

High-Density, +5.5V Capable DPDT Analog Switches

Features

- **– Negative Audio and Video Signal Capable**
- **– -0.3V to +5.5V Analog Signal Range Independent from VCC**
- **– On-Resistance 0.2W (typ)**
- **– +2.9V to +5.5V Single-Supply Range**
- **– Click-and-Pop Suppression**
- **Smooth Switch Transition**
- **– Break-Before-Make Operation**
- **Low Supply Current 30mA (typ) at 2.9V**
- **– Can be Powered by a GPIO**
- **– High-Impedance Mode When VCC Not Applied**
- **ESD Protection on NC_ and NO_**
- **– ±15kV Human Body Model**
- **WLCSP1.2x1.2-9 (1.2mm x 1.2mm) Package**
- **40°C to +85°C Operating Temperature Range**

General Description

The APL3157 is a high-density, double-pole/ double-throw (DPDT) analog switch which allows signals from -0.3V to +5.5V to pass without distortion even when the power supply is below the signal range. The low RON resistance (0.2Ω) makes the devices ideal for low-distortion switching, such as audio.

The APL3157 has internal shunt switches that discharge the audio amplifier AC-coupling capacitance at the normally open (NO1 and NO2) terminals. This feature reduces click-and-pop sounds that occur when switching audio signals between precharged points.

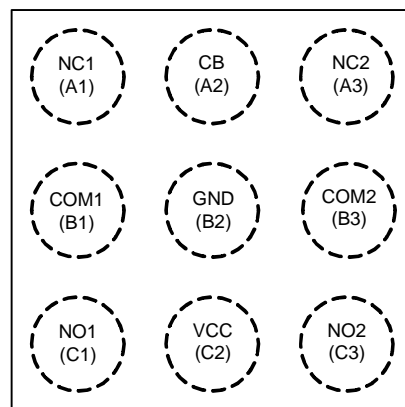
The switches are fully specified to operate from a single +2.9V to +5.5V power supply. Because of the low supply current requirement, V_{cc} can be provided by a GPIO. When the power is not applied, switches go to a high-impedance mode and all analog signal ports can withstand signals from -0.3V to +5.5V. The devices control the switches with a control bit, CB.

The APL3157 is available in a 1.2mm x 1.2mm, 0.4mm pitch, 9-bump wafer-level package (WLCSP), and operate over the -4°C to +85°C extended temperature range.

Applications

- **Smartphones**
- **Tablets**
- **Portable Audio/Video Equipment**
- **Portable Navigation Devices**

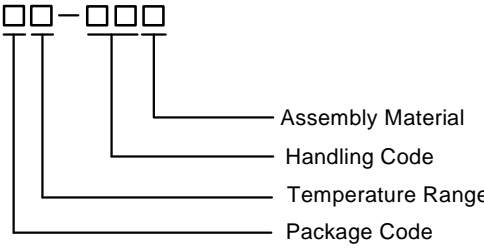
Pin Configuration



WLCSP1.2x1.2-9
(Top View)

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Ordering and Marking Information

<p>APL3157 □□-□□□</p>  <p> Assembly Material Handling Code Temperature Range Package Code </p>	<p> Package Code HA : WLCSP1.2x1.2-9 Operating Junction Temperature I : -40 to 85 °C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device </p>
<p>APL3157 HA: L7 X</p>	<p>X - Date Code</p>

Note : ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. ANPEC defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V _{CC} , C _B		-0.3 to 6	V
V _{SIG}	NC1, NC2, NO1, NO2, COM1, COM2 <20ns pulse width >20ns pulse width	-3~V _{CC} +3V -1~V _{CC} +0.3V	
I _{CC(SIG)}	Continuous Current NC1, NC2, NO1, NO2, COM1, COM2	-500 to 500	mA
I _{PEAK(SIG)}	Peak Current NC1, NC2, NO1, NO2, COM1, COM2 (50% duty cycle)	-850 to 850	
T _J	Maximum Junction Temperature	150	°C
T _{STG}	Storage Temperature Range	-6 to 150	
T _S	Soldering Temperature Range	260	

Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
θ _{JA}	Junction-to-Ambient Thermal Resistance <small>(Note 2)</small> WLCSP1.2x1.2-9	83	°C/W

Note 2 : θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operating Conditions (Note3)

Symbol	Parameter	Range	Unit
V _{CC}	Supply Voltage	2.9 ~ 5.5	V
V _{analog}	Analog Signal Range	-0.3 ~ 5.5	V
T _A	Ambient Temperature	-40 ~ 85	°C
T _J	Junction Temperature	-40 ~ 125	°C

Note 3 : Refer to the typical application circuit

Electrical Characteristics

Unless otherwise specified, these specifications apply over $V_{IN}=5V, V_{CB}=2V$ and $T_A = -40$ to $85^\circ C$. Typical values are at $T_A=25^\circ C$.

Symbol	Parameter	Test Conditions	APL3157			Unit
			Min	Typ	Max	
SPOWER SUPPLY						
V_{CC}	Power Supply Range		2.9	-	5.5	V
PSRR	PSRR	$R_{COM} = 32\Omega, f = 20kHz$	-	80	-	dB
I_{CC}	V_{CC} Supply Current	$V_{CC} = 2.9V, V_{CB} = 0V$ or V_{CC}	-	30	50	μA
		$V_{CC} = 4.2V, V_{CB} = 0V$ or V_{CC}	-	35	60	μA
ANALOG SWITCH						
$V_{NC_}, V_{NO_}, V_{COM_}$	Analog Signal Range	$V_{CC} > 2.9V$	0	-	5.5	V
		$V_{CC} < 2.9V, R_S = 50\Omega$	0	-	5.5	V
R_{ON}	On-Resistance	$V_{COM_}=0V, I_{COM_}=100mA$ (Note 3) $V_{CC}=3.6V$	-	0.2	0.3	Ω
$\Delta R_{ON(NC)}$	On-Resistance Match Between Channels	$V_{CC} = 2.9V, V_{NC_} = 0V, I_{COM_}=100mA,$ between same NC_ and NO_ channel (Note 4)	-	0.005	0.05	Ω
$R_{FLAT(ON)}$	On-Resistance Flatness	$V_{CC}=2.9V, I_{COM_} = 100mA, V_{COM_} = 0V$ to $+5.5V$ (Notes 5, 6)	-	0.001	0.01	Ω
$I_{NC_ (OFF)}, I_{NO_ (OFF)}$	NC_ or NO_ Off-Leakage Current	$V_{CC}=2.9V;$ open switch; $V_{NO_}$ or $V_{NC_}=0V,$ $+5.5V; V_{COM_}=+5.5V, 0,$ unconnected	-400	-	400	nA
		$V_{CC}=0V; V_{NO_}$ or $V_{NC_}=0V, +5.5V;$ $V_{COM_}=+5.5V, 0V,$ unconnected	-400	-	400	nA
$I_{COM_ (OFF)}$	COM_ Off-Leakage Current	$V_{CC}=0V; V_{COM_}=+5.5V, 0V;$ $V_{NO_}$ or $V_{NC_}=0V, +5.5V,$ unconnected	-400	-	400	nA
$I_{COM_ (ON)}$	COM_ On-Leakage Current	$V_{CC}=2.9V;$ switch closed; $V_{COM_}=+5.5V, 0V;$ $V_{NO_}$ or $V_{NC_}=+5.5V, 0V,$ unconnected	-400	-	400	nA
DYNAMIC TIMING						
t_{ON}	Turn-On Time	$V_{NO_}$ or $V_{NC_} = 0V, R_L = 50\Omega,$ Figure 1a	-	5	10	ms
t_{OFF}	Turn-Off Time	$V_{NO_}$ or $V_{NC_} = 0V, R_L = 50\Omega,$ Figure 1a	-	1	2.5	ms
t_{BBM}	Break-Before-Make Time	$R_L = 50\Omega, V_{CC} = 3.3V,$ time for both NC_/NO_ switches are open during transition, Figure 1b (Note 5)	0	5	10	ms

Electrical Characteristics

Unless otherwise specified, these specifications apply over $V_{IN}=5V, V_{CB}=2V$ and $T_A = -40$ to $85^\circ C$. Typical values are at $T_A=25^\circ C$.

Symbol	Parameter	Test Conditions	APL3157			Unit
			Min	Typ	Max	
AUDIO PERFORMANCE						
THD+N	Total Harmonic Distortion Plus Noise	$f = 20\text{Hz to } 20\text{kHz}, V_{COM_} = 0.5V_{P-P}, R_S = R_L = 50\Omega, DC \text{ bias} = 0V$	-	0.001	-	%
V_{ISO}	Off-Isolation	$R_S = R_L = 50\Omega, V_{COM_} = 0.5V_{P-P}, f = 100\text{kHz}, V_{CC}=0V, DC \text{ bias} = 0.25V,$ Figure 2	-	-60	-	dB
Crosstalk		$R_S = R_L = 50\Omega, V_{COM_} = 0.5V_{P-P}, f = 100\text{kHz},$ Figure 2 (Note 7)	-	-80	-	dB
BW	-3dB Bandwidth	$R_S = R_L = 50\Omega,$ Figure 2	-	200	-	MHz
$C_{NC_ (OFF)}$ $C_{NO_ (OFF)}$	NC_ or NO_ Off-Capacitance	$V_{NC_ / NO_} = 0.5V_{P-P}, f = 1\text{MHz}$	-	25	-	pF
$C_{COM_ (ON)}$	COM_ On-Capacitance	$V_{NC_ / NO_} = 0.5V_{P-P}, f = 1\text{MHz}$	-	50	-	pF
DIGITAL I/O (CB)						
V_{IH}	Input Logic-High Voltage		1.6	-	-	V
V_{IL}	Input Logic-Low Voltage		-	-	0.4	V
I_{IN}	Input Leakage Current	$V_{CB}= 0V \text{ or } V_{CC}$	-1	-	1	μA

Note2: All specifications are 100% production tested at $T_A = +25^\circ C$, unless otherwise noted. Specifications are over $-40^\circ C$ to $+85^\circ C$ and are guaranteed by design.

Note3: The same limits apply for $V_{COM_} = -5.5V$ to $+5.5V$ and are guaranteed by design.

Note4: $DR_{ON(MAX)} = |R_{ON(CH1)} - R_{ON(CH2)}|$.

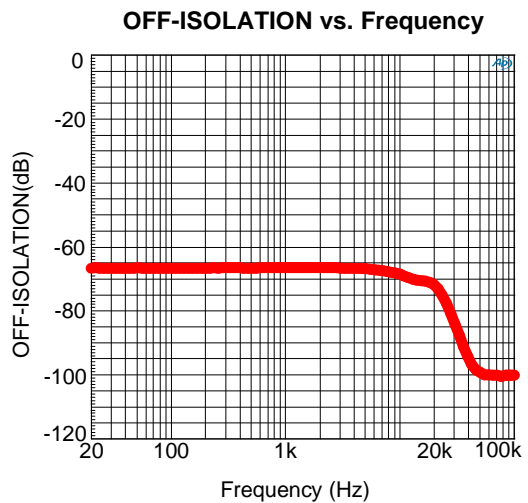
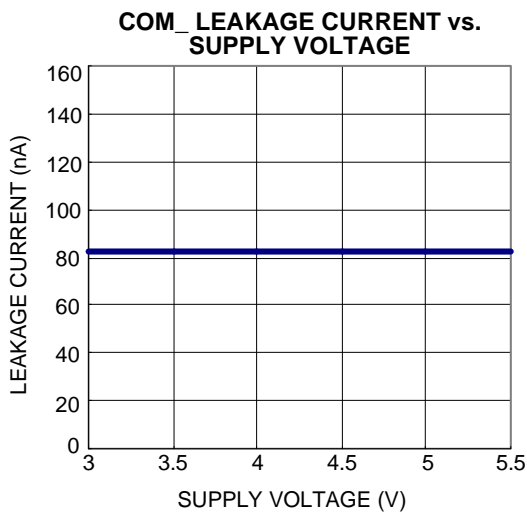
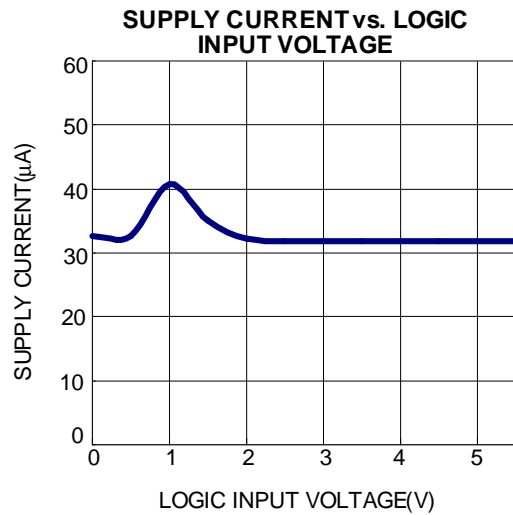
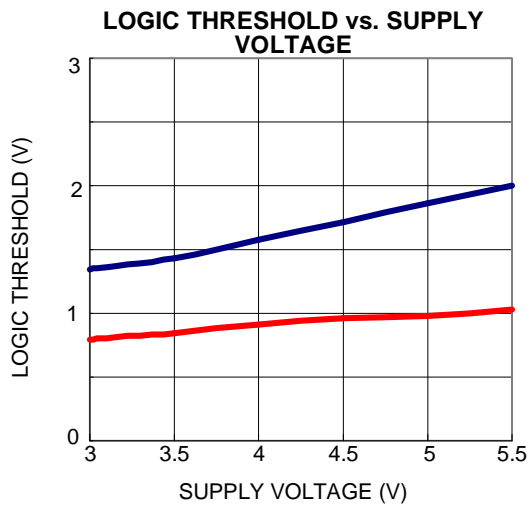
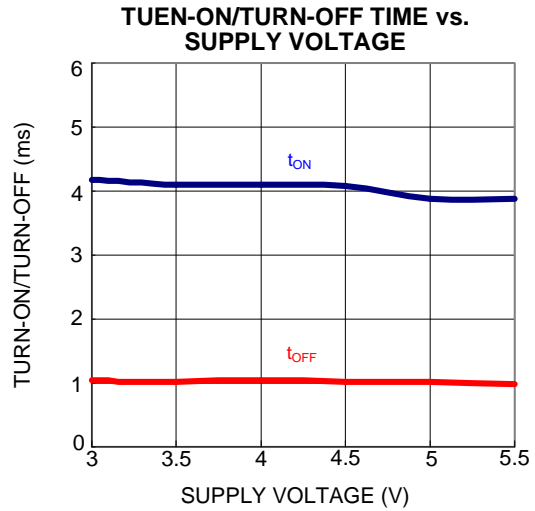
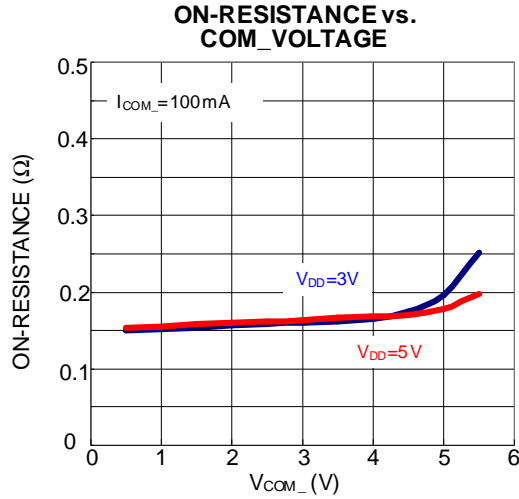
Note5: Guaranteed by design; not production tested.

Note6: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over specified analog signal ranges.

Note7: Between two switches.

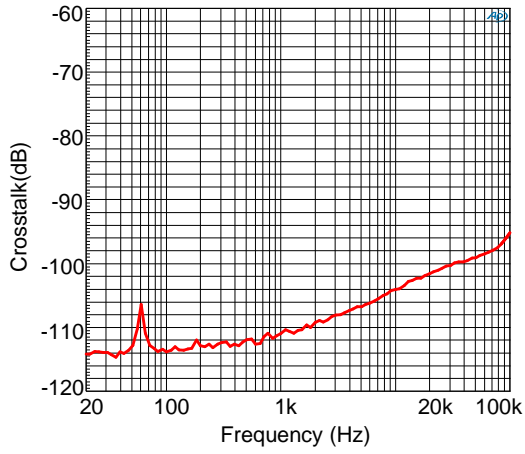
Typical Operating Characteristics

AC Test Use Audio Precision With 20kHz AES17 Filter

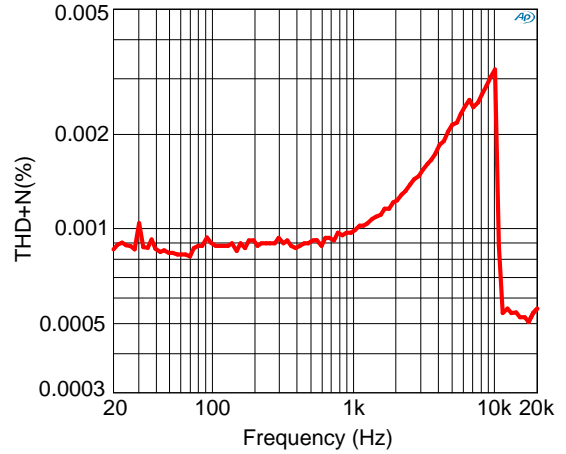


Typical Operating Characteristics (Cont.)

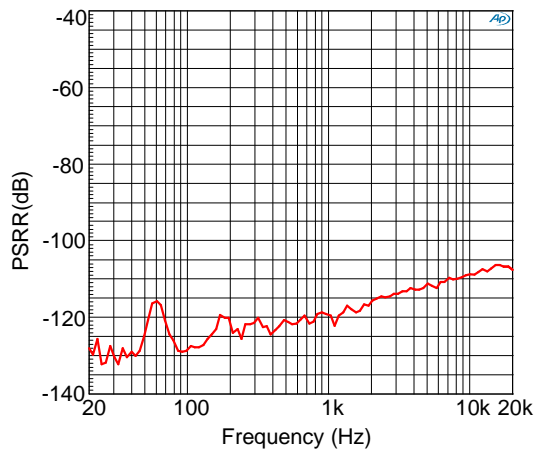
Crosstalk vs. Frequency



THD+N vs. Frequency



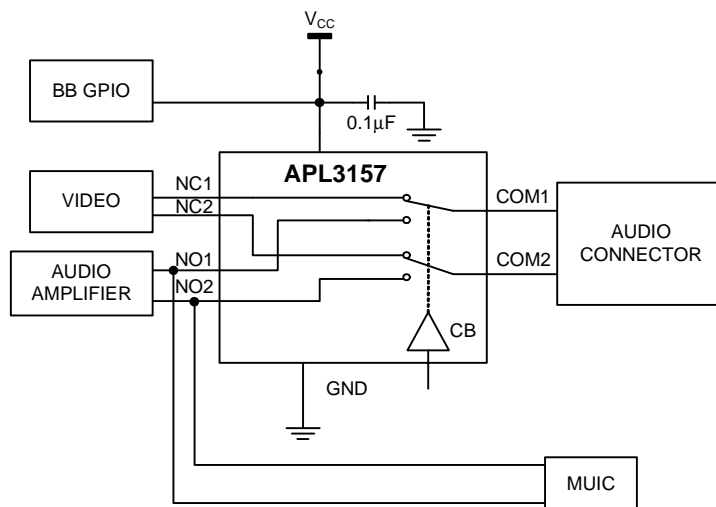
PSRR vs. Frequency



Pin Description

PIN		FUNCTION
NO.	NAME	
A1	NC1	Normally Closed Terminal for Switch 1
A2	CB	Digital Control Input. Drive CB low to connect COM_ to NC_-. Drive CB high to connect COM_ to NO_.
A3	NC2	Normally Closed Terminal for Switch 2
B1	COM1	Common Terminal for Switch 1
B2	GND	Ground
B3	COM2	Common Terminal for Switch 2
C1	NO1	Normally Open Terminal for Switch 1
C2	VCC	Positive Supply Voltage Input. Bypass VCC to GND with a 0.1μF capacitor as close as possible to the device.
C3	NO2	Normally Open Terminal for Switch 2

Block Diagram / Typical Application Circuit



Timing Chart

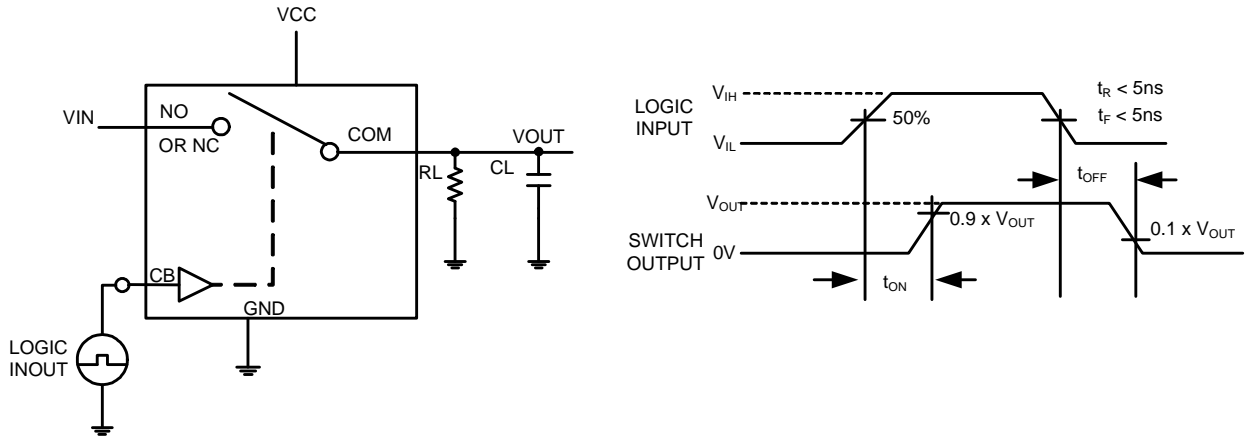


Figure 1a. Switching Time

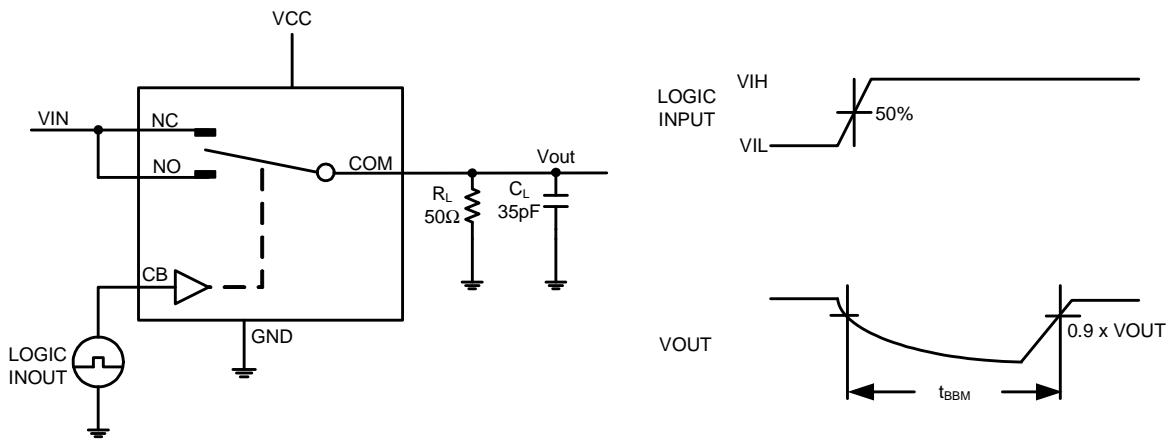
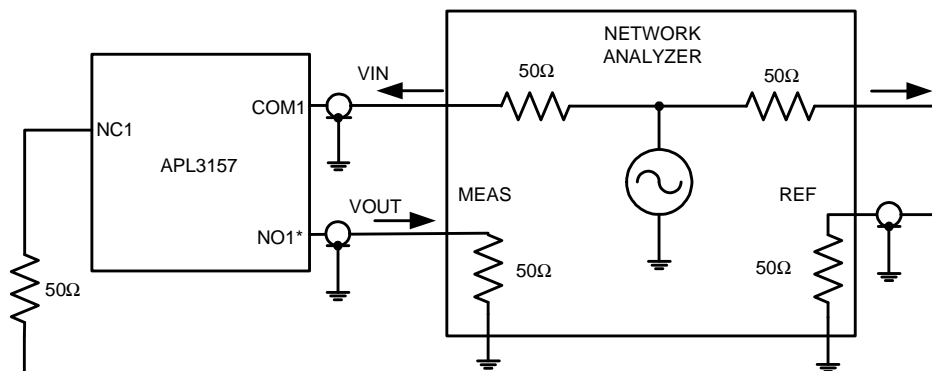


Figure 1b. Break-Before-Make Interval

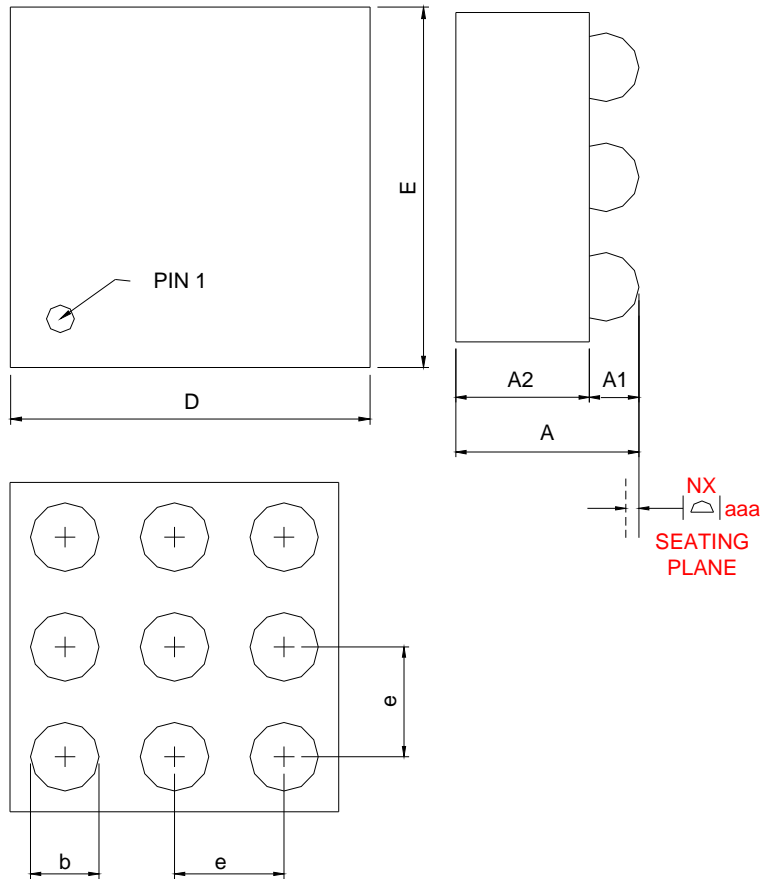


Note:
 “*” For Cross-talk, this pin is NO2. NC2 and COM2 are open

Figure 2. On-Loss, Off-Isolation, and Crosstalk

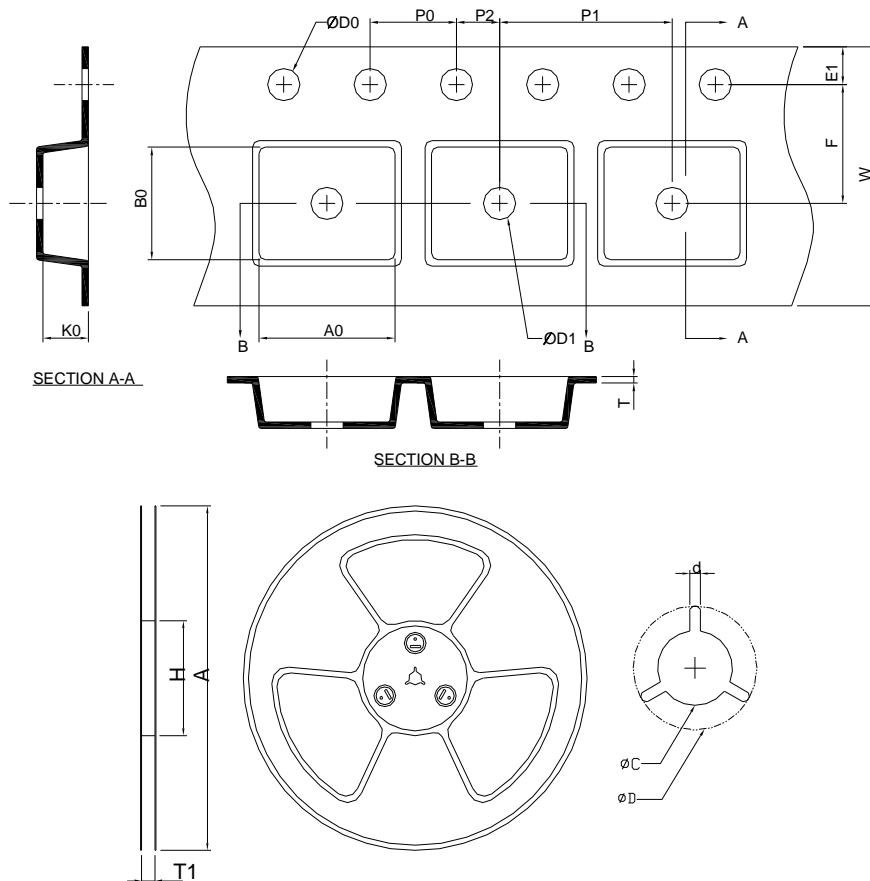
Package Information

WLCSP1.2x1.2-9



SYMBOL	WLCSP1.2x1.2-9			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		0.63		0.025
A1	0.12	0.20	0.005	0.008
A2	0.37	0.43	0.015	0.017
b	0.20	0.30	0.008	0.012
D	1.10	1.25	0.043	0.049
E	1.10	1.25	0.043	0.049
e	0.40 BSC		0.016 BSC	
aaa	0.05 BSC		0.002	

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
WLCSP1.5X1.5-9A	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	1.70±0.20	1.70±0.20	0.90±0.20

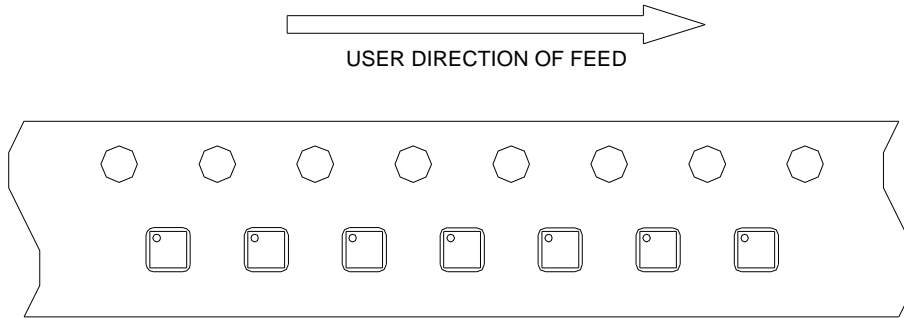
(mm)

Devices Per Unit

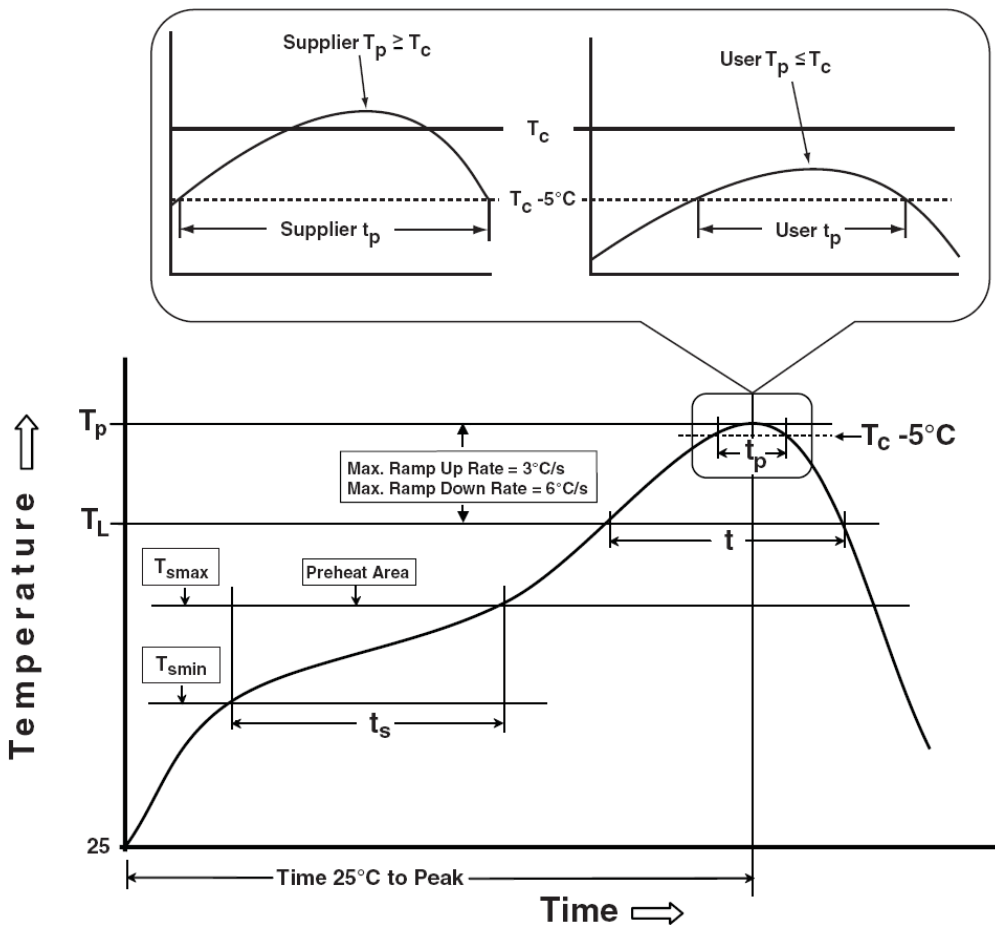
Package Type	Unit	Quantity
WLCSP1.2X1.2-9	Tape & Reel	3000

Taping Direction Information

WLCSP1.2x1.2-9



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_p)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HOLT	JESD-22, A108	1000 Hrs, Bias @ $T_f=125^\circ\text{C}$
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
HBM	MIL-STD-883-3015.7	VHBM ≥ 2KV
MM	JESD-22, A115	VMM ≥ 200V
Latch-Up	JESD 78	10ms, $1_{tr} \geq 100\text{mA}$

Customer Service

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