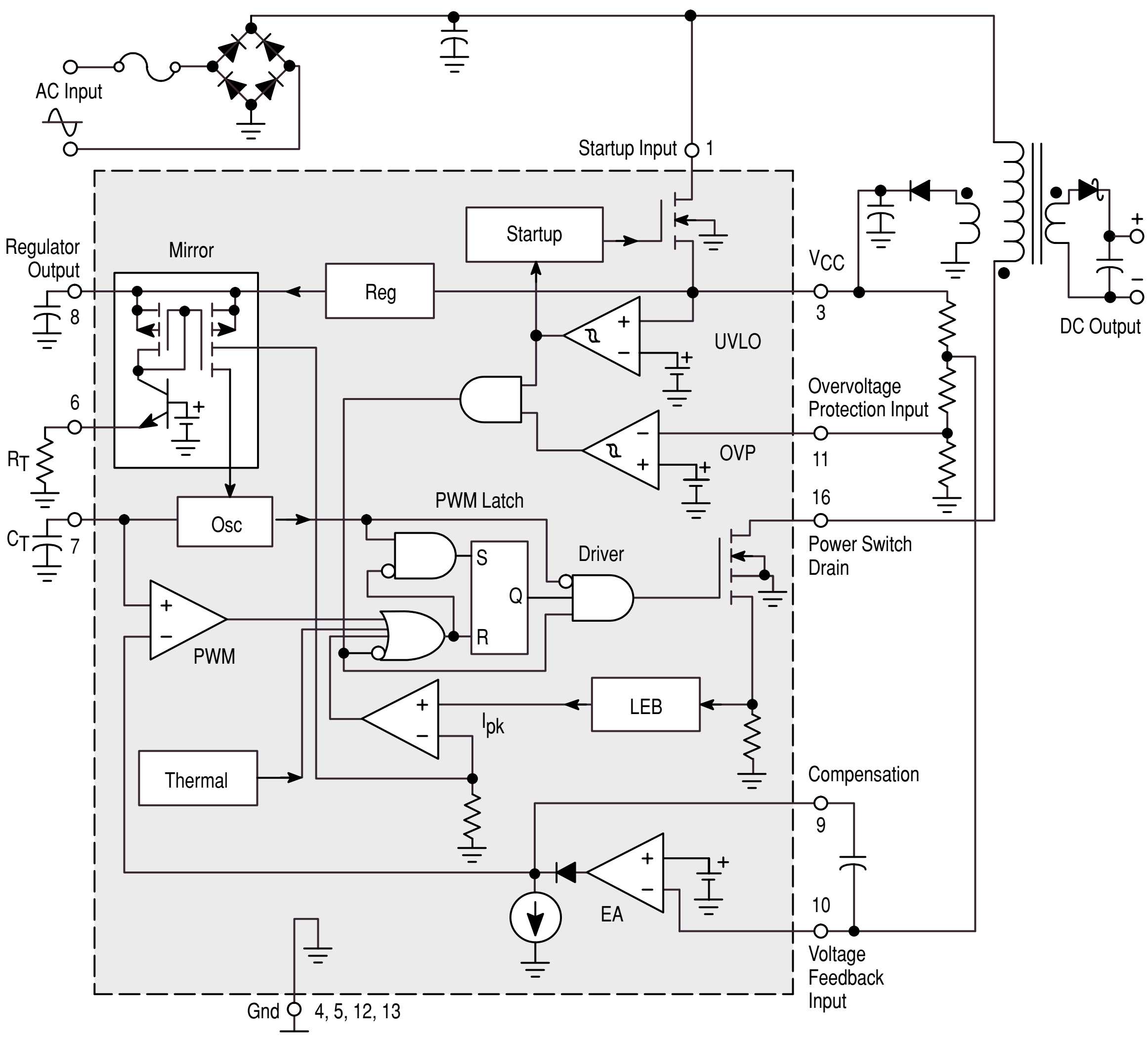
Very High Voltage Switching Regulator

MC33363ADW, AP

T_J = –25° to +125°C, DIP–16, SOP–16L

The MC33363A is a monolithic high voltage switching regulator that is specifically designed to operate from a rectified 240 Vac line source. This integrated circuit features an on–chip 700 V/1.5 A SenseFET power switch, 550 V active off–line startup FET, duty cycle controlled oscillator, current limiting comparator with a programmable threshold and leading edge blanking, latching pulse width modulator for double pulse suppression, high gain error amplifier, and a trimmed internal bandgap reference. Protective features include cycle–by–cycle current limiting, input undervoltage lockout with hysteresis, output overvoltage protection, and thermal shutdown. This device is available in a 16–lead dual–in–line and wide body surface mount packages.

- On–Chip 700 V, 1.5 A SenseFET Power Switch
- Rectified 240 Vac Line Source Operation
- On–Chip 500 V Active Off–Line Startup FET
- Latching PWM for Double Pulse Suppression
- Cycle–By–Cycle Current Limiting
- Input Undervoltage Lockout with Hysteresis
- Output Overvoltage Protection Comparator
- Trimmed Internal Bandgap Reference
- Internal Thermal Shutdown



Switching Regulator Control Circuits (continued)

High Voltage Switching Regulator

MC33363B

T_J = –25° to +125°C

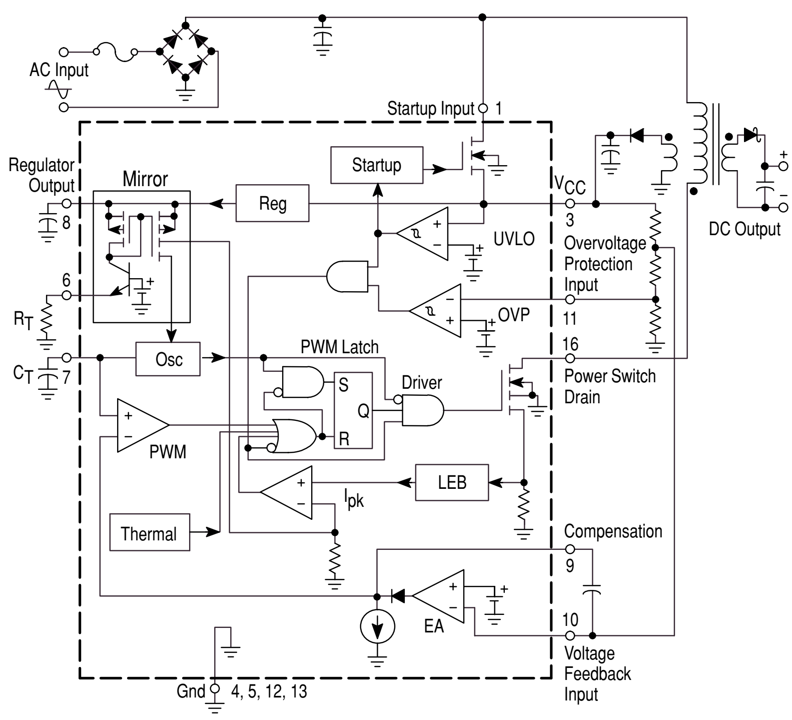
The MC33363B is a monolithic high voltage switching regulator that is specifically designed to operate from a rectified 240 Vac line source. This integrated circuit features an on–chip 700 V/1.0 A SenseFET power switch, 450 V active off–line startup FET, duty cycle controlled oscillator, current limiting comparator with a programmable threshold and leading edge blanking, latching pulse width modulator for double pulse suppression, high gain error amplifier, and a trimmed internal bandgap reference. Protective features include cycle–by–cycle current limiting, input undervoltage lockout with hysteresis, overvoltage protection, and thermal shutdown. This device is available in a 16–lead dual–in–line and wide body surface mount packages.

- On–Chip 700 V, 1.0 A SenseFET Power Switch
- Rectified 240 Vac Line Source Operation
- On–Chip 450 V Active Off–Line Startup FET
- Latching PWM for Double Pulse Suppression
- Cycle–By–Cycle Current Limiting
- Input Undervoltage Lockout with Hysteresis
- Output Overvoltage Protection
- Trimmed Internal Bandgap Reference
- Internal Thermal Shutdown

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33363BDW	T_J = –25° to +125°C	SOP–16L
MC33363BP		DIP–16

Simplified Application



Switching Regulator Control Circuits (continued)

Critical Conduction SMPS Controller

MC33364D, D1, D2

T_J = –25° to +125°C, SO–8, SO–16

The MC33364 series are variable frequency SMPS controllers that operate in the critical conduction mode. They are optimized for low power, high density power supplies requiring minimum board area, reduced component count, and low power dissipation. Each narrow body SOIC package provides a small footprint. Integration of the high voltage startup saves approximately 0.7 W of power compared to resistor bootstrapped circuits.

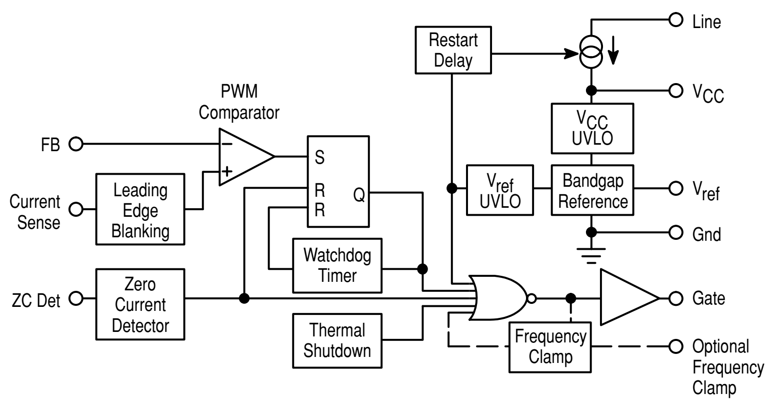
Each MC33364 features an on–board reference, UVLO function, a watchdog timer to initiate output switching, a zero current detector to ensure critical conduction operation, a current sensing comparator, leading edge blanking, and a CMOS driver. Protection features include the ability to shut down switching, and cycle–by–cycle current limiting.

The MC33364D1 is available in a surface mount SO–8 package. It has an internal 126 kHz frequency clamp. For loads which have a low power operating condition, the frequency clamp limits the maximum operating frequency, preventing excessive switching losses and EMI radiation.

The MC33364D2 is available in the SO–8 package without an internal frequency clamp.

The MC33364D is available in the SO–16 package. It has an internal 126 kHz frequency clamp which is pinned out, so that the designer can adjust the clamp frequency by connecting appropriate values of resistance and capacitance.

- Lossless Off–Line Startup
- Leading Edge Blanking for Noise Immunity
- Watchdog Timer to Initiate Switching
- Minimum Number of Support Components
- Shutdown Capability
- Over Temperature Protection
- Optional Frequency Clamp



Switching Regulator Control Circuits (continued)

High Voltage Switching Regulator

MC33365

T_J = –25° to +125°C, DIP–16

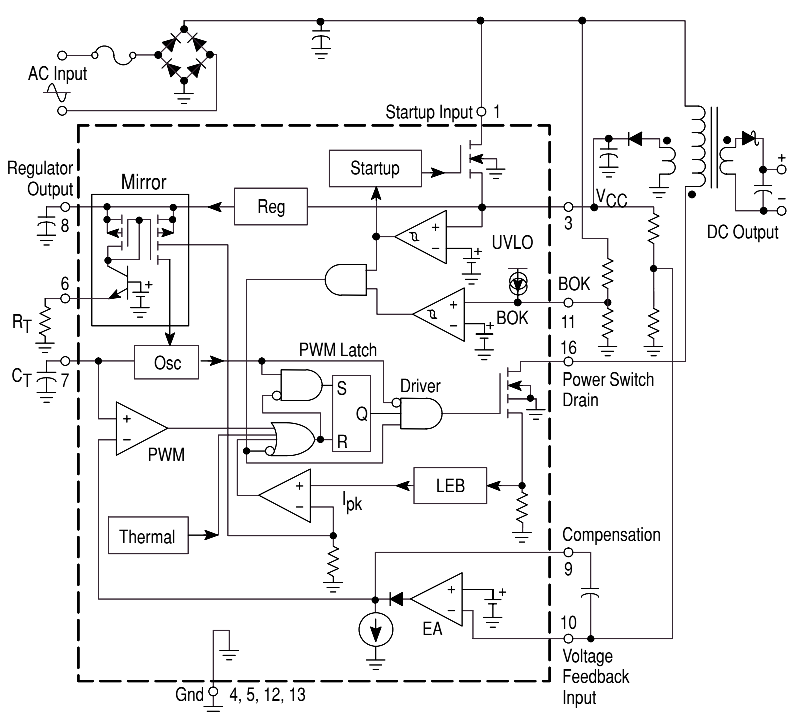
The MC33365 is a monolithic high voltage switching regulator that is specifically designed to operate from a rectified 240 Vac line source. This integrated circuit features an on–chip 700 V/1.0 A SenseFET power switch, 450 V active off–line startup FET, duty cycle controlled oscillator, current limiting comparator with a programmable threshold and leading edge blanking, latching pulse width modulator for double pulse suppression, high gain error amplifier, and a trimmed internal bandgap reference. Protective features include cycle–by–cycle current limiting, input undervoltage lockout with hysteresis, bulk capacitor voltage sensing, and thermal shutdown. This device is available in a 16–lead dual–in–line package.

- On–Chip 700 V, 1.0 A SenseFET Power Switch
- Rectified 240 Vac Line Source Operation
- On–Chip 450 V Active Off–Line Startup FET
- Latching PWM for Double Pulse Suppression
- Cycle–By–Cycle Current Limiting
- Input Undervoltage Lockout with Hysteresis
- Bulk Capacitor Voltage Comparator
- Trimmed Internal Bandgap Reference
- Internal Thermal Shutdown

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33365P	T_J = –25° to +125°C	DIP–16

Simplified Application



Switching Regulator Control Circuits (continued)

High Voltage Power Switching Regulator

MC33370T, MC33371T, MC33372T, MC33373T, MC33374T

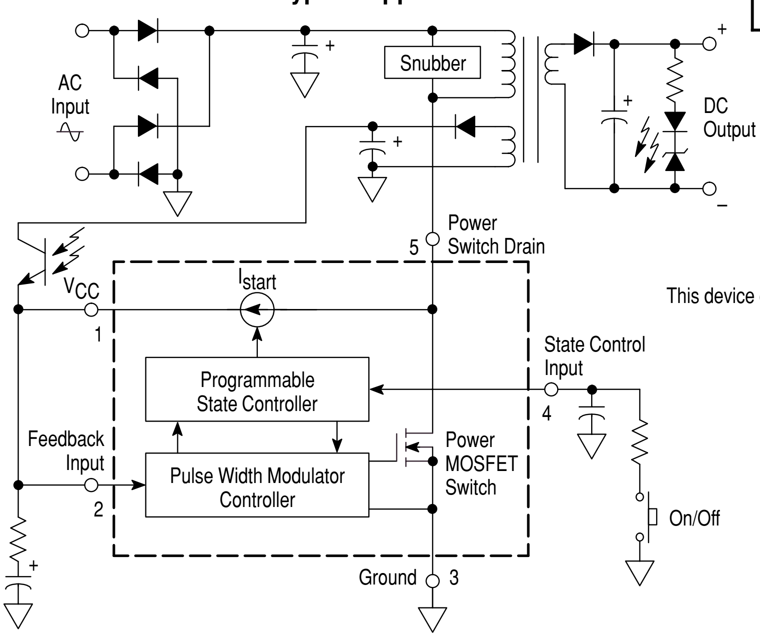
T_J = –40°C to +150°C, TO–220

The MC33370 series are monolithic high voltage power switching regulators that combine the required converter functions with a unique programmable state controller, allowing a simple and economical power system solution for office automation, consumer, and industrial products. These devices are designed to operate directly from a rectified AC line source, and in flyback converter applications are capable of providing an output power in excess of 150 W with a fixed AC input of 100 V, 115 V, or 230 V, and in excess of 90 W with a variable AC input that ranges from 85 V to 265 V.

This device series features a programmable state controller, an on–chip 700 V SENSEFET power switch, 700 V active off–line startup FET, auto restart logic, fixed frequency duty cycle controlled oscillator, current limiting comparator with leading edge blanking, latching pulse width modulator for double pulse suppression, and a high gain error amplifier with a bandgap reference for primary or secondary side regulation. Protective features include cycle–by–cycle current limiting, input undervoltage lockout with hysteresis, and a non–latching thermal shutdown. These devices are available in economical five pin TO–220 style packages.

- Programmable State Controller
- On–Chip 700 V SENSEFET Power Switch
- Rectified AC Line Source Operation from 85 V to 265 V
- On–Chip 700 V Active Off–Line Start–Up FET
- Latching PWM for Double Pulse Suppression
- Cycle–By–Cycle Current Limiting
- Input Undervoltage Lockout with Hysteresis
- Non–Latching Internal Thermal Shutdown
- Enhanced Functionality Over TOP200 and TOP221 Series

Typical Application



ORDERING INFORMATION

Device	Power Switch: On Resistance (Ω)	Power Switch: Peak Current (A)	Package
MC33370T	12	0.9	Straight Lead
MC33371T	6.8	1.5	
MC33372T	4.8	2.0	
MC33373T	3.8	2.7	
MC33374T	3.0	3.3	
MC33370TV	12	0.9	Vertical Mount
MC33371TV	6.8	1.5	
MC33372TV	4.8	2.0	
MC33373TV	3.8	2.7	
MC33374TV	3.0	3.3	
MC33369T/TV	12	0.5	
MC33369AP	12	0.5	DIP–8
MC33370P	12	0.9	
MC33371P	6.8	1.5	
MC33372P	4.8	2.0	
MC33373AP	3.8	2.7	

This device contains 391 active transistors.

Power Factor Controllers

In Brief . . .

The new PFC's are developed to control Power Factor Correction pre–converters meeting IEC1000–3–2 standard requirements in electronic ballast and off–line power conversion applications. These devices are designed to work in free frequency critical conduction mode. They can be synchronized and feature very effective protection to ensure a safe and reliable operation. They also optimized to offer extremely compact and cost–effective PFC solutions. Ultimately, the solution system cost is significantly lowered. The portfolio offers products that can propose a free output voltage level mode (follower boost technique) that enables a drastic size reduction of both the inductor and the power Mosfet. Also, they are able to function in a traditional way (constant output voltage regulation level), and any intermediary solutions can be easily implemented. This flexibility makes them ideal to optimally cope with a wide range of applications.

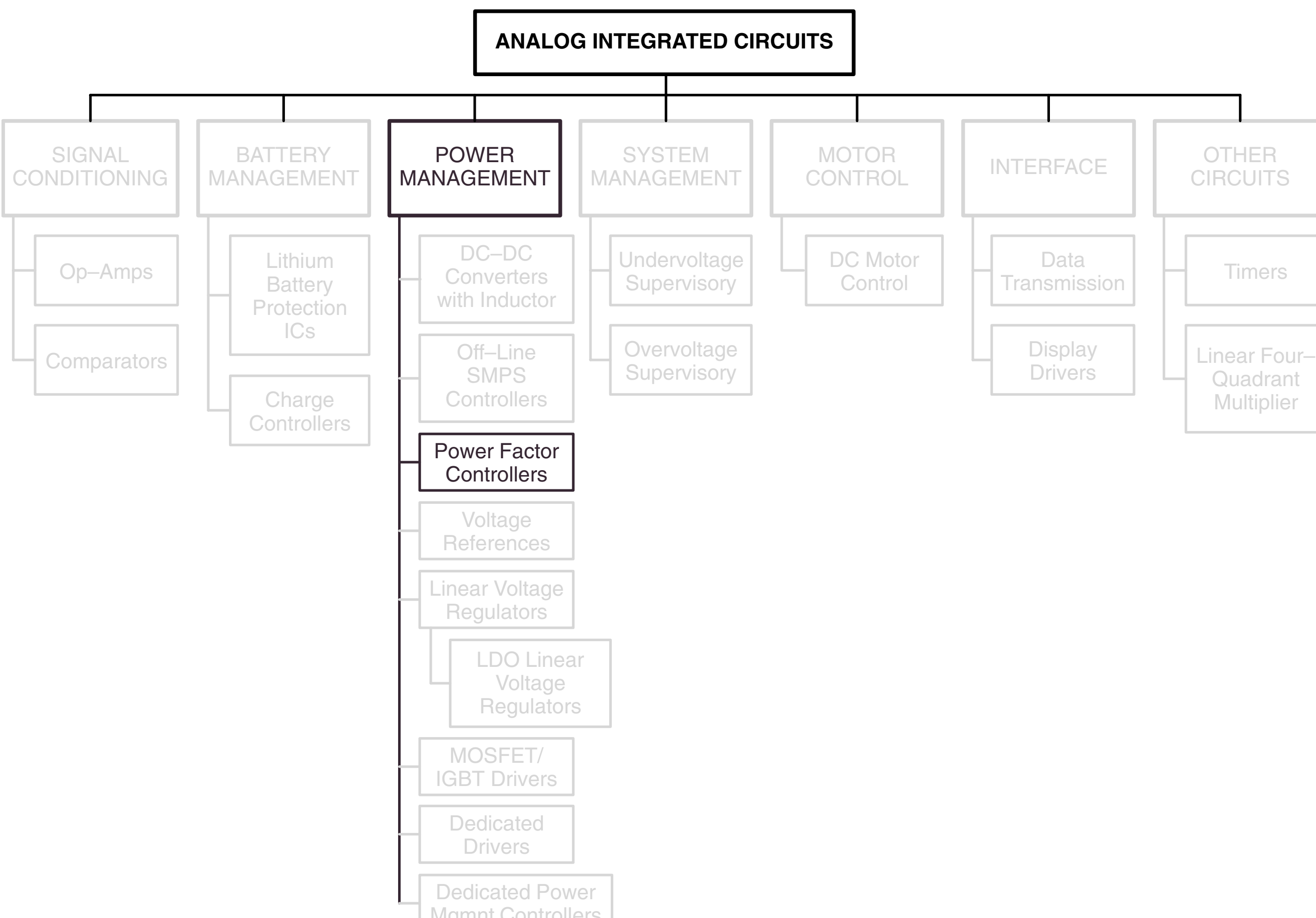


Table 7. Power Factor Controllers

I_O (mA) Max	Minimum Operating Voltage Range (V)	Maximum Startup Voltage (V)	Reference (V)	Features	Device	T_A (°C)	Package
± 500 (Totem Pole MOSFET Drive Outputs)	9.0 to 30	30	2.5 ± 1.4%	Undervoltage Lockout, Internal Startup Timer	MC34261	0 to +70	DIP–8
					MC33261	–40 to +85	SO–8
							DIP–8
				Overvoltage Comparator, Undervoltage Lockout, Internal Startup Timer	MC34262	0 to +85	SO–8
							DIP–8
					MC33262	–40 to +105	SO–8
							DIP–8
1500 (CMOS Totem Pole MOSFET Drive Outputs)	9.0 to 16	500	5.0 ± 1.5%	Off–Line High Voltage Startup Overvoltage Comparator, Undervoltage Lockout, Timer, Low Load Detect	MC33368	–25 to +125	SO–16
							DIP–16

Power Factor Controllers

MC34262D, P

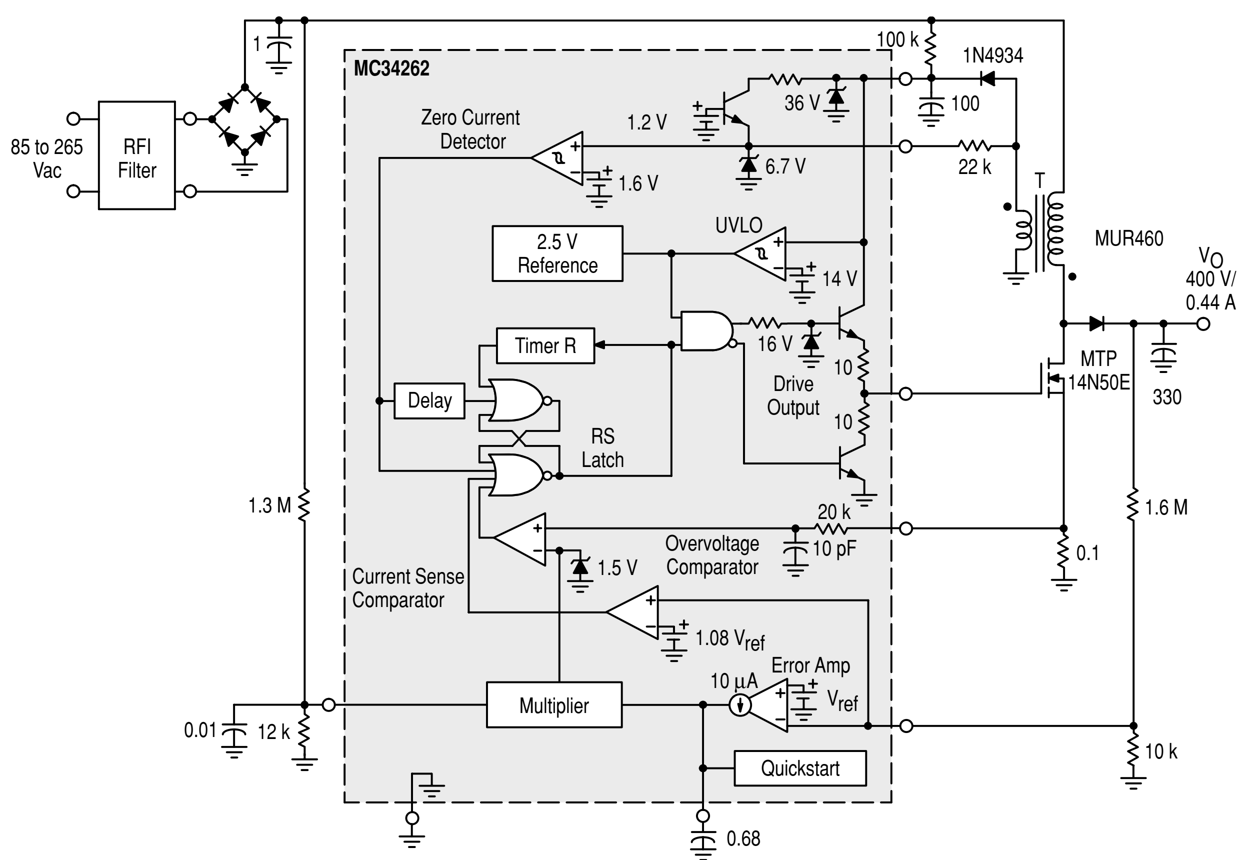
T_A = 0° to +85°C, DIP–8, SO–8

MC33262D, P

T_A = –40° to +105°C, DIP–8, SO–8

The MC34262, MC33262 series are active power factor controllers specifically designed for use as a preconverter in electronic ballast and in off–line power converter applications. These integrated circuits feature an internal startup timer for stand alone applications, a one quadrant multiplier for near unity power factor, zero current detector to ensure critical conduction operation, transconductance error amplifier, quickstart circuit for enhanced startup, trimmed internal bandgap reference, current sensing comparator, and a totem pole output ideally suited for driving a power MOSFET.

Also included are protective features consisting of an overvoltage comparator to eliminate runaway output voltage due to load removal, input undervoltage lockout with hysteresis, cycle–by–cycle current limiting, multiplier output clamp that limits maximum peak switch current, an RS latch for single pulse metering, and a drive output high state clamp for MOSFET gate protection. These devices are available in dual–in–line and surface mount plastic packages.



Power Factor Controllers (continued)

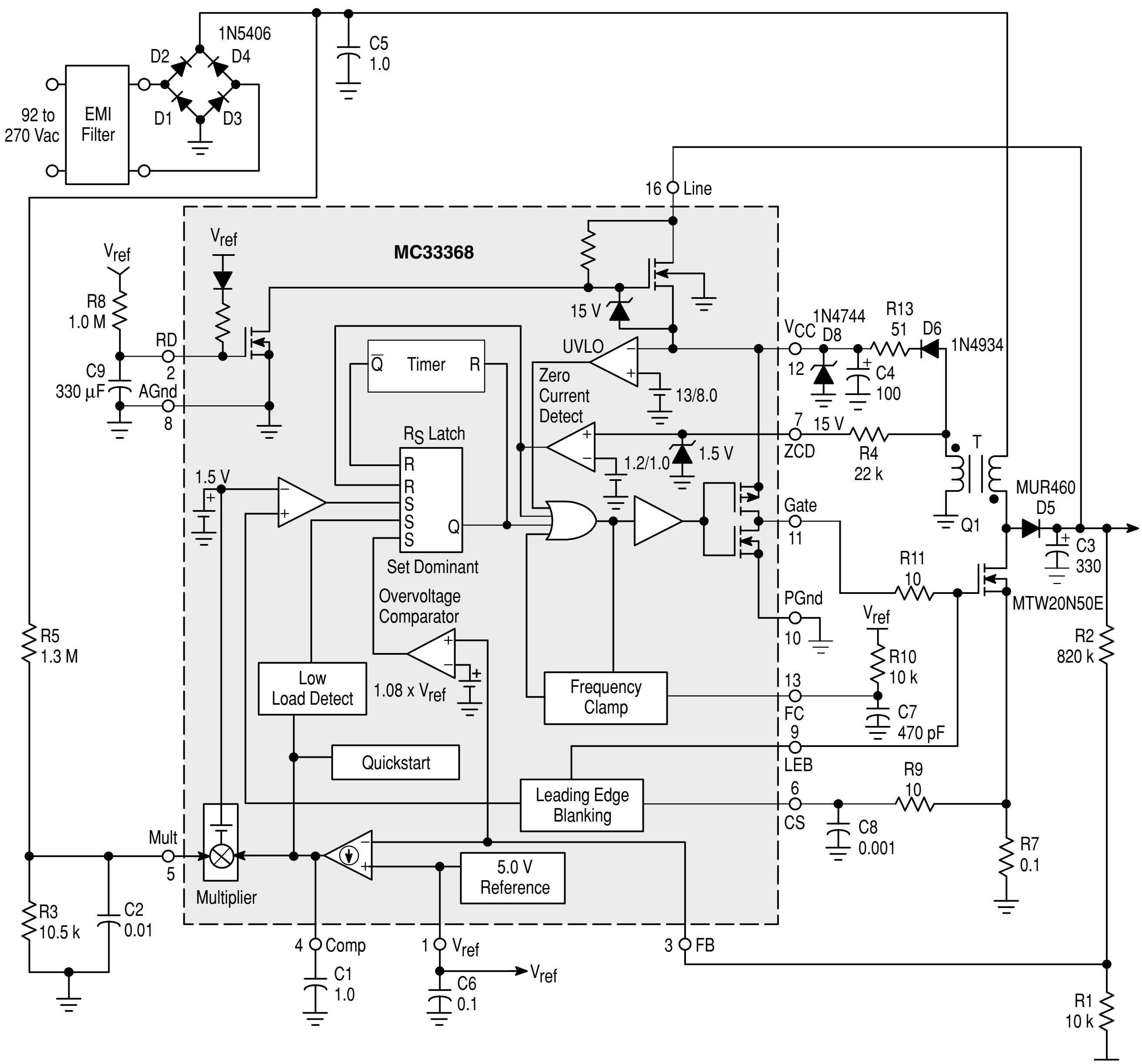
MC33368D, P

T_J = –25° to +125°C, DIP–16, SO–16

The MC33368 is an active power factor controller that functions as a boost preconverter in off–line power supply applications. MC33368 is optimized for low power, high density power supplies requiring minimum board area, reduced component count, and low power dissipation. The narrow body SOIC package provides a small footprint. Integration of the high voltage startup saves approximately 0.7 W of power compared to resistor bootstrapped circuits.

The MC33368 features a watchdog timer to initiate output switching, a one quadrant multiplier to force the line current to follow the instantaneous line voltage, a zero current detector to ensure critical conduction operation, a transconductance error amplifier, a current sensing comparator, a 5.0 V reference, an undervoltage lockout (UVLO) circuit which monitors the V_{CC} supply voltage, and a CMOS driver for driving MOSFETs. The MC33368 also includes a programmable output switching frequency clamp. Protection features include an output overvoltage comparator to minimize overshoot, a restart delay timer, and cycle–by–cycle current limiting.

- Lossless Off–Line Startup
- Output Overvoltage Comparator
- Leading Edge Blanking (LEB) for Noise Immunity
- Watchdog Timer to Initiate Switching
- Restart Delay Timer



GreenLine™ Power Factor Controller

MC33260P

The MC33260 is developed to control Power Factor Correction preconverters meeting IEC1000–3–2 standard requirements in electronic ballast and off–line power conversion applications. Designed to work in free frequency critical conduction mode, it can also be synchronized and in any case, it features very effective protections to ensure a safe and reliable operation.

This circuit is also optimized to offer extremely compact and cost–effective PFC solutions. In effect, while requiring a minimum number of external components, the MC33260 also proposes a free output voltage level mode (follower boost technique) that enables a drastic size reduction of both the inductor and the power mosfet. Ultimately, the solution system cost is significantly lowered.

Also able to function in traditional way (constant output voltage regulation level), any intermediary solutions can be easily implemented. This flexibility makes it ideal to optimally cope with a wide range of applications.

General Features

- “Free Level” or Traditional Constant Output Level Mode
- Switch Mode Operation: Voltage Mode
- Latching PWM for Cycle–by–Cycle On–Time Control
- Totem Pole Gate Drive
- Undervoltage Lockout with Hysteresis
- Low Start–up and Operating Current
- Improved Regulation Block Dynamic Behaviour
- Synchronization Facility
- Internally Trimmed Reference Current Source

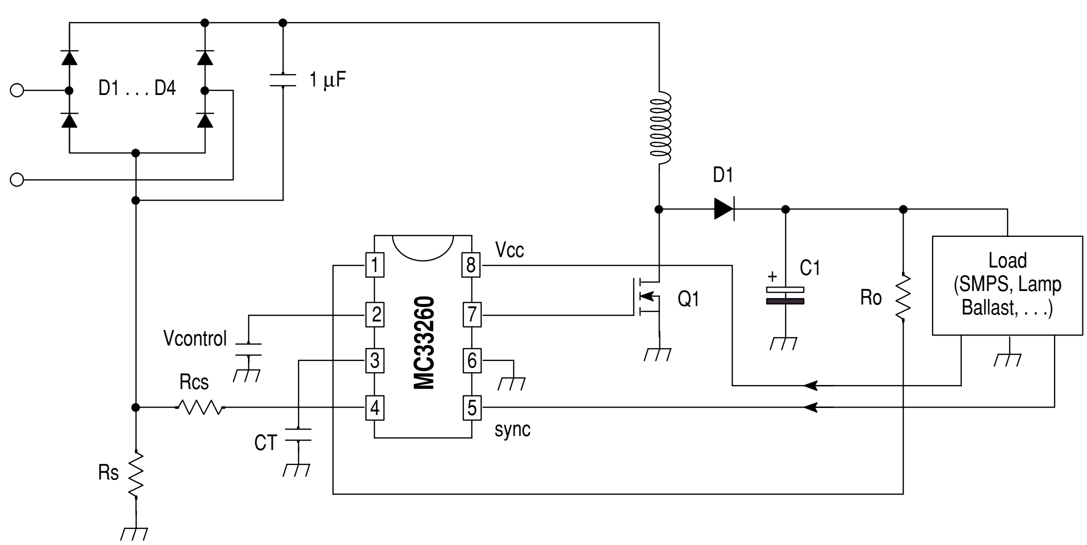
Safety/Protection Features

- Overvoltage Protection: Output Overvoltage Detection
- Undervoltage Protection: Protection Against Open Loop
- Accurate Demagnetization (Zero Current Detection) Protection
- Precise and Adjustable Maximum On–Time Limitation
- Over Current Protection

ORDERING INFORMATION

Device	Temperature Range	Package
MC33260P	–40° to +105°C	Plastic DIP–8

Typical Application



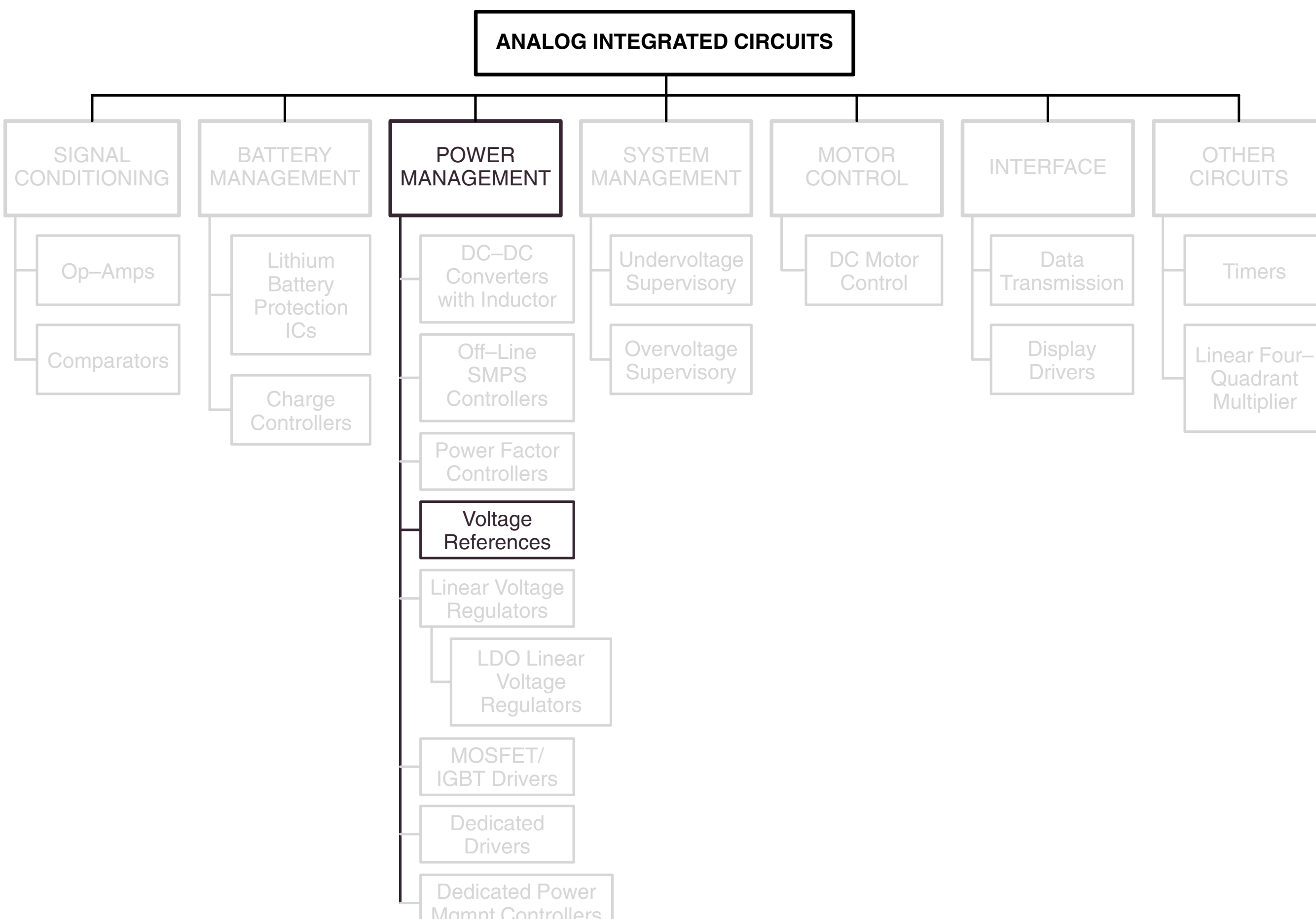
GreenLine is a trademark of Semiconductor Components Industries, LLC (SCILLC)

Voltage References

In Brief . . .

ON Semiconductor's line of precision voltage references is designed for applications requiring high initial accuracy, low temperature drift, and long term stability. Initial accuracies of ±1.0%, and ±2.0% mean production line adjustments can be eliminated. Temperature coefficients of 25 ppm/°C max (typically 10 ppm/°C) provide excellent stability. Uses for the references include D/A converters, A/D converters, precision power supplies, voltmeter systems, temperature monitors, and many others.

Page



Precision Low Voltage References

A family of precision low voltage bandgap reference devices designed for applications requiring low temperature drift.

Table 8. Precision Low Voltage References

V_{out} (V) Typ	I_O (mA) Max	V_{out}/T (ppm/°C) Max	Device 0° to +70°C	Device –40° to +85°C	Reg_{line} (mV) Max	Reg_{load} (mV) Max	Package
1.235 ± 12 mV 1.235 ± 25 mV	20	80 Typ	LM385BZ–1.2 LM385Z–1.2	LM285Z–1.2	(Note 1)	1.0 (Note 2)	TO–92, SO–8
2.5 ± 38 mV 2.5 ± 75 mV			LM385BZ–2.5 LM385Z–2.5	LM285Z–2.5		2.0 (Note 3)	
2.5 ± 25 mV	10	25	MC1403B	–	3.0/4.5 (Note 4)	10 (Note 5)	SO–8, DIP–8
		40	MC1403				
5.0 ± 50 mV		40	MC1404P5	–	6.0 (Note 6)		DIP–8
2.5 to 37	100	50 Typ	TL431C, AC, BC	TL431I, AI, BI	Shunt Reference Dynamic Impedance (z) ≤ 0.5 Ω		TO–92, DIP–8, SO–8, Micro–8

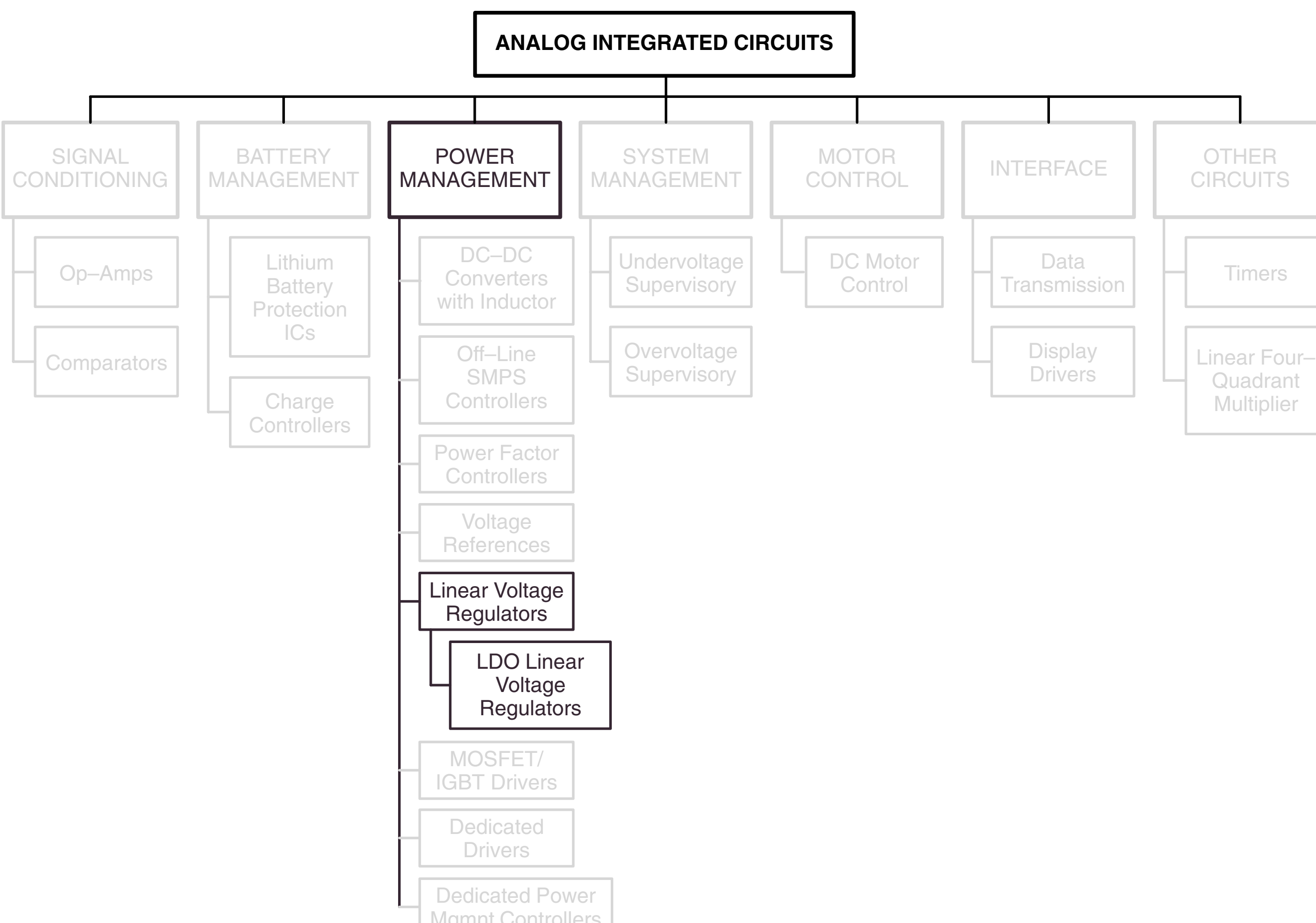
Notes: 1. Micropower Reference Diode Dynamic Impedance (z) ≤ 1.0 Ω at I_R = 100 μA.
2. 10 μA ≤ I_R ≤ 1.0 mA.
3. 20 μA ≤ I_R ≤ 1.0 mA.
4. 4.5 V ≤ V_{in} ≤ 15 V/15 V ≤ V_{in} ≤ 40 V.
5. 0 mA ≤ I_L ≤ 10 mA.
6. (V_{out} + 2.5 V) ≤ V_{in} ≤ 40 V.

Linear Voltage Regulators

In Brief . . .

ON Semiconductor's broad portfolio of voltage regulators covers the whole spectrum of current levels, from low current levels of 80 mA to very high current levels of up to 5 A, and in a very wide selection of voltages. All these products are available in multiple package versions with a strong emphasis on surface mount packages, from TSOP–5 or SOT23–5 leads up to D^{2}PAK 5 leads.

New developments have included low dropout, more accuracy, and less noise using bipolar technology or CMOS technology for a reduction of current consumption.



Linear Voltage Regulators

Fixed Output

These low cost monolithic circuits provide positive and/or negative regulation at currents from 100 mA to 3.0 A. They are ideal for on–card regulation employing current limiting and thermal shutdown. Low V_{Diff} devices are offered for battery powered systems.

Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Table 9. Linear Voltage Regulators

Device	V_{out}	25°C Tol. ±%	V_{in} Max	V_{in}–V_{out} Diff. Typ.	Reg_{line} Max (% V_{out})	Reg_{load} Max (% V_{out})	Typ. Temp. Coefficient mV (V_{out}) / °C	Package
Fixed Voltage, 3–Terminal Regulators, 0.1 Amperes								
LM2931*/A–5.0*	5.0	5.0/3.8	40	0.16	0.6	1.0	0.2	SO–8, TO–92, D^2PAK, DPAK, TO–220
LP2950C*/AC*	3.0	0.5	30	0.38	0.2/0.1	0.2/0.1	0.04	DPAK, TO–92
	3.3							DPAK, TO–92
	5.0							DPAK, TO–92
MC78LXXC/AC/AB*	5.0, 8.0, 9.0	8.0/4.0	30	1.7	4.0/3.0	1.2	0.2	DIP–8, SOP–8
MC78LXXC/AC/AB*	12, 15, 18	8.0/4.0	35	1.7	2.0	1.0	0.2	DIP–8, SOP–8
MC78L24C/AC/AB*	24	8.0/4.0	40	1.7	2.0	1.0	0.2	DIP–8, SOP–8
MC79L05C/AC/AB*	–5.0	8.0/4.0	30	1.7	4.0/3.0	1.2	0.2	DIP–8, SOP–8
MC79LXXC/AC/AB*	–(12, 15, 18)	8.0/4.0	35	1.7	2.0	1.0	0.2	DIP–8, SOP–8
MC79L24C/AC/AB*	–24	8.0/4.0	40	1.7	2.0	1.0	0.2	DIP–8, SOP–8
MC33160**	5.0	5.0	40	2.0	0.8	1.0	–	DIP–16, SO–16L
Fixed Voltage, 3–Terminal Regulators, 0.5 Amperes								
MC78MXXB*/C	5.0, 6.0, 8.0, 12	4.0	35	2.0	1.0	2.0	±0.04	DPAK, TO–220
MC78MXXB*/C	15, 18	4.0	35	2.0	1.0	2.0	±0.04	DPAK, TO–220
MC78MXXB*/C	20, 24	4.0	40	2.0	0.25	2.0	±0.04	DPAK, TO–220
MC79MXXB*/C	–(5.0, 8.0, 12, 15)	4.0	35	1.1	1.0	2.0	–0.07 to ±0.04	DPAK, TO–220

Unless otherwise noted, T_J = 0° to +125°C
* T_J = –40° to +125°C
** T_A = –40° to +85°C

Table 9. Linear Voltage Regulators (continued)

Device	V_{out}	25°C Tol. ±%	V_{in} Max	V_{in}–V_{out} Diff. Typ.	Reg_{line} Max (% V_{out})	Reg_{load} Max (% V_{out})	Typ. Temp. Coefficient mV (V_{out}) / °C	Package
Fixed Voltage, 3–Terminal Regulators, 0.5 Amperes								
MC33267*	5.05	2.0	40	0.58	1.0	1.0	–	D^2PAK, TO–220
Fixed Voltage, 3–Terminal Medium Dropout Regulators, 0.8 Amperes								
MC33269–XX*	3.3, 5.0, 12	1.0	20	1.0	0.3	1.0	–	SO–8, DPAK, TO–220, SOT–223
MC34268	2.85	1.0	15	0.95	0.3	1.0	–	SO–8, DPAK
Fixed Voltage, 3–Terminal Regulators, 1.0 Amperes								
MC78XXB*/C/AC	5.0, 6.0, 8.0, 12, 18	4.0/2.0	35	2.0	2.0/1.0	2.0	–0.06 to –0.22	D^2PAK, TO–220
MC7824B*/C/AC	24	4.0/2.0	40	2.0	2.0/1.0	2.0/0.4	0.125	D^2PAK, TO–220
MC79XXC/AC	–(5.0, 6.0)	4.0/2.0	35	2.0	2.0/1.0	2.0	–0.2	D^2PAK, TO–220
MC79XXC/AC	–(8.0, 12, 15, 18)	4.0/2.0	35	2.0	2.0/1.0	2.0/1.25	–0.12 to –0.06	D^2PAK, TO–220
MC7924C	–24	4.0	40	2.0	1.0	2.0	–0.04	D^2PAK, TO–220
LM340/A–XX	5.0, 12, 15	4.0/2.0	35	1.7	1.0/0.2	1.0/0.5	±0.12	TO–220
Fixed Voltage, 3–Terminal Regulators, 3.0 Amperes								
MC78TXXC/AC	5.0, 8.0, 12	4.0/2.0	35	2.5	0.5	0.6	0.04	TO–220
MC78T15C/AC	15	4.0/2.0	40	2.5	0.5	0.6	0.04	TO–220
LM323/A	5.0	4.0/2.0	20	2.3	0.5/0.3	2.0/1.0	±0.2	TO–220

Unless otherwise noted, T_J = 0° to +125°C
* T_J = –40° to +125°C
** T_A = –40° to +85°C

Table 10. Fixed Voltage Medium and Low Dropout Regulators

Device	V_{out}	25°C Tol. ±%	I_O (mA) Max	V_{in} Max	V_{in}–V_{out} Diff. Typ.	Reg_{line} Max (% V_{out})	Reg_{load} Max (% V_{out})	Typ. Temp. Coefficient mV (V_{out}) / °C	Package
Fixed Voltage, Medium Dropout Regulators									
MC33267*	5.05	2.0	500	40	0.58	1.0	1.0	–	D^2PAK, TO–220
MC34268	2.85	1.0	800	15	0.95	0.3	1.0		SO–8, DPAK
MC33269–XX*	3.3, 5.0, 12			20	1.0				SO–8, DPAK, TO–220, SOT–223
Fixed Voltage, Low Dropout Regulators									
LM2931*/A*	5.0	5.0/3.8	100	37	0.16	1.12	1.0	±2.5	SO–8, D^2PAK, DPAK, TO–220, TO–92
LP2950C*/AC*	3.0	1.0/0.5	100	30	0.38	0.2/0.1	0.2/0.1	0.2	DPAK, TO–92
	3.3								DPAK, TO–92
	5.0								DPAK, TO–92
LP2951C*/AC*	3.0	1.0/0.5	100	28.75	0.38	0.04/0.02	0.04/0.02	±1.0	SO–8, Micro–8, DIP–8
	3.3								SO–8, Micro–8, DIP–8
	5.0								SO–8, Micro–8, DIP–8
LM2935*	5.0/5.0	5.0/5.0	500/10	60	0.45/0.55	1.0	1.0	–	TO–220, D^2PAK

Unless otherwise noted, T_J = 0° to +125°C
* T_J = –40° to +125°C

Adjustable Output

ON Semiconductor offers a broad line of adjustable output voltage regulators with a variety of output current capabilities. Adjustable voltage regulators provide users the capability of stocking a single integrated circuit offering a wide range of output voltages for industrial and communications applications. The three–terminal devices require only two external resistors to set the output voltage.

Table 11. Adjustable Output Regulators

Device	V_{out}	I_O (mA) Max	V_{in} Max	V_{in}–V_{out} Diff. Typ.	Reg_{line} Max (% V_{out})	Reg_{load} Max (% V_{out})	Typ. Temp. Coefficient mV (V_{out}) / °C	Package
Adjustable Regulators								
LM317L/B*	2.0–37	100	40	1.9	0.07	1.5	±0.35	SO–8, TO–92
LM2931C*	3.0–24	100	37	0.16	1.12	1.0	±2.5	SO–8, D^{2}PAK, TO–220, TO–92
LP2951C*/AC*	1.25–29	100	28.75	0.38	0.04/0.02	0.04/0.02	±1.0	SO–8, DIP–8, Micro–8
								SO–8, DIP–8, Micro–8
								SO–8, DIP–8, Micro–8
MC1723C#	2.0–37	150	38	2.5	0.5	0.2	±0.033	DIP–14, SO–14
LM317M/B*	1.2–37	500	40	2.1	0.04	0.5	±0.35	DPAK, TO–220
LM337M/B*	–(1.2–37)	500	40	1.9	0.07	1.5	±0.3	TO–220
MC33269*	1.25–19	800	18.75	1.0	0.3	0.5	±0.4	SO–8, DPAK, TO–220, SOT–223
LM317/B*	1.2–37	1500	40	2.25	0.07	1.5	±0.35	TO–220, D^{2}PAK
LM337/B*	–(1.2–37)	1500	40	2.3	0.07	1.5	±0.3	TO–220, D^{2}PAK
LM350/B*	1.2–33	3000	35	2.7	0.07	1.5	±0.5	TO–220

Unless otherwise noted, T_J = 0° to +125°C
* T_J = –40° to +125°C
# T_A = 0° to +70°C

Micropower Voltage Regulators for Portable Applications

80 mA Micropower Voltage Regulator

MC78LC00H, N

T_A = –30° to +80°C, SOT–89, SOT–23 5 Leads

The MC78LC00 series voltage regulators are specifically designed for use as a power source for video instruments, handheld communication equipment, and battery powered equipment.

The MC78LC00 series features an ultra–low quiescent current of 1.1 µA and a high accuracy output voltage. Each device contains a voltage reference, an error amplifier, a driver transistor and resistors for setting the output voltage. These devices are available in either SOT–89, 3 pin, or SOT–23, 5 pin, surface mount packages.

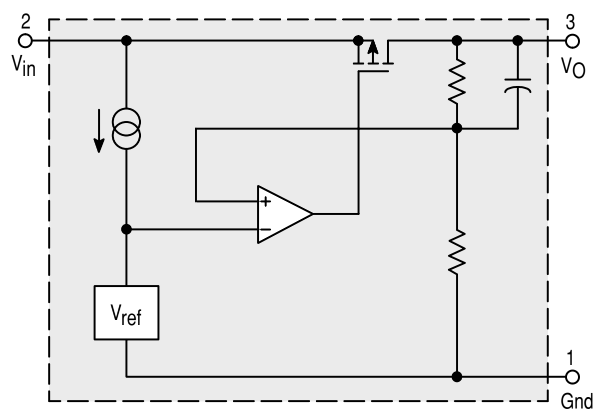
MC78LC00 Series Features:

- Low Quiescent Current of 1.1 µA Typical
- Low Dropout Voltage (220 mV at 10 mA)
- Excellent Line Regulation (0.1%)
- High Accuracy Output Voltage (±2.5%)
- Wide Output Voltage Range (2.0 V to 6.0 V)
- Output Current for Low Power (up to 80 mA)
- Two Surface Mount Packages (SOT–89, 3 Pin, or SOT–23, 5 Pin)

ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78LC30HT1	3.0	T_A = –30° to +80°C	SOT–89
MC78LC33HT1	3.3		
MC78LC40HT1	4.0		
MC78LC50HT1	5.0		
MC78LC30NTR	3.0		SOT–23
MC78LC33NTR	3.3		
MC78LC40NTR	4.0		
MC78LC50NTR	5.0		

Other voltages from 2.0 to 6.0 V, in 0.1 V increments, are available upon request. Consult factory for information.



120 mA Micropower Voltage Regulator

MC78FC00H

T_A = –30° to +80°C, SOT–89

The MC78FC00 series voltage regulators are specifically designed for use as a power source for video instruments, handheld communication equipment, and battery powered equipment.

The MC78FC00 series voltage regulator ICs feature a high accuracy output voltage and ultra–low quiescent current. Each device contains a voltage reference unit, an error amplifier, a driver transistor, and resistors for setting output voltage, and a current limit circuit. These devices are available in SOT–89 surface mount packages, and allow construction of an efficient, constant voltage power supply circuit.

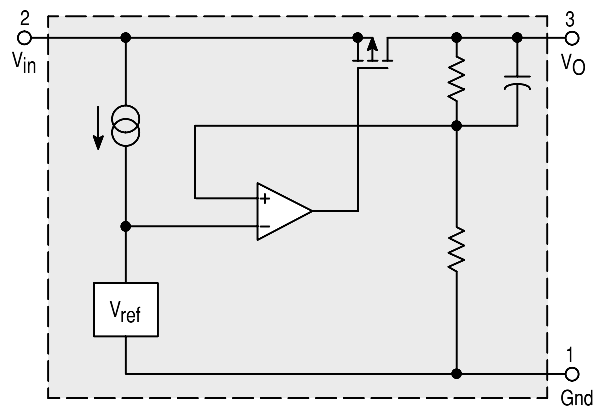
MC78FC00 Series Features:

- Ultra–Low Quiescent Current of 1.1 µA Typical
- Ultra–Low Dropout Voltage (100 mV at 10 mA)
- Large Output Current (up to 120 mA)
- Excellent Line Regulation (0.1%)
- Wide Operating Voltage Range (2.0 V to 10 V)
- High Accuracy Output Voltage (±2.5%)
- Wide Output Voltage Range (2.0 V to 6.0 V)
- Surface Mount Package (SOT–89)

ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78FC30HT1	3.0	T_A = –30° to +80°C	SOT–89
MC78FC33HT1	3.3		
MC78FC40HT1	4.0		
MC78FC50HT1	5.0		

Other voltages from 2.0 to 6.0 V, in 0.1 V increments, are available upon request. Consult factory for information.



Micropower Voltage Regulator for External Power Transistor

MC78BC00N

T_A = –30° to +80°C, SOT–23 5 Leads

The MC78BC00 voltage regulators are specifically designed to be used with an external power transistor to deliver high current with high voltage accuracy and low quiescent current.

The MC78BC00 series are devices suitable for constructing regulators with ultra–low dropout voltage and output current in the range of several tens of mA to hundreds of mA. These devices have a chip enable function, which minimizes the standby mode current drain. Each of these devices contains a voltage reference unit, an error amplifier, a driver transistor and feedback resistors. These devices are available in the SOT–23, 5 pin surface mount packages.

These devices are ideally suited for battery powered equipment, and power sources for hand–held audio instruments, communication equipment and domestic appliances.

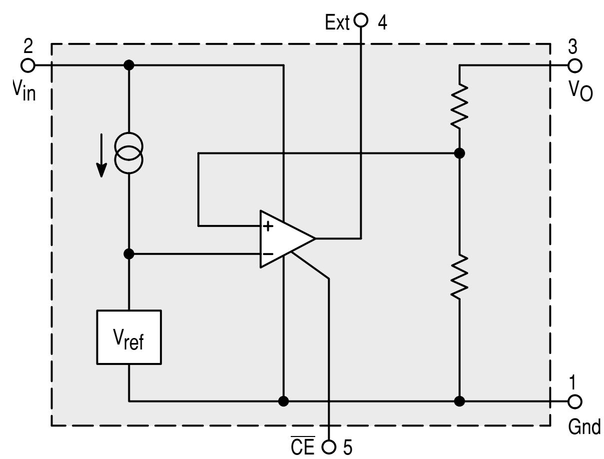
MC78BC00 Series Features:

- Ultra–Low Supply Current (50 μA)
- Standby Mode (0.2 μA)
- Ultra–Low Dropout Voltage (0.1 V with External Transistor and I_O = 100 mA)
- Excellent Line Regulation (Typically 0.1%/V)
- High Accuracy Output Voltage (±2.5%)

ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78BC30NTR	3.0	T_A = –30° to +80°C	SOT–23 5 Leads
MC78BC33NTR	3.3		
MC78BC40NTR	4.0		
MC78BC50NTR	5.0		

Other voltages from 2.0 to 6.0 V, in 0.1 V increments, are available upon request. Consult factory for information.



Micropower Voltage Regulators for Portable Applications (continued)

Low Noise 150 mA Low Drop Out (LDO) Linear Voltage Regulator

MC78PC00

T_A = –40° to +85°C, SOT–23 5 Lead Package

The MC78PC00 are a series of CMOS linear voltage regulators with high output voltage accuracy, low supply current, low dropout voltage, and high Ripple Rejection. Each of these voltage regulators consists of an internal voltage reference, an error amplifier, resistors, a current limiting circuit and a chip enable circuit.

The dynamic Response to line and load is fast, which makes these products ideally suited for use in hand–held communication equipment.

The MC78PC00 series are housed in the SOT–23 5 lead package, for maximum board space saving.

MC78PC00 Series Features:

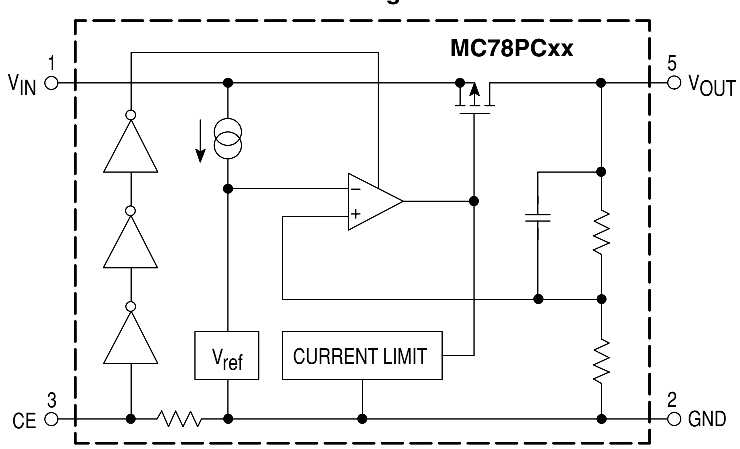
- Ultra–Low Supply Current: typical 35 µA in ON mode with no load
- Standby Mode: typical 0.1 µA
- Low Dropout Voltage: typical 0.2 V @ I_{OUT} = 100 mA
- High Ripple Rejection: typical 70 dB @ f = 1 kHz
- Low Temperature–Drift Coefficient of Output Voltage: typical ±100 ppm/°C
- Excellent Line Regulation: typical 0.05%/V
- High Accuracy Output Voltage: ±2.0%
- Fast Dynamic Response to Line and Load
- Small Package: SOT–23 5 leads
- Built–in Chip Enable circuit (CE input pin)
- Similar Pinout to the LP2980/1/2 and MIC5205

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC78PC28NTR MC78PC30NTR MC78PC33NTR MC78PC50NTR	T_A = –40° to +85°C	SOT–23 5 Leads

Other voltages are available. Consult your ON Semiconductor representative.

Block Diagram



Micropower Voltage Regulators for Portable Applications (continued)

Ultra Low Noise 150 mA Low Dropout Voltage Regulator with ON/OFF Control

MC33263

T_A = –40° to +85°C, SOT23–L

Housed in a SOT23–L package, the MC33263 delivers up to 150 mA where it exhibits a typical 180 mV dropout. With an incredible noise level of 25 µVRMS (over 100 Hz to 100 kHz, with a 10 nF bypass capacitor), the MC33263 represents the ideal choice for sensitive circuits, especially in portable applications where noise performance and space are premium. The MC33263 also excels in response time and reacts in less than 25 µs when receiving an OFF to ON signal (with no bypass capacitor).

Thanks to a novel concept, the MC33263 accepts output capacitors without any restrictions regarding their Equivalent Series Resistance (ESR) thus offering an obvious versatility for immediate implementation.

With a typical DC ripple rejection better than –90 dB (–70 dB @ 1 kHz), it naturally shields the downstream electronics against choppy power lines.

Additionally, thermal shutdown and short–circuit protection provide the final product with a high degree of ruggedness.

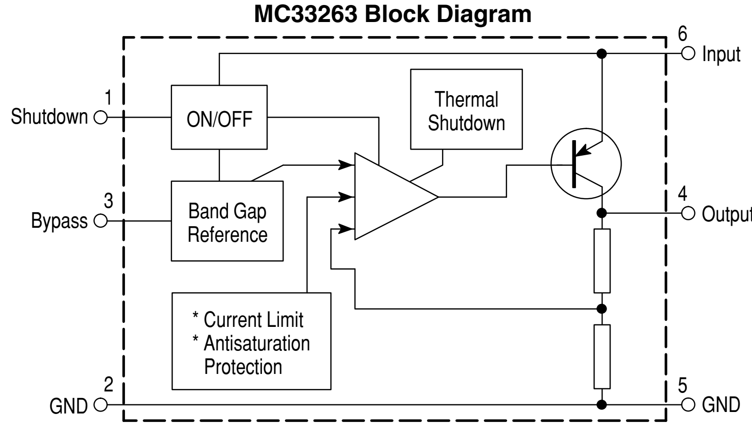
MC33263 Features:

- Very Low Quiescent Current 170 µA (ON, no load), 100 nA (OFF, no load)
- Very Low Dropout Voltage, typical value is 137 mV at an output current of 100 mA
- Very Low Noise with external bypass capacitor (10 nF), typically 25 µVrms over 100 Hz to 100 kHz
- Internal Thermal Shutdown
- Extremely Tight Line Regulation typically –90 dB
- Ripple Rejection –70 dB @ 1 kHz
- Line Transient Response: 1 mV for ΔV_{in} = 3 V
- Extremely Tight Load Regulation, typically 20 mV at ΔI_{out} = 150 mA
- Multiple Output Voltages Available
- Logic Level ON/OFF Control (TTL–CMOS Compatible)
- ESR can vary from 0 to 3Ω
- Functionally and Pin Compatible with TK112xxA/B Series

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33263NW–28R2 MC33263NW–30R2 MC33263NW–32R2 MC33263NW–33R2 MC33263NW–38R2 MC33263NW–40R2 MC33263NW–47R2 MC33263NW–50R2	T_A = –40° to +85°C	SOT23–L

MC33263 Block Diagram



Micropower Voltage Regulators for Portable Applications (continued)

Micropower smallCAP™ Voltage Regulators with On/Off Control

MC33264D, DM

T_A = –40° to +85°C, SO–8, Micro–8

The MC33264 series are micropower low dropout voltage regulators available in SO–8 and Micro–8 surface mount packages and a wide range of output voltages. These devices feature a very low quiescent current (100 µA in the ON mode; 0.1 µA in the OFF mode), and are capable of supplying output currents up to 100 mA. Internal current and thermal limiting protection is provided. They require only a small output capacitance for stability.

Additionally, the MC33264 has either active HIGH or active LOW control (Pins 2 and 3) that allows a logic level signal to turn–off or turn–on the regulator output.

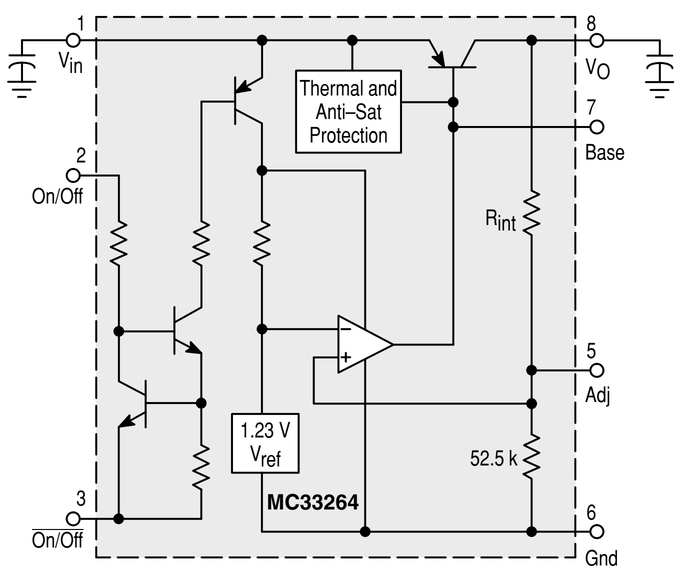
Due to the low input–to–output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

MC33264 Features:

- Low Quiescent Current (0.3 µA in OFF Mode; 95 µA in ON Mode)
- Low Input–to–Output Voltage Differential of 47 mV at 10 mA, and 131 mV at 50 mA
- Multiple Output Voltages Available
- Extremely Tight Line and Load Regulation
- Stable with Output Capacitance of Only 0.22 µF for 4.0 V, 4.75 V and 5.0 V Output Voltages 0.33 µF for 2.8 V, 3.0 V, 3.3 V and 3.8 V Output Voltages
- Internal Current and Thermal Limiting
- Logic Level ON/OFF Control
- Functionally Equivalent to TK115XXMC and LP2980

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33264D–2.8 MC33264D–3.0 MC33264D–3.3 MC33264D–3.8 MC33264D–4.0 MC33264D–4.75 MC33264D–5.0	T_A = –40° to +85°C	SO–8
MC33264DM–2.8 MC33264DM–3.0 MC33264DM–3.3 MC33264DM–3.8 MC33264DM–4.0 MC33264DM–4.75 MC33264DM–5.0		Micro–8



Micropower Voltage Regulators for Portable Applications (continued)

5A Low Dropout Fast Response Positive Adjustable and Fixed Voltage Regulators

LT1585A

T_A = 0° to 125°C, TO–220, D^2PAK

The LT1585A is a low dropout 3–terminal voltage regulator with 5A output current capability.

Design has been optimized for low voltage applications where transient response and minimum input voltage are critical. This voltage regulator features a low dropout voltage and fast transient response. These improvements make them ideal for low voltage microprocessor applications requiring a regulated 2.5V to 3.6V output with an input supply below 7V.

Current limits is trimmed to ensure specified output current and controlled short–circuit current. On–chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures. The LT1585A is available in the industry standard 3–pin TO–220 and D^2PAK power package.

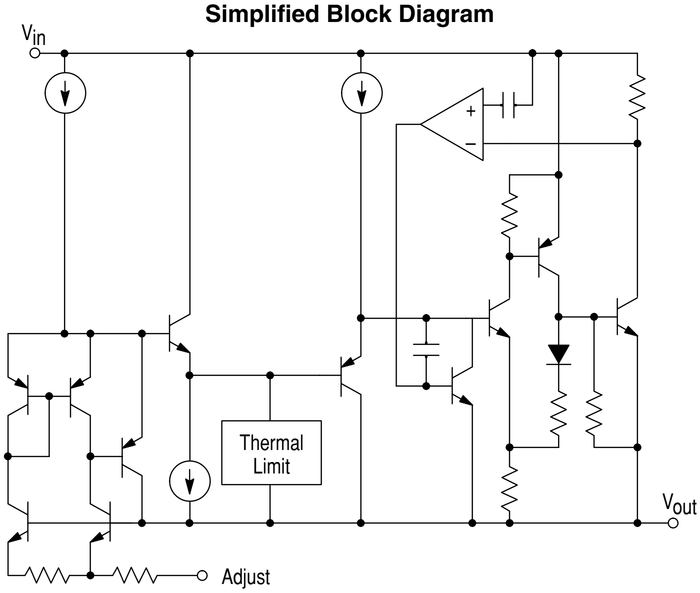
LT1585A Features:

- Fast Transient Response
- Guaranteed Dropout Voltage at Multiple Currents
- Load Regulation: 0.05% Typ
- Trimmed Current Limit
- On–Chip Thermal Limiting
- Standard 3–Pin Power Package

ORDERING INFORMATION

Device	Operating Temperature Range	Package
LT1585ACT	T_A = 0° to 125°C	TO–220
LT1585ACM		D^2PAK
LT1585ACT–1.5		TO–220
LT1585ACM–1.5		D^2PAK

Simplified Block Diagram



Special Voltage Regulators

Table 12. Voltage Regulators

Function	Features	Package	Device
Multifunction Very Low Dropout Voltage Regulator	A monolithic integrated 5.0 V voltage regulator with a very low dropout and additional functions such as power–on reset and input voltage sense. It is designed for supplying the micro–computer controlled systems especially in automotive applications.	DIP–8, SO–8	L4949
Low Dropout Voltage Regulator	Fixed and adjustable positive output voltage regulators which maintain regulation with very low input–to–output voltage differential.	TO–92, TO–220, DPAK, D^2PAK, SO–8	LM2931 Series
Low Dropout Voltage Regulator	Low voltage differential regulator featuring dual positive 5.0 V outputs; switched currents in excess of 750 mA and 10 mA standby current. Fixed quiescent current is less than 3.0 mA.	TO–220, D^2PAK	LM2935
Low Dropout Voltage Regulator	Positive 5.0 V, 500 mA regulator with on–chip power–up–reset circuit with externally programmable delay, current limit, and thermal shutdown.	TO–220, D^2PAK	MC33267
Low Dropout Voltage Regulator	Positive 3.3 V, 5.0 V, 12 V, 800 mA regulator.	SO–8, DPAK, SOT–223, TO–220	MC33269
Low Dropout Voltage Regulator	Positive regulator with 5 outputs fixed 2.8 V and 13 V.	TSSOP–16	MC33765

Special Regulators

Voltage Regulator/Supervisory

Table 13. Voltage Regulator/Supervisory

Device	V_{out} (V)		I_O (mA) Max	V_{in} (V)		Reg_{line} (mV) Max	Reg_{load} (mV) Max	T_A (°C)	Suffix/ Package
	Min	Max		Min	Max				
MC34160	4.75	5.25	100	7.0	40	40	50	0 to +70	DIP–16, SO–16L
MC33160								–40 to +85	
MC33267	4.9	5.2	500	6.0	26	50	50	–40 to +105	TO–220, D^2PAK

* These ICs are intended for powering cellular phone GaAs power amplifiers and can be used for other portable applications as well.

Voltage Regulator/Supervisory (continued)

Microprocessor Voltage Regulator and Supervisory Circuit

MC34160P, DW

T_A = 0° to +70°C, DIP–16, SO–16L

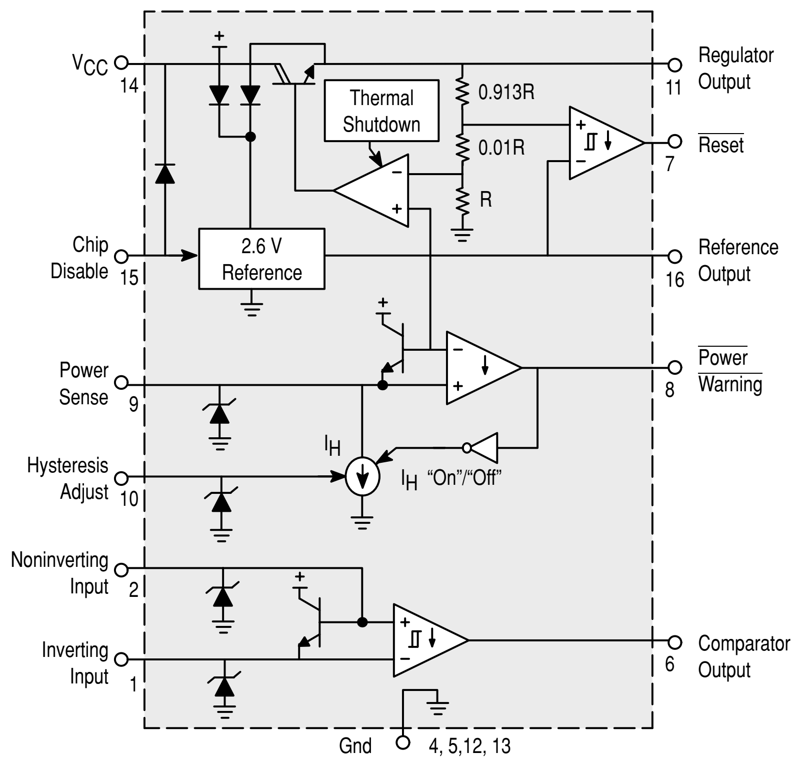
MC33160P, DW

T_A = –40° to +85°C, DIP–16, SO–16L

The MC34160 series is a voltage regulator and supervisory circuit containing many of the necessary monitoring functions required in microprocessor based systems. It is specifically designed for appliance and industrial applications offering the designer a cost effective solution with minimal external components. These integrated circuits feature a 5.0 V, 100 mA regulator with short circuit current limiting, pinned out 2.6 V bandgap reference, low voltage reset comparator, power warning comparator with programmable hysteresis, and an uncommitted comparator ideally suited for microprocessor line synchronization.

Additional features include a chip disable input for low standby current, and internal thermal shutdown for over temperature protection.

These devices are contained in a 16 pin dual–in–line heat tab plastic package for improved thermal conduction.



Voltage Regulator/Supervisory (continued)

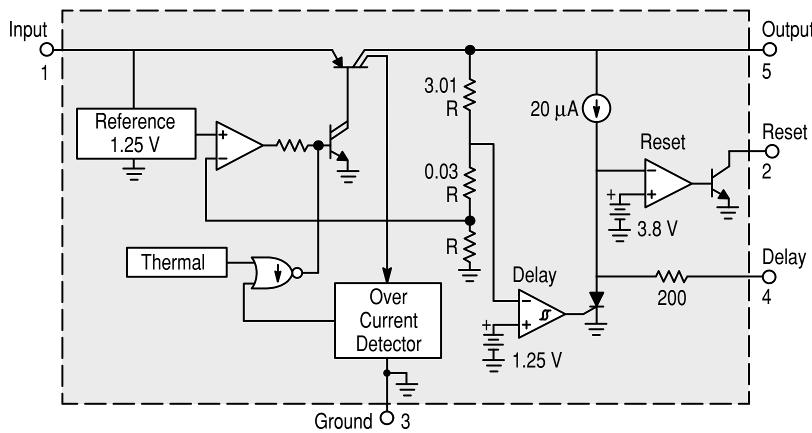
Low Dropout Regulator

MC33267T, TV

T_J = –40° to +105°C, TO–220 5 Leads, D^2PAK 5 Leads

The MC33267 is a positive fixed 5.0 V regulator that is specifically designed to maintain proper voltage regulation with an extremely low input–to–output voltage differential. This device is capable of supplying output currents in excess of 500 mA and contains internal current limiting and thermal shutdown protection. Also featured is an on–chip power–up reset circuit that is ideally suited for use in microprocessor based systems. Whenever the regulator output voltage is below nominal, the reset output is held low. A programmable time delay is initiated after the regulator has reached its nominal level and upon timeout, the reset output is released.

Due to the low dropout voltage specifications, the MC33267 is ideally suited for use in battery powered industrial and consumer equipment where an extension of useful battery life is desirable. This device is contained in an economical five lead TO–220 type package.



Voltage Regulator/Supervisory (continued)

Very Low Dropout Regulator

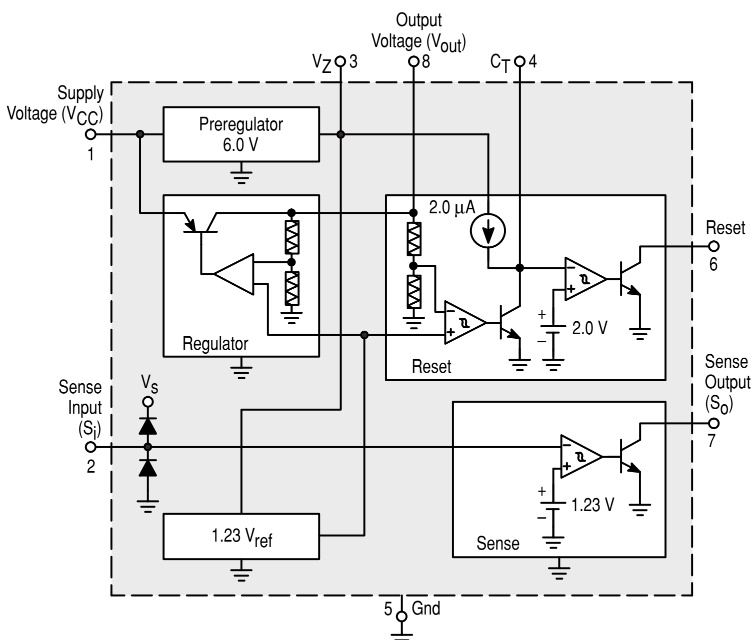
L4949N, D

T_J = –40° to +125°C, DIP–8, SO–8

The L4949 is a monolithic integrated 5.0 V voltage regulator with a very low dropout and additional functions such as power–on reset and input voltage sense.

It is designed for supplying the micro–computer controlled systems especially in automotive applications.

- Operating DC Supply Voltage Range 5.0 V to 28 V
- Transient Supply Voltage Up to 40 V
- Extremely Low Quiescent Current in Standby Mode
- High Precision Standby Output Voltage 5.0 V ±1%
- Output Current Capability Up to 100 mA
- Very Low Dropout Voltage Less Than 0.4 V
- Reset Circuit Sensing The Output Voltage
- Programmable Reset Pulse Delay With External Capacitor
- Voltage Sense Comparator
- Thermal Shutdown and Short Circuit Protections



Voltage Regulator/Supervisory (continued)

Very Low Dropout/Ultra Noise 5 Outputs Voltage Regulator

MC33765

T_A = −40° to +85°C, TSSOP16

The MC33765 is an ultra low noise, very low dropout voltage regulator with five independent outputs which is available in TSSOP 16 surface mount package.

Two versions are available: 2.8 V or 3.0 V. The voltage of all five outputs is 2.8 V or 3.0 V typical but each output is capable of supplying different currents up to 150 mA for output 4. The device features a very low dropout voltage (0.11 V typical for maximum output current), very low quiescent current (5.0 mA maximum in OFF mode, 130 mA typical in ON mode) and one of the output (output 3) exhibits a very low noise level which allows the driving of noise sensitive circuitry. Internal current and thermal limiting protections are provided.

Additionally, the MC33765 has an independent Enable input pin for each output. It includes also a common Enable pin to shutdown the complete circuit when not used. *The Common Enable pin has the highest priority over the five independent Enable input pins.*

The voltage regulators VR1, VR2 and VR3 have a common input voltage pin $V_{CC}1$.

The other voltage regulators VR4 and VR5 have a common input voltage pin $V_{CC}2$.

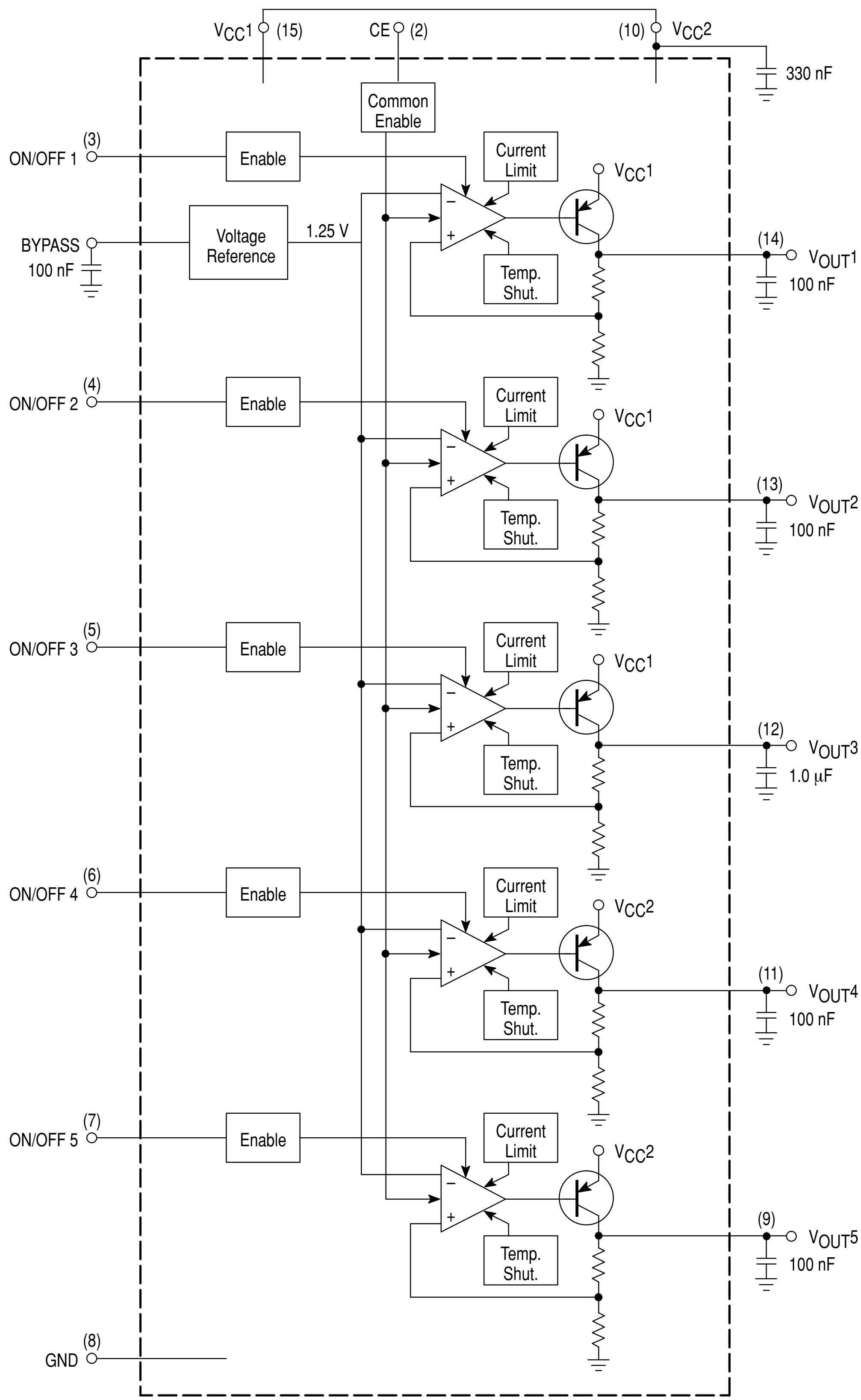
MC33765 Features:

- Five Independent Outputs at 2.8 V or 3.0 V Typical
- Internal Trimmed Voltage Reference
- V_{out} Tolerance ±3.0% at 25°C
- Enable Input Pin (Logic–Controlled Shutdown) for Each of the Five Outputs
- Common Enable Pin to Shutdown the Whole Circuit
- Very Low Dropout Voltage (0.11 V Typical for Output 1, 2, 3 and 5; 0.17 V Typical for Output 4 at Maximum Current)
- Very Low Quiescent Current (Maximum 5.0 µA in OFF Mode, 130 µA Typical in ON Mode)
- Ultra Low Noise for VR3 (30 µV RMS Max, 100 Hz < f < 100 kHz)
- Internal Current and Thermal Limit
- 100 nF for VR1, VR2, VR4 and VR5 and 1.0 µF for VR3 for Stability
- Supply Voltage Rejection: 60 dB (Typical) @ f = 1.0 kHz

ORDERING INFORMATION

Device	Voltage Version	Operating Temperature Range	Package
MC33765DTB, R2 MC33765DTB–30, R2	2.8 V Fixed 3.0 V Fixed	T_A = −40° to +85°C	TSSOP–16

Simplified Block Diagram



SCSI Regulator

Table 14. SCSI Regulator

Device	V_{out} (V)		I_{sink} (mA)	V_{in} (V)		Reg_{line} (%)	Reg_{load} (%)	T_J (°C)	Package
	Min	Max		Min	Max				
MC34268	2.81	2.89	800	3.9	20	0.3	0.5	150	SO–8, DPAK

SCSI–2 Active Terminator Regulator

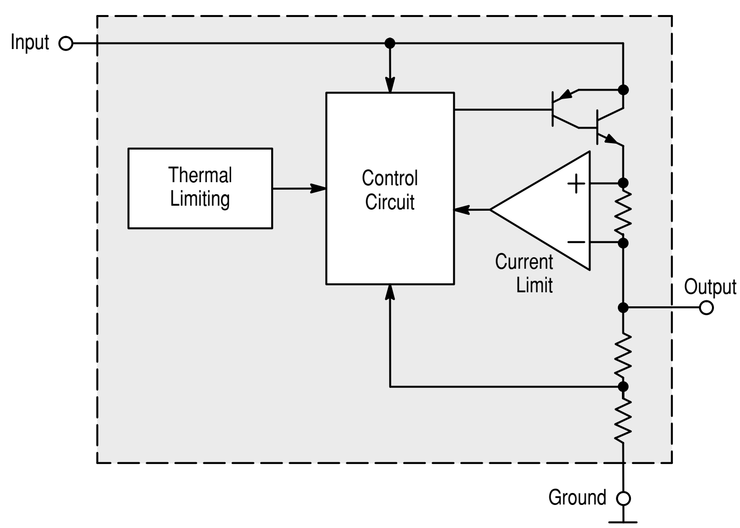
MC34268D, DT

T_J = 0° to +125°C, DIP–8, SO–8

The MC34268 is a medium current, low dropout positive voltage regulator specifically designed for use in SCSI–2 active termination circuits. This device offers the circuit designer an economical solution for precision voltage regulation, while keeping power losses to a minimum. The regulator consists of a 1.0 V dropout composite PNP/NPN pass transistor, current limiting, and thermal limiting. These devices are packaged in the 8–pin SOP–8 and 3–pin DPAK surface mount power packages.

Applications include active SCSI–2 terminators and post regulation of switching power supplies.

- 2.85 V Output Voltage for SCSI–2 Active Termination
- 1.0 V Dropout
- Output Current in Excess of 800 mA
- Thermal Protection
- Short Circuit Protection
- Output Trimmed to 1.4% Tolerance
- No Minimum Load Required
- Space Saving DPAK and SOP–8 Surface Mount Power Packages

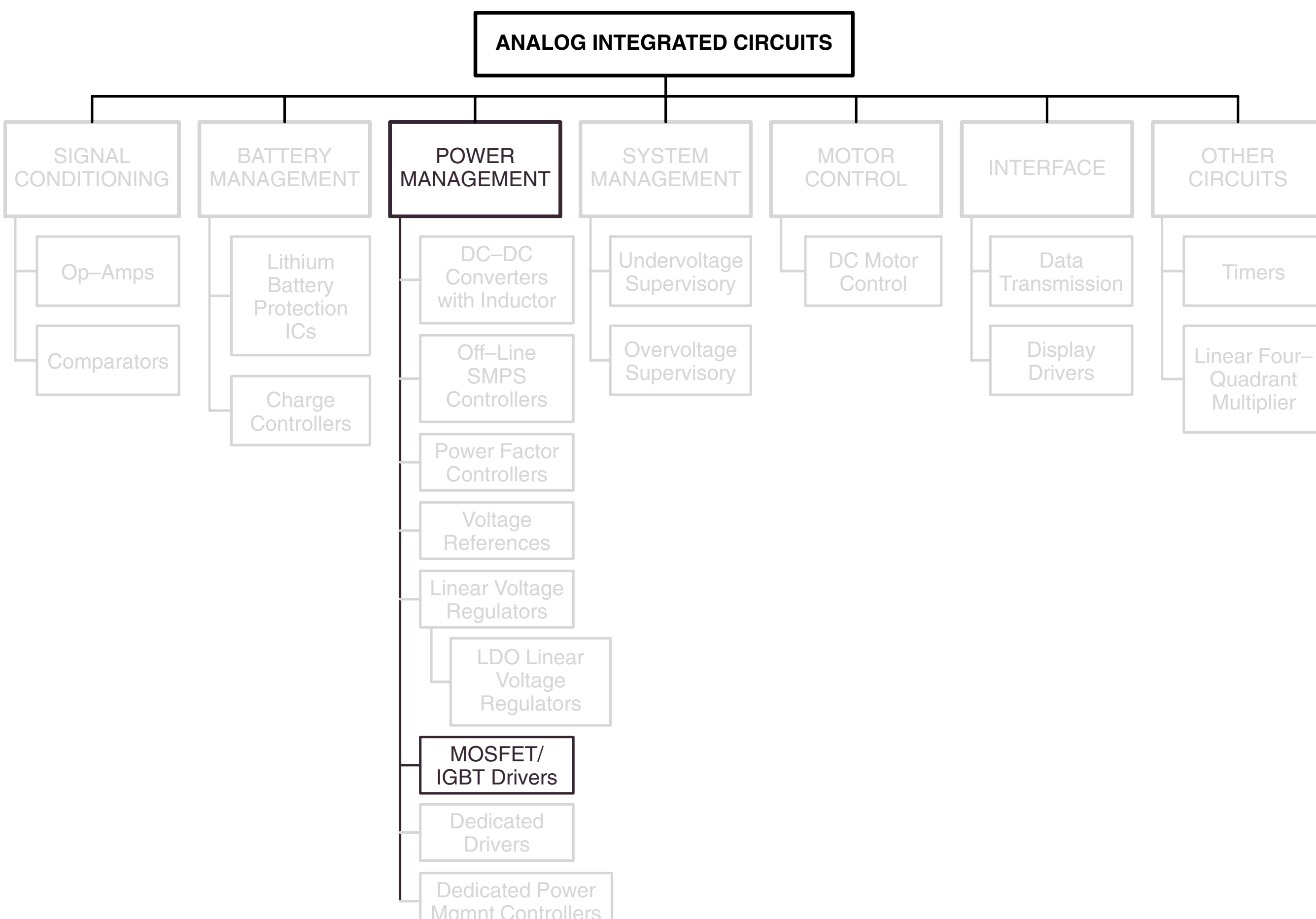


MOSFET/IGBT Drivers

In Brief . . .

The most important design aspect of a MOSFET/IGBT gate drive is optimization of the switching characteristics. The switching characteristics are especially important in motor control applications in which PWM transistors are used in a bridge configuration. In these applications, the gate drive circuit components should be selected to optimize turn–on, turn–off and off–state impedance.

Page



MOSFET/IGBT Drivers

High Speed Dual Drivers

(Inverting)

MC34151P, D

T_A = 0° to +70°C, DIP–8, SO–8

MC33151P, D

T_A = –40° to +85°C, DIP–8, SO–8

(Noninverting)

MC34152P, D

T_A = 0° to +70°C, DIP–8, SO–8

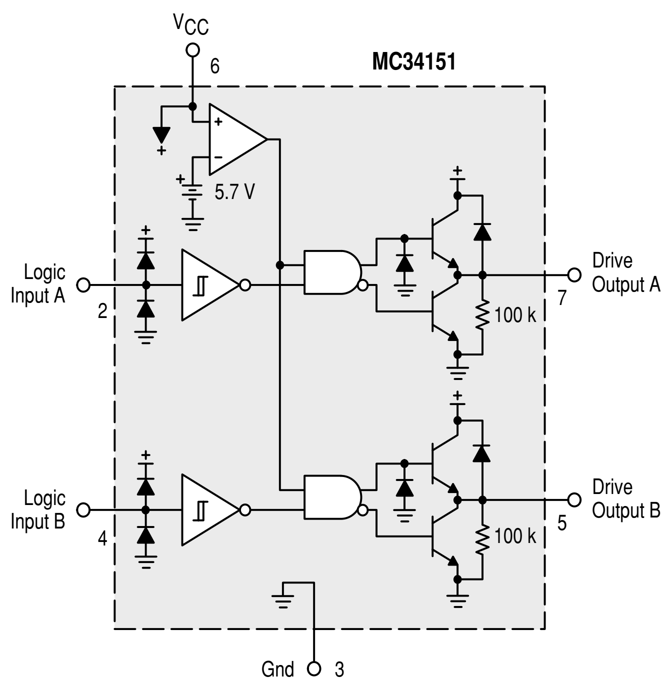
MC33152P, D

T_A = –40° to +85°C, DIP–8, SO–8

These two series of high speed dual MOSFET driver ICs are specifically designed for applications requiring low current digital circuitry to drive large capacitive loads at high slew rates. Both series feature a unique undervoltage lockout function which puts the outputs in a defined low state in an undervoltage condition. In addition, the low "on" state resistance of these bipolar drivers allows significantly higher output currents at lower supply voltages than with competing drivers using CMOS technology.

The MC34151 series is pin–compatible with the MMH0026 and DS0026 dual MOS clock drivers, and can be used as drop–in replacements to upgrade system performance. The MC34152 noninverting series is a mirror image of the inverting MC34151 series.

These devices can enhance the drive capabilities of first generation switching regulators or systems designed with CMOS/TTL logic devices. They can be used in dc–to–dc converters, motor controllers, capacitor charge pump converters, or virtually any other application requiring high speed operation of power MOSFETs.



MOSFET/IGBT Drivers (continued)

Single IGBT Driver

MC33153P, D

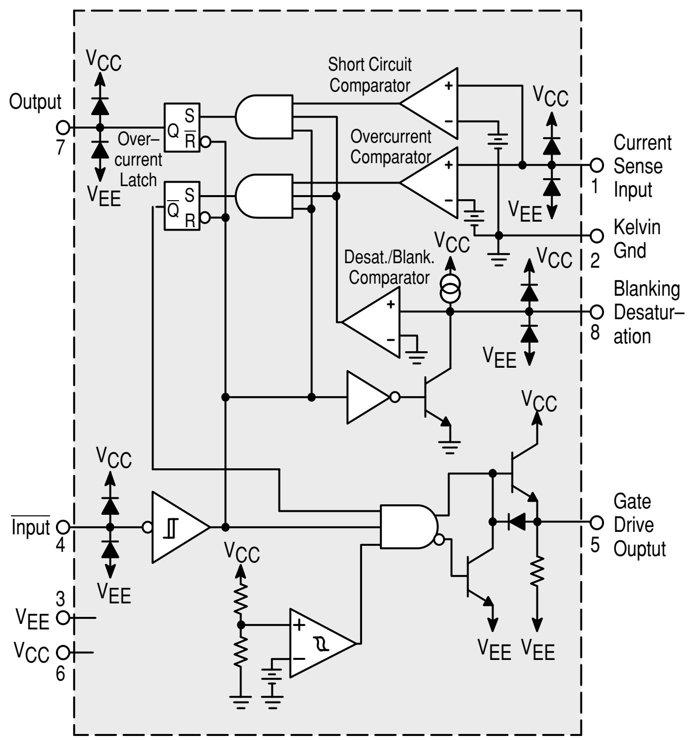
T_A = –40° to +105°C, DIP–8, SO–8

The MC33153 is specifically designed to drive the gate of an IGBT used for ac induction motors. It can be used with discrete IGBTs and IBGT modules up to 100 A.

Typical applications are ac induction motor control, brushless dc motor control, and uninterruptable power supplies.

These devices are available in dual–in–line and surface mount packages and include the following features:

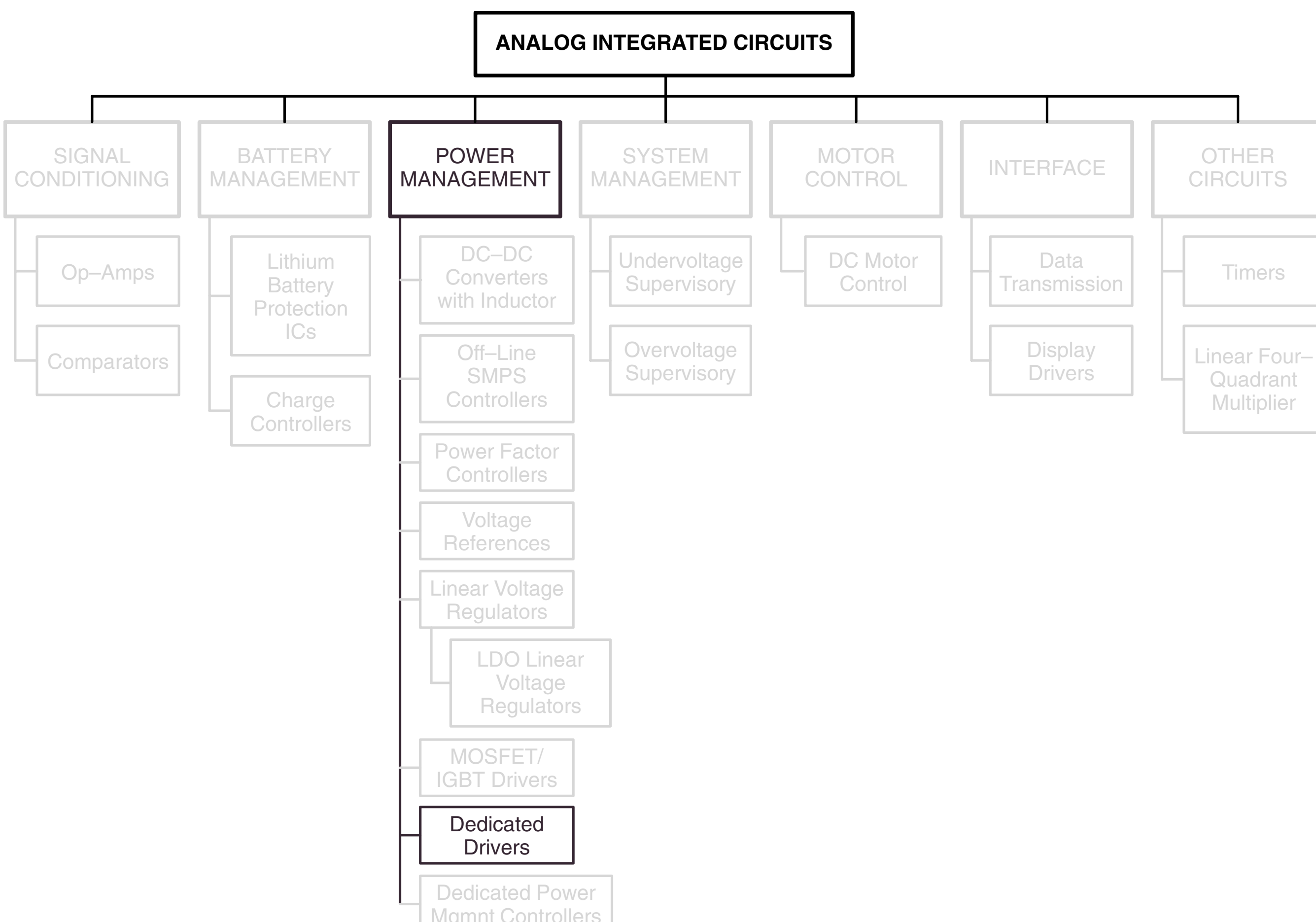
- High Current Output Stage : 1.0 A Source – 2.0 A Sink
- Protection Circuits for Both Conventional and SenseIGBTs
- Current Source for Blanking Timing
- Protection Against Overcurrent and Short Circuit
- Undervoltage Lockout Optimized for IGBT's
- Negative Gate Drive Capability



Dedicated Drivers

In Brief . . .

Dedicated drivers are designed and developed for specific application like electronic ballast. These drivers are designed to meet the specific application requirements. Therefore the overall system performance as well as cost is highly maintained and minimized respectively. Ultimately the uses of these devices require a simpler system design.



Half Bridge Controller and Driver for Industrial Linear Tubes

MC33157DW

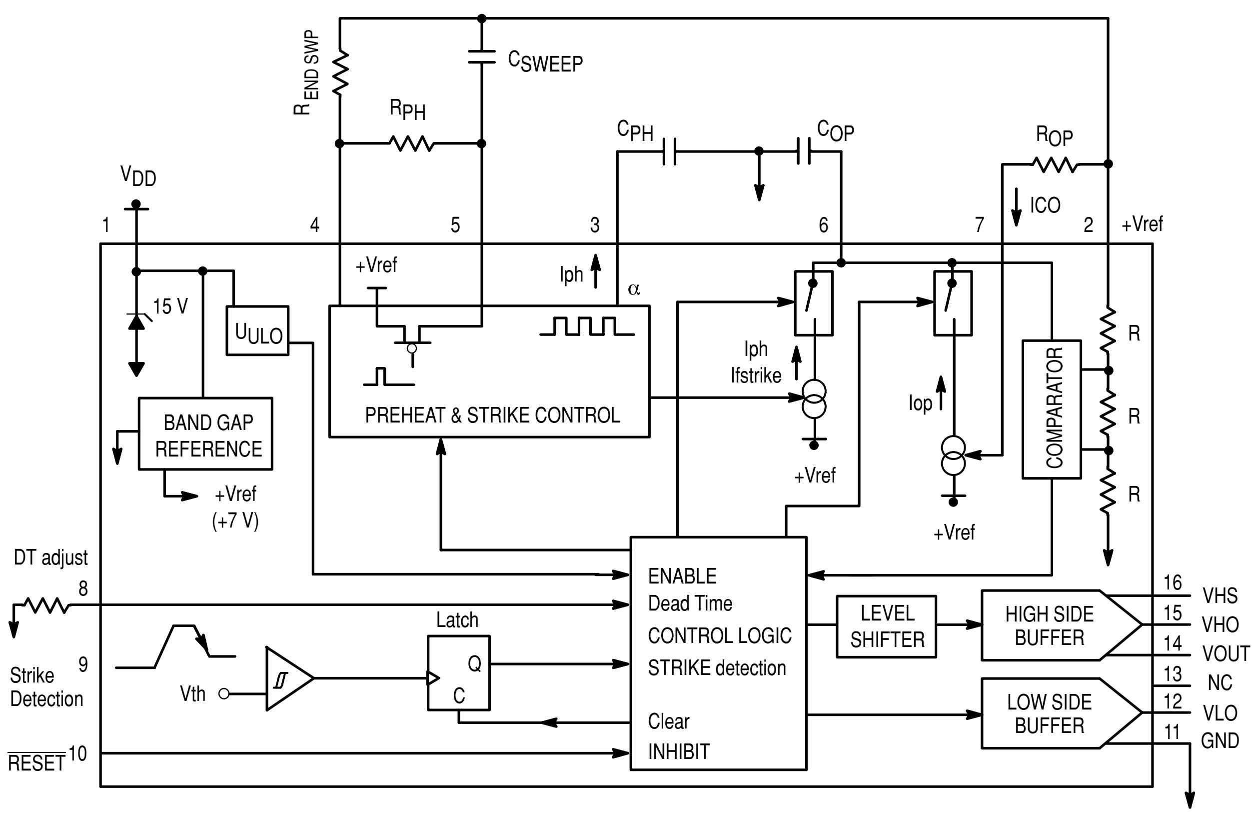
The MC33157DW includes the oscillator circuit and two output channels to control a half–bridge power stage. One of the channels is ground–referenced. The second one is floating to provide a bootstrap operation for the high side switch.

Dedicated Driver for Industrial Linear Tubes

- Main oscillator is current controlled, making it easy to set up by a single external resistor. On top of that, such a feature is useful to implement a dimming function by frequency shift.
- Filament preheating time control built–in.
- The strike sequence is controllable by external passive components, the resonant frequency being independently adjustable. This frequency can be made different from the preheating and the steady state values. A frequency sweep between two defined values makes this IC suitable for any serie resonant topologies.
- Dedicated internal comparator provides an easy lamp strike detection implementation.
- Digital RESET pin provides a fast reset of the system (less than 10 μs). Both output Mosfet are set to "OFF" state when RESET is zero.
- Adjustable dead time makes the product suitable for any snubber capacitor and size of MOSFET used as power switches.
- Designed to be used with standard setting capacitors ≤ 470 nF.
- A voltage reference, derived from the internal bandgap, is provided for external usage. This voltage is 100% trimmed at probe level yielding a 2% tolerance over the temperature range.

ORDERING INFORMATION

Device	Tested Operating Temperature Range	Package
MC33157DW	T_A = –40° to +85°C	Plastic SO–16L



Power Controllers

An assortment of battery and ac line–operated control ICs for specific applications are shown. They are designed to enhance system performance and reduce complexity in a wide variety of control applications.

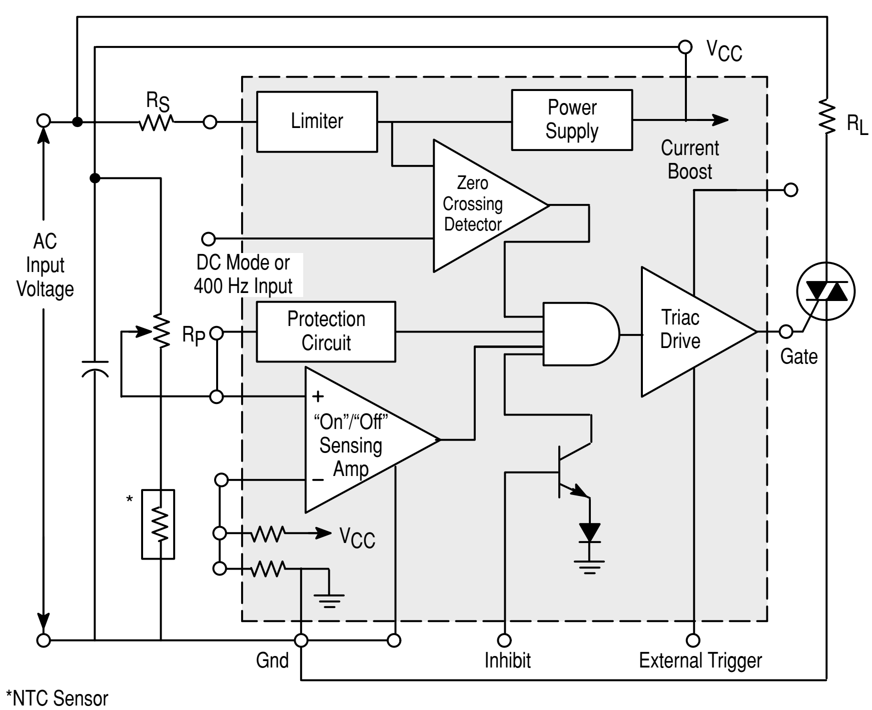
Zero Voltage Switch

CA3059

T_A = –40° to +85°C, DIP–14

This device is designed for thyristor control in a variety of ac power switching applications for ac input voltages of 24 V, 120 V, 208/230 V, and 227 V @ 50/60 Hz.

- **Limiter–Power Supply** – Allows operation directly from an ac line.
- **Differential "On"/"Off" Sensing Amplifier** – Tests for condition of external sensors or input command signals. Proportional control capability or hysteresis may be implemented.
- **Zero–Crossing Detector** – Synchronizes the output pulses to the zero voltage point of the ac cycle. Eliminates RFI when used with resistive loads.
- **Triac Drive** – Supplies high current pulses to the external power controlling thyristor.
- **Protection Circuit** – A built–in circuit may be actuated, if the sensor opens or shorts, to remove the drive circuit from the external triac.
- **Inhibit Capability** – Thyristor firing may be inhibited by the action of an internal diode gate.
- **High Power DC Comparator Operation** – Operation in this mode is accomplished by connecting Pin 7 to 12 (thus overriding the action of the zero–crossing detector).



Power Controllers (continued)

Zero Voltage Controller

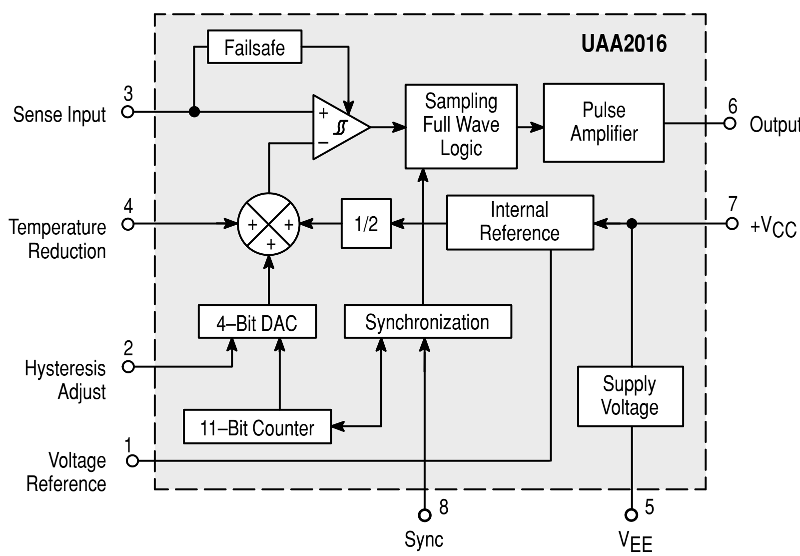
UAA2016P, D

T_A = –20° to +85°C, DIP–8, SO–8

The UAA2016 is designed to drive triacs with the Zero Voltage technique which allows RFI free power regulation of resistive loads. Operating directly on the ac power line, its main application is the precision regulation of electrical heating systems such as panel heaters or irons.

A built–in digital sawtooth waveform permits proportional temperature regulation action over a ±1°C band around the set point. For energy savings there is a programmable temperature reduction function, and for security, a sensor failsafe inhibits output pulses when the sensor connection is broken. Preset temperature (i.e., defrost) application is also possible. In applications where high hysteresis is needed, its value can be adjusted up to 5°C around the set point. All these features are implemented with a very low external component count.

- Zero Voltage Switch for Triacs, up to 2.0 kW (MAC212A8)
- Direct AC Line Operation
- Proportional Regulation of Temperature over a 1°C Band
- Programmable Temperature Reduction
- Preset Temperature (i.e., Defrost)
- Sensor Failsafe
- Adjustable Hysteresis
- Low External Component Count

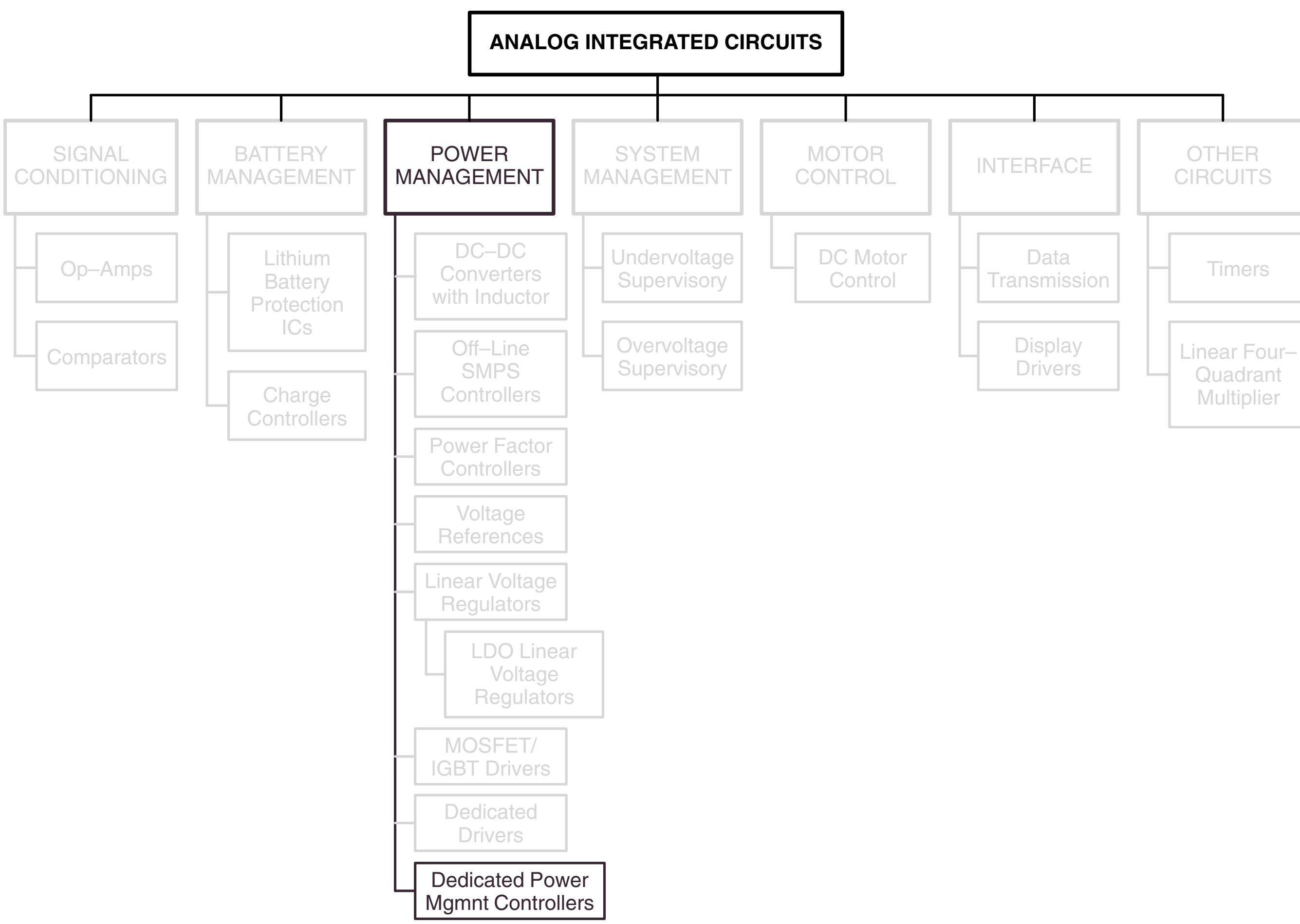


Dedicated Power Management Controllers

In Brief . . .

Dedicated power management controllers are designed and developed for specific applications like PDAs, Smart Card–based systems, or cellular phones. These controllers are utilizing mixed–signal processes such as SMARTMOS™ for improved high performance and precision characteristics. They have a high integration level and may integrate multiple analog or digital functions such as LDO voltage regulators, DC–DC converters, Analog–to–Digital converters, latches, and multiple gates.

Page



Power Supply and Management IC for Handheld Electronic Products

MC34280

0°C to +70°C, LQFP 32–Pins

The MC34280 is a power supply integrated circuit which provides two boost regulated outputs and some power management supervisory functions. Both regulators apply Pulse–Frequency–Modulation (PFM). The main step–up regulator output can be externally adjusted from 2.7V to 5V. An internal synchronous rectifier is used to ensure high efficiency (achieve 87%). The auxiliary regulator with a built–in power transistor can be configured to produce a wide range of positive voltage (can be used for LCD contrast voltage). This voltage can be adjusted from +5V to +25V by an external potentiometer; or by a microprocessor, digitally through a 6–bit internal DAC.

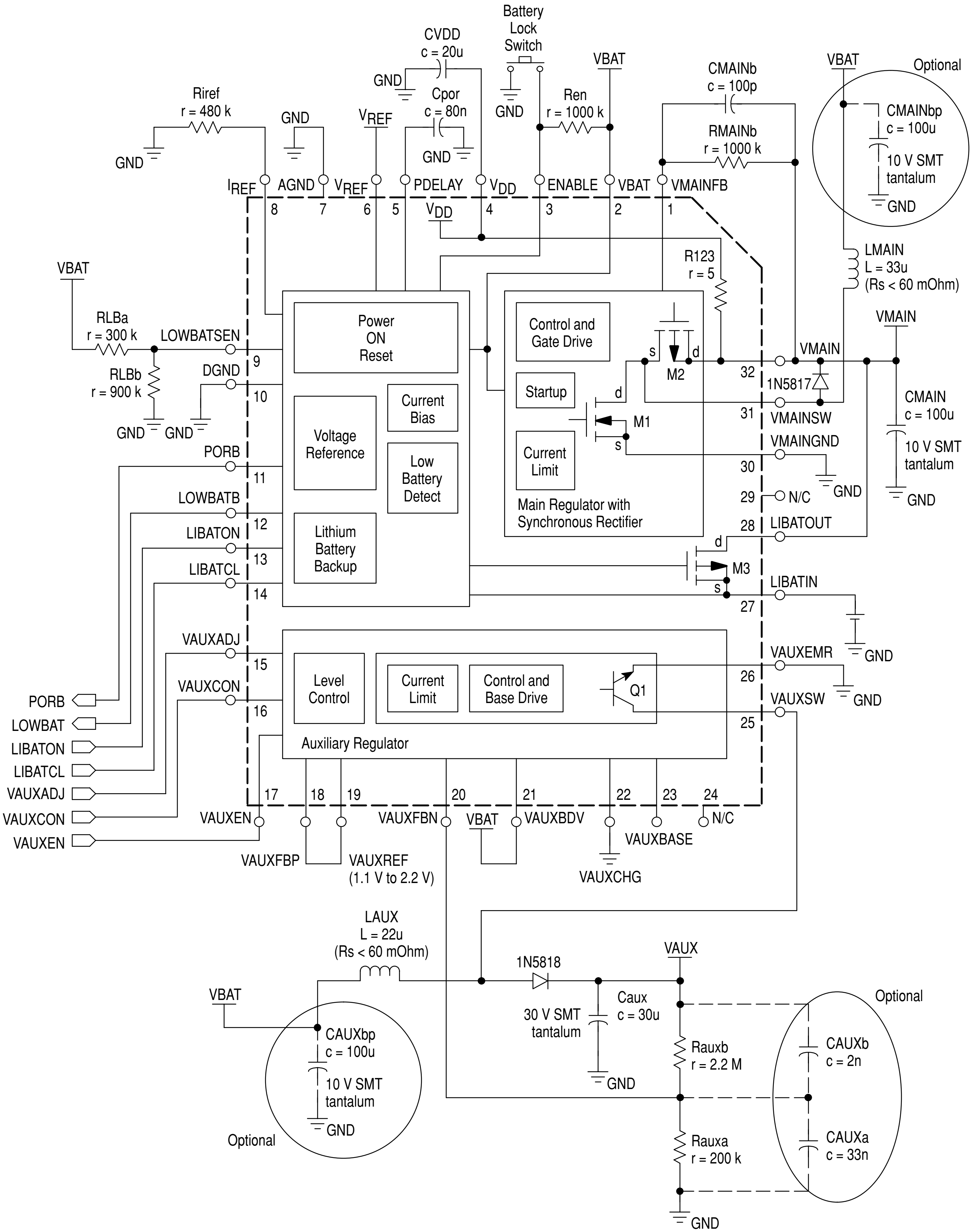
The MC34280 has been designed for battery powered hand–held products. With the low start–up voltage from 1V and the low quiescent current (typical 35 µA); the MC34280 is best suited to operate from 1 to 2 AA/ AAA cell. Moreover, supervisory functions such as low battery detection, CPU power–on reset, and back–up battery control, are also included in the chip. It makes the MC34280 the best one–chip power management solution for applications such as electronic organizers and PDAs.

- Low Input Voltage, 1V up
- Low Quiescent Current in Standby Mode: 35µA typical
- PFM and Synchronous Rectification to ensure high efficiency (87% @200mA Load)
- Adjustable Main Output: nominal 3.3V @ 200mA max, with 1.8V input
- Auxiliary Output Voltage can be digitally controlled by microprocessor
- Auxiliary Output Voltage:
  +5V @ 25mA max, with 1.8V input
  +25V @ 15mA max, with 1.8V input
- Current Limit Protection
- Power–ON Reset Signal with Programmable Delay
- Battery Low Detection
- Lithium Battery Back–up
- 32–Pin LQFP Package

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC34280	0°C to +70°C	32–pin LQFP

Typical Application Block Diagram



GaAs Power Amplifier Support IC

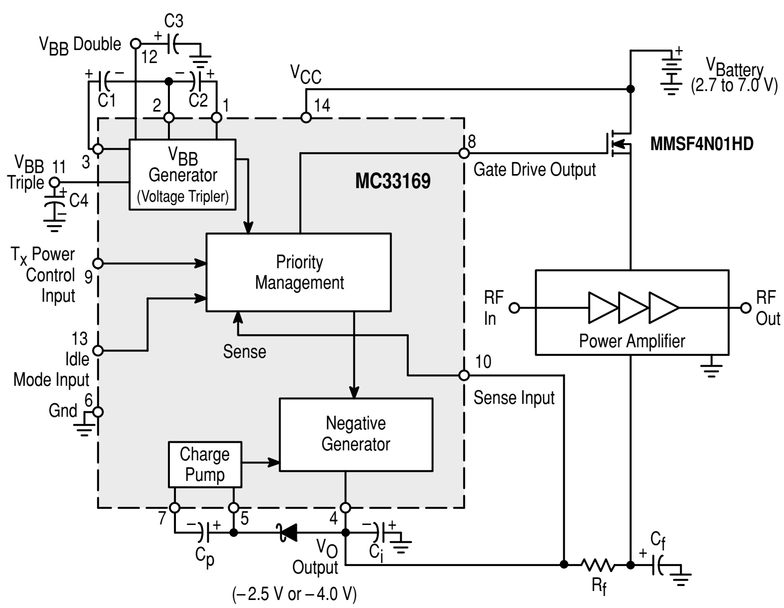
MC33169DTB

T_A = –40° to +85°C, TSSOP–14

The MC33169 is a support IC for GaAs Power Amplifier Enhanced FETs used in hand portable telephones such as GSM, PCN and DECT. This device provides negative voltages for full depletion of Enhanced MESFETs as well as a priority management system of drain switching, ensuring that the negative voltage is always present before turning "on" the Power Amplifier. Additional features include an idle mode input and a direct drive of the N–Channel drain switch transistor.

This product is available in one version, –4.0 V. The –4.0 V version is intended for supplying RF modules for GSM and DCS1800 applications.

- Negative Regulated Output for Full Depletion of GaAs MESFETs
- Drain Switch Priority Management Circuit
- CMOS Compatible Inputs
- Idle Mode Input (Standby Mode) for Very Low Current Consumption
- Output Signal Directly Drives N–Channel FET
- Low Startup and Operating Current



Smartcard Power Management Controller and Interface IC for Smartcard–based Systems

MC33560

T_A = – 25°C to +85°C, SO–24WB, TSSOP–24

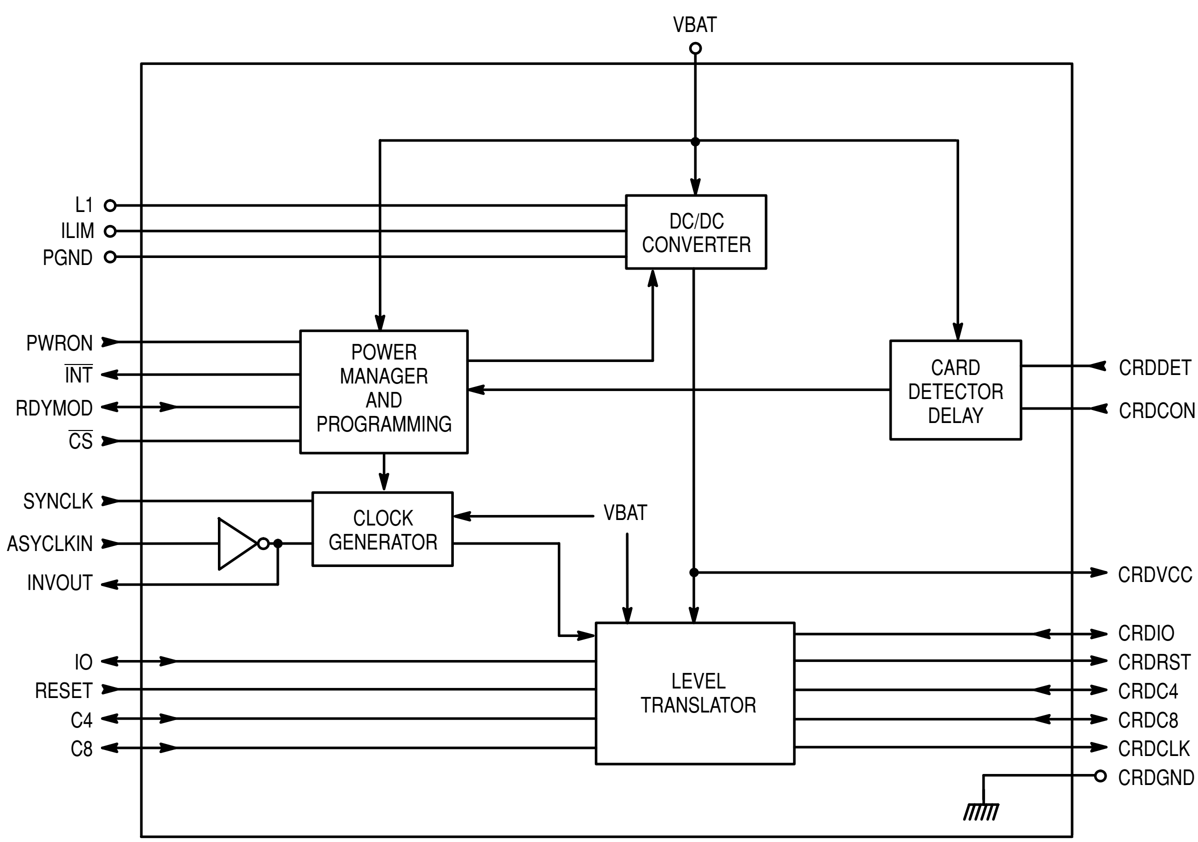
The MC33560A is an interface IC for smartcard reader/writer applications. It allows to manage any type of smart or memory card through a simple and flexible microcontroller interface, and several couplers may be managed in parallel. The MC33560A is particularly suited to low power and portable applications because of its power saving features and the minimum of external parts required. Battery life is extended by the wide operating range and the low quiescent current in standby mode. A highly sophisticated protection system guarantees timely and controlled shutdown upon error conditions.

- 100% Compatible with ISO 7816–3 Standard
- Wide Battery Supply Voltage Range: 1.8 V < V_{BAT} < 6.6 V
- Programmable V_{CC} Supply for 3 V or 5 V Card Operation
- Power Management for Very Low Quiescent Current in Standby Mode (MC33560A: 10 µA max)
- Microprocessor Wake–up Signal Generated Upon Card Insertion
- Self–contained DC/DC Converter to Generate V_{CC} using a Minimum of Passive Components
- Controlled Power Up/Down Sequence for High Signal Integrity on the Card I/O and Signal Lines
- Programmable Card Clock Generator
- Chip Select Capability for Parallel Coupler Operation
- High ESD Protection on Card Pins (4 kV, Human Body Model)
- Fault Monitoring V_{BATlow}, V_{CClow} and I_{CClim}
- All card outputs current limited and short circuit protected

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33560ADW	T_A = – 25° to +85°C	SO–24WB
MC33560ADTB		TSSOP–24

Simplified Functional Block Diagram



Versatile 6 Regulator Power Management Circuit for Cellular Subscriber Terminal

MC33283

T_A = – 20°C to +70°C, TQFP–32

The MC33283 is a complete power management solution for portable devices such as telephone handsets, two–way radios, etc. Thanks to its large scale integration, the device offers up to seven Low DropOut regulators (LDO), two of them delivering a voltage higher than the battery's.

Despite the presence of an internal charge pump, the overall noise specification makes the circuit an ideal candidate where noise is an important feature. Outputs deliver 40µVRMS typical (10–100kHz) at nominal output current.

With a 50dB ripple rejection under 10kHz, the circuit naturally shields the downstream electronics against DC choppy lines. This parameter guarantees a clean operation for battery operated devices.

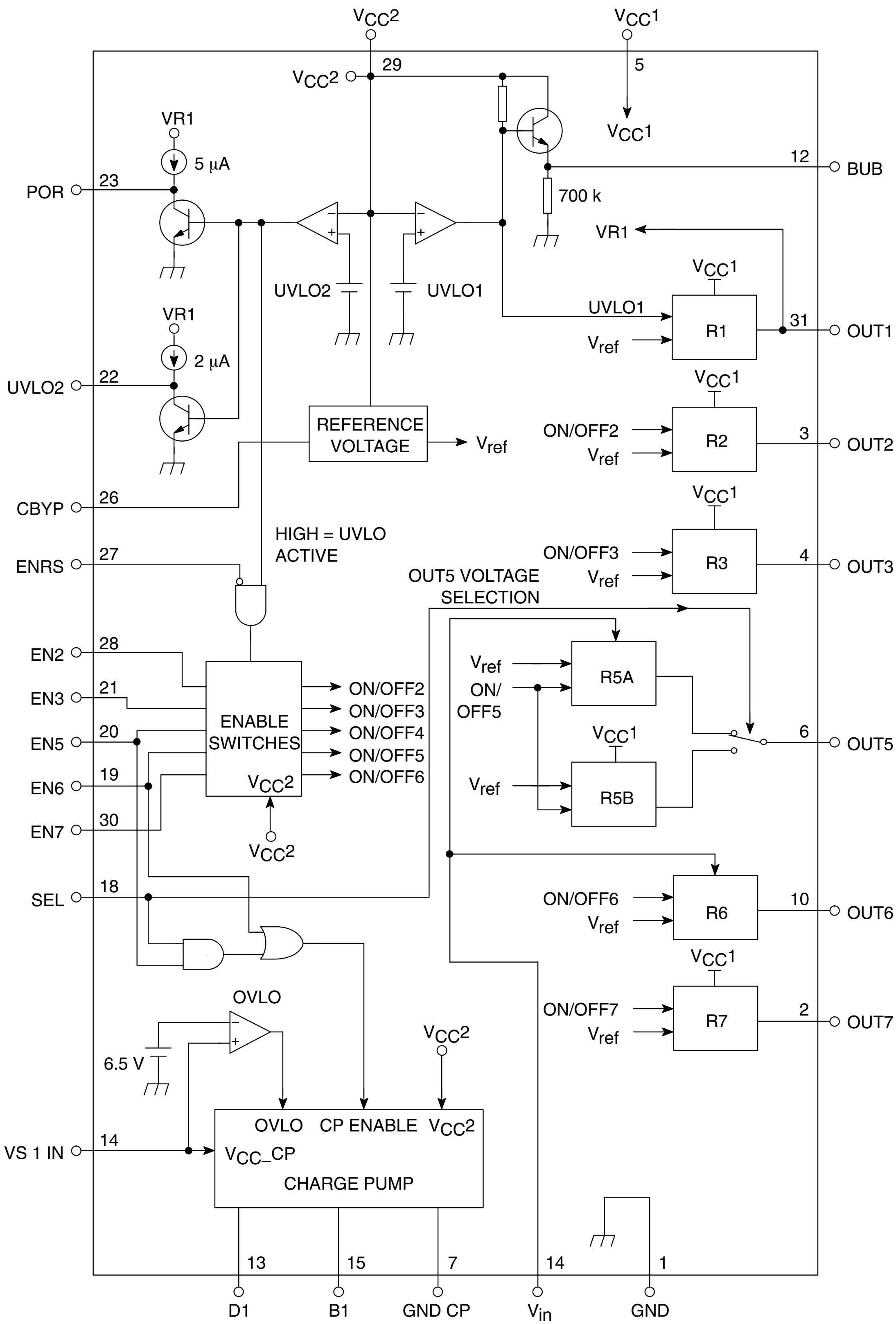
Finally, housed in a compact Thin Quad Flat Pack TQFP–32 package, the MC33283 gathers all the features necessary to power future portable radios.

- 6 regulated outputs:
  2.85V, four outputs: 10–135mA
  4.75V @ 15mA
  5.0V @ 20mA
- Low–noise: 40µVRMS at nominal output levels (10Hz–100kHz)
- Ultra–low reverse current in OFF mode (200nA typical)
- Two–mode regulator: output 5 switches from 3 to 5V with SEL pin activated
- Thermal shutdown for a rugged and reliable operation
- All outputs are short–circuit proof

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33283FTB28,R2	– 20°C to +70°C	TQFP–32

Simplified Block Diagram



System Management

In Brief . . .

Power supplies, MCU–based systems, industrial controls, computer systems and many other products, portable or not, are requiring system management functions which monitor voltages to ensure proper system operation.

These circuits monitor critical circuit conditions and report any violations of prescribed limits to a microprocessor. The microprocessor will then take appropriate action such as storing data before executing a graceful shutdown.

ON Semiconductor offers a wide variety of voltage supervisory circuits (Undervoltage or Overvoltage) designed for use where precise voltage limits or windows are required for reliable system operation.

Newer supervisory circuits have utilized CMOS technology and miniature surface mount packages (SOT23–5 leads) to reduce the current consumption and the PCB board area. This makes them particularly suited for battery–powered applications.

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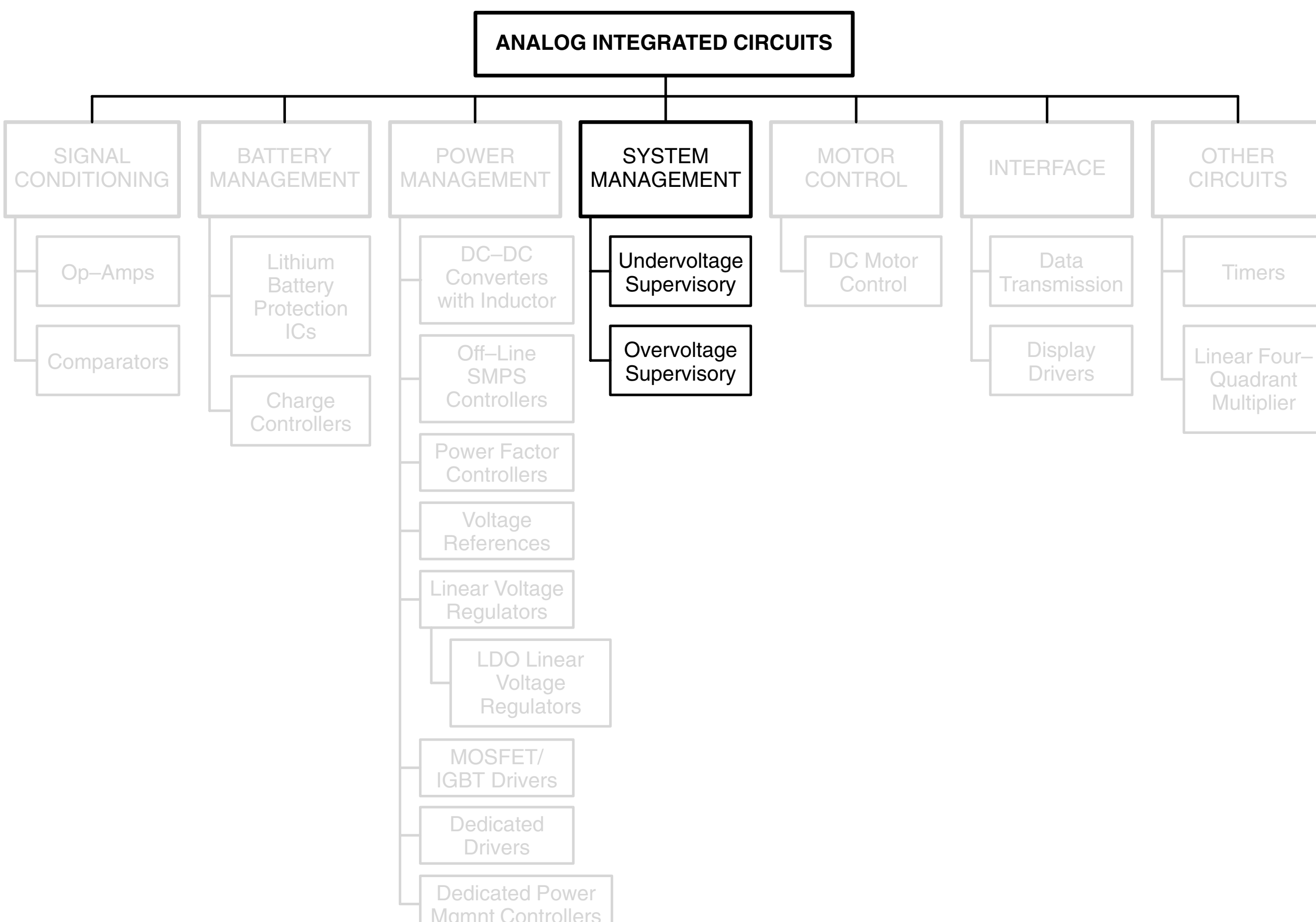


Supervisory Circuits

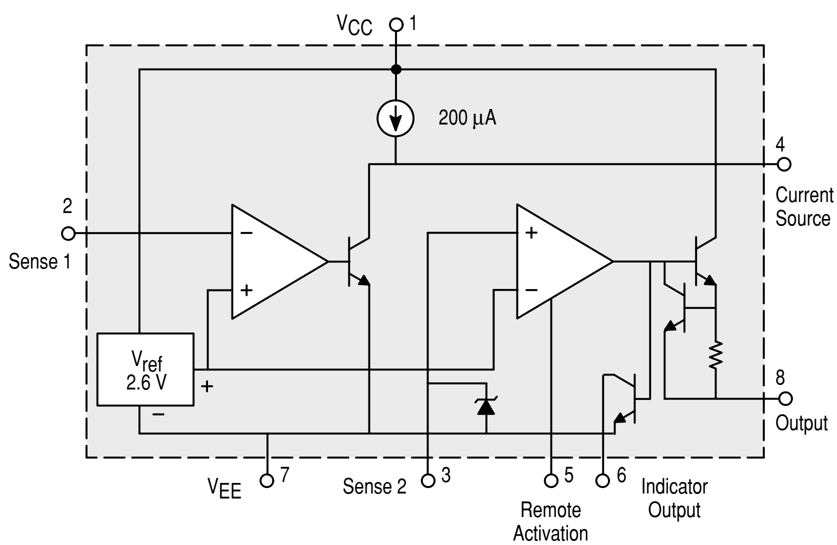
A variety of Power Supervisory Circuits are offered. Overvoltage sensing circuits which drive "Crowbar" SCRs are provided in several configurations from a low cost three–terminal version to 8–pin devices which provide pin–programmable trip voltages or additional features, such as an indicator output drive and remote activation capability. An over/undervoltage protection circuit is also offered.

Overvoltage Crowbar Sensing Circuit

MC3423P1, D

T_A = 0° to +70°C, DIP–8, SO–8 Packages

This device can protect sensitive circuitry from power supply transients or regulator failure when used with an external "Crowbar" SCR. The device senses voltage and compares it to an internal 2.6 V reference. Overvoltage trip is adjustable by means of an external resistive voltage divider. A minimum duration before trip is programmable with an external capacitor. Other features include a 300 mA high current output for driving the gate of a "Crowbar" SCR, an open–collector indicator output and remote activation capability.

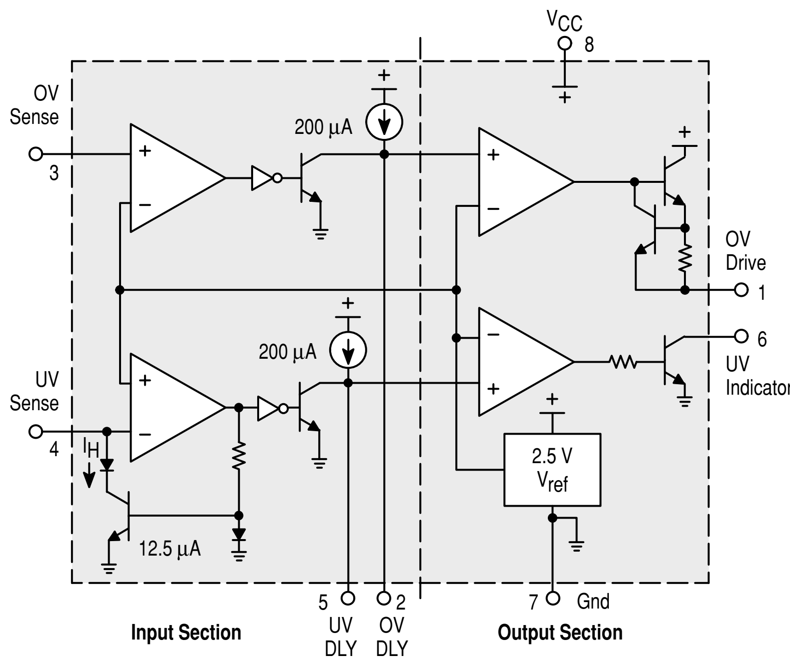


Over/Undervoltage Protection Circuit

MC3425P1

T_A = 0° to +70°C, DIP–8 Package

The MC3425 is a power supply supervisory circuit containing all the necessary functions required to monitor over and undervoltage fault conditions. This device features dedicated over and undervoltage sensing channels with independently programmable time delays. The overvoltage channel has a high current drive output for use in conjunction with an external SCR ‘‘Crowbar’’ for shutdown. The undervoltage channel input comparator has hysteresis which is externally programmable, and an open–collector output for fault indication.



Supervisory Circuits (continued)

Micropower Undervoltage Sensing Circuits

MC33464H, N

T_A = –30° to +80°C, SOT–89, SOT–23 5 Leads Packages

The MC33464 series are micropower undervoltage sensing circuits that are specifically designed for use with battery powered microprocessor based systems, where extended battery life is required. A choice of several threshold voltages from 0.9 V to 4.5 V are available. These devices feature a very low quiescent bias current of 0.8 µA typical.

The MC33464 series features a highly accurate voltage reference, a comparator with precise thresholds and built–in hysteresis to prevent erratic reset operation, a choice of output configurations between open drain or complementary MOS, and guaranteed operation below 1.0 V with extremely low standby current. These devices are available in either SOT–89 3–pin or SOT–23 5–pin surface mount packages.

Applications include direct monitoring of the MPU/logic power supply used in portable, appliance, automotive and industrial equipment.

MC33464 Features:

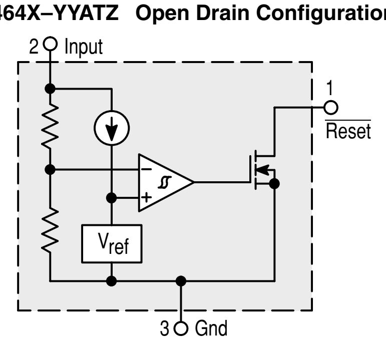
- Extremely Low Standby Current of 0.8 µA at V_{in} = 1.5 V
- Wide Input Voltage Range (0.7 V to 10 V)
- Monitors Power Supply Voltages from 1.1 V to 5.0 V
- High Accuracy Detector Threshold (±2.5%)
- Two Reset Output Types (Open Drain or Complementary Drive)
- Two Surface Mount Packages (SOT–89 or SOT–23 5–Pin)

ORDERING INFORMATION

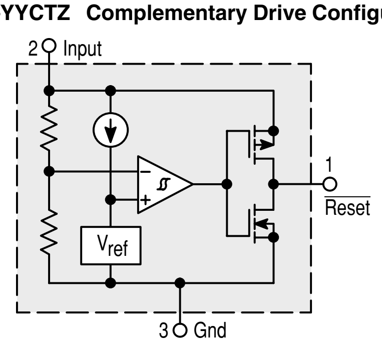
Device	Threshold Voltage	Type	Operating Temperature Range	Package (Qty/Reel)
MC33464H–09AT1	0.9	Open Drain $\overline{\text{Reset}}$	T_A = –30° to +80°C	SOT–89 (1000)
MC33464H–20AT1	2.0			
MC33464H–27AT1	2.7			
MC33464H–30AT1	3.0			
MC33464H–45AT1	4.5			
MC33464H–09CT1	0.9	Compl. MOS $\overline{\text{Reset}}$		
MC33464H–20CT1	2.0			
MC33464H–27CT1	2.7			
MC33464H–30CT1	3.0			
MC33464H–45CT1	4.5			
MC33464N–09ATR	0.9	Open Drain $\overline{\text{Reset}}$		SOT–23 (3000) 5 Leads
MC33464N–20ATR	2.0			
MC33464N–21ATR	2.1			
MC33464N–27ATR	2.7			
MC33464N–30ATR	3.0			
MC33464N–45ATR	4.5			
MC33464N–09CTR	0.9	Compl. MOS $\overline{\text{Reset}}$		
MC33464N–20CTR	2.0			
MC33464N–27CTR	2.7			
MC33464N–30CTR	3.0			
MC33464N–45CTR	4.5			

Other voltages from 0.9 to 6.0 V, in 0.1 V increments, are available. Consult factory for information.

MC33464X–YYATZ Open Drain Configuration



MC33464X–YYCTZ Complementary Drive Configuration



X Denotes Package Type
YY Denotes Threshold Voltage
TZ Denotes Taping Type

Supervisory Circuits (continued)

Micropower Undervoltage Sensing Circuits with Programmable Output Delay

MC33465N

T_A = –30° to +80°C, SOT–23 5 Leads

The MC33465 series are micropower undervoltage sensing circuits that are specifically designed for use with battery powered microprocessor based systems, where extended battery life is required. A choice of several threshold voltages from 0.9 V to 4.5 V are available. This device features a very low quiescent bias current of 1.0 µA typical.

The MC33465 series features a highly accurate voltage reference, a comparator with precise thresholds and built–in hysteresis to prevent erratic reset operation, a choice of output configurations between open drain or complementary, a time delayed output, which can be programmed by the system designer, and guaranteed operation below 1.0 V with extremely low standby current. This device is available in a SOT–23 5–pin surface mount package.

Applications include direct monitoring of the MPU/logic power supply used in appliance, automotive, industrial and portable equipment.

MC33465 Features:

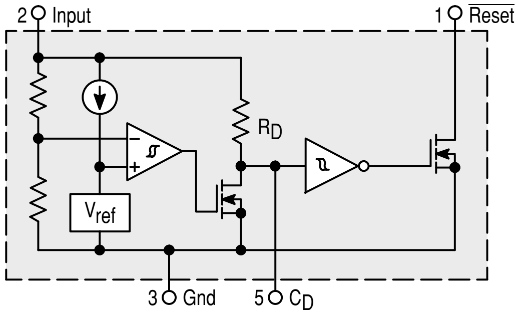
- Extremely Low Standby Current of 1.0 µA at V_{in} = 3.5 V
- Wide Input Voltage Range (0.7 V to 10 V)
- Monitors Power Supply Voltages from 1.1 V to 5.0 V
- High Accuracy Detector Threshold (±2.5%)
- Two $\overline{\text{Reset}}$ Output Types (Open Drain or Complementary Drive)
- Programmable Output Delay by External Capacitor (100 ms typ. with 0.15 µF)
- Surface Mount Package (SOT–23 5–Pin)
- Convenient Tape and Reel (3000 per Reel)

ORDERING INFORMATION

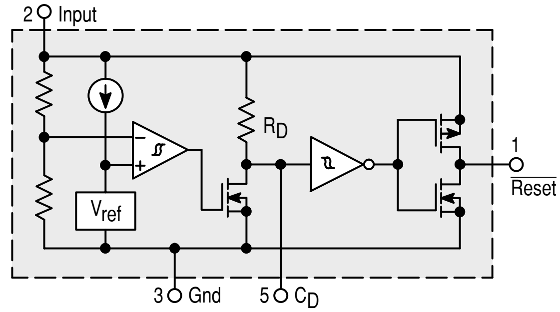
Device	Threshold Voltage	Type	Operating Temperature Range	Package
MC33465N–09ATR	0.9	Open Drain $\overline{\text{Reset}}$	T_A = –30° to +80°C	SOT–23 5 Leads
MC33465N–20ATR	2.0			
MC33465N–27ATR	2.7			
MC33465N–30ATR	3.0			
MC33465N–32ATR	3.2			
MC33465N–45ATR	4.5			
MC33465N–09CTR	0.9	Compl. MOS $\overline{\text{Reset}}$		
MC33465N–20CTR	2.0			
MC33465N–27CTR	2.7			
MC33465N–30CTR	3.0			
MC33465N–43CTR	4.3			
MC33465N–45CTR	4.5			

Other voltages from 0.9 to 6.0 V, in 0.1 V increments, are available. Consult factory for information.

MC33465N–YYATR
Open Drain Output Configuration



MC33465N–YYCTR
Complementary Output Configuration



YY Denotes Threshold Voltage

Supervisory Circuits (continued)

Undervoltage Sensing Circuit

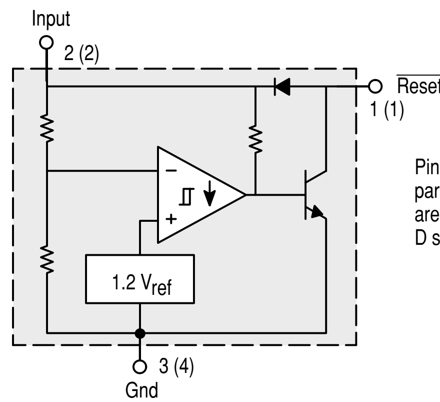
MC34064P–5, D–5, DM–5
T_A = 0° to +70°C, TO–92, SO–8
MC33064P–5, D–5, DM–5
T_A = –40° to +85°C, TO–92, SO–8
MC34164P–3, P–5, D–3, D–5, DM–3, DM–5
T_A = 0° to +70°C, TO–92, SO–8
MC33164P–3, P–5, D–3, D–5, DM–3, DM–5
T_A = –40° to +85°C, TO–92, SO–8

The MC34064 and MC34164 are two families of undervoltage sensing circuits specifically designed for use as reset controllers in microprocessor–based systems. They offer the designer an economical solution for low voltage detection with a single external resistor. Both parts feature a trimmed bandgap reference, and a comparator with precise thresholds and built–in hysteresis to prevent erratic reset operation.

The two families of undervoltage sensing circuits taken together, cover the needs of the most commonly specified power supplies used in MCU/MPU systems. Key parameter specifications of the MC34164 family were chosen to complement the MC34064 series. The table summarizes critical parameters of both families. The MC34064 fulfills the needs of a 5.0 V ± 5% system and features a tighter hysteresis specification. The MC34164 series covers 5.0 V ± 10% and 3.0 V ± 5% power supplies with significantly lower power consumption, making them ideal for applications where extended battery life is required such as consumer products or hand held equipment.

Applications include direct monitoring of the 5.0 V MPU/ logic power supply used in appliance, automotive, consumer, and industrial equipment.

The MC34164 is specifically designed for battery powered applications where low bias current (1/25th of the MC34064's) is an important characteristic.



Pin numbers in parenthesis are for the D suffix package.

Table 1. Undervoltage Sense/Reset Controller Features

MC34X64 devices are specified to operate from 0° to +70°C, and MC33X64 devices operate from –40° to +85°C.

Device	Standard Power Supply Supported	Typical Threshold Voltage (V)	Typical Hysteresis Voltage (V)	Minimum Output Sink Current (mA)	Power Supply Input Voltage Range (V)	Maximum Quiescent Input Current	Package
MC34064/MC33064	5.0 V ± 5%	4.6	0.02	10	1.0 to 10	500 µA @ V_{in} = 5.0 V	TO–92
							SO–8
MC34164/MC33164	5.0 V ± 10%	4.3	0.09	7.0	1.0 to 12	20 µA @ V_{in} = 5.0 V	TO–92
							SO–8
MC34164/MC33164	3.0 V ± 5%	2.7	0.06	6.0	1.0 to 12	15 µA @ V_{in} = 3.0 V	TO–92
							SO–8

Supervisory Circuits (continued)

Universal Voltage Monitor

MC34161P, D

T_A = 0° to +70°C, DIP–8, SO–8

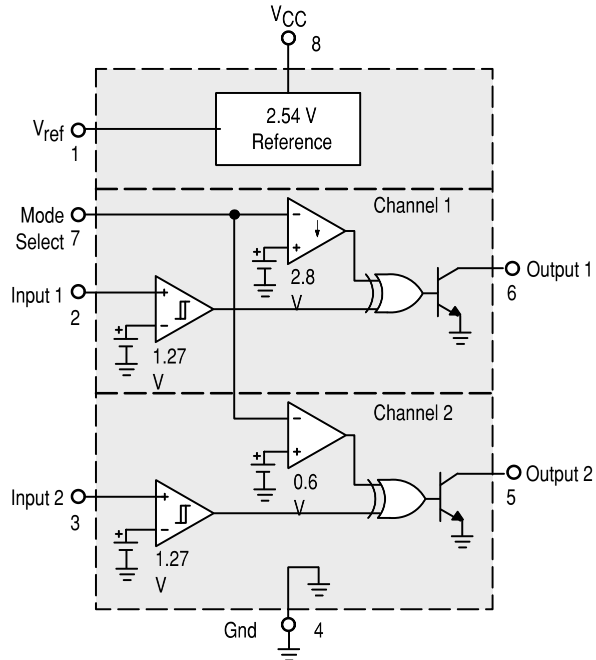
MC33161P, D

T_A = –40° to +85°C, Case 626, 751

The MC34161, MC33161 series are universal voltage monitors intended for use in a wide variety of voltage sensing applications. These devices offer the circuit designer an economical solution for positive and negative voltage detection. The circuit consists of two comparator channels each with hysteresis, a unique Mode Select Input for channel programming, a pinned out 2.54 V reference, and two open collector outputs capable of sinking in excess of 10 mA. Each comparator channel can be configured as either inverting or noninverting by the Mode Select Input. This allows over, under, and window detection of positive and negative voltages. The minimum supply voltage needed for these devices to be fully functional is 2.0 V for positive voltage sensing and 4.0 V for negative voltage sensing.

Applications include direct monitoring of positive and negative voltages used in appliance, automotive, consumer, and industrial equipment.

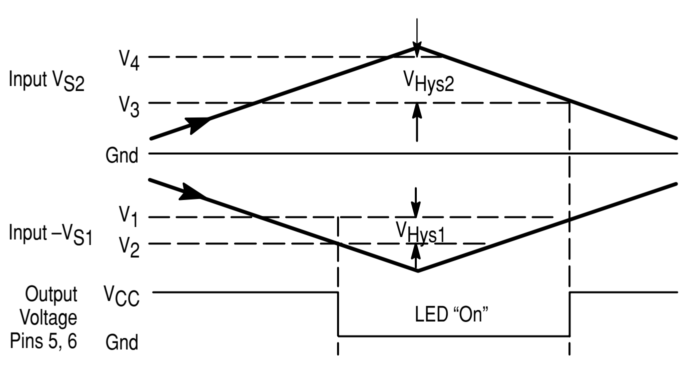
- Unique Mode Select Input Allows Channel Programming
- Over, Under, and Window Voltage Detection
- Positive and Negative Voltage Detection
- Fully Functional at 2.0 V for Positive Voltage Sensing and 4.0 V for Negative Voltage Sensing
- Pinned Out 2.54 V Reference with Current Limit Protection
- Low Standby Current
- Open Collector Outputs for Enhanced Device Flexibility

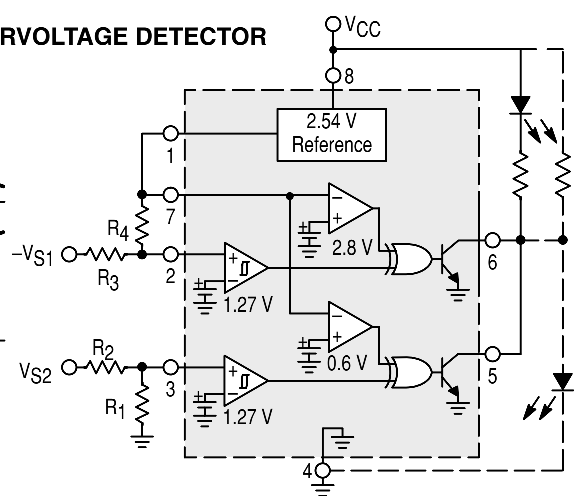


TRUTH TABLE

Mode Select Pin 7	Input 1 Pin 2	Output 1 Pin 6	Input 2 Pin 3	Output 2 Pin 5	Comments
GND	0 1	0 1	0 1	0 1	Channels 1 & 2: Noninverting
V_{ref}	0 1	0 1	0 1	1 0	Channel 1: Noninverting Channel 2: Inverting
V_{CC} (>2.0 V)	0 1	1 0	0 1	1 0	Channels 1 & 2: Inverting

POSITIVE AND NEGATIVE OVERVOLTAGE DETECTOR

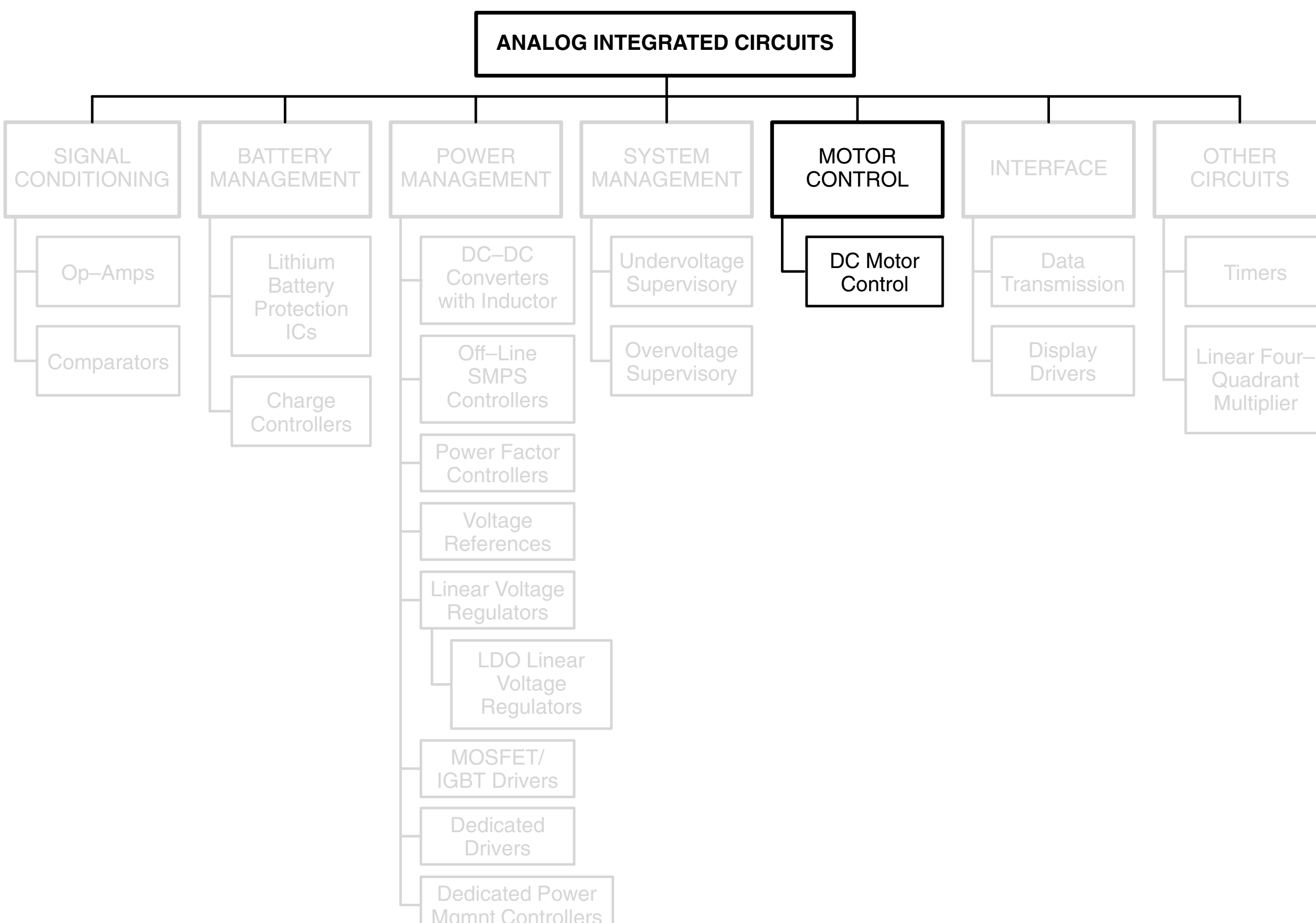




Motor Control

In Brief . . .

With the expansion of electronics into more and more mechanical systems, there comes an increasing demand for simple but intelligent circuits that can blend these two technologies. In the past, the task of power/motor control was once accomplished with discrete devices. But today this task is being performed by bipolar IC technology due to cost, size, and reliability constraints. ON Semiconductor offers integrated circuits designed to anticipate the requirements for both simple and sophisticated control systems, while providing cost effective solutions to meet the needs of the applications.



Motor Controllers

This section contains integrated circuits designed for cost effective control of specific motor families. Included are controllers for brushless, dc servo, stepper, and universal type motors.

Brushless DC Motor Controllers

Advances in magnetic materials technology and integrated circuits have contributed to the unprecedented rise in popularity of brushless dc motors. Analog control ICs are making the many features and advantages of brushless motors available at a much more economical price. ON Semiconductor offers a family of monolithic integrated brushless dc motor controllers. These ICs provide a choice of control functions which allow many system features to be easily implemented at a fraction of the cost of discrete solutions. The following table summarizes and compares the features of ON Semiconductor's brushless motor controllers.

Table 1. Features Summary for ON Semiconductor Brushless DC Motor Controllers

Device	Operating Voltage Range (V)		Undervoltage Lockout	Internal Thermal Shutdown	Fwd/Rev Control	Sensor Electrical Phasing	Output Enable	Output Drivers		6.25 V Reference Output	Current Sense Comparator Input(s)	Error Amplifier	$\overline{\text{FAULT}}$ Output	Separate Drive V_C	Brake Input	Package
	V_{CC}	V_C						Totem Pole (Bottom)	Open Collector (Top)							
MC33033	10–30	–	✓	✓	✓	60°/300° and 120°/240°	✓	✓	✓	✓	Noninv. Only	✓	–	–	–	DIP–20, SO–20L
MC33035	10–40	10–30	✓	✓	✓		✓	✓	✓	✓	Noninv. and Inv.	✓	✓	✓	✓	DIP–24, SO–24L

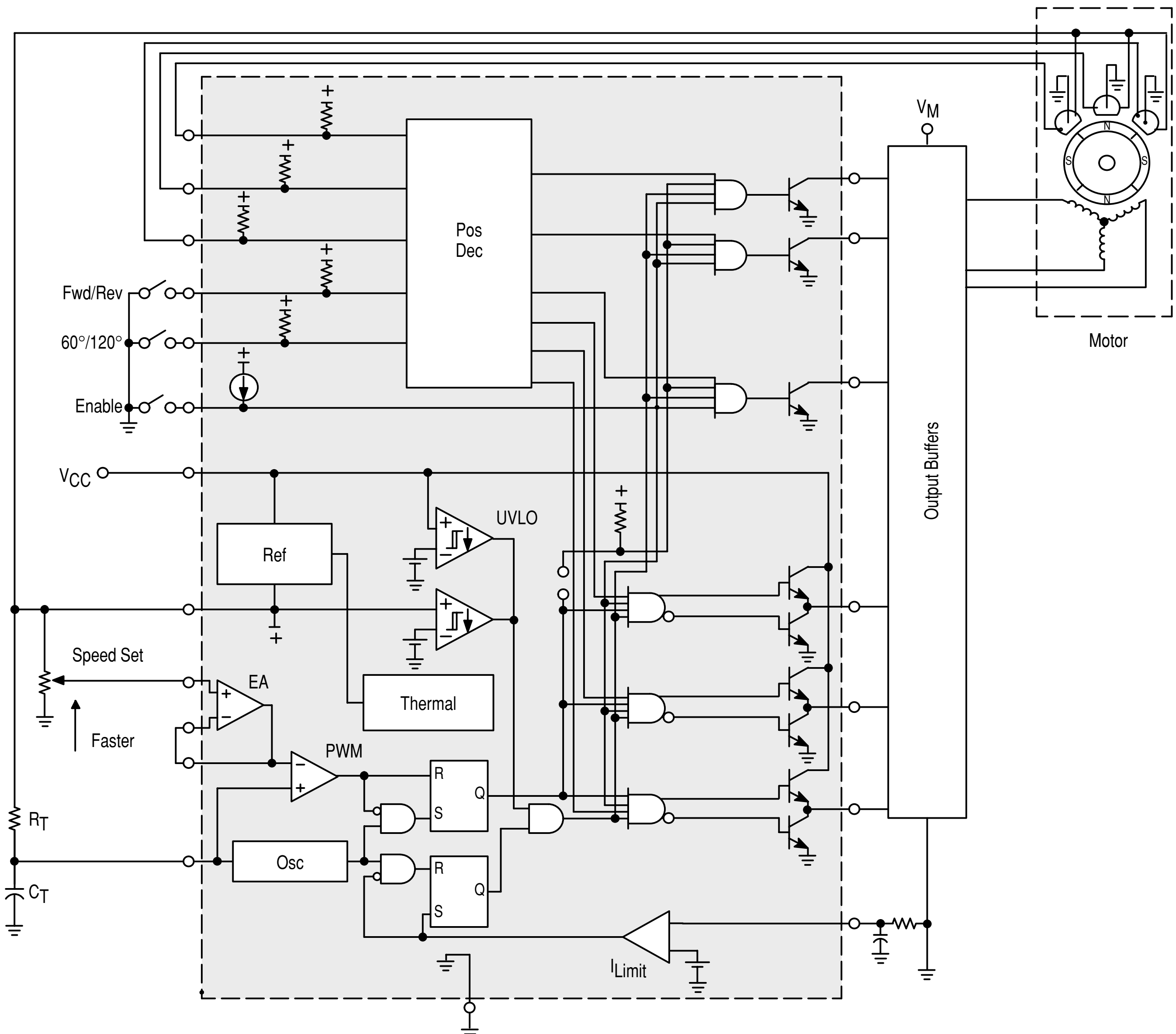
Motor Controllers (continued)

MC33033P, DW

T_A = –40° to +85°C, DIP–20, SO–20L Packages

The MC33033 is a lower cost second generation brushless dc motor controller which has evolved from the full featured MC33035 controller. The MC33033 contains all of the active functions needed to implement a low cost open loop motor control system. This IC has all of the key control and protection functions of the two full featured devices with the following secondary features deleted: separate drive–circuit supply and ground pins, the brake input, and the fault output signal. Like its MC33035 predecessor, the MC33033 has a control pin which allows the user to select 60°/300° or 120°/240° sensor electrical phasings.

Because of its low cost, the MC33033 can efficiently be used to control brush dc motors as well as brushless. A brush dc motor can be driven using two of the three drive output phases provided in the MC33033, while the Hall sensor input pins are selectively tied to V_{ref} or ground. Other features such as forward/reverse, output enable, speed control, current limiting, undervoltage lockout and internal thermal shutdown will still remain functional.

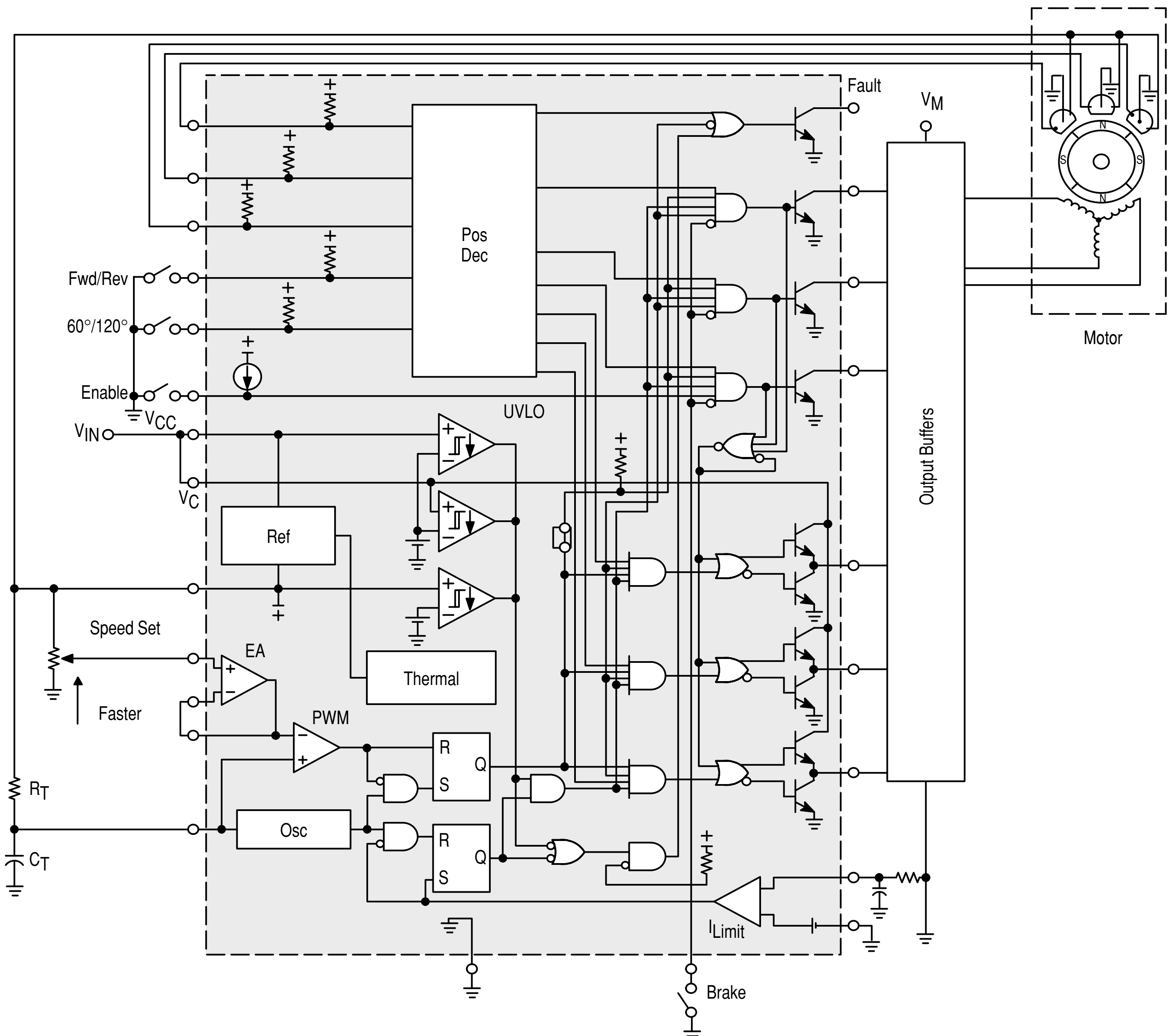


Motor Controllers (continued)

MC33035P, DW

T_A = –40° to +85°C, DIP–24, SO–24L Packages

The MC33035 is a second generation high performance brushless dc motor controller which contains all of the active functions required to implement a full featured open loop motor control system. While being pin–compatible with an earlier device, the MC33035 offers additional features at a lower price. The two additional features provided by the MC33035 are a pin which allows the user to select 60°/300° or 120°/240° sensor electrical phasings, and access to both inverting and noninverting inputs of the current sense comparator. The earlier devices had two part numbers which were needed to support the different sensor phasings, and the inverting input to the current sense comparator was internally grounded. All of the control and protection features of the earlier device are also provided in the MC33035.



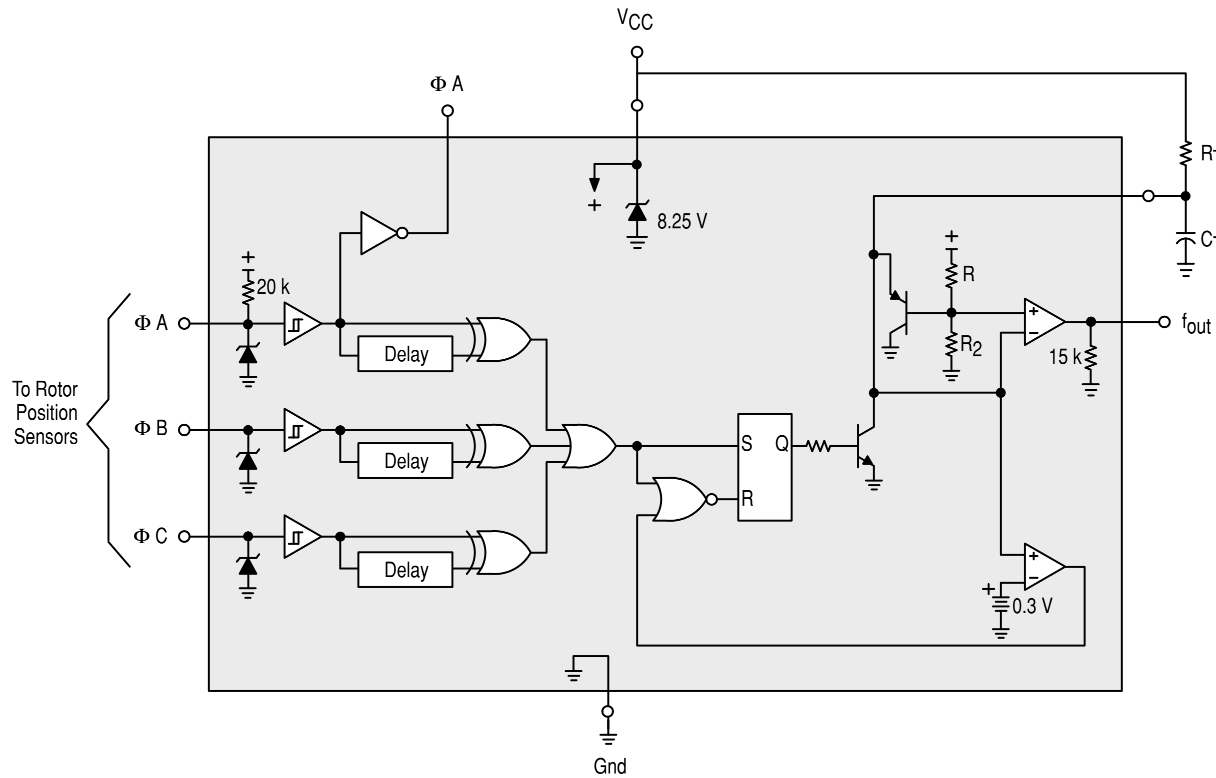
Motor Controllers (continued)

Closed Loop Brushless Motor Adapter

MC33039P, D

T_A = –40° to +85°C, DIP–8, SO–8

The MC33039 is a high performance close loop speed control adapter specifically designed for use in brushless dc motor control systems. Implementation will allow precise speed regulation without the need for a magnetic or optical tachometer. These devices contain three input buffers each with hysteresis for noise immunity, three digital edge detectors, a programmable monostable, and an internal shunt regulator. Also included is an inverter output for use in systems that require conversion of sensor phasing. Although this device is primarily intended for use with the MC33033/35 brushless motor controllers, it can be used cost effectively in many other closed loop speed control applications.



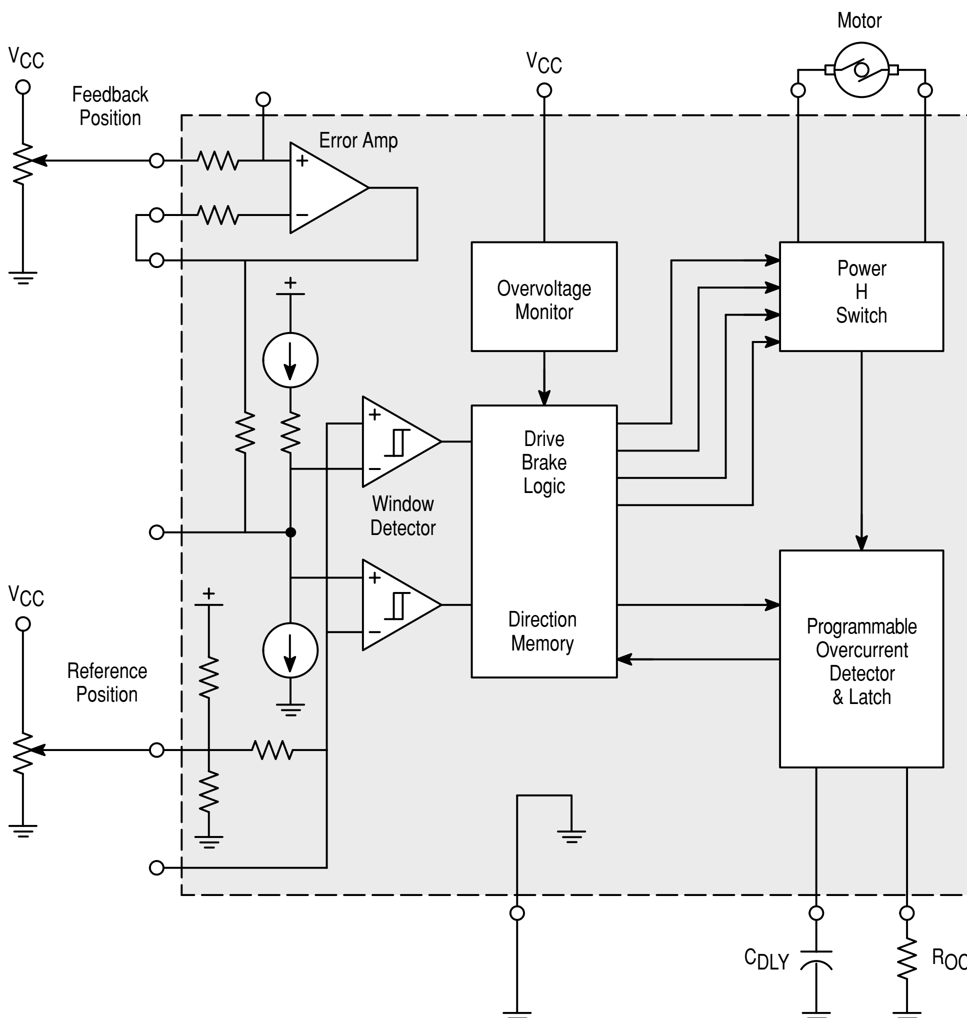
Motor Controllers (continued)

DC Servo Motor Controller/Driver

MC33030P, DW

T_A = –40° to +85°C, DIP–16, SO–16L

A monolithic dc servo motor controller providing all active functions necessary for a complete closed loop system. This device consists of an on–chip op amp and window comparator with wide input common mode range, drive and brake logic with direction memory, a power H switch driver capable of 1.0 A, independently programmable over current monitor and shutdown delay, and over voltage monitor. This part is ideally suited for almost any servo positioning application that requires sensing of temperature, pressure, light, magnetic flux, or any other means that can be converted to a voltage.



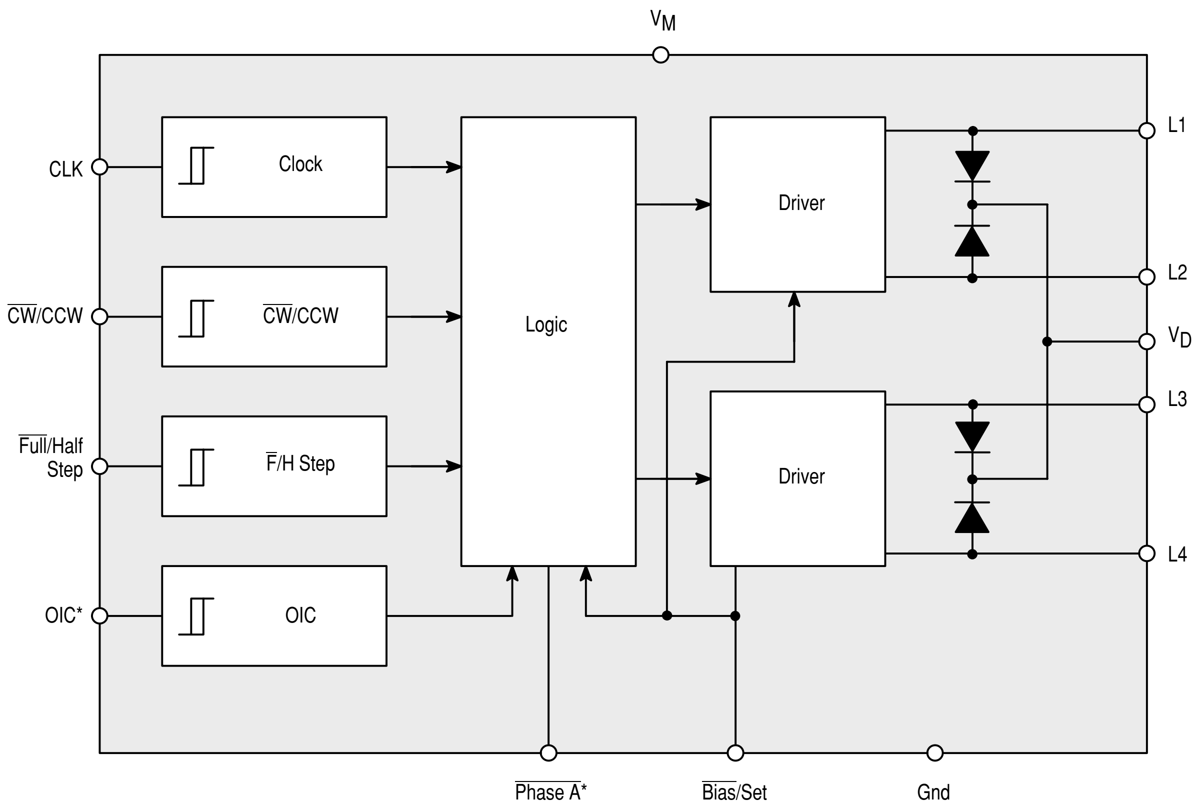
Motor Controllers (continued)

Stepper Motor Driver

MC3479P

T_A = 0° to +70°C, DIP–16

This Stepper Motor Driver provides up to 500 mA of drive per coil for two phase 6.0 V to 24 V stepper motors. Control logic is provided to accept commands for clockwise, counter clockwise and half or full step operation. The MC3479 has an added Output Impedance Control (OIC) and a $\overline{\text{Phase A}}$ drive state indicator.



* MC3479 Only

Interface

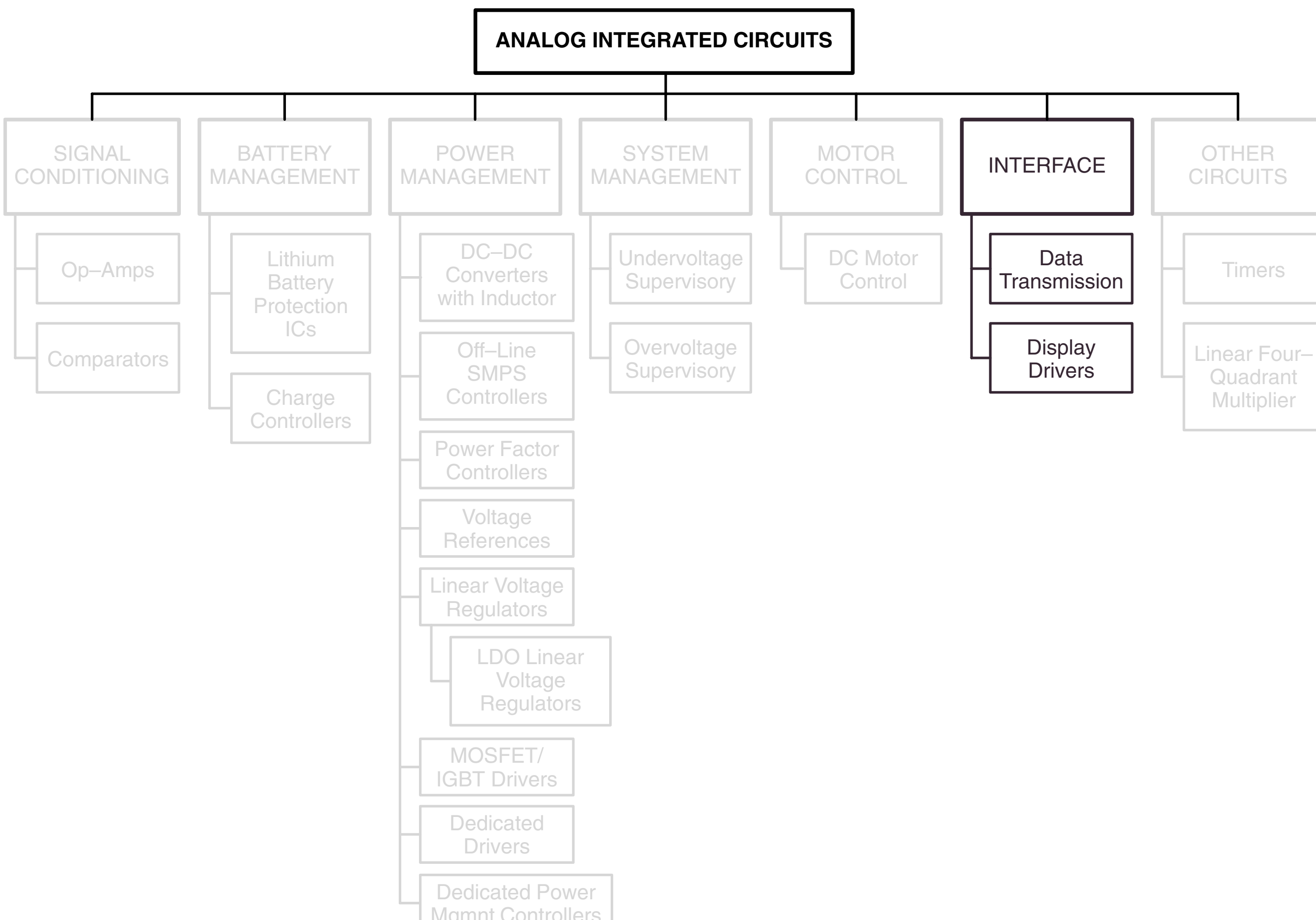
In Brief . . .

Described in this section is ON Semiconductor's line of interface circuits, which provide the means for interfacing with microprocessor or digital systems and the external world, or to other systems.

Also included are devices which allow a microprocessor to communicate with its own array of memory and peripheral I/O circuits.

The line drivers, receivers, and transceivers permit communication between systems over cables of several thousand feet in length, and at data rates of up to several megahertz. The common EIA data transmission standards, several European standards, and IEEE–488 are addressed by these devices.

The peripheral drivers are designed to handle high current loads such as relay coils, lamps, stepper motors, and others. Input levels to these drivers can be TTL, CMOS, high voltage MOS, or other user defined levels. The display drivers are designed for LCD or LED displays, and provide various forms of decoding.



Line Receivers

Table 1. EIA Standard

S = Single Ended D = Differ-ential	Type of Out–put	t_{prop} Delay Time Max (ns)	Party Line Opera–tion	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Pack–age	Receivers Per Package	Com–panion Drivers	Comments
S	TP	4000	–	–	+5.0	MC14C89AB	DIP–16, SO–16	4	MC1488 MC14C88B	EIA–232–D/ EIA–562
	R(1)	85	–	–		MC1489 MC1489A				EIA–232–D

(1) R = Resistor Pull–up, TP = Totem–pole output.

Line Drivers

Table 2. EIA Standard

Output Current Capa–bility (mA)	t_{prop} Delay Time Max (ns)	S = Single Ended D = Differ-ential	Party Line Opera–tion	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Pack–age	Drivers Per Pack–age	Companion Receivers	Comments
85	35	D	✓	✓	+5.0	MC75174B MC75172B	SO–20L	4	–	EIA–485
15	3500	S	–		±7.0 to ±12	MC14C88B	DIP–8, SO–8		MC14C89B MC14C89AB	EIA–232–D/ EIA–562
10	350				±9.0 to ±12	MC1488			MC1489 MC1489A	EIA–232–D
60	300	S/D		EIA–422 ✓ EIA–423 –	±5.0	MC26LS30	SO–16	4 (423) 2 (422)	–	EIA–422 or EIA–423 Switchable

Table 3. Peripheral Drivers

Output Current Capability (mA)	Input Capability	Propagation Delay Time Max (μs)	Output Clamp Diode	Off State Voltage Max (V)	Device	Drivers Per Package	Suffix/ Package	Logic Function
500	TTL, CMOS	1.0	✓	50	ULN2803	8	DIP–18	Invert
	6.0 V to 15 V MOS				ULN2804			
	TTL, 5.0 V CMOS				MC1413, B (ULN2003A)	7	DIP–16, SO–16	
	8.0 V to 18 V MOS				MC1416, B (ULN2004A)			

Electroluminescent Lamp Driver IC

MC33441

T_A = – 20°C to +70°C, TSSOP 8–Pins

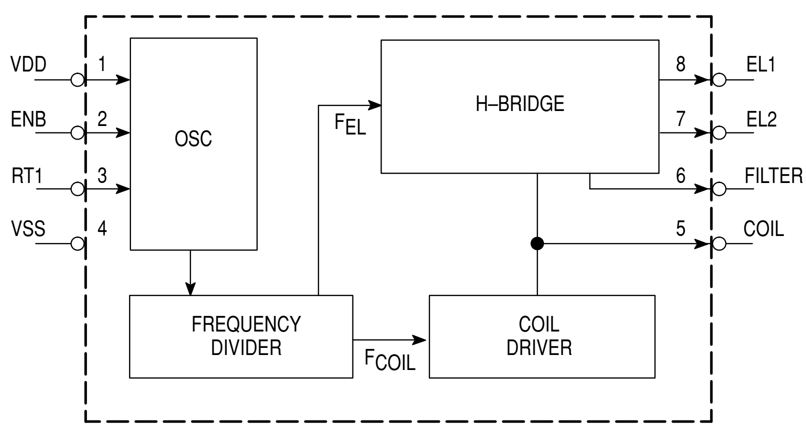
The MC33441 is a high voltage output DC–AC inverter integrated circuit for driving EL lamps. It can boost the supply voltage to the level required by EL panels and also provide high voltage AC lamp excitation. It consists of an oscillator, a frequency divider, a coil driving circuit and a switched H–bridge network. The input supply voltage range is from 1.8V to 3.5V and is capable of supplying up to 150Vpp output signal. The standby current of the device is typically 10nA which is ideal for low power portable products. Externally, one inductor and one resistor are needed to generate the desirable voltage charge and to fine tune the oscillator's frequency. This device is offered in 8–Pin TSSOP miniature package. The operating temperature is –20°C to 70°C.

- Battery Operation 1.8V – 3.5V
- Maximum Voltage Output 150Vpp
- Typical Standby Current 10nA
- Internal Oscillator with External Tuning Resistor
- Enable Control Pin with a 300K Internal Pull–Down Resistor
- 8–Pin TSSOP Package (Thickness = 1.05mm, Width = 4.5mm, Length = 3.1mm & Lead Pitch = 0.65mm)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33441DTB	– 20°C to +70°C	8–PIN TSSOP
MC33441DTBEL		

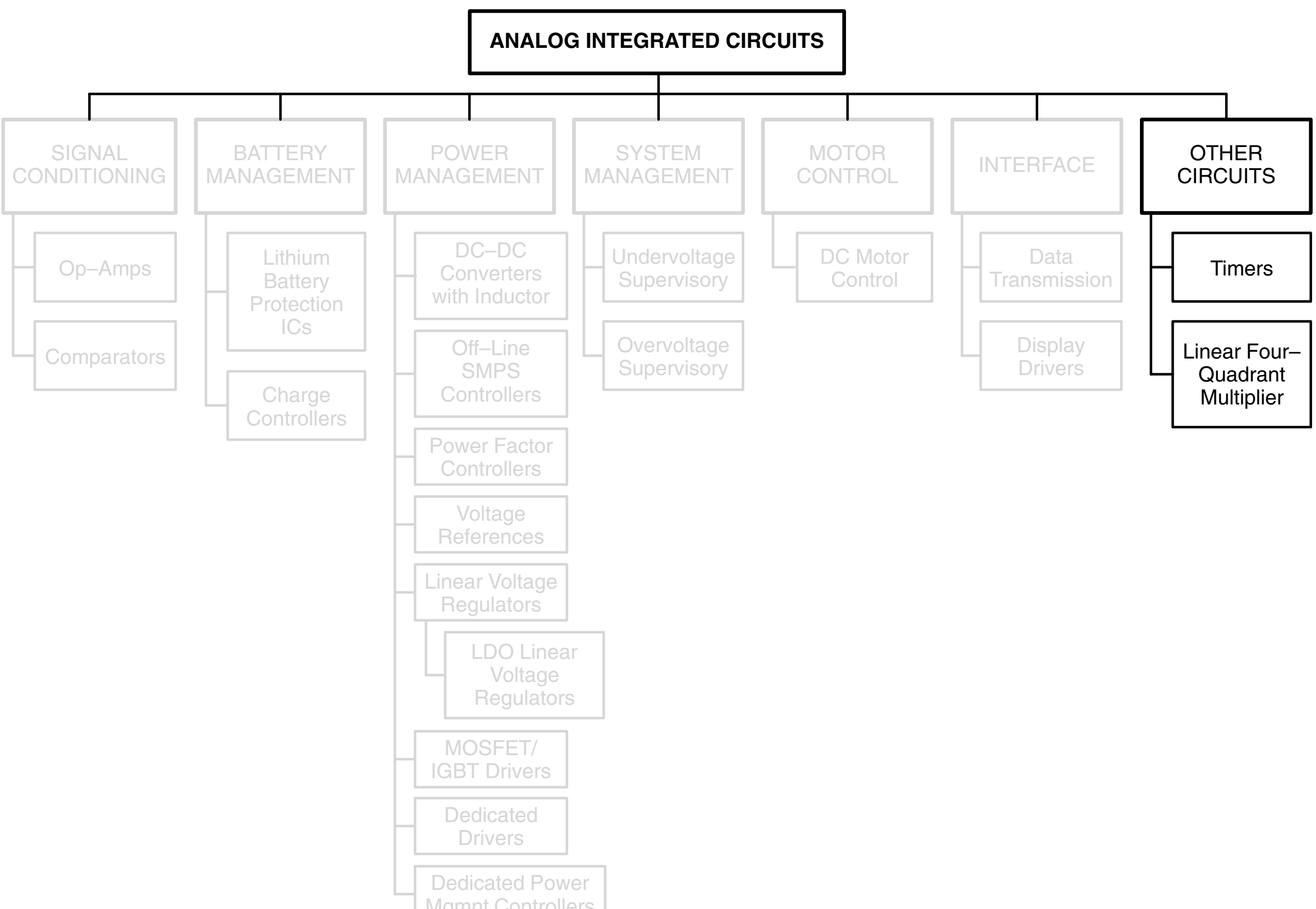
Simplified Block Diagram



Other Circuits

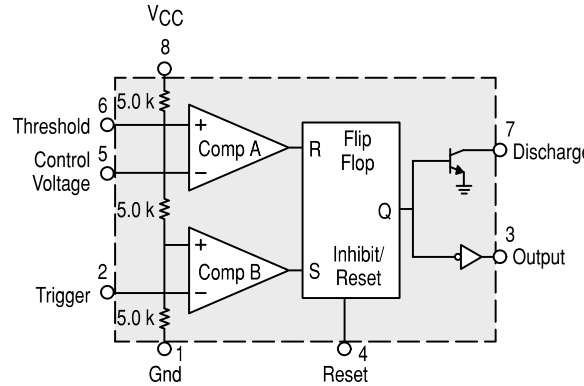
In Brief . . .

Other analog circuits are provided for special applications with both bipolar and CMOS technologies. These circuits range from the industry standard analog timing circuits and multipliers to specialized CMOS smoke detectors. These products provide key functions in a wide range of applications, including data transmission, commercial smoke detectors, and various industrial controls.



Timing Circuits

These highly stable timers are capable of producing accurate time delays or oscillation. 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 output structure can source or sink up to 200 mA or drive TTL circuits. Timing intervals from microseconds through hours can be obtained. Additional terminals are provided for triggering or resetting if desired.



Singles

MC1455P1, D

T_A = 0° to +70°C, SO–8, DIP–8

MC1455BP1, D

T_A = −40° to +85°C, SO–8, DIP–8

Duals

MC3456P

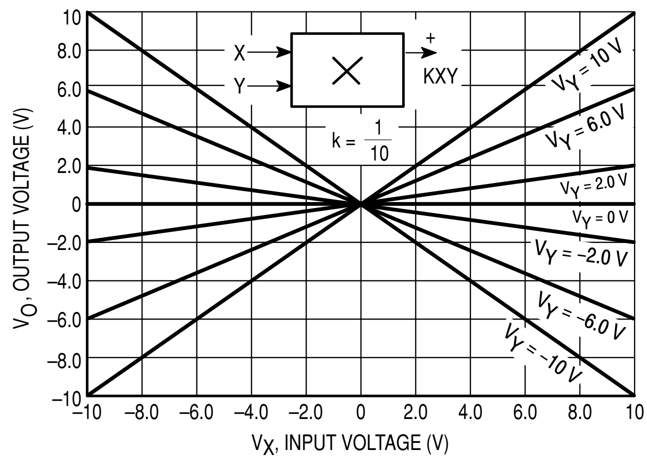
T_A = 0° to +70°C, DIP–14

Multipliers

Linear Four–Quadrant Multipliers

Multipliers are 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.

Multiplier Transfer Characteristics



MC1494P

T_A = 0° to +70°C, DIP–16

This device has all the necessary internal regulation and references. The single–ended output is referenced to ground.

MC1495D, P, BP

T_A = 0° to +70°C, DIP–14, SO–14

Maximum versatility is assured by allowing the user to select the level shift method.

Tape and Reel Options

In Brief . . .

ON Semiconductor offers the convenience of Tape and Reel packaging for our growing family of standard integrated circuit products. Reels are available to support the requirements of both first and second generation pick–and–place equipment. The packaging fully conforms to the latest EIA–481A specification. The antistatic embossed tape provides a secure cavity, sealed with a peel–back cover tape.

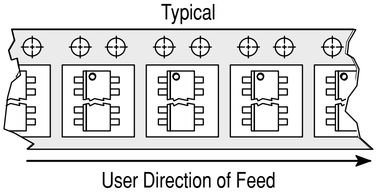
Page

Tape and Reel Configurations

Mechanical Polarization

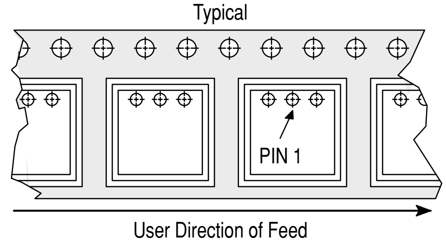
SOIC and Micro–8 DEVICES

Typical



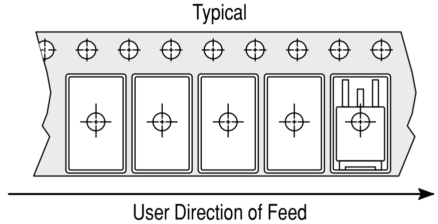
PLCC DEVICES

Typical



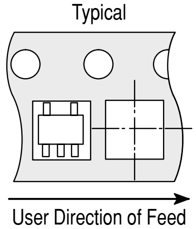
DPAK and D2PAK DEVICES

Typical



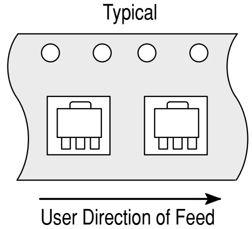
SOT–23 (5 Pin) DEVICES

Typical



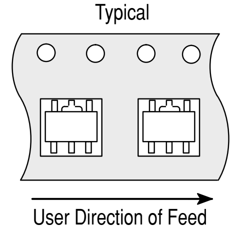
SOT–89 (3 Pin) DEVICES

Typical



SOT–89 (5 Pin) DEVICES

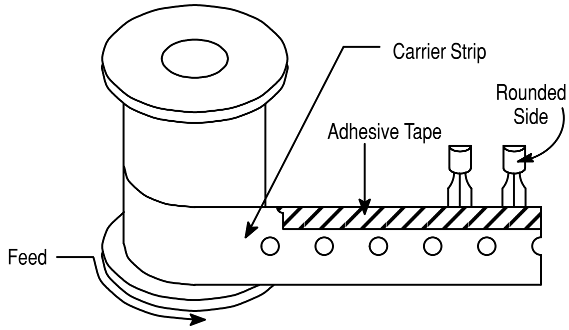
Typical



Tape and Reel Configurations (continued)

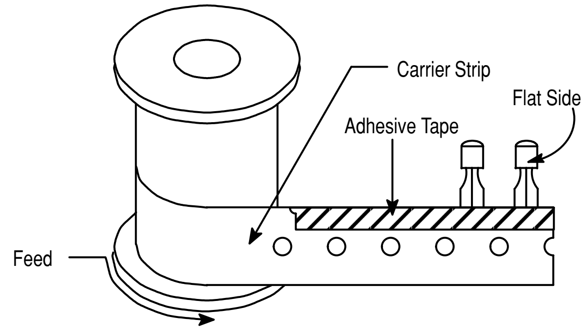
TO–92 Reel Styles

STYLE A
(Preferred)



Rounded side of transistor and adhesive tape visible.

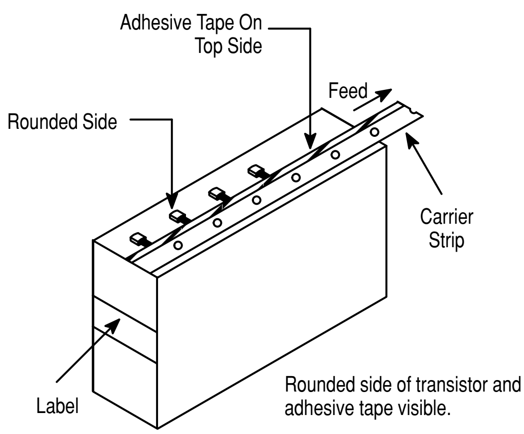
STYLE E



Flat side of transistor and adhesive tape visible.

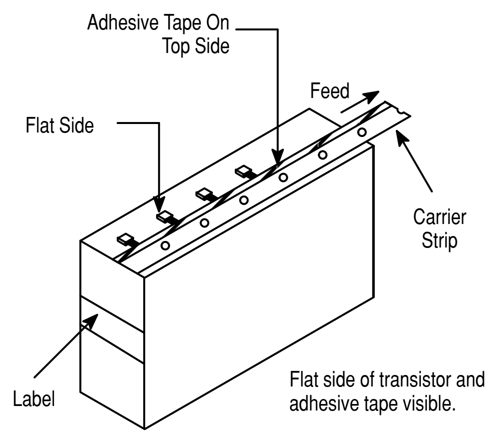
TO–92 Ammo Pack Styles

STYLE P
(Preferred)



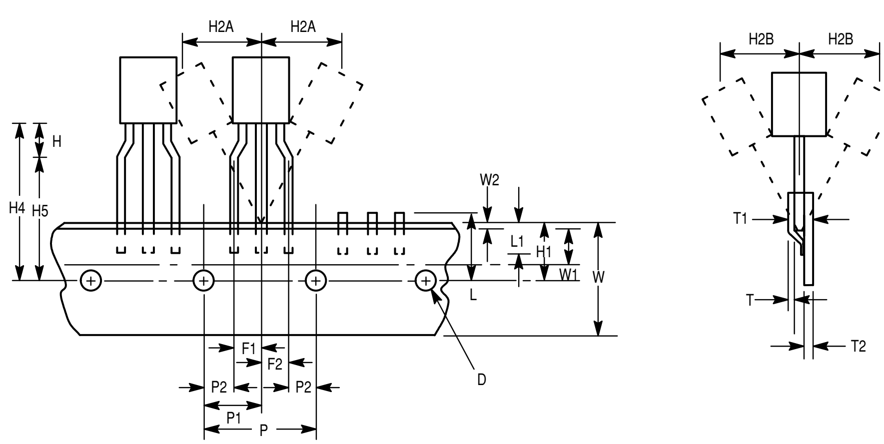
Style P ammo pack is equivalent to Styles A and B of reel pack dependent on feed orientation from box.

STYLE M



Style M ammo pack is equivalent to Style E of reel pack dependent on feed orientation from box.

TO–92 EIA Radial Tape in Fan Fold Box or On Reel



Tape and Reel Information Table

Package	Tape Width (mm)	Devices(1) per Reel	Reel Size (inch)	Device Suffix
SO–8, SOP–8	12	2,500	13	R2
SO–14	16	2,500	13	R2
SO–16	16	2,500	13	R2
SO–16L, SO–8+8L WIDE	16	1,000	13	R2
SO–20L WIDE	24	1,000	13	R2
SO–24L WIDE	24	1,000	13	R2
SO–28L WIDE	24	1,000	13	R2
SO–28L WIDE	32	1,000	13	R3
Micro–8	12	2,500	13	R2
PLCC–20	16	1,000	13	R2
PLCC–28	24	500	13	R2
PLCC–44	32	500	13	R2
PLCC–52	32	500	13	R2
PLCC–68	44	250	13	R2
PLCC–84	44	250	13	R2
TO–226AA (TO–92)(2)	18	2,000	13	RA, RE, RP, or RM (Ammo Pack) only
DPAK	16	2,500	13	RK
D^2PAK	24	800	13	R4
SOT–23 (5 Pin)	8	3,000	7	TR
SOT–89 (3/5 Pin)	12	1,000	7	T1

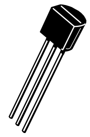
(1) Minimum order quantity is 1 reel. Distributors/OEM customers may break lots or reels at their option, however broken reels may not be returned.
(2) Integrated circuits in TO–226AA packages are available in Styes A and E only, with optional "Ammo Pack" (Suffix RP or RM). The RA and RP configurations are preferred. For ordering information please contact your local ON Semiconductor Sales Office.

Analog MPQ Table

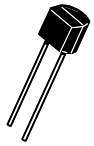
Tape/Reel and Ammo Pack

Package Type	Package Code	MPQ
PLCC		
Case 775	0802	1000/reel
Case 776	0804	500/reel
Case 777	0801	500/reel
SOIC		
Case 751	0095	2500/reel
Case 751A	0096	2500/reel
Case 751B	0097	2500/reel
Case 751G	2003	1000/reel
Case 751D	2005	1000/reel
Case 751E	2008	1000/reel
Case 751F	2009	1000/reel
Micro–8		
Case 846A	–	2500/reel
TO–92		
Case 29	0031	2000/reel
Case 29	0031	2000/Ammo Pack
DPAK		
Case 369A	–	2500/reel
D^2PAK		
Case 936	–	800/reel
SOT–23 (5 Pin)		
Case 1212	–	3000/reel
SOT–89 (3 Pin)		
Case 1213	–	1000/reel
SOT–89 (5 Pin)		
Case 1214	–	1000/reel

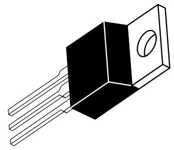
Package Overview



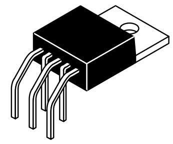
CASE 29
LP, P, Z SUFFIX



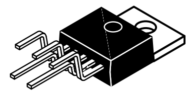
CASE 182



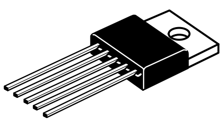
CASE 221A
T SUFFIX



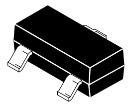
CASE 314A
TH SUFFIX



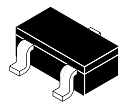
CASE 314B
TV SUFFIX



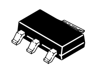
CASE 314D
T, T–1 SUFFIX



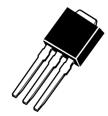
CASE 318



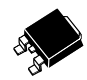
CASE 318D



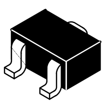
CASE 318E
ST SUFFIX



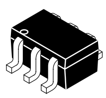
CASE 369
DT–1 SUFFIX



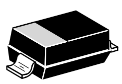
CASE 369A
DT SUFFIX



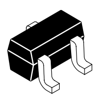
CASE 419



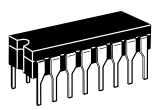
CASE 419B



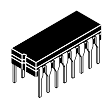
CASE 425



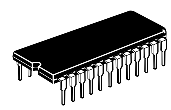
CASE 463



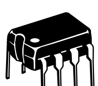
CASE 620



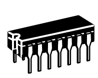
CASE 620A
L, J SUFFIX



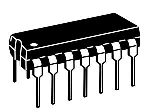
CASE 623
L, J, JW SUFFIX



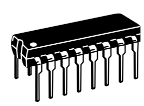
CASE 626
B, N, NO, P, P1 SUFFIX



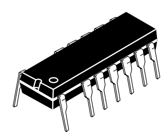
CASE 632
L, J SUFFIX



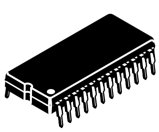
CASE 646
N, P, P1 SUFFIX



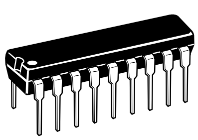
CASES 648, 648C
DP2, N, P, PC, P2, V SUFFIX



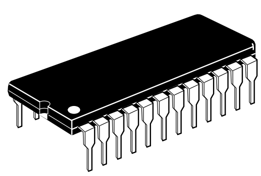
CASE 648E
P SUFFIX



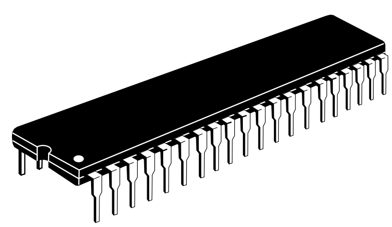
CASE 649
N, P, PW SUFFIX



CASE 707
A, N, P SUFFIX

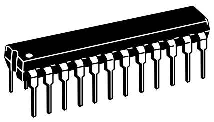


CASE 709
N, P SUFFIX

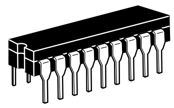


CASE 711
N, P SUFFIX

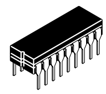
Package Overview (continued)



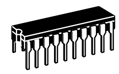
CASE 724
N, P SUFFIX



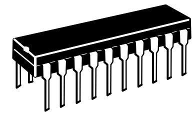
CASE 726



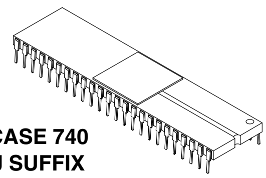
CASE 726B
L, J SUFFIX



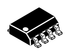
CASE 732
L, J SUFFIX



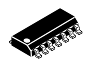
CASE 738
N, P SUFFIX



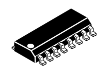
CASE 740
J SUFFIX



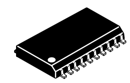
CASE 751
D, D1, D2 SUFFIX



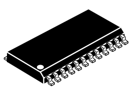
CASE 751A
D SUFFIX



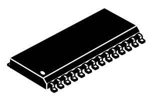
CASE 751B
D SUFFIX



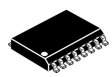
CASE 751D
DW SUFFIX



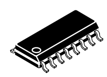
CASE 751E
DW SUFFIX



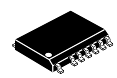
CASE 751F
DW SUFFIX



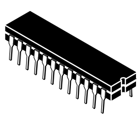
CASE 751G
DW SUFFIX



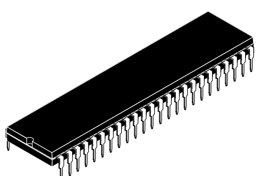
CASE 751K
D SUFFIX



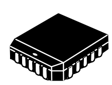
CASE 751N
DW SUFFIX



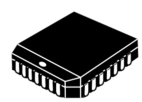
CASE 758
J SUFFIX



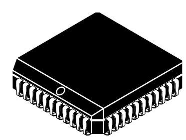
CASE 767
N SUFFIX



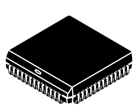
CASE 775
FN SUFFIX



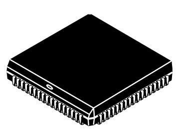
CASE 776
FN SUFFIX



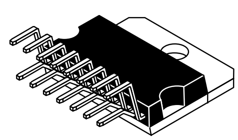
CASE 777
FN SUFFIX



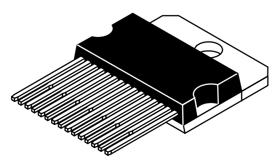
CASE 778
FN SUFFIX



CASE 779
FN SUFFIX

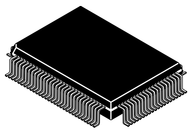


CASE 821C
TV SUFFIX

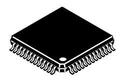


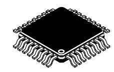
CASE 821D
T SUFFIX

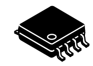
Package Overview (continued)

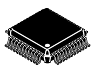

CASE 842D
FU SUFFIX

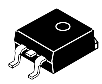

CASE 846A
DM SUFFIX

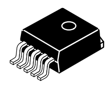

CASE 848D
FA, FB SUFFIX

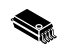

CASE 873A
FA, FB SUFFIX

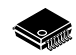

CASE 904
F SUFFIX

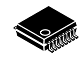

CASE 932
FTA SUFFIX

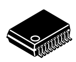

CASE 936
D2T SUFFIX

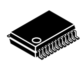

CASE 936A
D2T SUFFIX

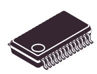

CASE 940
SD SUFFIX

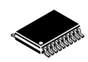

CASE 940A
SD SUFFIX

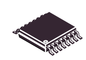

CASE 940B
SD SUFFIX

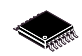

CASE 940C
SD SUFFIX

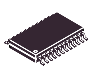

CASE 940D
SD SUFFIX

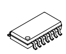

CASE 940J
VF SUFFIX

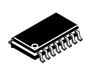

CASE 948E
DT, DTB SUFFIX

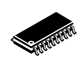

CASE 948F
DT, DTB SUFFIX

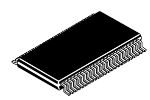

CASE 948G
DT, DTB SUFFIX

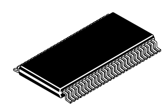

CASE 948H
DT, DTB SUFFIX


CASE 965
M SUFFIX


CASE 966
M SUFFIX


CASE 967
M SUFFIX


CASE 1201
DT SUFFIX


CASE 1202
DT SUFFIX


CASE 1212
N SUFFIX


CASE 1213
H SUFFIX

Logic Devices

In Brief . . .

This selector guide is a quick reference to ON Semiconductor's vast offering of standard logic integrated circuits. In TTL, popular due to its ease of use, low cost, medium–to–high speed operation and good output drive capability, ON Semiconductor offers LS. ON Semiconductor's CMOS portfolio includes MC14000B standard CMOS series devices, High–Speed CMOS consisting of a full line of products that are pinout– compatible with many LSTTL and MC14000B standard CMOS logic devices which offers designers a solution to the long–standing combined barrier — high speed and low power. ON Semiconductor also offers a several new advanced lines of CMOS which include low–voltage, voltage tolerance and very high–speed features (LVX, LCX, VCX, VHC and VHCT) consisting of the most commonly used CMOS products. ON Semiconductor's Emitter Coupled Logic (MECL) is a non–saturated form of digital logic which eliminates transistor storage time permitting very high speed operation. ON Semiconductor offers a wide variety of MECL: MECL 10K; MECL 10H; ECLinPS (ECL in picoseconds); ECLinPS Lite; Low–Voltage ECLinPS and ECLinPS Lite; and ECLinPS and Low–Voltage ECLinPS level translation. Also available is ECLinPS Plus, a recently introduced higher performance family of ECLinPS products. Timing solution products such as clock drivers, clock generators and programmable delay chips are also included. High performance and communications products such as VCO's, a wide variety of translators, low–voltage bus interface and serial data transmission devices are also available.

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Selection by Function

In order to better serve our customers, we have made some modifications to the Selection by Function portion of the Logic Selector Guide. For easy selection of Logic's newer, more complex functions, as well as standard family functions, refer to the subject index below. Within the Selection by Function tables you will find functions sorted by these broad subjects, and then broken down alphabetically into more precise functions.

Logic Functions

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
AMPLIFIER						
Fiber Optic Post Amplifier	ECL	MC10SX1125	–	16		D
ARITHMETIC OPERATORS						
4–Bit Arithmetic Logic Unit/Function Generator	ECL	MC10H181	–	24	P,L, PW, LW	FN
4–Bit Binary Full Adder With Fast Carry	TTL	SN74LS283	–	16	N,J	D
4–Bit Full Adder	CMOS	MC14008B	–	16	P,L	D
Dual 2–Bit Adder/Subtractor	ECL	MC10H180	–	16	P,L	FN
Look Ahead Carry Block	ECL	MC10H179	–	16	P,L	FN
BOUNCE ELIMINATOR						
Hex Contact Bounce Eliminator	CMOS	MC14490	–	16	P,L	DW
BUFFERS						
1:2 Differential Fanout Buffer	ECL	MC100LVEL11	–	8		D
	ECL	MC10EL11	MC100EL11	8		D
2:8 Differential Fanout Buffer	ECL	MC100LVE310	MC100E310	28		FN
Dual 1:3 Fanout Buffer	ECL	MC100LVEL13	MC100EL13	20		DW
Low Voltage Dual 1:4, 1:5 Differential Fanout Buffer, ECL/PECL Compatible	ECL	MC100LVE210	MC100E210	28		FN
Octal Bus Buffer Inverting	CMOS	MC74VHC540	–	20		DW, DT,M
Quad Bus Buffer With 5V–Tolerant Inputs	CMOS	MC74LVX125	–	14		D,DT, M
Quad Bus Buffer With 3–State Control Inputs	CMOS	MC74VHC126	–	14		D,DT, M
BUFFERS, 3–STATE						
Low–Voltage CMOS 16–Bit Buffer, 3–State, Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX16240A	–	20		DW,M, DT
	CMOS	MC74LCX16240	–	48		DT
Low–Voltage CMOS 16–Bit Buffer, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX16244	–	20		DW,M, DT
Low–Voltage CMOS Octal Buffer, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX244	–	20		DW,M, DT
Low–Voltage CMOS Octal Buffer, 3–State, Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX240	–	20		DW,M, DT
Low–Voltage CMOS Octal Buffer Flow Through Pinout, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX541	–	20		DW,M, DT
Low–Voltage CMOS Octal Buffer Flow Through Pinout, 3–State, Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX540	–	20		DW,M, DT
Low–Voltage CMOS Quad Buffer, 3–State, Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX125	–	20		DW,M, DT
Octal Bus Buffer Inverting With 5V–Tolerant Inputs	CMOS	MC74LVX240	–	20		DW, DT,M
Octal Bus Buffer Non–Inverting 3–State Buffer/Line Driver/Line Receiver	CMOS	MC74VHCT541A	–	20		DW, DT,M
Octal Bus Buffer Non–Inverting With 5V–Tolerant Inputs	CMOS	MC74LVX244	–	20		DW, DT,M
Octal Bus Buffer/Line Driver Inverting With 3–State Outputs	CMOS	MC74VHC240	–	20		DW, DT,M
Octal Bus Buffer/Line Driver Inverting With 3–State Outputs	CMOS	MC74VHCT240A	–	20		DW, DT,M
Octal Bus Buffer/Line Driver Non–Inverting With 3–State Outputs	CMOS	MC74VHCT244A	–	20		DW, DT,M

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
BUFFERS, 3–STATE						
Quad 3–State Non–Inverting Buffer	CMOS	MC74HC126	–	14	N	D,DT
BUS INTERFACE						
Dual Bus Driver/Receiver With 4–to–1 Output Multiplexer (25Ω)	ECL	MC10H332	–	20	P,L	FN
Hex Buffer 4/2–Bit/Inverting With 3–State Outputs	TTL	SN74LS368A	–	16	N,J	D
Hex Buffer 4/2–Bit/Non–Inverting With 3–State Outputs	TTL	SN74LS367A	–	16	N,J	D
Hex Buffer Gated Enable Non–Inverting With 3–State Outputs	TTL	SN74LS365A	–	16	N,J	D
Hex With 3–State Outputs Buffer (Non–Inverting)	CMOS	MC14503B	–	16	P,L	D
Octal 3–State Non–Inverting Bus Transceiver With LSTTL Compatible Inputs	CMOS	MC74HCT245A	–	20	N,J	DW, SD,DT
Octal Bidirectional Transceiver With 3–State Inputs/Outputs	CMOS	MC74AC245	–	20	N	DW
	CMOS	MC74ACT245	–	20	N	DW
Octal Bidirectional Transceiver With 3–State Outputs	CMOS	MC74ACT640	–	20	N	DW
Octal Buffer/Line Driver With 3–State Outputs	TTL	SN74LS244	–	20	N,J	DW
	TTL	SN74LS240	–	20	N,J	DW
	TTL	SN74LS541	–	20	N,J	DW
	CMOS	MC74AC244	–	20	N	DW
	CMOS	MC74ACT244	–	20	N	DW
	CMOS	MC74AC540	–	20	N	DW
	CMOS	MC74ACT540	–	20	N	DW
	CMOS	MC74AC541	–	20	N	DW
	CMOS	MC74ACT541	–	20	N	DW
	CMOS	MC74AC240	–	20	N	DW
	CMOS	MC74ACT240	–	20	N	DW
	CMOS	MC74ACT241	–	20	N	DW
Octal Bus Transceiver	TTL	SN74LS245	–	20	N,J	DW
Octal Bus Transceiver/Inverting With 3–State Outputs	TTL	SN74LS640	–	20	N,J	DW
Octal Bus Transceiver/Register With 3–State Outputs Non–Inverting	CMOS	MC74AC652	–	24	N	DW
	CMOS	MC74ACT652	–	24	N	DW
Octal Transceiver/Register With 3–State Outputs Non–Inverting	CMOS	MC74AC646	–	24	N	DW
	CMOS	MC74ACT646	–	24	N	DW
Octal With 3–State Non–Inverting Buffer/Line Driver/Line Receiver With LSTTL Compatible Inputs	CMOS	MC74HCT244A	–	20	N,J	DW, SD,DT
Octal With 3–State Outputs Inverting Buffer/Line Driver/Line Receiver	CMOS	MC74HC240A	–	20	N,J	DW, DT
	CMOS	MC74HC540A	–	20	N,J	DW
Octal With 3–State Outputs Non–Inverting Buffer/Line Driver/Line Receiver	CMOS	MC74HC541A	–	20	N,J	DW
	CMOS	MC74VHC541	–	20		DW, DT,M
Octal With 3–State Outputs Non–Inverting Buffer/Line Driver/Line Receiver With LSTTL Compatible Inputs	CMOS	MC74HCT541A	–	20	N	DW
Octal With 3–State Outputs Non–Inverting Buffer/Line Driver/Line Receiver	CMOS	MC74HC244A	–	20	N,J	DW, SD,DT
	CMOS	MC74VHC244	–	20		DW, DT,M

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
BUS INTERFACE						
Octal With 3–State Outputs Non–Inverting Bus Transceiver	CMOS	MC74HC245A	–	20	N,J	DW
	CMOS	MC74VHC245	–	20		DW DT,M
Quad Buffers With 3–State Outputs	TTL	SN74LS125A	–	14	N,J	D
Quad 3–State Non–Inverting Buffers	CMOS	MC74HC125A	–	14	N	D,DT
	CMOS	MC74VHC125	–	14		D, DT,M
	CMOS	MC74HC126A	–	14	N	D,DT
Quad Buffer With 3–State Outputs	CMOS	MC74AC125	–	14	N	D
	CMOS	MC74ACT125	–	14	N	D
	TTL	SN74LS126A	–	14	N,J	D
Quad Bus Driver	ECL	MC10192	–	16	P,L	FN
Quad Bus Driver/Receiver With 2–to–1 Output Multiplexer (25Ω)	ECL	MC10H330	–	24	P,L	FN
Quad Bus Driver/Receiver With Transmit & Receiver Latches (25Ω)	ECL	MC10H334	–	20	P,L	FN
Triple 4–3–3 Input Bus Driver (25Ω)	ECL	MC10H123	–	16	P,L	FN
	ECL	MC10123	–	16	P,L	FN
CBM						
CBM – Carrier Band Modem	SXLG	MC68194	–	52		*FJ
CLOCK DISTRIBUTION CHIPS						
1:4 Clock Distribution Chip	ECL	MC10EL15	MC100EL15	16		D
1:5 Clock Distribution Chip	ECL	MC100LVEL14	MC100EL14	20		DW
1:6 Differential Clock Distribution Chip	ECL	MC10E211	MC100E211	28		FN
CLOCK DRIVERS						
1:9 Differential Clock Driver	ECL	MC10E111	MC100E111	28		FN
1:9 Differential ECL/PECL RAMBus Clock Buffer	ECL	MC10E411	–	28		FN
1:9 TTL Clock Driver	ECL	MC10H645	–	28		FN
68030/040 PECL/TTL Clock Driver	ECL	MC10H640	MC100H640	28		FN
	ECL	MC10H642	MC100H642	28		FN
	ECL	MC10H644	MC100H644	20		FN
Dual Supply ECL/TTL 1:8 Clock Driver	ECL	MC10H643	MC100H643	28		FN
Low–Voltage 1:5 Differential ÷1/÷2 ECL/PECL Clock Driver	ECL	MC100LVE222	–	52		FA
Low–Voltage 1:9 Differential ECL/PECL Clock Driver	ECL	MC100LVE111	–	28		FN
PECL/TTL to TTL 1:8 Clock Distribution Chip	ECL	MC10H646	MC100H646	28		FN
Single Supply PECL/TTL 1:9 Clock Distribution Chip	ECL	MC10H641	MC100H641	28		FN
÷2, 4, 8 Differential Clock Driver	ECL	MC10EL34	MC100EL34	16		D
÷2, ÷4/6 Clock Generation Chip	ECL	MC100LVEL38	MC100EL38	20		DW
÷2/4, ÷4/6 Clock Generation Chip	ECL	MC100LVEL39	MC100EL39	20		DW
COAX CABLE DRIVERS						
Fibre Channel Coaxial Cable Driver and Loop Resiliency Circuit	SDX	MC10SX1189	–	16		D
300 MBit/s LED Driver for FDDI and Fibre Channel	SDX	MC10SX1130	–	16		D
COMPARATORS						
4–Bit Magnitude Comparator	TTL	SN74LS85	–	16	N,J	D
	CMOS	MC14585B	–	16	P,L	D

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
COMPARATORS						
5–Bit Magnitude Comparator	ECL	MC10H166	–	16	P,L	FN
8–Bit Magnitude Comparator	TTL	SN74LS682	–	20	N,J	DW
	TTL	SN74LS684	–	20	N,J	DW
	TTL	SN74LS688	–	20	N,J	DW
9–Bit Magnitude Comparator	ECL	MC10E166	MC100E166	28		FN
Dual Analog Comparator With Latch	ECL	MC10E1651	–	16,20	L	FN
Dual Analog Comparator With Latch (Hi–Perf MC1651)	ECL	MC10E1652	–	16,20	L	FN
CONVERTERS						
2.5 GBit/s Parallel to Serial Converter	SDX	MC100SX1481	–	64		FU
2.5 GBit/s Serial to Parallel Converter	SDX	MC100SX1482	–	64		FU
4–Bit Parallel to Serial Converter	ECL	MC10E446	MC100E446	28		FN
4–Bit Serial to Parallel Converter	ECL	MC10E445	MC100E445	28		FN
COUNTERS						
12–Bit Binary Counter	CMOS	MC14040B	–	16	P,L	D
12–Stage Binary Ripple Counter	CMOS	MC74HC4040A	–	16	N,J	D,DT
14–Bit Binary Counter	CMOS	MC14020B	–	16	P,L	D
14–Bit Binary Counter and Oscillator	CMOS	MC14060B	–	16	P,L	D
14–Stage Binary Ripple Counter	CMOS	MC74HC4020A	–	16	N	D,DT
14–Stage Binary Ripple Counter With Oscillator	CMOS	MC74HC4060A	–	16	N,J	D,DT
3–Digit BCD Counter	CMOS	MC14553B	–	16	P	DW
4–Bit Binary Counter	ECL	MC10H016	–	16	P,L	FN
4–Bit Binary Counter, Synchronous Reset	TTL	SN74LS161A	–	16	N,J	D
	TTL	SN74LS163A	–	16	N,J	D
4–Bit Presettable Counter	CMOS	MC74HC163A	–	16	N	D,DT
6–Bit Universal Counter, (Lookahead Carry)	ECL	MC10E136	MC100E136	28		FN
7–Stage Ripple Counter	CMOS	MC14024B	–	14	P,L	D
8–Bit Ripple Counter	ECL	MC10E137	MC100E137	28		FN
8–Bit Synchronous Binary Up Counter	ECL	MC10E016	MC100E016	28		FN
Bi–Quinary Counter	ECL	MC10138	–	16	P,L	FN
Binary Counter	ECL	MC10178	–	16	P,L	FN
Decade Counter	CMOS	MC14017B	–	16	P,L	D
Dual 4–Bit Binary Ripple Counter	CMOS	MC74VHC393	–	14		D,DT, M
Dual 4–Stage Binary Counter	TTL	SN74LS393	–	16	N,J	D
Dual 4–Stage Binary Ripple Counter	CMOS	MC74HC393A	–	14	N,J	D
Dual 4–Stage Binary Ripple Counter W ÷2, ÷5 Sections	CMOS	MC74HC390A	–	16	N,J	D
Dual BCD Up Counter	CMOS	MC14518B	–	16	P,L	DW
Dual Binary Up Counter	CMOS	MC14520B	–	16	P,L	DW
Octal Counter	CMOS	MC14022B	–	16	P,L	D
Presettable 4–Bit Binary Down Counter	CMOS	MC14526B	–	16	P,L	DW
Presettable 4–Bit Binary Up/Down Counter	TTL	SN74LS193	–	16	N,J	D
Presettable Binary Up/Down Counter	CMOS	MC14516B	–	16	P,L	D
Presettable Binary/BCD Up/Down Counter	CMOS	MC14029B	–	16	P,L	D
Presettable Counter	CMOS	MC74HC161A	–	16	N,J	D
Presettable Divide–by–N Counter	CMOS	MC14018B	–	16	P	D
Programmable Dual Binary/BCD Counter	CMOS	MC14569B	–	16	P,L	DW

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
COUNTERS						
Synchronous Presettable Binary Counter	CMOS	MC74AC161	–	16	N	D
	CMOS	MC74ACT161	–	16	N	D
Synchronous Presettable Binary Counter	CMOS	MC74AC163	–	16	N	D
	CMOS	MC74ACT163	–	16	N	D
Universal Hexadecimal Counter	ECL	MC10H136	–	16	P,L	FN
	ECL	MC10136	–	16	P,L	FN
DECODERS						
3–to–8 Line Decoder With 5V–Tolerant Inputs	CMOS	MC74LVX138	–	16		D,DT, M
3–to–8 Line Decoder	CMOS	MC74VHCT138A	–	16		D,DT, M
CMI Coder/Decoder	SDX	MC100SX1230	–	28		FN
DECODER/DEMULTIPLEXERS						
1–of–10 Decoder	TTL	SN74LS42	–	16	N,J	D
1–of–10 Decoder/Driver Open–Collector	TTL	SN74LS145	–	16	N,J	D
1–of–8 Decoder/Demultiplexer	CMOS	MC74AC138	–	16	N	D
	CMOS	MC74ACT138	–	16	N	D
	CMOS	MC74HC138A	–	16	N,J	D
	CMOS	MC74VHC138	–	16		D,DT, M
	CMOS	MC74HCT138A	–	16	N	D,DT
	TTL	SN74LS138	–	16	N,J	D
4–Bit Transparent Latch/4–to–16 Line Decoder (High)	CMOS	MC14514B	–	24	P,L	DW
4–Bit Transparent Latch/4–to–16 Line Decoder (Low)	CMOS	MC14515B	–	24	P,L	DW
BCD–to–Decimal Decoder/Binary–to–Octal Decoder	CMOS	MC14028B	–	16	P,L	D
Binary to 1–4 Decoder (Low)	ECL	MC10171	–	16	P,L	FN
Binary to 1–8 Decoder, (High)	ECL	MC10H162	–	16	P,L	FN
	ECL	MC10162	–	16	P,L	FN
Binary to 1–8 Decoder, (Low)	ECL	MC10H161	–	16	P,L	FN
	ECL	MC10161	–	16	P,L	FN
Dual 1–of–4 Decoder Open–Collector	TTL	SN74LS156	–	16	N,J	D
Dual 1–of–4 Decoder/Demultiplexer	CMOS	MC74AC139	–	16	N	D
	CMOS	MC74ACT139	–	16	N	D
Dual 1–of–4 Decoder/Demultiplexer	CMOS	MC74HC139A	–	16	N,J	D
	TTL	SN74LS139	–	16	N,J	D
Dual 2–to–4 Decoder/Demultiplexer	CMOS	MC74VHC139	–	16		D,DT, M
Dual Binary to 1–4 Decoder (High)	ECL	MC10H172	–	16	P,L	FN
Dual Binary to 1–4 Decoder (Low)	ECL	MC10H171	–	16	P,L	FN
Dual Binary to 1–of–4 Decoder (Active High Outputs)	CMOS	MC14555B	–	16	P	D
Dual Binary to 1–of–4 Decoder (Active Low Outputs)	CMOS	MC14556B	–	16	P	D
Low–Voltage CMOS 1–of–8 Decoder/Demultiplexer With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX138	–	16		D,DT
DISPLAY DECODE DRIVERS						
BCD–to–Seven Segment Decoder/Driver	TTL	SN74LS47	–	16	N,J	D
	TTL	SN74LS247	–	16	N,J	D
BCD–to–Seven Segment Latch/Decoder/Driver	CMOS	MC14511B	–	16	P,L	D,DW

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
DISPLAY DECODE DRIVERS						
BCD–to–Seven Segment Latch/Decoder/Driver for Liquid Crystals	CMOS	MC14543B	–	16	P,L	D
BCD–to–Seven Segment Latch/Decoder/Driver With Ripple Blanking	CMOS	MC14513B	–	18	P	
DIVIDERS						
÷ 2 Divider	ECL	MC10EL32	MC100EL32	8		D
	ECL	MC100LVEL32	–	8		D
÷ 4 Divider	ECL	MC10EL33	MC100EL33	8		D
	ECL	MC100LVEL33	–	8		D
DRIVER						
Coaxial Cable Driver	ECL	MC10EL89	–	8		D
300MBit/s LED Driver for FDDI and Fibre Channel	ECL	MC10SX1130	–	16		D
ENCODERS						
10–Line to 4–Line Priority Encoder	TTL	SN74LS147	–	16	N,J	D
8–Bit Priority Encoder	CMOS	MC14532B	–	16	P,L	D
8–Input Priority Encoder	ECL	MC10H165	–	16	P,L	FN
8–Line to 3–Line Priority Encoder	TTL	SN74LS148	–	16	N,J	D
ENCODER/DECODERS						
CMI Encoder/Decoder	ECL	MC100SX1230	–	28		FN
FLIP–FLOPS						
3–Bit Differential Flip–Flop	ECL	MC10E431	MC100E431	28		FN
4–Bit D–Type Flip–Flop Individual Clock, Reset Differential Output	ECL	MC10E131	MC100E131	28		FN
5–Bit Differential Register	ECL	MC10E452	MC100E452	28		FN
6–Bit 2:1 Mux–Register With Common Clock, Asynchronous Master Reset Single Ended	ECL	MC10E167	MC100E167	28		FN
6–Bit D–Type Register With Common Clock, Asynchronous Master Reset, Differential Outputs	ECL	MC10E151	MC100E151	28		FN
6–Bit D–Type Register, With Differential Inputs, (Data & Clock) , VBB, Common Reset	ECL	MC10E451	MC100E451	28		FN
9–Bit Hold Register, 700MHz, With Asynchronous Master Reset	ECL	MC10E143	MC100E143	28		FN
D–Type Flip–Flop With Set & Reset	ECL	MC10EL31	MC100EL31	8		D
Differential Clock D–Type Flip–Flop	ECL	MC10EL51	MC100EL51	8		D
	ECL	MC100LVEL51	–	8		D
Differential Data & Clock D–Type Flip–Flop	ECL	MC10EL52	MC100EL52	8		D
Dual D–Type Flip–Flop	CMOS	MC74AC74	–	14	N	D
	CMOS	MC74ACT74	–	14	N	D
	CMOS	MC14013B	–	14	P,L	D
Dual D–Type Flip–Flop With Set and Reset	CMOS	MC74HC74A	–	14	N,J	D,DT
	CMOS	MC74VHC74	–	14		D, DT,M
	CMOS	MC74VHCT74A	–	14		D, DT,M
Dual D–Type Flip–Flop With Set and Reset With LSTTL Compatible Inputs	CMOS	MC74HCT74A	–	14	N	D
Dual D–Type Flip–Flop With Set and Clear, With 5V–Tolerant Inputs	CMOS	MC74LVX74	–	14		D,DT, M
Dual D–Type Positive Edge–Triggered Flip–Flop	TTL	SN74LS74A	–	16	N,J	D

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
FLIP–FLOPS						
Dual Differential Data and Clock D–Type Flip–Flop With Set and Reset	ECL	MC100LVEL29	MC100EL29	20		DW
Dual J–K Positive Edge–Triggered Flip–Flop	TTL	SN74LS109A	–	16	N,J	D
Dual J–K Flip–Flop With Set and Clear	TTL	SN74LS76A	–	16	N,J	D
Dual J–K Flip–Flop	CMOS	MC14027B	–	16	P,L	D
Dual J–K Master–Slave Flip–Flop	ECL	MC10135	–	16	P,L	FN
	ECL	MC10H135	–	16	P,L	FN
Dual J–K Positive Edge–Triggered Flip–Flop With Set & Clear	CMOS	MC74AC109	–	16	N	D
	CMOS	MC74ACT109	–	16	N	D
Dual D–Type Master–Slave Flip–Flop	ECL	MC10131	–	16	P,L	FN
	ECL	MC10H131	–	16	P,L	FN
Hex D–Type Flip–Flop	TTL	SN74LS174	–	16	N,J	D
	CMOS	MC14174B	–	16	P,L	D
Hex D–Type Flip–Flop With Master Reset	CMOS	MC74AC174	–	16	N	D
	CMOS	MC74ACT174	–	16	N	D
Hex D–Type Flip–Flop With Common Clock & Reset	CMOS	MC74HC174A	–	16	N,J	D
Hex D–Type Master–Slave Flip–Flop	ECL	MC10H176	–	16	P,L	FN
	ECL	MC10176	–	16	P,L	FN
Hex D–Type Master–Slave Flip–Flop With Reset	ECL	MC10H186	–	16	P,L	FN
	ECL	MC10186	–	16	P,L	FN
High Speed Dual D–Type Master–Slave Flip–Flop	ECL	MC10231	–	16	P,L	FN
J–K Flip–Flop	ECL	MC10EL35	MC100EL35	8		D
Low–Voltage CMOS Octal D–Type Flip–Flop With Set and Reset, 3–State, Non–Inverting With 5V Tolerant Inputs	CMOS	MC74LCX74	–	14		D,DT
Low–Voltage CMOS 16–Bit D–Type Flip–Flop, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX16374	–	20		DW,M, DT
Low–Voltage CMOS Dual D–Type Flip–Flop With 5V–Tolerant Inputs	CMOS	MC74LCX74	–	14		D,M, SD,DT
Low–Voltage CMOS Octal D–Type Flip–Flop, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX374	–	20		DW,M, DT
Low–Voltage CMOS Octal D–Type Flip–Flop Flow Through Pinout, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX574	–	20		DW,M, DT
Low Voltage D–Type Flip–Flop With Set & Reset	ECL	MC100LVEL31	–	8		D
Octal 3–State Non–Inverting D–Type Flip–Flop With LSTTL Compatible Inputs	CMOS	MC74HCT374A	–	20	N,J	DW, SD,DT
Octal D–Type Flip–Flop	CMOS	MC74AC273	–	20	N	DW
	CMOS	MC74ACT273	–	20	N	DW
Octal D–Type Flip–Flop With Clear	TTL	SN74LS273	–	20	N,J	DW
Octal D–Type Flip–Flop With Clock Enable	CMOS	MC74AC377	–	20	N	DW
	CMOS	MC74ACT377	–	20	N	DW
Octal D–Type Flip–Flop With Common Clock & Reset	CMOS	MC74HC273A	–	20	N,J	DW, DT
Octal D–Type Flip–Flop With Common Clock and Reset With LSTTL Compatible Inputs	CMOS	MC74HCT273A	–	20	N	DW
Octal D–Type Flip–Flop With Enable/ Non–Inverting	TTL	SN74LS377	–	20	N,J	DW
Octal D–Type Flip–Flop With 3–State Outputs	CMOS	MC74AC374	–	20	N	DW
	CMOS	MC74ACT374	–	20	N	DW
	TTL	SN74LS374	–	20	N,J	DW

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
FLIP–FLOPS						
Octal D–Type Flip–Flop With 3–State Outputs	CMOS	MC74VHCT374A	–	20		DW, DT,M
	CMOS	MC74VHCT574A	–	20		DW, DT,M
	CMOS	MC74LVX574	–	20		DW, DT
Octal D–Type Latch With 3–State Outputs	CMOS	MC74ACT564	–	20	N	DW
	CMOS	MC74AC574	–	20	N	DW
	CMOS	MC74ACT574	–	20	N	DW
Octal D–Type Flip–Flop, 3–State Outputs, With 5V–Tolerant Inputs	CMOS	MC74LVX374	–	20		DW, DT,M
Octal With 3–State Outputs Non–Inverting D–Type Flip–Flop	CMOS	MC74HC374A	–	20	N,J	DW, SD,DT
	CMOS	MC74VHC374	–	20		DW, DT,M
	CMOS	MC74HC574A	–	20	N,J	DW
	CMOS	MC74VHC574	–	20		DW, DT,M
Octal With 3–State Outputs Non–Inverting D–Type Flip–Flop With LSTTL Compatible Inputs	CMOS	MC74HCT574A	–	20	N,J	DW
Quad D–Type Flip–Flop	CMOS	MC74AC175	–	16	N	D
	CMOS	MC74ACT175	–	16	N	D
Quad D–Type Flip–Flop	TTL	SN74LS175	–	16	N,J	D
	CMOS	MC14175B	–	16	P,L	D
Quad D–Type Flip–Flop With Common Clock & Reset	CMOS	MC74HC175	–	16	N,J	D
Quad D–Type Register With 3–State Outputs	CMOS	MC14076B	–	16	P,L	D
Triple D–Type Flip–Flop With Set and Reset	ECL	MC100LVEL30	MC100EL30	20		DW
GATES, AND/NAND						
Dual 4–Input AND Gate	CMOS	MC14082B	–	14	P,L	D
Dual 4–Input NAND Gate	CMOS	MC74AC20	–	14	N	D
	CMOS	MC74ACT20	–	14	N	D
	CMOS	MC14012B	–	14	P,L	D
Hex AND Gate	ECL	MC10197	–	16	P,L	FN
Low–Voltage CMOS Quad 2–Input AND Gate, 5V–Tolerant Inputs	CMOS	MC74LCX08	–	14		D,DT
Low–Voltage CMOS Quad 2–Input NAND Gate, 5V–Tolerant Inputs	CMOS	MC74LCX00	–	14		D,DT
Quad 2–Input AND Gate	CMOS	MC74AC08	–	14	N	D
	CMOS	MC74ACT08	–	14	N	D
	CMOS	MC74HC08A	–	14	N,J	D,DT
	CMOS	MC74VHC08	–	14		D, DT,M
	TTL	SN74LS08	–	14	N,J	D
	ECL	MC10H104	–	16	P,L	FN
	ECL	MC10104	–	16	P,L	FN
	CMOS	MC14081B	–	14	P,L	D
Quad 2–Input AND Gate With 5V–Tolerant Inputs	CMOS	MC74LVX08	–	14		D,DT, M
Quad 2–Input NAND Buffer Open–Collector	TTL	SN74LS38	–	14	N,J	D
Quad 2–Input NAND Gate	CMOS	MC74AC00	–	14	N	D

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM

GATES, AND/NAND

Description	Tech.	Device(s)		Pins	DIP	SM
Quad 2–Input NAND Gate	CMOS	MC74ACT00	–	14	N	D
	CMOS	MC74HC00A	–	14	N,J	D,DT
	CMOS	MC74VHC00	–	14		D, DT,M
	CMOS	MC74VHCT00A	–	14		D, DT,M
	TTL	SN74LS00	–	14	N,J	D
	CMOS	MC14011B	–	14	P,L	D
	CMOS	MC74VHC00	–	14		D, DT, M
Quad 2–Input NAND Gate (Unbuffered)	CMOS	MC14011UB	–	14	P,L	D
Quad 2–Input NAND Gate With 5V–Tolerant Inputs	CMOS	MC74LVX00	–	14		D,DT, M
Quad 2–Input NAND Gate With Open–Drain Outputs	CMOS	MC74HC03A	–	14	N	D,DT
Triple 3–Input AND Gate	CMOS	MC74AC11	–	14	N	D
	CMOS	MC74ACT11	–	14	N	D
	CMOS	MC14073B	–	14	P,L	D
Triple 3–Input NAND Gate	CMOS	MC74AC10	–	14	N	D
	CMOS	MC74ACT10	–	14	N	D
	CMOS	MC14023B	–	14	P,L	D

GATES, COMPLEX

Description	Tech.	Device(s)		Pins	DIP	SM
2–Input AND/NAND Gate	ECL	MC10EL04	MC100EL04	8		D
2–Input Differential AND/NAND Gate	ECL	MC10EL05	MC100EL05	8		D
	ECL	MC100LVEL05	–	8		D
2–Input XOR/NOR Gate	ECL	MC10EL07	MC100EL07	8		D
4–Input OR/NOR Gate	ECL	MC10EL01	MC100EL01	8		D
	ECL	MC100LVEL01	–	8		D
4–Wide OR–AND/OR–AND–Invert Gate	ECL	MC10H121	–	16	P,L	FN
4–Wide OR–AND/OR–AND–Invert Gate	ECL	MC10121	–	16	P,L	FN
Dual 2–Wide 2–3–Input OR–AND/OR–AND–Invert Gate	ECL	MC10117	–	16	P,L	FN
	ECL	MC10H117	–	16	P,L	FN
Dual 4–5 Input OR/NOR Gate	ECL	MC10H109	–	16	P,L	FN
	ECL	MC10109	–	16	P,L	FN
	ECL	MC10H209	–	16	P,L	FN
Hex NAND/NOR/Invert Gate (Unbuffered)	CMOS	MC14572UB	–	16	P	D
Quad 4–Input OR/NOR Gate	ECL	MC10E101	MC100E101	28		FN
Quad Differential AND/NAND Gate	ECL	MC10E404	MC100E404	28		FN
Quad OR/NOR Gate	ECL	MC10H101	–	16	P,L	FN
	ECL	MC10101	–	16	P,L	FN
Quint 2–Input AND/NAND Gate	ECL	MC10E104	MC100E104	28		FN
Quint 2–Input XOR/XNOR Gate	ECL	MC10E107	MC100E107	28		FN
Triple 2–3–2 Input OR/NOR Gate	ECL	MC10H105	–	16	P,L	FN
	ECL	MC10105	–	16	P,L	FN
Triple 2–Input Exclusive OR/Exclusive NOR Gate	ECL	MC10H107	–	16	P,L	FN
	ECL	MC10107	–	16	P,L	FN

GATES, EXCLUSIVE OR/EXCLUSIVE NOR

Description	Tech.	Device(s)		Pins	DIP	SM
Low–Voltage CMOS Quad 2–Input Exclusive OR Gate With 5V–Tolerant Inputs	CMOS	MC74LCX86	–	14		D,M SD,DT

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
GATES, EXCLUSIVE OR/EXCLUSIVE NOR						
Quad Exclusive NOR Gate	CMOS	MC14077B	–	14	P,L	D
Quad 2–Input Exclusive OR Gate	CMOS	MC74AC86	–	14	N	D
	CMOS	MC74ACT86	–	14	N	D
	CMOS	MC74VHC86	–	14		D,DT, M
	CMOS	MC74HC86A	–	14	N,J	D,DT
Quad 2–Input Exclusive OR Gate With 5V–Tolerant Inputs	CMOS	MC74LVX86	–	14		D,DT, M
Quad Exclusive OR Gate	TTL	SN74LS86	–	14	N,J	D
	ECL	MC10H113	–	16	P,L	FN
	ECL	MC10113	–	16	P,L	FN
	CMOS	MC14070B	–	14	P,L	D
GATES, NOR						
Dual 3–Input 3–Output NOR Gate	ECL	MC10H211	–	16	P,L	FN
Dual 5–Input NOR Gate	TTL	SN74LS260	–	14	N,J	D
Low–Voltage CMOS Quad 2–Input NOR Gate, 5V–Tolerant Inputs	CMOS	MC74LCX02	–	14		D,DT
Quad 2–Input NOR Gate	CMOS	MC74AC02	–	14	N	D
	CMOS	MC74ACT02	–	14	N	D
	CMOS	MC74HC02A	–	14	N,J	D,DT
	CMOS	MC74VHC02	–	14		D, DT,M
	ECL	MC10H102	–	16	P,L	FN
	ECL	MC10102	–	16	P,L	FN
	CMOS	MC14001B	–	14	P,L	D
Quad 2–Input NOR Gate (Unbuffered)	CMOS	MC14001UB	–	14	P,L	D
Quad 2–Input NOR Gate With 5V–Tolerant Inputs	CMOS	MC74LVX02	–	14		D,DT, M
Quad 2–Input NOR Gate With strobe	ECL	MC10H100	–	16	P,L	FN
Triple 3–Input NOR Gate	CMOS	MC14025B	–	14	P,L	D
Triple 4–3–3 Input NOR Gate	ECL	MC10H106	–	16	P,L	FN
	ECL	MC10106	–	16	P,L	FN
GATES, OR						
Dual 3–Input 3–Output OR Gate	ECL	MC10H210	–	16	P,L	FN
Low–Voltage CMOS Quad 2–Input OR Gate, 5V–Tolerant Inputs	CMOS	MC74LCX32	–	14		D,DT
Quad 2–Input OR Gate	CMOS	MC74AC32	–	14	N	D
	CMOS	MC74ACT32	–	14	N	D
	CMOS	MC74HC32A	–	14	N,J	D,DT
	CMOS	MC74VHC32	–	14		D, DT,M
	TTL	SN74LS32	–	14	N,J	D
	ECL	MC10H103	–	16	P,L	FN
	ECL	MC10103	–	16	P,L	FN
	CMOS	MC14071B	–	14	P,L	D
Quad 2–Input OR Gate With 5V–Tolerant Inputs	CMOS	MC74LVX32	–	14		D,DT, M

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
INVERTERS						
Hex Inverter	CMOS	MC74VHCT04A	–	14		D,DT, M
Hex Inverter (Unbuffered)	CMOS	MC74VHCU04	–	14		D,DT, M
Hex Inverter With 5V–Tolerant Inputs	CMOS	MC74LVX04	–	14		D,DT, M
Hex Schmitt Inverter With 5V–Tolerant Inputs	CMOS	MC74LVX14	–	14		D,DT, M
INVERTER/BUFFERS, 2–STATE						
9–Bit Buffer	ECL	MC10E122	MC100E122	28		FN
Driver	ECL	MC10EL12	MC100EL12	8		D
	ECL	MC100LVEL12	–	8		D
Dual Complementary Pair Plus Inverter (Unbuffered)	CMOS	MC14007UB	–	14	P	D
Hex Buffer With Enable	ECL	MC10H188	–	16	P,L	FN
	ECL	MC10188	–	16	P,L	FN
Hex Buffer/Non–Inverting	CMOS	MC14050B	–	16	P,L	D
Hex Inverter	CMOS	MC74AC04	–	14	N	D
	CMOS	MC74ACT04	–	14	N	D
	CMOS	MC74HC04A	–	14	N,J	D,SD, DT
	CMOS	MC74VHC04	–	14		D, DT,M
	TTL	SN74LS04	–	14	N,J	D
	TTL	SN74LS05	–	14	N,J	D
Hex Inverter Gate (Unbuffered)	CMOS	MC14069UB	–	14	P,L	D
Hex Inverter With Enable	ECL	MC10H189	–	16	P,L	FN
	ECL	MC10189	–	16	P,L	FN
Hex Inverter With LSTTL Compatible Inputs	CMOS	MC74HCT04A	–	14	N	D,DT
Hex Inverter With open Drain Outputs	CMOS	MC74AC05	–	14	N	D
	CMOS	MC74ACT05	–	14	N	D
Hex Inverter/Buffer	ECL	MC10195	–	16	P,L	FN
	CMOS	MC14049B	–	16	P	D
Hex Inverter/Buffer (Unbuffered)	CMOS	MC14049UB	–	16	P,L	D
Hex Unbuffered Inverter	CMOS	MC74HCU04A	–	14	N	D,DT
Low–Voltage CMOS Hex Inverter, With 5V–Tolerant Inputs	CMOS	MC74LCX04	–	14		D,DT
Quad Driver	ECL	MC10E112	MC100E112	28		FN
LATCHES						
3–Bit 4:1 Mux–Latch, With Common Enable, Asynchronous Master Reset, Differential Output	ECL	MC10E156	MC100E156	28		FN
3–Bit 4:1 Mux–Latch	ECL	MC10E256	MC100E256	28		FN
5–Bit 2:1 Mux–Latch, With Common Enable, Asynchronous Master Reset Differential Output	ECL	MC10E154	MC100E154	28		FN
6–Bit 2:1 Mux–Latch, With Common Enable, Asynchronous Master Reset Single Ended	ECL	MC10E155	MC100E155	28		FN
6–Bit D Latch	ECL	MC10E150	MC100E150	28		FN
8–Bit Addressable Latch	CMOS	MC74AC259	–	16	N	D
	CMOS	MC74ACT259	–	16	N	D
	TTL	SN74LS259	–	16	N,J	D
	CMOS	MC14099B	–	16	P	DW

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
LATCHES						
8–Bit Bus Compatible Addressable Latch	CMOS	MC14598B	–	18	P,L	
9–Bit Latch, With Parity	ECL	MC10E175	MC100E175	28		FN
Dual Latch	ECL	MC10H130	–	16	P,L	FN
Low–Voltage CMOS Octal Transparent Latch, 3–State, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX373	–	20		DW,M, DT
Low–Voltage CMOS 16–Bit Transparent Latch, 3–State, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX16373	–	48		DT
Low–Voltage CMOS Octal Transparent Latch Flow Through Pinout, 3–State, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX573	–	20		DW,M, SD,DT
Octal 3–State Non–Inverting Transparent Latch With LSTTL Compatible Inputs	CMOS	MC74HCT373A	–	20	N,J	DW, SD,DT
Octal D–Type Latch With 3–State Outputs	CMOS	MC74AC573	–	20	N	DW
	CMOS	MC74ACT573	–	20	N	DW
	CMOS	MC74VHCT373A	–	20		DW, DT,M
	CMOS	MC74VHCT573A	–	20		DW, DT,M
Octal D–Type Latch, 3–State Outputs, With 5V–Tolerant Inputs	CMOS	MC74LVX373	–	20		DW, DT,M
	CMOS	MC74LVX573	–	20		DW, DT,M
Octal Transparent Latch With 3–State Outputs	CMOS	MC74AC373	–	20	N	DW
	CMOS	MC74ACT373	–	20	N	DW
	TTL	SN74LS373	–	20	N,J	DW
Octal With 3–State Outputs Non–Inverting Transparent Latch	CMOS	MC74HC373A	–	20	N,J	DW, DT,SD
	CMOS	MC74VHC373	–	20		DW, DT,M
	CMOS	MC74HC573A	–	20	N,J	DW
	CMOS	MC74VHC573	–	20		DW, DT,M
Octal With 3–State Outputs Non–Inverting Transparent Latch With LSTTL Compatible Inputs	CMOS	MC74HCT573A	–	20	N	DW
Quad Latch	ECL	MC10153	–	16	P,L	FN
Quad NAND R–S Latch	CMOS	MC14044B	–	16	P	D
Quad NOR R–S Latch	CMOS	MC14043B	–	16	P,L	D
Quad Transparent Latch	CMOS	MC14042B	–	16	P,L	D
Quint Latch	ECL	MC10H175	–	16	P,L	FN
	ECL	MC10175	–	16	P,L	FN
MISCELLANEOUS						
Data Separator	ECL	MC10E197	–	28		FN
MULTIPLEXERS						
Analog Multiplexer/Demultiplexer High Performance Silicon–Gate CMOS	CMOS	MC74VHC4051	–	16		D, DT
Low–Voltage CMOS Quad 2–Input Multiplexer	CMOS	MC74LCX257	–	16		D,M, SD,DT
Quad 2–Channel Multiplexer With 5V–Tolerant Inputs	CMOS	MC74LVX157	–	16		D,DT, M
MULTIPLEXER/DATA SELECTORS						
1–of–8 Decoder/Demultiplexer	CMOS	MC74AC151	–	16	N	D

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
MULTIPLEXER/DATA SELECTORS						
1–of–8 Decoder/Demultiplexer	CMOS	MC74ACT151	–	16	N	D
16–Channel Analog Multiplexer/Demultiplexer	CMOS	MC14067B	–	24	P	DW
16:1 Multiplexer	ECL	MC10E164	MC100E164	28		FN
2–Bit 8:1 Multiplexer	ECL	MC10E163	MC100E163	28		FN
2:1 Multiplexer	ECL	MC10EL58	MC100EL58	8		D
3–Bit 4:1 Multiplexer, With Split Select Differential Output	ECL	MC10E171	MC100E171	28		FN
4:1 Differential Multiplexer	ECL	MC10EL57	MC100EL57	16		D
5–Bit 2:1 Multiplexer, With Differential Output	ECL	MC10E158	MC100E158	28		FN
8–Channel Analog Multiplexer/Demultiplexer	CMOS	MC74HC4051A	–	16	N,J	D, DW ,DT
	CMOS	MC14051B	–	16	P,L	D
8–Channel Data Selector	CMOS	MC14512B	–	16	P,L	D
8–Input Multiplexer	TTL	SN74LS151	–	16	N,J	D
8–Input Multiplexer With 3–State Outputs	TTL	SN74LS251	–	16	N,J	D
8–Line Multiplexer	ECL	MC10H164	–	16	P,L	FN
	ECL	MC10164	–	16	P,L	FN
Analog Multiplexer/Demultiplexer With Injection Current Effect Control, Automotive Customized	CMOS	MC74HC4851A	MC74HC4852A	16	N	D,DW, DT
Dual 4–Channel Analog Data Selector	CMOS	MC14529B	–	16	P,L	D
Dual 4–Channel Analog Multiplexer/Demultiplexer	CMOS	MC74HC4052A	–	16	N	D, DW
	CMOS	MC14052B	–	16	P,L	D
Dual 4–Input Multiplexer	CMOS	MC74AC153	–	16	N	D
	CMOS	MC74ACT153	–	16	N	D
	TTL	SN74LS153	–	16	N,J	D
Dual 4–Input Multiplexer With 3–State Outputs	CMOS	MC74AC253	–	16	N	DW
	CMOS	MC74ACT253	–	16	N	DW
	TTL	SN74LS253	–	16	N,J	D
Dual 4–to–1 Multiplexer	ECL	MC10H174	–	16	P,L	FN
	ECL	MC10174	–	16	P,L	FN
Dual Differential 2:1 Multiplexer (3.3V)	ECL	MC100LVEL56	MC100EL56	20		DW
Low Voltage 16:1 Multiplexer	ECL	MC100LVE164	–	32		FA
Low–Voltage CMOS Quad 2–Input, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX157	–	16		M,D, SD,DT
Quad 2–Input Multiplexer With Latch	ECL	MC10H173	–	16	P,L	FN
Quad 2–Channel Analog Multiplexer/Demultiplexer	CMOS	MC14551B	–	16	P	D
Quad 2–Input Data Selectors/Multiplexers	CMOS	MC74HC157A	–	16	N,J	D,DT
Quad 2–Channel Multiplexer	CMOS	MC74VHC157	–	16		D, DT,M
Quad 2–Input Multiplexer	TTL	SN74LS157	–	16	N,J	D
Quad 2–Input Multiplexer (Inverting)	ECL	MC10159	–	16	P,L	FN
Quad 2–Input Multiplexer (Non–Inverting)	ECL	MC10158	–	16	P,L	FN
Quad 2–Input Multiplexer Non–Inverting With 3–State Outputs	CMOS	MC74ACT257	–	16	N	D
	CMOS	MC74AC257	–	16	N	D
Quad 2–Input Multiplexer With 3–State Outputs	TTL	SN74LS257B	–	16	N,J	D
Quad 2–Input Multiplexer With Storage	TTL	SN74LS298	–	16	N,J	D
Quad 2–Input Multiplexer, Inverting Output	ECL	MC10H159	–	16	P,L	FN

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
MULTIPLEXER/DATA SELECTORS						
Quad 2–Input Multiplexer, Inverting, With 3–State Outputs	TTL	SN74LS258B	–	16	N,J	D
Quad 2–Input Multiplexer, Non–Inverting	CMOS	MC74AC157	–	16	N	D
	CMOS	MC74ACT157	–	16	N	D
Quad 2–Input Multiplexer, Non–Inverting Output	ECL	MC10H158	–	16	P,L	FN
Quad 2–Input Multiplexer/Latch	ECL	MC10173	–	16	P,L	FN
Quad 2:1 Mux, Individual–Select	ECL	MC10E157	MC100E157	28		FN
Quad Analog Switch/Multiplexer	CMOS	MC14016B	–	14	P,L	D
	CMOS	MC14066B	–	14	P,L	D
Quad Analog Switch/Multiplexer/Demultiplexer	CMOS	MC74HC4066A	–	14	N,J	D,DT
Quad Analog Switch/Multiplexer/Demultiplexer With Separate Analog/Digital Power Supplies	CMOS	MC74HC4316A	–	16	N	D
Triple 2–Channel Analog Multiplexer/Demultiplexer	CMOS	MC74HC4053A	–	16	N,J	D, DW
	CMOS	MC14053B	–	16	P,L	D
Triple 2:1 Multiplexer	ECL	MC100EL59	–	20		DW
Triple 2:1 Multiplexer (3.3V)	ECL	MC100LVEL59	–	20		DW
Triple Differential 2:1 Multiplexer	ECL	MC100E457	–	28		FN
	ECL	MC10E457	–	28		FN
MULTIVIBRATORS						
Dual Monostable Multivibrator	CMOS	MC14528B	–	16	P,L	D
Dual Monstable Multivibrators With Schmitt Trigger Inputs	TTL	SN74LS221	–	16	N,J	D
Dual Precision Monostable Multivibrator Retriggerable, Resettable)	CMOS	MC74HC4538A	–	16	N,J	D
Dual Precision Monostable Multivibrator	CMOS	MC14538B	–	16	P,L	D, DW
Monostable Multivibrator	ECL	MC10198	–	16	P,L	FN
Retriggerable Monostable Multivibrators	TTL	SN74LS122	–	14	N,J	D
	TTL	SN74LS123	–	14	N,J	D
OSCILLATOR/TIMERS						
24–Stage Frequency Divider	CMOS	MC14521B	–	16	P,L	D
Programmable Oscillator Timer	CMOS	MC14541B	–	14	P,L	D
Programmable Timer	CMOS	MC14536B	–	16	P,L	DW
PARITY CHECKERS						
12–Bit Parity Generator/Checker	ECL	MC10H160	–	16	P,L	FN
12–Bit Parity Generator/Checker, Register–Shiftable, Diff Output	ECL	MC10E160	MC100E160	28		FN
9–Bit Odd/Even Parity Generator/Checker	TTL	SN74LS280	–	14	N,J	D
Error Detection and Correction Circuit	ECL	MC10E193	MC100E193	28		FN
PHASE–LOCKED LOOP						
Phase–Locked Loop	CMOS	MC14046B	–	16	P,L	DW
Phase–Locked–Loop With VCO	CMOS	MC74HC4046A	–	16	N	D
PROGRAMMABLE DELAY CHIPS						
Programmable Delay Chip (Dig 80ps Anal. 1.6 Ps/mv)	ECL	MC10E196	MC100E196	28		FN
Programmable Delay Chip (Digitally Selectable 20ps Res)	ECL	MC10E195	MC100E195	28		FN
RECEIVERS						
155Mb/s / 622Mb/s Receiver (Demultiplexer) With Clock Recovery	ECL	MC10SX1401	–	52		FJ
Differential Receiver	ECL	MC10EL16	MC100EL16	8		D

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
RECEIVERS						
Differential Receiver	ECL	MC100LVEL16	–	8		D
High Speed Triple Line Receiver	ECL	MC10216	–	16	P,L	FN
Low–Voltage Quad Differential Line Receiver	ECL	MC100LVEL17	MC100EL17	20		DW
Quad Line Receiver	ECL	MC10H115	–	16	P,L	FN
	ECL	MC10115	–	16	P,L	FN
Quint Differential Line Receiver	ECL	MC10E116	MC100E116	28		FN
	ECL	MC10E416	MC100E416	28		FN
Triple Line Receiver	ECL	MC10H116	–	16	P,L	D,FN
	ECL	MC10114	–	16	P,L	FN
	ECL	MC10116	–	16	P,L	FN
REGISTERS						
8–Bit Serial or Parallel–Input/Serial–Output Shift Register	CMOS	MC74HC165A	–	16	N	D,DT
8–Bit Scannable Register	ECL	MC10E241	MC100E241	28		FN
REGISTER FILES						
16 X 4–Bit Register File (RAM)	ECL	MC10H145	–	16	P,L	FN
4 X 4 Register File With 3–State Outputs	TTL	SN74LS670	–	16	N,J	D
SCHMITT TRIGGERS						
Hex Inverter Schmitt Trigger	CMOS	MC74AC14	–	14	N	D
	CMOS	MC74ACT14	–	14	N	D
	TTL	SN74LS14	–	14	N,J	D
Hex Schmitt Trigger	CMOS	MC14106B	–	14	P,L	D
	CMOS	MC14584B	–	14	P,L	D
Hex Schmitt Trigger Inverter	CMOS	MC74HC14A	–	14	N,J	D,DT
	CMOS	MC74VHC14	–	14		D, DT,M
	CMOS	MC74HCT14A	–	14	N,J	D
Quad 2–Input NAND Gate With Schmitt Trigger Inputs	CMOS	MC74HC132A	–	14	N,J	D
Quad 2–Input NAND Schmitt Trigger	CMOS	MC74AC132	–	14	N	D
	CMOS	MC74ACT132	–	14	N	D
	CMOS	MC14093B	–	14	P,L	D
	CMOS	MC74VHC132	–	14		D,DT, M
Quad 2–Input Schmitt Trigger NAND Gate	TTL	SN74LS132	–	14	N,J	D
SHIFT REGISTERS						
1–to–64–Bit Variable Length Shift Register	CMOS	MC14557B	–	16	P,L	DW
128–Bit Static Shift Register	CMOS	MC14562B	–	14	P,L	
3–Bit Scannable Registered Address Driver, ECL	ECL	MC10E212	MC100E212	28		FN
4–Bit Bidirectional Universal Shift Register	TTL	SN74LS194A	–	16	N,J	D
4–Bit Universal Shift Register	ECL	MC10H141	–	16	P,L	FN
	ECL	MC10141	–	16	P,L	FN
8–Bit Parallel–to–Serial Shift Register	TTL	SN74LS165	–	16	N,J	D
8–Bit Serial or Parallel–Input/Serial–Output Shift Register With 3–State Outputs	CMOS	MC74HC589A	–	16	N,J	D,SD DT
8–Bit Serial–In/Parallel–Out Shift Register	TTL	SN74LS164	–	14	N,J	D
8–Bit Serial–Input/Parallel–Output Shift Register	CMOS	MC74HC164A	–	14	N,J	D,DT
8–Bit Serial–Input/Serial or Parallel–Output Shift Register With Latched 3–State Outputs	CMOS	MC74HC595A	–	16	N,J	D,DT

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
SHIFT REGISTERS						
8–Bit Serial–Input/Serial or Parallel–Output Shift Register With Latched 3–State Outputs	CMOS	MC74VHC595	–	16		D, DT,M
8–Bit Shift Register	ECL	MC10E141	MC100E141	28		FN
	TTL	SN74LS166	–	16	N,J	D
8–Bit Shift/Storage Register With 3–State Outputs	TTL	SN74LS299	–	20	N,J	DW
8–Bit Static Shift Register	CMOS	MC14014B	–	16	P,L	D
	CMOS	MC14021B	–	16	P,L	D
8–Input Universal Shift/Storage Register With Common Parallel I/O Pins: With 3–State Outputs	CMOS	MC74AC299	–	20	N	DW
	CMOS	MC74ACT299	–	20	N	DW
8–Input Universal Shift/Storage Register With Syn Reset/Common Parallel I/O Pins: With 3–State Outputs	CMOS	MC74ACT323	–	20	N	DW
8–Stage Shift/Store Register With 3–State Outputs	CMOS	MC14094B	–	16	P,L	D
9–Bit Shift Register, 700MHz, With Asynchronous Master Reset	ECL	MC10E142	MC100E142	28		FN
Dual 5–Bit Shift Register	CMOS	MC14015B	–	16	P,L	D
Dual 64–Bit Static Shift Register	CMOS	MC14517B	–	16	P	DW
Successive Approximation Register	CMOS	MC14549B	–	16	P,L	DW
	CMOS	MC14559B	–	16	P,L	DW
Universal 4–Bit Shift Register	TTL	SN74LS195A	–	16	N,J	D
TRANSCEIVERS						
3–Bit Scannable Registered Bus Transceiver	ECL	MC10E337	MC100E337	28		FN
3–Bit Registered Bus Transceiver	ECL	MC10E336	MC100E336	28		FN
4–Bit Differential ECL Bus/TTL Bus Transceiver	ECL	MC10H680	MC100H680	28		FN
155Mb/s / 622Mb/s Transmitter (Multiplexer) With Clock Generation	ECL	MC10SX1405	–	52		FJ
Configurable Dual Supply Octal Transceiver with 3–State Outputs for 3V Systems	CMOS	MC74LVXC3245	–	24		DW, DT
Dual Supply Octal Translating Transceiver	CMOS	MC74LVX4245	–	24		DW, DT
Hex ECL/TTL Transceiver With Latches	ECL	MC10H681	MC100H681	28		FN
Low–Voltage CMOS 16–Bit Latching Transceiver, 3–State, Non–Inverting With 5V Tolerant Inputs and Outputs	CMOS	MC74LCX16543A	–	56		DT
Low–Voltage CMOS 16–Bit Transceiver, 3–State, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX16245	–	48		DT
Low–Voltage CMOS Octal Registered Transceiver With Dual Output and Clock Enables, With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX2952	–	24		DW, SD,DT
Low–Voltage CMOS Octal Transceiver, 3–State, Non–Inverting With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX245	–	20		M,DW, DT
Low–Voltage CMOS Octal Transceiver/Registered Transceiver With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX646	–	24		DW, SD,DT
Low–Voltage CMOS Octal Transceiver/Registered Transceiver With Dual Enable, With 5V–Tolerant Inputs and Outputs	CMOS	MC74LCX652	–	24		DW, DT
Octal Bus Transceiver	CMOS	MC74VHCT245A	–	20		DW, DT,M
Octal Bus Transceiver With 5V–Tolerant Inputs	CMOS	MC74LVX245	–	20		DW, DT,M
Octal Bus Transceiver/Inverting With Open Collector	TTL	SN74LS642	–	20	N,J	DW
Octal Bus Transceiver/Non–Inverting With Open Collector	TTL	SN74LS641	–	20	N,J	DW

Selection by Function

Description	Tech.	Device(s)		Pins	DIP	SM
TRANSLATORS						
9–Bit ECL/TTL Translator	ECL	MC10H601	MC100H601	28		FN
9–Bit Latch ECL/TTL Translator	ECL	MC10H603	MC100H603	28		FN
9–Bit Latch TTL/ECL Translator	ECL	MC10H602	MC100H602	28		FN
9–Bit TTL/ECL Translator	ECL	MC10H600	MC100H600	28		FN
1:2 Fanout Differential PECL to TTL Translator	ECL	MC10ELT26	MC100ELT26	8		D
Differential ECL/TTL Translator	ECL	MC10ELT25	MC100ELT25	8		D
Differential PECL/TTL Translator	ECL	MC10ELT21	MC100ELT21	8		D
Dual Differential PECL/TTL Translator	ECL	MC100ELT23	–	8		D
Dual LVTTL/LVCMOS to Differential PECL Translator	ECL	MC100LVELT22	–	8		D
Dual TTL/Differential PECL Translator	ECL	MC10ELT22	MC100ELT22	8		D
ECL/TTL Translator (Single P.S. @+ 5.0V)	ECL	MC10H350	–	16	P,L	FN
Hex TTL OR CMOS/CMOS Hex Level Shifter	CMOS	MC14504B	–	16	P,L	D
Quad CMOS/ECL Translator (Single P.S. @+ 5.0V)	ECL	MC10H352	–	20	P,L	FN
Quad MECL/TTL Translator	ECL	MC10H125	–	16	P,L	FN
	ECL	MC10125	–	16	P,L	FN
Quad TTL/ECL Translator (ECL Strobe)	ECL	MC10H424	–	16	P,L	FN
Quad TTL/MECL Translator	ECL	MC10124	–	16	P,L	FN
Quad TTL/MECL Translator, With TTL Strobe Input	ECL	MC10H124	–	16	P,L	FN
Quad TTL/NMOS–to–PECL Translator (Single P.S. @+ 5.0V)	ECL	MC10H351	–	20	P,L	FN
Registered Hex ECL/TTL Translator	ECL	MC10H605	MC100H605	28		FN
Registered Hex PECL/TTL Translator	ECL	MC10H607	MC100H607	28		FN
Registered Hex TTL/ECL Translator	ECL	MC10H604	MC100H604	28		FN
Registered Hex TTL/PECL Translator	ECL	MC10H606	MC100H606	28		FN
Triple ECL to PECL Translator	ECL	MC100LVEL90	MC100EL90	20		DW
Triple PECL to LVPECL Translator	ECL	MC100LVEL92	–	20		DW
Triple PECL to ECL Translator	ECL	MC100LVEL91	MC100EL91	20		DW
TTL/Differential ECL Translator	ECL	MC10ELT24	MC100ELT24	8		D
TTL/Differential PECL Translator	ECL	MC10ELT20	MC100ELT20	8		D
TTL to Differential PECL/Differential PECL to TTL Translator	ECL	MC10ELT28	MC100ELT28	8		D
VCO						
Phase–Locked–Loop With VCO	CMOS	MC74HC4046A	–	16	N	D

Device Index

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Ordering Information
Device Nomenclatures

LS – Low Power Schottky

SN VV WW XXXX Y

Standard Prefix (SN)

Temperature Range (VV)
- 74 Series (0 to +70°C)
- 54 Series (–55 to +125°C)

Family (WW)
- LS = Low Power Schottky

Function Type (XXXX)

Package Type (Y)
- N for Plastic (74 Series Only)
- J for Ceramic
- D for 150 mil Plastic SOIC (74 Series Only)
- DW for 300 mil Plastic SOIC (74 Series Only)

MECL 10K, MECL 10H/100H

MC WWW XXX YY

Circuit Identifier (MC)

Temperature Range (WWW)
- 10 = 10K (–30 to +85°C)
- 10H = 10H (0 to +75°C)
- 100H = 100K Compatible (0 to +85°C)

Function Type (XXX)

Package Type (YY)
- P for Plastic
- L for Ceramic
- FN for PLCC

ECLinPS, ECLinPS Lite, ECLinPS Plus

MC WWW XXX YYY ZZ

Circuit Identifier (MC)
- MC = Fully Qualified Circuit
- XC = Non Reliability Qualified

Compatibility Identifier (WWW)
- 10 = 10H Compatible (0 to +85°C)
- 100 = 100K Compatible (0 to +85°C)

ECLinPS Family Identifier (XXX)
- E = ECLinPS
- EL = ECLinPS Lite
- ELT = ECLinPS Lite Translator
- LVE = Low Voltage ECLinPS
- LVEL = Low Voltage ECLinPS Lite
- LVELT = Low Voltage ECLinPS Lite Translator

Function Type (YYY)
- YYY = 3–Digits for ECLinPS
- YY= 2–Digits for ECLinPS Lite

Package Type (ZZ)
- FN = PLCC
- D = Plastic SOIC
- L = Ceramic DIP
- P = Plastic DIP

Logic Devices

FACT

MC WWWWW XXX YY

- **MC** – **Circuit Identifier**
- **WWWWW** – **Temperature Range Family**
  - 74AC = FACT (–40 to +85°C)
  - 74ACT = TTL Compatible (–40 to +85°C)
- **XXX** – **Function Type**
- **YY** – **Package Type**
  - N for Plastic
  - D for Narrow SOIC
  - DW for Wide SOIC
  - SD for Plastic SSOP
  - DT for Plastic TSSOP

Metal Gate 14000 Series CMOS

MC 14XXX YY ZZ

- **MC** – **Circuit Identifier**
- **14XXX** – **Function Type**
- **YY** – **Identifier (per JEDEC Standard)**
  - B (or Blank)= Buffered Outputs
  - UB = Unbuffered Outputs
- **ZZ** – **Package and Temperature Range**
  - CL for Ceramic –55 to +125°C
  - CP for Plastic –55 to +125°C
  - D/DW for Small Outline Package (Plastic) –55 to +125°C
  - DT for Plastic TSSOP

High–Speed CMOS

MC VV WWW XXXX Y

- **MC** – **Circuit Identifier**
- **VV** – **Temperature Range**
  - 74 Series (–55 to +125°C)
  - 54 Series (–55 to +125°C)
- **WWW** – **High–Speed CMOS Specification Identifier**
  - HC = Buffered High–Speed CMOS
  - HCU = Unbuffered High–Speed CMOS*
  - HCT = High–Speed CMOS TTL Compatible
- **XXXX** – **Function Type**
  - XX(X) Same Function and Pin Configuration as LSTTL
  - 4XXX Same Function and Pin Configuration as CMOS 14000
  - 7XX(X) Variation of LSTTL or CMOS 14000 Device
- **Y** – **Package Type**
  - N for Plastic (74 Series Only)
  - J for Ceramic (54 Series Only)
  - D for 150 mil Plastic SOIC (74 Series Only)
  - DW for 300 mil Plastic SOIC (74 Series Only)
  - SD for Plastic SSOP
  - DT for Plastic TSSOP

***Not Available On All Devices**

VHC Products – Very High–Speed CMOS

MC 74 VHCX YYY A ZZ

- **MC** – **Circuit Identifier**
- **74** – **Temperature Range**
  - 74 = –40 to +85°C
- **VHCX** – **Family Identifier**
  - VHC = Very High Speed CMOS
  - VHCT = Very High Speed CMOS, TTL Compatible Inputs
  - VHCU = Very High Speed CMOS, Unbuffered
- **YYY** – **Function Type**
- **A** – **Output Type**
  - Indicates Full CMOS Output Swing (Shown on VHCT Only; all VHC parts have full CMOS output swings)
- **ZZ** – **Package Type**
  - D = Plastic Narrow JEDEC SOIC
  - DW = Plastic Wide JEDEC SOIC
  - M = Plastic EIAJ SOIC
  - DT = Plastic TSSOP

LCX Products – Low Voltage CMOS

MC 74 LCX YYYYY ZZ

Circuit Identifier (MC)

Temperature Range (74)
- 74 = –40 to +85°C

Family Identifier (LCX)
- LCX = 5V–Tolerant Low–Voltage CMOS

Function Type (YYYYY)

Package Type (ZZ)
- D for Plastic Narrow JEDEC SOIC
- DW for Plastic Wide JEDEC SOIC
- M for Plastic EIAJ SOIC
- SD for Plastic SSOP
- DT for Plastic TSSOP

LVX Products – Low Voltage CMOS

MC 74 LVX C YYY ZZ

Circuit Identifier (MC)

Temperature Range (74)
- 74 = –40 to +85°C

Family Identifier (LVX)

Configurable (C)
- Blank = Non–Configurable
- C = Configurable

Function Type (YYY)

Package Type (ZZ)
- D = Plastic Narrow JEDEC SOIC
- DW = Plastic Wide JEDEC SOIC
- M = Plastic EIAJ SOIC
- DT = Plastic TSSOP

VCX Products – Very Low–Voltage CMOS

MC 74 VCX YYYYY ZZ

Circuit Identifier (MC)

Temperature Range (74)
- 74 = –40 to +85°C

Family Identifier (VCX)

Function Type (YYYYY)

Package Type (ZZ)
- D for Plastic Narrow JEDEC SOIC
- DW for Plastic Wide JEDEC SOIC
- M for Plastic EIAJ SOIC
- SD for Plastic SSOP
- DT for Plastic TSSOP

Other Logic Circuits

MC/MCCS WWWWWW X YY ZZ

Circuit Identifier (MC/MCCS)
- MC = Standard Circuit Identifier
- MCCS = Circuit Chip–Set Identifier

Function Type (WWWWWW)

Option Suffix Indicator (X)

Option Type (YY)

Package Type (ZZ)
- N for Plastic
- D for Narrow SOIC
- FN for PLCC
- FJ for CLCC

Packaging Information

Surface Mount

Why Surface Mount?

Surface Mount Technology is utilized to offer answers to many problems that have been created in the use of insertion technology.

Limitations have been reached with insertion packages and PC board technology. Surface Mount Technology offers the opportunity to continue to advance the state– of–the–art designs that cannot be accomplished with Insertion Technology.

Surface Mount Packages allow more optimum device performance with the smaller Surface Mount configuration. Internal lead lengths, parasitic capacitance and inductance that placed limitations on chip performance have been reduced.

The lower profile of Surface Mount Packages allows more boards to be utilized in a given amount of space. They are stacked closer together and utilize less total volume than insertion populated PC boards.

Printed circuit costs are lowered with the reduction of the number of board layers required. The elimination or reduction of the number of plated through holes in the board, contributes significantly to lower PC board prices.

Automatic placement equipment is available that can place Surface Mount components at the rate of a few thousand per hour to hundreds of thousands of components per hour.

Surface Mount Technology is cost effective, allowing the manufacturer the opportunity to produce smaller units and/or offer increased functions with the same size product.

Surface Mount assembly does not require the preparation of components that are common on insertion technology lines. Surface Mount components are sent directly to the assembly line, eliminating an intermediate step.

Pin Conversion Tables

Dual–in–Line Package to PLCC Pin Conversion Data

The following table gives the equivalent I/O pinouts of Dual–In–Line Package (DIP) configuration and Plastic Leaded Chip Carrier (PLCC) packages.*

Conversion Tables

8 PIN DIP	1	2	3	4	5	6	7	8
20 PIN PLCC	2	5	7	10	12	15	17	20

14 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14
20 PIN PLCC	2	3	4	6	8	9	10	12	13	14	16	18	19	20

16 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20 PIN PLCC	2	3	4	5	7	8	9	10	12	13	14	15	17	18	19	20

20 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20 PIN PLCC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

24 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
28 PIN PLCC	2	3	4	5	6	7	9	10	11	12	13	14	16	17	18	19	20	21	23	24	25	26	27	28

* The MC1648 has a Non–Standard Conversion Table. For more information, refer to the ON Semiconductor MECL Data Book, DL122/D.

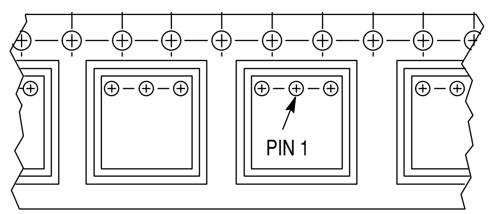
Tape and Reel

Logic Integrated Circuits

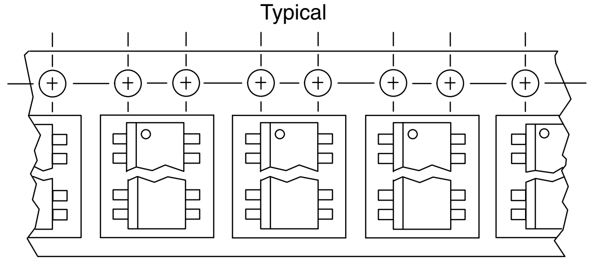
ON Semiconductor's tape and reel packaging fully conforms to the latest EIA RS–481A specification. The antistatic embossed tape provides a secure cavity sealed with a peel–back cover tape.

Mechanical Polarization

PLCC Devices



SOIC Devices



General Information

— Reel Size 13 inch (330 mm) Suffix: R2
— Tape Width 12 mm to 24 mm (see table)
— Units/Reel 500 to 5000 (see table)

Ordering Information

To order devices which are to be delivered in Tape and Reel, add the suffix R2 to the device number being ordered.

Tape and Reel Data

Device Type	Tape Width (mm)	Device/Reel	Reel Size (inch)	Min Lot Size Per Part No. Tape and Reel
PLCC–20	16	1,000	13	3,000
PLCC–28	24	500	13	500
SO–8	12	2,500	13	5,000
SO–14	16	2,500	13	5,000
SO–16	16	2,500	13	5,000
SO–16 Wide	16	1,000	13	5,000
SO–20 Wide	24	1,000	13	5,000

Small Signal Transistors, FETs and Diodes

In Brief . . .

This section highlights semiconductors that are the most popular and have a history of high usage for most applications.

It covers a wide range of Small Signal plastic semiconductors.

A large selection of encapsulated plastic transistors, FETs and diodes are available for surface mount and insertion assembly technology. Plastic packages include TO–92 (TO–226AA), 1 Watt TO–92 (TO–226AE), SOT–23, SC–59, SC–70/SOT–323 and SOT–223.

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Bipolar Transistors
Plastic–Encapsulated Transistors

Table 1. Plastic–Encapsulated General–Purpose Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C		I_C mA Max	h_{FE} @ I_C			NF dB Max
			MHz Min	mA		Min	Max	mA	
Case 29–11 — TO–226AA (TO–92)									
MPS8099	—	80	150	10	500	100	300	1.0	—
MPSA06	***MPSA56***	80	100	10	500	100	—	100	—
2N4410	—	80	60	10	250	60	400	10	—
BC546	—	65	150	10	100	120	450	2.0	10
BC546B	BC556B	65	150	10	100	180	450	2.0	10
MPSA05	MPSA55	60	100	10	500	100	—	100	—
—	***MPS2907A***	60	200	50	600	100	300	150	—
BC182	BC212	50	200(1)	10	100	120	500	2.0	10
BC237B	BC307B	45	150	10	100	200	460	2.0	10
BC337	BC327	45	210(1)	10	800	100	630	100	—
—	BC557	45	150	10	100	120	800	2.0	10
BC547A	BC557A	45	150	10	100	120	220	2.0	10
BC547B	BC557B	45	150	10	100	180	450	2.0	10
BC547C	BC557C	45	150	10	100	380	800	2.0	10
MPSA20	—	40	125	5.0	100	40	400	5.0	—
MPS2222A	—	40	300	20	600	100	300	150	—
2N4401	***2N4403***	40	200	20	600	100	300	150	—
MPS6602	***MPS6652***	40	100	50	1000	50	—	500	—
2N3904	***2N3906***	40	250	10	200	100	300	10	5.0
BC548B	BC558B	30	300(1)	10	100	200	450	2.0	10
BC548C	—	30	300	10	100	420	800	2.0	10

(1) Typical

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C		I_C A Max	h_{FE} @ I_C			$V_{CE(sat)}$ @ I_C @ I_B		
			MHz Min	mA		Min	Max	mA	Volts Max	mA	mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW06	***MPSW56***	80	50	200	0.5	80	—	50	0.4	250	10

Devices listed in ***bold, italic*** are ON Semiconductor preferred devices.

Plastic–Encapsulated Transistors (continued)

Table 2. Plastic–Encapsulated Low–Noise and Good h_{FE} Linearity

NPN	PNP	$V_{(BR)CEO}$ Volts	h_{FE} @ I_C Min	Max	mA	V_T(4) mV Typ	NF(5) dB Max	f_T MHz Typ
Case 29–11 — TO–226AA (TO–92)								
—	***2N5087***	50	250	800	0.1	—	2.0	40(2)
BC550C	BC560C	45	380	800	2.0	—	2.5	250
MPSA18	—	45	500	—	1.0	6.5(1)	—	160
MPS3904	—	40	100	300	10	—	5.0	200(2)
2N5088	—	30	350	—	1.0	—	3.0	50
2N5089(6)	—	25	450	—	1.0	—	2.0	50
MPS6521	MPS6523	25	300	600	2.0	—	3.0	—

(1) Typical
(2) Min
(4) V_T: Total Input Noise Voltage (see BC413/BC414 and BC415/BC416 Data Sheets) at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts.
(5) N_F: Noise Figure at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts. f = 30 Hz to 15 kHz.
(7) R_S = 10 kΩ, BW = 1.0 Hz, f = 100 MHz
(8) R_S = 500 Ω, BW = 1.0 Hz, f = 10 MHz

Table 3. Plastic–Encapsulated Darlington Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts	I_C Max	h_{FE} @ I_C Min	Max	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C Min	mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW45A	—	50	1000	25K	150K	200	1.5	1000	2.0	100	200
—	***MPSW64***	30	1000	20K	—	100	1.5	100	0.1	125	10
Case 29–11 — TO–226AA (TO–92)											
MPSA29	—	100	500	10K	—	100	1.5	100	0.1	125	10
BC373	—	80	1000	10K	160K	100	1.1	250	0.25	100	100
MPSA27	MPSA77	60	500	10K	—	100	1.5	100	0.1	—	—
BC618	—	55	1000	10K	50K	200	1.1	200	0.2	150	500
—	MPSA75	40	500	10K	—	100	1.5	100	0.1	—	—
2N6427	—	40	500	20K	200K	100	1.5	500	0.5	—	—
2N6426	—	40	500	30K	300K	100	1.5	500	0.5	125	10
MPSA14	***MPSA64***	30	500	20K	—	100	1.5	100	0.1	125	10
MPSA13	MPSA63	30	500	10K	—	100	1.5	100	0.1	125	10
BC517	—	30	1000	30K	—	20	1.0	100	0.1	200(1)	10

(1) Typical

Table 4. Plastic–Encapsulated High–Current Transistors

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	mA	I_C mA Max	h_{FE} @ I_C Min	Max	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA
Case 29–10 — TO–226AE (1–WATT TO–92)											
MPSW01A	***MPSW51A***	40	50	50	1000	50	—	1000	0.5/0.7	1000	100
Case 29–11 — TO–226AA (TO–92)											
BC489	BC490	80	200/150(1)	50	1000	60	400	100	0.3/0.5	1000	100
BC639	BC640	80	60	10	500	40	160	150	0.5	500	50
MPS651	***MPS751***	60	75	50	2000	75	—	1000	0.5	2000	200
BC368	BC369	20	65	10	1000	60	—	1000	0.5	1000	100

(1) Typical

Plastic–Encapsulated Transistors (continued)

Table 5. Plastic–Encapsulated High–Voltage Amplifier Transistors

Device Type	$V_{(BR)CEO}$ Volts Min	I_C Amp Max	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA	Polarity
Case 29–10 — TO–226AE (1–WATT TO–92)										
MPSW42	300	0.5	40	30	0.5	20	2.0	50	10	**NPN**
MPSW92	300	0.5	25	30	0.5	20	2.0	50	10	**PNP**
2N6517	350	0.5	30	30	0.3	10	1.0	40	10	**NPN**
BF393	300	0.5	40	10	0.2	20	2.0	50	10	**NPN**
MPSA42	300	0.5	40	10	0.5	20	2.0	50	10	**NPN**
2N5551	160	0.6	80	10	0.15	10	1.0	100	10	**NPN**
BF493S	350	0.5	40	10	20	20	2.0	50	10	**PNP**
2N6520	350	0.5	30	30	0.3	10	1.0	40	10	**PNP**
MPSA92	300	0.5	40	10	0.5	20	2.0	50	10	**PNP**
2N6519	300	0.5	45	30	0.3	10	1.0	40	10	**PNP**
2N5401	150	0.6	60	10	0.2	10	1.0	100	10	**PNP**

NPN	PNP	$V_{(BR)CEO}$ Volts Min	I_C Amp Cont	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA
Case 29–11 — TO–226AA (TO–92)										
BF422	BF423	250	0.5	50	25	2.0	20	2.0	60	10

Table 6. Plastic–Encapsulated RF Transistors

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C Min	mA	V_{CE} V	f_T MHz Typ	CRE/CRB pF Max	NF dB Typ	f MHz	Polarity
Case 29–11 — TO–226AA (TO–92)										
MPSH10	25	—	60	4.0	10	650(2)	0.65	—	—	**NPN**
BF959	20	100	40	20	10	600(2)	0.65	3.0	200	**NPN**
MPSH17	15	—	25	5.0	10	800(2)	0.9	6.0(3)	200	**NPN**
MPS918	15	50	20	8.0	10	600(2)	1.7	6.0(3)	60	**NPN**
MPS5179	12	50	25	3.0	1.0	2000(3)	—	5.0(3)	200	**NPN**
MPS3563	12	50	20	8.0	10	800	1.7	6.0(3)	60	**NPN**

(2) Min
(3) Max

Table 7. Plastic–Encapsulated Telecom Transistors

Device Type	$V_{(BR)CEO}$ Volts	P_D mW 25°C Amb	I_C mA Cont	h_{FE} @ I_C @ V_{CE} Min	Max	mA	Volts	f_T MHz Min	Polarity
Case 29–11 — TO–226AA (TO–92)									
P2N2222A	40	625	600	75	—	10	10	300	**NPN**
P2N2907A	60	625	600	100	—	10	10	200	**PNP**

Plastic–Encapsulated Surface Mount Transistors

Table 8. Plastic–Encapsulated Surface Mount General–Purpose Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min	Polarity
Case 318–08 — TO–236AB (SOT–23)							
BC846ALT1	1A	65	110	220	2.0	100	**NPN**
BC846BLT1	1B	65	200	450	2.0	100	**NPN**
BC817–16LT1	6A	45	100	250	100	200	**NPN**
BC817–25LT1	6B	45	160	400	100	200	**NPN**
BC817–40LT1	6C	45	250	600	100	200	**NPN**
BC847ALT1	1E	45	110	220	2.0	100	**NPN**
BC847BLT1	1F	45	200	450	2.0	100	**NPN**
BC847CLT1	1G	45	420	800	2.0	100	**NPN**
MMBT2222ALT1	1P	40	100	300	150	200	**NPN**
MMBT3904LT1	1AM	40	100	300	10	200	**NPN**
MMBT4401LT1	2X	40	100	300	150	250	**NPN**
BC848ALT1	1J	30	110	220	2.0	100	**NPN**
BC848BLT1	1K	30	200	450	2.0	100	**NPN**
BC848CLT1	1L	30	420	800	2.0	100	**NPN**
BC856ALT1	3A	65	125	250	2.0	100	**PNP**
BC856BLT1	3B	65	220	475	2.0	100	**PNP**
MMBT2907ALT1	2F	60	100	300	150	200	**PNP**
BC807–16LT1	5A	45	100	250	100	200	**PNP**
BC807–25LT1	5B	45	160	400	100	200	**PNP**
BC807–40LT1	5C	45	250	600	100	200	**PNP**
BC857ALT1	3E	45	125	250	2.0	100	**PNP**
BC857BLT1	3F	45	220	475	2.0	100	**PNP**
MMBT3906LT1	2A	40	100	300	10	250	**PNP**
MMBT4403LT1	2T	40	100	300	150	200	**PNP**
BC858ALT1	3J	30	125	250	2.0	100	**PNP**
BC858BLT1	3K	30	220	475	2.0	100	**PNP**
BC858CLT1	3L	30	420	800	2.0	100	**PNP**
Case 318D–04 — SC–59							
MSD601–RT1	YR	25	210	340	2.0	150(1)	**NPN**
MSD601–ST1	YS	25	290	460	2.0	150(1)	**NPN**
MSD602–RT1	WR	25	120	240	150	200(1)	**NPN**
MSD1328–RT1	1DR	20	200	350	500	200(1)	**NPN**
MSB709–RT1	AR	25	210	340	2.0	100(1)	**PNP**
MSB710–RT1	CR	25	120	240	150	200(1)	**PNP**

Plastic–Encapsulated Surface Mount Transistors (continued)

Table 8. Plastic–Encapsulated Surface Mount General–Purpose Transistors (continued)

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min	Polarity
Case 419–02 — SC–70/SOT–323							
BC846AWT1	1A	65	110	220	2.0	100	**NPN**
BC847AWT1	1E	45	110	220	2.0	100	**NPN**
BC847BWT1	1F	45	200	450	2.0	100	**NPN**
BC848AWT1	1J	30	110	220	2.0	100	**NPN**
BC848BWT1	1K	30	200	450	2.0	100	**NPN**
MMBT2222AWT1	1P	40	100	300	150	300	**NPN**
MMBT3904WT1	AM	40	100	300	10	300	**NPN**
MSC3930–BT1	VB	20	70	140	1.0	150	**NPN**
MSD1819A–RT1	ZR	50	210	340	2.0	—	**NPN**
BC856BWT1	3B	65	220	475	2.0	100	**PNP**
BC857BWT1	3F	45	220	475	2.0	100	**PNP**
BC858AWT1	3J	30	110	220	2.0	100	**PNP**
BC858BWT1	3K	30	200	450	2.0	100	**PNP**
MMBT2907AWT1	20	60	100	300	150	200	**PNP**
MMBT3906WT1	2A	40	100	300	10	250	**PNP**
MSB1218A–RT1	BR	45	210	340	2.0	—	**PNP**
Case 419B–01 — SOT–363							
MBT3904DW1T1	MA	40	100	300	10	300	**Dual NPN**
MBT3906DW1T1	A2	–40	100	300	10	250	**Dual PNP**
MBT3946DW1T1	46	40	100	300	10	250	**Dual NPN & PNP**

(1) Typical

Case 463–01 — SOT–416/SC–90

Device	Marking	$V_{(BR)CEO}$	h_{FE} Min	Max	mA	f_T MHz Min	Polarity
2SC4617	B9	50	120	560	1.0	180	**NPN**
2SA1774	F9	50	120	560	1.0	140	**PNP**

Plastic–Encapsulated Surface Mount Transistors (continued)

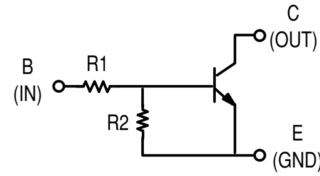


Table 9. Plastic–Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications

These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.

Device		Marking		$V_{(BR)CEO}$ Volts	h_{FE} @ I_C		I_C mA	R_1	R_2
NPN	PNP	NPN	PNP	(Min)	Min	mA	Max	Ohm	Ohm
Case 318D–04 — SC–59									
MUN2211T1	***MUN2111T1***	8A	6A	50	35	5.0	100	10K	10K
MUN2212T1	***MUN2112T1***	8B	6B	50	60	5.0	100	22K	22K
MUN2213T1	***MUN2113T1***	8C	6C	50	80	5.0	100	47K	47K
MUN2214T1	***MUN2114T1***	8D	6D	50	80	5.0	100	10K	47K
MUN2215T1	***MUN2115T1***	8E	6E	50	160	5.0	100	10K	∞
MUN2216T1	***MUN2116T1***	8F	6F	50	160	5.0	100	4.7K	∞
MUN2230T1	***MUN2130T1***	8G	6G	50	3.0	5.0	100	1.0K	1.0K
MUN2231T1	***MUN2131T1***	8H	6H	50	8.0	5.0	100	2.2K	2.2K
MUN2232T1	***MUN2132T1***	8J	6J	50	15	5.0	100	4.7K	4.7K
MUN2233T1	***MUN2133T1***	8K	6K	50	80	5.0	100	4.7K	47K
MUN2234T1	***MUN2134T1***	8L	6L	50	80	5.0	100	22K	47K
Case 318–08 — TO–236AB (SOT–23)									
MMUN2211LT1	***MMUN2111LT1***	A8A	A6A	50	35	5.0	100	10K	10K
MMUN2212LT1	***MMUN2112LT1***	A8B	A6B	50	60	5.0	100	22K	22K
MMUN2213LT1	***MMUN2113LT1***	A8C	A6C	50	80	5.0	100	47K	47K
MMUN2214LT1	***MMUN2114LT1***	A8D	A6D	50	80	5.0	100	10K	47K
MMUN2215LT1	***MMUN2115LT1***	A8E	A6E	50	160	5.0	100	10K	∞
MMUN2216LT1	***MMUN2116LT1***	A8F	A6F	50	160	5.0	100	4.7K	∞
MMUN2230LT1	***MMUN2130LT1***	A8G	A6G	50	3.0	5.0	100	1.0K	1.0K
MMUN2231LT1	***MMUN2131LT1***	A8H	A6H	50	8.0	5.0	100	2.2K	2.2K
MMUN2232LT1	***MMUN2132LT1***	A8J	A6J	50	15	5.0	100	4.7K	4.7K
MMUN2233LT1	***MMUN2133LT1***	A8K	A6K	50	80	5.0	100	4.7K	47K
MMUN2234LT1	***MMUN2134LT1***	A8L	A6L	50	80	5.0	100	22K	47K
Case 419–02 — SC–70/SOT–323									
MUN5211T1	***MUN5111T1***	8A	6A	50	35	5.0	50	10K	10K
MUN5212T1	***MUN5112T1***	8B	6B	50	60	5.0	50	22K	22K
MUN5213T1	***MUN5113T1***	8C	6C	50	80	5.0	50	47K	47K
MUN5214T1	***MUN5114T1***	8D	6D	50	80	5.0	50	10K	47K
MUN5215T1	***MUN5115T1***	8E	6E	50	160	5.0	50	10K	∞
MUN5216T1	***MUN5116T1***	8F	6F	50	160	5.0	50	4.7K	∞
MUN5230T1	***MUN5130T1***	8G	6G	50	3.0	5.0	50	1.0K	1.0K
MUN5231T1	***MUN5131T1***	8H	6H	50	8.0	5.0	50	2.2K	2.2K
MUN5232T1	***MUN5132T1***	8J	6J	50	15	5.0	50	4.7K	4.7K
MUN5233T1	***MUN5133T1***	8K	6K	50	80	5.0	50	4.7K	47K
MUN5234T1	***MUN5134T1***	8L	6L	50	80	5.0	50	22K	47K

Plastic–Encapsulated Surface Mount Transistors (continued)

Table 9. Plastic–Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications (continued)

Device		Marking		$V_{(BR)CEO}$ Volts (Min)	h_{FE} @ I_C		I_C mA Max	R_1 Ohm	R_2 Ohm
NPN	PNP	NPN	PNP		Min	mA			
Case 419B–01 — SOT–363 Duals									
MUN5211DW1T1	*MUN5111DW1T1*	7A	8A	50	35	5.0	100	10K	10K
MUN5212DW1T1	*MUN5112DW1T1*	7B	8B	50	60	5.0	100	22K	22K
MUN5213DW1T1	*MUN5113DW1T1*	7C	8C	50	80	5.0	100	47K	47K
MUN5214DW1T1	*MUN5114DW1T1*	7D	8D	50	80	5.0	100	10K	47K
MUN5215DW1T1	*MUN5115DW1T1*	7E	8E	50	160	5.0	100	10K	∞
MUN5216DW1T1	*MUN5116DW1T1*	7F	8F	50	160	5.0	100	4.7K	∞
MUN5230DW1T1	*MUN5130DW1T1*	7G	8G	50	3.0	5.0	100	1.0K	1.0K
MUN5231DW1T1	*MUN5131DW1T1*	7H	8H	50	8.0	5.0	100	2.2K	2.2K
MUN5232DW1T1	*MUN5132DW1T1*	7J	8J	50	15	5.0	100	4.7K	4.7K
MUN5233DW1T1	*MUN5133DW1T1*	7K	8K	50	80	5.0	100	4.7K	47K
MUN5234DW1T1	*MUN5134DW1T1*	7L	8L	50	80	5.0	100	22K	47K
MUN5235DW1T1	*MUN5135DW1T1*	7M	8M	50	80	5.0	100	2.2K	47K

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	mA	I_C mA Max	R_1 Ohm	R_2 Ohm
Case 419B–01 — SOT–363 — Dual Combination NPN and PNP							
MUN5311DW1T1	11	50	35	5.0	100	10K	10K
MUN5312DW1T1	12	50	60	5.0	100	22K	22K
MUN5313DW1T1	13	50	80	5.0	100	47K	47K
MUN5314DW1T1	14	50	80	5.0	100	10K	47K
MUN5315DW1T1	15	50	160	5.0	100	10K	∞
MUN5316DW1T1	16	50	160	5.0	100	4.7K	∞
MUN5330DW1T1	3X	50	3.0	5.0	100	1.0K	1.0K
MUN5331DW1T1	31	50	8.0	5.0	100	2.2K	2.2K
MUN5332DW1T1	32	50	15	5.0	100	4.7K	4.7K
MUN5333DW1T1	33	50	80	5.0	100	4.7K	47K
MUN5334DW1T1	34	50	80	5.0	100	22K	47K
MUN5335DW1T1	35	50	80	5.0	100	2.2K	47K

Device		Marking		$V_{(BR)CEO}$ Volts (Min)	h_{FE} @ I_C		I_C mA Max	R_1 Ohm	R_2 Ohm
NPN	PNP	NPN	PNP		Min	mA			
Case 463–01 — SOT–416/SC–90									
DTC114TE	—	94	—	50	100	1.0	100	10K	∞
DTC114YE	*DTA114YE*	69	59	50	80	5.0	100	10K	47K
—	*DTA143EE*	—	43	50	15	5.0	100	4.7K	4.7K

Plastic–Encapsulated Surface Mount Transistors (continued)

Table 10. Plastic–Encapsulated Surface Mount VHF/UHF Amplifiers, Mixers, Oscillators

Device	Marking	$V_{(BR)CEO}$	C_{cb}(13) pF Max	f_T @ I_C GHz Min	mA
Case 318–08 — TO–236AB (SOT–23) — NPN					
MMBTH10LT1	3EM	25	0.7	0.65	4.0
MMBT918LT1	M3B	15	1.7(14)	0.6	4.0
Case 318D–04 — SC–59 — NPN					
MSC2295–BT1	VB	20	1.5(13)	0.15	1.0
MSC2295–CT1	VC	20	1.5(13)	0.15	1.0
MSC3130T1	1S	10	—	1.4	5.0

(13) C_{re}
(14) C_{ob}

Table 11. Plastic–Encapsulated Surface Mount Darlingtons

Device	Marking	$V_{(BR)CES}$	$V_{CE(sat)}$ Volts Max	h_{FE} @ I_C Min	Max	mA
Case 318–08 — TO–236AB (SOT–23) — NPN						
MMBTA14LT1	1N	30	1.5	20K	—	100
Case 318–08 — TO–236AB (SOT–23) — PNP						
MMBTA64LT1	2V	30	1.5	20K	—	100

Table 12. Plastic–Encapsulated Surface Mount Low–Noise Transistors

Device	Marking	NF dB Typ	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min	Polarity
Case 318–08 — TO–236AB (SOT–23)								
MMBT5089LT1	1R	2.0(15)	25	400	—	10	50	**NPN**
MMBT2484LT1	1U	3.0(15)	60	—	800	10	—	**NPN**
MMBT6428LT1	1KM	3.0	50	250	—	10	100	**NPN**
MMBT6429LT1	1L	3.0	45	500	—	10	100	**NPN**
MMBT5087LT1	2Q	2.0(15)	50	250	—	10	40	**PNP**

(15) Max

Table 13. Plastic–Encapsulated Surface Mount High–Voltage Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min	Polarity
Case 318–08 — TO–236AB (SOT–23)							
MMBT6517LT1	1Z	350	15	—	100	40	**NPN**
MMBTA42LT1	1D	300	40	—	30	50	**NPN**
MMBT5551LT1	G1	160	30	—	50	100	**NPN**
MMBT6520LT1	2Z	350	15	—	100	40	**PNP**
MMBTA92LT1	2D	300	25	—	30	50	**PNP**
MMBT5401LT1	2L	150	50	—	50	100	**PNP**

Table 14. Plastic–Encapsulated Surface Mount Drivers

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$	$V_{BE(sat)}$	h_{FE} @ I_C Min	Max	mA	Polarity
Case 318–08 — TO–236AB (SOT–23)								
MMBTA06LT1	1GM	80	0.25	—	100	—	100	**NPN**
BSS64LT1	AM	80	0.15	—	20	—	10	**NPN**
BSS63LT1	T1	100	−0.25	−0.90	30	—	25	**PNP**
MMBTA56LT1	2GM	80	−0.25	—	100	—	100	**PNP**

Plastic–Encapsulated Surface Mount Transistors (continued)

Table 15. Plastic–Encapsulated Surface Mount General Purpose Amplifiers

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	Polarity
Case 318E–04 — SOT–223						
BCP56T1	BH	80	40	250	150	**NPN**
BCP53T1	AH	80	40	25	150	**PNP**

Table 16. Plastic–Encapsulated Surface Mount Switching Transistors

Device	Marking	t_{on}	t_{off}	$V_{(BR)CEO}$	h_{FE} Min	h_{FE} Max	f_T @ I_C (mA)	f_T Min (MHz)	Polarity
Case 318E–04 — SOT–223									
PZT2222AT1	P1F	35	285	40	100	300	20	300	**NPN**
PZT2907AT1	P2F	45	100	60	100	300	50	200	**PNP**

Table 17. Plastic–Encapsulated Surface Mount Darlingtons

Device	Marking	$V_{(BR)CER}$	$V_{CE(sat)}$ Max (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)	Polarity
Case 318E–04 — SOT–223							
BSP52T1	AS3	80	1.3	2000	—	500	**NPN**

Table 18. Plastic–Encapsulated Surface Mount High–Voltage Transistors

Device	Marking	$V_{(BR)CEO}$	h_{FE} Min	h_{FE} Max	f_T @ I_C (mA)	f_T Min (MHz)	Polarity
Case 318E–04 — SOT–223							
BSP19AT1	SP19A	350	40	—	20	70	**NPN**
PZTA42T1	P1D	300	40	—	10	50	**NPN**
BF720T1	BF720	250	50	—	10	60	**NPN**
PZTA92T1	P2D	300	40	—	10	50	**PNP**
BSP16T1	BSP16	300	30	150	10	15	**PNP**
BF721T1	BF721	250	50	—	10	60	**PNP**

Table 19. Plastic–Encapsulated Surface Mount High Current Transistors

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$ Volts	h_{FE} @ I_C Min	Max	mA	Polarity
Case 318E–04 — SOT–223							
PZT651T1	651	60	0.5	75	—	1000	**NPN**
BCP68T1	CA	20	0.5	60	—	1000	**NPN**
PZT751T1	ZT751	60	0.5	75	—	1000	**PNP**
BCP69T1	CE	20	0.5	60	—	1000	**PNP**

Field–Effect Transistors

JFETs

Table 20. JFET Low–Frequency/Low–Noise

Device	$R_e \lvert Y_{fs} \rvert$ @ f		$R_e \lvert Y_{os} \rvert$ @ f		C_{iss} pF Max	C_{rss} pF Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts		I_{DSS} mA		Polarity
	mmho Min	kHz	µmho Max	kHz				Min	Max	Min	Max	
Case 29–11 — TO–226AA (TO–92)												
2N5457	1.0	1.0	50	1.0	7.0	3.0	25	0.5	6.0	1.0	5.0	**N–Channel**
2N5458	1.5	1.0	50	1.0	7.0	3.0	25	1.0	7.0	2.0	9.0	**N–Channel**
2N5460	1.0	1.0	75	1.0	7.0	2.0	40	0.75	6.0	1.0	5.0	**P–Channel**
2N5461	1.5	1.0	75	1.0	7.0	2.0	40	1.0	7.5	2.0	9.0	**P–Channel**
2N5462	2.0	1.0	75	1.0	7.0	2.0	40	1.8	9.0	4.0	16	**P–Channel**

Table 21. JFET High–Frequency Amplifiers

Device	$R_e \lvert Y_{fs} \rvert$ @ f		$R_e \lvert Y_{os} \rvert$ @ f		C_{iss} pF Max	C_{rss} pF Max	NF @ R_G = 1K		$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts		I_{DSS} mA		Polarity
	mmho Min	MHz	µmho Max	MHz			dB Max	f MHz		Min	Max	Min	Max	
Case 29–11 — TO–226AA (TO–92)														
MPF102	1.6	100	200	100	7.0	3.0	—	—	25	—	8.0	2.0	20	**N–Channel**
2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	0.5	4.0	4.0	10	**N–Channel**
2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20	**N–Channel**
J309	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	4.0	12	30	**N–Channel**
J310	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	2.0	6.5	24	60	**N–Channel**

(1) Typical

Table 22. JFET Switches and Choppers

Device	$R_{DS(on)}$ @ I_D		$V_{GS(off)}$ Volts		I_{DSS} mA		$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Polarity
	Ω Max	mA	Min	Max	Min	Max						
Case 29–11 — TO–226AA (TO–92)												
J112	50	—	1.0	5.0	5.0	—	35	28	5.0	—	—	**N–Channel**
MPF4392	60	—	—	—	25	75	30	10	3.5	15	35	**N–Channel**
2N5639	60	1.0	—	(8.0)(1)	25	—	30	10	4.0	—	—	**N–Channel**
MPF4393	100	—	—	(12)(1)	5.0	30	30	10	3.5	15	55	**N–Channel**
J110	18	—	0.5	4.0	10	—	25	—	—	—	—	**N–Channel**

(1) Typical
(16) $V_{GS(f)}$

TMOS FETs

Table 23. TMOS Switches and Choppers

Device	$R_{DS(on)}$ @ I_D Ω Max	$R_{DS(on)}$ @ I_D A	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	$V_{(BR)DSS}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Polarity
Case 29–11 — TO–226AA (TO–92)										
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10	**N–Channel**
BS170	5.0	0.2	0.8	3.0	60	25(1)	3.0(1)	10	10	**N–Channel**
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10	**N–Channel**
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20	**N–Channel**
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10	**N–Channel**

(1) Typical

Table 24. TMOS FETs

Device	Marking	$R_{DS(on)}$ @ I_D Max Ohms	$R_{DS(on)}$ @ I_D mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Polarity
Case 318–08 — TO–236AB (SOT–23)									
MMBF170LT1	6Z	5.0	200	60	0.8	3.0	10	10	**N–Channel**
BSS123LT1	SA	6.0	100	100	0.8	2.8	20	40	**N–Channel**
2N7002LT1	702	7.5	500	60	1.0	2.5	20	40	**N–Channel**
MMBF0201NLT1	N1	1.0	300	20	1.0	2.4	2.5	15	**N–Channel**
MGSF1N02LT1	N2	0.085	1200	20	1.0	2.4	2.5	16	**N–Channel**
MGSF1N03LT1	N3	0.09	1200	30	1.0	2.4	2.5	16	**N–Channel**
BSS84LT1	PD	10	100	50	0.8	2.0	2.5	16	**P–Channel**
MMBF0202PLT1	P3	1.4	200	20	1.0	2.4	2.5	16	**P–Channel**
MGSF1P02LT1	PC	0.35	1500	20	1.0	2.4	2.5	16	**P–Channel**
MGSF1P02ELT1	PE	0.26	750	20	0.7	1.2	2.5	15	**P–Channel**

Device	Marking	$R_{DS(on)}$ Ohm	$R_{DS(on)}$ mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Polarity
Case 419–02 — SC–70/SOT–323									
MMBF2201NT1	N1	1.0	300	20	1.0	2.4	2.5	15	**N–Channel**
MMBF2202PT1	P3	2.2	200	20	1.0	2.4	2.5	16	**P–Channel**

Tuning and Switching Diodes

Tuning Diodes — Abrupt Junction

Table 25. General–Purpose Plastic Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/30 Volts

Device	C_T @ V_R = 4.0 V, 1.0 MHz			$V_{R(BR)R}$ Volts	Cap Ratio C4/C30 Min	Q 4.0 V, 50 MHz Typ
	pF Min	pF Nominal	pF Max			
Case 182–06 — TO–226AC (TO–92) — 2–Lead						
MV2105	13.5	15	16.5	30	2.5	350
MV2109	29.7	33	36.3	30	2.5	200

Table 26. Surface Mount Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/30 Volts

Device	C_T @ V_R = 4.0 V, 1.0 MHz			$V_{R(BR)R}$ Volts	Cap Ratio C2/C30 Min	Q 4.0 V, 50 MHz Typ
	pF Min	pF Nominal	pF Max			
Case 318–08 — TO–236AB (SOT–23)						
MMBV2105LT1	13.5	15	16.5	30	2.5	350
MMBV2107LT1	19.8	22	24.2	30	2.5	300
MMBV2109LT1	29.7	33	36.3	30	2.5	200

Tuning Diodes — Hyper–Abrupt Junction

Table 27. Hyper–Abrupt Tuning Diodes for Telecommunications — Single

Device	C_T @ V_R (f = 1.0 MHz)			Cap Ratio @ V_R			Q		$V_{(BR)R}$ Volts	Device Marking	Case Style	CV Curve Fig
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max				
Case 182–06 — TO–226AC (TO–92)												
MV209	26	32	3.0	5.0	6.5	3/25	200	—	30	—	1	2
Case 318–08 — TO–236AB (SOT–23)												
MMBV105GLT1	1.5	2.8	25	4.0	6.5	3/25	200	—	30	M4E	8	1
MMBV109LT1	26	32	3.0	5.0	6.5	3/25	200	—	30	M4A	8	2
MMBV409LT1	26	32	3.0	1.5	1.9	3/8	200	—	20	X5	8	3
MMBV809LT1	4.5	6.1	2.0	1.8	2.6	2/8	300	—	20	5K	8	4

Table 28. Hyper–Abrupt Tuning Diodes for Communications — Dual

Device	C_T @ V_R (f = 1.0 MHz)			Cap Ratio @ V_R			Q		$V_{(BR)R}$ Volts	Device Marking	Case Style	CV Curve Fig
	pF Min	pF Max	Volts	Min	Max	Volts	3.0 V Min	50 MHz Max				
Case 318–08 — TO–236AB (SOT–23)												
MMBV609LT1	26	32	3.0	1.8	2.4	3/8	250	—	20	5L	9	6

Schottky Diodes

Table 29. Schottky Diodes

Device	$V_{(BR)R}$ Volts	C_T @ V_R pF Max	V_F @ 10 mA Volts Max	I_R @ V_R nA Max	Minority Lifetime pS (TYP)	Device Marking
Case 182–06 — TO–226AC (TO–92)						
MBD701	70	1.0 @ 20 V	1.0	200 @ 35 V	15	—
MBD301	30	1.5 @ 15 V	0.6	200 @ 25 V	15	—
Case 318–08 — TO–236AB (SOT–23) – Single						
BAS40LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	B1
BAS40–04LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	—
BAS70LT1	70	2.0 @ 0 V	0.75	100 @ 50 V	—	BE
BAT54ALT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
BAT54LT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	LV3
BAT54SLT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	LD3
MMBD701LT1	70	1.0 @ 20 V	1.0	200 @ 35 V	15	5H
MMBD301LT1	30	1.5 @ 15 V	0.6	200 @ 25 V	15	4T
Case 318–08 — TO–236AB (SOT–23) – Dual						
BAS40–06LT1	40	5.0 @ 1.0 V	0.5 @ 30 mA	1000 @ 25 V	—	—
BAS70–04LT1(23)	70	2.0 @ 0 V	0.75	100 @ 50 V	—	—
MMBD452LT1	30	1.5 @ 1.5 V	0.6	200 @ 25 V	15	5N
Case 425–04 — (SOD–123)						
BAT54T1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMSD301T1	30	1.5 @ 15 V	0.6	0.2 @ 25 V	15	XT
Case 419–02 — (SC–70/SOT–323) – Single						
BAT54WT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMBD330T1	30	1.5 @ 15 V	0.6	0.2 @ 25 V	—	—
MMBD770T1	70	1.0 @ 20 V	1.0	0.2 @ 35 V	—	—
Case 419–02 — (SC–70/SOT–323) – Dual						
BAT54SWT1	30	10 @ 1.0 V	0.4	2000 @ 25 V	—	—
MMBD717LT1(23)	20	2.5 @ 1.0 V	0.37 @ 1 mA	0.2 @ 10 V	—	B3

(23) Common Anode

Case 419B–01 — SOT–363 – Duals

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T(30) Max (pF)	t_{rr} Max (ns)
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)		
MBD54DWT1	BL	30	10	2.0	25	—	0.32	1.0	1.0	5.0
MBD330DWT1	T4	30	10	200	25	—	0.4	1.0	1.5	—
MBD770DWT1	H5	70	10	200	25	—	0.5	1.0	1.0	—

(30) V_R = 0 V, f = 1.0 MHz

Switching Diodes

Table 30. PIN Switching Diodes

Device	$V_{(BR)R}$ Volts Min	C_T @ V_R @ 1.0 MHz		I_R @ V_R μA Max	Series Resistance Ohm Max	Device Marking
		pF Max	Volts			
Case 182–06 — TO–226AC (TO–92)						
MPN3700	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	—
MPN3404	20	2.0	15	0.1 @ 25 V	0.85 @ 10 mA	—
Case 318–08 — TO–236AB (SOT–23)						
MMBV3700LT1	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	4R
MMBV3401LT1	35	1.0	20	0.1 @ 25 V	0.7 @ 10 mA	4D

Table 31. General–Purpose Signal and Switching Diodes — Single

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T(30)	t_{rr}
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)
Case 318–08 — TO–236AB (SOT–23)										
BAS21LT1	JS	250	100	0.1	200	—	1.0	100	5.0	50
MMBD914LT1	5D	100	100	5.0	75	—	1.0	10	4.0	4.0
BAS16LT1	A6	75	100	1.0	75	—	1.0	50	2.0	6.0
MMBD6050LT1	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0
BAL99LT1	JF	70	100	2.5	70	—	1.0	50	1.5	6.0
Case 318D–04 — SC–59										
M1MA151AT1	MA	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA151KT1	MH	40	100	0.1	35	—	1.2	100	2.0	3.0
Case 419–02 — SC–70/SOT–323										
BAS16WT1	A6	75	1.0	0.02	20	—	1.25	150	2.0	6.0
M1MA141KT1	MH	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA142KT1	MI	80	100	0.1	75	—	1.2	100	2.0	3.0
M1MA174T1	J6	100	100	5.0	75	—	1.0	10	4.0	4.0
Case 425–04— SOD–123										
MMSD914T1	5D	100	100	5.0	75	—	1.0	10	4.0	4.0
MMSD71RKT1	6S	—	—	0.5	80	—	1.2	100	2.0	4.0

(30) V_R = 0 V, f = 1.0 MHz

Switching Diodes (continued)

Table 32. General–Purpose Signal and Switching Diodes — Dual

Device	Marking	$V_{(BR)R}$ Min Volts	$V_{(BR)R}$ @ I_{BR} (μA)	I_R Max (μA)	I_R @ V_R Volts	V_F Min Volts	V_F Max Volts	V_F @ I_F (mA)	C_T(30) Max (pF)	t_{rr} Max (ns)
Case 318–08 — TO–236AB (SOT–23)										
MMBD7000LT1	M5C	100	100	1.0	50	0.75	1.1	100	1.5	4.0
MMBD2836LT1	A2	75	100	0.1	50	—	1.0	10	4.0	4.0
MMBD2838LT1	A6	75	100	0.1	50	—	1.0	10	4.0	4.0
BAV70LT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0
BAV99LT1	A7	70	100	2.5	70	—	1.0	50	1.5	4.0
BAW56LT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0
MMBD6100LT1	5BM	70	100	0.1	50	0.85	1.1	100	2.5	4.0
BAV74LT1	JA	50	5.0	0.1	50	—	1.0	100	2.0	4.0
MMBD2835LT1	A3	35	100	0.1	30	—	1.0	10	4.0	4.0
MMBD2837LT1	A5	35	100	0.1	30	—	1.0	10	4.0	4.0
Case 318D–04 — SC–59										
M1MA151WAT1	MN	40	100	0.1	35	—	1.2	100	15	10
M1MA151WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0
Case 419–02 — SC–70/SOT–323										
M1MA142WKT1	MU	80	100	0.1	75	—	1.2	100	2.0	3.0
M1MA142WAT1	MO	80	100	0.1	75	—	1.2	100	15	10
BAW56WT1	A1	70	100	2.5	70	—	1.0	50	2.0	6.0
BAV70WT1	A4	70	100	5.0	70	—	1.0	50	1.5	6.0
BAV99WT1	A7	70	100	2.5	70	—	1.0	50	1.5	6.0
BAV99RWT1	F7	70	100	2.5	70	—	1.0	50	1.5	6.0
M1MA141WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0
M1MA141WAT1	MN	40	100	0.1	35	—	1.2	100	15	10
Case 463–01 — SOT–416/SC–90 (Common Anode)										
DAP222	P9	80	100	100	70	—	1.2	100	3.5	4.0
Case 463–01 — SOT–416/SC–90 (Common Cathode)										
DAN222	N9	80	100	100	70	—	1.2	100	3.5	4.0

(30) V_R = 0 V, f = 1.0 MHz

TVS/Zeners
Transient Voltage Suppressors (TVS)
Zener Regulator Diodes

In Brief . . .

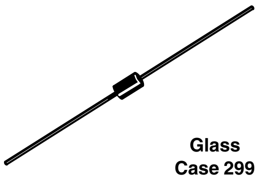
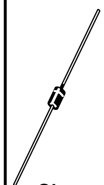
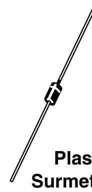
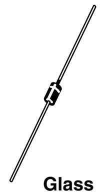
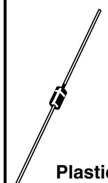
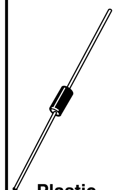
ON Semiconductor's standard TVS (Transient Voltage Suppressors) and Zener diodes comprise the largest inventoried line in the industry. Continuous development of improved manufacturing techniques have resulted in computerized diffusion and test, as well as critical process controls learned from surface–sensitive MOS fabrication. The resulting higher yields have lowered the factory costs. Check the following features for application to your specific requirements:

- Wide selection of package materials and styles:
  - — Plastic (Surmetic) for low cost, mechanical ruggedness
  - — Glass for high reliability, low cost
  - — Surface Mount packages for state of the art designs
- Power Ratings from 0.25 to 5.0 Watts
- Breakdown voltages from 1.8 to 400 Volts in approximately 10% steps
- TVS from 24 to 1500 Watts and from 6.2 to 250 Volts
- ESD protection devices
- Special selection of electrical characteristics available at low cost due to high–volume lines (check your ON Semiconductor sales representative for special quotations)
- UL Recognition on many TVS device types
- Tape and Reel options available on all axial leaded and surface mount types
- Many TVS are offered as bidirectional (clipper devices)
- Standard Zener tolerance is ± 5%

Page

Zener Diodes — Regulation in Axial Leads

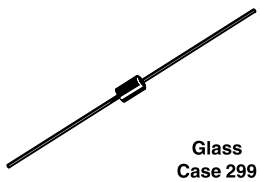
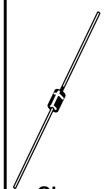
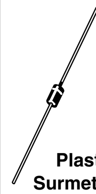
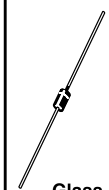
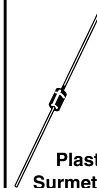
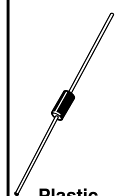
Table 1. Axial Leaded — .5, 1, 1.3, 1.5, 3 and 5 Watt

Nominal Zener Breakdown Voltage	500 mW Low Level Cathode = Polarity Band	500 mW Cathode = Polarity Band		1 Watt Cathode = Polarity Band		1.3 Watt Cathode = Polarity Band	1.5 Watt Cathode = Polarity Band	5 Watt Cathode = Polarity Band
Volts	 Glass Case 299 DO-204AH (DO-35)			 Glass Case 59-03 (DO-41)	 Plastic Surmetic 30 Case 59-03 (DO-41)	 Glass Case 59-03 (DO-41)	 Plastic Surmetic 30 Case 59-03 (DO-41)	 Plastic Surmetic 40 Case 17
1.8	1N4678							
2.0	1N4679							
2.2	1N4680							
2.4	1N4681	1N5221B	BZX79C2V4RL					
2.5		1N5222B						
2.7	1N4682	1N5223B	BZX79C2V7RL					
2.8		1N5224B						
3.0	1N4683	1N5225B	BZX79C3V0RL					
3.3	1N4684	***1N5226B***	BZX79C3V3RL	1N4728A	MZP4728A	BZX85C3V3RL	1N5913B	1N5333B
3.6	1N4685	1N5227B	BZX79C3V6RL	1N4729A	MZP4729A	***BZX85C3V6RL***	1N5914B	1N5334B
3.9	1N4686	***1N5228B***	BZX79C3V9RL	1N4730A	MZP4730A	BZX85C3V9RL	1N5915B	1N5335B
4.3	1N4687	1N5229B	BZX79C4V3RL	1N4731A	MZP4731A	BZX85C4V3RL	1N5916B	1N5336B
4.7	***1N4688***	1N5230B	BZX79C4V7RL	1N4732A	MZP4732A	BZX85C4V7RL	1N5917B	1N5337B
5.1	1N4689	***1N5231B***	BZX79C5V1RL	***1N4733A***	MZP4733A	BZX85C5V1RL	***1N5918B***	1N5338B
5.6	1N4690	***1N5232B***	BZX79C5V6RL	***1N4734A***	MZP4734A	BZX85C5V6RL	1N5919B	1N5339B
6.0		1N5233B						1N5340B
6.2	1N4691	***1N5234B***	BZX79C6V2RL	***1N4735A***	MZP4735A	BZX85C6V2RL	***1N5920B***	1N5341B
6.8	1N4692	***1N5235B***	BZX79C6V8RL	***1N4736A***	MZP4736A	BZX85C6V8RL	1N5921B	1N5342B
7.5	1N4693	1N5236B	BZX79C7V5RL	1N4737A	MZP4737A	BZX85C7V5RL	1N5922B	1N5343B
8.2	1N4694	***1N5237B***	BZX79C8V2RL	***1N4738A***	MZP4738A	BZX85C8V2RL	1N5923B	1N5344B
8.7	1N4695	1N5238B						1N5345B
9.1	1N4696	1N5239B	BZX79C9V1RL	1N4739A	MZP4739A	BZX85C9V1RL	1N5924B	1N5346B
10	1N4697	***1N5240B***	BZX79C10RL	***1N4740A***	MZP4740A	BZX85C10RL	1N5925B	1N5347B
11	1N4698	1N5241B	BZX79C11RL	***1N4741A***	MZP4741A	BZX85C11RL	1N5926B	1N5348B
12	1N4699	***1N5242B***	BZX79C12RL	***1N4742A***	MZP4742A	BZX85C12RL	1N5927B	1N5349B
13	1N4700	1N5243B	BZX79C13RL	1N4743A	MZP4743A	BZX85C13RL	1N5928B	1N5350B
14	1N4701	1N5244B						1N5351B
15	1N4702	***1N5245B***	BZX79C15RL	***1N4744A***	MZP4744A	BZX85C15RL	***1N5929B***	1N5352B
16	1N4703	***1N5246B***	BZX79C16RL	***1N4745A***	MZP4745A	BZX85C16RL	1N5930B	1N5353B
17	1N4704	1N5247B						1N5354B
18	1N4705	1N5248B	BZX79C18RL	***1N4746A***	***MZP4746A***	BZX85C18RL	1N5931B	1N5355B
19	1N4706	1N5249B						1N5356B
20	1N4707	***1N5250B***	BZX79C20RL	***1N4747A***	MZP4747A	BZX85C20RL	1N5932B	1N5357B
22	1N4708	1N5251B	BZX79C22RL	***1N4748A***	MZP4748A	***BZX85C22RL***	1N5933B	1N5358B
24	1N4709	1N5252B	BZX79C24RL	***1N4749A***	***MZP4749A***	***BZX85C24RL***	1N5934B	1N5359B

Devices listed in bold, italic are ON Semiconductor preferred devices.

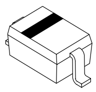
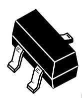
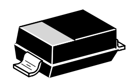
Zener Diodes — Regulation in Axial Leads (continued)

Table 1. Axial Leaded — .5, 1, 1.3, 1.5, 3 and 5 Watt (continued)

Nominal Zener Breakdown Voltage	**500 mW Low Level Cathode = Polarity Band**	**500 mW Cathode = Polarity Band**		**1 Watt Cathode = Polarity Band**		**1.3 Watt Cathode = Polarity Band**	**1.5 Watt Cathode = Polarity Band**	**5 Watt Cathode = Polarity Band**
Volts		**Glass Case 299 DO-204AH (DO-35)**		 **Glass Case 59-03 (DO-41)**	 **Plastic Surmetic 30 Case 59-03 (DO-41)**	 **Glass Case 59-03 (DO-41)**	 **Plastic Surmetic 30 Case 59-03 (DO-41)**	 **Plastic Surmetic 40 Case 17**
25	1N4710	1N5253B						1N5360B
27	1N4711	1N5254B	BZX79C27RL	***1N4750A***	MZP4750A	BZX85C27RL	1N5935B	1N5361B
28	1N4712	1N5255B						1N5362B
30	1N4713	1N5256B	BZX79C30RL	***1N4751A***	***MZP4751A***	BZX85C30RL	***1N5936B***	1N5363B
33	1N4714	1N5257B	BZX79C33RL	***1N4752A***	MZP4752A	BZX85C33RL	1N5937B	1N5364B
36	1N4715	1N5258B	BZX79C36RL	1N4753A	MZP4753A	BZX85C36RL	1N5938B	1N5365B
39	1N4716	1N5259B	BZX79C39RL	1N4754A	MZP4754A	BZX85C39RL	1N5939B	1N5366B
43	1N4717	1N5260B	BZX79C43RL	1N4755A	MZP4755A	BZX85C43RL	1N5940B	1N5367B
47		1N5261B	BZX79C47RL	1N4756A	MZP4756A	BZX85C47RL	1N5941B	1N5368B
51		1N5262B	BZX79C51RL	1N4757A	MZP4757A	BZX85C51RL	1N5942B	1N5369B
56		1N5263B	BZX79C56RL	1N4758A	MZP4758A	BZX85C56RL	1N5943B	1N5370B
60		1N5264B						1N5371B
62		1N5265B	BZX79C62RL	1N4759A	MZP4759A	BZX85C62RL	1N5944B	1N5372B
68		1N5266B	BZX79C68RL	1N4760A	MZP4760A	BZX85C68RL	1N5945B	1N5373B
75		1N5267B	BZX79C75RL	1N4761A	MZP4761A	BZX85C75RL	1N5946B	1N5374B
82		1N5268B	BZX79C82RL	1N4762A	MZP4762A	BZX85C82RL	1N5947B	1N5375B
87		1N5269B						1N5376B
91		1N5270B	BZX79C91RL	1N4763A	MZP4763A	BZX85C91RL	1N5948B	1N5377B
100				1N4764A	MZP4764A	BZX85C100RL	1N5949B	1N5378B
110					1M110ZS5		1N5950B	1N5379B
120					1M120ZS5		1N5951B	1N5380B
130					1M130ZS5		1N5952B	1N5381B
140								1N5382B
150					1M150ZS5		1N5953B	1N5383B
160					1M160ZS5		1N5954B	1N5384B
170								1N5385B
180					1M180ZS5		***1N5955B***	1N5386B
190								1N5387B
200					1M200ZS5		1N5956B	1N5388B
220								
240								
270								
300								
330								
360								
400								

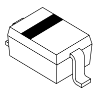
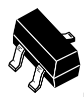
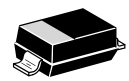
Zener Diodes — Regulation in Surface Mount

Table 2. Surface Mount Packages — .2, .225, .5, 1.5, 3 Watt

Nom–inal Zener Break–down Voltage	200 mW SOD–323	225 mW SOT-23		500 mW SOD-123			1.5 Watt SMA	3 Watt SMB
Volts	 Case 477 Style 1	Anode  Cathode No Connection Plastic Case 318 TO-236AB		 Plastic Case 425, Style 1			 Plastic Case 403A Cathode = Notch	 Plastic Case 403B
1.8					MMSZ4678T1			
2.0					MMSZ4679T1			
2.2					MMSZ4680T1			
2.4	MM3Z2V4T1	BZX84C2V4LT1	MMBZ5221BLT1	MMSZ2V4T1	MMSZ4681T1	MMSZ5221BT1		
2.5			MMBZ5222BLT1			MMSZ5222BT1		
2.7		BZX84C2V7LT1	MMBZ5223BLT1	MMSZ2V7T1	MMSZ4682T1	MMSZ5223BT1		
2.8			MMBZ5224BLT1			MMSZ5224BT1		
3.0		BZX84C3V0LT1	MMBZ5225BLT1	MMSZ3V0T1	MMSZ4683T1	MMSZ5225BT1		
3.3		BZX84C3V3LT1	MMBZ5226BLT1	MMSZ3V3T1	MMSZ4684T1	MMSZ5226BT1	1SMA5913BT3	1SMB5913BT3
3.6		BZX84C3V6LT1	MMBZ5227BLT1	MMSZ3V6T1	MMSZ4685T1	MMSZ5227BT1	1SMA5914BT3	1SMB5914BT3
3.9	MM3Z3V9T1	BZX84C3V9LT1	MMBZ5228BLT1	MMSZ3V9T1	MMSZ4686T1	MMSZ5228BT1	1SMA5915BT3	1SMB5915BT3
4.3	MM3Z4V3T1	BZX84C4V3LT1	MMBZ5229BLT1	MMSZ4V3T1	MMSZ4687T1	MMSZ5229BT1	1SMA5916BT3	1SMB5916BT3
4.7	MM3Z4V7T1	BZX84C4V7LT1	MMBZ5230BLT1	MMSZ4V7T1	MMSZ4688T1	MMSZ5230BT1	1SMA5917BT3	1SMB5917BT3
5.1	MM3Z5V1T1	BZX84C5V1LT1	MMBZ5231BLT1	MMSZ5V1T1	MMSZ4689T1	MMSZ5231BT1	1SMA5918BT3	1SMB5918BT3
5.6	MM3Z5V6T1	BZX84C5V6LT1	MMBZ5232BLT1	MMSZ5V6T1	MMSZ4690T1	MMSZ5232BT1	1SMA5919BT3	1SMB5919BT3
6.0			MMBZ5233BLT1			MMSZ5233BT1		
6.2	MM3Z6V2T1	BZX84C6V2LT1	MMBZ5234BLT1	MMSZ6V2T1	MMSZ4691T1	MMSZ5234BT1	1SMA5920BT3	1SMB5920BT3
6.8	MM3Z6V8T1	BZX84C6V8LT1	MMBZ5235BLT1	MMSZ6V8T1	MMSZ4692T1	MMSZ5235BT1	1SMA5921BT3	1SMB5921BT3
7.5	MM3Z7V5T1	BZX84C7V5LT1	MMBZ5236BLT1	MMSZ7V5T1	MMSZ4693T1	MMSZ5236BT1	1SMA5922BT3	1SMB5922BT3
8.2	MM3Z8V2T1	BZX84C8V2LT1	MMBZ5237BLT1	MMSZ8V2T1	MMSZ4694T1	MMSZ5237BT1	1SMA5923BT3	1SMB5923BT3
8.7			MMBZ5238BLT1		MMSZ4695T1	MMSZ5238BT1		
9.1	MM3Z9V1T1	BZX84C9V1LT1	MMBZ5239BLT1	MMSZ9V1T1	MMSZ4696T1	MMSZ5239BT1	1SMA5924BT3	1SMB5924BT3
10	MM3Z10VT1	BZX84C10LT1	MMBZ5240BLT1	MMSZ10T1	MMSZ4697T1	MMSZ5240BT1	1SMA5925BT3	1SMB5925BT3
11	MM3Z11VT1	BZX84C11LT1	MMBZ5241BLT1	MMSZ11T1	MMSZ4698T1	MMSZ5241BT1	1SMA5926BT3	1SMB5926BT3
12	MM3Z12VT1	BZX84C12LT1	MMBZ5242BLT1	MMSZ12T1	MMSZ4699T1	MMSZ5242BT1	1SMA5927BT3	1SMB5927BT3
13	MM3Z13VT1	BZX84C13LT1	MMBZ5243BLT1	MMSZ13T1	MMSZ4700T1	MMSZ5243BT1	1SMA5928BT3	1SMB5928BT3
14			MMBZ5244BLT1		MMSZ4701T1	MMSZ5244BT1		1SMB5929BT3
15	MM3Z15VT1	BZX84C15LT1	MMBZ5245BLT1	MMSZ15T1	MMSZ4702T1	MMSZ5245BT1	1SMA5929BT3	
16	MM3Z16VT1	BZX84C16LT1	MMBZ5246BLT1	MMSZ16T1	MMSZ4703T1	MMSZ5246BT1	1SMA5930BT3	1SMB5930BT3
17			MMBZ5247BLT1		MMSZ4704T1	MMSZ5247BT1		
18	MM3Z18VT1	BZX84C18LT1	MMBZ5248BLT1	MMSZ18T1	MMSZ4705T1	MMSZ5248BT1	1SMA5931BT3	1SMB5931BT3
19			MMBZ5249BLT1		MMSZ4706T1	MMSZ5249BT1		
20	MM3Z20VT1	BZX84C20LT1	MMBZ5250BLT1	MMSZ20T1	MMSZ4707T1	MMSZ5250BT1	1SMA5932BT3	1SMB5932BT3
22	MM3Z22VT1	BZX84C22LT1	MMBZ5251BLT1	MMSZ22T1	MMSZ4708T1	MMSZ5251BT1	1SMA5933BT3	1SMB5933BT3
24	MM3Z24VT1	BZX84C24LT1	MMBZ5252BLT1	MMSZ24T1	MMSZ4709T1	MMSZ5252BT1	1SMA5934BT3	1SMB5934BT3
25			MMBZ5253BLT1		MMSZ4710T1	MMSZ5253BT1		
27	MM3Z27VT1	BZX84C27LT1	MMBZ5254BLT1	MMSZ27T1	MMSZ4711T1	MMSZ5254BT1	1SMA5935BT3	1SMB5935BT3
28			MMBZ5255BLT1		MMSZ4712T1	MMSZ5255BT1		
30		BZX84C30LT1	MMBZ5256BLT1	MMSZ30T1	MMSZ4713T1	MMSZ5256BT1	1SMA5936BT3	1SMB5936BT3
33		BZX84C33LT1	MMBZ5257BLT1	MMSZ33T1	MMSZ4714T1	MMSZ5257BT1	1SMA5937BT3	1SMB5937BT3
36		BZX84C36LT1	MMBZ5258BLT1	MMSZ36T1	MMSZ4715T1	MMSZ5258BT1	1SMA5938BT3	1SMB5938BT3
39		BZX84C39LT1	MMBZ5259BLT1	MMSZ39T1	MMSZ4716T1	MMSZ5259BT1	1SMA5939BT3	1SMB5939BT3

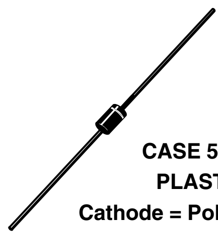
Zener Diodes — Regulation in Surface Mount (continued)

Table 2. Surface Mount Packages — .2, .225, .5, 1.5, 3 Watt (continued)

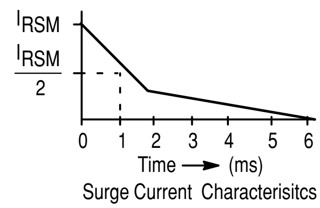
Nom–inal Zener Break–down Voltage	200 mW SOD–323	225 mW SOT-23		500 mW SOD-123			1.5 Watt SMA	3 Watt SMB
Volts	 Case 477 Style 1	 Plastic Case 318 TO-236AB		 Plastic Case 425, Style 1			 Plastic Case 403A Cathode = Notch	 Plastic Case 403B
43		BZX84C43LT1	MMBZ5260BLT1	MMSZ43T1	MMSZ4717T1	MMSZ5260BT1	1SMA5940BT3	1SMB5940BT3
47		BZX84C47LT1	MMBZ5261BLT1	MMSZ47T1		MMSZ5261BT1	1SMA5941BT3	1SMB5941BT3
51		BZX84C51LT1	MMBZ5262BLT1	MMSZ51T1		MMSZ5262BT1	1SMA5942BT3	1SMB5942BT3
56		BZX84C56LT1	MMBZ5263BLT1	MMSZ56T1		MMSZ5263BT1	1SMA5943BT3	1SMB5943BT3
60			MMBZ5264BLT1			MMSZ5264BT1		
62		BZX84C62LT1	MMBZ5265BLT1	MMSZ62T1		MMSZ5265BT1	1SMA5944BT3	1SMB5944BT3
68		BZX84C68LT1	MMBZ5266BLT1	MMSZ68T1		MMSZ5266BT1	1SMA5945BT3	1SMB5945BT3
75	MM3Z75VT1	BZX84C75LT1	MMBZ5267BLT1	MMSZ75T1		MMSZ5267BT1		1SMB5946BT3
82			MMBZ5268BLT1			MMSZ5268BT1		1SMB5947BT3
87			MMBZ5269BLT1			MMSZ5269BT1		
91			MMBZ5270BLT1			MMSZ5270BT1		1SMB5948BT3
100								1SMB5949BT3
110								1SMB5950BT3
120								1SMB5951BT3
130								1SMB5952BT3
150								1SMB5953BT3
160								1SMB5954BT3
180								1SMB5955BT3
200								1SMB5956BT3

TVS — in Axial Leads

Table 3. Peak Power Dissipation (*500 Watts* @ 1 ms Surge)
Case 59-04 — Mini Mosorb



CASE 59-04 (Mini Mosorb™)
PLASTIC
Cathode = Polarity Band



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 35 A Pulse (except bidirectional devices).

Working Peak Reverse Voltage V_{RWM} (Volts)	Device	Breakdown Voltage V_{BR} (Volts) Min	Breakdown Voltage V_{BR} (Volts) Max	@ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
5	***SA5.0A***	6.4	7	10	600	54.3	9.2
6	***SA6.0A***	6.67	7.37	10	600	48.5	10.3
6.5	SA6.5A	7.22	7.98	10	400	44.7	11.2
7	SA7.0A	7.78	8.6	10	150	41.7	12
7.5	SA7.5A	8.33	9.21	1	50	38.8	12.9
8	SA8.0A	8.89	9.83	1	25	36.7	13.6
8.5	SA8.5A	9.44	10.4	1	5	34.7	14.4
9	SA9.0A	10	11.1	1	1	32.5	15.4
10	SA10A	11.1	12.3	1	1	29.4	17
11	***SA11A***	12.2	13.5	1	1	27.4	18.2
12	***SA12A***	13.3	14.7	1	1	25.1	19.9
13	SA13A	14.4	15.9	1	1	23.2	21.5
14	SA14A	15.6	17.2	1	1	21.5	23.2
15	***SA15A***	16.7	18.5	1	1	20.6	24.4
16	SA16A	17.8	19.7	1	1	19.2	26
17	SA17A	18.9	20.9	1	1	18.1	27.6
18	SA18A	20	22.1	1	1	17.2	29.2
20	SA20A	22.2	24.5	1	1	15.4	32.4
22	SA22A	24.4	26.9	1	1	14.1	35.5
24	SA24A	26.7	29.5	1	1	12.8	38.9
26	SA26A	28.9	31.9	1	1	11.9	42.1
28	SA28A	31.1	34.4	1	1	11	45.4
30	SA30A	33.3	36.8	1	1	10.3	48.4
33	SA33A	36.7	40.6	1	1	9.4	53.3

For bidirectional types use CA suffix, ***SA6.5CA, SA12CA, SA13CA and SA15CA*** are ON Semiconductor preferred devices. Have cathode polarity band on each end. (Consult factory for availability).

TVS — in Axial Leads (continued)

Table 3. Peak Power Dissipation (*500 Watts* @ 1 ms Surge)
Case 59-04 — Mini Mosorb (continued)

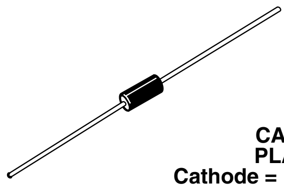
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 35 A Pulse (except bidirectional devices).

Working Peak Reverse Voltage V_{RWM} (Volts)	Device	Breakdown Voltage V_{BR} (Volts) Min	Max	@ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
36	SA36A	40	44.2	1	1	8.6	58.1
40	SA40A	44.4	49.1	1	1	7.8	64.5
43	SA43A	47.8	52.8	1	1	7.2	69.4
45	SA45A	50	55.3	1	1	6.9	72.7
48	SA48A	53.3	58.9	1	1	6.5	77.4
51	SA51A	56.7	62.7	1	1	6.1	82.4
54	SA54A	60	66.3	1	1	5.7	87.1
58	SA58A	64.4	71.2	1	1	5.3	93.6
60	SA60A	66.7	73.7	1	1	5.2	96.8
64	SA64A	71.1	78.6	1	1	4.9	103
70	SA70A	77.8	86	1	1	4.4	113
75	SA75A	83.3	92.1	1	1	4.1	121
78	SA78A	86.7	95.8	1	1	4	126
85	SA85A	94.4	104	1	1	3.6	137
90	***SA90A***	100	111	1	1	3.4	146
100	SA100A	111	123	1	1	3.1	162
110	SA110A	122	135	1	1	2.8	177
120	SA120A	133	147	1	1	2.5	193
130	SA130A	144	159	1	1	2.4	209
150	SA150A	167	185	1	1	2.1	243
160	SA160A	178	197	1	1	1.9	259
170	SA170A	189	209	1	1	1.8	275

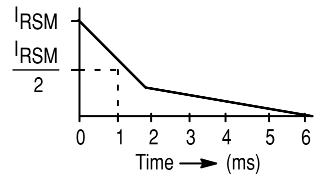
For bidirectional types use CA suffix, ***SA18CA*** and ***SA24CA*** are ON Semiconductor preferred devices.
Have cathode polarity band on each end. (Consult factory for availability).

TVS — in Axial Leads (continued)

Table 4. Peak Power Dissipation (*600 Watts* @ 1 ms Surge)
Case 17 — Surmetic 40



CASE 17
PLASTIC
Cathode = Polarity Band



Surge Current Characterisitcs

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse (except bidirectional devices).

Breakdown Voltage V_{BR} (Volts) Nom	@ I_T Pulse (mA)	Device	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
6.8	10	***P6KE6.8A***	5.8	1000	57	10.5
7.5	10	P6KE7.5A	6.4	500	53	11.3
8.2	10	P6KE8.2A	7.02	200	50	12.1
9.1	1	P6KE9.1A	7.78	50	45	13.4
10	1	P6KE10A	8.55	10	41	14.5
11	1	P6KE11A	9.4	5	38	15.6
12	1	P6KE12A	10.2	5	36	16.7
13	1	P6KE13A	11.1	5	33	18.2
15	1	***P6KE15A***	12.8	5	28	21.2
16	1	P6KE16A	13.6	5	27	22.5
18	1	P6KE18A	15.3	5	24	25.2
20	1	P6KE20A	17.1	5	22	27.7
22	1	P6KE22A	18.8	5	20	30.6
24	1	P6KE24A	20.5	5	18	33.2
27	1	P6KE27A	23.1	5	16	37.5
30	1	P6KE30A	25.6	5	14.4	41.4
33	1	P6KE33A	28.2	5	13.2	45.7
36	1	P6KE36A	30.8	5	12	49.9
39	1	P6KE39A	33.3	5	11.2	53.9
43	1	P6KE43A	36.8	5	10.1	59.3
47	1	P6KE47A	40.2	5	9.3	64.8
51	1	P6KE51A	43.6	5	8.6	70.1
56	1	P6KE56A	47.8	5	7.8	77
62	1	P6KE62A	53	5	7.1	85
68	1	P6KE68A	58.1	5	6.5	92
75	1	P6KE75A	64.1	5	5.8	103
82	1	P6KE82A	70.1	5	5.3	113
91	1	P6KE91A	77.8	5	4.8	125
100	1	P6KE100A	85.5	5	4.4	137
110	1	P6KE110A	94	5	4	152
120	1	P6KE120A	102	5	3.6	165
130	1	P6KE130A	111	5	3.3	179

For bidirectional types use CA suffix, ***P6KE7.5CA*** and ***P6KE11CA*** are ON Semiconductor preferred devices.

TVS — in Axial Leads (continued)

Table 4. Peak Power Dissipation (*600 Watts* @ 1 ms Surge)
Case 17 — Surmetic 40 (continued)

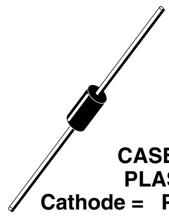
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse (except bidirectional devices).

Breakdown Voltage						
V_{BR} (Volts) Nom	@ I_T Pulse (mA)	Device	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
150	1	P6KE150A	128	5	2.9	207
160	1	P6KE160A	136	5	2.7	219
170	1	P6KE170A	145	5	2.6	234
180	1	P6KE180A	154	5	2.4	246
200	1	P6KE200A	171	5	2.2	274

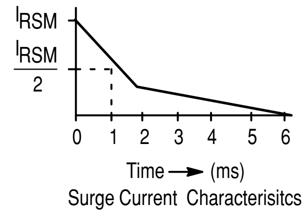
For bidirectional types use CA suffix. Have cathode polarity band on each end. (Consult factory for availability).

TVS — in Axial Leads (continued)

Table 5. Peak Power Dissipation (*1500 WATTS* @ 1 ms Surge)
Case 41A — Mosorb



CASE 41A
PLASTIC
Cathode = Polarity Band



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse)
(C suffix denotes standard back to back bidirectional versions. Test both polarities)

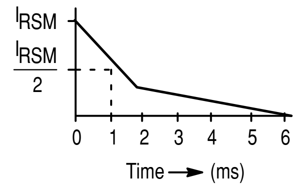
Max Reverse Stand-Off Voltage V_{RWM} (Volts)	JEDEC Device	Device	Breakdown Voltage		Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current I_{RSM} (Volts)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Clamping Voltage(9)	
			V_{BR} Volts Min	@ I_T Pulse (mA)				Peak Pulse Current @ I_{pp1} = 1 A V_{C1} (Volts max)	Peak Pulse Current @ I_{pp2} = 10 A V_{C2} (Volts max)
5	***1N5908***		6	1	300	120	8.5	7.6 @ 30 A	8 @ 60 A
5	***1N6373***	***ICTE-5***/MPTE-5	6	1	300	160	9.4	7.1	7.5
8	1N6374	ICTE-8/MPTE-8	9.4	1	25	100	15	11.3	11.5
8	1N6382	ICTE-8C/MPTE-8C	9.4	1	25	100	15	11.4	11.6
10	1N6375	ICTE-10/MPTE-10	11.7	1	2	90	16.7	13.7	14.1
10	1N6383	ICTE-10C/MPTE-10C	11.7	1	2	90	16.7	14.1	14.5
12	1N6376	ICTE-12/MPTE-12	14.1	1	2	70	21.2	16.1	16.5
12	1N6384	ICTE-12C/MPTE-12C	14.1	1	2	70	21.2	16.7	17.1
15	1N6377	ICTE-15/MPTE-15	17.6	1	2	60	25	20.1	20.6
15	1N6385	ICTE-15C/MPTE-15C	17.6	1	2	60	25	20.8	21.4
18	1N6378	ICTE-18/MPTE-18	21.2	1	2	50	30	24.2	25.2
18	1N6386	ICTE-18C/MPTE-18C	21.2	1	2	50	30	24.8	25.5
22	1N6379	ICTE-22/MPTE-22	25.9	1	2	40	37.5	29.8	32
22	1N6387	ICTE-22C/MPTE-22C	25.9	1	2	40	37.5	30.8	32
36	1N6380	ICTE-36/MPTE-36	42.4	1	2	23	65.2	50.6	54.3
36	1N6388	ICTE-36C/MPTE-36C	42.4	1	2	23	65.2	50.6	54.3
45	1N6381	ICTE-45/MPTE-45	52.9	1	2	19	78.9	63.3	70
45	1N6389	ICTE-45C/MPTE-45C	52.9	1	2	19	78.9	63.3	70

1N6382 thru 1N6389 and C suffix ICTE/MPTE device types are bidirectional. Have cathode polarity band on each end. All other device types are unidirectional only. (Consult factory for availability)

TVS — in Axial Leads (continued)

Table 6. Peak Power Dissipation *(1500 Watts* @ 1 ms Surge)
Case 41A – Mosorb

CASE 41A
PLASTIC
Cathode = Polarity Band



Surge Current Characterisitcs

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse

Breakdown Voltage V_{BR} Volts Nom	Breakdown Voltage @ I_T Pulse (mA)	JEDEC Device	Device	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
6.8	10	***1N6267A***	1.5KE6.8A	5.8	1000	143	10.5
7.5	10	1N6268A	1.5KE7.5A	6.4	500	132	11.3
8.2	10	1N6269A	1.5KE8.2A	7.02	200	124	12.1
9.1	1	1N6270A	1.5KE9.1A	7.78	50	112	13.4
10	1	1N6271A	1.5KE10A	8.55	10	103	14.5
11	1	1N6272A	1.5KE11A	9.4	5	96	15.6
12	1	1N6273A	1.5KE12A	10.2	5	90	16.7
13	1	1N6274A	1.5KE13A	11.1	5	82	18.2
15	1	***1N6275A***	1.5KE15A	12.8	5	71	21.2
16	1	1N6276A	1.5KE16A	13.6	5	67	22.5
18	1	1N6277A	1.5KE18A	15.3	5	59.5	25.2
20	1	1N6278A	1.5KE20A	17.1	5	54	27.7
22	1	1N6279A	***1.5KE22A***	18.8	5	49	30.6
24	1	***1N6280A***	1.5KE24A	20.5	5	45	33.2
27	1	***1N6281A***	1.5KE27A	23.1	5	40	37.5
30	1	***1N6282A***	1.5KE30A	25.6	5	36	41.4
33	1	***1N6283A***	1.5KE33A	28.2	5	33	45.7
36	1	1N6284A	1.5KE36A	30.8	5	30	49.9
39	1	***1N6285A***	***1.5KE39A***	33.3	5	28	53.9
43	1	1N6286A	1.5KE43A	36.8	5	25.3	59.3
47	1	1N6287A	1.5KE47A	40.2	5	23.2	64.8
51	1	***1N6288A***	1.5KE51A	43.6	5	21.4	70.1
56	1	1N6289A	1.5KE56A	47.8	5	19.5	77
62	1	1N6290A	1.5KE62A	53	5	17.7	85
68	1	1N6291A	1.5KE68A	58.1	5	16.3	92
75	1	1N6292A	1.5KE75A	64.1	5	14.6	103
82	1	1N6293A	1.5KE82A	70.1	5	13.3	113
91	1	1N6294A	1.5KE91A	77.8	5	12	125
100	1	1N6295A	1.5KE100A	85.5	5	11	137
110	1	1N6296A	1.5KE110A	94	5	9.9	152
120	1	1N6297A	1.5KE120A	102	5	9.1	165
130	1	1N6298A	1.5KE130A	111	5	8.4	179

For bidirectional types use CA suffix on 1.5KE series only. Have cathode polarity band on each end. (Consult factory for availability) 1N6267-6303A series do not have CA option since the CA is not included in EIA Registration.

TVS — in Axial Leads (continued)

Table 6. Peak Power Dissipation *(1500 Watts* @ 1 ms Surge)
Case 41A – Mosorb (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse							
Breakdown Voltage							
V_{BR} Volts Nom	@ I_T Pulse (mA)	JEDEC Device	Device	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
150	1	1N6299A	1.5KE150A	128	5	7.2	207
160	1	1N6300A	1.5KE160A	136	5	6.8	219
170	1	1N6301A	1.5KE170A	145	5	6.4	234
180	1	1N6302A	1.5KE180A	154	5	6.1	246
200	1	1N6303A	1.5KE200A	171	5	5.5	274
220	1		1.5KE220A	185	5	4.6	328
250	1		1.5KE250A	214	5	5	344

For bidirectional types use CA suffix. Have cathode polarity band on each end. (Consult factory for availability). 1N6267-6303A series do not have CA option since the CA is not included in EIA Registration.

TVS — in Surface Mount

Table 7. 1SMA Series Unidirectional Overvoltage Transient Suppressors; 400 Watts Peak Power

ELECTRICAL CHARACTERISTICS (V_F = 3.5 Volts @ I_F = 40 A for all types)

Device	Reverse Stand–off Voltage V_{RWM} (Volts)	Breakdown Voltage		Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Devce Marking
		V_{BR} Volts (Min)	I_T mA				
 SMA CASE 403B–01 PLASTIC							
1SMA5.0AT3	5.0	6.4	10	9.2	43.5	400	QE
1SMA6.0AT3	6.0	6.67	10	10.3	38.8	400	QG
1SMA6.5AT3	6.5	7.22	10	11.2	35.7	250	QK
1SMA7.0AT3	7.0	7.78	10	12.0	33.3	250	QM
1SMA7.5AT3	7.5	8.33	1	12.9	31.0	50	QP
1SMA8.0AT3	8.0	8.89	1	13.6	29.4	25	QR
1SMA8.5AT3	8.5	9.44	1	14.4	27.8	5.0	QT
1SMA9.0AT3	9.0	10	1	15.4	26.0	2.5	QV
1SMA10AT3	10	11.1	1	17.0	23.5	2.5	QX
1SMA11AT3	11	12.2	1	18.2	22.0	2.5	QZ
1SMA12AT3	12	13.3	1	19.9	20.1	2.5	RE
1SMA13AT3	13	14.4	1	21.5	18.6	2.5	RG
1SMA14AT3	14	15.6	1	23.2	17.2	2.5	RK
1SMA15AT3	15	16.7	1	24.4	16.4	2.5	RM
1SMA16AT3	16	17.8	1	26.0	15.4	2.5	RP
1SMA17AT3	17	18.9	1	27.6	14.5	2.5	RR
1SMA18AT3	18	20	1	29.2	13.7	2.5	RT
1SMA20AT3	20	22.2	1	32.4	12.3	2.5	RV
1SMA22AT3	22	24.4	1	35.5	11.3	2.5	RX
1SMA24AT3	24	26.7	1	38.9	10.3	2.5	RZ
1SMA26AT3	26	28.9	1	42.1	9.5	2.5	SE
1SMA28AT3	28	31.1	1	45.4	8.8	2.5	SG
1SMA30AT3	30	33.3	1	48.4	8.3	2.5	SK
1SMA33AT3	33	36.7	1	53.3	7.5	2.5	SM
1SMA36AT3	36	40	1	58.1	6.9	2.5	SP
1SMA40AT3	40	44.4	1	64.5	6.2	2.5	SR
1SMA43AT3	43	47.8	1	69.4	5.8	2.5	ST
1SMA45AT3	45	50	1	72.2	5.5	2.5	SV
1SMA48AT3	48	53.3	1	77.4	5.2	2.5	SX
1SMA51AT3	51	56.7	1	82.4	4.9	2.5	SZ
1SMA54AT3	54	60	1	87.1	4.6	2.5	TE
1SMA58AT3	58	64.4	1	93.6	4.8	2.5	TG
1SMA60AT3	60	66.7	1	96.8	4.1	2.5	TK
1SMA64AT3	64	71.1	1	103.0	3.9	2.5	TM
1SMA70AT3	70	77.8	1	113.0	3.5	2.5	TP
1SMA75AT3	75	83.3	1	121.0	3.3	2.5	TR
1SMA78AT3	78	86.7	1	126.0	3.2	2.5	TS

TVS — in Surface Mount (continued)

Table 8. 1SMA Series Bidirectional Zener Overvoltage Transient Suppressors; 400 Watts Peak Power

ELECTRICAL CHARACTERISTICS

Device	Reverse Stand–off Voltage V_{RWM} (Volts)	Breakdown Voltage		Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Devce Marking
		V_{BR} Volts (Min)	I_T mA				
 SMA CASE 403B–01 PLASTIC							
1SMA10CAT3	10	11.1	1	17.0	23.5	2.5	QXC
1SMA11CAT3	11	12.2	1	18.2	22.0	2.5	QZC
1SMA12CAT3	12	13.3	1	19.9	20.1	2.5	REC
1SMA13CAT3	13	14.4	1	21.5	18.6	2.5	RGC
1SMA14CAT3	14	15.6	1	23.2	17.2	2.5	RKC
1SMA15CAT3	15	16.7	1	24.4	16.4	2.5	RMC
1SMA16CAT3	16	17.8	1	26.0	15.4	2.5	RPC
1SMA17CAT3	17	18.9	1	27.6	14.5	2.5	RRC
1SMA18CAT3	18	20	1	29.2	13.7	2.5	RTC
1SMA20CAT3	20	22.2	1	32.4	12.3	2.5	RVC
1SMA22CAT3	22	24.4	1	35.5	11.3	2.5	RXC
1SMA24CAT3	24	26.7	1	38.9	10.3	2.5	RZC
1SMA26CAT3	26	28.9	1	42.1	9.5	2.5	SEC
1SMA28CAT3	28	31.1	1	45.4	8.8	2.5	SGC
1SMA30CAT3	30	33.3	1	48.4	8.3	2.5	SKC
1SMA33CAT3	33	36.7	1	53.3	7.5	2.5	SMC
1SMA36CAT3	36	40	1	58.1	6.9	2.5	SPC
1SMA40CAT3	40	44.4	1	64.5	6.2	2.5	SRC
1SMA43CAT3	43	47.8	1	69.4	5.8	2.5	STC
1SMA45CAT3	45	50	1	72.2	5.5	2.5	SVC
1SMA48CAT3	48	53.3	1	77.4	5.2	2.5	SXC
1SMA51CAT3	51	56.7	1	82.4	4.9	2.5	SZC
1SMA54CAT3	54	60	1	87.1	4.6	2.5	TEC
1SMA58CAT3	58	64.4	1	93.6	4.3	2.5	TGC
1SMA60CAT3	60	66.7	1	96.8	4.1	2.5	TKC
1SMA64CAT3	64	71.1	1	103.0	3.9	2.5	TMC
1SMA70CAT3	70	77.8	1	113.0	3.5	2.5	TPC
1SMA75CAT3	75	83.3	1	121.0	3.3	2.5	TRC
1SMA78CAT3	78	86.7	1	126.0	3.2	2.5	TSC

TVS — in Surface Mount (continued)

Table 9. 1SMB Series Unidirectional Overvoltage Transient Suppressors; 600 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted).

Device	Reverse Stand-Off Voltage V_R Volts (1)	Breakdown Voltage V_{BR} @ I_T Volts Min	mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R μA	Device Marking
 SMB CASE 403A PLASTIC							
1SMB5.0AT3	***5.0***	***6.40***	***10***	***9.2***	***65.2***	***800***	***KE***
1SMB6.0AT3	***6.0***	***6.67***	***10***	***10.3***	***58.3***	***800***	***KG***
1SMB6.5AT3	6.5	7.22	10	11.2	53.6	500	KK
1SMB7.0AT3	7.0	7.78	10	12.0	50.0	200	KM
1SMB7.5AT3	7.5	8.33	1.0	12.9	46.5	100	KP
1SMB8.0AT3	8.0	8.89	1.0	13.6	44.1	50	KR
1SMB8.5AT3	8.5	9.44	1.0	14.4	41.7	10	KT
1SMB9.0AT3	9.0	10.0	1.0	15.4	39.0	5.0	KV
1SMB10AT3	10	11.1	1.0	17.0	35.3	5.0	KX
1SMB11AT3	11	12.2	1.0	18.2	33.0	5.0	KZ
1SMB12AT3	12	13.3	1.0	19.9	30.2	5.0	LE
1SMB13AT3	13	14.4	1.0	21.5	27.9	5.0	LG
1SMB14AT3	14	15.6	1.0	23.2	25.8	5.0	LK
1SMB15AT3	15	16.7	1.0	24.4	24.0	5.0	LM
1SMB16AT3	16	17.8	1.0	26.0	23.1	5.0	LP
1SMB17AT3	17	18.9	1.0	27.6	21.7	5.0	LR
1SMB18AT3	18	20.0	1.0	29.2	20.5	5.0	LT
1SMB20AT3	20	22.2	1.0	32.4	18.5	5.0	LV
1SMB22AT3	***22***	***24.4***	***1.0***	***35.5***	***16.9***	***5.0***	***LX***
1SMB24AT3	24	26.7	1.0	38.9	15.4	5.0	LZ
1SMB26AT3	26	28.9	1.0	42.1	14.2	5.0	ME
1SMB28AT3	28	31.1	1.0	45.4	13.2	5.0	MG
1SMB30AT3	30	33.3	1.0	48.4	12.4	5.0	MK
1SMB33AT3	33	36.7	1.0	53.3	11.3	5.0	MM
1SMB36AT3	36	40.0	1.0	58.1	10.3	5.0	MP
1SMB40AT3	40	44.4	1.0	64.5	9.3	5.0	MR
1SMB43AT3	43	47.8	1.0	69.4	8.6	5.0	MT
1SMB45AT3	45	50.0	1.0	72.7	8.3	5.0	MV
1SMB48AT3	48	53.3	1.0	77.4	7.7	5.0	MX
1SMB51AT3	51	56.7	1.0	82.4	7.3	5.0	MZ
1SMB54AT3	54	60.0	1.0	87.1	6.9	5.0	NE
1SMB58AT3	***58***	***64.4***	***1.0***	***93.6***	***6.4***	***5.0***	***NG***
1SMB60AT3	60	66.7	1.0	96.8	6.2	5.0	NK
1SMB64AT3	64	71.1	1.0	103	5.8	5.0	NM
1SMB70AT3	70	77.8	1.0	113	5.3	5.0	NP
1SMB75AT3	75	83.3	1.0	121	4.9	5.0	NR
1SMB78AT3	78	86.7	1.0	126	4.7	5.0	NT
1SMB85AT3	85	94.4	1.0	137	4.4	5.0	NV
1SMB90AT3	90	100	1.0	146	4.1	5.0	NX
1SMB100AT3	100	111	1.0	162	3.7	5.0	NZ
1SMB110AT3	110	122	1.0	177	3.4	5.0	PE
1SMB120AT3	120	133	1.0	193	3.1	5.0	PG
1SMB130AT3	130	144	1.0	209	2.9	5.0	PK
1SMB150AT3	150	167	1.0	243	2.5	5.0	PM
1SMB160AT3	160	178	1.0	259	2.3	5.0	PP
1SMB170AT3	170	189	1.0	275	2.2	5.0	PR

A transient suppressor is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

TVS — in Surface Mount (continued)

Table 10. 1SMB Series Bidirectional Overvoltage Transient Suppressors; 600 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted).

Device	Reverse Stand-Off Voltage V_R Volts	Breakdown Voltage V_{BR} @ I_T		Maximum Clamping Voltage V_C @ I_{PP} Volts	Peak Pulse Current I_{PP} Amps	Maximum Reverse Leakage @ V_R I_R μA	Device Marking
		Volts Min	mA				
 SMB CASE 403A PLASTIC							
1SMB10CAT3	10	11.1	1.0	17.0	35.3	5.0	KXC
1SMB11CAT3	11	12.2	1.0	18.2	33.0	5.0	KZC
1SMB12CAT3	12	13.3	1.0	19.9	30.2	5.0	LEC
1SMB13CAT3	13	14.4	1.0	21.5	27.9	5.0	LGC
1SMB14CAT3	14	15.6	1.0	23.2	25.8	5.0	LKC
1SMB15CAT3	***15***	***16.7***	***1.0***	***24.4***	***24.0***	***5.0***	***LMC***
1SMB16CAT3	16	17.8	1.0	26.0	23.1	5.0	LPC
1SMB17CAT3	17	18.9	1.0	27.6	21.7	5.0	LRC
1SMB18CAT3	18	20.0	1.0	29.2	20.5	5.0	LTC
1SMB20CAT3	20	22.2	1.0	32.4	18.5	5.0	LVC
1SMB22CAT3	22	24.4	1.0	35.5	16.9	5.0	LXC
1SMB24CAT3	24	26.7	1.0	38.9	15.4	5.0	LZC
1SMB26CAT3	26	28.9	1.0	42.1	14.2	5.0	MEC
1SMB28CAT3	28	31.1	1.0	45.4	13.2	5.0	MGC
1SMB30CAT3	30	33.3	1.0	48.4	12.4	5.0	MKC
1SMB33CAT3	33	36.7	1.0	53.3	11.3	5.0	MMC
1SMB36CAT3	36	40.0	1.0	58.1	10.3	5.0	MPC
1SMB40CAT3	40	44.4	1.0	64.5	9.3	5.0	MRC
1SMB43CAT3	43	47.8	1.0	69.4	8.6	5.0	MTC
1SMB45CAT3	45	50.0	1.0	72.7	8.3	5.0	MVC
1SMB48CAT3	48	53.3	1.0	77.4	7.7	5.0	MXC
1SMB51CAT3	51	56.7	1.0	82.4	7.3	5.0	MZC
1SMB54CAT3	54	60.0	1.0	87.1	6.9	5.0	NEC
1SMB58CAT3	58	64.4	1.0	93.6	6.4	5.0	NGC
1SMB60CAT3	60	66.7	1.0	96.8	6.2	5.0	NKC
1SMB64CAT3	64	71.1	1.0	103	5.8	5.0	NMC
1SMB70CAT3	70	77.8	1.0	113	5.3	5.0	NPC
1SMB75CAT3	75	83.3	1.0	121	4.9	5.0	NRC
1SMB78CAT3	78	86.7	1.0	126	4.7	5.0	NTC

A transient suppressor is normally selected according to the reverse “Stand Off Voltage” (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

TVS — in Surface Mount (continued)

Table 11. P6SMB Series Unidirectional Overvoltage Transient Suppressors; 600 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A for all types.

SMB
CASE 403A
PLASTIC

Device	Breakdown Voltage V_{BR} @ I_T Volts Min	Nom	Max	mA	Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R μA	Maximum Reverse Surge Current I_{RSM} Amps	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} Volts	Maximum Temperature Coefficient of V_{BR} %/°C	Device Marking
P6SMB6.8AT3	***6.45***	***6.8***	***7.14***	***10***	***5.8***	***1000***	***57***	***10.5***	***0.057***	***6V8A***
P6SMB7.5AT3	***7.13***	***7.5***	***7.88***	***10***	***6.4***	***500***	***53***	***11.3***	***0.061***	***7V5A***
P6SMB8.2AT3	7.79	8.2	8.61	10	7.02	200	50	12.1	0.065	8V2A
P6SMB9.1AT3	8.65	9.1	9.55	1	7.78	50	45	13.4	0.068	9V1A
P6SMB10AT3	***9.5***	***10***	***10.5***	***1***	***8.55***	***10***	***41***	***14.5***	***0.073***	***10A***
P6SMB11AT3	10.5	11	11.6	1	9.4	5	38	15.6	0.075	11A
P6SMB12AT3	11.4	12	12.6	1	10.2	5	36	16.7	0.078	12A
P6SMB13AT3	***12.4***	***13***	***13.7***	***1***	***11.1***	***5***	***33***	***18.2***	***0.081***	***13A***
P6SMB15AT3	***14.3***	***15***	***15.8***	***1***	***12.8***	***5***	***28***	***21.2***	***0.084***	***15A***
P6SMB16AT3	***15.2***	***16***	***16.8***	***1***	***13.6***	***5***	***27***	***22.5***	***0.086***	***16A***
P6SMB18AT3	***17.1***	***18***	***18.9***	***1***	***15.3***	***5***	***24***	***25.2***	***0.088***	***18A***
P6SMB20AT3	***19***	***20***	***21***	***1***	***17.1***	***5***	***22***	***27.7***	***0.09***	***20A***
P6SMB22AT3	***20.9***	***22***	***23.1***	***1***	***18.8***	***5***	***20***	***30.6***	***0.092***	***22A***
P6SMB24AT3	22.8	24	25.2	1	20.5	5	18	33.2	0.094	24A
P6SMB27AT3	***25.7***	***27***	***28.4***	***1***	***23.1***	***5***	***16***	***37.5***	***0.096***	***27A***
P6SMB30AT3	***28.5***	***30***	***31.5***	***1***	***25.6***	***5***	***14.4***	***41.4***	***0.097***	***30A***
P6SMB33AT3	31.4	33	34.7	1	28.2	5	13.2	45.7	0.098	33A
P6SMB36AT3	***34.2***	***36***	***37.8***	***1***	***30.8***	***5***	***12***	***49.9***	***0.099***	***36A***
P6SMB39AT3	***37.1***	***39***	***41***	***1***	***33.3***	***5***	***11.2***	***53.9***	***0.1***	***39A***
P6SMB43AT3	40.9	43	45.2	1	36.8	5	10.1	59.3	0.101	43A
P6SMB47AT3	44.7	47	49.4	1	40.2	5	9.3	64.8	0.101	47A
P6SMB51AT3	***48.5***	***51***	***53.6***	***1***	***43.6***	***5***	***8.6***	***70.1***	***0.102***	***51A***
P6SMB56AT3	53.2	56	58.8	1	47.8	5	7.8	77	0.103	56A
P6SMB62AT3	58.9	62	65.1	1	53	5	7.1	85	0.104	62A
P6SMB68AT3	64.6	68	71.4	1	58.1	5	6.5	92	0.104	68A
P6SMB75AT3	71.3	75	78.8	1	64.1	5	5.8	103	0.105	75A
P6SMB82AT3	77.9	82	86.1	1	70.1	5	5.3	113	0.105	82A
P6SMB91AT3	86.5	91	95.5	1	77.8	5	4.8	125	0.106	91A
P6SMB100AT3	95	100	105	1	85.5	5	4.4	137	0.106	100A
P6SMB110AT3	105	110	116	1	94	5	4	152	0.107	110A
P6SMB120AT3	114	120	126	1	102	5	3.6	165	0.107	120A
P6SMB130AT3	124	130	137	1	111	5	3.3	179	0.107	130A
P6SMB150AT3	143	150	158	1	128	5	2.9	207	0.108	150A
P6SMB160AT3	***152***	***160***	***168***	***1***	***136***	***5***	***2.7***	***219***	***0.108***	***160A***
P6SMB170AT3	162	170	179	1	145	5	2.6	234	0.108	170A
P6SMB180AT3	171	180	189	1	154	5	2.4	246	0.108	180A
P6SMB200AT3	190	200	210	1	171	5	2.2	274	0.108	200A

TVS — in Surface Mount (continued)

Table 12. P6SMB Series Bidirectional Overvoltage Transient Suppressors; 600 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A for all types.

Device	Breakdown Voltage V_{BR} @ I_T Volts				Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R µA	Maximum Reverse Surge Current I_{RSM} Amps	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} Volts	Maximum Temperature Coefficient of V_{BR} %/°C	Device Marking
	Min	Nom	Max	mA						
 SMB CASE 403A PLASTIC										
P6SMB11CAT3	10.5	11	11.6	1	9.4	5	38	15.6	0.075	11C
P6SMB12CAT3	11.4	12	12.6	1	10.2	5	36	16.7	0.078	12C
P6SMB13CAT3	12.4	13	13.7	1	11.1	5	33	18.2	0.081	13C
P6SMB15CAT3	14.3	15	15.8	1	12.8	5	28	21.2	0.084	15C
P6SMB16CAT3	15.2	16	16.8	1	13.6	5	27	22.5	0.086	16C
P6SMB18CAT3	17.1	18	18.9	1	15.3	5	24	25.2	0.088	18C
P6SMB20CAT3	19	20	21	1	17.1	5	22	27.7	0.09	20C
P6SMB22CAT3	20.9	22	23.1	1	18.8	5	20	30.6	0.092	22C
P6SMB24CAT3	22.8	24	25.2	1	20.5	5	18	33.2	0.094	24C
P6SMB27CAT3	25.7	27	28.4	1	23.1	5	16	37.5	0.096	27C
P6SMB30CAT3	28.5	30	31.5	1	25.6	5	14.4	41.4	0.097	30C
P6SMB33CAT3	***31.4***	***33***	***34.7***	***1***	***28.2***	***5***	***13.2***	***45.7***	***0.098***	***33C***
P6SMB36CAT3	34.2	36	37.8	1	30.8	5	12	49.9	0.099	36C
P6SMB39CAT3	37.1	39	41	1	33.3	5	11.2	53.9	0.1	39C
P6SMB43CAT3	40.9	43	45.2	1	36.8	5	10.1	59.3	0.101	43C
P6SMB47CAT3	44.7	47	49.4	1	40.2	5	9.3	64.8	0.101	47C
P6SMB51CAT3	48.5	51	53.6	1	43.6	5	8.6	70.1	0.102	51C
P6SMB56CAT3	53.2	56	58.8	1	47.8	5	7.8	77	0.103	56C
P6SMB62CAT3	58.9	62	65.1	1	53	5	7.1	85	0.104	62C
P6SMB68CAT3	64.6	68	71.4	1	58.1	5	6.5	92	0.104	68C
P6SMB75CAT3	71.3	75	78.8	1	64.1	5	5.8	103	0.105	75C
P6SMB82CAT3	77.9	82	86.1	1	70.1	5	5.3	113	0.105	82C
P6SMB91CAT3	86.5	91	95.5	1	77.8	5	4.8	125	0.106	91C

TVS — in Surface Mount (continued)

Table 13. ISMC Series Unidirectional Overvoltage Transient Suppressors; 1500 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted).

Device	Reverse Stand-Off Voltage V_R Volts	Breakdown Voltage* V_{BR} @ I_T Volts Min	Breakdown Voltage* V_{BR} @ I_T mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R µA	Device Marking
 **SMC CASE 403B PLASTIC**							
1SMC5.0AT3	5.0	6.40	10	9.2	163.0	1000	GDE
1SMC6.0AT3	6.0	6.67	10	10.3	145.6	1000	GDG
1SMC6.5AT3	6.5	7.22	10	11.2	133.9	500	GDK
1SMC7.0AT3	7.0	7.78	10	12.0	125.0	200	GDM
1SMC7.5AT3	7.5	8.33	1.0	12.9	116.3	100	GDP
1SMC8.0AT3	8.0	8.89	1.0	13.6	110.3	50	GDR
1SMC8.5AT3	8.5	9.44	1.0	14.4	104.2	20	GDT
1SMC9.0AT3	9.0	10.0	1.0	15.4	97.4	10	GDV
1SMC10AT3	10	11.1	1.0	17.0	88.2	5.0	GDX
1SMC11AT3	11	12.2	1.0	18.2	82.4	5.0	GDZ
1SMC12AT3	12	13.3	1.0	19.9	75.3	5.0	GEE
1SMC13AT3	13	14.4	1.0	21.5	69.7	5.0	GEG
1SMC14AT3	14	15.6	1.0	23.2	64.7	5.0	GEK
1SMC15AT3	15	16.7	1.0	24.4	61.5	5.0	GEM
1SMC16AT3	16	17.8	1.0	26.0	57.7	5.0	GEP
1SMC17AT3	17	18.9	1.0	27.6	53.3	5.0	GER
1SMC18AT3	18	20.0	1.0	29.2	51.4	5.0	GET
1SMC20AT3	20	22.2	1.0	32.4	46.3	5.0	GEV
1SMC22AT3	22	24.4	1.0	35.5	42.2	5.0	GEX
1SMC24AT3	24	26.7	1.0	38.9	38.6	5.0	GEZ
1SMC26AT3	26	28.9	1.0	42.1	35.6	5.0	GFE
1SMC28AT3	28	31.1	1.0	45.4	33.0	5.0	GFG
1SMC30AT3	30	33.3	1.0	48.4	31.0	5.0	GFK
1SMC33AT3	33	36.7	1.0	53.3	28.1	5.0	GFM
1SMC36AT3	36	40.0	1.0	58.1	25.8	5.0	GFP
1SMC40AT3	40	44.4	1.0	64.5	23.2	5.0	GFR
1SMC43AT3	43	47.8	1.0	69.4	21.6	5.0	GFT
1SMC45AT3	45	50.0	1.0	72.7	20.6	5.0	GFV
1SMC48AT3	48	53.3	1.0	77.4	19.4	5.0	GFX
1SMC51AT3	51	56.7	1.0	82.4	18.2	5.0	GFZ
1SMC54AT3	54	60.0	1.0	87.1	17.2	5.0	GGE
1SMC58AT3	***58***	***64.4***	***1.0***	***93.6***	***16.0***	***5.0***	***GGG***
1SMC60AT3	60	66.7	1.0	96.8	15.5	5.0	GGK
1SMC64AT3	64	71.1	1.0	103	14.6	5.0	GGM
1SMC70AT3	70	77.8	1.0	113	13.3	5.0	GGP
1SMC75AT3	75	83.3	1.0	121	12.4	5.0	GGR
1SMC78AT3	78	86.7	1.0	126	11.4	5.0	GGT

A transient suppressor is normally selected according to the reverse “Stand Off Voltage” (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

TVS — in Surface Mount (continued)

Table 14. 1.5 SMC Series Unidirectional Overvoltage Transient Suppressors; 1500 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A for all types.

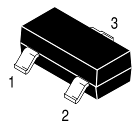
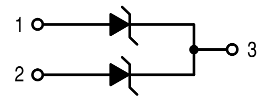
Device	Breakdown Voltage V_{BR} @ I_T Volts				Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R μA	Maximum Reverse Surge Current I_{RSM}† Amps	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} Volts	Maximum Temperature Coefficient of V_{BR} %/°C	Device Marking
	Min	Nom	Max	mA						
 SMC CASE 403B PLASTIC										
1.5SMC6.8AT3	6.45	6.8	7.14	10	5.8	1000	143	10.5	0.057	6V8A
1.5SMC7.5AT3	7.13	7.5	7.88	10	6.4	500	132	11.3	0.061	7V5A
1.5SMC8.2AT3	7.79	8.2	8.61	10	7.02	200	124	12.1	0.065	8V2A
1.5SMC9.1AT3	8.65	9.1	9.55	1	7.78	50	112	13.4	0.068	9V1A
1.5SMC10AT3	9.5	10	10.5	1	8.55	10	103	14.5	0.073	10A
1.5SMC11AT3	10.5	11	11.6	1	9.4	5	96	15.6	0.075	11A
1.5SMC12AT3	11.4	12	12.6	1	10.2	5	90	16.7	0.078	12A
1.5SMC13AT3	12.4	13	13.7	1	11.1	5	82	18.2	0.081	13A
1.5SMC15AT3	***14.3***	***15***	***15.8***	***1***	***12.8***	***5***	***71***	***21.2***	***0.084***	***15A***
1.5SMC16AT3	15.2	16	16.8	1	13.6	5	67	22.5	0.086	16A
1.5SMC18AT3	17.1	18	18.9	1	15.3	5	59.5	25.2	0.088	18A
1.5SMC20AT3	19	20	21	1	17.1	5	54	27.7	0.09	20A
1.5SMC22AT3	20.9	22	23.1	1	18.8	5	49	30.6	0.092	22A
1.5SMC24AT3	***22.8***	***24***	***25.2***	***1***	***20.5***	***5***	***45***	***33.2***	***0.094***	***24A***
1.5SMC27AT3	25.7	27	28.4	1	23.1	5	40	37.5	0.096	27A
1.5SMC30AT3	28.5	30	31.5	1	25.6	5	36	41.4	0.097	30A
1.5SMC33AT3	***31.4***	***33***	***34.7***	***1***	***28.2***	***5***	***33***	***45.7***	***0.098***	***33A***
1.5SMC36AT3	***34.2***	***36***	***37.8***	***1***	***30.8***	***5***	***30***	***49.9***	***0.099***	***36A***
1.5SMC39AT3	***37.1***	***39***	***41***	***1***	***33.3***	***5***	***28***	***53.9***	***0.1***	***39A***
1.5SMC43AT3	***40.9***	***43***	***45.2***	***1***	***36.8***	***5***	***25.3***	***59.3***	***0.101***	***43A***
1.5SMC47AT3	***44.7***	***47***	***49.4***	***1***	***40.2***	***5***	***23.2***	***64.8***	***0.101***	***47A***
1.5SMC51AT3	48.5	51	53.6	1	43.6	5	21.4	70.1	0.102	51A
1.5SMC56AT3	53.2	56	58.8	1	47.8	5	19.5	77	0.103	56A
1.5SMC62AT3	58.9	62	65.1	1	53	5	17.7	85	0.104	62A
1.5SMC68AT3	64.6	68	71.4	1	58.1	5	16.3	92	0.104	68A
1.5SMC75AT3	***71.3***	***75***	***78.8***	***1***	***64.1***	***5***	***14.6***	***103***	***0.105***	***75A***
1.5SMC82AT3	77.9	82	86.1	1	70.1	5	13.3	113	0.105	82A
1.5SMC91AT3	86.5	91	95.5	1	77.8	5	12	125	0.106	91A

Multiple TVS — Duals in Surface Mount (continued)

MMBZ15VDLT1

Table 15. SOT–23 Bipolar Zener Overvoltage Transient Suppressor; 40 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)
BIDIRECTIONAL (Circuit tied to pins 1 and 2)

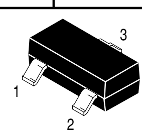
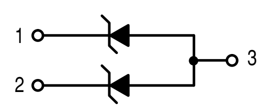
Breakdown Voltage V_{BR} (V) Min	Breakdown Voltage V_{BR} (V) Nom	Breakdown Voltage V_{BR} (V) Max	@ I_T (mA)	Reverse Voltage Working Peak V_{RWM} (V)	Max Reverse Leakage Current I_{RWM} I_R (nA)	Max Reverse Surge Current I_{RSM} (A)	Max Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (V)	Maximum Temperature Coefficient of V_{BR} (mV/°C)
				CASE 318–08 TO–236AB LOW PROFILE SOT–23				
14.3	15	15.8	1.0	12.8	100	1.9	21.2	12

Other Dual Common Cathode TVS
MMBZ27VCLT1 27 Volt Common Cathode

MMBZ5V6ALT1

Table 16. SOT–23 Dual Zener Overvoltage Transient Suppressor; 24 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)
UNIDIRECTIONAL (Circuit tied to pins 1 and 3 or Pins 2 and 3) (V_F = 0.9 V Max @ I_F = 10 mA)

Breakdown Voltage V_{BR} (V) Min	Breakdown Voltage V_{BR} (V) Nom	Breakdown Voltage V_{BR} (V) Max	@ I_T (mA)	Max Reverse Leakage Current I_R (µA)	@ V_R (V)	Max Zener Impedance Z_{ZT} (Ω)	@ I_{ZT} (mA)	Z_{ZK} (Ω)	@ I_{ZK} (mA)	Max Reverse Surge Current I_{RSM} (A)	Max Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (V)	Max Temp Co–efficient of V_{BR} (mV/°C)
					CASE 318–08 STYLE 12 LOW PROFILE SOT–23 PLASTIC							
5.32	5.6*	5.88	20	5.0	3.0	11		1600	0.25	3.0	8.0	1.26

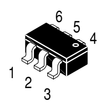
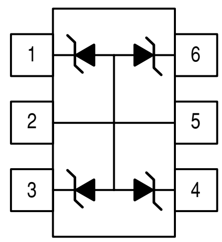
Other Dual Common Anode TVS
MMBZ6V2ALT1 6.2 Volt Common Anode
MMBZ6V8ALT1 6.8 Volt Common Anode
MMBZ15VALT1 15 Volt Common Anode
MMBZ20VALT1 20 Volt Common Anode
MMBZ33VALT1 33 Volt Common Anode

Multiple TVS — Quads in Surface Mount (continued)

MMQA Series

Table 17. SC–59 Quad Transient Voltage Suppressor; 24 Watts Peak Power

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)
UNIDIRECTIONAL (Circuit tied to pins 1, 2, and 5; Pins 2, 3, and 5; Pins 2, 4, and 5; or Pins 2, 5, and 6)
(V_F = 0.9 V Max @ I_F = 10 mA)

	Breakdown Voltage				Max Reverse Leakage Current		Max Zener Impedance	Max Reverse Surge Current	Max Reverse Voltage @ I_{RSM} (Clamping Voltage)	Max Temp Coef–ficient of V_Z
		V_{ZT} (V)		@ I_{ZT}	I_R	V_R				
Device	**Min**	**Nom**	**Max**	**(mA)**	**(nA)**	**(V)**	**Z_{ZT} (Ω) @ I_{ZT} (mA)**	**I_{RSM} (A)**	**V_{RSM} (V)**	**(mV/°C)**
	**CASE 318F-02 STYLE 1 SC-59 PLASTIC**									
MMQA5V6T1,T3	5.32	5.6	5.88	1.0	2000	3.0	400	3.0	8.0	1.26
MMQA6V2T1,T3	5.89	6.2	6.51	1.0	700	4.0	300	2.66	9.0	10.6
MMQA6V8T1,T3	6.46	6.8	7.14	1.0	500	4.3	300	2.45	9.8	10.9
MMQA12VT1,T3	11.4	12	12.6	1.0	75	9.1	80	1.39	17.3	14
MMQA13VT1,T3	12.4	13	13.7	1.0	75	9.8	80	1.29	18.6	15
MMQA15VT1,T3	14.3	15	15.8	1.0	75	11	80	1.1	21.7	16
MMQA18VT1,T3	17.1	18	18.9	1.0	75	14	80	0.923	26	19
MMQA20VT1,T3	19	20	21	1.0	75	15	80	0.84	28.6	20.1
MMQA21VT1,T3	20	21	22.1	1.0	75	16	80	0.792	30.3	21
MMQA22VT1,T3	20.9	22	23.1	1.0	75	17	80	0.758	31.7	22
MMQA24VT1,T3	22.8	24	25.2	1.0	75	18	100	0.694	34.6	25
MMQA27VT1,T3	25.7	27	28.4	1.0	75	21	125	0.615	39	28
MMQA30VT1,T3	28.5	30	31.5	1.0	75	23	150	0.554	43.3	32
MMQA33VT1,T3	31.4	33	34.7	1.0	75	25	200	0.504	48.6	37

TMOS Power MOSFETs

In Brief . . .

ON Semiconductors has been one of the premier suppliers of Power MOSFETs since the early 1980s and continues to develop new MOSFET products with the lowest possible on–resistance per silicon area. Continuing R&D has created MOSFET products that are manufactured with the same precision and versatility as the most advanced integrated circuits. The following new advances have been made in the area of silicon technology.

- New WaveFET™ high cell density MOSFETs utilizing ON Semiconductors's latest MOSFET technology provide ultra–low $R_{DS(on)}$ in both P– and N–channels in the SO–8 and DPAK surface mount packages and industry standard TO–220 package.
- New ESD FETs include monolithic back–to–back Zener diodes protecting the gate from ESD as well as providing extremely low $R_{DS(on)}$ in surface mount and through–hole packages.

Advances in packaging technology provide the end users with the broadest portfolio of surface mount MOSFETs in the industry. Advances in surface mount packaging from largest to smallest include:

- New Micro8 eight leaded low profile package for both single and dual MOSFETS.
- New TSOP–6 six leaded low profile package housing dual and single MOSFETs.
- New SC–70 three leaded package (smaller than a SOT–23) for single MOSFET chips.

Page

TMOS Power MOSFETs

TMOS Power MOSFETs Numbering System

Wherever possible, ON Semiconductors has used the following numbering systems for TMOS power MOSFET products.

MTP75N06HD

CIRCUIT IDENTIFIER
- X FOR ENGINEERING SAMPLES

TMOS
- T FOR TMOS
- L FOR SMARTDISCRETES
- G FOR IGBT (except MGSF)

PACKAGE TYPE
- P FOR PLASTIC TO–220
- D FOR DPAK
- A FOR TO–220 ISOLATED
- W FOR TO–247
- B FOR D^2PAK
- Y FOR TO–264

CURRENT

CHANNEL POLARITY, N OR P

VOLTAGE RATING DIVIDED BY 10

OPTIONAL SUFFIX:
- L FOR LOGIC LEVEL
- E FOR ENERGY RATED
- T4 FOR TAPE & REEL (DPAK/D^2PAK)
- RL FOR TAPE & REEL (DPAK)
- HD FOR HIGH CELL DENSITY
- V FOR TMOS V (FIVE)

Example of exceptions: MTD/MTP3055E
MTD/MTP2955E

SO–8 (MiniMOS)™, Micro8™, SOT–223, and TSOP–6 Power MOSFETs

MMSF4P01HDR1

CIRCUIT IDENTIFIER

TMOS
- M FOR MINIATURE

PACKAGE TYPE
- DF — DUAL FET (SO–8)
- SF — SINGLE FET (SO–8)
- FT — FET TRANSISTOR (SOT–223)
- MTSF — SINGLE FET (Micro8)
- MTDF — DUAL FET (Micro8)
- MGSF – TSOP–6, SOT–23

CURRENT

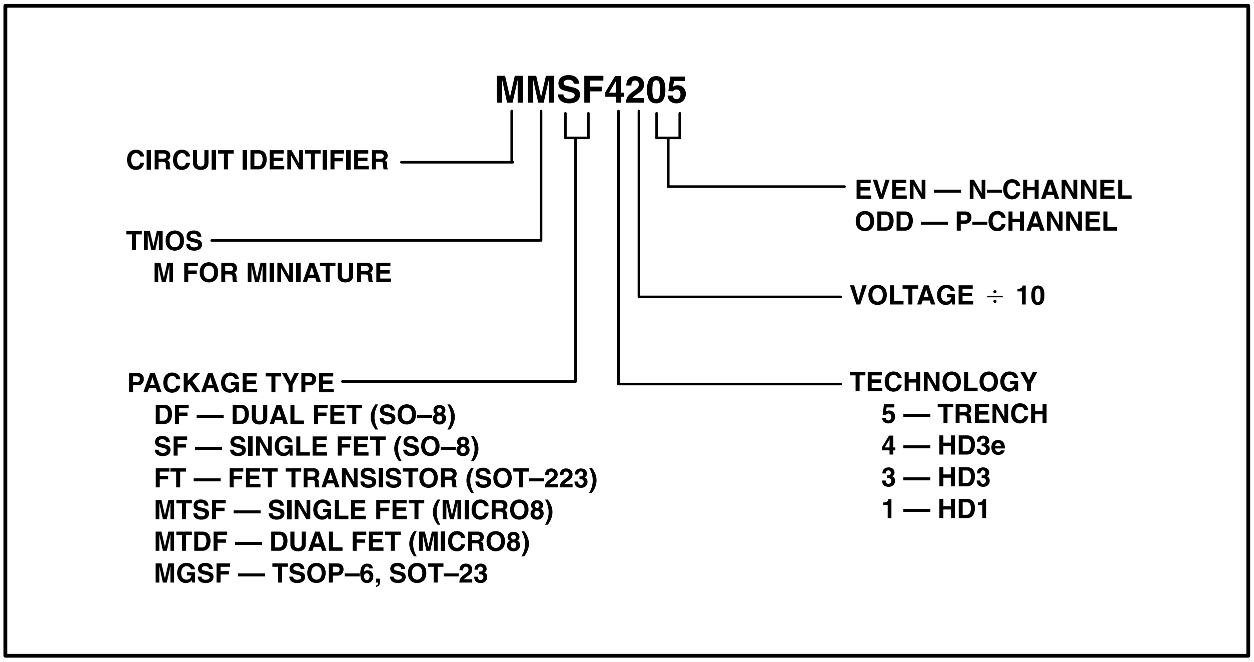
CHANNEL POLARITY, N OR P
- C FOR COMPLEMENTARY

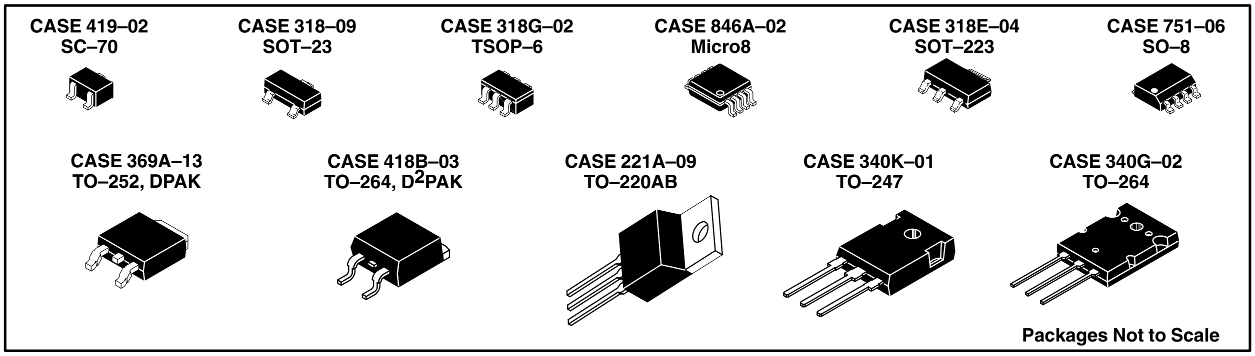
VOLTAGE RATING DIVIDED BY 10

OPTIONAL SUFFIX:
- E FOR ENERGY RATED
- HD FOR HIGH CELL DENSITY
- L FOR LOGIC LEVEL
- V FOR TMOS V (FIVE)
- Z FOR ESD

R1 AND R2 FOR TAPE & REEL
MiniMOS
T1 AND T3 FOR TAPE & REEL
SOT–223

Part Numbering System





TMOS® TMOS HD™ TMOS V™

Table 1. SO-8 (MiniMOS™) — Case 751–06

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (mΩ)	4.5 V (mΩ)	2.7 V (mΩ)	I_D (cont) Amps	Device(3)	P_D(1,2) (Watts) Max	Configuration
60	100	200	—	3.3	***MMDF3N06HD***	2.0	Dual N–Channel
50	300	500	—	1.5	***MMDF1N05E***		Dual N–Channel
40	80	100	—	3.4	***MMDF3N04HD***		
30	12.5	20	—	12	***MMSF3300***	2.5	Single N–Channel
	28	40	—	8	***MMSF7N03HD***		Single N–Channel
	40	50	—	5	***MMSF5N03HD***		Single N–Channel
	50/85	80/160	—	5.5/4.4	***MMDF4C03HD***		Complementary
	70	75	—	3	***MMDF3N03HD***	2.0	Dual N–Channel
	70/200(4)	75/300	—	2	***MMDF2C03HD***		Complementary
	85	160	—	4	***MMDF4P03HD***		Dual P–Channel
	35	50	—	6	***MMDFS6N303***		MOSFET/Schottky
	100	110	—	3	***MMSF3P03HD***	1.5	Single P–Channel
	200	300	—	2	***MMDF2P03HD***		Dual P–Channel
20	—	35	49*	6	***MMDF6N02HD***	2.5	Dual N–Channel
	25	40	—	8.2	***MMSF5N02HD***		Single N–Channel
	90	100	—	3	***MMDF3N02HD***	2.0	Dual N–Channel
	100	200	—	2	***MMDF2N02E***		
	250	400	—		***MMDF2P02E***		Dual P–Channel
	—	45	55	4	***MMDF4N01HD***		Dual N–Channel
	90/160(4)	100/180(4)	—		***MMDF2C02HD***		Complementary
	100/250(4)	200/400(4)	—		***MMDF2C02E***		
	—	30	45	6.4	***MMSF5P02HD***	2.5	Single P–Channel
	75	95	—	3	***MMSF3P02HD***	1.5	Dual P–Channel
	160	180	—	2	***MMDF2P02HD***		
12	—	45/180	55/220(4)	2	***MMDF2C01HD***	2.0	Complementary
	—	80	90	4	***MMSF4P01HD***	2.5	Single P–Channel
	—	180	220	2	***MMDF2P01HD***	2.0	Dual P–Channel

(1) $T_C = 25°C$
(2) Power rating when mounted on a 2″ square FR-4 board.
(3) Available in tape and reel only — R1 suffix = 500/reel, R2 suffix = 2500/reel.
(4) N-Channel/P-Channel $R_{DS(on)}$ with the minimum recommended footprint.
* $R_{DS(on)}$ @ V_{GS} other than listed.

Devices listed in ***bold, italic*** are ON Semiconductor preferred devices.

Table 2. EZFET™ — SO–8 Power MOSFETs with Zener Gate Protection — Case 751–06

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS}			I_D (cont) Amps	Device[3]	P_D[1,2] (Watts) Max	V_{GS} (Volts) Max	Configuration
	10 V (mΩ)	4.5 V (mΩ)	2.7 V (mΩ)					
50	300	500	—	2	***MMDF2N05Z***	2.0	±15	Dual N–Channel
30	13	18	—	10	***MMSF10N03Z***	1.6		Single N–Channel
20	—	15	19	6	***MMSF10N02Z***	2.5	±10	Single N–Channel
	—	27	35	5	***MMDF7N02Z***	2.0	±12	Dual N–Channel
30	30	40	—	7	***MMDF7N03Z***	1.6	±15	Dual N–Channel

(1) T_C = 25°C
(2) Power rating when mounted on 1" square copper pad on FR–4/G–10 Board (V_{GS} = 4.5 V, @ steady state).
(3) Available in tape and reel only — R1 suffix = 500/reel, R2 suffix = 2500/reel.

Table 3. Micro8™ — Case 846A–02

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS}			I_D (cont) Amps	Device[3]	P_D[1,2] (Watts) Max	Configuration
	10 V (mΩ)	4.5 V (mΩ)	2.7 V (mΩ)				
30	120	160	—	1	***MTDF1N03HD***	1.25	Dual N–Channel
	90	150	—	2.4	***MTSF2P03HD***	1.8	Single P–Channel
	40	60	—	3	***MTSF3N03HD***		Single N–Channel
20	—	120	160	1.7	***MTDF1N02HD***	1.25	Dual N–Channel
	—	175	280	1.6	***MTDF1P02HD***		Dual P–Channel
	—	160	190	1.5	***MTSF1P02HD***	1.8	Single P–Channel
	—	90	120	2.4	***MTSF2P02HD***	1.8	Single P–Channel
	—	40	50	3.8	***MTSF3N02HD***	1.8	Single N–Channel
	—	120/175	160/280	1.7	***MTDF1C02HD***	1.25	Complementary

(1) T_C = 25°C
(2) Power rating when mounted on 1" square copper pad on FR–4/G–10 Board (V_{GS} = 4.5 V, @ steady state).
(3) Available in tape and reel only — R1 suffix = 500/reel, R2 suffix = 2500/reel.

Table 4. SOT-223 — Case 318E–04

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS}			I_D (cont) Amps	Device[4]	P_D[1] (Watts) Max	Polarity
	10 V (Ω)	4.5 V (Ω)	2.7 V (Ω)				
100	0.25	—	—	1	***MMFT1N10E***	0.8[3]	N–Channel
60	—	0.14	—	1.5	***MMFT3055VL***[2]		N–Channel
	0.13	—	—	1.7	***MMFT3055V***		N–Channel
	0.30	—	—	1.2	***MMFT2955E***		P–Channel
20	—	0.15	—	2	***MMFT2N02EL***[2]		N–Channel
30	0.1		—	5.2	***MMFT5P03HD***	3.1	P–Channel

(1) T_C = 25°C
(2) $R_{DS(on)}$ @ V_{GS} = 5 V
(3) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.
(4) Available in tape and reel only — T1 suffix = 1000/reel, T3 suffix = 4000/reel.

Table 5. TSOP–6 — Case 318G–02

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS}			I_D (cont) Amps	Device	P_D[1,2] (Watts) Max	V_{GS} (Volts) Min	Polarity
	10 V (Ω)	4.5 V (Ω)	2.5 V (Ω)					
30	0.065	0.095	—	1.75	***MGSF3454X***	0.95	1.0	N–Channel
				4.2	***MGSF3454V***	2.0		N–Channel
	0.1	190		1.5	***MGSF3455X***	0.4		P–Channel
				3.5	***MGSF3455V***	2.0		P–Channel
20	—	0.07	0.095	1.7	***MGSF3442X***	0.5	0.6	N–Channel
				4.0	***MGSF3442V***	2.0		N–Channel
		0.90	.135	1.5	***MGSF3441X***	0.95	0.45	P–Channel
				3.3	***MGSF3441V***	2.0		P–Channel

(1) T_C = 25°C
(2) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.

Table 6. SOT–23 — Case 318–09

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	4.5 V (Ω)	2.5 V (Ω)	I_D (cont) Amps	Device	P_D(1,2) (Watts) Max	V_{GS} (Volts) Min	Polarity
60	5.0	—		0.5	***MMBF170LT1***	0.225	0.8	N–Channel
	7.5			0.12	***2N7002LT1***		1.0	N–Channel
50	—	10		0.1	***BSS84***			P–Channel
30	0.1	0.145		1.0	***MGSF1N03LT1***	0.4		N–Channel
20	0.09	0.13	—		***MGSF1N02LT1***			N–Channel
	1.0	1.4		0.3	***MMBF0201NLT1***	0.225		N–Channel
	—	0.26	0.5	0.75	***MGSF1P02ELT1***	0.4	0.7	P–Channel
	0.35	0.5	—		***MGSF1P02LT1***		1.0	P–Channel
	1.4	3.5		0.25	***MMBF0202PLT1***	0.225		P–Channel

(1) T_C = 25°C
(2) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.

Table 7. SC–70 / SOT–323 — Case 419–02

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	4.5 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device	P_D(1,2) (Watts) Max	V_{GS} (Volts) Min	Polarity
20	1.0	1.4	—	0.3	***MMBF2201NT1***	0.15	1.0	N–Channel
	2.2	3.5	—		***MMBF2202PT1***			P–Channel

(1) T_C = 25°C
(2) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.

Table 8. DPAK — Case 369A–13 (TO–252)

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	5.0 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device(4)	P_D(1,3) (Watts) Max
DPAK — N-Channel						
800	12	—	—	1	***MTD1N80E***	48
500	5	—	—	1	***MTD1N50E***	40
	3.60	—	—	2	***MTD2N50E***	
400	3.50	—	—	2	***MTD2N40E***	
250	1.40	—	—	3	***MTD3N25E***	
200	1.20	—	—	4	***MTD4N20E***	
100	0.25	—	—	9	***MTD9N10E***	
	0.14	—	—	14	***MTD14N10E***	72
60	—	0.18	—	12	***MTD3055VL***	48
	0.12	—	—	15	***MTD15N06V***	55
	0.15	—	—	8	***MTD3055V***	48
	0.045	—	—	20	***MTD20N06HD***	40
	—	0.045	—	20	***MTD20N06HDL***	
	0.080	—	—	20	***MTD20N06V***	60
30	0.010	0.016*	—	10.8	***MTD3302***	
	16	20*	—	25	***MTD1312***	72
	—	0.035	—	20	***MTD20N03HDL***	74
	0.022	0.029*	—	20	***MTD1302***	74
DPAK — P-Channel						
500	15.0	—	—	1	***MTD1P50E***	50
400	8	—	—	1	***MTD1P40E***	
60	0.45	—	—	5	***MTD5P06V***	40
	0.20	—	—	12	***MTD2955V***	60
	—	175	—	20	***MTD20P06HDL***	72
30	—	0.099	—	19	***MTD20P03HDL***	75

(1) T_C = 25°C
(3) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.
(4) Available in tape and reel — add T4 suffix to part number.
(5) ESD protected to 4 kV.
* $R_{DS(on)}$ @ V_{GS} other than specified.

Table 9. D^2PAK — Case 418B–03 (TO–264)

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	5.0 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device[4]	P_D[1,3] (Watts) Max
D^2PAK — N-Channel						
1200	5.0	—	—	3	***MTB3N120E***	125
1000	9	—	—	1	***MTB1N100E***	75
	4	—	—	3	***MTB3N100E***	125
800	3	—	—	4	***MTB4N80E***	
600	1.20	—	—	6	***MTB6N60E***	
	2.2	—	—	3	***MTB3N60E***	
500	0.80	—	—	8	***MTB8N50E***	
	1.5	—	—	4	***MTB4N50E***	
400	0.55	—	—	10	***MTB10N40E***	
250	0.45	—	—	9	***MTB9N25E***	80
200	0.16	—	—	20	***MTB20N20E***	125
150	0.07	—	—	29	***MTB29N15E***	
100	0.060	—	—	33	***MTB33N10E***	
100	0.04	—	—	40	***MTB40N10E***	169
60	—	0.05	—	30	***MTB30N06VL***	90
	0.04	—	—	32	***MTB36N06V***	
	0.028	—	—	42	***MTB50N06V***	125
	—	0.025	—	52	***MTB52N06VL***	188
	0.018	—	—	55	***MTB55N06Z***	136
	0.014	—	—	60	***MTB60N06HD***	125
	0.01	—	—	75	***MTB75N06HD***	
50	0.0095	—	—	75	***MTB75N05HD***	
	—	0.014	—	60	***MTB60N05HDL***	150
30	0.0065	—	—	75	***MTB1306***	150
25	—	0.009	—	75	***MTB75N03HDL***	125
D^2PAK — P-Channel						
60	0.12	—	—	23	***MTB23P06V***	90
	0.08	—	—	30	***MTB30P06V***	125
30	—	0.025	—	50	***MTB50P03HDL***	

(1) $T_C = 25°C$
(3) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.
(4) Available in tape and reel — add T4 suffix to part number.

Table 10. TO-220AB — Case 221A–09

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	5.0 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device	P_D(1) (Watts) Max
TO-220AB — N-Channel						
1200	5.0	—	—	3	***MTP3N120E***	125
1000	9	—	—	1	***MTP1N100E***	75
	4.0	—	—	3	***MTP3N100E***	125
800	3	—	—	4	***MTP4N80E***	
600	8	—	—	1	***MTP1N60E***	50
	3.80	—	—	2	***MTP2N60E***	
	2.20	—	—	3	***MTP3N60E***	75
	1.20	—	—	6	***MTP6N60E***	125
500	5	—	—	1	***MTP1N50E***	50
	3	—	—	3	***MTP3N50E***	50
	1.50	—	—	4	***MTP4N50E***	75
	0.80	—	—	8	***MTP8N50E***	125
400	3.50	—	—	2	***MTP2N40E***	50
	1.80	—	—	4	***MTP4N40E***	50
	1	—	—	5	***MTP5N40E***	75
	0.55	—	—	10	***MTP10N40E***	125
250	1.4	—	—	3	***MTP3N25E***	40
	0.45	—	—	9	***MTP9N25E***	75
	0.25	—	—	16	***MTP16N25E***	125
200	0.70	—	—	7	***MTP7N20E***	75
	0.16	—	—	20	***MTP20N20E***	125
150	0.07	—	—	29	***MTP29N15E***	125
	0.13	—	—	20	***MTP20N15E***	
100	0.25	—	—	10	***MTP10N10E***	75
	0.14	—	—	14	***IRF530***	78
	0.16	—	—	12	***MTP12N10E***	75
	0.077	—	—	27	***IRF540***	145
	0.070	—	—	27	***MTP27N10E***	125
	0.060	—	—	33	***MTP33N10E***	150
	0.04	—	—	40	***MTP40N10E***	169
60	—	0.18	—	12	***MTP3055VL***	48
	0.15	—	—	12	***MTP3055V***	
	0.12	—	—	15	***MTP15N06V***	55
	—	0.05	—	30	***MTP30N06VL***	90
	0.04	—	—	32	***MTP36N06V***	
	—	0.032	—	42	***MTP50N06VL***	150
	0.028	—	—	42	***MTP50N06V***	
	0.022	—	—	52	***MTP52N06V***	186
	—	0.025	—	52	***MTP52N06VL***	188
	0.014	—	—	60	***MTP60N06HD***	150
	0.01	—	—	75	***MTP75N06HD***	
50	—	0.10	—	15	***MTP15N05EL***	75
	0.0095	—	—	75	***MTP75N05HD***	150

Table 10. TO-220AB — Case 221A–09 (continued)

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	5.0 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device	P_D(1) (Watts) Max
TO-220AB — N-Channel (continued)						
30	0.0065	0.0085	—	75	***MTP1306***	150
	0.022	0.029	—	42	***MTP1302***	75
25	—	0.029	—	75	***MTP75N03HDL***	150
TO-220AB — P-Channel						
500	6	—	—	2	***MTP2P50E***	75
200	1	—	—	6	***MTP6P20E***	
100	0.30	—	—	12	***MTP12P10***	88
60	0.20	—	—	12	***MTP2955V***	60
	0.12	—	—	23	***MTP23P06V***	90
	0.08	—	—	30	***MTP30P06V***	125
30	—	0.025	—	50	***MTP50P03HDL***	125

(1) $T_C = 25°C$

Table 11. TO-247 (Isolated Mounting Hole) — Case 340K–01

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (Ω)	4.5 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device	P_D(1) (Watts) Max
TO-247 — N-Channel						
1000	1.50	—	—	6	***MTW6N100E***	180
	1.30	—	—	10	***MTW10N100E***	250
800	1	—	—	7	***MTW7N80E***	180
600	0.55	—	—	8	***MTW8N60E***	180
500	0.40	—	—	14	***MTW14N50E***	180
	0.24	—	—	20	***MTW20N50E***	250
400	0.24	—	—	16	***MTW16N40E***	180
	0.16	—	—	24	***MTW24N40E***	250
250	0.08	—	—	32	***MTW32N25E***	250
200	0.075	—	—	32	***MTW32N20E***	180
150	0.05	—	—	35	***MTW35N15E***	180
100	0.035	—	—	45	***MTW45N10E***	180

(1) $T_C = 25°C$

Table 12. TO-264 — Case 340G–02

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS}(2) 10 V (Ω)	4.5 V (Ω)	2.7 V (Ω)	I_D (cont) Amps	Device	P_D(1) (Watts) Max
TO-264 — N-Channel						
600	0.21	—	—	25	***MTY25N60E***	300
500	0.26	—	—	20	***MTY20N50E***	250
	0.15	—	—	30	***MTY30N50E***	300
200	0.028	—	—	55	***MTY55N20E***	

(1) $T_C = 25°C$
(2) V_{GS} = 10 V unless otherwise noted.

Table 13. Current Limit MOSFETs — SMARTDISCRETES™

$V_{(BR)DSS}$ (Volts) Min	Max $R_{DS(on)}$ @ V_{GS} 10 V (mΩ)	Max $R_{DS(on)}$ @ V_{GS} 4.5 V (mΩ)	Max $R_{DS(on)}$ @ V_{GS} 2.7 V (mΩ)	I_D (cont) Amps	Device	P_D(1) (Watts) Max
60 Clamped Voltage	0.75	—	—	Current Limited	***MLP1N06CL***	40
62 Clamped Voltage	0.4	—	—	Current Limited	MLP2N06CL	40

(1) T_C = 25°C
(2) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.
(3) Available in tape and reel — add T4 suffix to part number.

IGBT's

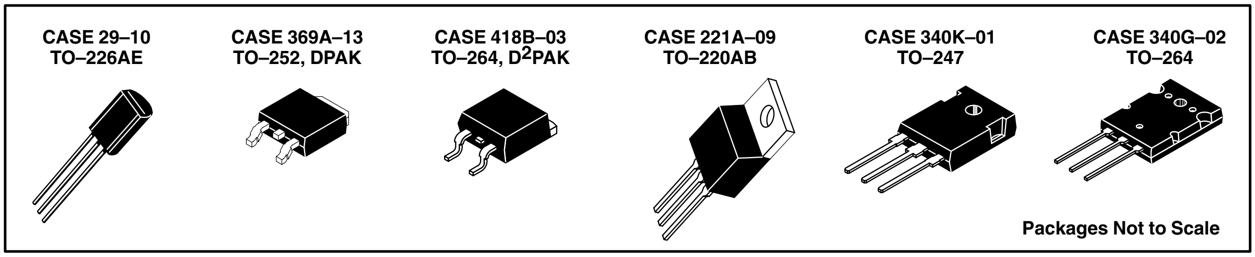


Table 14. Ignition IGBTs — SMARTDISCRETES™

BV_{CES} (Volts) Clamped	$V_{CE(on)}$ @ 10 A	Device	P_D(1) (Watts) Max	Package
140 V	1.8	***MGP20N14CL***	150	TO–220AB
350 V		***MGP20N35CL***	150	TO–220AB
400 V		***MGP20N40CL***	150	TO–220AB
		MGB20N40CL	2.5(2,3)	D^2PAK

(1) T_C = 25°C
(2) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum recommended footprint.
(3) Available in tape and reel — add T4 suffix to part number.

Table 15. TO–220AB — Short Circuit Capability Rated

$V_{(BR)CES}$ (V)	Device	I_C @ 90°C (A)	$V_{CE(on)}$ @ I_C typ (1) (V)	$V_{CE(on)}$ @ I_C typ (1) (A)	E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μS)	P_D(1) (W)
600	***MGP4N60E***	4.0	2.0	3.0	60	10	62.5
	MGP4N60ED						
	MGP7N60E	7.0		5.0	70		81
	MGP7N60ED						
	MGP11N60E	11		8.0	60		96
	MGP11N60ED	11	2.0	8.0	60	10	96
	MGP14N60E	14		10	63		112
	MGP21N60E	21	2.1	20	65		142
	MGP15N60U	15	1.7	8.0	63	—	96
	MGP20N60U(4)	20		10			112

(1) T_C = 25°C unless otherwise specified
(3) T_C = 125°C
(4) Non short circuit capability

Table 16. TO–247 — Short Circuit Capability Rated

$V_{(BR)CES}$ (V)	Device	I_C @ 90°C (A)	$V_{CE(on)}$ @ I_C typ (1)		E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μS)	P_D(1) (W)
			(V)	(A)			
600	*MGW14N60ED*	14	2.0	10	60	10	112
	MGW21N60ED	21	2.1	20	65		142
1200	*MGW12N120*	12	3.5	10	150		125
	MGW12N120D						
	MGW20N120	20	2.9	20	160		174

(1) T_C = 25°C unless otherwise specified
(3) T_C = 125°C

Table 17. TO–264 — Short Circuit Capability Rated

$V_{(BR)CES}$ (V)	Device	I_C @ 90°C (A)	$V_{CE(on)}$ @ I_C typ (1)		E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μS)	P_D(1) (W)
			(V)	(A)			
1200	*MGY20N120D*	20	2.9	20	160	10	174
	MGY25N120	25	3.0	25	216		212
	MGY25N120D						

(1) T_C = 25°C unless otherwise specified
(3) T_C = 125°C

Table 18. TO–226AE IGBT

$V_{(BR)CES}$ (V)	Device	I_C @ 90°C (A)	$V_{CE(on)}$ @ I_C typ (1)		E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μS)	P_D(1) (W)
			(V)	(A)			
600	*MGS05N60D*	0.3	1.6	0.3	16.2	—	1.0
	MGS13002D						

(1) T_C = 25°C unless otherwise specified
(3) T_C = 125°C
D suffix on part number indicates free wheeling diode is copackaged with IGBT

Bipolar Power Transistors

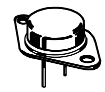
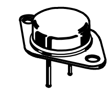
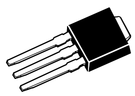
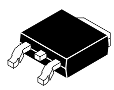
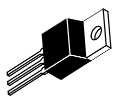
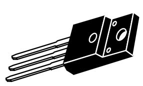
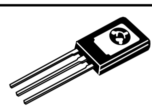
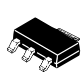
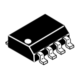
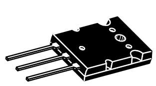
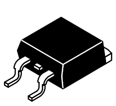
In Brief . . .

ON Semiconductor's broad line of Bipolar Power Transistors includes discrete and Darlington transistors in a variety of packages from the popular surface mount DPAK at 1.75 watts to the 250 watt TO-3 and TO–264. New products include the MJE/MJF 18000 series for lamp ballast and power supplies, MJW16212 — a new 1500 V deflection transistor for video monitor applications, and high performance audio output devices in the TO–264 package. We have the broadest line of Bipolar Power Transistors in the industry and the ON Semiconductor commitment to quality and total customer satisfaction to go with them.

Page

BIPOLAR POWER TRANSISTORS SELECTOR GUIDE

SELECTION BY PACKAGE

Package		I_C Range (Amps)	V_{CE} Range (Volts)	P_D (Watts)
	TO-204AA (TO-3) CASE 1-07	4-30	40-1500	90-250
	TO-204AE CASE 197A-05	50–80	60-1000	150-300
	DPAK CASE 369-07	0.5-10	40-400	12.5-20
	DPAK CASE 369A-13	0.5-10	40-400	12.5-20
	TO-220AB CASE 221A-09	0.5-15	30-1800	30-125
	ISOLATED TO-220 TYPE CASE 221D-02	1-12	80-450	20-45
	TO-225AA (TO-126 TYPE) CASE 77-09	0.3-5.0	25-400	12.5-40
	SOT–223 CASE 318E–04	3.0	30	2.0 (1)
	SO–8 CASE 751-06	3.0	30	2.0 (2)
	TO-264 CASE 340G-02	15-16	200-250	250
	D^2PAK CASE 418B-03	5.0–8.0	80–1000	50–65 W

(1) Tested on 1″ sq. FR4 Board
(2) Tested on 1″ sq., 2 oz. copper

ON Semiconductor Selector Guide – Discrete Devices

Table 1. PLASTIC TO–220AB — CASE 221A–09, Style 1

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
1	100	TIP29C	TIP30C	15/75	1	0.6 typ	0.3 typ	1	3	30
	250	TIP47		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	400	***TIP50***	***MJE5731A***	30/150	0.3	2 typ	0.18 typ	0.3	10	40
2	100	***TIP112***[2]	***TIP117***[2]	500 min	2	1.7 typ	1.3 typ	2	25[1]	50
	450/1000	***BUX85***		30	0.1	3.5	1.4	1	4	50
	450/1000	***MJE18002***		14/34	0.2	3	0.17	1	12 typ	40
3	100	***TIP31C***	***TIP32C***	25 min	1	0.6 typ	0.3 typ	1	3	40
4	80	***D44C12***	***D45C12***	40/120	0.2			1	40 typ	30
	400/700	***MJE13005***		6/30	3	3	0.7	3	4	60
5	100	***TIP122***[2]	***TIP127***[2]	1k min	3	1.5 typ	1.5 typ	4	4[1]	75
	400/700	***BUL45***		14/34	0.3	1.7	0.15	1	12 typ	75
	450/1000	MJE16002		5 min	5	3	0.3	3		80
	550/1200	***MJE18204***		18/35	0.5	2.75	0.2	2	12	75
6	100	***TIP41C***	***TIP42C***	15/75	3	0.4 typ	0.15 typ	3	3	65
	400/700	***BUL146***		14/34	0.5	1.75	0.15	3	14 typ	100
7	70	***2N6292***	***2N6107***	30/150	2	0.4 typ	0.15 typ	3	4	40
	150	BU407		30 min	1.5		0.75	5	10	60
8	100	***BDX53C***[2]	***BDX54C***[2]	750 min	3					
		TIP102[2]	***TIP107***[2]	1k/20k	3	1.5 typ	1.5 typ	3	4[1]	80
	150	***MJE15030***	***MJE15031***	20 min	4				30	50
	250	***MJE15032***	***MJE15033***	50 min	1				30	50
	350	***MJE13007***		5/30	5	3	0.7	5		80
			MJE5852	15 min	2	2	0.5	4		80
	400/700	***BUL147***		14/34	1	2.5	0.18	2	14 typ	125
10	60	***MJE3055T***	***MJE2955T***	20/70	4					75
	80	***2N6388***[2]	***2N6668***[2]	1k/20k	5				20[1]	65
		D44H11	***D45H11***	40 min	4	0.5 typ	0.14 typ	5	50 typ	50
	100	***BDX33C***[2]	***BDX34C***[2]	750 min	3				3	70
12	400/700	***MJE13009***		6/30	8	3	0.7	8	4	100
15	80	***D44VH10***	***D45VH10***	20 min	4	0.5	0.09	8	50 typ	83
	100	***BDW42***[2]	***BDW47***[2]	1k min	5	1 typ	1.5 typ	5	4	85

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington

Devices listed in bold, italic are ON Semiconductor preferred devices.

Table 2. PLASTIC TO–225AA Type (Formerly TO–126 Type) — CASE 77–09, Styles 1 & 3

		Device Type				Resistive Switching				
I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	NPN	PNP	h_{FE} Min/Max	@ I_C Amp	t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
0.3	350	***MJE3439***		40/160	0.02				15	15
0.5	200	***MJE344***		30/300	0.05				15	20.8
	250	2N5655		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
	300	***MJE340***	***MJE350***	30/240	0.05					20.8
	350	***2N5657***		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
1	80	***2N4923***	***2N4920***	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
1.5	45	BD135	BD136	40/250	0.15					12.5
	80	***BD139***	***BD140***	40/250	0.15					12.5
	400	***MJE13003***(1)		5/25	1	4	0.7	1	5	40
2	80	***BD237***	***BD238***	25 min	1				3	25
	100	***MJE270***(1)(2)	***MJE271***(1)(2)	1.5k min	0.12				6	15
3	60	MJE181	MJE171	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
	80	***MJE182***	***MJE172***	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
4	40	***MJE521***	***MJE371***	40 min	1					40
	45	***BD437***	***BD438***	40 min	2				3	36
	60		***BD440***	25 min	2				3	36
		BD677(2)	***BD678***(2)	750 min	1.5					40
		BD787	***BD788***	20 min	2				50	15
		2N5191	***2N5194***	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		MJE800(2)	***MJE700***(2)	750 min	1.5				1(3)	40
	80	***2N5192***	***2N5195***	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		BD679(2)	***BD680***(2)	750 min	1.5					40
		BD679A(2)	***BD680A***(2)	750 min	2					40
		MJE802(2)	MJE702(2)	750 min	1.5				1(3)	40
		MJE803(2)	***MJE703***(2)	750 min	2				1(3)	40
		2N6039(2)	***2N6036***(2)	750/18k	2	1.7 typ	1.2 typ	2	25	40
	100	***BD681***(2)	***BD682***(2)	750 min	1.5					40
		MJE243	***MJE253***	40/120	0.2	0.15 typ	0.07 typ	2	40	15
5	25	***MJE200***	***MJE210***	45/180	2	0.13 typ	0.035 ty p	2	65	15

(1) Case 77, Style 3
(2) Darlington
(3) | @ 1 MHz

Table 3. SO-8 — CASE 751–06, Style 16

		Device Type				Resistive Switching				
I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	NPN	PNP	h_{FE} Min/Max	@ I_C Amp	t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
3	30	***MMDJ3N03BJT***	***MMDJ3P03BJT***	50	1				3	2

Table 4. SURFACE MOUNT POWER PACKAGES
DPAK — CASE 369A-13 and 369-07

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
0.5	300	***MJD340***	***MJD350***	30/240	0.05					15
1	250	***MJD47***		30/150	0.3	2	0.2	0.3	10	15
	400	***MJD50***		30/150	0.3	2	0.2	0.3	10	15
2	100	***MJD112***(2)	***MJD117***(2)	1000 min	2	1.7	1.3	2	25(1)	20
	450/1000	***MJD18002D2***		6	1	1.2	.150	1.0 A	13 typ	25
3	40	***MJD31***	***MJD32***	10 min	1	0.6	0.3	1	3	15
	100	***MJD31C***	***MJD32C***	10 min	1	0.6	0.3	1	3	15
4	80	***MJD6039***(2)		1k/12k	2	1.7	1.2	2	25	20
	100	***MJD243***	***MJD253***	40/180	0.2	0.16	0.04	1	40	12.5
5	25	***MJD200***	***MJD210***	45/180	2	0.15	0.04	2	65	12.5
6	100	***MJD41C***	***MJD42C***	15/75	3	0.4	0.15	3	3	20
8	80	***MJD44H11***	***MJD45H11***	40 min	4	0.5	0.14	5	50 typ	20
	100	***MJD122***(2)	***MJD127***(2)	1k/12k	4	1.5	2	4	4(1)	20
10	60	***MJD3055***	***MJD2955***	20/100	4	1.5	1.5	3	2	20
	80	***MJD44E3***(2)		1k min	5	2	0.5	10		20

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington

Table 5. D^2PAK — CASE 418B-01, Style 1

I_CCont Amps Max	$V_{CEO(sus)}$ /V_{CES} Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Inductive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
5	450/1000	***MJB18004D2***		6	2	2.4	.175	2.5 A	13 typ	75
6	100	***MJB41C***	***MJB42C***	15/75	3				3	65
8	80	***MJB44H11***	***MJB45H11***	40/100	4	.5 typ	.14	5.0	40	50

Table 6. SOT-223 — CASE 318E–04, Style 1

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
3	30	***MMJT9410***	***MMJT9435***	50	1					0.8

Table 7. LARGE PLASTIC TO-264 — CASE 340G-02

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
15	200	***MJL3281A***	***MJL1302A***	60/175	0.1				30 typ	200
	650/1500	***MJL16218***		4/11	12				2.5 typ	170
16	250	***MJL21194***	***MJL21193***	25/75	8				4	200
16	250	***MJL21196***	***MJL21195***	25/75	8				4	200

Case 221D-02 is UL RECOGNIZED for its isolation feature. Case 221D-02 has been evaluated to 3500 volts RMS. Actual isolation rating depends on specific mounting position and maintaining required strike and creepage distances.

Table 8. PLASTIC (ISOLATED TO-220 TYPE) — CASE 221D–02, UL RECOGNIZED: File #E69369

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
			NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
1	250		***MJF47***		30/150	0.3	2 typ	0.17 typ	0.3	10	28
2	400	1000	***MJF18002***		14/34	0.2	2.75(3)	0.175(3)	1	13 typ	25
3	100		***MJF31C***	***MJF32C***	10 min	1	0.6	0.3	1	3	28
5	100		***MJF122***(2)	***MJF127***(2)	2000 min	3	1.5 typ	1.5 typ	3	4(1)	28
	400	700	***BUL45F***		14/34	0.3	1.7(3)	0.15(3)	1	12 typ	35
	450	1000	***BUT11AF***		10 min	.005	4	0.8	2.5		40
		1000	***MJF18004***		14/34	0.3	1.7(3)	0.15(3)	1	13 typ	35
6	400	700	***BUL146F***		14/34	0.5	2.5(3)	0.15(3)	3	14 typ	40
8	80			***MJF6107***	30/90	2	0.5 typ	0.13 typ	2	4	35
	150		***MJF15030***	***MJF15031***	40 min	3	1 typ	0.15 typ	3	30	35
	400	700	***MJF13007***		5/30	5	3	0.7	5	4	40
	450	1000	***MJF18008***		16/34	1	2.75(3)	0.18(3)	2	13 typ	45
10	60		***MJF3055***	***MJF2955***	20/100	4	—	—	—	2	40
	80		***MJF44H11***	***MJF45H11***	40/100	4	0.5 typ	0.14 typ	5	40	35
	100		***MJF6388***(2)	***MJF6668***(2)	3k/20k	3	1.5 typ	1.5 typ		20(1)	40

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington
(3) Switching tests performed w/special application simulator circuit. See data sheet for details.

Table 9. METAL TO–204AA (Formerly TO–3) — CASE 1–07
TO–204AE — CASE 197A–05, Style 1

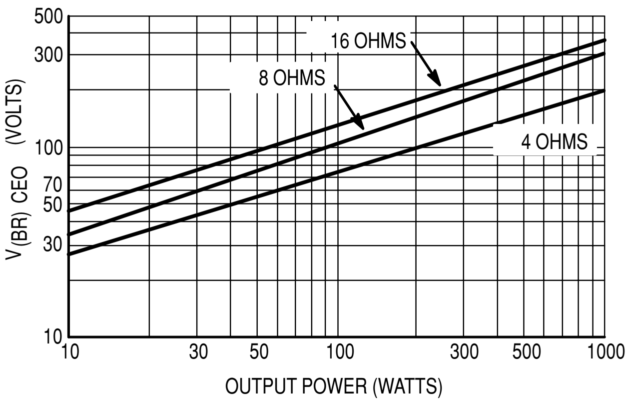
I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
4	250	***MJ15020***	***MJ15021***	30 min	1				20	150
10	80	2N3716	2N3792	30 min	3	0.3 typ	0.4 typ	5	4	150
		MJ3001 (2)	***MJ2501*** (2)	1k min	5					150
	250	***MJ15011***	***MJ15012***	20/100	2					200
	400	***MJ10012*** (2)		100/2k	6	15	15	6		175
12	100	***2N6059*** (2)	***2N6052*** (2)	750/18k	6	1.6 typ	1.5 typ	6	4 (1)	150
15	60	***2N3055***	***MJ2955***	20/70	4	0.7 typ	0.3 typ	4	2.5	115
	120	***MJ15015***	***MJ15016***	20/70	4	0.7 typ	0.3 typ	4	1	180
	140	MJ15001	MJ15002	25/150	4				2	200
	400/650	***MJ16110***		6/20	15	0.8 typ	0.1 typ	10		175
16	140	***2N3773***	2N6609	15/60	8	1.1 typ	1.5 typ	8	4	150
	200	MJ15022	MJ15023	15/60	8				5	250
	250	***MJ21194***	***MJ21193***	25/75	8				4	250
	250	***MJ21196***	***MJ21195***	25/75	8				5	250
20	80		2N6286 (2)	750/18k	10	2.5 typ	2.5 typ	10	4 (1)	160
	100	***2N6284*** (2)	***2N6287*** (2)	750/18k	10	2.5 typ	2.5 typ	10	4 (1)	160
	140	***MJ15003***	***MJ15004***	25/150	5				2	250
	400	***MJ13333***		10/60	5	4	0.7	10		175
	500	***MJ10009*** (2)		30/300	10	2	0.6	10	8 (1)	175
25	60	2N5885	2N5883	20/100	10	1	0.8	10	4	200
	150	***2N6341***		30/120	10	1	0.25	10	40	200
30	60	2N5302	2N4399	15/60	15	2	1	10	2	200
	100	***MJ802***	***MJ4502***	25/100	7.5				2	200
	120	***MJ11016*** (2)	***MJ11015*** (2)	1k min	20				4 (1)	200
	400/1000	***BUX98***		8 min	20	3	0.8	20		250
	450/850	MJ16020		5 min	30	1.8	0.2	20		250
40	400	***MJ10023*** (2)		50/600	10	2.5	0.9	20		250
50	80	***2N5686***	***2N5684***	15/60	25	0.5 typ	0.3 typ	25	2	300
	120	***MJ11032*** (2)	***MJ11033*** (2)	400 min	50					300
	125	***BUV20***		10 min	50	1.2	0.25	50	8	250
	400	***MJ10015*** (2)		10 min	40	2.5	1	20		250
60	80	***MJ14002***	***MJ14003***	15/100	50					300

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington

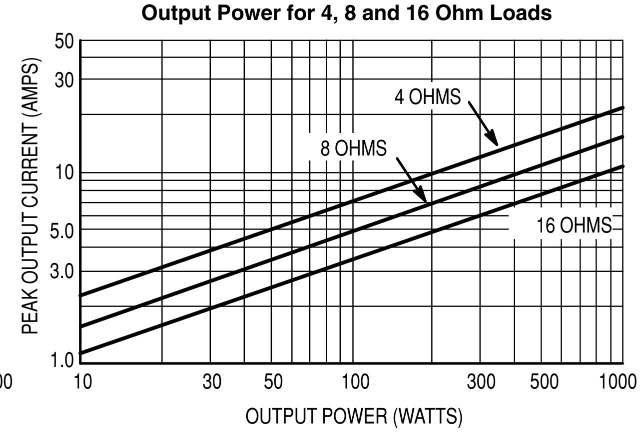
Audio

GENERAL DESIGN CURVES FOR POWER AUDIO OUTPUT STAGES

$V_{(BR)CEO}$ Required on Output and Driver Transistor versus Output Power for 4, 8 and 18 Ohm Loads



Output Transistor Peak Collector Current versus Output Power for 4, 8 and 16 Ohm Loads



Another important parameter that must be considered before selecting the output transistors is the safe–operating area these devices must withstand. For a complete discussion see Application Note AN485.

Table 10. Recommended Power Transistors for Audio/Servo Loads

RMS Power Output	NPN	PNP	Case	P_D Watts @ 25°C	V_{CEO}	h_{FE} @ Min/Max	I_C Amps	f_T MHz Typ	ISB Volts/Amps
To 25W	MJE15030	MJE15031	TO–220	50	150	20 min	4	30	14/3.6
	MJE15032	MJE15033	TO–220	50	250	50 min	1	40	50/1
25 to 50W	2N3055A	—	TO–204	120	120	20/70	4	3	60/2
	MJ15001	MJ15002	TO–204	200	140	25/150	4	3	40/5
50 to 100W	MJ15015	MJ15016	TO–204	180	120	20/70	4	3	60/3
	MJ15003	MJ15004	TO–204	250	140	25/150	5	3	100/1
	MJ15020	MJ15021	TO–204	150	250	30 min	1	20	50/3
Over 100W	MJ15024	MJ15025	TO–204	250	250	15/60	8	8	80/2.2
	MJL3281A	MJL1302A	340G–02	150	200	60/175	7	30	40/4
	MJ21194	MJ21193	TO–204	250	250	25/75	8	7	100/2
	MJL21194	MJL21193	340G–02	200	200	25/75	8	7	100/2
	MJ21195	MJ21195	TO–204	250	250	25/75	8	7	100/2
	MJL21196	MJL21195	340G–02	200	200	25/75	8	7	100/2

The Power Transistors shown are provided for reference only and show device capability. The final choice of the Power Transistors used is left to the circuit designer and depends upon the particular safe–operating area required and the mounting and heat sinking configuration used.

Bipolar Power Transistors for Electronic Lamp Ballasts

Table 11. PLASTIC TO–220AB — CASE 221A–09

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type	I_C Operating Amps	h_{FE} min @ I_C Operating V_{CE} = 1 V	Inductive Switching @ I_C Operating T_{si} Min/Max (μs)	P_D (Case) Watts @ 25°C
2	350	650	BUL43B	0.8	9	1.8 / 3.3	40
	400	700	BUL44	0.8	10	2.6 / 3.8	50
	400	700	BUL44D2*	0.8	20	2.05 / 2.35	50
	450	1000	MJE18002	1	6	/ 2.75	50
4	500	800	BUH50	2	8 typ	/ 2.5	50
5	400	700	BUL45	2	7	2.6 / 3.8	75
	400	700	BUL45D2*	2	10	1.95 / 2.25	75
	450	1000	MJE18004	2	6	/ 2.5	75
	450	1000	MJE18004D2*	2	6	2.1 / 2.4	75
	550	1200	MJE18204	2	5	/ 2.75	75
6	400	700	BUL146	3	8	2.6 / 3.8	100
	450	1000	MJE18006	3	6	/ 3.2	100
8	400	700	BUL147	4.5	8	2.6 / 3.8	125
	450	1000	MJE18008	4.5	6	/ 3.2	125
	550	1200	MJE18206	3	5	/ 2.75	100
10	400	700	BUH100	5	10 typ	/ 3.0	100
	450	1000	MJE18009	7	8	/ 2.75	150
15	400	700	BUH150	10	8 typ	/ 2.75	150

BUHXXX Series are specified for Halogen applications.
* D2 suffix indicates transistor with built in C–E freewheeling diode and antisaturation network.

Case 221D-02 is UL RECOGNIZED for its isolation feature. Case 221D-02 has been evaluated to 3500 volts RMS. Actual isolation rating depends on specific mounting position and maintaining required strike and creepage distances.

Table 12. PLASTIC (ISOLATED TO-220 TYPE) — CASE 221D–02, UL RECOGNIZED: File #E69369

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type	I_C Operating Amps	h_{FE} min @ I_C Operating V_{CE} = 1 V	Inductive Switching @ I_C Operating T_{si} Min/Max (µs)	P_D (Case) Watts @ 25°C
2	450	1000	MJF18002	1	6	/ 2.75	25
5	400	700	BUL45F	2	7	2.6 / 3.8	35
	450	1000	MJF18004	2	6	/ 2.5	35
	550	1200	MJF18204	2	5	/ 2.75	40
6	400	700	BUL146F	3	8	2.6 / 3.8	40
8	400	700	BUL147F	4.5	8	2.6 / 3.8	45
	450	1000	MJF18008	4.5	6	/ 3.2	45
10	450	1000	MJF18009	7	8	/ 2.75	50

Table 13. SURFACE MOUNT POWER PACKAGES
DPAK — CASE 369A-13 and 369-07

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type	I_C Operating Amps	h_{FE} min @ I_C Operating V_{CE} = 1 V	Inductive Switching @ I_C Operating T_{si} Min/Max (µs)	P_D (Case) Watts @ 25°C
2	350	650	BUD43B–1	0.8	9 typ	1.8 / 3.3	25
	400	700	BUD44D2–1*	0.8	20 typ	2.05 / 2.35	25

Table 14. SURFACE MOUNT POWER PACKAGES
DPAK — CASE 369A-13 and 369-07

I_CCont Amps Max	$V_{CEO(sus)}$ /V_{CES} Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Inductive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
2	450/1000	MJD18002D2		6	1	1.2	.150	1.0 A	13 typ	25

Table 15. D2PAK — 418B-01, Style 1

I_CCont Amps Max	$V_{CEO(sus)}$ /V_{CES} Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Inductive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
5	450/1000	MJB18004D2		6	2	2.4	.175	2.5 A	13 typ	75

Table 16. PLASTIC TO–225AA Type
(Formerly TO–126 Type) — CASE 77–09, Styles 1 & 3

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type	I_C Operating Amps	h_{FE} min @ I_C Operating V_{CE} = 1 V	Inductive Switching @ I_C Operating T_{si} Min/Max (µs)	P_D (Case) Watts @ 25°C
1.5	400	700	MJE13003	1	6 typ	/ 3.0	40
4	400	700	BUH51	1	8	/ 3.75	50

BUHXXX Series are specified for Halogen applications.
* D2 suffix indicates transistor with built in C–E freewheeling diode and antisaturation network.

Rectifiers

In Brief . . .

Continuing investment in research and development for discrete products has created a rectifier manufacturing facility that matches the precision and versatility of the most advanced integrated circuits. As a result, ON Semiconductor's silicon rectifiers span all high tech applications with quality levels capable of passing the most stringent environmental tests . . . including those for automotive under–hood applications.

Product Highlights:

- Surface Mount Devices — A major thrust has been the development and introduction of a broad range of power rectifiers, Schottky and Ultrafast, 1/2 amp to 25 amp, 15 to 600 volts.
- Application Specific Rectifiers —
  - — Schottky rectifiers having lower forward voltage drop (0.3 to 0.6 volts) for use in low voltage SMPS outputs and as "OR"ing diodes.
  - — MEGAHERTZ™ series for high frequency power supplies and power factor correction.
  - — Ultrasoft rectifiers for high speed rectification.
  - — Energy rated rectifiers with guaranteed energy handling capability.
  - — Automotive transient suppressors.
- Ultrafast rectifiers having reverse recovery times as low as 25 ns to complement the Schottky devices for higher voltage requirements in high frequency applications.
- A wide variety of package options to match virtually any potential requirement.

The rectifier selector section that follows has generally been arranged by package and technology. The individual tables have been sorted by voltage and current with the package types for the devices listed shown above each table. The Application Specific Rectifiers are also included in their respective tables.

ON Semiconductor's commitment to Six–Sigma is showing its worth. Refined processes no longer produce fallout as such and therefore only **ON Semiconductor Preferred Devices** are listed in the tables. The non–preferred devices will continue to be offered, but customers are encouraged to begin designing using the preferred types.

Page

RECTIFIER NUMBERING SYSTEM

PART NUMBER KEY XXX X XX XX XX X XX

- XXX — PREFIX (TYPE DESIGNATOR)
- X —
  - F = FULLY ISOLATED
  - A = SURFACE MT (SMA)
  - S = SURFACE MT (SMB/SMC)
  - D = DPAK
  - B = D^2PAK
  - H = MEGAHERTZ
  - M = POWERMITE
  - P = POWERTAP
- XX — I_O
- XX — V_R (X10 EXCEPT SCHOTTKY)
- XX — SUFFIX (DUAL DESIGNATOR)
- X —
  - R = REVERSE
  - L = LOW V_F
  - E = ENERGY
- XX — PACKAGING DESIGNATOR*

PREFIX KEY

MUR	=	ULTRA FAST RECTIFIER
MBR	=	(SCHOTTKY) BARRIER RECTIFIER
MR	=	STANDARD & FAST RECOVERY
MSR	=	ULTRASOFT

SUFFIX KEY

CT	=	CENTER TAP (DUAL) TO–220, POWERTAP, DPAK, D^2PAK
PT	=	CENTER TAP (DUAL) TO–218 PACKAGE
WT	=	CENTER TAP (DUAL) TO–247
–1	=	STRAIGHT LEAD D^2PAK

EXAMPLE:

MUR	30	20	WT
ULTRAFAST	30 AMP	200 V	CENTER TAP (DUAL) TO–247

EXAMPLE:

MBR	30	45	WT
SCHOTTKY	30 AMP	45 V	CENTER TAP (DUAL) TO–247

*For available packaging options consult Sales Office or see Data Sheet.

Application Specific Rectifiers

Table 1. Low V_F Schottky Rectifiers

Device	I_O Amps	V_{RRM} (Volts)	V_F @ Rated I_O and T_C = 25°C Volts (Max)	I_R @ Rated V_{RRM} mAmps (Max)	Package
MBR0520LT1, T3	0.5	20	0.33	0.25	SOD-123
MBRS130LT3	1	30	0.395	1	SMB
MBRD835L	8	35	0.41	1.4	DPAK
MBRD1035CTL	10	35	0.41	6	DPAK
MBR2030CTL	20	30	0.48	5	TO-220
MBRB2535CTL	25	35	0.41	10	D^2PAK
MBR2535CTL	25	35	0.41	5	TO-220
MBRB2515L	25	15	0.42	15	D^2PAK
MBR2515L	25	15	0.42	15	TO-220
MBRB3030CTL	30	30	0.51	5	D^2PAK
MBR4015LWT	40	15	0.42	5	TO-247
MBRP20030CTL	200	30	0.52	5	POWERTAP II
MBRP20035L	200	35	0.57	10	POWERTAP III
MBRP30035L	300	35	0.57	10	POWERTAP III
MBRP40045CTL	400	45	0.57	10	POWERTAP II
MBRP400100CTL	400	100	0.83	6	POWERTAP II
MBRP60035CTL	600	35	0.57	10	POWERTAP II

Table 2. MEGAHERTZ™ Rectifiers

Device	I_O Amps	V_{RRM} (Volts)	Maximum		t_{rr} (Nanosecond)
			V_F @ Rated I_O and Temp. (Volts)	I_R @ Rated V_{RRM} (mAmps)	
MURH840CT/MURHB840CT	8	400	1.7	0.01	28
MURH860CT	8	600	2.0	0.01	35
MURHB860CT	8	600	2.0	0.01	35
MURHF860CT	8	600	2.0	0.01	35

Table 3. UltraSoft Rectifiers (For High Speed Rectification)

Device	I_O Amps	V_{RRM} (Volts)	Max V_F @ I_F (Volts)	Max t_{rr} (ηSec)	T_JMax (°C)
MSRP10040	100	400	1.75 @ 100 A	75	150
MSRD620CT	6	200	1.2 @ 6.0 A	55	150
MSR860	8	600	1.7 @ 8.0 A	120	150

Application Specific Rectifiers (continued)

Table 4. Energy Rated Rectifiers

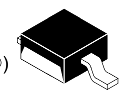
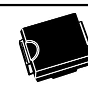
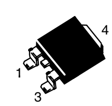
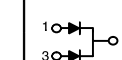
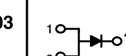
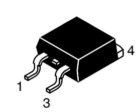
Device	I_O Amps	V_{RRM} (Volts)	Max V_F @ Rated unless Noted (Volts)	I_R @ V_{RRM} (mAmps)	Waval (M_J)
MUR180E	1.0	800	1.75	10	10
MUR1100E	1.0	1000	1.75	10	10
MUR480E	4.0	800	1.75	25	20
MUR4100E	4.0	1000	1.75	25	20
MUR880E	8.0	800	1.8	25	20
MUR8100E	8.0	1000	1.8	25	20
MUR10120E	10	1200	2.2 @ 6.5 A	100	20
MUR10150E	10	1500	2.5 @ 6.5 A	100	20
MUR5150E	5.0	1500	2.4	50	20

Table 5. Automotive Transient Suppressors

Device	I_O Amps	V_{RRM} (Volts)	Max V_F @ I_F (Volts)	I_{RSM} Amps	T_JMax (°C)
MR2535L	6.0	20	1.1 @ 100 A	62 @ 10 mS	175
MR2835S	32	23	1.1 @ 100 A	62 @ 10 mS	175
MR4027N, P	40	18	1.1 @ 100 A	110 @ 10 mS	200
MR4045N, P	40	30	1.1 @ 100 A	55 @ 10 mS	200

SCHOTTKY Rectifiers

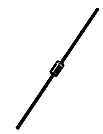
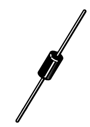
Table 6. Surface Mount Schottky Rectifiers

V_{RRM} (Volts)	I_O(1) (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R(2) T_J = 25°C (mA)	Max I_R(3) (mA)	Package	
20	0.5	T_L = 90°C	*MBR0520LT1* *MBR0520LT3*	0.310 @ 0.1 A 0.385 @ 0.5 A	5	125	.075 @ 10 V .250 @ 20 V	5 @ 10 V 8 @ 20 V	**CASE 425-04** (SOD-123) Cathode = Band 	
30	0.5	T_L = 100°C	*MBR0530T1* *MBR0530T3*	0.375 @ 0.1 A 0.430 @ 0.5 A	5	125	.020 @ 15 V .130 @ 30 V	—		
40	0.5	T_L = 110°C	*MBR0540T1* *MBR0540T3*	0.53 @ 0.5 A	5	150	.010 @ 20 V .020 @ 40 V	—		
20	1	T_C = 130°C	*MBRM120ET3*★	0.455 @ 0.1 A 0.530 @ 1.0 A	50	150	0.010 @ 20 V	1.6 @ 20 V	**CASE 457–04** (POWERMITE®) 	
20	1	T_{tab} ≤ 100°C	*MBRM120LT3*	0.36 @ 0.1 A 0.45 @ 1 A	50	125	0.4 @ 20 V	N/A		
40	1	T_{tab} ≤ 100°C	*MBRM140T3*	0.39 @ 0.1 A 0.55 @ 1 A	50	125	0.5 @ 40 V	N/A		
30	1	T_C ≤ 105°C	*MBRA130LT3*	0.41 @ 1 A 0.47 @ 2 A	25	125	1.0 @ 30 V 0.4 @ 15 V	25 @ 30 V	**CASE 403B–01** (SMA) 	
40	1	T_C ≤ 100°C	*MBRA140T3*	0.60 @ 1 A 0.73 @ 2 A	25	125	1.0 @ 40 V 0.2 @ 20 V	25 @ 40 V		
30	1	T_L = 120°C	*MBRS130LT3*★	0.395 @ 1.0 A	40	125	1	10	**CASE 403-03** (SMB) Cathode = Notch or Polarity Band 	
40	1	T_L = 115°C	*MBRS140T3*	0.6 @ 1.0 A	40	125	1	10		
40	2	T_C ≤ 95°C	*MBRS240LT3*	0.43 @ 2 A 0.53 @ 4 A	25	125	2.0 @ 40 V 0.5 @ 20 V	60 @ 40 V 40 @ 20 V		
40	2	T_C = 103°C	*MBRS2040LT3*★	0.43 @ 2 A 0.50 @ 4 A	70	125	0.80 @ 40 V 0.10 @ 20 V	20 @ 40 V 6.0 @ 20 V		
100	1	T_L = 120°C	*MBRS1100T3*	0.75 @ 1.0 A	40	150	0.5	5		
40	3	T_L = 100°C	*MBRS340T3*	0.525 @ 3.0 A	80	125	2	20	**CASE 403A-03** (SMC) Cathode = Notch 	
60	3	T_L = 100°C	*MBRS360T3*	0.74 @ 3.0 A	80	125	0.5	20		
60	3	T_C = 125°C	*MBRD360*	0.60 @ 3.0 A	75	150	0.2	20 @ 125°C	**CASE 369A-13** (DPAK) 	 "CT" Suffix  Non-"CT" Suffix
60	6	T_C = 130°C	*MBRD660CT*	0.70 @ 3.0 A	75	150	0.1	15 @ 125°C		
35	8	T_C = 100°C	*MBRD835L*	0.40 @ 3.0 A 0.51 @ 8.0 A	100	125	1.4	35		
35	10	T_C = 90°C	*MBRD1035CTL*	0.49 @ 10 A	100	125	2	130 @ 125°C		
45	15	T_C = 105°C	*MBRB1545CT*	0.84 @ 15 A	150	150	0.1	15 @ 125°C	**CASE 418B-03** (D²PAK) 	
60	20	T_C = 110°C	*MBRB2060CT*	0.95 @ 20 A	150	150	0.15	150 @ 125°C		
100	20	T_C = 110°C	*MBRB20100CT*	0.85 @ 10 A 0.95 @ 20 A	150	150	0.1	6 @ 125°C		
200	20	T_C = 125°C	*MBRB20200CT*	1.0 @ 20 A	150	150	1	50 @ 125°C		
15	25	T_C = 90°C	*MBRB2515L*	0.45 @ 25 A	150	100	15	200 @ 70°C		
35	25	T_C = 110°C	*MBRB2535CTL*	0.47 @ 12.5 A 0.55 @ 25 A	150	125	10	500 @ 125°C		
45	25	T_C = 130°C	*MBRB2545CT*	0.82 @ 30 A	150	150	0.2	40 @ 125°C		
30	30	T_C = 115°C	*MBRB3030CT*	0.54 @ 15 A 0.67 @ 30 A	300	150	1.2	145 @ 150°C 46 @ 10 V, 150°C		
30	30	T_C = 95°C	*MBRB3030CTL*★	0.45 @ 15 A 0.51 @ 30 A	150	125	2	195 @ 125°C 75 @ 10 V, 125°C		
30	40	T_C = 110°C	*MBRB4030*	0.46 @ 20 A 0.55 @ 40 A	300	150	1	150 @ 125°C		

(1)I_O is total device current capability.
(2)V_{RRM} unless noted
(3)V_{RRM}, T_J = 100°C unless noted
★ New Product

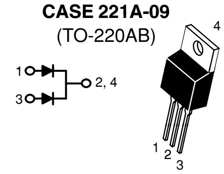
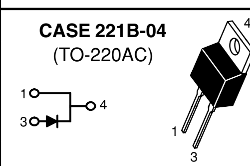
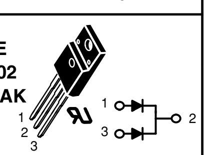
All devices listed are ON Semiconductor preferred devices

Table 7. Axial Lead Schottky Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_L = 25°C (mA)	Max I_R[3] T_L (mA)	Package
20	1	T_A = 55°C $R_{\theta JA}$ = 80°C/W	***1N5817***	0.45 @ 1.0 A	25	125	1	10	**CASE 59–04 Plastic**  Cathode = Polarity Band
30	1	T_A = 55°C $R_{\theta JA}$ = 80°C/W	***1N5818***	0.55 @ 1.0 A	25	125	1	10	
40	1	T_A = 55°C $R_{\theta JA}$ = 80°C/W	***1N5819***	0.60 @ 1.0 A	25	125	1	10	
60	1	T_A = 55°C $R_{\theta JA}$ = 80°C/W	***MBR160***	0.75 @ 1.0 A	25	150	0.5	5	
100	1	T_A = 120°C $R_{\theta JA}$ = 50°C/W	***MBR1100***	0.79 @ 1.0 A	50	150	0.5	5	
20	3	T_A = 76°C $R_{\theta JA}$ = 28°C/W	***1N5820***	0.457 @ 3.0 A	80	125	2	20	**CASE 267-03 Plastic**  Cathode = Polarity Band
30	3	T_A = 71°C $R_{\theta JA}$ = 28°C/W	***1N5821***	0.500 @ 3.0 A	80	125	2	20	
40	3	T_A = 61°C $R_{\theta JA}$ = 28°C/W	***1N5822***	0.525 @ 3.0 A	80	125	2	20	
40	3	T_A = 65°C $R_{\theta JA}$ = 28°C/W	***MBR340***	0.600 @ 3.0 A	80	150	0.6	20	
60	3	T_A = 65°C $R_{\theta JA}$ = 28°C/W	***MBR360***	0.740 @ 3.0 A	80	150	0.6	20	
100	3	T_A = 100°C $R_{\theta JA}$ = 28°C/W	***MBR3100***	0.79 @ 3.0 A	150	150	0.6	20	

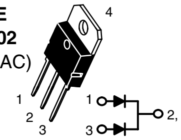
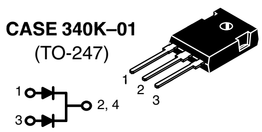
(2) V_{RRM} unless noted
(3) V_{RRM}, T_J = 100°C unless noted

Table 8. TO-220 and D^2PAK Thru–Hole Schottky Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_C = 25°C (mA)	Max I_R[3] (mA)	Package
45	15	T_C = 105°C	***MBR1545CT***	0.84 @ 15 A	150	150	0.1	15 @ 125°C	**CASE 221A-09** (TO-220AB) 
30	20	T_C = 137°C	***MBR2030CTL***	0.52 @ 10 A 0.58 @ 20 A	150	150	5	40	
45	20	T_C = 135°C	***MBR2045CT***	0.84 @ 20 A	150	150	0.1	15 @ 125°C	
60	20	T_C = 133°C	***MBR2060CT***	0.85 @ 10 A 0.95 @ 20 A	150	150	0.1	6 @ 125°C	
100	20	T_C = 133°C	***MBR20100CT***	0.85 @ 10 A 0.95 @ 20 A	150	150	0.1	6 @ 125°C	
200	20	T_C = 125°C	***MBR20200CT***	1.0 @ 20 A	150	150	1	50 @ 125°C	
15	25	T_C = 90°C	***MBR2515L***	0.45 @ 25 A	150	100	15	200 @ 70°C	
35	25	T_C = 95°C	***MBR2535CTL***	0.55 @ 25 A	150	125	5	500 @ 125°C	
45	25	T_C = 130°C	***MBR2545CT***	0.82 @ 30 A	150	150	0.2	40 @ 125°C	
45	30	T_C = 130°C	***MBR3045ST***	0.76 @ 30 A	150	150	0.2	40 @ 125°C	
45	7.5	T_C = 105°C	***MBR745***	0.84 @ 15 A	150	150	0.1	15 @ 125°C	**CASE 221B-04** (TO-220AC) 
45	10	T_C = 135°C	***MBR1045***	0.84 @ 20 A	150	150	0.1	15 @ 125°C	
60	10	T_C = 133°C	***MBR1060***	0.80 @ 10 A	150	150	0.1	6 @ 125°C	
100	10	T_C = 133°C	***MBR10100***	0.80 @ 10 A	150	150	0.1	6 @ 125°C	
45	16	T_C = 125°C	***MBR1645***	0.63 @ 16 A	150	150	0.2	40 @ 125°C	
100	20	T_C = 133°C	***MBRF20100CT***	0.95 @ 20 A	150	150	0.15	15 @ 125°C	**CASE 221D-02 FULL PAK** 
200	20	T_C = 125°C	***MBRF20200CT***	1.0 @ 20 A	150	150	1	50 @ 125°C	
45	25	T_C = 125°C	***MBRF2545CT***	0.82 @ 25 A	150	150	0.2	40 @ 125°C	

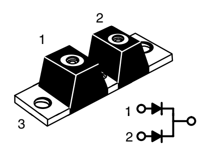
(2) V_{RRM} unless noted
(3) V_{RRM}, T_J = 100°C unless noted
UL Indicates UL Recognized — File #E69369

Table 9. TO-218 and TO-247 Schottky Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_C = 25°C (mA)	Max I_R[3] (mA)	Package
45	30	T_C = 105°C	***MBR3045PT***	0.76 @ 30 A	200	150	1	100 @ 125°C	**CASE 340D-02** (TO-218AC) 
45	40	T_C = 125°C	***MBR4045PT***	0.70 @ 20 A 0.80 @ 40 A	400	150	1	50	
45	60	T_C = 125°C	***MBR6045PT***	0.62 @ 30 A 0.75 @ 60 A	500	150	1	50	
45	30	T_C = 105°C	***MBR3045WT***	0.76 @ 30 A	200	150	1	100 @ 125°C	**CASE 340K–01** (TO-247) 
15	40	T_C = 125°C	***MBR4015LWT***	0.42 @ 20 A 0.50 @ 40 A	400	150	5	150 @ 75°C	
45	40	T_C = 125°C	***MBR4045WT***	0.70 @ 20 A 0.80 @ 40 A	400	150	1	50	
45	60	T_C = 125°C	***MBR6045WT***	0.62 @ 30 A 0.75 @ 60 A	500	150	1	50	
30	70	T_C = 135°C	***MBR7030WT***	0.55 @ 35 A 0.70	400	150	5	250	

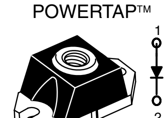
(2)V_{RRM} unless noted
(3)V_{RRM}, T_J = 100°C unless noted

Table 10. POWERTAP II Schottky Rectifiers

V_{RRM} (Volts)	I_O[1] (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_C = 25°C (mA)	Max I_R[3] (mA)	Package
30	200	T_C = 125°C	***MBRP20030CTL***	0.52 @ 100 A 0.60 @ 200 A	1500	150	5	—	**CASE 357C-03** POWERTAP™  Cathode = Mounting Plate Anode = Terminal
35	600	T_C = 100°C	***MBRP60035CTL***	0.57 @ 300 A	4000	150	10	250	
45	200	T_C = 125°C	***MBRP20045CT***	0.78 @ 100 A	1500	175	0.5	50 @ 125°C	
45	300	T_C = 120°C	***MBRP30045CT***	0.70 @ 150 A 0.82 @ 300 A	2500	175	0.8	75 @ 125°C	
45	400	T_C = 100°C	***MBRP40045CTL***	0.57 @ 200 A	2500	150	10	—	
60	200	T_C = 125°C	***MBRP20060CT***	0.800 @ 100 A	1500	175	0.5	50 @ 125°C	
60	300	T_C = 120°C	***MBRP30060CT***	0.79 @ 150 A 0.89 @ 300 A	2500	175	0.8	75 @ 125°C	
100	400	T_C = 100°C	***MBRP400100CTL***	0.83 @ 200 A	2500	150	6	—	

(1)I_O is total device current capability.
(2)V_{RRM} unless noted
(3)V_{RRM}, T_J = 100°C unless noted

Table 11. POWERTAP III Schottky Rectifiers

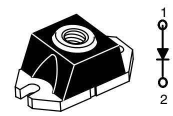
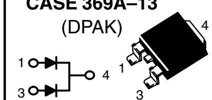
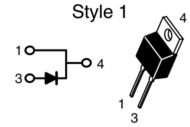
V_{RRM} (Volts)	I_O[1] (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_C = 25°C (μA)	Max I_R[3] (μA) T_J = 100°C	Package
35	200	T_C = 100°C	***MBRP20035L*** ★	0.57 @ 200 A	2000	150	10	250	**CASE 357D-01** POWERTAP™ 
	300	T_C = 100°C	***MBRP30035L*** ★	0.57 @ 300 A	3000	150	10	250	

(1)I_O is total device current capability.
(2)V_{RRM} unless noted
(3)V_{RRM}, T_J = 100°C unless noted

★ New Product

NEW UltraSoft Rectifiers

Table 12. UltraSoft Rectifiers (For High Speed Rectification)

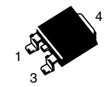
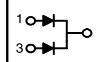
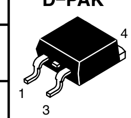
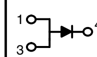
V_{RRM} (Volts)	I_O(1) (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_C = 29°C (Volts)	t_{rr} (ηSec)	T_J Max (°C)	Max I_R(2) T_C = 25°C (mA)	Max I_R(3) (mA) T_J = 100°C	Package
400	100	T_C = 100°C	***MSRP10040*** ★	1.75 @ 100 A	75	150	50	500	**CASE 357D-01** POWERTAP™ 
200	6	T_C = 145°C	***MSRD620CT*** ★	1.2 @ 6.0 A	55	150	0.001	500	**CASE 369A–13** (DPAK) 
600	8	T_C = 125°C	***MSR860***	1.7 @ 8.0 A	120	150	10 μA	1.0	**CASE 221B–03** Style 1 

(1) I_O is total device current capability.
(2) V_{RRM} unless noted
(3) V_{RRM}, T_J = 100°C unless noted

★ New Product

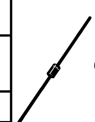
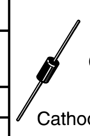
Ultrafast Rectifiers

Table 13. Surface Mount Ultrafast Rectifiers

V_{RRM} (Volts)	I_O(1) (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R(2) T_J = 25°C (µA)	Max I_R(4) (µA) Package	Package	
200	1	T_L = 155°C	***MURS120T3***	35	0.875 @ 1.0 A	40	175	2	50	**SMB** Cathode = Notch 	
600	1	T_L = 150°C	***MURS160T3***	75	1.25 @ 1.0 A	35	175	5	150		
200	3	T_L = 140°C	***MURS320T3***	35	0.875 @ 3.0 A	75	175	5	15	**SMC** Cathode = Notch 	
600	3	T_L = 130°C	***MURS360T3***	75	1.25 @ 3.0 A	75	175	10	250		
200	6	T_L = 145°C	***MURD620CT***	35	1.0 @ 3.0 A	63	175	5	250 @ 125°C	**DPAK** 	 "CT" Suffix
200	3	T_C = 158°C	***MURD320***	35	.95 @ 3.0 A	75	175	5	500 @ 125°C		
400	8	T_L = 120°C	***MURHB840CT***	28	2.2 @ 4.0 A	100	175	10	500	**D²PAK** 	 Non-"CT" Suffix
600	8	T_L = 120°C	***MURHB860CT***	35	2.8 @ 4.0 A	100	175	10	500		
200	16	T_L = 150°C	***MURB1620CT***	35	0.975 @ 8.0 A	100	175	5	250		

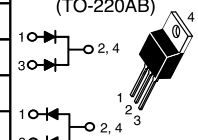
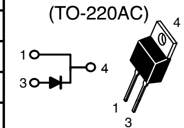
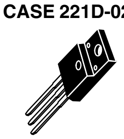
(1)I_O is total device current capability.
(2)V_{RRM} unless noted
(4)V_{RRM}, T_J = 150°C unless noted
★ New Product

Table 14. Axial Lead Ultrafast Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R(2) T_J = 25°C (µA)	Max I_R(4) (µA)	Package
200	1	T_A = 130°C $R_{θJA}$ = 50°C/W	***MUR120***	25	0.875 @ 1.0 A	35	175	2	50	 **CASE 59-04** Plastic Cathode = Polarity Band
600	1	T_A = 120°C $R_{θJA}$ = 50°C/W	***MUR160***	50	1.25 @ 1.0 A	35	175	5	150	
800	1	T_A = 95°C	***MUR180E***	100	1.75 @ 1.0 A	35	175	10	600	
1000	1	T_A = 95°C $R_{θJA}$ = 50°C/W	***MUR1100E***	75	1.75 @ 1.0 A	35	175	10	600 @ 100°C	
200	4	T_A = 80°C $R_{θJA}$ = 28°C/W	***MUR420***	25	0.875 @ 3.0 A	125	175	5	150	 **CASE 267-03** Plastic Cathode = Polarity Band
600	4	T_A = 40°C $R_{θJA}$ = 28°C/W	***MUR460***	50	1.25 @ 3.0 A	70	175	10	250	
800	4	T_A = 35°C	***MUR480E***	100	1.75 @ 3.0 A	70	175	25	900 @ 100°C	
1000	4	T_A = 35°C $R_{θJA}$ = 28°C/W	***MUR4100E***	75	1.75 @ 3.0 A	70	175	25	900 @ 100°C	

(2)V_{RRM} unless noted
(4)V_{RRM}, T_J = 150°C unless noted

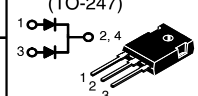
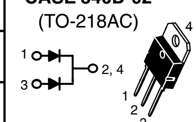
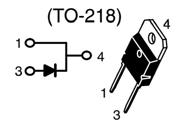
Table 15. TO-220 Ultrafast and MEGAHERTZ™ Rectifiers

V_{RRM} (Volts)	I_O[1] (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_C = 25°C (μA)	Max I_R[4] (μA)	Package
200	6	T_C = 130°C	***MUR620CT***	35	0.975 @ 3.0 A	75	175	5	250	**CASE 221A-09** (TO-220AB)  **MUR1620CTR Only**
400	8	T_C = 120°C	***MURH840CT***	28	2.0 @ 4.0 A	100	175	10	500	
600	8	T_C = 120°C	***MURH860CT***	35	2.8 @ 4.0 A	100	175	10	500	
200	16	T_C = 150°C	***MUR1620CT***	35	0.975 @ 8.0 A	100	175	5	250	
200	16	T_C = 160°C	***MUR1620CTR***	85	1.2 @ 8.0 A	100	175	5	500	
400	16	T_C = 150°C	***MUR1640CT***	60	1.30 @ 8.0 A	100	175	10	250	
600	16	T_C = 150°C	***MUR1660CT***	60	1.5 @ 8.0 A	100	175	10	500	
200	8	T_C = 150°C	***MUR820***	35	0.975 @ 8.0 A	100	175	5	250	**CASE 221B-04** (TO-220AC) 
400	8	T_C = 150°C	***MUR840***	50	1.30 @ 8.0 A	100	175	10	500	
600	8	T_C = 150°C	***MUR860***	50	1.50 @ 8.0 A	100	175	10	500	
800	8	T_C = 175°C	***MUR880E***	75	1.80 @ 8.0 A	100	175	25	500 @ 100°C	
1000	8	T_C = 150°C	***MUR8100E***	75	1.80 @ 8.0 A	100	175	25	500 @ 100°C	
1200	10	T_C = 125°C	***MUR10120E***	175	2.2 @ 6.5 A	100	125	100	1000 @ 125°C	
1500	10	T_C = 125°C	***MUR10150E***	175	2.4 @ 6.5 A	100	125	100	1000 @ 125°C	
1500	5	T_C = 100°C	***MUR5150E***	175	2.4 @ 5 A	100	125	50	500 @ 125°C	
200	15	T_C = 150°C	***MUR1520***	35	1.05 @ 15 A	200	175	10	500	
400	15	T_C = 150°C	***MUR1540***	60	1.25 @ 15 A	150	175	10	500	
600	15	T_C = 145°C	***MUR1560***	60	1.50 @ 15 A	150	175	10	1000	
200	16	T_C = 150°C	UL ***MURF1620CT***	25	0.975 @ 8.0 A	100	150	5	250	**CASE 221D-02** 
600	8	$T_C \leq$ 120°C	***MURHF860CT*** ★	35	2.8 @ 4.0 A	100	175	10	500	

(1) I_O is total device capability
(2) V_{RRM} unless noted
(4) V_{RRM}, T_J = 150°C unless noted

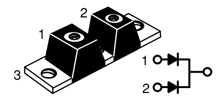
UL Indicates UL Recognized — File #E69369
★ New Product

Table 16. TO-218 and TO-247 Ultrafast Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max I_R[2] T_J = 25°C (μA)	Max I_R[4] (mA)	Package
200	30	T_C = 145°C	***MUR3020WT***	35	1.05 @ 15 A	150	175	10	0.5	**CASE 340K–01** (TO-247) 
600	30	T_C = 145°C	***MUR3060WT***	60	1.70 @ 15 A	150	175	10	1	
200	30	T_C = 150°C	***MUR3020PT***	35	1.12 @ 15 A	200	175	10	0.5	**CASE 340D-02** (TO-218AC) 
400	30	T_C = 150°C	***MUR3040PT***	60	1.12 @ 15 A	150	175	10	0.5	
600	30	T_C = 145°C	***MUR3060PT***	60	1.20 @ 15 A	150	175	10	1	
400	30	T_C = 70°C	***MUR3040***	100	1.5 @ 30 A	300	175	35	6 @ 100°C	**CASE 340E-02** (TO-218) 
800	30	T_C = 70°C	***MUR3080***	110	1.90 @ 30 A	300	175	100	5 @ 100°C	
400	60	T_C = 70°C	***MUR6040***	100	1.50 @ 60 A	600	175	60	10 @ 100°C	

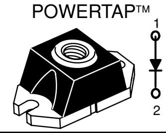
(1) I_O is total device capability
(2) V_{RRM} unless noted
(4) V_{RRM}, T_J = 150°C unless noted

Table 17. POWERTAP II Ultrafast Rectifiers

V_{RRM} (Volts)	$I_O^{(1)}$ (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max $I_R^{(2)}$ T_J = 25°C (μA)	Max $I_R^{(4)}$ (mA)	Package
200	200	T_C = 130°C	***MURP20020CT***	50	1.00 @ 100 A	800	175	150	1 @ 125°C	**CASE 357C-03** POWERTAP™  Cathode = Mounting Plate Anode = Terminal
400	200	T_C = 100°C	***MURP20040CT***	50	1.30 @ 100 A	800	175	50	0.5 @ 125°C	

(1) I_O is total device current capability.
(2) V_{RRM} unless noted
(4) V_{RRM}, T_J = 150°C unless noted
⋆ New Product

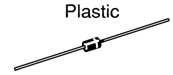
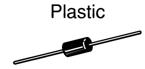
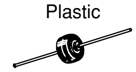
Table 18. POWERTAP III Ultrafast Rectifiers

V_{RRM} (Volts)	$I_O^{(1)}$ (Amperes)	I_O Rating Condition	Device	Max t_{rr} (ns)	Max V_F @ i_F T_C = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	Max $I_R^{(2)}$ T_J = 25°C (μA)	Max $I_R^{(4)}$ (mA)	Package
200	100	T_C = 130°C	***MURP10020⋆***	50	1.00 @ 100 A	800	175	150	1 @ 125°C	**CASE 357D-01** POWERTAP™ 
400	100	T_C = 100°C	***MURP10040⋆***	75	1.30 @ 100 A	800	175	50	0.5 @ 125°C	
600	100	T_C = 100°C	***MURP10060⋆***	100	1.5 @ 100 A	600	175	50	0.5 @ 125°C	

(1) I_O is total device current capability.
(2) V_{RRM} unless noted
(4) V_{RRM}, T_J = 150°C unless noted
⋆ New Product

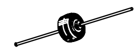
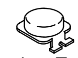
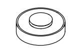
Fast Recovery Rectifiers/General-Purpose Rectifiers

Table 19. Fast Recovery Rectifiers/General Purpose Rectifiers

V_{RRM} (Volts)	I_O (Amperes)	I_O Rating Condition	Device	Max V_F @ i_F T_J = 25°C (Volts)	Max t_{rr} (ns)	I_{FSM} (Amperes)	T_J Max (°C)	Max $I_R^{(2)}$ T_J = 25°C (μA)	Max $I_R^{(3)}$ (μA)	Package
300	1	T_L = 150°C	***MRA4003T3⋆***	1.1 @ 1.0 A	—	30	175	10	50	**CASE 403B-01 SMA**  Cathode = Notch
400	1	T_L = 150°C	***MRA4004T3⋆***	1.1 @ 1.0 A	—	30	175	10	50	
600	1	T_L = 150°C	***MRA4005T3⋆***	1.1 @ 1.0 A	—	30	175	10	50	
800	1	T_L = 150°C	***MRA4006T3⋆***	1.1 @ 1.0 A	—	30	175	10	50	
1000	1	T_L = 150°C	***MRA4007T3⋆***	1.1 @ 1.0 A	—	30	175	10	50	
400	1	T_A = 75°C	***1N4004RL***	1.1 @ 1.0 A	—	30	150	10	50	**CASE 59-03$^{(7)}$** Plastic  Cathode = Polarity Band
1000	1	T_A = 75°C	***1N4007RL***	1.1 @ 1.0 A	—	30	150	10	50	
200	1	T_A = 75°C	***1N4935RL***	1.2 @ 3.14 A T_J = 125°C	200	30	150	5	100	
600	1	T_A = 75°C	***1N4937RL***	1.2 @ 3.14 A T_J = 125°C	200	30	150	5	100	
400	3	T_L = 105°C	***1N5404RL***	1.2 @ 9.4 A	—	200	150	—	500 @ 80°C	**CASE 267-03** Plastic  Cathode = Polarity Band
600	3	T_L = 105°C	***1N5406RL***	1.2 @ 9.4 A	—	200	150	—	500 @ 80°C	
200	3	T_A = 80°C$^{(8)}$	***MR852***	1.25 @ 3.0 A	200	100	150	10	200 @ 80°C	
400	6	T_A = 60°C $R_{\theta JA}$ = 25°C/W	***MR754***	1.25 @ 100 A	—	400	175	25	1000	**CASE 194-04** Plastic  Cathode indicated by diode symbol
1000	6	T_A = 60°C $R_{\theta JA}$ = 25°C/W	***MR760***	1.25 @ 100 A	—	400	175	25	1000	
400	25	T_C = 150°C	***MR2504***	1.18 @ 78.5 A	—	400	175	100	500	**CASE 193-04** Plastic  Cathode = Polarity Band
1000	25	T_C = 150°C	***MR2510***	1.18 @ 78.5 A	—	400	175	100	500	

(2) V_{RRM} unless noted
(3) V_{RRM}, T_J = 100°C unless noted
(7) Package Size: 0.120” max diameter by 0.260” length.
(8) Must be derated for reverse power dissipation. See data sheet.
(9) Overvoltage Transient Suppressor: 24–32 volts avalanche voltage.
⋆ New Product

Table 20. Overvoltage Transient Suppressors

V_{RRM} (Volts)	$V_{BR}^{(1)}$ (Volts)	V_{BR} (Volts)	I_O (Amperes)	Device	Max V_F T_J = 25°C (Volts)	I_{FSM} (Amperes)	T_J Max (°C)	I_{RSM} (Amperes)	Max $I_R^{(7)}$ (µA)	Package
20	24–32	40$^{(2)}$	6 T_C = 125°C	***MR2535L***	1.1 I_F = 100A	400	175	62$^{(5)}$	0.2	**CASE 194–04** Plastic  Cathode = Diode Symbol
23	24–32	40$^{(3)}$	32 T_C = 150°C	***MR2835S***	1.1 I_F = 100A	400	175	62$^{(5)}$	5 @ 20 V	**CASE 460–02** Top Can  Cathode = Terminal
18	20–27	37$^{(3)}$ 35$^{(4)}$	40 T_C = 185°C	***MR4027N*** and ***MR4027P***	1.1 I_F = 100A	500	200	110$^{(5)}$ 50$^{(6)}$	1 @ 16 V	**CASE 193A–02** Button Can  N = Anode to Case P = Cathode to Case
30	34–45	55$^{(3)}$ 53$^{(4)}$	40 T_C = 185°C	***MR4045N*** and ***MR4045P***	1.1 I_F = 100A	500	200	55$^{(5)}$ 25$^{(6)}$	1 @ 28 V	

(1) At Ir = 100 mA, 25°C
(2) At Ir = 90 A, Tc = 150°C, PW = 80 µS
(3) At Ir = 80 A, Tc = 85°C, PW = 80 µS
(4) At Ir = 80 A, Tc = 25°C, PW = 80 µS
(5) Time Constant = 10 mS, 25°C
(6) Time Constant = 80 mS, 25°C
(7) At V_{RRM}, T_j = 25°C unless noted

Thyristors, Triggers and Surge Suppressors

In Brief . . .

ON Semiconductor's broad line of Thyristors includes. . . .

- A full line of TRIACs and SCRs covering a forward current range from 0.6 to 55 amperes and blocking voltages from 30 to 800 volts.
- Plastic package for lowest cost which includes the fully insulated plastic Case 221C (TO–220 Isolated).

Then there are the special applications devices for Ignition circuits and Crowbar applications. Also included are isolated packaged devices for appliances and surface mount packages for surface mounting in space–saving requirements.

New in the ON Semiconductor Thyristor line–up are the high–performance TO–220 TRIACs, such as the MAC8 and MAC12 series designed specifically for white goods and motor control applications.

Page

SCRs

Silicon Controlled Rectifiers

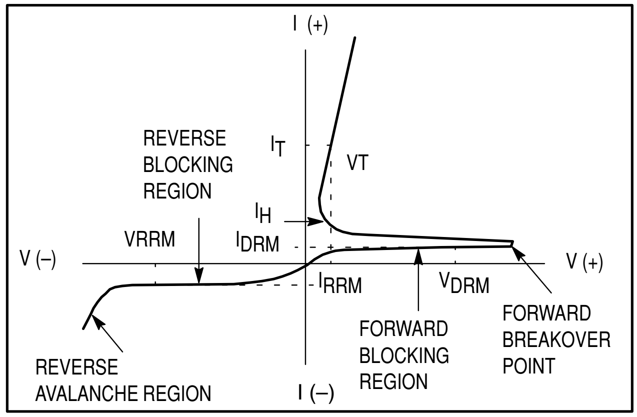
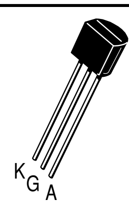
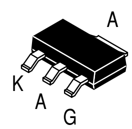
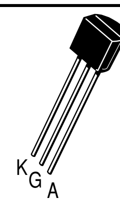


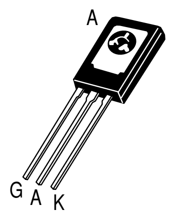
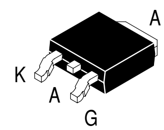
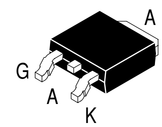
Table 1. SCRs — General Purpose Plastic Packages
0.8 to 55 Amperes RMS, 30 to 800 Volts

V_{DRM} V_{RRM} (Volts)	On–State (RMS) Current		
	0.8 AMP		1.5 AMPS
	T_C = 58°C	T_C = 80°C	T_C = 50°C
			
	Sensitive Gate		
	Case 29–11 TO–226AA (TO–92) Style 10	Case 318E SOT–223 STYLE 10	Case 29–11 TO–226AA (TO–92) Style 10
30	***2N5060***(1)	—	—
60	***2N5061***(1)	—	—
100	***2N5062***(1) ***MCR100–3***(1)	— —	— —
200	***2N5064***(1) ***MCR100–4***(1)	***MCR08BT1*** —	— —
400	***MCR100–6***(1)	—	***MCR22–6***(1)
600	***MCR100–8***(1)	***MCR08MT1***	***MCR22–8***(1)
Maximum Electrical Characteristics			
I_{TSM} (Amps) 60 Hz	10	10	15 150(3)
I_{GT} (mA)	0.2		
V_{GT} (V)	0.8		
T_J Operating Range (°C)	–65 to +110	–40 to +110	–40 to +125

(1) RLRA, RLRE, RL, RL1 Suffix: Radial Tape and Reel
RLRM, ZL1 Suffix: Radial Tape and Ammo Pack
(3) Exponential decay 2 μs wide at 5 time constants, f = 12 Hz

SCRs (continued)

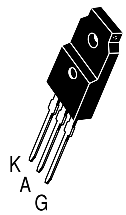
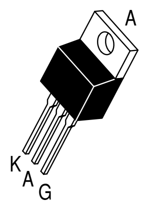
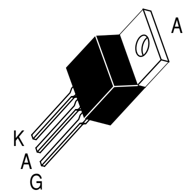
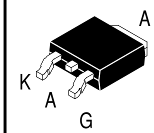
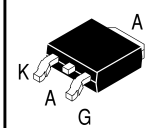
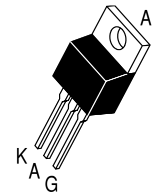
Table 1. SCRs — General Purpose Plastic Packages (continued)

V_{DRM} V_{RRM} (Volts)	On–State (RMS) Current			
	4 AMPS			
	T_C = 93°C		T_C = 30°C	T_C = 93°C
				
	Sensitive Gate			
	Case 77 TO–225AA (TO–126) Style 2		DPAK Case 369A Style 4	DPAK Case 369A Style 5
100	—	—	—	*MCR703A*[4]
200	—	*C106B*	—	*MCR704A*[4]
400	*MCR106–6*	*C106D, D1*	*MCR716*[4]	*MCR706A*[4]
600	*MCR106–8*	*C106M, M1*	*MCR718*[4]	*MCR708A*[4]
Maximum Electrical Characteristics				
I_{TSM} (Amps) 60 Hz	25	20	25	25
I_{GT} (mA)	0.2		0.075	
I_{GT} (μA)				75
V_{GT} (V)	1	0.8	1	1
DV/DT V/μsec				Typical 10
T_J Operating Range (°C)	−40 to +110			

(4) T4 Suffix: 2500/reel
(5) Add –001 suffix for straight lead DPAK

SCRs (continued)

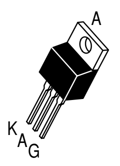
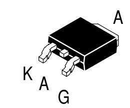
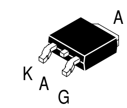
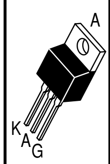
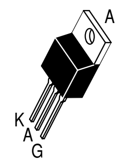
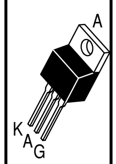
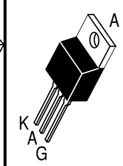
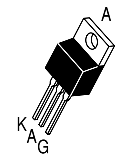
Table 1. SCRs — General Purpose Plastic Packages (continued)

V_{DRM} V_{RRM} (Volts)	On–State (RMS) Current						
	8 AMPS						10 AMPS
	T_C = 70°C	T_C = 83°C	T_C = 80°C		T_C = 105°C	T_C = 90°C	T_C = 75°C
			 High Performance				
	Isolated (UL)	Sensitive Gate		Sensitive Gate		Sensitive Gate	
	Case 221C–02 Style 2	Case 221A–07 TO–220AB Style 3	Case 221A–09 TO–220AB Style 3		DPAK Case 369A–13 Style 4		Case 221A–07 TO–220AB Style 3
100	—	*MCR72–3*	—	—	—	—	—
400	*MCR218–6FP*	*MCR72–6*	—	*MCR8SD*(2)	—	—	—
600	—	*MCR72–8*	*MCR8M*	*MCR8SM*(2)	*MCR8DCM*(4)	*MCR8DSM*(4)	—
800	*MCR218–10FP*	—	*MCR8N*(2)	*MCR8SN*(2)	*MCR8DCN*(4)	*MCR8DSN*(4)	*MCR310–10*
Maximum Electrical Characteristics							
I_{TSM} (Amps) 60 Hz	80	100	80			90	100
I_{GT} (mA)	25	0.2	15	0.2	15		0.2
I_{GT} (µA)						200	
V_{GT} (V)	1.5		1				1.5
DV/DT V/µsec			Min. 50	Min. 2	Min. 50, Typical 200	Min. 2, Typical 10	
T_J Operating Range (°C)	–40 to +125	–40 to +110	–40 to +125	–40 to +110	–40 to +125	–40 to +110	

(UL) Indicates UL Recognized — File #E69369
(2) No Suffix: Shipped in rails
(4) T4 Suffix: 2500/reel
(5) Add –001 suffix for straight lead DPAK

SCRs (continued)

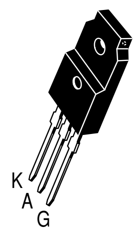
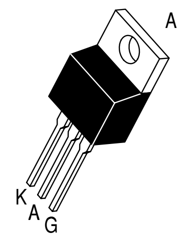
Table 1. SCRs — General Purpose Plastic Packages (continued)

	On–State (RMS) Current									
	10 AMPS	12 AMPS				16 AMPS		25 AMPS		
	T_C = 75°C	T_C = 90°C	T_C = 75°C	T_C = 90°C	T_C = 80°C		T_C = 90°C	T_C = 80°C	T_C = 85°C	
										
	Sensitive Gate		Sensitive Gate		High Performance			High Performance		
V_{DRM} V_{RRM} (Volts)	Case 221A–07 TO–220AB Style 3	DPAK Case 369A–13 Style 4		Case 221A–07 TO–220AB Style 3	Case 221A–09 TO–220AB Style 3		Case 221A–07 TO–220AB Style 3	Case 221A–09 TO–220AB Style 3	Case 221A–07 TO–220AB Style 3	
50	—	—	—	*2N6394*	—	—	*2N6400*	—	*2N6504*	*MCR69–2*
100	—	—	—	*2N6395*	—	—	*2N6401*	—	*2N6505*	*MCR69–3*
200	—	—	—	—	—	—	—	—	—	—
400	*MCR12LD*(2)	—	—	*2N6397*	*MCR12D*(2)	—	*2N6403*	*MCR25D*(2)	*2N6507*	—
600	*MCR12LM*(2)	*MCR12DCM*(4)	*MCR12DSM*(4)	*2N6398*	*MCR12M*(2)	—	*2N6404*	*MCR25M*(2)	*2N6508*	—
800	*MCR12LN*(2)	*MCR12DCN*(4)	*MCR12DSN*(4)	*2N6399*	*MCR12N*(2)	*MCR16N*(2)	*2N6405*	*MCR25N*(2)	*2N6509*	—
Maximum Electrical Characteristics										
I_{TSM} (Amps) 60 Hz	100					150	160	300		750(7)
I_{GT} (mA)	8	20		30	20		30	30	40	30
I_{GT} (μA)			200							
V_{GT} (V)	1.5	1		1.5	2.2	1.7	1.5	1	1.5	
	Min.	Min. Typical	Min. Typical		Min.	Min.		Min.		
DV/DT V/μsec	50	50 200	2 10		50	50		50		
T_J Op Range (°C)	−40 to +100	−40 to +125	−40 to +110	−40 to +125						

(2) No Suffix: Shipped in rails
(4) T4 Suffix: 2500/reel
(5) Add –001 suffix for straight lead DPAK
(7) Peak capacitor discharge current for t_W = 1 ms. t_W is defined as five time constants of an exponentially decaying current pulse (crowbar applications).

SCRs (continued)

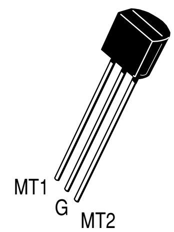
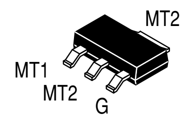
Table 1. SCRs — General Purpose Plastic Packages (continued)

V_{DRM} V_{RRM} (Volts)	On–State (RMS) Current		
	25 AMPS	**40 AMPS**	**55 AMPS**
	T_C = 85°C	**T_C = 80°C**	**T_C = 70°C**
	 Isolated		
	Case 221C–02 Style 2	**Case 221A–07 TO–220AB Style 3**	
200	—	***MCR264–4***	***MCR265–4***
400	—	***MCR264–6***	***MCR265–6***
600	***MCR225–8FP***	***MCR264–8***	***MCR265–8***
800	***MCR225–10FP***	—	***MCR265–10***
Maximum Electrical Characteristics			
I_{TSM} (Amps) 60 Hz	300	400	550
I_{GT} (mA)	40	50	
V_{GT} (V)	1.5		
T_J Operating Range (°C)	–40 to +125		

UL Indicates UL Recognized — File #E69369

TRIACs

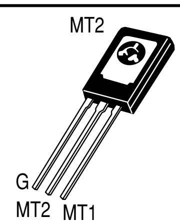
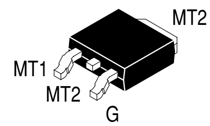
Table 2. TRIACs — General Purpose Plastic Packages
0.6 to 40 Amperes, 200 to 800 Volts

V_{DRM} (Volts)	On–State (RMS) Current		
	0.6 AMP		0.8 AMPS
	T_C = 50°C		T_C = 80°C
			
	Sensitive Gate		
	Case 29–11 TO–226AA (TO–92) Style 12		Case 318E Style 11 SOT–223
200	—	*MAC97A4*(1)	—
400	—	*MAC97A6*(1)	—
600	*MAC97–8*(1)	*MAC97A8*(1)	*MAC08MT1*
Maximum Electrical Characteristics			
I_{TSM} (Amps)	8		10
I_{GT} @ 25°C (mA) **MT2(+)G(+)** **MT2(+)G(–)** **MT2(–)G(–)** **MT2(–)G(+)**	 10 10 10 10	 5 5 5 7	 10 10 10 10
V_{GT} @ 25°C (V) **MT2(+)G(+)** **MT2(+)G(–)** **MT2(–)G(–)** **MT2(–)G(+)**	 2 2 2 2.5		0.8 2 2 2 2
T_J Operating Range (°C)	–40 to +110		

(1) RLRA, RLRE, RL, RL1 Suffix: Radial Tape and Reel
RLRM, ZL1 Suffix: Radial Tape and Ammo Pack

TRIACs (continued)

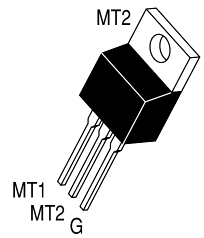
Table 2. TRIACs (continued)

V_{DRM} (Volts)	On–State (RMS) Current									
	4 AMPS									
	T_C = 85°C		T_C = 93°C				T_C = 108°C			
										
	Sensitive Gate									
	Case 77 TO–225AA (TO–126) Style 5		DPAK Case 369A–13 Style 6							
200	***2N6071A***	***2N6071B***	—		—		—		—	
400	***2N6073A***	***2N6073B***	—		—		—		—	
600	***2N6075A***	***2N6075B***	***MAC4DLM***(4)		***MAC4DHM***(4)		***MAC4DSM***(4)		***MAC4DCM***(4)	
800	—	—	—		—		***MAC4DSN***(4)		***MAC4DCN***(4)	
Maximum Electrical Characteristics										
I_{TSM} (Amps)	30		40							
			Typ.	Max.	Typ.	Max.	Max.			
I_{GT} @ 25°C (mA)										
MT2(+)G(+)	5	3	1.8	3	1.8	5	10		35	
MT2(+)G(–)	5	3	2.1	3	2.1	5	10		35	
MT2(–)G(–)	5	3	2.4	3	2.4	5	10		35	
MT2(–)G(+)	10	5	4.2	5	4.2	10	—		—	
			Min.	Max.	Min.	Max.	Max.			
V_{GT} @ 25°C (V)	@ −40°C									
MT2(+)G(+)	2.5		0.5	1.3	0.5	1.3	1.3			
MT2(+)G(–)	2.5		0.5	1.3	0.5	1.3	1.3			
MT2(–)G(–)	2.5		0.5	1.3	0.5	1.3	1.3			
MT2(–)G(+)	2.5		0.5	1.3	0.5	1.3	—			
			Typical				Min.	Typ.	Min.	Typ.
DV/DT V/µsec			10				50	175	500	1700
T_J Operating Range (°C)	−40 to +100		−40 to +110				−40 to +125			

(4) T4 Suffix: 2500/reel
(5) Add –001 suffix for straight lead DPAK

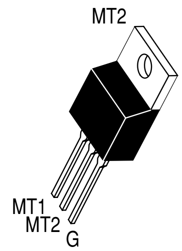
TRIACs (continued)

Table 2. TRIACs (continued)

	On–State (RMS) Current		
	4 AMPS		**6 AMPS**
	T_C = 100°C		**T_C = 80°C**
			
V_{DRM} (Volts)	**Case 221A–07 TO–220AB Style 4**		
200	—	—	—
400	—	—	***T2500D***
600	***MAC4SM***	***MAC4M***	—
800	***MAC4SN***	***MAC4N***	—
Maximum Electrical Characteristics			
I_{TSM} (Amps)	40		60
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 10 10 10 —	 35 35 35 —	 25 60 25 60
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 1.3 1.3 1.3 —		 2.5 2.5 2.5 2.5
T_J Operating Range (°C)	–40 to +125		–40 to 100

TRIACs (continued)

Table 2. TRIACs (continued)

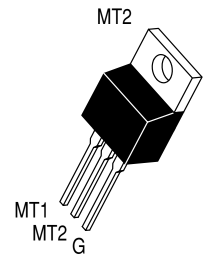


V_{DRM} (Volts)	On–State (RMS) Current				
	8 AMPS				
	T_C = 80°C	T_C = 70°C		T_C = 80°C	
		Sensitive Gate			
		High Performance			
	Case 221A–07 TO–220AB Style 4	Case 221A–09 TO–220AB Style 4			
400	—	***MAC8SD***(2)		***MAC8D***(2)	***MAC9D***(2)
600	***MAC218A8***	***MAC8SM***(2)		***MAC8M***(2)	***MAC9M***(2)
800	—	***MAC8SN***(2)		***MAC8N***(2)	***MAC9N***(2)
Maximum Electrical Characteristics					
I_{TSM} (Amps)	100	70		80	
I_{GT} @ 25°C (mA)		Min.	Max.		
MT2(+)G(+)	50	0.8	5.0	35	50
MT2(+)G(–)	50	0.8	5.0	35	50
MT2(–)G(–)	50	0.8	5.0	35	50
MT2(–)G(+)	75	—	—	—	—
V_{GT} @ 25°C (V)					
MT2(+)G(+)	2	0.45	1.5	1.5	
MT2(+)G(–)	2	0.45	1.5	1.5	
MT2(–)G(–)	2	0.45	1.5	1.5	
MT2(–)G(+)	2.5	—	—	—	
		Min.		Min.	Min.
DV/DT V/µsec		25		250	500
T_J Operating Range (°C)	–40 to +125	–40 to +110		–40 to +125	

(2) No Suffix: Shipped in rails

TRIACs (continued)

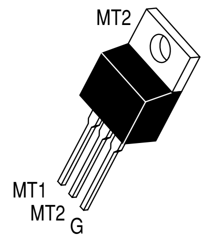
Table 2. TRIACs (continued)

V_{DRM} (Volts)	On–State (RMS) Current		
	8 AMPS		
	$T_C = 80°C$		
			
			Sensitive Gate
	Case 221A–07 TO–220AB Style 4		
200	—	—	*MAC228A4*
400	—	*T2800D*	*MAC228A6*
600	*2N6344*	—	*MAC228A8*
800	*2N6349*	—	*MAC228A10*
Maximum Electrical Characteristics			
I_{TSM} (Amps)	100		80
I_{GT} @ 25°C (mA)			
MT2(+)G(+)	50	25	5
MT2(+)G(–)	75(6)	60	5
MT2(–)G(–)	50	25	5
MT2(–)G(+)	75(6)	60	10(1)
V_{GT} @ 25°C (V)			
MT2(+)G(+)	2	2.5	2
MT2(+)G(–)	2.5(6)	2.5	2
MT2(–)G(–)	2.5	2.5	2
MT2(–)G(+)	2.5(6)	2.5	2.5
T_J Operating Range (°C)	–40 to +125	–40 to +100	–40 to +110

(6) Denotes 2N6349 Series only.

TRIACs (continued)

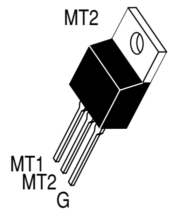
Table 2. TRIACs (continued)

	On–State (RMS) Current		
	10 AMPS	12 AMPS	
	T_C = 70°C	T_C = 80°C	T_C = 85°C
			
V_{DRM} (Volts)	Case 221A–07 TO–220AB Style 4		
400	—	*MAC12HCD*(2)	—
600	*MAC210A8*	*MAC12HCM*(2)	*MAC212A8*
800	—	*MAC12HCN*(2)	*MAC212A10*
Maximum Electrical Characteristics			
I_{TSM} (Amps)	100		
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 50 50 50 75	 50 50 50 —	 50 50 50 75
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2 2 2 2.5	 1.5 1.5 1.5 —	 2 2 2 2.5
T_J Operating Range (°C)	–40 to +125		

(2) No Suffix: Shipped in rails

TRIACs (continued)

Table 2. TRIACs (continued)

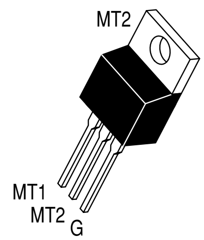


	On–State (RMS) Current					
	12 AMPS		15 AMPS			
	T_C = 80°C			T_C = 70°C	T_C = 90°C	T_C = 80°C
				Sensitive Gate		
		High Performance				High Performance
V_{DRM} (Volts)	Case 221A–07 TO–220AB Style 4	Case 221A–09 TO–220AB Style 4			Case 221A–07 TO–220AB Style 4	Case 221A–09 TO–220AB Style 4
400	—	***MAC12D***(2)	—	—	***MAC15A6***	***MAC16D***(2)
600	***2N6348A***	***MAC12M***(2)	***MAC15M***(2)	***MAC15SM***(2)	***MAC15A8***	***MAC16M***(2)
800	—	***MAC12N***(2)	***MAC15N***(2)	***MAC15SN***(2)	***MAC15A10***	***MAC16N***(2)
Maximum Electrical Characteristics						
I_{TSM} (Amps)	120		150	120	150	
I_{GT} @ 25°C (mA)				Min. / Max.		
MT2(+)G(+)	50		35	0.8 / 5.0	50	50
MT2(+)G(–)	75		35	0.8 / 5.0	50	50
MT2(–)G(–)	50		35	0.8 / 5.0	50	50
MT2(–)G(+)	75		—	— / —	75	—
V_{GT} @ 25°C (V)						
MT2(+)G(+)	2	1.5		0.45 / 1.5	2	1.5
MT2(+)G(–)	2.5	1.5		0.45 / 1.5	2	1.5
MT2(–)G(–)	2	1.5		0.45 / 1.5	2	1.5
MT2(–)G(+)	2.5	—		— / —	2.5	—
		Min.	Min.	Min.		Min.
DV/DT V/µsec		250	250	25		500
T_J Operating Range (°C)	−40 to +125			−40 to +110	−40 to +125	

(2) No Suffix: Shipped in rails

TRIACs (continued)

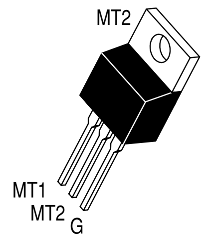
Table 2. TRIACs (continued)

V_{DRM} (Volts)	On–State (RMS) Current	
	16 AMPS	
	$T_C = 80°C$	
		
	Case 221A–07 TO–220AB Style 4	
400	*MAC16CD*(2)	*MAC16HCD*(2)
600	*MAC16CM*(2)	*MAC16HCM*(2)
800	*MAC16CN*(2)	*MAC16HCN*(2)
Maximum Electrical Characteristics		
I_{TSM} (Amps)	150	
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 35 35 35 —	 50 50 50 —
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 1.5 1.5 1.5 —	
T_J Operating Range (°C)	–40 to +125	

(2) No Suffix: Shipped in rails

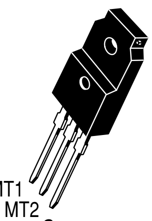
TRIACs (continued)

Table 2. TRIACs (continued)

	On–State (RMS) Current	
	25 AMPS	40 AMPS
	T_C = 80°C	T_C = 75°C
		
V_{DRM} (Volts)	Case 221A–07 TO–220AB Style 4	
200	—	*MAC224A4*
400	*MAC223A6*	*MAC224A6*
600	*MAC223A8*	*MAC224A8*
800	*MAC223A10*	*MAC224A10*
Maximum Electrical Characteristics		
I_{TSM} (Amps)	250	350
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	50 50 50 75	
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	2 2 2 2.5	
T_J Operating Range (°C)	–40 to +125	

TRIACs (continued)

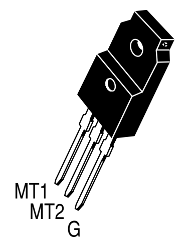
Table 2. TRIACs (continued)

	On–State (RMS) Current				
	6 AMPS	8 AMPS		10 AMPS	12 AMPS
	T_C = 80°C			T_C = 70°C	T_C = 85°C
					
	Isolated ®U				
V_{DRM} (Volts)	Case 221C–02 Style 3				
400	*T2500DFP*	*MAC218A6FP*	—	—	*MAC212A6FP*
600	—	—	*MAC229A8FP*	*MAC210A8FP*	*MAC212A8FP*
800	—	*MAC218A10FP*	—	*MAC210A10FP*	*MAC212A10FP*
Maximum Electrical Characteristics					
I_{TSM} (Amps)	100		80	100	
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 25 60 25 60	 50 50 50 75	 10 10 10 20	 50 50 50 75	
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2.5 2.5 2.5 2.5	 2 2 2 2.5	 2 2 2 2.5	 2 2 2 2.5	
DV/DT V/µsec					
T_J Operating Range (°C)	−40 to +100	−40 to +125	−40 to +110	−40 to +125	

®U Indicates UL Recognized — File #E69369

TRIACs (continued)

Table 2. TRIACs (continued)

V_{DRM} (Volts)	On–State (RMS) Current		
	15 AMPS	20 AMPS	25 AMPS
	T_C = 90°C	T_C = 75°C	T_C = 80°C
			
	Isolated (UL)		
	Case 221C–02 Style 3		
400	*MAC15A6FP*	—	*MAC223A6FP*
600	*MAC15A8FP*	*MAC320A8FP*	*MAC223A8FP*
800	*MAC15A10FP*	—	*MAC223A10FP*
Maximum Electrical Characteristics			
I_{TSM} (Amps)	150		250
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 50 50 50 75		
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2 2 2 2.5		
DV/DT V/µsec			
T_J Operating Range (°C)	–40 to +125		

(UL) Indicates UL Recognized — File #E69369

Thyristor Triggers

Table 3. Programmable Unijunction Transistor — 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.

Device Type	I_P R_G = 10 kΩ	I_P R_G = 1 MΩ	I_{GAO} @ 40 V	I_V R_G = 10 kΩ	I_V R_G = 1 MΩ
	μA Max	μA Max	nA Max	μA Min	μA Max
Plastic TO–92 (Case 29–11/16)					
2N6027	5	2	10	70	50
2N6028	1	0.15	10	25	25

Thyristor Surge Suppressors

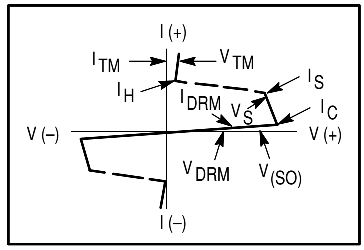


Table 4. SIDAC's

High voltage trigger devices similar in operation to a Triac. Upon reaching the breakover voltage in either direction, the device switches to a low–voltage on–state.

Device Type	I_{TSM} Amps	V_{BO} Volts Min	V_{BO} Volts Max
Case 59–04/1			
MKP1V120RL	4	110	130
MKP1V130RL	4	120	140
MKP1V160RL	4	150	170
Case 267–03/1			
MKP3V120RL	20	110	130
MKP3V240RL	20	220	250

Table 5. High Voltage Bidirectional Surge Protector Devices (SIDAC's)

These Thyristor Surge Protection devices prevent over-voltage damage to sensitive circuits by lightning, induction, and power line crossings. They are breakover triggered crowbar protectors with turn–off occurring when the surge current falls below the holding current value.

Device Type	Ipps1 Surge Amps	VDM Volts
Case 403A–03 SMB		
MMT05B230T3	50	170
MMT05B260T3	50	200
MMT05B310T3	50	270
MMT10B230T3	150	170
MMT10B260T3	150	200
MMT10B310T3	150	270

IGBT Products

In Brief . . .

ON Semiconductor adds Insulated Gate Bipolar Transistors (IGBTs) to its line of world class power transistors. As a supplier of logic, analog integrated circuits and discretes, we strive to offer our customers system solutions. Our IGBT portfolio consists of devices for automotive applications, lighting, motor drives and power conversion. Advancements in silicon and packaging technologies have led to the following:

- State of the art IGBTs co–packaged with fast, soft recovery diodes up to 600 volts.
- Ignition IGBTs with integrated gate and collector voltage protection.
- IGBTs with an integrated diode for high frequency lighting applications.
- Surface mount IGBTs with free wheeling diodes.

Page

The Discrete IGBT Data Sheet

INTRODUCTION

ON Semiconductor prides itself in having the most complete and accurate data sheets in the industry. For consistency, data sheet templates have been established for each technology and or application grouping. This insures that the best approach is used in describing the performance characteristics of each device for the applications they are used in. Additionally, this allows for the automation of the data sheet generation process which has lead to a reduction in new product introduction cycle time as well as providing more accurate and repeatable data.

HEADLINE INFORMATION

ON Semiconductor's IGBT part numbering system contains coded information describing technology, package, current and voltage information. A complete explanation of the nomenclature is contained in Figure 1.

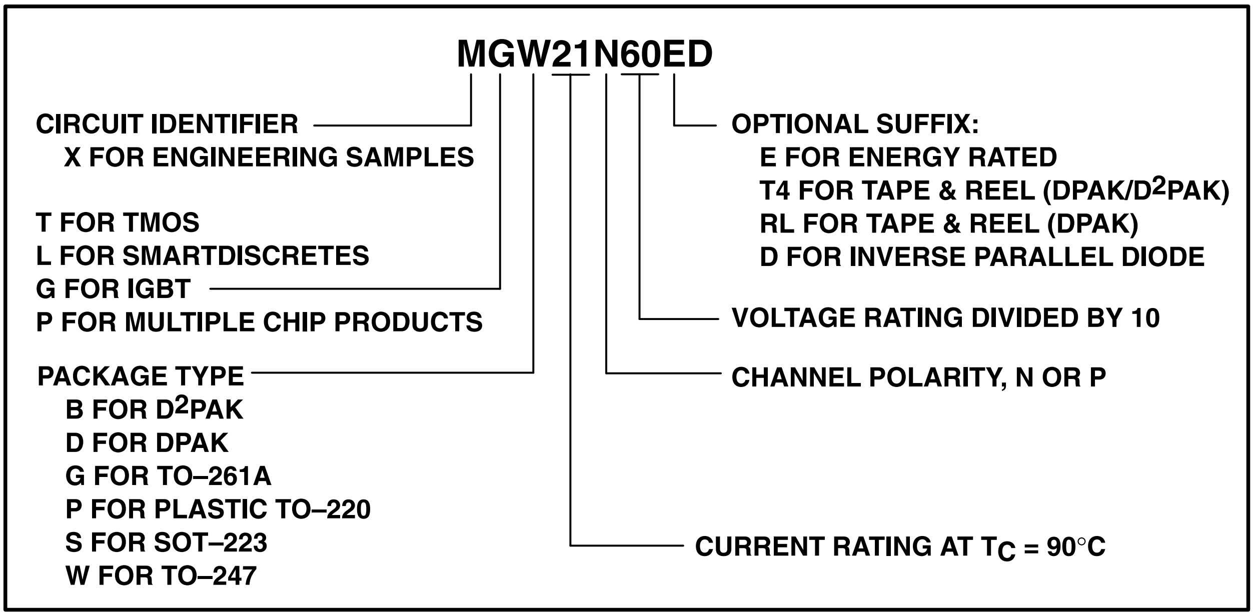


Figure 1. ON Semiconductor Discrete IGBT Numbering System

ON Semiconductor Part Number

MGB15N35CLT4	MGP19N35CLT4
MGB15N38CLT4	MGP20N14CL
MGB15N40CLT4	MGP20N35CL
MGB15N43CLT4	MGP20N40CL
MGB19N35CLT4	MGP20N60U
MGB20N35CLT4	MGP21N60E
MGB20N36CLT4	MGP4N60E
MGB20N40CLT4	MGP4N60ED
MGP11N60E	MGP7N60E
MGP11N60ED	MGP7N60ED
MGP14N60E	MGS05N60D
MGP15N35CL	MGS13002D
MGP15N38CL	MGW14N60ED
MGP15N40CL	MGW21N60ED
MGP15N43CL	MMG05N60D
MGP15N60U	

IGBTs

Insertion Mount IGBTs

Table 1. TO–220

$V_{(BR)CES}$ (V)	Device (1)	I_C @ T_C (A)	I_C @ T_C (°C)	$V_{CE(on)}$ @ I_C typical (2) (V)	$V_{CE(on)}$ @ I_C typical (2) (A)	E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μs)	P_D(2) (W)
600	MGP4N60E	4.0	90	2.0	3.0	60	10	62.5
600	MGP4N60ED	4.0	90	2.0	3.0	60	10	62.5
600	MGP7N60E	7.0	90	2.0	5.0	70	10	81
600	MGP7N60ED	7.0	90	2.0	5.0	70	10	81
600	MGP11N60E	11	90	2.0	8.0	60	10	96
600	MGP11N60ED	11	90	2.0	8.0	60	10	96
600	MGP14N60E	14	90	2.0	10	63	10	112
600	MGP15N60U	15	90	1.7	8.0	63	N/A	96
600	MGP20N60U	20	90	1.7	10	63	N/A	112
600	MGP21N60E	21	90	2.1	20	65	10	142
350	MGP15N35CL	15	25	1.8 (4)	10	N/A	N/A	136
380	MGP15N38CL	15	25	1.8 (4)	10	N/A	N/A	137
400	MGP15N40CL	15	25	1.8 (4)	10	N/A	N/A	138
430	MGP15N43CL	15	25	1.8 (4)	10	N/A	N/A	138
350	MGP19N35CL	19	25	1.8 (4)	14	N/A	N/A	140
135	MGP20N14CL	20	25	1.8 (4)	10	N/A	N/A	150
350	MGP20N35CL	20	25	1.4 (5)	10	N/A	N/A	150
400	MGP20N40CL	20	25	1.4 (5)	10	N/A	N/A	150

Table 2. TO–247

$V_{(BR)CES}$ (V)	Device (1)	I_C @ T_C (A)	I_C @ T_C (°C)	$V_{CE(on)}$ @ I_C typical (2) (V)	$V_{CE(on)}$ @ I_C typical (2) (A)	E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μs)	P_D(2) (W)
600	MGW14N60ED	14	90	2.0	10	63	10	112
600	MGW21N60ED	21	90	2.1	20	65	10	142

Table 3. TO–226AE

$V_{(BR)CES}$ (V)	Device (1)	I_C @ T_C (A)	I_C @ T_C (°C)	$V_{CE(on)}$ @ I_C typical (2) (V)	$V_{CE(on)}$ @ I_C typical (2) (A)	E_{off} typ (3) (μJ/A)	t_{sc} min (3) (μs)	P_D(2) (W)
600	MGS05N60D	0.3	90	1.6	0.3	16.2	N/A	1.0
600	MGS13002D	0.3	90	1.6	0.3	16.2	N/A	1.0

(1) D suffix on part number indicates free wheeling diode is copackaged with the IGBT
(2) T_C = 25°C unless otherwise specified
(3) T_C = 125°C
(4) Maximum value at T_J = 150°C
(5) Typical value at T_J = 150°C

Surface Mount IGBTs

Table 4. D^2PAK

$V_{(BR)CES}$ (V)	Device(1)	I_C @ T_C		$V_{CE(on)}$ @ I_C typical (2)		E_{off} typ (3)	t_{sc} min (3)	P_D(2)
		(A)	(°C)	(V)	(A)	(μJ/A)	(μs)	(W)
350	MGB15N35CLT4	15	25	1.8(4)	10	N/A	N/A	136
380	MGB15N38CLT4	15	25	1.8(4)	10	N/A	N/A	137
400	MGB15N40CLT4	15	25	1.8(4)	10	N/A	N/A	138
430	MGB15N43CLT4	15	25	1.8(4)	10	N/A	N/A	138
350	MGB19N35CLT4	19	25	1.8(4)	14	N/A	N/A	140
350	MGB20N35CLT4	20	25	1.4(5)	10	N/A	N/A	150
360	MGB20N36CLT4	20	25	1.4(5)	10	N/A	N/A	150
400	MGB20N40CLT4	20	25	1.4(5)	10	N/A	N/A	150

Table 5. SOT–223

$V_{(BR)CES}$ (V)	Device(1)	I_C @ T_C		$V_{CE(on)}$ @ I_C typical (2)		E_{off} typ (3)	t_{sc} min (3)	P_D(2)
		(A)	(°C)	(V)	(A)	(μJ/A)	(μs)	(W)
600	MMG05N60D	0.3	90	1.6	0.3	16.2	N/A	1.0

(1) D suffix on part number indicates free wheeling diode is copackaged with the IGBT
(2) T_C = 25°C unless otherwise specified
(3) T_C = 125°C
(4) Maximum value at T_J = 150°C
(5) Typical value at T_J = 150°C

Symbols, Terms and Definitions

The following are the most commonly used letter symbols, terms and definitions associated with IGBTs:

Symbol	Term	Definition
$V_{(BR)CER}$	collector–emitter breakdown voltage with (resistance between gate and emitter)	The breakdown voltage between the collector terminal and the emitter terminal when the gate terminal is (as indicated by the last subscript letter) as follows: R = returned to the emitter terminal through a specified resistance.
$V_{(BR)CES}$	gate short–circuited to emitter	S = short–circuited to the emitter terminal.
$V_{(BR)CEV}$	voltage between gate and emitter	V = returned to the emitter terminal through a specified voltage.
$V_{(BR)CEX}$	circuit between gate and emitter	X = returned to the emitter terminal through a specified circuit.
C_{ce}	collector–emitter capacitance	The capacitance between the collector and emitter terminals with the gate terminal connected to the guard terminal of a three–terminal bridge.
C_{cg}	collector–gate capacitance	The same as C_{res} — See C_{res}.
C_{ge}	gate–emitter capacitance	The capacitance between the gate and emitter terminals with the collector terminal connected to the guard terminal of a three–terminal bridge.
C_{ies}	short–circuit input capacitance, common–emitter	The capacitance between the input terminals (gate and emitter) with the collector short–circuited to the emitter for alternating current. (Ref. IEEE No. 255)
C_{oes}	short–circuit output capacitance, common–emitter	The capacitance between the output terminals (collector and emitter) with the gate short–circuited to the emitter for alternating current. (Ref. IEEE No. 255)
C_{res}	short–circuit reverse transfer capacitance, common–emitter	The capacitance between the collector and gate terminals with the emitter connected to the guard terminal of a three–terminal bridge.
E_{off}	turn–off energy loss	Energy loss during turn–off measured over a period of time that starts with 5% of test voltage and goes on for 5 μs.
E_{on}	turn–on energy loss	Energy loss during turn–on measured from 5% of test current to 5% of test voltage.
E_{ts}	total switching loss	The sum of turn–on and turn–off energy losses.
g_{FE}	common–emitter large–signal transconductance	The ratio of the change in collector current due to a change in gate–to–emitter voltage.
I_C	collector current, dc	The direct current into the collector terminal.
$I_{C(on)}$	on–state collector current	The direct current into the collector terminal with a specified forward gate–emitter voltage applied to bias the device to the on–state.
I_{CES}	zero–gate–voltage collector current	The direct current into the collector terminal when the gate–emitter voltage is zero.
I_G	gate current, dc	The direct current into the gate terminal.

Symbol	Term	Definition
I_{GESF}	forward gate current, collector short–circuited to emitter	The direct current into the gate terminal of an insulated–gate bipolar transistor with a forward gate–emitter voltage applied and the collector terminal short–circuited to the emitter terminal.
I_{GESR}	reverse gate current, collector short–circuited to emitter	The direct current into the gate terminal of an insulated–gate bipolar transistor with a reverse gate–emitter voltage applied and the collector terminal short–circuited to the emitter terminal.
I_E	emitter current, dc	The direct current into the emitter terminal.
P_T, P_D	total nonreactive power input to all terminals	The sum of the products of the dc input currents and voltages.
Q_g	total gate charge	The total gate charge required to charge the IGBTs input capacitance to $V_{GE(on)}$.
Q_{gc}	gate–to–collector charge	The amount of charge required to charge the gate–to–collector capacitance to a specified value.
Q_{ge}	gate–to–emitter charge	The amount of charge required to charge the gate–to–emitter capacitance to a specified value.
$R_{CE(on)}$	static collector–emitter on–state resistance	The dc resistance between the collector and emitter terminals with a specified gate–emitter voltage applied to bias the device to the on state.
$R_{\theta CA}$	thermal resistance, case–to–ambient	The thermal resistance (steady–state) from the device case to the ambient.
$R_{\theta JA}$	thermal resistance, junction–to–ambient	The thermal resistance (steady–state) from the semiconductor junction(s) to the ambient.
$R_{\theta JC}$	thermal resistance, junction–to–case	The thermal resistance (steady–state) from the semiconductor junction(s) to a stated location on the case.
$R_{\theta JM}$	thermal resistance, junction–to–mounting surface	The thermal resistance (steady–state) from the semiconductor junction(s) to a stated location on the mounting surface.
T_A	ambient temperature or free–air temperature	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.
T_C	case temperature	The temperature measured at a specified location on the case of a device.
t_c	turn–off crossover time	The time interval during which drain voltage rises from 10% of its peak off–state value and drain current falls to 10% of its peak on–state value, in both cases ignoring spikes that are not charge–carrier induced.
T_J	channel temperature	The temperature of the channel of an IGBT.
T_{stg}	storage temperature	The temperature at which the device, without any power applied, may be stored.
$t_{d(off)}$	turn–off delay time	Synonym for current turn–off delay time (see Note 1)*.

Symbol	Term	Definition
$t_{d(off)i}$	current turn–off delay time	The interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector current waveform falls to 90% of its on–state amplitude, ignoring spikes that are not charge–carrier induced.
$t_{d(off)v}$	voltage turn–off delay time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector voltage waveform rises to 10% of its off–state amplitude, ignoring spikes that are not charge–carrier induced.
$t_{d(on)}$	turn–on delay time	Synonym for current turn–on delay time (see Note 1)*.
$t_{d(on)i}$	current turn–on delay time	The time interval during which can input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector current waveform rises to 10% of its on–state amplitude, ignoring spikes that are not charge–carrier induced.
$t_{d(on)v}$	voltage turn–on delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector voltage waveform falls to 90% of its off–state amplitude, ignoring spikes that are not charge–carrier induced.
t_f	fall time	Synonym for current fall time (see Note 1)*.
t_{fi}	current fall time	The time interval during which the drain current changes from 90% to 10% of its peak off–state value, ignoring spikes that are not charge–carrier induced.
t_{fv}	voltage fall time	The time interval during which the drain voltage changes from 90% to 10% of its peak off–state value, ignoring spikes that are not charge–carrier induced.
t_{off}	turn–off time	Synonym for current turn–off time (see Note 1)*.
$t_{off(i)}$	current turn–off time	The sum of current turn–off delay time and current fall time, i.e., $t_{d(off)i} + t_{fi}$.
$t_{off(v)}$	voltage turn–off time	The sum of voltage turn–off delay time and voltage rise time, i.e., $t_{d(off)v} + t_{rv}$.
t_{on}	turn–on time	Synonym for current turn–on time (see Note 1)*.
$t_{on(i)}$	current turn–on time	The sum of current turn–on delay time and current rise time, i.e., $t_{d(on)i} + t_{ri}$.
$t_{on(v)}$	voltage turn–on time	The sum of voltage turn–on delay time and voltage fall time, i.e., $t_{d(on)v} + t_{fv}$.

Symbol	Term	Definition
t_p	pulse duration	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform. **Note:** The two reference points are usually 90% of the steady–state amplitude of the waveform existing after the leading edge, measured with respect to the steady–state amplitude existing before the leading edge. If the reference points are 50% points, the symbol t_w and term average pulse duration should be used.
t_r	rise time	Synonym for current rise time (see Note 1)*.
t_{ri}	current rise time	The time interval during which the drain current changes from 10% to 90% of its peak on–state value, ignoring spikes that are not charge–carrier induced.
t_{rv}	voltage rise time	The time interval during which the collector voltage changes from 10% to 90% of its peak off–state value, ignoring spikes that are not charge–carrier induced.
t_{sc}	short circuit withstand time	The duration a device can withstand a short circuit at a specified temperature and gate bias.
t_w	average pulse duration	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform, with both reference points being 50% of the steady–state amplitude of the waveform existing after the leading edge, measured with respect to the steady–state amplitude existing before the leading edge. **Note:** If the reference points are not 50% points, the symbol t_p and term pulse duration should be used.
$V_{(BR)GESF}$	forward gate–emitter breakdown voltage	The breakdown voltage between the gate and emitter terminals with a forward gate–emitter voltage applied and the collector terminal short–circuited to the emitter terminal.
$V_{(BR)GESR}$	reverse gate–emitter breakdown voltage	The breakdown voltage between the gate and emitter terminals with a reverse gate–emitter voltage applied and the collector terminal short–circuited to the emitter terminal.
V_{CC}, V_{GG} V_{EE}	supply voltage, dc (collector, gate, emitter) voltage	The dc supply voltage applied to a circuit or connected to the reference terminal.
V_{CG} V_{CE} V_{GC} V_{GE} V_{EC} V_{EG}	collector–to–gate collector–to–emitter gate–to–collector gate–to–emitter emitter–to–collector emitter–to–gate	The dc voltage between the terminal indicated by the first subscript and the reference terminal indicated by the second subscript (stated in terms of the polarity at the terminal indicated by the first subscript).
$V_{CE(on)}$	collector–emitter on–state voltage	The voltage between the collector and emitter terminals with a specified forward gate–emitter voltage applied to bias the device to the on state.
$V_{CE(sat)}$	collector–to–emitter saturation voltage	Voltage measured from collector–to–emitter at a specified collectorcurrent and gate–to–emitter voltage. Interchangeable with $V_{CE(on)}$ for IGBTs.

Symbol	Term	Definition
$V_{GE(th)}$	gate–emitter threshold voltage	The forward gate–emitter voltage at which the magnitude of the collector current of an enhancement–type insulated gate bipolar transistor has been increased to a specified low value.
$Z_{\theta JA(t)}$	transient thermal impedance, junction–to–ambient	The transient thermal impedance from the semiconductor junction(s) to the ambient.
$Z_{\theta JC(t)}$	transient thermal impedance, junction–to–case	The transient thermal impedance from the semiconductor junction(s) to a stated location on the case.

Note 1: As names of time intervals for characterizing switching transistors, the terms “fall time” and “rise time” always refer to the change that is taking place in the magnitude of the output current even though measurements may be made using voltage waveforms. In a purely resistive circuit, the (current) rise time may be considered equal and coincident to the voltage fall time and the (current) fall time may be considered equal and coincident to the voltage rise time. The delay times for current and voltage will be equal and coincident. When significant amounts of inductance are present in a circuit, these equalities and coincidences no longer exist, and use of the unmodified terms delay time, fall time, and rise time must be avoided. See figures 1 and 2 for reference.

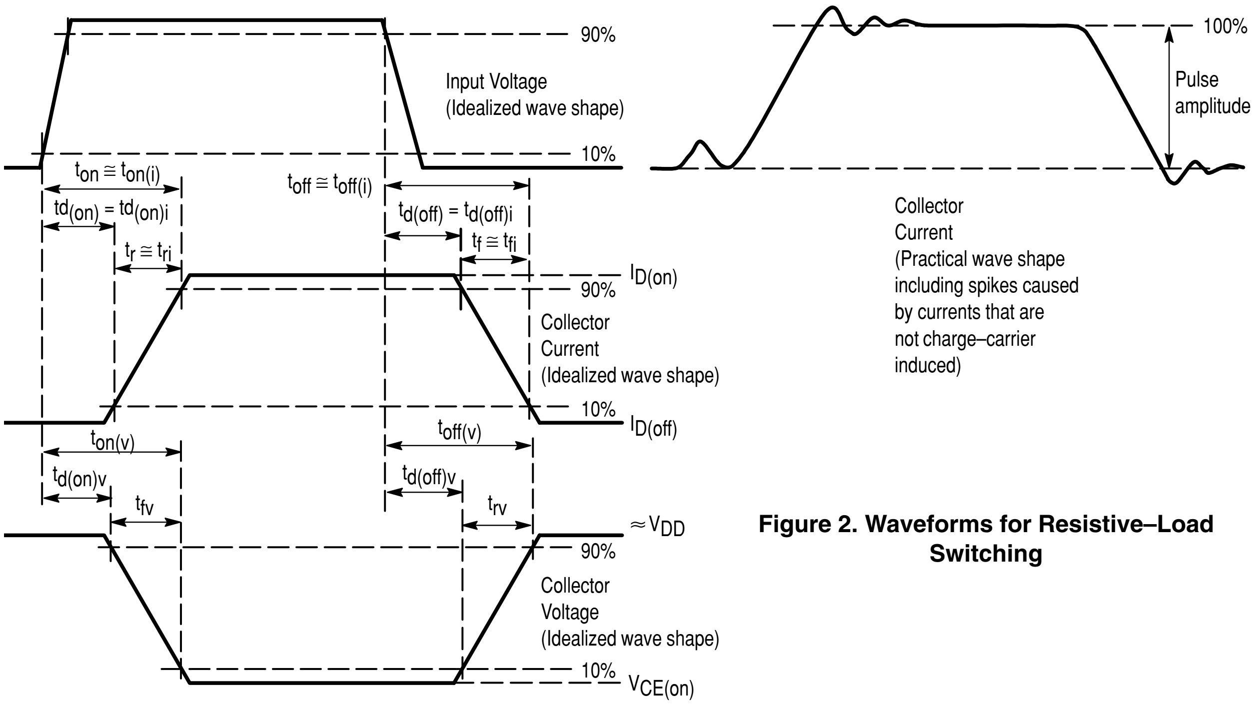
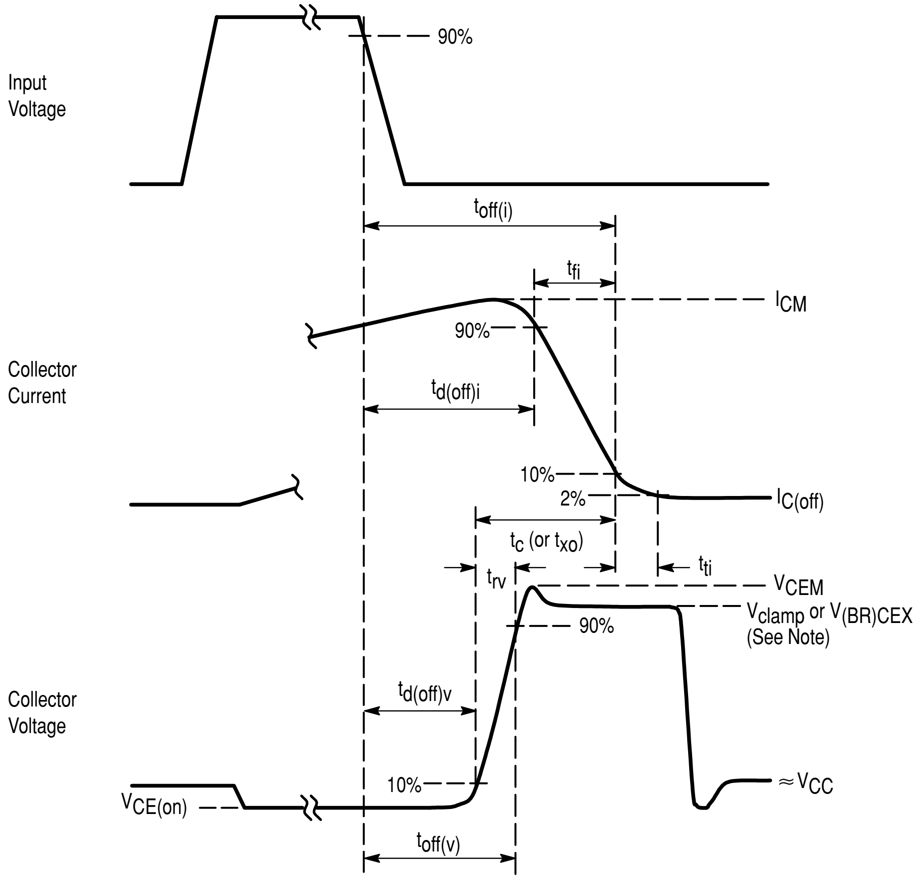


Figure 2. Waveforms for Resistive–Load Switching



NOTE: V_{clamp} (in a clamped inductive–load switching circuit) or $V_{(BR)CEX}$ (in an unclamped circuit) is the peak off–state voltage excluding spikes.

Figure 3. Waveforms for Inductive Load Switching, Turn–Off

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings represent the extreme capabilities of the device. They can best be described as device characterization boundaries and are given to facilitate "worst–case" design.

Collector–to–Emitter Voltage (V_{CES}, V_{CER}) This represents the lower limit of the device's blocking voltage capability from Collector–to–Emitter when the gate is shorted to the source (V_{CES}), or when a 1.0 MΩ Gate–to–Emitter resistor is present (V_{CER}). It is measured at a specific leakage current and has a positive temperature coefficient. The voltage across the IGBT should never exceed this rating in order to prevent breakdown of the Collector–to–Emitter junction.

Maximum Gate–to–Emitter Voltage (V_{GE}) The maximum allowable Gate–to–Emitter voltage. Exceeding this limit may result in permanent device degradation.

Continuous Collector Current (I_{C25}, I_{C90}) The dc current level that will raise the device's junction temperature to its rated maximum while its case temperature is held at either 25°C (I_{C25}), or 90°C (I_{C90}). This can be calculated by the equation:

$$I_{CX} = (T_{JMAX} - T_X) * (V_{CE(on)} @ T_{JMAX}) / R_{\theta JC}$$

where,

T_X = Case temperature
$V_{CE(on)}$ = Device's "on" voltage
T_{JMAX} = Device's maximum rated junction temperature
$R_{\theta JC}$ = Device's thermal resistance junction–to–case

Pulsed Collector Current (I_{CM}) The maximum allowable peak collector current the device can safely handle under a 10 µs pulsed condition. This rating takes into consideration the device's thermal limitation as well as $V_{CE(on)}$, wire bond and source metal limitations.

Maximum Power Dissipation (P_D) Specifies the power dissipation limit which takes the junction temperature to its maximum rating while the reference temperature is being held at 25° C. It is calculated by the following equation:

$$P_D = (T_{JMAX} - T_R)/R_{\theta JR}$$

where,

P_D = Maximum power dissipation
T_{JMAX} = Maximum allowable junction temperature
T_R = Reference (case and ambient) temperature
$R_{\theta JR}$ = Thermal resistance junction–to–reference (case or ambient)

Maximum Junction Temperature (T_{JMAX}) This value represents the maximum allowable junction temperature of the device. It is derived and based off of long term reliability data. Exceeding this value will only serve to shorten the device's long term operating life.

Short Circuit Withstand Time (t_{sc}) The permissible time, for given values of Collector–to–Emitter voltage, gate voltage and starting temperature, that the device can safely handle while in a shorted load condition.

Thermal Resistance ($R_{\theta JC}$, $R_{\theta JA}$) The quantity that resists or impedes the flow of heat energy in a device is called thermal resistance. Thermal resistance values are needed for proper thermal design. These values are measured as detailed in Section 3–8A.

ELECTRICAL CHARACTERISTICS

The intent of this section of the data sheet is to provide detailed device characterization information so that the designer can predict with a high degree of accuracy the behavior of the device in a specific application.

Collector–to–Emitter Breakdown Voltage ($V_{(BR)CES}$) This represents the lower limit of the device's blocking voltage capability from Collector–to–Emitter with the gate shorted to the source. It is measured at a specific leakage current and has a positive temperature coefficient.

Zero Gate Voltage Collector Current (I_{CES}) The direct current into the collector terminal of the device when the Gate–to–Emitter voltage is zero and the collector terminal is reversed biased with respect to the source terminal. This parameter generally increases with temperature as shown in the "Collector–to–Emitter Leakage Current versus Voltage" figure found in the device's data sheet.

Gate–Body Leakage Current (I_{GES}) The direct current flow in the gate terminal of the device when the gate terminal is biased with either a positive or negative voltage with respect to the source terminal and the collector terminal is short–circuited to the source terminal.

Gate Threshold Voltage ($V_{GE(th)}$) The forward Gate–to–Emitter voltage at which the magnitude of collector current has been increased to some low threshold value, usually specified as 250 µa or 1.0 ma. This parameter has a negative temperature coefficient.

Collector–to–Emitter On–Voltage ($V_{CE(on)}$) The dc voltage between the Collector–to–Emitter terminals at a specified collector current and with a Gate–to–Emitter voltage applied to bias the device into the on–state. This parameter has a positive temperature coefficient.

Forward Transconductance (g_{FE}) The ratio of the change in collector current due to a change in Gate–to–Emitter voltage (i.e., $\Delta I_E / \Delta V_{GE}$).

Device Capacitance (C_{ies}, C_{oes}, C_{res}) Power IGBT devices have internal parasitic capacitance from terminal–to–terminal. This capacitance is voltage dependent as shown by the "Capacitance Variation" figure in the device's data sheet. C_{iee} is the capacitance between the Gate–to–Emitter terminals with the collector terminal short–circuited to the source terminal for alternating current. C_{oee} is the capacitance between the Collector–to–Emitter terminals with the gate short–circuited to the source terminal for alternating current. C_{ree} is the capacitance between the Collector–to–Gate terminals with the source terminal connected to the guard terminal of a three–terminal bridge (Ref. IEEE No. 255). Figures 4, 5 and 6 show test circuits used for Power IGBT capacitance measurements.

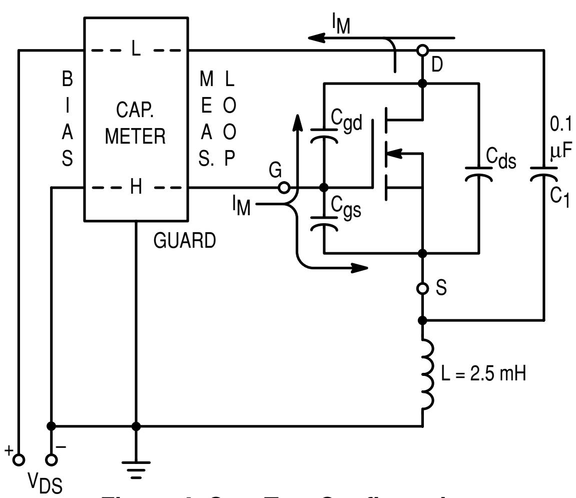


Figure 4. C_{ies} Test Configuration

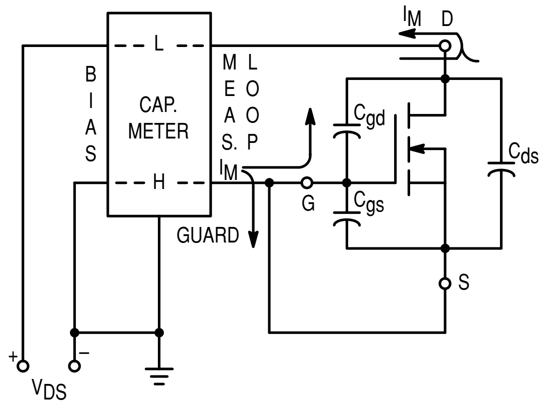


Figure 5. C_{oes} Test Configuration

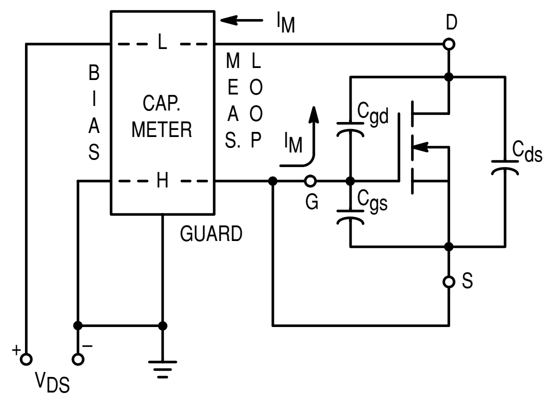


Figure 6. C_{res} Test Configuration

Inductive Switching ($t_{d(on)}$, t_r, $t_{d(off)}$, t_f, E_{on}, E_{off}, E_{ts}) IGBT clamped inductive switching is tested and measured using the inductive switching test circuit as shown in Figure 7. A typical switching waveform showing parameter measurement points is shown in Figure 8. Switching values are listed for both 25°C and 125°C junction temperatures on the data sheet.

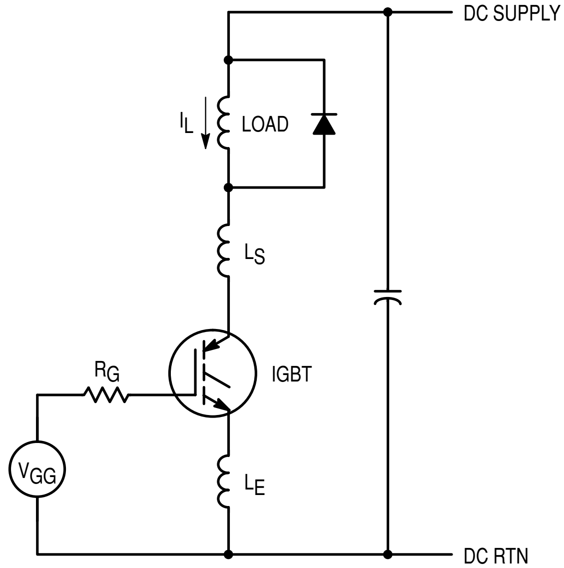


Figure 7. Switching Test Circuit

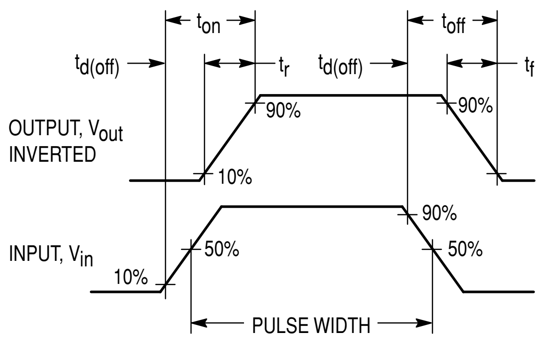


Figure 8. Switching Waveforms

Gate Charge (Q_T, Q_1, Q_2) Gate charge values are used to size the gate drive circuit. Q_T is defined as the total gate charge required to charge the device's input capacitance to the applied gate voltage. Q_1 is defined as the charge required to charge the device's input capacitance C_{GE} to the $V_{GS(on)}$ value required to maintain the test current I_C. Q_2 is defined as the charge time required to charge C_{GD} to the same value as C_{GE}.

Diode Forward Voltage Drop (V_{FEC}) Co–Package IGBT devices contain an integral power diode between the Collector–to–Emitter terminals. The dc voltage between the Emitter–to–Collector terminals when the power diode is forward biased is called the diode forward voltage drop (V_{FEC}).

Reverse Recovery Time (t_{rr}, t_a, t_b, Q_{RR}) Co–Package IGBT devices contain an integral power diode. A power diode is a minority carrier device and thus has a finite reverse recovery time. t_a is defined as the time between the dropping I_S current's zero crossing point to the peak I_{RM}. t_b is defined as the time between the peak I_{RM} to a projected I_{RM} zero current crossing point through a 25% I_{RM} projection as shown in Figure 9. Total reverse recovery time, t_{rr}, is defined as the sum of t_a and t_b. Q_{RR} is defined as the integral of the area made up by the I_{RM} waveform and V_R, the reapplied blocking voltage which forces reverse recovery. A relative softness factor s, is defined as the ratio of t_b to t_a. General purpose rectifiers have a softness factor of around 1.0, fast recovery rectifiers have a softness factor of approximately 0.5 and ultra fast rectifiers are very abrupt and have a softness factor of around 0.2. The tradeoff is the rectifier speed versus softness. The higher the softness factor, the less undesirable induced voltages in switching circuits. Diode reverse recovery values are listed for both 25°C and 125°C junction temperatures on the data sheet.

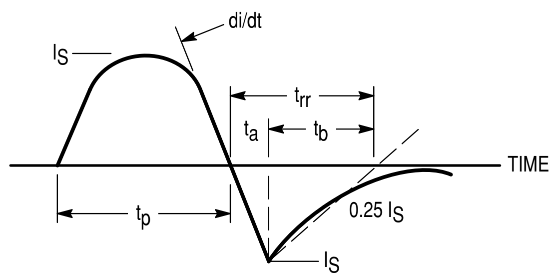


Figure 9. Diode Reverse Recovery Waveform

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