

Power Supply 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 $V_{D_{diff}}$ 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. Motorola offers a diverse portfolio of full featured switching regulator control circuits which meet the needs of today's modern compact electronic equipment.

Power supplies, MPU/MCU-based systems, industrial controls, computer systems and many other product applications are requiring power supervisory functions which monitor voltages to ensure proper system operation. Motorola offers a wide range of power supervisory circuits that fulfill these needs in a cost effective and efficient manner. MOSFET drivers are also provided to enhance the drive capabilities of first generation switching regulators or systems designed with CMOS/TTL logic devices. These drivers can also be used in dc-to-dc converters, motor controllers or virtually any other application requiring high speed operation of power MOSFETs.

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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 1. Linear Voltage Regulators

Device	V_{out}	25°C Tol. ±%	V_{in} Max	$V_{in}-V_{out}$ Diff. Typ.	Regline Max (% V_{out})	Regload Max (% V_{out})	Typ. Temp. Coefficient mV (V_{out}) / °C	Suffix/ Package
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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	D/751, D2T/936, DT, DT-1, T/221A, Z
LP2950C*/AC*	3.0	0.5	30	0.38	0.2/0.1	0.2/0.1	0.04	DT-3.0, Z-3.0
	3.3							DT-3.3, Z-3.3
	5.0							DT-5.0, Z-5.0
MC78LXXC/AC/AB*	5.0, 8.0, 9.0	8.0/4.0	30	1.7	4.0/3.0	1.2	0.2	D/751, P/29
MC78LXXC/AC/AB*	12, 15, 18	8.0/4.0	35	1.7	2.0	1.0	0.2	D/751, P/29
MC78L24C/AC/AB*	24	8.0/4.0	40	1.7	2.0	1.0	0.2	D/751, P/29
MC79L05C/AC/AB*	-5.0	8.0/4.0	30	1.7	4.0/3.0	1.2	0.2	D/751, P/29
MC79LXXC/AC/AB*	-(12, 15, 18)	8.0/4.0	35	1.7	2.0	1.0	0.2	D/751, P/29
MC79L24C/AC/AB*	-24	8.0/4.0	40	1.7	2.0	1.0	0.2	D/751, P/29
MC33160**	5.0	5.0	40	2.0	0.8	1.0	-	P/626

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	DT, DT-1, T/221A
MC78MXXB*/C	15, 18	4.0	35	2.0	1.0	2.0	±0.04	DT, DT-1, T/221A
MC78MXXB*/C	20, 24	4.0	40	2.0	0.25	2.0	±0.04	DT, DT-1, T/221A
MC79MXXB*/C	-(5.0, 8.0, 12, 15)	4.0	35	1.1	1.0	2.0	-0.07 to ±0.04	DT, DT-1, T/221A
MC33267*	5.05	2.0	40	0.58	1.0	1.0	-	D2T/936A, T/314D, TV

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	-	D/751, DT, T/221A, ST
MC34268	2.85	1.0	15	0.95	0.3	1.0	-	D/751, DT

Unless otherwise noted, $T_J = 0^\circ$ to $+125^\circ\text{C}$

* $T_J = -40^\circ$ to $+125^\circ\text{C}$

** $T_A = -40^\circ$ to $+85^\circ\text{C}$

Table 1. Linear Voltage Regulators (continued)

Device	V _{out}	25°C Tol. ±%	V _{in} Max	V _{in} -V _{out} Diff. Typ.	Regline Max (% V _{out})	Regload Max (% V _{out})	Typ. Temp. Coefficient mV (V _{out}) / °C	Suffix/ Package
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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	D2T/936, T/221A
MC7824B*/C/AC	24	4.0/2.0	40	2.0	2.0/1.0	2.0/0.4	0.125	D2T/936, T/221A
MC79XXC/AC	-(5.0, 5.2, 6.0)	4.0/2.0	35	2.0	2.0/1.0	2.0	-0.2	D2T/936, T/221A
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	D2T/936, T/221A
MC7924C	-24	4.0	40	2.0	1.0	2.0	-0.04	D2T/936, T/221A
LM340/A-XX	5.0, 6.0, 12, 15, 18	4.0/2.0	35	1.7	1.0/0.2	1.0/0.5	±0.12	T/221A
LM340-24	24	4.0	40	1.7	1.0	1.0	±0.12	T/221S

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	T/221A
MC78T15C/AC	15	4.0/2.0	40	2.5	0.5	0.6	0.04	T/221A
LM323/A	5.0	4.0/2.0	20	2.3	0.5/0.3	2.0/1.0	±0.2	T/221A

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

 * T_J = -40° to +125°C

 ** T_A = -40° to +85°C

Table 2. 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.	Regline Max (% V _{out})	Regload Max (% V _{out})	Typ. Temp. Coefficient mV (V _{out}) / °C	Suffix/ Package
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Fixed Voltage, Medium Dropout Regulators

MC33267*	5.05	2.0	500	40	0.58	1.0	1.0	-	D2T/936A, T/314D, TV
MC34268	2.85	1.0	800	15	0.95	0.3	1.0		D/751, DT
MC33269-XX*	3.3, 5.0, 12			20	1.0				D/751, DT, T/221A, ST/318E

Fixed Voltage, Low Dropout Regulators

LM2931*/A*	5.0	5.0/3.8	100	37	0.16	1.12	1.0	±2.5	D/751, D2T/936A, DT, DT-1, T/221A, Z
LP2950C*/AC*	3.0	1.0/0.5	100	30	0.38	0.2/0.1	0.2/0.1	0.2	DT-3.0, Z-3.0
	3.3								DT-3.3, Z-3.3
	5.0								DT-5.0, Z-5.0

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

 * T_J = -40° to +125°C

Table 2. Fixed Voltage Medium and Low Dropout Regulators (continued)

Device	V _{out}	25°C Tol. ±%	I _O (mA) Max	V _{in} Max	V _{in} -V _{out} Diff. Typ.	Regline Max (% V _{out})	Regload Max (% V _{out})	Typ. Temp. Coefficient mV (V _{out}) / °C	Suffix/ Package
Fixed Voltage, Low Dropout Regulators									
LP2951C*/AC*	3.0	1.0/0.5	100	28.75	0.38	0.04/0.02	0.04/0.02	±1.0	D-3.0/751, DM-3.0/846A, N-3.0/626
	3.3								D-3.3/751, DM-3.3/846A, N-3.3/626
	5.0								D/751, DM/846A, N/626
LM2935*	5.0/5.0	5.0/5.0	500/10	60	0.45/0.55	1.0	1.0	-	D2T/936A, T/314D, TH, TV

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

 * T_J = -40° to +125°C

Adjustable Output

Motorola 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 3. Adjustable Output Regulators

Device	V _{out}	I _O (mA) Max	V _{in} Max	V _{in} -V _{out} Diff. Typ.	Regline Max (% V _{out})	Regload Max (% V _{out})	Typ. Temp. Coefficient mV (V _{out}) / °C	Suffix/ Package
Adjustable Regulators								
LM317L/B*	2.0-37	100	40	1.9	0.07	1.5	±0.35	D/751, Z
LM2931C*	3.0-24	100	37	0.16	1.12	1.0	±2.5	D/751, D2T/936A, T/314D, TH, TV
LP2951C*/AC*	1.25-29	100	28.75	0.38	0.04/0.02	0.04/0.02	±1.0	D-3.0/751, DM-3.0/846A, N-3.0/626
								D-3.3/751, DM-3.3/846A, N-3.3/626
								D/751, DM/846A, N/626

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

 * T_J = -40° to +125°C

 # T_A = 0° to +70°C

Table 3. Adjustable Output Regulators (continued)

Device	V _{out}	I _O (mA) Max	V _{in} Max	V _{in} -V _{out} Diff. Typ.	Regline Max (% V _{out})	Regload Max (% V _{out})	Typ. Temp. Coefficient mV (V _{out}) °C	Suffix/ Package
Adjustable Regulators								
MC1723C#	2.0-37	150	38	2.5	0.5	0.2	±0.033	D/751, P/646
LM317M/B*	1.2-37	500	40	2.1	0.04	0.5	±0.35	DT, DT-1, T/221A
LM337M/B*	-(1.2-37)	500	40	1.9	0.07	1.5	±0.3	T/221A
MC33269*	1.25-19	800	18.75	1.0	0.3	0.5	±0.4	D/751, DT, T/221A, ST
LM317/B*	1.2-37	1500	40	2.25	0.07	1.5	±0.35	D2T/936, T/221A
LM337/B*	-(1.2-37)	1500	40	2.3	0.07	1.5	±0.3	D2T/936, T/221A
LM350/B*	1.2-33	3000	35	2.7	0.07	1.5	±0.5	T/221A

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, Case 1213, 1212

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.

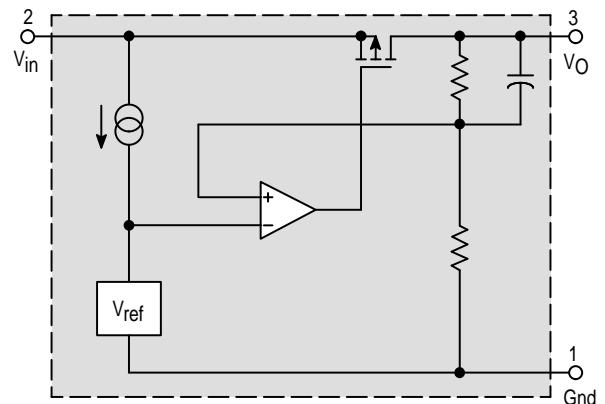
MC78LC00 Series Features:

- 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.



Micropower Voltage Regulators for Portable Applications (continued)

120 mA Micropower Voltage Regulator

MC78FC00H

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1213

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.

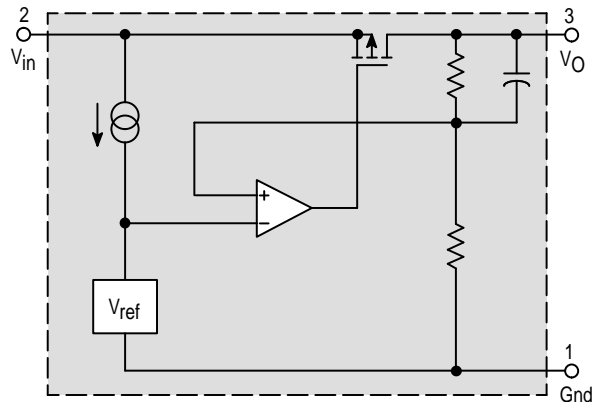
MC78FC00 Series Features:

- 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 ($\pm 2.5\%$)
- 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	$T_A = -30^\circ$ to $+80^\circ\text{C}$	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

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1212

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.

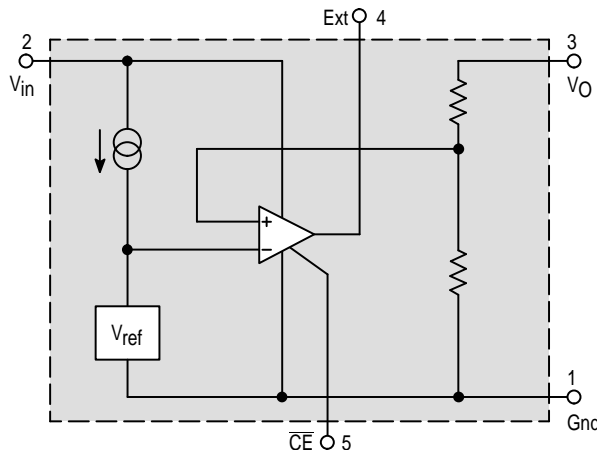
MC78BC00 Series Features:

- 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 ($\pm 2.5\%$)

ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78BC30NTR	3.0	$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-23
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

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 1212

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:

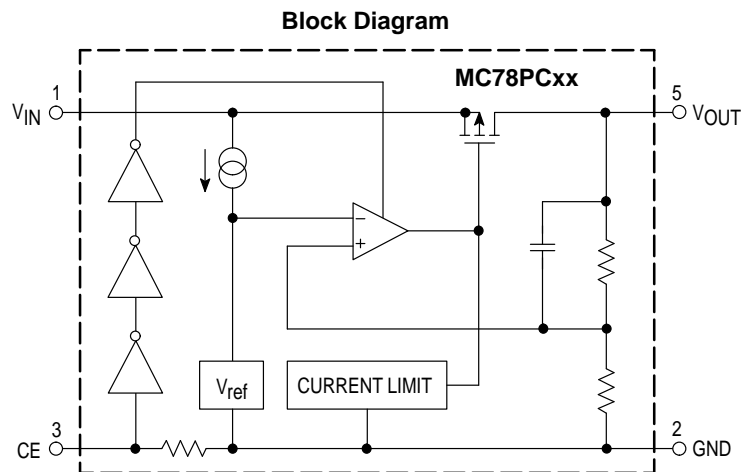
- Ultra-Low Supply Current: typical 35 μA in ON mode with no load
- Standby Mode: typical 0.1 μA
- Low Dropout Voltage: typical 0.2 V @ $I_{\text{OUT}} = 100$ mA
- High Ripple Rejection: typical 70 dB @ $f = 1$ kHz
- Low Temperature-Drift Coefficient of Output Voltage: typical ± 100 ppm/ $^\circ\text{C}$

- Excellent Line Regulation: typical 0.05%/V
- High Accuracy Output Voltage: $\pm 2.0\%$
- 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	$T_A = -40^\circ$ to $+85^\circ\text{C}$	SOT-23 5 Leads

Other voltages are available. Consult your Motorola representative.



Micropower Voltage Regulators for Portable Applications (continued)

Micropower smallCAP™ Voltage Regulators with On/Off Control

MC33264D, DM

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 751, 846A

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.

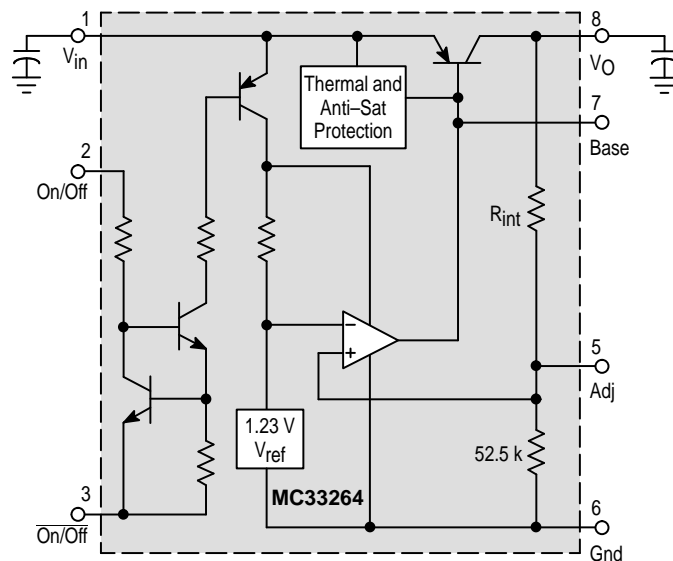
MC33264 Features:

- 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	$T_A = -40^\circ$ to $+85^\circ\text{C}$	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



Special Regulators

Voltage Regulator/Supervisory

Table 4. 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				
MC33128*	2.9	3.1	35	3.2	7.0	n/a	30	-30 to +60	D/751B
	2.9	3.1	60				40		
	2.9	3.1	20				25		
	-2.65	-2.35	1.0				20		
MC34160	4.75	5.25	100	7.0	40	40	50	0 to +70	P/648C, DW/751G
MC33160							-40 to +85		
MC33267	4.9	5.2	500	6.0	26	50	50	-40 to +105	T/314D, TH, TV
MC33169*	4.7	6.4	-	2.7	9.5	-	-	-40 to +85	DTB/948G
	6.4	7.0							
	-2.35	-2.65							

* 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

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 648C, 751G

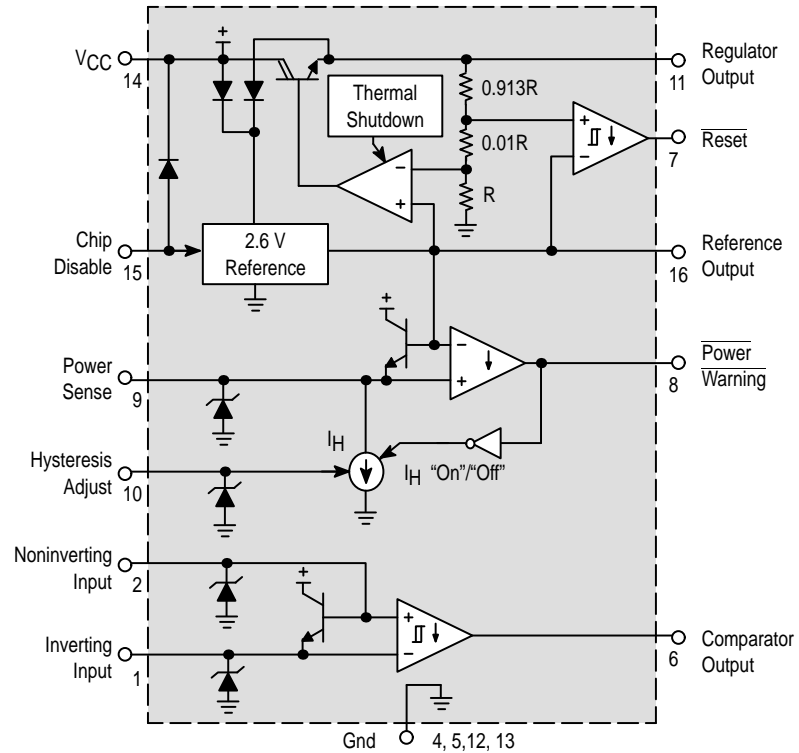
MC33160P, DW

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 648C, 751G

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.



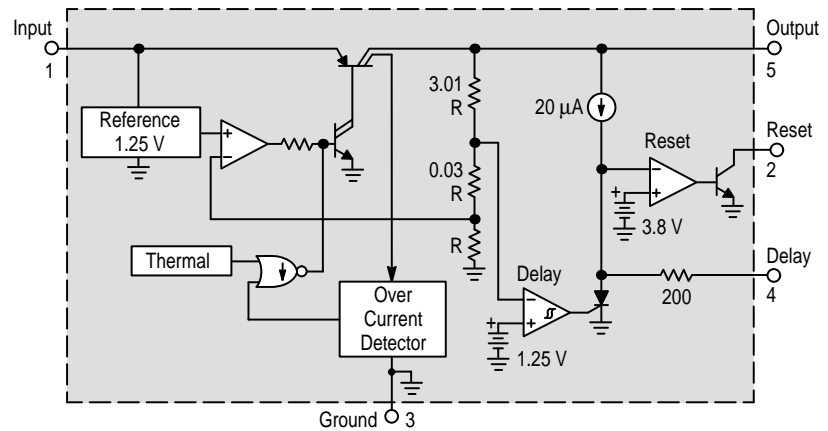
Low Dropout Regulator

MC33267T, TV

$T_J = -40^\circ$ to $+105^\circ\text{C}$, Case 314D, 314B

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

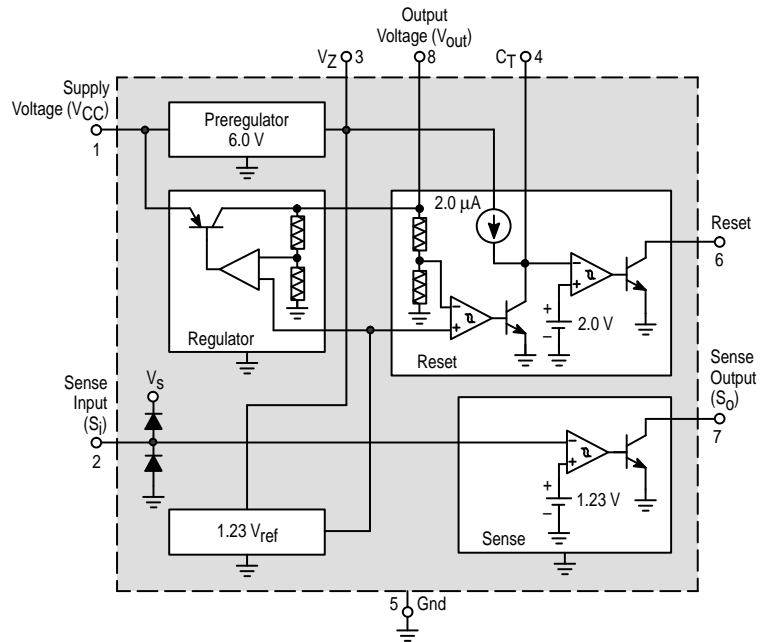
L4949N, D

$T_J = -40^\circ$ to $+125^\circ\text{C}$, Case 626, 751

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 $\pm 1\%$
- 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



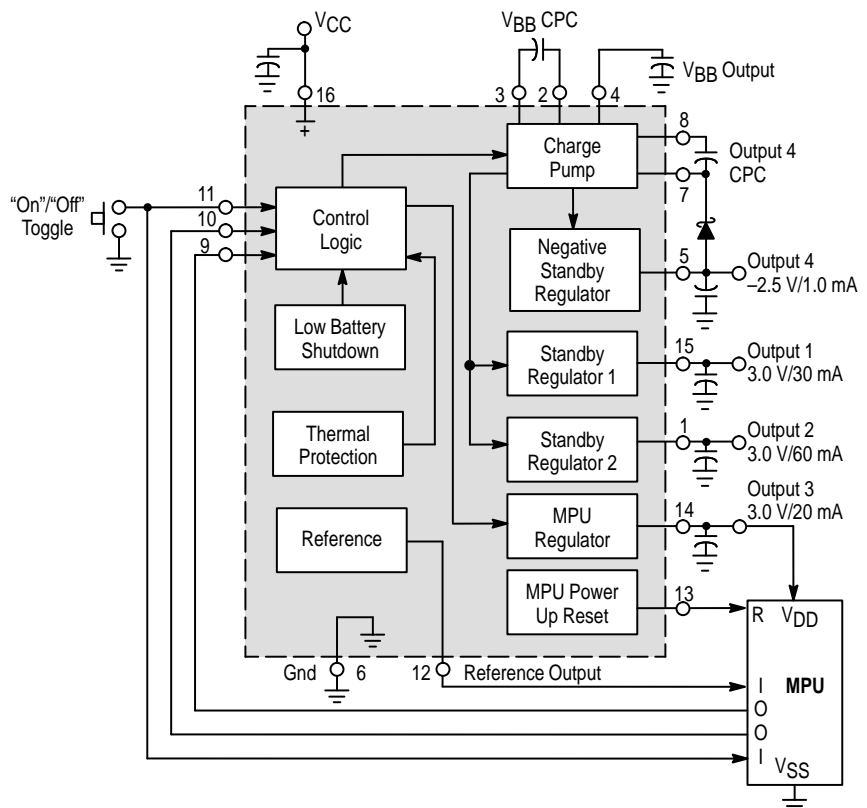
Power Management Controller

MC33128D

$T_A = -30^\circ$ to $+60^\circ\text{C}$, Case 751B

The MC33128 is a power management controller specifically designed for use in battery powered cellular telephone and pager applications. This device contains all of the active functions required to interface the user to the system electronics via a microprocessor. This integrated circuit consists of a low dropout voltage regulator with power-up reset for MPU power, two low dropout voltage regulators for independent powering of analog and digital circuitry, and a negative charge pump voltage regulator for full depletion of gallium arsenide MESFETs.

Also included are protective system shutdown features consisting of a battery latch that is activated upon battery insertion, low battery voltage shutdown, and a thermal over temperature detector. This device is available in a 16-pin narrow body surface mount plastic package.



GaAs Power Amplifier Support IC

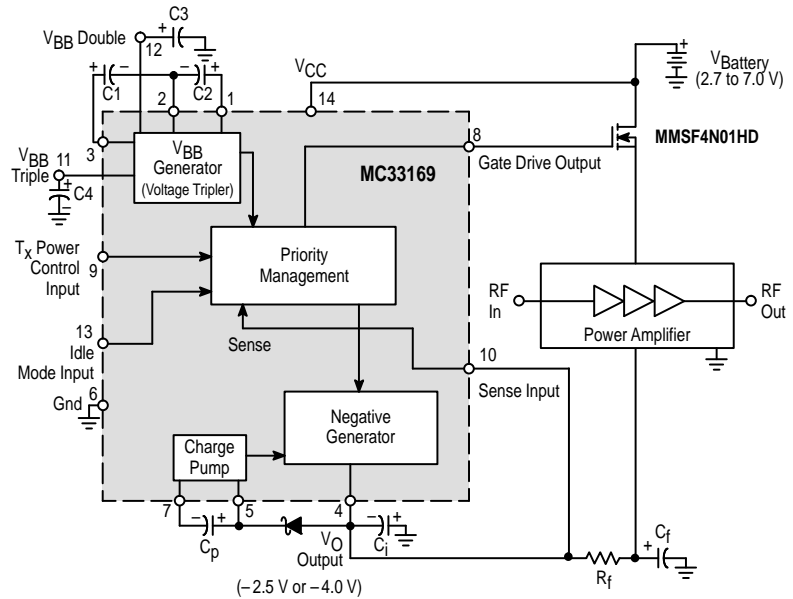
MC33169DTB

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 948G

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 two versions, -2.5 and -4.0 V. The -4.0 V version is intended for supplying RF modules for GSM and DCS1800 applications, whereas the -2.5 V version is dedicated for DECT and PHS systems.

- 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



SCSI Regulator

Table 5. SCSI Regulator

Device	V _{out} (V)		I _{sink} (mA)	V _{in} (V)		Reg _{line} (%)	Reg _{load} (%)	T _J (°C)	Suffix/Package
	Min	Max		Min	Max				
MC34268	2.81	2.89	800	3.9	20	0.3	0.5	150	D/751, DT

SCSI-2 Active Terminator Regulator

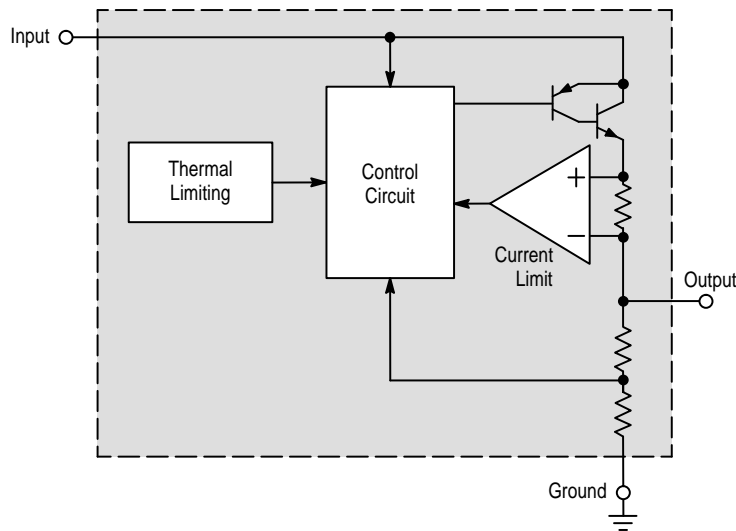
MC34268D, DT

T_J = 0° to +125°C, Case 751, 369A

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



Switching Regulator Control Circuits

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 6. 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)	Suffix/ Package
500 (Uncommitted Drive Output)	7.0 to 40	Voltage	$5.0 \pm 1.5\%$	200	MC34060A	0 to +70	D/751A P/646
					MC33060A	-40 to +85	D/751A P/646
1000 (Totem Pole MOSFET Drive Output)	4.2 to 12	Current	$1.25 \pm 2.0\%$	300	MC34129	0 to +70	D/751A P/646
					MC33129	-40 to +85	D/751A P/646
	11.5 to 30		$5.0 \pm 2.0\%$	500	UC3842A	0 to +70	D/751A N/626
					UC2842A	-25 to +85	D/751A N/626
	11 to 30		$5.0 \pm 1.0\%$	500	UC3843A	0 to +70	D/751A N/626
					UC2843A	-25 to +85	D/751A N/626
	8.2 to 30		$5.0 \pm 2.0\%$	500 (50% Duty Cycle Limit)	UC3844	0 to +70	D/751A N/626
					UC2844	-25 to +85	D/751A N/626
	11.5 to 30		$5.0 \pm 1.0\%$	500	UC3845	0 to +70	D/751A N/626
					UC2845	-25 to +85	D/751A N/626
	11 to 30		$5.0 \pm 2.0\%$	500 (Improved Oscillator Specifications with Frequency Guaranteed at 250 kHz)	UC3842B	0 to +70	D/751A D1/751 N/626
					UC3842BV	-40 to +105	D/751A D1/751 N/626
	8.2 to 30		$5.0 \pm 1.0\%$	500	UC3845	0 to +70	D/751A N/626
					UC2845	-25 to +85	D/751A N/626
11.5 to 30	$5.0 \pm 2.0\%$	500	UC3844	0 to +70	D/751A N/626		
			UC2844	-25 to +85	D/751A N/626		

Table 6. 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)	Suffix/ Package
1000 (Totem Pole MOSFET Drive Output)	11 to 30	Current	$5.0 \pm 1.0\%$	500 (Improved Oscillator Specifications with Frequency Guaranteed at 250 kHz)	UC2842B	-25 to +85	D/751A
							D1/751
	N/626						
	8.2 to 30		$5.0 \pm 2.0\%$		UC3843B	0 to +70	D/751A
							D1/751
	N/626						
	11.5 to 30		$5.0 \pm 2.0\%$	UC3843BV	-40 to +105	D/751A	
						D1/751	
	N/626						
	11 to 30		$5.0 \pm 1.0\%$	UC2843B	-25 to +85	D/751A	
						D1/751	
	N/626						
	8.2 to 30		$5.0 \pm 2.0\%$	500 (50% Duty Cycle Limit)	UC3844B	0 to +70	D/751A
							D1/751
	N/626						
	11 to 30		$5.0 \pm 1.0\%$	UC3844BV	-40 to +105	D/751A	
D1/751							
N/626							
8.2 to 30	$5.0 \pm 2.0\%$	UC2844B	-25 to +85	D/751A			
				D1/751			
N/626							
11 to 18	$5.0 \pm 2.0\%$	UC3845B	0 to +70	D/751A			
				D1/751			
N/626							
9.2 to 30	$5.0 \pm 1.0\%$	UC3845BV	-40 to +105	D/751A			
				D1/751			
N/626							
1000 Source 1500 Sink (Split Totem Pole Bipolar Drive Output)	$5.0 \pm 6.0\%$	MC44602				P2/648C	
2000 (Totem Pole MOSFET Drive Output)	9.2 to 30	Current or Voltage	$5.1 \pm 1.0\%$	1000	MC34023	0 to +70	DW/751G
							FN/775
					MC33023	-40 to +105	DW/751G
							FN/775
P/648							

Table 7. 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)	Suffix/ Package
1500 (Uncommitted Power Switch)	2.5 to 40	Voltage	$1.25 \pm 5.2\%$ ⁽¹⁾	100	$\mu A78S40$	0 to +70	PC/648
						-40 to +85	PV/648
			$1.25 \pm 2.0\%$		MC34063A	0 to +70	D/751
							P1/626
			MC33063A		-40 to +85	D/751	
					-40 to +125	D/751	
3400 (Uncommitted Power Switch)	2.5 to 40	Voltage	$1.25 \pm 2.0\%$ and $5.05 \pm 3.0\%$	100	MC34163	0 to +70	P/648C, DW/751G
					MC33163	-40 to +85	
3400 ⁽²⁾ (Dedicated Emitter Power Switch)	7.5 to 40	Voltage	$5.05 \pm 2.0\%$	72 \pm 12% Internally Fixed	MC34166	0 to +70	D2T/936A, TH, TV, T/314D
					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 8. 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)	Suffix/ Package
500	4.75 to 40	Voltage	52 Fixed Internal	3.3	LM2574N-3.3 LM2574N-5 LM2574N-12 LM2574N-15 LM2574N-ADJ	-40 to +125	N/626
	8.0 to 40 15 to 40 18 to 40 8.0 to 40			5.0 12 15 1.23 to 37			
1000	4.75 to 40	Voltage	52 Fixed Internal	3.3	LM2575T-3.3 LM2575T-5 LM2575T-12 LM2575T-15 LM2575T-ADJ	-40 to +125	T/314D
	8.0 to 40			5.0			
	15 to 40			12			
	18 to 40			15			
	8.0 to 40			1.23 to 37			
	4.75 to 40			3.3	LM2575TV-3.3 LM2575TV-5 LM2575TV-12 LM2575TV-15 LM2575TV-ADJ		TV/314B
8.0 to 40	5.0	LM2575D2T-3.3 LM2575D2T-5 LM2575D2T-12 LM2575D2T-15 LM2575D2T-ADJ	D2T/936A				
15 to 40	12						
18 to 40	15						
8.0 to 40	1.23 to 37						

Table 8. 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)	Suffix/ Package
3000	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	LM2576T-3.3 LM2576T-5 LM2576T-12 LM2576T-15 LM2576T-ADJ	-40 to +125	T/314D
	4.75 to 40 8.0 to 40 15 to 40 18 to 40 8.0 to 40			3.3 5.0 12 15 1.23 to 37	LM2576TV-3.3 LM2576TV-5 LM2576TV-12 LM2576TV-15 LM2576TV-ADJ		TV/314B
	4.75 to 40 8.0 to 40 15 to 40 18 to 40 8.0 to 40			3.3 5.0 12 15 1.23 to 37	LM2576D2T-3.3 LM2576D2T-5 LM2576D2T-12 LM2576D2T-15 LM2576D2T-ADJ		D2T/936A

Table 9. 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.

Power Switch Maximum Rating		Startup Input Max (V)	Operating Mode	Feedback Threshold (V)	Maximum Useful Oscillator Frequency (kHz)	Device	T_J (°C)	Suffix/ Package
V_{DS} (V)	I_{DS} (mA)							
500	2000	250	Voltage	$2.6 \pm 3.1\%$	1000	MC33362	-25 to +125	DW/751N, P/648E
700	1000	450				MC33363		
700	1000	450				MC33363A		

Table 10. 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)	Suffix/ Package
500 (Uncommitted Drive Outputs)	7.0 to 40	Voltage	$5.0 \pm 5.0\%$ ⁽¹⁾	200	TL494	0 to +70	CN/648
						-25 to +85	IN/648
			$5.0 \pm 1.5\%$	300	TL594	0 to +70	CN/648
						-25 to +85	IN/648
± 500 (Totem Pole MOSFET Drive Outputs)	8.0 to 40		$5.1 \pm 2.0\%$	400	SG3525A	0 to +70	N/648
± 200 (Totem Pole MOSFET Drive Outputs)			$5.0 \pm 2.0\%$		SG3526	0 to +125 ⁽²⁾	N/707

Table 10. Double-Ended Controllers (continued)

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)	Suffix/ Package
±1500 (Totem Pole MOSFET Drive Outputs)	9.6 to 20	Resonant (Zero Current)	5.1 ± 2.0%	1000	MC34066	0 to +70	DW/751G
							P/648
					MC33066	-40 to +85	DW/751G
		P/648					
		Resonant (Zero Voltage)		2000	MC34067	0 to +70	DW/751G
							P/648
MC33067	-40 to +85		DW/751G				
		P/648					
2000 (Totem Pole MOSFET Drive Outputs)	9.2 to 30	Current or Voltage	5.1 ± 1.0%	1000	MC34025	0 to +70	DW/751G
							FN/775
							P/648
					MC33025	-40 to +105	DW/751G
							FN/775
							P/648

(1) Tolerance applies over the specified operating temperature range.

(2) Junction Temperature Range.

Switching Regulator Control Circuits (continued)

CMOS Micropower DC-to-DC Converters

Variable Frequency Micropower DC-to-DC Converter

MC33463H

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1213

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 $4.0\ \mu\text{A}$ 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.

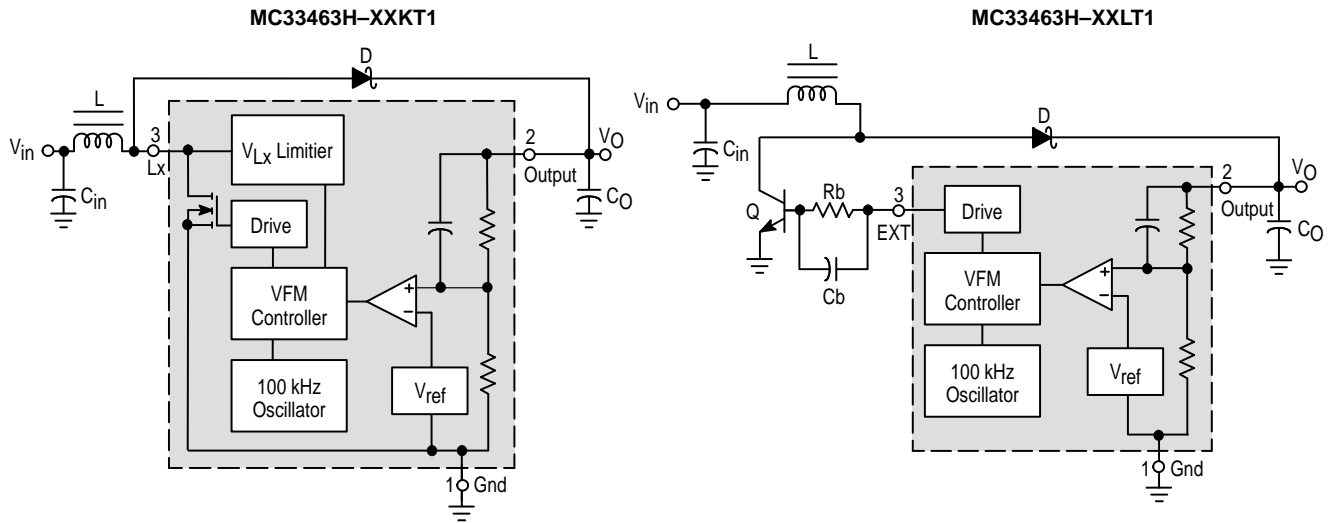
MC33463 Series Features:

- Low Quiescent Bias Current of $4.0\ \mu\text{A}$
- High Output Voltage Accuracy of $\pm 2.5\%$
- Low Startup Voltage of $0.9\ \text{V}$ at $1.0\ \text{mA}$
- Wide Output Voltage Range of $2.5\ \text{V}$ to $7.5\ \text{V}$ Available
- High Efficiency of 80% Typical
- Surface Mount Package

ORDERING INFORMATION

Device	Output Voltage	Type	Operating Temperature Range	Package (Tape/Reel)
MC33463H-30KT1	3.0	Int. Switch	$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-89 (Tape)
MC33463H-33KT1	3.3	Switch		
MC33463H-50KT1	5.0			
MC33463H-30LT1	3.0	Ext. Switch		SOT-89 (Tape)
MC33463H-33LT1	3.3	Drive		
MC33463H-50LT1	5.0			

Other voltages from $2.5\ \text{V}$ to $7.5\ \text{V}$, in $0.1\ \text{V}$ increments are available. Consult factory for information.



XX Denotes Output Voltage

CMOS Micropower DC-to-DC Converters (continued)

Fixed Frequency PWM Micropower DC-to-DC Converter

MC33466H

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1213

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 $15\ \mu\text{A}$ 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.

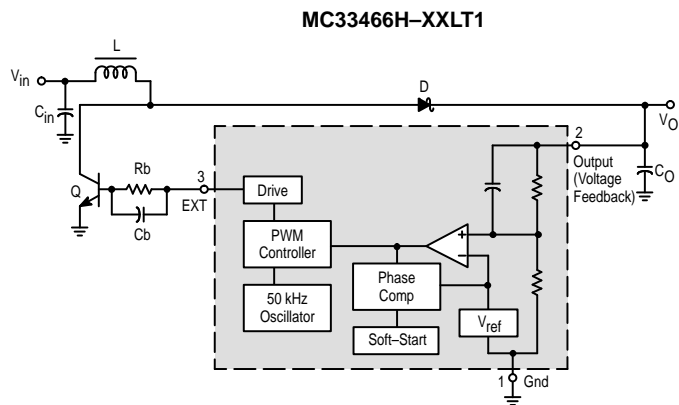
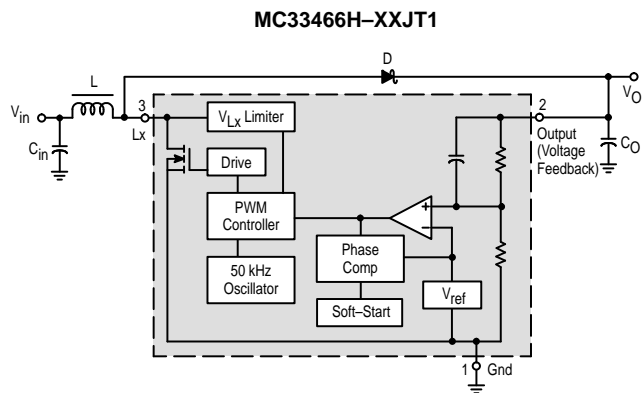
MC33466 Series Features:

- Low Quiescent Bias Current of $15\ \mu\text{A}$
- High Output Voltage Accuracy of $\pm 2.5\%$
- Low Startup Voltage of $0.9\ \text{V}$ at $1.0\ \text{mA}$
- Soft-Start = $500\ \mu\text{s}$
- Surface Mount Package

ORDERING INFORMATION

Device	Output Voltage	Type	Operating Temperature Range	Package (Tape/Reel)
MC33466H-30JT1	3.0	Int. Switch	$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-89 (Tape)
MC33466H-33JT1	3.3	Switch		
MC33466H-50JT1	5.0			
MC33466H-30LT1	3.0	Ext. Switch		SOT-89 (Tape)
MC33466H-33LT1	3.3	Drive		
MC33466H-50LT1	5.0			

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



XX Denotes Output Voltage

Switching Regulator Control Circuits (continued)

Synchronous Rectification DC/DC Converter Programmable Integrated Controller

MC33470

$T_A = 0^\circ$ to $+75^\circ\text{C}$, Case 751D

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.

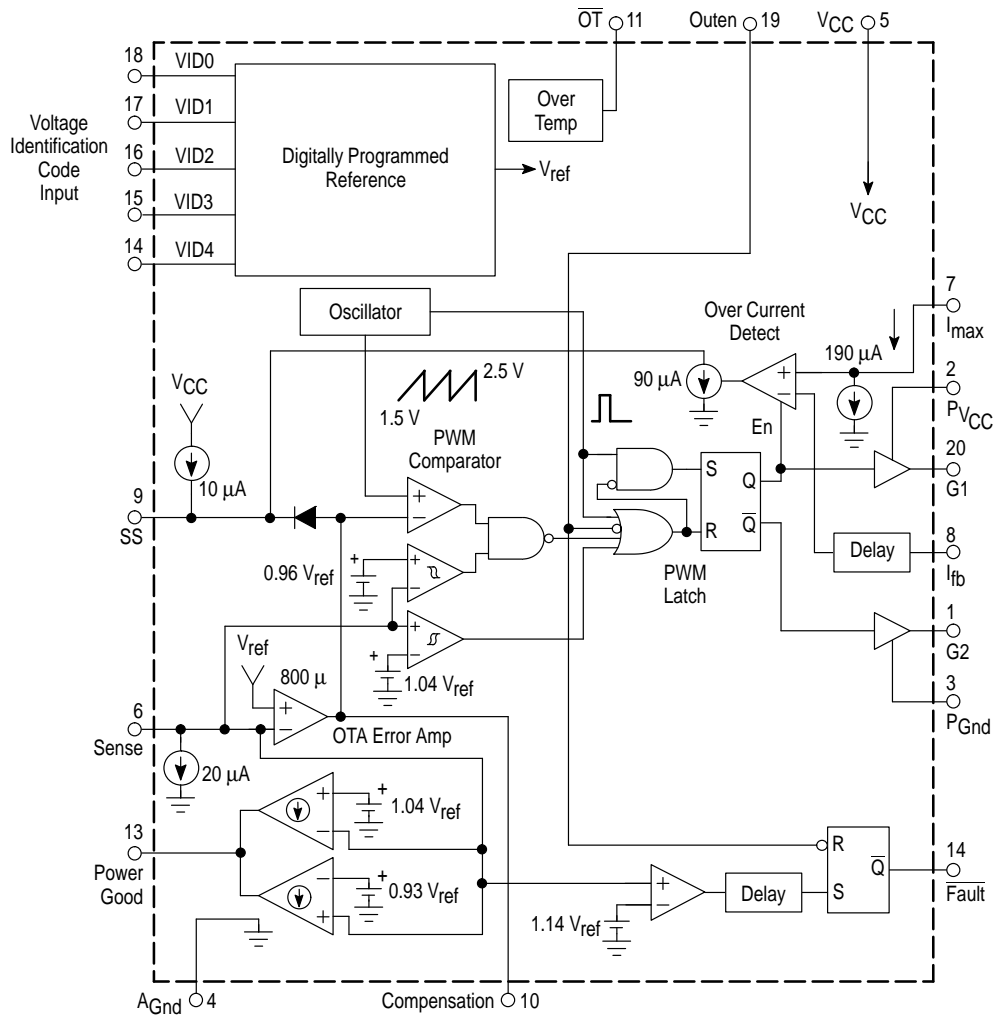
MC33470 Features:

- 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	$T_A = 0^\circ$ to $+75^\circ\text{C}$	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

$T_J = -40^\circ$ to $+125^\circ\text{C}$, Case 626

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 $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 10\%$ on the oscillator frequency ($\pm 2\%$ over 0°C to $+125^\circ\text{C}$). 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

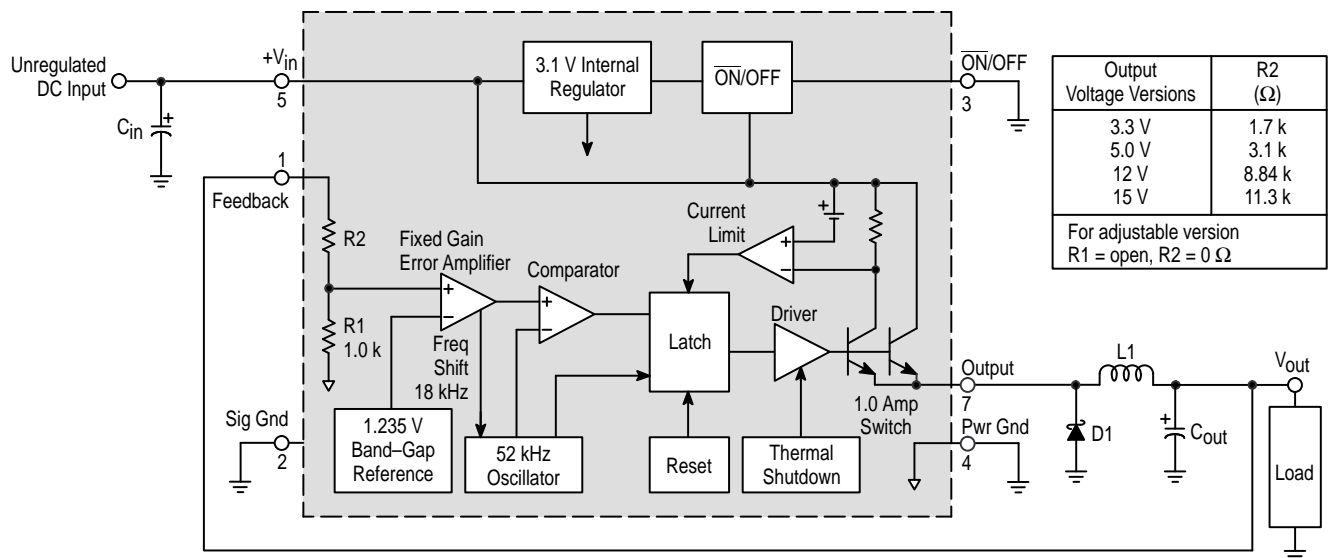
- 3.3 V, 5.0 V, 12 V, 15 V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range, 1.23 to 37 V $\pm 4\%$ max over Line and Load Conditions
- Guaranteed **0.5 A** Output Current
- Wide Input Voltage Range: 4.75 to 40 V
- Requires Only 4 External Components
- 52 kHz Fixed Frequency 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



Step-Down Voltage Regulators (continued)

LM2575T-XX, TV, D2T, LM2576T-XX, TV, D2T

$T_J = -40^\circ$ to $+125^\circ\text{C}$, Case 314D, 314B, 936A

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 $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 10\%$ on the oscillator frequency ($\pm 2\%$ 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

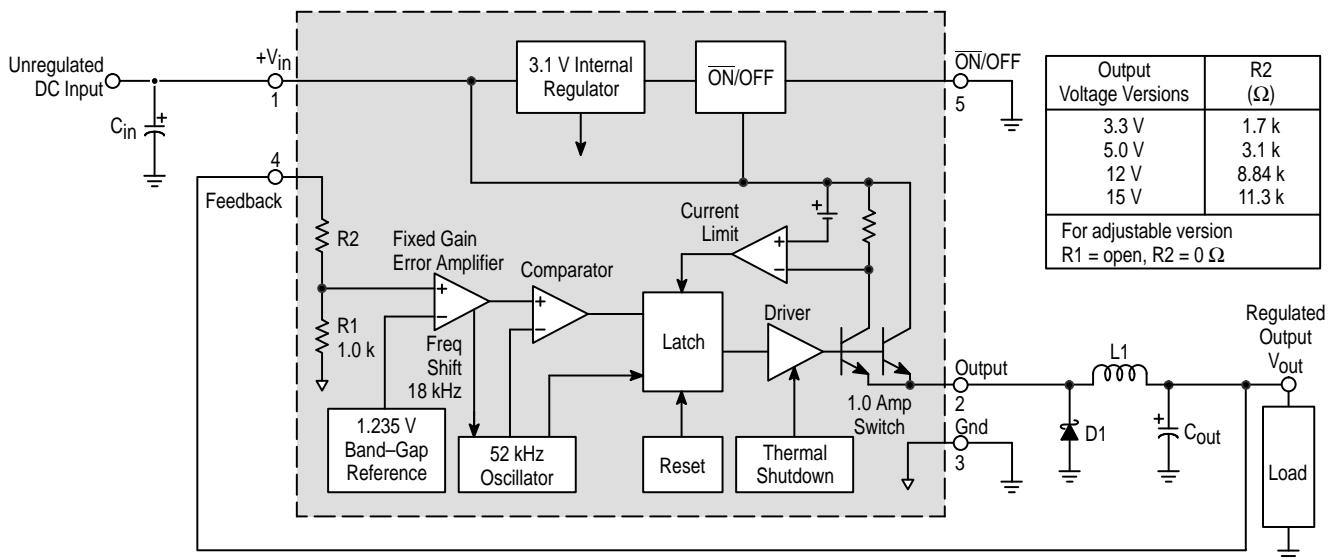
- 3.3 V, 5.0 V, 12 V, 15 V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range of 1.23 V to 37 V $\pm 4\%$ Maximum Over Line and Load Conditions
- Guaranteed **1.0 A** (LM2575) **3.0 A** (LM2576) Output Current
- Wide Input Voltage Range: 4.75 V to 40 V
- Requires Only 4 External 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.

Switching Regulator Control Circuits (continued)

Single-Ended GreenLine™ Controllers

Enhanced Mixed Frequency Mode GreenLine™ PWM Controller: Fixed Frequency, Variable Frequency, Standby Mode

MC44603AP, DW

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 648, 751G

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

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 648

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

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

Single-Ended GreenLine™ Controllers (continued)

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

MC44605P

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 648

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 motor 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

Switching Regulator Control Circuits (continued)

Very High Voltage Switching Regulator

MC33362DW, P

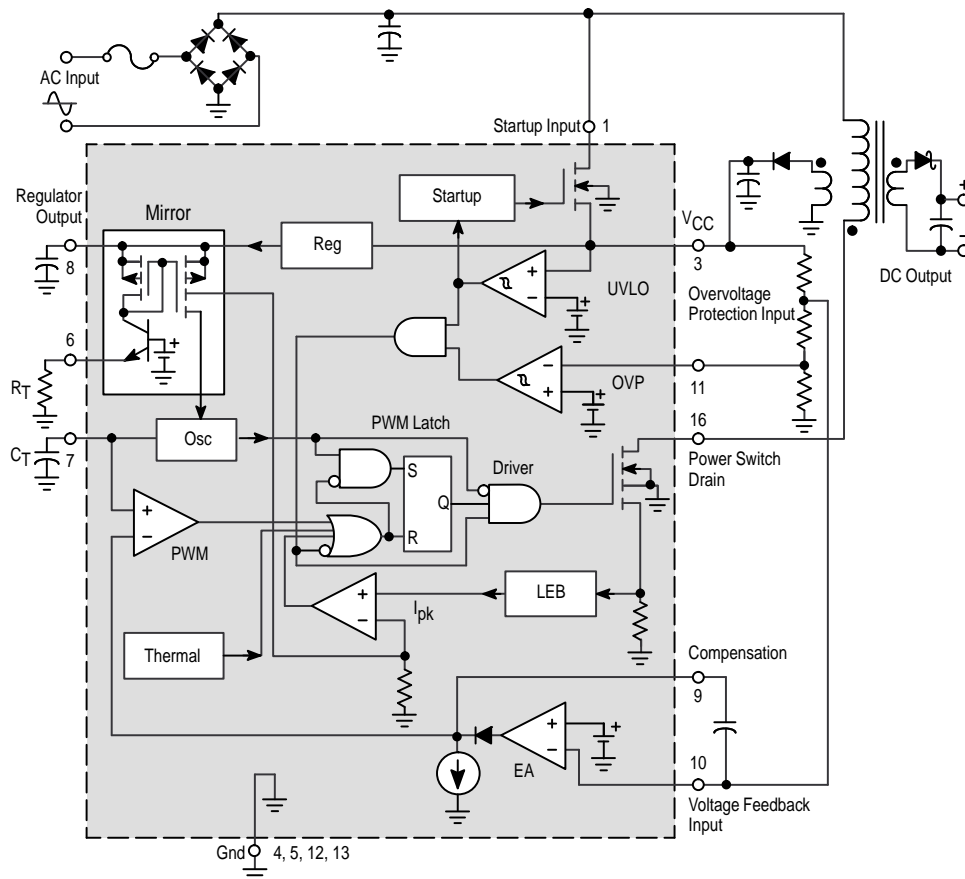
$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 751N, 658E

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)

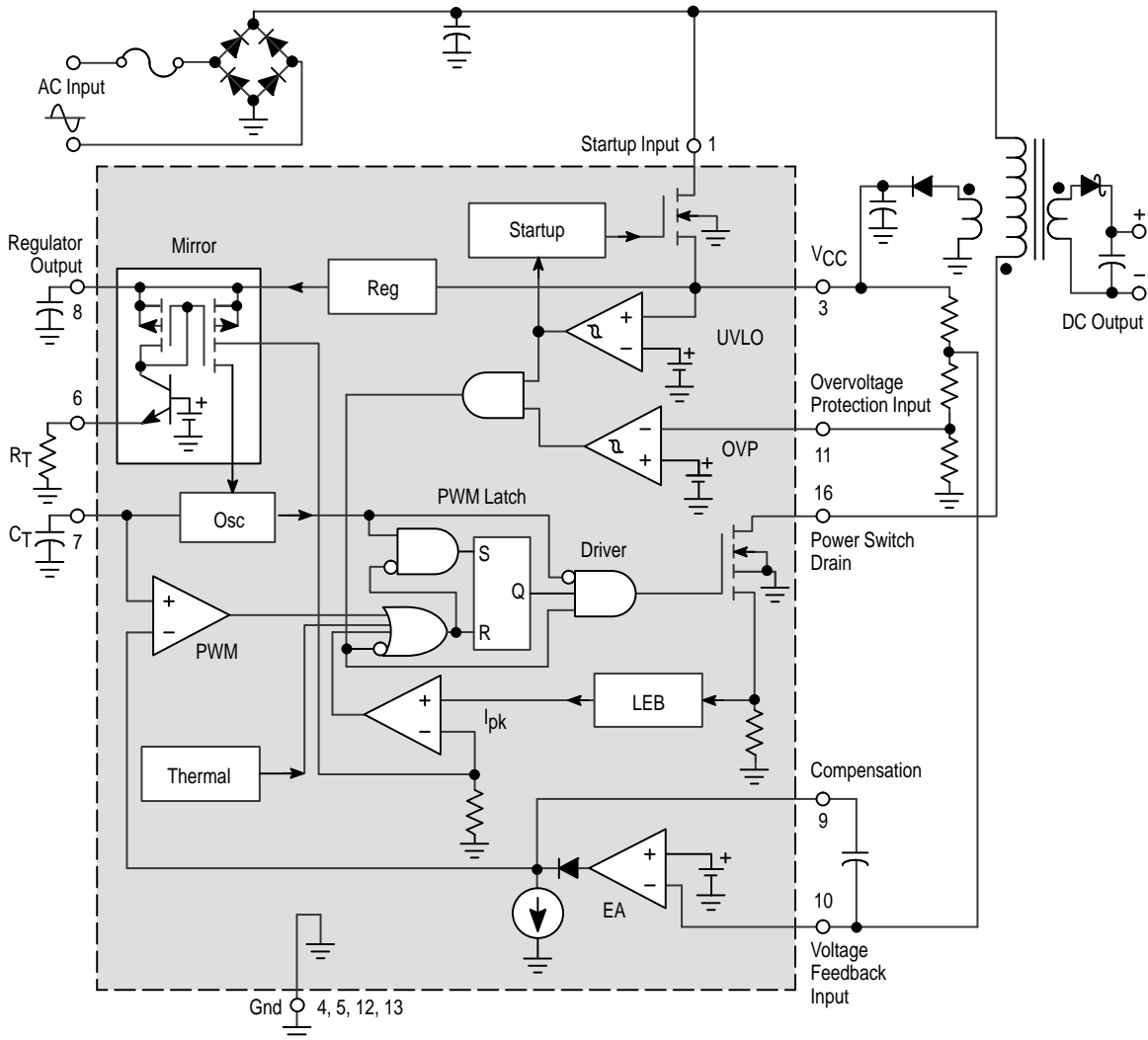
Very High Voltage Switching Regulator

MC33363DW, P, MC33363ADW, AP

$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 751N, 648E

The MC33363 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 (1.5 A in MC33363A) SenseFET power switch, 450 V (500 V in MC33363A) 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, 1.0 A SenseFET Power Switch
- On-Chip 700 V, 1.5 A SenseFET Power Switch in MC33363A
- Rectified 240 Vac Line Source Operation
- On-Chip 450 V Active Off-Line Startup FET
- On-Chip 500 V Active Off-Line Startup FET in MC33363A
- 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

$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 751G, 648E

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, output overvoltage protection, and thermal shutdown. This device is available in a 16-lead dual-in-line and wide body surface mount packages.

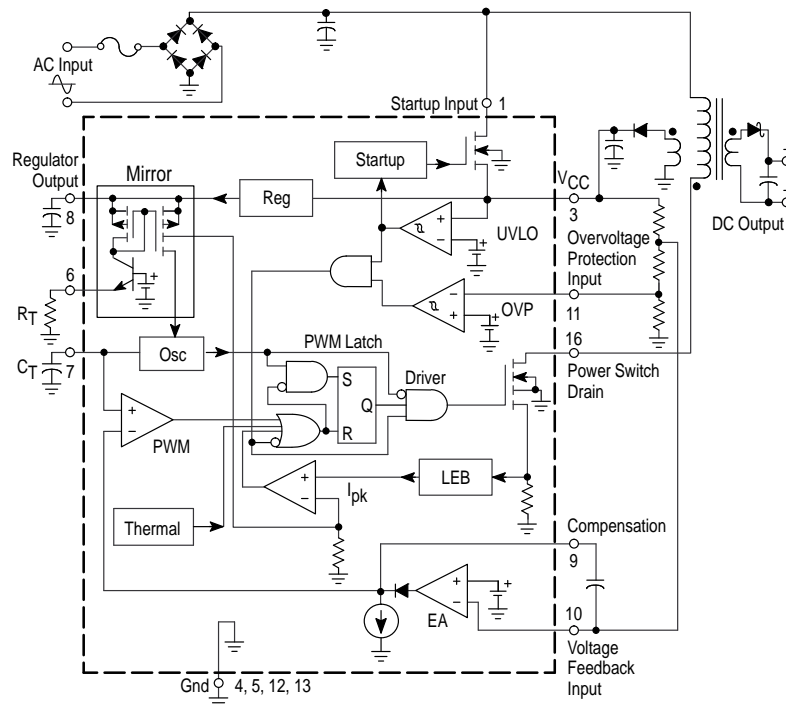
- On-Chip 700 V, 1.0 A SenseFET Power Switch
- Rectified 240 Vac Line Source Operation

- 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	$T_J = -25^\circ$ to $+125^\circ\text{C}$	SOP-16L
MC33363BP		DIP-16

Simplified Application



Switching Regulator Control Circuits (continued)

Critical Conduction SMPS Controller

MC33364D, D1, D2

$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 751, 751B

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.

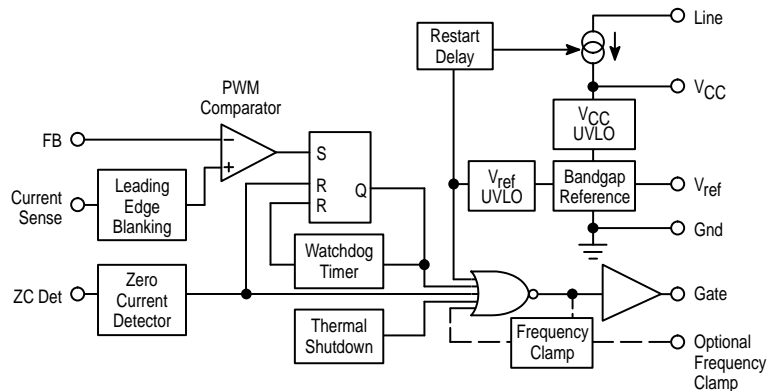
The MC33364D1 is available in a surface mount SO-8 package. It has an internal 126 kHz frequency clamp. For loads which have a low power operating condition, the fre-

quency 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

$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 648E

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 comparator, trimmed internal bandgap reference, and thermal shutdown. This device is available in a 16-lead dual-in-line package.

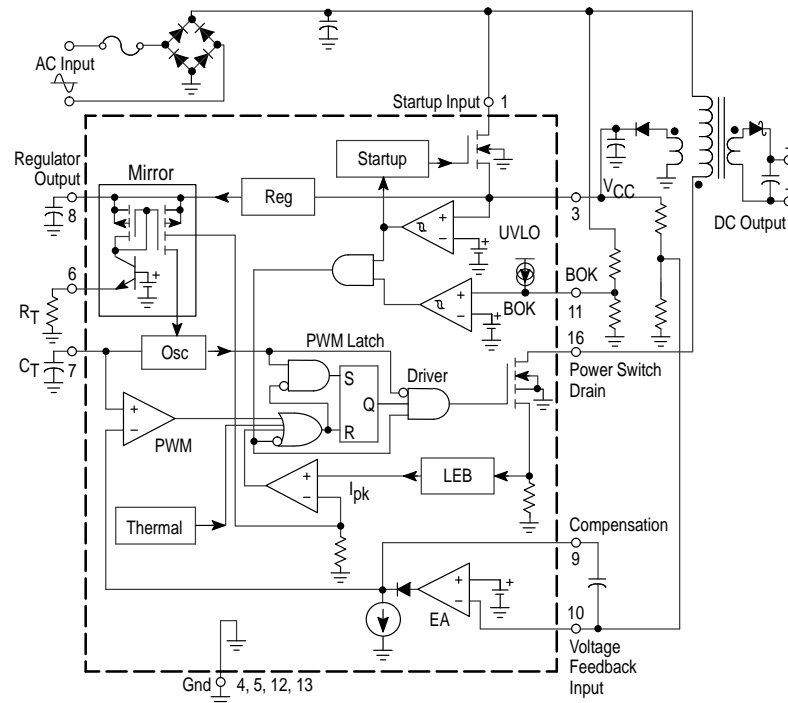
- On-Chip 700 V, 1.0 A SenseFET Power Switch
- Rectified 240 Vac Line Source Operation

- 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	$T_J = -25^\circ$ to $+125^\circ\text{C}$	DIP-16

Simplified Application



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 11. 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)	Suffix/ Package
500	4.0	Voltage	$1.25 \pm 2.0\%$	700	MC34270	0 to +70	FB/873A
					MC34271		
± 1000 (Totem Pole MOSFET Drive Outputs)	11 to 15.5	Current	$5.0 \pm 2.6\%$	500	MC34065	0 to +70	DW/751G
							P/648
	11 to 20				MC33065	-40 to +85	DW/751G
						P/648	
	8.4 to 20				MC34065	0 to +70	DW-H/751G
						P-H/648	
					MC33065	-40 to +85	DW-H/751G
						P-H/648	
					MC34065	0 to +70	DW-L/751G
						P-L/648	
	MC33065	-40 to +85	DW-L/751G				
		P-L/648					

Table 12. Universal Microprocessor Power Supply Controllers

A versatile power supply control circuit for microprocessor-based systems, this device is mainly intended for automotive applications and battery powered instruments. The circuit provides a power-on reset delay and a Watchdog feature for orderly microprocessor operation.

Regulated Outputs	Output Current (mA)	V_{CC} (V)		Reference (V)	Key Supervisory Features	Device	T_A (°C)	Package
		Min	Max					
E ² PROM Programmable Output: 24 V (Write Mode) 5.0 V (Read Mode)	150 peak	6.0	35	$2.5 \pm 3.2\%$	MPU Reset and Watchdog Circuit	TCF5600	-40 to +85	707

Table 13. Power Factor Controllers

I_O (mA) Max	Minimum Operating Voltage Range (V)	Maximum Startup Voltage (V)	Reference (V)	Features	Device	T_A (°C)	Suffix/ 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	D/751
							P/626
					MC33261	-40 to +85	D/751
							P/626
				Overvoltage Comparator, Undervoltage Lockout, Internal Startup Timer	MC34262	0 to +85	D/751
							P/626
		MC33262	-40 to +105	D/751			
				P/626			
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	D/751K
							P/648

Power Factor Controllers

MC34262D, P

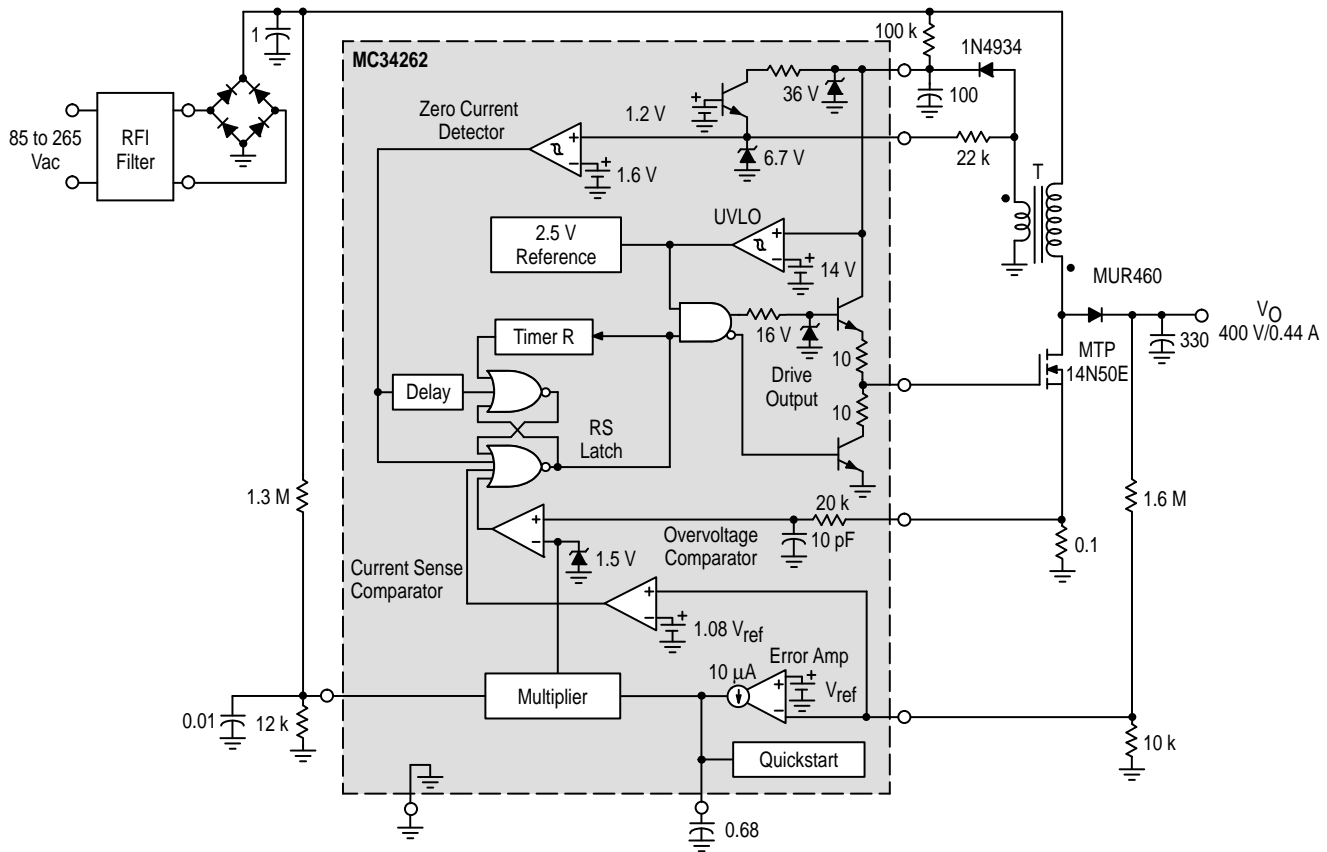
$T_A = 0^\circ$ to $+85^\circ\text{C}$, Case 751, 626

MC33262D, P

$T_A = -40^\circ$ to $+105^\circ\text{C}$, Case 751, 626

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

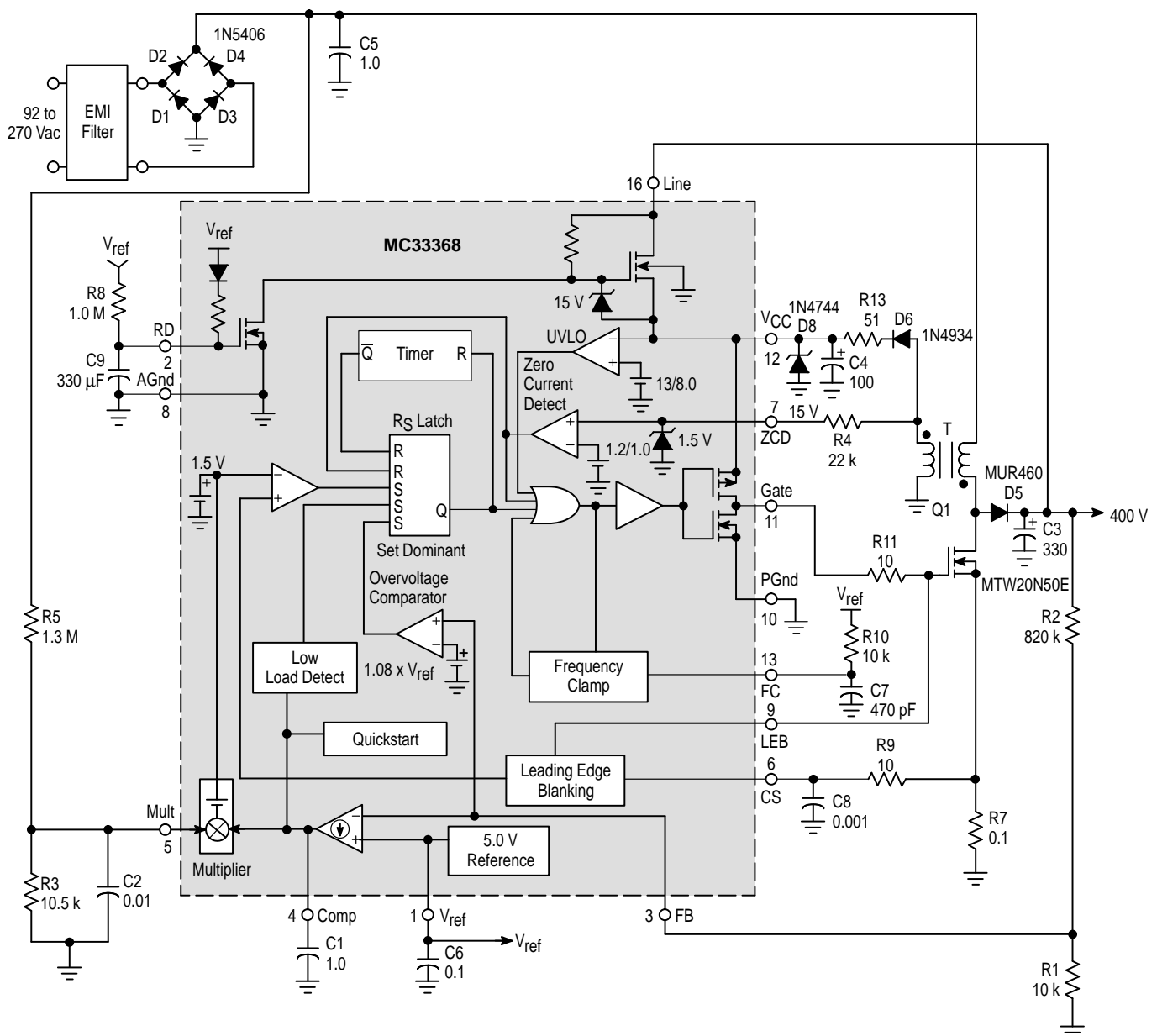
$T_J = -25^\circ$ to $+125^\circ\text{C}$, Case 751K, 648

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



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

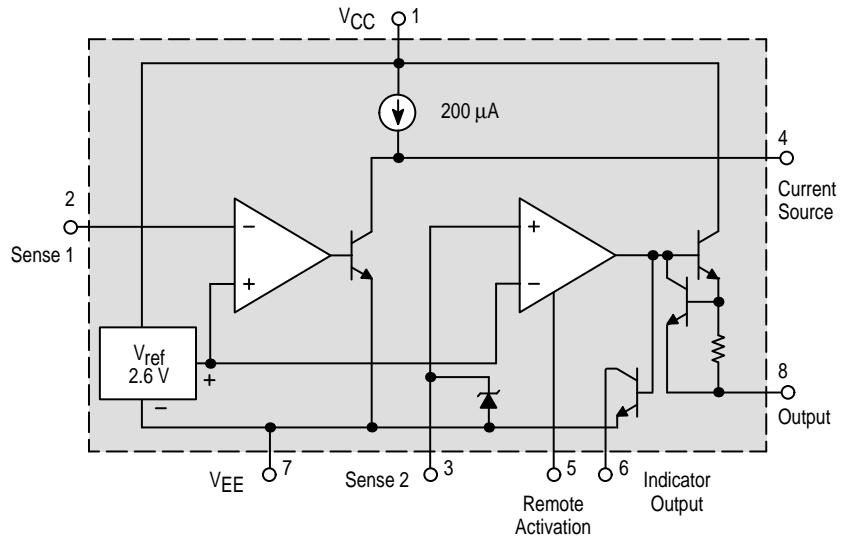
pin-programmable trip voltages or additional features, such as an indicator output drive and remote activation capability. An over/undervoltage protection circuit is also offered.

Overvoltage Crowbar Sensing Circuit

MC3423P1, D

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 626, 751

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.

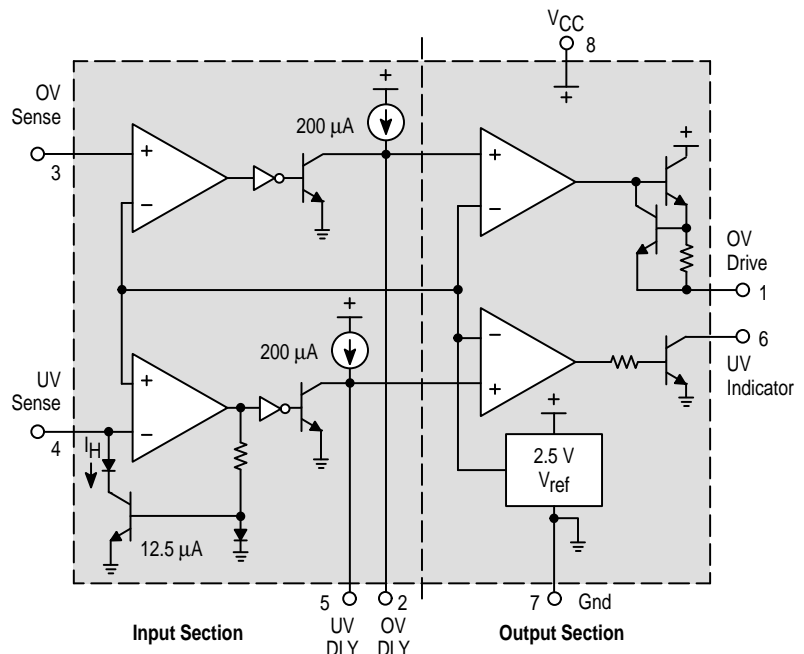


Over/Undervoltage Protection Circuit

MC3425P1

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 626

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

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1213, 1212

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.

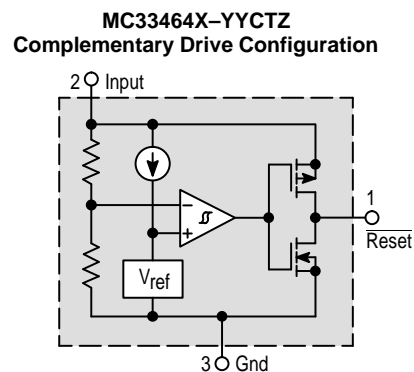
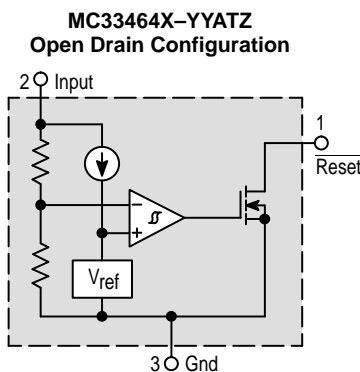
MC33464 Features:

- Extremely Low Standby Current of 0.8 μA at $V_{\text{IN}} = 1.5 \text{ V}$
- 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 ($\pm 2.5\%$)
- Two $\overline{\text{Reset}}$ 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 $\overline{\text{Reset}}$	$T_A = -30^\circ$ to $+80^\circ\text{C}$	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 $\overline{\text{Reset}}$		$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-89 (1000)
MC33464H-20CT1	2.0				
MC33464H-27CT1	2.7				
MC33464H-30CT1	3.0				
MC33464H-45CT1	4.5				
MC33464N-09ATR	0.9	Open Drain $\overline{\text{Reset}}$	$T_A = -30^\circ$ to $+80^\circ\text{C}$		SOT-23 (3000)
MC33464N-20ATR	2.0				
MC33464N-27ATR	2.7				
MC33464N-30ATR	3.0				
MC33464N-45ATR	4.5				
MC33464N-09CTR	0.9	Compl. MOS $\overline{\text{Reset}}$		$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-23 (3000)
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.



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

Supervisory Circuits (continued)

Micropower Undervoltage Sensing Circuits with Programmable Output Delay

MC33465N

$T_A = -30^\circ$ to $+80^\circ\text{C}$, Case 1212

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:

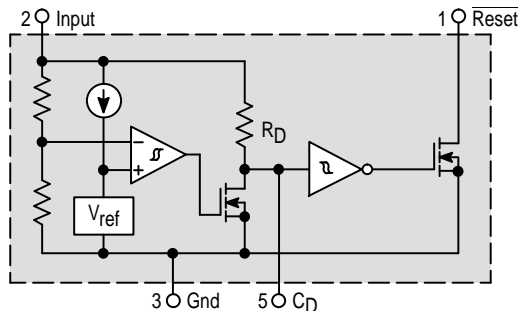
- Extremely Low Standby Current of 1.0 μA at $V_{in} = 3.5\text{ V}$
- Wide Input Voltage Range (0.7 V to 10 V)
- Monitors Power Supply Voltages from 1.1 V to 5.0 V
- High Accuracy Detector Threshold ($\pm 2.5\%$)
- Two Reset Output Types (Open Drain or Complementary Drive)
- Programmable Output Delay 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

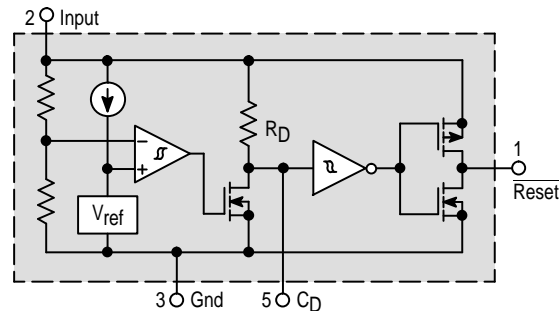
Device	Threshold Voltage	Type	Operating Temperature Range	Package
MC33465N-09ATR	0.9	Open Drain Reset	$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-23
MC33465N-20ATR	2.0			
MC33465N-27ATR	2.7			
MC33465N-30ATR	3.0			
MC33465N-45ATR	4.5			
MC33465N-09CTR	0.9	Compl. MOS Reset		
MC33465N-20CTR	2.0			
MC33465N-27CTR	2.7			
MC33465N-30CTR	3.0			
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

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 29, 751, 846A

MC33064P-5, D-5, DM-5

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 29, 751, 846A

MC34164P-3, P-5, D-3, D-5, DM-3, DM-5

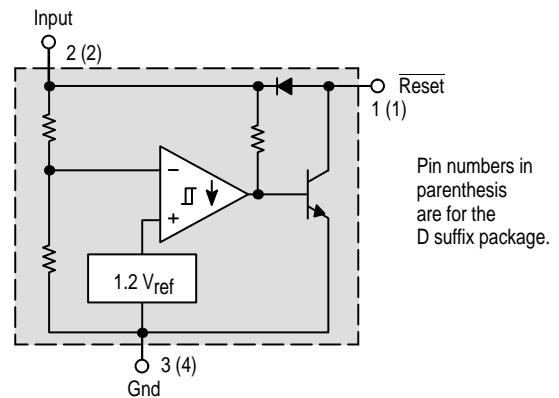
$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 29, 751, 846A

MC33164P-3, P-5, D-3, D-5, DM-3, DM-5

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 29, 751, 846A

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 $5.0\text{ V} \pm 5\%$ system and features a tighter hysteresis specification. The MC34164 series covers $5.0\text{ V} \pm 10\%$ and



$3.0\text{ V} \pm 5\%$ 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 ($1/25\text{th}$ of the MC34064's) is an important characteristic.

Table 14. Undervoltage Sense/Reset Controller Features

MC34X64 devices are specified to operate from 0° to $+70^\circ\text{C}$, and MC33X64 devices operate from -40° to $+85^\circ\text{C}$.

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	Suffix/Package
MC34064/MC33064	$5.0\text{ V} \pm 5\%$	4.6	0.02	10	1.0 to 10	500 μA @ $V_{in} = 5.0\text{ V}$	P-5/29
							D-5/751
							DM-5/846A
MC34164/MC33164	$5.0\text{ V} \pm 10\%$	4.3	0.09	7.0	1.0 to 12	20 μA @ $V_{in} = 5.0\text{ V}$	P-5/29
							D-5/751
							DM-5/846A
MC34164/MC33164	$3.0\text{ V} \pm 5\%$	2.7	0.06	6.0	1.0 to 12	15 μA @ $V_{in} = 3.0\text{ V}$	P-3/29
							D-3/751
							DM-3/846A

Supervisory Circuits (continued)

Universal Voltage Monitor

MC34161P, D

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 626, 751

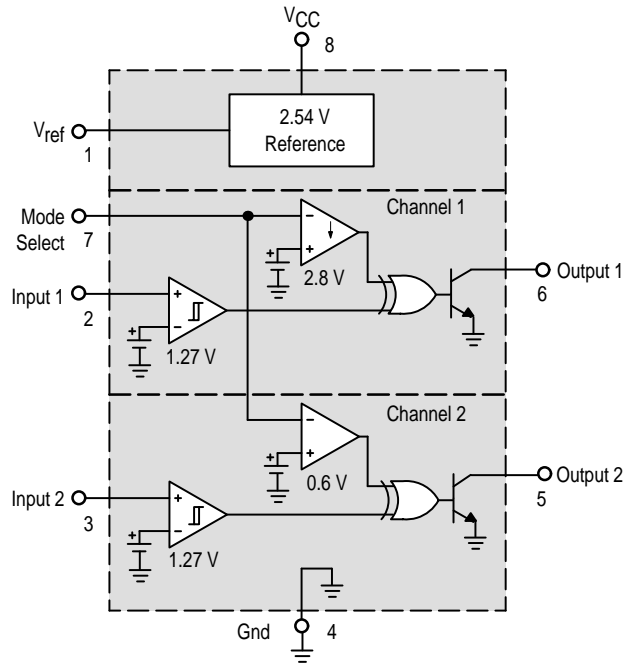
The MC34161, MC33161 series are universal voltage monitors intended for use in a wide variety of voltage sensing applications. These devices offer the circuit designer an economical solution for positive and negative voltage detection. The circuit consists of two comparator channels each with hysteresis, 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

MC33161P, D

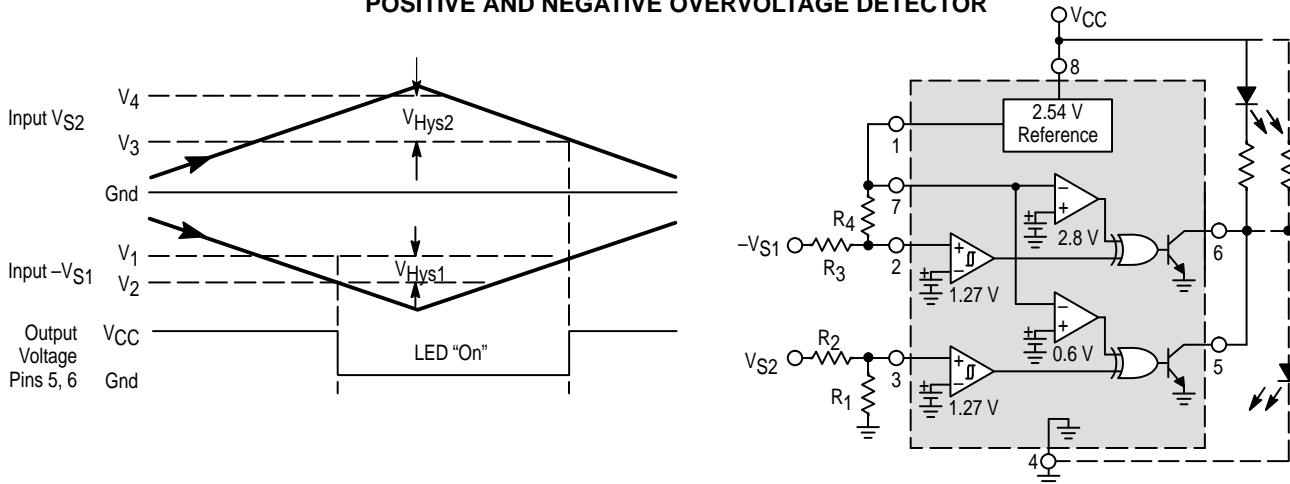
$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 626, 751



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
$V_{CC} (>2.0\text{ V})$	0 1	1 0	0 1	1 0	Channels 1 & 2: Inverting

POSITIVE AND NEGATIVE OVERVOLTAGE DETECTOR



Battery Management Circuits

Battery Charger ICs

Battery Fast Charge Controller

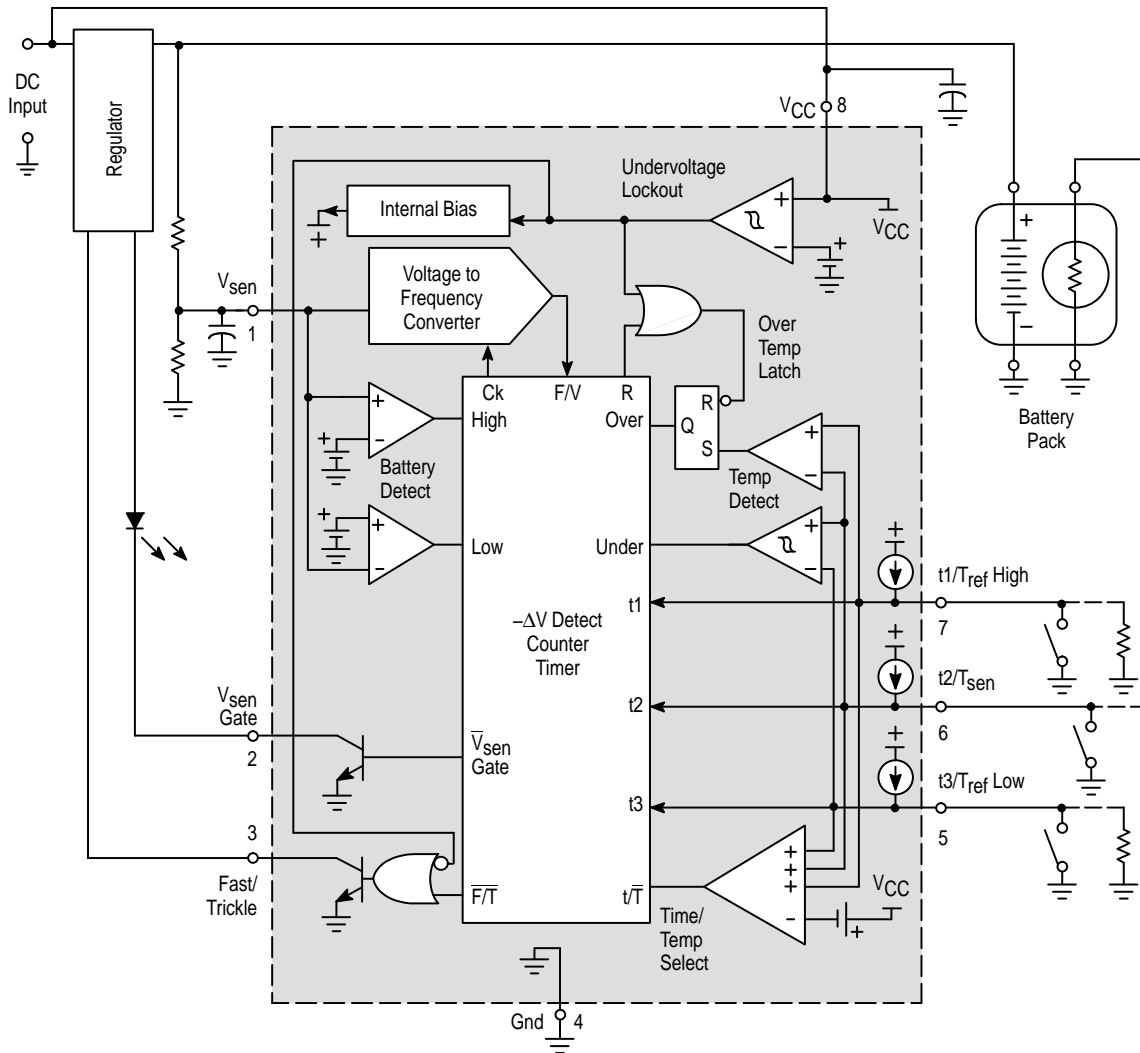
MC33340P, D

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 626, 751

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



Battery Charger ICs (continued)

Power Supply

Battery Charger

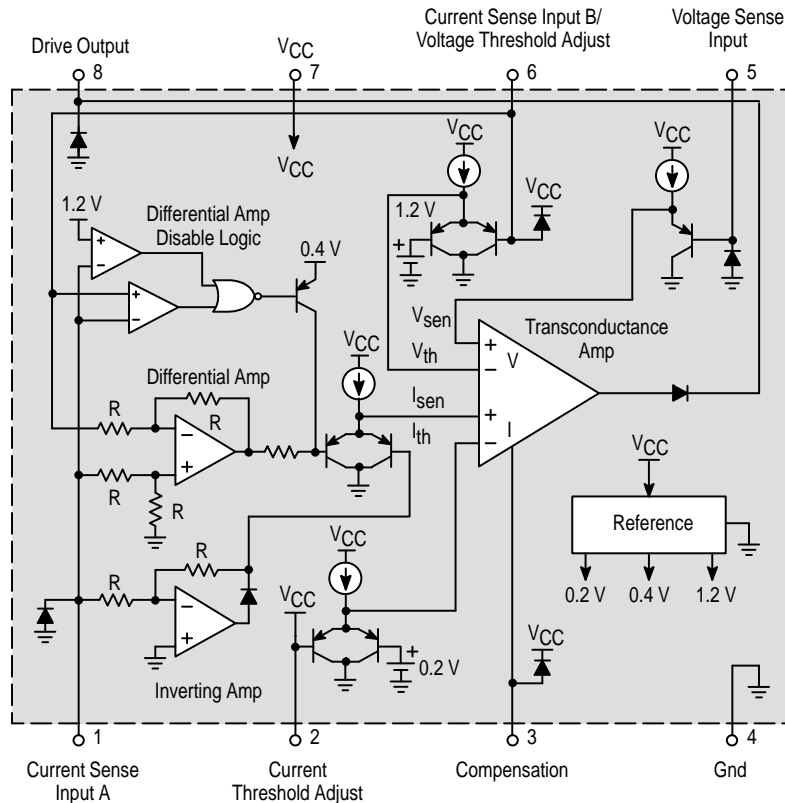
Regulation Control Circuit

MC33341P, D

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 626, 751

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 in 8-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



Battery Pack ICs

Lithium Battery Protection Circuit for One to Four Cell Battery Packs

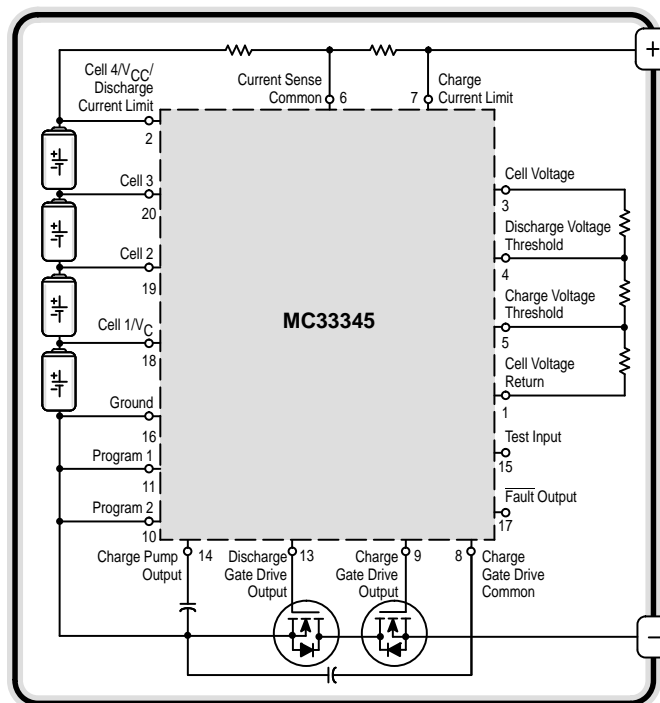
MC33345DW, DTB

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 751D, 948E

The MC33345 is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of one to four 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, cell voltage balancing with on-chip 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 a one to four cell battery pack. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. The MC33345 is available in standard and low profile 20 lead surface mount packages.

- Independently Programmable Charge and Discharge Limits for Both Voltage and Current
- Charge and Discharge Current Limit Detection with Delayed Shutdown
- Cell Voltage Balancing
- On-Chip 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, Two, Three or Four Cell Applications
- Minimum External Components for Inclusion within the Battery Pack
- Available in Low Profile Surface Mount Packages

Typical Four Cell Smart Battery Pack



Battery Pack ICs (continued)

Lithium Battery Protection Circuit for Three or Four Cell Battery Packs

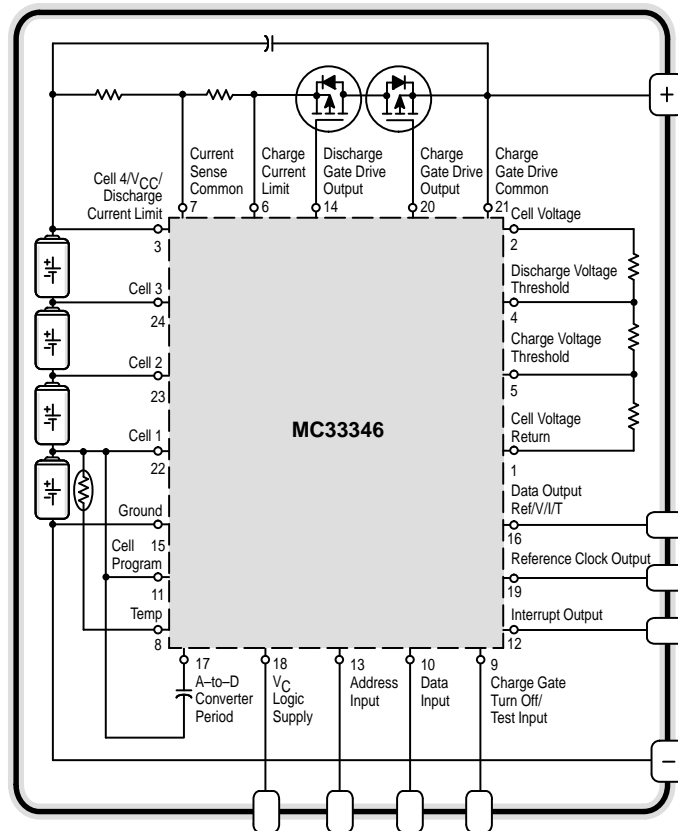
MC33346DW, DTB

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 751E, 948H

The MC33346 is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of three or four 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, cell voltage balancing with on-chip balancing resistors, and virtually zero current sleepmode state when the cells are discharged. Additional features consists of a six wire microcontroller interface bus that can selectively provide a pulse output that represents the internal reference voltage, cell voltage, cell current and temperature, as well as control the states of four internal balancing and two external MOSFET switches. A microcontroller time reference output is available for gas gauge implementation. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. The MC33346 is available in standard and low profile 24 lead surface mount packages.

- Independently Programmable Charge and Discharge Limits for Both Voltage and Current
- Delayed Current Shutdown
- Cell Voltage Balancing with On-Chip Resistors
- Six Wire Microcontroller Interface Bus
- Data Output for Reference, Voltage, Current, and Temperature
- Microcontroller Time Reference Output for Gas Gauging
- Virtually Zero Current Sleepmode State when Cells are Discharged
- Programmable for Three or Four Cell Applications
- Minimum External Components for Inclusion within the Battery Pack
- Available in Low Profile Surface Mount Packages

Typical Four Cell Smart Battery Pack



Battery Pack ICs (continued)

Lithium Battery Protection Circuit for One or Two Cell Battery Packs

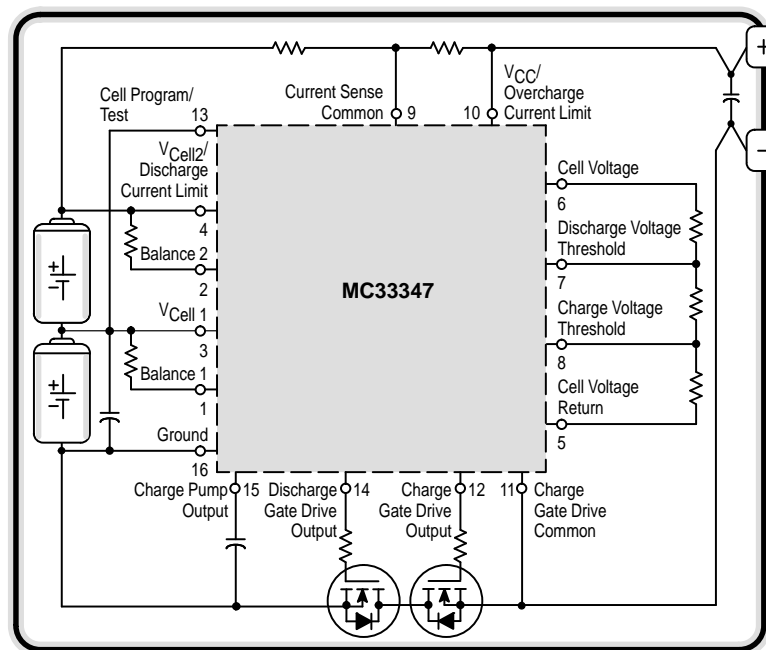
MC33347D, DTB

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 751B, 948F

The MC33347 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 MC33347 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



Battery Pack ICs (continued)

Lithium Battery Protection Circuit for One Cell Battery Packs

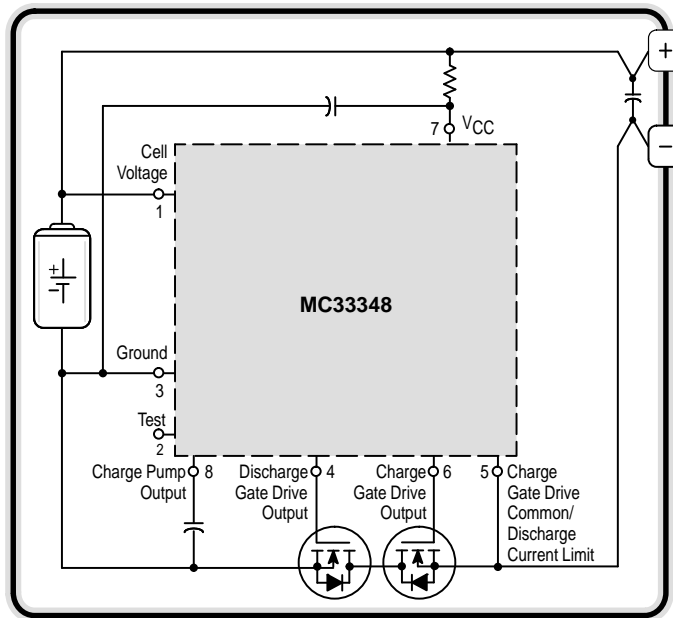
MC33348D

$T_A = -25^\circ$ to $+85^\circ\text{C}$, Case 751

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 shut-down, 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	$T_A = -25^\circ$ to $+85^\circ\text{C}$	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		

NOTE: Additional threshold limit options can be made available. Consult factory for information.

Battery Pack ICs (continued)

Lithium Battery Protection Circuit for One Cell Battery Packs

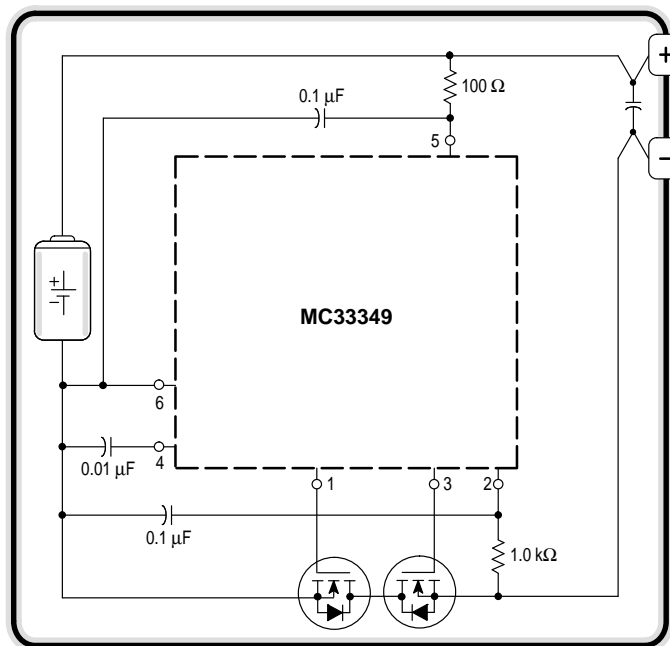
MC33349

$T_A = -40^\circ$ to 85°C , Case 1262

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-1	4.2	200	2.28	150	$T_A = -40^\circ$ to 85°C	SOT-23 (6 Lead)
MC33349N-2	4.2			75		
MC33349N-3	4.25		2.28	150		
MC33349N-4	4.25			75		
MC33349N-5	4.3		2.29	150		
MC33349N-6	4.3			75		
MC33349N-7	4.35		2.30	150		
MC33349N-8	4.35			75		
MC33349N-9	4.65		2.35	150		
MC33349N-10	4.65			75		

Power Supply and Management IC for Handheld Electronic Products

MC34280

0°C to +70°C, Case 873A

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 μ A); 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: 35 μ A typical

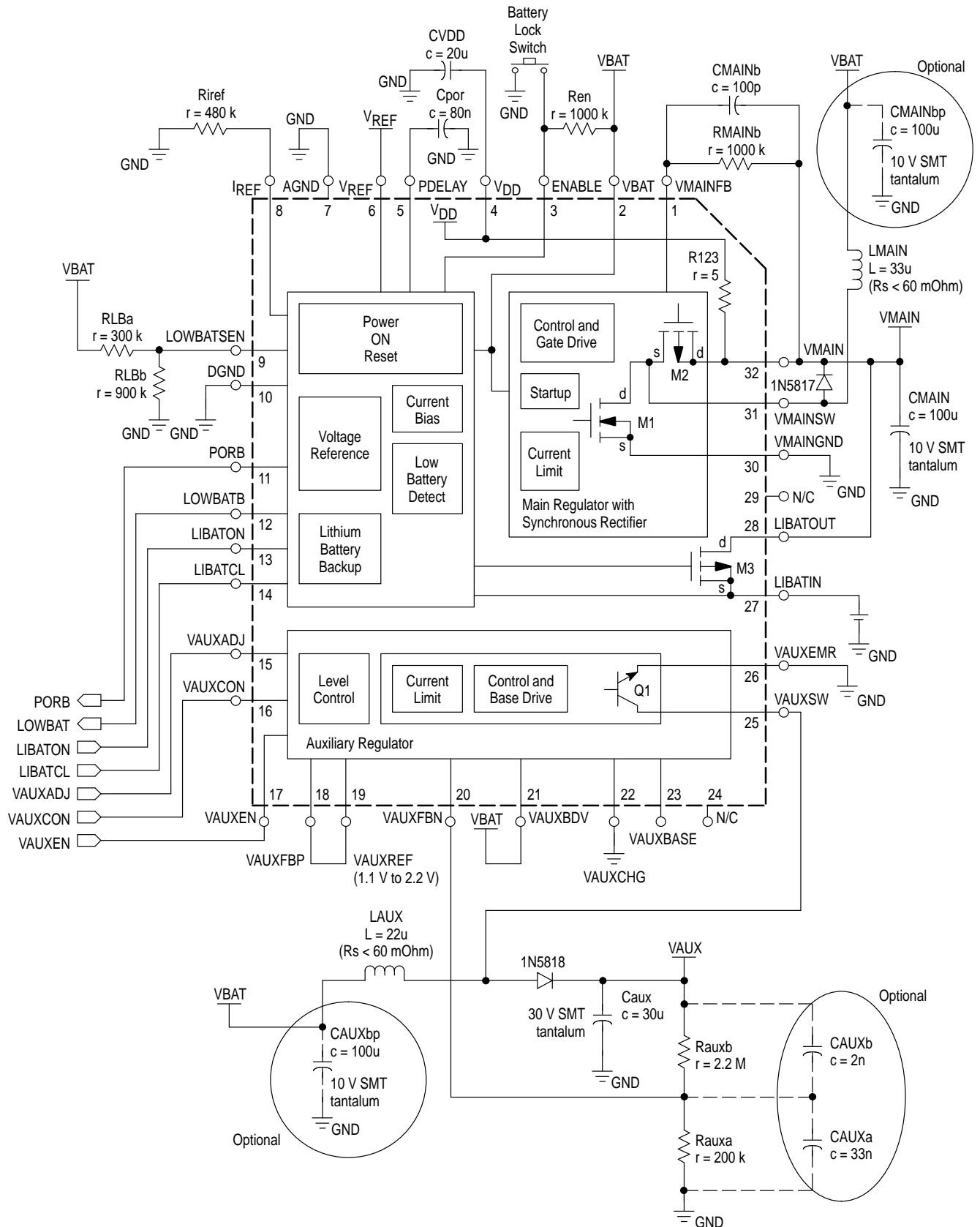
- PFM and Synchronous Rectification to ensure high efficiency (87% @200mA Load)
- Adjustable Main Output: nominal 3.3V @ 200mA max, with 1.8V input
- Auxiliary Output Voltage can be digitally controlled by microprocessor
- Auxiliary Output Voltage:
 - +5V @ 25mA max, with 1.8V input
 - +25V @ 15mA max, 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

Power Supply and Management IC for Handheld Electronic Products (continued)

Typical Application Block Diagram



MOSFET/IGBT Drivers

High Speed Dual Drivers

(Inverting)

MC34151P, D

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 626, 751

MC33151P, D

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 626, 751

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.

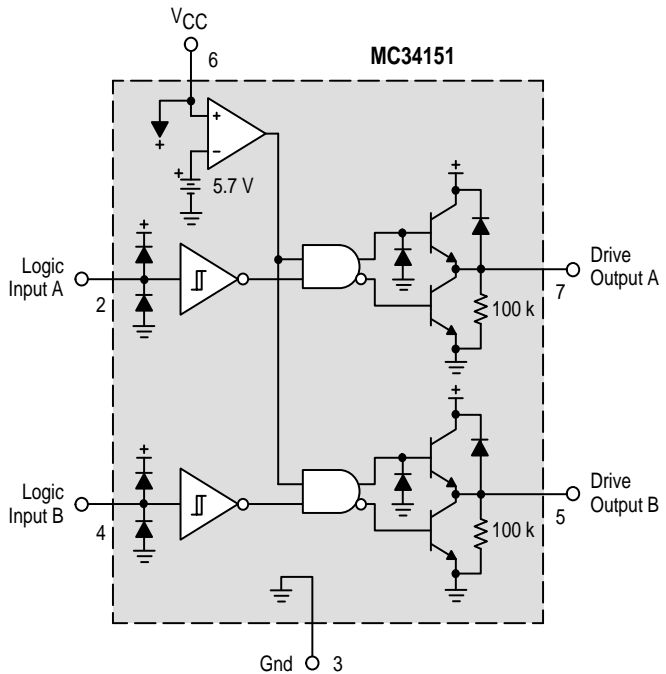
(Noninverting)

MC34152P, D

$T_A = 0^\circ$ to $+70^\circ\text{C}$, Case 626, 751

MC33152P, D

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 626, 751



Single IGBT Driver

MC33153P, D

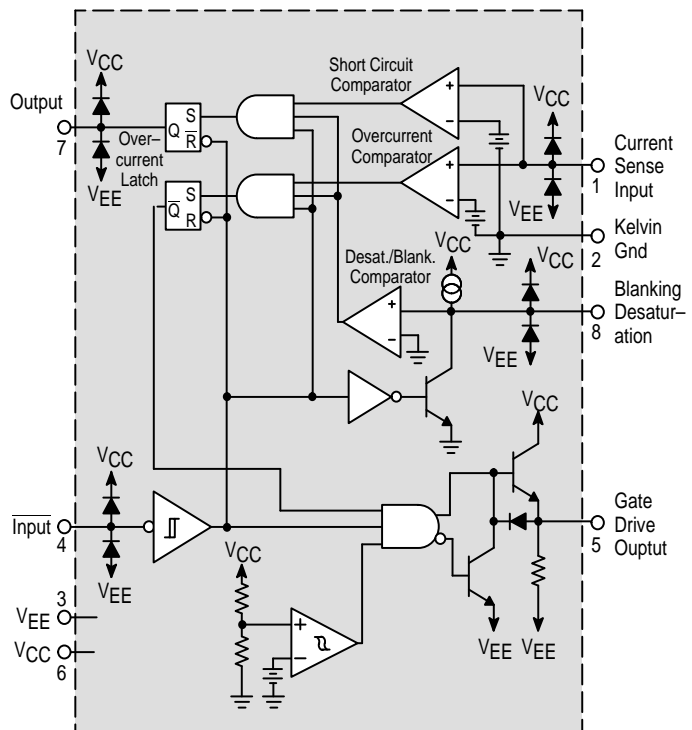
$T_A = -40^\circ$ to $+105^\circ\text{C}$, Case 626, 751

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 IGBT 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



MOSFET/IGBT Drivers (continued)

Single IGBT Gate Driver

MC33154D, P

$T_A = -40^\circ$ to $+85^\circ\text{C}$, Case 626, 751

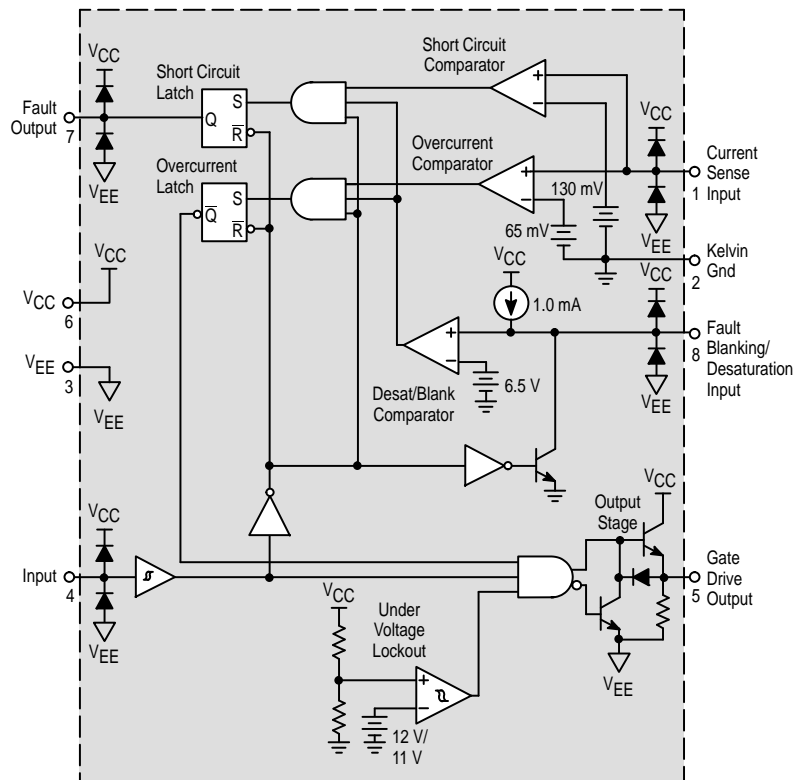
The MC33154 is specifically designed as an IGBT driver for high power applications including ac induction motor control, brushless dc motor control and uninterruptible power supplies.

The MC33154 is similar to the MC33153, except that the output drive is in-phase with the logic input, the output source current drive is four times higher and the supply voltage rating is higher.

Although designed for driving discrete and module IGBTs, this device offers a cost effective solution for driving power MOSFETs and Bipolar Transistors.

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

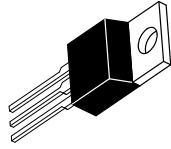
- High Current Output Stage: 4.0 A Source/2.0 A Sink
- Protection Circuits for Both Conventional and Sense IGBTs
- Programmable Fault Blanking Time
- Protection against Overcurrent and Short Circuit
- Undervoltage Lockout Optimized for IGBTs
- Negative Gate Drive Capability
- Cost Effectively Drives Power MOSFETs and Bipolar Transistors



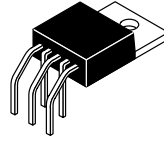
Power Supply Circuits Package Overview



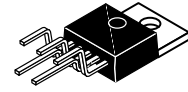
CASE 29
P, Z SUFFIX



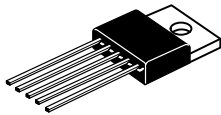
CASE 221A
T SUFFIX



CASE 314A
TH SUFFIX



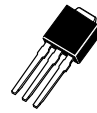
CASE 314B
TV SUFFIX



CASE 314D
T SUFFIX



CASE 318E
ST SUFFIX



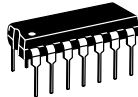
CASE 369
DT-1 SUFFIX



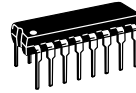
CASE 369A
DT SUFFIX



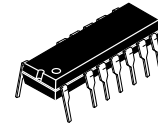
CASE 626
N, P, P1 SUFFIX



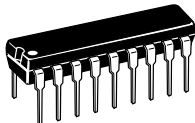
CASE 646
P SUFFIX



CASES 648, 648C
N, P, P2 SUFFIX



CASE 648E
P SUFFIX



CASE 707
N SUFFIX



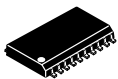
CASE 751
D, D1, D2 SUFFIX



CASE 751A
D SUFFIX



CASE 751B
D SUFFIX



CASE 751D
DW SUFFIX



CASE 751E
DW SUFFIX















CASE 751G
DW SUFFIX



CASE 751K
D SUFFIX

Power Supply Circuits Package Overview (continued)

 CASE 751N DW SUFFIX	 CASE 775 FN SUFFIX	 CASE 846A DM SUFFIX	 CASE 873A FB SUFFIX
 CASE 936 D2T SUFFIX	 CASE 936A D2T SUFFIX	 CASE 948E DTB SUFFIX	 CASE 948F DTB SUFFIX
 CASE 948G DTB SUFFIX	 CASE 948H DTB SUFFIX	 CASE 1212 N SUFFIX	 CASE 1213 H SUFFIX

