

MITSUBISHI HYBRID IC  
**M57161L-01**

FOR DRIVING TRENCH-GATE IGBT

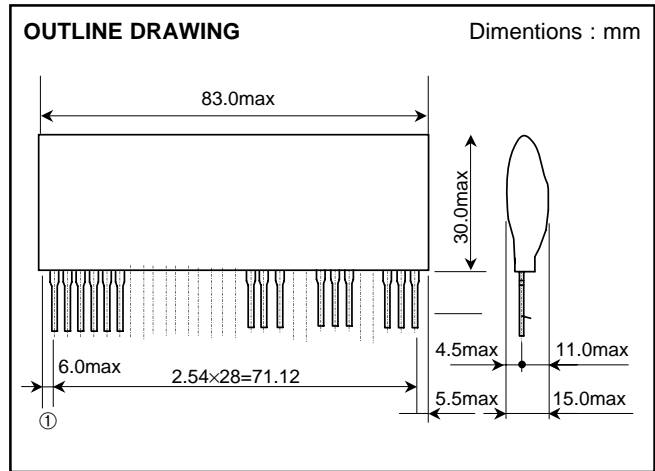
**DESCRIPTION**

M57161L-01 is a hybrid IC designed to drive trench-gate IGBT module with built in RTC.

This device can operate by an input of +15V because of electrical isolation between the input and output by an opto coupler, and the built in DC-DC converter isolated between a pair of positive/negative outputs for gate driving.

With built in protection circuits, this device can maintain a reverse bias for a predetermined time after the detection of an over current (short circuit). Therefore, the protective system operates with a margin of time.

The over current (short circuit) detector functions with RTC circuit built in IGBT module to detect a drop of gate voltage.



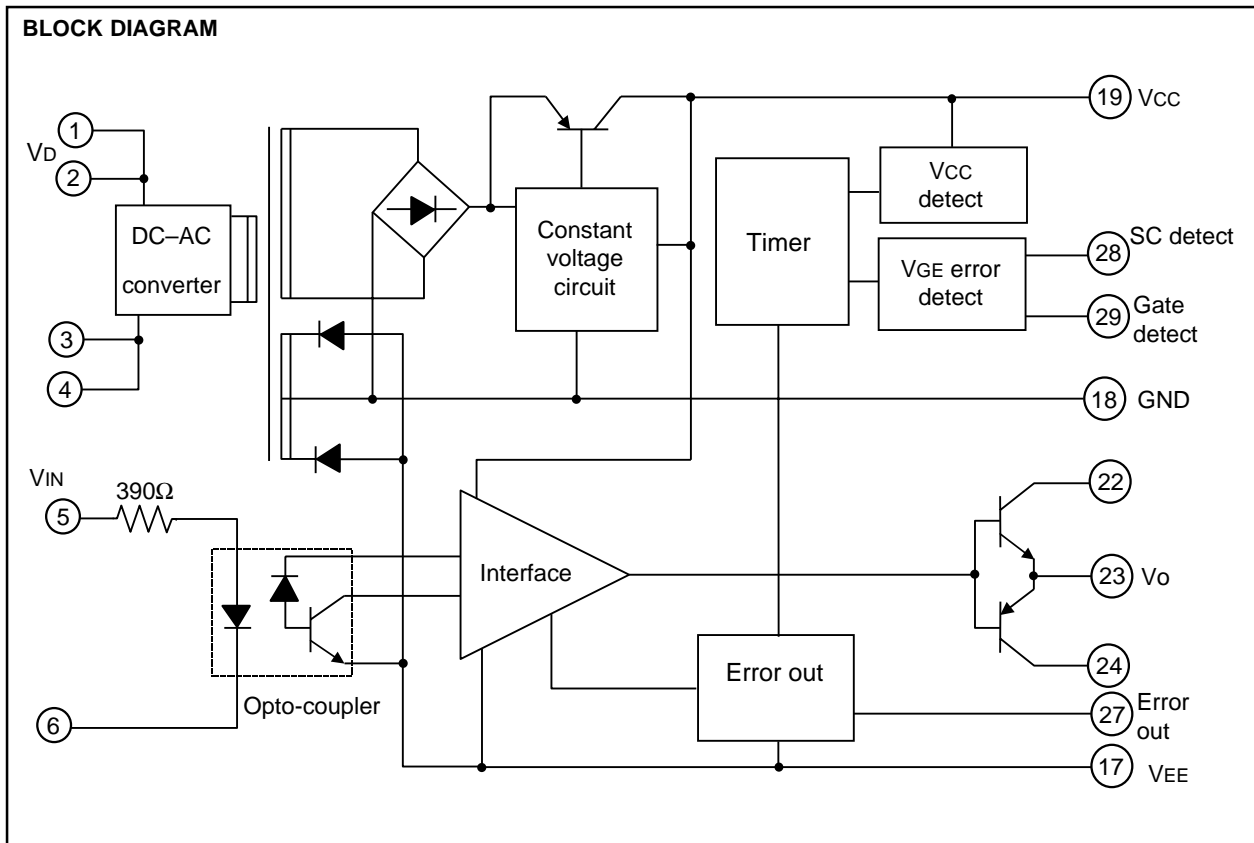
Recommend module ; IGBT module (F)series

**FEATURES**

- Built in insulated DC-DC converter for IGBT drive
- Built in short circuit protection circuit
- Electrical isolation between input and output with opto-coupler ( $V_{ios}=2500V_{rms}$  for 1minute)

**APPLICATION**

To drive IGBT module for inverter or AC servo systems application



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**ABSOLUTE MAXIMUM RATINGS** (Unless otherwise specified, Ta = 25°C)

Symbol	Parameter	Conditions	Ratings	Units
V <sub>D</sub>	Supply voltage		16	V
V <sub>I</sub>	Input voltages	Applied between:⑤-⑥	-1 ~ +7	V
V <sub>O</sub>	Output voltages	At the output voltage "H" V <sub>D</sub> =15.7V	16.5	V
I <sub>OHP</sub>	Output current	Pulse width 1μs, f≤20kHz	-7	A
I <sub>OLP</sub>			7	A
V <sub>iso</sub>	Isolation voltage	Sine-wave voltage 60Hz, 1min	2500	V <sub>rms</sub>
T <sub>c</sub>	Case temperature		85	°C
T <sub>opr</sub>	Operating temperature		-20 ~ +60	°C
T <sub>stg</sub>	Storage temperature		-25 ~ +100	°C
I <sub>FO</sub>	Fault output current	Input current 27pin	25	mA
V <sub>R</sub>	Applied 29 pin		V <sub>CC</sub>	V

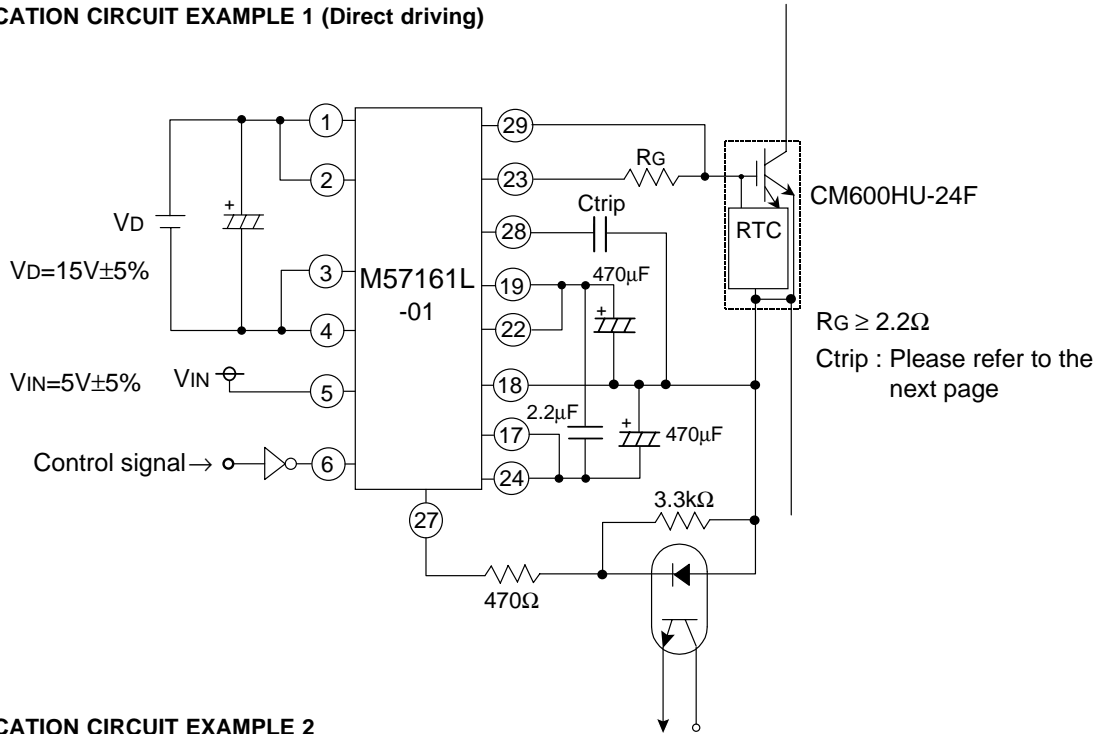
**ELECTRICAL CHARACTERISTICS** (Ta = 25°C, V<sub>D</sub> = 15.0V, V<sub>IN</sub> = 5.0V, f = 20kHz, R<sub>G</sub> = 2.2Ω : CM600HU-24F)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
V <sub>D</sub>	Supply voltage	Recommended range	14.3	15.0	15.7	V
V <sub>IN</sub>	Pull-up voltage on input side	Recommended range	4.5	5.0	5.5	V
I <sub>IH</sub>	"H" Input current	Recommended range	9	10	11	mA
f	Switching frequency	Recommended range	—	—	20	kHz
R <sub>G</sub>	Gate resistor	Recommended range	2.2	—	—	Ω
I <sub>IH</sub>	"H" Input current	V <sub>IN</sub> =5V	—	10	—	mA
V <sub>CC</sub>	Gate + supply voltage	V <sub>IN</sub> =0V, f=0Hz	17.0	17.4	17.8	V
V <sub>EE</sub>	Gate - supply voltage	V <sub>IN</sub> =0V, f=0Hz	-5.5	-6.5	-7.5	V
V <sub>OH</sub>	"H" Output voltage		14	15.5	16.5	V
V <sub>OL</sub>	"L" Output voltage		-4.0	-5.0	-6.0	V
t <sub>PLH</sub>	"L-H" Propagation time	I <sub>IH</sub> =10mA	—	0.4	1	μs
t <sub>r</sub>	"L-H" Rise time	I <sub>IH</sub> =10mA	—	0.4	0.5	μs
t <sub>PHL</sub>	"H-L" Propagation time	I <sub>IH</sub> =10mA	—	1.3	2.0	μs
t <sub>f</sub>	"H-L" Fall time	I <sub>IH</sub> =10mA	—	0.4	0.5	μs
t <sub>timer</sub>	Timer	Between start and cancel(Under input signal "L")	1.5	—	2.5	ms
I <sub>FO</sub>	Fault output current	Applied 27pin R=470Ω	—	12	—	mA
t <sub>c</sub>	Controlled time detect delay time	In the rise time 29pin :11V, 28pin :open	—	3.5	—	μs
t <sub>d</sub>	Short-circuit protect delay time	In the rise time 29pin :11V, 28pin :open	—	6.5	—	μs
V <sub>CL</sub>	Start voltage for protection at lower V <sub>CC</sub>	The required minimum of positive power supply for gate when V <sub>O</sub> is in the state of "H"	14.2	15.2	16.2	V
V <sub>SC</sub>	Over-current detect voltage		11.0	11.6	12.2	V

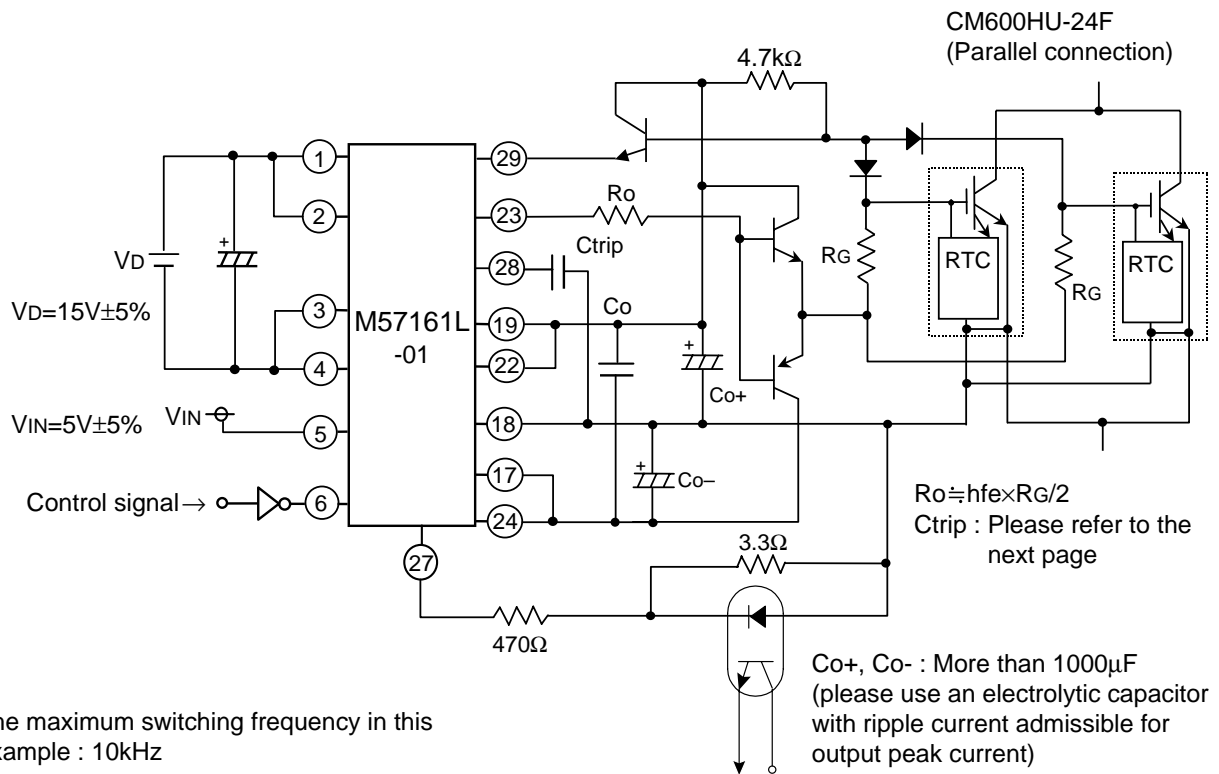
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**APPLICATION CIRCUIT EXAMPLE 1 (Direct driving)**



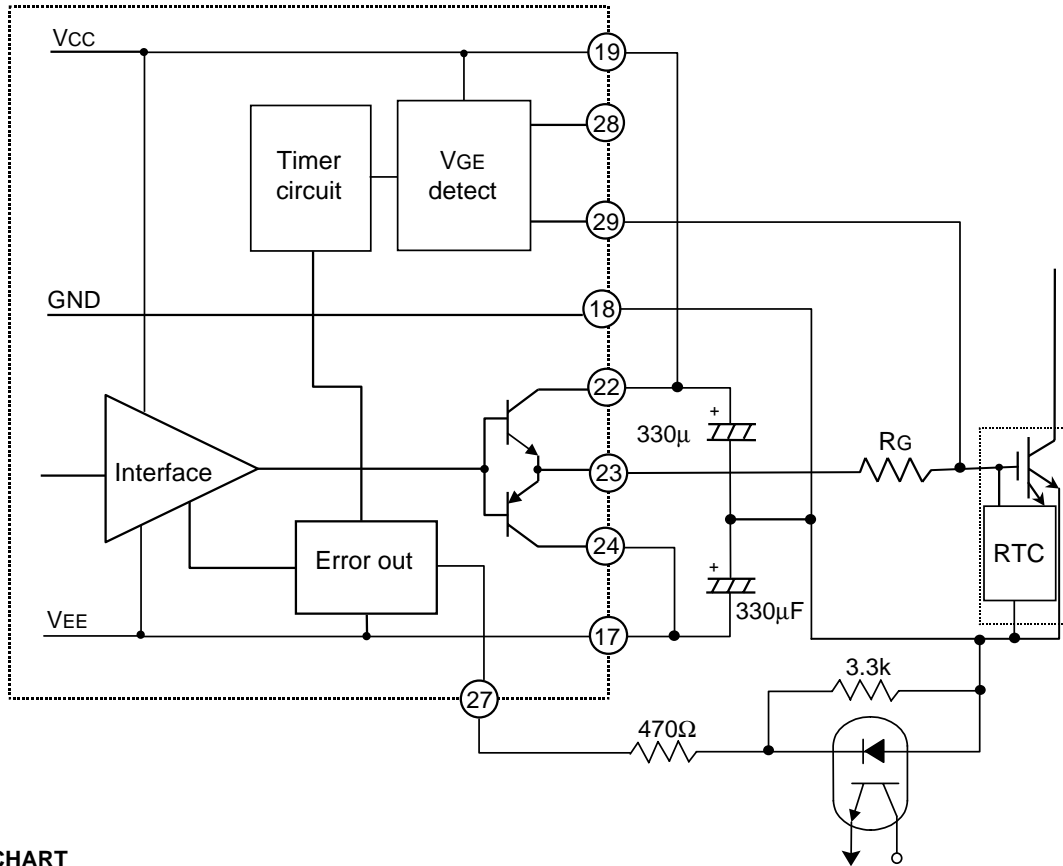
**APPLICATION CIRCUIT EXAMPLE 2 (Additional transistor for output current)**



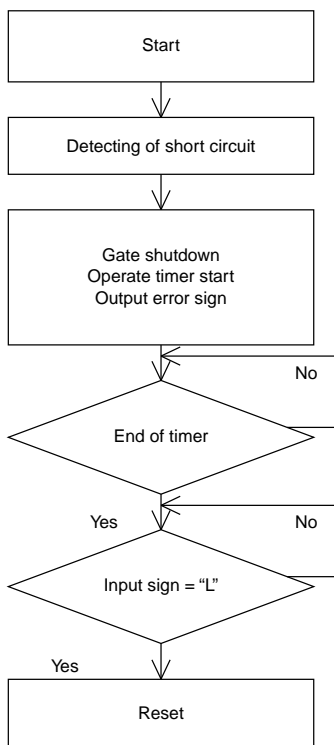
The maximum switching frequency in this example : 10kHz

$Co+, Co- : \text{More than } 1000\mu F$   
 (please use an electrolytic capacitor with ripple current admissible for output peak current)  
 $Co : \text{A few } \mu F$   
 The connection to decrease the peak of ripple current

OPERATION OF PROTECTION CIRCUIT



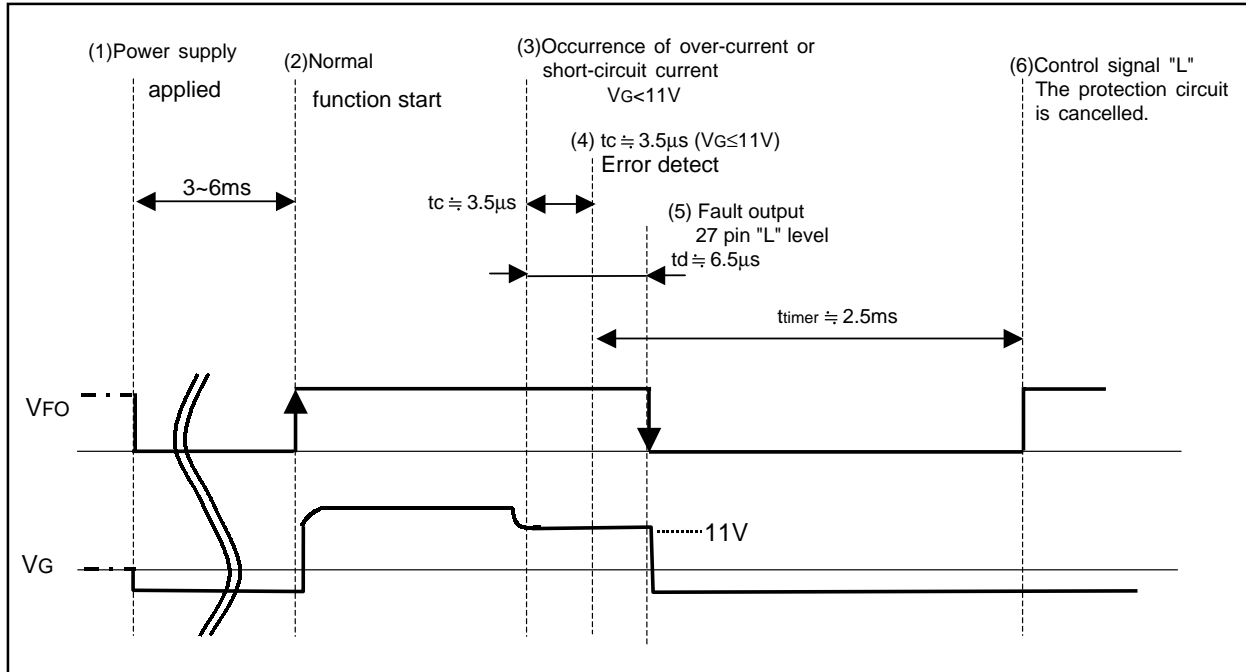
FLOW CHART



1. The V<sub>GE</sub> error detect circuit operates when an input signal is in the state of "H".
2. An error judgment is made when V<sub>GE</sub> becomes below V<sub>sc</sub> (=11v : min).
3. The V<sub>GE</sub> error detect circuit does not function until the time when the gate voltage reaches V<sub>sc</sub> (=12.2V : max).  
The t<sub>c</sub> (=3.5μs) of controlled time detect short circuit is set in order to ensure the turn-on of IGBT modules.
4. If a rise time of gate voltage is longer than 3.5μs, the t<sub>c</sub> can be adjusted by connecting a capacitor (C<sub>trip</sub>) between pins 28 and 18. Please refer to t<sub>d</sub> vs. C<sub>trip</sub> CHARACTERISTICS on page 6/6.
5. The t<sub>d</sub> is a delay time due to signal transmission of each protection circuit.
6. If short-circuit current flows at turn-on, the controlled time detect short circuit (t<sub>d</sub>) is included to the t<sub>d</sub> of short-circuit protect delay time.  
The t<sub>d</sub> can be changed through C<sub>trip</sub>.  
As a gate shutdown of IGBT modules within 10 μs is recommended, C<sub>trip</sub> should be below 220pF in order to set the maximum of t<sub>d</sub> below 10μs

**CONTROL OF IGBT MODULE DRIVER**

The timing chart for control of IGBT module drivers with electrical isolation between the input and output is as follows.



Timing chart when protection circuit operates under over-current (short circuit) with power supply applied.

**DESCRIPTION OF TIMING CHART**

- (1) When Vcc is within 10 to 15 voltages, S/C detect output (VFO) is in the low state. The output voltage remains in the low state for 3 to 6 ms. If the power supply is applied in the high state of input signal, the output (Vo) remains in the low state. But VFO becomes in the low state for 3 to 6 ms. After normal function starts, if Vcc is below the start voltage of protection circuit (Typ. 15.2V), VFO is low and Vo is low voltage for the same period.
- (2) After VFO returns to high level, control signal should be applied.
- (3) If over-current or short-circuit current flows between the collector and emitter of IGBT modules, the internal RTC circuit pulls the gate voltage down below 11V
- (4) When the turn-on of IGBT coincides with over-current or short-circuit current, the timer circuit functions after tc.
- (5) After td from the short-circuit or over-current, the output voltage of Vo is low and VFO is low voltage at the same time. The output remains low during the operating time of timer circuit regardless of input signals.
- (6) If the input signal is low level after ttimer, the protection function is cancelled. And then VFO returns to high voltage.

CHARACTERISTICS CURVES

