NEW PRODUCT

Description

The PAM8013/PAM8015 is a 3W mono filter-less class-D amplifier with high PSRR and differential input that eliminate noise and RF rectification.

Features like greater than 90% efficiency and small PCB area make the PAM8013/PAM8015 Class-D amplifier ideal for portable applications. The output uses a filter-less architecture minimizing the number of external components and PCB area whilst providing a high performance, simple and lower cost system.

The PAM8013/PAM8015 features short circuit protection and thermal shutdown.

The PAM8013/PAM8015 is available in U-FLGA1515-9 packages.
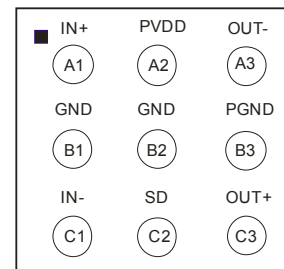
Features

- Ultra Low EMI, -20dB Better Than FCC Class-B @ 300MHz
- High Efficiency up to 90% @1W with an 8Ω Speaker
- Shutdown Current <1μA
- 3W@10% THD Output with a 4Ω Load at 5V Supply
- Demanding Few External Components
- Superior Low Noise without Input
- Supply Voltage from 2.8V to 5.5V
- Short Circuit Protection
- Thermal Shutdown
- Available in Space Saving U-FLGA1515-9 Packages
- Pb-Free Package

Pin Assignments

U-FLGA1515-9

IN+	GND	OUT-
A1	A2	A3
VDD	PVDD	PGND
B1	B2	B3
IN-	SD	OUT+
C1	C2	C3

PAM8013
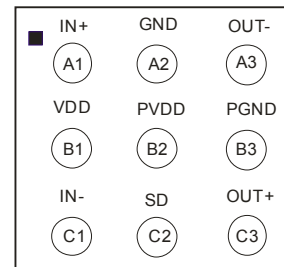
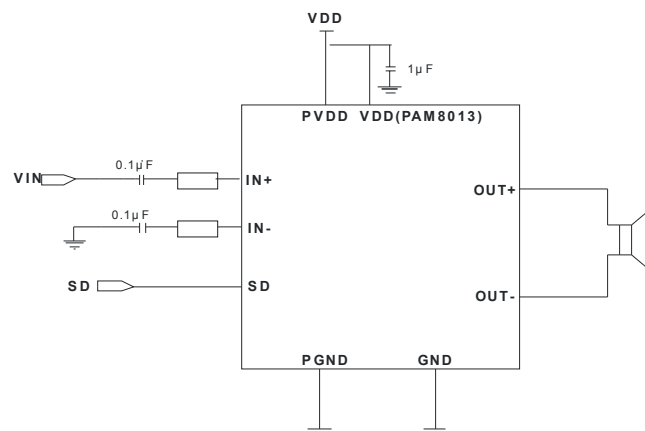| IN+	PVDD	OUT-
A1	A2	A3
GND	GND	PGND
B1	B2	B3
IN-	SD	OUT+
C1	C2	C3

PAM8015

Applications

- Cellular Phones/Smart Phones
- MP4/MP3
- GPS
- Digital Photo Frame
- Electronic Dictionary
- Portable Game Machines

## Typical Applications Circuit

PAM8013/PAM8015
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Pin Descriptions

Pin Name	PAM8013	PAM8015	Function
IN+	A1	A1	Positive Differential Input
GND	A2	B1/B2	Ground
OUT-	A3	A3	Negative BTL output
VDD	B1	—	Power Supply
PVDD	B2	A2	Power Supply
PGND	B3	B3	Power Ground
IN-	C1	C1	Negative Differential Input
SD	C2	C2	SD Terminal to Disable the Chip
OUT+	C3	C3	Positive BTL Output

Functional Block Diagram
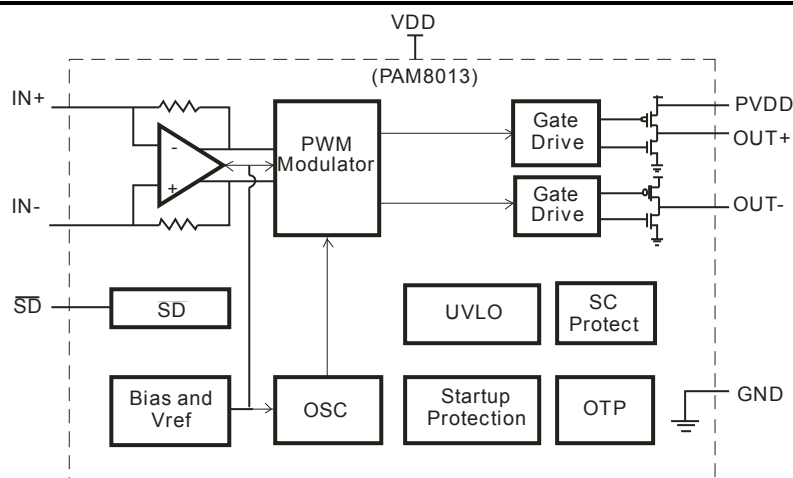
Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Parameter	Rating	Unit
Supply Voltage (VDD)	6.0	V
Input Voltage(IN+, IN-, SD)	-0.3 to V_{DD}+0.3	V
Storage Temperature	-65 to +150	°C
Maximum Junction Temperature	150	°C

## Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V_{DD}	Supply Voltage	2.8	5.5	V
T_A	Operating Ambient Temperature Range	-25	85	°C
T_J	Junction Temperature	-40	+125	°C

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Electrical Characteristics (@T_A = +25°C, V_{DD} = 5V, Gain = 18dB, R_L = L(33µH)+R+L(33µH), unless otherwise noted.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
VDD	Supply Voltage			2.8		5.5	V
Po	Output Power	THD+N = 10%, f = 1kHz, R = 4Ω	V_{DD} = 5.0V		3.0		W
			V_{DD} = 3.6V		1.5		
			V_{DD} = 3.2V		1.2		
		THD+N = 1%, f = 1kHz, R = 4Ω	V_{DD} = 5.0V		2.4		W
			V_{DD} = 3.6V		1.25		
			V_{DD} = 3.2V		1.0		
		THD+N = 10%, f = 1kHz, R = 8Ω	V_{DD} = 5.0V		1.75		W
			V_{DD} = 3.6V		0.90		
			V_{DD} = 3.2V		0.70		
		THD+N = 1%, f = 1kHz, R = 8Ω	V_{DD} = 5.0V		1.40		W
			V_{DD} = 3.6V		0.72		
			V_{DD} = 3.2V		0.60		
THD+N	Total Harmonic Distortion Plus Noise	V_{DD} = 5.0V, P_O = 1W, R = 8Ω	f = 1kHz		0.17		%
		V_{DD} = 3.6V, P_O = 0.1W, R = 8Ω			0.16		
		V_{DD} = 3.2V, P_O = 0.1W, R = 8Ω			0.14		
		V_{DD} = 5.0V, P_O = 0.5W, R = 4Ω	f = 1kHz		0.14		%
		V_{DD} = 3.6V, P_O = 0.2W, R = 4Ω			0.16		
		V_{DD} = 3.2V, P_O = 0.1W, R = 4Ω			0.17		
PSRR	Power Supply Ripple Rejection	V_{DD} = 3.6V, Inputs ac-grounded with C = 1µF	f = 217Hz		-68		dB
			f = 1kHz		-70		
			f = 10kHz		-67		
Dyn	Dynamic Range	V_{DD} = 5V,THD = 1%, R = 8Ω	f = 1kHz		95		dB
Vn	Output Noise	Inputs AC-grounded	No A weighting		170		µV
			A-weighting		130		
η	Efficiency	RL= 8Ω, THD = 10%	f = 1kHz		93		%
		RL= 4Ω, THD = 10%			86		
IQ	Quiescent Current	V_{DD} = 5V	No Load		5		mA
Isd	Shutdown Current	V_{DD} = 2.8V to 5V	S_D = 0V			1	µA
Rdson	Static Drain-to Source On-state Resistor	High Side PMOS, I = 500mA	V_{DD} = 5.0V		325		mΩ
		Low Side NMOS, I = 500mA	V_{DD} = 5.0V		200		mΩ
fsw	Switching Frequency	V_{DD} = 2.8V to 5V			400		kHz
Gv	Closed-loop Gain	V_{DD} = 2.8V to 5V			300K/R_{IN}		V/V
RIN	Input Impedance	V_{DD} = 2.8V to 5V			28.5		KΩ
Vos	Output Offset Voltage	Input AC-ground, V_{DD} = 5V				20	mV
VIH	SD Input High Voltage	V_{DD} = 5V		1.4			V
VIL	SD Input Low Voltage	V_{DD} = 5V				1.0	

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Performance Characteristics (@T_A = +25°C, V_{DD} = 5V, Gain = 18dB, R_L = L(33µH)+R+L(33µH), unless otherwise noted.)
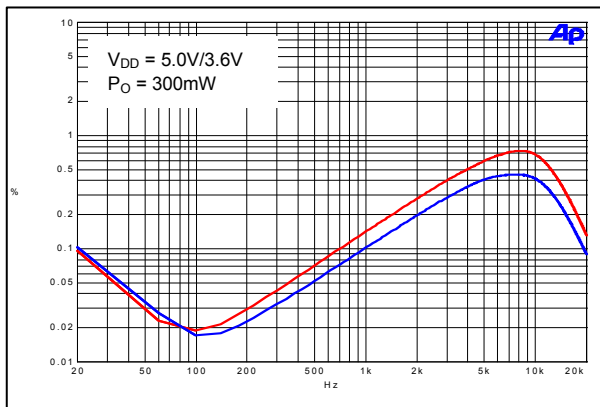
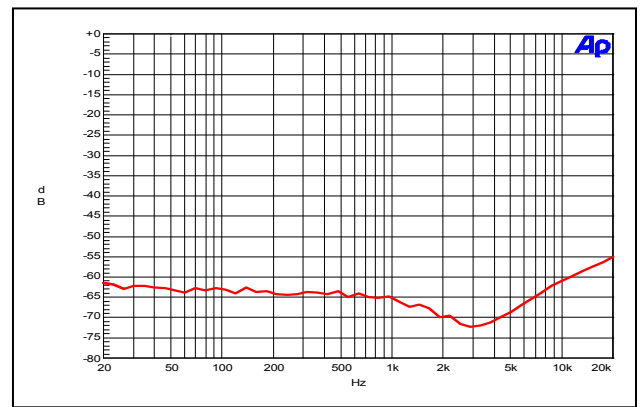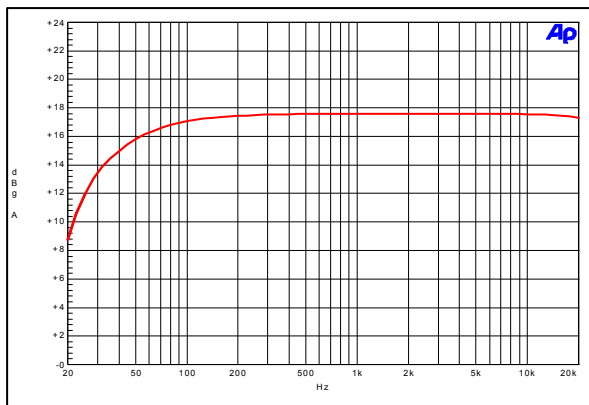THD+N Vs. Output Power (RL = 4Ω)
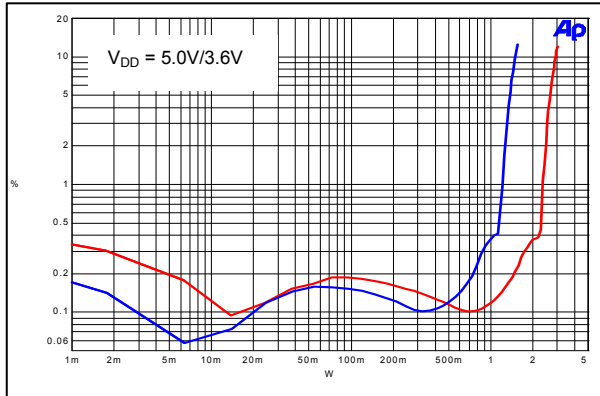
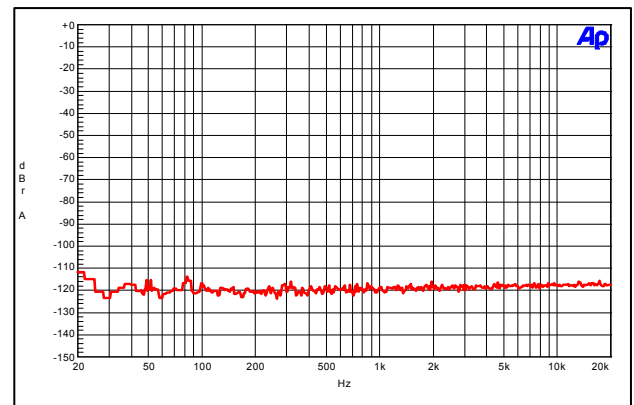THD+N Vs. Output Power (RL = 8Ω)
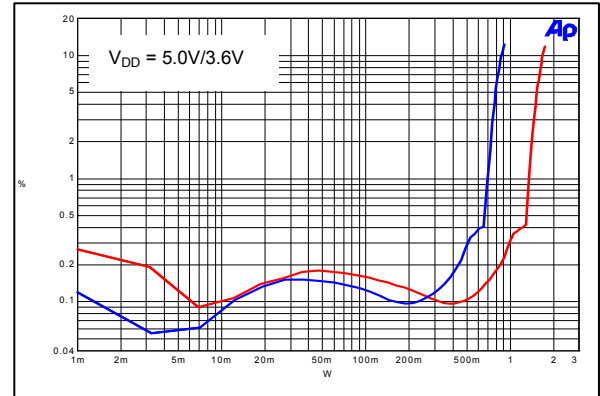
THD+N vs. Frequency

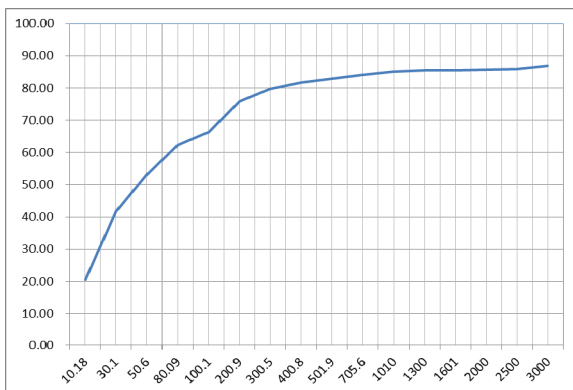
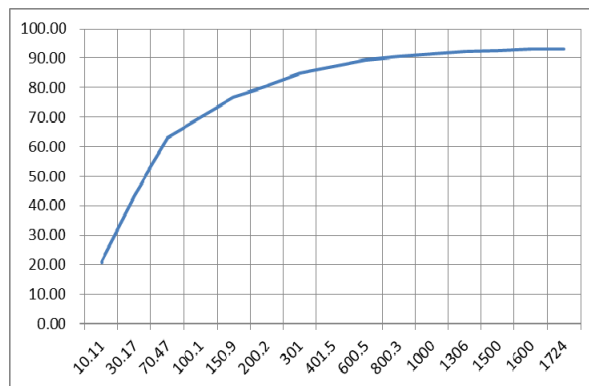PSRR vs. Frequency

Frequency Response

Noise Floor

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Performance Characteristics (cont.) (@T$_A$ = +25°C, V$_{DD}$ = 5V, Gain = 18dB, R$_L$ = L(33µH)+R+L(33µH), unless otherwise noted.)
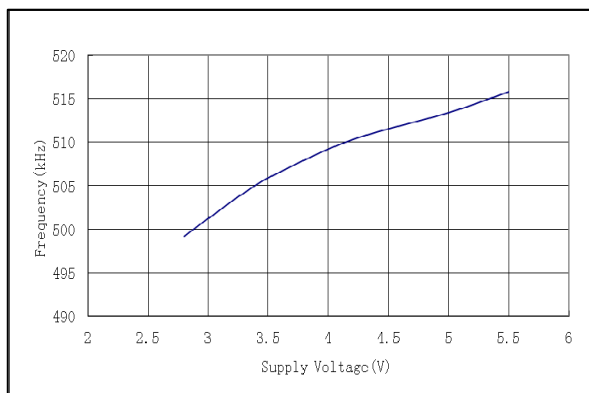
Efficiency vs. Output Power (RL = 4Ω)
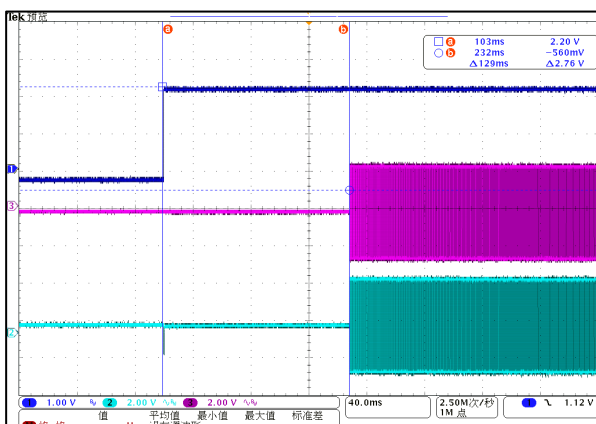

Efficiency vs. Output Power (RL = 8Ω)
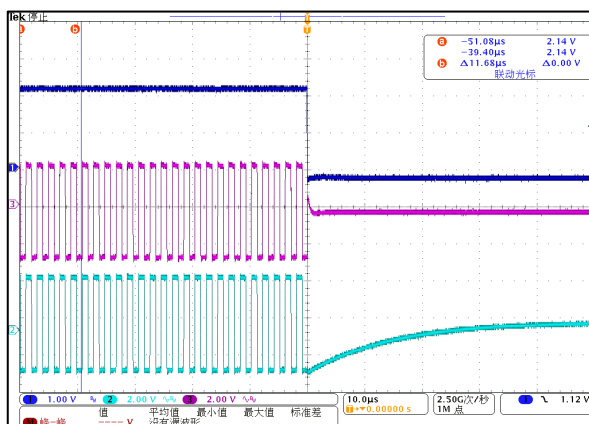

Quiescent Current Vs. Supply Voltage
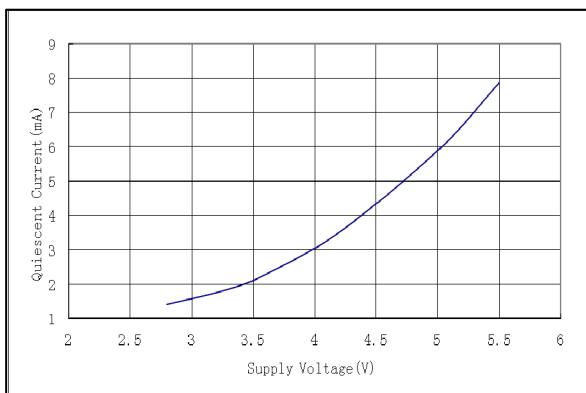
OSC Frequency Vs. Supply Voltage

Start-up Response

Shutdown Response

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Application Information

Input Capacitors (Ci)

In the typical application, an input capacitor, Ci, is required to allow the amplifier to bias the input signal to the proper DC level for optimum operation. In this case, Ci and the minimum input impedance Ri form is a high-pass filter with the corner frequency determined in the follow equation:

$$f_C = \frac{1}{(2\pi RiCi)}$$

It is important to consider the value of Ci as it directly affects the low frequency performance of the circuit. For example, when Ri is 150kΩ and the specification calls for a flat bass response are down to 150Hz. Equation is reconfigured as followed:

$$Ci = \frac{1}{(2\pi Ri f_c)}$$

When input resistance variation is considered, the Ci is 7nF, so one would likely choose a value of 10nF. A further consideration for this capacitor is the leakage path from the input source through the input network (Ci, Ri + Rf) to the load. This leakage current creates a DC offset voltage at the input to the amplifier that reduces useful headroom, especially in high gain applications. For this reason, a low-leakage tantalum or ceramic capacitor is the best choice. When polarized capacitors are used, the positive side of the capacitor should face the amplifier input in most applications as the DC level is held at VDD/2, which is likely higher than the source DC level. Please note that it is important to confirm the capacitor polarity in the application.

Decoupling Capacitor (CS)

The PAM8013/PAM8015 is a high-performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output total harmonic distortion (THD) as low as possible. Power supply decoupling also prevents the oscillations causing by long lead length between the amplifier and the speaker.

The optimum decoupling is achieved by using two different types of capacitors that target on different types of noise on the power supply leads. For higher frequency transients, spikes, or digital hash on the line, a good low equivalent-series-resistance (ESR) ceramic capacitor, typically 1µF, is placed as close as possible to the device VDD pin for the best operation. For filtering lower frequency noise signals, a large ceramic capacitor of 10µF or greater placed near the audio power amplifier is recommended.

How to Reduce EMI

Most applications require a ferrite bead filter for EMI elimination shown at Figure 1. The ferrite filter reduces EMI around 1MHz and higher. When selecting a ferrite bead, choose one with high impedance at high frequencies, but low impedance at low frequencies.
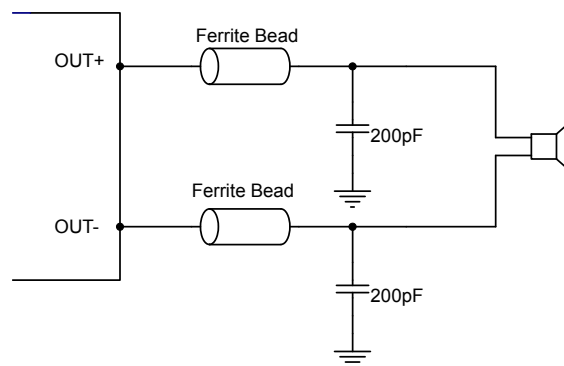

Figure 1 Ferrite Bead Filter to Reduce EMI

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Application Information (cont.)

Shutdown Operation

In order to reduce power consumption while not in use, the PAM8013/PAM8015 contains shutdown circuitry amplifier off when logic low is placed on the SD pin. By switching the shutdown pin connected to GND, the PAM8013/ PAM8015 supply current draw will be minimized in idle mode.

Under Voltage Lock-out (UVLO)

The PAM8013/PAM8015 incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 2.0V or below, the PAM8013/PAM8015 goes into a state of shutdown, and the device comes out of its shutdown state and restore to normal function only when VDD higher than 2.2V.

Short Circuit Protection (SCP)

The PAM8013/PAM8015 has short circuit protection circuitry on the outputs to prevent the device from damage when output-to-output shorts or output-to-GND shorts occur. When a short circuit occurs, the device immediately goes into shutdown state. Once the short is removed, the device will be reactivated.

Over Temperature Protection (OTP)

Thermal protection on the PAM8013/PAM8015 prevents the device from damage when the internal die temperature exceeds 150°C. There is a 15°C tolerance on this trip point from device to device. Once the die temperature exceeds the set point, the device will enter the shutdown state and the outputs are disabled. This is not a latched fault. The thermal fault is cleared once the temperature of the die decreased by 40°C. This large hysteresis will prevent motor boating sound well and the device begins normal operation at this point with no external system interaction.

POP and Click Circuitry

The PAM8013/PAM8015 contains circuitry to minimize turn-on and turn-off transients or "click and pops", where turn-on refers to either power supply turn-on or device recover from shutdown mode. When the device is turned on, the amplifiers are internally muted. An internal current source ramps up the internal reference voltage. The device will remain in mute mode until the reference voltage reach half supply voltage, 1/2 VDD. As soon as the reference voltage is stable, the device will begin full operation. For the best power-off pop performance, the amplifier should be set in shutdown mode prior to removing the power supply voltage.
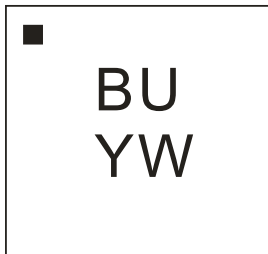
Ordering Information

PAM8013/PAM8015 X X X

Pin Configuration	Package Type	Shipping Package
A: 9 Pin	K: U-FLGA1515-9	R: Tape & Real
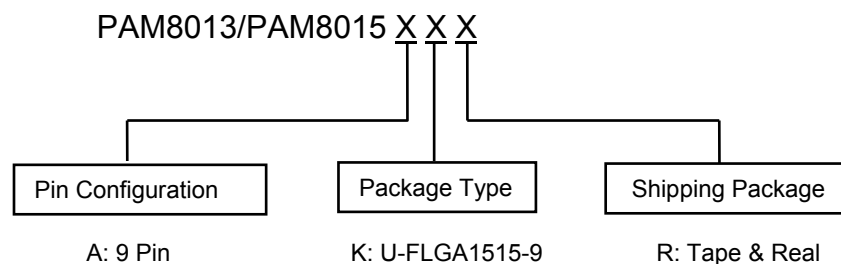
Part Number	Package	Standard Package
PAM8013AKR	U-FLGA1515-9	3,000Units/Tape&Real
PAM8015AKR	U-FLGA1515-9	3,000Units/Tape&Real

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Marking Information
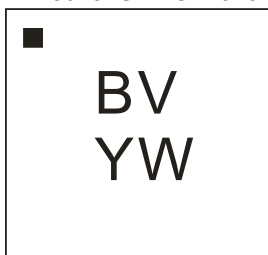
PAM8013- U-FLGA1515-9

BU
YW

BU: PAM8013 Product Code

Y: Year

W: Week

PAM8015- U-FLGA1515-9

BV
YW
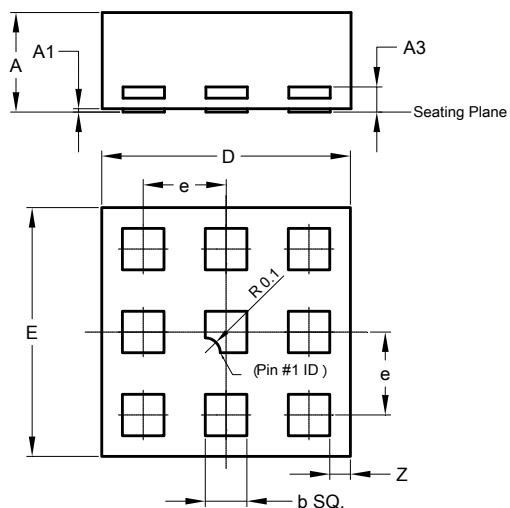
BV: PAM8015 Product Code
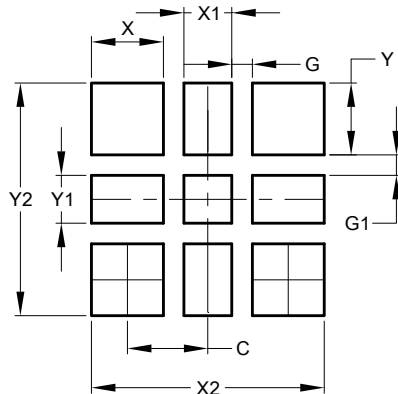
Y: Year

W: Week

Package Outline Dimensions (All dimensions in mm.)

Please see AP02002 at http://www.diodes.com/datasheets/ap02002.pdf for the latest version.

U-FLGA1515-9			
Dim	Min	Max	Typ
A	0.55	0.65	0.60
A1	0	0.05	0.02
A3	0.13 BSC		
b	0.20	0.30	0.25
D	1.45	1.55	1.50
E	1.45	1.55	1.50
e	0.50 BSC		
Z	0.125 BSC		
All Dimensions in mm			

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Suggested Pad Layout

Please see AP02001 at http://www.diodes.com/datasheets/ap02001.pdf for the latest version.

Dimensions	Value (in mm)
C	0.587
G	0.150
G1	0.150
X	0.525
X1	0.350
X2	1.700
Y	0.525
Y1	0.350
Y2	1.700

IMPORTANT NOTICE

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