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

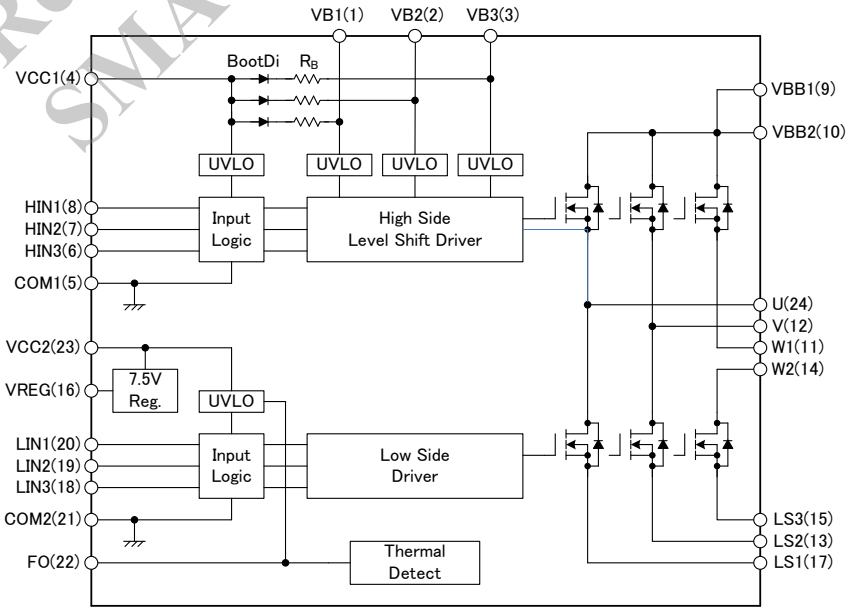
- Package Name: SMA
- Pin Pitch: 1.27 mm
- External Size: 31 × 10.2 × 4 mm

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

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

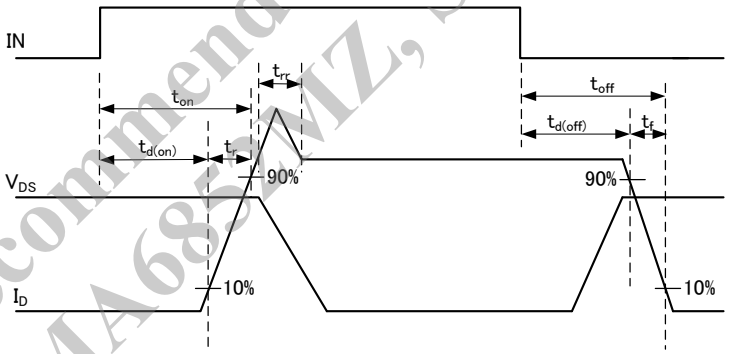
3. Electrical Characteristics

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

Characteristics	Symbol	Remarks		Ratings Min.	Ratings Typ.	Ratings Max.	Unit
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

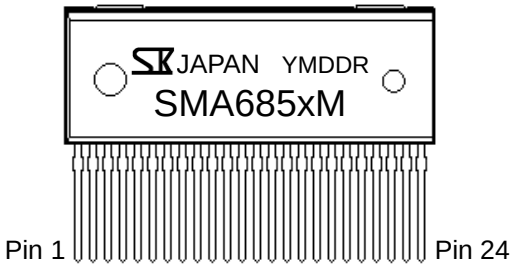
3-3. Truth Table

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).

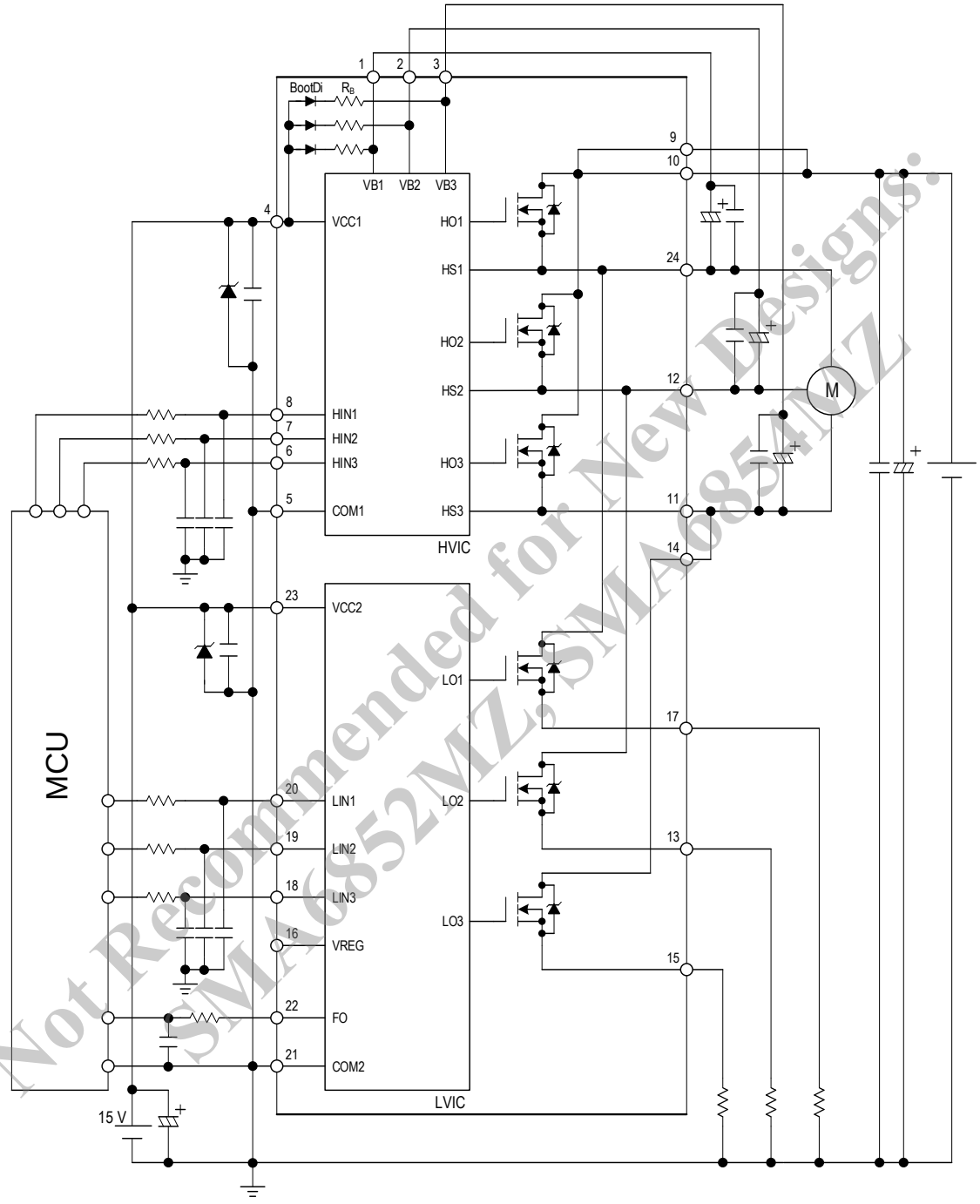
4. Pin-Out Diagram



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

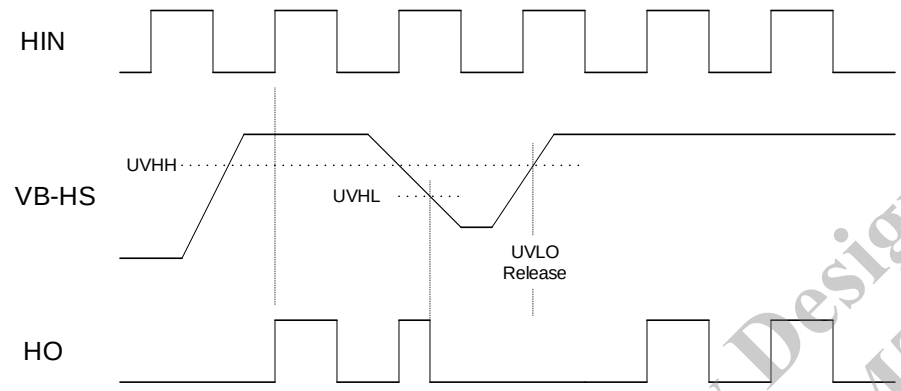


NOTES:

- 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.

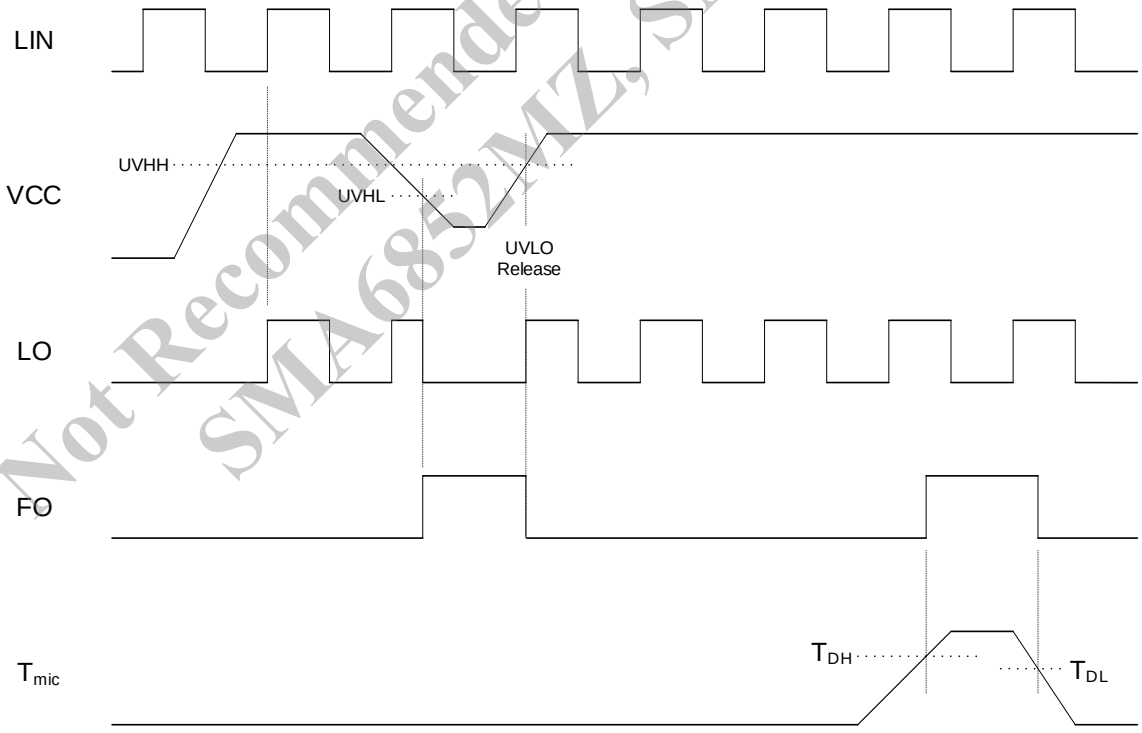
6. Timing Diagrams for Protection Operations

High-Side Input/Output



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

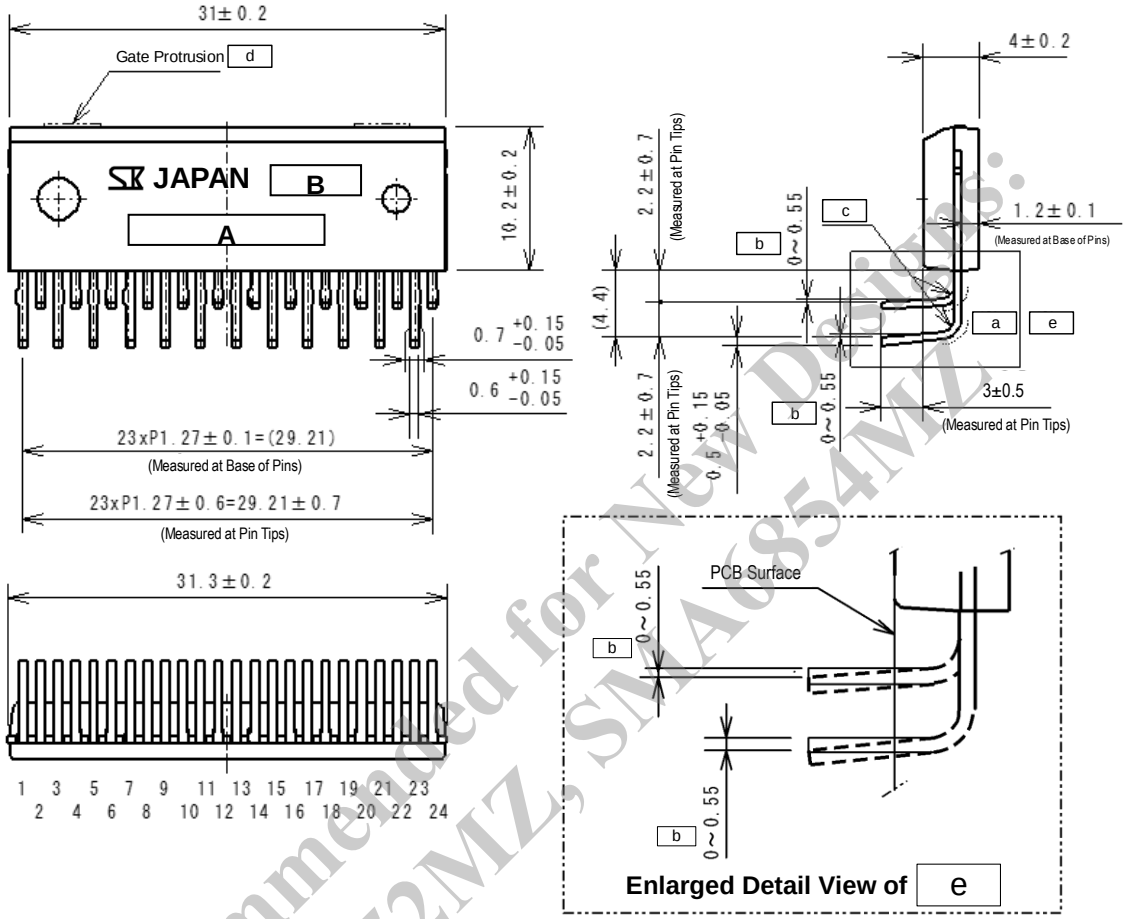
Low-Side Input/Output



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.)

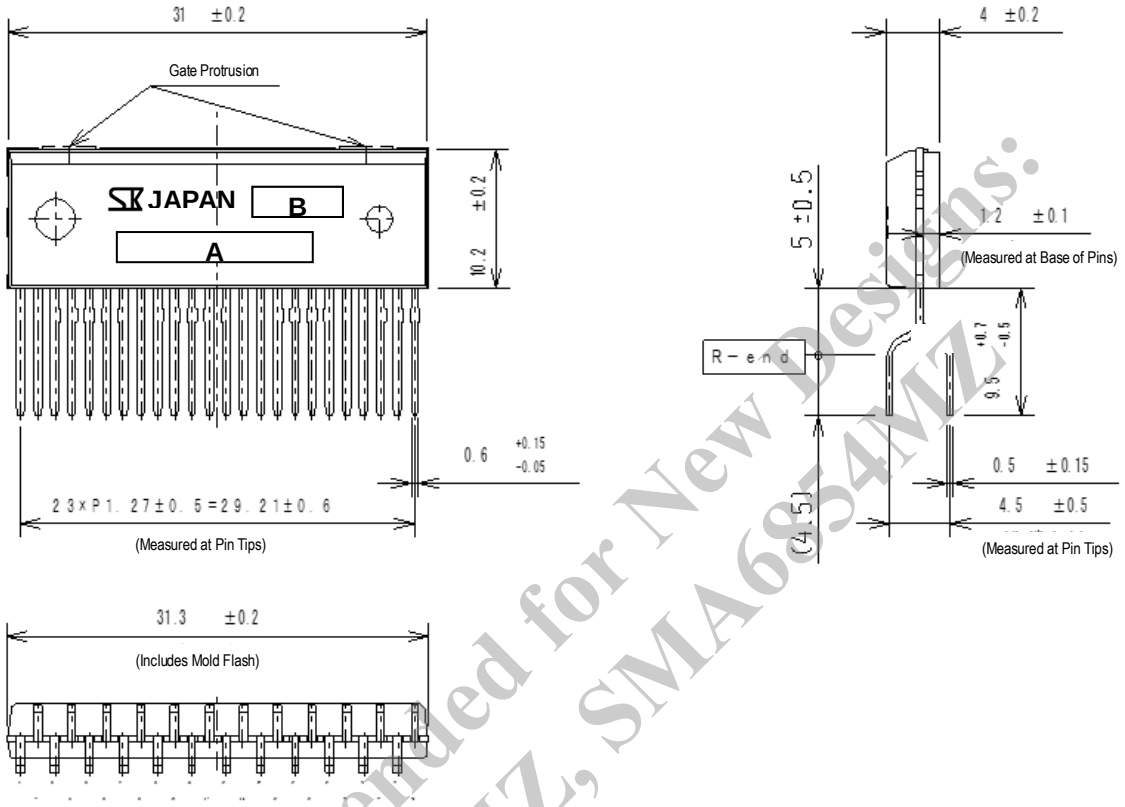
■ Branding Codes

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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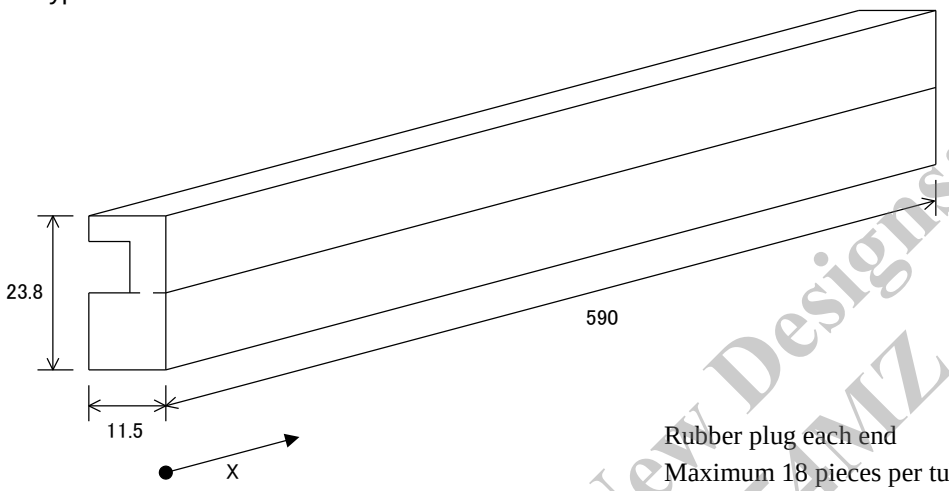
8. Packing Specifications

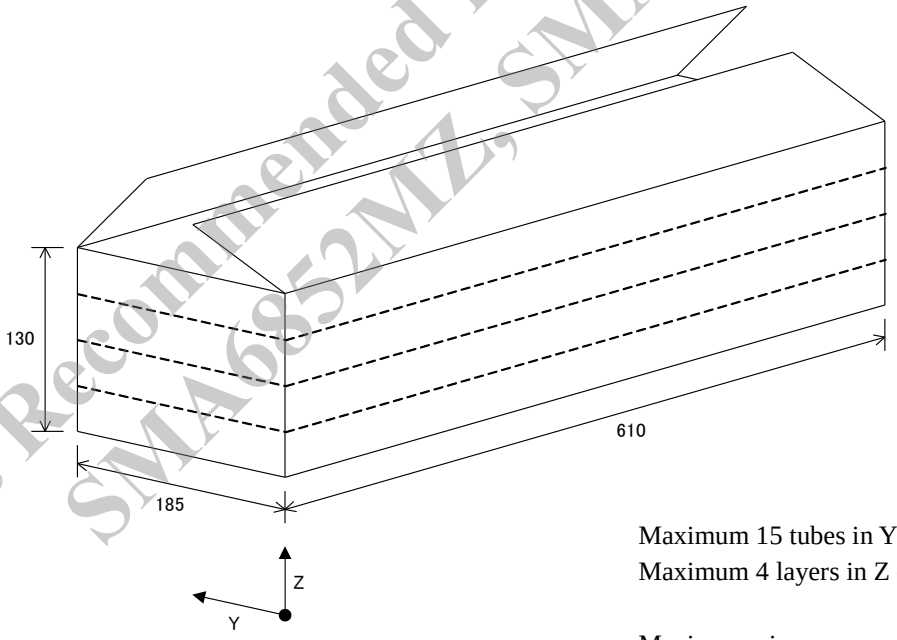
8-1. Leadform 2451 (Dimensions in Millimeters)

■ Tube Type: SCM-C



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

■ Corrugated Shipping Carton

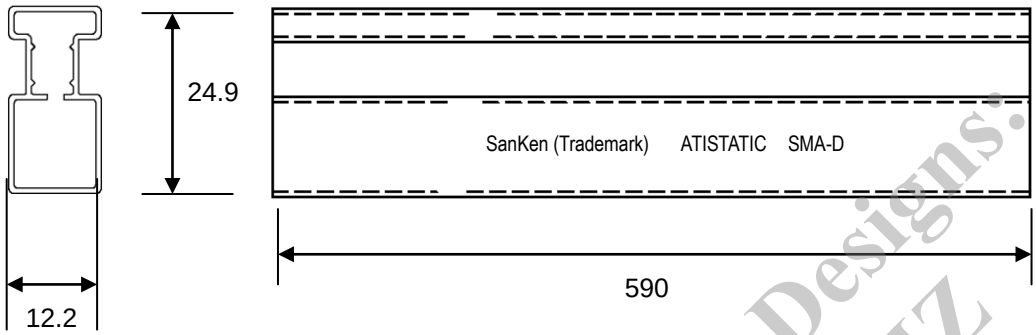


Maximum 15 tubes in Y direction
Maximum 4 layers in Z direction

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

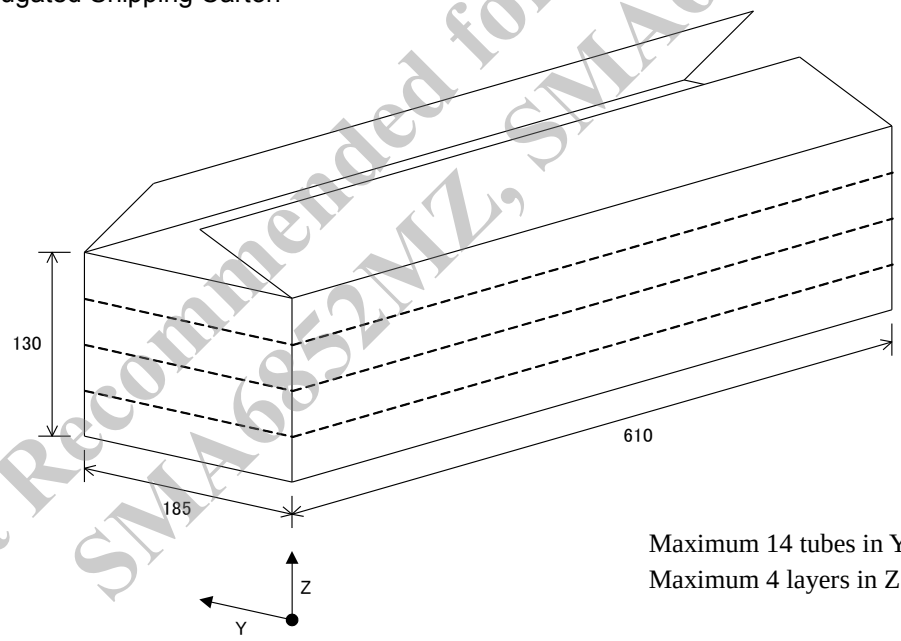
8-2. Leadform 2452 (Dimensions in Millimeters)

■ 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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