

## 1.5 Amp Output Current IGBT Gate Driver Optocoupler

**with Integrated ( $V_{CE}$ ) Desaturation Detection, UVLO  
Fault Status Feedback, Active Miller Clamping**

### Description

The SJS-331J is an advanced 1.5 A output current, easy-to-use, intelligent gate driver which makes IGBT  $V_{CE}$  fault protection compact, affordable, and easy-to implement. Features such as integrated  $V_{CE}$  detection, under voltage lockout (UVLO), “soft” IGBT turn-off, isolated open collector fault feedback and active Miller clamping provide maximum design flexibility and circuit protection.

The SJS-331J contains a LED. The LED is optically coupled to an integrated circuit with a power output stage. SJS-331J is ideally suited for driving power IGBTs and MOSFETs used in motor control inverter applications. The voltage and current supplied by these optocouplers make them ideally suited for directly driving IGBTs with ratings up to 1200 V and 100 A.

For IGBTs with higher ratings, the SJS-331J can be used to drive a discrete power stage which drives the IGBT gate.

The SJS-331J has an insulation voltage of  $V_{IORM} = 1414 V_{PEAK}$ .

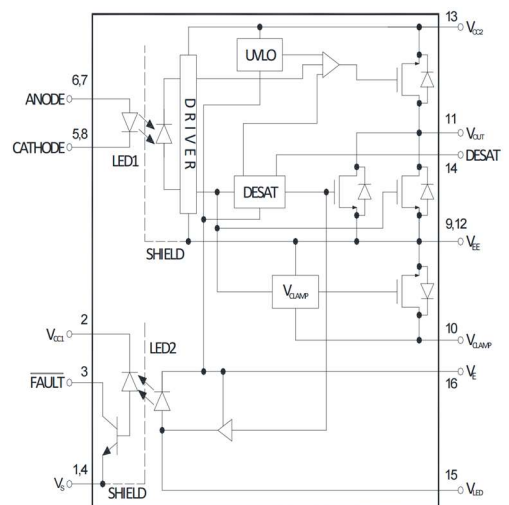
### Features

- 1.5 A maximum peak output current
- 1.0 A minimum peak output current
- 250 ns maximum propagation delay over temperature range
- 1.0 A Active Miller Clamp. Clamp pin short to  $V_{EE}$  if not in used
- Miller Clamping
- Desaturation Detection
- Under Voltage Lock-Out Protection (UVLO) with Hysteresis
- “Soft” IGBT Turn-off
- Fault Reset by next LED turn-on (low to high) after fault mute period
- Available in SO-16 package
- 100 ns maximum pulse width distortion (PWD)
- 50 kV/ $\mu$ s minimum common mode rejection (CMR) at  $V_{CM} = 1500 V$
- $I_{CC(max)} < 5 mA$  maximum supply current
- Wide  $V_{CC}$  operating range: 15 V to 30 V over temperature range
- Wide operating temperature range:  $-40^{\circ}C$  to  $110^{\circ}C$

### Applications

- Isolated IGBT/Power MOSFET gate drive
- AC and brushless DC motor drives
- Industrial inverters and Uninterruptible Power Supply (UPS)

### Block Diagram



SCHEMATIC		PIN DEFINITION	
1	$V_S$	16	$V_E$
2	$V_{CC1}$	15	$V_{LED}$
3	FAULT	14	DESAT
4	$V_S$	13	$V_{CC2}$
5	CATHODE	12	$V_{EE}$
6	ANODE	11	$V_{OUT}$
7	ANODE	10	$V_{CLAMP}$
8	CATHODE	9	$V_{EE}$

ABSOLUTE MAXIMUM RATINGS					
PARAMETER	SYMBOL	MIN.	MAX.	UNIT	Note
Storage Temperature	Tstg	-55	125	°C	
Operating Temperature	$T_A$	-40	110	°C	2
Output IC Junction Temperature	$T_J$		125	°C	2
Average Forward Input Current	$I_F$		25	mA	1
Peak Transient Input Current ( $<1\ \mu\text{s}$ pulse width, 300pps)	$I_{F(TRAN)}$		1.0	A	
Reverse Input Voltage	$V_R$		5	V	
“High” Peak Output Current	$I_{OH(PEAK)}$		1.5	A	3
“Low” Peak Output Current	$I_{OL(PEAK)}$		1.5	A	3
Positive Input Supply Voltage	$V_{CC1}$	-0.5	7.0	V	
FAULT Output Current	$I_{FAULT}$		8.0	mA	
FAULT Pin Voltage	$V_{FAULT}$	-0.5	$V_{CC1}$	V	
Total Output Supply Voltage	$(V_{CC2} - V_{EE})$	-0.5	33	V	
Negative Output Supply Voltage	$(V_E - V_{EE})$	-0.5	15	V	6
Positive Output Supply Voltage	$(V_{CC2} - V_E)$	-0.5	$33 - (V_E - V_{EE})$	V	
Gate Drive Output Voltage	$V_{O(PEAK)}$	-0.5	$V_{CC2}$	V	
Peak Clamping Sinking Current	$I_{CLAMP}$		1.0	A	
Miller Clamping Pin Voltage	$V_{CLAMP}$	-0.5	$V_{CC2}$	V	
DESAT Voltage	$V_{DESAT}$	$V_E$	$V_E + 10$	V	
Output IC Power Dissipation	$P_O$		600	mW	2
Input IC Power Dissipation	$P_I$		150	mW	2
Solder Reflow Temperature Profile	See Package Outline Drawings section				

**RECOMMENDED OPERATION CONDITIONS**

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	Note
Operating Temperature	$T_A$	-40	110	°C	2
Total Output Supply Voltage	$(V_{CC2} - V_{EE})$	15	30	V	7
Negative Output Supply Voltage	$(V_E - V_{EE})$	0	15	V	4
Positive Output Supply Voltage	$(V_{CC2} - V_E)$	15	$30 - (V_E - V_{EE})$	V	
Input Current (ON)	$I_{F(ON)}$	8	12	mA	
Input Voltage (OFF)	$V_{F(OFF)}$	-3.6	0.8	V	

**ELECTRICAL OPTICAL CHARACTERISTICS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	Note
INPUT CHARACTERISTICS							
FAULT Logic Low Output Voltage	$V_{FAULTL}$		0.01	0.4	V	$I_{FAULT} = 1.1 \text{ mA}$ , $V_{CC1} = 5.5\text{V}$	
			0.02	0.4	V	$I_{FAULT} = 1.1 \text{ mA}$ , $V_{CC1} = 3.3\text{V}$	
FAULT Logic High Output Current	$I_{FAULTH}$		0.01	0.5	μA	$V_{FAULT} = 5.5 \text{ V}$ , $V_{CC1} = 5.5\text{V}$	
			0.006	0.3	μA	$V_{FAULT} = 3.3 \text{ V}$ , $V_{CC1} = 3.3\text{V}$	
High Level Output Current	$I_{OH}$	-0.3	-1		A	$V_O = V_{CC2} - 4$	5
		-1.0			A	$V_O = V_{CC2} - 15$	3
Low Level Output Current	$I_{OL}$	0.3	1		A	$V_O = V_{EE} + 2.5$	5
		1.0			A	$V_O = V_{EE} + 15$	3
Low Level Output Current During Fault Condition	$I_{OLF}$	70	110	230	mA	$V_{OUT} - V_{EE} = 14 \text{ V}$	6
High Level Output Voltage	$V_{OH}$	$V_{CC} - 0.5$	$V_{CC} - 0.1$		V	$I_O = -650 \text{ μA}$	7,8,9,23
Low Level Output Voltage	$V_{OL}$		0.1	0.5	V	$I_O = 100 \text{ mA}$	
Clamp Pin Threshold Voltage	$V_{tClamp}$		2.2		V		
Clamp Low Level Sinking Current	$I_{CL}$	0.21	0.8		A	$V_O = V_{EE} + 2.5$	
High Level Supply Current	$I_{CC2H}$		2.23	5	mA	$I_O = 0 \text{ mA}$	9
Low Level Supply Current	$I_{CC2L}$		2.36	5	mA	$I_O = 0 \text{ mA}$	
Blanking Capacitor Charging Current	$I_{CHG}$	0.13	-0.24	-0.33	mA	$V_{DESAT} = 2 \text{ V}$	9,10
Blanking Capacitor Discharge Current	$I_{DSCHG}$	10	31		mA	$V_{DESAT} = 7.0 \text{ V}$	
DESAT Threshold	$V_{DESAT}$	6	6.7	7.5	V	$V_{CC2} - V_E > V_{UVLO-}$	9
UVLO Threshold	$V_{UVLO+}$	10.5	11.5	12.5	V	$V_O > 5 \text{ V}$	7,9,11
	$V_{UVLO-}$	9.2	10.5	11.1	V	$V_O < 5 \text{ V}$	7,9,12
UVLO Hysteresis	$(V_{UVLO+} - V_{UVLO-})$	0.4	1		V		
Threshold Input Current Low to High	$I_{FLH}$		0.27	6	mA	$I_O = 0 \text{ mA}$ , $V_O > 5 \text{ V}$	
Threshold Input Voltage High to Low	$V_{FHL}$	0.8	1.74		V		

Input Forward Voltage	$V_F$	1.6	2.0	2.4	V	$I_F = 10 \text{ mA}$	
Input Reverse Breakdown Voltage	$BV_R$	5			V	$I_R = 10 \text{ }\mu\text{A}$	
Input Capacitance	$C_{IN}$		70		pF	$f = 1 \text{ MHz}, V_F = 0 \text{ V}$	

■ Unless otherwise noted, all typical values at  $T_A = 25^\circ\text{C}$ ,  $V_{CC2} - V_{EE} = 30 \text{ V}$ ,  $V_E - V_{EE} = 0 \text{ V}$ ; all Minimum/Maximum specifications are at Recommended Operating Conditions.

SWITCHING SPECIFICATION							
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	Note
SWITCHING CHARACTERISTICS							
Propagation Delay Time to Output Low Level	$t_{PHL}$	50	103	250	ns	$R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $f = 10 \text{ kHz}$ , Duty Cycle = 50%, $I_F = 10 \text{ mA}$ , $V_{CC2} = 30 \text{ V}$	
Propagation Delay Time to Output High Level	$t_{PLH}$	50	74	250	ns		13,15
Pulse Width Distortion	PWD	-100		100	ns		14,17
Propagation Delay Difference Between Any Two Parts	PDD ( $t_{PHL} - t_{PLH}$ )	-150		150	ns		17,16
Rise Time	$t_r$		45		ns		
Fall Time	$t_f$		40		ns		
DESAT Sense to 90% VO Delay	$t_{DESAT(90\%)}$		0.1	0.3	$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC2} = 30 \text{ V}$	19
DESAT Sense to 10% VO Delay	$t_{DESAT(10\%)}$		1.2	1.5	$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC2} = 30 \text{ V}$	
DESAT Sense to Low Level FAULT Signal Delay	$t_{DESAT(FAULT)}$		0.15	0.5	$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $C_F = \text{Open}$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC2} = 30 \text{ V}$	18
			0.8		$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $C_F = 1 \text{ nF}$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC2} = 30 \text{ V}$	
DESAT Sense to DESAT Low Propagation Delay	$t_{DESAT(LOW)}$		0.1		$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC2} = 30 \text{ V}$	19
DESAT Input Mute	$t_{DESAT(MUTE)}$	5			$\mu\text{s}$	$C_{DESAT} = 100 \text{ pF}$ , $R_F = 2.1\text{k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{CC1} = 5.5\text{V}$ , $V_{CC2} = 30 \text{ V}$	20

RESET to High Level FAULT Signal Delay	$t_{\text{RESET(FAULT)}}$	0.2	0.6	2.0	$\mu\text{s}$	$C_{\text{DESAT}} = 100 \text{ pF}$ , $R_F = 2.1 \text{ k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{\text{CC1}} = 5.5\text{V}$ , $V_{\text{CC2}} = 30 \text{ V}$	
	$t_{\text{RESET(FAULT)}}$	0.2	0.6	2.0	$\mu\text{s}$	$C_{\text{DESAT}} = 100 \text{ pF}$ , $R_F = 2.1 \text{ k}\Omega$ , $R_g = 20 \text{ }\Omega$ , $C_g = 5 \text{ nF}$ , $V_{\text{CC1}} = 3.3\text{V}$ , $V_{\text{CC2}} = 30 \text{ V}$	
Output High Level Common Mode Transient Immunity	$ CM_H $	15			$\text{kV}/\mu\text{s}$	$T_A = 25^\circ\text{C}$ , $I_F = 10 \text{ mA}$ $V_{\text{CM}} = 1500 \text{ V}$ , $V_{\text{CC2}} = 30 \text{ V}$ , $R_F = 2.1 \text{ k}\Omega$ , $C_F = 15 \text{ pF}$	21
		50				$T_A = 25^\circ\text{C}$ , $I_F = 10 \text{ mA}$ $V_{\text{CM}} = 1500 \text{ V}$ , $V_{\text{CC2}} = 30 \text{ V}$ , $R_F = 2.1 \text{ k}\Omega$ , $C_F = 1 \text{ nF}$	21,26
Output Low Level Common Mode Transient Immunity	$ CM_L $	15			$\text{kV}/\mu\text{s}$	$T_A = 25^\circ\text{C}$ , $V_F = 0 \text{ V}$ $V_{\text{CM}} = 1500 \text{ V}$ , $V_{\text{CC2}} = 30 \text{ V}$ , $R_F = 2.1 \text{ k}\Omega$ , $C_F = 15 \text{ pF}$	22
		50				$T_A = 25^\circ\text{C}$ , $V_F = 0 \text{ V}$ $V_{\text{CM}} = 1500 \text{ V}$ , $V_{\text{CC2}} = 30 \text{ V}$ , $R_F = 2.1 \text{ k}\Omega$ , $C_F = 1 \text{ nF}$	

■ Unless otherwise noted, all typical values at  $T_A = 25^\circ\text{C}$ ,  $V_{\text{CC2}} - V_{\text{EE}} = 30 \text{ V}$ ,  $V_E - V_{\text{EE}} = 0 \text{ V}$ ; all Minimum/Maximum specifications are at Recommended Operating Conditions.

ISOLATION CHARACTERISTIC								
PARAMETER	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	Note
Withstand Insulation Test Voltage	$V_{\text{ISO}}$	SJS-331J	5000	-	-	V	$\text{RH} \leq 40\%-60\%$ , $t = 1\text{min}$ , $T_A = 25^\circ\text{C}$	24,25
Input-Output Resistance	$R_{\text{I-O}}$	-	-	$10^{12}$	-	$\Omega$	$V_{\text{I-O}} = 500\text{V DC}$	25

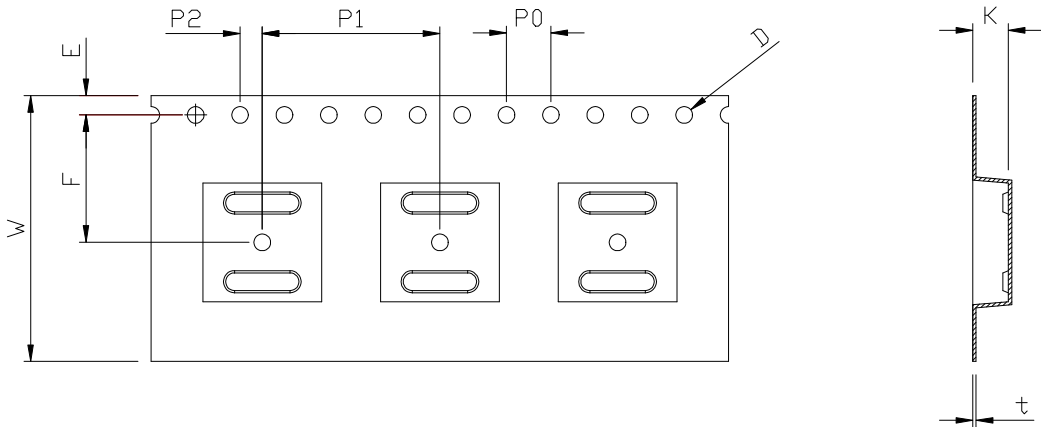
**Notes:**

- Derate linearly above  $70^\circ\text{C}$  free air temperature at a rate of  $0.3 \text{ mA}/^\circ\text{C}$ .
- In order to achieve the absolute maximum power dissipation specified, pins 4, 9, and 10 require ground plane connections and may require airflow. See the Thermal Model section in the application notes at the end of this data sheet for details on how to estimate junction temperature and power dissipation. In most cases the absolute maximum output IC junction temperature is the limiting factor. The actual power dissipation achievable will depend on the application environment (PCB Layout, air flow, part placement, etc.). See the Recommended PCB Layout section in the application notes for layout considerations. Output IC power dissipation is derated linearly at  $10 \text{ mW}/^\circ\text{C}$  above  $90^\circ\text{C}$ . Input IC power dissipation does not require derating.
- Maximum pulse width =  $10 \mu\text{s}$ . This value is intended to allow for component tolerances for designs with IO peak minimum =  $1.0 \text{ A}$ . Derate linearly from  $2.0 \text{ A}$  at  $+25^\circ\text{C}$  to  $1.5 \text{ A}$  at  $+105^\circ\text{C}$ . This compensates for increased  $I_{\text{OPEAK}}$  due to changes in  $V_{\text{OL}}$  over temperature.

4. This supply is optional. Required only when negative gate drive is implemented.
5. Maximum pulse width = 50  $\mu$ s.
6. See the Slow IGBT Gate Discharge During Fault Condition section in the applications notes at the end of this data sheet for further details.
7. 15 V is the recommended minimum operating positive supply voltage ( $V_{CC2} - V_E$ ) to ensure adequate margin in excess of the maximum  $V_{UVLO+}$  threshold of 12.5 V. For High Level Output Voltage testing,  $V_{OH}$  is measured with a dc load current. When driving capacitive loads,  $V_{OH}$  will approach  $V_{CC}$  as  $I_{OH}$  approaches zero units.
8. Maximum pulse width = 1.0 ms.
9. Once VO of the SJS-331J is allowed to go high ( $V_{CC2} - V_E > V_{UVLO+}$ ), the DESAT detection feature of the SJS-331J will be the primary source of IGBT protection. UVLO is needed to ensure DESAT is functional. Once  $V_{CC2}$  is increased from 0V to above  $V_{UVLO+}$ , DESAT will remain functional until  $V_{CC2}$  is decreased below  $V_{UVLO-}$ . Thus, the DESAT detection and UVLO features of the SJS-331J work in conjunction to ensure constant IGBT protection.
10. See the DESAT fault detection blanking time section in the applications notes at the end of this data sheet for further details.
11. This is the "increasing" (i.e. turn-on or "positive going" direction) of  $V_{CC2} - V_E$
12. This is the "decreasing" (i.e. turn-off or "negative going" direction) of  $V_{CC2} - V_E$
13. This load condition approximates the gate load of a 1200 V/75A IGBT.
14. Pulse Width Distortion (PWD) is defined as  $|t_{PHL} - t_{PLH}|$  for any given unit.
15. As measured from  $I_F$  to  $V_O$ .
16. The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two SJS-331J parts under the same test conditions.
17. As measured from ANODE, CATHODE of LED to  $V_{OUT}$
18. This is the amount of time from when the DESAT threshold is exceeded, until the FAULT output goes low.
19. This is the amount of time the DESAT threshold must be exceeded before  $V_{OUT}$  begins to go low, and the FAULT output to go low. This is supply voltage dependent.
20. Auto Reset: This is the amount of time when  $V_{OUT}$  will be asserted low after DESAT threshold is exceeded. See the Description of Operation (Auto Reset) topic in the application information section.
21. Common mode transient immunity in the high state is the maximum tolerable  $dV_{CM}/dt$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in the high state (i.e.,  $V_O > 15$  V or FAULT > 2 V).
22. Common mode transient immunity in the low state is the maximum tolerable  $dV_{CM}/dt$  of the common mode pulse,  $V_{CM}$ , to assure that the output will remain in a low state (i.e.,  $V_O < 1.0$  V or FAULT < 0.8 V).
23. To clamp the output voltage at  $V_{CC} - 3 V_{BE}$ , a pull-down resistor between the output and  $V_{EE}$  is recommended to sink a static current of 650  $\mu$ A while the output is high. See the Output Pull-Down Resistor section in the application notes at the end of this data sheet if an output pull-down resistor is not used.
24. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage  $\geq 6000$  Vrms for 1 second. This test is performed before the 100% production test for partial discharge (method b) shown in IEC/EN/DIN EN 60747-5-5 Insulation Characteristic Table.
25. This is a two-terminal measurement: pins 1-8 are shorted together and pins 9-16 are shorted together.
26. Split resistors network with a ratio of 1:1 is needed at input LED1. See Figure 34.

TAPING DIMENSIONS (Dimensions in mm unless otherwise stated)

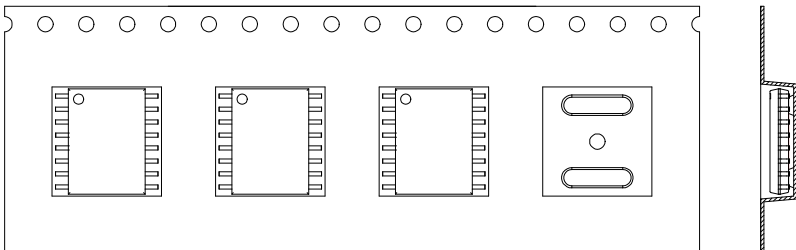
Taping Dimensions



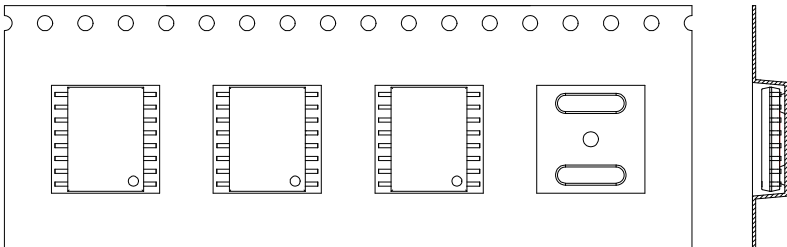
Dimension Symbol	D	E	F	P0	P1	P2	t	W	K
Dimension (mm)	1.5±0.1	1.75±0.1	11.5±0.1	4.0±0.1	16.0±0.1	2.0±0.1	0.3±0.1	24.0±0.3	3.2±0.1

Tape & Reel Packing Specifications

Option T1

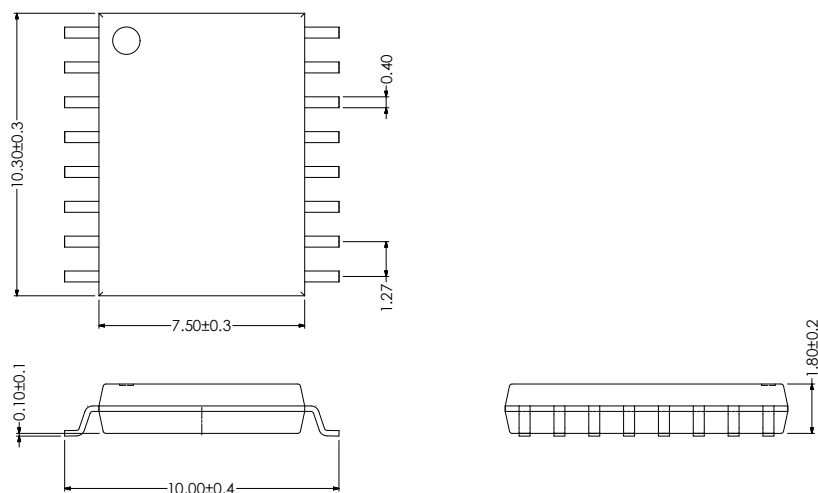


Option T2

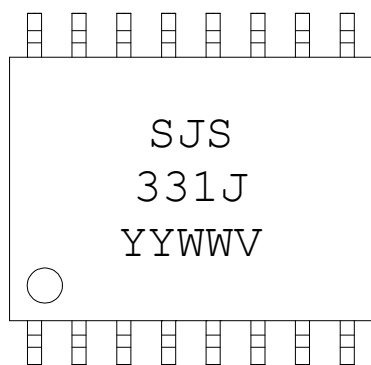


## PACKAGE DIMENSIONS (Dimensions in mm unless otherwise stated)

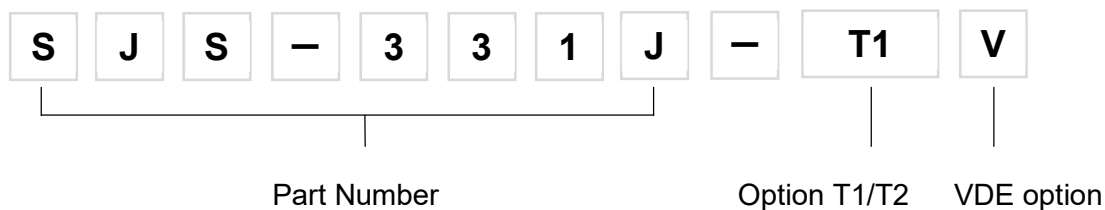
### SURFACE MOUNT LEAD FORMING



## MARKING AND ORDERING INFORMATION



MARKING SYMBOL	DESCRIPTION
SJS	Part Number
331J	
YY	Year Date Code
WW	Two Digit Work Week
V	VDE Option ( V or None )

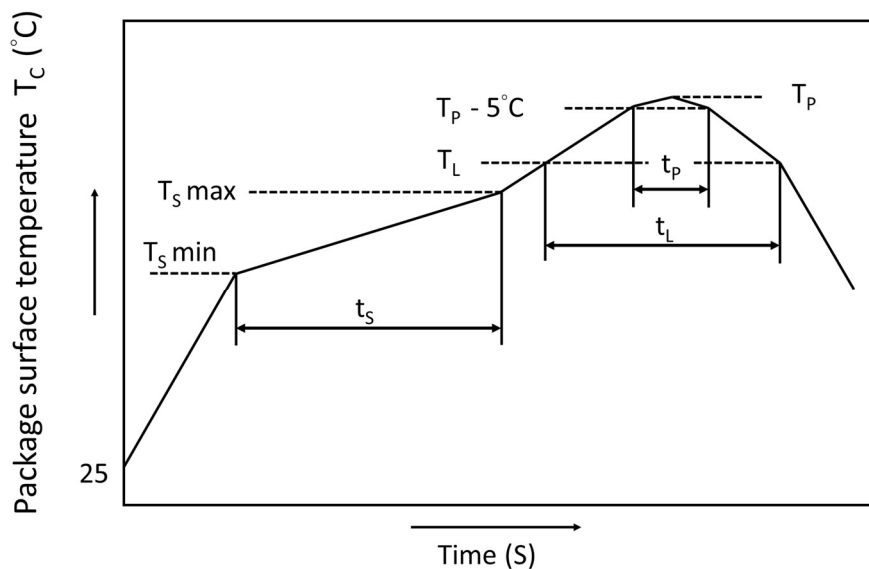




# PRECAUTIONS FOR SOLDERING

## IR Reflow soldering

One time soldering reflow is recommended within the condition of temperature and time profile shown below. Do not solder more than three times.



DESCRIPTION	SYMBOL	MIN.	MAX.	UNIT
Preheat temperature	$T_s$	150	200	$^{\circ}\text{C}$
Preheat time	$t_s$	60	120	s
Ramp-up rate ( $T_L$ to $T_P$ )			3	$^{\circ}\text{C/s}$
Liquidus temperature	$T_L$	217		$^{\circ}\text{C}$
Time above $T_L$	$t_L$	60	100	s
Peak Temperature	$T_P$		260	$^{\circ}\text{C}$
Time during which $T_c$ is between ( $T_P - 5$ ) and $T_P$	$t_p$		20	s
Ramp-down rate			6	$^{\circ}\text{C/s}$