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

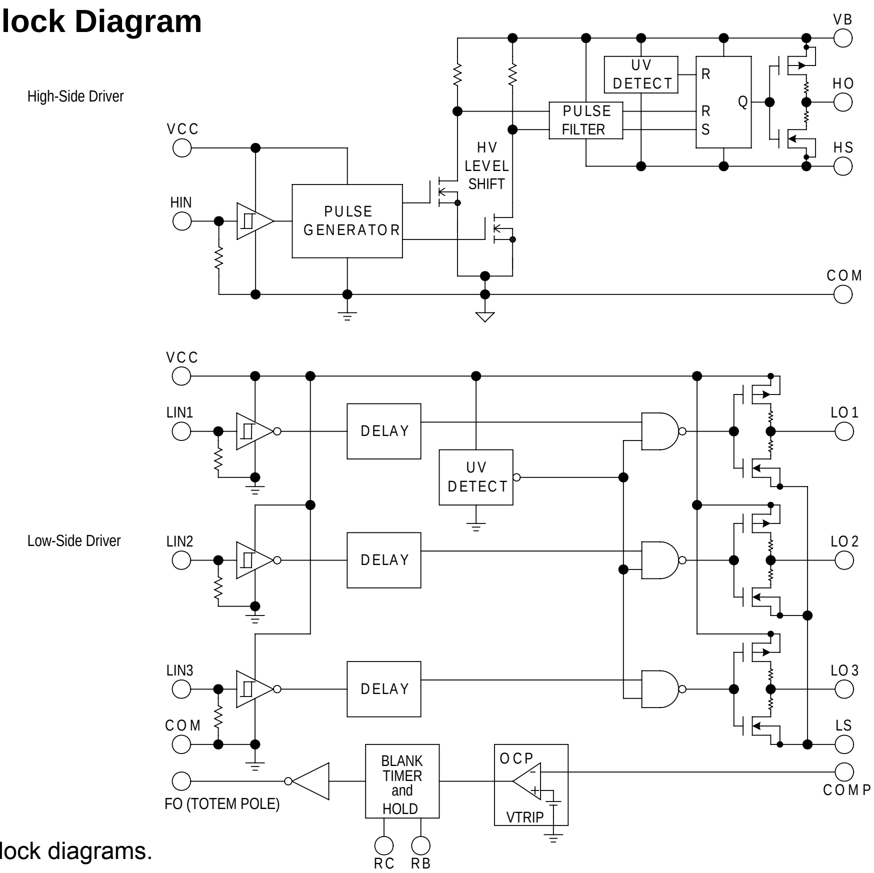


Figure 1. Driver block diagrams.

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°C

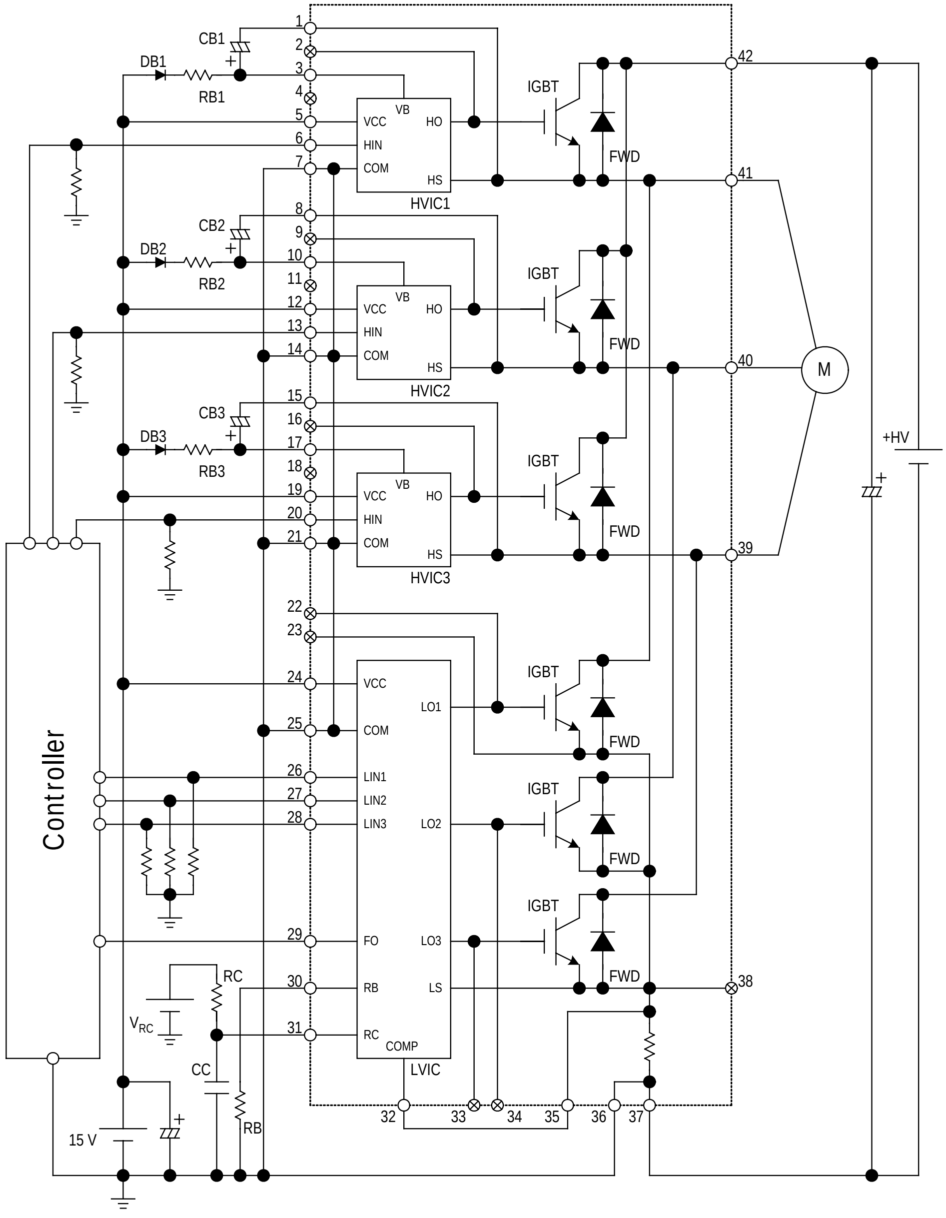
Characteristic	Symbol	Remarks	Rating	Unit
Main Supply Voltage	V_{BB}	Between VBB and GND	450	V
Logic Supply Voltage	V_{CC}	Between VCC and COM	20	V
Bootstrap Voltage	V_{BS}	Between VB and HS (U,V, and W phases)	20	V
Output Current, Continuous	I_O	T_C = 25°C	25	A
Output Current, Pulsed	I_{OP}	PW ≤ 5 ms	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°C, 1 element operating (IGBT)	45	W
Allowable Power Dissipation for Shunt Resistance	P_{DR}	T_C = 25°C	6	W
Thermal Resistance (Junction to Case)	$R_{\theta JC}$	1 element operating (IGBT)	2.78	°C/W
		1 element operating (FWD)	3.98	°C/W
Case Operating Temperature	T_{COP}		–20 to 100	°C
Junction Temperature (IGBT)	T_J		150	°C
Storage Temperature	T_{stg}		–40 to 150	°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 VBB 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	°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



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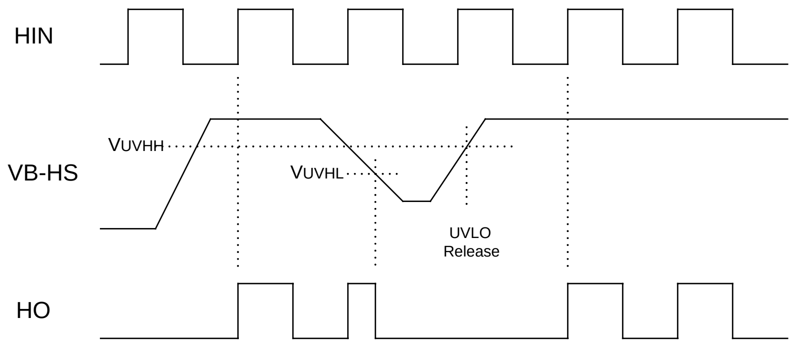
ELECTRICAL CHARACTERISTICS, valid at T_A=25°C, unless otherwise noted

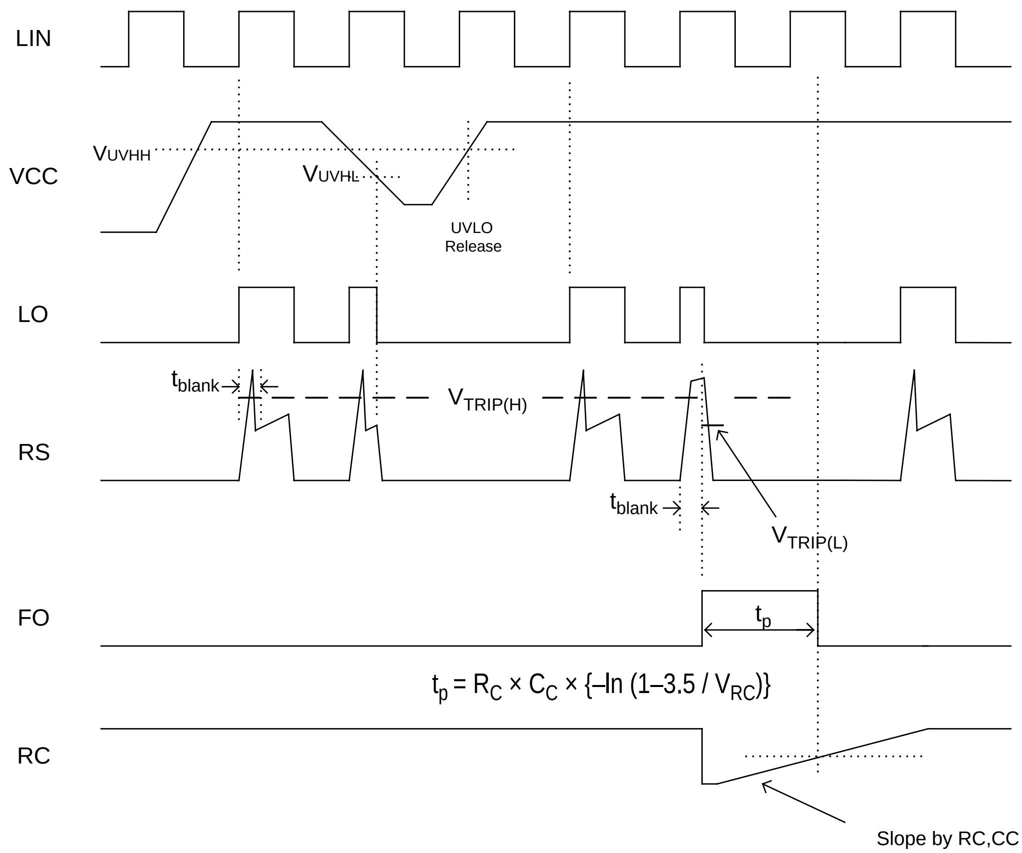
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Logic Supply Voltage	V_{CC}	Between VCC and COM	13.5	–	16.5	V
Logic Supply Current	I_{CC}	V_{CC} = 15 V	–	–	8	mA
Input Voltage	V_{IH}	V_{CC} = 15 V, output on	4	–	–	V
	V_{IL}	V_{CC} = 15 V, output off	–	–	1	V
Input Voltage Hysteresis	V_{Ihys}	V_{CC} = 15 V	–	0.8	–	V
Input Current	I_{IHH}	High side, V_{CC} = 15 V, V_{IN} = 5 V	–	50	100	μA
	I_{ILH}	High side, V_{CC} = 15 V, V_{IN} = 0 V	–	–	2	μA
	I_{IHL}	Low side, V_{CC} = 15 V, V_{IN} = 5 V	–	50	100	μA
	I_{ILL}	Low side, V_{CC} = 15 V, V_{IN} = 0 V	–	–	2	μA
Undervoltage Lock Out	V_{UVHL}	High side, V_{CC} = 15 V	9.5	–	11.5	V
	V_{UVHH}		10.0	–	12.0	V
	V_{UVLL}	Low side, V_{CC} = 15 V	10.0	–	12.0	V
	V_{UVLH}		10.5	–	12.5	V
FO Terminal Output Voltage	V_{FOL}	V_{CC} = 15 V	0	–	1.0	V
	V_{FOH}		4.0	–	5.5	V
FO Terminal Output Current	I_{FOL}	V_{CC} = 15 V, V_{FOL} = 1 V	–	–	–1.6	mA
	I_{FOH}	V_{CC} = 15 V, V_{FOH} = 4 V	–	–	1	mA
Overcurrent Protection Trip Voltage	V_{TRIP}	V_{CC} = 15 V	0.45	0.50	0.55	V
Overcurrent Protection Hold Time	t_{p1}	V_{RC} = 15 V, R_C = 1 MΩ, C_C = 1000 pF, R_B = 30 kΩ	–	260	–	μs
	t_{p2}	V_{RC} = 5 V, R_C = 1.5 MΩ, C_C = 2200 pF, R_B = 30 kΩ	–	5	–	ms
Blanking Time	t_{blank}	V_{CC} = 15 V, R_B = 30 kΩ	–	1.6	–	μs
IGBT Breakdown Voltage	V_{CES}	V_{CC} = 15 V, I_C = 250 μA, V_{IN} = 0 V	600	–	–	V
IGBT Leakage Current	I_{CES}	V_{CC} = 15 V, V_{CE} = 600 V, V_{IN} = 0 V	–	–	1	mA
IGBT Saturation Voltage	$V_{CE(sat)}$	V_{CC} = 15 V, I_C = 25 A, V_{IN} = 5 V	–	1.6	2.0	V
Diode Forward Voltage	V_F	V_{CC} = 15 V, I_F = 25 A, V_{IN} = 0 V	–	1.8	2.2	V
Diode Recovery Time	t_{rr}	I_F = 25 A, di/dt = 100 A/μs	–	50	–	ns
Switching Time, High Side	$t_{dH(on)}$	V_{BB} = 280 V, V_{CC} = 15 V, I_C = 25 A, 0 V ≤ V_{IN} ≤ 5 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 A	11.6	12	12.4	mΩ

High Side Driver Input/Output Timing Diagrams



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

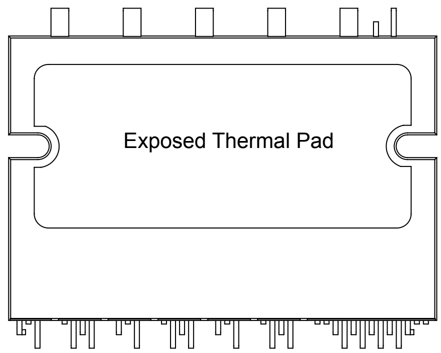
Low Side Driver Input/Output Timing Diagrams



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

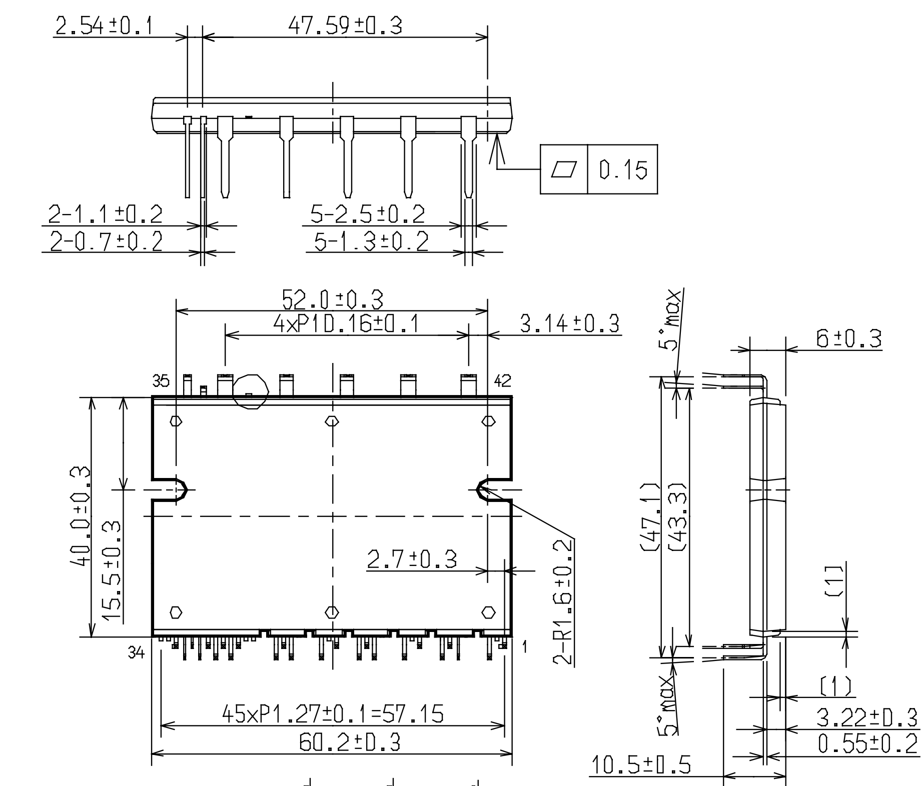
Pin-out Diagram

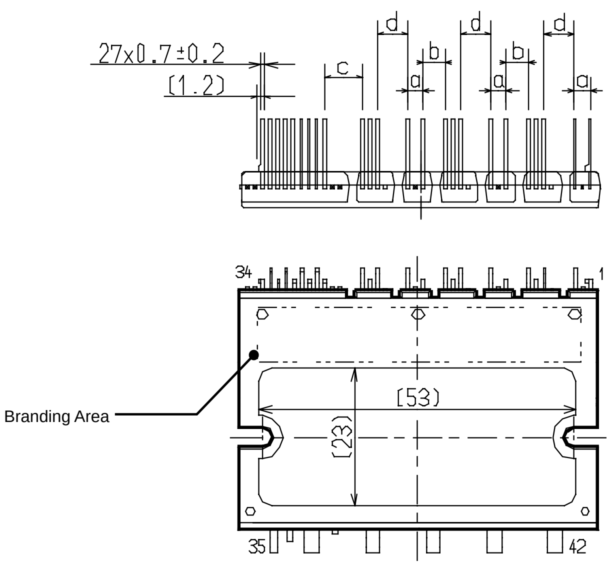


Terminal List Table

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





Pin pitch measured at root

a:2.54±0.1
b:3.81±0.1
c:6.35±0.1
d:5.08±0.1

Leadform: 2502
Terminal core material: Cu
Terminal plating: Ni
Recommended attachment: Solder dip (Sn-Ag-Cu)

Dimensions in millimeters

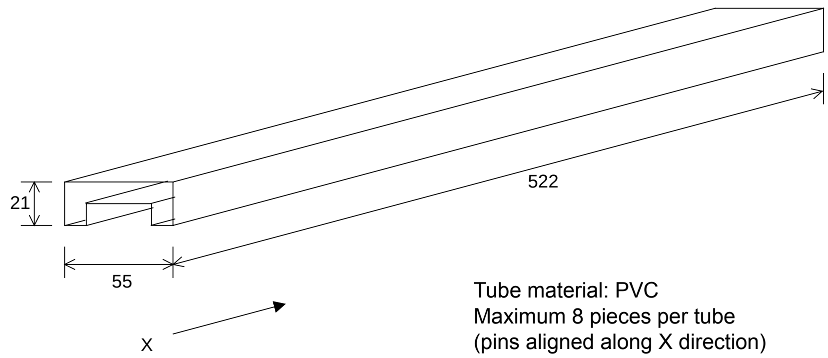
Branding codes (exact appearance at manufacturer discretion):
1st line, type: SSM1002MA

2nd line, 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

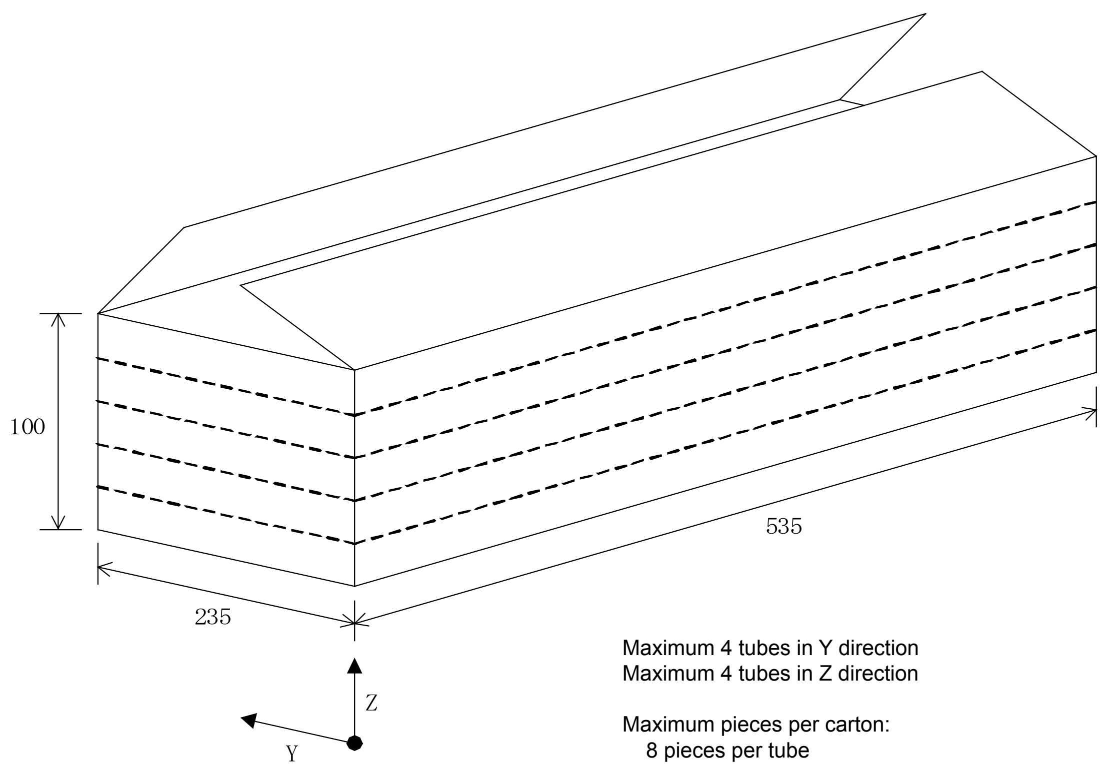
Leadframe plating Pb-free. Device composition complies with the RoHS directive.

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 other 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.

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High Voltage 3 Phase Motor Driver

SSM1002MA

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SSM1002MA

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