# 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

Not to scale

Fully molded
LF 2551

Heatsink pad
LF2552
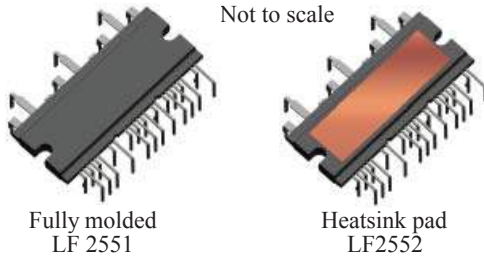
Description

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
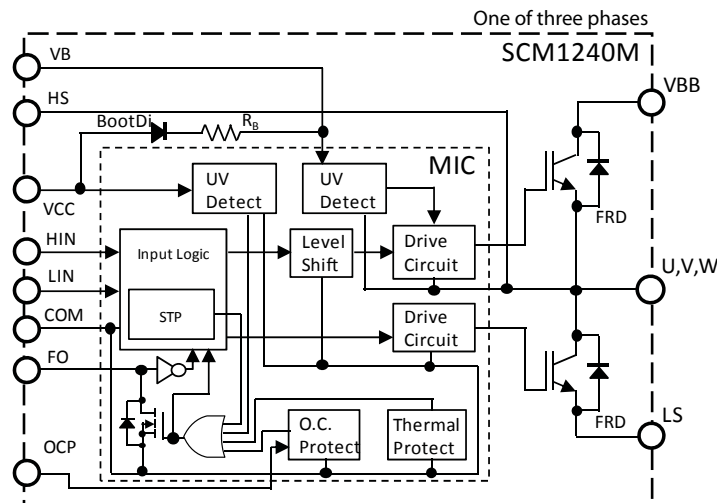- Washing machine main motor

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°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 V, I_C = 1 mA, V_{IN} = 0 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	SCM1241M	T_{Case} = 25°C	10	Adc
		SCM1243MF	T_{Case} = 25°C	15	Adc
		SCM1245MF	T_{Case} = 25°C	20	Adc
		SCM1246MF	T_{Case} = 25°C	30	Adc
Output Current, Pulsed	I_{OP}	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_{IN}	HIN, LIN, and OCP		−0.5 to 7	V
$\overline{FO}$ Terminal Voltage	V_{FO}	Between $\overline{FO}$ and COM		7	V
Thermal Resistance, Junction-to-Case	$R_{(j-c)Q}$	SCM1241M	1 element operation (IGBT)	6.0	°C/W
		SCM1243MF SCM1245MF SCM1246MF		3.0	°C/W
	$R_{(j-c)F}$	SCM1241M	1 element operation (FRD)	6.5	°C/W
		SCM1243MF SCM1245MF SCM1246M		4.0	°C/W
Case Operating Temperature	T_{OPC}			−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 pad and each pin; 1 minute, ac		2000	V_{rms}

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.

SANKEN ELECTRIC CO., LTD.

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	$t_{INmin(on)}$	On pulse		0.5	–	–	µs
	$t_{INmin(off)}$	Off pulse		0.5	–	–	µs
Dead Time*	t_{dead}			1.0	–	–	µs
$\overline{FO}$ Pull-up Resistor	R_{FO}			1	–	22	kΩ
$\overline{FO}$ Pull-up Voltage	V_{FO}			3.0	–	5.5	V
Bootstrap Capacitor	C_{BOOT}			10	–	220	µF
Shunt Resistor	R_S	SCM1241M	For I_P ≤ 20 A	27	–	–	mΩ
		SCM1243MF SCM1245MF SCM1246MF	For I_P ≤ 30 A	15	–	–	mΩ
RC Filter Resistor	R_O			–	–	100	Ω
RC Filter Capacitor	C_O			–	–	2200	pF
PWM Carrier Frequency	f_C			–	–	20	kHz
Junction Temperature	T_J			–	–	125	°C

*Dead Time must be controlled from an external source.

Typical Application Diagram

Typical application utilizing one shunt resistor, RS
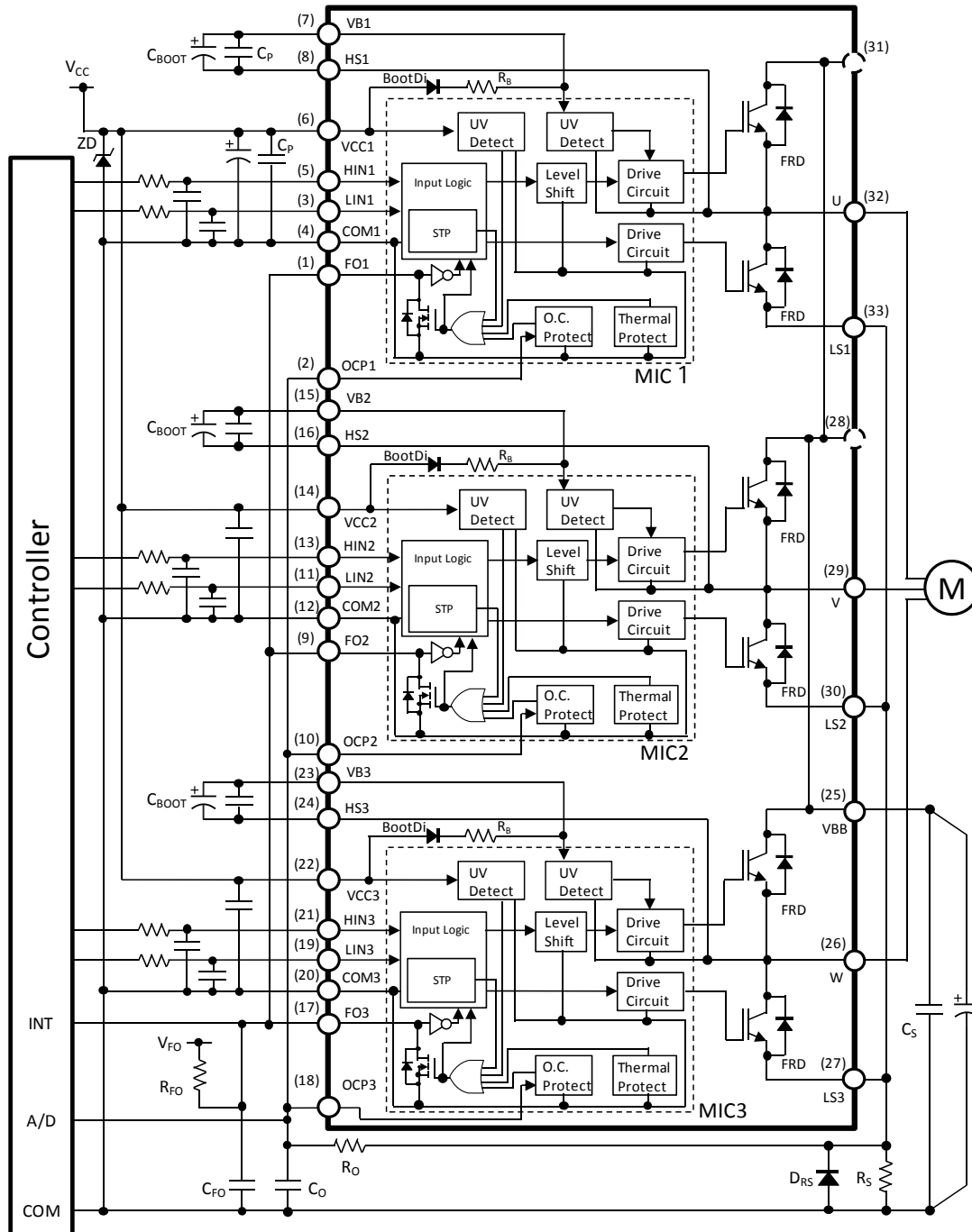
See application notes on next page.

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 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.

- 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 µs. The internal OCP circuit has a 1.5 µs (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 µs, permanent damage to the SCM1240M may result.

- To suppress noise, connect a resistor, RF, and capacitor, CF, to the $\overline{FO}$x pins. Also, when an overcurrent condition is detected, the $\overline{FO}$x pin goes low for 25 µs (typ) as an active low fault flag, and then returns up to its normal state. It is recommended to connect the $\overline{FO}$x pin directly to an interrupt pin of the external controller, to ensure the 25 µs interval is detected.

- To provide the best thermal shutdown protection (TSD), it is strongly recommended that the three $\overline{FO}$x 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 $\overline{FO}$x 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°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, 3 phases operating		–	3	–	mA
Bootstrap Supply Current	I_{BS}	VB – HS = 15 V, one phase operating		–	140	–	µA
Input Voltage	V_{IH}	V_{CC} = 15 V, output on		–	2.0	2.5	V
	V_{IL}	V_{CC} = 15 V, output off		1.0	1.5	–	V
Input Voltage Hysteresis	V_{Ihys}	V_{CC} = 15 V		–	0.5	–	V
Input Current	I_{IHH}	V_{CC} = 15 V, V_{IN} = 5 V		–	230	500	µA
	I_{ILH}	V_{CC} = 15 V, V_{IN} = 0 V		–	–	2	µA
Undervoltage Lock Out (High Side)	U_{VHL}	V_{CC} = 15 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 V		10.0	11.0	12.0	V
	U_{VLH}			10.5	11.5	12.5	V
$\overline{FO}$ Terminal Output Voltage	V_{FOL}	V_{CC} = 15 V, V_{FO} = 5 V, R_{FO} = 10 kΩ		–	–	0.5	V
	V_{FOH}			4.8	–	–	V
Overcurrent Protection Trip Voltage	V_{TRIP}	V_{CC} = 15 V		0.46	0.50	0.54	V
Overcurrent Protection Hold Time	t_P	V_{CC} = 15 V		20	25	–	µs
Overtemperature Protection Activation and Releasing Temperature	T_{DH}	V_{CC} = 15 V		135	150	165	°C
	T_{DL}			105	120	135	°C
Blanking Time	t_{blank}	V_{CC} = 15 V		–	1.65	–	µs
IGBT Breakdown Voltage	V_{CES}	V_{CC} = 15 V, I_C = 1 mA, 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	$V_{CE(sat)}$	SCM1241M	V_{CC} = 15 V, I_C = 10 A, V_{IN} = 5 V	–	1.7	2.2	V
		SCM1243MF	V_{CC} = 15 V, I_C = 15 A, V_{IN} = 5 V	–	1.7	2.2	V
		SCM1245MF	V_{CC} = 15 V, I_C = 20 A, V_{IN} = 5 V	–	1.7	2.2	V
		SCM1246MF	V_{CC} = 15 V, I_C = 30 A, V_{IN} = 5 V	–	1.7	2.2	V
Diode Forward Voltage	V_F	SCM1241M	V_{CC} = 15 V, I_F = 10 A, V_{IN} = 0 V	–	1.9	2.4	V
		SCM1243MF	V_{CC} = 15 V, I_F = 15 A, V_{IN} = 0 V	–	1.75	2.2	V
		SCM1245MF	V_{CC} = 15 V, I_F = 20 A, V_{IN} = 0 V	–	1.9	2.4	V
		SCM1246MF	V_{CC} = 15 V, I_F = 30 A, V_{IN} = 0 V	–	1.5	2.0	V
Diode Recovery Time (Bootstrap)	t_{rr}	I_F = $I_{RECOVERY(PEAK)}$ = 100 mA		–	70	–	ns
Diode Leakage Current (Boot Strap)	I_{IB}	V_R = 600 V		–	–	10	µA
Diode Forward Voltage (Boot Strap)	V_{FB}	I_F = 0.15 A		–	1.1	1.3	V
Diode Series Resistor (Boot Strap)	R_B			17.6	22.0	26.4	Ω

Continued on the next page…

ELECTRICAL CHARACTERISTICS, valid at T$_A$=25°C, unless otherwise noted

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

Continued on the next page…

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

| Characteristics	Symbol	Conditions		Min	Typ	Max	Units
Low Side Switching Time	$t_{dL(on)}$	SCM1241M	V_{DC} = 300 V, V_{CC} = 15 V, I_C = 10 A, inductive load; LIN = 0→5 V or 5→0 V	–	570	–	ns
	t_{rL}			–	100	–	ns
	t_{rrL}			–	70	–	ns
	$t_{dL(off)}$			–	560	–	ns
	t_{fL}			–	100	–	ns
	$t_{dL(on)}$	SCM1243MF	V_{DC} = 300 V, V_{CC} = 15 V, I_C = 15 A, inductive load; LIN = 0→5 V or 5→0 V	–	600	–	ns
	t_{rL}			–	100	–	ns
	t_{rrL}			–	80	–	ns
	$t_{dL(off)}$			–	600	–	ns
	t_{fL}			–	70	–	ns
	$t_{dL(on)}$	SCM1245MF	V_{DC} = 300 V, V_{CC} = 15 V, I_C = 20 A, inductive load; LIN = 0→5 V or 5→0 V	–	715	–	ns
	t_{rL}			–	135	–	ns
	t_{rrL}			–	115	–	ns
	$t_{dL(off)}$			–	670	–	ns
	t_{fL}			–	50	–	ns
	$t_{dL(on)}$	SCM1246MF	V_{DC} = 300 V, V_{CC} = 15 V, I_C = 30 A, inductive load; LIN = 0→5 V or 5→0 V	–	660	–	ns
	t_{rL}			–	150	–	ns
	t_{rrL}			–	70	–	ns
	$t_{dL(off)}$			–	690	–	ns
	t_{fL}			–	50	–	ns

Switching Timing Definitions
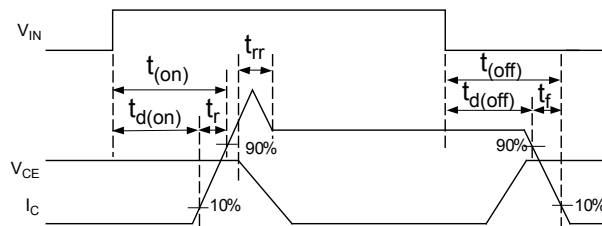
Input-Output Truth Table

Mode	HINx	LINx	High-side MOSFET	Low-side MOSFET
Normal[1]	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[2]	L	L	Off	Off
	H	L	Off	Off
	L	H	Off	Off
	H	H	Off	Off
VBx UVLO[3]	L	L	Off	Off
	H	L	Off	Off
	L	H	Off	On
	H	H	Off	Off
$\overline{FO}$x Low	L	L	Off	Off
	H	L	Off	Off
	L	H	Off	Off
	H	H	Off	Off

[1]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.
[2]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).
[3]After the VBx power rail recovers from a UVLO condition, a rising edge of HINx starts driving the high-side IGBT (edge trigger).
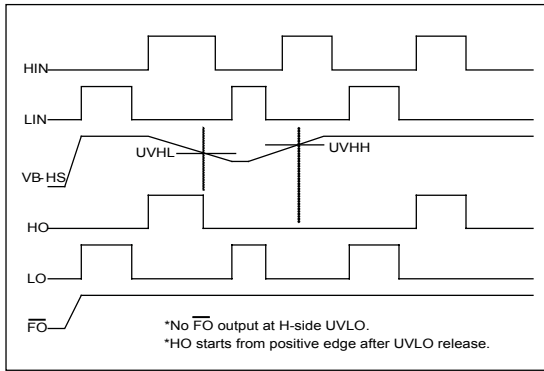
Pin-out Diagram
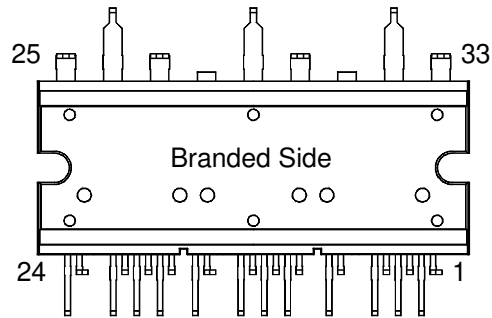
(Bottom View)

Terminal List Table

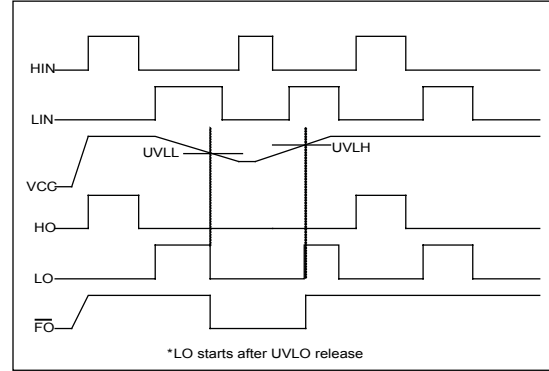| Name	Number	Function
1	$\overline{FO}$1	U phase fault output for overcurrent and UVLO detected
2	OCP1	Input for U phase overcurrent protection
3	LIN1	Signal input for low-side U phase (active high)
4	COM1	Supply ground for U phase IC
5	HIN1	Signal input for high-side U phase (active high)
6	VCC1	Supply 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	$\overline{FO}$2	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	$\overline{FO}$3	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
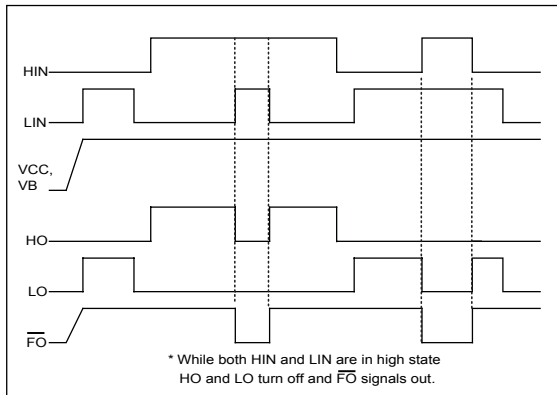V_{CC} = 15 V

HIN
LIN
UVHL · UVHH
VB-HS
HO
LO
$\overline{FO}$

*No $\overline{FO}$ output at H-side UVLO.
*HO starts from positive edge after UVLO release.

Low-Side Driver Input/Output and UVLO Protection
VB – HS = 15 V

HIN
LIN
UVLL · UVLH
VCC
HO
LO
$\overline{FO}$

*LO starts after UVLO release

Shoot-Through Prevention
V_{CC}, VB – HS = 15 V

HIN
LIN
VCC, VB
HO
LO
$\overline{FO}$

* While both HIN and LIN are in high state
HO and LO turn off and $\overline{FO}$ signals out.

Thermal Shutdown

HIN
LIN
Tmic · TDH · TDL
HO
LO
$\overline{FO}$

*Tmic is the temperature of the predriver IC (MIC)
*HO and LO start after TSD release

Overcurrent Protection

HIN
LIN
HO
LO
Vtrip
(0.5 V TYP)
OCP
Blanking Time
(1.65 µs TYP)
$\overline{FO}$
20 µs(min)

*HO and LO start after OCP release
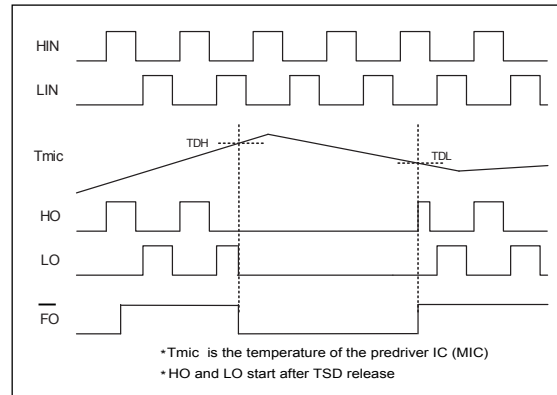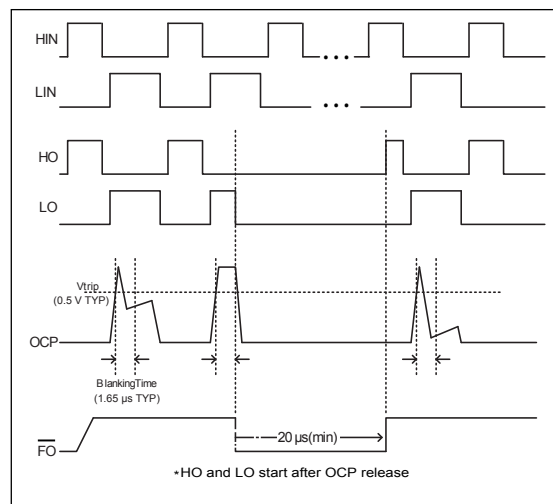
PACKAGE OUTLINE DRAWING

(Bottom View)

Branding Area

Two different types of marks to be used:
Mark 1: ◯ Mark 2: ◎

(Top View)

Cu Thermal Pad

Pin pitch measured at root
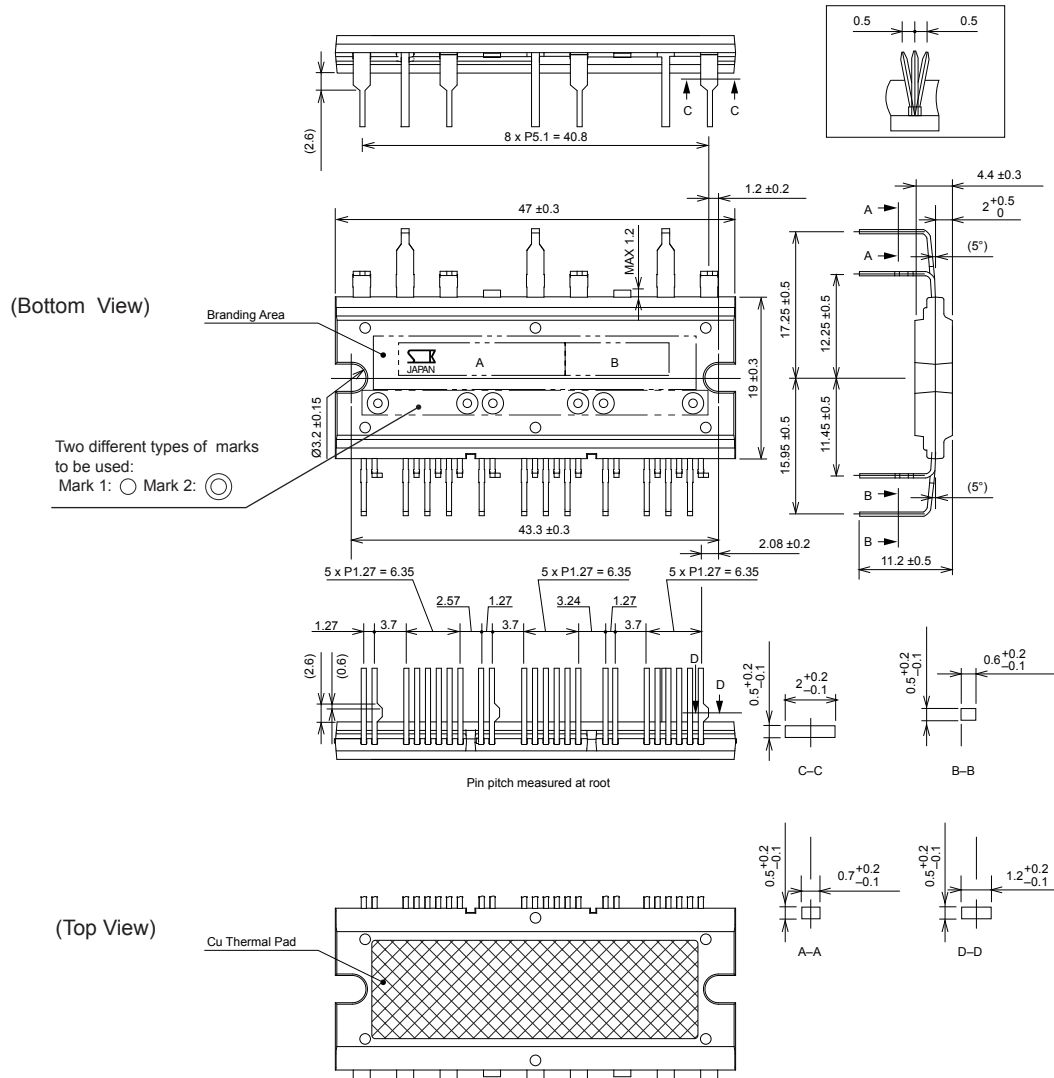
Leadform: 2551 (SCM1241M: Fully molded) or
2552 (SCM1243MF, SCM1245MF, SCM1246MF:
Exposed copper thermal pad)
Dimensions in millimeters

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
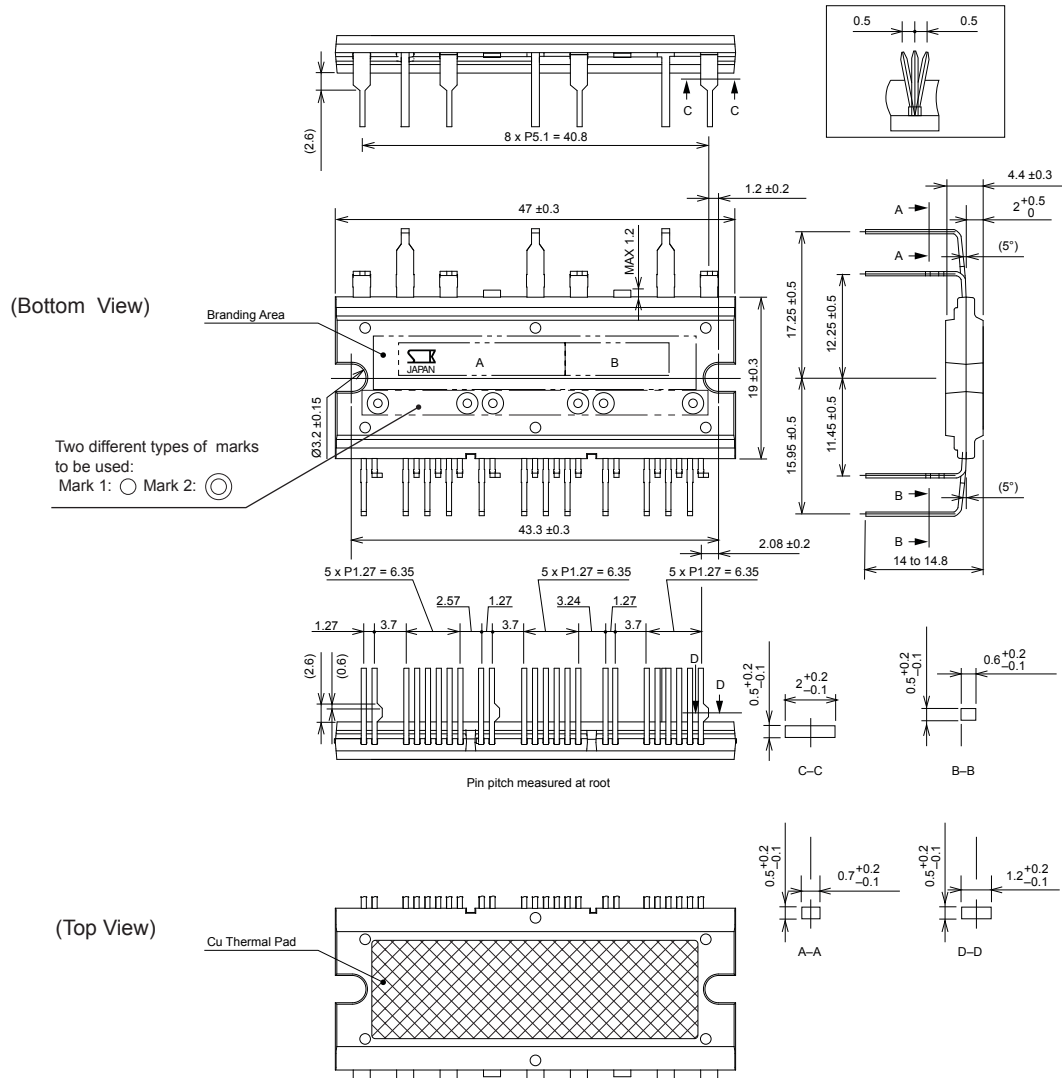laser on the body so that cannot be erased easily.

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.

(Bottom View)

Branding Area

Two different types of marks to be used:
Mark 1: ◯ Mark 2: ◎

Pin pitch measured at root

(Top View)

Cu Thermal Pad

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
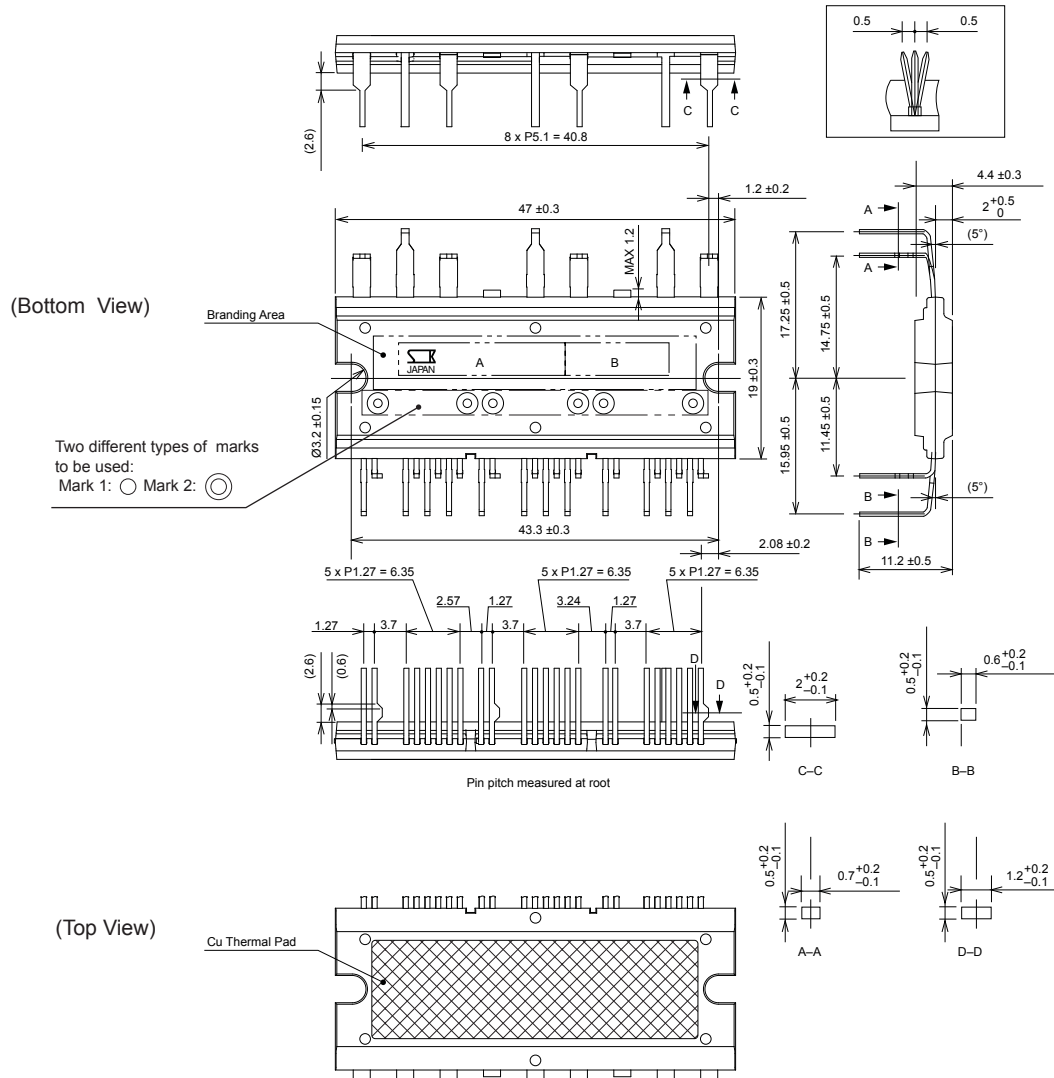laser on the body so that cannot be erased easily.

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Device composition complies with the RoHS directive.

(Bottom View)

Branding Area

Two different types of marks
to be used:
Mark 1: ○ Mark 2: ◎

(Top View)

Cu Thermal Pad

Pin pitch measured at root

C–C

B–B

A–A

D–D

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
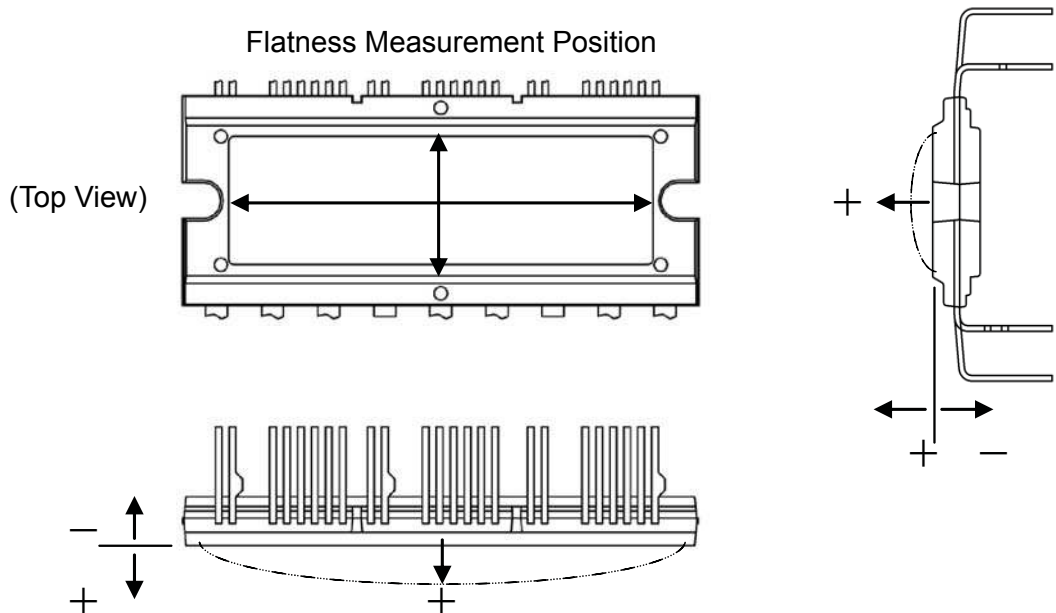laser on the body so that cannot be erased easily.

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)

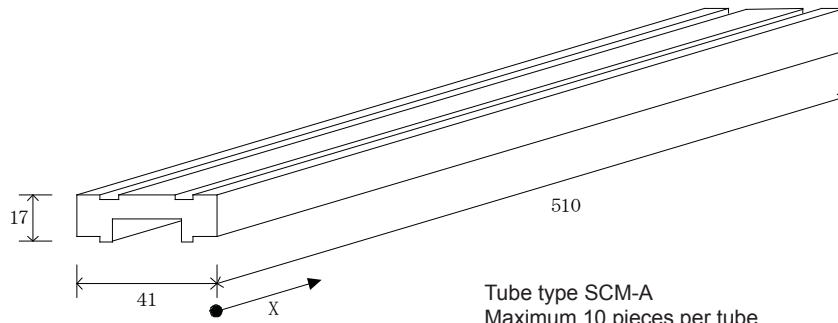*Device composition complies with the RoHS directive.*

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

Flatness Measurement Position

(Top View)

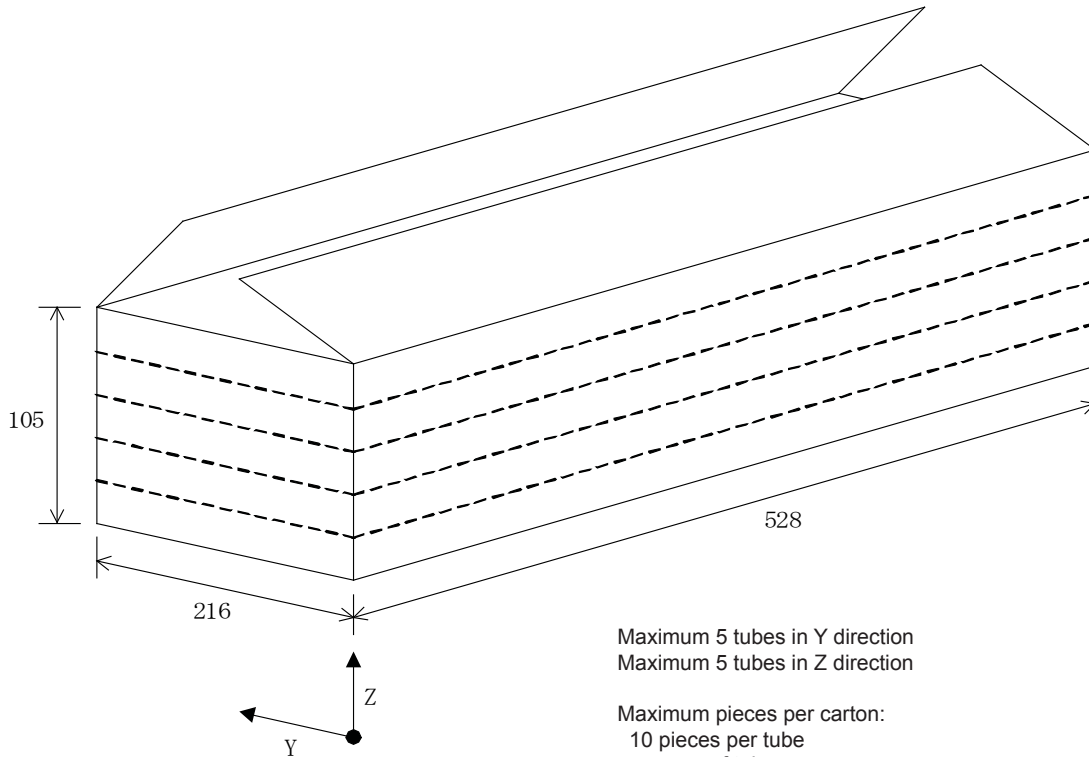# SCM1240M   *High Voltage, High Current 3-Phase Motor Drivers*

PACKING SPECIFICATION

Dimensions in millimeters

17

510

41

X

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

105

528

216

Z

Y

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

SCM1240M   *High Voltage, High Current 3-Phase Motor Drivers*
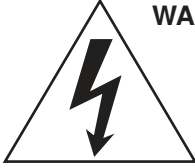
<table>
<tr><td>⚠</td><td>WARNING — These devices are designed to be operated at lethal voltages and energy levels. Circuit designs that embody these components must conform with applicable safety requirements. Precautions must be taken to prevent accidental contact with power-line potentials. Do not connect grounded test equipment.

The use of an isolation transformer is recommended during circuit development and breadboarding.</td></tr>
</table>

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 Kgf•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 other 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.

SANKEN ELECTRIC CO., LTD.

- The contents in this document are subject to changes, for improvement and other purposes, without notice. Make sure that this is the latest revision of the document before use.

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- In the case that you use our semiconductor devices or design your products by using our semiconductor devices, the reliability largely depends on the degree of derating to be made to the rated values. Derating may be interpreted as a case that an operation range is set by derating the load from each rated value or surge voltage or noise is considered for derating in order to assure or improve the reliability. In general, derating factors include electric stresses such as electric voltage, electric current, electric power etc., environmental stresses such as ambient temperature, humidity etc. and thermal stress caused due to self-heating of semiconductor devices. For these stresses, instantaneous values, maximum values and minimum values must be taken into consideration.
  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.

- When using the products specified herein by either (i) combining other products or materials therewith or (ii) physically, chemically or otherwise processing or treating the products, please duly consider all possible risks that may result from all such uses in advance and proceed therewith at your own responsibility.

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