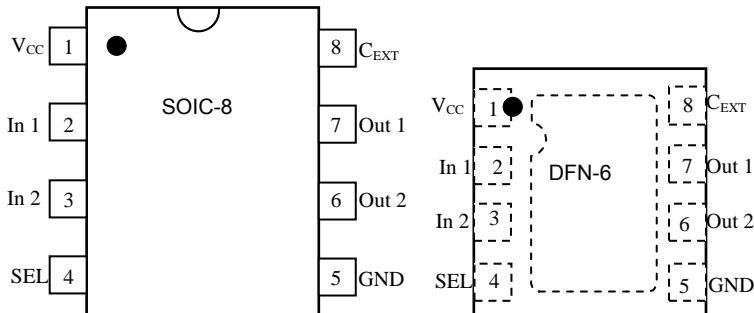


FEATURES

9V or 12V operation
 3V RMS Capability
 Power-Up and Power-Down "POP" suppression
 ESD protected outputs
 8-Lead SOIC package
 Series operation
 Only 1 external component required
 Ron (On resistance): 0.8 ohms
 Ron Flatness: 0.4 ohms
 Total Harmonic Distortion: <1%
 Current drain: <5mA
 Load: 600 ohms

APPLICATIONS

Portable DVD players
 Set-top boxes
 Car Audio
 High End Audio
 Televisions
 Stereo Systems
 Digital Video Recorders
 LCD TVs
 Home Theater systems

Pin Layout and Description

Pin	Symbol	Designation
1	VCC	Voltage
2	In1	Audio Input 1
3	In2	Audio Input 2
4	SEL	Select 12 or 9Volt Operation
5	GND	Ground
6	Out2	Audio Output 2
7	Out1	Audio Output 1
8	CEXT	External Capacitor

GENERAL DESCRIPTION

The PA4401 provides click-pop suppression for devices that lack a click-less/pop-less startup or shutdown. The PA4401 is placed between the codec and the output coupling capacitor.

The click-pop noise is generated at the coupling capacitors while the system is starting up as well as shutting down. The PA4401 controls the ramping of the DC voltage into the coupling capacitors thus reducing the click-pop noise generated during the startup and shutdown. The start time can be controlled or changed using an external capacitor.

ESD protection circuits are provided at the inputs and outputs of the device.

The PA4401 consumes less than 5mA of current and provides a THD of less than 1% for a load of 600 ohms.

The PA4401 is available in an 8L-SOIC and DFN-6 Packages.

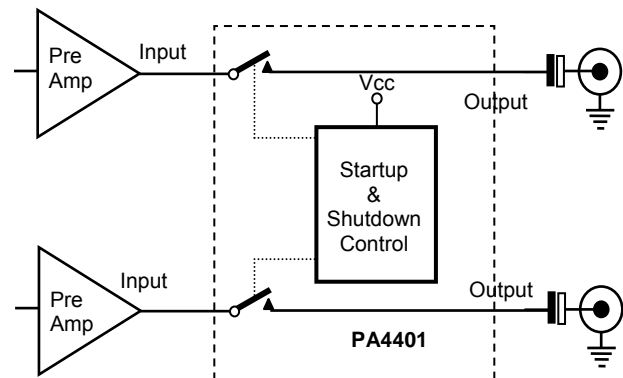
FUNCTIONAL DIAGRAM

Figure 1: Functional block diagram of PA4401

Ordering Information

Temperature Range	Package	Part Number
-40 to 85 °C	SOIC-8	PA4401DQ-T7
	DFN-6	PA4401DN-T7

SEL Logic

System Voltage	SEL Status
9V	Ground
12V	V _{CC}

ABSOLUTE MAXIMUM RATINGS

(All Voltages are referenced to GND)

V_{CC}+15V
 Continuous Current (IN₊, OUT₋).....±150mA
 Continuous Current (All Other Pins)±20mA
 Continuous Power Dissipation (T_A = +70°C)

Operating Temperature Range-40°C to +85°C
 Storage Temperature Range-65°C to +150°C
 Junction Temperature+150°C
 Lead Temperature (soldering, 10s)+300°C

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS.

Unless otherwise specified, V_{DD}=12V, SEL = V_{DD}, T_A = Ambient Temperature = 25 °C.

Symbol	Parameter	Condition	Limit			Unit
			Min	Typical	Max	
V _{DD}	Power Supply	Normal Operation	9.0		12.0	V
I _{DD}	Supply Current	Normal Operation			5	mA
T _A	Ambient Temperature	Normal Operation	-40		+85	°C
R _{ON}	FET ON Resistance	V _{GATE} = 10V, I _{DFET} = 100mA		1.8	2.0	Ω
		V _{GATE} = 15V, I _{DFET} = 100mA		1.5	1.8	
		V _{GATE} = 20V, I _{DFET} = 100mA		1.3	1.5	
R _{FLAT(ON)}	ON Resistance Flatness	Over Input Voltage Range		15		mΩ
THD	Total Harmonic Distortion	R _L = 600 Ω, V _{SIG} = 2V _{RMS} f = 1kHz		.020	1	%
X _{TALK}	Crosstalk (on)	f = 20kHz		-100		dB
Q _{IRR}	Off Isolation	f = 20kHz R _L = 600 Ω		-108		dB
V _{SIG}	Analog Signal Range	Normal Operation			2.0	V _{RMS}
V _{ESD}	ESD Protection	HBM		4		kV
R _{OUT}	Output Discharge Resistor			100		kΩ
f _{CO}	Bandwidth			>100		kHz
V _{UVLO}	Power Off Threshold	V _{CC} Falling		90%		V _{CC}

DETAILED DESCRIPTION

Figure2. Shows the normal setup of a Pre Amplifier system. Since the system is built on a single ended power supply the outputs of the pre-amplifier need to be routed through a bypass capacitor to get rid of the DC bias.

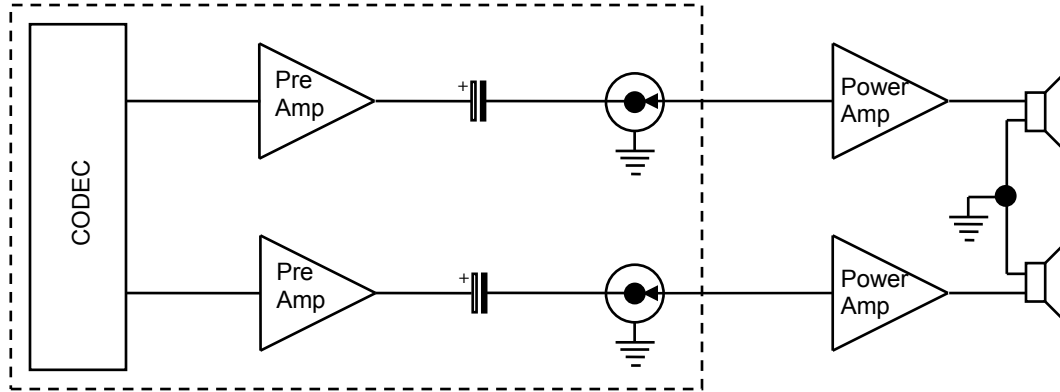


Figure 2: Normal setup for a pre amplifier output

When the power supply to the system is turned ON there is a spike in the output of the system because of the charging of various components in the system. This spike is called a "Click or Pop Noise". When this click/pop noise passes through the Power Amplifiers, the noise is amplified and listeners hear an audible 'pop' which causes discomfort. The reverse operation happens when the system is powering down. These operations are shown below in figure3. The top waveform shows the power supply Powering Up and Powering Down. The middle waveform shows the voltage appearing at the positive terminal of the bypass capacitor. The bottom waveform shows the voltage at the output of the bypass capacitor. This is the Pop-Noise that is amplified by the power amplifier.

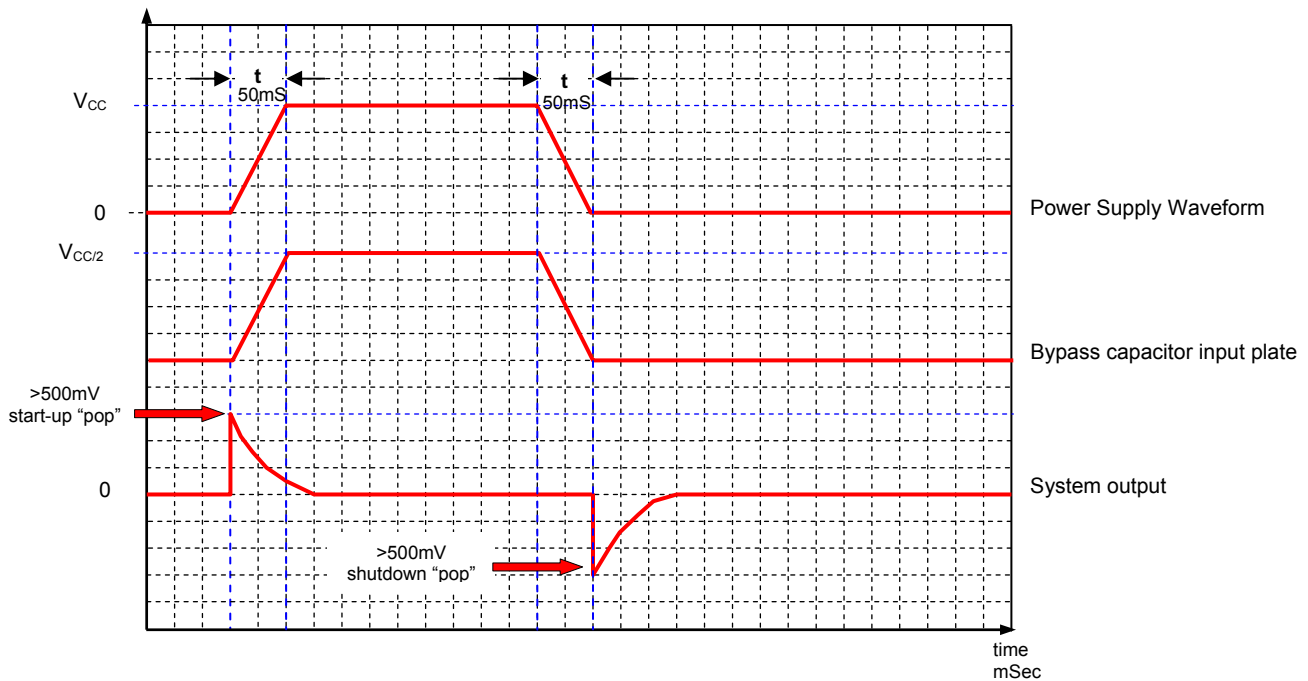


Figure 3: Power Up and Power Down sequences and waveforms

CONNECTION DIAGRAM

The PA4401 will be placed after the pre-amplifier and before the output bypass capacitors.

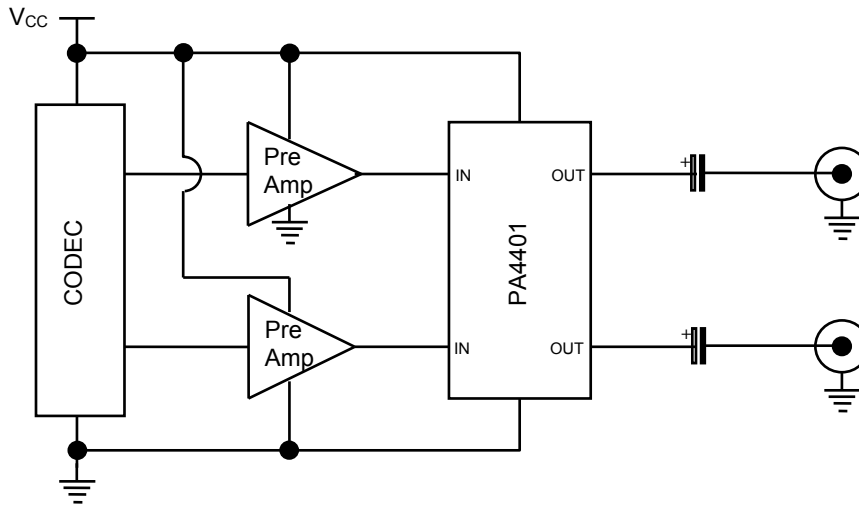


Figure 4: Typical Connection Configuration for PA4401

STARTUP

At Startup, the Power supply ramps from 0V to V_{CC} between 20 -200ms. The PA4401 detects the ramp in the voltage at its inputs and controls the ramp rate of the DC bias voltage going to the +ve terminal of the bypass capacitor. The ramping behavior of the device can be controlled by an external capacitor. This startup operation is shown in figure 5.

SHUTDOWN

At Shutdown, The PA4401 detects a "power fail" condition and the control switches are turned off, opening the connection between INx and OUTx providing a discharge path through an internal 100K Ω resistor for the bypass capacitor. The time constant of the internal resistor and by-pass capacitor, allows for a slow discharge, which will prevent any audible "pop" appearing at the system output. This shutdown operation is shown in figure 5.

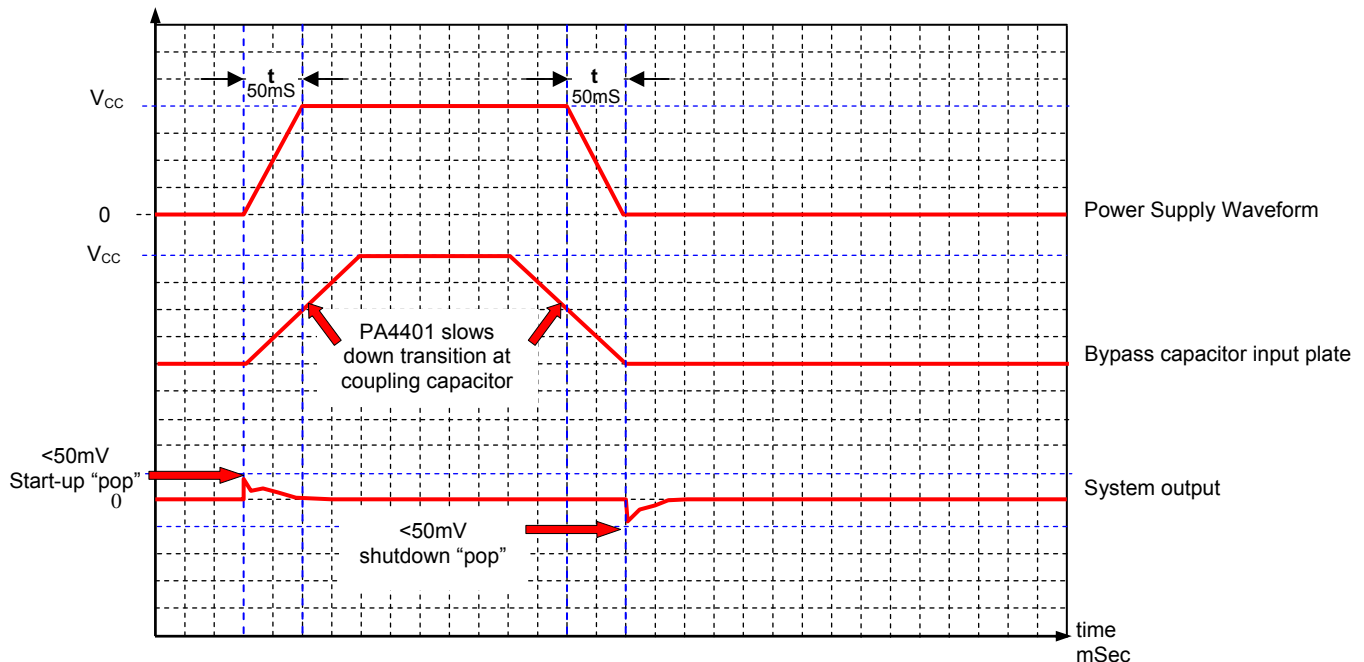
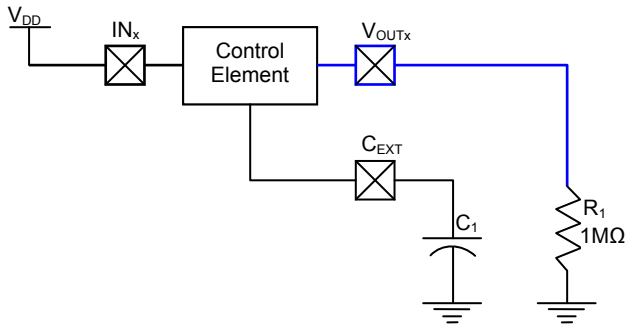
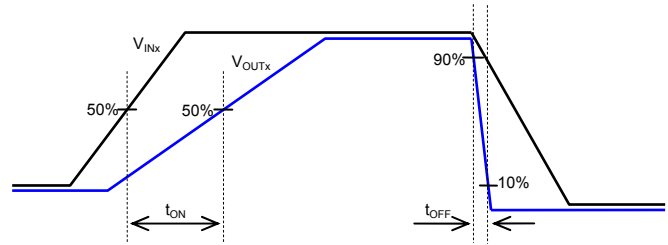


Figure 5: Power-Up and Power-Down sequences and waveforms with PA4401

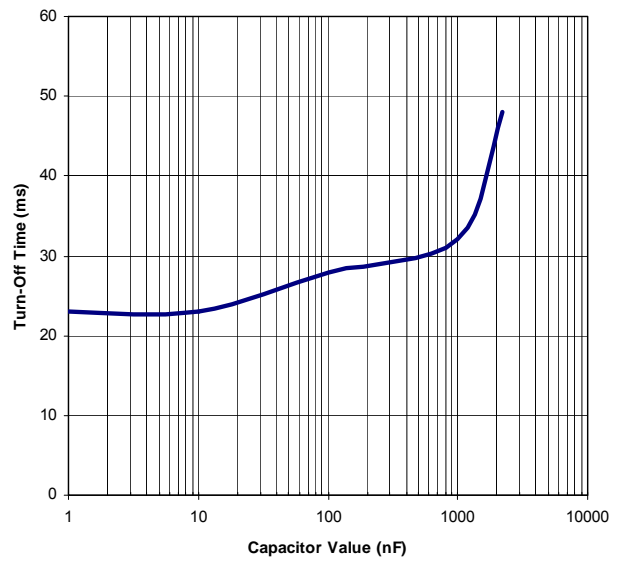
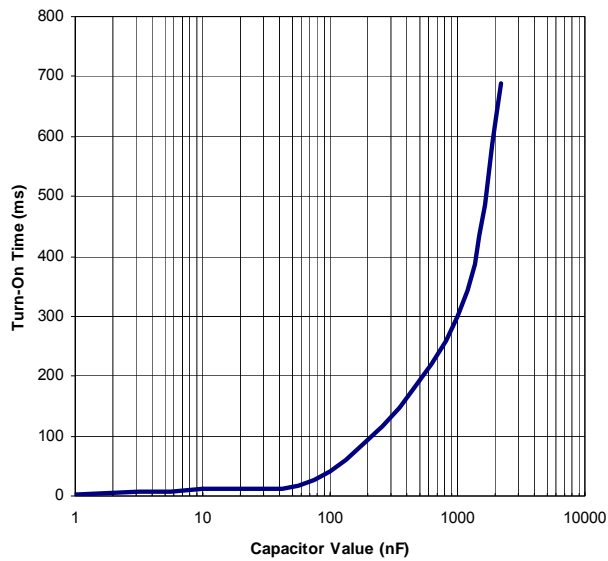
Test Circuit for Turn-On time vs. C_{EXT} and Turn-Off Time vs. C_{EXT}



Turn-On time vs. C_{EXT}



Turn-Off time vs. C_{EXT}



C_{EXT} (nF)	t_{ON} (mS)	t_{OFF} (mS)
1	3.6	23
10	12	23
100	42	28
1000	300	32
2200	690	48

SO-8 PACKAGE OUTLINE & DIMENSIONS

PACKAGE OUTLINE

$\oplus 0.010'' (0.25 \text{ MM}) \text{ (M) B (M)}$
 4 PL

$\oplus 0.010'' (0.25 \text{ MM}) \text{ (M) T B (S) A (S)}$
 8 PL

SO-8

PACKAGE DIMENSIONS

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.250	0.016	0.049
G	1.27 BSC	1.27 BSC	0.05 BSC	0.05 BSC
J	0.18	0.25	0.007	0.009
K	0.10	0.25	0.004	0.008
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

NOTES

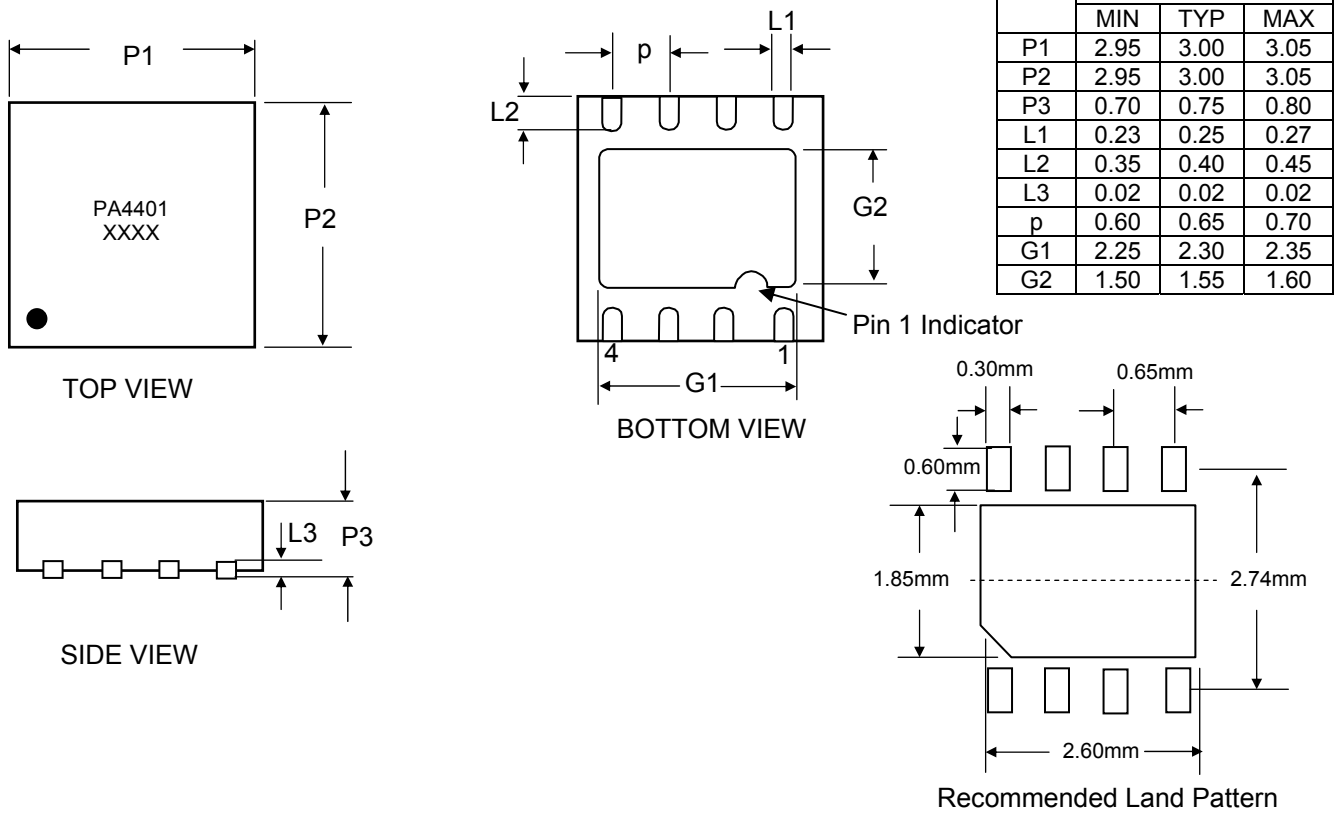
1. - T - = Seating Plane and Datum Surface.
2. Dimensions "A" and "B" are Datum.
3. Dimensions "A" and "B" do not include mold protrusion.
4. Maximum mold protrusion is 0.015" (0.380 mm) per side.
5. Dimensioning and tolerances per ANSI Y14.5M, 1982.
6. Dimensions are exclusive of mold flash and metal burrs.

TAPE & REEL/BULK ORDERING NOMENCLATURE

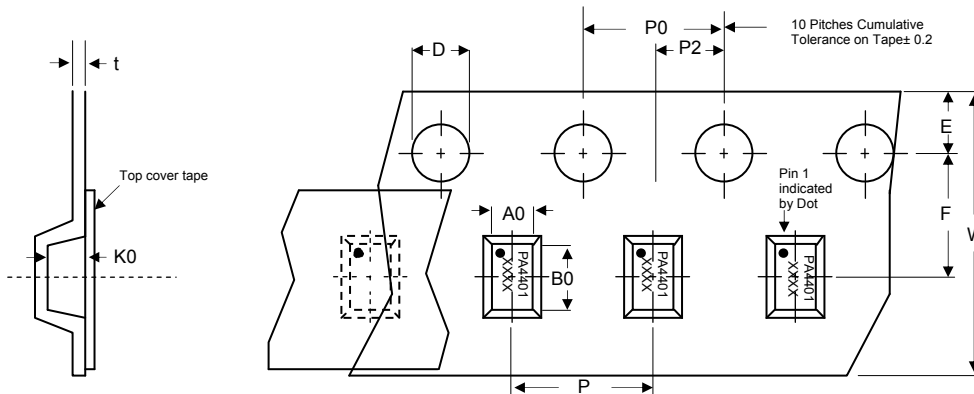
1. Surface mount product is taped and reeled in accordance with EIA-481.
2. Suffix-T7 = 7 Inch Reel - 1,000 pieces per 12mm tape.
3. Suffix-T13 = 13 Inch Reel - 2,500 pieces per 12mm tape.
4. No Suffix = Product Shipped in Tubes of 98 pcs per Tube.

Outline & Dimensions: Rev 1 - 11/01, 06009

MOUNTING PAD

Package Outline and Dimensions DFN-8

Tape and Reel Specifications

Reel Dia	A0	B0	K0	D	E	F	W	P0	P2	P	t-max
178 (7")	3.00±0.10	3.00±0.10	0.85±0.10	1.50±0.10	1.75±0.10	3.50±0.05	12.00±0.30	4.00±0.10	2.00±0.05	4.00±0.10	0.25


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