MAS6241

Piezo Driver with 3x Charge Pump

- **Self-Drive Method**
- **Differential Output**
- **Up to 18Vpp Output from 3V Supply**
- **High Efficiency**
- **Solution without Inductors**
- **Low External Part Count**

DESCRIPTION

MAS6241 is a piezo driver device suitable for driving self-drive type piezoelectric sounder or diaphragm. It can drive outputs up to 18Vpp from 3V supply. An internal 3x charge pump generates boosted supply voltage for piezo driver.

The charge pump and piezo driver are controlled on and off using enable (EN) input pin.

MAS6241 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 using as small as 100nF external flying and output capacitors.

The piezo driver has two outputs (VOB, VOS) and one feedback input (FEED) to drive 3-terminal self-drive type piezo in bridge tied load (BTL) configuration.

MAS6241 is available in 3x3x0.75 mm size QFN-12 package.

FEATURES

- Self-Drive Method
- Differential Output
- Up to 18Vpp Output from 3V Supply
- Inductorless Low EMI Solution
- 1MHz Switching Frequency
- Low External Part Count
- Thin 3x3x0.75 mm QFN-12 Package

APPLICATIONS

- Piezoelectric Buzzer
- Smoke Alarm
- Alarm Clock
- White Goods
- Portable Device with Sound Feature

BLOCK & APPLICATION DIAGRAM

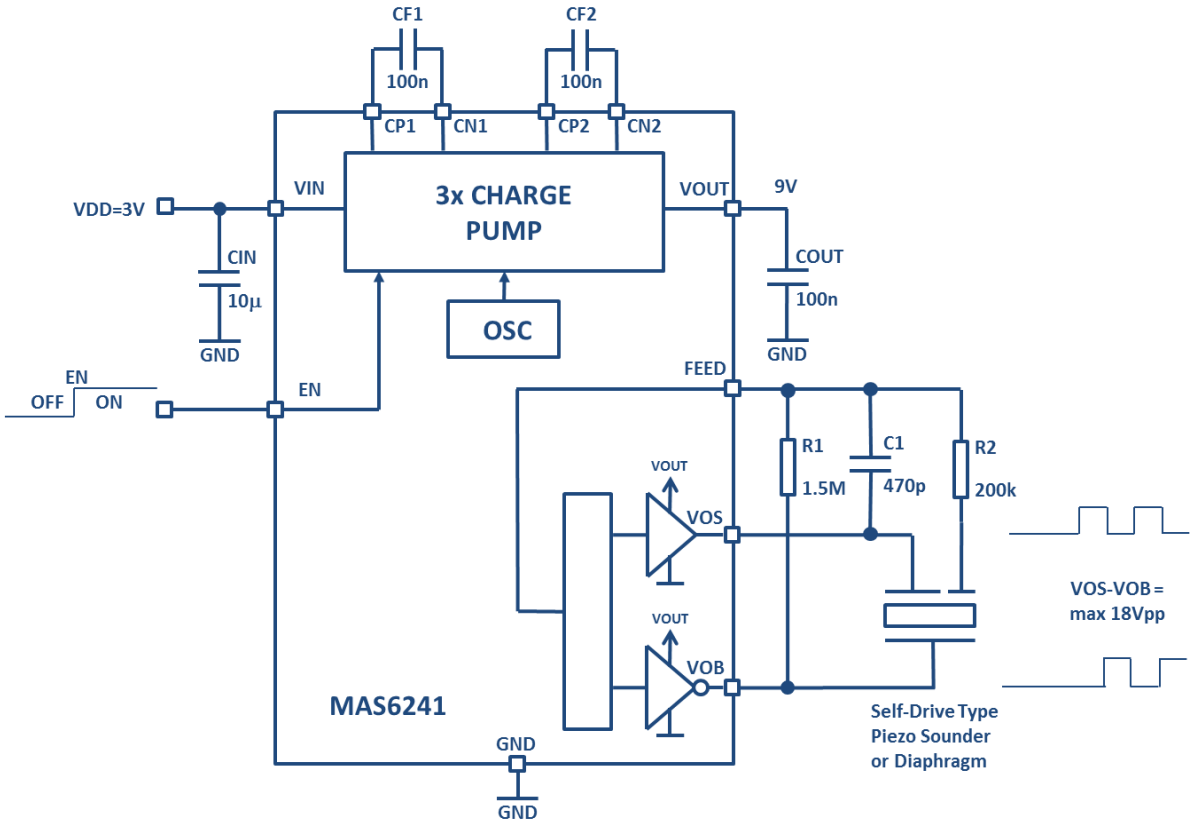


Figure 1. Enable pin controlled differential piezo driver - max 18Vpp signal for piezo from 3V supply voltage

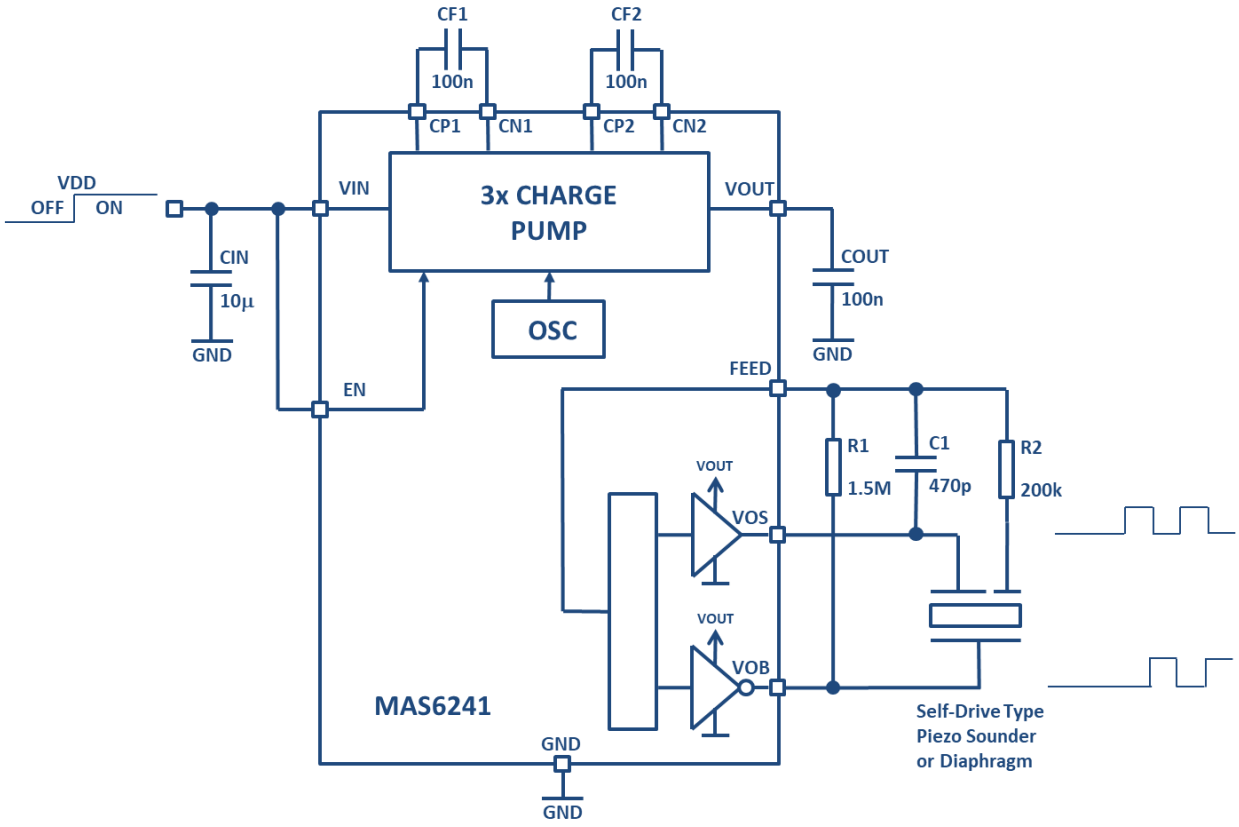


Figure 2. Supply voltage controlled differential piezo driver - max 18Vpp signal for piezo from 3V supply voltage

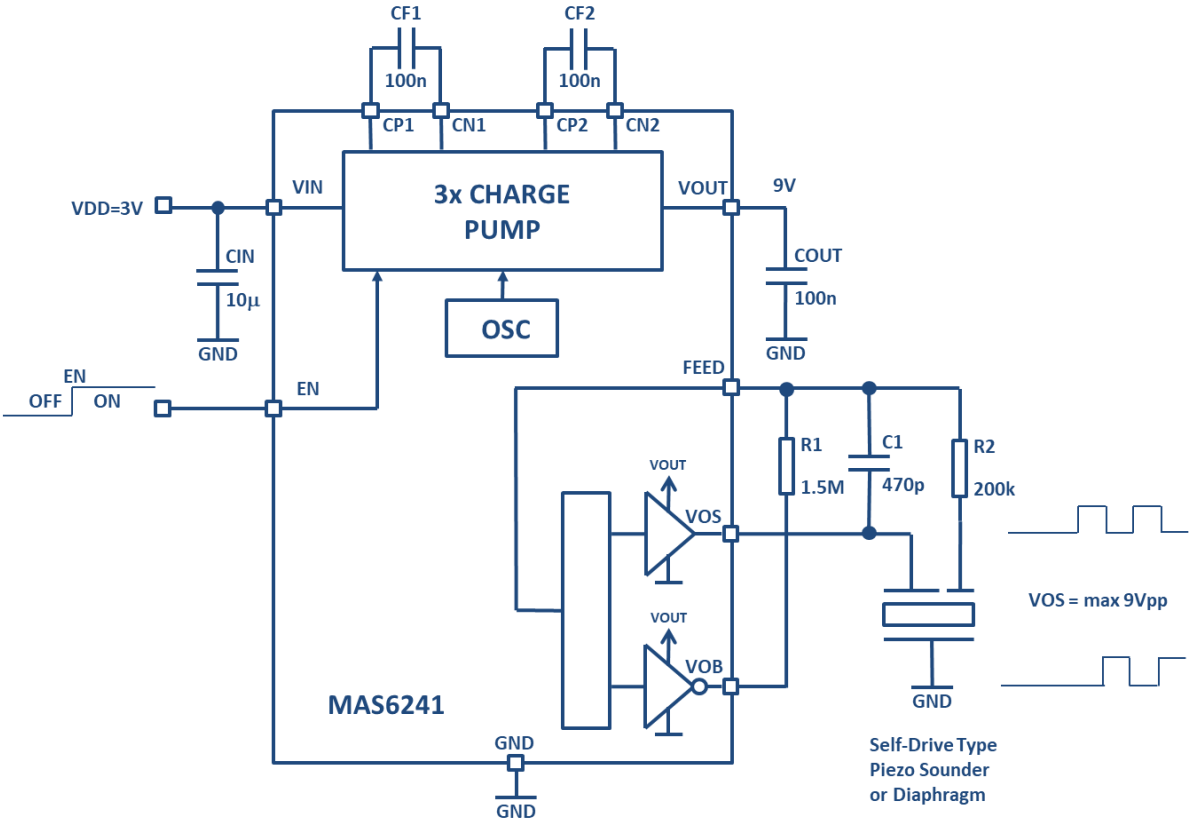


Figure 3. Enable pin controlled single-ended piezo driver - max 9Vpp signal for piezo from 3V supply voltage

Charge pump flying capacitor configurations

The 3x charge pump is configured either to 3x or 2x charge pump operation depending on the flying capacitor configuration. The 2x operation requires only one flying capacitor (CF) between pins CP2 and CN1. The 3x operation requires two flying capacitors (CF1, CF2) between CP1 and CN1 and CP2 and CN2 pins respectively. See figure 4.

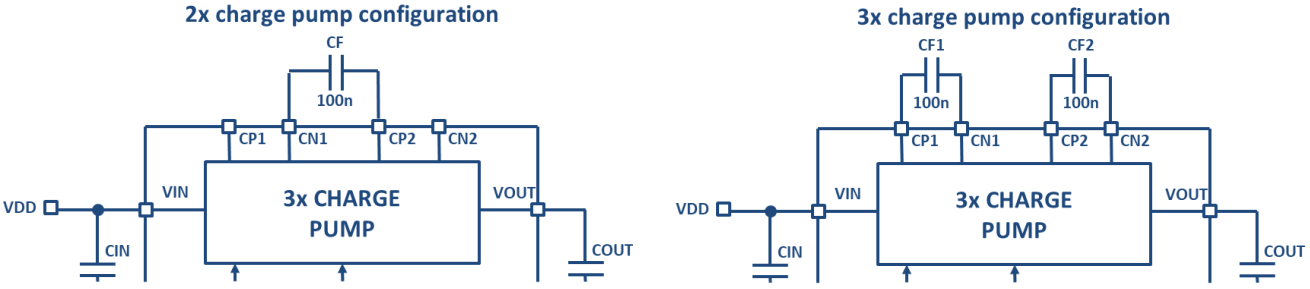


Figure 4. 2x and 3x charge pump operation configurations

Piezo drive voltage depends on supply voltage (VIN) and charge pump and piezo load configurations (table 1).

Table 1. Maximum piezo drive voltage [Vpp] at different VIN and charge pump and output load configurations

VIN	2x CHARGE PUMP CONFIG.		3x CHARGE PUMP CONFIG.	
	SINGLE-ENDED	DIFFERENTIAL	SINGLE-ENDED	DIFFERENTIAL
2.2	4.4	8.8	6.6	13.2
3	6	12	9	18
3.6	7.2	14.4	10.8	21.6

Capacitor and resistor values

Capacitors must be ceramic type with low ESR and meeting sufficient minimum voltage ratings. The CIN input, CF1 and CF2 flying capacitors see one VIN voltage and they have minimum 6.3V voltage rating. The COUT capacitor sees 2 x VIN voltage in 2x configuration and 3 x VIN voltage in 3x configuration. Then the COUT capacitor should have minimum 9V voltage rating in the 2x configuration and minimum 16V rating in the 3x configuration. See table 2 for recommended capacitor and resistor values.

Table 2. Recommended capacitor and resistor values

Capacitor	Nominal value	Voltage rating
CIN	10µF (min 1µF)	min 6.3V
CF1, CF2	100nF	min 6.3V
COUT	100nF	min 9V in 2x configuration min 16V in 3x configuration
C1	470p	min 9V in 2x configuration min 16V in 3x configuration
R1	1.5M	
R2	200k	

Note: Some capacitor dielectric materials such as Y5V have strong voltage dependence. The actual capacitance value may drop remarkably when operating near rated voltage. In such case the nominal capacitor value should be chosen larger to compensate the voltage dependence.

The input (CIN), flying (CF1, CF2) and output (COUT) capacitor value selections have influence on output (VOUT) ripple and disturbances at supply voltage input (VIN). Table 3 shows alternative capacitor value selections in different applications. In battery operated applications it is recommended to use CIN=10µF which keeps the start-up inrush current low.

Table 3. Capacitor value selections in different applications

CIN	CF1-2	COUT	Application
1µF	100nF	100nF	Minimum size layout
10µF	100nF	100nF	Low input disturbances
10µF	100nF	1µF	Low input disturbances and low output ripple

Note: the voltage ripple at VOUT output is approximately proportional to ratio of piezo load capacitance (C_{PIEZO}) and charge pump output capacitor (COUT). Then the output ripple can be reduced by choosing output capacitor value which is much larger relative to piezo capacitance value. However, note that large output capacitor also lengthens output voltage rise time and increases inrush current during start-up.

ABSOLUTE MAXIMUM RATINGS

All voltages with respect to ground.

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	VIN	Charge pump OFF Charge pump ON		5.5 4.5	V
Output and Flying Capacitor Pin Voltages	VOUT, CP1, CP2, VOS, VOB		-0.3	15	V
	CN2		-0.3	13	V
	CN1		-0.3	VIN + 0.3	V
Input Pins Voltages	EN		-0.3	VIN + 0.3	V
	FEED		-20	30	V
Storage Temperature			-55	+150	°C
Operating Junction Temperature	T_J		-40	+125	°C
ESD Rating	V_{HBM}	Human Body Model (HBM) (1)		±2000	V
	V_{CDM}	Charged Device Model (CDM) (2)		±500	V

Note: Stresses beyond the values listed may cause a permanent damage to the device. The device may not operate under these conditions, but it will not be destroyed.
Note 1: JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
Note 2: JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

RECOMMENDED OPERATING CONDITIONS

All voltages with respect to ground.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Ambient Temperature	T_A		-40	+27	+125	°C
Operating Supply Voltage	V_{IN}		2.2	3.0	3.6	V
Piezo Resonance Frequency	F_{PIEZO}		2	3.4	5	kHz

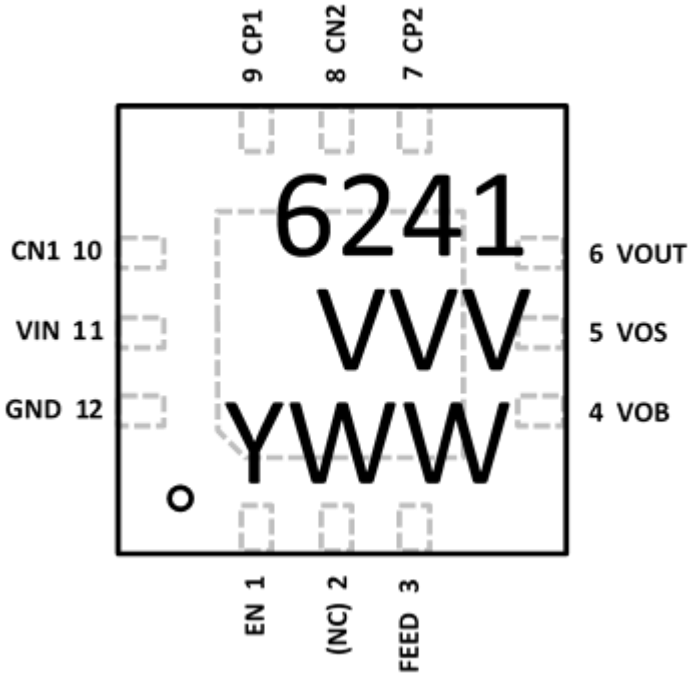
ELECTRICAL CHARACTERISTICS

T_A = -40°C to +125°C, typical values at T_A = +27°C, V_{IN} = 3.0 V, C_{IN} = 10 µF, C_{F1} = C_{F2} = C_{OUT} = 100 nF, C_{LOAD} = 15 nF, f_{FEED}=3.4kHz; unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage	VOUT	VIN = 3.0 V, T_A=+27°C	7.2		9	V
Shutdown Current	I_{SD}	EN=low		0.1	1	µA
Current Consumption	I_{DD}	EN=high, VIN=3.0V Charge Pump (no loading)		2.4	5	mA
		EN=high, VIN=3.0V C_{LOAD} = 15 nF, f_{FEED} = 3.4kHz		5.4	10	mA
		EN=high, VIN=3.0V PKM24SPH3805 piezo, f_{PIEZO} = 3.4kHz		14.2		mA
Internal Switching Frequency (Charge Pump)	F_{OSC}		0.6	1.15	1.8	MHz
VOUT Start-Up Time	t_{ON}	No piezo loading Power-up when EN=VDD Start-up from EN pin control		 530 470	 1000 1000	µs
EN Input Threshold	VIH (1)		0.9			V
	VIL				0.4	V
EN Input Current	IIH (2)	EN = 3V, VIN = 3V EN = 0.4V		0.01 1	1 2	µA
	IIL	EN = 0V, VIN = 3V		0.01	1	µA

Note 1: EN input can be driven even from low supply voltage controller due to low 0.9V VIH min threshold.
Note 2: EN input has active pull-down by 400kΩ which is disabled to save current when inputs are pulled high.

DEVICE OUTLINE CONFIGURATION



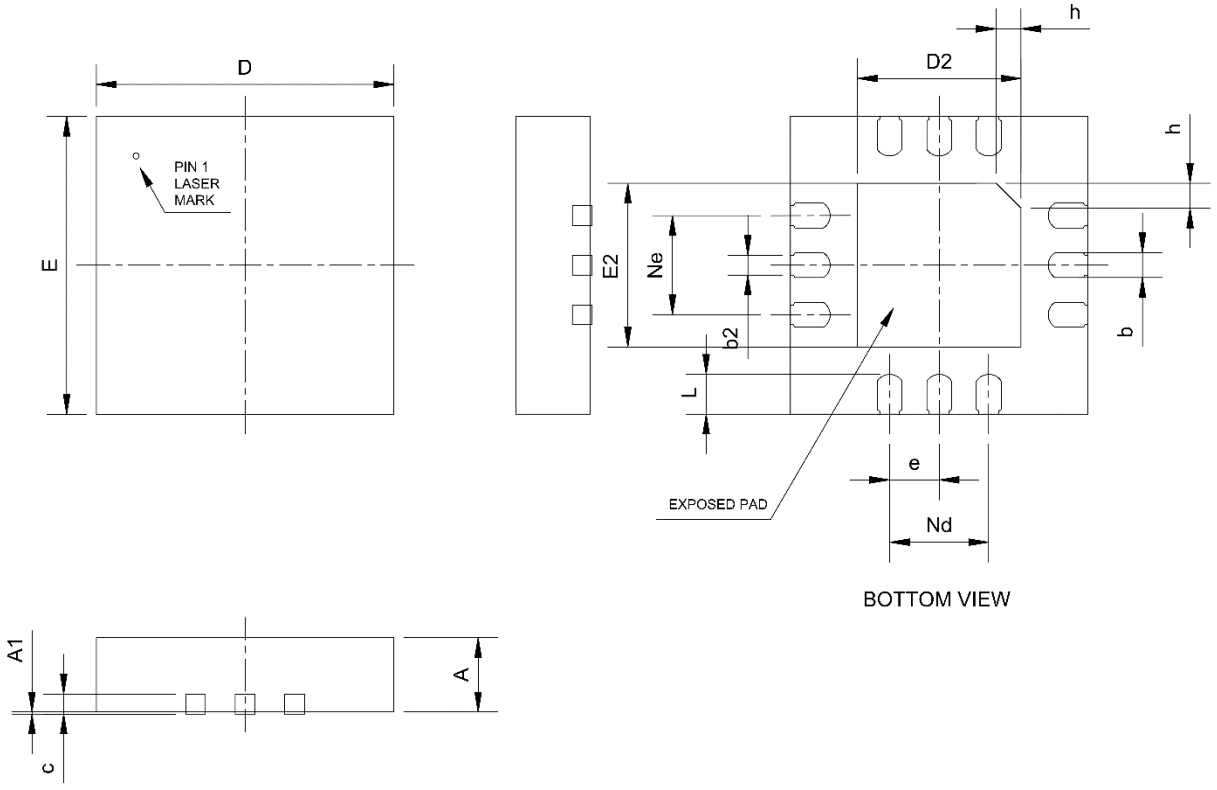
Top Marking Information:
6241 = Product Number
VVV = Version
YWW = Year Week

QFN-12 3x3x0.75 PIN DESCRIPTION

Pin Name	Pin	Type	Function	Note
EN	1	DI	Enable input for on/off control OFF: EN=low ON: EN=high	
	2	NC		1
FEED	3	AI	Input for Piezo Sounder Feedback Terminal	
VOB	4	DO	Output for Piezo Sounder Brass (Ground) Terminal	
VOS	5	DO	Output for Piezo Sounder Silver Terminal	
VOUT	6	AO	Charge pump output	
CP2	7	AI/O	Flying capacitor 2 positive terminal	
CN2	8	AI/O	Flying capacitor 2 negative terminal	
CP1	9	AI/O	Flying capacitor 1 positive terminal	
CN1	10	AI/O	Flying capacitor 1 negative terminal	
VIN	11	P	Power supply	
GND	12	G	Supply ground	
EXP_PAD	-	G	Exposed pad connected to GND	1

G = Ground, P = Power, D = Digital, A = Analog, I = Input, O = Output, NC = Not Connected
Note 1: On PCB the NC pin and the exposed pad are recommended to be connected to GND

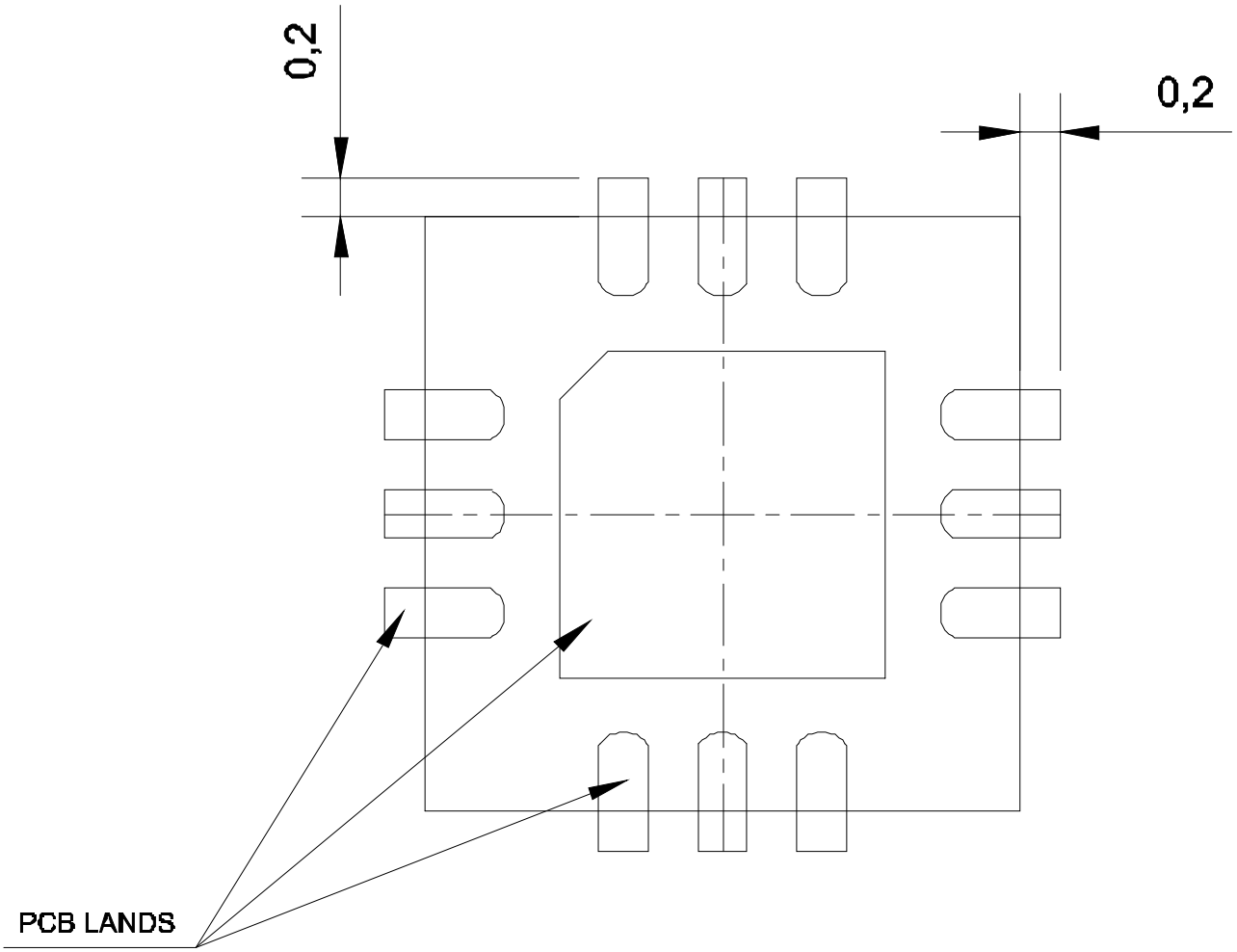
PACKAGE (QFN-12 3X3x0.75) OUTLINE



Symbol	Min	Nom	Max	Unit
PACKAGE DIMENSIONS				
A	0.70	0.75	0.80	mm
A1	---	0.02	0.05	mm
b	0.20	0.25	0.30	mm
b2	0.15	0.20	0.25	mm
c	0.18	0.20	0.25	mm
D	2.90	3.00	3.10	mm
D2 (Exposed.pad)	1.55	1.65	1.75	mm
e	0.50 BSC			mm
Ne	1.00 BSC			mm
Nd	1.00 BSC			mm
E	2.90	3.00	3.10	mm
E2 (Exposed.pad)	1.55	1.65	1.75	mm
L	0.35	0.40	0.45	mm
h	0.20	0.25	0.30	mm

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

QFN-12 3X3x0.75 PCB LAND PATTERN



Notes

- I/O lands should be 0.2mm longer than QFN pads and extend the same 0.2mm outside package outline
- exposed pad land size should be the same as QFN exposed pad size
- solder resist opening should be 120µm…150µm larger than the land size resulting in 60µm…75µm clearance between copper land and solder resist

ORDERING INFORMATION

Product Code	Product	Package	Comments
MAS6241CA1Q1306	Piezo Driver	QFN-12 3x3x0.75, Pb free, RoHS compliant	Tape and Reel 3000 pcs / r
MAS6241CA1WAD00	Piezo Driver	Tested inked 8” wafer, thickness 370 µm	
MAS6241CA1WAD05	Piezo Driver	Bare die in tray, thickness 370 µm	

Contact Micro Analog Systems Oy for other wafer thickness options.

LOCAL DISTRIBUTOR

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