

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
- 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



Package: Power DIP

Not to scale

Description

The SSM1002MA 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 25 A (continuous) output current. They can withstand voltages of up to 600 V (IGBT breakdown voltage).

The SSM1000M series employs a new proprietary DIP package. The IC itself consists of all of the necessary power elements (six IGBTs), pre-driver ICs (four), and flyback diodes (six), needed to configure the main circuit of an inverter, as well as a shunt resistor. This enables the main circuit of the inverter to be configured with fewer external components than traditional designs.

Applications include residential white goods (home applications) and commercial appliance motor control:

- Air conditioner compressor
- Washing machine main drum

Functional Block Diagram

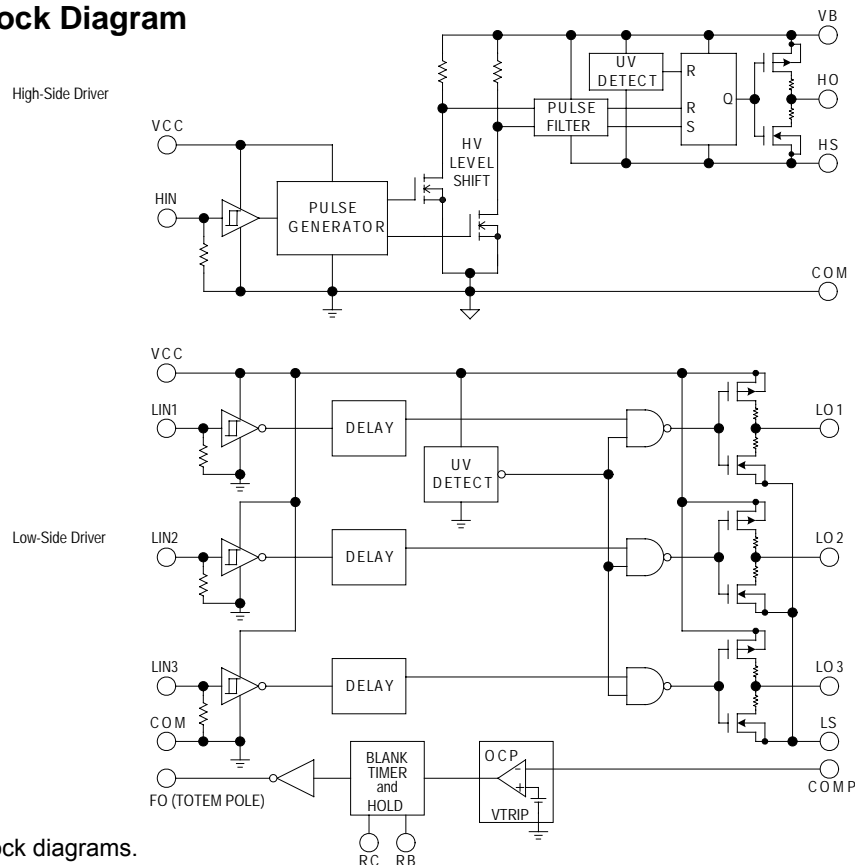


Figure 1. Driver block diagrams.

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) |
| SSM1002MA | 8 pieces per tube | 600 | 1.6 | 25 | 40 |

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

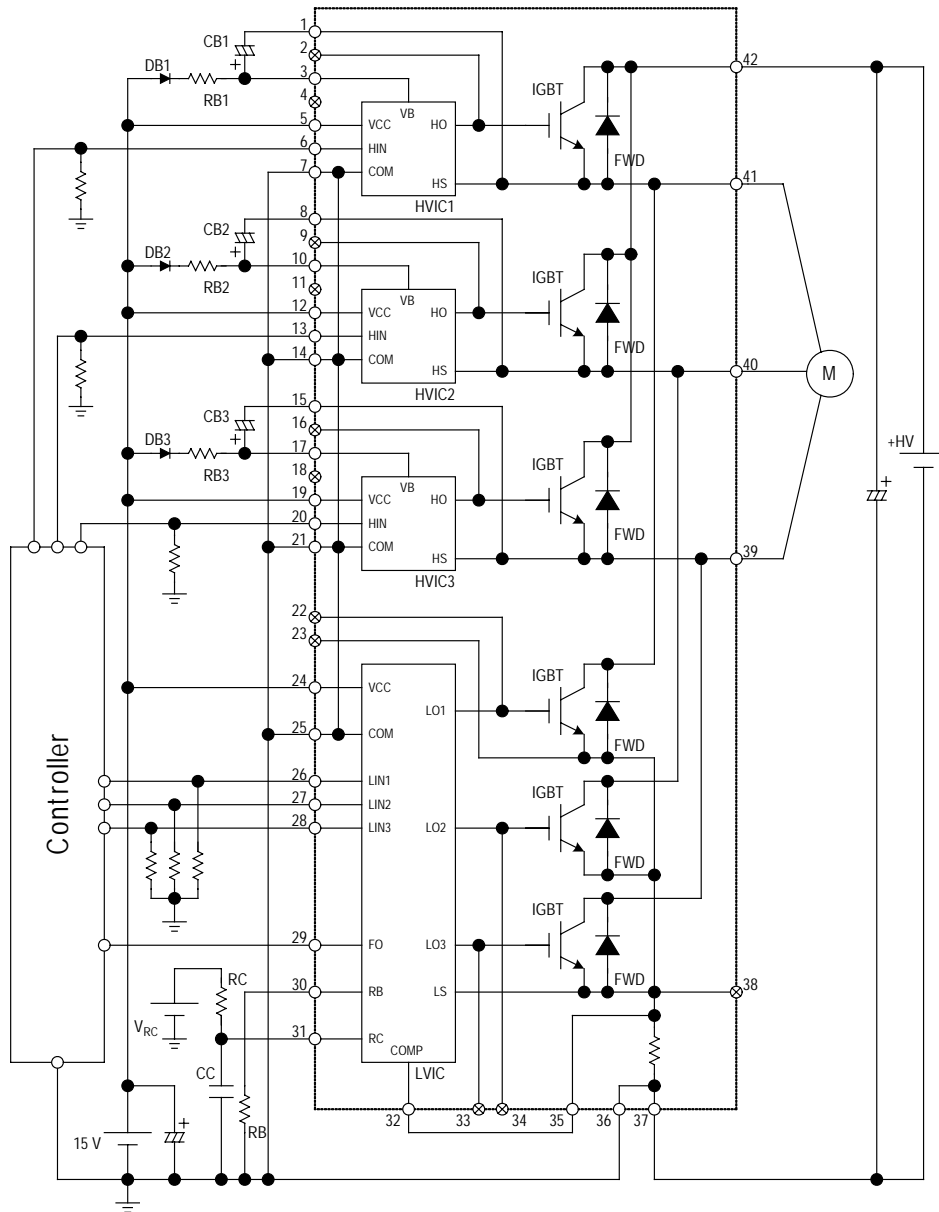
| Characteristic | Symbol | Remarks | Rating | Unit |
|--|-----------------|--|------------|--------------------|
| Main Supply Voltage | V_{BB} | Between V_{BB} and GND | 450 | V |
| Logic Supply Voltage | V_{CC} | Between VCC and COM | 20 | V |
| Bootstrap Voltage | V_{BS} | Between VB and HS (U,V, and W phases) | 20 | V |
| Output Current, Continuous | I_O | $T_C = 25^\circ\text{C}$ | 25 | A |
| Output Current, Pulsed | I_{OP} | $PW \leq 5 \text{ ms}$ | 40 | A |
| Input Voltage | V_{IN} | | -0.5 to 7 | V |
| RC Pin Input Voltage | V_{RC} | Between RC and COM | 20 | V |
| Allowable Power Dissipation | P_D | $T_C = 25^\circ\text{C}$, 1 element operating (IGBT) | 45 | W |
| Allowable Power Dissipation for Shunt Resistance | P_{DR} | $T_C = 25^\circ\text{C}$ | 6 | W |
| Thermal Resistance (Junction to Case) | $R_{\theta JC}$ | 1 element operating (IGBT) | 2.78 | $^\circ\text{C/W}$ |
| | | 1 element operating (FWD) | 3.98 | $^\circ\text{C/W}$ |
| Case Operating 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 dissipation pad and each pin; for 1 minute, AC | 1500 | V_{RMS} |

Recommended Operating Conditions

| Characteristic | Symbol | Remarks | Min. | Typ. | Max. | Units |
|----------------------|------------|-------------------------|------|------|------|------------------|
| Main Supply Voltage | V_{BB} | Between V_{BB} and LS | - | 300 | 450 | V |
| Logic Supply Voltage | V_{CC} | Between VCC and COM | 13.5 | - | 16.5 | V |
| Dead Time | t_{dead} | | 2.5 | - | - | μs |
| 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.

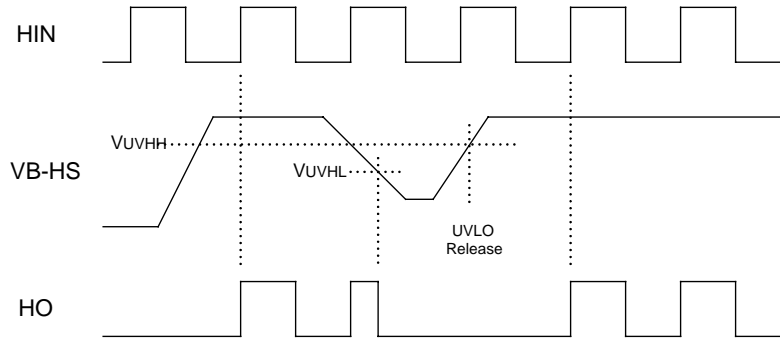
Typical Application Diagram



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

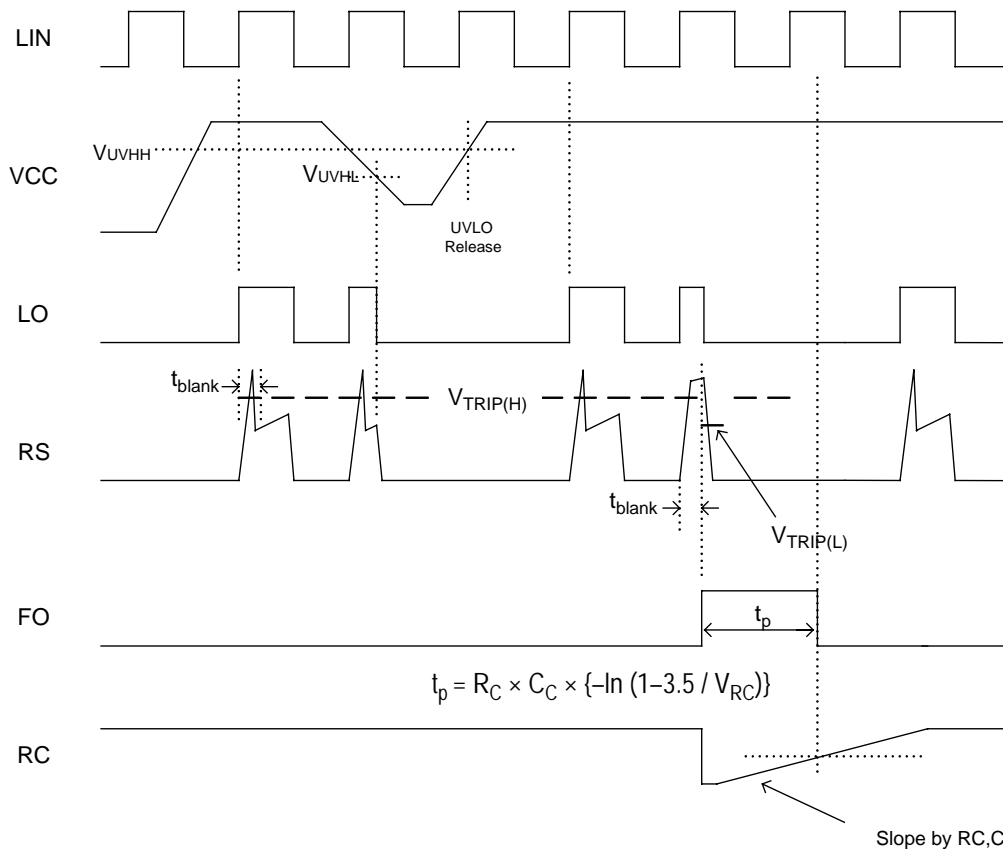
| Characteristics | Symbol | Conditions | Min | Typ | Max | Units |
|-------------------------------------|---------------|--|------|------|------|---------------|
| Logic Supply Voltage | V_{CC} | Between VCC and COM | 13.5 | – | 16.5 | V |
| Logic Supply Current | I_{CC} | $V_{CC} = 15\text{ V}$ | – | – | 8 | mA |
| Input Voltage | V_{IH} | $V_{CC} = 15\text{ V}$, output on | 4 | – | – | V |
| | V_{IL} | $V_{CC} = 15\text{ V}$, output off | – | – | 1 | V |
| Input Voltage Hysteresis | V_{Ihys} | $V_{CC} = 15\text{ V}$ | – | 0.8 | – | V |
| Input Current | I_{IHH} | High side, $V_{CC} = 15\text{ V}$, $V_{IN} = 5\text{ V}$ | – | 50 | 100 | μA |
| | I_{ILH} | High side, $V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$ | – | – | 2 | μA |
| | I_{IHL} | Low side, $V_{CC} = 15\text{ V}$, $V_{IN} = 5\text{ V}$ | – | 50 | 100 | μA |
| | I_{ILL} | Low side, $V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$ | – | – | 2 | μA |
| Undervoltage Lock Out | V_{UVHL} | High side, $V_{CC} = 15\text{ V}$ | 9.5 | – | 11.5 | V |
| | V_{UVHH} | | 10.0 | – | 12.0 | V |
| | V_{UVLL} | Low side, $V_{CC} = 15\text{ V}$ | 10.0 | – | 12.0 | V |
| | V_{UVLH} | | 10.5 | – | 12.5 | V |
| FO Terminal Output Voltage | V_{FOL} | $V_{CC} = 15\text{ V}$ | 0 | – | 1.0 | V |
| | V_{FOH} | | 4.0 | – | 5.5 | V |
| FO Terminal Output Current | I_{FOL} | $V_{CC} = 15\text{ V}$, $V_{FOL} = 1\text{ V}$ | – | – | –1.6 | mA |
| | I_{FOH} | $V_{CC} = 15\text{ V}$, $V_{FOH} = 4\text{ V}$ | – | – | 1 | mA |
| Overcurrent Protection Trip Voltage | V_{TRIP} | $V_{CC} = 15\text{ V}$ | 0.45 | 0.50 | 0.55 | V |
| Overcurrent Protection Hold Time | t_{p1} | $V_{RC} = 15\text{ V}$, $R_C = 1\text{ M}\Omega$, $C_C = 1000\text{ pF}$, $R_B = 30\text{ k}\Omega$ | – | 260 | – | μs |
| | t_{p2} | $V_{RC} = 5\text{ V}$, $R_C = 1.5\text{ M}\Omega$, $C_C = 2200\text{ pF}$, $R_B = 30\text{ k}\Omega$ | – | 5 | – | ms |
| Blanking Time | t_{blank} | $V_{CC} = 15\text{ V}$, $R_B = 30\text{ k}\Omega$ | – | 1.6 | – | 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 | $V_{CE(sat)}$ | $V_{CC} = 15\text{ V}$, $I_C = 25\text{ A}$, $V_{IN} = 5\text{ V}$ | – | 1.6 | 2.0 | V |
| Diode Forward Voltage | V_F | $V_{CC} = 15\text{ V}$, $I_F = 25\text{ A}$, $V_{IN} = 0\text{ V}$ | – | 1.8 | 2.2 | V |
| Diode Recovery Time | t_{rr} | $I_F = 25\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | – | 50 | – | ns |
| Switching Time, High Side | $t_{dH(on)}$ | $V_{BB} = 280\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 25\text{ A}$, $0\text{ V} \leq V_{IN} \leq 5\text{ V}$, inductive load | – | 0.6 | – | μs |
| | t_{rH} | | – | 0.1 | – | μs |
| | $t_{dH(off)}$ | | – | 1.2 | – | μs |
| | t_{fH} | | – | 0.4 | – | μs |
| Switching Time, Low Side | $t_{dL(on)}$ | | – | 0.3 | – | μs |
| | t_{rL} | | – | 0.1 | – | μs |
| | $t_{dL(off)}$ | | – | 1.0 | – | μs |
| | t_{fL} | | – | 0.4 | – | μs |
| Shunt Resistance | R_S | $I_R = 25\text{ A}$ | 11.6 | 12 | 12.4 | m Ω |

High Side Driver Input/Output Timing Diagrams



After UVLO is released, IC operation is started by the first rising edge of input

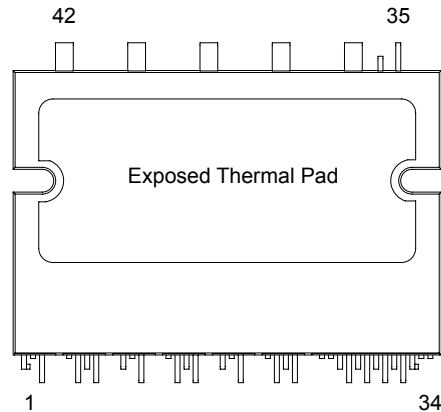
Low Side Driver Input/Output Timing Diagrams



After UVLO is released, IC operation is started by the first rising edge of input

After RC charging and releasing, the OCP operation is started by the first rising edge of input

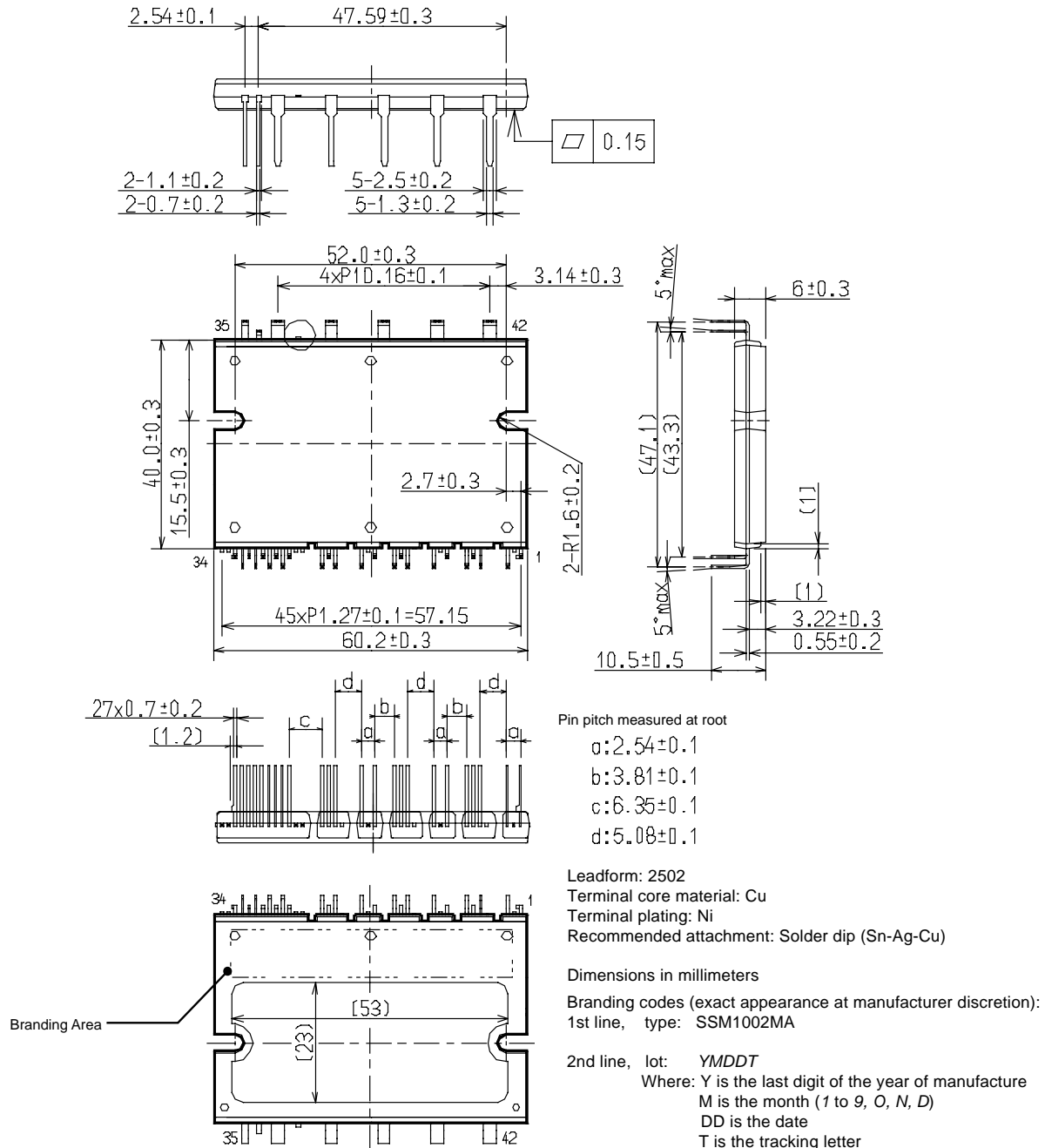
Pin-out Diagram



Terminal List Table

| Number | Name | Function | Number | Name | Function |
|--------|------|---|--------|-------|--|
| 1 | HS1 | High-side floating supply ground (U phase) | 22 | NC | Low-side IGBT gate (U phase) |
| 2 | NC | High-side IGBT gate (U phase) | 23 | NC | Low-side IGBT emitter |
| 3 | VB1 | High-side floating supply voltage (U phase) | 24 | VCC4 | Low-side |
| 4 | NC | NC | 25 | COM4 | Low-side GND |
| 5 | VCC1 | Control circuit supply voltage (U phase) | 26 | LIN1 | Signal input for low-side (U phase), active high |
| 6 | HIN1 | Signal input for high-side (U phase), active high | 27 | LIN2 | Signal input for low-side (V phase), active high |
| 7 | COM1 | Logic supply ground (U phase) | 28 | LIN3 | Signal input for low-side (W phase), active high |
| 8 | HS2 | High-side floating supply ground (V phase) | 29 | FO | Fault output for overcurrent condition detected |
| 9 | NC | High-side IGBT gate (V phase) | 30 | RB | Blanking time setting resistor terminal |
| 10 | VB2 | High-side floating supply voltage (V phase) | 31 | RC | Overcurrent protection setting resistor terminal |
| 11 | NC | NC | 32 | COMP | Feedback comparator terminal |
| 12 | VCC2 | Control circuit supply voltage (V phase) | 33 | NC | Low-side IGBT gate (W phase) |
| 13 | HIN2 | Signal input for high-side (V phase), active high | 34 | NC | Low-side IGBT gate (V phase) |
| 14 | COM2 | Logic supply ground (V phase) | 35 | RSPOS | Shunt resistor terminal, positive phase |
| 15 | HS3 | High-side floating supply ground (W phase) | 36 | RSNEG | Shunt resistor terminal, negative phase |
| 16 | NC | High-side IGBT gate (W phase) | 37 | GND | Main supply voltage GND |
| 17 | VB3 | High-side floating supply voltage (W phase) | 38 | NC | Low-side IGBT emitter |
| 18 | NC | NC | 39 | W | Output for W phase |
| 19 | VCC3 | Control circuit supply voltage (W phase) | 40 | V | Output for V phase |
| 20 | HIN3 | Signal input for high-side (W phase), active high | 41 | U | Output for U phase |
| 21 | COM3 | Logic supply ground (W phase) | 42 | VBB | Main DC bus supply voltage |

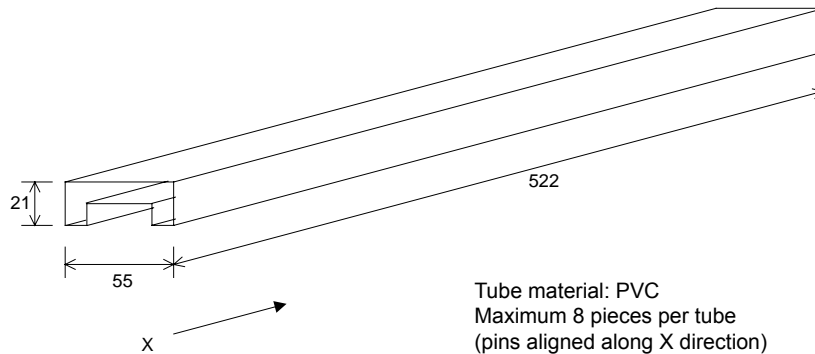
PACKAGE OUTLINE DRAWING



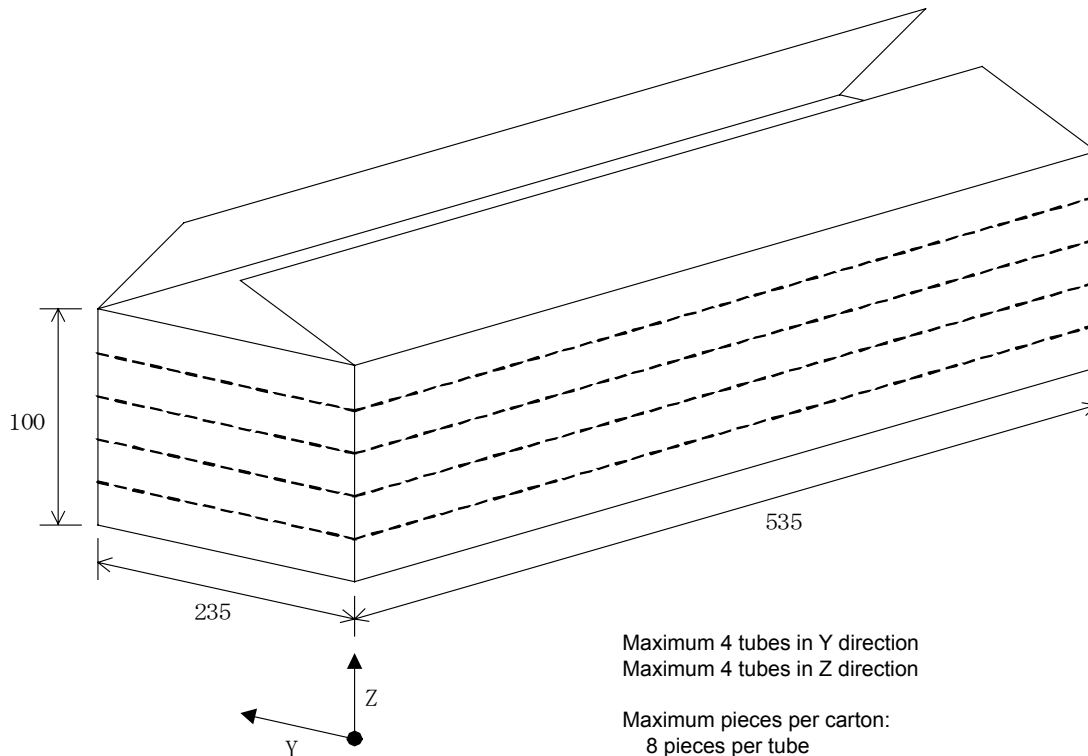
Leadframe plating Pb-free. Device composition complies with the RoHS directive.

PACKING SPECIFICATION

Dimensions in millimeters



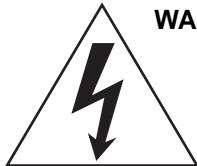
Tube material: PVC
Maximum 8 pieces per tube
(pins aligned along X direction)
Rubber plug each end



Maximum 4 tubes in Y direction
Maximum 4 tubes in Z direction

Maximum pieces per carton:
8 pieces per tube
4 rows of tubes
x 4 layers of tubes
128 pieces per carton

Carton weight, with maximum
contents: 7.1 kg



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 products that have 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 products from power surges from the testing device, shorts between adjacent products, and shorts to the heatsink.

Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting this product on a heatsink, it 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.
- 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 | GE Toshiba Silicone Co., Ltd. |
| SC102 | Dow Corning Toray Silicone Co., Ltd. |

Heatsink Mounting Method

Torque When Tightening Mounting Screws. The recommended tightening torque for this product package type is: 78.4 to 88.2 N•cm (8.0 to 9.0 kgf•cm).

Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:
 - 260±5°C 10 s
 - 380±5°C 3 s
- Soldering iron should be at a distance of at least 1.5 mm from the body of the products

Electrostatic Discharge

- When handling the products, 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 products are 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 products, 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 products.
- The products 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.

Sanken and Allegro reserve the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the performance, reliability, or manufacturability of its products. Therefore, the user is cautioned to verify that the information in this publication is current before placing any order.

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