MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MC3484S2-2
MC3484S4-2

SOLENOID DRIVER
2.4 A — S2
4.0 A — S4

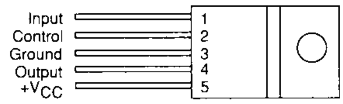
Integrated Solenoid Driver

The MC3484 is an integrated monolithic solenoid driver. Its typical function is to apply full battery voltage to fuel injector(s) for rapid current rise, in order to produce positive injector opening. When load current reaches a preset level (4.0 A in MC3484S4 or 2.4 A in MC3484S2) the injector driver reduces the load current by a 4-to-1 ratio and operates as a constant current supply. This condition holds the injector open and reduces system dissipation. Other solenoid or relay applications could be served by the MC3484. Two high impedance inputs are provided which permit a variety of control options and can be driven by TTL or CMOS logic.

- Microprocessor Compatible Inputs
- On-Chip Power Device
  MC3484S2-2 2.4 A Peak 0.6 A Sustain
  MC3484S4-2 4.0 A Peak 1.0 A Sustain
- Low Thermal Resistance to Grounded Tab—$R_{\theta JC}$ = 2.5°C/W
- Overvoltage Protection Cutoff
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.6 V Typ @ 4.0 A
- Uncompromised Performance – 40° to + 85°C Junction Temperature
- Fully Functional from V_{bat} = 4.0 V to 24 V
- High $V_{CEO(sus)}$ = 42 V min @ I_{sus}
- Alternate Lead Forms are Available

S SUFFIX
PLASTIC PACKAGE
CASE 314D

PIN CONNECTIONS

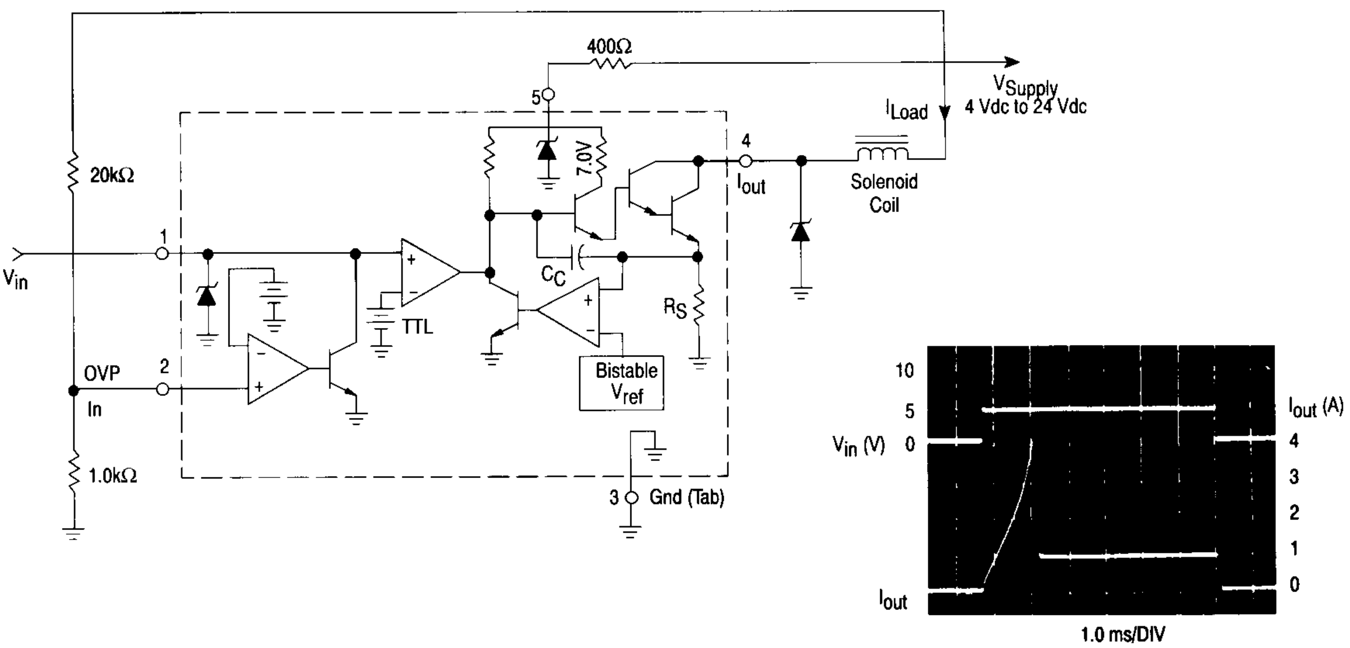


(Unformed Package)

ORDERING INFORMATION

Device	Tested Ambient Temperature Range	Peak Current
MC3484S2-2	–40° to +85°C	2.4 A
MC3484S4-2		4.0 A

Figure 1. Typical Application
Single Injector with Overvoltage Protection at 30 V (V_{bat})



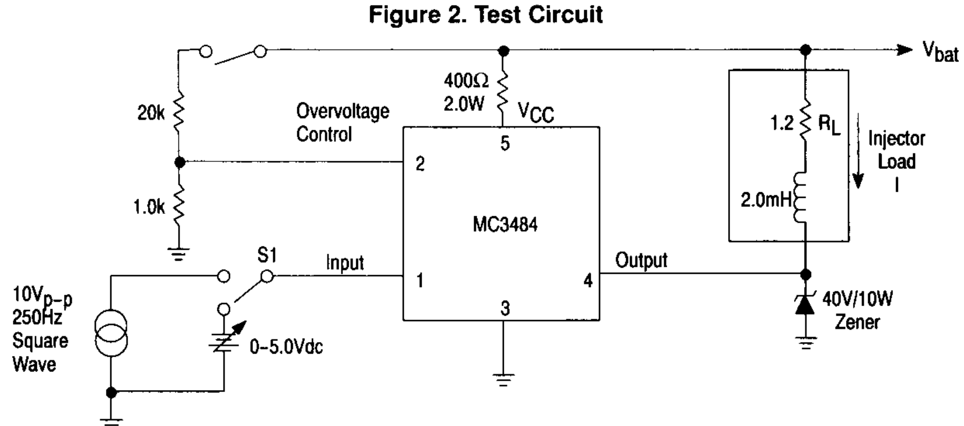
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage (V_{bat})	V_{bat}	24	V
Input (Pin 1) Control (Pin 2)	V_{in} V_{cont}	–0.3 to +6.0 0 to +5.0	V
Internal Regulator (Pin 5)	—	50	mA
Junction Temperature	T_J	150	°C
Operating Temperature (Tab Temperature)	T_A	–40 to +105	°C
Storage Temperature	T_{stg}	–65 to + 150	°C
Thermal Resistance, Junction-to-Case	θ_{JC}	2.5	°C/W

ELECTRICAL CHARACTERICISTICS (V_{bat} = 12 Vdc, T_C = –40° to +85°C, test circuit of Figure 2, unless otherwise noted.)

Characteristics		Symbol	Min	Typ	Max	Unit
Output Peak Current	S4-2 S2-2	$I_{pk(sense)}$	3.6 1.7	4.0 2.4	5.2 2.9	A
Output Sustaining Current		I_{sus}	0.95 0.50	1.0 0.6	1.3 0.7	A
$V_{CEO(sus)}$ @ 2.0 A		—	42	50	—	V
Output Voltage in Saturated Mode S2 @ 1.5 A S4 @ 3.0 A		V_{out}	 — —	 1.2 1.6	 — —	V
Internal Regulated Voltage (V_{CC}, Figure 2)		V_{reg}	—	7.1	—	V
Input "On" Threshold Voltage		V_{on}	—	1.4	2.0	V
Input "Off" Threshold Voltage		V_{off}	0.7	1.3	—	V
Input "On" Current @ V_I = 2.0 Vdc @ V_I = 5.0 Vdc		I_{in}	 — —	 50 220	 — —	µA
Control "On" Threshold Voltage		V_{cont}	—	1.5	—	V
Control "On" Current		I_{in2}	—	75	—	µA
Control Pin Impedance		V_1 Low	—	10	—	kΩ
Input Turn on Delay		t_i	—	0.5	—	µs
I_{pk} sense to I_{sus} delay		t_p	—	60	—	µs
Control Signal Delay		t_t	—	15	—	µs
Input Turn Off from Saturated Mode Delay		t_s	—	1.0	—	µs
Input Turn Off from Sustain Mode Delay		t_d	—	0.2	—	µs
Output Voltage Rise Time		t_v	—	0.4	—	µs
Output Current Fall Time	2.0 A 4.0 A	t_f	— —	0.3 0.6	— —	µs

Figure 2. Test Circuit



GENERAL INFORMATION

Inductive actuators such as automotive electronic fuel injectors, relays, solenoids and hammer drivers can be powered more efficiently by providing a high current drive until actuation (pull-in) occurs and then decreasing the drive current to a level which will sustain actuation. Pull-in and especially drop-out times of the actuators are also improved.

The fundamental output characteristic of the MC3484 provides a low impedance saturated power switch until the load current reaches a predetermined high-current level and then changes to a current source of lower magnitude until the device is turned off. This output characteristic allows the inductive load to control its actuation time during turn-on while minimizing power and stored energy during the sustain period, thereby promoting a fast turn-off time.

Automotive injectors at present come in two types. The large throttle body injectors have an impedance of about 2.0 mH and 1.2 Ω and required the MC3484S4 driver. The smaller type, popular world-wide, has an impedance of 4.0 mH and 2.4 Ω and needs about a 2.0 A pulse for good results. Some designs are planned which employ two of the smaller types in parallel. The inductance of an injector is much larger at low current, decreasing due to armature movement and core saturation to the values above at rated current.

Operating frequencies range form 5.0 Hz to 250 Hz depending on the injector location and engine type. Duty cycle in some designs reaches 80%.

APPLICATIONS INFORMATION

The MC3484 is provided with an input pin (Pin 1) which turns the injector driver "on" and "off." This pin has a nominal trip level of 1.4 V and an input impedance of 20 kΩ. It is internally protected against negative voltages and is compatible with TTL and most other logic.

There is also a control pin (Pin 2) which may be used as an overvoltage, load dump, shutdown. When a nominal 1.5 V is applied to Pin 2, via a 20:1 voltage divider the driver and circuit are set in a safe off state at 30 V (V_{bat}).

Figure 3 shows the operating waveforms for the simplest mode; i.e., with control Pin 2 grounded. When the driver is turned on, the current ramps up to the peak current sense level, where some overshoot occurs because of internal delay. The MC3484 then reduces its output to I_{sus}. The fall time of the device is very rapid (≤ 1.0 µs), but the decay of the load current takes 150 µs to 220 µs, while dumping the load energy into the protection zener clamp. It is essential that the zener voltage be lower than the $V_{CEO(sus)}$, but not so low as to greatly stretch the load current decay time. Without the zener, the discharge of the load energy would be totally into the MC3484, which, for the high current applications could cause the device to fail. (See SOA, Figure 11.)

Also in Figure 3 is the graphically derived instantaneous power dissipation of the MC3484. It shows that, for practical purposes, the worst case dissipation is less than (I_{sus}) (V_{bat}) (duty cycle).

Provided in Figures 3 and 4 are definitions of the switching intervals specified in the Electrical Characteristics. Figure 5 shows that the critical switching parameters stay under control at elevated temperatures.

Figure 3. Operating Waveforms
(Max Frequency 250 Hz, Pin 2 Grounded)

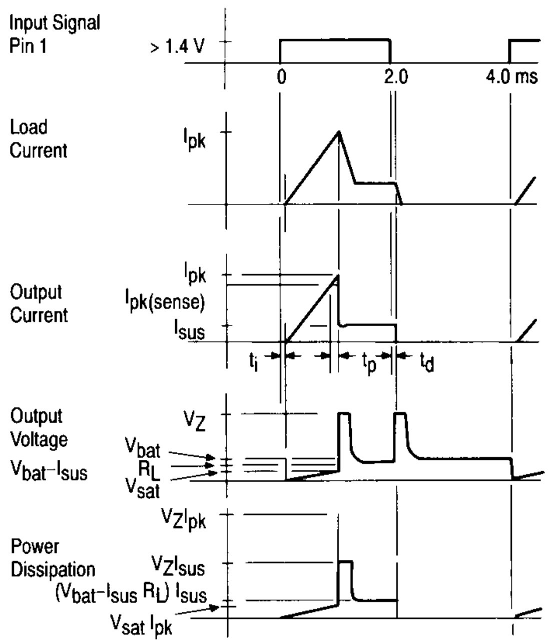


Figure 4. Switching Waveforms (Expanded Time Scale)

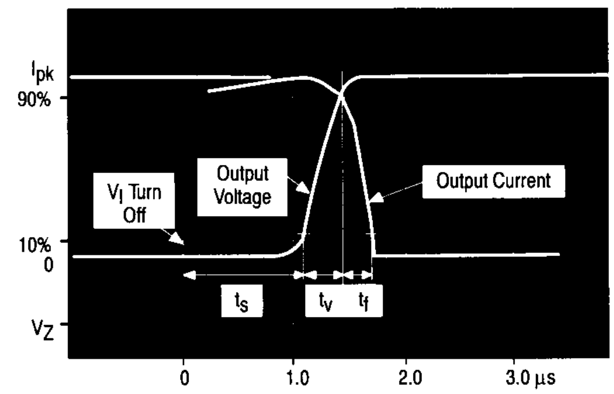
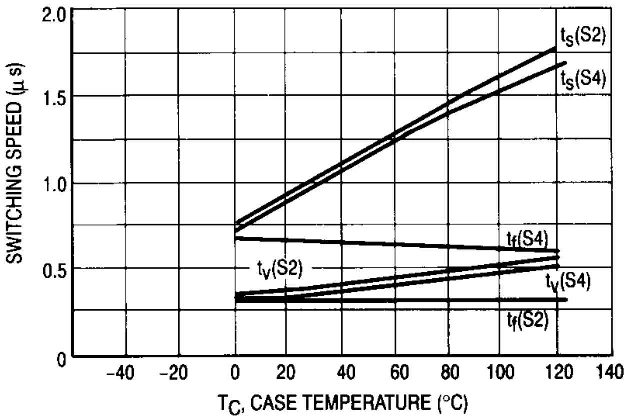


Figure 5. Switching Speed versus Temperature



TYPICAL CHARACTERISTICS

(Unless otherwise noted, test circuit of Figure 2, V_{bat} = 12 Vdc, T_C = –40° to +85°C, 250 Hz square wave input)

Figure 6. Output Current versus Temperature

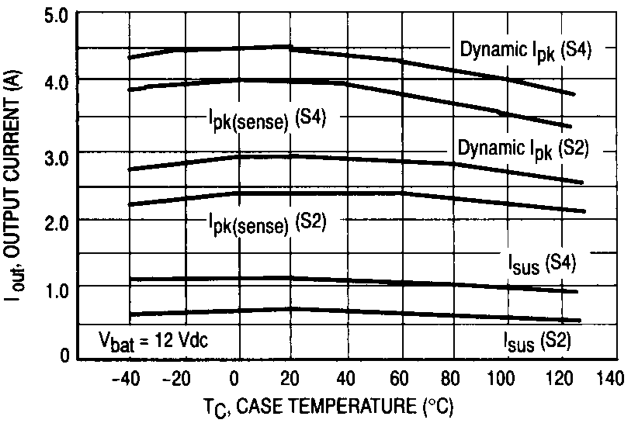


Figure 7. Saturation Voltage

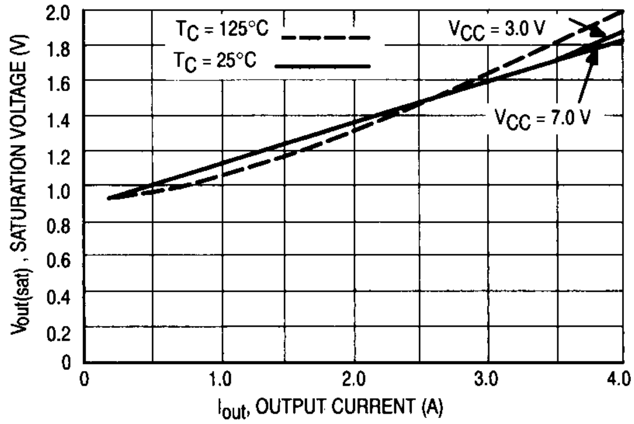


Figure 8. Output Current versus Supply Voltage

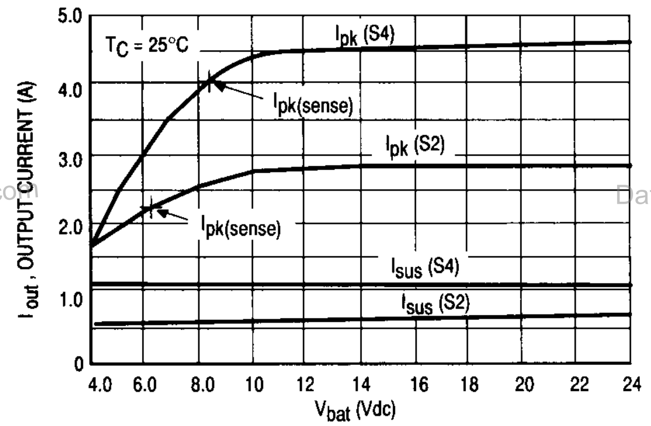


Figure 9. Operating Voltages

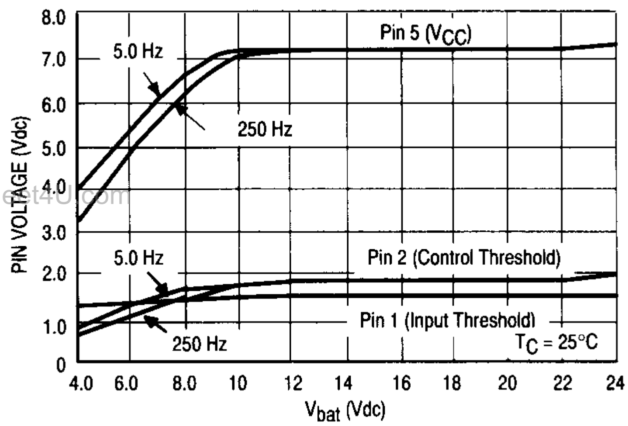


Figure 10. Breakdown Voltage versus Temperature

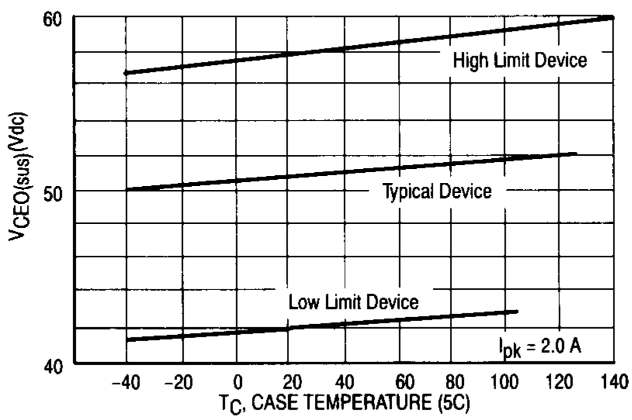
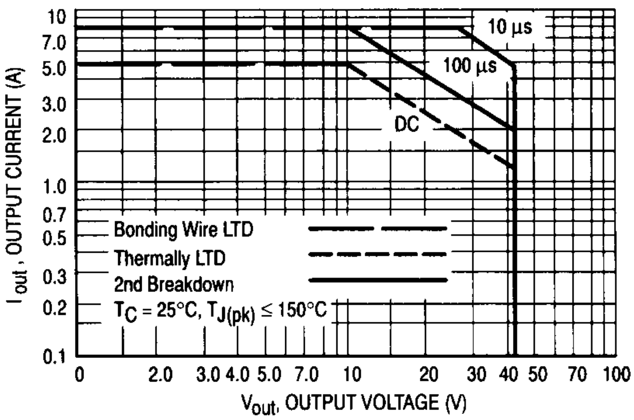


Figure 11. Safe Operating Area



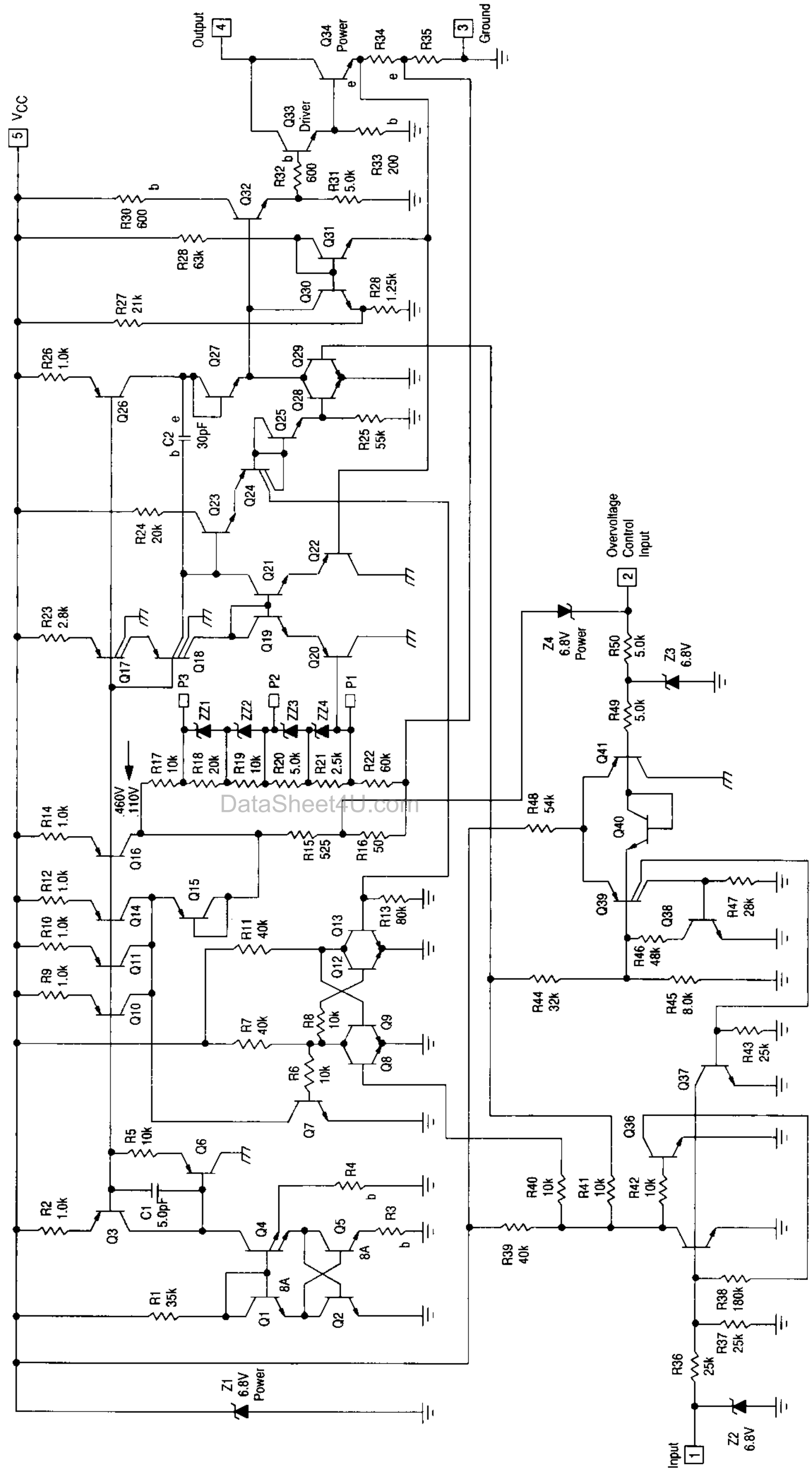


Figure 12. Internal Schematic