

### Hybrid Integrated Circuit For Driving IGBT Modules

#### Description:

M57160AL-01 is a hybrid integrated circuit designed for driving Powerex 600V and 1200V F-Series IGBT Modules. This device operates as an isolation amplifier for these modules and provides the required electrical isolation between the input and output with an opto-coupler. Short circuit protection is provided by a built-in gate voltage detector that monitors the F-Series IGBT's internal RTC circuit. A fault signal is provided if the short circuit protection is activated.

#### Features:

- Built-in Short Circuit Protection with Timer and Reset Functions
- Adjustable Blanking Time
- Low Voltage of  $V_{EE}$  (-3V)
- Electrical Isolation Between Input and Output with Opto-couplers  
( $V_{iso} = 2500V_{RMS}$  for 1 min.)

#### Application:

To drive IGBT modules for inverter, AC Servo systems, etc.

#### Recommended Modules:

Powerex 600V and 1200V  
F-Series IGBT Modules



Powerex, Inc., 200 Hillis Street, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

M57160AL-01  
Hybrid IC for IGBT Gate Driver

**Absolute Maximum Ratings,  $T_a = 25^\circ\text{C}$  unless otherwise specified**

Item	Symbol	Test Conditions	Limit	Units
Supply Voltage	$V_{CC}$	DC	18	Volts
	$V_{EE}$	DC	-15	Volts
Input Voltage	$V_I$	Applied between: (13) – (14)	-1 ~ 7	Volts
Output Voltage	$V_O$	Applied at the Output Voltage "H"	$V_{CC}$	Volts
Output Current	$I_{OHP}$	Pulse Width 2 $\mu\text{s}$ , $f \leq 20\text{kHz}$	-5	Amperes
	$I_{OLP}$	Pulse Width 2 $\mu\text{s}$ , $f \leq 20\text{kHz}$	5	Amperes
Isolation Voltage	$V_{RMS}$	Sinewave Voltage 60Hz, 1 min.	2500	Volts
Case Temperature	$T_c$		85	$^\circ\text{C}$
Operating Temperature	$T_{opg}$	No Condensation Permitted	-20 ~ 60	$^\circ\text{C}$
Storage Temperature	$t_{stg}$		* -25 ~ 100	$^\circ\text{C}$
Fault Output Current	$I_{FO}$	Applied (8) pin	20	mA
Input Voltage	$V_{R1}$	Applied (1) pin	$V_{CC}$	Volts

\* Differs from H/C conditions

**Electrical Characteristics,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 15\text{V}$ ,  $V_{EE} = -5\text{V}$ ,  $R_G = 2\Omega$  unless otherwise specified**

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage	$V_{CC}$		14	15	—	Volts
	$V_{EE}$	Recommended Range	-3.0	-5.0	-10	Volts
Pull-up Voltage on Input Side	$V_{IN}$		4.75	5.00	5.25	Volts
"H" Input Current	$I_{IH}$	Recommended Range	15.2	16	19	mA
Switching Frequency	$f$	Recommended Range**	—	—	20	kHz
Gate Resistor	$R_G$	Recommended Range	2.0	—	—	$\Omega$
"H" Input Current	$I_{IH}$	$V_{IN} = 5\text{V}$	—	16	—	mA
"H" Output Voltage	$V_{OH}$		13	14	—	Volts
"L" Output Voltage	$V_{OL}$		-3.0	-4.0	—	Volts
"L-H" Propagation Time	$t_{PLH}$		—	0.4	1.0	$\mu\text{s}$
"L-H" Rise Time	$t_r$	$I_{IH} = 16\text{mA}$	—	0.5	1.0	$\mu\text{s}$
"H-L" Propagation Time	$t_{PHL}$		—	0.8	1.3	$\mu\text{s}$
"H-L" Fall Time	$t_f$		—	0.4	1.0	$\mu\text{s}$
Timer	$t_{timer}$	Between Start and Cancel (Under Input Sign "L")	1.0	—	2.0	ms
Fault Output Current	$I_{FO}$	Applied (8) pin, $R = 3.9\text{k}\Omega$	—	5.0	—	mA
Controlled Time Detect Short Circuit 1	$t_{trip1}$	Pin (1) : 11.5V, Pin (2) : Open	—	4.0	—	$\mu\text{s}$
Controlled Time Detect Short Circuit 2***	$t_{trip2}$	Pin (1) : 11.5V, Pin (2) – (4) : 22pF (Connective Capacitance)	—	6.2	—	$\mu\text{s}$
Over-current Detect Voltage	$V_{SC}$	Difference Between $V_{CC}$ and Gate Voltage of IGBT	—	3.0	—	Volts

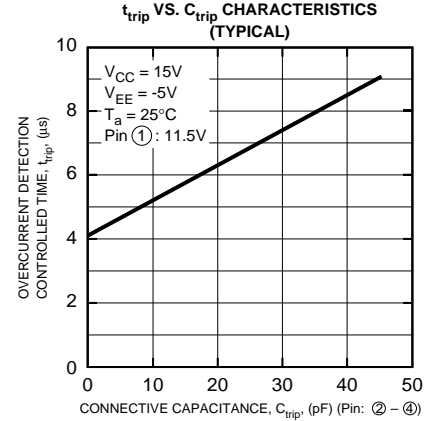
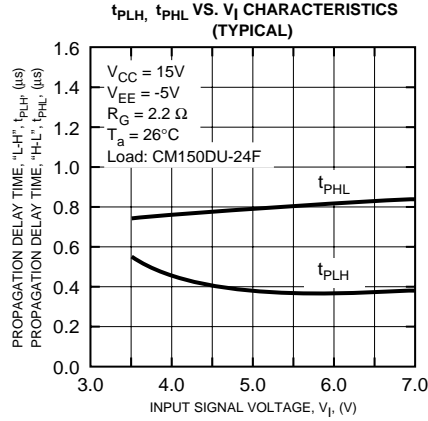
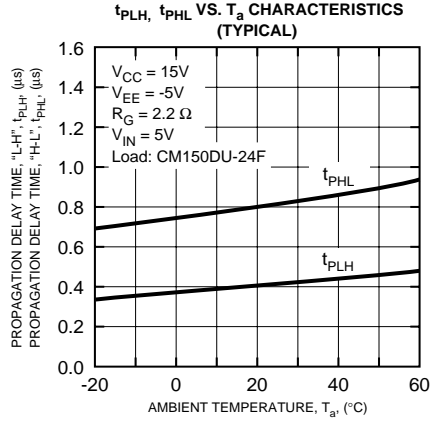
\*\*Please refer to the Maximum Limit of Switching Frequency curves

\*\*\*Length of wiring of capacitor controlled time detect short circuit is within 5cm from (2) and (4) pin coming and going.

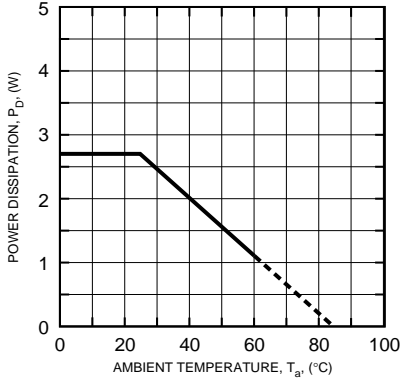


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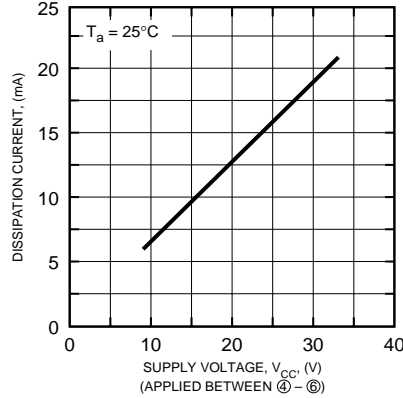
**M57160AL-01**  
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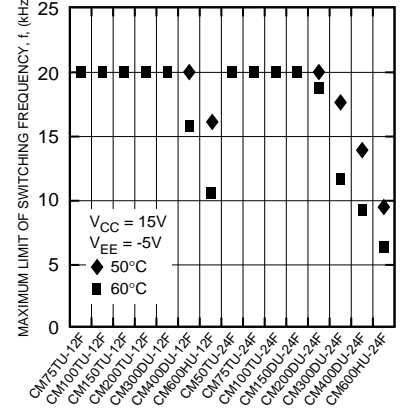
**POWER DISSIPATION VS. AMBIENT TEMPERATURE (MAXIMUM RATING)**



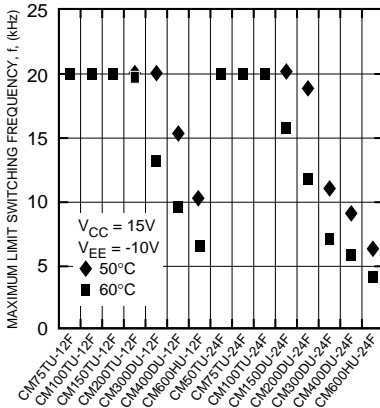
**DISSIPATION CURRENT VS. SUPPLY VOLTAGE (APPLIED BETWEEN: ④ - ⑥) INPUT SIGNAL "L" (TYPICAL)**



**MAXIMUM LIMIT OF SWITCHING FREQUENCY**



**MAXIMUM LIMIT OF SWITCHING FREQUENCY**

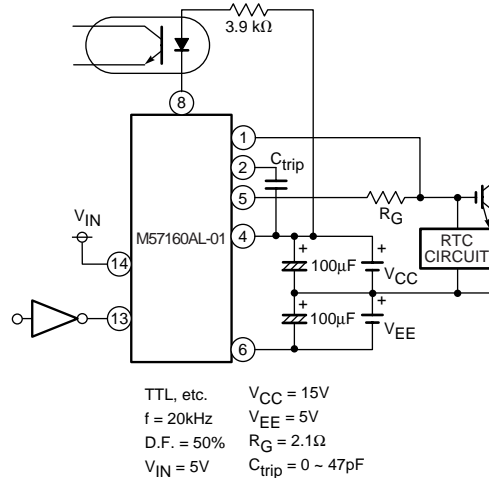


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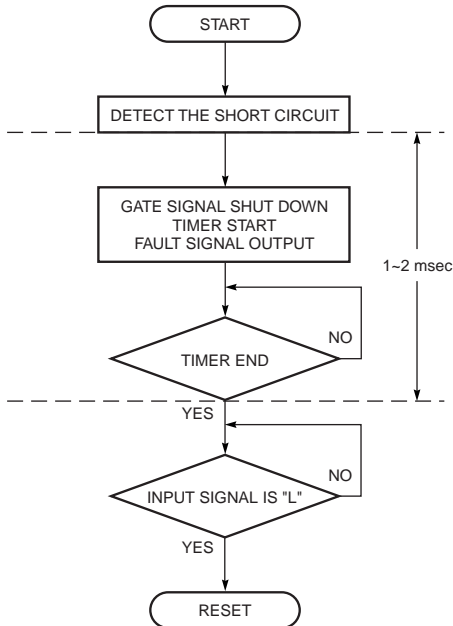
### Operation of Protection Circuit

1. During a short circuit, high current causes the F-Series IGBT module's built in RTC to activate and pull the gate voltage down. This reduction of gate voltage is detected by pin ① of the M57160AL-01. If the gate voltage remains more than 3 volts below  $V_{CC}$  for more than  $t_{trip}$ , then a soft shutdown and fault output signal are initiated by the M57160AL-01.
2. When a short circuit is detected the M57160AL-01 output will remain latched in the low (off) state for  $t_{timer}$ , which is typically 1.5ms. After  $t_{timer}$  has expired an off state input command of at least  $5\mu s$  will unlatch the output and normal operation will resume.
3. The  $t_{trip}$  time can be extended by connecting external capacitance between pin ② and pin ④.

### Application Circuit Example



### Operation Flow on Detecting Short Circuit



Note: When the protection circuit is activated the output voltage becomes  $-|V_{EE}| + 2$  Volts.

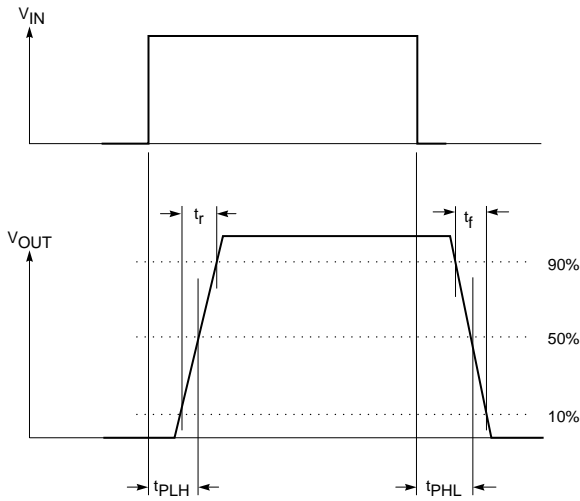
### Precaution

1. The ③, ⑦, and ⑩ pins are for production test purposes only. Do not use these pins for any connections.
2. The  $100\mu F$  capacitors for power supply decoupling must be located as close as possible to the M57160AL-01.
3. If  $C_{trip}$  is used it must be connected as close as possible to pins ② and ④.
4. To avoid possible misoperation, the input signal should be maintained in the off state during power up/down.
5. If it is necessary or desirable to disable the short circuit protection function this can be accomplished by leaving pin ① not connected.

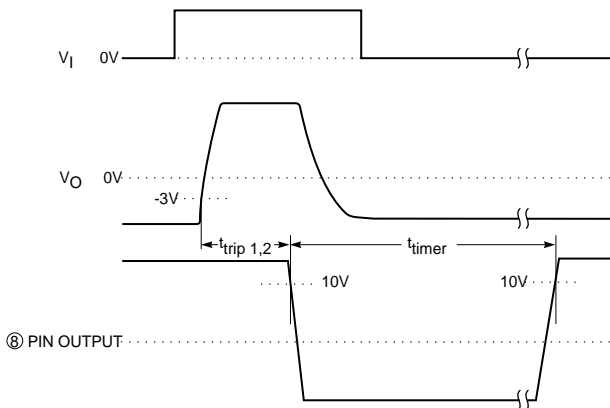
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**Definition of Characteristics**

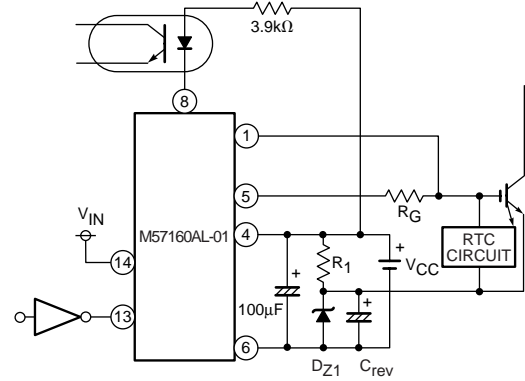
1. Switching Operation



2. The Timing When the Over Current or Short Circuit Protection Operates

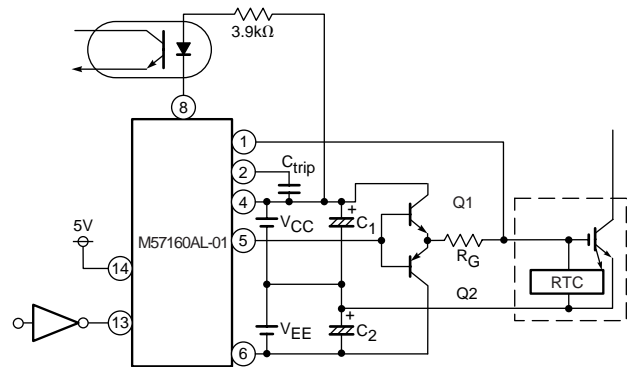


**Application Example for Single Power Supply**



$V_{CC} = 20V$   
 $R_1 = 3.3k\Omega$   
 $V_Z (D_{Z1}) = 5.1V$   
 $C_{rev} = 47\mu F$  min.  
 Note: Input signals must be delayed until  $C_{rev}$  is fully charged.

**Application Example for High Power Module**



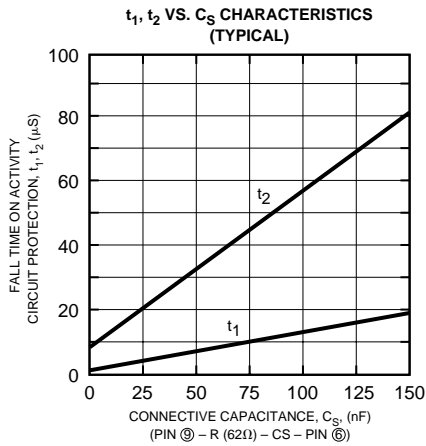
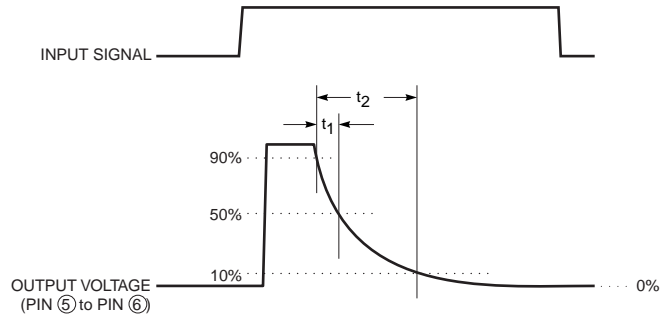
$V_{CC} = 15V$   
 $V_{EE} = 5V$   
 $C_{trip} = 0 \sim 47pF$   
 $C_1 \cdot C_2 \geq 100\mu F$  (low impedance type)

Manufacturer	Q1 (NPN)	Q2 (PNP)
Motorola	D44VH10	D45VH10
Shindengen	2SC4151	2SA1601
Zetex	ZTX851	ZTX951

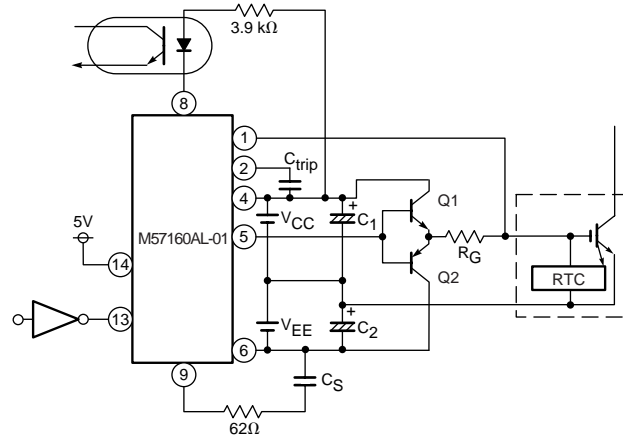
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### Adjustment of Soft Shutdown

If it is necessary to make the soft shutdown slower in order to control transient voltages, an external capacitor ( $C_S$ ) and  $62\Omega$  resistor can be connected between pin (6) and pin (9).



### Application Example for Softer Shutdown



$V_{CC} = 15V$   
 $V_{EE} = 5V$   
 $C_{trip} = 22pF$   
 $C_1 \cdot C_2 \geq 100\mu F$  (low impedance)

Manufacturer	Q1 (NPN)	Q2 (PNP)
Motorola	D44VH10	D45VH10
Shindengen	2SC4151	2SA1601
Zetex	ZTX851	ZTX951