

**MAS6240****Piezo Driver with Multi-Mode Charge Pump**

This is preliminary information on a new product under development. Micro Analog Systems Oy reserves the right to make any changes without notice.

*Preliminary*

- **Both Single Ended and Differential Output**
- **Three-Step Volume Adjusting**
- **Up to 18Vpp Output from 3V Supply**
- **One Wire Audio & Shutdown Control**
- **High Efficiency**
- **Solution without Inductors**
- **Low External Part Count**

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**DESCRIPTION**

MAS6240 is a piezo driver device that can drive outputs up to 18Vpp from 3V supply. An internal three-mode charge pump generates boosted supply voltage for piezo driver. For adjusting the piezo element sound volume, the charge pump can operate in either of a 1x, 2x or 3x mode. In 1x mode the input voltage is bypassed to the output, in 2x or 3x mode the input voltage is boosted up accordingly 2 or 3 times. Charge pump mode is selected by control pins EN1 and EN2 (see Table1 at page 2).

MAS6240 is an easy and low-cost solution for piezo driver, since only 4 small value capacitors are needed in addition to sound element - the use of inductors can be avoided. The inductorless design also causes significantly less disturbance to the surrounding circuits making it an ideal choice for sensitive designs. Its charge pump switches at 1MHz, allowing to use as small as 100nF external capacitors.

Control logic is switching the charge pump on at first rising signal of digital input (DIN) pin. The switch-off signal will be generated while the signal at DIN has been low at least for 10ms. The piezo driver is enabled at a second rising edge of a pulse at DIN and the signal is transferred to piezo output VO1. The same signal is inverted into output VO2 for using differential output.

Continuous logic high level at DIN input causes the charge pump to be turned ON but leaves the audio amplifier disabled. In that state the charge pump output can be used to power the external LEDs or any other external circuit. The output voltage is still selectable at three steps.

In "disabled" mode (DIN has been low for 10ms) all functional blocks are switched off to achieve the quiescent current less than 1µA.

See more information in the chapter Detailed Description.

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**FEATURES**

**Thin 0.75 mm QFN 12 package**

**Piezo Driver**

- Three-Step Volume Adjusting
- Both Single Ended and Differential Output
- Up to 18Vpp Output from 3V Supply
- One Wire Audio & Shutdown Control

**Charge Pump**

- Low External Part Count
- Solution without Inductors
- 1 MHz Switching Frequency
- Multi-Mode Charge Pump (1x/2x/3x)

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**APPLICATIONS**

- Wrist Watches
- Alarm Clocks
- Handheld GPS devices
- PDAs
- Portable Device with Sound Feature

**BLOCK & APPLICATION DIAGRAM**

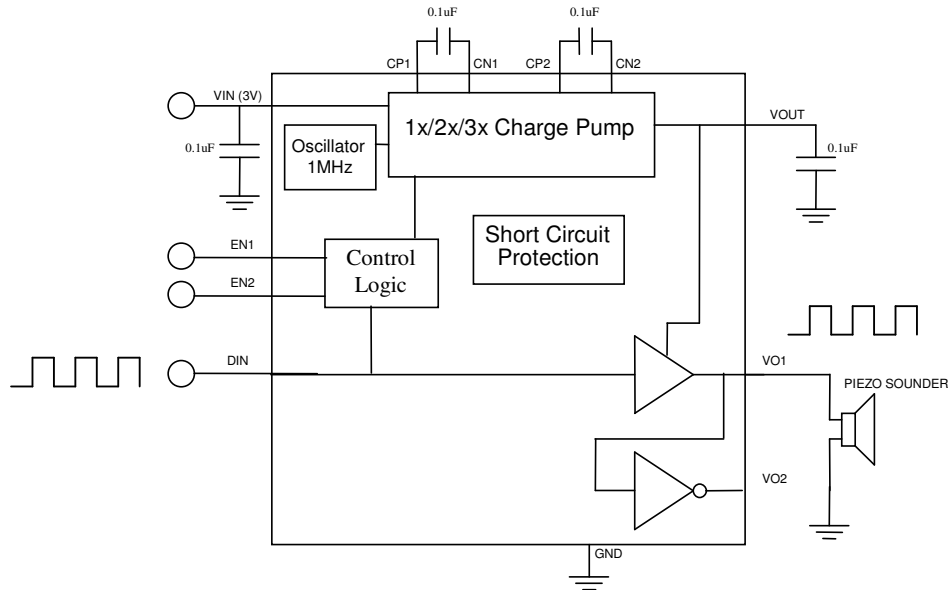


Figure 1: Charge Pump + Single End Piezo Driver (max 9Vpp)

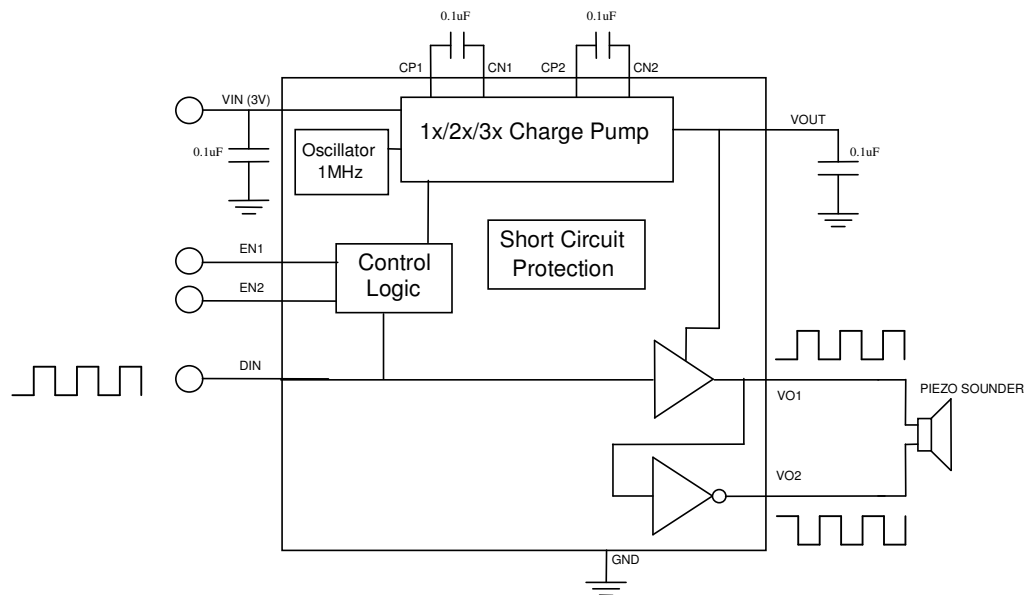


Figure 2: Charge Pump + Differential Piezo Driver (max 18Vpp)

**Table 1** Charge Pump boosting mode selection

DIN	EN1	EN2	Charge Pump
0	-	-	OFF
1	0	0	OFF
1	0	1	1x Mode (VIN)
1	1	0	2x Mode (2xVIN)
1	1	1	3x Mode (3xVIN)

**Note:** Pulsed signal at digital input DIN is taken as “1” if pulse low time is less than 10 ms!

## PIN DESCRIPTION

Pin Description	Symbol	Type	X-coordinate	Y-coordinate
Control signal input for setting charge pump mode	EN1	DI	152 $\mu\text{m}$	989 $\mu\text{m}$
Control signal input for setting charge pump mode	EN2	DI	152 $\mu\text{m}$	804 $\mu\text{m}$
Enable signal + Digital signal input	DIN	DI	152 $\mu\text{m}$	588 $\mu\text{m}$
Flying capacitor negative terminal	CN1	I/O	672 $\mu\text{m}$	200 $\mu\text{m}$
Supply ground	GND	G	808 $\mu\text{m}$	202 $\mu\text{m}$
Digital audio signal output	VO2	DO	980 $\mu\text{m}$	225 $\mu\text{m}$
Digital audio signal output	VO1	DO	980 $\mu\text{m}$	378 $\mu\text{m}$
Flying capacitor negative terminal	CN2	I/O	980 $\mu\text{m}$	558 $\mu\text{m}$
Flying capacitor positive terminal	CP1	I/O	980 $\mu\text{m}$	711 $\mu\text{m}$
Charge pump output	VOUT	AO	765 $\mu\text{m}$	1000 $\mu\text{m}$
Flying capacitor positive terminal	CP2	I/O	612 $\mu\text{m}$	1000 $\mu\text{m}$
Power supply	VIN	P	447 $\mu\text{m}$	999 $\mu\text{m}$

G = Ground, P = Power, D = Digital, A = Analog, I = Input, O = Output.

**Note:** Because the substrate of the die is internally connected to GND, the die has to be connected to GND or left floating. Please make sure that GND is the first pad to be bonded. Pick-and-place and all component assembly are recommended to be performed in ESD protected area.

**Note:** Pad coordinates are measured from the left bottom corner of the chip to the center of the pads. The coordinates may vary depending on sawing width and location, however, distances between pads are accurate.

**Note:** See IC outlines on a page 6 for IC layout.

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	VIN		-0.3	5.5	V
Outputs and Flying Capacitors Pins Voltages	VOUT, CP1, CP2, CN1, CN2, VO1, VO2		-0.3	10	V
Voltage Range for Input Pins	DIN, EN1, EN2		-0.3	VIN + 0.3	V
VOUT Short-Circuit Duration	$t_{\text{sc}}$	Note 1		Indefinite	
Storage Temperature			-55	+150	$^{\circ}\text{C}$
ESD Rating		Human Body Model (HBM)		1	kV

**NOTE 1.** SHORT CIRCUIT CURRENT INTERNALLY LIMITED.

## RECOMMENDED OPERATING CONDITIONS

All voltages with respect to ground.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Junction Temperature	$T_{\text{J}}$		-40		+125	$^{\circ}\text{C}$
Operating Ambient Temperature	$T_{\text{A}}$		-40	+27	+85	$^{\circ}\text{C}$
Operating Supply Voltage	VIN		2.5	3.0	3.3	V

## ELECTRICAL CHARACTERISTICS

$T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , typical values at  $T_A = 27^{\circ}\text{C}$ ,  $V_{IN} = 3.0\text{ V}$ ,  $C_1 = 100\text{ nF}$ ,  $C_2 = 100\text{ nF}$ ,  $C_{OUT} = 100\text{ nF}$ ,  $C_{IN} = 100\text{ nF}$ ,  $C_{piezo} = 15\text{ nF}$ , digital input DIN=4kHz; unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage	V <sub>OUT</sub>	V <sub>OUT</sub> pin voltage towards ground at V <sub>DD</sub> = 3 V 1x Mode (no load) 2x Mode (no load) 3x Mode (no load)			3 6 9	V
Current Consumption	I <sub>CC</sub>	Charge Pump (no load): 1x Mode 2x Mode 3x Mode		50 490 820		μA
		Single ended application (C <sub>piezo</sub> = 15nF; f=4kHz): 1x Mode 2x Mode 3x Mode		0.27 1.3 2.7		mA
		Differential application (C <sub>piezo</sub> = 15 nF; f=4kHz): 1x Mode 2x Mode 3x Mode		0.88 3.5 7.6		mA
Signal Frequency	F <sub>AUDIO</sub>		0.2	4	8	kHz
Shutdown Current	I <sub>SD</sub>	DIN = 0V,			1	μA
Internal Switching Frequency (Charge Pump)	F <sub>OSC</sub>		0.6	1	1.8	MHz
V <sub>OUT</sub> Turn-ON Time (From DIN signal HIGH to 90% V <sub>OUT</sub> steady state)	t <sub>ON</sub>	1x Mode 2x Mode 3x Mode		10 60 120		μs
Shut Down delay	t <sub>OFF</sub>	Time before device shutdown after DIN signal goes to LOW	10	20		ms
Short Circuit Current Limit	I <sub>SC</sub>	From VIN pin	10	30		mA
Control Input Threshold	V <sub>IH</sub>	EN1, EN2, DIN pins	1.6		0.55	V
	V <sub>IL</sub>					V
Control Input Current	I <sub>IH</sub>	V <sub>DIN</sub> = 3V, (900kΩ pull down) V <sub>DIN</sub> = 0V		3.4 0	7 1	μA
	I <sub>IL</sub>					μA
	I <sub>IH</sub>	V <sub>DIN</sub> = 3V V <sub>EN1,EN2</sub> = 3V, (900kΩ pull down) V <sub>EN1,EN2</sub> = 0V		3.4 0	7 1	μA
	I <sub>IL</sub>					μA
I <sub>IH</sub>	V <sub>DIN</sub> = 0V V <sub>EN1,EN2</sub> = 3V V <sub>EN1,EN2</sub> = 0V		0 0	1 1	μA	
I <sub>IL</sub>					μA	

**DETAILED DESCRIPTION**

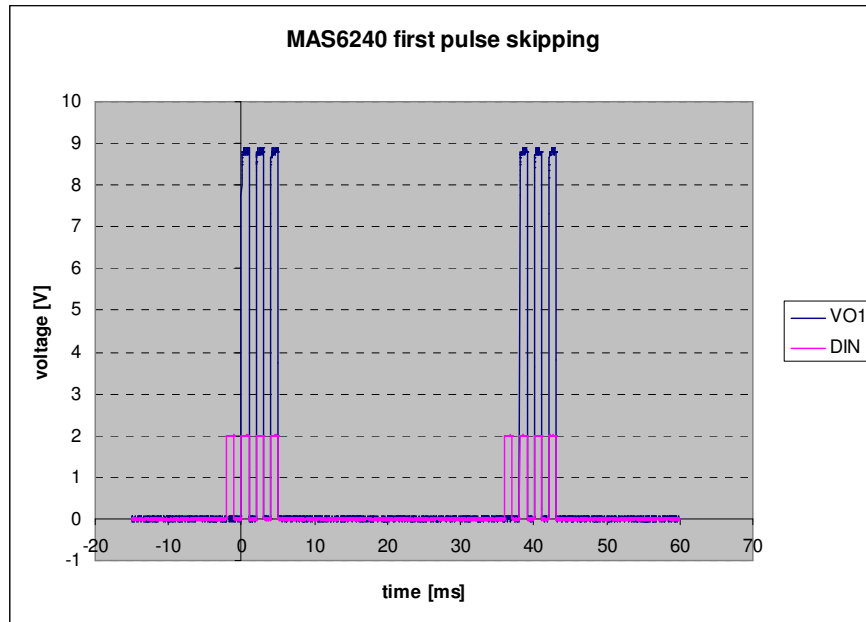


Figure 3: Enabling output VO1

The piezo driver is enabled at the second rising edge of the pulse at DIN, thus the signal is transferred to the piezo output VO1. An output VO2 is enabled at the same time, but it is optional to take it in use. Control logic is switching the charge pump on at first rising signal of digital input DIN pin. If only one continuous pulse is fed to the input DIN, the output VO1 is not enabled. This make it possible to control e.g. a white LED or other device through pin VOUT while charge pump is enabled, without enabling the piezo output VO1.

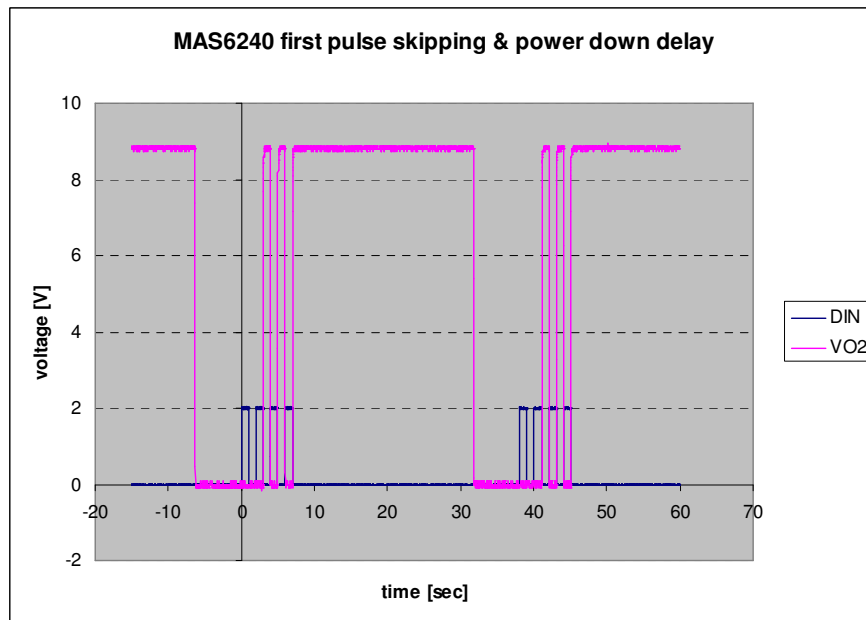
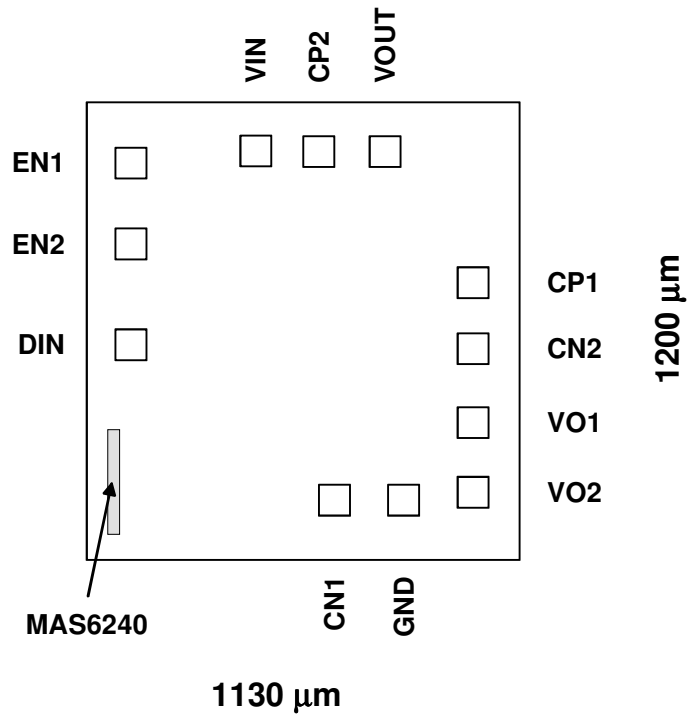


Figure 4: Disabling VO2

Figure 4 is drawn in the case of VO2. The switch-off signal will be generated after the signal at DIN has been low at least for 10 ms. In the figure 4 the switch-off delay is about 25 ms. Again when new pulses are fed into DIN, the charge pump and piezo driver will be enabled.

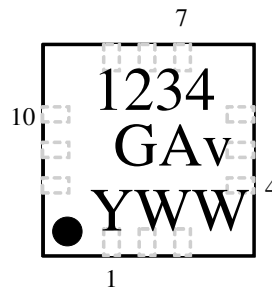
## IC OUTLINES



DIE size = 1.13 x 1.20 mm; PAD size = 80 x 80 μm

## DEVICE OUTLINE CONFIGURATION

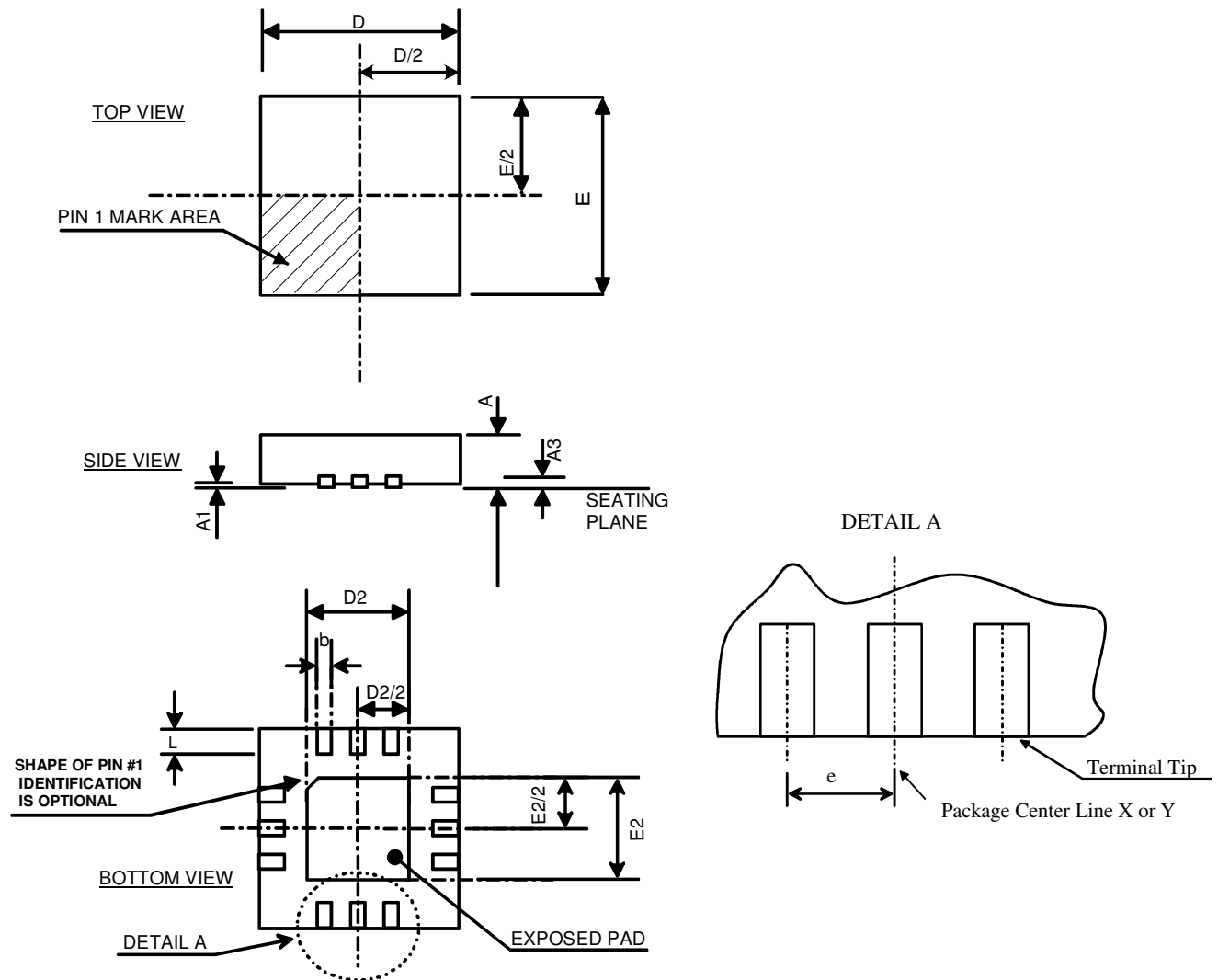
### QFN 3x3 12ld



Top Marking Information:  
1234 = Product Number  
Av = Version Number  
G = Lead Free, RoHS Compliant Package  
YWW = Year Week

Pin nr.	Pin Name	Pin nr.	Pin Name	Pin nr.	Pin Name	Pin nr.	Pin Name
1	EN1	4	CN1	7	VO1	10	VOUT
2	EN2	5	GND	8	CN2	11	CP2
3	DIN	6	VO2	9	CP1	12	VIN

## PACKAGE (QFN 3X3x0.75 12ld) OUTLINE



Symbol	Min	Nom	Max	Unit
PACKAGE DIMENSIONS				
A	0.700	0.750	0.800	mm
A1	0.000	0.020	0.050	mm
A3	0.178	---	0.228	mm
b	0.180	---	0.300	mm
D	2.950	3.000	3.050	mm
D2 (Exposed.pad)	1.300	---	1.550	mm
E	2.950	3.000	3.050	mm
E2 (Exposed.pad)	1.300	---	1.550	mm
e	0.500 BSC			mm
L	0.300	---	0.500	mm

Dimensions do not include mold or interlead flash, protrusions or gate burrs.

2500 Components on Each Reel

Reel Material: Conductive, Plastic Antistatic or Static Dissipative

Carrier Tape Material: Conductive

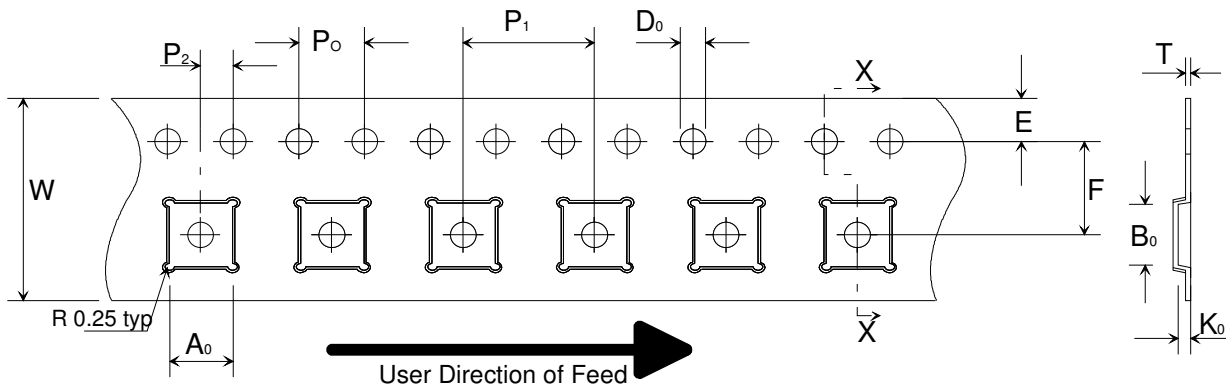
Cover Tape Material: Static Dissipative

## SOLDERING INFORMATION

◆ For Lead-Free / Green QFN 3mm x 3mm x 0.75mm

Resistance to Soldering Heat	According to RSH test IEC 68-2-58/20
Maximum Temperature	260°C
Maximum Number of Reflow Cycles	3
Reflow profile	Thermal profile parameters stated in IPC/JEDEC J-STD-020 should not be exceeded. <a href="http://www.jedec.org">http://www.jedec.org</a>
Lead Finish	7.62 - 25.4 μm, Matte Tin

## EMBOSED TAPE SPECIFICATIONS

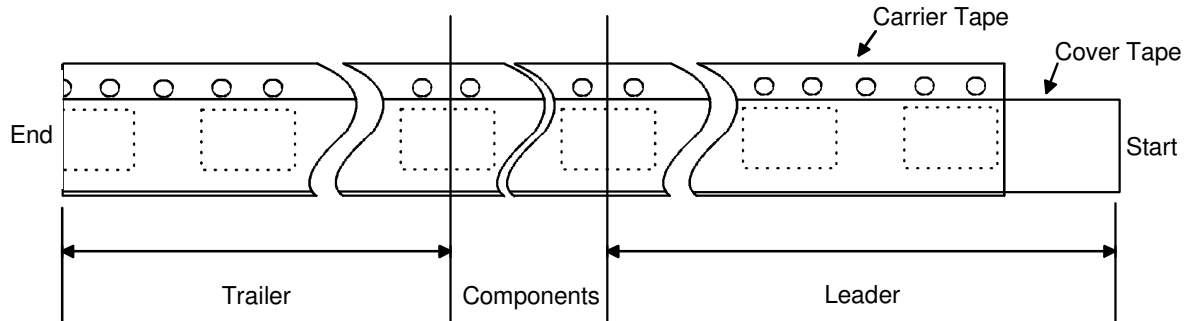
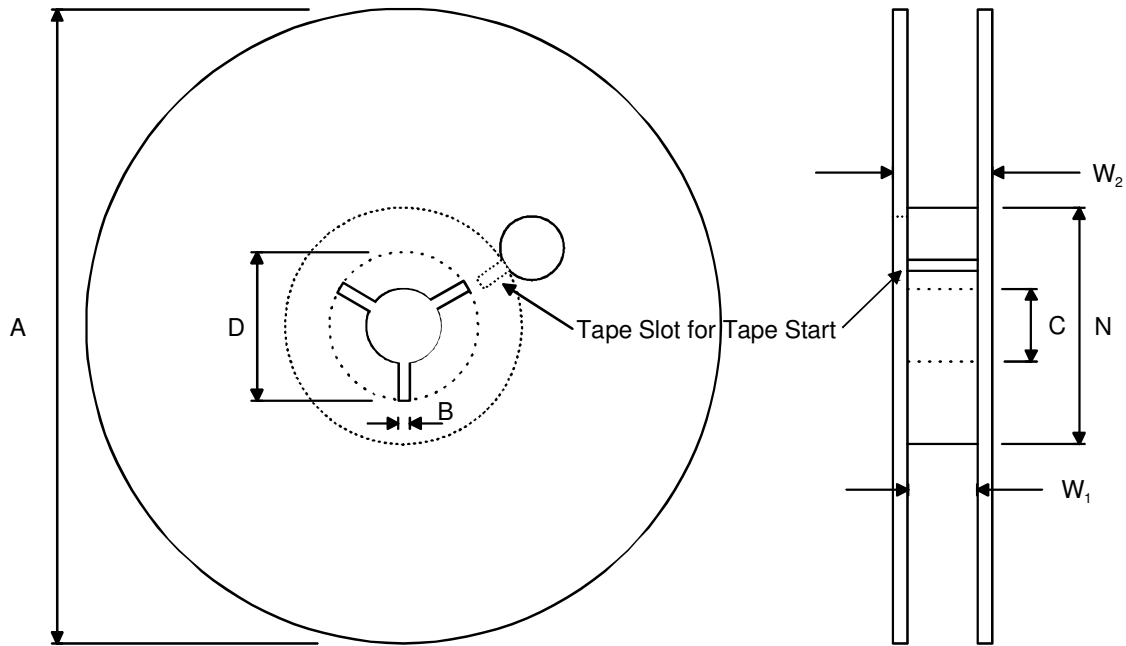


Dimension	Min/Max	Unit
$A_0$	3.30 ±0.10	Mm
$B_0$	3.30 ±0.10	Mm
$D_0$	1.50 +0.1/-0.0	Mm
$E$	1.75	Mm
$F$	5.50 ±0.05	Mm
$K_0$	1.10 ±0.10	Mm
$P_0$	4.0	Mm
$P_1$	8.0 ±0.10	Mm
$P_2$	2.0 ±0.05	Mm
$T$	0.3 ±0.05	Mm
$W$	12.00 ±0.3	Mm

All dimensions in millimeters



## REEL SPECIFICATIONS



Dimension	Min	Max	Unit
A		330	mm
B	1.5		mm
C	12.80	13.50	mm
D	20.2		mm
N	100		mm
$W_1$ (measured at hub)	12.4	14.4	mm
$W_2$ (measured at hub)		18.4	mm
Trailer	160		mm
Leader	390, of which minimum 160 mm of empty carrier tape sealed with cover tape		mm

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## ORDERING INFORMATION

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Product Code	Product	Package	Comments
MAS6240A1HP06	Piezo Driver with Multi-Mode Charge Pump	QFN 3x3x0.75 12ld, Pb Free, RoHS Compliant	Tape and Reel
MAS6240A1TC00	Piezo Driver with Multi-Mode Charge Pump	EWS Tested wafers 400 µm	Die size 1.13 x 1.20 mm

◆ **The formation of product code**

An example for MAS6240A1HP06:

MAS6240	A	1	HP	06
Product name	Design version	Product Version	Package: HP = QFN 3 x 3 x 0.75 (Pb free, RoHS compliant)	Delivery format: 06 = T&R 08 = Loose components

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## LOCAL DISTRIBUTOR

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## MICRO ANALOG SYSTEMS OY CONTACTS

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