Product Specification

SP43204

50 Ω RF Digital Attenuator
2-bit; 0, 6, 12, and 18 dB States

Features

- HaRP™-enhanced CMOS device
- Fast switching speed: Typical 26 ns
- High Linearity: Typical +61 dBm IP3
- Small α-Error
- Best in class 2000 V HBM ESD tolerance
- Attenuation: 6, 12, and 18 dB States
- Parallel Control
- CMOS Compatible
- Packaged in a 12-lead 3x3x0.85 mm QFN

Product Description

The SP43204 is a 50Ω, HaRP™-enhanced, high linearity, 2-bit RF Digital Step Attenuator (DSA) covering an 18 dB attenuation range in 6 dB steps. With a parallel control interface, it maintains high attenuation accuracy, fast switching speed, low insertion loss and low power consumption. This next generation SIPAT DSA is available in a 3x3 mm 12-lead QFN footprint.

The SP43204 is manufactured on SIPAT's CMOS process, a patented variation of silicon-on-insulator (SOI) technology on a sapphire substrate, offering the performance of GaAs with the economy and integration of conventional CMOS.

Figure 1. Package Type

12-lead 3x3x0.85 mm QFN Package

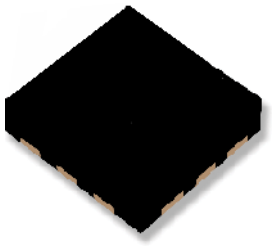


Figure 2. Functional Schematic Diagram

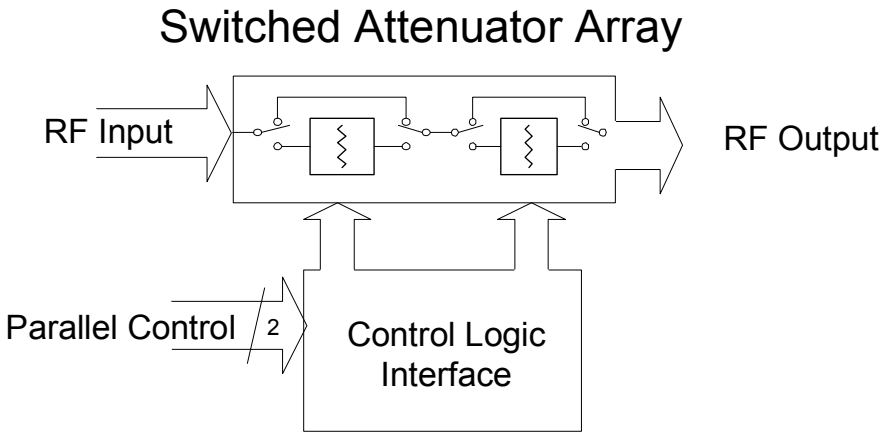


Table 1. Electrical Specifications @ +25°C, V_{DD} = 3.3 V

Parameter	Test Conditions	Min	Typical	Max	Units
Frequency Range			50 - 3000		MHz
Attenuation Range	6 dB,12 dB and 18 dB steps		0 -18		dB
Insertion Loss			0.6	0.7	dB
Attenuation Error	0 dB - 18 dB Attenuation Settings 50 MHz to < 2000 MHz 2000 MHz – 3000 MHz		 +0.1 +0.2	 -0.25 / + 0.40 -0.10 / +0.50	 dB dB
Return Loss			15		dB
Relative Phase	All States		11		deg
P1dB	Input	+28	+30		dBm
IIP3	IIP3 Two tones at +18 dBm, 20 MHz spacing		+61		dBm
Switching Speed	50% DC CTRL to 10% / 90% RF		26		ns

Performance Plots

Figure 3. Attenuation vs. Attenuation Setting

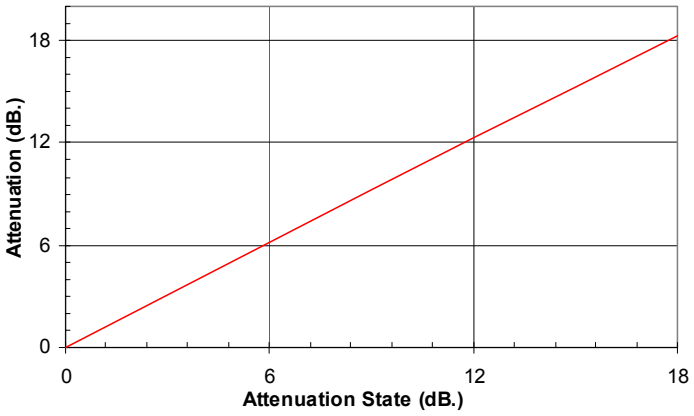
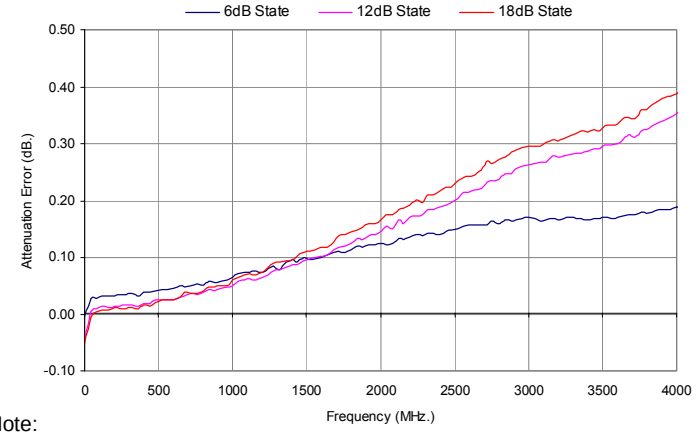


Figure 4. Attenuation Error vs. Frequency @ T = +25C



Note:
Attenuation Error Equation - AE = [ABS {ABS(Insertion Loss @ Attenuation Setting) - ABS(Reference Loss) }] - [ABS(Attenuation Setting)]

Figure 5. Insertion Loss vs. Temperature

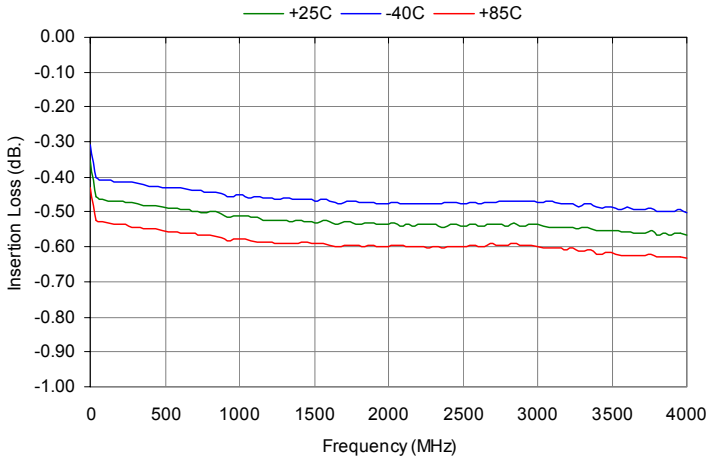


Figure 6. Input Return Loss vs Attenuation @ T = +25C

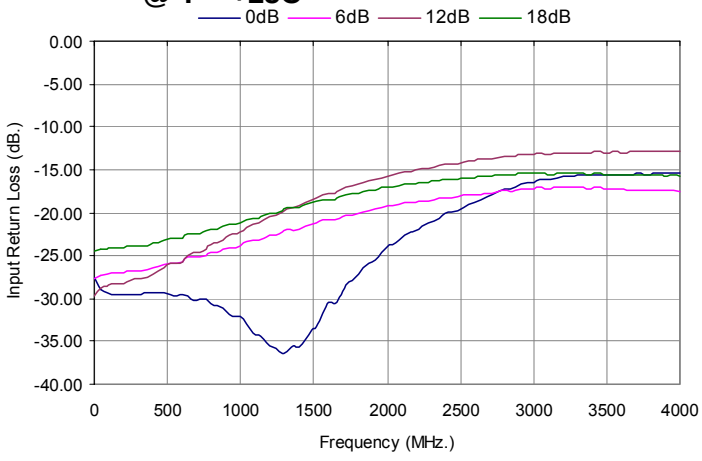


Figure 7. Output Return Loss vs Attenuation @ T = +25C

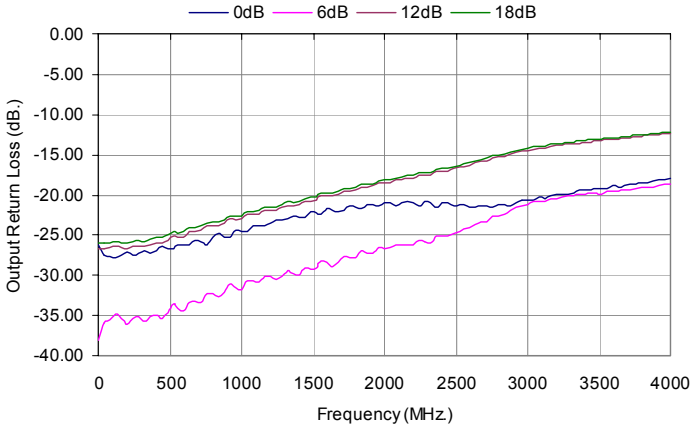


Figure 8. Input Return Loss vs Temperature @ 12dB State

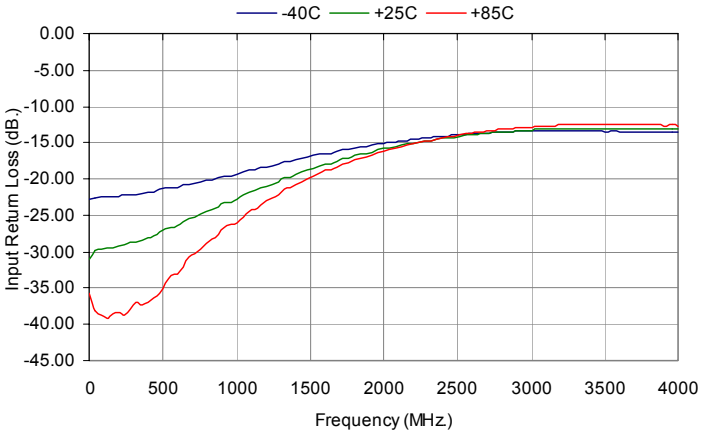


Figure 9. Output Return Loss vs Temperature @ 12dB State

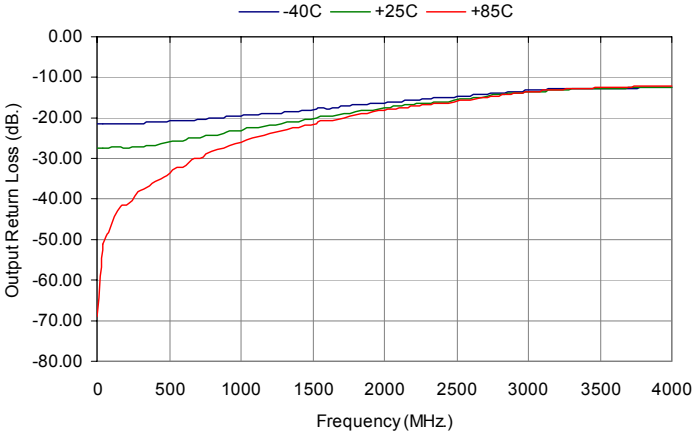
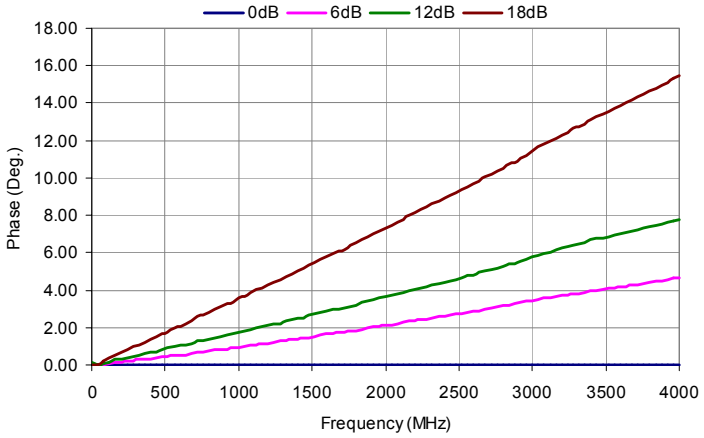


Figure 10. Relative Phase* vs Frequency @ T = +25C



*Relative Phase = Phase (attenuation state) – Phase (Insertion Loss state)

Figure 11. Input IP3 vs Attenuation Setting @ T = +25C

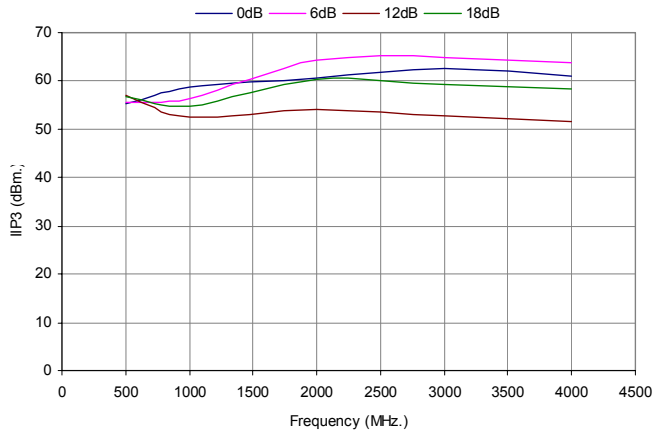


Figure 12. Attenuation Error vs. Attenuation Setting @ 3000 MHz

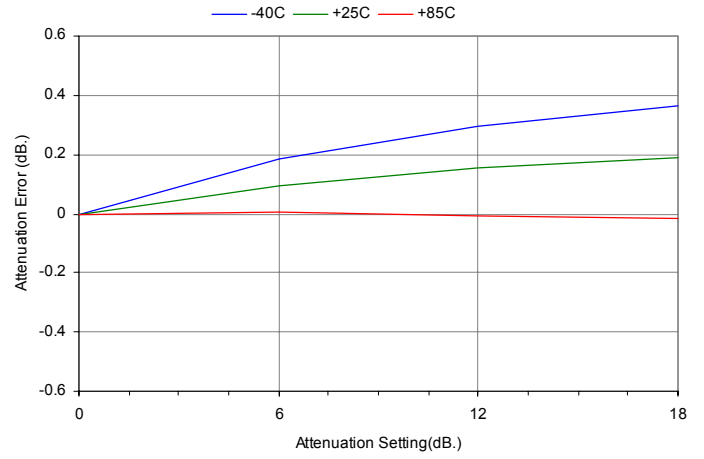


Figure 13. Pin Configuration (Top View)

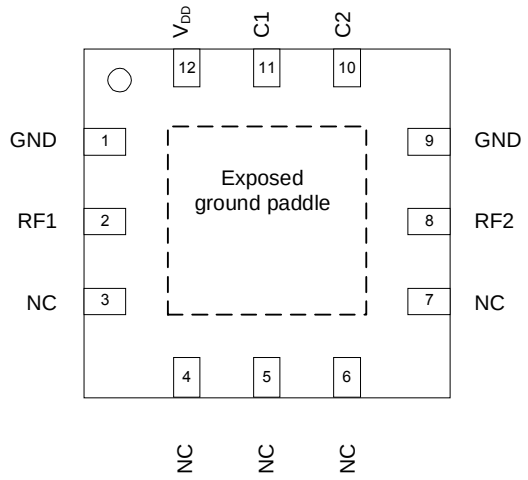


Table 2. Pin Descriptions

Pin No.	Pin Name	Description
1	GND	Ground
2	RF1[2]	RF1 port
3	NC[1]	No Connect
4	NC[1]	No Connect
5	NC[1]	No Connect
6	NC[1]	No Connect
7	NC[1]	No Connect
8	RF2[2]	RF2 port
9	GND	Ground
10	C2	Attenuation control bit, 12 dB
11	C1	Attenuation control bit, 6 dB
12	V_{DD}	Power Supply Pin

Notes: 1. Pins 3 through 7 may be tied to ground if desired, but they are not connected to ground internal to the package
2. All RF pins must be DC blocked with an external series capacitor or held at 0 VDC.

Exposed Solder Pad Connection

The exposed solder pad on the bottom of the package must be grounded for proper device operation.

Table 3. Attenuation Word Truth Table

C1	C2	Attenuation Setting RF1-RF2
L	L	Reference I.L.
H	L	6 dB
L	H	12 dB
H	H	18 dB

Table 4. Operating Ranges

Parameter	Min	Typ	Max	Units
V_{DD} Power Supply Voltage	3.0	3.3	3.6	V
I_{DD} Power Supply Current		8	200	µA
Digital Input High	0.7xV_{DD}		3.6	V
Digital Input Low	0		0.3xV_{DD}	V
Digital Input Leakage			10	µA
P_{IN} Input power (50Ω) 20 MHz ≤ 4.0 GHz			+23	dBm
T_{OP} Operating temperature range	-40	25	85	°C

Table 5. Absolute Maximum Ratings

Symbol	Parameter/Conditions	Min	Max	Units
V_{DD}	Power supply voltage	-0.3	4.0	V
V_I	Voltage on any Digital input	-0.3	V_{DD}+ 0.3	V
T_{ST}	Storage temperature range	-65	150	°C
P_{IN}	Input power (50Ω) 20 MHz ≤ 4.0 GHz		+23	dBm
V_{ESD}	ESD voltage (Human Body Model, MIL_STD 883 Method 3015.7)		2000	V

Exceeding absolute maximum ratings may cause permanent damage. Operation should be restricted to the limits in the Operating Ranges table. Operation between operating range maximum and absolute maximum for extended periods may reduce reliability.

Electrostatic Discharge (ESD) Precautions

When handling this CMOS device, observe the same precautions that you would use with other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, precautions should be taken to avoid exceeding the specified rating.

Latch-Up Avoidance

Unlike conventional CMOS devices, SIPAT'S CMOS devices are immune to latch-up.

Moisture Sensitivity Level

The Moisture Sensitivity Level rating for the SP43204 in the 12-lead 3x3 QFN package is MSL1.

Switching Frequency

The SP43204 has a maximum 25 kHz switching rate. Switching rate is defined to be the speed at which the DSA can be toggled across attenuation states.

Evaluation Kit

The 2-bit DSA EK Board was designed to ease customer evaluation of SIPAT's SP43204.

For automated programming, connect the test harness provided with the EVK to the parallel port of the PC and to the 6-pin header of the PCB. Connect the loose wire of the supplied cable to a power supply set at 3.3V DC. Set the SP3T switches S1 and S2 to the 'MIDDLE' toggle position. After downloading and installing the DSA EVK software from www.psemi.com, run the software and select 'SP43204' from the drop down menu. Using the software, enable or disable each setting to the desired attenuation state. The software automatically programs the DSA each time an attenuation state is enabled or disabled.

For manual programming, disconnect the test harness provided with the EVK. Apply 3.3V to the Vdd header pin and Ground to the GND header pin. The DUT can be controlled two ways:
1. *The mechanical switches in conjunction with the VCTL pin can be used.* Apply desired control voltage to VCTL header pin. The top mechanical switch controls the 6dB stage, the bottom mechanical switch controls the 12dB stage. For each switch, the left position is the 0V condition, while the right position is the Vctrl condition. The middle position leaves the control pin floating.
2. *The CTL1 and CTL2 pins on the header can be used.* Each pin directly controls the 6dB and 12dB stage respectively. The VCTL pin on the header is left open. The mechanical switches may be left uninstalled or must be kept in the middle position.

Note: To minimize switching time, C3 and C4 can be removed.

Power-up Control Settings

The SP43204 will always power up into the state determined by the voltages on the 2 control pins. The DSA can be preset to any state within the 18 dB range by pre-setting the parallel control pins prior to power-up. There is a 10µs delay between the time the DSA is powered-up to the time the desired state is set. If the control pins are left floating during power-up, the device will default to the minimum attenuation setting (insertion loss state).

Figure 14. Evaluation Board Layouts
SIPAT Specification 101/0344

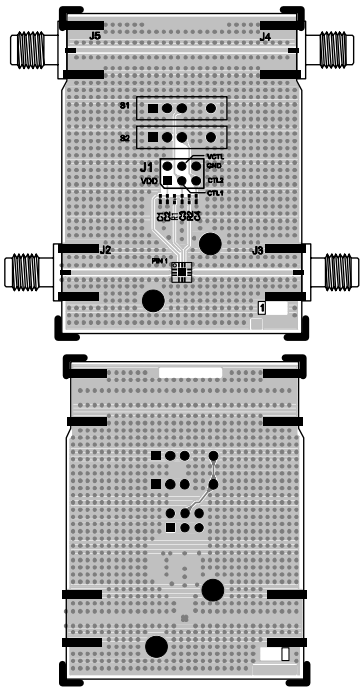


Figure 15. Evaluation Board Schematic
SIPAT Specification 102/0416

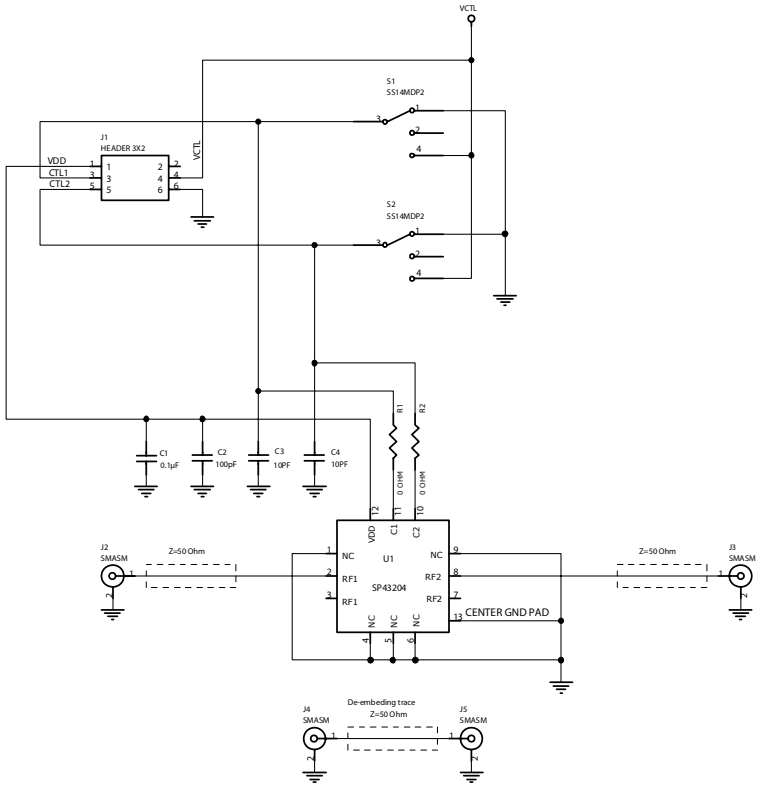
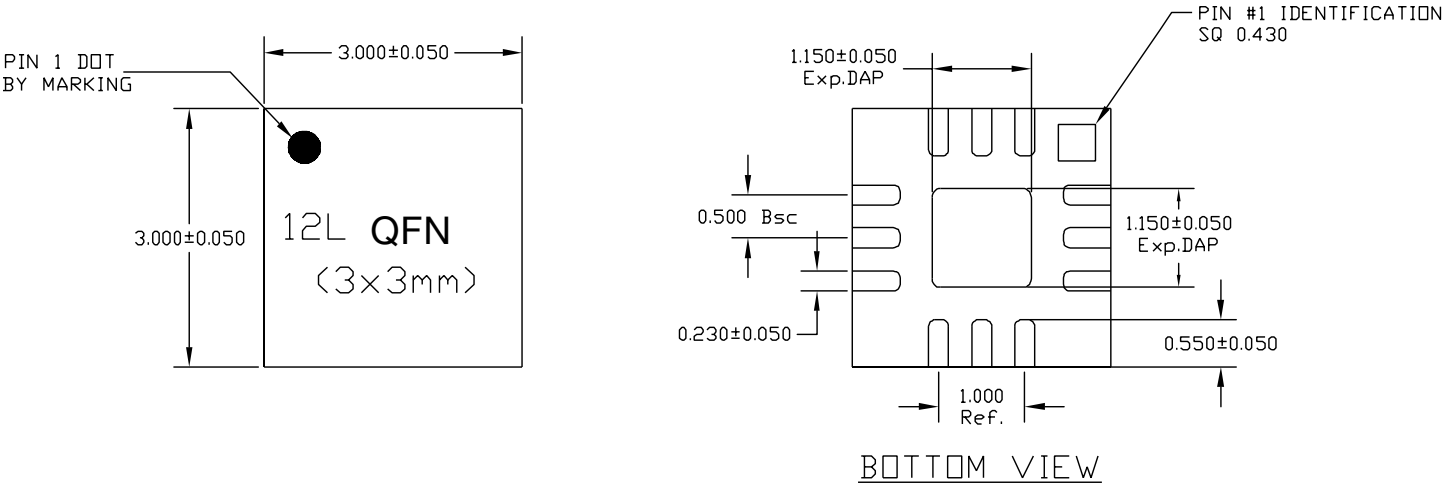
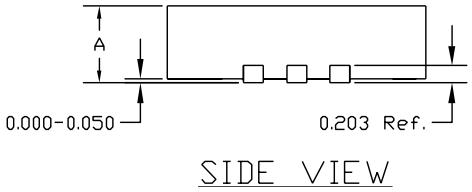


Figure 16. Package Drawing

3x3 mm 12-lead QFN, BOM 19/0104

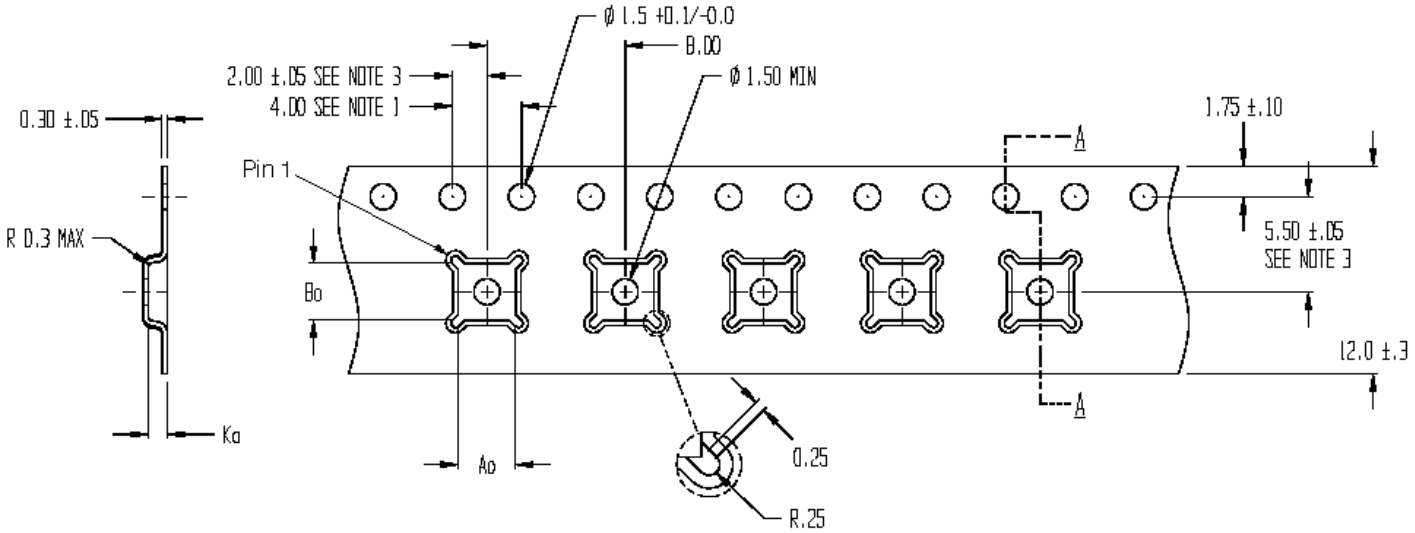


		QFN 3x3 mm
A	MAX	0.900
	NOM	0.850
	MIN	0.800



Note: Pin 1 Identification tab is electrically connected to the exposed ground paddle

Figure 17. Tape and Reel Drawing



SECTION A - A

Tape Feed Direction

Pin 1

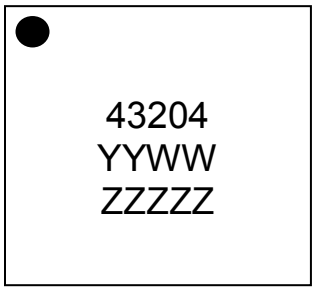
Top of Device

Device Orientation in Tape

Ao = 3.30
Bo = 3.30
Ko = 1.10

NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. CAMBER IN COMPLIANCE WITH EIA 481
3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

Figure 18. Marking Specifications



YYWW = Date Code
ZZZZZ = Last five digits of Lot Number

Table 6. Ordering Information

Order Code	Part Marking	Description	Package	Shipping Method
EK-43204-02	SP43204 -EK	SP43204 – 12QFN 3x3mm-EK	Evaluation Kit	1 / Box
SP43204MLIBA	43204	SP43204 G - 12QFN 3x3mm-75A	Green 12-lead 3x3mm QFN	Cut tape or loose
SP43204MLIBA-Z	43204	SP43204 G – 12QFN 3x3mm-3000C	Green 12-lead 3x3mm QFN	3000 units / T&R