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SLA6806M and SLA6816MZ

High Voltage 3-Phase Motor Drivers

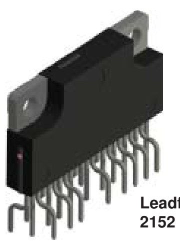
Features and Benefits

- Built-in pre-drive IC
- IGBT power element
- CMOS compatible input (3.3 to 5 V)
- High-side gate driver using bootstrap circuit or floating power supply
- Integrated Fast Recovery Diode (FRD) as freewheeling diode for each IGBT
- Built-in protection circuit for controlling power supply voltage drop on VCC and VB (UVLO)
- Overcurrent protection circuit (OCP)
- OCP holding time configurable with RCIN pin
- Output of fault signal during operation of protection circuit
- Output current 3 A and 5 A
- Small SIP (SLA 23-pin)

Packages: Power SIP

Not to scale

Leadform 2151



Leadfor... 2152 (IEC)

Leadform 2153

Description

The SLA6806M and SLA6816MZ 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 230 VAC input voltage, and 3 A or 5 A (continuous) output current. They can withstand voltages of up to 600 V (IGBT breakdown voltage).

The SLA6806M and SLA6816MZ power package includes an IC with all of the necessary power elements (six IGBTs), pre-driver ICs (two), and freewheeling 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
- Refrigerator compressor
- Dishwasher pump

Functional Block Diagram

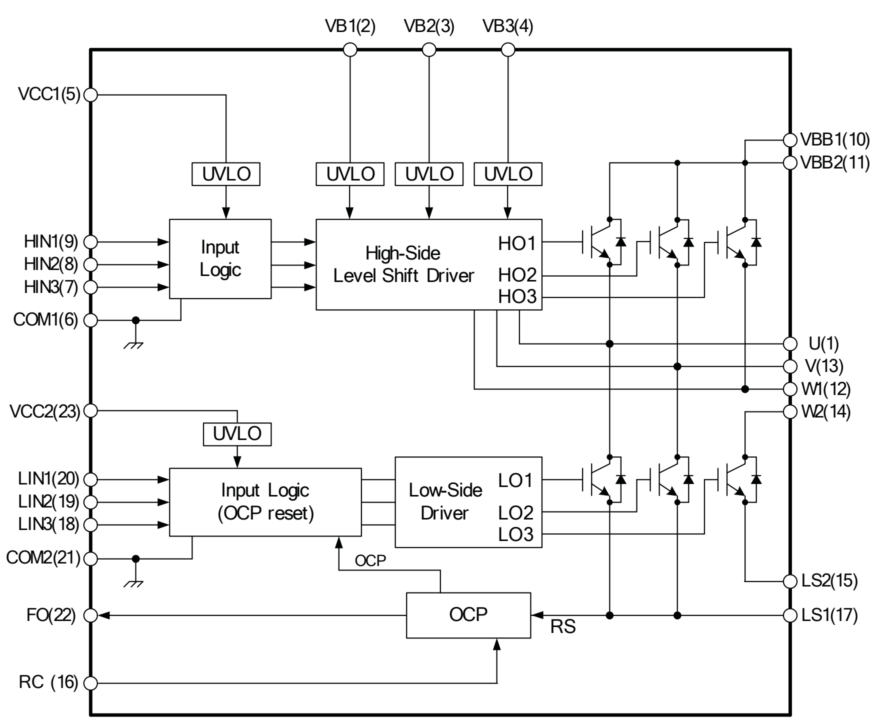


Figure 1. Driver block diagrams.

Selection Guide

Part Number	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)
SLA6806M	600	1.75	5	7.5
SLA6816MZ	600	1.75	3	4.5

Absolute Maximum Ratings, valid at T_A = 25°C

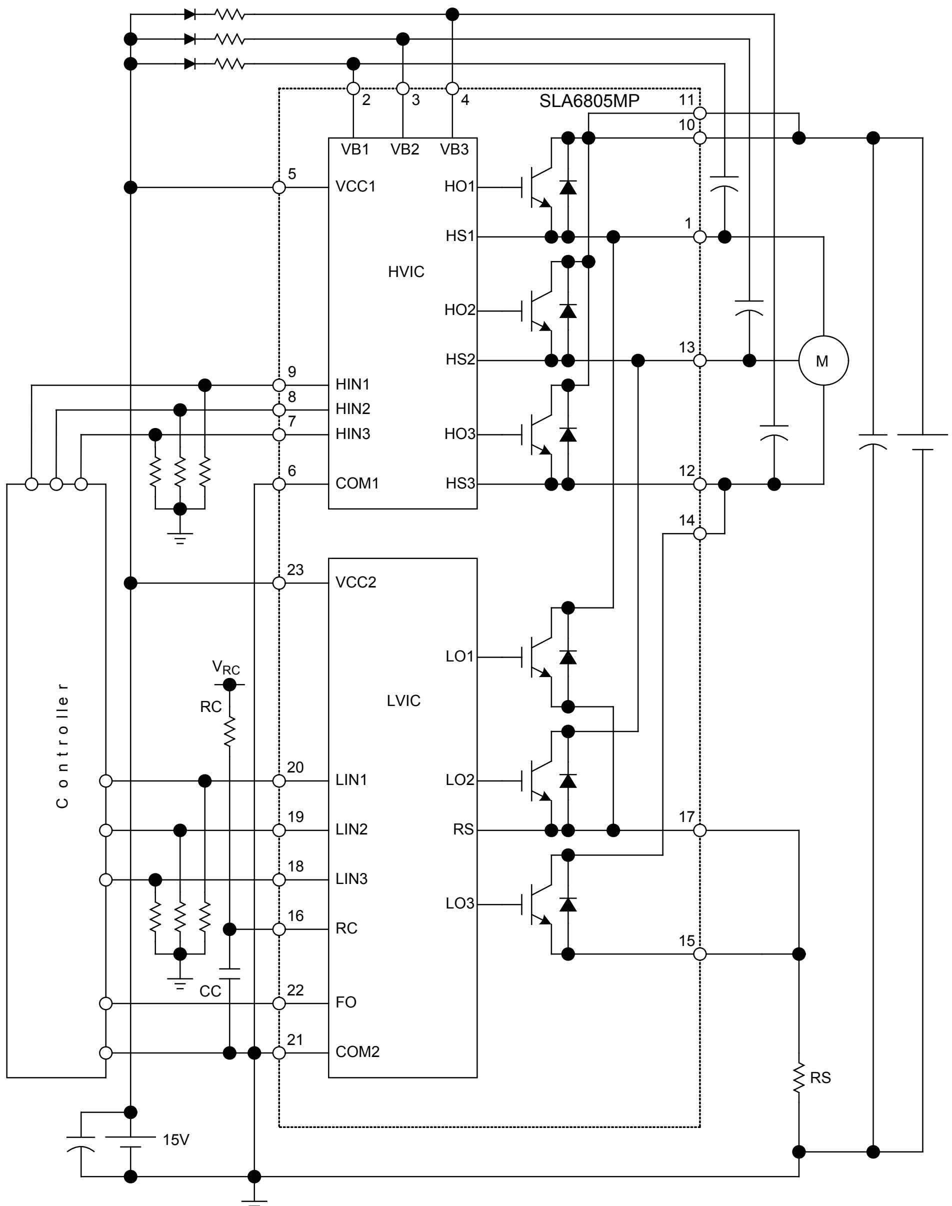
Characteristic	Symbol	Remarks		Rating	Unit
IGBT Breakdown Voltage	V_{CES}	V_{CC} = 15 V, I_C = 1 mA, V_{IN} = 0 V		600	V
Main Supply Voltage	V_{BB}	Between VBB and GND		400	V
Main Supply Voltage (Surge)	$V_{BB(surge)}$	Between VBB and GND		450	V
Logic Supply Voltage	V_{CC}	Between VCC and COM		20	V
Bootstrap Voltage	V_{BS}	Between VB and HS (U,V, and W phases)		20	V
Output Current, Continuous	I_O	SLA6806M	T_C = 25°C	5	A
		SLA6816MZ		3	A
Output Current, Pulsed	I_{OP}	SLA6806M	PW ≤ 100 μs	7.5	A
		SLA6816MZ		4.5	A
Input Voltage	V_{IN}			–0.5 to 7	V
RC Pin Input Voltage	V_{RC}	Between RC and COM		7	V
Allowable Power Dissipation	P_D	SLA6806M	T_C = 25°C, all elements operating	32.8	W
		SLA6816MZ		32.8	W
Thermal Resistance (Junction to Case)	$R_{θJC}$	All elements operating (IGBT)		3.8	°C/W
		All elements operating (FRD)		5.4	°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

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.

Recommended Operating Conditions

Characteristic	Symbol	Remarks	Min.	Typ.	Max.	Units
Main Supply Voltage	V_{BB}	Between VBB and LS, $I_{BB} \leq 2$ A	–	–	400	V
Logic Supply Voltage	V_{CC}	Between VCC and COM	13.5	–	16.5	V
Pull-Up Resistor (RC Input)	R_C		33	–	390	kΩ
Capacitor (RC Input)	C_C		1000	–	2200	pF
Bootstrap Resistor	R_B		22	–	220	Ω
Minimum Input Pulse Width	$t_{inmin(on)}$	On pulse	0.5	–	–	μs
	$t_{inmin(off)}$	Off pulse	0.5	–	–	μs
PWM Carrier Frequency	f_C		–	–	20	kHz
Dead Time	t_{dead}		1.5	–	–	μs

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

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

- A blanking timer is built-in to mask the noise generated on RS at turn-on.
- 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

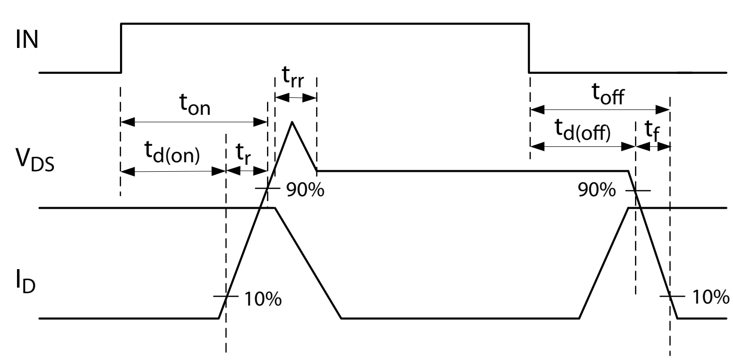
Characteristics	Symbol	Conditions		Min	Typ	Max	Units
Logic Supply Voltage	V_{CC}	Between VCC and COM		13.5	15	16.5	V
Logic Supply Current	I_{CC}	V_{CC} = 15 V		–	4	6	mA
Boot Supply Current	I_{BOOT}	VB1 to U, VB2 to V, and VB3 to W = 15 V, HIN = 5 V per circuit		–	140	400	μA
Input Voltage	V_{IH}	V_{CC} = 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_{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 VB and U, V, or W		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
Overcurrent Protection Trip Voltage	V_{TRIP}	V_{CC} = 15 V		0.45	0.50	0.55	V
RC Threshold Voltage	V_{RCH}	V_{CC} = 15 V		3.1	–	3.85	V
Overcurrent Protection Hold Time	t_p	V_{RC} = 5 V, R_C = 330 kΩ, C_C = 2200 pF		–	870	–	μs
Blanking Time	t_{blank}	V_{CC} = 15 V		–	2	–	μs
IGBT Leakage Current	I_{CES}	V_{CC} = 15 V, V_{CE} = 600 V, V_{IN} = 0 V		–	–	1	mA
IGBT Saturation Voltage	$V_{CE(sat)}$	SLA6806M	V_{CC} = 15 V, I_C = 5 A, V_{IN} = 5 V	–	1.75	2.2	V
		SLA6816MZ	V_{CC} = 15 V, I_C = 3 A, V_{IN} = 5 V	–	1.75	2.1	V
Diode Forward Voltage	V_F	SLA6806M	V_{CC} = 15 V, I_C = 5 A, V_{IN} = 0 V	–	2.0	2.4	V
		SLA6816MZ	V_{CC} = 15 V, I_F = 3 A, V_{IN} = 0 V	–	1.65	2.0	V

SLA6806M ELECTRICAL 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_C = 5 A, 0 V ≤ V_{IN} ≤ 5 V, inductive load	–	510	–	ns
	t_{rH}		–	80	–	ns
	t_{rrH}		–	90	–	ns
	$t_{dH(off)}$		–	330	–	ns
	t_{fH}		–	115	–	ns
Switching Time, Low Side	$t_{dL(on)}$		–	500	–	ns
	t_{rL}		–	110	–	ns
	t_{rrL}		–	100	–	ns
	$t_{dL(off)}$		–	330	–	ns
	t_{fL}		–	115	–	ns

SLA6016MZ ELECTRICAL 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_C = 3 A, 0 V ≤ V_{IN} ≤ 5 V, inductive load	–	315	–	ns
	t_{rH}		–	50	–	ns
	t_{rrH}		–	80	–	ns
	$t_{dH(off)}$		–	375	–	ns
	t_{fH}		–	165	–	ns
Switching Time, Low Side	$t_{dL(on)}$		–	395	–	ns
	t_{rL}		–	60	–	ns
	t_{rrL}		–	75	–	ns
	$t_{dL(off)}$		–	395	–	ns
	t_{fL}		–	170	–	ns



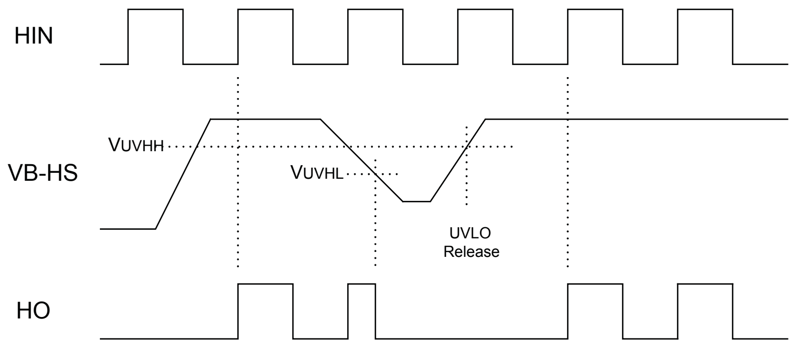
Switching Characteristics Definitions

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	On	On
OCP	L	L	Off	Off
	H	L	On	Off
	L	H	Off	Off
	H	H	On	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	On

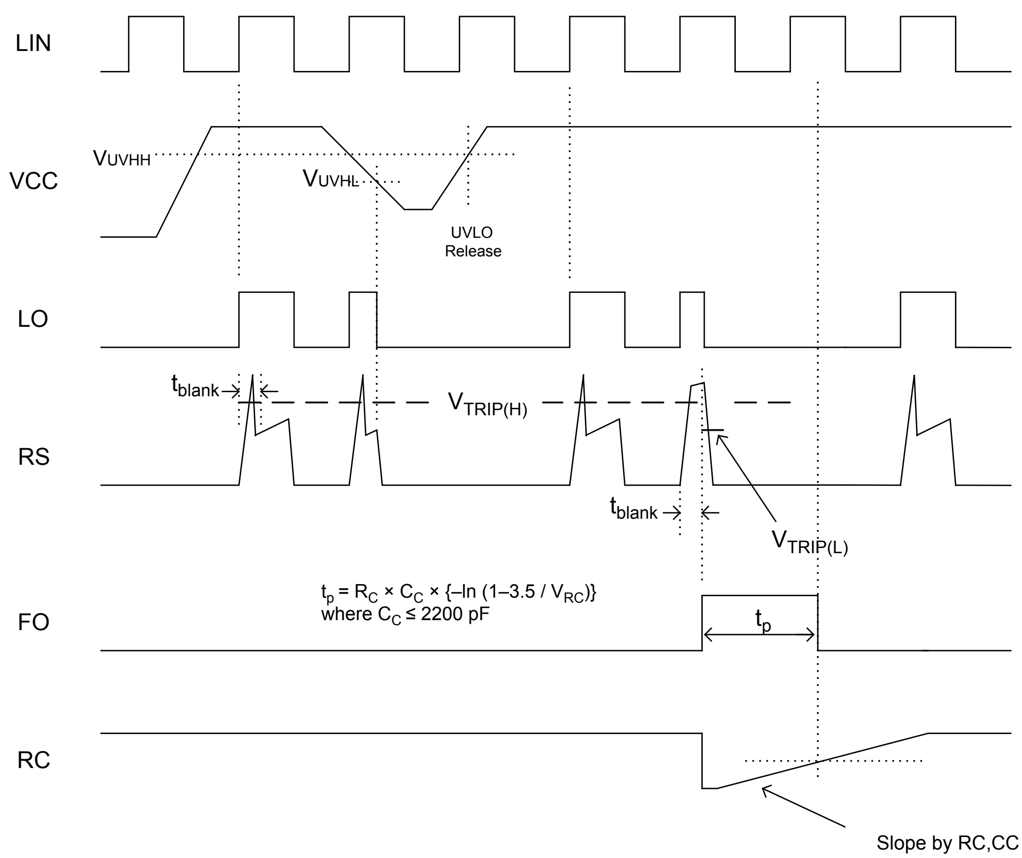
[1]In the case where a pair of HINx and LINx signals are asserted at the same time, a shoot-through condition will occur. Software and hardware must be carefully designed to prevent this failure by setting both the high-side and the low-side IGBTs off.
[2]After the VCCx power rail recovers from a UVLO 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).

High Side Driver Input/Output Timing Diagrams



After UVLO is released, IC operation is started by the first rising edge of input

Low Side Driver Input/Output Timing Diagrams

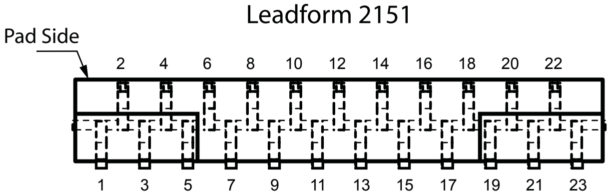


After UVLO is released, IC operation is started by the first rising edge of input

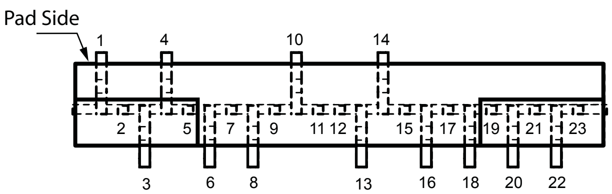
After RC charging and releasing, the OCP operation is started by the first rising edge of input

Pin-out Diagrams

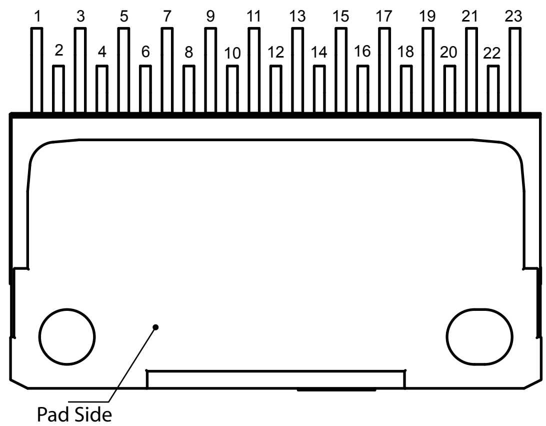
Leadform 2151



Leadform 2152



Leadform 2153



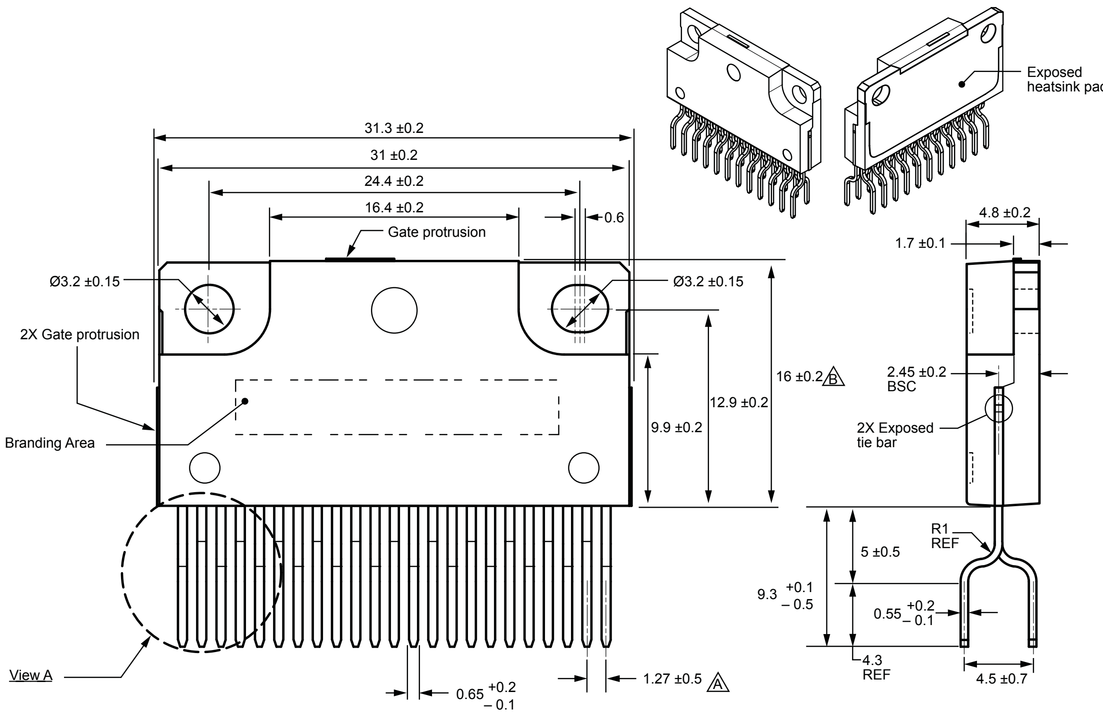
Terminal List Table

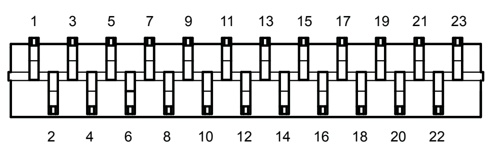
Number	Name	Function
1	U	Output of U phase
2	VB1	High side bootstrap terminal (U phase)
3	VB2	High side bootstrap terminal (V phase)
4	VB3	High side bootstrap terminal (W phase)
5	VCC1	High side logic supply voltage
6	COM1	High side logic GND terminal
7	HIN3	High side input terminal (W phase)
8	HIN2	High side input terminal (V phase)
9	HIN1	High side input terminal (U phase)
10	VBB1	Main supply voltage 1 (connect to VBB2 externally)
11	VBB2	Main supply voltage 2 (connect to VBB1 externally)
12	W1	Output of W phase (connect to W2 externally)
13	V	Output of V phase
14	W2	Output of W phase (connect to W1 externally)
15	LS2	Low side emitter terminal (connect to LS1 externally)
16	RC	Overcurrent protection hold time adjustment terminal
17	LS1	Low side emitter terminal (connect to LS1 externally)
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	Overcurrent protection fault-signal output terminal
23	VCC2	Low side logic supply voltage

Package Outline Drawing

Leadform 2151

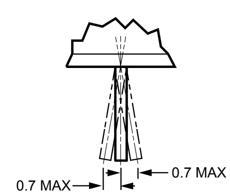
Dual rows, 23 alternating pins; vertical case mounting; pin #1 opposite pad side





A Measured at pin tips
B To case top

Terminal core material: Cu
Terminal plating: Ni, with Pb-free solder coating
Recommended attachment: Solder dip (Sn-Ag-Cu)



Deflection at pin bend
View A

Dimensions in millimeters

Branding codes (exact appearance at manufacturer discretion):
1st line, type: SLA6806M or SLA6816MZ

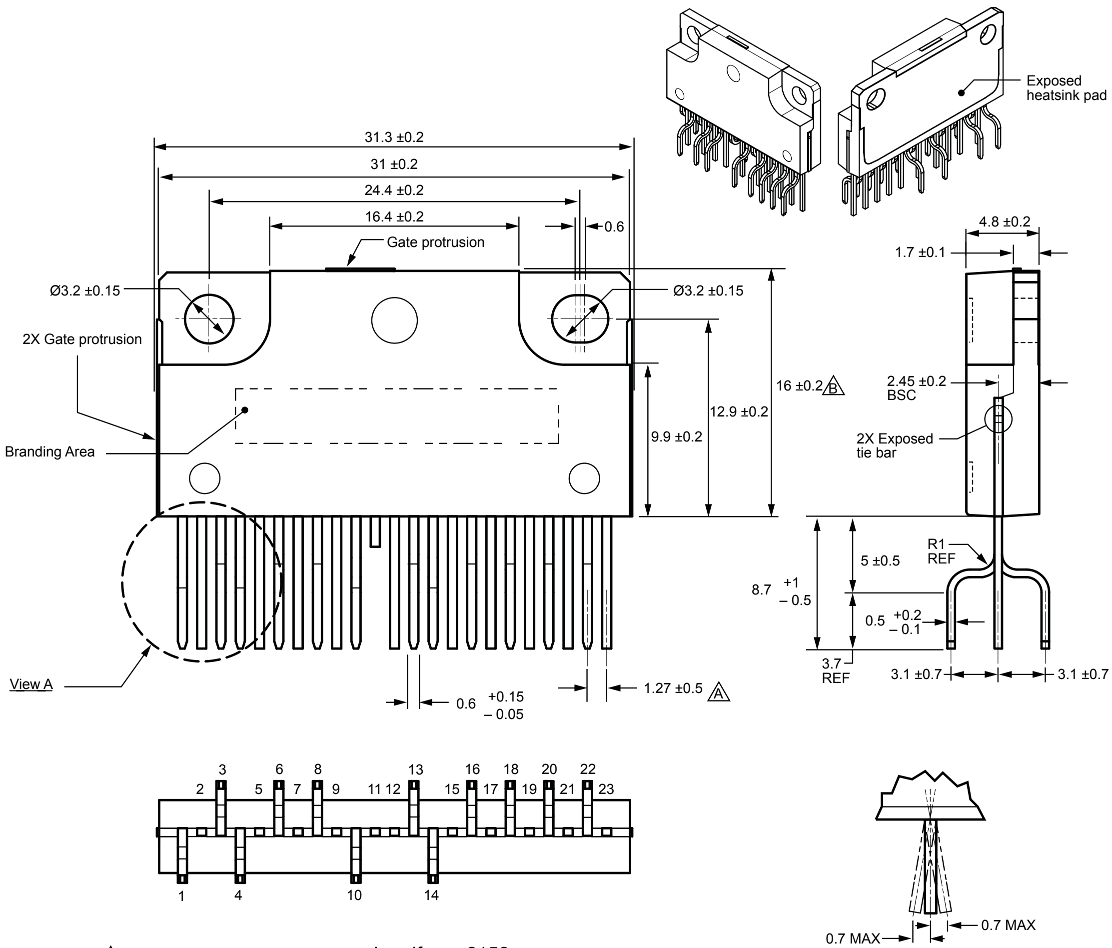
2nd line, lot: *YMDD*
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9, O, N, D*)
DD is the date

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

Package Outline Drawing

Leadform 2152

Triple rows (IEC compliant), 23 alternating pins; vertical case mounting; pin #1 on pad side



Deflection at pin bend
View A

A Measured at pin tips
B To case top

Leadform: 2152
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, type: SLA6806M or SLA6816MZ

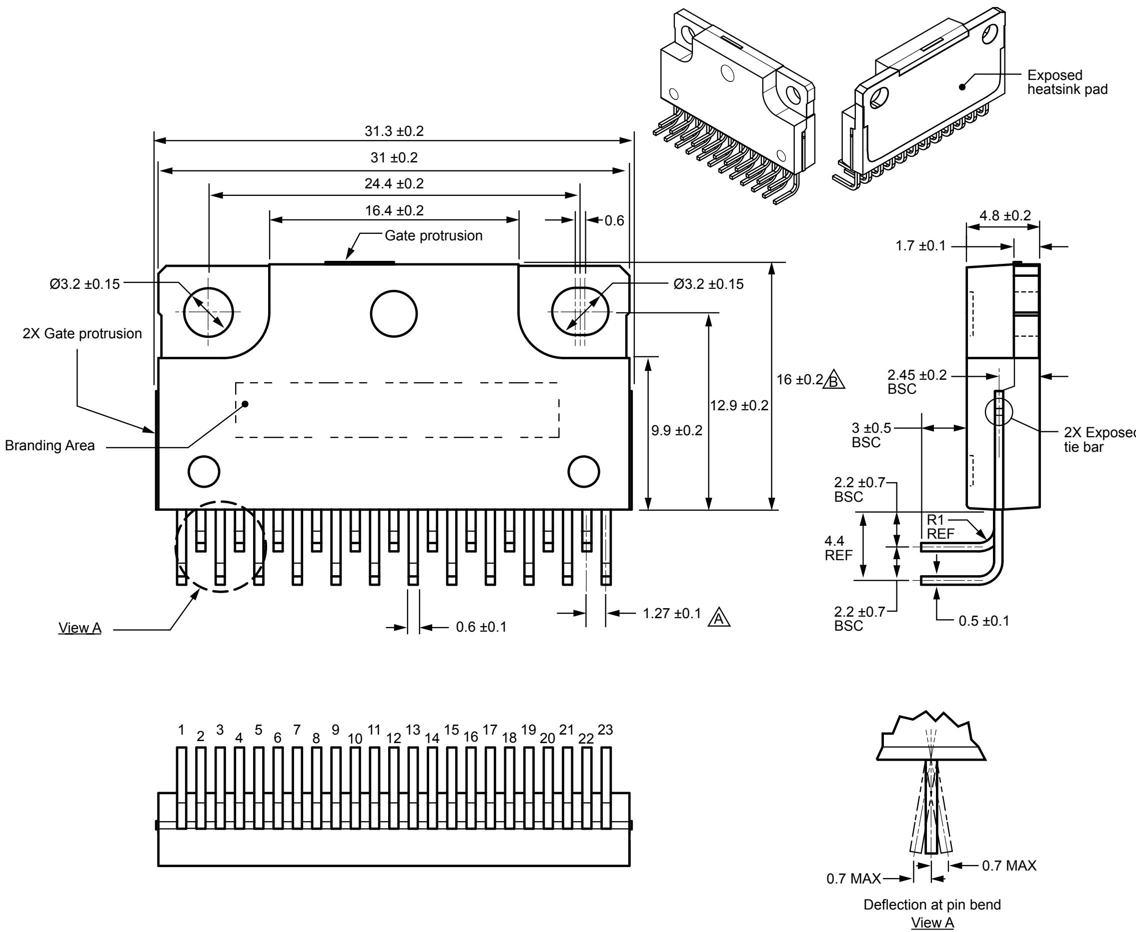
2nd line, lot: *YMDDT*
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9, O, N, D*)
DD is the date
T is the tracking letter

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

Package Outline Drawing

Leadform 2153

Dual rows, 23 alternating pins; pins bent 90° for horizontal case mounting; pin #1 in outer row



A: Measured at pin exit from case
B: To case top

Leadform: 2153
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, type: SLA6806M or SLA6816MZ

2nd line, 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

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

Material Composition

Description	Material	Specification
Lead Terminal	Cu	Ni plating, solder dip, or solder plating
Resin	Epoxy resin	
Heatsink	Al	

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 on 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 below:

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

Heatsink Mounting Method

Torque When Tightening Mounting Screws. The recommended tightening torque for this product package type is: 58.8 to 78.4 N•cm (6.0 to 8.0 kgf•cm).

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 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 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 affects the reliability significantly.
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