SMA685xM Series

March, 2015

General Description

The SMA685xM series provides a highly-integrated solution by incorporating key components into one package – MOSFETs in a 3-phase full-bridge configuration, built-in protection functions such as UVLO (undervoltage lockout) and TD (thermal detection) circuits, pre-driver ICs with 7.5 V regulator output, and bootstrap diodes with limiting resistors.

The products are capable of detecting overcurrent through three shunt resistors. And their packages are fully-molded SIPs.

Applications

Include motor control for:
- Air conditioner fan
- Air purifier fan
- Washer-dryer fan

Features and Benefits

- Built-in bootstrap diodes with limiting resistors
- CMOS-compatible input (3.3 or 5 V)
- Built-in protection circuit for controlling power supply voltage drop (UVLO)
- Built-in overheat detection circuit (TD)
- Regulator output: 7.5 V, 35 mA
- Overcurrent detection enabled via three shunt resistors
- Small SIP (SMA, 24 pins)

Package

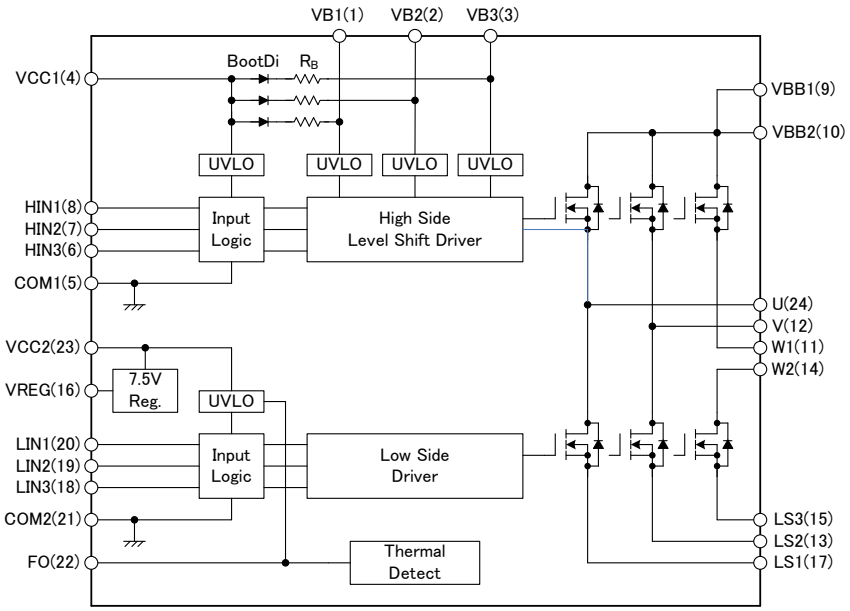
- Package Name: SMA
- Pin Pitch: 1.27 mm
- External Size: 31 × 10.2 × 4 mm

Not to scale

Product Specifications

Part Number	MOSFET Breakdown Voltage, V_{DDS} (V)	Output Current (Continuous), I_O (A)	MOSFET On-Resistance, $R_{DS(ON)}$ (Ω Max.)
SMA6852MZ	500	1.5	4.0
SMA6853MX	500	2.5	2.4
SMA6854MZ	600	1.5	3.5

Functional Block Diagram



SMA685xM Series

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1. Scope

The specifications described in this document shall apply to the SMA685xM series, high-voltage 3-phase motor driver ICs.

2. Absolute Maximum Ratings, valid at T_A = 25°C

Characteristics	Symbol	Remarks		Ratings	Unit
MOSFET Breakdown Voltage	V_{DSS}	SMA6852MZ	V_{CC} = 15 V, I_D = 100 µA, V_{IN} = 0 V	500	V
		SMA6853MX	V_{CC} = 15 V, I_D = 100 µA, V_{IN} = 0 V	500	V
		SMA6854MZ	V_{CC} = 15 V, I_D = 100 µA, V_{IN} = 0 V	600	V
Logic Supply Voltage	V_{CC}	Between VCC and COM		20	V
Bootstrap Voltage	V_{BS}	Between VB and phase U, V, or W		20	V
Output Current (Continuous)	I_O	SMA6852MZ		1.5	A
		SMA6853MX		2.5	A
		SMA6854MZ		1.5	A
Output Current (Pulsed)	I_{OP}	SMA6852MZ	$P_W \leq$ 100 µs	2.25	A
		SMA6853MX	$P_W \leq$ 100 µs	3.75	A
		SMA6854MZ	$P_W \leq$ 100 µs	2.25	A
Output Current for Regulator	I_{REG}			35	mA
Input Voltage	V_{IN}	HIN and LIN pins		−0.5 to 7	V
Allowable Power Dissipation	P_D	T_C = 25°C		28	W
Thermal Resistance (Junction-to-Case)	R_{j-c}	All elements operating		4.46	°C/W
Thermal Resistance (Junction-to-Ambient)	R_{j-a}	All elements operating		31.25	°C/W
Case Operating Temperature	$T_{C(OP)}$			−20 to 100	°C
Junction Temperature	T_j			150	°C
Storage Temperature	T_{stg}			−40 to 150	°C

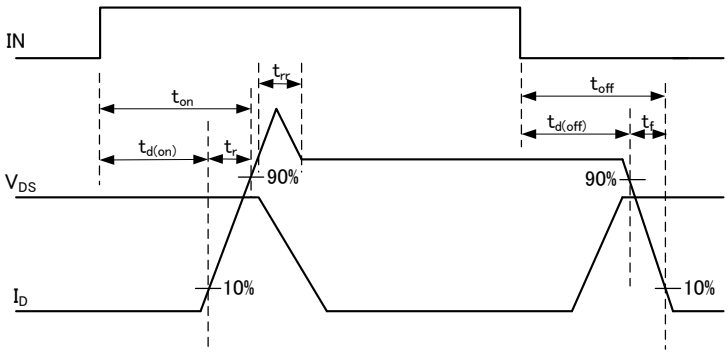
3. Electrical Characteristics

3-1. Electrical Characteristics, valid at T_a = 25°C, V_{CC} = 15 V

Characteristics	Symbol	Remarks		Ratings			Unit
				Min.	Typ.	Max.	
Logic Supply Current	I_{CC}	I_{REG} = 0 A		—	2.5	4	mA
Input Voltage	V_{IH}	Output ON		—	2.0	2.5	V
	V_{IL}	Output OFF		1.0	1.5	—	V
	V_{HYS}	Hysteresis		—	0.5	—	V
Input Current	I_{IH}	V_{IN} = 5 V		—	50	100	µA
	I_{IL}	V_{IN} = 0 V		—	—	2	µA
Undervoltage Lockout (Bootstrap)	V_{UVHL}	Between VB and U, V, or W		9.0	10.0	11.0	V
	V_{UVHH}	Between VB and U, V, or W		9.5	10.5	11.5	V
	V_{UVhys}	Between VB and U, V, or W; hysteresis		—	0.5	—	V
Undervoltage Lockout (Logic Supply)	V_{UVLL}	Between VCC and COM		10.0	11.0	12.0	V
	V_{UVLH}	Between VCC and COM		10.5	11.5	12.5	V
	V_{UVhys}	Between VCC and COM; hysteresis		—	0.5	—	V
FO Terminal Output Voltage	V_{FOL}			0	—	1.0	V
	V_{FOH}			4.0	—	5.5	V
Overheat Detection Threshold Temperature (Activation/Deactivation)	T_{DH}	I_{REG} = 0 mA, no heatsink		135	150	165	°C
	T_{DL}	I_{REG} = 0 mA, no heatsink		105	120	135	°C
	T_{DHYS}	I_{REG} = 0 mA, no heatsink, hysteresis		—	30	—	°C
Output Voltage for Regulator	V_{REG}	I_{REG} = 0 to 35 mA		6.75	7.5	8.25	V
Bootstrap Diode Leakage Current	I_{LBD}	SMA6852MZ	V_R = 500 V	—	—	10	µA
		SMA6853MX	V_R = 500 V	—	—	10	µA
		SMA6854MZ	V_R = 600 V	—	—	10	µA
Bootstrap Diode Forward Voltage	V_{FB}	I_{FB} = 0.15 A		—	1.1	1.3	V
Bootstrap Diode Series Resistor	R_B	SMA6852MZ		17.6	22.0	26.4	Ω
		SMA6853MX		17.6	22.0	26.4	Ω
		SMA6854MZ		48	60	72	Ω
MOSFET Breakdown Voltage	I_{DSS}	SMA6852MZ	V_{DS} = 500 V, V_{IN} = 0 V	—	—	100	µA
		SMA6853MX	V_{DS} = 500 V, V_{IN} = 0 V	—	—	100	µA
		SMA6854MZ	V_{DS} = 600 V, V_{IN} = 0 V	—	—	100	µA
MOSFET On-Resistance	$R_{DS(ON)}$	SMA6852MZ	I_D = 0.75 A, V_{IN} = 5 V	—	3.6	4.0	Ω
		SMA6853MX	I_D = 1.25 A, V_{IN} = 5 V	—	2.0	2.4	Ω
		SMA6854MZ	I_D = 0.75 A, V_{IN} = 5 V	—	3.0	3.5	Ω
MOSFET Diode Forward Voltage	V_{SD}	SMA6852MZ	I_{SD} = 0.75 A, V_{IN} = 0 V	—	1.1	1.5	V
		SMA6853MX	I_{SD} = 1.25 A, V_{IN} = 0 V	—	1.1	1.5	V
		SMA6854MZ	I_{SD} = 0.75 A, V_{IN} = 0 V	—	1.1	1.5	V

3-1. Electrical Characteristics, valid at T_a = 25°C (continued)

Characteristics	Symbol	Remarks		Ratings						Unit
				H-Side			L-Side			
				Min.	Typ.	Max.	Min.	Typ.	Max.	
Switching Time	$t_{d(on)}$	SMA6852MZ	V_{DC} = 300 V, V_{CC} = 15 V, I_D = 1.5 A, V_{IN} = 0→5 V or 5→0 V, T_j = 25°C, inductive load	—	530	—	—	530	—	ns
	t_r			—	95	—	—	95	—	ns
	t_{rr}			—	130	—	—	120	—	ns
	$t_{d(off)}$			—	385	—	—	445	—	ns
	t_f			—	40	—	—	30	—	ns
	$t_{d(on)}$	SMA6853MX	V_{DC} = 300 V, V_{CC} = 15 V, I_D = 2.5 A, V_{IN} = 0→5 V or 5→0 V, T_j = 25°C, inductive load	—	650	—	—	700	—	ns
	t_r			—	100	—	—	100	—	ns
	t_{rr}			—	150	—	—	150	—	ns
	$t_{d(off)}$			—	520	—	—	580	—	ns
	t_f			—	50	—	—	40	—	ns
	$t_{d(on)}$	SMA6854MZ	V_{DC} = 300 V, V_{CC} = 15 V, I_D = 1.5 A, V_{IN} = 0→5 V or 5→0 V, T_j = 25°C, inductive load	—	530	—	—	530	—	ns
	t_r			—	55	—	—	60	—	ns
	t_{rr}			—	125	—	—	125	—	ns
	$t_{d(off)}$			—	510	—	—	540	—	ns
	t_f			—	50	—	—	55	—	ns



Switching Characteristics Definitions

3-2. Recommended Operating Conditions

Characteristics	Symbol	Remarks		Ratings			Unit
				Min.	Typ.	Max.	
Main Supply Voltage	V_{DC}	SMA6852MZ	Between VBB and LS	—	300	400	V
		SMA6853MX	Between VBB and LS	—	300	400	V
		SMA6854MZ	Between VBB and LS	—	300	450	V
Logic Supply Voltage	V_{CC}	Between VCC and COM		13.5	—	16.5	V
Minimum Input Pulse Width	$t_{INmin(on)}$			0.5	—	—	µs
	$t_{INmin(off)}$			0.5	—	—	µs
Dead Time	t_{dead}			1.5	—	—	µs

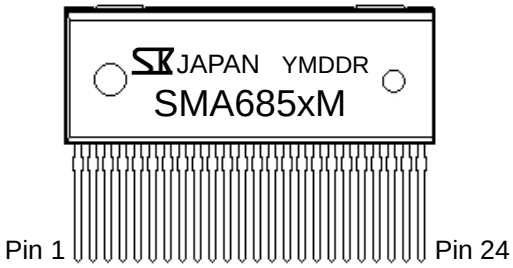
3-3. Truth Table

Mode	HIN	LIN	High-Side MOSFET	Low-Side MOSFET
Normal	L	L	OFF	OFF
	H	L	ON	OFF
	L	H	OFF	ON
	H	H	ON	ON
Thermal Detection (TD)	L	L	OFF	OFF
	H	L	ON	OFF
	L	H	OFF	ON
	H	H	ON	ON
UVLO (VCC)	L	L	OFF	OFF
	H	L	OFF	OFF
	L	H	OFF	OFF
	H	H	OFF	OFF
UVLO (VB)	L	L	OFF	OFF
	H	L	OFF	OFF
	L	H	OFF	ON
	H	H	OFF	ON

NOTES:

- An arm short-circuit may occur when inputs on the HIN and LIN pins for the same phase are all logic high. Therefore, extra attention should be paid to prevent a condition in which the pins for the same phase are fully ON at once.
- A MOSFET in a V_{CC} UVLO state gets re-activated when an input signal is detected at a certain logic level (level triggering), while a MOSFET in a V_B UVLO state resumes its operation at a point where an input signal transits from one state to another (edge triggering).

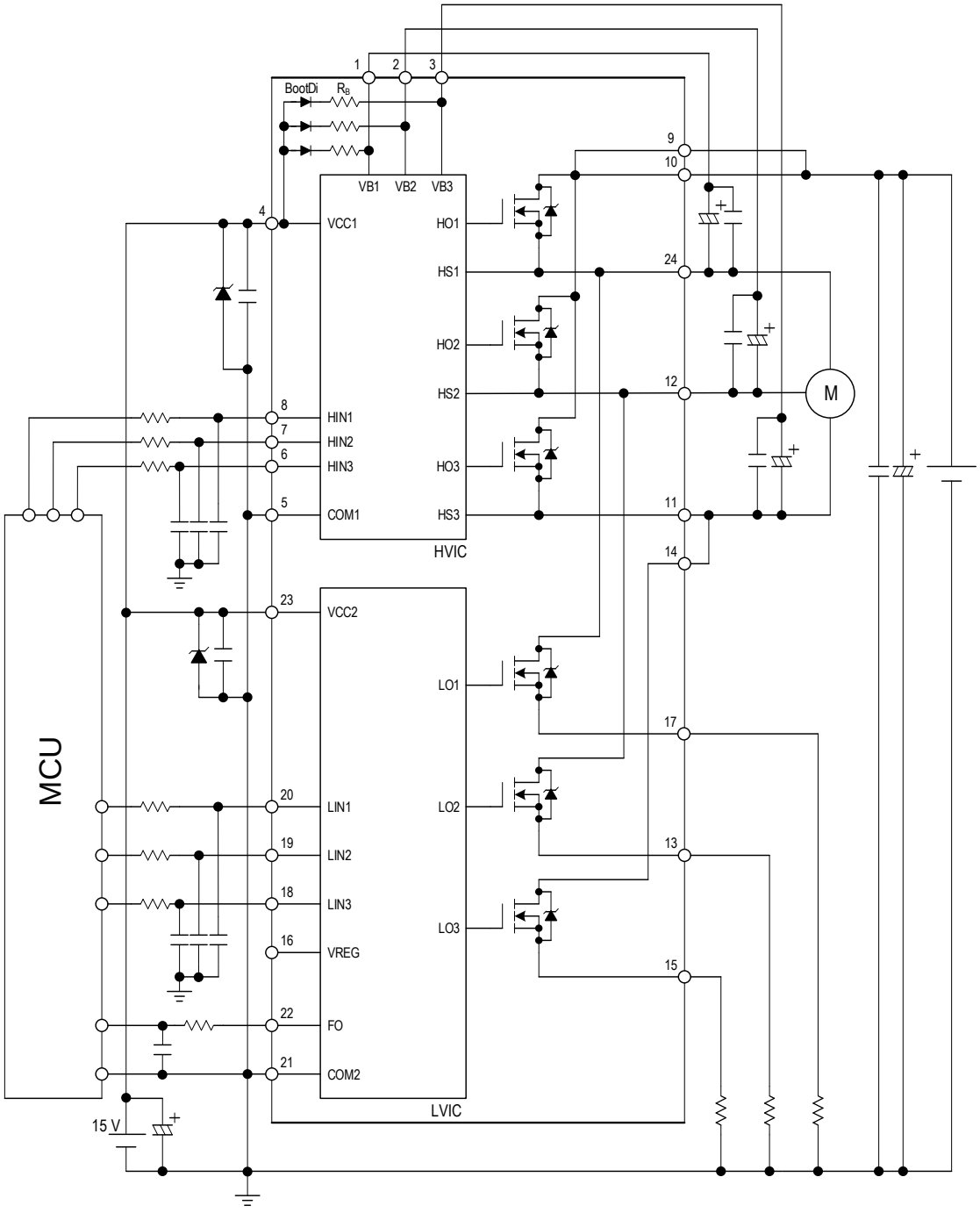
4. Pin-Out Diagram



Terminal List Table

Pin Number	Pin Name	Functions	I/O
1	VB1	High-side bootstrap (phase U)	—
2	VB2	High-side bootstrap (phase V)	—
3	VB3	High-side bootstrap (phase W)	—
4	VCC1	High-side logic supply voltage	—
5	COM1	High-side logic GND	—
6	HIN3	High-side input (phase W)	Input
7	HIN2	High-side input (phase V)	Input
8	HIN1	High-side input (phase U)	Input
9	VBB1	Main supply voltage 1 (connected to VBB2 externally)	—
10	VBB2	Main supply voltage 2 (connected to VBB1 externally)	—
11	W1	Phase W output (connected to W2 externally)	—
12	V	Phase V output	—
13	LS2	Low-side source (phase V)	—
14	W2	Phase W output (connected to W1 externally)	—
15	LS3	Low-side source (phase W)	—
16	VREG	Internal regulator output	Output
17	LS1	Low-side source (phase U)	—
18	LIN3	Low-side input (phase W)	Input
19	LIN2	Low-side input (phase V)	Input
20	LIN1	Low-side input (phase U)	Input
21	COM2	Low-side logic GND	—
22	FO	Error output	Output
23	VCC2	Low-side logic supply voltage	—
24	U	Phase U output	—

5. Application Example

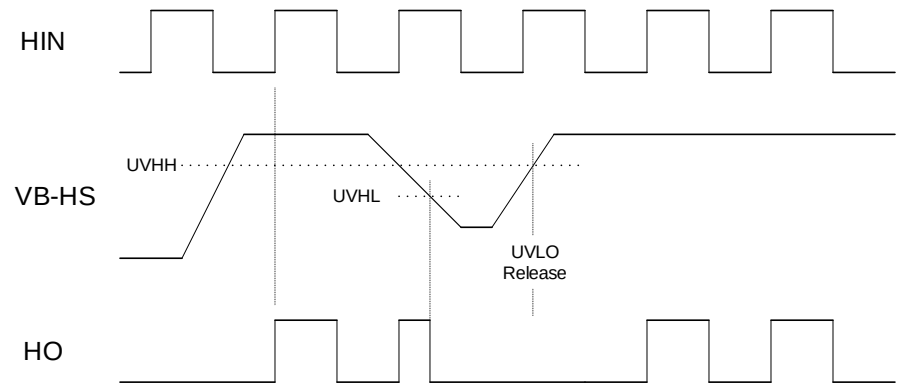


NOTES:

- 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.

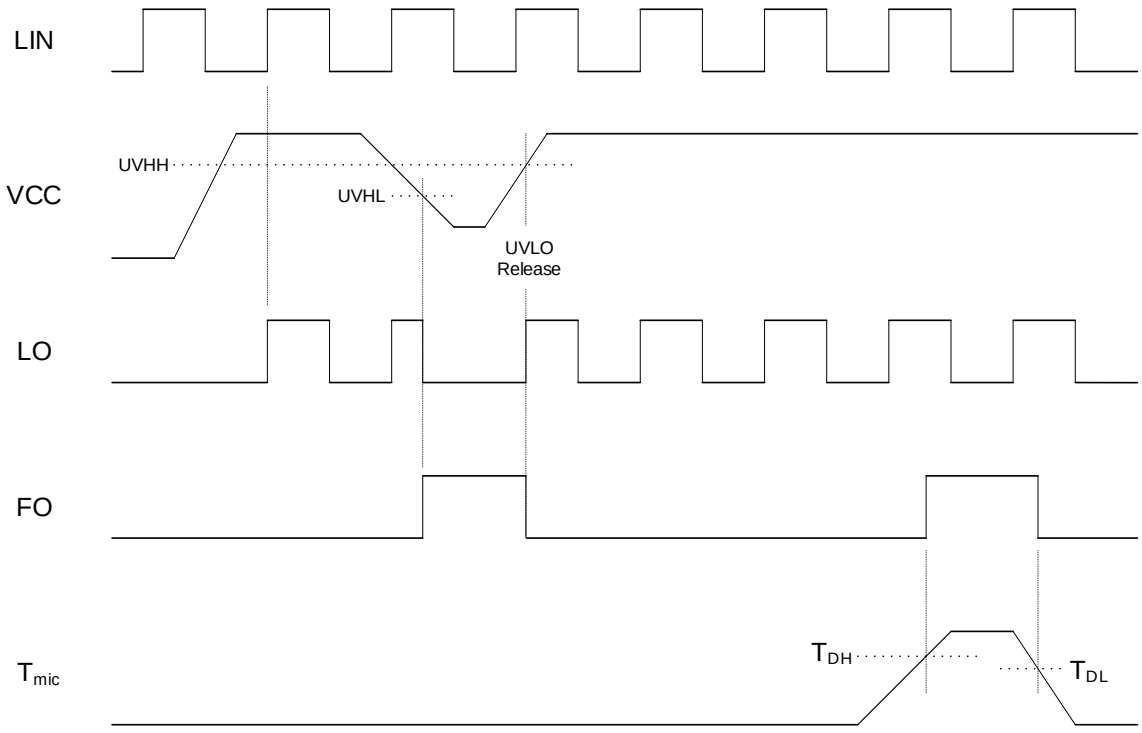
6. Timing Diagrams for Protection Operations

High-Side Input/Output



High-side turn-on at the next rising edge on HIN signal after UVLO release.

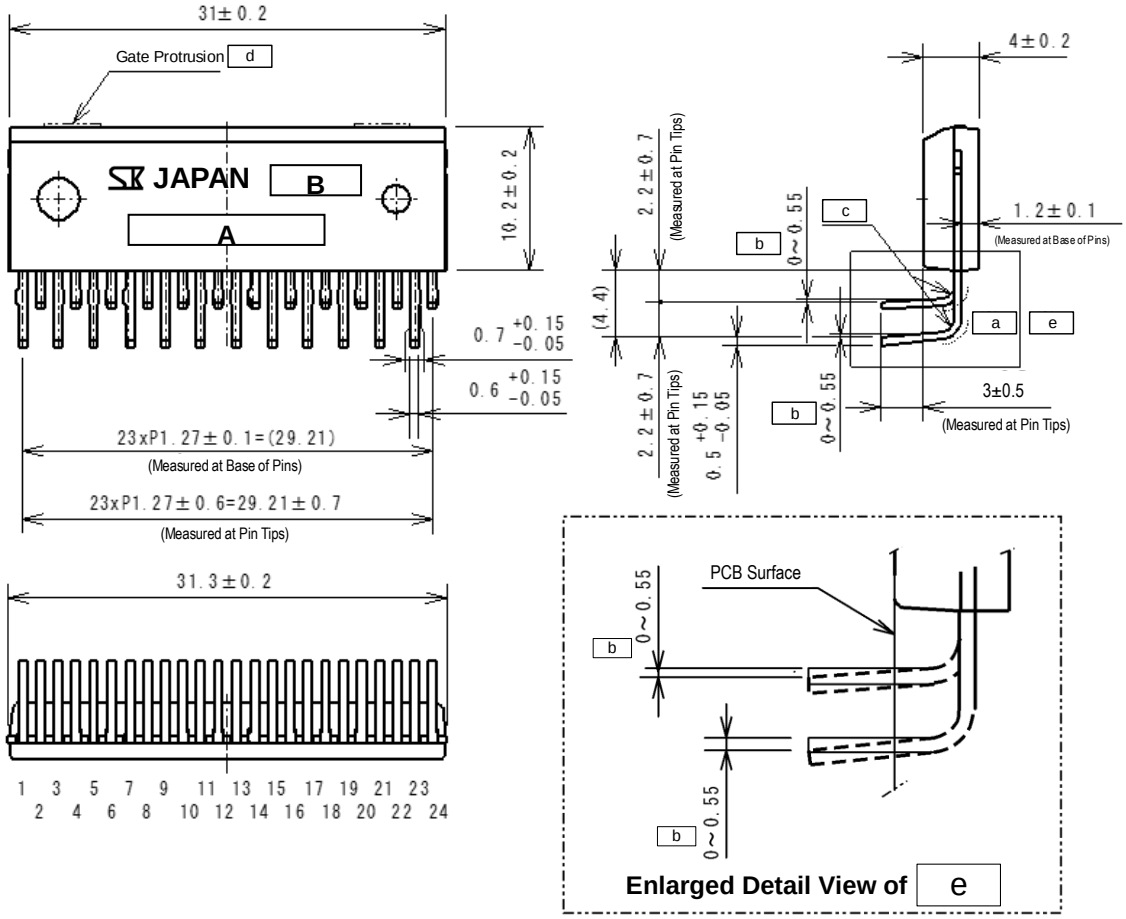
Low-Side Input/Output



Low-side turn-on in accordance with LIN signal level after UVLO release.

7. Package Outline Drawing

7-1. Leadform 2451 (Dimensions in Millimeters)



NOTES:

- a depicts the intentionally-curved part of a pin whose plated surface may easily be cracked and/or peeled off. Note that this kind of damaged surface does NOT indicate negative effects on terminal flexural toughness or any other reliability characteristics.
- b represents terminal curvature exaggerated for illustration purposes, not actual states of being bent or curved.
- c shows pins with a minimum inside radius (R) of 0.65 mm.
- d describes the area(s) where either one or two gate protrusions up to 0.3 mm high will appear on the package surface, drawn with dashed double-dotted lines. (The number of gate protrusions varies depending on the package mold type used.)

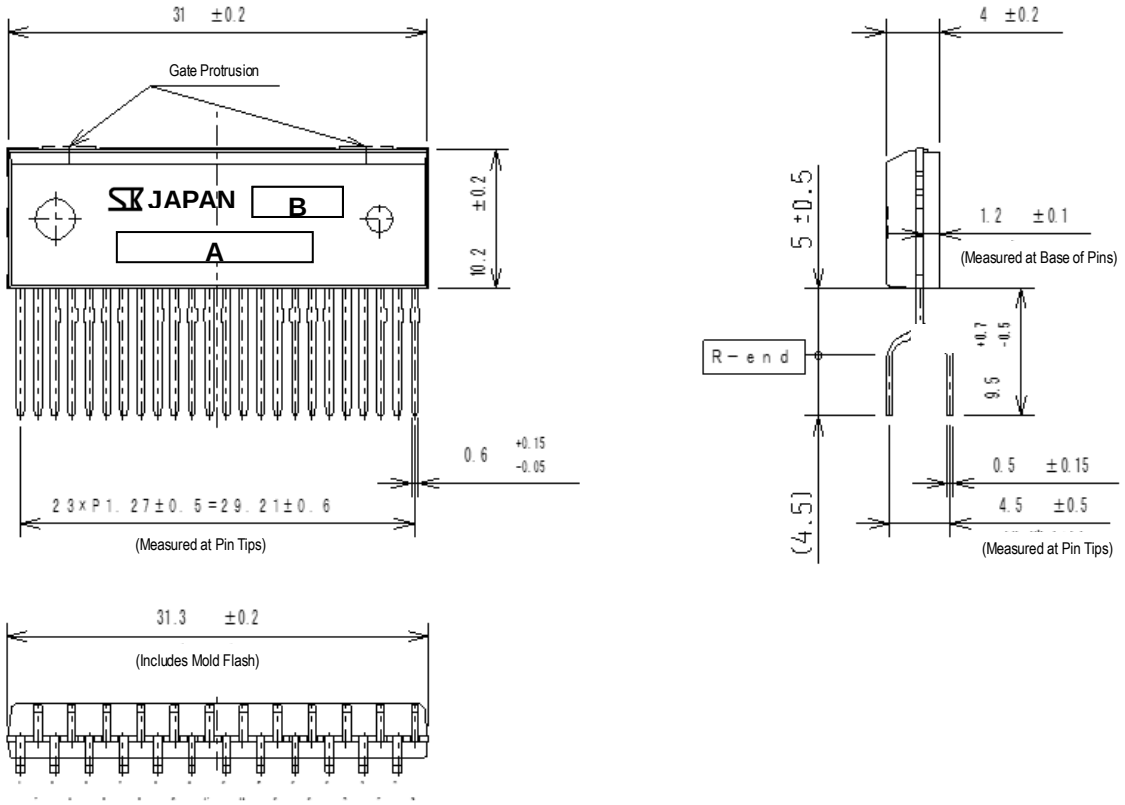
■ Branding Codes

A. Part number: *SMA685xMX/MZ*

B. Lot number: *YMDDR*

- *Y* is the last digit of the year of manufacture
- *M* is the month of the year manufactured (1 to 9, O, N, or D)
- *DD* is the day of the month manufactured (01 to 31)
- *R* is the Sanken control number

7-2. Leadform 2452 (Dimensions in Millimeters)



NOTE: Either one or two gate protrusions up to 0.3 mm high will appear on the package surface, as drawn with dashed double-dotted lines in the illustration above. (The number of gate protrusions varies depending on the package mold type used.)

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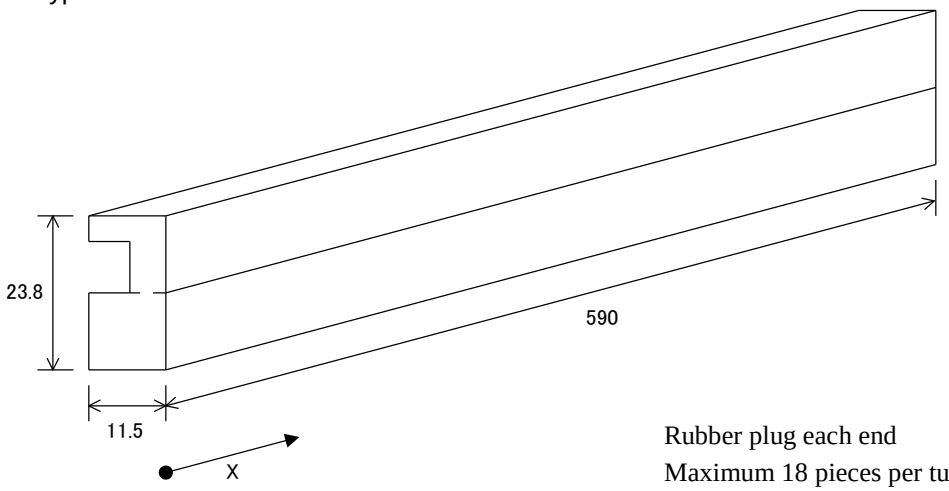
8. Packing Specifications

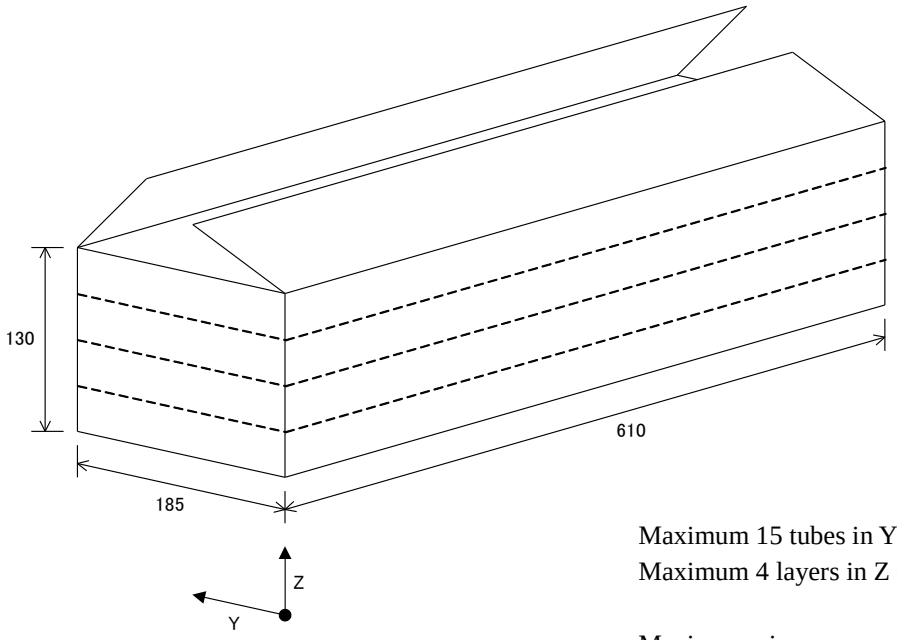
8-1. Leadform 2451 (Dimensions in Millimeters)

■ Tube Type: SCM-C



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

■ Corrugated Shipping Carton

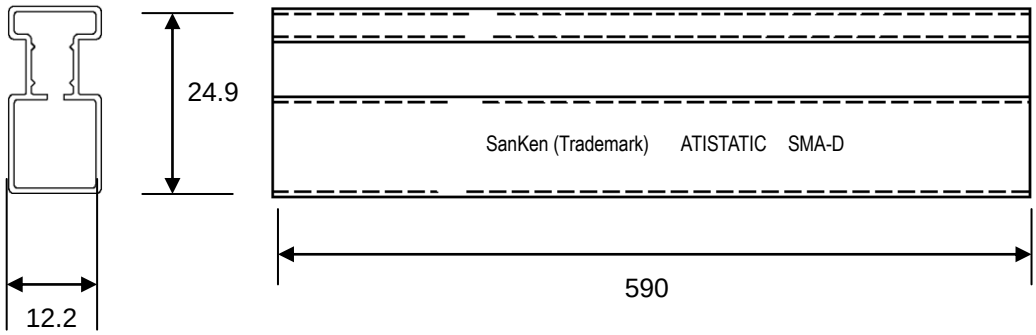


Maximum 15 tubes in Y direction
Maximum 4 layers in Z direction

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

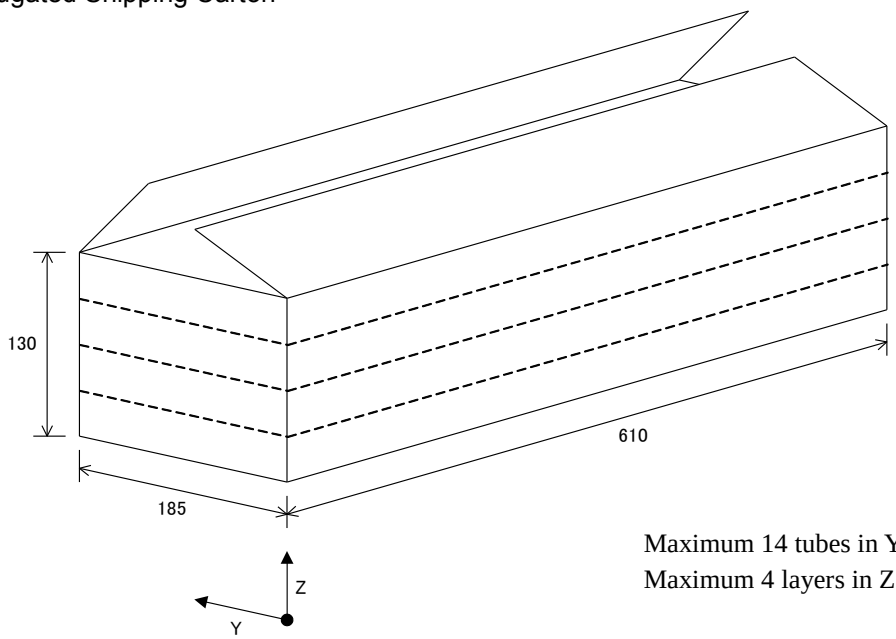
8-2. Leadform 2452 (Dimensions in Millimeters)

■ Tube Type: SMA-D



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

■ Corrugated Shipping Carton



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

Maximum pieces per carton:
18 pieces per tube
14 tubes per layer
× 4 layers of tubes
1008 pieces per carton

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