High Voltage 3-Phase Motor Drivers

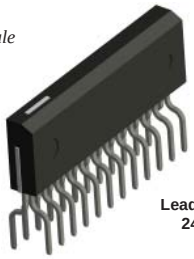
Features and Benefits

- Built-in pre-drive IC
- MOSFET power element
- CMOS compatible input (5 V)
- High-side gate driver using bootstrap circuit or floating power supply
- Built-in protection circuit for controlling power supply voltage drop
- Built-in overtemperature detection circuit (TD)
- Output of fault signal during operation of protection circuits
- Output current 1.5, 2, and 2.5 A
- Small SIP (SMA 24-pin)

Packages: Power SIP

Not to scale

Leadform 2451



Leadform 2452

Description

The SMA6850M inverter power module (IPM) series 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 230 VAC input voltage, and up to 2.5 A (continuous) output current. They can withstand voltages of up to 500 V (MOSFET breakdown voltage).

The SMA6850M power package includes an IC with all of the necessary power elements (six MOSFETs), pre-driver ICs (two), and flyback diodes (six), needed to configure the main circuit of an inverter. 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 fan
- Small ventilation fan
- Dishwasher pump

Functional Block Diagram

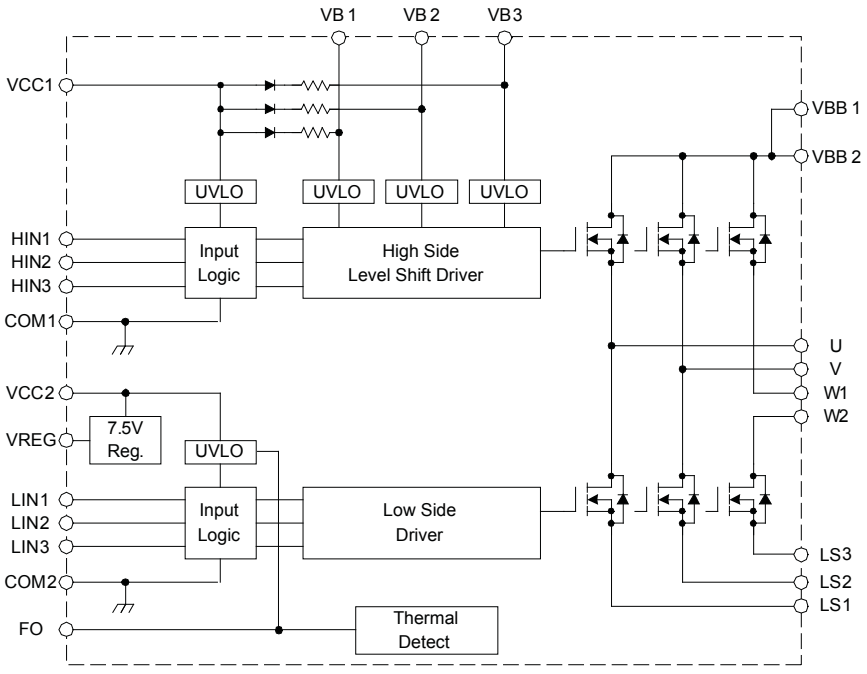


Figure 1. Driver block diagram

Selection Guide

Part Number	Packing	MOSFET Breakdown Voltage, V_{DSS}(min) (V)	Output Current	
			Continuous, I_O(max) (A)	Pulsed, I_{OP} (max) (A)
SMA6851M	18 pieces per tube	250	2	4
SMA6852M	18 pieces per tube	500	1.5	3
SMA6853M	18 pieces per tube	500	2.5	5

Absolute Maximum Ratings, valid at T_A = 25°C

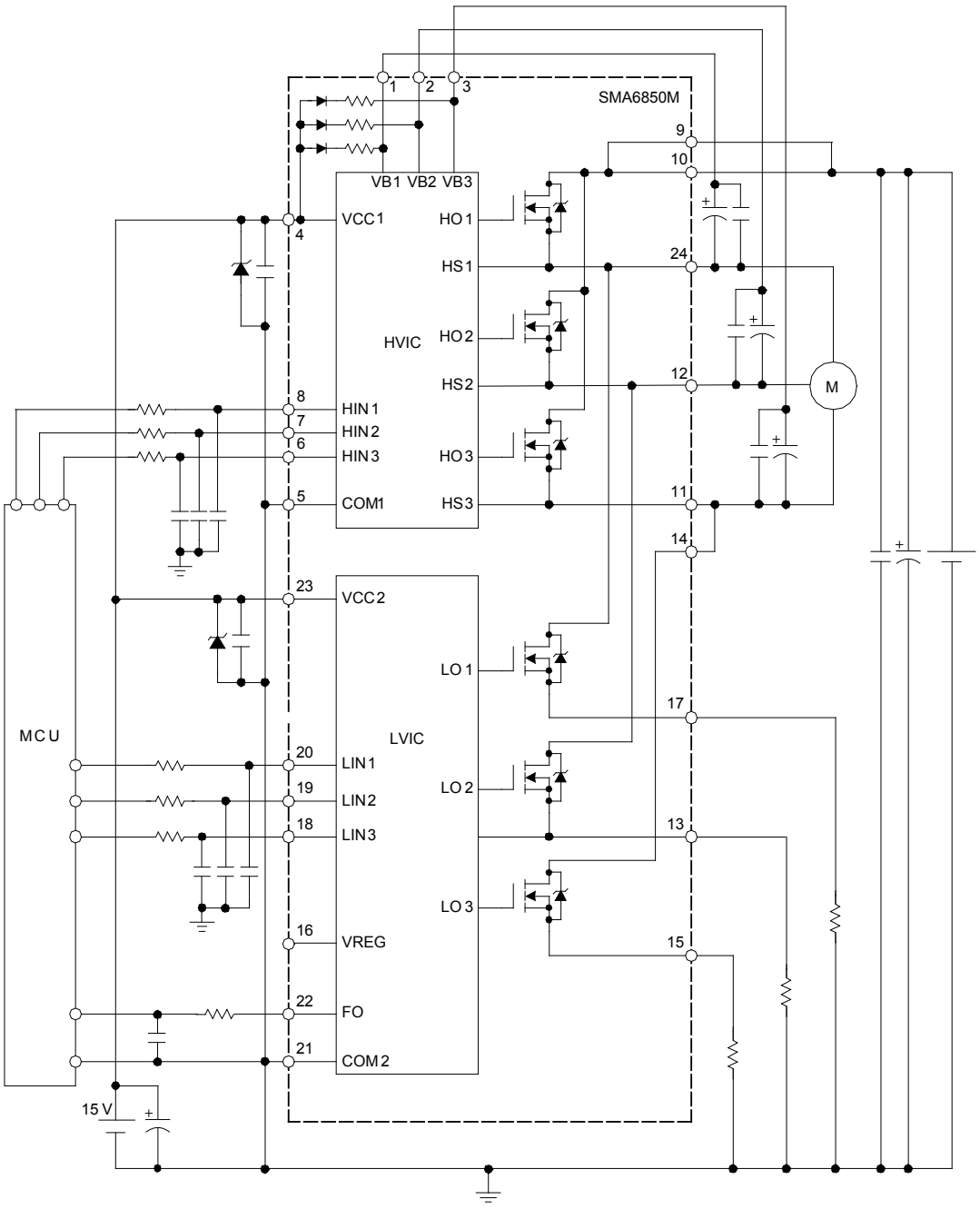
Characteristic	Symbol	Remarks		Rating	Unit
MOSFET Breakdown Voltage	V_{DSS}	SMA6851M	V_{CC} = 15 V, I_D = 100 µA, V_{IN} = 0 V	250	V
		SMA6852M		500	V
		SMA6853M		500	V
Logic Supply Voltage	V_{CC}	Between VCC and COM		20	V
Bootstrap Voltage	V_{BS}	Between VB and HS (U,V, and W phases)		20	V
Output Current, Continuous	I_O	SMA6851M		2	A
		SMA6852M		1.5	A
		SMA6853M		2.5	A
Output Current, Pulsed	I_{OP}	SMA6851M	PW ≤ 100 µs, duty cycle = 1%	4	A
		SMA6852M		3	A
		SMA6853M		5	A
Input Voltage	V_{IN}			–0.5 to 7	V
Allowable Power Dissipation	P_D	T_C = 25°C		28	W
Thermal Resistance (Junction to Case)	$R_{\theta JC}$	All elements operating		4.46	°C/W
Thermal Resistance (Junction to Ambient)	$R_{\theta JA}$	All elements operating		31.25	°C/W
Case Operating Temperature	T_{COP}			–20 to 100	°C
Junction Temperature (MOSFET)	T_J			150	°C
Storage Temperature	T_{stg}			–40 to 150	°C

Recommended Operating Conditions

Characteristic	Symbol		Remarks	Min.	Typ.	Max.	Units
Main Supply Voltage	V_{BB}	SMA6851M	Between VBB and LS	–	150	200	V
		SMA6852M		–	280	400	V
		SMA6853M		–	280	400	V
Logic Supply Voltage	V_{CC}		Between VCC and COM	13.5	–	16.5	V
Minimum Input Pulse	T_W(min)			0.5	–	–	µs
Dead Time	t_{dead}			1.5	–	–	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



NOTE:

- All of the input pins are connected to GND with internal pull-down resistors rated at 100 kΩ, however, an external pull-down resistor may be required to secure stable condition of the inputs if high impedance conditions are applied to them.
- The external electrolytic capacitors should be placed as close to the IC as possible, in order to avoid malfunctions from external noise interference. Put a ceramic capacitor in parallel with the electrolytic capacitor if further reduction of noise susceptibility is necessary.

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	15	16.5	V
Logic Supply Current	I_{CC}	V_{CC} = 15 V, I_{REG} = 0 A		–	4	6	mA
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_{IH}	High side, V_{CC} = 15 V, V_{IN} = 5 V		–	50	100	µA
	I_{IL}	Low side, V_{CC} = 15 V, V_{IN} = 0 V		–	–	2	µA
Undervoltage Lock Out	V_{UVHL}	High side, between VB and U, V, or W		9.0	10.0	11.0	V
	V_{UVHH}			9.5	10.5	11.5	V
	V_{UVHhys}	High side, hysteresis		–	0.5	–	V
	V_{UVLL}	Low side, between VCC and COM		10.0	11.0	12.0	V
	V_{UVLH}			10.5	11.5	12.5	V
	V_{UVLhys}	Low side, hysteresis		–	0.5	–	V
FO Terminal Output Voltage	V_{FOL}	V_{CC} = 15 V		0	–	1.0	V
	V_{FOH}			4.0	–	5.5	V
Overtemperature Detection Threshold Temperature (activation and deactivation)	T_{DH}	V_{CC} = 15 V, no heatsink		135	150	165	°C
	T_{DL}			105	120	135	°C
	T_{Dhys}			–	30	–	°C
Output Voltage for Regulator	V_{REG}	I_{REG} = 35 mA, T_C = –20°C to 100°C		6.75	7.5	8.25	V
Bootstrap Diode Leakage Current	I_{LBD}	V_R = 500 V		–	–	10	µA
Bootstrap Diode Forward Voltage	V_{FBD}	I_F = 0.15 A		–	1.1	1.3	V
Bootstrap Diode Series Resistor	R_{BD}			17.6	22	26.4	Ω
MOSFET Breakdown Voltage	V_{DSS}	SMA6851M	V_{CC} = 15 V, I_D = 100 µA, V_{IN} = 0 V	250	–	–	V
		SMA6852M		500	–	–	V
		SMA6853M		500	–	–	V
MOSFET Leakage Current	I_{DSS}	SMA6851M	V_{CC} = 15 V, V_{DS} = 250 V, V_{IN} = 0 V	–	–	100	µA
		SMA6852M	V_{CC} = 15 V, V_{DS} = 500 V, V_{IN} = 0 V	–	–	100	µA
		SMA6853M	V_{CC} = 15 V, V_{DS} = 500 V, V_{IN} = 0 V	–	–	100	µA
MOSFET On State Resistance	$R_{DS(on)}$	SMA6851M	V_{CC} = 15 V, I_D = 1 A, V_{IN} = 5 V	–	1.4	1.8	Ω
		SMA6852M	V_{CC} = 15 V, I_D = 1 A, V_{IN} = 5 V	–	3.6	4.0	Ω
		SMA6853M	V_{CC} = 15 V, I_D = 1.5 A, V_{IN} = 5 V	–	2.0	2.4	Ω
MOSFET Diode Forward Voltage	V_{SD}	SMA6851M	V_{CC} = 15 V, I_{SD} = 1 A, V_{IN} = 0 V	–	1.1	1.5	V
		SMA6852M	V_{CC} = 15 V, I_{SD} = 1 A, V_{IN} = 0 V	–	1.0	1.5	V
		SMA6853M	V_{CC} = 15 V, I_{SD} = 1.5 A, V_{IN} = 0 V	–	1.0	1.5	V
MOSFET Diode Recovery Time	t_{rr}	SMA6851M	I_{SD} = 1.5 A, di/dt = 100 A/µs	–	50	–	ns
		SMA6852M		–	75	–	ns
		SMA6853M		–	75	–	ns

SMA6851M SWITCHING CHARACTERISTICS, valid at T_A=25°C, unless otherwise noted

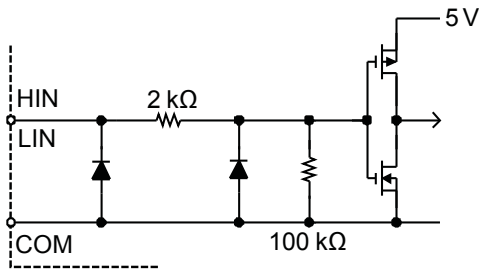
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Switching Time, High Side	$t_{dH(on)}$	V_{BB} = 150 V, V_{CC} = 15 V, I_D = 2 A, 0 V ≤ V_{IN} ≤ 5 V	–	450	–	ns
	t_{rH}		–	100	–	ns
	t_{rr}		–	90	–	ns
	$t_{dH(off)}$		–	350	–	ns
	t_{fH}		–	20	–	ns
Switching Time, Low Side	$t_{dL(on)}$	V_{BB} = 150 V, V_{CC} = 15 V, I_D = 2 A, 0 V ≤ V_{IN} ≤ 5 V	–	550	–	ns
	t_{rL}		–	110	–	ns
	t_{rr}		–	90	–	ns
	$t_{dL(off)}$		–	360	–	ns
	t_{fL}		–	20	–	ns

SMA6852M SWITCHING CHARACTERISTICS, valid at T_A=25°C, unless otherwise noted

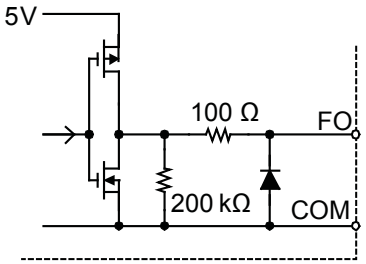
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Switching Time, High Side	$t_{dH(on)}$	V_{BB} = 300 V, V_{CC} = 15 V, I_D = 1.5 A, 0 V ≤ V_{IN} ≤ 5 V	–	550	–	ns
	t_{rH}		–	100	–	ns
	t_{rr}		–	120	–	ns
	$t_{dH(off)}$		–	420	–	ns
	t_{fH}		–	30	–	ns
Switching Time, Low Side	$t_{dL(on)}$	V_{BB} = 300 V, V_{CC} = 15 V, I_D = 1.5 A, 0 V ≤ V_{IN} ≤ 5 V	–	570	–	ns
	t_{rL}		–	100	–	ns
	t_{rr}		–	120	–	ns
	$t_{dL(off)}$		–	450	–	ns
	t_{fL}		–	30	–	ns

SMA6853M SWITCHING CHARACTERISTICS, valid at T_A=25°C, unless otherwise noted

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Switching Time, High Side	$t_{dH(on)}$	V_{BB} = 300 V, V_{CC} = 15 V, I_D = 2.5 A, 0 V ≤ V_{IN} ≤ 5 V	–	640	–	ns
	t_{rH}		–	100	–	ns
	t_{rr}		–	150	–	ns
	$t_{dH(off)}$		–	520	–	ns
	t_{fH}		–	30	–	ns
Switching Time, Low Side	$t_{dL(on)}$	V_{BB} = 300 V, V_{CC} = 15 V, I_D = 2.5 A, 0 V ≤ V_{IN} ≤ 5 V	–	650	–	ns
	t_{rL}		–	100	–	ns
	t_{rr}		–	150	–	ns
	$t_{dL(off)}$		–	580	–	ns
	t_{fL}		–	30	–	ns

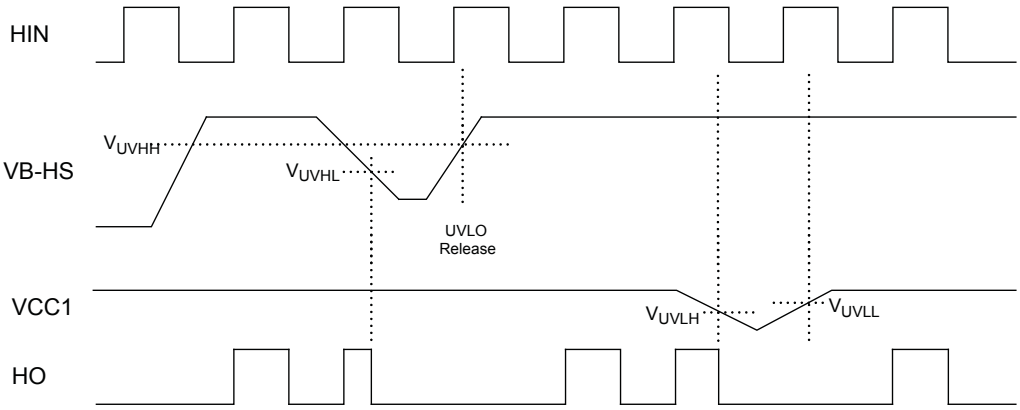


HINx and LINx Terminals Internal Equivalent Circuit

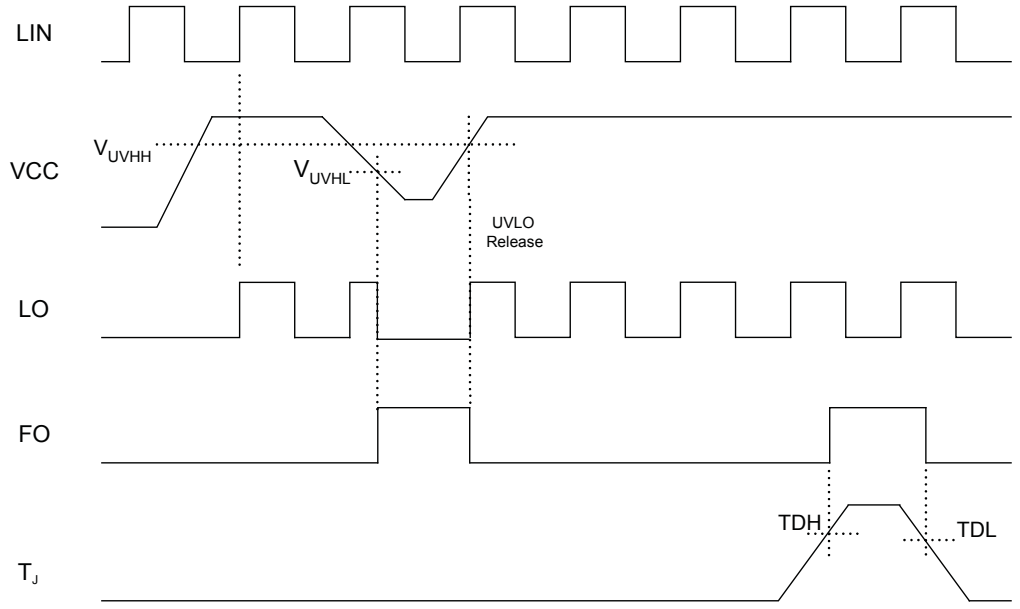


FO Terminal Internal Equivalent Circuit

High Side Driver Input/Output Timing Diagrams

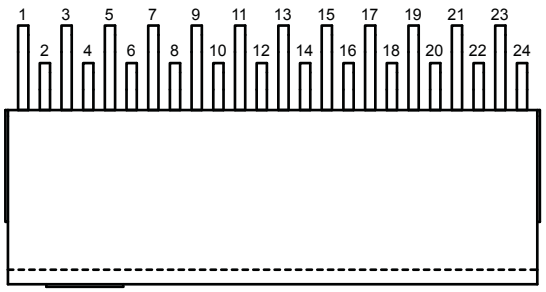


Low Side Driver Input/Output Timing Diagrams



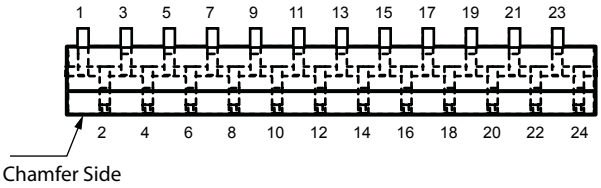
Pin-out Diagrams

Leadform 2451



Chamfer on Opposite Side

Leadform 2452



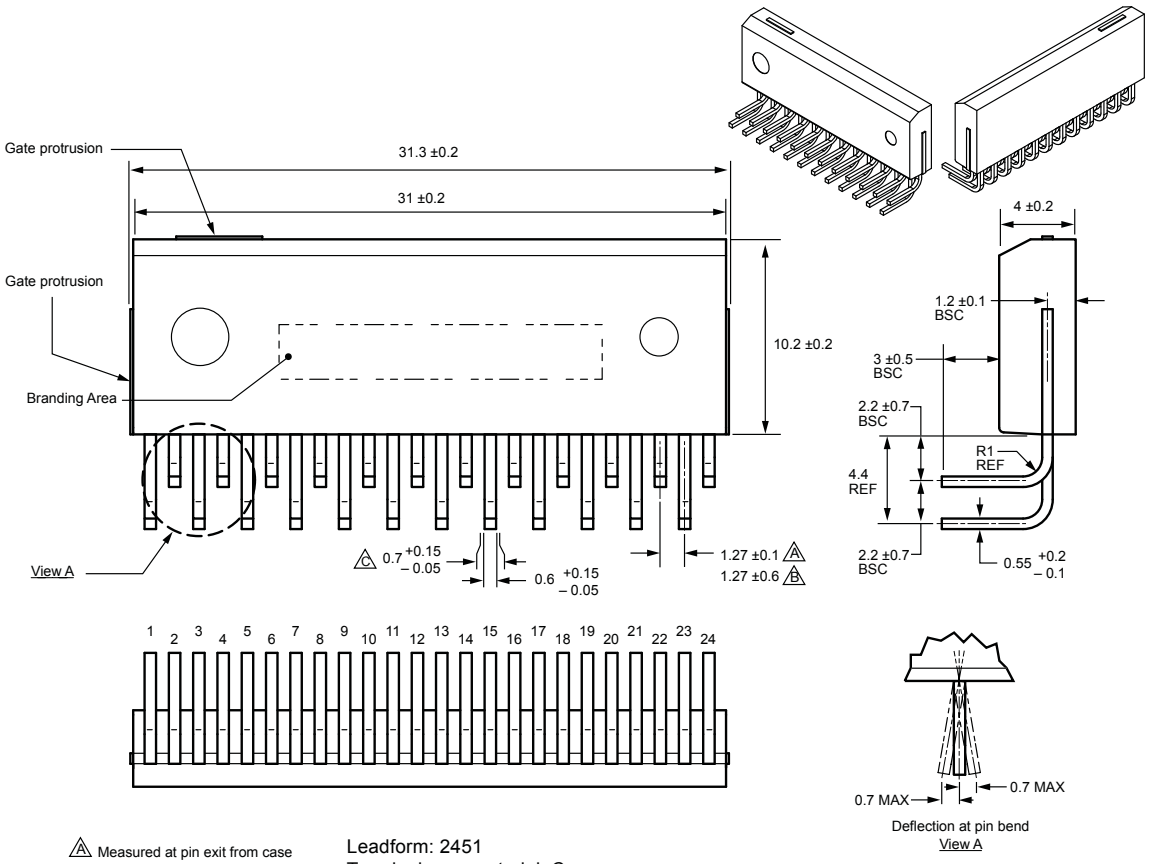
Terminal List Table

Number	Name	Function
1	VB1	High side bootstrap terminal (U phase)
2	VB2	High side bootstrap terminal (V phase)
3	VB3	High side bootstrap terminal (W phase)
4	VCC1	High side logic supply voltage
5	COM1	High side logic GND terminal
6	HIN3	High side input terminal (W phase)
7	HIN2	High side input terminal (V phase)
8	HIN1	High side input terminal (U phase)
9	VBB1	Main supply voltage 1 (connect to VBB2 externally)
10	VBB2	Main supply voltage 2 (connect to VBB1 externally)
11	W1	Output of W phase (connect to W2 externally)
12	V	Output of V phase
13	LS2	Source terminal of V phase
14	W2	Output of W phase (connect to W1 externally)
15	LS3	Source terminal of W phase
16	VREG	Internal regulator output terminal
17	LS1	Source terminal of U phase
18	LIN3	Low side input terminal (W phase)
19	LIN2	Low side input terminal (V phase)
20	LIN1	Low side input terminal (U phase)
21	COM2	Low side GND terminal
22	FO	Overtemperature detection fault-signal output terminal
23	VCC2	Low side logic supply voltage
24	U	Output of U phase

Package Outline Drawing

Leadform 2451

Dual rows, 24 alternating pins; pins bent 90° for horizontal case mounting; pin #1 in outer row



A Measured at pin exit from case
B Measured at pin tips
C Maximum dambar protrusion

Leadform: 2451
Terminal core material: Cu
Terminal plating: Ni and solder (Sn 97.5%, Ag 2.5%) plating
Case material: Epoxy resin

Dimensions in millimeters

Branding codes (exact appearance at manufacturer discretion):

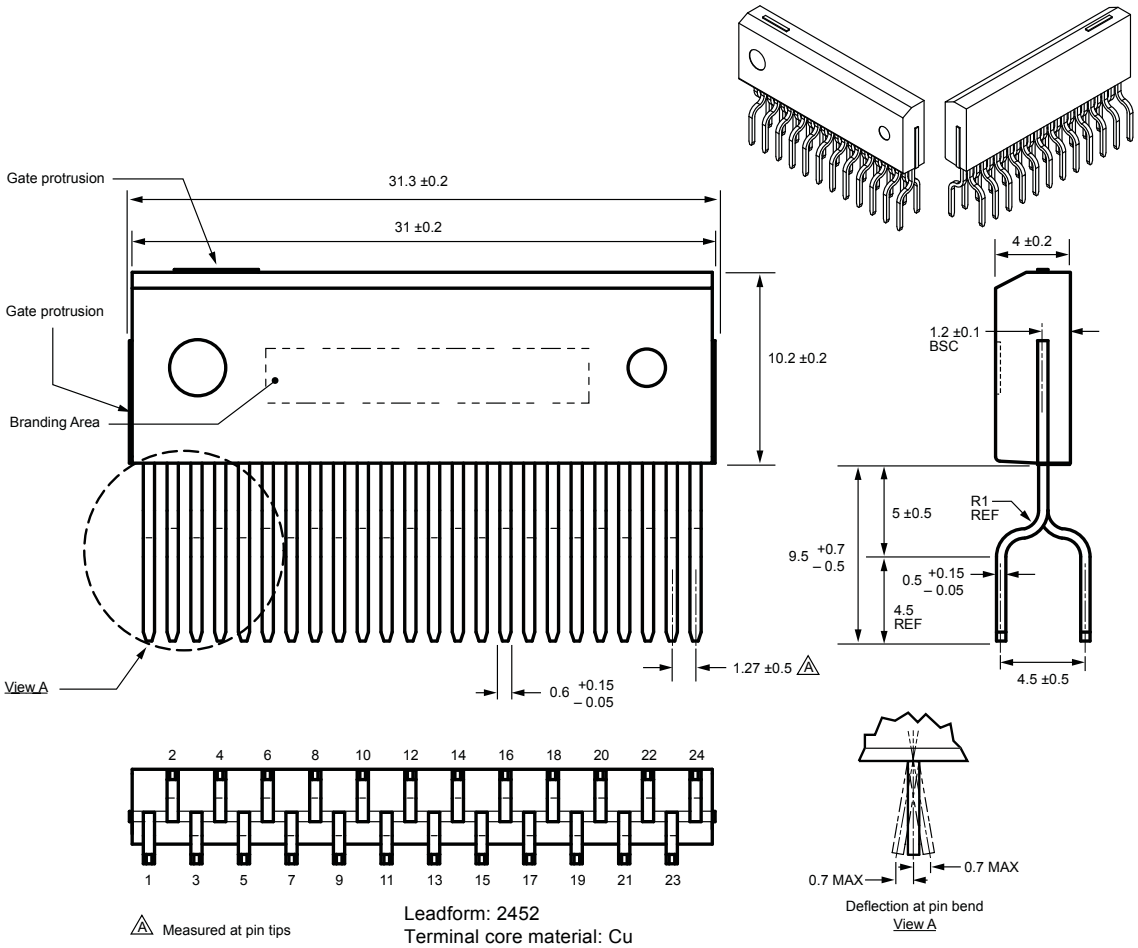
1st line, lot: *YMDD#*
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9, O, N, D*)
DD is the date
is the tracking letter
2nd line, type: SMA685xM

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

Package Outline Drawing

Leadform 2452

Dual rows, 24 alternating pins; vertical case mounting; pin #1 opposite chamfer side



A Measured at pin tips

Leadform: 2452
Terminal core material: Cu
Terminal plating: Ni
Recommended attachment: Solder dip (Sn-Ag-Cu)

Dimensions in millimeters

Branding codes (exact appearance at manufacturer discretion):

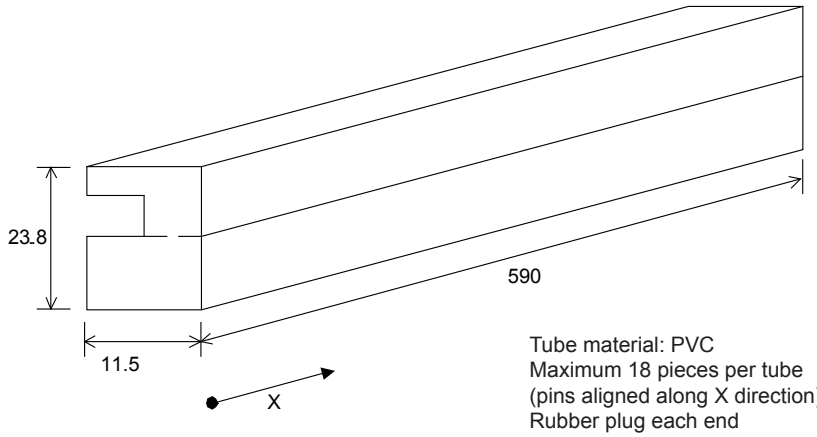
1st line, lot: *YMDD#*
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9*, *O*, *N*, *D*)
DD is the date
is the tracking letter
2nd line, type: SMA685xM

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

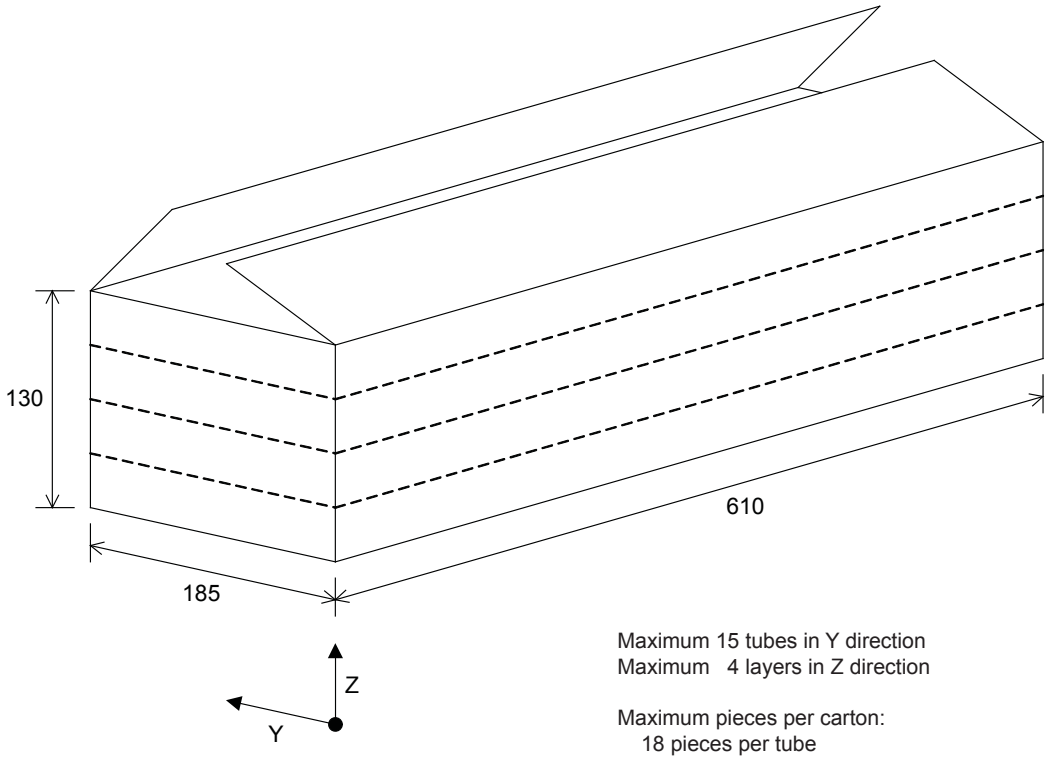
Packing Specification

Leadform 2451

Dimensions in millimeters



Tube material: PVC
Maximum 18 pieces per tube
(pins aligned along X direction)
Rubber plug each end



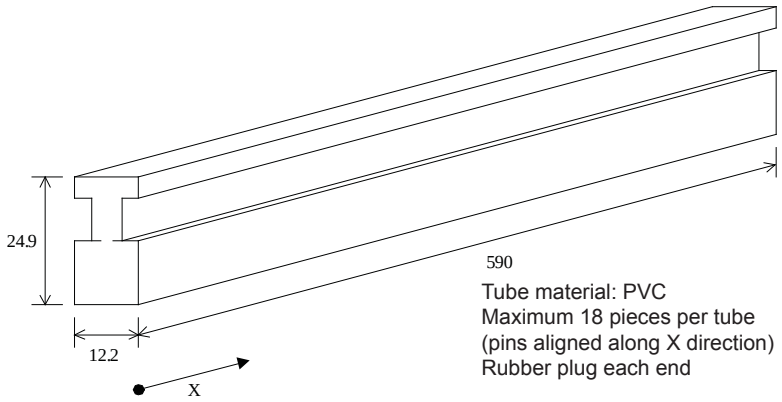
Maximum 15 tubes in Y direction
Maximum 4 layers in Z direction

Maximum pieces per carton:
18 pieces per tube
15 tubes per layer
x 4 layers of tubes
1080 pieces per carton

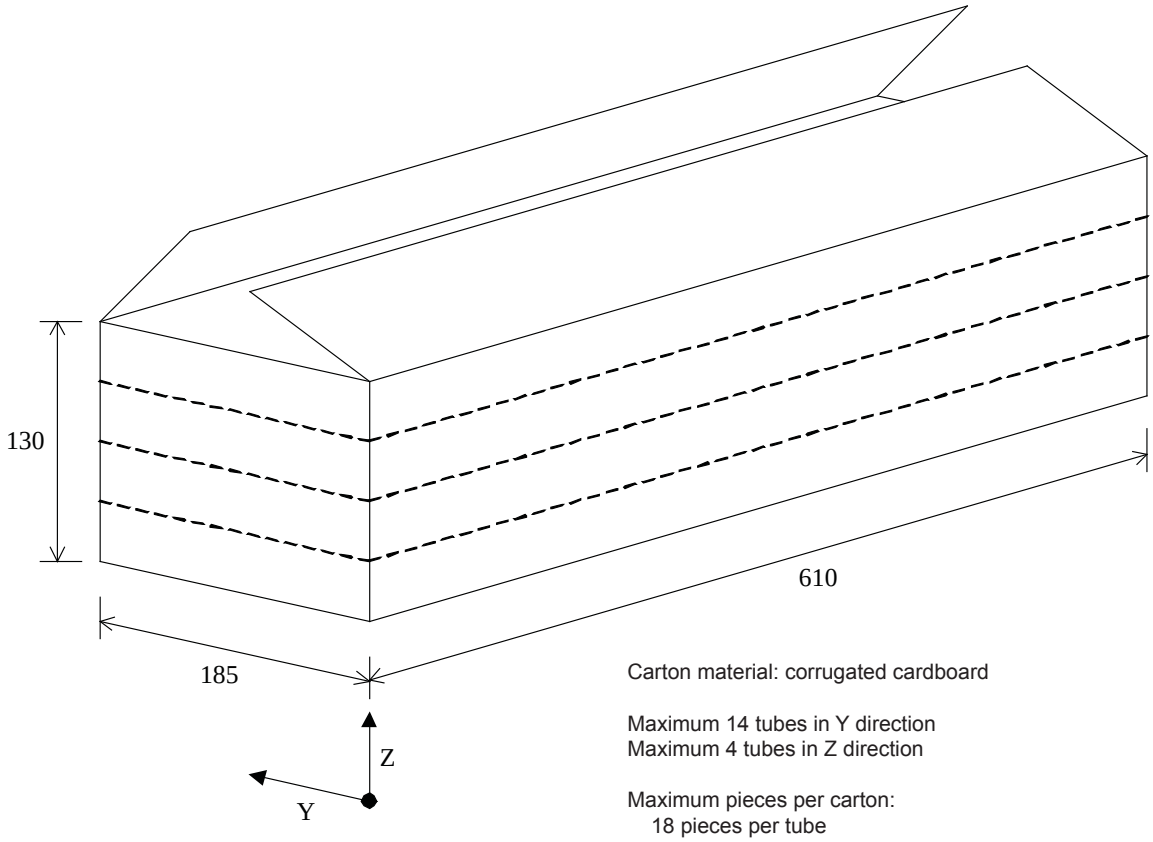
Packing Specification

Leadform 2452

Dimensions in millimeters



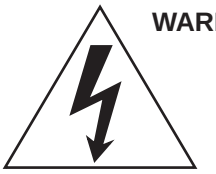
Tube material: PVC
Maximum 18 pieces per tube
(pins aligned along X direction)
Rubber plug each end



Carton material: corrugated cardboard

Maximum 14 tubes in Y direction
Maximum 4 tubes in Z direction

Maximum pieces per carton:
18 pieces per tube
14 tubes per layer
x 4 layers of tubes
1008 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 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 to 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 in the following table:

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	Momentive Performance Materials, Inc.
SC102	Dow Corning Toray Silicone Co., Ltd.

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 5 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.

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.

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.

Sanken products listed in this publication are designed and intended for use as components in general-purpose electronic equipment or apparatus (home appliances, office equipment, telecommunication equipment, measuring equipment, etc.). Their use in any application requiring radiation hardness assurance (e.g., aerospace equipment) is not supported.

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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