RE46C317/18

Piezoelectric Horn Driver with Boost Converter

Features:

- 3V Operation
- Low Quiescent Current
- 10V Boost Converter
- Low Horn Driver On-Resistance
- Compatible with RE46C117

Applications:

- Smoke Detectors
- CO Detectors
- Personal Security Products
- Electronic Toys

Description:

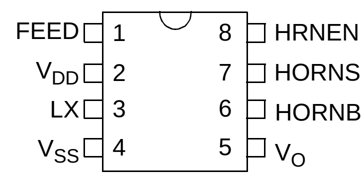
The RE46C317/18 are CMOS piezoelectric horn driver ICs with built-in boost converter. They are intended for use in 3V battery or battery-backed applications. The circuits feature a boost converter and a driver circuit suitable for driving a piezoelectric horn.

The RE46C317/18 are compatible with the RE46C117 device and offer lower standby current.

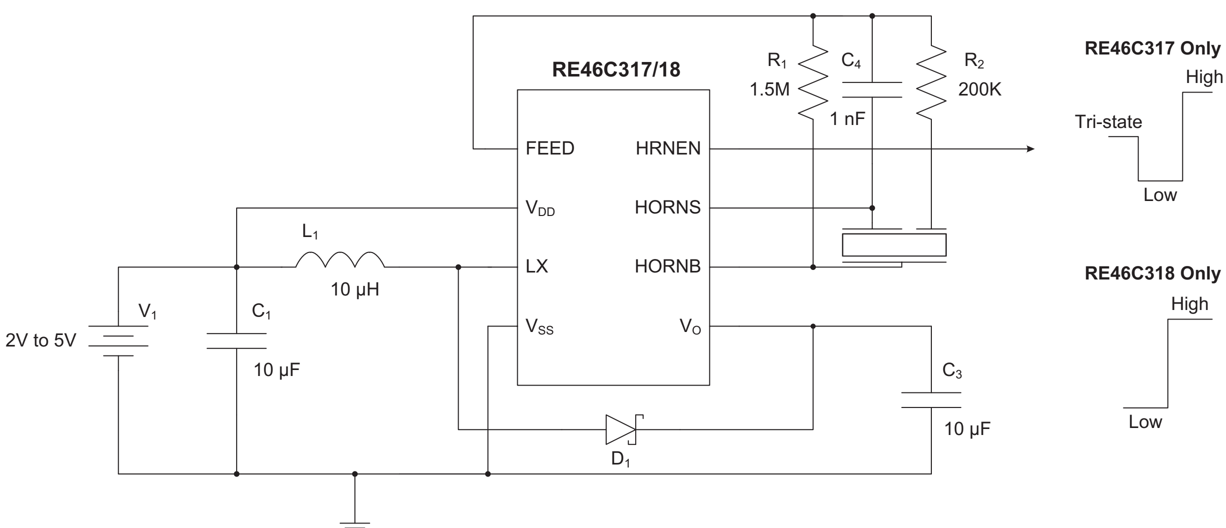
The RE46C317 has three valid states of Horn Enable (tri-state, low and high), while the RE46C318 has only two valid states, low and high.

Package Types

RE46C317/18
PDIP, SOIC



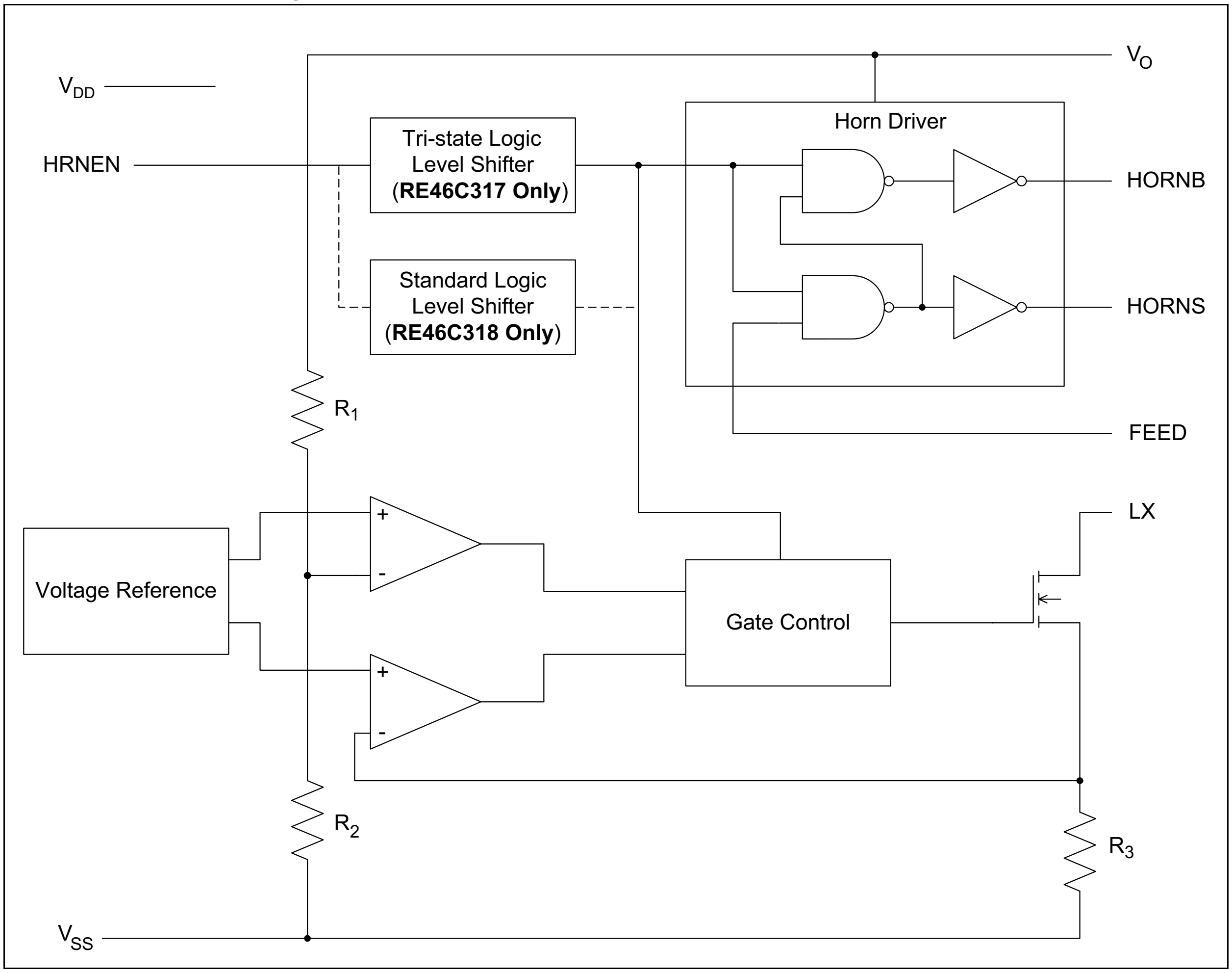
Typical Application



Note 1: Schottky diode D_1 must have the maximum peak current rating of at least 1A. For best results, the forward voltage spec should be less than 0.5V at 1A.

2: Inductor L_3 must have the maximum peak current rating of at least 1A. For best results, the DC resistance should be less than 0.5Ω.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

V_{DD} 5.5V
V_{OUT} 12.5V
Input Voltage Range Except FEED, LX .... $V_{IN} = V_{SS}$ – .3V to V_{DD} + .3V
FEED Input Voltage Range .... V_{INFD} = -10V to + 22V
LX Input Voltage .... $V_{INLX} = V_{OUT}$ + 0.8V
Input Current except FEED, LX .... I_{IN} = 10 mA
LX Current (Peak) .... I_{INLX} = 1.0A
Operating Temperature .... T_A = -10°C to +60°C
Storage Temperature .... T_{STG} = -55°C to +125°C
Continuous Operating Current (HORNS, HORNB, V_O) .... I_O = 40 mA
Maximum Human Body Model ESD 1500V

† **Notice:** Stresses above those listed under “Maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. This product utilizes CMOS technology with static protection; however proper ESD prevention procedures should be used when handling this product. Damage can occur when exposed to extremely high static electrical charge.

DC ELECTRICAL CHARACTERISTICS – RE46C317

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_3 = 10 µF. Typical values are at T_A = +25°C

Parameter	Symbol	Test Pin	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	2	2	—	5	V	Operating
Standby Supply Current	I_{DD1}	2	—	0.5	1	µA	HRNEN = Float; No loads
Standby I_{VO}	I_{VO1}	5	—	0	0.3	µA	HRNEN = Float; No loads
Quiescent Supply Current	I_{DD2}	2	—	27	49	µA	HRNEN = Low; No Loads; V_O = 11V; V_{LX} = 0.5V
Quiescent I_{VO}	I_{VO2}	5	—	71	115	µA	HRNEN = Low; No Loads; V_O = 11V; V_{LX} = 0.5V
Supply current	I_{SUP}	2	—	300	—	µA	HRNEN = Low; No Loads, Boost Running
Input Current for Tri-state	I_{IT}	8	-5	—	5	µA	HRNEN = Float (**Note 4**)
Input Voltage High	V_{IHH}	8	2.6	—	—	V	HRNEN input
	V_{IHF}	1	7	—	—	V	FEED input; V_O = 10V

Note 1: The boost converter in Boost mode (normal V_O = 10V) can draw current pulses of ~0.8A and therefore is very sensitive to series resistance. The critical components of this resistance are the inductor DC resistance, the internal resistance of the battery and the resistance in the connections from the inductor to the battery, from the inductor to the LX pin. In order to function properly under full load at V_{DD} = 2V, the total of the inductor and the interconnect resistances should not exceed 0.3Ω. The internal battery resistance should be no more than 0.5Ω. A low ESR capacitance of 10 µF or more should be connected in parallel with the battery to average current over the boost converter cycle.

2: In the above table, wherever a specific V_O value is listed under test conditions, the V_O is forced externally with the inductor disconnected, and the boost converter is not running.

3: The limits shown are 100% tested at +25°C only. Test limits are guard-banded, based on temperature characterization to ensure compliance at temperature extremes.

4: This is the maximum input current that will not cause a logic high or logic low to be asserted.

DC ELECTRICAL CHARACTERISTICS – RE46C317 (CONTINUED)

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_3 = 10 µF. Typical values are at T_A = +25°C

Parameter	Symbol	Test Pin	Min.	Typ.	Max.	Units	Conditions
Input Voltage Low	V_{ILH}	8	—	—	0.4	V	HRNEN input
	V_{ILF}	1	—	—	3	V	FEED input; V_O = 10V
Input Leakage	I_{IHF}	1	—	20	50	µA	FEED = 22V; V_O = 10V
	I_{ILF}	1	-50	-15	—	µA	FEED = -10V; V_O = 10V
	I_{IHH}	8	—	20	50	µA	HRNEN = V_{DD}
	I_{ILH}	8	-50	-20	—	µA	HRNEN = V_{SS}
Output Leakage	I_{OZH}	3	—	—	1	µA	HRNEN = Float; V_O = 12.5V; V_{LX} = 10V
V_O Output Voltage	V_{VO}	5	9	10	11	V	V_{DD} = 3V, HRNEN = Low or High, I_{OUT} = 10 mA
V_O Efficiency	V_{OEFF}	5	—	80	—	%	I_{LOAD} = 10 mA, V_{DD} = 3V, HRNEN = 0V
Output Low Voltage	V_{OL}	6, 7	—	0.3	0.5	V	HORNB or HORNS I_{OUT} = -16 mA, V_{DD} = 3V
Output High Voltage	V_{OH}	6, 7	9.5	9.7	—	V	HORNB or HORNS V_O =10V V_{DD} = HRNEN = 3V I_{OUT} = 16 mA

Note 1: The boost converter in Boost mode (normal V_O = 10V) can draw current pulses of ~0.8A and therefore is very sensitive to series resistance. The critical components of this resistance are the inductor DC resistance, the internal resistance of the battery and the resistance in the connections from the inductor to the battery, from the inductor to the LX pin. In order to function properly under full load at V_{DD} = 2V, the total of the inductor and the interconnect resistances should not exceed 0.3Ω. The internal battery resistance should be no more than 0.5Ω. A low ESR capacitance of 10 µF or more should be connected in parallel with the battery to average current over the boost converter cycle.

2: In the above table, wherever a specific V_O value is listed under test conditions, the V_O is forced externally with the inductor disconnected, and the boost converter is not running.

3: The limits shown are 100% tested at +25°C only. Test limits are guard-banded, based on temperature characterization to ensure compliance at temperature extremes.

4: This is the maximum input current that will not cause a logic high or logic low to be asserted.

DC ELECTRICAL CHARACTERISTICS - RE46C318

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_3 = 10 µF. Typical values are at T_A = +25°C.

Parameter	Symbol	Test Pin	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	2	2	—	5	V	Operating
Standby Supply Current	I_{DD1}	2	—	—	0.1	µA	HRNEN = Low; No loads
Input Voltage High	V_{IHH}	8	2.3	—	—	V	HRNEN input
	V_{IHF}	1	7	—	—	V	FEED input; V_O = 10V
Input Voltage Low	V_{ILH}	8	—	—	1	V	HRNEN input
	V_{ILF}	1	—	—	3	V	FEED input; V_O = 10V
Input Leakage	I_{IHF}	1	—	20	50	µA	FEED = 22V; V_O = 10V
	I_{ILF}	1	-50	-15	—	µA	FEED = -10V; V_O = 10V
	I_{IN}	8	-100	—	100	nA	HRNEN = V_{DD} or V_{SS}
Output Leakage	I_{OZH}	3	—	—	1	µA	HRNEN = V_{SS}, V_O = 12.5V, V_{LX} = 10V
V_O Output Voltage	V_{VO}	5	9	10	11	V	V_{DD} = 3V, HRNEN = High, I_{OUT} = 10 mA
V_O Efficiency	V_{VOEFF}	5	—	80	—	%	I_{LOAD} = 10 mA, V_{DD} = 3V, HRNEN = 0V
Output Low Voltage	V_{OL}	6, 7	—	0.3	0.5	V	HORNB or HORNS; I_{OUT} = -16 mA; V_{DD} = 3V
Output High Voltage	V_{OH}	6, 7	9.5	9.7	—	V	HORNB or HORNS; V_O = 10V; V_{DD} = HRNEN = 3V; I_{OUT} = 16 mA

AC ELECTRICAL CHARACTERISTICS

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_3 = 10 µF. Typical values are at T_A = +25°C.

Parameter	Symbol	Test Pin	Min.	Typ.	Max.	Units	Conditions
Horn Delay	T_{HRN}	8/6 or 8/7	—	—	1	ms	HRNEN = High; Boost Running; 16 mA Load

Note 1: Horn Delay is the delay between a high signal on HRNEN and the horn output turning ON. The internal circuitry delays the horn output until the Boost voltage reaches its set point, 10V nominally.

TEMPERATURE CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = 3V, V_{SS} = 0V

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature Range	T_A	-10	—	60	°C	
Storage Temperature Range	T_{STG}	-55	—	125	°C	
Thermal Package Resistances						
Thermal Resistance, 8L-PDIP	θ_{JA}	—	89.3	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	149.5	—	°C/W	

NOTES:

2.0 PIN DESCRIPTION

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

RE46C317/18 PDIP, SOIC	Symbol	Description
1	FEED	Horn Feedback
2	V_{DD}	Positive supply voltage
3	LX	External inductor
4	V_{SS}	Negative supply voltage
5	V_O	Output of Boost converter
6	HORNB	Horn Brass
7	HORNS	Horn Silver
8	HRNEN	Horn Enable

2.1 Horn Feedback Pin (FEED)

This pin is usually connected to the feedback electrode of the piezoelectric horn through a current limiting resistor. If not used, this pin must be connected to V_{SS}.

2.2 Positive Supply Pin (V_{DD})

This pin is connected to the positive supply voltage of the system.

2.3 External Inductor Pin (LX)

This is the open drain NMOS output used to drive the boost converter inductor. The inductor should be connected from this pin to the positive supply voltage through a low resistance path.

2.4 Negative Supply Pin (V_{SS})

This pin is connected to the negative supply voltage of the system.

2.5 Boost Converter Output Pin (V_O)

This is the output pin of the boost converter, typically 10V.

2.6 Horn Brass Pin (HORNB)

This pin is connected to the metal electrode (B) of the piezoelectric transducer.

2.7 Horn Silver Pin (HORNS)

This is the complementary output to HORNB. It connects to the ceramic electrode (S) of the piezoelectric transducer.

2.8 Horn Enable Pin (HRNEN)

This is the logic input for horn enable. Tables 2-2 and 2-3 show the different HRNEN states and their description.

TABLE 2-2: RE46C317 HORN ENABLE

State	Description
Tri-state	Standby mode; Boost converter is Disabled, Horn is Disabled
Low	Boost converter is Enabled, Horn is Disabled
High	Boost converter is Enabled, Horn is Enabled

TABLE 2-3: RE46C318 HORN ENABLE

State	Description
Low	Standby mode; Boost converter is Disabled, Horn is Disabled
High	Boost converter is Enabled, Horn is Enabled

NOTES:

3.0 DEVICE DESCRIPTION

RE46C317 and RE46C318 have three main blocks:

- Horn driver
- Boost regulator
- Horn Enable logic

The following sections describe these blocks.

3.1 Horn Driver

The horn driver is a push-pull circuit, capable of driving a three-terminal piezoelectric horn. It can also drive a modified two-terminal Piezo horn.

3.2 Horn Enable

In RE46C317, the HRNEN is a tri-state signal with three valid states: low, high and tri-state (or mid-supply). The three levels of HRNEN determine the modes of operation.

When HRNEN is in tri-state, the device is in Standby mode and all circuits are disabled. This is the lowest current operating mode.

When HRNEN is low, the device is in Boost-Only mode. In this mode, only the boost regulator is enabled and the output voltage is boosted to 10V nominally. The horn driver circuit is disabled in this mode. This mode can be used to check for a low battery condition.

When HRNEN is high, the part is in Normal Operation. The boost regulator and the horn driver circuits are enabled in this mode.

The RE46C318 uses a binary logic circuit, rather than tri-state logic, to determine the mode of operation.

When HRNEN is low, the boost and horn driver circuits are disabled and the device is in Standby. This is the lowest current operating mode.

When HRNEN is high, the boost and horn driver circuits are enabled.

3.3 Boost Regulator

The boost regulator in the RE46C317/18 is a current-mode controller with two control loops, that work together in maintaining a constant output voltage and supply the required load current. The inner current control loop provides cycle-by-cycle current limiting, while the outer control loop provides output voltage control. When the boost converter is turned on using the HRNEN input, the NMOS switch turns on and the inductor current ramps up to its peak value, approximately 0.6A nominally.

The current comparator turns off the NMOS switch for a fixed period of time to allow energy to be transferred to the output capacitor. When the voltage on the output capacitor equals or exceeds the desired output voltage, 10V nominally, the current loop is disabled until the load discharges the output capacitor to a voltage lower than the desired output voltage.

Every time the output voltage falls below the desired value, the switching cycle starts and continues until the desired value is reached. The constant switching resulting in the charging and discharging of the output capacitor causes a ripple on the output voltage. The ripple on the output voltage depends on the external component parameters, such as the value of external capacitor, its ESR, etc.

In both RE46C317 and RE46C318, when logic high is asserted on the HRNEN pin, the boost regulator is enabled. However, the horn output is not enabled until the output voltage reaches its nominal set point, 10V nominally. This ensures that the output voltage rises quickly to the necessary drive voltage for the Piezo horn.

The boost regulator has been optimized to work with the external components as shown in the Typical Application circuit.

[Figure 3-1](#) shows the horn turn-on delay after the HRNEN has been asserted high. After the boost voltage reaches its nominal set point, the HORNB output turns on. In this case, the HORNB output is driving a load current of 20 mA DC.

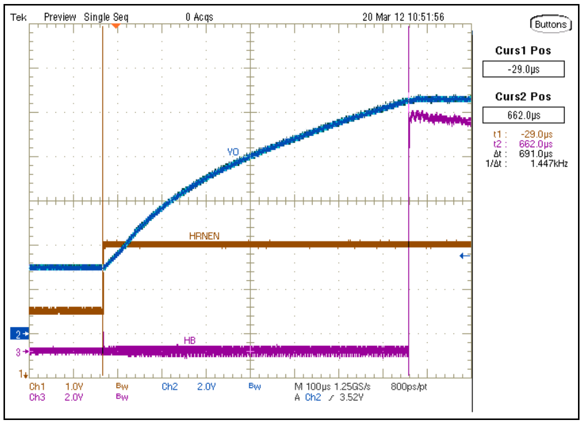


FIGURE 3-1: *RE46C317 Horn Turn-On Delay.*

[Figure 3-2](#) shows the typical switching waveforms of the boost regulator. The top waveform shows the boost output, the center waveform shows the LX switching waveform, and the lower waveform shows the inductor current.

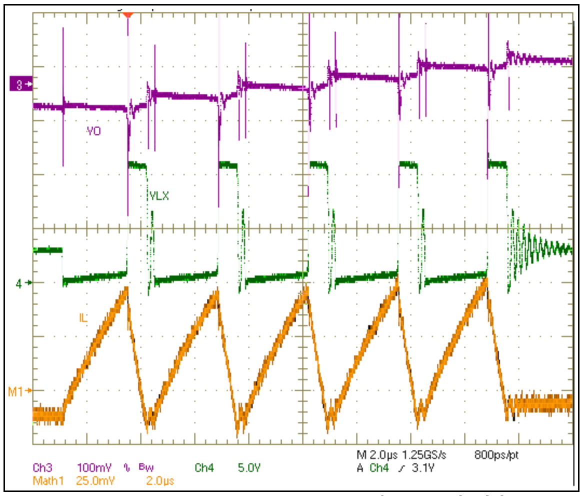
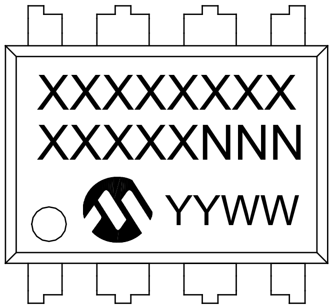


FIGURE 3-2: *RE46C317/18 Switching Waveforms.*

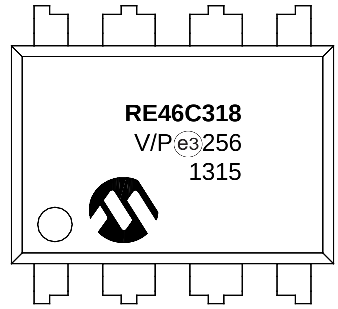
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

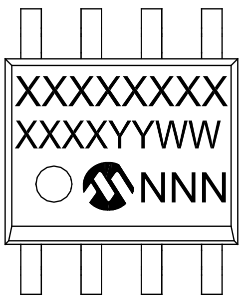
8-Lead PDIP (300 mil)



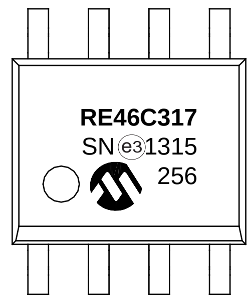
Example



8-Lead SOIC (3.90 mm)



Example

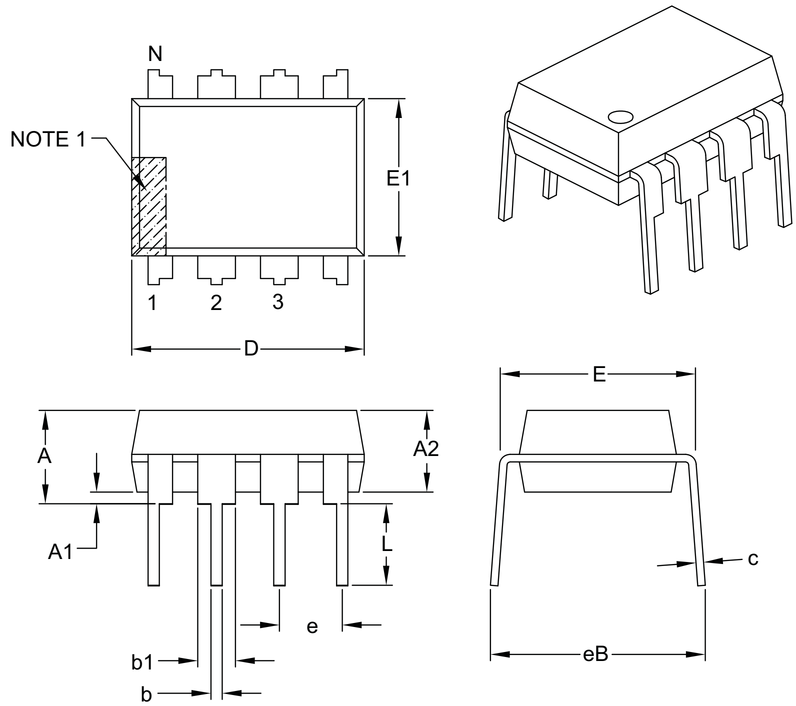


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

8-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	8		
Pitch	e	.100 BSC		
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.348	.365	.400
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.040	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

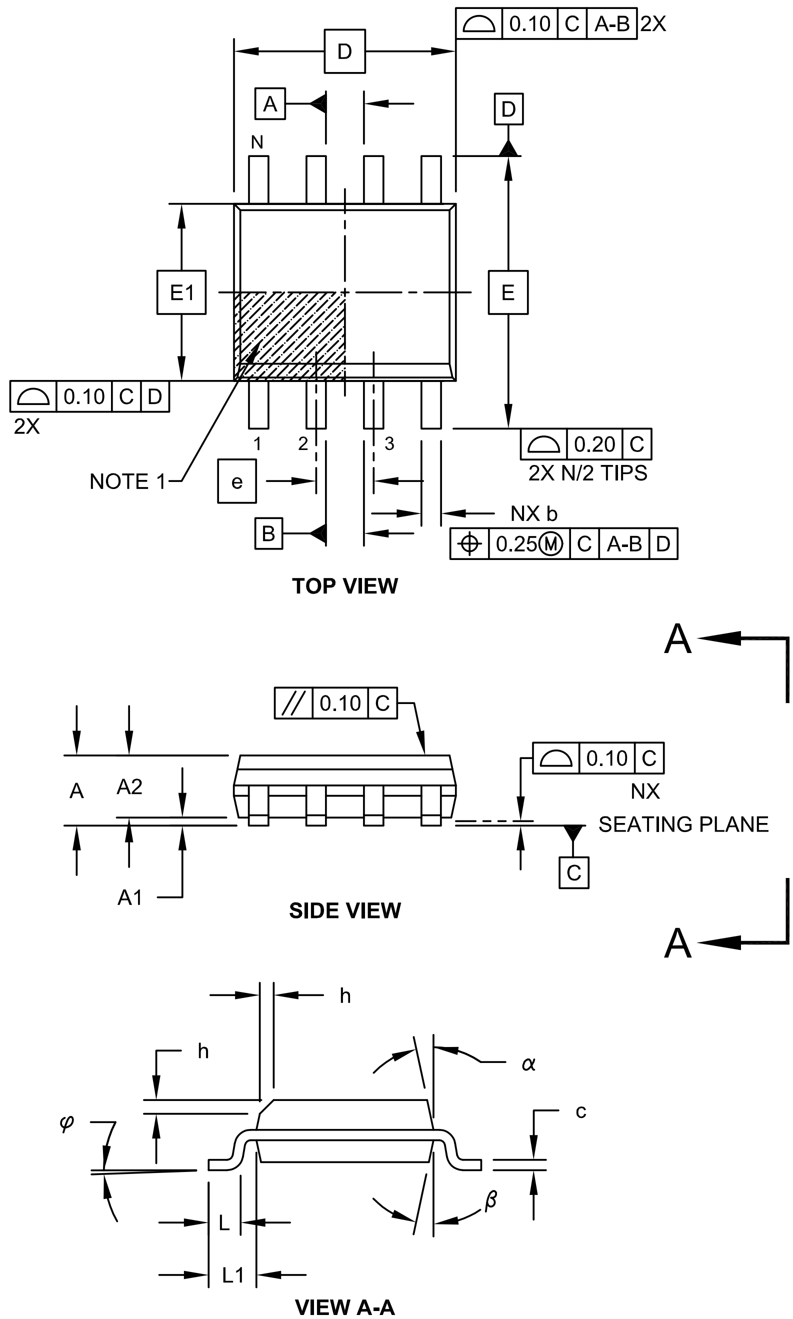
1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-018B

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm Body [SOIC]

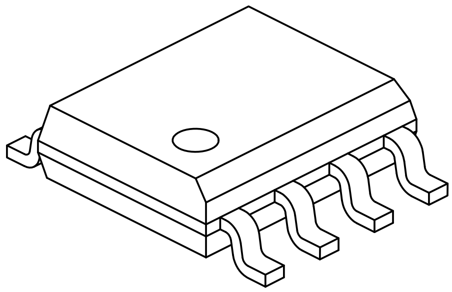
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-057C Sheet 1 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		4.90 BSC	
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.17	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

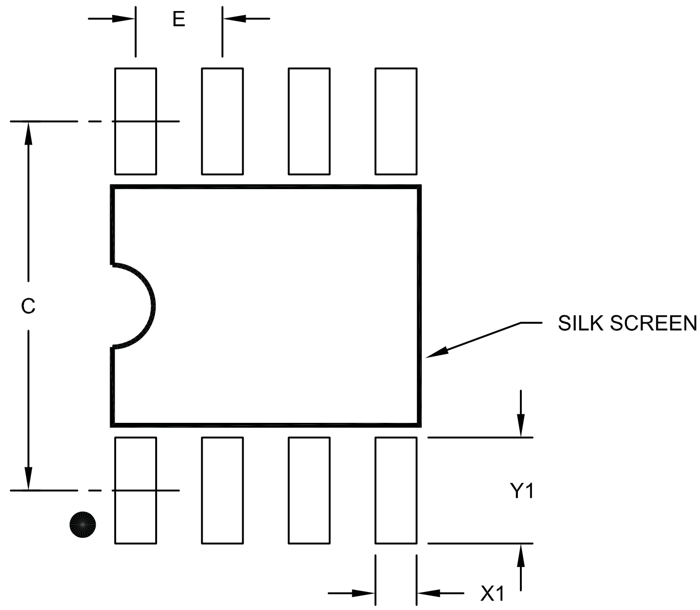
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-057C Sheet 2 of 2

8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Contact Pitch	E	1.27 BSC		
Contact Pad Spacing	C		5.40	
Contact Pad Width (X8)	X1			0.60
Contact Pad Length (X8)	Y1			1.55

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2057A

NOTES:

APPENDIX A: REVISION HISTORY

Revision B (May 2013)

The following has been modified:

1. Added Maximum Human Body Model ESD value to Section 1.1, Absolute Maximum Ratings†.

Revision A (June 2012)

- Original Release of this Document.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO. – **X** – **X** – **X**

- PART NO.: **Device**
- X: **Package**
- X: **Number of Pins**
- X: **Lead Free/ Tape and Reel**

Device:	RE46C317	CMOS Piezo Horn Driver IC
	RE46C318	CMOS Piezo Horn Driver IC
Package:	E	= Plastic Dual In-Line (300 mil Body), 8-Lead (PDIP)
	S	= Small Plastic Outline - Narrow, 3.90 mm Body, 8-Lead (SOIC)

Examples:

a) RE46C317E8F: 8LD PDIP package, Lead Free
b) RE46C317S8F: 8LD SOIC package, Lead Free
c) RE46C317S8TF: 8LD SOIC package, Tape and Reel

a) RE46C318E8F: 8LD PDIP package, Lead Free
b) RE46C318S8F: 8LD SOIC package, Lead Free
c) RE46C318S8TF: 8LD SOIC package, Tape and Reel

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
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