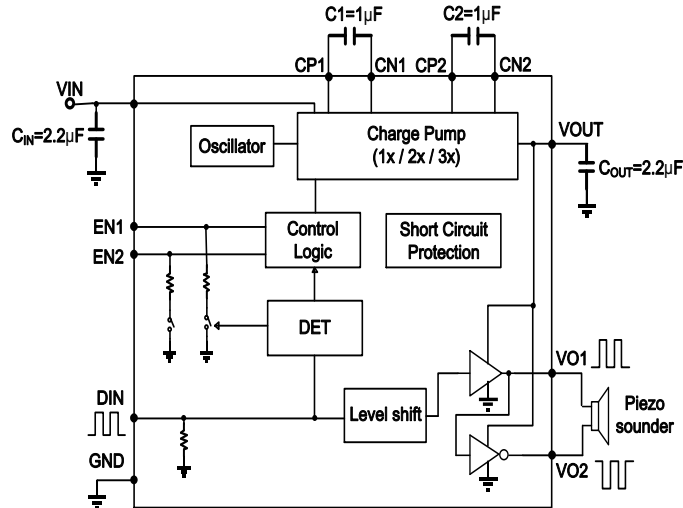


**Typical Applications Circuit**

**Pin Descriptions**

| Pin Number               |                          | Pin Name | I/O/P | Function                      |
|--------------------------|--------------------------|----------|-------|-------------------------------|
| U-QFN3030-16<br>(Type B) | U-QFN3030-12<br>(Type A) |          |       |                               |
| 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                       | VOOUT    | O     | Boost Output                  |
| 14                       | 11                       | CP2      | I     | Capacitor 2 Positive Terminal |
| 15                       | 12                       | VIN      | P     | Power Supply                  |
| 16                       | —                        | NC       | —     | No Connection                 |

### Absolute Maximum Ratings (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

| 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                 | $^\circ\text{C}$ |
| $T_J$              | Operating Junction Temperature Range | -40 to +150                | $^\circ\text{C}$ |
| $T_{STG}$          | Storage Temperature Range            | -65 to +150                | $^\circ\text{C}$ |

### Recommended Operating Conditions (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

| Symbol   | Characteristics                | Min      | Max                   | Unit             |   |
|----------|--------------------------------|----------|-----------------------|------------------|---|
| $V_{IN}$ | Supply Voltage                 | —        | 2.3                   | 5.5              | V |
| $V_{IH}$ | High-Level Input Voltage       | EN1, EN2 | 1.2 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                   | $^\circ\text{C}$ |   |

### Thermal Information

| Parameter                                | Symbol        | Package  | Maximum | Unit               |
|--|---------------|--|---------|--------------------|
| Thermal Resistance (Junction to Ambient) | $\theta_{JA}$ | U-QFN3030-16 (Type B)<br>U-QFN3030-12 (Type A) | 35      | $^\circ\text{C/W}$ |
| Thermal Resistance (Junction to Case)    | $\theta_{JC}$ | U-QFN3030-16 (Type B)<br>U-QFN3030-12 (Type A) | 14      | $^\circ\text{C/W}$ |

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

| Parameter                    | Symbol     | Conditions  | Min                | Typ   | Max                | Unit          |
|------------------------------|------------|---|--------------------|-------|--------------------|---------------|
| Output Voltage Range         | $V_{OUT}$  | (Note 4)  | 2.1                | —     | 12                 | V             |
| Output Voltage               | $V_{OUT1}$ | 1x Mode   | 2.8                | —     | 3                  | V             |
|                              | $V_{OUT2}$ | 2x Mode   | 5.2                | —     | 6                  | V             |
|                              | $V_{OUT3}$ | 3x Mode (Note 5)  | 7.2                | —     | 9                  | V             |
| Operating Current 1          | $I_{DD11}$ | 1x Mode, $C_{PIEZO} = \text{No Load}$                       | —                  | 50    | —                  | $\mu\text{A}$ |
|                              | $I_{DD12}$ | 2x Mode, $C_{PIEZO} = \text{No Load}$                       | —                  | 720   | —                  | $\mu\text{A}$ |
|                              | $I_{DD13}$ | 3x Mode, $C_{PIEZO} = \text{No Load}$                       | —                  | 1,700 | —                  | $\mu\text{A}$ |
| 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             | $I_{SD}$   | $DIN = 0\text{V}$   | —                  | —     | 1                  | $\mu\text{A}$ |
| 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   | —                  | $\mu\text{s}$ |
|                              | $t_{ON2}$  | 2x Mode, From DIN signal High to 90% $V_{OUT}$ steady state | —                  | 320   | —                  | $\mu\text{s}$ |
|                              | $t_{ON3}$  | 3x Mode From DIN signal High to 90% $V_{OUT}$ steady state  | —                  | 350   | —                  | $\mu\text{s}$ |
| Shutdown Delay Time          | $t_{OFF}$  | $DIN = H \rightarrow L$                                     | —                  | 42    | —                  | ms            |
| Output Short-Circuit Current | $I_{SC}$   | —   | —                  | 40    | —                  | mA            |
| Control Terminal Voltage H   | $V_{IH}$   | EN1, EN2, DIN pins  | $0.8 \cdot V_{IN}$ | —     | $V_{IN}$           | V             |
| Control Terminal Voltage L   | $V_{IL}$   | EN1, EN2, DIN pins  | 0                  | —     | $0.2 \cdot V_{IN}$ | V             |
| Control Terminal Current 1   | $I_{IH1}$  | $DIN = 3\text{V}$   | —                  | —     | 1                  | $\mu\text{A}$ |
| Control Terminal Current 2   | $I_{IH2}$  | $V_{EN1}, V_{EN2} = 3\text{V}, DIN = 3\text{V}$             | —                  | —     | 1                  | $\mu\text{A}$ |
| Control Terminal Current 3   | $I_{IH3}$  | $V_{EN1}, V_{EN2} = 3\text{V}, DIN = 0\text{V}$             | —                  | —     | 1                  | $\mu\text{A}$ |

- Notes:
- It is possible to drive  $V_{OUT}$ ,  $VO1$  and  $VO2$  to  $3x V_{DD}$ . A supply voltage of 4V or more should not be used in 3x mode as this will exceed the maximum output voltage rating.
  - When designed under 3x mode, it should be carefully noted that the  $V_{OUT}$  absolute maximum value should not exceed 15V.

## 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<sub>DD</sub>, 2x V<sub>DD</sub>, 3x V<sub>DD</sub> 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       |

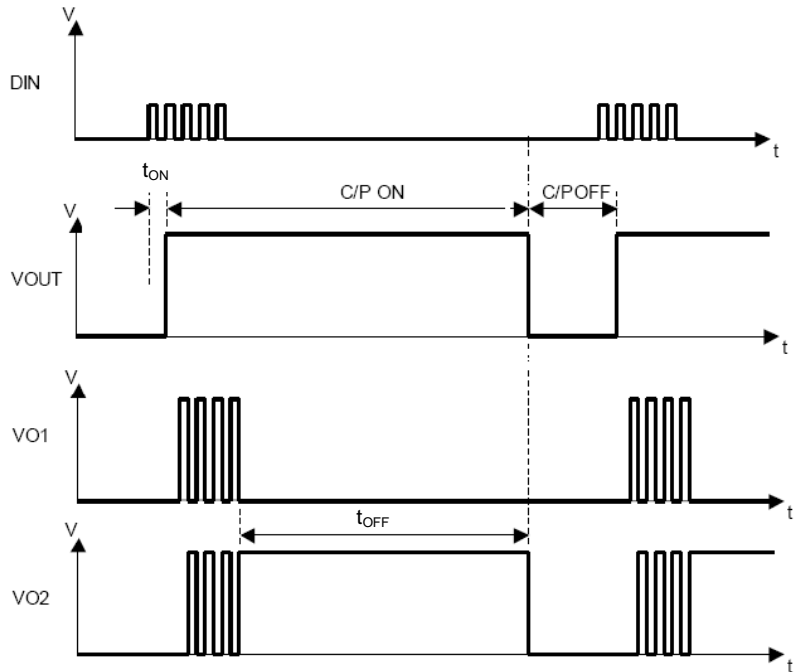
Care must be taken when using the 3x mode with a V<sub>DD</sub> supply of 5V or more, as this will force the V<sub>OUT</sub> to exceed its Absolute Maximum specification (15V).

| V <sub>DD</sub> Range | Mode          |
|-----------------------|---------------|
| 2.3V to 5.5V          | 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 V<sub>OUT</sub> pin and the output drive VO1 and VO2 start to function after time t<sub>ON</sub> 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<sub>OFF</sub>, 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.

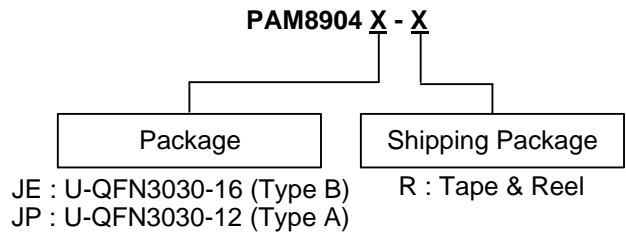
**Short-Circuit Protection**

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 re-start automatically.

**Ordering Information**

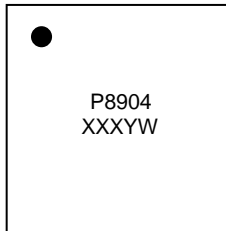


| Part Number | Package Type          | Shipping          |
|-------------|-----------------------|-------------------|
| PAM8904JER  | U-QFN3030-16 (Type B) | 3,000/Tape & Reel |
| PAM8904JPR  | U-QFN3030-12 (Type A) | 3,000/Tape & Reel |

**Marking Information**

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

(Top View)

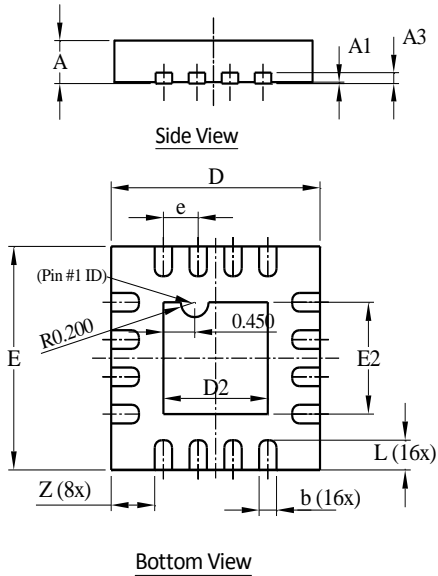


P8904: Product Code  
 XXX: Internal Code  
 Y: Year 0-9  
 W: Week: A-Z: 1~26 weeks;  
 a-z: 27~52 weeks;  
 z represents 52 and 53 weeks

**Package Outline Dimensions**

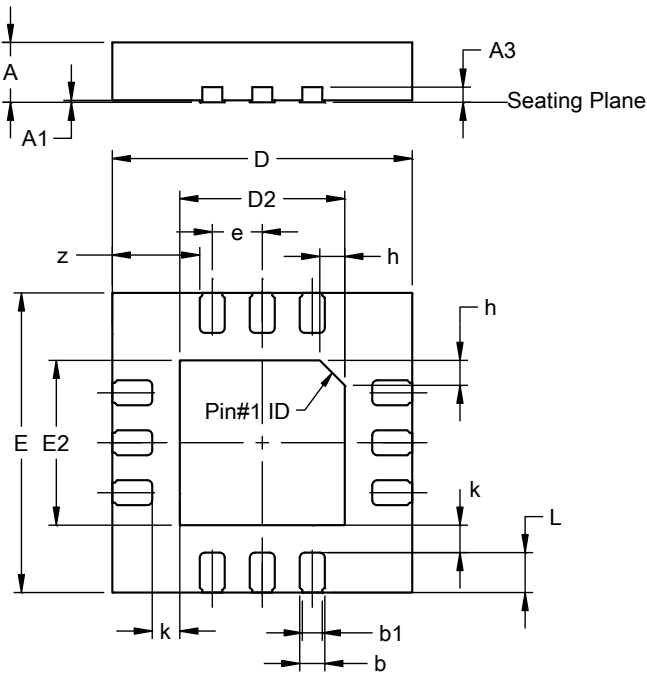
Please see <http://www.diodes.com/package-outlines.html> for the latest version.

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



| U-QFN3030-16<br>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)**

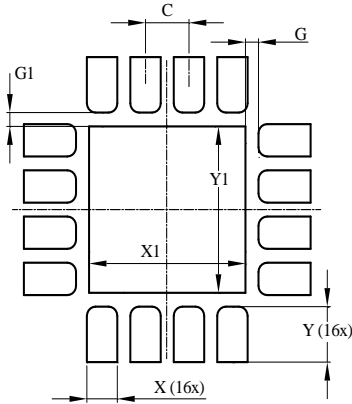


| U-QFN3030-12<br>(Type A) |      |      |       |
|--------------------------|------|------|-------|
| Dim                      | Min  | Max  | Typ   |
| A                        | 0.55 | 0.65 | 0.60  |
| A1                       | 0.00 | 0.05 | 0.02  |
| A3                       | --   | --   | 0.152 |
| 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     |      |      |       |

**Suggested Pad Layout**

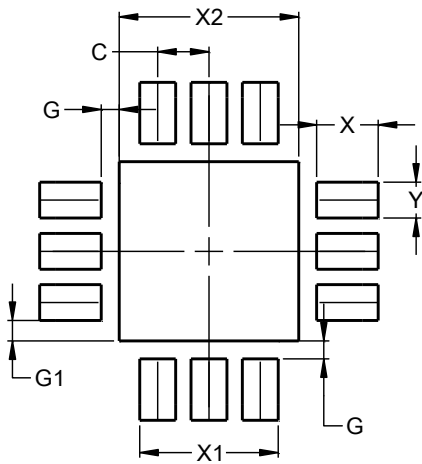
Please see <http://www.diodes.com/package-outlines.html> for the latest version.

**(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         |

**(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         |

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