M57161L-01

FOR DRIVING TRENCH-GATE IGBT

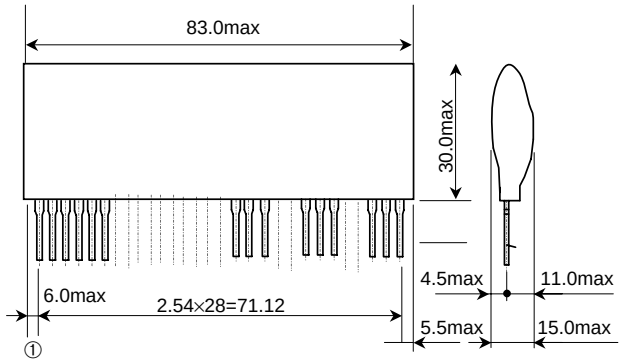
DESCRIPTION

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 devices 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

OUTLINE DRAWING

Dimentions : mm



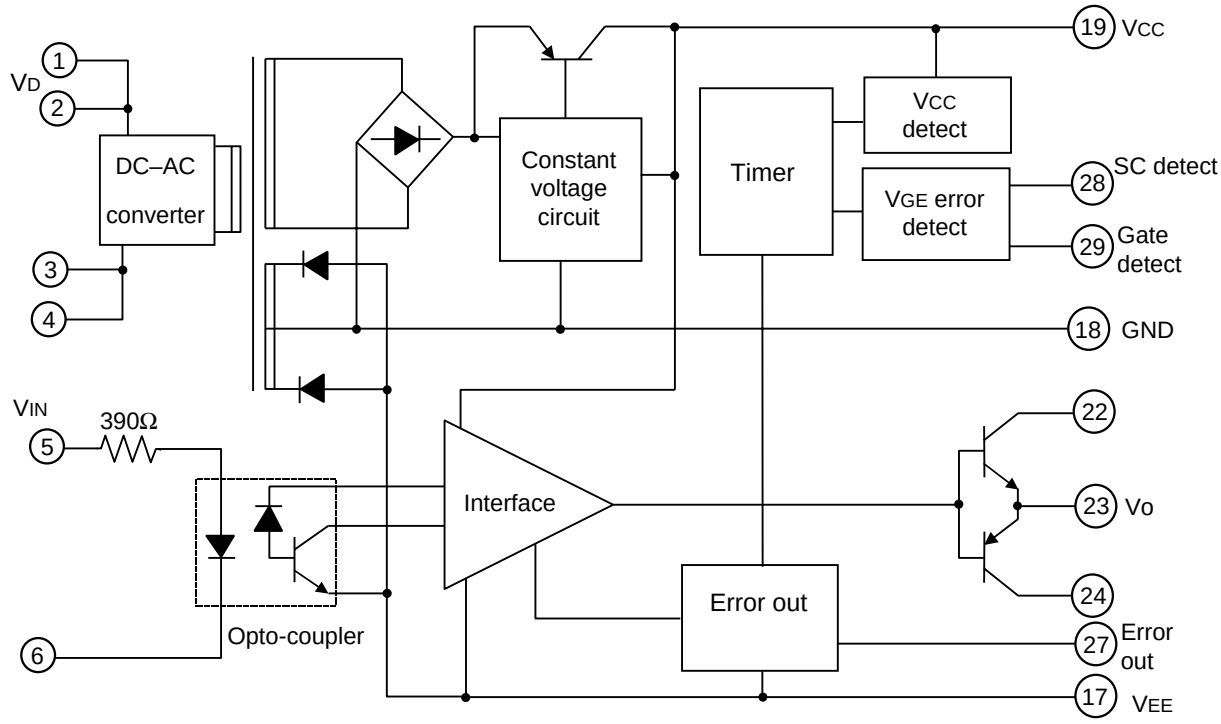
FEATURES

- Built in insulated DC-DC converter for IGBT drive
- Built in short circuit protection circuit
- Electrical isolation between input and output with opto-coupler (Vios=2500Vrms for 1minute)

APPLICATION

To drive IGBT module for inverter or AC servo systems application

BLOCK DIAGRAM



MITSUBISHI ELECTRIC

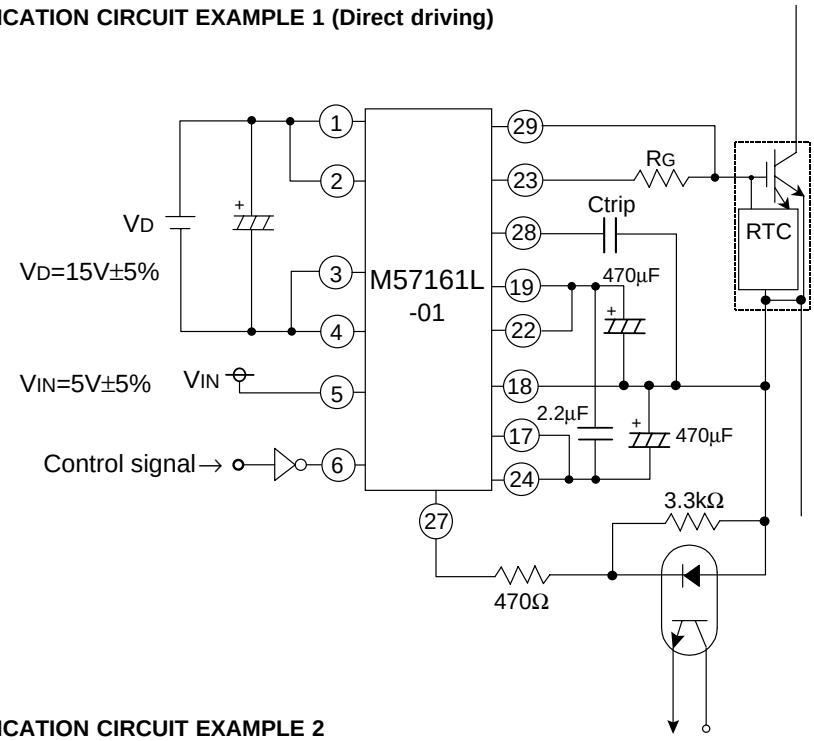
ABSOLUTE MAXIMUM RATINGS (Unless otherwise specified, Ta = 25°C)

Symbol	Parameter	Conditions	Ratings	Units
V_D	Supply voltage		16	V
V_I	Input voltages	Applied between:⑤-⑥	–1 ~ +7	V
Vo	Output voltages	At the output voltage "H" V_D=15.7V	16.5	V
I_{OHP}	Output current	Pulse width 1µs, f≤20kHz	–7	A
I_{OLP}			7	A
Viso	Isolation voltage	Sine-wave voltage 60Hz, 1min	2500	Vrms
Tc	Case temperature		85	°C
Topr	Operating temperature		–20 ~ +60	°C
Tstg	Storage temperature		–25 ~ +100	°C
I_{FO}	Fault output current	Input current 27pin	25	mA
V_R	Applied 29 pin		V_{CC}	V

ELECTRICAL CHARACTERISTICS (Ta = 25°C, V_D = 15.0V, V_{IN} = 5.0V, f = 20kHz, R_G = 2.2Ω : CM600HU-24F)

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

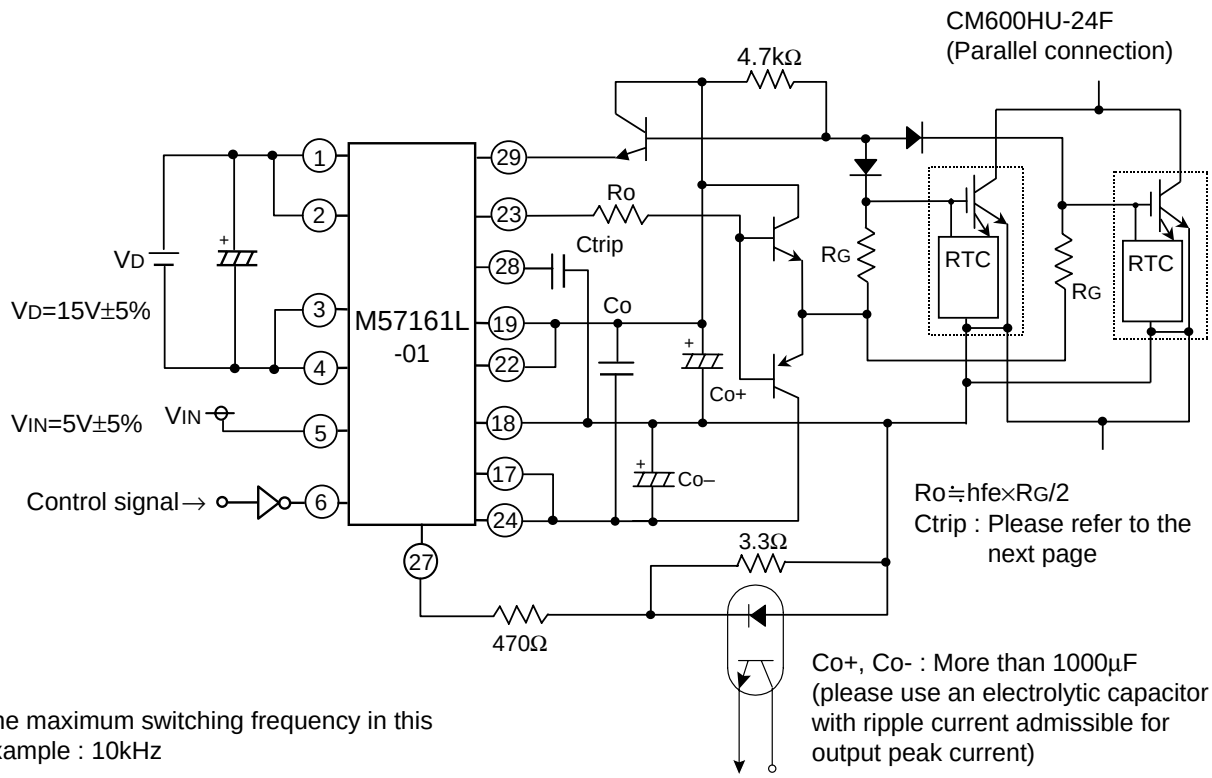
APPLICATION CIRCUIT EXAMPLE 1 (Direct driving)



RG ≥ 2.2Ω

Ctrip : Please refer to the next page

APPLICATION CIRCUIT EXAMPLE 2
(Additional transistor for output current)



Ro≒hfe×RG/2

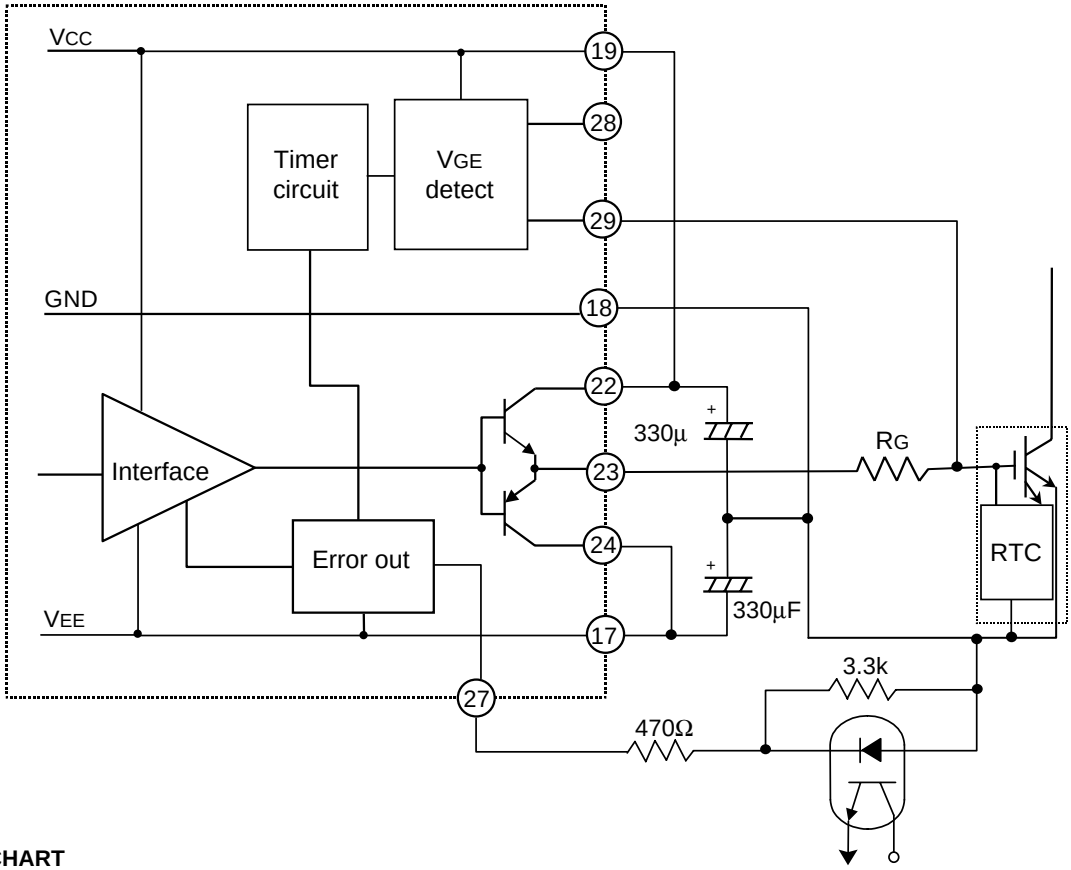
Ctrip : Please refer to the next page

Co+, Co- : More than 1000µF (please use an electrolytic capacitor with ripple current admissible for output peak current)

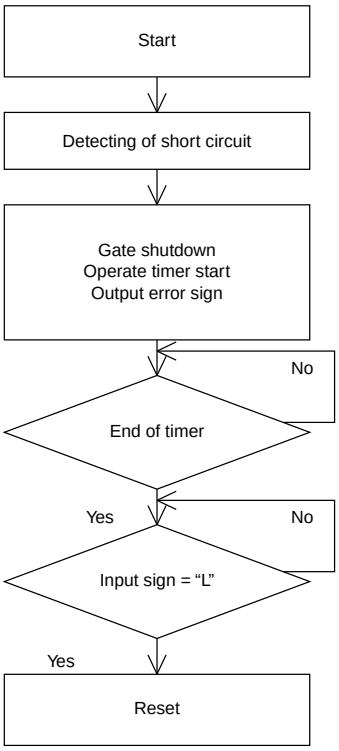
The maximum switching frequency in this example : 10kHz

Co : A few µF
The connection to decrease the peak of ripple current

OPERATION OF PROTECTION CIRCUIT



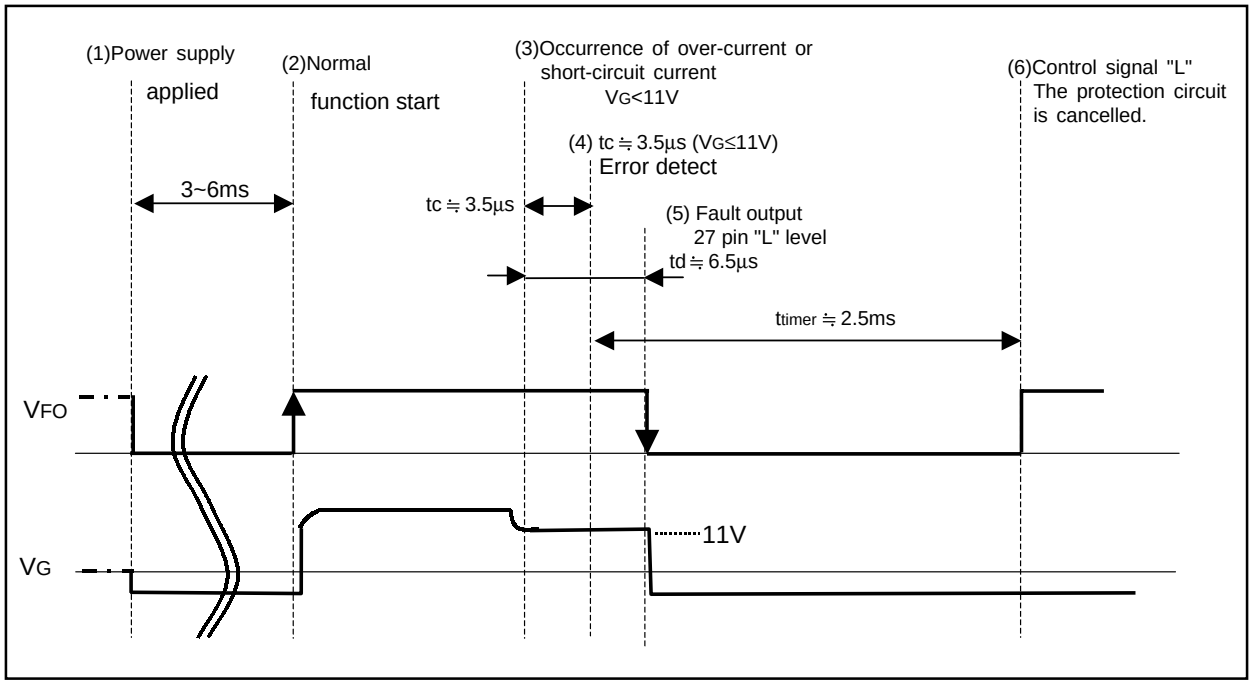
FLOW CHART



1. The V_{GE} error detect circuit operates when an input signal is in the state of "H".
2. An error judgment is made when V_{GE} becomes below V_{SC} (=11v : min).
3. The V_{GE} error detect circuit does not function until the time when the gate voltage reaches V_{SC} (=12.2V : max).
   The tc (=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 tc can be adjusted by connecting a capacitor (Ctrip) between pins 28 and 18. Please refer to td vs. Ctrip CHARACTERISTICS on page 6/6.
5. The td 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 (td) is included to the td of short-circuit protect delay time.
   The td can be changed through Ctrip.
   As a gate shutdown of IGBT modules within 10 µs is recommended, Ctrip should be below 220pF in order to set the maximum of td 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 V_{CC} is within 10 to 15 voltages, S/C detect output (V_{FO}) is in the low state. The output vontage 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 V_{FO} becomes in the low state for 3 to 6 ms. After normal function starts, if V_{CC} is below the start voltage of protection circuit (Typ. 15.2V), V_{FO} is low and Vo is low voltage for the same period.

(2) After V_{FO} returns to high level, control signal shoud 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

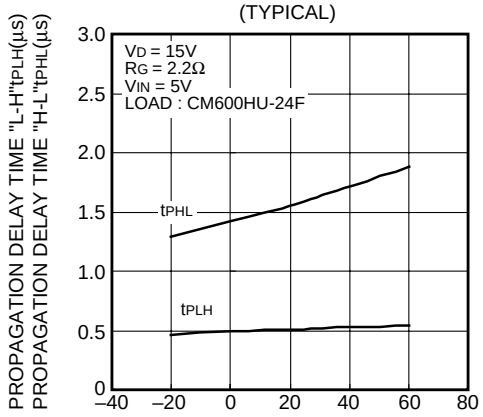
(4) When the turn-on of IGBT coincides with over-current or short-circuit current, the timer circuit functions after tc.

(5) After td from the short-circuit or over-current, the output voltage of Vo is low and V_{FO} is low voltage at the same time. The output remains low during the operating time of timer circuit regardless of input signals.

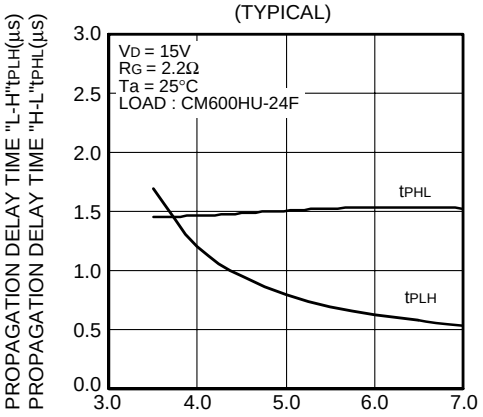
(6) If the input signal is low level after ttimer, the protection function is cancelled. And then V_{FO} returns to high voltage.

CHARACTERISTICS CURVES

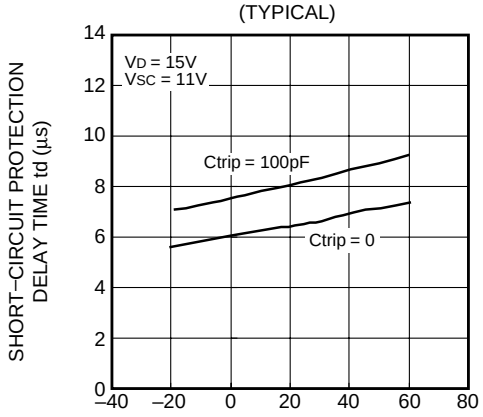
tPLH, tPHL vs. Ta CHARACTERISTICS (TYPICAL)



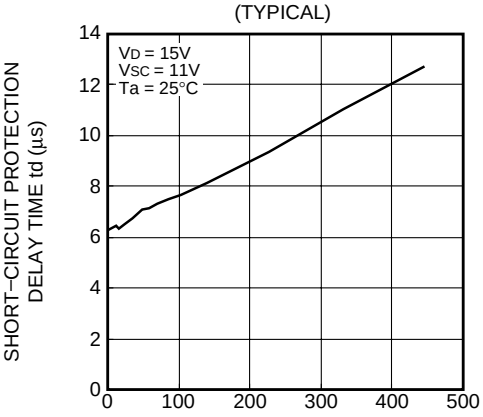
tPLH, tPHL vs. VI CHARACTERISTICS (TYPICAL)



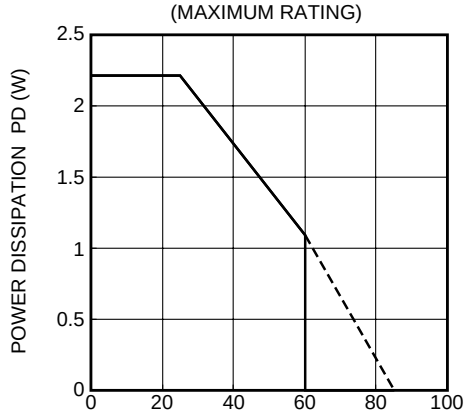
td vs. Ta CHARACTERISTICS (TYPICAL)



td vs. Ctrip CHARACTERISTICS (TYPICAL)



POWER DISSIPATION vs. AMBIENT TEMPERATURE (MAXIMUM RATING)



DISSIPATION CURRENT vs. SUPPLY VOLTAGE (TYPICAL)