

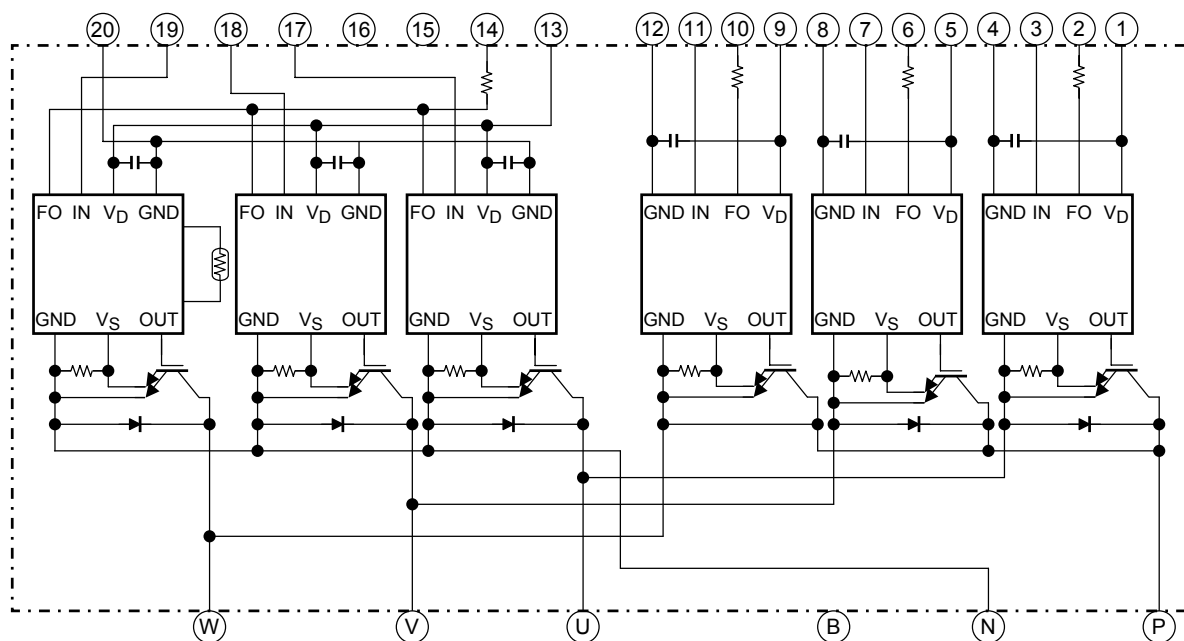
# MIG50Q6CSB1X (1200V/50A 6in1)

High Power Switching Applications

Motor Control Applications

- Integrates inverter and control circuits (IGBT drive units, protection units for short-circuit current, over current, under voltage and over temperature) in one package.
- The electrodes are isolated from case.
- $V_{CE(sat)} = 2.2 \text{ V (typ.)}$
- UL recognized: File No. E87989

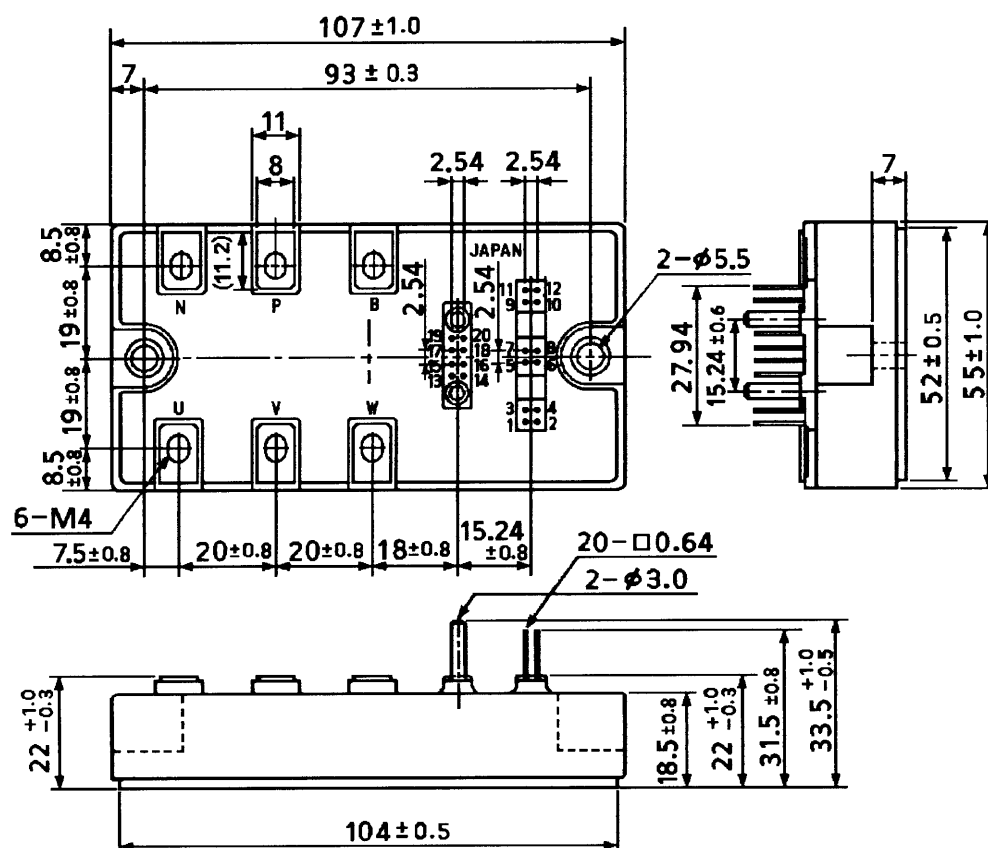
## Equivalent Circuit



|              |              |            |            |              |               |            |
|--------------|--------------|------------|------------|--------------|---------------|------------|
| 1. $V_D$ (U) | 2. FO (U)    | 3. IN (U)  | 4. GND (U) | 5. $V_D$ (V) | 6. FO (V)     | 7. IN (V)  |
| 8. GND (V)   | 9. $V_D$ (W) | 10. FO (W) | 11. IN (W) | 12. GND (W)  | 13. $V_D$ (L) | 14. FO (L) |
| 15. Open     | 16. Open     | 17. IN (X) | 18. IN (Y) | 19. IN (Z)   | 20. GND (L)   |            |

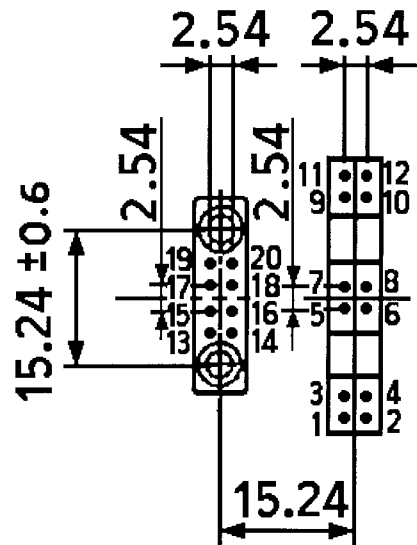
## Package Dimensions: TOSHIBA 2-108G1D

Unit: mm



- |               |             |              |            |              |             |
|---------------|-------------|--------------|------------|--------------|-------------|
| 1. $V_D$ (U)  | 2. FO (U)   | 3. IN (U)    | 4. GND (U) | 5. $V_D$ (V) | 6. FO (V)   |
| 7. IN (V)     | 8. GND (V)  | 9. $V_D$ (W) | 10. FO (W) | 11. IN (W)   | 12. GND (W) |
| 13. $V_D$ (L) | 14. FO (L)  | 15. Open     | 16. Open   | 17. IN (X)   | 18. IN (Y)  |
| 19. IN (Z)    | 20. GND (L) |              |            |              |             |

## Unit: mm



- |     |                    |     |         |     |                    |     |         |     |                    |     |         |
|-----|--------------------|-----|---------|-----|--------------------|-----|---------|-----|--------------------|-----|---------|
| 1.  | V <sub>D</sub> (U) | 2.  | FO (U)  | 3.  | IN (U)             | 4.  | GND (U) | 5.  | V <sub>D</sub> (V) | 6.  | FO (V)  |
| 7.  | IN (V)             | 8.  | GND (V) | 9.  | V <sub>D</sub> (W) | 10. | FO (W)  | 11. | IN (W)             | 12. | GND (W) |
| 13. | V <sub>D</sub> (L) | 14. | FO (L)  | 15. | Open               | 16. | Open    | 17. | IN (X)             | 18. | IN (Y)  |
| 19. | IN (Z)             | 20. | GND (L) |     |                    |     |         |     |                    |     |         |

Maximum Ratings (unless otherwise specified,  $T_j = 25^\circ\text{C}$ )

| Stage    | Characteristic              | Condition                     | Symbol    | Ratings    | Unit             |
|----------|-----------------------------|-------------------------------|-----------|------------|------------------|
| Inverter | Supply voltage              | P-N power terminal            | $V_{CC}$  | 900        | V                |
|          | Collector-emitter voltage   | —                             | $V_{CES}$ | 1200       | V                |
|          | Collector current           | $T_c = 25^\circ\text{C}$ , DC | $I_C$     | 50         | A                |
|          | Forward current             | $T_c = 25^\circ\text{C}$ , DC | $I_F$     | 50         | A                |
|          | Collector power dissipation | $T_c = 25^\circ\text{C}$      | $P_C$     | 580        | W                |
|          | Junction temperature        | —                             | $T_j$     | 150        | $^\circ\text{C}$ |
| Control  | Control supply voltage      | $V_D$ -GND terminal           | $V_D$     | 20         | V                |
|          | Input voltage               | IN-GND terminal               | $V_{IN}$  | 20         | V                |
|          | Fault output voltage        | FO-GND terminal               | $V_{FO}$  | 20         | V                |
|          | Fault output current        | FO sink current               | $I_{FO}$  | 14         | mA               |
| Module   | Operating temperature       | —                             | $T_c$     | -20 to 100 | $^\circ\text{C}$ |
|          | Storage temperature range   | —                             | $T_{stg}$ | -40 to 125 | $^\circ\text{C}$ |
|          | Isolation voltage           | AC 1 minute                   | $V_{ISO}$ | 2500       | V                |
|          | Screw torque (terminal)     | M4                            | —         | 2          | N·m              |
|          | Screw torque (mounting)     | M5                            | —         | 3          | N·m              |

## Electrical Characteristics

## 1. Inverter Stage

| Characteristic                       | Symbol            | Test Condition                                                                                                                                                                        |                           | Min | Typ. | Max | Unit          |
|--------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----|------|-----|---------------|
| Collector cut-off current            | $I_{CEX}$         | $V_{CE} = 1200\text{ V}$                                                                                                                                                              | $T_j = 25^\circ\text{C}$  | —   | —    | 1   | mA            |
|                                      |                   |                                                                                                                                                                                       | $T_j = 125^\circ\text{C}$ | —   | —    | 10  |               |
| Collector-emitter saturation voltage | $V_{CE(sat)}$     | $V_D = 15\text{ V}$ ,<br>$I_C = 50\text{ A}$ ,<br>$V_{IN} = 15\text{ V} \leftrightarrow 0\text{ V}$                                                                                   | $T_j = 25^\circ\text{C}$  | —   | 2.2  | 2.6 | V             |
|                                      |                   |                                                                                                                                                                                       | $T_j = 125^\circ\text{C}$ | —   | —    | 3.0 |               |
| Forward voltage                      | $V_F$             | $I_F = 50\text{ A}$ , $T_j = 25^\circ\text{C}$                                                                                                                                        |                           | —   | 2.4  | 2.8 | V             |
| Switching time                       | $t_{on}$          | $V_{CC} = 600\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$V_D = 15\text{ V}$ , $V_{IN} = 15\text{ V} \leftrightarrow 0\text{ V}$ ,<br>$T_j = 25^\circ\text{C}$ , Inductive load<br>(Note 1) |                           | —   | 2.0  | 3.0 | $\mu\text{s}$ |
|                                      | $t_c(\text{on})$  |                                                                                                                                                                                       |                           | —   | 0.3  | —   |               |
|                                      | $t_{rr}$          |                                                                                                                                                                                       |                           | —   | 0.3  | —   |               |
|                                      | $t_{off}$         |                                                                                                                                                                                       |                           | —   | 1.5  | 2.5 |               |
|                                      | $t_c(\text{off})$ |                                                                                                                                                                                       |                           | —   | 0.4  | —   |               |

Note 1: Switching time test circuit and timing chart.

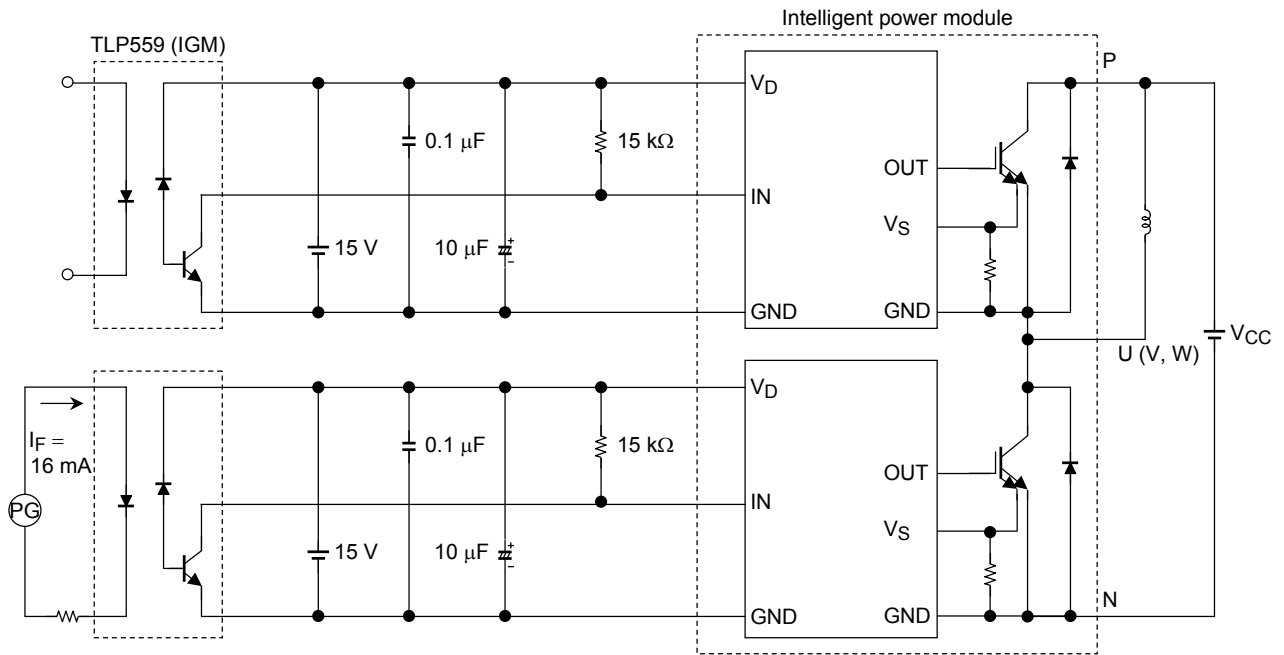
## 2. Control Stage ( $T_j = 25^\circ\text{C}$ )

| Characteristic                              |             | Symbol         | Test Condition                                  | Min  | Typ. | Max  | Unit             |
|---------------------------------------------|-------------|----------------|-------------------------------------------------|------|------|------|------------------|
| Control circuit current                     | High side   | $I_D (H)$      | $V_D = 15\text{ V}$                             | —    | 13   | 17   | mA               |
|                                             | Low side    | $I_D (L)$      |                                                 | —    | 39   | 51   |                  |
| Input-on signal voltage                     |             | $V_{IN} (on)$  | $V_D = 15\text{ V}$                             | 1.4  | 1.6  | 1.8  | V                |
| Input-off signal voltage                    |             | $V_{IN} (off)$ | $V_D = 15\text{ V}$                             | 2.2  | 2.5  | 2.8  | V                |
| Fault output current                        | Protection  | $I_{FO} (on)$  | $V_D = 15\text{ V}$                             | 8    | 10   | 12   | mA               |
|                                             | Normal      | $I_{FO} (off)$ |                                                 | —    | —    | 0.1  |                  |
| Over current protection trip level          | Inverter    | OC             | $V_D = 15\text{ V}, T_j \leq 125^\circ\text{C}$ | 80   | —    | —    | A                |
| Short-circuit current protection trip level | Inverter    | SC             | $V_D = 15\text{ V}, T_j \leq 125^\circ\text{C}$ | 80   | —    | —    | A                |
| Over current cut-off time                   |             | $t_{off} (OC)$ | $V_D = 15\text{ V}$                             | —    | 5    | —    | $\mu\text{s}$    |
| Over temperature protection                 | Trip level  | OT             | Case temperature                                | 110  | 118  | 125  | $^\circ\text{C}$ |
|                                             | Reset level | OTr            |                                                 | —    | 98   | —    |                  |
| Control supply under voltage protection     | Trip level  | UV             | —                                               | 11.0 | 12.0 | 12.5 | V                |
|                                             | Reset level | UVr            |                                                 | 12.0 | 12.5 | 13.0 |                  |
| Fault output pulse width                    |             | $t_{FO}$       | $V_D = 15\text{ V}$                             | 1    | 2    | 3    | ms               |

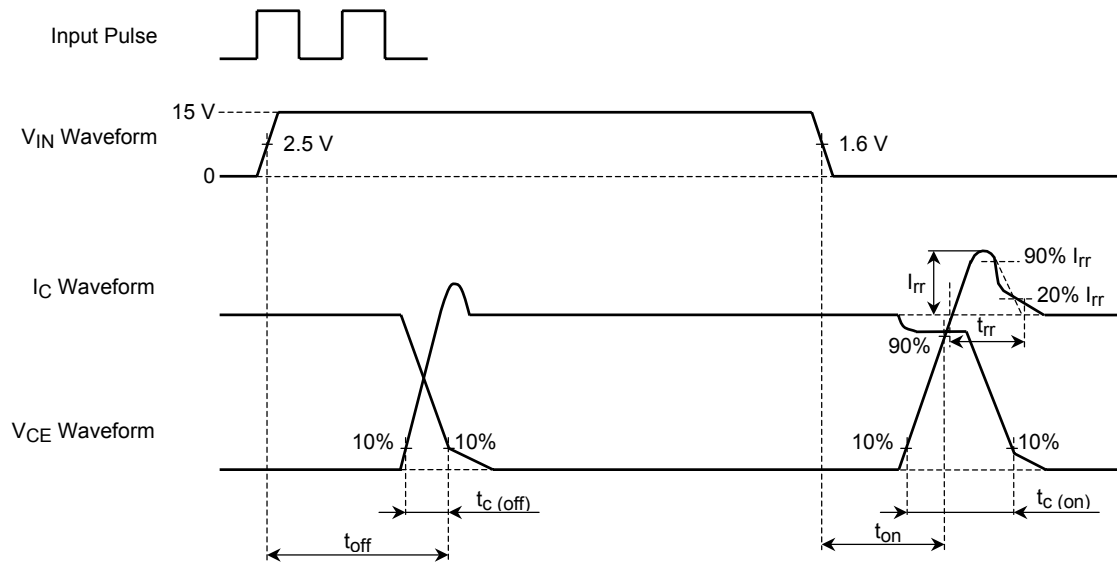
## 3. Thermal Resistance ( $T_c = 25^\circ\text{C}$ )

| Characteristic                      | Symbol         | Test Condition      | Min | Typ.  | Max   | Unit               |
|-------------------------------------|----------------|---------------------|-----|-------|-------|--------------------|
| Junction to case thermal resistance | $R_{th} (j-c)$ | Inverter IGBT stage | —   | —     | 0.215 | $^\circ\text{C/W}$ |
|                                     |                | Inverter FRD stage  | —   | —     | 0.464 |                    |
| Case to fin thermal resistance      | $R_{th} (c-f)$ | Compound is applied | —   | 0.017 | —     | $^\circ\text{C/W}$ |

## Switching Time Test Circuit



## Timing Chart

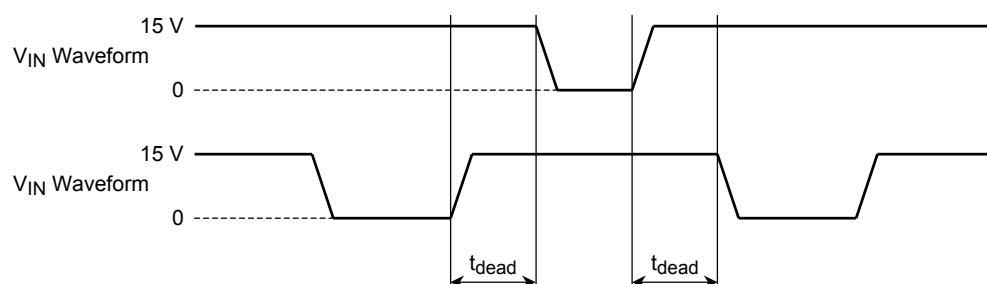


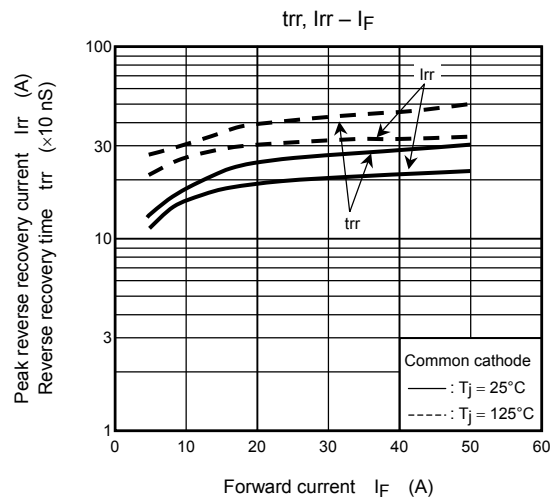
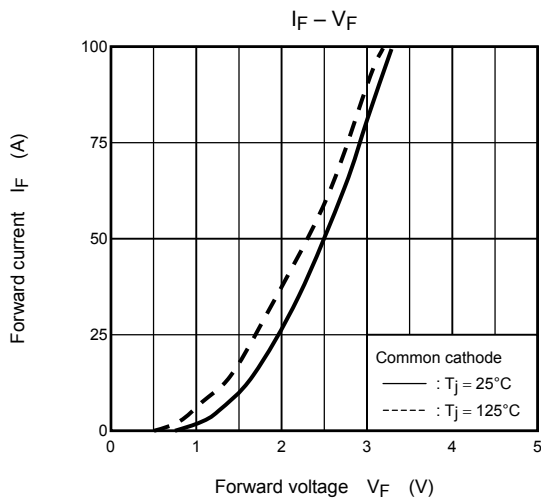
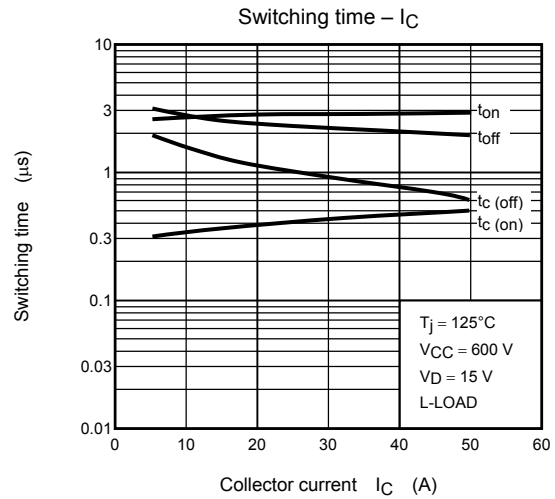
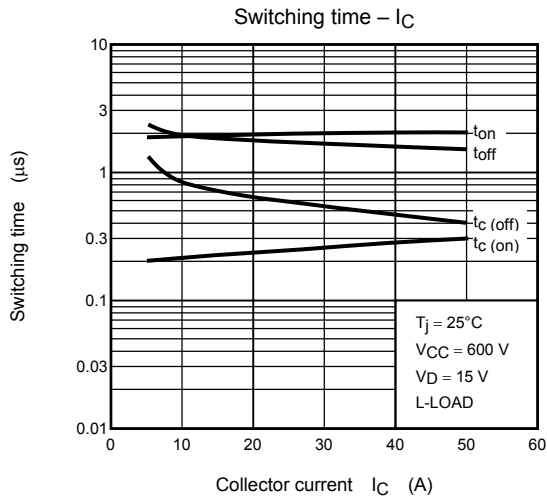
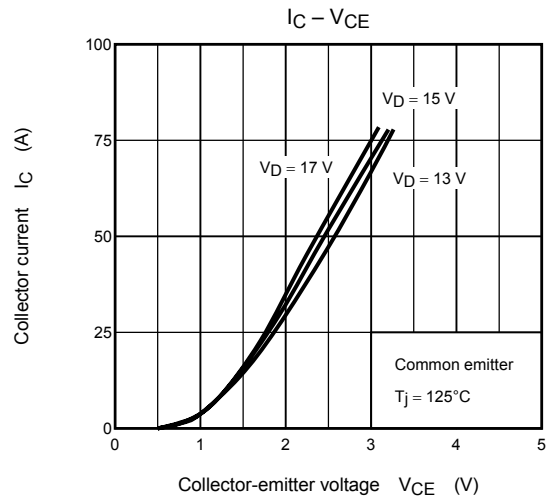
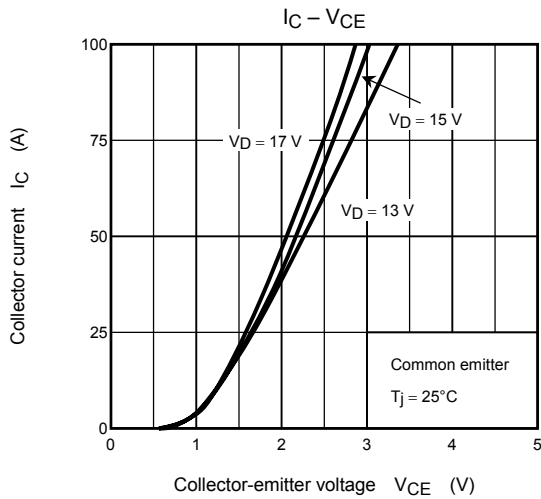
## 4. Recommended conditions for application

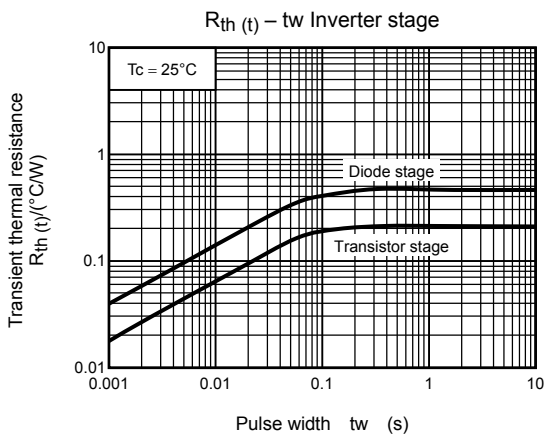
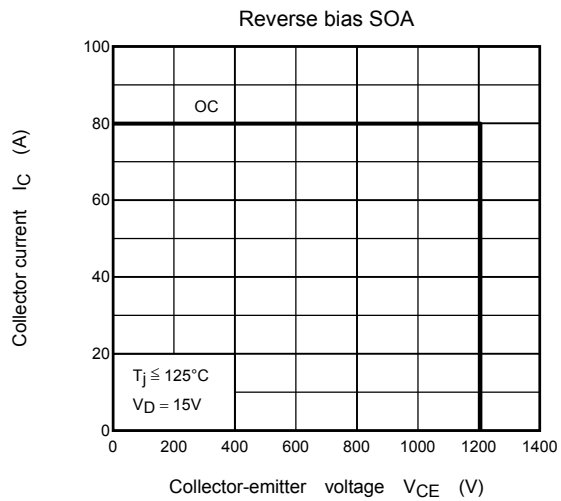
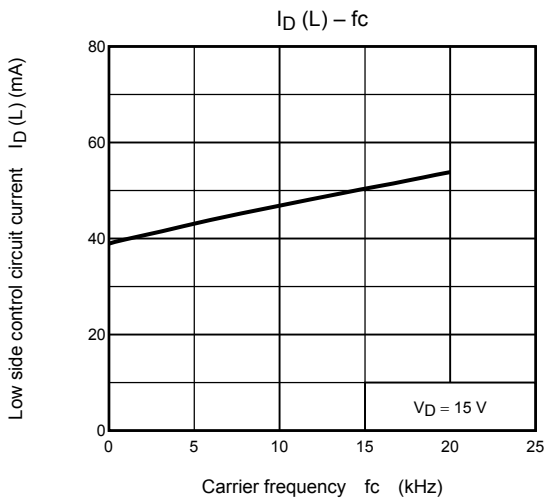
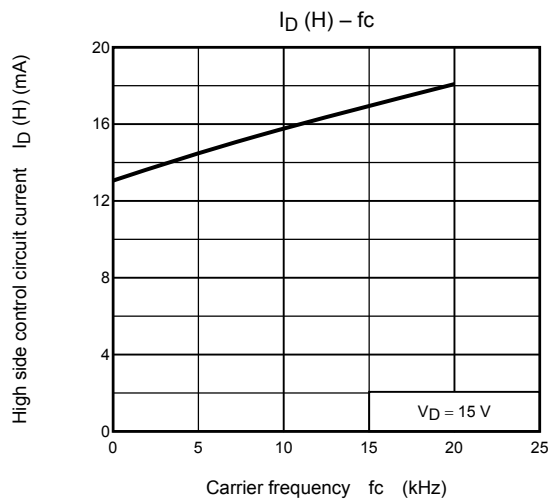
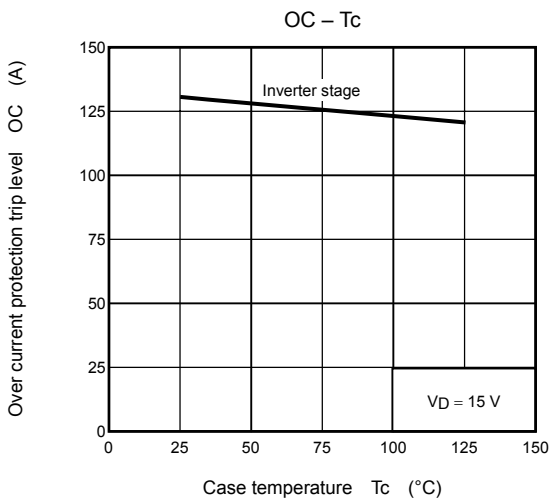
| Characteristic         | Symbol     | Test Condition                                       | Min  | Typ. | Max  | Unit    |
|------------------------|------------|------------------------------------------------------|------|------|------|---------|
| Supply voltage         | $V_{CC}$   | P-N Power terminal                                   | —    | 600  | 800  | V       |
| Control supply voltage | $V_D$      | $V_D$ -GND Signal terminal                           | 13.5 | 15   | 16.5 | V       |
| Carrier frequency      | $f_c$      | PWM Control                                          | —    | —    | 20   | kHz     |
| Dead time              | $t_{dead}$ | Switching time test circuit<br>(see page.6) (Note 2) | 3    | —    | —    | $\mu s$ |

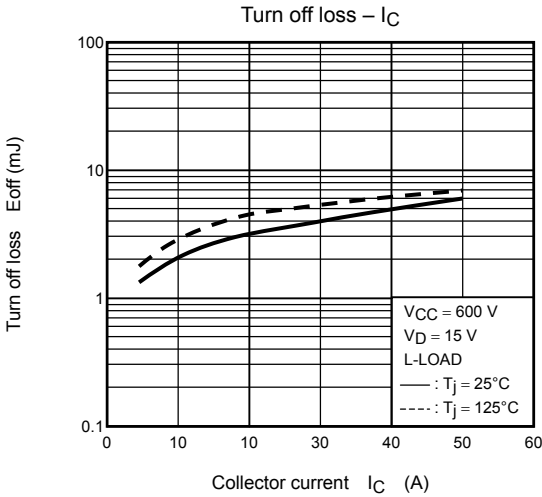
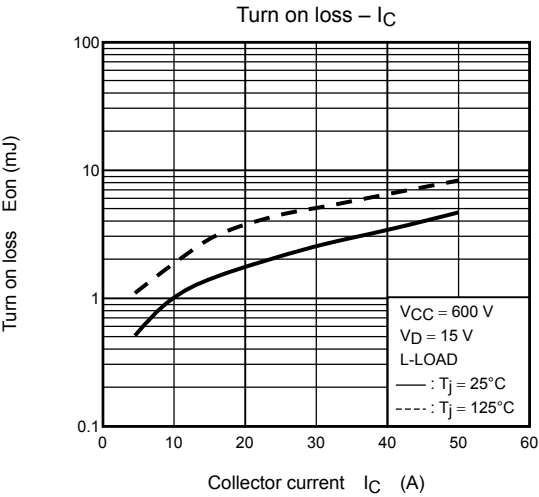
Note 2: The table lists Dead time requirements for the module input, excluding photocoupler delays. When specifying dead time requirements for the photocoupler input, please add photocoupler delays to the dead time given above.

## Dead Time Timing Chart









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