# *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
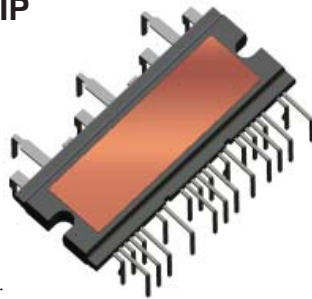
Not to scale.
Thermal pad shown attached.

Description

The SCM1105MF 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 15 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 with exposed thermal pad for enhanced power dissipation capacity. 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
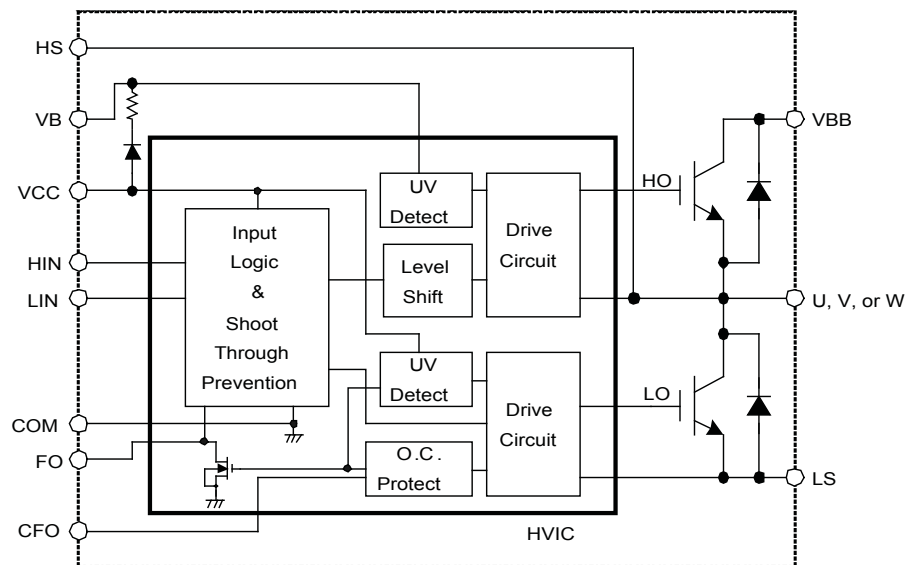- Air conditioner compressor motor

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)
SCM1105MF	10 pieces per tube	600	1.75	15	30

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	T_{Case} = 25°C	15	Adc
		T_{Case} = 100°C	10.5	Adc
Output Current, Pulsed	I_{OP}	Pulse Width ≤ 1 ms	30	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°C, 1 element operation (IGBT)	41.7	W
		T_{Case} = 100°C, 1 element operation (IGBT)	16.7	W
Thermal Resistance, Junction-to-Case	$R_{(j-c)Q}$	1 element operation (IGBT)	3.0	°C/W
	$R_{(j-c)F}$	1 element operation (FRD)	4.0	°C/W
Case Operation 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 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	$t_{INmin(on)}$	On pulse	0.5	–	–	µs
	$t_{INmin(off)}$	Off pulse	0.5	–	–	µs
Dead Time	t_{dead}		1.5	–	–	µs
FO Pull-up Resistor	R_{FO}		1	–	22	kΩ
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 ≤ 30 A	16.3	–	–	mΩ
PWM Carrier Frequency	f_C		–	–	10	kHz
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.

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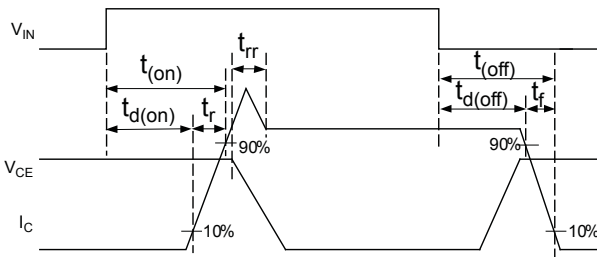1.508.853.5000; www.allegromicro.com

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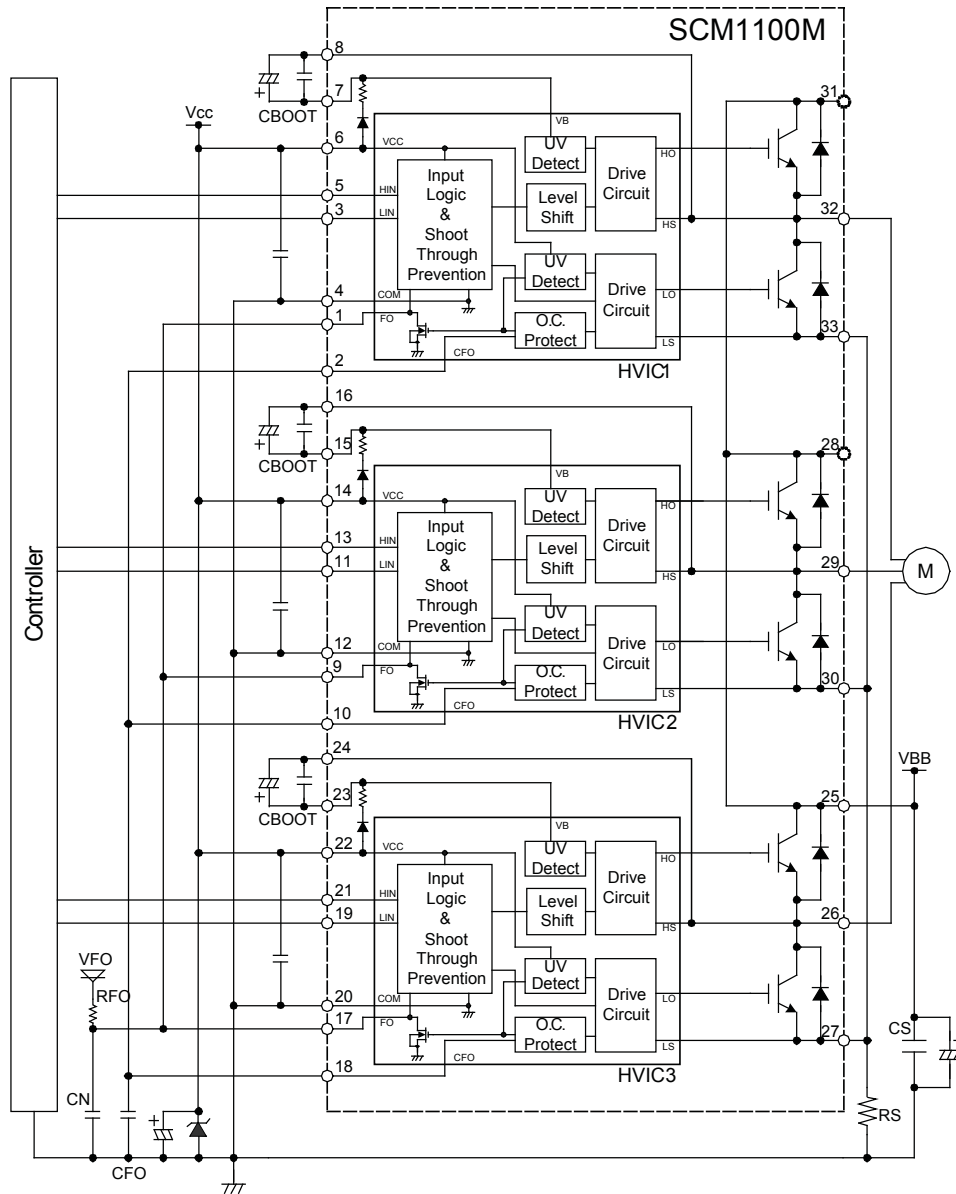
NOTE:
- To use the OCP circuit, an external shunt resistor, RS, is needed. The RS value can be obtained from the formula:

$$R_S(\Omega) = 0.5 \text{ (V)} / \text{Overcurrent Detection Set Current (A)} - 0.0024 \text{ } (\Omega).$$

- 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°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	–	5	8	mA
Bootstrap Supply Current	I_{BS}	VB – HS = 15 V, one phase operating	–	400	800	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	–	50	100	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	–	12.0	V
	U_{VHH}		10.5	–	12.5	V
Undervoltage Lock Out (Low Side)	U_{VLL}	V_{CC} = 15 V	10.5	–	12.5	V
	U_{VLH}		11.0	–	13.0	V
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, C_{FO} = 0.0022 µF	2	–	–	ms
Blanking Time	t_{blank}	V_{CC} = 15 V	–	2	–	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	$V_{CE(sat)}$	V_{CC} = 15 V, I_C = 15 A, V_{IN} = 5 V	–	1.75	2.2	V
Diode Forward Voltage	V_F	V_{CC} = 15 V, I_F = 15 A, V_{IN} = 0 V	–	1.75	2.2	V
Diode Recovery Time (Bootstrap)	t_{rr}	I_F / I_{RP} = 100 mA/100 mA	–	70	–	ns
Diode Leakage Current (Bootstrap)	I_{IB}	V_R = 600 V	–	5	10	µA
Diode Forward Voltage (Bootstrap)	V_{FB}	I_F = 0.15 A	–	1.1	1.3	V
Diode Series Resistor (Bootstrap)	R_B		17.6	22.0	26.4	Ω
High Side Switching Time	$t_{dH(on)}$	V_{DC} = 300 V, V_{CC} = 15V, I_C = 15 A, inductive load; HIN 0→5 V or 5→0 V	–	365	–	ns
	t_{rH}		–	80	–	ns
	t_{rrH}		–	90	–	ns
	$t_{dH(off)}$		–	690	–	ns
	t_{fH}		–	200	–	ns
Low Side Switching Time	$t_{dL(on)}$	V_{DC} = 300 V, V_{CC} = 15V, I_C = 15 A, inductive load; LIN 0→5 V or 5→0 V	–	415	–	ns
	t_{rL}		–	135	–	ns
	t_{rrL}		–	115	–	ns
	$t_{dL(off)}$		–	790	–	ns
	t_{fL}		–	205	–	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

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SCM1105MF

High Voltage 3-Phase Motor Driver

Pin-out Diagram

25   33

Branded Side

24   1
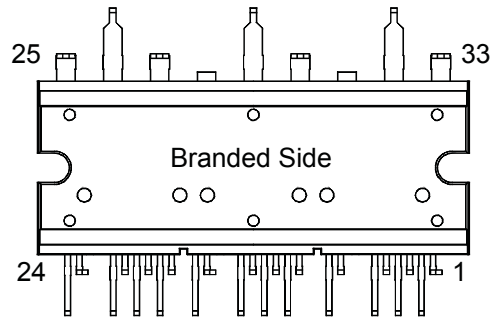
(Bottom View)

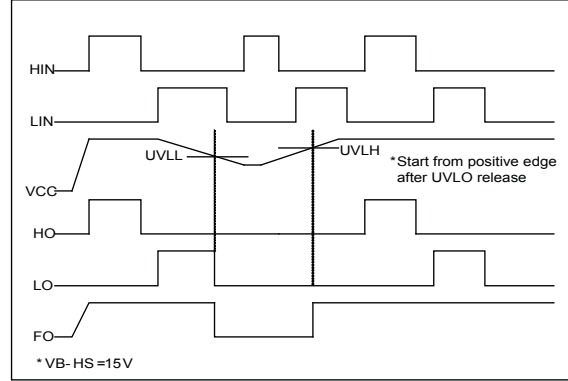**Terminal List Table**

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

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Timing Diagrams

High-Side Driver Input/Output

HIN
LIN
UVHL
UVHH
*Start from positive edge after UVLO release
VB-HS
HO
LO
FO
* No output at H-side UVLO
*V_{CC} = 15 V

Low-Side Driver Input/Output

HIN
LIN
UVLL
UVLH
*Start from positive edge after UVLO release
VCC
HO
LO
FO
* VB-HS =15 V
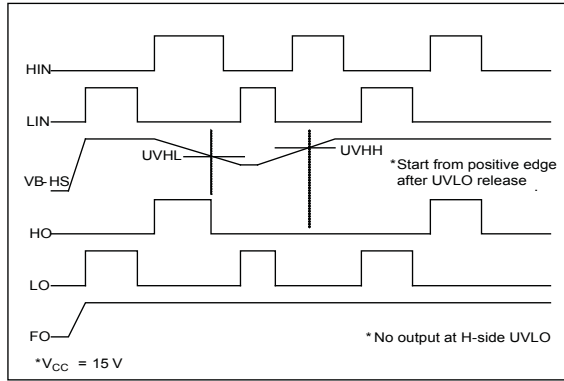
Shoot-Through Prevention

HIN
LIN
VCC
HO
LO
FO
*V_{CC} ,VB-HS = 15 V
*While both HIN and LIN are in high state HO and LO turn off and FO signals out

Overcurrent Protection

LIN
VB-HS
VCC
IGBT turns off softly after overcurrent condition is detected
LS
Blanking Time (2 μs typ.)
FO
CFO
V_{rc} (3.5 V typ.)
The slope depends on C_{FO} capacitance
OCP Assist Timer (2 μs min.)
* Off operation of all phases can be done by wired OR system with the three FO pins short circuited
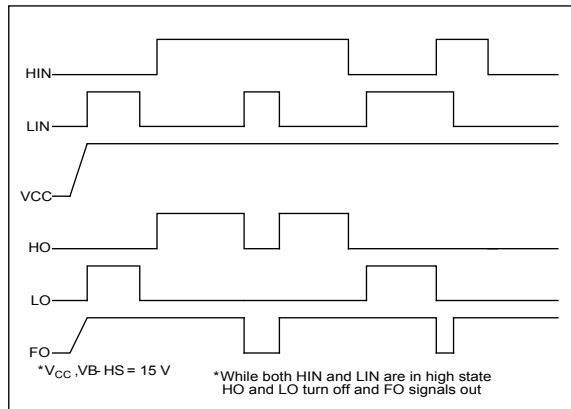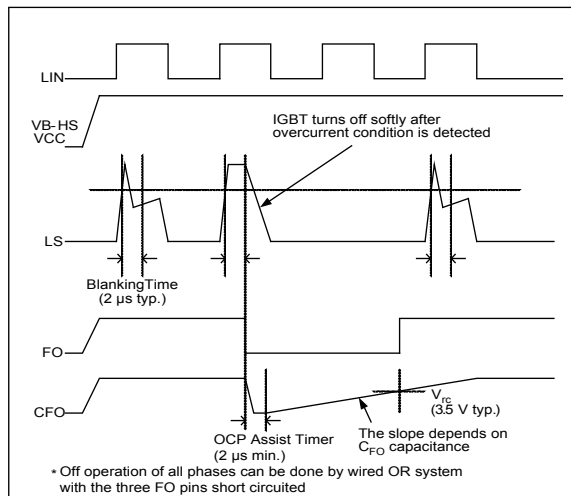
PACKAGE OUTLINE DRAWING
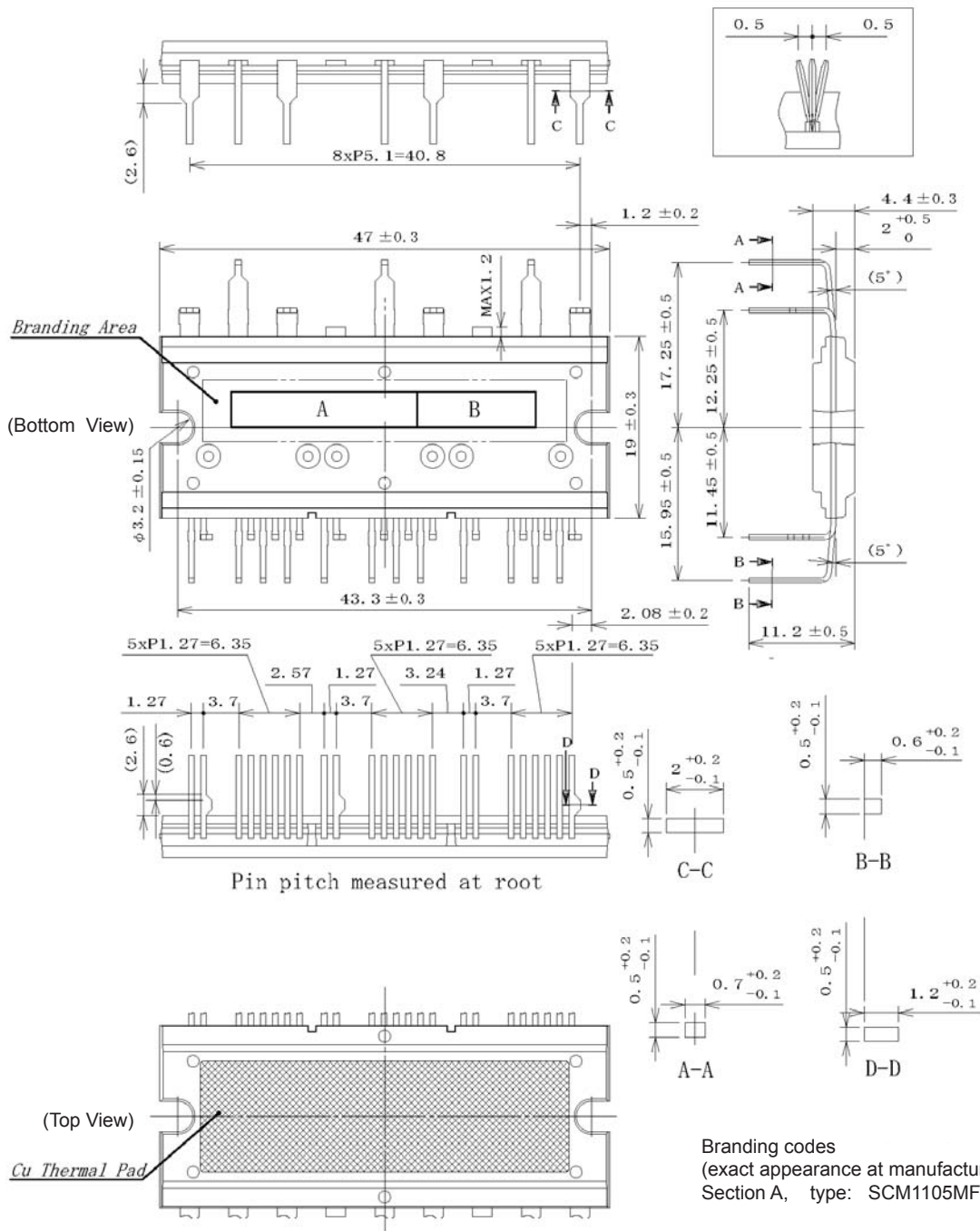
Branding codes
(exact appearance at manufacturer discretion):
Section A, type: SCM1105MF

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)
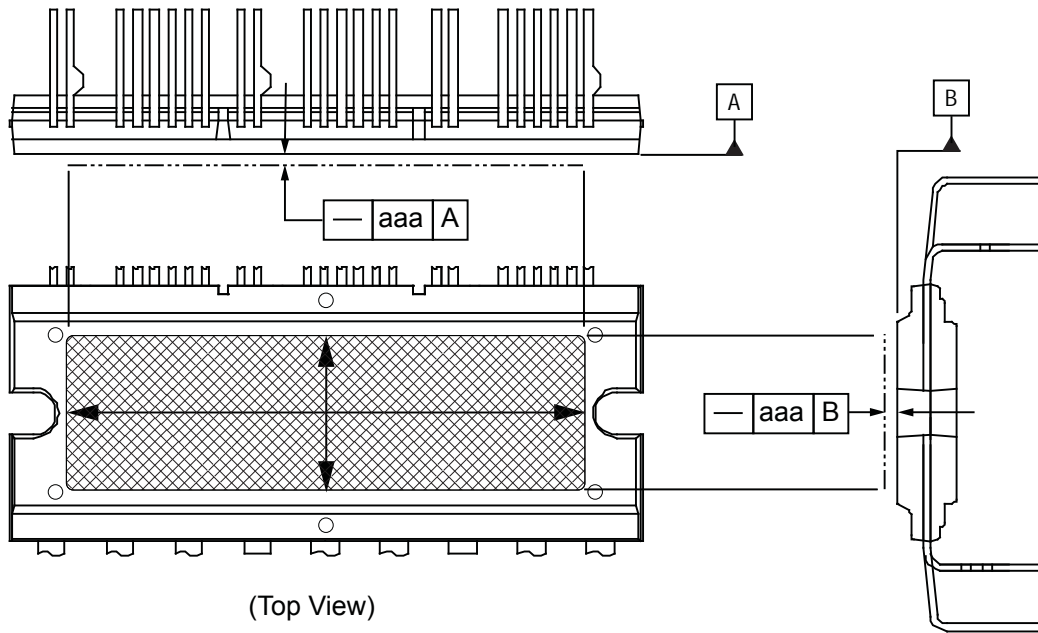 DD is the date
  T is the tracking letter (A to Z)

(Bottom View)

(Top View)
Cu Thermal Pad

Leadform: 2552
Dimensions in millimeters

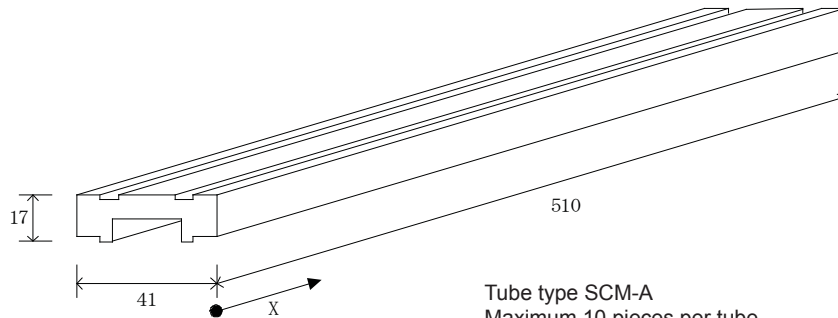*Leadframe plating Pb-free. Device composition complies with the RoHS directive.*

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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)	0	–	150	μm
Package Weight		–	13.5	–	g

(Top View)

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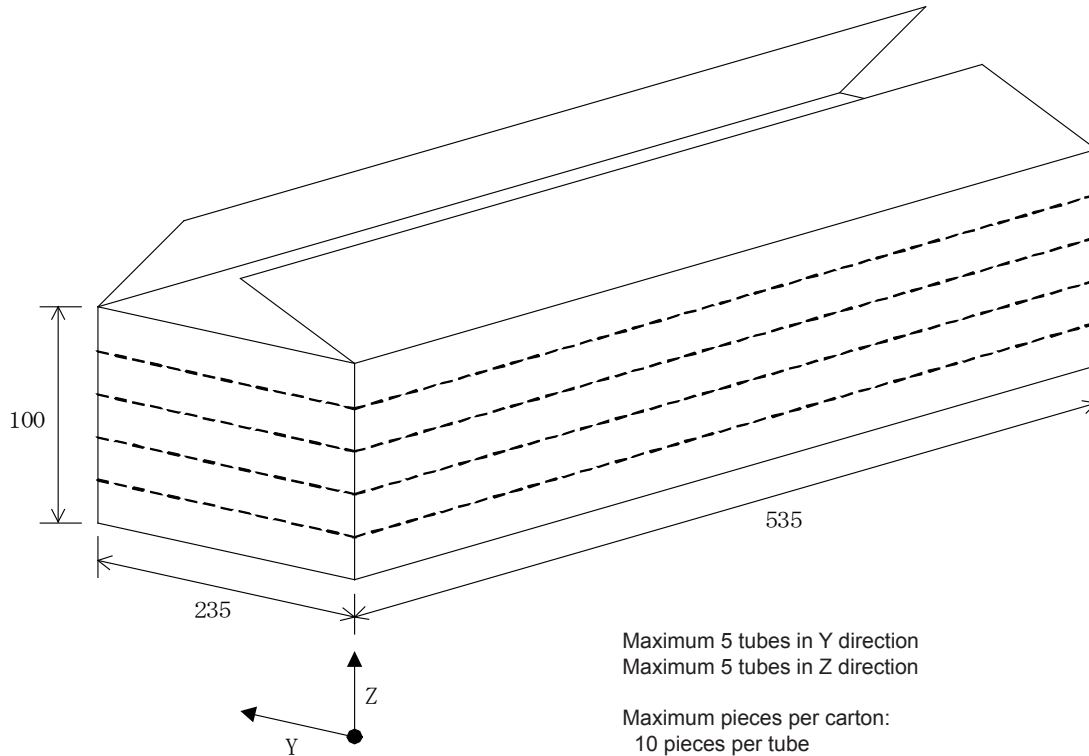1.508.853.5000; www.allegromicro.com

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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

100

535

235

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

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> ⚠ **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 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.

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

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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.

The use of Sanken products without the written consent of Sanken in applications where extremely high reliability is required (aerospace equipment, nuclear power-control stations, life-support systems, etc.) is strictly prohibited.

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