

# MAS6251

## Piezo and LED Driver with Synchronous Boost DC/DC Converter

- Both Single Ended and Differential Output
- Up to 35Vpp Output from min 1.2V Supply
- Self-Drive for 3-Terminal Piezo
- LED Driver
- High Efficiency
- External Schottky Diode Not Needed
- Small 0806 Size 2.2μH Inductor

### DESCRIPTION

MAS6251 is a piezo and LED driver device that can drive piezo outputs up to 35Vpp and sink up to 15mA LED current using wide range of supply voltage 1.2V...5.5V. An internal high efficiency DC/DC boost converter with adjustable output voltage generates up to 17.5V supply voltage for the piezo driver. Internal over voltage protection (OVP) allows also operating without external feedback resistors and when connecting FB feedback pin to GND. This configuration reduces external part count further and provides highest output voltage 17.5V typically.

MAS6251 uses synchronous type boost DC/DC converter which makes external Schottky diode unnecessary. Thus MAS6251 is a low part count and low-cost solution for a high sound pressure piezo driver.

Two piezo driver outputs (VOB, VOS) allow driving piezo in both single-ended and differential bridge-tied

load (BTL) configurations. MAS6251 supports self-drive of a 3-terminal piezo.

The piezo driver is activated by setting DIN pin to logic high (DIN>0.9V). When disabled (logic low DIN<0.4V) the piezo driver outputs (VOB, VOS) are pulled actively to ground (GND).

MAS6251 has ILED pin for sinking up to 15mA current from series connected LEDs. The current sink is enabled by setting CTRL pin to logic high (CTRL>0.9V) which can be also controlled by PWM signal in LED dimming purposes. The DC/DC converter is turned on if either one of DIN or CTRL is at logic high (>0.9V).

The boost DC/DC converter and piezo driver disable signal (shutdown mode) will be generated while the signal at DIN and CTRL has been at low mostly for 15ms.

MAS6251 is available in a small 3x3x0.75 mm QFN-16 package.

### FEATURES

- Thin 3x3x0.75 mm QFN-16 package
- Wide Supply Voltage Range 1.2V...5.5V
- Both Single Ended and Differential Output
- Self-Drive for 3-Terminal Piezo
- Up to 15mA LED Driver
- External Schottky Diode Not Needed
- Small 0806 Size 2.2μH Inductor
- Low External Part Count
- Over Voltage Protection (OVP)

### APPLICATIONS

- Piezo Buzzers
- Smoke Alarms
- White Goods
- Alarm Clocks
- Handheld GPS devices
- Portable Devices with Sound Feature

## ABSOLUTE MAXIMUM RATINGS

All voltages with respect to ground.

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	VIN		-0.3	6	V
High Voltage Pins	VOUT, VOB, VOS, SW, ILED		-0.3	20	V
	FEED		-20	30	V
Voltage Range for Input Pins	DIN, CTRL		-0.3	6	V
	FB, RLED		-0.3	3	V
VOB, VOS Piezo Buffer Output Short-Circuit Duration	t <sub>SC</sub>	VOB=VOS=GND <b>Note 1</b>		Continuous	
Storage Temperature		<b>Note 2</b>	-40	+125	°C
Junction Temperature			-40	+150	°C
ESD Rating	V <sub>HBM</sub>	Human Body Model (HBM) All pins except RLED pin RLED pin <b>Note 3</b>		±1000 ±500	V
	V <sub>CDM</sub>	Charged Device Model (CDM) <b>Note 4</b>		±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:** The VOUT pin is not allowed to be shorted to ground.

**Note 2:** On chip EEPROM memory storing factory trimming values has data retention of minimum 10 years at +125°C.

**Note 3:** JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.

**Note 4:** 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 Supply Voltage	$V_{IN}$	<b>Note 1</b>	1.2	3.0	5.5	V
Steady State Operating Output Voltage	$V_{OUT}$	<b>Note 2</b>	$V_{IN}+1V$			V
Operating Ambient Temperature	$T_A$	<b>Note 3</b>	-40	+27	+85	°C
Operating Junction Temperature	$T_J$	<b>Note 4</b>	-40		+125	°C
Inductor Specification	L	Shielded inductor <b>Note 5</b>	1.5	2.2	3	$\mu H$
	$I_{RATED}$	$L=2.2\mu H$	500	600		mA
	$R_{DC}$	$L=2.2\mu H$		0.18	0.5	$\Omega$
Peak Inductor Current	$I_{L\_PEAK}$	$V_{IN}=3.0V$ , $V_{OUT}=15V$ , $L=2.2\mu H$			480	mA
Piezo Resonance Frequency	$F_{PIEZO}$			3.8	10	kHz
LED PWM Dimming Signal	$F_{CTRL}$	CTRL signal frequency	150		3000	Hz
	$t_{ON\_CTRL}$	CTRL signal ON-time	30			$\mu s$

**Note 1:** Achieving minimum operating supply voltage 1.2V requires a low loss inductor. See note 5 for two low loss inductor examples. When driving LEDs or resistive load the minimum supply voltage can be higher than specified here. See figures 20-22 for output current drive capability at LED and resistive loading.

**Note 2:** For stable start-up and good output regulation the steady state output voltage ( $V_{OUT}$ ) should meet following condition;  $V_{OUT} \geq V_{IN} + 1V$ . When driving one or two LEDs the output voltage may not satisfy this requirement but depending on input voltage. In this case there can be added resistor in series with LED(s) to rise output voltage above the minimum requirement.

**Note 3:** Ambient temperature plus self-heating should not exceed +125°C in extended periods of time to not degrade EEPROM memory data retention time. Additionally user has to note that the on chip thermal shutdown feature can turn off the device at minimum +140°C rising temperature point.

**Note 4:** On chip EEPROM memory storing factory trimming values has data retention of minimum 10 years at +125°C.

**Note 5:** For small PCB footprint a 2x1.6x0.7mm (0806) size 2.2 $\mu H$  inductor is available from Murata (LQM2MPN2R2MEH#). For high efficiency a 3x3x1.2mm size 2.2 $\mu H$  inductor is available from Taiyo Yuden (NR3012T2R2M).

## ELECTRICAL CHARACTERISTICS

$T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , typical values at  $T_A = 27^{\circ}\text{C}$ ,  $V_{IN} = 3.0\text{ V}$ ,  $L = 2.2\text{ }\mu\text{H}$ ,  $C_{IN} = 10\text{ }\mu\text{F}$ ,  $C_{OUT} = 100\text{ nF}$ ,  $C_{LOAD} = 15\text{ nF}$ ,  $f_{PIEZO} = 3.8\text{ kHz}$ ; unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Thermal Shutdown Temperature	$T_{TSD}$	Rising temperature (device off) Falling temperature (device on) <b>Note 1</b>	+140 +125	+150 +135	+160 +145	$^{\circ}\text{C}$
Undervoltage-Lockout Threshold Levels	$UVLO_{RISE}$ $UVLO_{FALL}$	Turn on level at VDD rising Turn off level at VDD falling	1.10 1.05	1.15 1.10	1.20 1.15	V
Over Voltage Protection Voltage	VOVP	VOUT without feedback resistors	17	17.5	18	V
Output Voltage at Current Load	VOUT	$V_{IN}=3\text{V}$ , $V_{OUT}=15\text{V}$ ( $R_2/R_1=36.5$ ) $I_{LOAD}=15\text{mA}$ ( $R_{LOAD}=1\text{k}\Omega$ )		15		V
Output Voltage at Capacitive Load	VOB, VOS	$V_{IN}=3\text{V}$ , $V_{OUT}=10\text{V}$ ( $R_2/R_1=24$ ) VOS: $C_{LOAD}=15\text{nF}$ VOB-VOS: $C_{LOAD}=15\text{nF}$ VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$ VOB-VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$		10 20 10 20		Vpp
		$V_{IN}=1.2\text{V}$ , $V_{OUT}=10\text{V}$ ( $R_2/R_1=24$ ) VOB: $C_{LOAD}=15\text{nF}$ VOB-VOS: $C_{LOAD}=15\text{nF}$ VOB: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$ VOB-VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$		9.8 19.6 9.5 19		Vpp
Feedback Voltage	VFB		0.38	0.4	0.42	V
LED Current Resistor Voltage	VRLED		0.19	0.2	0.21	V
Shutdown Current	$I_{SD}$	CTRL=DIN=LOW, $V_{OUT}=17.5\text{V}$ (no external feedback resistors). <b>Note 2</b>		0.11	2	$\mu\text{A}$
Quiescent Current	$I_Q$	CTRL=LOW, DIN=HIGH, no load $V_{OUT}=15\text{V}$ ( $R_2/R_1=36.5$ ). <b>Note 3</b> $V_{IN}=3.0\text{V}$ , $V_{IN}=4.2\text{V}$		400 140		$\mu\text{A}$
Current Consumption at Shorted Piezo Driver Outputs	$I_{SC\_VIN}$	$V_{IN}=3.0\text{V}$ , VOP=VON=GND		176		mA
Current Consumption	$I_{IN}$	$V_{IN}=3\text{V}$ , $V_{OUT}=10\text{V}$ ( $R_2/R_1=24$ ) VOS: $C_{LOAD}=15\text{nF}$ VOB-VOS: $C_{LOAD}=15\text{nF}$ VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$ VOB-VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$		3.3 6.7 12.7 23.4		mA
		$V_{IN}=1.2\text{V}$ , $V_{OUT}=10\text{V}$ ( $R_2/R_1=24$ ) VOB: $C_{LOAD}=15\text{nF}$ VOB-VOS: $C_{LOAD}=15\text{nF}$ VOB: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$ VOB-VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$		12.7 23.4 43 90		mA
		LED loading $I_{LED}=10\text{mA}$ ( $R_{LED}=20\Omega$ ) $V_{IN}=3\text{V}$ , $V_{OUT}=6.4\text{V}$ (two 3V LEDs) $V_{IN}=3\text{V}$ , $V_{OUT}=9.4\text{V}$ (three 3V LEDs) $V_{IN}=3\text{V}$ , $V_{OUT}=12.4\text{V}$ (four 3V LEDs)		31 46 66		mA
		LED loading $V_{IN}=3\text{V}$ , $V_{OUT}=6.4\text{V}$ (two 3V LEDs) $I_{LED}=10\text{mA}$ . <b>Note 4</b>		71		%

**Note 1:** Tested at room temperature. Min and max limits guaranteed by design.

**Note 2:** DIN has been low at least 15 ms. This shutdown current value is valid for case when no external feedback resistors are connected. When using external VOUT adjusting feedback resistors ( $R_1$ ,  $R_2$ ) the shutdown current will increase by amount of  $I_{EXT\_FB} = V_{IN}/(R_1+R_2)$  since VOUT follows VIN voltage when the device is in shutdown. To keep the shutdown current low the external feedback resistance ( $R_1+R_2$ ) should be kept above  $10\text{M}\Omega$  level.

**Note 3:** Current consumption when boost converter is active but outputs are not loaded

**Note 4:**  $3\times 3\times 1.2\text{mm}$  size  $2.2\text{ }\mu\text{H}$  inductor from Taiyo Yuden (NR3012T2R2M)

## ELECTRICAL CHARACTERISTICS

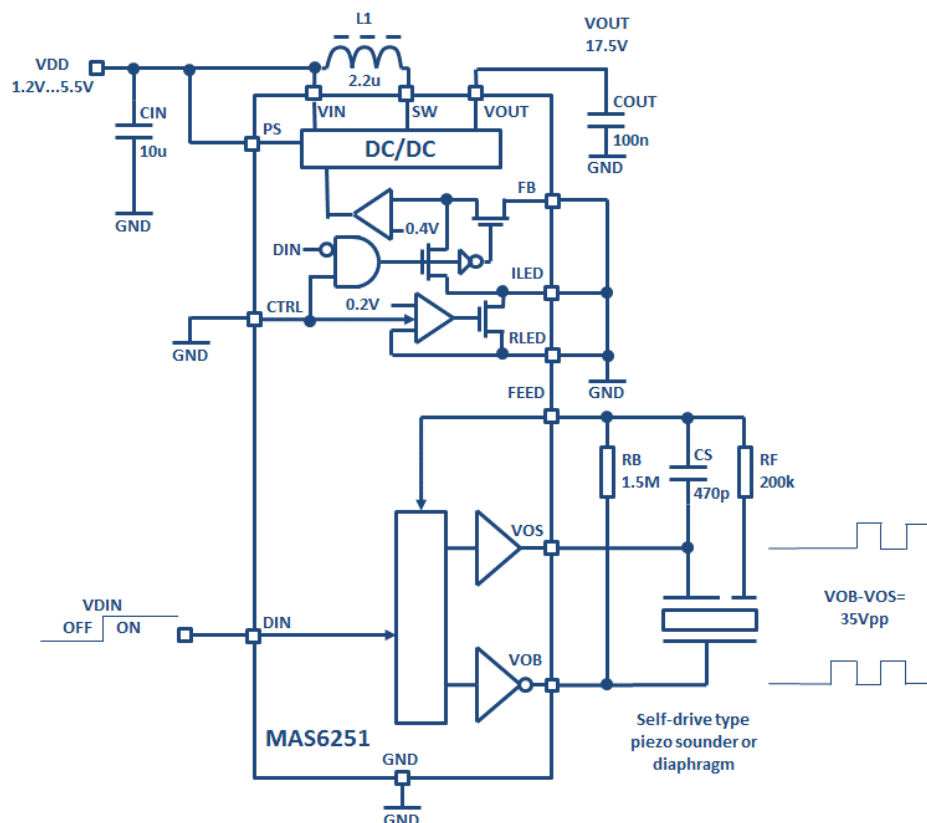
$T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , typical values at  $T_A = 27^{\circ}\text{C}$ ,  $V_{IN} = 3.0\text{ V}$ ,  $L = 2.2\text{ }\mu\text{H}$ ,  $C_{IN} = 10\text{ }\mu\text{F}$ ,  $C_{OUT} = 100\text{ nF}$ ,  $C_{LOAD} = 15\text{ nF}$ ,  $f_{PIEZO} = 3.8\text{ kHz}$ ; unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Boost DC/DC Converter Switch ON-Resistance	$R_{DS(ON)_LS}$	Low side switch $V_{IN}=3\text{V}$ , $V_{OUT}=15\text{V}$ , $T_A = 27^{\circ}\text{C}$		0.55	1.0	$\Omega$
	$R_{DS(ON)_HS}$	High side switch $V_{IN}=3\text{V}$ , $V_{OUT}=15\text{V}$ , $T_A = 27^{\circ}\text{C}$		1.1	2.5	
DC/DC Converter Startup-Up Time	$t_{START-UP}$	$V_{OUT}=10\text{V}$ ( $R2/R1=24$ ) $V_{IN}=3.0\text{V}$ $V_{IN}=1.2\text{V}$		200 340		$\mu\text{s}$
Output Rise/Fall Time	$t_{SLEW}$	$V_{IN}=3\text{V}$ , $V_{OUT}=10\text{V}$ ( $R2/R1=24$ ) VOB: $C_{LOAD}=15\text{nF}$ VOB-VOS: $C_{LOAD}=15\text{nF}$ VOB: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$ VOB-VOS: $C_{LOAD}=75\text{nF}$ , $C_{OUT}=470\text{nF}$		10 20 50 100		$\mu\text{s}$
Shutdown Delay	$t_{OFF}$	Time before device off mode after both DIN and CTRL have gone to LOW	7	10	15	ms
Control Input Threshold	$V_{IH}$	DIN and CTRL pins. <b>Note 1</b>	0.9			V
	$V_{IL}$	DIN and CTRL pins			0.4	V
Control Input Current	$I_{IH}$	DIN, CTRL = 3V DIN, CTRL = 0.4V. <b>Note 2</b>		0.01 1	1	$\mu\text{A}$
	$I_{IL}$	DIN, CTRL = 0V		0.01	1	$\mu\text{A}$

**Note 1:** Control inputs can be driven even from low supply voltage controller due to low 0.9V  $V_{IH}$  min threshold.

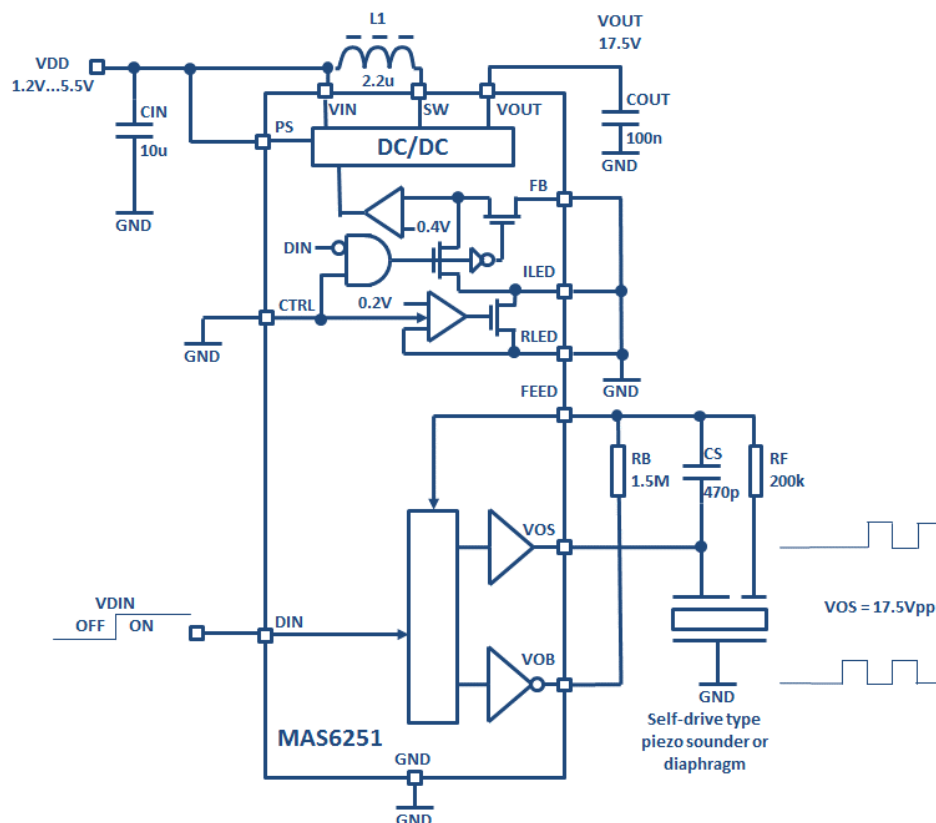
**Note 2:** DIN and CTRL pins have active pull-down by 400k $\Omega$  which disabled to save current when inputs are pulled high.

## BLOCK AND APPLICATION DIAGRAMS

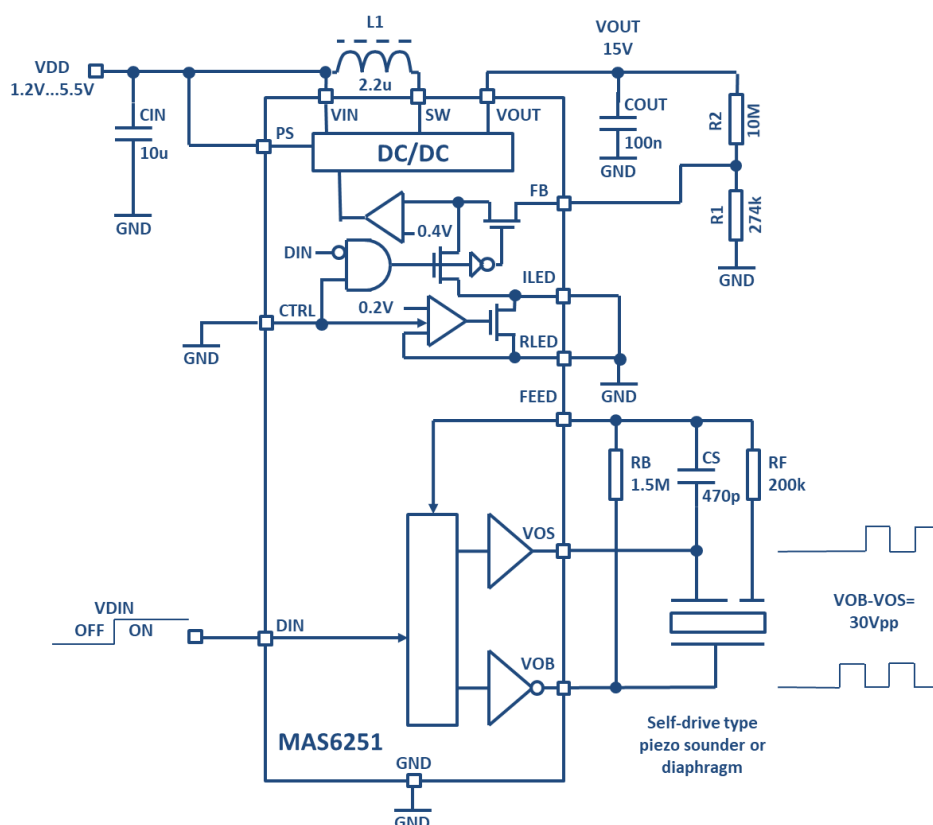


**Figure 1.** 35Vpp piezo drive in differential configuration by DIN control

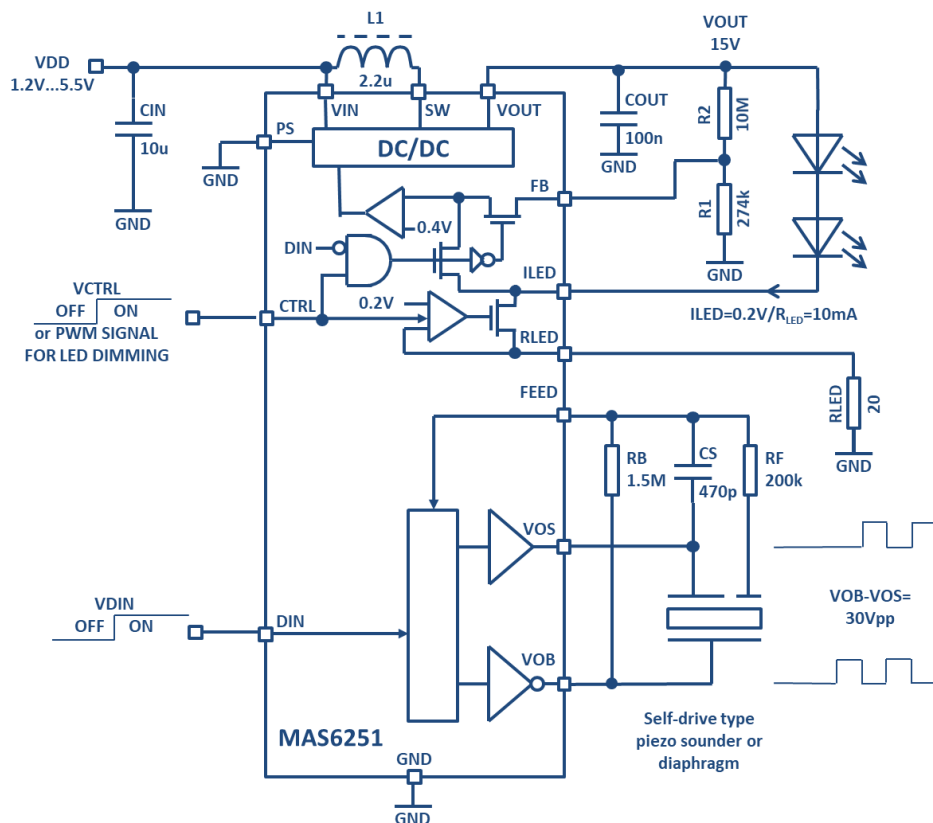
In figure 1 there is utilized output over voltage protection (OVP) feature of MAS6251 which limits the output voltage to 17.5V when the feedback resistors are left out which also reduces external part count.



**Figure 2.** 17.5Vpp piezo drive in single-ended configuration by DIN control

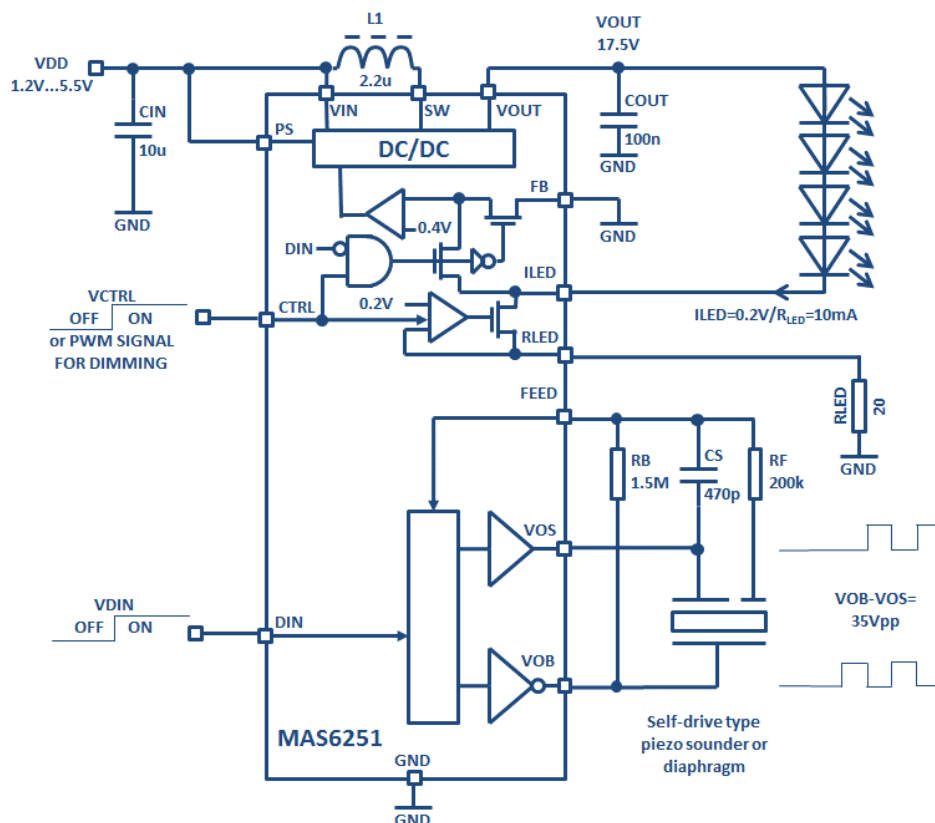


**Figure 3.** 30Vpp piezo drive in differential configuration by DIN control

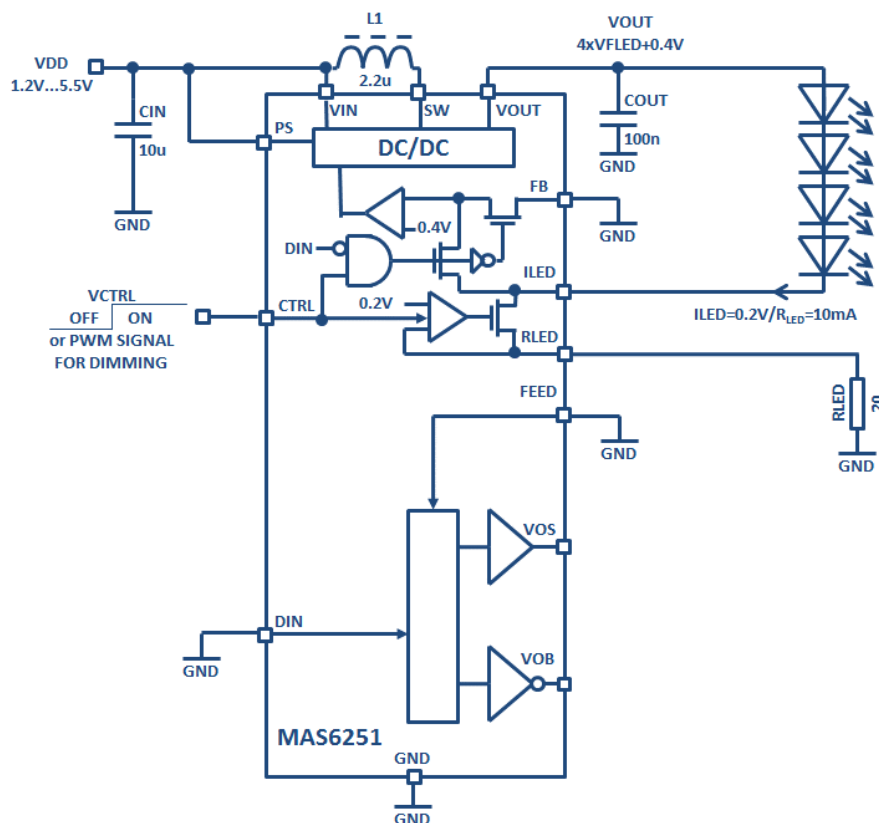


**Figure 4.** 30Vpp piezo drive in differential configuration and two series 10mA LEDs by DIN and CTRL controls

Normally the PS pin is connected to VIN. In case the VOUT voltage is below 7V the PS pin should be connected GND for best efficiency. For example when driving only one or two 3V LEDs the PS pin should be connected to GND. See figure 4.

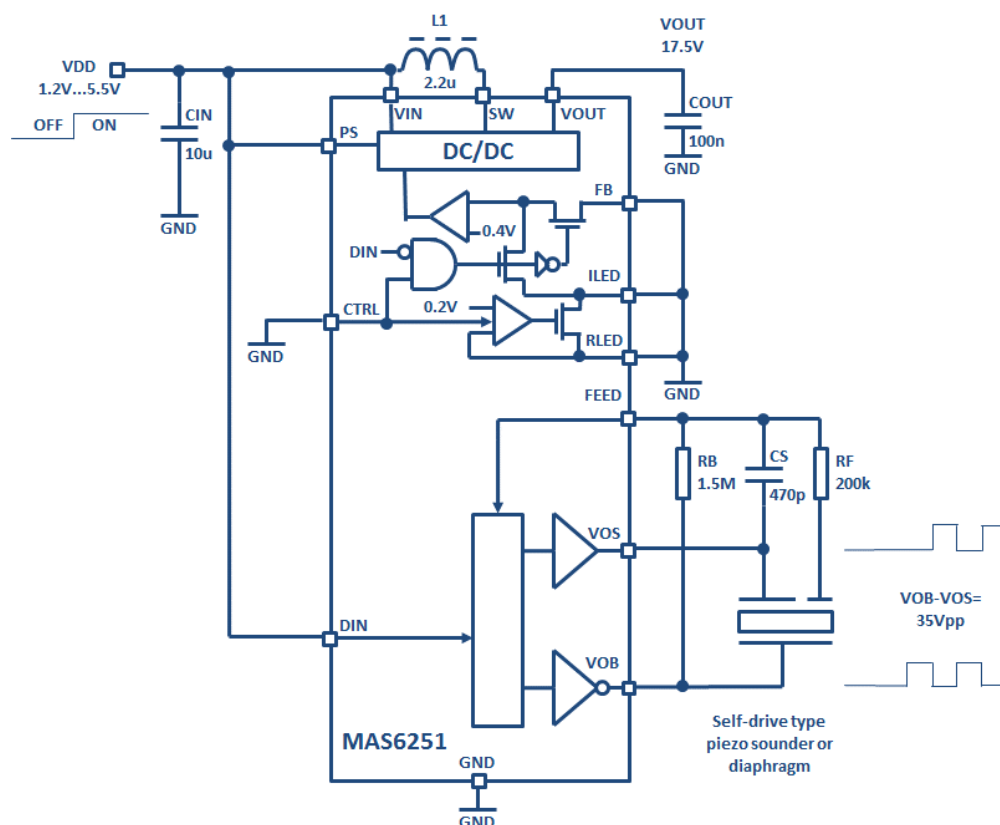


**Figure 5.** 35Vpp piezo drive in differential configuration and four series 10mA LEDs by DIN and CTRL controls

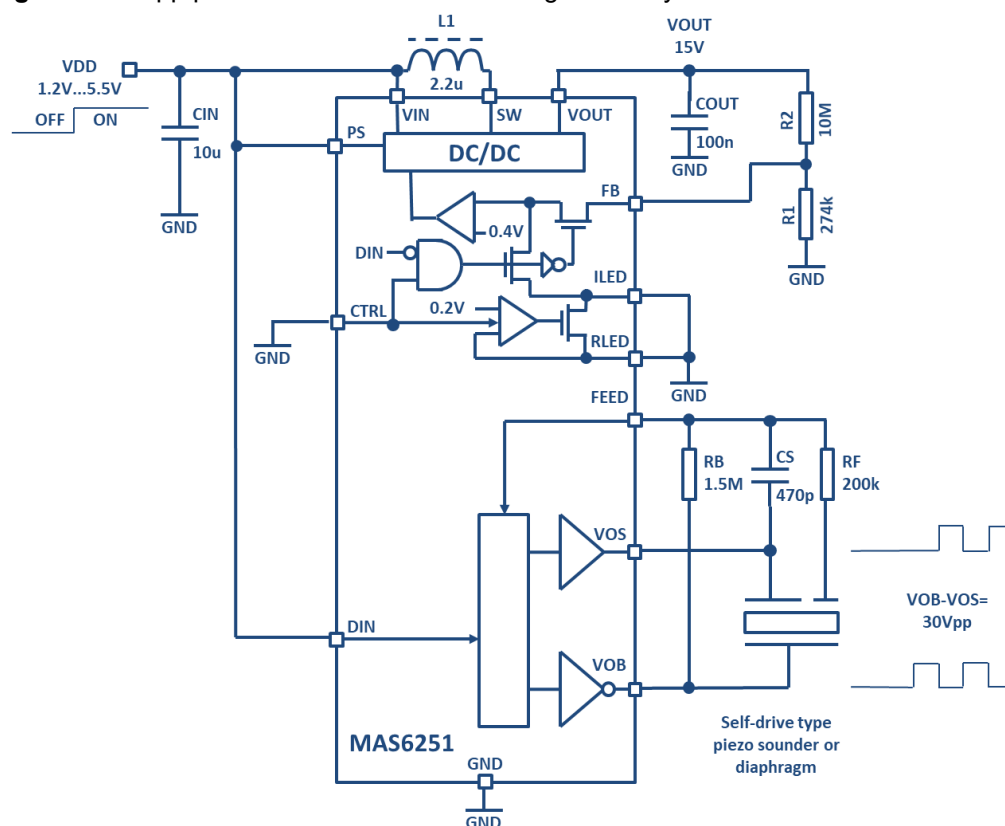


**Figure 6.** MAS6251 circuit for driving only series connected LEDs by CTRL control





**Figure 7.** 35Vpp piezo drive in differential configuration by VDD on/off control



**Figure 8.** 30Vpp piezo drive in differential configuration by VDD on/off control

## DETAILED DESCRIPTION

MAS6251 operating modes are controlled by DIN and CTRL pins as follows.

**Table 1.** Operating modes

CONTROL INPUTS		OPERATING MODES					
DIN	CTRL	DC/DC	OSC	PIEZO	LED	FB FET	MODE
LOW 1)	LOW 1)	OFF	OFF	OFF 2)	OFF	OFF	SHUTDOWN
LOW 1)	HIGH	ON	OFF	OFF 2)	ON	ON 3)	LED
HIGH	LOW 1)	ON	OFF	ON	OFF	OFF	PIEZO
HIGH	HIGH	ON	OFF	ON	ON	OFF	PIEZO+LED

Note 1: For DIN and CTRL "LOW" means being low at least max 15ms

Note 2: Piezo "OFF" is disable mode in which both piezo outputs are pulled to ground (VOB=VOS=GND)

Note 3: Feedback switch between FB and ILED is activated when only LED is driven

Both DIN and CTRL pins have internal pull-down by 400kΩ which is disabled to save current when the inputs are pulled high. When selecting DIN=CTRL=GND the device is in shutdown mode and consumes only very small leakage current.

### Capacitor and resistor values

The external CIN and COUT capacitors must be low loss (low ESR) ceramic capacitors. Recommended capacitor and resistor values are shown in the table 2.

**Table 2.** Recommended capacitor and resistor values

Capacitor	Nominal value
CIN	10μF
COUT	100nF
CS	470pF
RB	1.5M
RF	200k

Note: the voltage ripple at VOUT output is approximately proportional to ratio of piezo load capacitance ( $C_{LOAD}$ ) and boost DC/DC converter output capacitor (COUT). Thus 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.

In piezo driving mode (DIN=HIGH or switching) the boost DC/DC converter output voltage can be controlled by external voltage division resistors R1 and R2. See figures 3-4 and 8. The output voltage is regulated to level which sets the FB feedback pin voltage to 0.4V typically. Table 3 shows example resistors values for different output voltages. Note that the feedback resistors are not always necessary since when not connected the output voltage will be regulated to over voltage protection (OVP) voltage 17.5V typically. See figures 1-2 and 5-7. When driving only LEDs (CTRL=HIGH or PWM signal, DIN=LOW) the maximum output voltage (VOUT) is limited to OVP voltage regardless of the FB pin connection.

**Table 3.** Feedback resistor (R1, R2) and DC/DC boost output voltage (VOUT) examples

R1 [kΩ]	R2 [MΩ]	VOUT [V]
200	4.3	9
150	3.6	10
162	4.7	12
274	10	15
-	-	17.5

Note:  $VOUT = VFB \cdot (1 + R2/R1)$ ,  $VFB = 0.4V$

Note that use of external VOUT adjusting feedback resistors increases shutdown current by amount of  $I_{EXT\_FB} = V_{IN}/(R1+R2)$  since VOUT follows VIN voltage when the device is in shutdown. To keep the shutdown current low the external feedback resistance (R1+R2) path should be kept near 10M $\Omega$  level. For good feedback regulation the max R1 should not exceed 400k $\Omega$ .

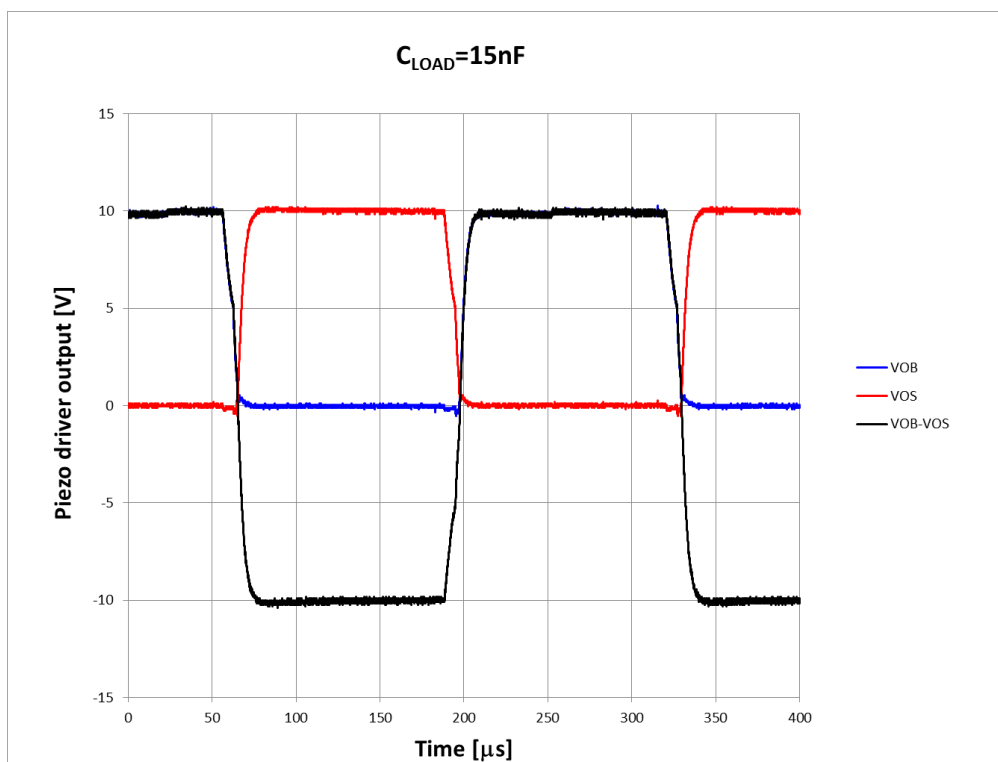
When driving LEDs they are connected in series from VOUT to ILED which is the current sink pin. Additionally LED current setting resistor RLED needs to be connected from RLED pin to GND. See figures 4-6. The table 4 shows example RLED resistor values and corresponding LED current levels. Additionally PWM signal can be applied to the CTRL pin for LED dimming to reduce average LED current from level defined with the RLED resistor.

**Table 4.** LED current setting resistor examples

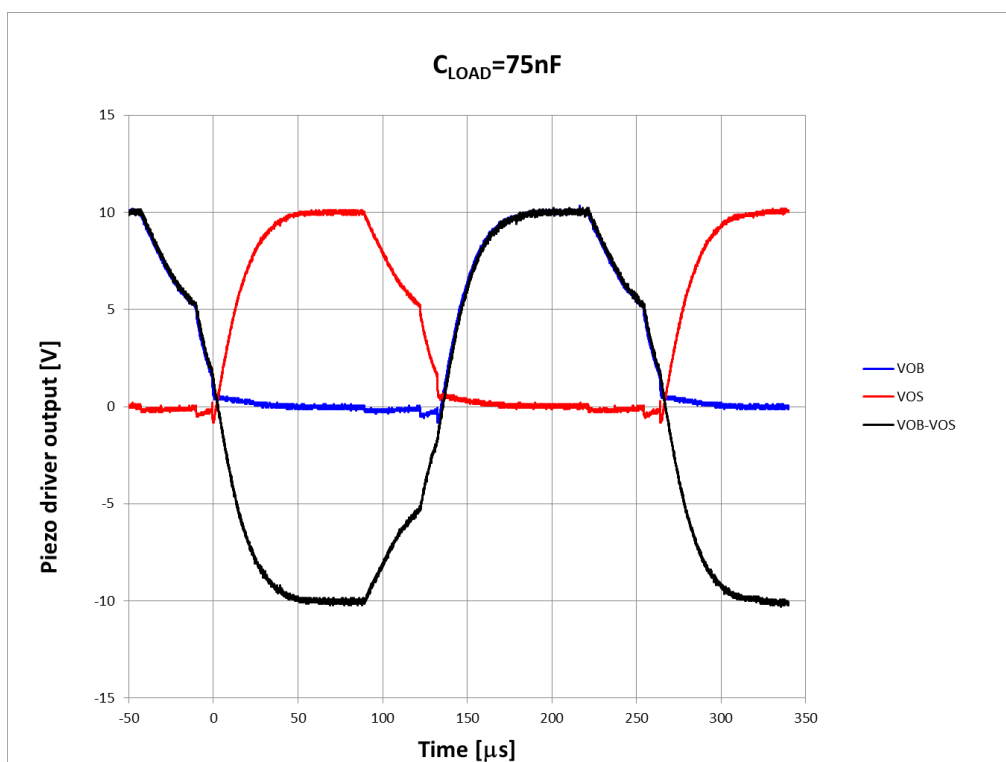
RLED [ $\Omega$ ]	ILED [mA]
40.2	5.0
20	10.0
13.3	15.0

**Note:**  $I_{LED} = V_{RLED}/R_{LED}$ ,  $V_{RLED} = 0.2V$  typ

## TYPICAL CHARACTERISTICS

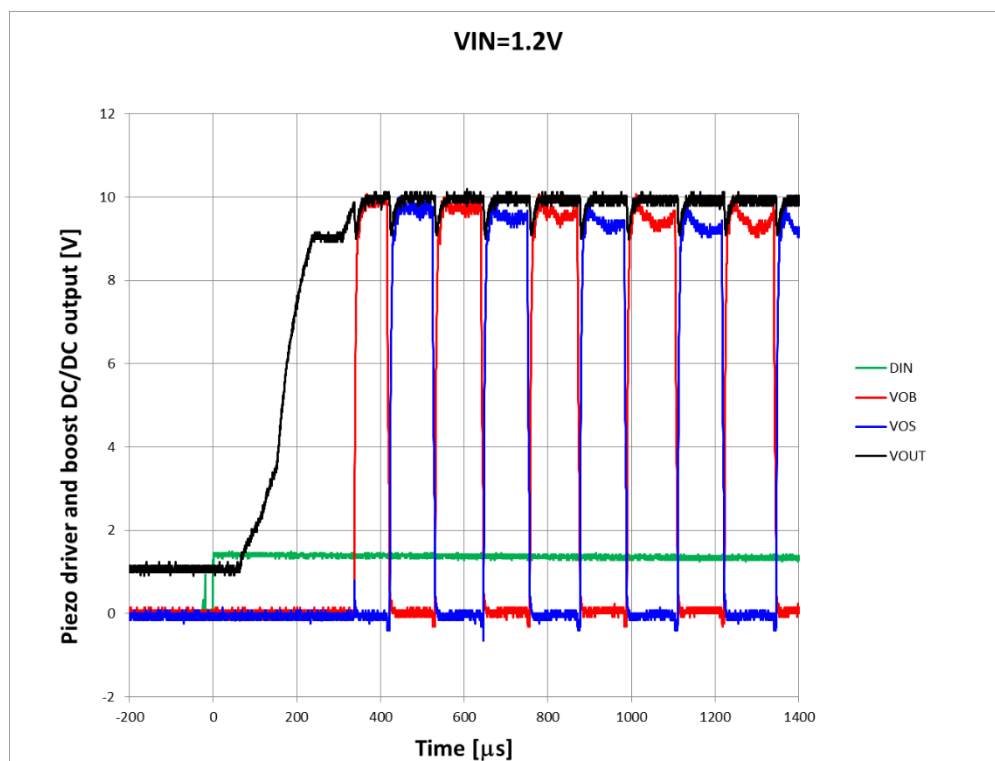


**Figure 9.** Piezo driver outputs at  $V_{IN}=3V$ ,  $V_{OUT}=10V$ ,  $F_{PIEZO}=3.8kHz$ ,  $C_{LOAD}=15nF$ ,  $C_{OUT}=100nF$

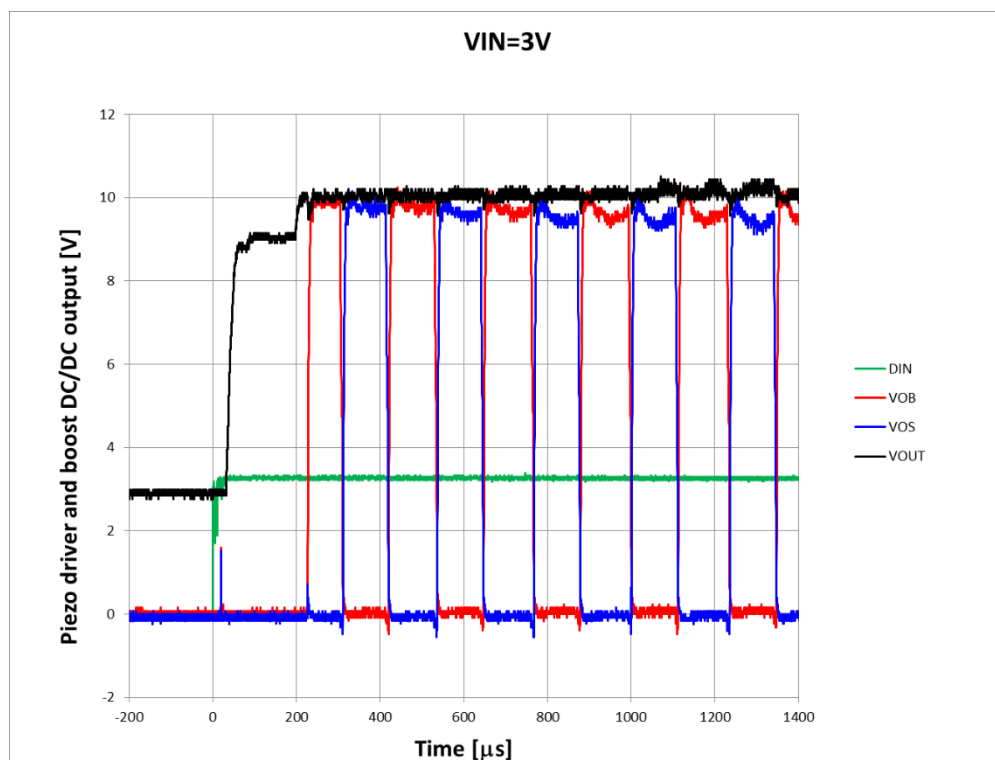


**Figure 10.** Piezo driver outputs at  $V_{IN}=3V$ ,  $V_{OUT}=10V$ ,  $F_{PIEZO}=3.8kHz$ ,  $C_{LOAD}=75nF$ ,  $C_{OUT}=470nF$

## TYPICAL CHARACTERISTICS (continued)

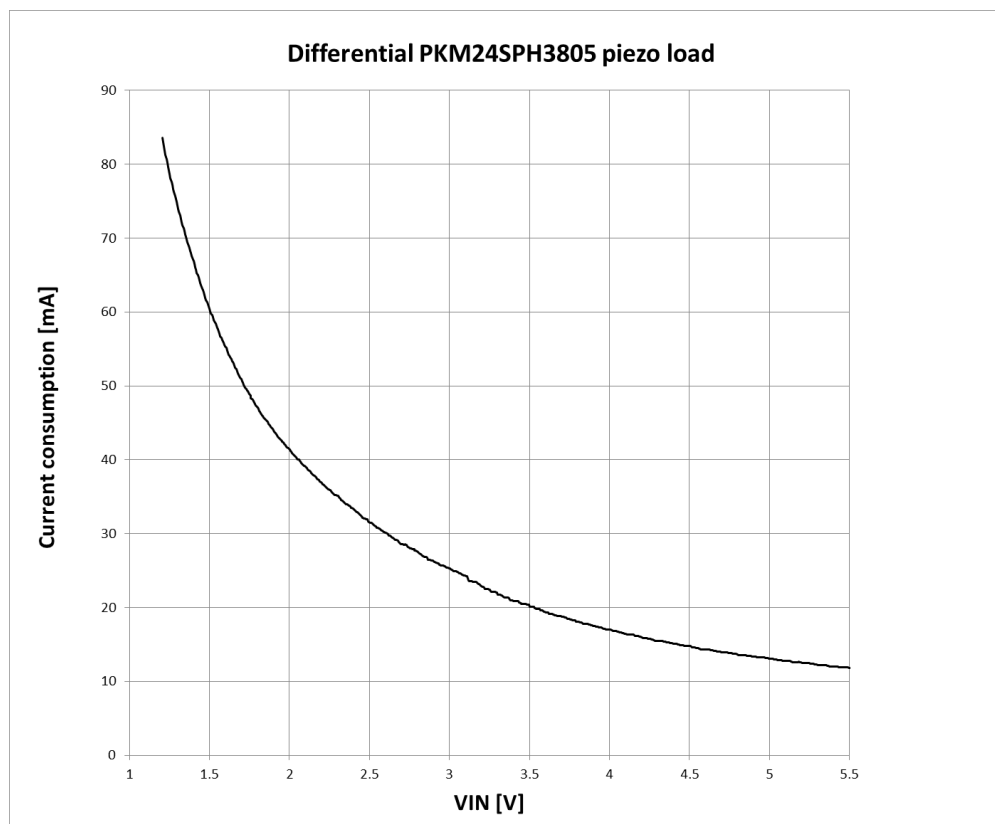


**Figure 11.** Piezo driver and boost DC/DC output start-up VIN=1.2V, VOUT=10V,  $F_{PIEZO}=3.8\text{kHz}$



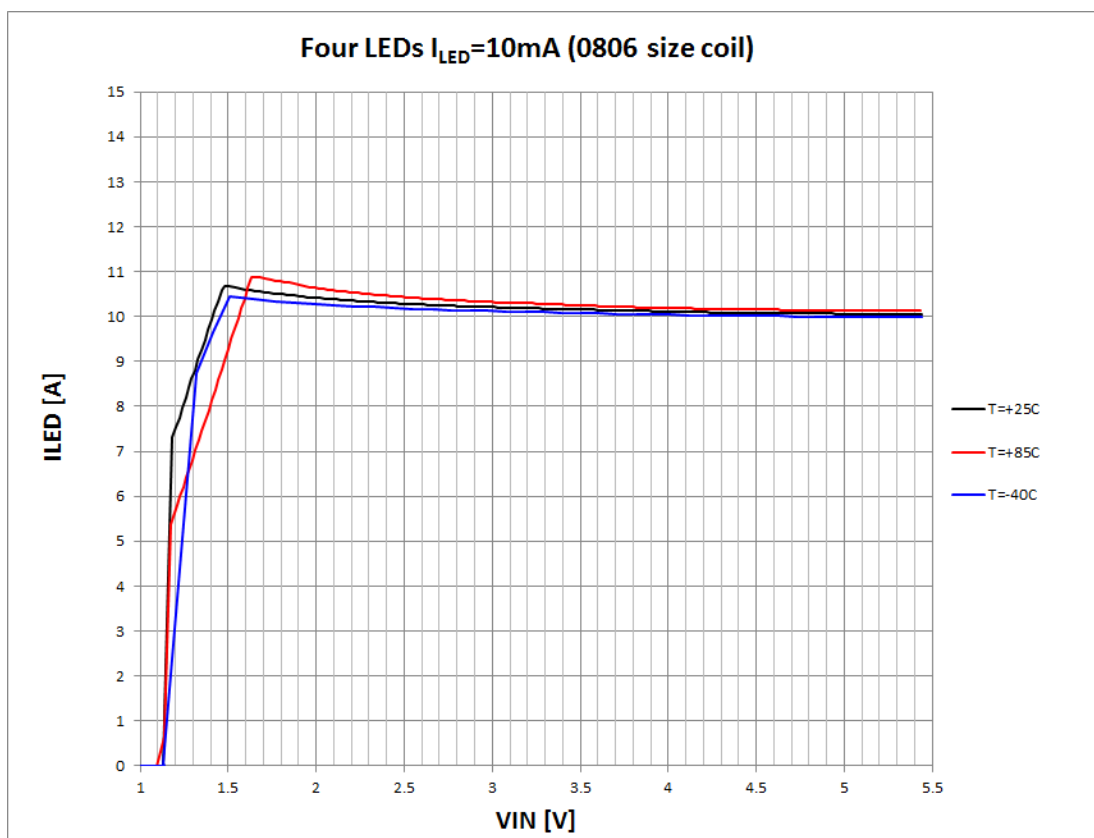
**Figure 12.** Piezo driver and boost DC/DC output start-up VIN=3V, VOUT=10V,  $F_{PIEZO}=3.8\text{kHz}$

## TYPICAL CHARACTERISTICS (continued)

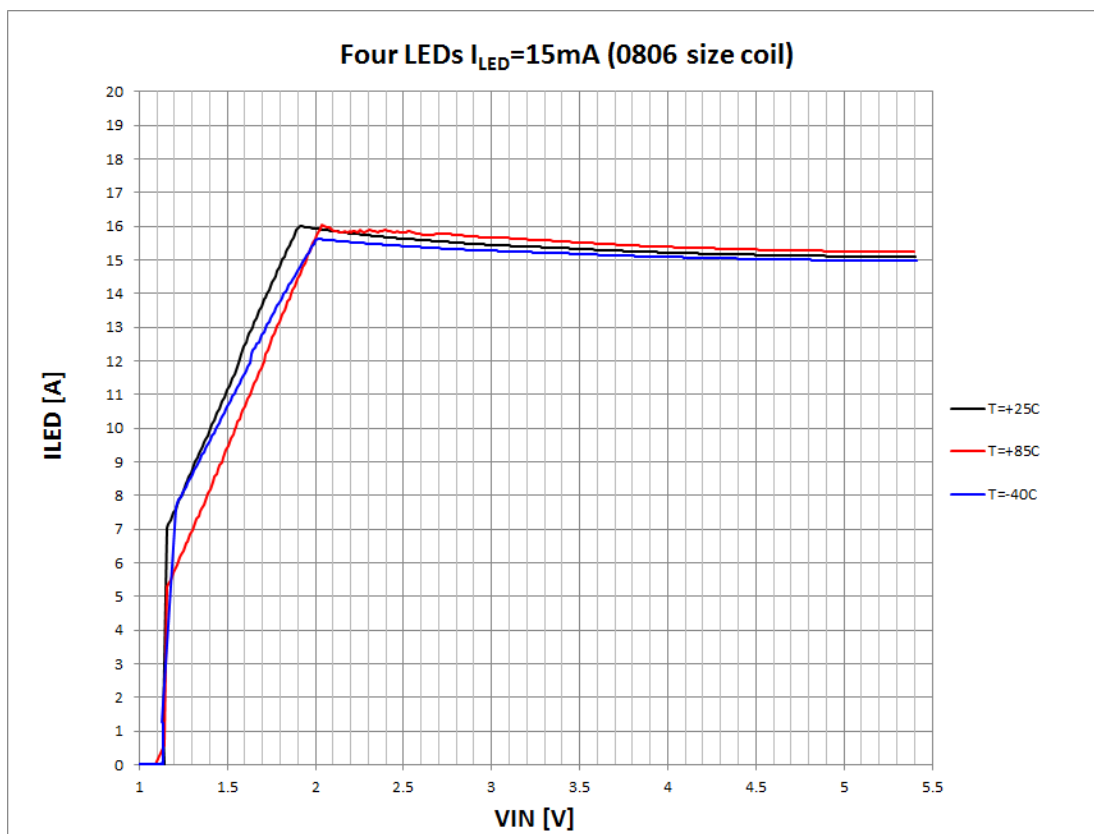


**Figure 13.** Current consumption at differential PKM24SPH3805 (Murata) piezo loading;  $V_{OUT}=10V$ ,  $F_{PIEZO}=3.8kHz$

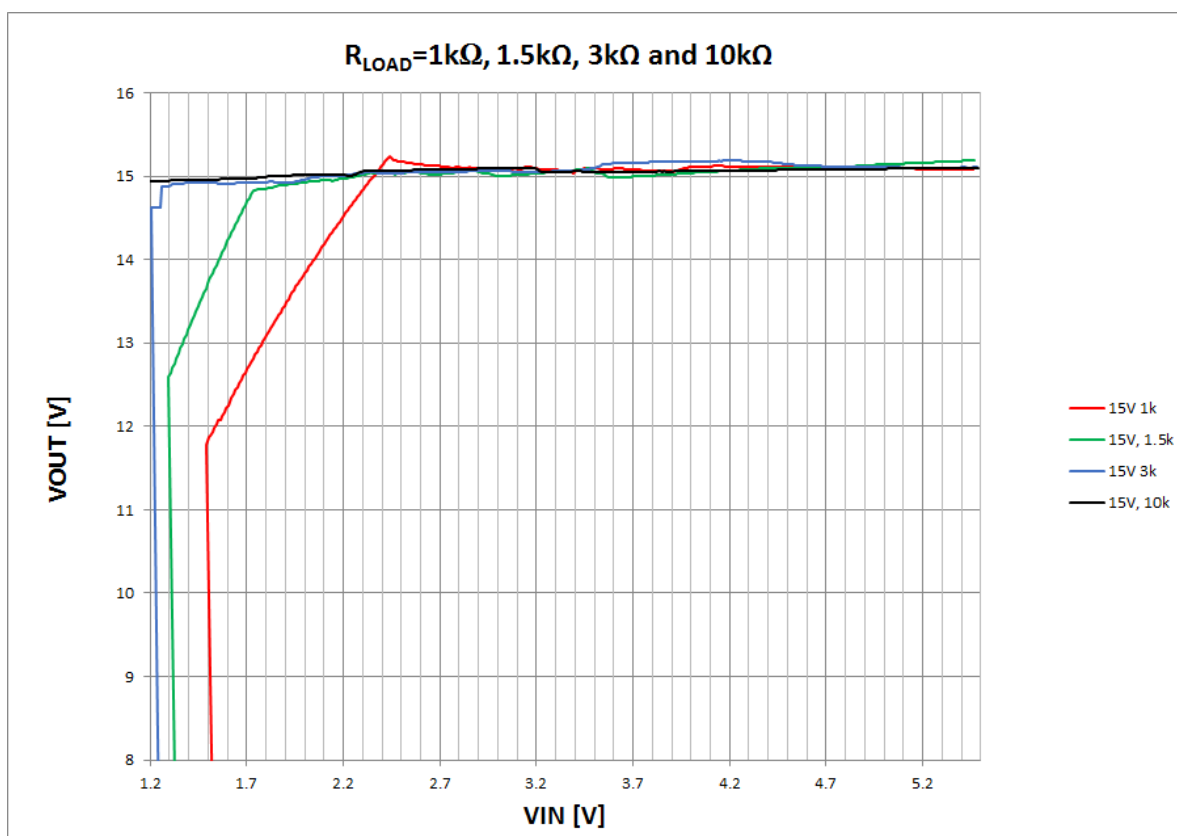
## TYPICAL CHARACTERISTICS (continued)



**Figure 14.** LED current drive capability over  $V_{IN}$ ; four LEDs ( $V_{OUT}=11.7\text{V}$ ),  $I_{LED}=10\text{mA}$



**Figure 15.** LED current drive capability over  $V_{IN}$ ; four LEDs ( $V_{OUT}=12.4\text{V}$ ),  $I_{LED}=15\text{mA}$



**Figure 16.** DC/DC converter output drive capability for a resistive loading at  $V_{OUT}=15V$  ( $R_2/R_1=36.5$ ) regulation

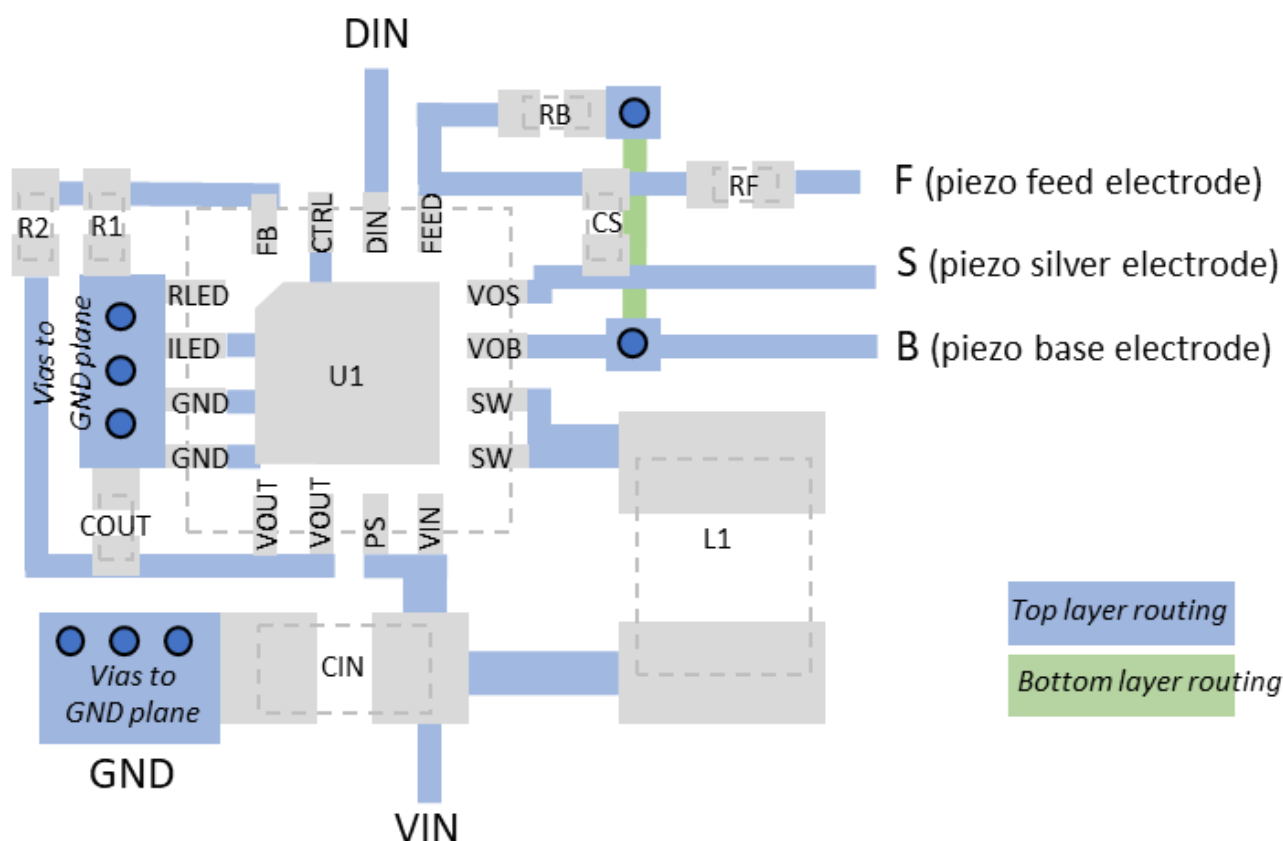
The figure 22 shows minimum supply ( $V_{IN}$ ) and maximum output ( $V_{OUT}$ ) voltage operating ranges at different resistive loading as follows.

$R_{LOAD}=1k\Omega$ :  $V_{IN\ MIN}=2.4V$  @  $V_{OUT}=15V$  and  $V_{IN\ MIN}=1.5V$  @  $V_{OUT}=12V$   
 $R_{LOAD}=1.5k\Omega$ :  $V_{IN\ MIN}=1.8V$  @  $V_{OUT}=15V$  and  $V_{IN\ MIN}=1.3V$  @  $V_{OUT}=12.5V$   
 $R_{LOAD}=3k\Omega$ :  $V_{IN\ MIN}=1.3V$  @  $V_{OUT}=15V$  and  $V_{IN\ MIN}=1.2V$  @  $V_{OUT}=14.5V$   
 $R_{LOAD}=10k\Omega$ :  $V_{IN\ MIN}=1.2V$  @  $V_{OUT}=15V$



## PRINTED CIRCUIT BOARD (PCB) LAYOUT CONSIDERATIONS

In PCB layout design the input (CIN) and output (COUT) capacitors should be placed as close to the MAS6251 (U1) as possible and routed with low inductance connection to ground plane. See figure 17 below for a PCB layout example of figure 3 application circuit which includes output voltage adjustment resistors R1 and R2.

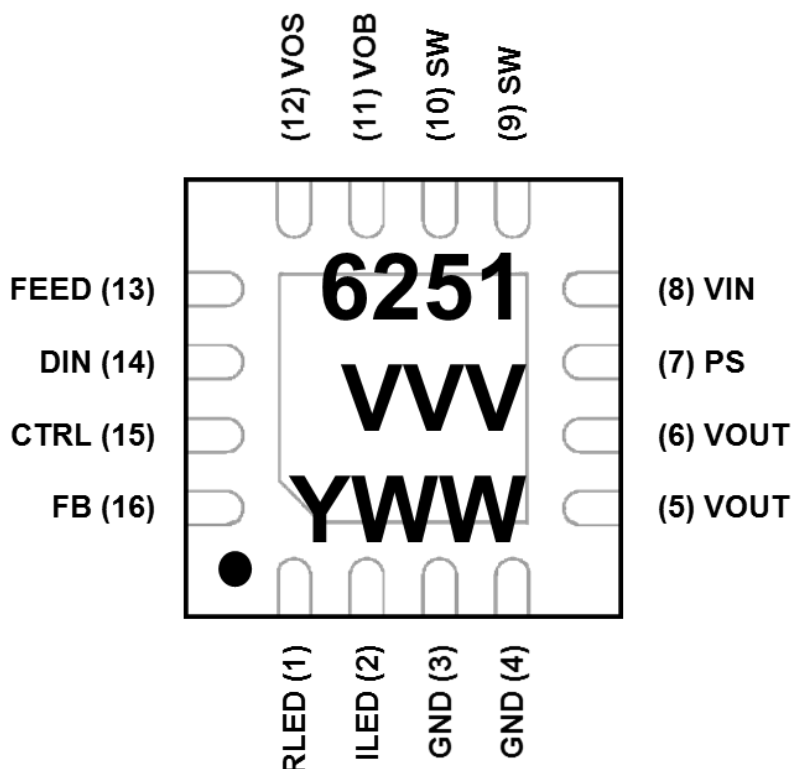


**Figure 17.** PCB layout example

**Table 6.** PCB layout example component details

Ref	Manuf. part	Value	Rating	Case inch (metric)	Dimensions (LxWxT)
U1	MAS6251AA1Q13	MAS6251		QFN-16 3x3	3.0x3.0x0.75 mm
L1	LQM2MPN2R2MEH	2.2 $\mu$ H	0.7A (Isat)	0806 (2016)	2.0x1.6x0.7 mm
CIN	GRM188R60J106KE47D	10 $\mu$ F	6.3V (X5R)	0603 (1608)	1.6x0.8x0.9 mm
COUT	C0603X5R1E104K030BB	100nF	25V (X5R)	0201 (0603)	0.6x0.3x0.3 mm
CS		470pF	25V (X5R)	0201 (0603)	0.6x0.3 mm
RB		33k $\Omega$		0201 (0603)	0.6x0.3 mm
RF		1.5M $\Omega$		0201 (0603)	0.6x0.3 mm
R1		274k $\Omega$		0201 (0603)	0.6x0.3 mm
R2		10M $\Omega$		0201 (0603)	0.6x0.3 mm

## DEVICE OUTLINE CONFIGURATION



Top Marking Information:  
6251 = Product Number  
VVV = Version Number  
YWW = Year Week

## QFN-16 3.0x3.0x0.75 PIN DESCRIPTION

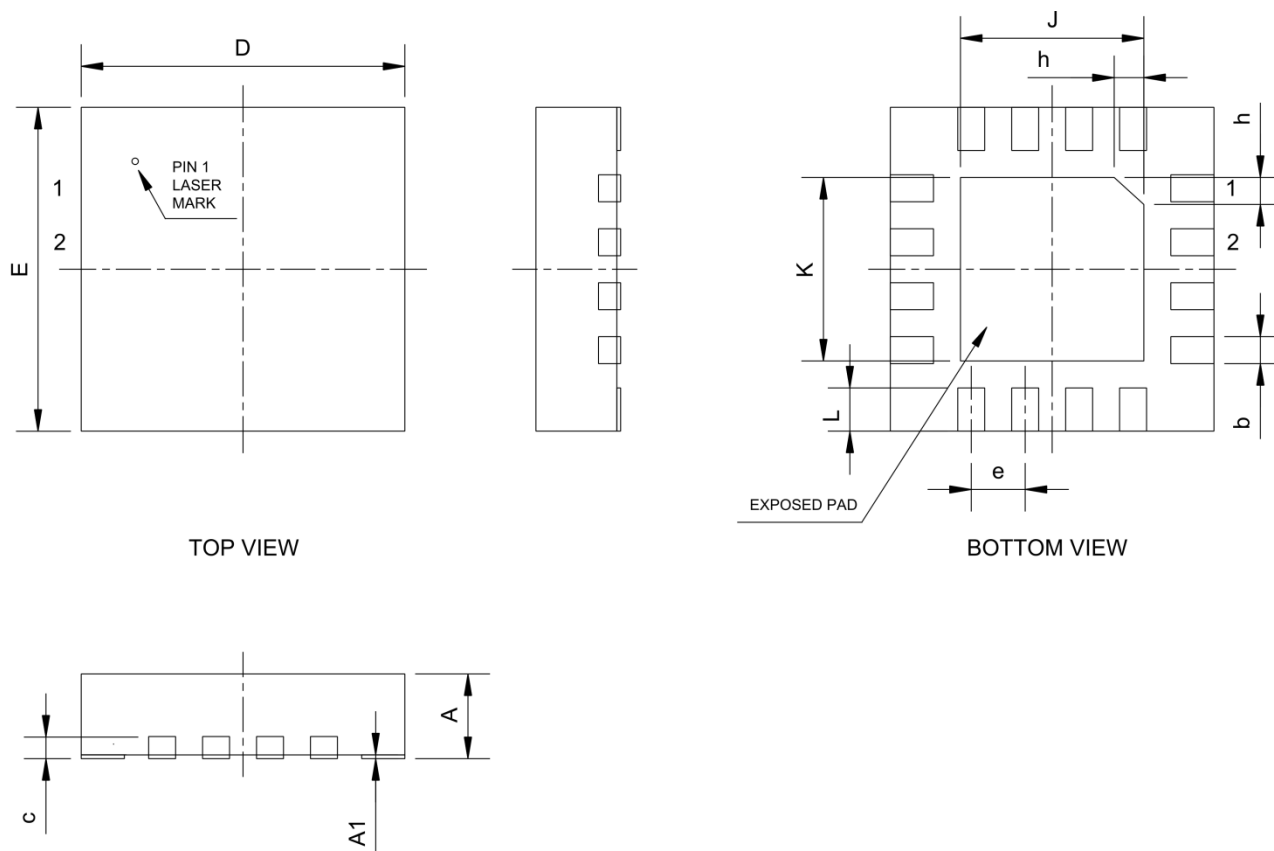
Pin Name	Pin	Type	Function	Note
RLED	1	AIO	LED current adjustment resistor	
ILED	2	AO	LED current sink	
GND	3-4	G	Supply ground	
VOUT	5-6	AO	Boost DC/DC converter voltage output	
PS	7	P	Power save pin	1
VIN	8	P	Positive supply voltage input	
SW	9-10	AO	Boost DC/DC converter switch	
VOB	11	AO	Piezo driver brass terminal output	
VOS	12	AO	Piezo driver silver terminal output	
FEED	13	AI	Piezo driver feedback terminal input	
DIN	14	DI	DC/DC and Piezo Drive ON (HIGH) / OFF (LOW) control	
CTRL	15	DI	LED current sink ON (HIGH) / OFF (LOW) control	
FB	16	AI	Boost DC/DC converter output voltage feedback input	
EXP_PAD	-	G	Exposed thermal pad connected to GND	2

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

Note 1: Normally the PS pin is connected to VIN. This offers reduced power consumption as part of electrical charge from piezo load is transferred back to input. In case the VOUT voltage is below 7V the PS pin should be connected GND for best efficiency. For example when driving only one or two 3V LEDs the PS pin should be connected to GND. See figure 4.

Note 2: On PCB the exposed thermal pad must be connected to GND plane using thermal vias functioning as thermal heat sink.

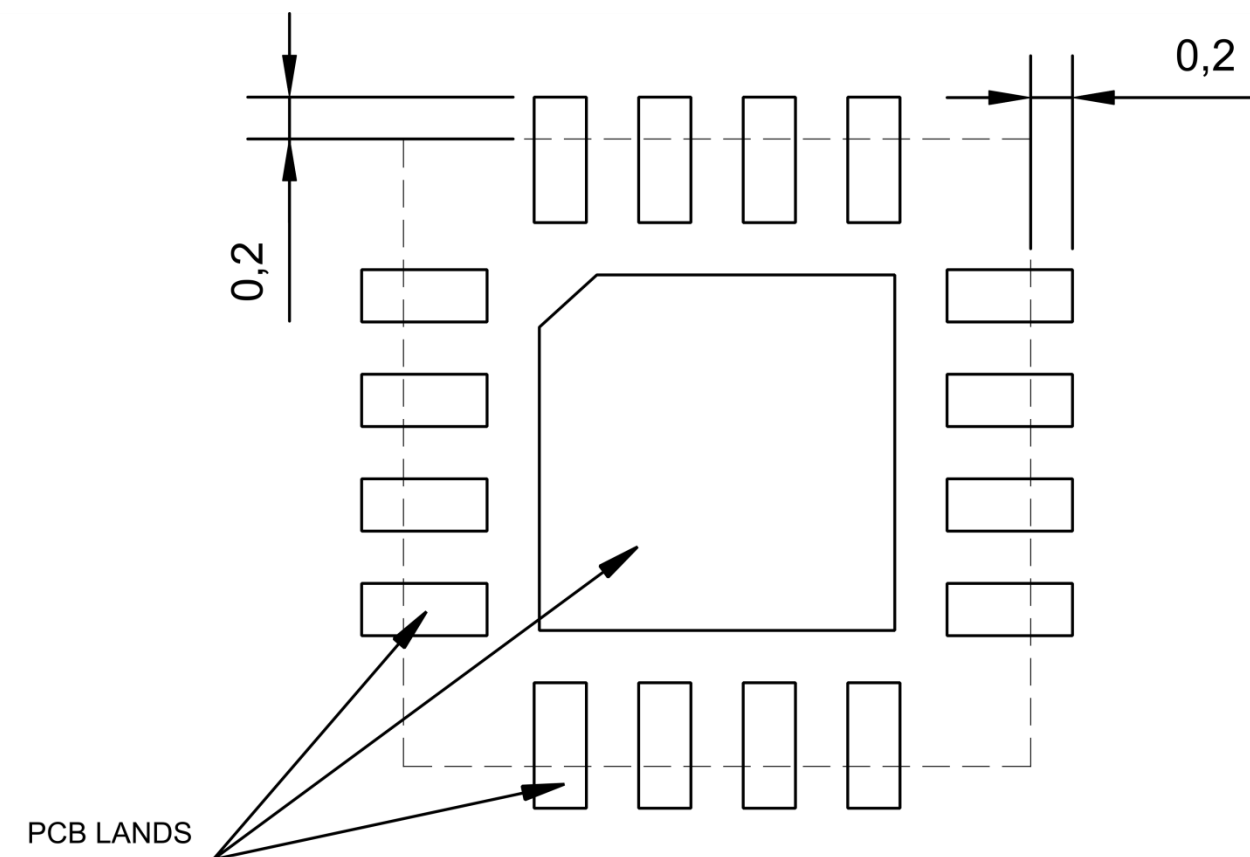
## PACKAGE (QFN-16 3X3x0.75) OUTLINE



Symbol	Min	Nom	Max	Unit
PACKAGE DIMENSIONS				
A	0.7	0.75	0.8	mm
A1	0	0.02	0.05	mm
b	0.18	0.24	0.3	mm
c	0.203 REF			mm
D	3 BSC			mm
E	3 BSC			mm
e	0.5 BSC			mm
J (Exposed.pad)	1.6	1.7	1.8	mm
K (Exposed.pad)	1.6	1.7	1.8	mm
L	0.30	0.4	0.5	mm
h	0.35	0.4	0.45	mm

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

## QFN-16 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
MAS6251AA1Q1306	Piezo and LED Driver with Synchronous Boost DC/DC Converter	QFN-16 3.0x3.0x0.75, Pb Free, RoHS Compliant	Tape and Reel 5000 pcs / r

Contact Micro Analog Systems Oy for bare die delivery options.

## LOCAL DISTRIBUTOR

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