

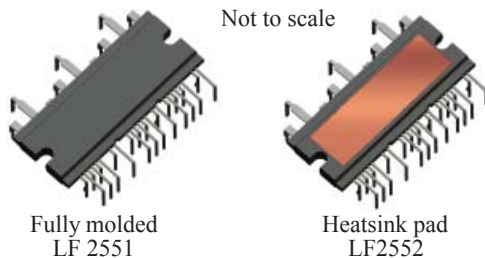
## High Voltage, High Current 3-Phase Motor Drivers

### Features and Benefits

- Each half-bridge circuit consists of a pre-driver circuit that is completely independent from the others
- 10 to 30 A continuous output IPM in a small-footprint package
- Protection against simultaneous high- and low-side turning on
- Bootstrap diodes with series resistors for suppressing inrush current are incorporated
- CMOS compatible input (3.3 to 5 V)
- Designed to minimize simultaneous current through both high- and low-side IGBTs by optimizing gate drive resistors
- Integrated Fast Recovery Diode (FRD) as freewheeling diode for each IGBT
- UVLO protection with auto restart
- Thermal shutdown (TSD) with auto restart
- Fault ( $\overline{FO}$  indicator) signal output at protection activation: UVLO (low side only), OCP, STP, and TSD
- Proprietary power DIP package
- UL Recognized Component (File No.: E118037)



### Packages: Power DIP



### Description

The SCM1240M inverter power module (IPM) devices provide a robust, highly-integrated solution for optimally controlling 3-phase motor power inverter systems and variable speed control systems used in energy-conserving designs to drive motors of residential and commercial appliances. These ICs take 85 to 253 VAC input voltage, and 10 to 30 A (continuous) output current. They can withstand voltages of up to 600 V (IGBT breakdown voltage).

The high current SCM1240M employs a new, small-footprint proprietary DIP package. The IC itself consists of all of the necessary power elements (six IGBTs), pre-drive ICs (three), and freewheeling diodes (six), needed to configure the main circuit of an inverter, as well as a bootstrap circuit (three bootstrap diodes and three boot resistors) as a high-side drive power supply. This enables the main circuit of the inverter to be configured with fewer external components than traditional designs.

Applications include residential white goods (home appliances) and commercial appliance motor control, such as:

- Air conditioner compressor motor
- Air conditioner fan motor
- Refrigerator compressor motor
- Washing machine main motor

### Functional Block Diagram

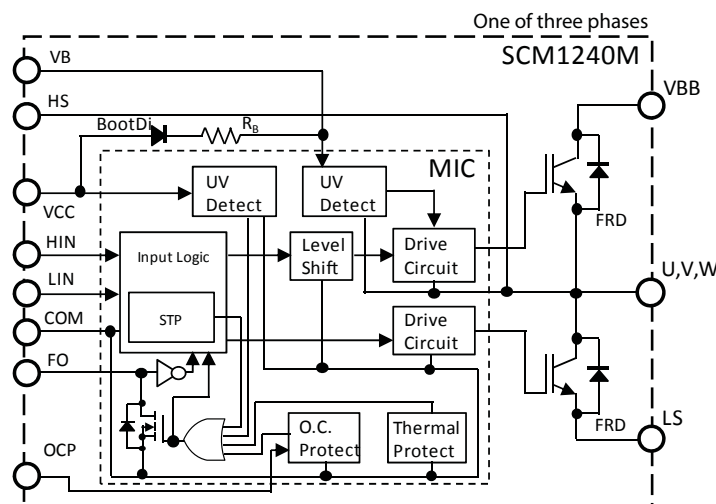


Figure 1. Diagram of one of three phases in the device.

# SCM1240M

## High Voltage, High Current 3-Phase Motor Drivers

### Selection Guide

| Part Number | Package      | Packing            | IGBT Breakdown Voltage, $V_{CES(min)}$ (V) | IGBT Saturation Voltage, $V_{CE(sat)}(typ)$ (V) | Output Current               |                           |
|-------------|--------------|--------------------|--------------------------------------------|-------------------------------------------------|------------------------------|---------------------------|
|             |              |                    |                                            |                                                 | Continuous, $I_{O(max)}$ (A) | Pulsed, $I_{OP(max)}$ (A) |
| SCM1241M    | Fully Molded | 10 pieces per tube | 600                                        | 1.7                                             | 10                           | 20                        |
| SCM1243MF   | Heatsink Pad | 10 pieces per tube | 600                                        | 1.7                                             | 15                           | 30                        |
| SCM1245MF   | Heatsink Pad | 10 pieces per tube | 600                                        | 1.7                                             | 20                           | 30                        |
| SCM1246MF   | Heatsink Pad | 10 pieces per tube | 600                                        | 1.7                                             | 30                           | 45                        |

### Absolute Maximum Ratings, valid at $T_A = 25^{\circ}\text{C}$

| Characteristic                          | Symbol                 | Remarks                                                              |                            | Rating     | Units            |
|-----------------------------------------|------------------------|----------------------------------------------------------------------|----------------------------|------------|------------------|
| Supply Voltage                          | V <sub>DC</sub>        | Between VBB and LS1, LS2, and LS3                                    |                            | 450        | V                |
| Supply Voltage (Surge)                  | V <sub>DC(surge)</sub> | Between VBB and LS1, LS2, and LS3                                    |                            | 500        | V                |
| IGBT Breakdown Voltage                  | V <sub>CES</sub>       | V <sub>CC</sub> = 15 V, I <sub>C</sub> = 1 mA, V <sub>IN</sub> = 0 V |                            | 600        | V                |
| Logic Supply Voltage                    | V <sub>CC</sub>        | Between VCC and COM                                                  |                            | 20         | V                |
| Boot-strap Voltage                      | V <sub>BS</sub>        | Between VB and HS (U,V,W)                                            |                            | 20         | V                |
| Output Current, Continuous              | I <sub>O</sub>         | SCM1241M                                                             | T <sub>Case</sub> = 25°C   | 10         | Adc              |
|                                         |                        | SCM1243MF                                                            | T <sub>Case</sub> = 25°C   | 15         | Adc              |
|                                         |                        | SCM1245MF                                                            | T <sub>Case</sub> = 25°C   | 20         | Adc              |
|                                         |                        | SCM1246MF                                                            | T <sub>Case</sub> = 25°C   | 30         | Adc              |
| Output Current, Pulsed                  | I <sub>OP</sub>        | SCM1241M                                                             | Pulse Width ≤ 1 ms         | 20         | A                |
|                                         |                        | SCM1243MF                                                            | Pulse Width ≤ 1 ms         | 30         | A                |
|                                         |                        | SCM1245MF                                                            | Pulse Width ≤ 1 ms         | 30         | A                |
|                                         |                        | SCM1246MF                                                            | Pulse Width ≤ 1 ms         | 45         | A                |
| Input Voltage                           | V <sub>IN</sub>        | HIN, LIN, and OCP                                                    |                            | −0.5 to 7  | V                |
| $\overline{\text{FO}}$ Terminal Voltage | V <sub>FO</sub>        | Between $\overline{\text{FO}}$ and COM                               |                            | 7          | V                |
| Thermal Resistance, Junction-to-Case    | R <sub>(j-c)Q</sub>    | SCM1241M                                                             | 1 element operation (IGBT) | 6.0        | °C/W             |
|                                         |                        | SCM1243MF<br>SCM1245MF<br>SCM1246MF                                  |                            | 3.0        | °C/W             |
|                                         | R <sub>(j-c)F</sub>    | SCM1241M                                                             | 1 element operation (FRD)  | 6.5        | °C/W             |
|                                         |                        | SCM1243MF<br>SCM1245MF<br>SCM1246M                                   |                            | 4.0        | °C/W             |
| Case Operating Temperature              | T <sub>OPC</sub>       |                                                                      |                            | −20 to 100 | °C               |
| Junction Temperature (IGBT)             | T <sub>J</sub>         |                                                                      |                            | 150        | °C               |
| Storage Temperature                     | T <sub>stg</sub>       |                                                                      |                            | −40 to 150 | °C               |
| Isolation Voltage                       | V <sub>iso</sub>       | Between exposed thermal pad and each pin; 1 minute, ac               |                            | 2000       | V <sub>rms</sub> |

All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and an ambient temperature,  $T_A$ , of  $25^{\circ}\text{C}$ , unless otherwise stated.

# SCM1240M *High Voltage, High Current 3-Phase Motor Drivers*

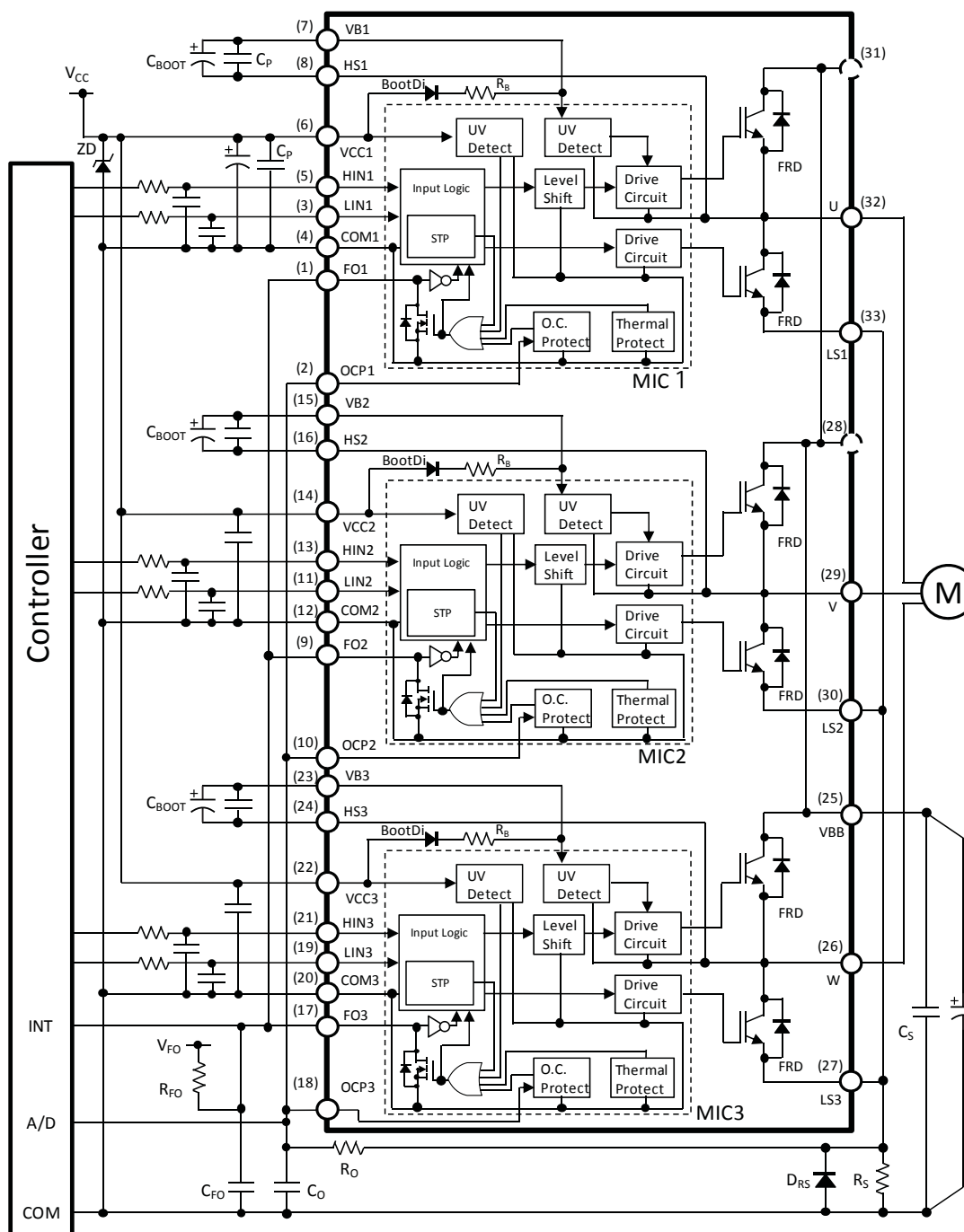
## Recommended Operating Conditions

| Characteristic                   | Symbol                  | Remarks             |                           | Min. | Typ. | Max. | Units |
|----------------------------------|-------------------------|---------------------|---------------------------|------|------|------|-------|
| Main Supply Voltage              | V <sub>DC</sub>         | Between VBB and LS  |                           | –    | 300  | 400  | V     |
| Logic Supply Voltage             | V <sub>CC</sub>         | Between VCC and COM |                           | 13.5 | –    | 16.5 | V     |
| Logic Supply Voltage             | V <sub>BS</sub>         | Between VB and HS   |                           | 13.5 | –    | 16.5 | V     |
| Minimum Input Pulse Width        | t <sub>INmin(on)</sub>  | On pulse            |                           | 0.5  | –    | –    | μs    |
|                                  | t <sub>INmin(off)</sub> | Off pulse           |                           | 0.5  | –    | –    | μs    |
| Dead Time*                       | t <sub>dead</sub>       |                     |                           | 1.0  | –    | –    | μs    |
| $\overline{FO}$ Pull-up Resistor | R <sub>FO</sub>         |                     |                           | 1    | –    | 22   | kΩ    |
| $\overline{FO}$ Pull-up Voltage  | V <sub>FO</sub>         |                     |                           | 3.0  | –    | 5.5  | V     |
| Bootstrap Capacitor              | C <sub>BOOT</sub>       |                     |                           | 10   | –    | 220  | μF    |
| Shunt Resistor                   | R <sub>S</sub>          | SCM1241M            | For I <sub>P</sub> ≤ 20 A | 27   | –    | –    | mΩ    |
|                                  |                         | SCM1243MF           | For I <sub>P</sub> ≤ 30 A | 15   | –    | –    | mΩ    |
|                                  |                         | SCM1245MF           |                           |      |      |      |       |
|                                  |                         | SCM1246MF           |                           |      |      |      |       |
| RC Filter Resistor               | R <sub>O</sub>          |                     |                           | –    | –    | 100  | Ω     |
| RC Filter Capacitor              | C <sub>O</sub>          |                     |                           | –    | –    | 2200 | pF    |
| PWM Carrier Frequency            | f <sub>C</sub>          |                     |                           | –    | –    | 20   | kHz   |
| Junction Temperature             | T <sub>J</sub>          |                     |                           | –    | –    | 125  | °C    |

\*Dead Time must be controlled from an external source.

## Typical Application Diagram

Typical application utilizing one shunt resistor, RS



See application notes on next page.

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# SCM1240M *High Voltage, High Current 3-Phase Motor Drivers*

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## Notes for Typical Application Diagram

- To use the OCP circuit shown in the Typical Application drawing, an external shunt resistor, RS, is needed. The RS value depends on how many low-side IGBTs turn on simultaneously.
  - To avoid malfunction, the wiring between the LS and COM pins should be as short as possible.
  - To prevent surge destruction, put a 0.01 to 1  $\mu$ F snubber capacitor, CS, in parallel with the electrolytic capacitor.
  - To prevent surge destruction, put a 18 to 20 V Zener diode between the VCC and COM pins.
  - To prevent surge malfunction, put a 0.01 to 0.1  $\mu$ F ceramic capacitor between the VCC and COM pins and the VB and HS pins.
  - To add an external low pass filter, place RO and CO between the A to D pin of the application controller and shunt resistor RS, ensuring that the time constant of this low pass filter is less than 0.2  $\mu$ s. The internal OCP circuit has a 1.5  $\mu$ s (min) filtering delay.
- However, the low pass filter causes an additional delay to detecting an overcurrent condition of the SCM1240M, and if the total delay exceeds 1.7  $\mu$ s, permanent damage to the SCM1240M may result.
- To suppress noise, connect a resistor, RF, and capacitor, CF, to the  $\overline{\text{FOx}}$  pins. Also, when an overcurrent condition is detected, the  $\overline{\text{FOx}}$  pin goes low for 25  $\mu$ s (typ) as an active low fault flag, and then returns up to its normal state. It is recommended to connect the  $\overline{\text{FOx}}$  pin directly to an interrupt pin of the external controller, to ensure the 25  $\mu$ s interval is detected.
  - To provide the best thermal shutdown protection (TSD), it is strongly recommended that the three  $\overline{\text{FOx}}$  pins be tied together. In this way an overtemperature event (internal temperature rise above 150°C) in any of the three phases will cause all three phases to shut down. If the  $\overline{\text{FOx}}$  pins are not tied together, but are independently pulled up to +5 V, the TSD function for each phase shuts down only that phase.

ELECTRICAL CHARACTERISTICS, valid at  $T_A=25^{\circ}\text{C}$ , unless otherwise noted

| Characteristics                                                 | Symbol        | Conditions                                                                     | Min  | Typ  | Max  | Units              |
|-----------------------------------------------------------------|---------------|--------------------------------------------------------------------------------|------|------|------|--------------------|
| Logic Supply Voltage                                            | $V_{CC}$      | Between VCC and COM                                                            | 13.5 | –    | 16.5 | V                  |
| Logic Supply Current                                            | $I_{CC}$      | $V_{CC} = 15\text{ V}$ , 3 phases operating                                    | –    | 3    | –    | mA                 |
| Bootstrap Supply Current                                        | $I_{BS}$      | $V_B - HS = 15\text{ V}$ , one phase operating                                 | –    | 140  | –    | $\mu\text{A}$      |
| Input Voltage                                                   | $V_{IH}$      | $V_{CC} = 15\text{ V}$ , output on                                             | –    | 2.0  | 2.5  | V                  |
|                                                                 | $V_{IL}$      | $V_{CC} = 15\text{ V}$ , output off                                            | 1.0  | 1.5  | –    | V                  |
| Input Voltage Hysteresis                                        | $V_{Ihys}$    | $V_{CC} = 15\text{ V}$                                                         | –    | 0.5  | –    | V                  |
| Input Current                                                   | $I_{IHH}$     | $V_{CC} = 15\text{ V}$ , $V_{IN} = 5\text{ V}$                                 | –    | 230  | 500  | $\mu\text{A}$      |
|                                                                 | $I_{ILH}$     | $V_{CC} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$                                 | –    | –    | 2    | $\mu\text{A}$      |
| Undervoltage Lock Out (High Side)                               | $U_{VHL}$     | $V_{CC} = 15\text{ V}$                                                         | 10.0 | 11.0 | 12.0 | V                  |
|                                                                 | $U_{VHH}$     |                                                                                | 10.5 | 11.5 | 12.5 | V                  |
| Undervoltage Lock Out (Low Side)                                | $U_{VLL}$     | $V_{CC} = 15\text{ V}$                                                         | 10.0 | 11.0 | 12.0 | V                  |
|                                                                 | $U_{VLH}$     |                                                                                | 10.5 | 11.5 | 12.5 | V                  |
| $\overline{\text{FO}}$ Terminal Output Voltage                  | $V_{FOL}$     | $V_{CC} = 15\text{ V}$ , $V_{FO} = 5\text{ V}$ , $R_{FO} = 10\text{ k}\Omega$  | –    | –    | 0.5  | V                  |
|                                                                 | $V_{FOH}$     |                                                                                | 4.8  | –    | –    | V                  |
| Overcurrent Protection Trip Voltage                             | $V_{TRIP}$    | $V_{CC} = 15\text{ V}$                                                         | 0.46 | 0.50 | 0.54 | V                  |
| Overcurrent Protection Hold Time                                | $t_p$         | $V_{CC} = 15\text{ V}$                                                         | 20   | 25   | –    | $\mu\text{s}$      |
| Overtemperature Protection Activation and Releasing Temperature | $T_{DH}$      | $V_{CC} = 15\text{ V}$                                                         | 135  | 150  | 165  | $^{\circ}\text{C}$ |
|                                                                 | $T_{DL}$      |                                                                                | 105  | 120  | 135  | $^{\circ}\text{C}$ |
| Blanking Time                                                   | $t_{blank}$   | $V_{CC} = 15\text{ V}$                                                         | –    | 1.65 | –    | $\mu\text{s}$      |
| IGBT Breakdown Voltage                                          | $V_{CES}$     | $V_{CC} = 15\text{ V}$ , $I_C = 1\text{ mA}$ , $V_{IN} = 0\text{ V}$           | 600  | –    | –    | V                  |
| IGBT Leakage Current                                            | $I_{CES}$     | $V_{CC} = 15\text{ V}$ , $V_{CE} = 600\text{ V}$ , $V_{IN} = 0\text{ V}$       | –    | –    | 1    | mA                 |
| IGBT Saturation Voltage                                         | $V_{CE(sat)}$ | SCM1241M $V_{CC} = 15\text{ V}$ , $I_C = 10\text{ A}$ , $V_{IN} = 5\text{ V}$  | –    | 1.7  | 2.2  | V                  |
|                                                                 |               | SCM1243MF $V_{CC} = 15\text{ V}$ , $I_C = 15\text{ A}$ , $V_{IN} = 5\text{ V}$ | –    | 1.7  | 2.2  | V                  |
|                                                                 |               | SCM1245MF $V_{CC} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $V_{IN} = 5\text{ V}$ | –    | 1.7  | 2.2  | V                  |
|                                                                 |               | SCM1246MF $V_{CC} = 15\text{ V}$ , $I_C = 30\text{ A}$ , $V_{IN} = 5\text{ V}$ | –    | 1.7  | 2.2  | V                  |
| Diode Forward Voltage                                           | $V_F$         | SCM1241M $V_{CC} = 15\text{ V}$ , $I_F = 10\text{ A}$ , $V_{IN} = 0\text{ V}$  | –    | 1.9  | 2.4  | V                  |
|                                                                 |               | SCM1243MF $V_{CC} = 15\text{ V}$ , $I_F = 15\text{ A}$ , $V_{IN} = 0\text{ V}$ | –    | 1.75 | 2.2  | V                  |
|                                                                 |               | SCM1245MF $V_{CC} = 15\text{ V}$ , $I_F = 20\text{ A}$ , $V_{IN} = 0\text{ V}$ | –    | 1.9  | 2.4  | V                  |
|                                                                 |               | SCM1246MF $V_{CC} = 15\text{ V}$ , $I_F = 30\text{ A}$ , $V_{IN} = 0\text{ V}$ | –    | 1.5  | 2.0  | V                  |
| Diode Recovery Time (Bootstrap)                                 | $t_{tr}$      | $I_F = I_{RECOVERY(PEAK)} = 100\text{ mA}$                                     | –    | 70   | –    | ns                 |
| Diode Leakage Current (Boot Strap)                              | $I_{IB}$      | $V_R = 600\text{ V}$                                                           | –    | –    | 10   | $\mu\text{A}$      |
| Diode Forward Voltage (Boot Strap)                              | $V_{FB}$      | $I_F = 0.15\text{ A}$                                                          | –    | 1.1  | 1.3  | V                  |
| Diode Series Resistor (Boot Strap)                              | $R_B$         |                                                                                | 17.6 | 22.0 | 26.4 | $\Omega$           |

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ELECTRICAL CHARACTERISTICS, valid at  $T_A=25^{\circ}\text{C}$ , unless otherwise noted

| Characteristics          | Symbol        | Conditions |                                                                                                               | Min | Typ | Max | Units |
|--------------------------|---------------|------------|---------------------------------------------------------------------------------------------------------------|-----|-----|-----|-------|
| High Side Switching Time | $t_{dH(on)}$  | SCM1241M   | $V_{DC} = 300\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 10\text{ A}$ , inductive load; HIN = 0→5 V or 5→0 V | —   | 590 | —   | ns    |
|                          | $t_{rH}$      |            |                                                                                                               | —   | 80  | —   | ns    |
|                          | $t_{rrH}$     |            |                                                                                                               | —   | 60  | —   | ns    |
|                          | $t_{dH(off)}$ |            |                                                                                                               | —   | 550 | —   | ns    |
|                          | $t_{fH}$      |            |                                                                                                               | —   | 90  | —   | ns    |
|                          | $t_{dH(on)}$  | SCM1243MF  | $V_{DC} = 300\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 15\text{ A}$ , inductive load; HIN = 0→5 V or 5→0 V | —   | 600 | —   | ns    |
|                          | $t_{rH}$      |            |                                                                                                               | —   | 70  | —   | ns    |
|                          | $t_{rrH}$     |            |                                                                                                               | —   | 70  | —   | ns    |
|                          | $t_{dH(off)}$ |            |                                                                                                               | —   | 620 | —   | ns    |
|                          | $t_{fH}$      |            |                                                                                                               | —   | 60  | —   | ns    |
|                          | $t_{dH(on)}$  | SCM1245MF  | $V_{DC} = 300\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 20\text{ A}$ , inductive load; HIN = 0→5 V or 5→0 V | —   | 695 | —   | ns    |
|                          | $t_{rH}$      |            |                                                                                                               | —   | 95  | —   | ns    |
|                          | $t_{rrH}$     |            |                                                                                                               | —   | 75  | —   | ns    |
|                          | $t_{dH(off)}$ |            |                                                                                                               | —   | 675 | —   | ns    |
|                          | $t_{fH}$      |            |                                                                                                               | —   | 55  | —   | ns    |
|                          | $t_{dH(on)}$  | SCM1246MF  | $V_{DC} = 300\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 30\text{ A}$ , inductive load; HIN = 0→5 V or 5→0 V | —   | 660 | —   | ns    |
|                          | $t_{rH}$      |            |                                                                                                               | —   | 110 | —   | ns    |
|                          | $t_{rrH}$     |            |                                                                                                               | —   | 60  | —   | ns    |
|                          | $t_{dH(off)}$ |            |                                                                                                               | —   | 700 | —   | ns    |
|                          | $t_{fH}$      |            |                                                                                                               | —   | 50  | —   | ns    |

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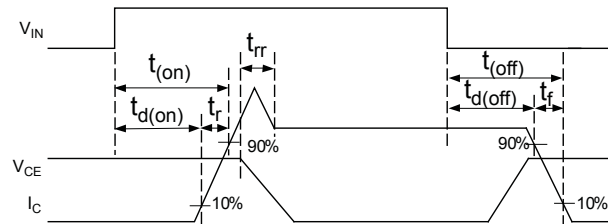
SCM1240M

High Voltage, High Current 3-Phase Motor Drivers

ELECTRICAL CHARACTERISTICS, valid at T<sub>A</sub>=25°C, unless otherwise noted

| Characteristics         | Symbol               | Conditions |                                                                                                              | Min | Typ | Max | Units |
|-------------------------|----------------------|------------|--------------------------------------------------------------------------------------------------------------|-----|-----|-----|-------|
| Low Side Switching Time | t <sub>dL(on)</sub>  | SCM1241M   | V <sub>DC</sub> = 300 V, V <sub>CC</sub> = 15 V, I <sub>C</sub> = 10 A, inductive load; LIN = 0→5 V or 5→0 V | —   | 570 | —   | ns    |
|                         | t <sub>rL</sub>      |            |                                                                                                              | —   | 100 | —   | ns    |
|                         | t <sub>rrL</sub>     |            |                                                                                                              | —   | 70  | —   | ns    |
|                         | t <sub>dL(off)</sub> |            |                                                                                                              | —   | 560 | —   | ns    |
|                         | t <sub>fL</sub>      |            |                                                                                                              | —   | 100 | —   | ns    |
|                         | t <sub>dL(on)</sub>  | SCM1243MF  | V <sub>DC</sub> = 300 V, V <sub>CC</sub> = 15 V, I <sub>C</sub> = 15 A, inductive load; LIN = 0→5 V or 5→0 V | —   | 600 | —   | ns    |
|                         | t <sub>rL</sub>      |            |                                                                                                              | —   | 100 | —   | ns    |
|                         | t <sub>rrL</sub>     |            |                                                                                                              | —   | 80  | —   | ns    |
|                         | t <sub>dL(off)</sub> |            |                                                                                                              | —   | 600 | —   | ns    |
|                         | t <sub>fL</sub>      |            |                                                                                                              | —   | 70  | —   | ns    |
|                         | t <sub>dL(on)</sub>  | SCM1245MF  | V <sub>DC</sub> = 300 V, V <sub>CC</sub> = 15 V, I <sub>C</sub> = 20 A, inductive load; LIN = 0→5 V or 5→0 V | —   | 715 | —   | ns    |
|                         | t <sub>rL</sub>      |            |                                                                                                              | —   | 135 | —   | ns    |
|                         | t <sub>rrL</sub>     |            |                                                                                                              | —   | 115 | —   | ns    |
|                         | t <sub>dL(off)</sub> |            |                                                                                                              | —   | 670 | —   | ns    |
|                         | t <sub>fL</sub>      |            |                                                                                                              | —   | 50  | —   | ns    |
|                         | t <sub>dL(on)</sub>  | SCM1246MF  | V <sub>DC</sub> = 300 V, V <sub>CC</sub> = 15 V, I <sub>C</sub> = 30 A, inductive load; LIN = 0→5 V or 5→0 V | —   | 660 | —   | ns    |
|                         | t <sub>rL</sub>      |            |                                                                                                              | —   | 150 | —   | ns    |
|                         | t <sub>rrL</sub>     |            |                                                                                                              | —   | 70  | —   | ns    |
|                         | t <sub>dL(off)</sub> |            |                                                                                                              | —   | 690 | —   | ns    |
|                         | t <sub>fL</sub>      |            |                                                                                                              | —   | 50  | —   | ns    |

Switching Timing Definitions



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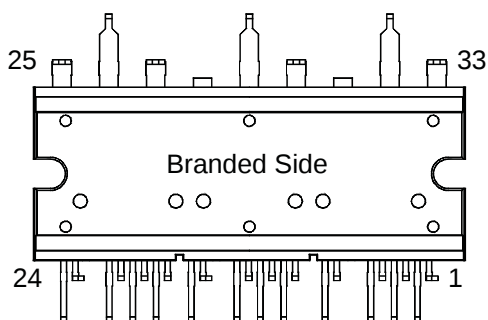
Input-Output Truth Table

| Mode                        | HINx | LINx | High-side MOSFET | Low-side MOSFET |
|-----------------------------|------|------|------------------|-----------------|
| Normal <sup>1</sup>         | L    | L    | Off              | Off             |
|                             | H    | L    | On               | Off             |
|                             | L    | H    | Off              | On              |
|                             | H    | H    | Off              | Off             |
| TSD                         | L    | L    | Off              | Off             |
|                             | H    | L    | Off              | Off             |
|                             | L    | H    | Off              | Off             |
|                             | H    | H    | Off              | Off             |
| OCP                         | L    | L    | Off              | Off             |
|                             | H    | L    | Off              | Off             |
|                             | L    | H    | Off              | Off             |
|                             | H    | H    | Off              | Off             |
| VCCx UVLO <sup>2</sup>      | L    | L    | Off              | Off             |
|                             | H    | L    | Off              | Off             |
|                             | L    | H    | Off              | Off             |
|                             | H    | H    | Off              | Off             |
| VBx UVLO <sup>3</sup>       | L    | L    | Off              | Off             |
|                             | H    | L    | Off              | Off             |
|                             | L    | H    | Off              | On              |
|                             | H    | H    | Off              | Off             |
| $\overline{\text{FOx}}$ Low | L    | L    | Off              | Off             |
|                             | H    | L    | Off              | Off             |
|                             | L    | H    | Off              | Off             |
|                             | H    | H    | Off              | Off             |

<sup>1</sup>In the case where a pair of HINx and LINx signals are asserted at the same time, the shoot-through prevention feature sets both the high-side and the low-side IGBTs off.

<sup>2</sup>After the VCCx power rail recovers from a UVLO condition, a rising edge of HINx starts driving the high-side IGBT (edge trigger). On the other hand, after the UVLO condition is released, the input level of the LINx pins reflects the state of the low-side IGBTs (level trigger).

<sup>3</sup>After the VBx power rail recovers from a UVLO condition, a rising edge of HINx starts driving the high-side IGBT (edge trigger).

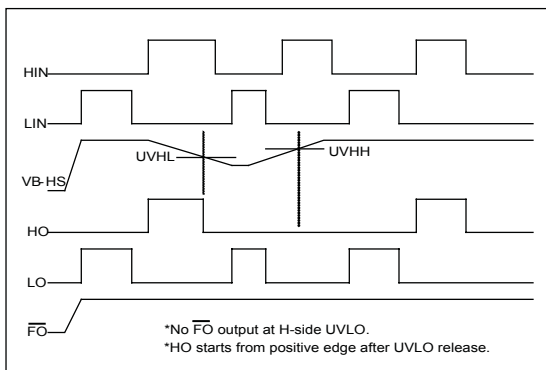
**Pin-out Diagram****(Bottom View)****Terminal List Table**

| Name | Number | Function                                               |
|------|--------|--------------------------------------------------------|
| 1    | FO1    | U phase fault output for overcurrent and UVLO detected |
| 2    | OCP1   | Input for U phase overcurrent protection               |
| 3    | LIN1   | Signal input for low-side U phase (active high)        |
| 4    | COM1   | Supply ground for U phase IC                           |
| 5    | HIN1   | Signal input for high-side U phase (active high)       |
| 6    | VCC1   | Supply voltage for U phase IC                          |
| 7    | VB1    | High-side floating supply voltage for U phase          |
| 8    | HS1    | High-side floating supply ground for U phase           |
| 9    | FO2    | V phase fault output for overcurrent and UVLO detected |
| 10   | OCP2   | Input for V phase overcurrent protection               |
| 11   | LIN2   | Signal input for low-side V phase (active high)        |
| 12   | COM2   | Supply ground for V phase IC                           |
| 13   | HIN2   | Signal input for high-side V phase (active high)       |
| 14   | VCC2   | Supply voltage for V phase IC                          |
| 15   | VB2    | High-side floating supply voltage for V phase          |
| 16   | HS2    | High-side floating supply ground for V phase           |
| 17   | FO3    | W phase fault output for overcurrent and UVLO detected |
| 18   | OCP3   | Input for W phase overcurrent protection               |
| 19   | LIN3   | Signal input for low-side W phase (active high)        |
| 20   | COM3   | Supply ground for W phase IC                           |
| 21   | HIN3   | Signal input for high-side W phase (active high)       |
| 22   | VCC3   | Supply voltage for W phase IC                          |
| 23   | VB3    | High-side floating supply voltage for W phase          |
| 24   | HS3    | High-side floating supply ground for W phase           |
| 25   | VBB    | Positive DC bus supply voltage                         |
| 26   | W      | Output for W phase                                     |
| 27   | LS3    | Negative DC bus supply ground for W phase              |
| 28   | VBB    | (Pin trimmed) positive DC bus supply voltage           |
| 29   | V      | Output for V phase                                     |
| 30   | LS2    | Negative DC bus supply ground for V phase              |
| 31   | VBB    | (Pin trimmed) positive DC bus supply voltage           |
| 32   | U      | Output for U phase                                     |
| 33   | LS1    | Negative DC bus supply ground for U phase              |

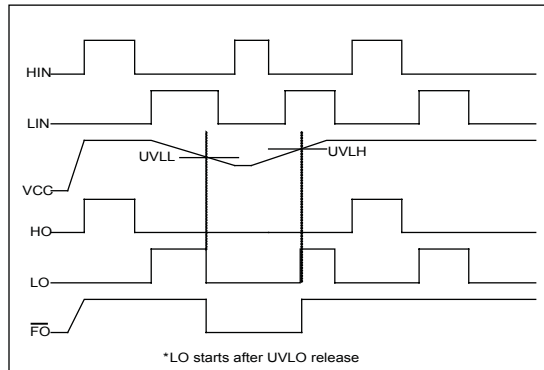
### Timing Diagrams

(one phase of three phases)

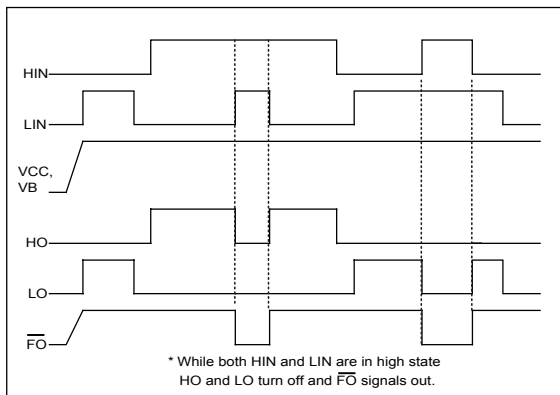
High-Side Driver Input/Output and UVLO Protection

 $V_{CC} = 15\text{ V}$ 

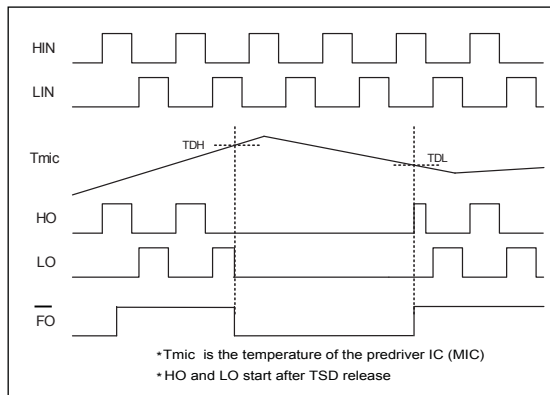
Low-Side Driver Input/Output and UVLO Protection

 $VB - HS = 15\text{ V}$ 

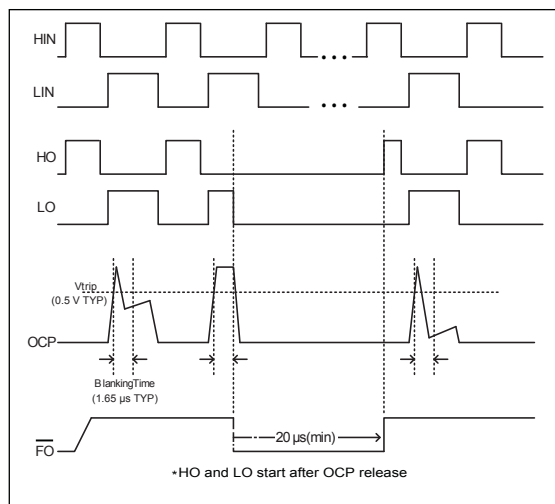
Shoot-Through Prevention

 $V_{CC}, VB - HS = 15\text{ V}$ 

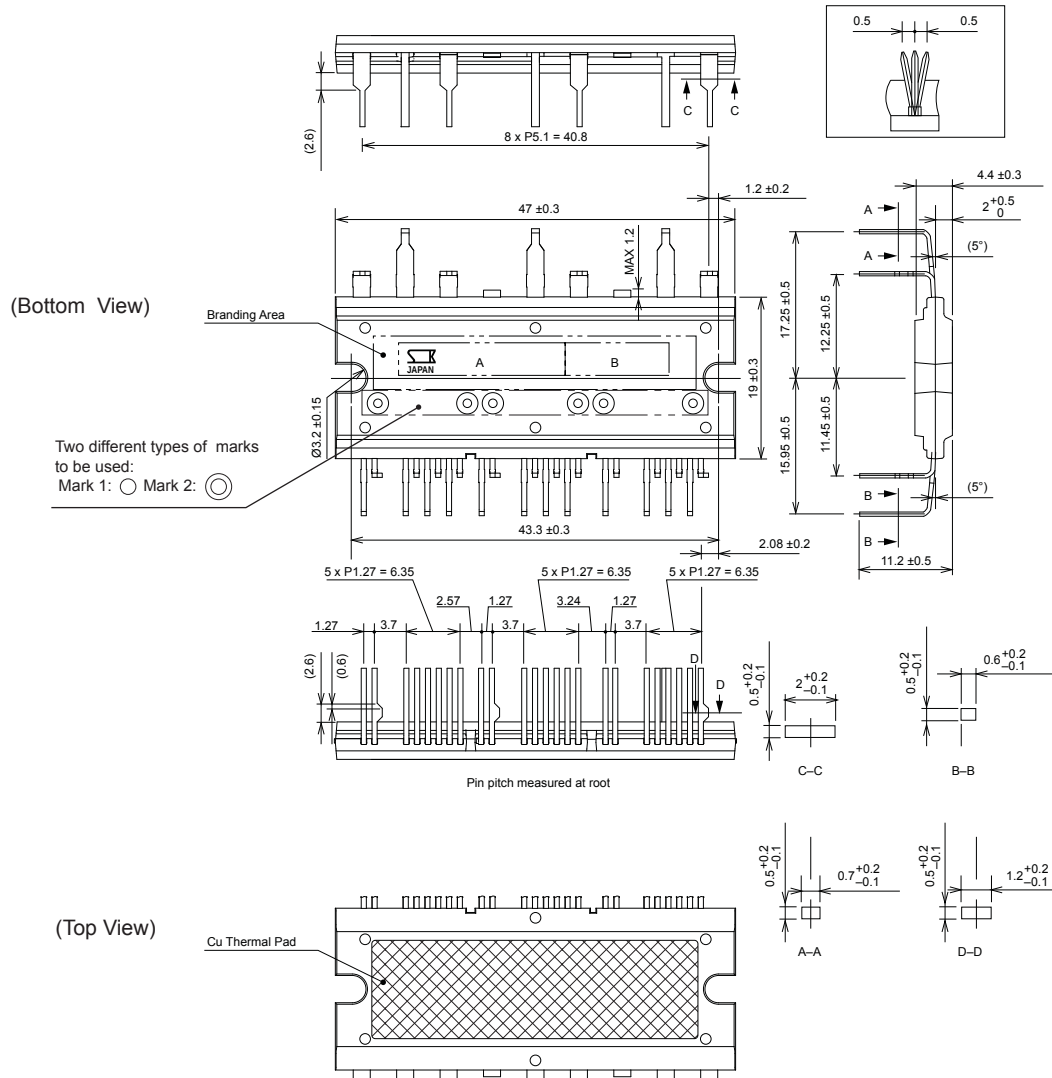
Thermal Shutdown



Overcurrent Protection



## PACKAGE OUTLINE DRAWING



Leadform: 2551 (SCM1241M: Fully molded) or  
2552 (SCM1243MF, SCM1245MF, SCM1246MF:  
Exposed copper thermal pad)

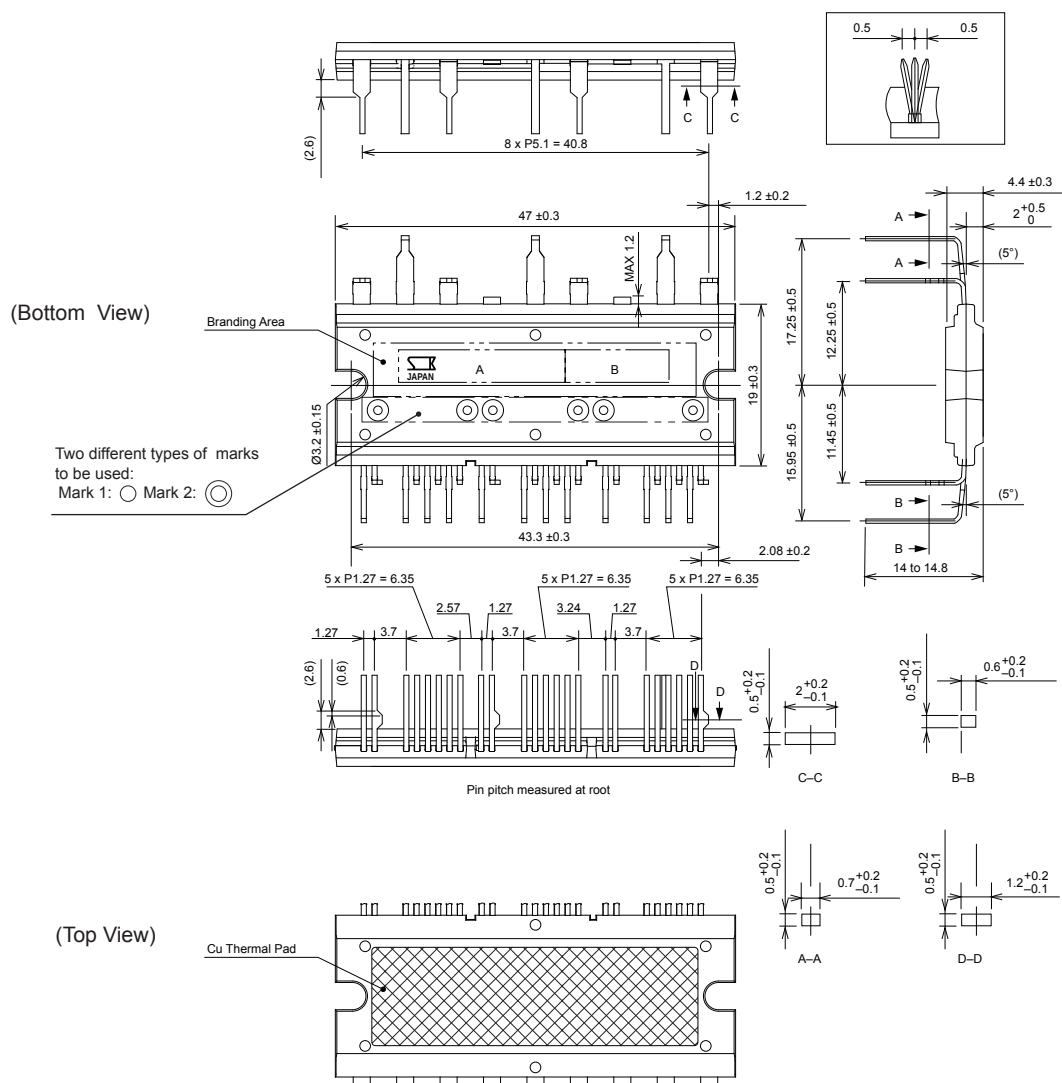
Dimensions in millimeters

The body shall be clean and shall not bear any stain, rust or flaw.  
The type number and lot number shall be clearly stamped by  
laser on the body so that cannot be erased easily.

Branding codes  
(exact appearance at manufacturer discretion):  
Section A, type: SCM124xMF or SCM1241M

Section B, lot: YMDDT  
Where: Y is the last digit of the year of manufacture  
M is the month (1 to 9, O, N, D)  
DD is the date  
T is the tracking letter (A to Z)

*Device composition complies with the RoHS directive.*



Leadform: 2557 (SCM1241M: Fully molded) or  
(SCM1243MF, SCM1245MF, SCM1246MF:  
Exposed copper thermal pad)

Dimensions in millimeters

The body shall be clean and shall not bear any stain, rust or flaw.

The type number and lot number shall be clearly stamped by  
laser on the body so that cannot be erased easily.

Branding codes

(exact appearance at manufacturer discretion):

Section A, type: SCM124xMF or SCM1241M

Section B, lot: YMDDT

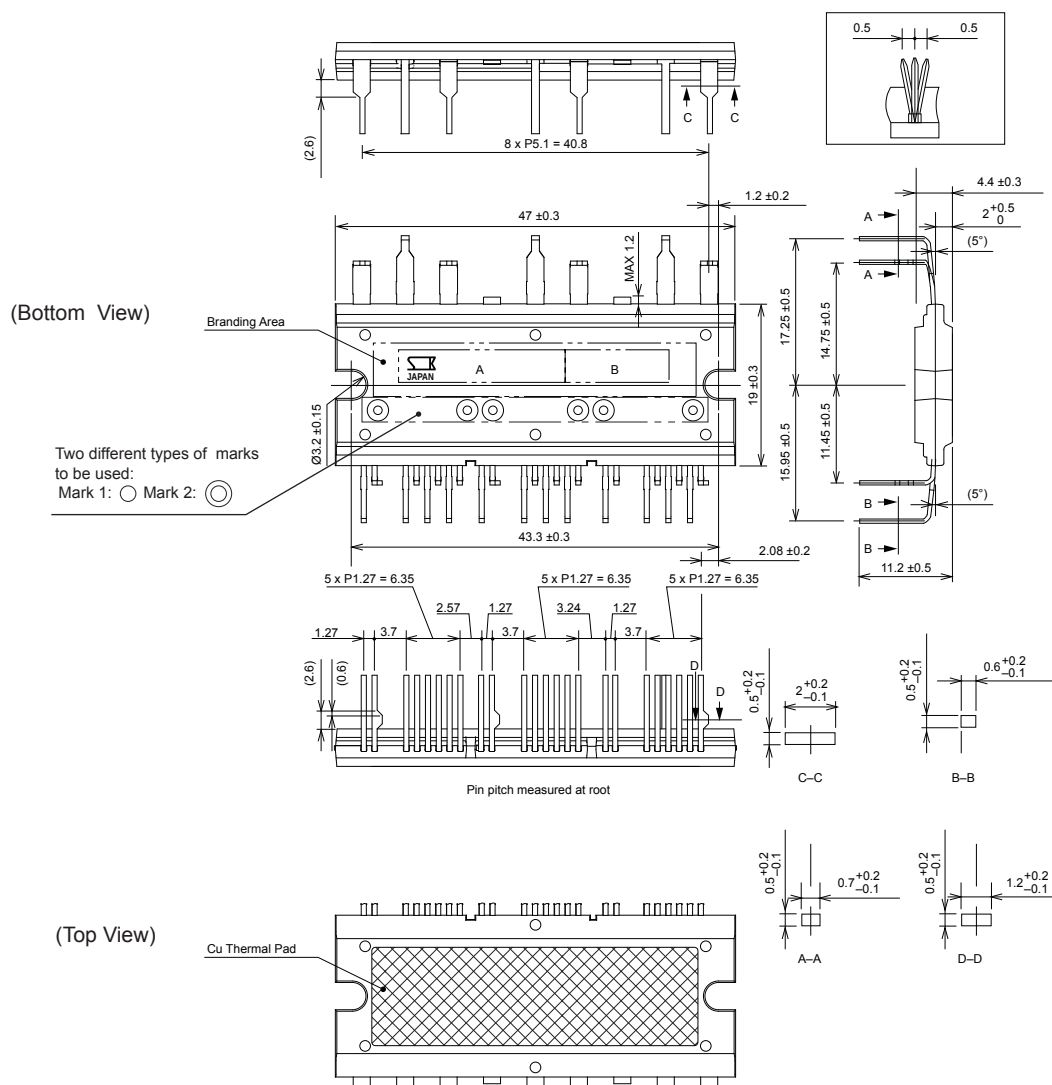
Where: Y is the last digit of the year of manufacture

M is the month (1 to 9, O, N, D)

DD is the date

T is the tracking letter (A to Z)

*Device composition complies with the RoHS directive.*



Leadform: 2558 (SCM1241M: Fully molded) or  
(SCM1243MF, SCM1245MF, SCM1246MF:  
Exposed copper thermal pad)

Dimensions in millimeters

The body shall be clean and shall not bear any stain, rust or flaw.

The type number and lot number shall be clearly stamped by  
laser on the body so that cannot be erased easily.

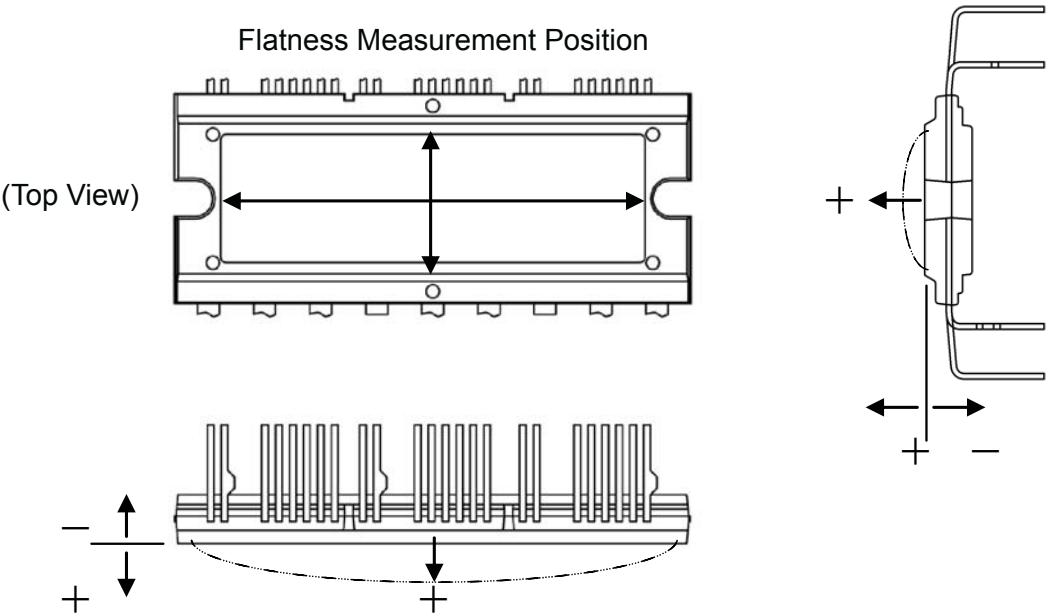
Branding codes  
(exact appearance at manufacturer discretion):  
Section A, type: SCM124xMF or SCM1241M

Section B, lot: YMDDT  
Where: Y is the last digit of the year of manufacture  
M is the month (1 to 9, O, N, D)  
DD is the date  
T is the tracking letter (A to Z)

*Device composition complies with the RoHS directive.*

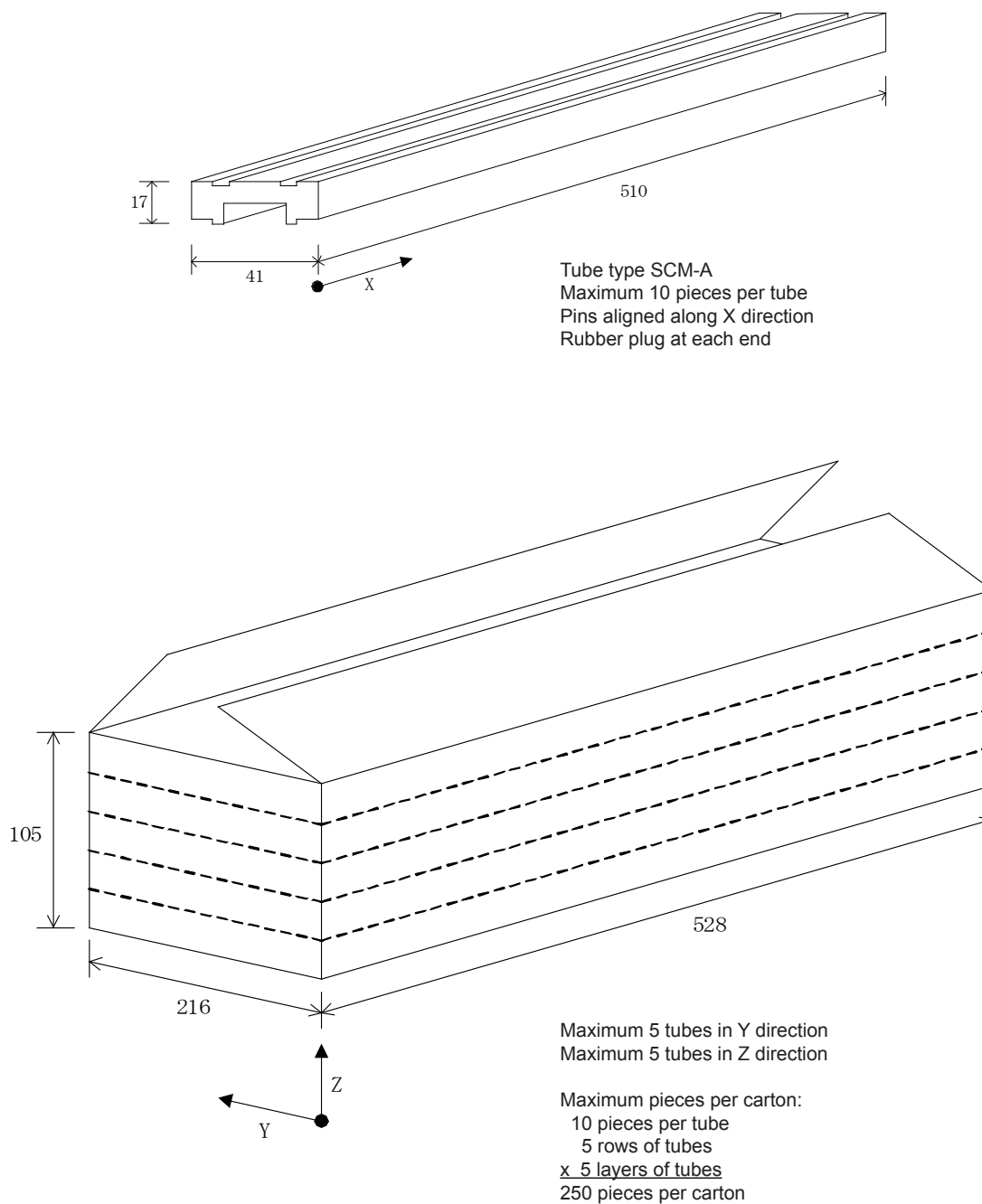
MECHANICAL CHARACTERISTICS

| Characteristic                       | Remarks                   | Min. | Typ. | Max. | Units  |
|--------------------------------------|---------------------------|------|------|------|--------|
| Heatsink Mounting Screw Torque       | Use one M3 screw each end | 58.8 | –    | 78.4 | N•cm   |
|                                      |                           | 6.0  | –    | 8.0  | kgf•cm |
| Flatness of Heatsink Attachment Area | Refer to figure below     | 0    | –    | 200  | μm     |
| Package Weight                       | SCM1241M                  | –    | 10.8 | –    | g      |
|                                      | SCM124xMF                 | –    | 11.8 | –    | g      |

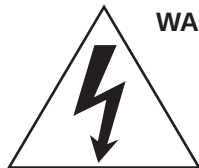


**PACKING SPECIFICATION**

Dimensions in millimeters



# SCM1240M *High Voltage, High Current 3-Phase Motor Drivers*



**WARNING** — These devices are designed to be operated at lethal voltages and energy levels. Circuit designs that embody these components must conform with applicable safety requirements. Precautions must be taken to prevent accidental contact with power-line potentials. Do not connect grounded test equipment.

The use of an isolation transformer is recommended during circuit development and breadboarding.

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

#### Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5°C to 35°C) and the standard relative humidity (around 40 to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of product that has been stored for a long time.

#### Cautions for Testing and Handling

- When tests are carried out during inspection testing and other standard test periods, protect the product from power surges from the testing device, shorts between adjacent product packages, and shorts to the heatsink.
- The screwing torque for attaching a heatsink shall be 58.8 to 78.4 N•cm (6.0 to 8.0 Kg•cm).
- Ensure there are no foreign objects between the heatsink and thermal pad; only silicone thermal grease is allowed.

#### Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting this product with a heatsink, grease shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce stress.
- Volatile-type silicone greases may permeate the product and produce cracks after long periods of time, resulting in reduced heat radiation effect, and possibly shortening the lifetime of the product.
- Hard silicone greases may cause cracks in the product when screwing the product to a heatsink.

- Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

| Type   | Suppliers                                     |
|--------|-----------------------------------------------|
| G746   | Shin-Etsu Chemical Co., Ltd.                  |
| YG6260 | Momentive Performance Materials Holding, Inc. |
| SC102  | Dow Corning Toray Silicone Co., Ltd.          |

#### Soldering

- When soldering the product, please be sure to minimize the working time, within the following limits:  
260±5°C 10 s  
380±5°C 5 s
- Soldering iron should be at a distance of at least 1.5 mm from the body of the product

#### Electrostatic Discharge

- When handling the product, operator must be grounded. Grounded wrist straps worn should have at least 1 MΩ of resistance to ground to prevent shock hazard.
- Workbenches where the product is handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the product, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the product.
- The product should always be stored and transported in our shipping containers or conductive containers, or be wrapped in aluminum foil.

- 
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In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature ( $T_J$ ) affects the reliability significantly.
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