Negative Voltage SPDT Switch

NLHV4157N

The NLHV4157N is an advanced CMOS analog switch fabricated with silicon gate CMOS technology. The device passes analog and digital negative voltages that may vary across the full power−supply range (from V_{EE} to GND).

Features

- Operating Voltage Range: V_{EE} = −12 V to −4 V
- Switch Signal Voltage Range: V_{IS} = V_{EE} to GND
- Positive Control Signal Voltage: V_{IN} = 0 to 3.3 V
- Low ON Resistance: $R_{ON} \leq 5\ \Omega$ @ V_{EE} = −10 V
- Latch−up Performance Exceeds 200 mA
- Available in: SC−88 6−Pin Package
- These Devices are Pb−Free, Halogen−Free/BFR-Free and are RoHS−Compliant

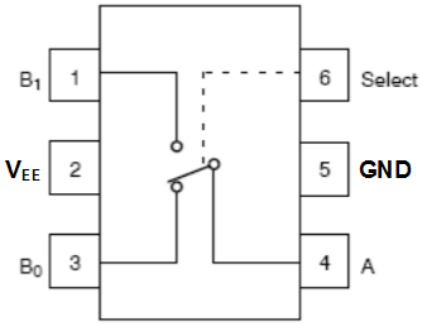
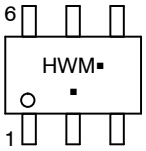


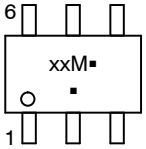
Figure 1. Pin Assignment and logic Diagram

MARKING DIAGRAM

SC−88
DF SUFFIX
CASE 419B



SC−88
DF SUFFIX
CASE 419AD



HW/xx = Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

FUNCTION TABLE

Select Input	Function
L	B0 Connected to A
H	B1 Connected to A

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

ORDERING INFORMATION

Device	Marking	Package	Case Code	Shipping†
NLHV4157NDFT2G	HW	SC−88	419B	3000 / Tape & Reel
NLHV4157NSDFT2G (In Development, please contact **onsemi**)	XX	SC−88	419AD	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

MAXIMUM RATINGS

Symbol	Rating		Value	Unit
V_{EE}	DC Supply Voltage		−13 to +0.5	V
V_{IS}	Analog Input Voltage (Note 1)		V_{EE}−0.5 to +0.5	V
V_{IN}	Digital Select Input Voltage (Note 1)		−0.5 to +3.6	V
I_{IOK}	Switch Input/Output diode current		±50	mA
I_{IK}	Select input diode current		−50	mA
P_D	Power Dissipation in Still Air		60	mW
T_L	Lead Temperature, 1 mm from Case for 10 seconds		260	°C
T_J	Junction Bias Under Bias		150	°C
MSL	Moisture Sensitivity		Level 1	
F_R	Flammability Rating	Oxygen Index: 30% − 35%	UL94−V0 (0.125 in)	°C
I_L	Latch−up Current (Note1)	Below GND and above V_{EE} at 125°C	±200	mA
		Below GND and above V_{EE} at 25°C	±300	
T_s	Storage Temperature		−65 to +150	°C
θ_{JA}	Thermal Resistance		400	°C/W
ESD	ESD Protection	Human Body Model	3000	V
		Machine Model	150	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The input and output voltage ratings may be exceeded if the input and output diode current ratings are observed.

RECOMMENDED OPERATING CONDITIONS (Note 2)

Symbol	Parameter		Min	Max	Unit
V_{EE}	DC Supply Voltage		−12	−4	V
V_S	Switch Input / Output Voltage	(B0, B1, A)	V_{EE}	GND	V
V_{IN}	Digital Select Input Voltage		GND	3.3	V
T_A	Operating Temperature Range		−55	+125	°C
t_r, t_f	Input Transition Rise or Fall Time (Select Input)		0	100	ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

2. Select input must be held HIGH or LOW, it must not float.

DC ELECTRICAL CHARACTERISTICS (Voltages referenced to GND; Typical characteristics are T_A at 25°C.)

Symbol	Parameter	Condition	V_{EE}, V	−55° to 125°C			Unit
				Min	Typ	Max	
SELECT INPUT							
V_{IH}	Minimum High−Level Input Voltage		−12	1.8		3.3	V
			−10	1.6		3.3	
			−8	1.4		3.3	
			−6	1.2		3.3	
			−4	1.0		3.3	
V_{IL}	Maximum Low−Level Input Voltage		−12	0		0.8	V
			−10	0		0.7	
			−8	0		0.6	
			−6	0		0.5	
			−4	0		0.4	
I_{IN}	Maximum Input Leakage Current	V_{IN} = 3.3 V or GND	−10		±0.2	±50	μA
		V_{IN} = 3.3 V or GND, test at 25°C only	−10			±0.5	
POWER SUPPLY							
I_{CC}	Maximum Quiescent Supply Current	Select = 3.3 V or GND, V_{IS} = V_{EE} or GND	−10 to −4		25	80	μA
ANALOG SWITCH							
R_{ON}	Maximum ON Resistance (Note 3)	V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND $I_O \leq$ 10 mA	−12		2.6	4.5	Ω
			−10		3.0	5	
			−8		3.5	5.8	
			−6		4.5	7.5	
		V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND $I_O \leq$ 5 mA	−4		9	15	
R_{FLAT}	ON Resistance Flatness (Notes 3, 4, 6)	V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND $I_O \leq$ 10 mA	−12		0.4		Ω
			−10		1.2		
			−8		1.7		
			−6		2.5		
		V_{IN} = V_{IL} or V_{IH} V_{IS} = V_{EE} to GND $I_O \leq$ 5 mA	−4		6		
ΔR_{ON}	R_{ON} Mismatch Between (Notes 3, 4, 5)	I_A = −10 mA, V_{Bn} = −8.4 V	−12		0.2		Ω
		I_A = −10 mA, V_{Bn} = −7 V	−10		0.2		
		I_A = −10 mA, V_{Bn} = −5.6 V	−8		0.25		
		I_A = −10 mA, V_{Bn} = −4.2 V	−6		0.25		
		I_A = −5 mA, V_{Bn} = −2.8 V	−4		0.3		
$I_{NC(OFF)}$, $I_{NO(OFF)}$	NC or NO OFF Leakage Current (Figure 9)	V_{IN} = V_{IL} or V_{IH}, V_{Bn} = GND, V_A = V_{EE} to GND	−10		±1.0	±20	μA
$I_{COM(ON)}$	COM ON Leakage Current (Figure 9)	V_{IN} = V_{IL} or V_{IH}; V_A = GND V or V_{EE}; V_{B1} = GND or V_{EE} with V_{B0} floating, or V_{B0} = GND or V_{EE} with V_{B1} floating	−10		±2.0	±20	μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Measured by the voltage drop between A and B pins at the indicated current through the switch. On Resistance is determined by the lower of the voltages on the two (A or B Ports).
4. Parameter is characterized but not tested in production.
5. $\Delta R_{ON} = R_{ON}max - R_{ON}min$ measured at identical V_{EE}, temperature and voltage levels.
6. Flatness is defined as the difference between the maximum and minimum value of ON Resistance over the specified range of conditions.

AC ELECTRICAL CHARACTERISTICS (Voltages referenced to GND; Typical characteristics are T_A at 25°C.)

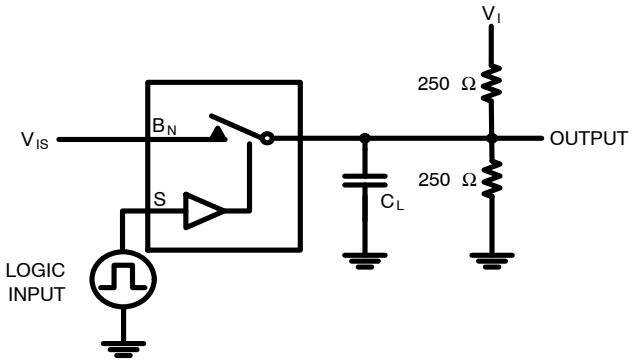
Symbol	Parameter	Condition	V_{EE}, V	−55° to 125°C			Unit
				Min	Typ	Max	
t_{PHL}, t_{PLH}	Propagation Delay, Bus to Bus (Note 8) (A to B_n)	C_L = 100 pF (Figures 2, 3)	−12 to −4			2	ns
t_{PZL}, t_{PZH}	Switch Enable Time Turn−On Time (A to B_n)	C_L = 100 pF (Figures 2, 3)	−12			220	ns
			−10			175	
			−8			165	
			−6			165	
			−4			200	
t_{PLZ}, t_{PHZ}	Switch Disable Time Turn−Off Time (A to B_n)	C_L = 100 pF (Figures 2, 3)	−12			225	ns
			−10			155	
			−8			150	
			−6			120	
			−4			145	
t_B	Switch Break Time	R_L = 50 Ω, C_L = 100 pF, V_{IS} = −2.5 V (Figure 4)	−12	5		60	ns
			−10	5		60	
			−8	10		75	
			−6	10		90	
			−4	40		135	
t_{POR}	Power ON Reset Time	Measured from V_{EE} = −4 V	−12 to −4			20	μs
Q	Charge Injection (Note 7)	C_L = 1 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω (Figure 5)	−12		170		pC
			−10		120		
			−8		95		
			−6		55		
			−4		40		
OIRR	Off−Isolation (Note 9)	R_L = 50 Ω, f = 10 MHz (Figure 6)	−12 to −4		−33		dB
Xtalk	Crosstalk	R_L = 50 Ω, f = 10 MHz (Figure 7)	−12 to −4		−42		dB
BW	−3 dB Bandwidth	R_L = 50 Ω (Figure 10)	−12 to −4		200		MHz

7. Guaranteed by Design.
8. This parameter is guaranteed by design but not tested. The bus switch contributes no propagation delay other than the RC delay of the ON Resistance of the switch and the 50 pF load capacitance, when driven by an ideal voltage source (zero output impedance).
9. Off Isolation = 20 $\log_{10}$ [V_A/V_{Bn}].

CAPACITANCES (Note 10)

Symbol	Parameter	Test Conditions	Typical @ 25°C	Unit
C_{IN}	Input Capacitance, Select Inputs	V_{EE} = −12 V	6	pF
C_{IOB}	B−Port OFF Capacitance	V_{EE} = −10 V	45	pF
C_{IOA_ON}	A Port Capacitance when Switch is Enabled	V_{EE} = −10 V	100	pF

10. T_A = +25°C, f = 1 MHz, Capacitance is characterized but not tested in production.



Note: Input V_{IS} driven by 50 Ω source terminated by 50 Ω.
Note: C_L includes load and stray capacitance.
Input PRR = 100 kHz, t_W = 5 μs.

Parameter	V_I	V_{IS}
t_{PLH} / t_{PHL}	Open	Source
t_{PZL} / t_{PLZ}	GND	V_{EE}
t_{PZH} / t_{PHZ}	2 x V_{EE}	GND

Figure 2. AC Test Circuit

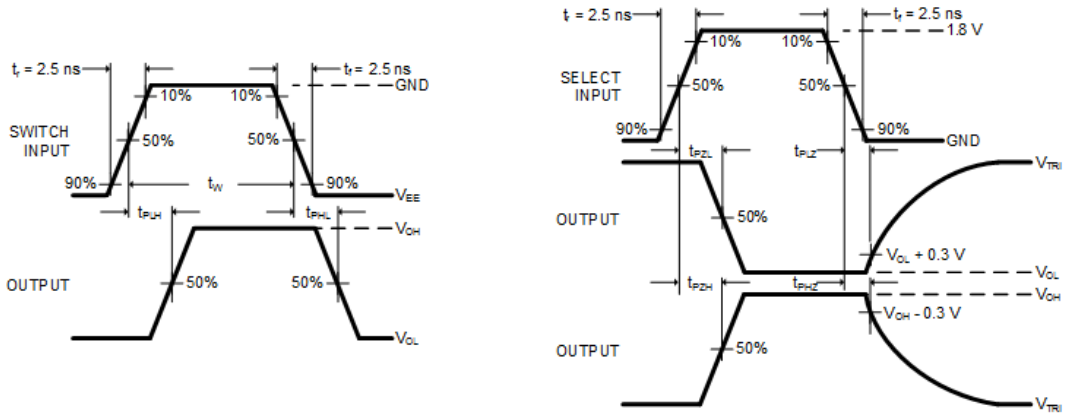


Figure 3. AC Test Waveforms

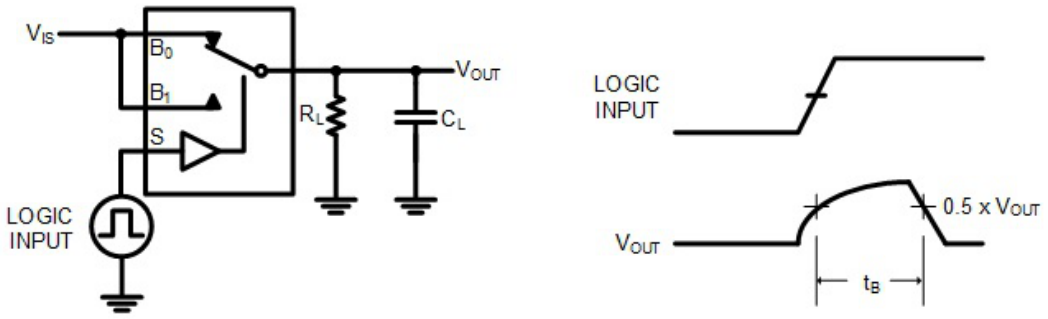


Figure 4. Switch Break Interval Timing

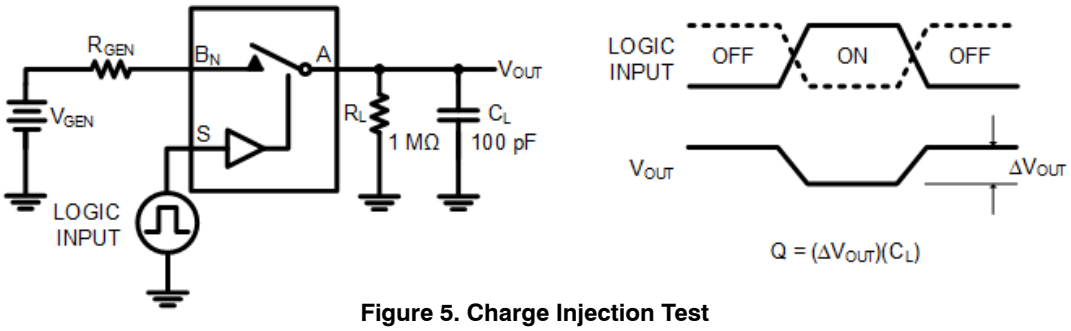


Figure 5. Charge Injection Test

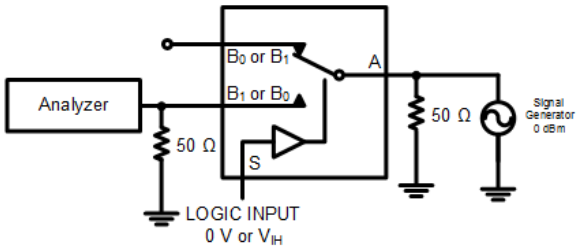


Figure 6. Off Isolation

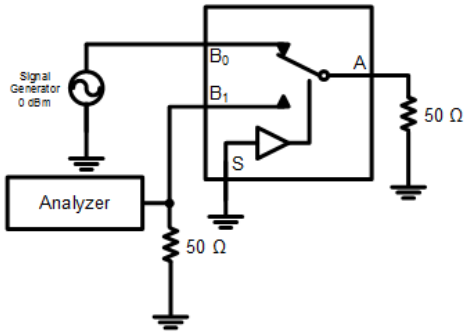


Figure 7. Crosstalk

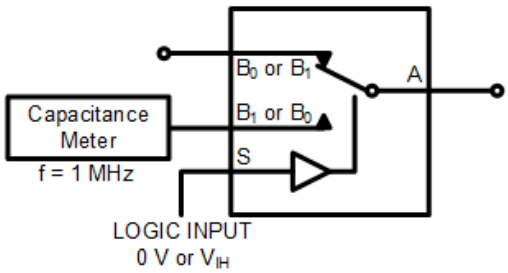


Figure 8. Channel Off Capacitance

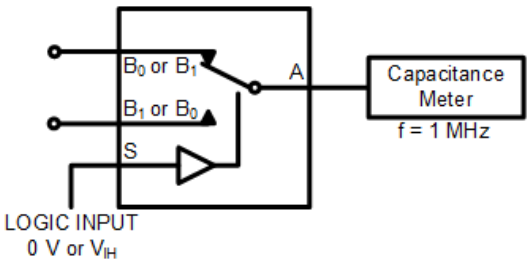
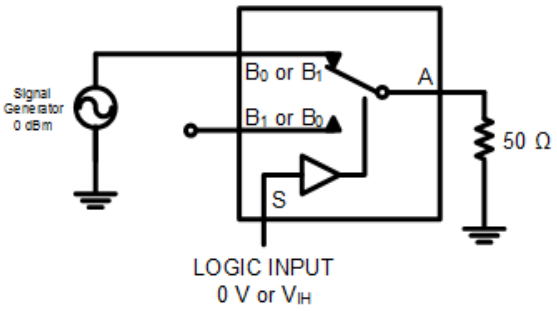


Figure 9. Channel On Capacitance



$$BW = \frac{0.707 \cdot VA}{VBn}, \quad n = 0 \text{ or } 1$$

Figure 10. Bandwidth

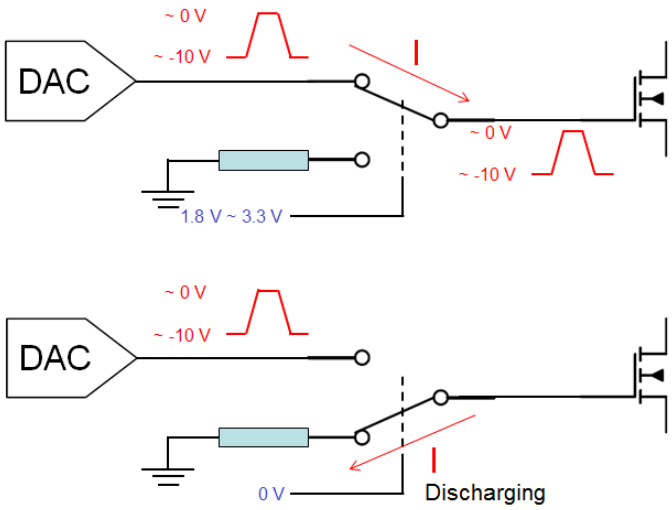
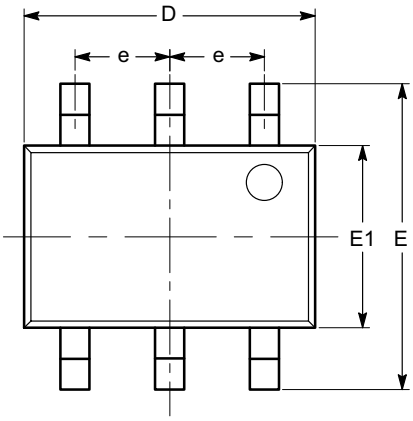


Figure 11. Typical Application

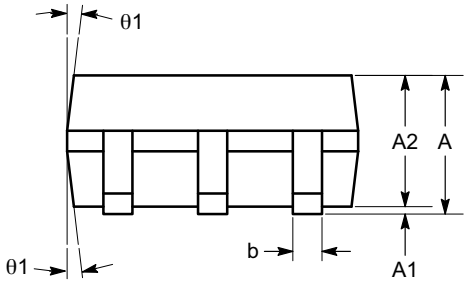
PACKAGE DIMENSIONS

SC−88 (SC−70 6 Lead), 1.25x2
CASE 419AD
ISSUE A

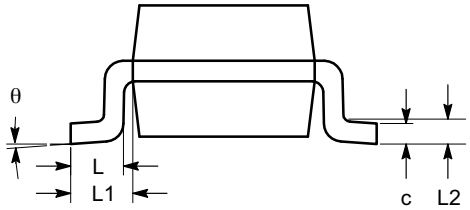


TOP VIEW

SYMBOL	MIN	NOM	MAX
A	0.80		1.10
A1	0.00		0.10
A2	0.80		1.00
b	0.15		0.30
c	0.10		0.18
D	1.80	2.00	2.20
E	1.80	2.10	2.40
E1	1.15	1.25	1.35
e		0.65 BSC	
L	0.26	0.36	0.46
L1		0.42 REF	
L2		0.15 BSC	
θ	0°		8°
θ1	4°		10°



SIDE VIEW

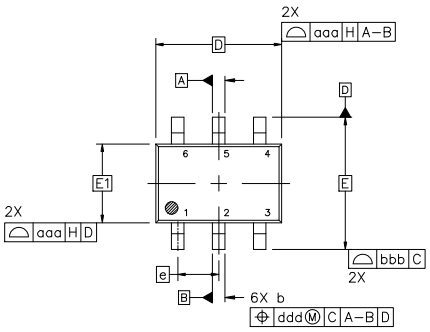


END VIEW

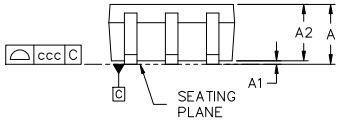
Notes:
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-203.

SC−88 2.00x1.25x0.90, 0.65P
CASE 419B−02
ISSUE Z

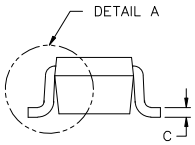
DATE 18 APR 2024



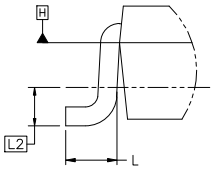
TOP VIEW



SIDE VIEW



END VIEW

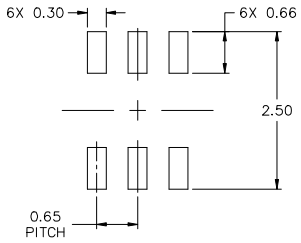


DETAIL A
SCALE 2:1

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5−2018.
2. ALL DIMENSION ARE IN MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF DIMENSION b AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

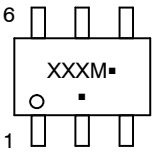
	MILLIMETERS		
DIM	MIN.	NOM.	MAX.
A	−−−	−−−	1.10
A1	0.00	−−−	0.10
A2	0.70	0.90	1.00
b	0.15	0.20	0.25
c	0.08	0.15	0.22
D	2.00 BSC		
E	2.10 BSC		
E1	1.25 BSC		
e	0.65 BSC		
L	0.26	0.36	0.46
L2	0.15 BSC		
aaa	0.15		
bbb	0.30		
ccc	0.10		
ddd	0.10		



RECOMMENDED MOUNTING FOOTPRINT*

* FOR ADDITIONAL INFORMATION ON OUR Pb−FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



XXX = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

SC−88 2.00x1.25x0.90, 0.65P
CASE 419B−02
ISSUE Z

DATE 18 APR 2024

STYLE 1:
PIN 1. EMITTER 2
2. BASE 2
3. COLLECTOR 1
4. EMITTER 1
5. BASE 1
6. COLLECTOR 2

STYLE 2:
CANCELLED

STYLE 3:
CANCELLED

STYLE 4:
PIN 1. CATHODE
2. CATHODE
3. COLLECTOR
4. EMITTER
5. BASE
6. ANODE

STYLE 5:
PIN 1. ANODE
2. ANODE
3. COLLECTOR
4. EMITTER
5. BASE
6. CATHODE

STYLE 6:
PIN 1. ANODE 2
2. N/C
3. CATHODE 1
4. ANODE 1
5. N/C
6. CATHODE 2

STYLE 7:
PIN 1. SOURCE 2
2. DRAIN 2
3. GATE 1
4. SOURCE 1
5. DRAIN 1
6. GATE 2

STYLE 8:
CANCELLED

STYLE 9:
PIN 1. EMITTER 2
2. EMITTER 1
3. COLLECTOR 1
4. BASE 1
5. BASE 2
6. COLLECTOR 2

STYLE 10:
PIN 1. SOURCE 2
2. SOURCE 1
3. GATE 1
4. DRAIN 1
5. DRAIN 2
6. GATE 2

STYLE 11:
PIN 1. CATHODE 2
2. CATHODE 2
3. ANODE 1
4. CATHODE 1
5. CATHODE 1
6. ANODE 2

STYLE 12:
PIN 1. ANODE 2
2. ANODE 2
3. CATHODE 1
4. ANODE 1
5. ANODE 1
6. CATHODE 2

STYLE 13:
PIN 1. ANODE
2. N/C
3. COLLECTOR
4. EMITTER
5. BASE
6. CATHODE

STYLE 14:
PIN 1. VREF
2. GND
3. GND
4. IOUT
5. VEN
6. VCC

STYLE 15:
PIN 1. ANODE 1
2. ANODE 2
3. ANODE 3
4. CATHODE 3
5. CATHODE 2
6. CATHODE 1

STYLE 16:
PIN 1. BASE 1
2. EMITTER 2
3. COLLECTOR 2
4. BASE 2
5. EMITTER 1
6. COLLECTOR 1

STYLE 17:
PIN 1. BASE 1
2. EMITTER 1
3. COLLECTOR 2
4. BASE 2
5. EMITTER 2
6. COLLECTOR 1

STYLE 18:
PIN 1. VIN1
2. VCC
3. VOUT2
4. VIN2
5. GND
6. VOUT1

STYLE 19:
PIN 1. I OUT
2. GND
3. GND
4. V CC
5. V EN
6. V REF

STYLE 20:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. EMITTER
5. COLLECTOR
6. COLLECTOR

STYLE 21:
PIN 1. ANODE 1
2. N/C
3. ANODE 2
4. CATHODE 2
5. N/C
6. CATHODE 1

STYLE 22:
PIN 1. D1 (i)
2. GND
3. D2 (i)
4. D2 (c)
5. VBUS
6. D1 (c)

STYLE 23:
PIN 1. Vn
2. CH1
3. Vp
4. N/C
5. CH2
6. N/C

STYLE 24:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE

STYLE 25:
PIN 1. BASE 1
2. CATHODE
3. COLLECTOR 2
4. BASE 2
5. EMITTER
6. COLLECTOR 1

STYLE 26:
PIN 1. SOURCE 1
2. GATE 1
3. DRAIN 2
4. SOURCE 2
5. GATE 2
6. DRAIN 1

STYLE 27:
PIN 1. BASE 2
2. BASE 1
3. COLLECTOR 1
4. EMITTER 1
5. EMITTER 2
6. COLLECTOR 2

STYLE 28:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. SOURCE
5. DRAIN
6. DRAIN

STYLE 29:
PIN 1. ANODE
2. ANODE
3. COLLECTOR
4. EMITTER
5. BASE/ANODE
6. CATHODE

STYLE 30:
PIN 1. SOURCE 1
2. DRAIN 2
3. DRAIN 2
4. SOURCE 2
5. GATE 1
6. DRAIN 1

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

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