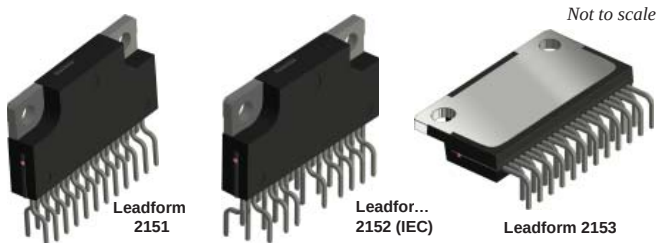


High Voltage 3-Phase Motor Drivers

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



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

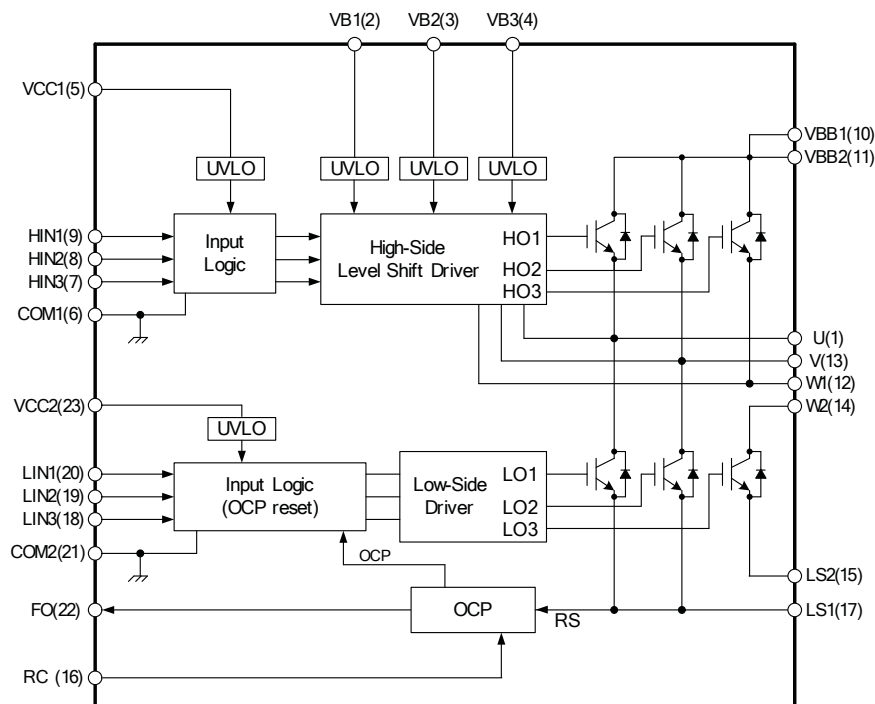


Figure 1. Driver block diagrams.

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 $T_A = 25^\circ\text{C}$

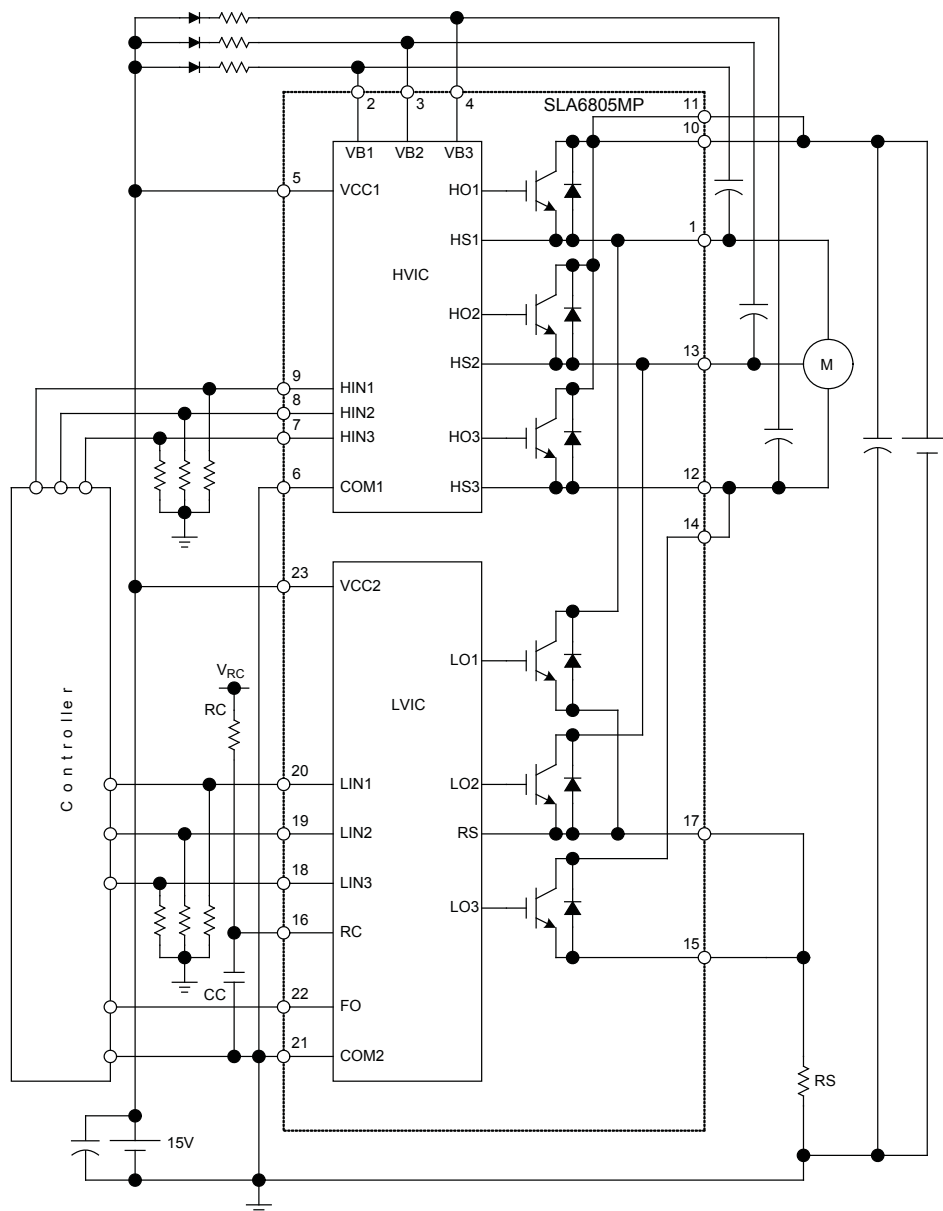
Characteristic	Symbol	Remarks	Rating	Unit
IGBT Breakdown Voltage	V_{CES}	$V_{CC} = 15\text{ V}$, $I_C = 1\text{ mA}$, $V_{IN} = 0\text{ V}$	600	V
Main Supply Voltage	V_{BB}	Between V_{BB} and GND	400	V
Main Supply Voltage (Surge)	$V_{BB(surge)}$	Between V_{BB} and GND	450	V
Logic Supply Voltage	V_{CC}	Between V_{CC} 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	5	A
		SLA6816MZ	3	A
Output Current, Pulsed	I_{OP}	SLA6806M	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	32.8	W
		SLA6816MZ	32.8	W
Thermal Resistance (Junction to Case)	$R_{\theta JC}$	All elements operating (IGBT)	3.8	$^\circ\text{C/W}$
		All elements operating (FRD)	5.4	$^\circ\text{C/W}$
Case Operating Temperature	T_{COP}		-20 to 100	$^\circ\text{C}$
Junction Temperature (MOSFET)	T_J		150	$^\circ\text{C}$
Storage Temperature	T_{stg}		-40 to 150	$^\circ\text{C}$

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 V_{BB} and LS, $I_{BB} \leq 2\text{ A}$	–	–	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	k Ω
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 $T_A = 25^\circ\text{C}$, unless otherwise noted

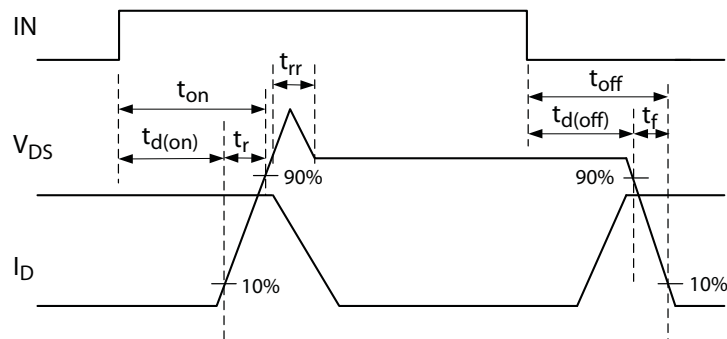
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Logic Supply Voltage	V_{CC}	Between VCC and COM	13.5	15	16.5	V
Logic Supply Current	I_{CC}	$V_{CC} = 15\text{ V}$	–	4	6	mA
Boot Supply Current	I_{BOOT}	VB1 to U, VB2 to V, and VB3 to W = 15 V, HIN = 5 V per circuit	–	140	400	μA
Input Voltage	V_{IH}	$V_{CC} = 15\text{ V}$, output on	–	2.0	2.5	V
	V_{IL}	$V_{CC} = 15\text{ V}$, output off	1.0	1.5	–	V
Input Voltage Hysteresis	V_{Ihys}	$V_{CC} = 15\text{ V}$	–	0.5	–	V
Input Current	I_{IH}	High side, $V_{CC} = 15\text{ V}$, $V_{IN} = 5\text{ V}$	–	50	100	μA
	I_{IL}	Low side, $V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$	–	–	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}	$V_{CC} = 15\text{ V}$	0	–	1.0	V
	V_{FOH}		4.0	–	5.5	V
Overcurrent Protection Trip Voltage	V_{TRIP}	$V_{CC} = 15\text{ V}$	0.45	0.50	0.55	V
RC Threshold Voltage	V_{RCH}	$V_{CC} = 15\text{ V}$	3.1	–	3.85	V
Overcurrent Protection Hold Time	t_p	$V_{RC} = 5\text{ V}$, $R_C = 330\text{ k}\Omega$, $C_C = 2200\text{ pF}$	–	870	–	μs
Blanking Time	t_{blank}	$V_{CC} = 15\text{ V}$	–	2	–	μs
IGBT Leakage Current	I_{CES}	$V_{CC} = 15\text{ V}$, $V_{CE} = 600\text{ V}$, $V_{IN} = 0\text{ V}$	–	–	1	mA
IGBT Saturation Voltage	$V_{CE(sat)}$	SLA6806M $V_{CC} = 15\text{ V}$, $I_C = 5\text{ A}$, $V_{IN} = 5\text{ V}$	–	1.75	2.2	V
		SLA6816MZ $V_{CC} = 15\text{ V}$, $I_C = 3\text{ A}$, $V_{IN} = 5\text{ V}$	–	1.75	2.1	V
Diode Forward Voltage	V_F	SLA6806M $V_{CC} = 15\text{ V}$, $I_C = 5\text{ A}$, $V_{IN} = 0\text{ V}$	–	2.0	2.4	V
		SLA6816MZ $V_{CC} = 15\text{ V}$, $I_F = 3\text{ A}$, $V_{IN} = 0\text{ V}$	–	1.65	2.0	V

SLA6806M ELECTRICAL CHARACTERISTICS, valid at $T_A = 25^\circ\text{C}$, unless otherwise noted

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Switching Time, High Side	$t_{dH(on)}$	$V_{BB} = 300\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 5\text{ A}$, $0\text{ V} \leq V_{IN} \leq 5\text{ V}$, 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 $T_A = 25^\circ\text{C}$, unless otherwise noted

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Switching Time, High Side	$t_{dH(on)}$	$V_{BB} = 300\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 3\text{ A}$, $0\text{ V} \leq V_{IN} \leq 5\text{ V}$, 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

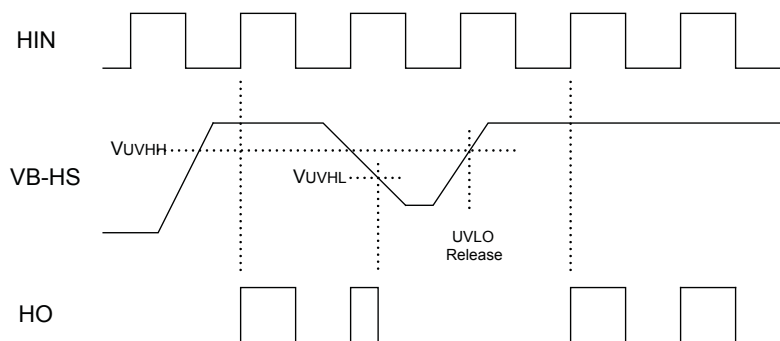
Mode	HINx	LINx	High-side MOSFET	Low-side MOSFET
Normal ¹	L	L	Off	Off
	H	L	On	Off
	L	H	Off	On
	H	H	On	On
OCP	L	L	Off	Off
	H	L	On	Off
	L	H	Off	Off
	H	H	On	Off
VCCx UVLO ²	L	L	Off	Off
	H	L	Off	Off
	L	H	Off	Off
	H	H	Off	Off
VBx UVLO ³	L	L	Off	Off
	H	L	Off	Off
	L	H	Off	On
	H	H	Off	On

¹In 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.

²After 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).

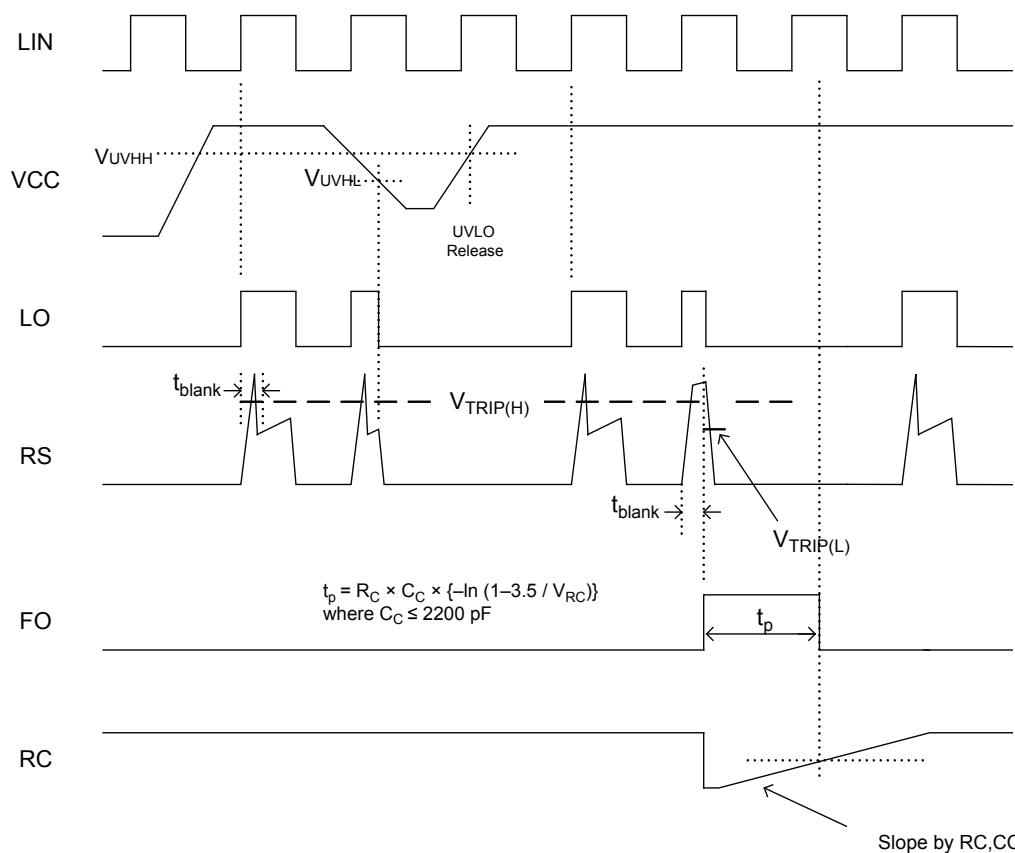
³After the VBx power rail recovers from a UVLO condition, a rising edge of HINx starts driving the high-side IGBT (edge trigger).

High Side Driver Input/Output Timing Diagrams



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

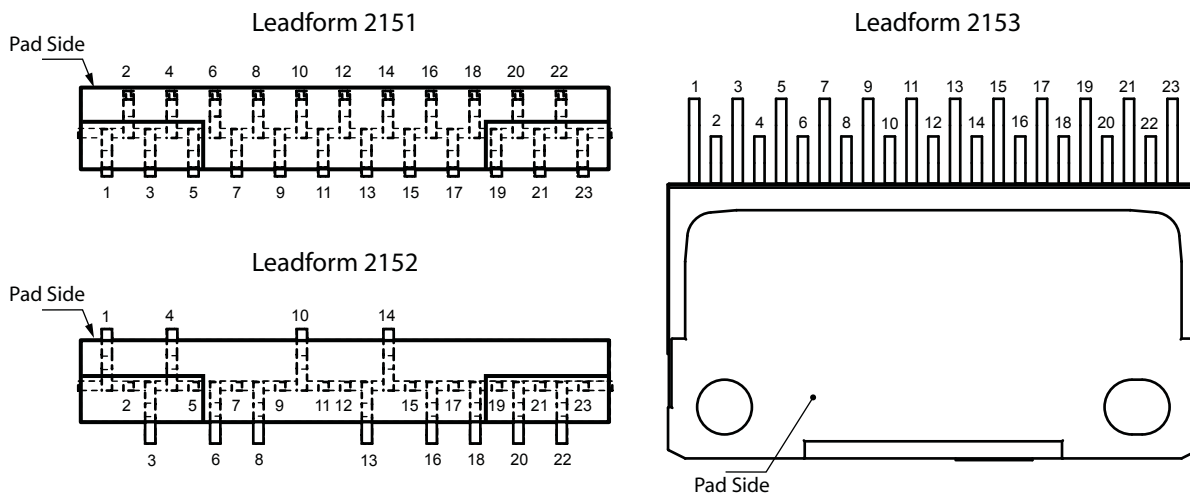
Low Side Driver Input/Output Timing Diagrams



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

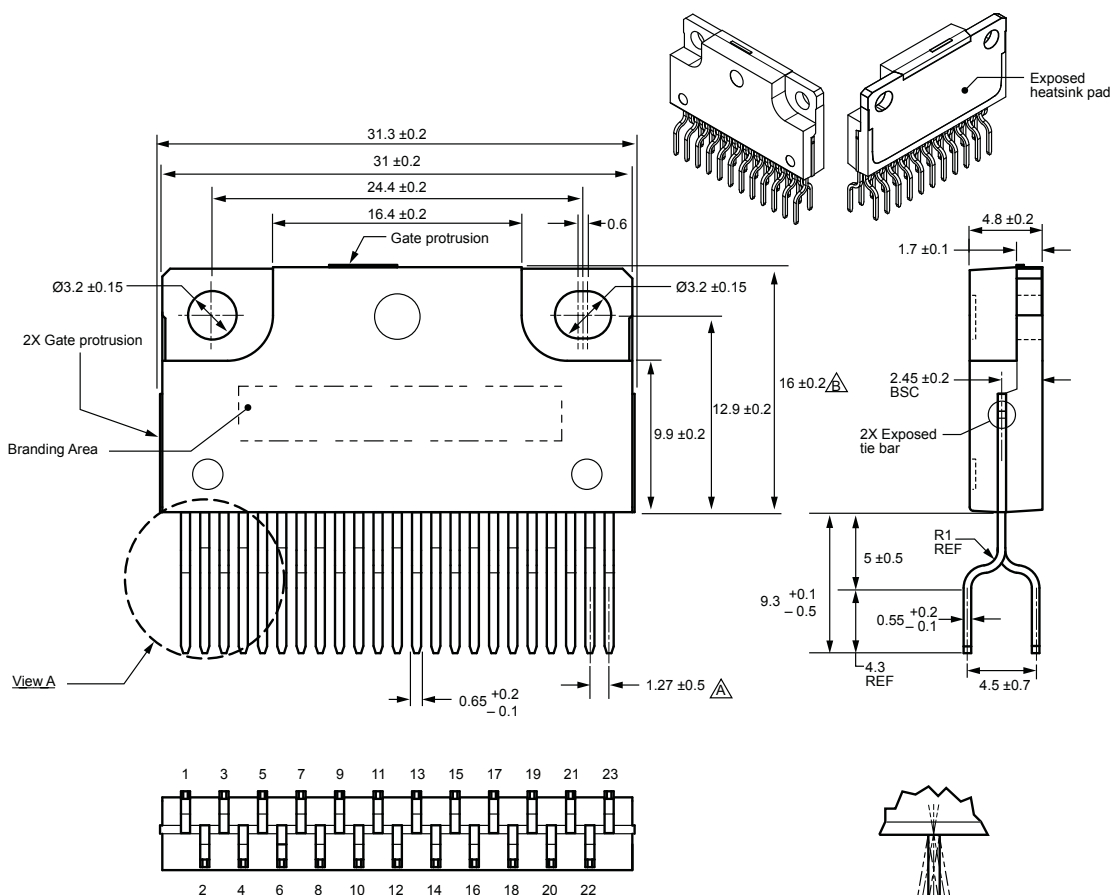


Terminal List Table

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



Measured at pin tips
 To case top

Terminal core material: Cu
Terminal plating: Ni, with Pb-free solder coating
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: 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

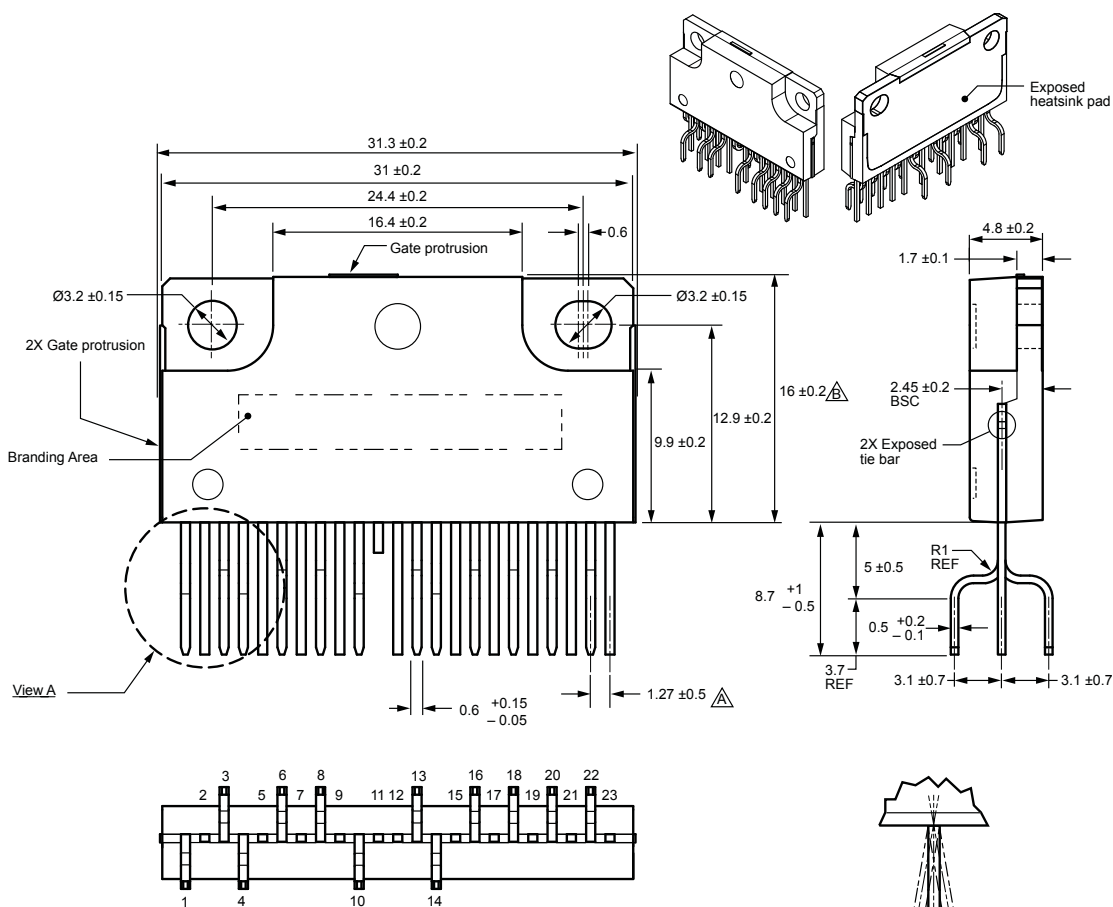


Leadframe plating Pb-free. Device composition
complies with the RoHS directive.

Package Outline Drawing

Leadform 2152

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



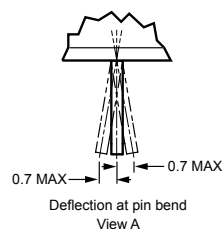
△ Measured at pin tips
△ To case top

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

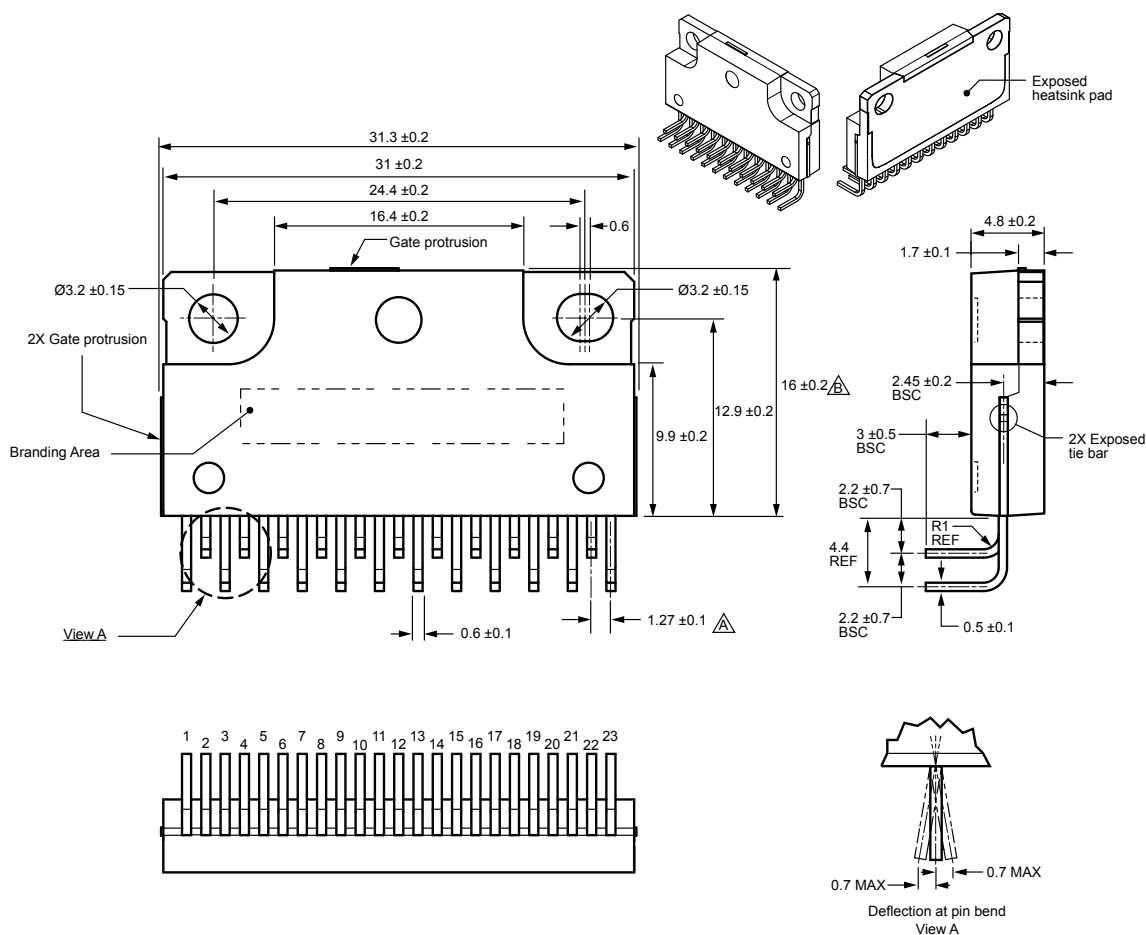
2nd line, lot: YMDDT
Where: Y is the last digit of the year of manufacture
M is the month (1 to 9, O, N, D)
DD is the date
T is the tracking letter



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



△ Measured at pin exit from case
△ 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

Material Composition

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



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

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 order 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.
 - Application and operation examples described in this document are quoted for the sole purpose of reference for the use of the products herein and Sanken can assume no responsibility for any infringement of industrial property rights, intellectual property rights or any other rights of Sanken or any third party which may result from its use.
 - 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 the society due to device failure or malfunction.
 - Sanken products listed in this document are designed and intended for the use as components in general purpose electronic equipment or apparatus (home appliances, office equipment, telecommunication equipment, measuring equipment, etc.).

When considering the use of Sanken products in the applications where higher reliability is required (transportation equipment and its control systems, traffic signal control systems or equipment, fire/crime alarm systems, various safety devices, etc.), and whenever long life expectancy is required even in general purpose electronic equipment or apparatus, please contact your nearest Sanken sales representative to discuss, prior to the use of the products herein.

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

- In the case that you use Sanken products or design your products by using Sanken products, the reliability largely depends on the degree of derating to be made to the rated values. Derating may be interpreted as a case that an operation range is set by derating the load from each rated value or surge voltage or noise is considered for derating in order to assure or improve the reliability. In general, derating factors include electric stresses such as electric voltage, electric current, electric power etc., environmental stresses such as ambient temperature, humidity etc. and thermal stress caused due to self-heating of semiconductor products. For these stresses, instantaneous values, maximum values and minimum values must be taken into consideration.

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.

- When using the products specified herein by either (i) combining other products or materials therewith or (ii) physically, chemically or otherwise processing or treating the products, please duly consider all possible risks that may result from all such uses in advance and proceed therewith at your own responsibility.
- Anti radioactive ray design is not considered for the products listed herein.
- Sanken assumes no responsibility for any troubles, such as dropping products caused during transportation out of Sanken's distribution network.
- The contents in this document must not be transcribed or copied without Sanken's written consent.