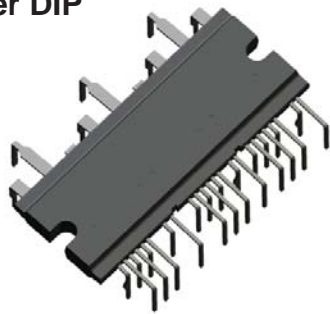


High Voltage 3-Phase Motor Driver

Features and Benefits

- Each half-bridge circuit consists of a pre-driver circuit that is completely independent from the others
- 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
- Overcurrent protection with off-time period adjustable by an external capacitor
- Fault (FO indicator) signal output at protection activation: UVLO (low side only), OCP, and STP
- Proprietary power DIP package
- UL Recognized Component (File No.: E118037)

Package: Power DIP



Not to scale

Description

The SCM1101M inverter power module (IPM) device provides 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 A (continuous) output current. They can withstand voltages of up to 600 V (IGBT breakdown voltage).

The SCM1100M series 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 fan motor
- Refrigerator compressor motor
- Washing machine main motor
- Air conditioner compressor motor

Functional Block Diagram

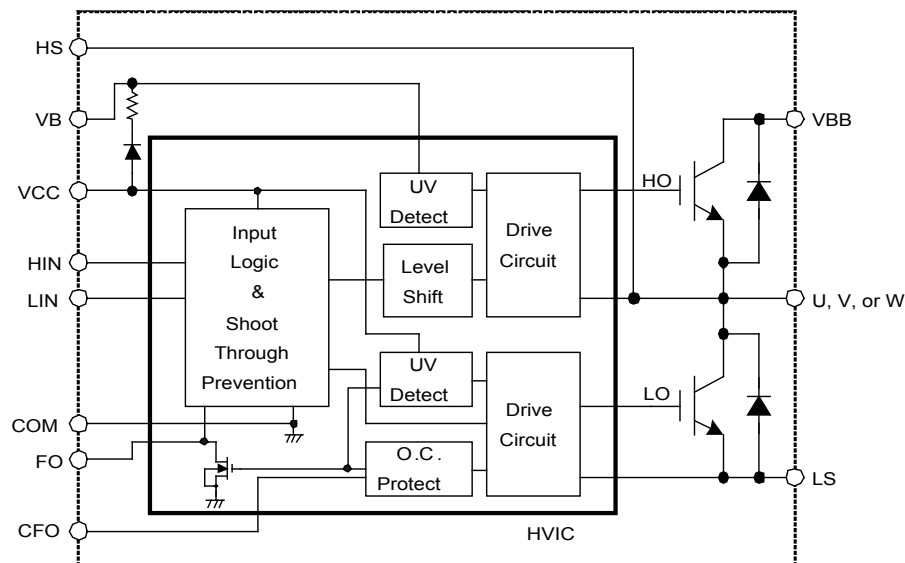


Figure 1. Diagram of one of three phases in the device.

Selection Guide

| Part Number | 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) |
| SCM1101M | 10 pieces per tube | 600 | 1.75 | 10 | 20 |

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

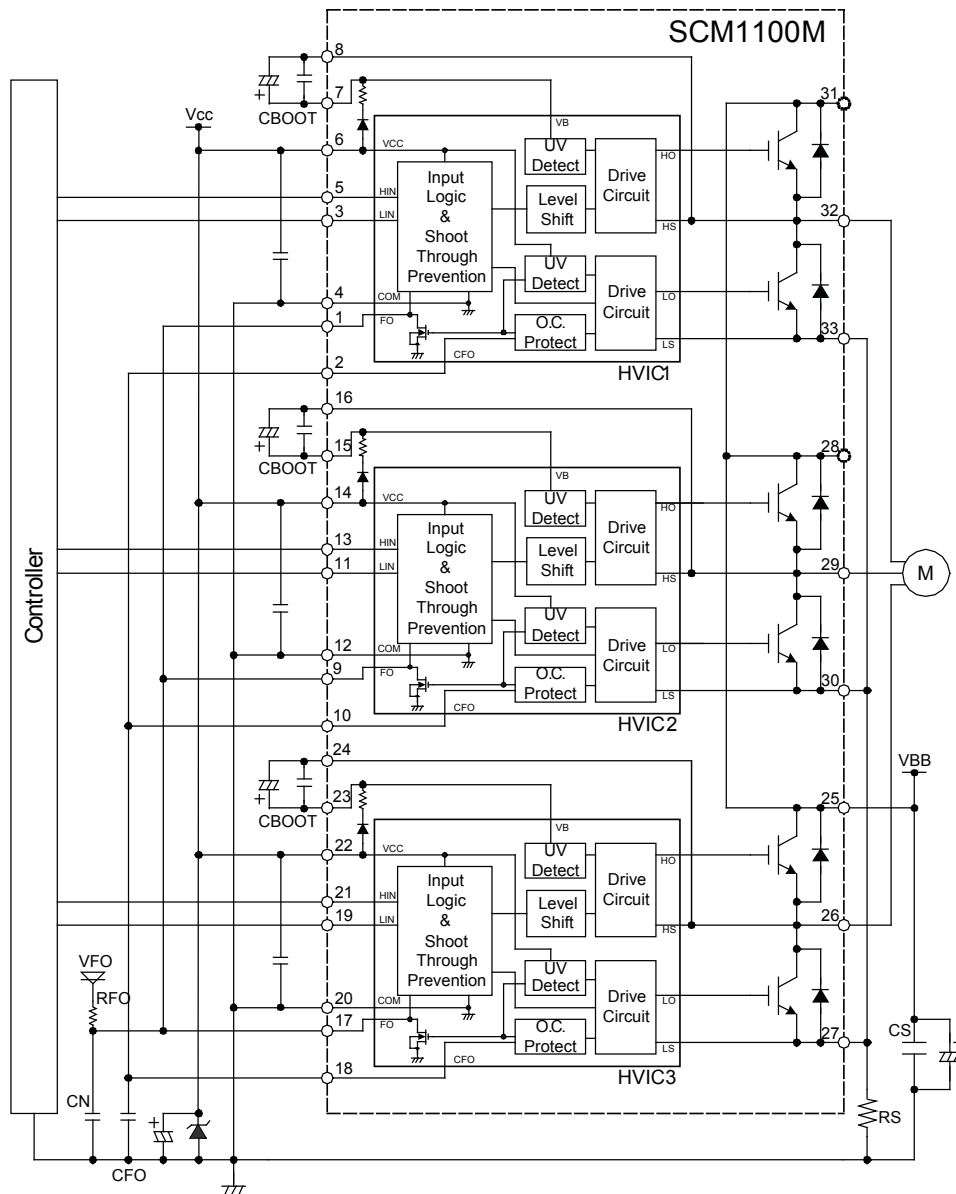
| Characteristic | Symbol | Remarks | Rating | Units |
|--------------------------------------|-----------------|--|------------|--------------------|
| Supply Voltage | V_{DC} | Between VBB and LS1, LS2, and LS3 | 450 | V |
| Supply Voltage (Surge) | $V_{DC(surge)}$ | Between VBB and LS1, LS2, and LS3 | 500 | V |
| IGBT Breakdown Voltage | V_{CES} | $V_{CC} = 15\text{ V}$, $I_C = 1\text{ mA}$, $V_{IN} = 0\text{ V}$ | 600 | V |
| Logic Supply Voltage | V_{CC} | Between VCC and COM | 20 | V |
| Boot-strap Voltage | V_{BS} | Between VB and HS (U,V,W) | 20 | V |
| Output Current, Continuous | I_O | $T_{Case} = 25^\circ\text{C}$ | 10 | Adc |
| | | $T_{Case} = 100^\circ\text{C}$ | 5.9 | Adc |
| Output Current, Pulsed | I_{OP} | Pulse Width $\leq 1\text{ ms}$ | 20 | A |
| Input Voltage | V_{IN} | | -0.5 to 7 | V |
| FO Terminal Voltage | V_{FO} | Between FO and COM | 7 | V |
| Maximum Allowable Power Dissipation | P_D | $T_{Case} = 25^\circ\text{C}$, 1 element operation (IGBT) | 20.8 | W |
| | | $T_{Case} = 100^\circ\text{C}$, 1 element operation (IGBT) | 8.3 | W |
| Thermal Resistance, Junction-to-Case | $R_{(j-c)Q}$ | 1 element operation (IGBT) | 6 | $^\circ\text{C/W}$ |
| | $R_{(j-c)F}$ | 1 element operation (FRD) | 6.5 | $^\circ\text{C/W}$ |
| Case Operation Temperature | T_{COP} | | -20 to 100 | $^\circ\text{C}$ |
| Junction Temperature (IGBT) | T_J | | 150 | $^\circ\text{C}$ |
| Storage Temperature | T_{stg} | | -40 to 150 | $^\circ\text{C}$ |
| Isolation Voltage | V_{iso} | Between exposed thermal pad and each pin; 1 minute, ac | 2000 | V_{rms} |

Recommended Operating Conditions

| Characteristic | Symbol | Remarks | Min. | Typ. | Max. | Units |
|---------------------------|-----------------|----------------------------|------|------|------|------------------|
| Main Supply Voltage | V_{DC} | Between VBB and LS | - | 300 | 400 | V |
| Logic Supply Voltage | V_{CC} | Between VCC and COM | 13.5 | - | 16.5 | V |
| Logic Supply Voltage | V_{BS} | Between VB and HS | 13.5 | - | 16.5 | V |
| Minimum Input Pulse Width | $t_{Nmin(on)}$ | On pulse | 0.5 | - | - | μs |
| | $t_{Nmin(off)}$ | Off pulse | 0.5 | - | - | μs |
| Dead Time | t_{dead} | | 1.5 | - | - | μs |
| FO Pull-up Resistor | R_{FO} | | 1 | - | 22 | $\text{k}\Omega$ |
| CFO Capacitor | C_{FO} | | 1 | - | 10 | nF |
| FO Pull-up Voltage | V_{FO} | | 4.5 | - | 5.5 | V |
| Bootstrap Capacitor | C_{BOOT} | | 10 | - | 220 | μF |
| Shunt Resistor | R_S | For $I_P \leq 20\text{ A}$ | 25.5 | - | - | $\text{m}\Omega$ |
| PWM Carrier Frequency | f_C | | - | - | 10 | kHz |
| Junction Temperature | T_J | | - | - | 125 | $^\circ\text{C}$ |

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°C , unless otherwise stated.

Typical Application Diagram



NOTE:

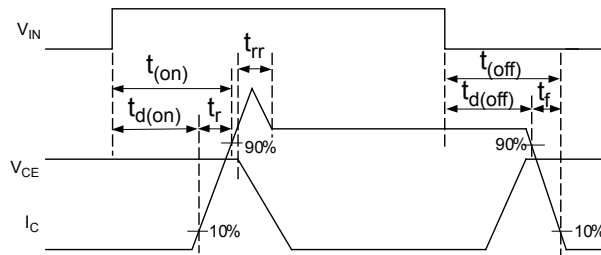
- To use the OCP circuit, an external shunt resistor, RS, is needed. The RS value can be obtained from the formula:

$$R_S(\Omega) = 0.5 (V) / \text{Overcurrent Detection Set Current (A)} - 0.0024 (\Omega)$$
- 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 μF 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 μF ceramic capacitor between the VCC and COM pins and the VB and HS pins.

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 | – | 5 | 8 | mA |
| Bootstrap Supply Current | I_{BS} | $V_B - HS = 15\text{ V}$, one phase operating | – | 400 | 800 | μA |
| 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} | $V_{CC} = 15\text{ V}$, $V_{IN} = 5\text{ V}$ | – | 50 | 100 | μA |
| | I_{ILH} | $V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$ | – | – | 2 | μA |
| Undervoltage Lock Out (High Side) | U_{VHL} | $V_{CC} = 15\text{ V}$ | 10.0 | – | 12.0 | V |
| | U_{VHH} | | 10.5 | – | 12.5 | V |
| Undervoltage Lock Out (Low Side) | U_{VLL} | $V_{CC} = 15\text{ V}$ | 10.5 | – | 12.5 | V |
| | U_{VLH} | | 11.0 | – | 13.0 | V |
| 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 | $V_{CC} = 15\text{ V}$, $C_{FO} = 0.0022\text{ }\mu\text{F}$ | 2 | – | – | ms |
| Blanking Time | t_{blank} | $V_{CC} = 15\text{ V}$ | – | 2 | – | μs |
| IGBT Breakdown Voltage | V_{CES} | $V_{CC} = 15\text{ V}$, $I_C = 250\text{ }\mu\text{A}$, $V_{IN} = 0\text{ V}$ | 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 | $V_{CE(sat)}$ | $V_{CC} = 15\text{ V}$, $I_C = 10\text{ A}$, $V_{IN} = 5\text{ V}$ | – | 1.75 | 2.2 | V |
| Diode Forward Voltage | V_F | $V_{CC} = 15\text{ V}$, $I_F = 10\text{ A}$, $V_{IN} = 0\text{ V}$ | – | 1.7 | 2.2 | V |
| Diode Recovery Time (Bootstrap) | t_{rr} | $I_F / I_{RP} = 100\text{ mA}/100\text{ mA}$ | – | 70 | – | ns |
| Diode Leakage Current (Boot Strap) | I_{IB} | $V_R = 600\text{ V}$ | – | 5 | 10 | μA |
| 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 | Ω |
| High Side Switching Time | $t_{dH(on)}$ | $V_{DC} = 300\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 10\text{ A}$, inductive load; $HIN = 0 \rightarrow 5\text{ V}$ or $5 \rightarrow 0\text{ V}$ | – | 320 | – | ns |
| | t_{rH} | | – | 50 | – | ns |
| | t_{rrH} | | – | 80 | – | ns |
| | $t_{dH(off)}$ | | – | 560 | – | ns |
| | t_{fH} | | – | 210 | – | ns |
| Low Side Switching Time | $t_{dL(on)}$ | $V_{DC} = 300\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 10\text{ A}$, inductive load; $LIN = 0 \rightarrow 5\text{ V}$ or $5 \rightarrow 0\text{ V}$ | – | 350 | – | ns |
| | t_{rL} | | – | 80 | – | ns |
| | t_{rrL} | | – | 140 | – | ns |
| | $t_{dL(off)}$ | | – | 610 | – | ns |
| | t_{fL} | | – | 200 | – | ns |

Switching Timing Definitions



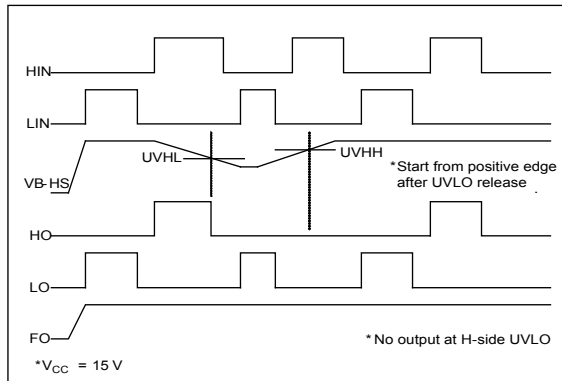
Input Output Truth Table

| HIN | LIN | OUT |
|-----|-----|--------|
| L | L | High Z |
| L | H | L |
| H | L | H |
| H | H | High Z |

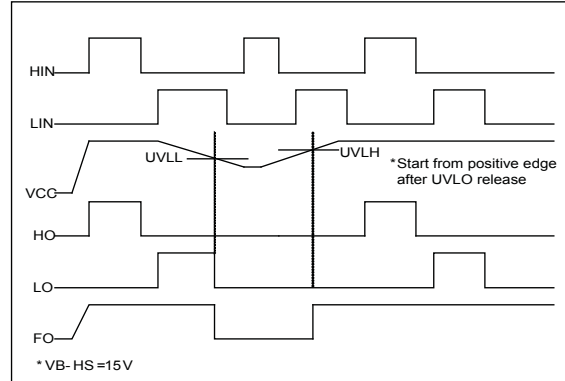
High Z = High Impedance

Timing Diagrams

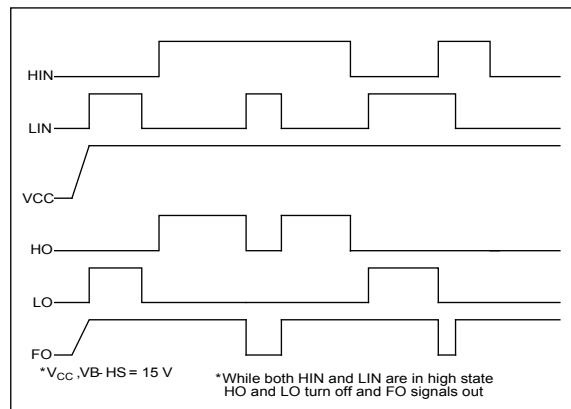
High-Side Driver Input/Output



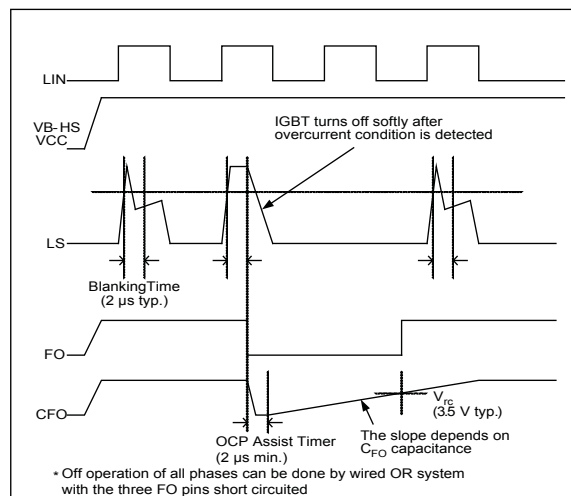
Low-Side Driver Input/Output



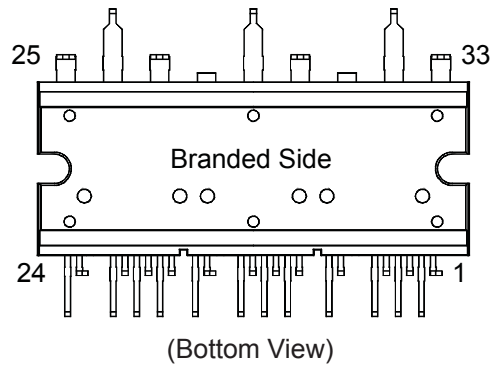
Shoot-Through Prevention



Overcurrent Protection



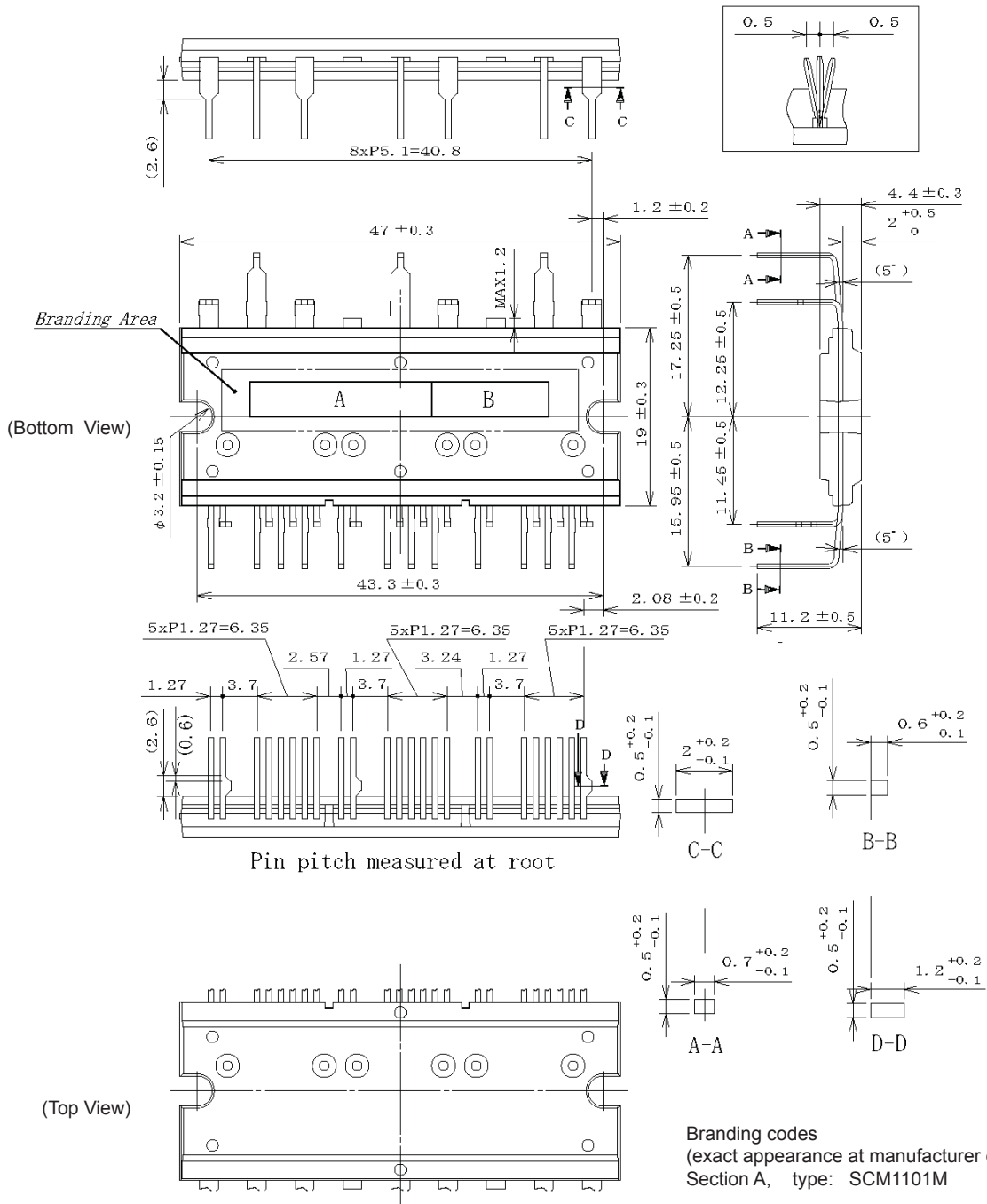
Pin-out Diagram



Terminal List Table

| Name | Number | Function |
|------|--------|--|
| 1 | FO1 | U phase fault output for overcurrent and UVLO detected |
| 2 | CFO1 | Capacitor for U phase overcurrent protection hold time |
| 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 | CFO2 | Capacitor for V phase overcurrent protection hold time |
| 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 | CFO3 | Capacitor for W phase overcurrent protection hold time |
| 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 | Cut-pin (positive DC bus supply voltage) |
| 29 | V | Output for V phase |
| 30 | LS2 | Negative DC bus supply ground for V phase |
| 31 | VBB | Cut-pin (positive DC bus supply voltage) |
| 32 | U | Output for U phase |
| 33 | LS1 | Negative DC bus supply ground for U phase |

PACKAGE OUTLINE DRAWING

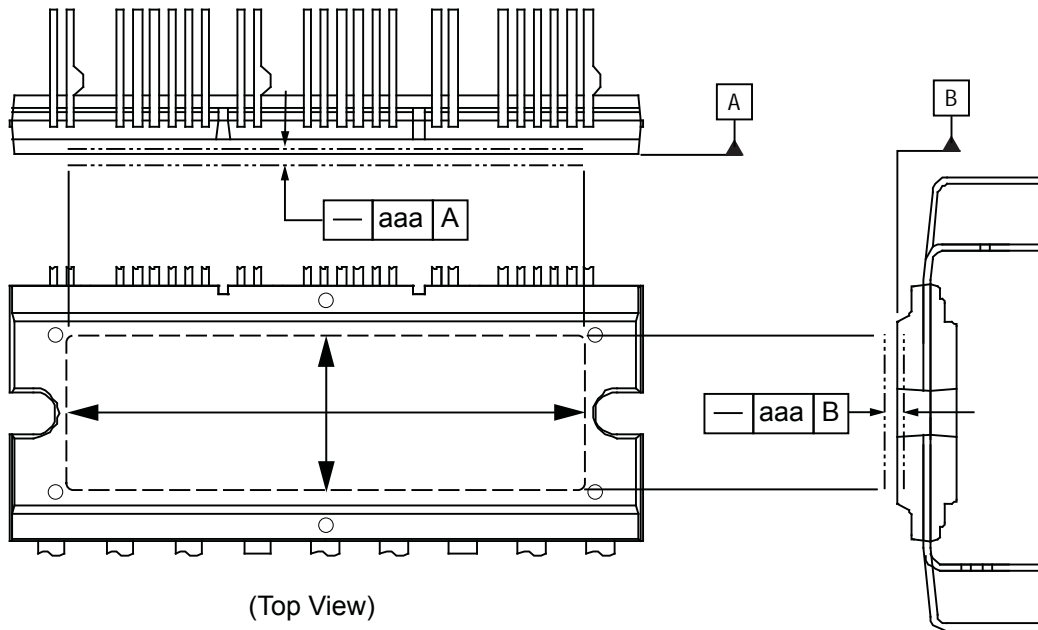


Leadform: 2552
Dimensions in millimeters

Leadframe plating Pb-free. Device composition complies with the RoHS directive.

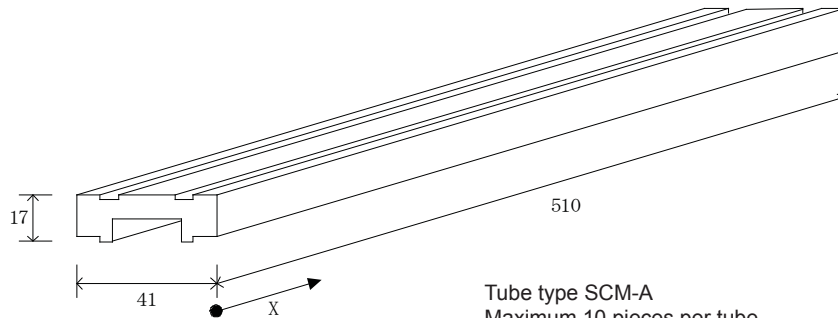
MECHANICAL CHARACTERISTICS

| 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 (aaa) | –50 | – | 100 | μm |
| Package Weight | | – | 13.5 | – | g |

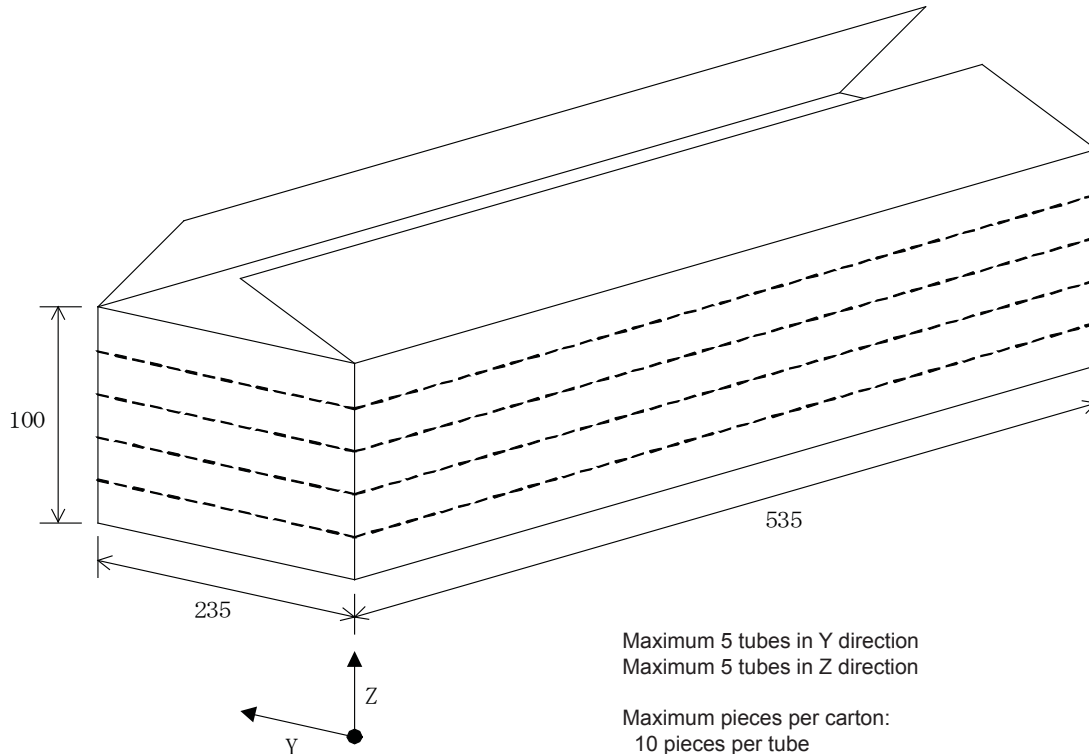


PACKING SPECIFICATION

Dimensions in millimeters

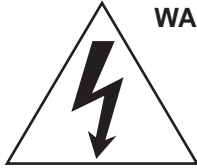


Tube type SCM-A
Maximum 10 pieces per tube
Pins aligned along X direction
Rubber plug at each end



Maximum 5 tubes in Y direction
Maximum 5 tubes in Z direction

Maximum pieces per carton:
10 pieces per tube
5 rows of tubes
x 5 layers of tubes
250 pieces per carton



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.

Remarks About Using Silicone Grease with a Heatsink

- Ensure there are no foreign objects between the heatsink and thermal pad; only silicone thermal grease is allowed.
- 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 |
| 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.

The products described herein are manufactured in Japan by Sanken Electric Co., Ltd. for sale by Allegro MicroSystems, Inc.

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When using the products described herein, the applicability and suitability of such products for the intended purpose shall be reviewed at the users responsibility.

Although Sanken undertakes to enhance the quality and reliability of its products, the occurrence of failure and defect of semiconductor products at a certain rate is inevitable.

Users of Sanken products are requested to take, at their own risk, preventative measures including safety design of the equipment or systems against any possible injury, death, fires or damages to society due to device failure or malfunction.

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When considering the use of Sanken products in applications where higher reliability is required (transportation equipment and its control systems or equipment, fire- or burglar-alarm systems, various safety devices, etc.), contact a company sales representative to discuss and obtain written confirmation of your specifications.

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