Description

The PAM8904 is a piezo sounder driver with integrated charge pump boost converter. The PAM8904 is capable of driving a ceramic/piezo sounder with $24V_{PP}$ from a 5.5V power supply. The charge pump can operate in a 1x, 2x, or 3x mode.

The boost converter operates at a fixed frequency of 1.0MHz and provides a 12V output with a minimum number of external components. The PAM8904 can drive up to 15nF loading. Diodes Incorporated's unique drive technology provides a small inrush current, low EMI and high efficiency.

The PAM8904 includes built-in automatic shutdown and wake up that guarantees longer battery life. The PAM8904 features thermal shutdown, overcurrent protection, overvoltage protection and undervoltage lock-out.

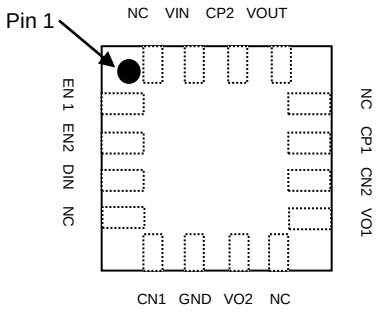
The PAM8904 is available in a 16-pin U-QFN3030-16 (Type B) package, a 12-pin U-QFN3030-12 (Type A) package, or a 12-pin U-QFN2020-12 (Type UX) package.

Features

- Supply Voltage Range from 1.8V to 5.5V
- $18V_{PP}$ Output from a 3V Supply
- Integrated Boost Converter Generates Up to 12V Supply
- No Voltage Cross Output at Shutdown Mode
- Low Current Consumption
- Automatic Standby and Wake-Up Control
- Available in Space-Saving Packages:
  - 16-Pin U-QFN3030-16 (Type B)
  - 12-Pin U-QFN3030-12 (Type A)
  - 12-Pin U-QFN2020-12 (Type UX)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **An Automotive-Compliant Part is Available Under Separate Datasheet (PAM8904Q)**

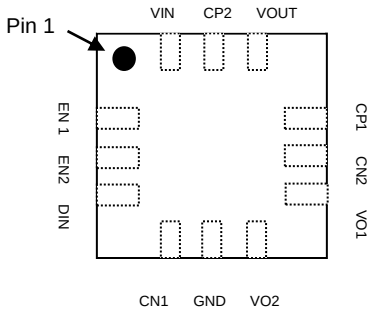
Pin Assignments

(Top View)



U-QFN3030-16 (Type B)

(Top View)



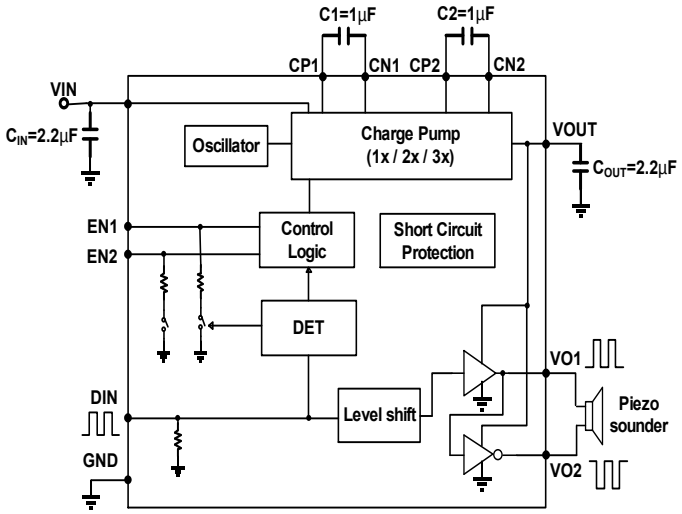
U-QFN3030-12 (Type A)
U-QFN2020-12 (Type UX)

Applications

- Health care systems
- Alarm clocks
- Security devices
- Home appliances

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit



Pin Descriptions

Pin Number		Pin Name	I/O/P	Function
U-QFN3030-16 (Type B)	U-QFN3030-12 (Type A) U-QFN2020-12 (Type UX)			
1	1	EN1	I	Charge pump mode select 1
2	2	EN2	I	Charge pump mode select 2
3	3	DIN	I	Signal Input
4	—	NC	—	No Connection
5	4	CN1	I	Capacitor 1 Negative Terminal
6	5	GND	P	Ground
7	6	VO2	O	Positive Output
8	—	NC	—	No Connection
9	7	VO1	O	Negative Output
10	8	CN2	I	Capacitor 2 Negative Terminal
11	9	CP1	I	Capacitor 1 Positive Terminal
12	—	NC	—	No Connection
13	10	VOUT	O	Boost Output
14	11	CP2	I	Capacitor 2 Positive Terminal
15	12	VIN	P	Power Supply
16	—	NC	—	No Connection

Absolute Maximum Ratings (@ T_A = +25°C, unless otherwise specified.) (Note 4)

Symbol	Characteristics	Value	Unit
V_{IN}	Supply Voltage	-0.3 to +6.0	V
V_{OUT}	Output Voltage	15	V
V_{EN1}, V_{EN2}	EN1, EN2 Voltage	GND -0.3 to V_{IN} +0.3	V
T_A	Operating Free-Air Temperature Range	-40 to +85	°C
T_J	Operating Junction Temperature Range	-40 to +150	°C
T_{STG}	Storage Temperature Range	-65 to +150	°C

Note 4: Stresses greater than those listed under *"Absolute Maximum Ratings"* can 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 Ratings"* for extended periods can affect device reliability.

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

Symbol	Characteristics		Min.	Max.	Unit
V_{IN}	Supply Voltage	—	1.8	5.5	V
V_{IH}	High-Level Input Voltage	EN1, EN2	0.5* V_{IN} to V_{IN} +0.3		V
V_{IL}	Low-Level Input Voltage	EN1, EN2	-0.3	+0.4	V
T_A	Operating Free-Air Temperature		-40	+85	°C

Thermal Information

Parameter	Symbol	Package	Max.	Unit
Thermal Resistance (Junction to Ambient)	θ_{JA}	U-QFN3030-16 (Type B)	35	°C/W
		U-QFN3030-12 (Type A)	35	
		U-QFN2020-12 (Type UX)	68	
Thermal Resistance (Junction to Case)	θ_{JC}	U-QFN3030-16 (Type B)	14	°C/W
		U-QFN3030-12 (Type A)	14	
		U-QFN2020-12 (Type UX)	25	

Electrical Characteristics (@T_A = +25°C, V_{IN} = 3.0V, C_{PIEZO} = 15nF, f_{DIN} = 4kHz, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage Range	V_{OUT}	(Note 5)	1.8	—	13.5	V
Output Voltage	V_{OUT1}	1x Mode	2.8	—	3	V
	V_{OUT2}	2x Mode	5.2	—	6	V
	V_{OUT3}	3x Mode (Note 6)	7.2	—	9	V
Operating Current 1	I_{DD11}	1x Mode, C_{PIEZO} = No Load	—	50	—	μA
	I_{DD12}	2x Mode, C_{PIEZO} = No Load	—	720	—	μA
	I_{DD13}	3x Mode, C_{PIEZO} = No Load	—	1,700	—	μA
Operating Current 2	I_{DD21}	1x Mode, Single-Ended Application	—	0.3	—	mA
	I_{DD22}	2x Mode, Single-Ended Application	—	1.4	—	mA
	I_{DD23}	3x Mode, Single-Ended Application	—	3.9	—	mA
Operating Current 3	I_{DD31}	1x Mode, Differential Application	—	0.9	—	mA
	I_{DD32}	2x Mode, Differential Application	—	3.6	—	mA
	I_{DD33}	3x Mode, Differential Application	—	7.9	—	mA
Shutdown Current	I_{SD}	DIN = 0V	—	—	1	μA
Input Frequency	f_{IN}	Rectangular Pulse	—	4	—	kHz
Oscillating Frequency	f_{OSC}	—	—	1	—	MHz
VOUT Start Delay Time	t_{ON1}	1x Mode, From DIN Signal High to 90% V_{OUT} Steady State	—	270	—	μs
	t_{ON2}	2x Mode, From DIN Signal High to 90% V_{OUT} Steady State	—	320	—	μs
	t_{ON3}	3x Mode From DIN Signal High to 90% V_{OUT} Steady State	—	350	—	μs
Shutdown Delay Time	t_{OFF}	DIN = H- > L	—	42	—	ms
Output Short-Circuit Current	I_{SC}	—	—	40	—	mA
Control Terminal Voltage H	V_{IH}	EN1, EN2, DIN Pins	0.5*V_{IN}	—	V_{IN}	V
Control Terminal Voltage L	V_{IL}	EN1, EN2, DIN Pins	0	—	0.4	V
Control Terminal Current 1	I_{IH1}	DIN = 3V	—	—	1	μA
Control Terminal Current 2	I_{IH2}	V_{EN1}, V_{EN2} = 3V, DIN = 3V	—	—	1	μA
Control Terminal Current 3	I_{IH3}	V_{EN1}, V_{EN2} = 3V, DIN = 0V	—	—	1	μA

Notes: 5. It is possible to drive VOUT, VO1 and VO2 to 3x V_{DD}. A supply voltage of 4.5V of more should not be used in 3x mode as this will exceed the maximum output voltage rating.
6. When designed under 3x mode, it should be carefully noted that the V_{OUT} absolute maximum value should not exceed 13.5V.

Application Information

Charge Pump Mode Setting

The Charge Pump Mode (CPM) pins EN1 and EN2 are used to set the charge pump into mode 1x V_{DD}, 2x V_{DD}, 3x V_{DD} or they can be used to put the PAM8904 in to a forced low current shutdown mode.

DIN	EN1	EN2	MODE
0	—	—	Shutdown Mode
1	0	0	Shutdown Mode
1	0	1	1x Mode
1	1	0	2x Mode
1	1	1	3x Mode

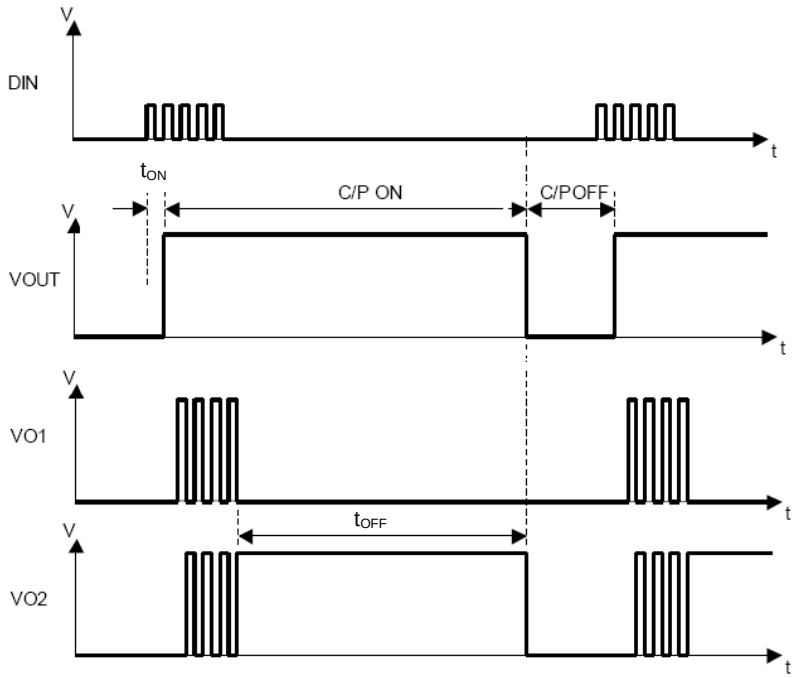
Care must be taken when using the 3x mode with a V_{DD} supply of 4.5V or more, as this will force the V_{OUT} to exceed its Absolute Maximum specification (13.5V).

V_{DD} Range	Mode
1.8V to 5.5V	1x, 2x
1.8V to 4.5V	1x, 2x and 3x

Timing Chart and Device Operation

When one or both of the EN pins are pulled high, the device enters normal operation mode, refer to the above table for the mode selection. Once the PAM8904 senses a valid signal on the DIN pin, the charge pump will start and provide the desired voltage on the VOUT pin and the output drive VO1 and VO2 start to function after time t_{ON} which is typically between 270µs and 350µs depending on the mode chosen. Once the input signal on DIN is removed, the PAM8904 senses this and waits typically 42ms to ensure the signal has been removed. If there is no further valid signal within the time period t_{OFF}, the PAM8904 enters into a low current standby mode.

Timing Chart



Application Information (continued)

Output Configuration

The PAM8904 is able to be configured either in a differential or a single-ended configuration.

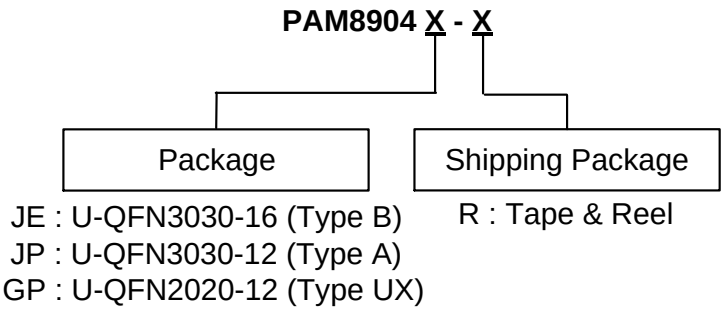
Short-Circuit Protection

The PAM8904 has short-circuit protection circuitry on the outputs to prevent damage. Once a short circuit is detected on the outputs the chip will limit the total current to protect the output device. This is not a latched fault; once the short is removed the normal operation is restored.

Thermal Protection

If the junction temperature of the PAM8904 exceeds +150°C the device will enter overtemperature shutdown. The outputs and the charge pump will be switched off. Once the junction temperature cools down to its normal operating condition, the IC will restart automatically.

Ordering Information



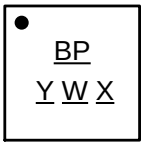
Part Number	Package	Packing	
		Qty.	Carrier
PAM8904JER	U-QFN3030-16 (Type B)	3,000	Tape & Reel (13inch)
PAM8904JPR	U-QFN3030-12 (Type A)	3,000	Tape & Reel (13inch)
PAM8904GPR	U-QFN2020-12 (Type UX)	3,000	Tape & Reel (7inch)

Marking Information

U-QFN3030-16 (Type B) / U-QFN3030-12 (Type A)
(Top View)

P8904: Product Code
XXX: Internal Code
Y: Year 0 to 9
W: Week: A to Z: 1 to 26 Week;
a to z: 27 to 52 Week;
z Represents 52 and 53 Week

U-QFN2020-12 (Type UX)
(Top View)

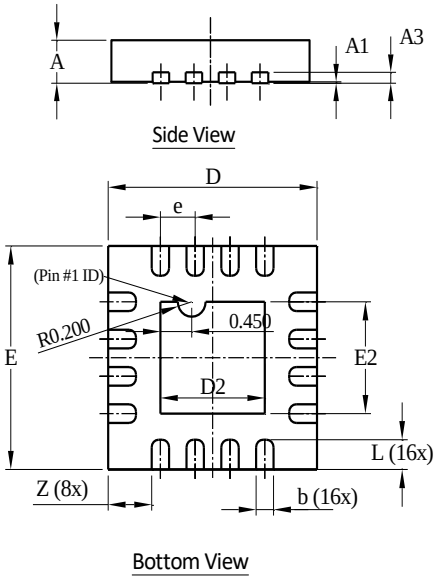


BP: Identification Code
Y: Year: 0 to 9
W: Week: A to Z: 1 to 26 Week;
a to z: 27 to 52 Week; Z Represents 52 and 53 Week
X: Internal Code

Package Outline Dimensions

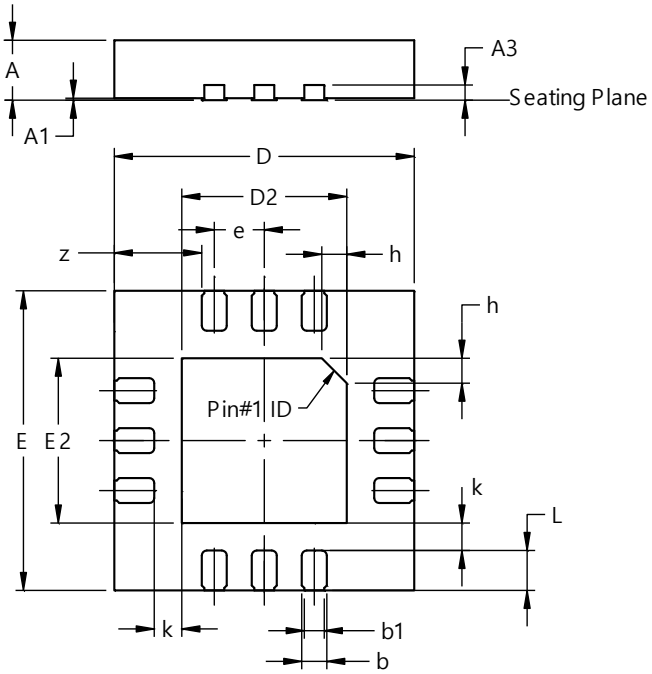
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: U-QFN3030-16 (Type B)



U-QFN3030-16 Type B			
Dim	**Min**	**Max**	**Typ**
A	0.55	0.65	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.18	0.28	0.23
D	2.95	3.05	3.00
D2	1.40	1.60	1.50
E	2.95	3.05	3.00
E2	1.40	1.60	1.50
e	-	-	0.50
L	0.35	0.45	0.40
Z	-	-	0.625
All Dimensions in mm			

(2) Package Type: U-QFN3030-12 (Type A)

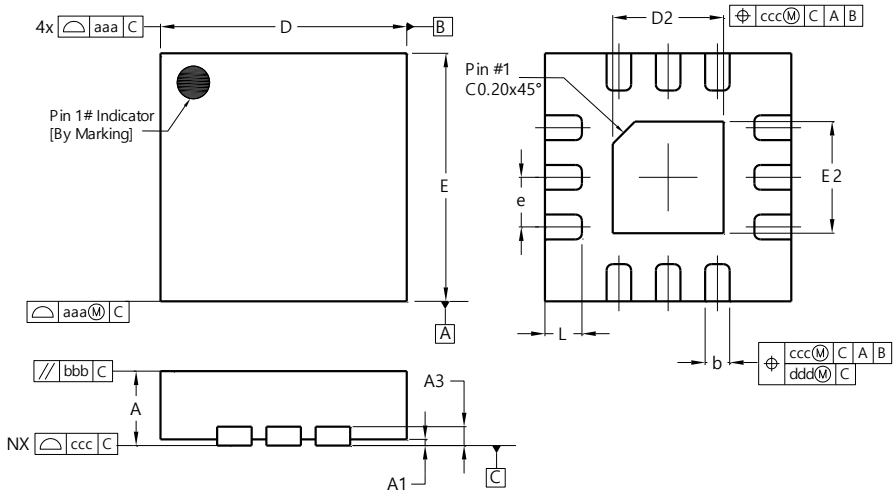


U-QFN3030-12 (Type A)			
Dim	**Min**	**Max**	**Typ**
A	0.55	0.65	0.60
A1	0.00	0.05	0.02
A3	--	--	0.152
b	0.20	0.35	0.25
b1	0.15	0.25	0.20
D	2.95	3.05	3.00
D2	1.55	1.75	1.65
E	2.95	3.05	3.00
E2	1.55	1.75	1.65
e	--	--	0.50
h	--	--	0.25
L	0.35	0.45	0.40
k	--	--	0.275
z	--	--	0.875
All Dimensions in mm			

Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3) Package Type: U-QFN2020-12 (Type UX)

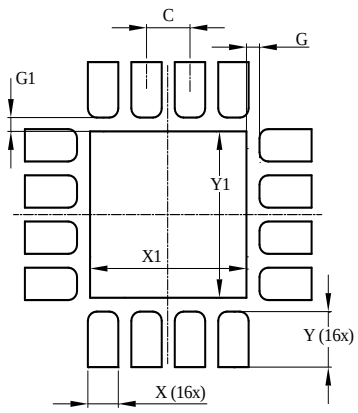


U-QFN2020-12 (Type UX)			
Dim	**Min**	**Max**	**Typ**
A	0.550	0.650	0.600
A1	—	0.05	—
A3	0.127 REF		
b	0.180	0.280	0.230
D	1.950	2.050	2.00
D2	0.850	0.950	0.900
E	1.950	2.050	2.00
E2	0.850	0.950	0.900
e	0.400 BSC		
L	0.250	0.350	0.300
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.05		
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: U-QFN3030-16 (Type B)

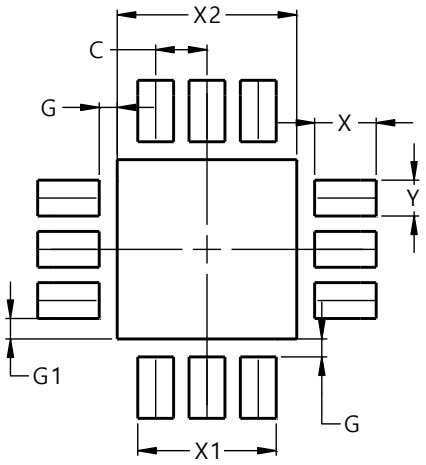


Dimensions	Value (in mm)
C	0.500
G	0.150
G1	0.150
X	0.350
X1	1.800
Y	0.600
Y1	1.800

Suggested Pad Layout

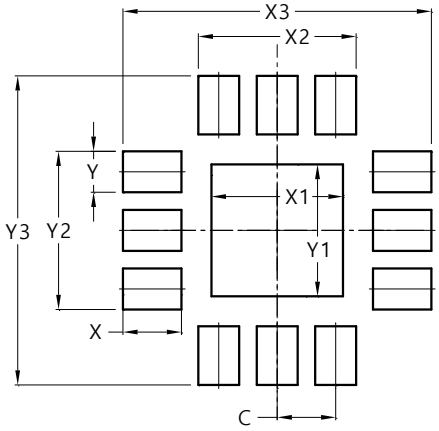
Please see http://www.diodes.com/package-outlines.html for the latest version.

(2) Package Type: U-QFN3030-12 (Type A)



Dimensions	Value (in mm)
C	0.500
G	0.175
G1	0.200
X	0.600
X1	1.350
X2	1.750
Y	0.350
Y1	1.750

(3) Package Type: U-QFN2020-12 (Type UX)



Dimensions	Value (in mm)
C	0.400
X	0.400
X1	0.900
X2	1.080
X3	2.110
Y	0.280
Y1	0.900
Y2	1.080
Y3	2.110

Mechanical Data

U-QFN3030-16 (Type B)/U-QFN3030-12 (Type A)

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish—NiPdAu Leads, Solderable per MIL-STD-202, Method 208 e4
- Weight: 0.016 grams (Approximate)

U-QFN2020-12 (Type UX)

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish—NiPdAu Leads, Solderable per MIL-STD-202, Method 208 e4
- Weight: 0.0068 grams (Approximate)

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