

PM400DV1A060

FLAT-BASE TYPE
INSULATED PACKAGE

PM400DV1A060



FEATURE

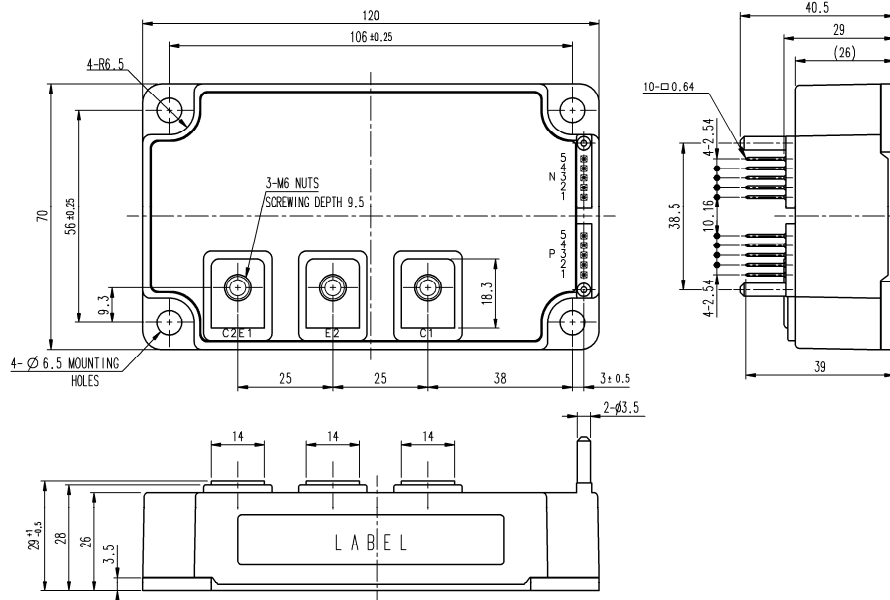
- a) Adopting new 5th generation Full-Gate CSTBT™ chip
 - b) The over-temperature protection which detects the chip surface temperature of CSTBT™ is adopted.
 - c) Error output signal is possible from all each protection upper and lower arm of IPM.
 - d) Compatible V-series package.
- Monolithic gate drive & protection logic
 - Detection, protection & status indication circuits for, short-circuit, over-temperature & under-voltage.

APPLICATION

General purpose inverter, servo drives and other motor controls

PACKAGE OUTLINES

Dimensions in mm



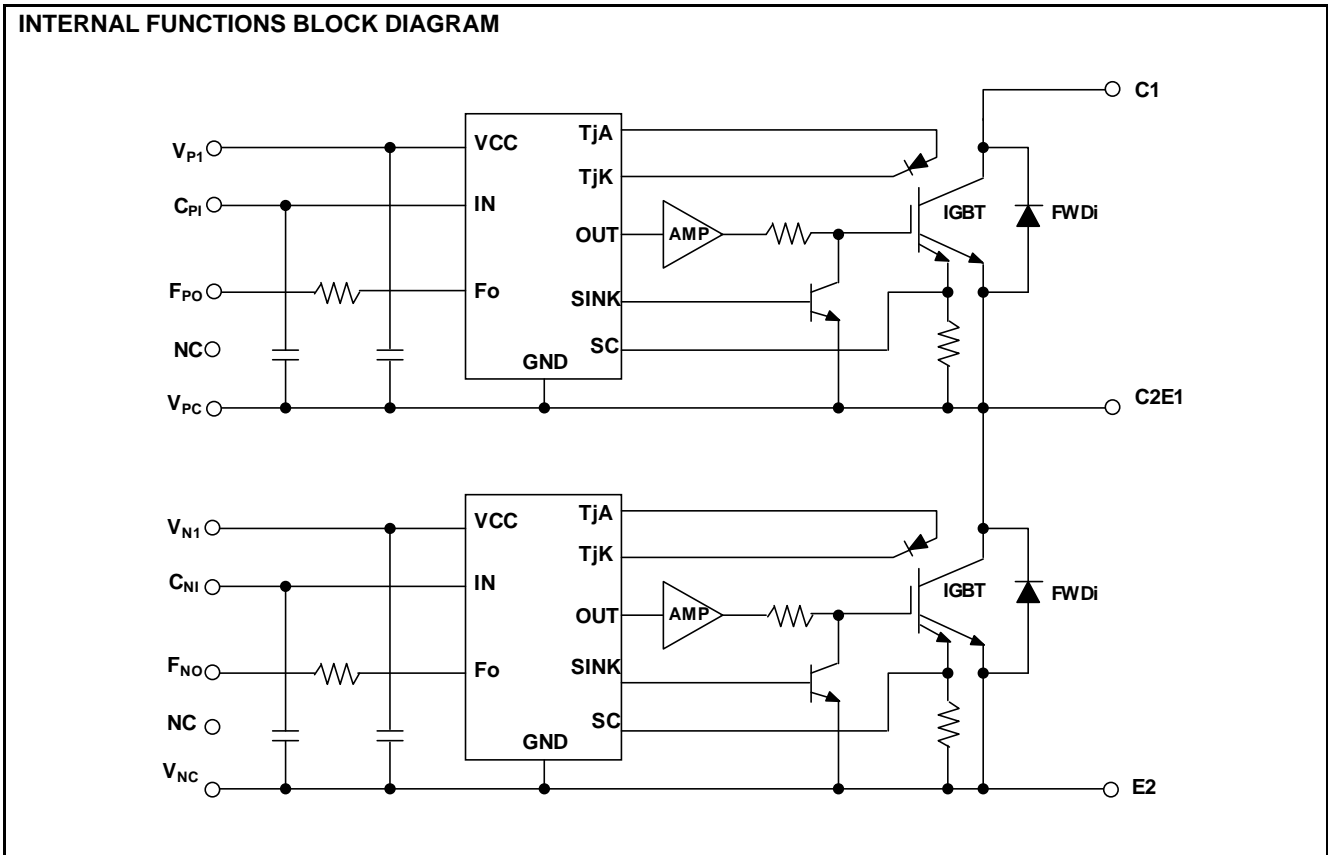
TERMINAL CODE

- | | |
|---|---------|
| | 5 : FNO |
| | 4 : VNC |
| N | 3 : CNI |
| | 2 : NC |
| | 1 : VN1 |
| | |
| P | 5 : FPO |
| | 4 : VPC |
| | 3 : CPI |
| | 2 : NC |
| | 1 : VP1 |

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INTERNAL FUNCTIONS BLOCK DIAGRAM



MAXIMUM RATINGS ($T_j = 25^\circ\text{C}$, unless otherwise noted)

INVERTER PART

| Symbol | Parameter | Conditions | Ratings | Unit |
|-----------|---------------------------------------|--------------------------------------|------------|------------------|
| V_{CES} | Collector-Emitter Voltage | $V_D=15\text{V}, V_{CIN}=15\text{V}$ | 600 | V |
| I_C | Collector Current | $T_C=25^\circ\text{C}$ | 400 | A |
| I_{CRM} | | Pulse | 800 | |
| P_{tot} | Total Power Dissipation | $T_C=25^\circ\text{C}$ | 1262 | W |
| I_E | Emitter Current | $T_C=25^\circ\text{C}$ | 400 | A |
| I_{ERM} | (Free wheeling Diode Forward current) | Pulse | 800 | |
| T_j | Junction Temperature | | -20 ~ +150 | $^\circ\text{C}$ |

*: T_c measurement point is just under the chip.

CONTROL PART

| Symbol | Parameter | Conditions | Ratings | Unit |
|-----------|-----------------------------|--|---------|------|
| V_D | Supply Voltage | Applied between : $V_{P1}-V_{PC}, V_{N1}-V_{NC}$ | 20 | V |
| V_{CIN} | Input Voltage | Applied between : $C_{P1}-V_{PC}, C_{N1}-V_{NC}$ | 20 | V |
| V_{FO} | Fault Output Supply Voltage | Applied between : $F_{P0}-V_{PC}, F_{N0}-V_{NC}$ | 20 | V |
| I_{FO} | Fault Output Current | Sink current at F_{P0}, F_{N0} terminals | 20 | mA |

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TOTAL SYSTEM

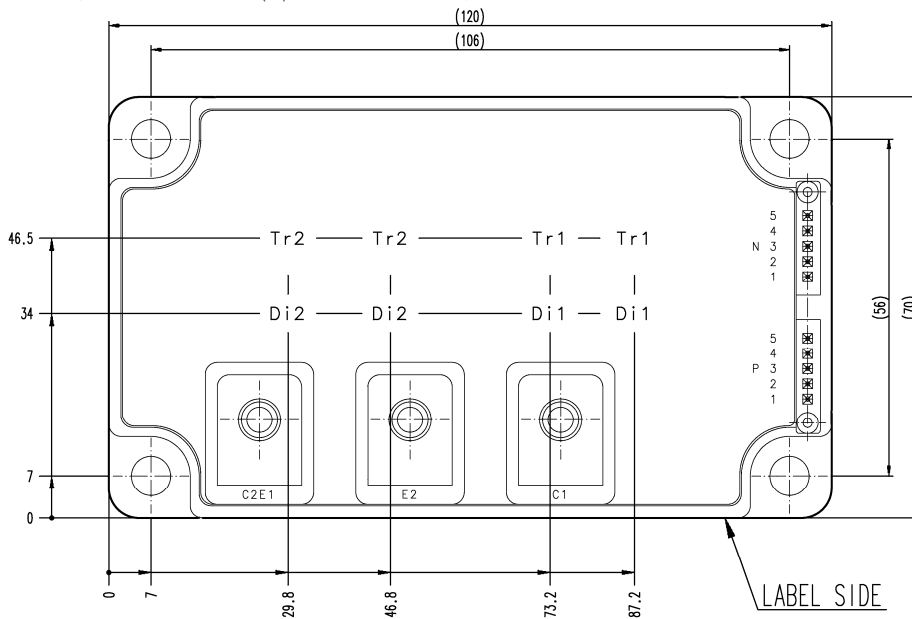
| Symbol | Parameter | Conditions | Ratings | Unit |
|-----------------|-----------------------------------|---|------------|------------|
| $V_{CC(Prot)}$ | Supply Voltage Protected by SC | $V_D = 13.5V \sim 16.5V$ Inverter Part, $T_j = +125^\circ C$ Start | 400 | V |
| $V_{CC(surge)}$ | Supply Voltage (Surge) | Applied between : C1-E2, Surge value | 500 | V |
| T_C | Module case operating temperature | | -20 ~ +100 | $^\circ C$ |
| T_{stg} | Storage Temperature | | -40 ~ +125 | $^\circ C$ |
| V_{isol} | Isolation Voltage | 60Hz, Sinusoidal, Charged part to Base plate, AC 1min, RMS | 2500 | V |

*: T_C measurement point is just under the chip.

THERMAL RESISTANCE

| Symbol | Parameter | Conditions | Limits | | | Unit |
|----------------|----------------------------|--|--------|-------|-------|------|
| | | | Min. | Typ. | Max. | |
| $R_{th(j-c)Q}$ | Thermal Resistance | Junction to case, IGBT (per 1 element) (Note.1) | - | - | 0.099 | K/W |
| $R_{th(j-c)D}$ | | Junction to case, FWDi (per 1 element) (Note.1) | - | - | 0.153 | |
| $R_{th(c-s)}$ | Contact Thermal Resistance | Case to heat sink, (per 1 module) Thermal grease applied (Note.1) | - | 0.018 | - | |

Note1: If you use this value, $R_{th(s-a)}$ should be measured just under the chips.



ELECTRICAL CHARACTERISTICS ($T_j = 25^\circ C$, unless otherwise noted)

INVERTER PART

| Symbol | Parameter | Conditions | Limits | | | Unit |
|--------------|--------------------------------------|--|--------|------|------|---------|
| | | | Min. | Typ. | Max. | |
| V_{CEsat} | Collector-Emitter Saturation Voltage | $V_D = 15V, I_C = 400A$ $V_{CIN} = 0V$, Pulsed (Fig. 1) | - | 1.90 | 2.35 | V |
| | | | - | 1.90 | 2.35 | |
| V_{EC} | Emitter-Collector Voltage | $I_E = 400A, V_D = 15V, V_{CIN} = 15V$ (Fig. 2) | - | 1.7 | 2.8 | V |
| t_{on} | Switching Time | $V_D = 15V, V_{CIN} = 0V \leftrightarrow 15V$ $V_{CC} = 300V, I_C = 400A$ $T_j = 125^\circ C$ Inductive Load (Fig. 3,4) | 0.3 | 0.8 | 2.0 | μs |
| t_{rr} | | | - | 0.4 | 0.8 | |
| $t_{c(on)}$ | | | - | 0.4 | 1.0 | |
| t_{off} | | | - | 1.0 | 2.3 | |
| $t_{c(off)}$ | | | - | 0.3 | 1.0 | |
| I_{CES} | Collector-Emitter Cut-off Current | $V_{CE} = V_{CES}, V_D = 15V, V_{CIN} = 15V$ (Fig. 5) | - | - | 1 | mA |
| | | | - | - | 10 | |

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CONTROL PART

| Symbol | Parameter | Conditions | Limits | | | Unit | |
|----------------------|---|---|----------------------------------|------|------|------|----|
| | | | Min. | Typ. | Max. | | |
| I _D | Circuit Current | V _D =15V, V _{CIN} =15V | V _{P1} -V _{PC} | - | 2 | 4 | mA |
| | | | V _{N1} -V _{NC} | - | 2 | 4 | |
| V _{th(ON)} | Input ON Threshold Voltage | Applied between : C _{P1} -V _{PC} , C _{N1} -V _{NC} | 1.2 | 1.5 | 1.8 | V | |
| V _{th(OFF)} | Input OFF Threshold Voltage | | 1.7 | 2.0 | 2.3 | | |
| SC | Short Circuit Trip Level | -20≤T _J ≤125°C, V _D =15V (Fig. 3, 6) | 600 | - | - | A | |
| t _{off(SC)} | Short Circuit Current Delay Time | V _D =15V (Fig. 3, 6) | - | 0.2 | - | μs | |
| OT | Over Temperature Protection | Detect Temperature of IGBT chip | Trip level | 135 | - | - | °C |
| OT _(hys) | | | Hysteresis | - | 20 | - | |
| UV _t | Supply Circuit Under-Voltage Protection | -20≤T _J ≤125°C | Trip level | 11.5 | 12.0 | 12.5 | V |
| UV _r | | | Reset level | - | 12.5 | - | |
| I _{FO(H)} | Fault Output Current | V _D =15V, V _{FO} =15V (Note.2) | - | - | 0.01 | mA | |
| I _{FO(L)} | | | - | 10 | 15 | | |
| t _{FO} | Fault Output Pulse Width | V _D =15V (Note.2) | 1.0 | 1.8 | - | ms | |

Note.2: Fault output is given only when the internal SC, OT & UV protections schemes of either upper or lower arm device operate to protect it.

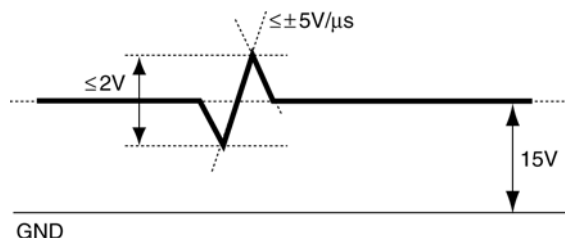
MECHANICAL RATINGS AND CHARACTERISTICS

| Symbol | Parameter | Conditions | Limits | | | Unit |
|----------------|-----------------|-------------------------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| M _s | Mounting Torque | Mounting part screw : M6 | 3.92 | 4.90 | 5.88 | N·m |
| M _t | | Main terminal part screw : M6 | 3.92 | 4.90 | 5.88 | |
| m | Weight | - | - | 510 | - | g |

RECOMMENDED CONDITIONS FOR USE

| Symbol | Parameter | Conditions | Recommended value | Unit |
|-----------------------|---------------------------------|--|-------------------|------|
| V _{CC} | Supply Voltage | Applied across C1-E2 terminals | ≤ 400 | V |
| V _D | Control Supply Voltage | Applied between : V _{P1} -V _{PC} , V _{N1} -V _{NC} (Note.3) | 15.0±1.5 | V |
| V _{CIN(ON)} | Input ON Voltage | Applied between : C _{P1} -V _{PC} , C _{N1} -V _{NC} | ≤ 0.8 | V |
| V _{CIN(OFF)} | Input OFF Voltage | | ≥ 4.0 | |
| f _{PWM} | PWM Input Frequency | Using Application Circuit of Fig. 8 | ≤ 20 | kHz |
| t _{dead} | Arm Shoot-through Blocking Time | For IPM's each input signals (Fig. 7) | ≥ 3.0 | μs |

Note.3: With ripple satisfying the following conditions: dv/dt swing ≤ ±5V/μs, Variation ≤ 2V peak to peak



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PRECAUTIONS FOR TESTING

1. Before applying any control supply voltage (V_D), the input terminals should be pulled up by resistors, etc. to their corresponding supply voltage and each input signal should be kept off state.
After this, the specified ON and OFF level setting for each input signal should be done.
2. When performing "SC" tests, the turn-off surge voltage spike at the corresponding protection operation should not be allowed to rise above V_{CES} rating of the device.
(These test should not be done by using a curve tracer or its equivalent.)

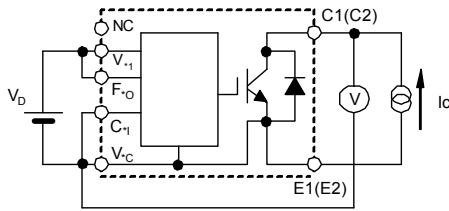


Fig. 1 V_{CEsat} Test

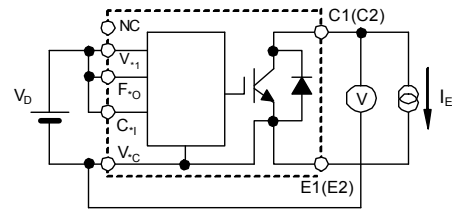


Fig. 2 V_{EC} Test

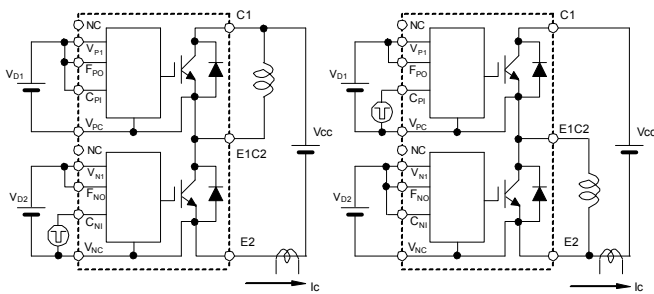


Fig. 3 Switching time and SC test circuit

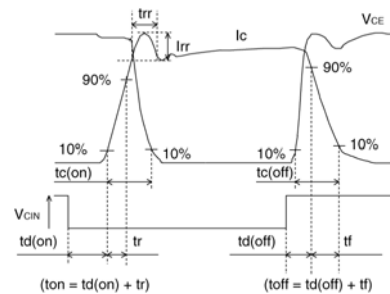


Fig. 4 Switching time test waveform

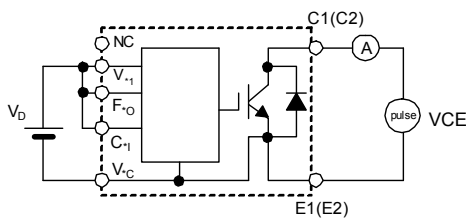


Fig. 5 I_{CES} Test

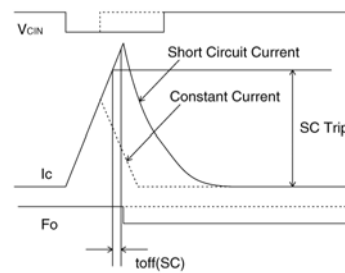
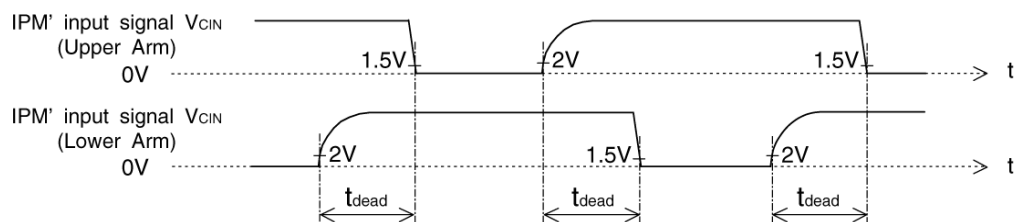


Fig. 6 SC test waveform



1.5V: Input on threshold voltage $V_{th(on)}$ typical value, 2V: Input off threshold voltage $V_{th(off)}$ typical value

Fig. 7 Dead time measurement point example

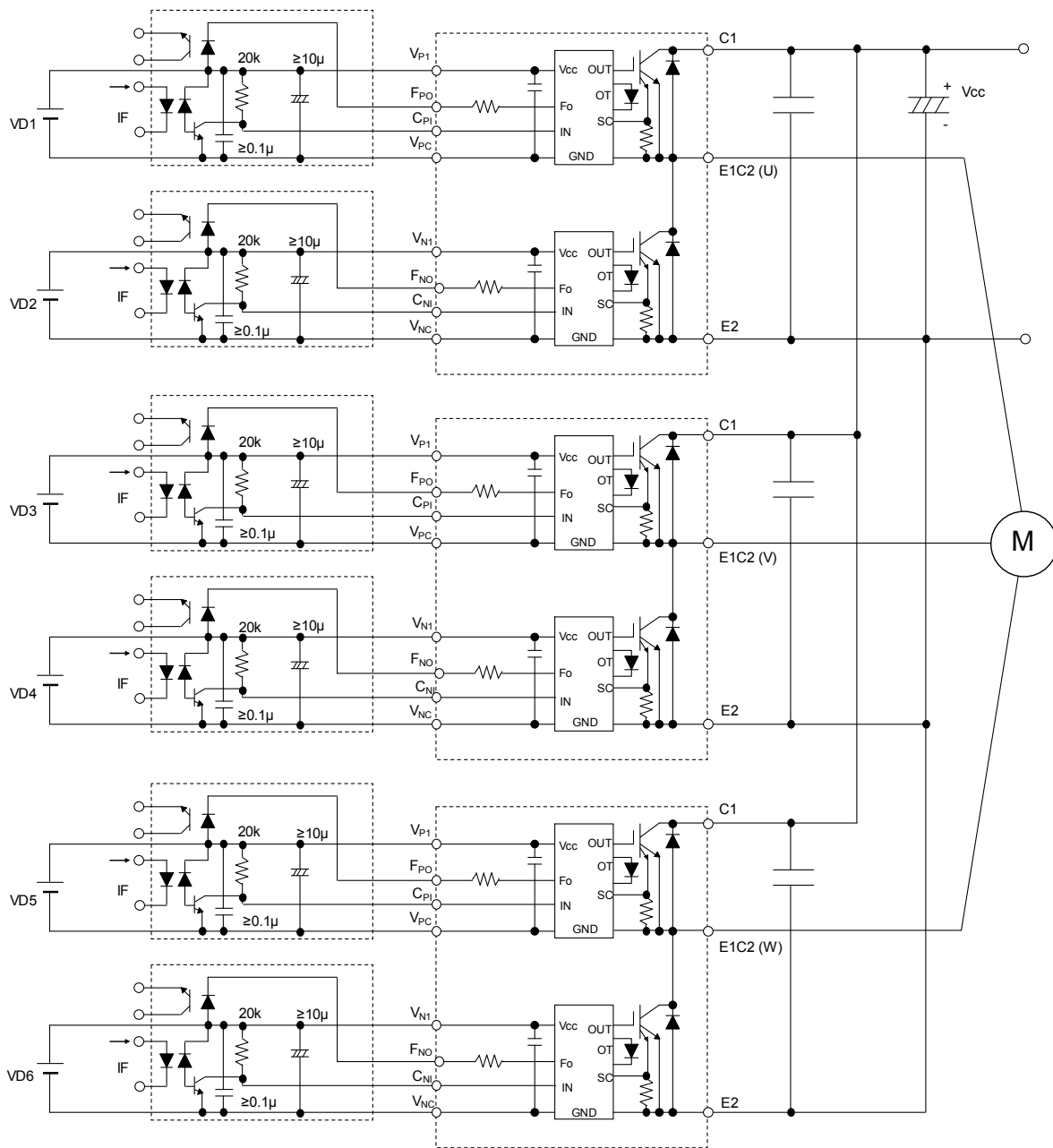


Fig. 8 Application Example Circuit

NOTES FOR STABLE AND SAFE OPERATION ;

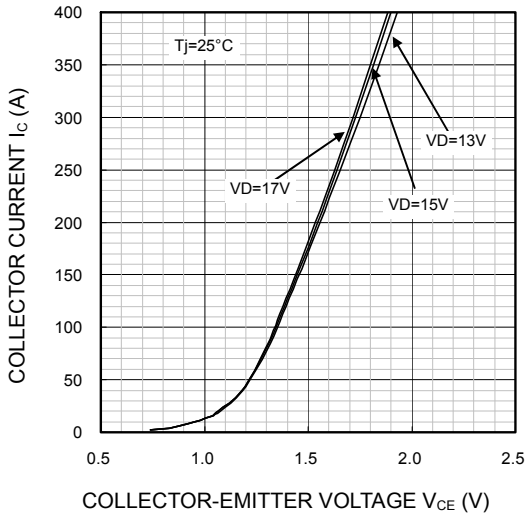
- Design the PCB pattern to minimize wiring length between opto-coupler and IPM's input terminal, and also to minimize the stray capacity between the input and output wirings of opto-coupler.
- Connect low impedance capacitor between the Vcc and GND terminal of each fast switching opto-coupler.
- Fast switching opto-couplers: $t_{PLH}, t_{PHL} \leq 0.8\mu s$, Use High CMR type.
- Slow switching opto-coupler: CTR > 100%
- Use 6 isolated control power supplies (V_D). Also, care should be taken to minimize the instantaneous voltage charge of the power supply.
- Make inductance of DC bus line as small as possible, and minimize surge voltage using snubber capacitor between C1 and E2 terminal.

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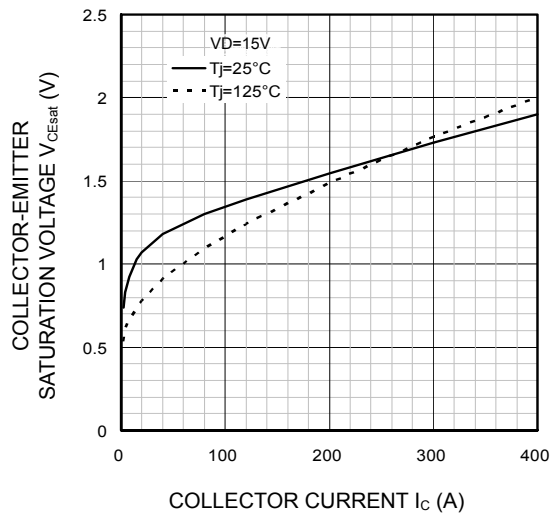
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PERFORMANCE CURVES

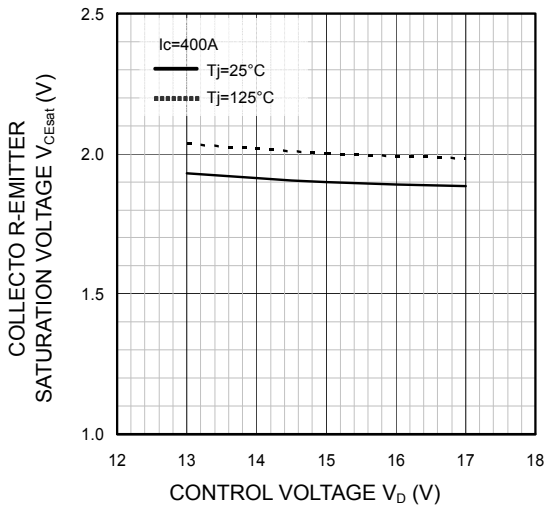
OUTPUT CHARACTERISTICS (TYPICAL)



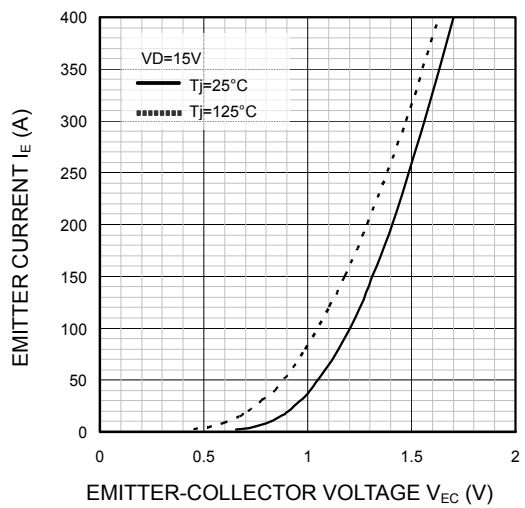
COLLECTOR-EMITTER SATURATION VOLTAGE (VS. I_c) CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE (VS. V_D) CHARACTERISTICS (TYPICAL)



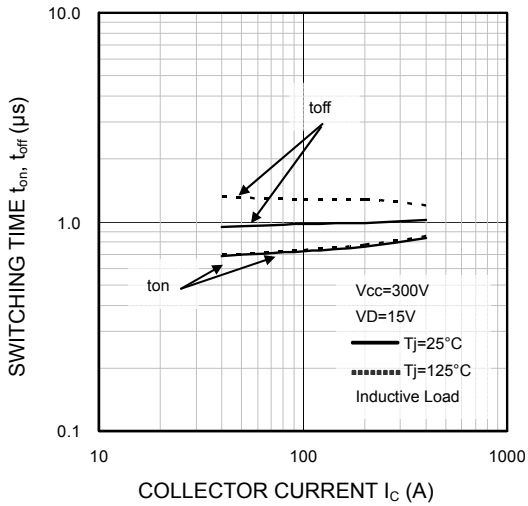
FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



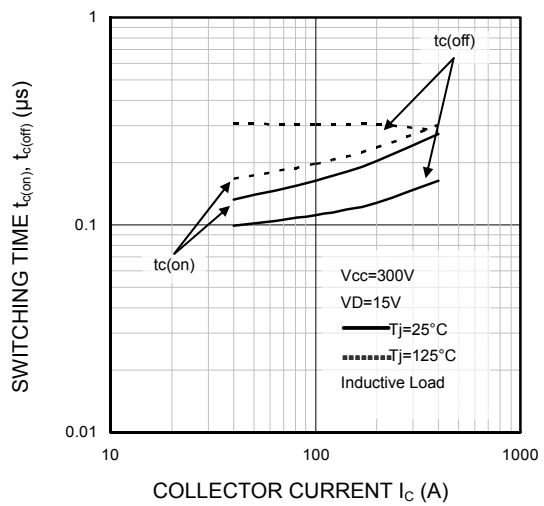
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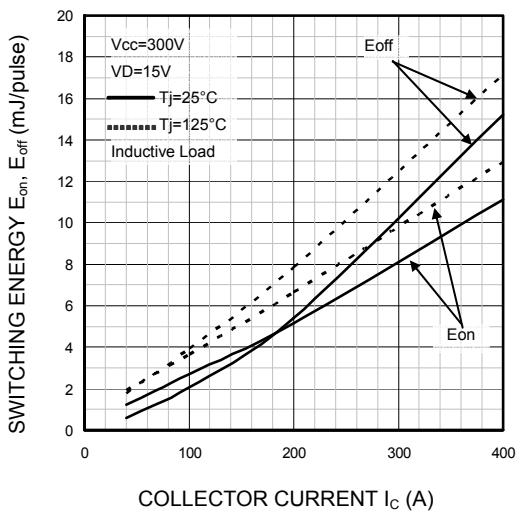
SWITCHING TIME (t_{on} , t_{off}) CHARACTERISTICS (TYPICAL)



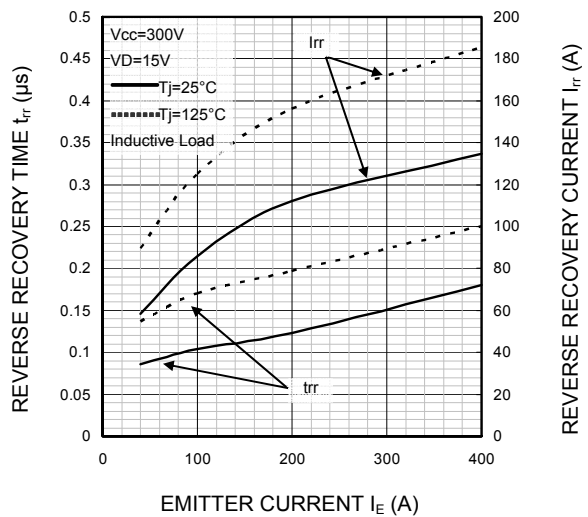
SWITCHING TIME ($t_{c(on)}$, $t_{c(off)}$) CHARACTERISTICS (TYPICAL)



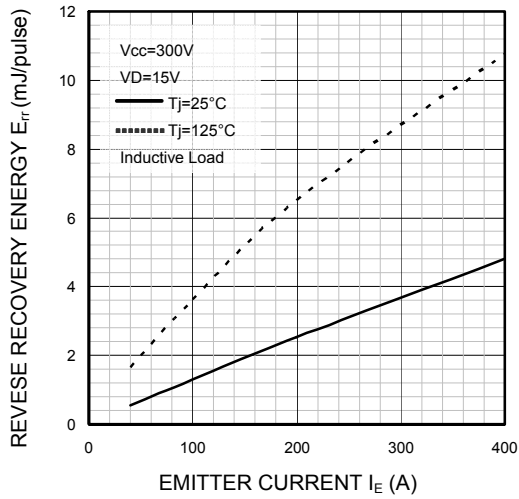
SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



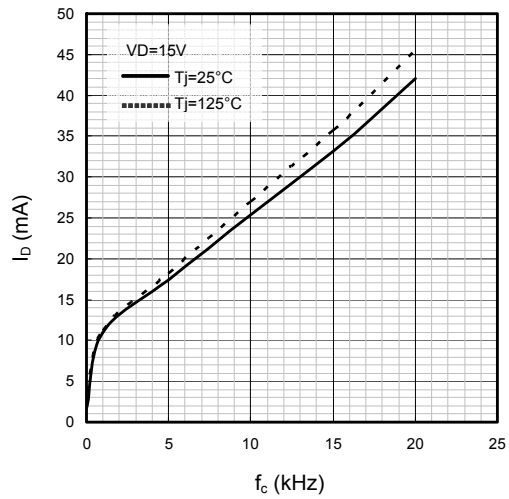
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



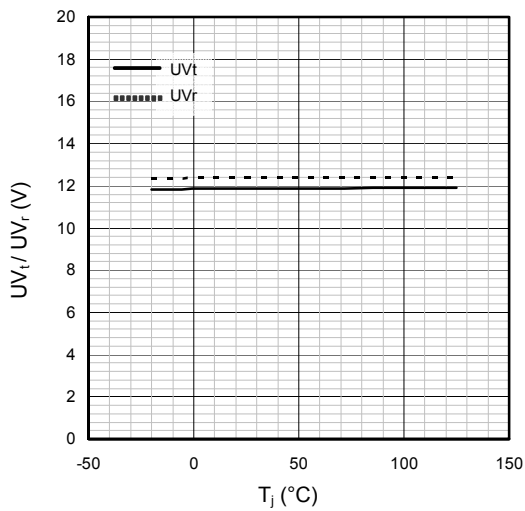
**FREE WHEELING DIODE
REVERSE RECOVERY ENERGY CHARACTERISTICS
(TYPICAL)**



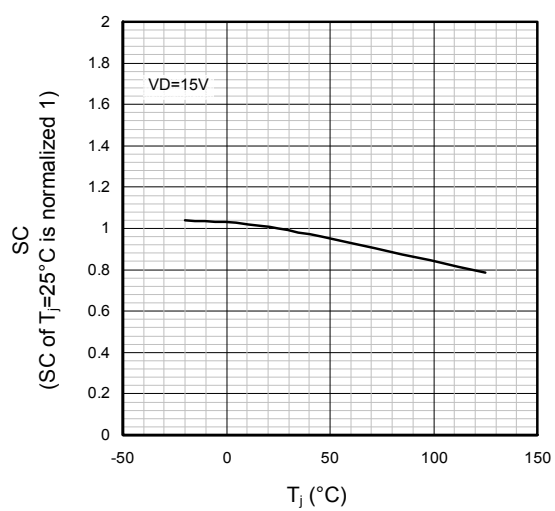
**I_D VS. f_c CHARACTERISTICS
(TYPICAL)**



**UV TRIP LEVEL VS. T_j CHARACTERISTICS
(TYPICAL)**



**SC TRIP LEVEL VS. T_j CHARACTERISTICS
(TYPICAL)**



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