RE46C600

Ionization Smoke Detector Companion IC

Features

- Low Quiescent Current
- Operation from 3V Battery or AC with 3V Battery Backup
- 9V Boost Converter
- Horn Driver
- 4V Regulated Voltage for Microcontroller Operation in AC Condition
- Low Leakage DETECT Input (+/- 1 pA)
- Alarm Interconnect
- Internal Operational Amplifiers:
  - Rail-to-rail Input and Output
  - 10 kHz Gain Bandwidth Product
  - Unity Gain Stable

Applications

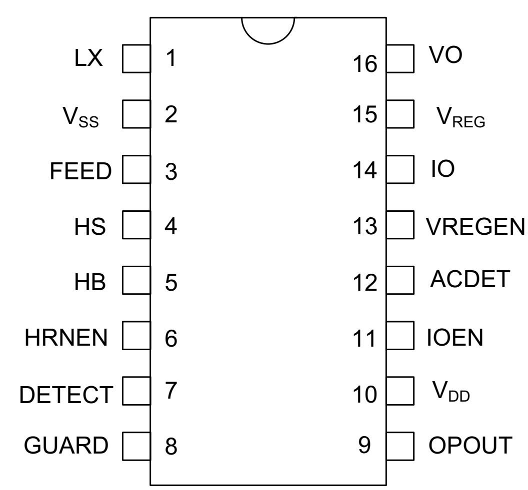
- Smoke Detector

Description

The RE46C600 is a low-power CMOS ionization smoke detector companion IC. The RE46C600 provides all of the analog, interface, and power regulation functions for a microcontroller-based ionization smoke detector. It is intended for use in both 3V battery and AC battery-backed applications. It features a boost converter and driver circuit suitable for driving a piezoelectric horn, a 4V regulator for microcontroller voltage regulation, an operational amplifier and an IO for communication with interconnected units.

Package Types

RE46C600
PDIP, SOIC



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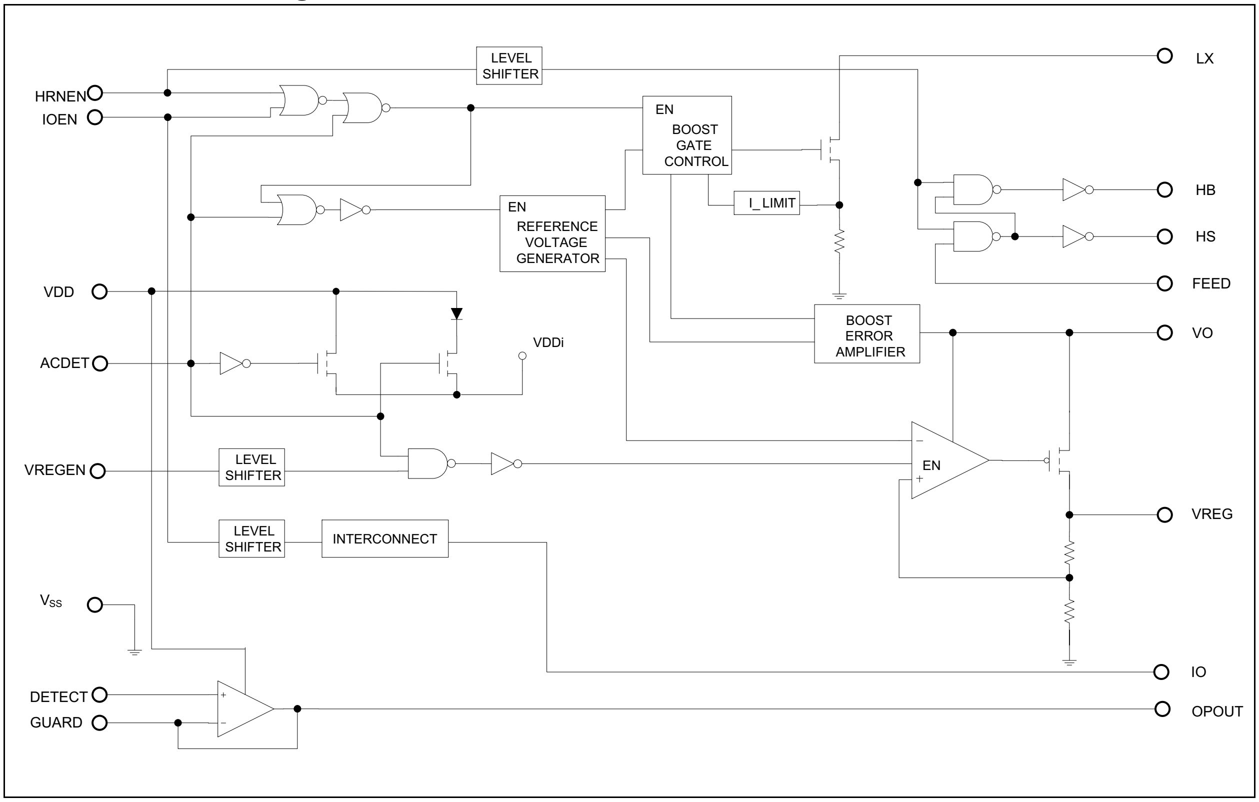
Functional Block Diagram



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1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

V_{DD} .... +5V
V_O, LX .... +15V
I_O .... +18V
Input Voltage Range Except ACDET, FEED .... V_{IN1} = -0.3V to V_{REG} + 0.3V
ACDET .... V_{IN2} = -0.3V to V_O + 0.3V
FEED Input Voltage Range .... V_{INFD} = -10V to + 22V
Input Current except FEED .... I_{IN} = 10 mA
Output Current V_{REG} .... I_{REG} = 50 mA
Sink Current OP_{OUT} .... I_{OPO}= 20 mA
Output Current IHS, IHB .... IHS = IHB = 75 mA
Storage Temperature .... T_{STG} = -55°C to +125°C
HBM ESD 1500V
Maximum Junction Temperature .... T_J = +150°C

† 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.

DC ELECTRICAL CHARACTERISTICS

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_5 = 10 µF, C_4 = 10 µF, ACDET low. (Note 1) (Note 2) (Note 3)

Parameter	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	10	2	—	3.6	V	Operating, battery-only operation
			2	—	4.2	V	Operating, AC operation, ACDET high, VREGEN high
	V_{OPU}	16	7	—	14	V	At Power-up, if supplied by V_O, ACDET = High, VREGEN = High
	V_{ONO}	16	6.5	—	14	V	Normal Operation
Standby I_{DD}	$I_{DDSTBY1}$	10	—	0.9	1.6	µA	Inputs low, No loads, boost regulator not running, V_O = 10V
	$I_{DDSTBY2}$		—	34	50	µA	AC operation, ACDET high, VREGEN high, V_O = 10V

Note 1: By default, V_O is forced externally with the inductor disconnected and the Boost converter is NOT running, with the exception of V_{VO} and V_{EFF}.
2: Typical values are for design information only.
3: The limits shown are 100% tested at 25°C only. Test limits are guard-banded, based on temperature characterization to warrant compliance at temperature extremes.
4: In this test, ACDET = High and VREGEN = High.

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DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_5 = 10 µF, C_4 = 10 µF, ACDET low. (Note 1) (Note 2) (Note 3)

Parameter	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Standby I_{VO}	$I_{VOSTBY1}$	16	—	—	0.8	µA	Inputs low, No loads, boost regulator not running, V_O = 10V
	$I_{VOSTBY2}$		—	52	68	µA	AC operation, ACDET high, VREGEN high, V_O = 10V
Quiescent I_{DD}	I_{DDQ}	10	—	34	50	µA	Inputs low, No loads, V_O = 10V, V_{LX} = 0.5V, HRNEN high, ACDET low
Quiescent I_{VO}	I_{VOQ1}	16	—	27	33	µA	Inputs low, No loads, VO = 10V, V_{LX} = 0.5V, HRNEN high, ACDET low
	I_{VOQ2}		—	257	314	µA	Inputs low, No loads, V_O = 10V, V_{LX} = 0.5V, IOEN high, ACDET low
Input Leakage Low	I_{IL}	11, 12, 13, 6	—	—	-100	nA	IOEN, ACDET, VREGEN, HRNEN, Inputs V_{IN} = V_{SS}
	I_{ILOP}	7	—	—	-1	pA	DETECT input, V_{IN} = V_{SS}, T_a = 27°C, 0-40% RH
	I_{ILF}	3	—	-15	-50	µA	FEED = -10V, V_O = 14V
Input Leakage High	I_{IH1}	11, 13, 6	—	—	100	nA	IOEN, VREGEN, HRNEN Inputs V_{DD} = 4.2V, V_{IN} = 4.2V (**Note 4**)
	I_{IH2}	12	—	—	100	nA	ACDET Input, V_{IN} = 14V, V_O = 14V
	I_{IHOP}	7	—	—	1	pA	DETECT input, V_{DD} = 4.2V, V_{IN} = 4.2V, T_a = 27°C, 0-40% RH (**Note 4**)
	I_{IHF}	3	—	20	50	µA	FEED = +22V, V_O = 14V
Output Off Leakage High	I_{IHOZ}	1	—	—	1	µA	LX = V_O = 14V
Input Voltage Low	V_{IL1}	11, 13, 6	—	—	1	V	IOEN, VREGEN, HRNEN Inputs
	V_{IL2}	12, 3	—	—	3	V	ACDET, FEED Inputs, V_O = 10V
Input Voltage High	V_{IH1}	11, 13, 6	2.3	—	—	V	IOEN, VREGEN, HRNEN Inputs
	V_{IH2}	12, 3	7	—	—	V	ACDET, FEED Inputs, V_O = 10V
Output Voltage Low	V_{OL}	4, 5	—	0.3	0.5	V	HS or HB, I_{OUT} = 16 mA, V_O = 10V, HRNEN = V_{SS}

Note 1: By default, V_O is forced externally with the inductor disconnected and the Boost converter is NOT running, with the exception of V_{VO} and V_{EFF}.

2: Typical values are for design information only.

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

4: In this test, ACDET = High and VREGEN = High.

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DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Unless otherwise indicated, all parameters apply at T_A = -10°C to +60°C, V_{DD} = 3V, V_{SS} = 0V, C_5 = 10 µF, C_4 = 10 µF, ACDET low. (Note 1) (Note 2) (Note 3)							
Output Voltage High	V_{OH}	4, 5	9.5	9.7	—	V	HS or HB, I_{OUT} = -16 mA, V_O = 10V, HRNEN high
	V_{OHIO}	14	3	—	—	V	IO output, I_{OUT} = -4 mA, V_O = 10V, IO_{EN} high
V_O Output Voltage	V_{VO}	16	8.2	9	9.8	V	HRNEN high, I_{OUT} = 10 mA
V_O Efficiency	V_{EFF}	—	—	85	—	%	I_{LOAD} = 10 mA, HRNEN high
V_{REG} Voltage	V_{REG}	15	3.92	4	4.08	V	I_{OUT} < 20 mA, VREGEN high, ACDET high, V_O = 10V
V_{REG} Load Regulation	V_{REGLD}	15	—	30	50	mV	I_{OUT} = 0 to 20 mA, HRNEN = High, VREGEN high, ACDET high, V_O = 10V
V_{REG} Line Regulation	V_{REGLN}	15	—	—	5	mV	V_O = 6.5 to 14V, I_{OUT} = 1 mA, HRNEN high, VREGEN high, ACDET high
IO Output Current	IO_{IH1}	14	25	—	60	µA	IOEN = V_{SS}, IO = 1V, VO = 10V
	IO_{IH2}	14	—	—	150	µA	IOEN = V_{SS}, IO = 15V, VO = 10V
	IO_{IOH1}	14	-4	-5	—	mA	IOEN high, IO = 3V, VO = 10V
	IO_{IOH2}	14	—	-5	-16	mA	IOEN high, IO = V_{SS}, VO = 10V
	$IO1_{IOL1}$	14	—	10	—	mA	IO Dump Current, at falling edge of IOEN, IOEN = V_{SS}, IO = 1V, VO = 10V
IO Dump	T_{IODUMP}	14	—	500	—	ms	IO Dump duration, at falling edge of IOEN, VO = 10V
Input Offset Voltage	V_{GOS1}	7, 8, 9	-3	—	3	mV	V_{DD} = 2V, V_{CM} = 0.3V or V_{CM} = 1.7V
Common-Mode Voltage Range	V_{CMR}	7, 8, 9	0.3	—	V_{DD} – 0.3	V	—
Common-Mode Rejection Ratio	CMRR	7, 8, 9	—	80	—	dB	VCM = 0.3V to V_{DD} – 0.3V

Note 1: By default, V_O is forced externally with the inductor disconnected and the Boost converter is NOT running, with the exception of V_{VO} and V_{EFF}.

2: Typical values are for design information only.

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

4: In this test, ACDET = High and VREGEN = High.

TEMPERATURE CHARACTERISTICS

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Electrical Characteristics: Unless otherwise indicated.						
Temperature Ranges						
Operating Temperature Range	T_A	-10	—	+60	°C	—
Storage Temperature Range	T_{STG}	-55	—	+125	°C	—

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TEMPERATURE CHARACTERISTICS

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Electrical Characteristics: Unless otherwise indicated.						
Thermal Package Resistances						
Thermal Resistance, 16L-PDIP	θ_{JA}	—	+70	—	°C/W	—
Thermal Resistance, 16L-SOIC	θ_{JA}	—	+86.1	—	°C/W	—

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NOTES:

2.0 PIN DESCRIPTIONS

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

TABLE 2-1: PIN FUNCTION TABLE

RE46C600 PDIP, SOIC	Name	Description
1	LX	Open-drain NMOS output used to drive the boost converter inductor. The inductor should be connected from this pin to the positive supply through a low-resistance path.
2	V_{SS}	Connect to the negative supply voltage.
3	FEED	Usually connected to the feedback electrode (F) of the piezoelectric horn through a current-limiting resistor. If not used, this pin must be connected to V_{SS}.
4	HS	HS is a complementary output to HB and connects to the ceramic electrode (M) of the piezoelectric transducer.
5	HB	This pin is connected to the metal electrode (G) of a piezoelectric transducer.
6	HRNEN	Logic input to control the operation of the horn driver.
7	DETECT	Noninverting input of the op amp.
8	GUARD	Inverting input of the op amp.
9	OPOUT	Output of the op amp.
10	V_{DD}	Connect to the positive supply voltage.
11	IOEN	Logic input to drive the IO to V_{VO}.
12	ACDET	AC detect pin.
13	VREGEN	Logic input to enable the regulator.
14	IO	Output pin for connection to remote units. This pin has an internal pull-down device. High level is V_{VO}.
15	V_{REG}	Regulated output voltage. Nominal output is 4V.
16	V_O	Regulated output voltage. Nominal output is 9V.

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NOTES:

3.0 DEVICE DESCRIPTION

3.1 Introduction

The RE46C600 provides the necessary analog and interface functions to build a microcontroller-based ionization smoke detector. This includes a low-leakage op amp, a voltage regulator for the microcontroller, a horn driver, a detector interconnect function, a boost regulator for 3-volt operation, and a power-control system that allows operation from 3V battery or AC-derived power with or without battery backup. The RE46C600 provides a simple means for the microcontroller to control the operation of the ion smoke detector and provides the necessary signaling functions during an alarm condition.

3.2 Ionization Sensor Detect Circuit

The RE46C600 provides a low-leakage, high-impedance op amp for an ionization smoke sensor. The unity gain stable op amp provides rail-to-rail inputs and output. The op amp output is monitored by the microcontroller to determine the smoke density.

3.3 Power Control System

The power control system allows the RE46C600 to be powered from a 3V battery or AC-derived power. AC power is supplied as a DC voltage derived from an AC power supply. The DC voltage is diode-connected to the V_O pin of the RE46C600. A 3V battery is connected to the V_{DD} pin for low-voltage systems. When only a 3V battery is available, the internal circuitry is powered from V_{DD}. When AC power is available, the internal circuitry is powered from V_{REG}, which is a regulated 4V.

The AC detect (ACDET) pin will disable the boost converter if ACDET is high. For a 3V battery-only system, the ACDET pin should be connected to V_{SS}, which will enable the boost converter. Under this condition, the boost converter will turn on as necessary to achieve the desired output voltage at V_O.

3.4 Boost Regulator

The boost regulator only operates in low-voltage applications. The ACDET pin will disable the boost converter if ACDET is high. The boost regulator can be enabled with HORNEN, or with IOEN asserted high. The boost regulator is a fixed off-time boost converter with peak current limiting. In boost operation, the peak current is nominally 0.8A. The boost regulator provides a nominal 9V on the V_O pin.

3.5 Voltage Regulator

The voltage regulator provides a nominal 4V output at the V_{REG} pin and is intended to power a microcontroller when AC-supplied power is available. The voltage regulator is disabled if ACDET is low. The voltage regulator is enabled if both ACDET and VREGEN are high. VREGEN has a pull-up current to V_{DD}. In normal operation, the regulator will source current up to 20 mA, but the current sinking capability is typically under 1 µA. The voltage regulator is powered from the V_O pin. In low-voltage applications, the regulator is disabled.

3.6 Interconnect Operation

The interconnect circuitry provides the means for the smoke detector to be connected to other smoke detectors. The IO pin is an output-only pin that connects to other detectors. IOEN connects to the microcontroller and determines when IO is driven high. When IOEN is asserted high, the IO output acts as a current source that is biased from V_O. In low-voltage applications when IOEN is asserted high, the boost regulator will be active. This ensures there is adequate IO drive capability.

An internal sink device on the IO pin helps to discharge the interconnect line. This charge dump device is activated automatically when IOEN transitions from high to low.

3.7 Horn Driver

The horn driver drives a standard three-terminal piezoelectric horn connected to the HB, HS, and FEED pins. The alarm is sounded when the microcontroller drives the HRNEN pin with the required horn modulation pattern. In low-voltage applications when HRNEN is asserted high, the boost regulator is active. This ensures there is adequate horn drive capability to achieve the necessary sound pressure levels. The horn will begin to sound before the boost regulator reaches the high boost level.

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NOTES:

4.0 APPLICATION NOTES

4.1 Boost Regulator

The boost converter in Active mode (nominal V_O = 9V) can draw current pulses of greater than 1A and is therefore very sensitive to series resistance. 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, from the inductor through the boost capacitor, and from the V_{SS} pin to the battery. In order to function properly under full load at V_{DD} = 2V, the total of the inductor and interconnect resistances should not exceed 0.3Ω.

The internal battery resistance should be no more than 0.5Ω and a low-ESR capacitor of 10 µF or more should be connected in parallel with the battery to average the current draw over the boost converter switching cycle.

The Schottky diode and inductor should be specified with a maximum operating current of 1.5A or higher. The boost capacitor should have a low ESR.

The horn driver requires a high voltage, so the piezoelectric horn can achieve the necessary sound pressure levels. The interconnect function provided by IO needs a high voltage to provide proper interconnect operation with interconnected alarms.

4.2 Operation Truth Table

Table 4-1 summarizes the basic logic inputs required to enable various operating modes for the RE46C600.

TABLE 4-1: RE46C600 TRUTH TABLE

Inputs				Outputs			
ACDET	VREGEN	HRNEN	IOEN	Boost Reg	V_{REG}	HORN	IO
0	0	0	0	Off	Off	Off	Off
0	1	0	0	Off	Off	Off	Off
0	0	1	0	On	Off	On	Off
0	1	1	0	On	Off	On	Off
0	0	0	1	On	Off	Off	On
0	1	0	1	On	Off	Off	On
0	0	1	1	On	Off	On	On
0	1	1	1	On	Off	On	On
1	0	0	0	Off	Off	Off	Off
1	1	0	0	Off	On	Off	Off
1	0	1	0	Off	Off	On	Off
1	1	1	0	Off	On	On	Off
1	0	0	1	Off	Off	Off	On
1	1	0	1	Off	On	Off	On
1	0	1	1	Off	Off	On	On
1	1	1	1	Off	On	On	On

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4.3 Typical Applications

A few typical applications using the RE46C600 are shown in Figure 4-1, Figure 4-2 and Figure 4-3.

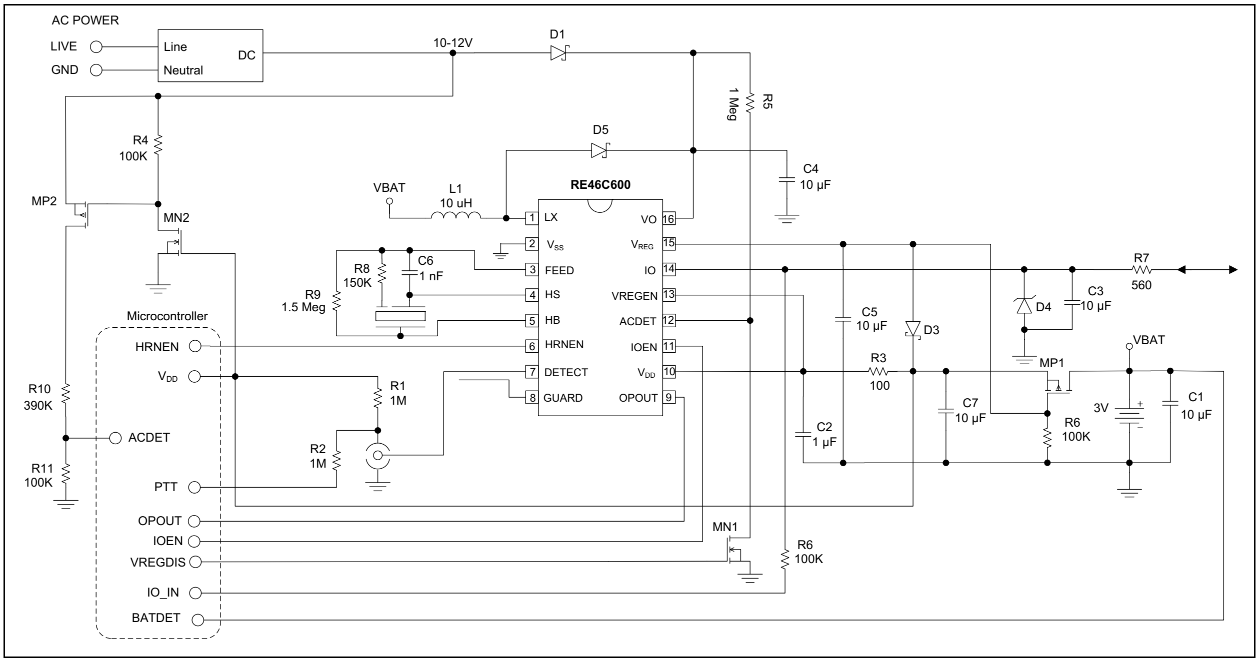

FIGURE 4-1: *Typical Application: AC with 3V Battery Backup.*

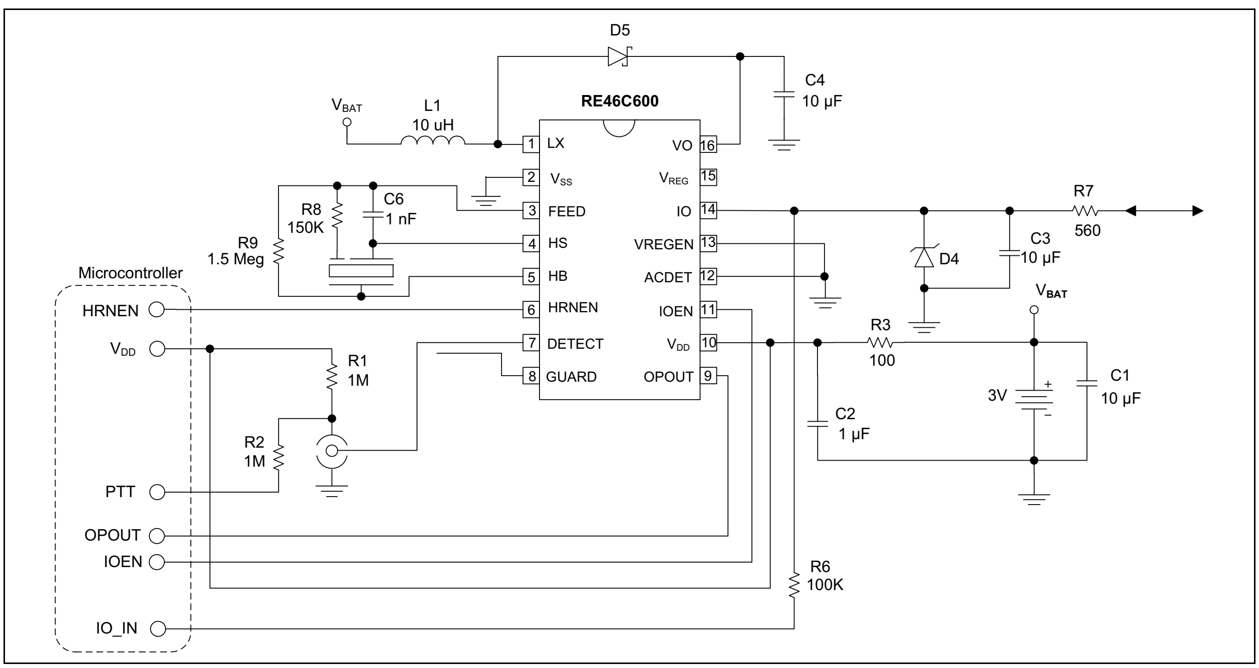

FIGURE 4-2: *Typical Application: 3V Battery Operation.*

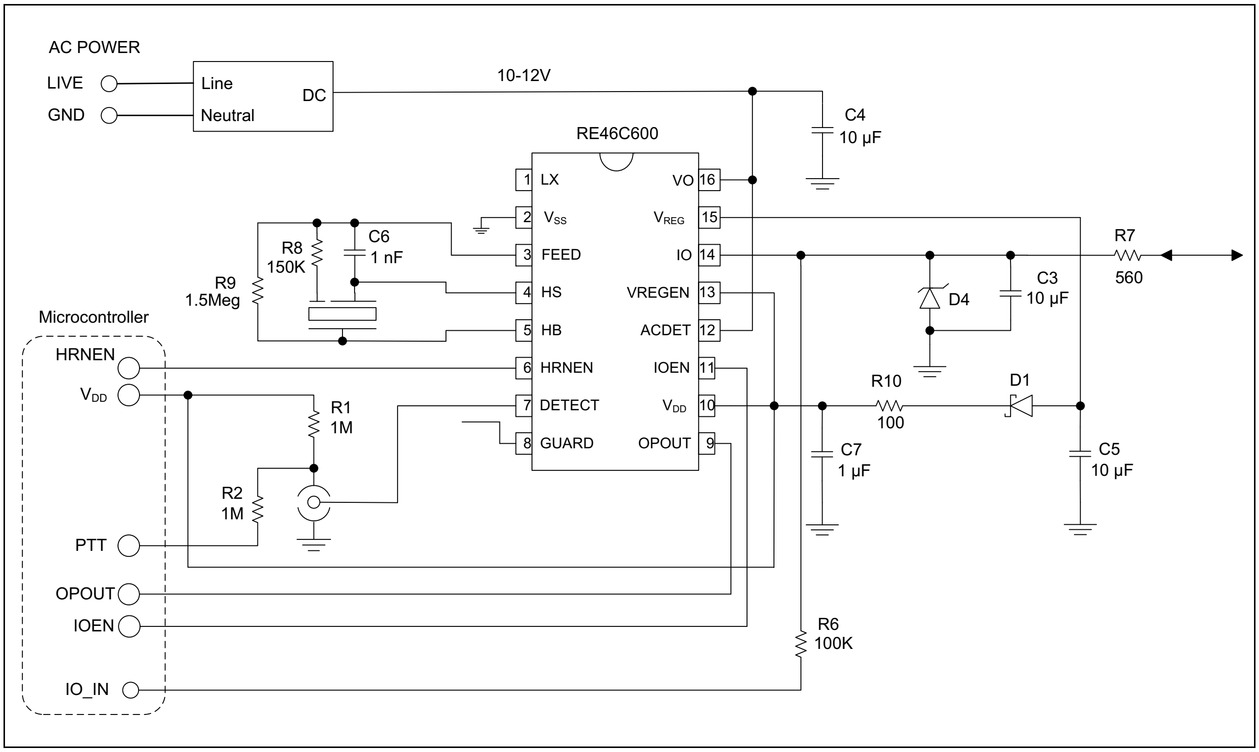

FIGURE 4-3: *Typical Application: AC Only.*

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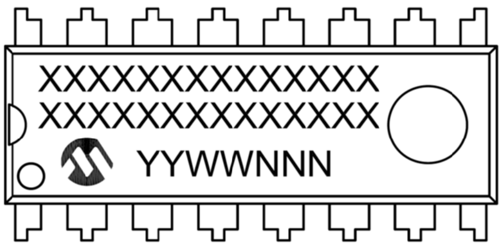
NOTES:

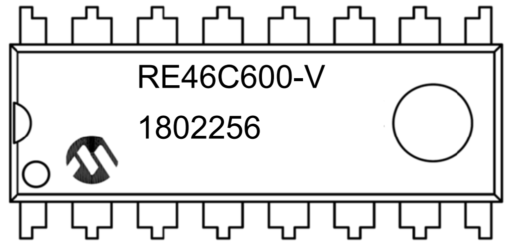
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

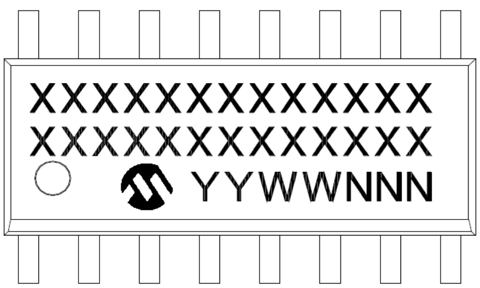
16-Lead PDIP



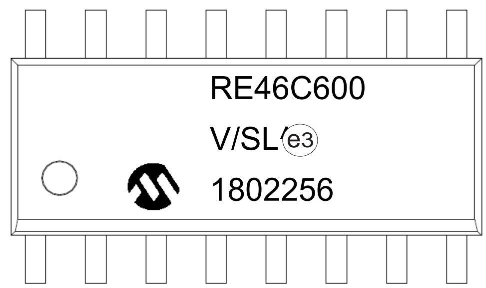
Example



16-Lead SOIC



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.

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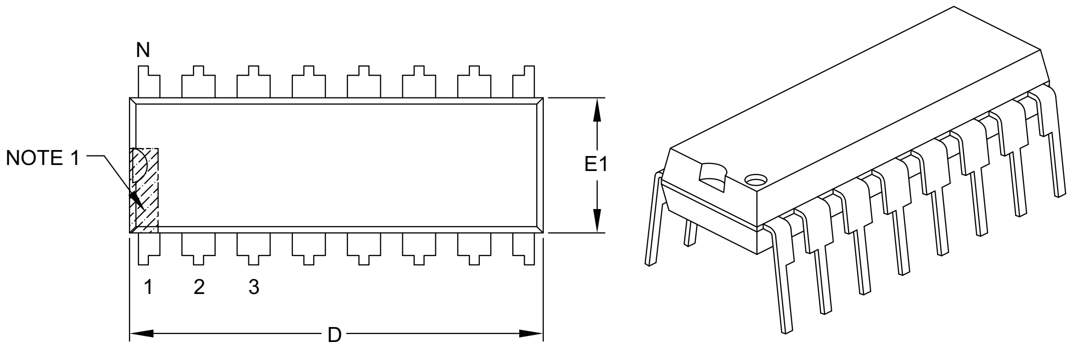
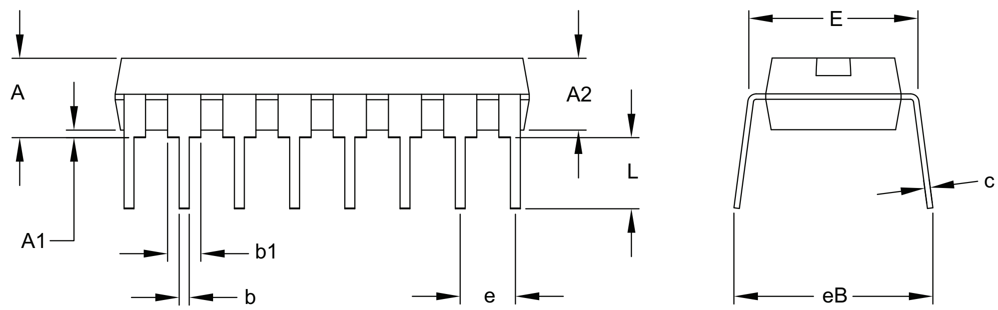
16-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

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	16		
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	.735	.755	.775
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

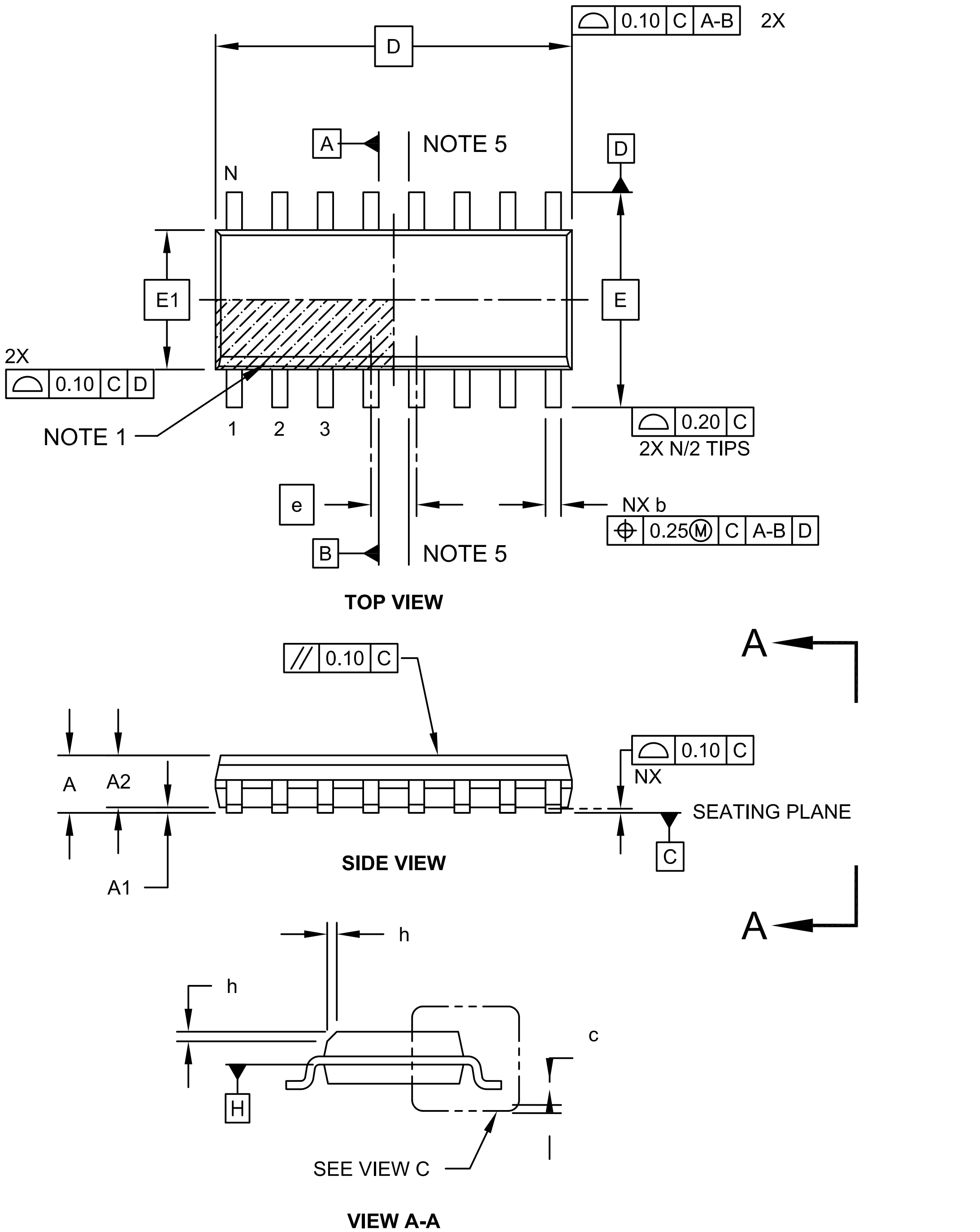
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

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

Microchip Technology Drawing C04-017B

16-Lead Plastic Small Outline (SL) - 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. C04-108C Sheet 1 of 2

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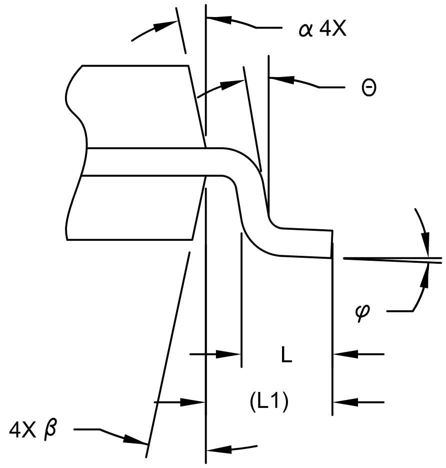
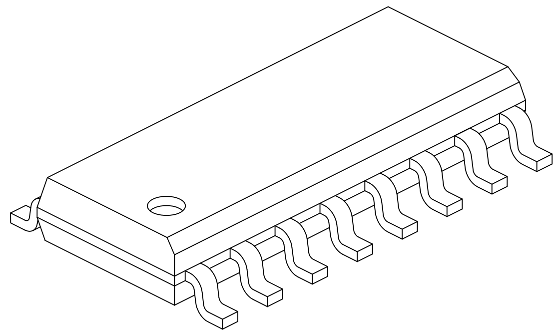
16-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

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



VIEW C



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	16		
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	9.90 BSC		
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1	1.04 REF		
Lead Angle	Θ	0°	-	-
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.10	-	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. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm 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.
5. Datums A & B to be determined at Datum H.

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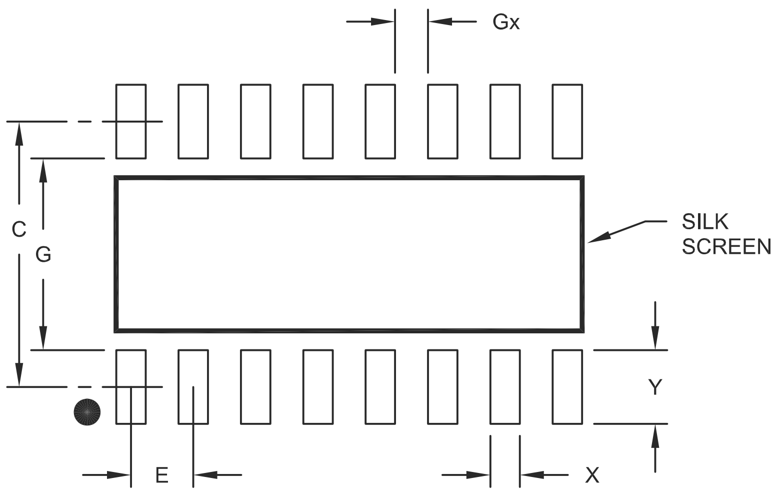
16-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

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	X			0.60
Contact Pad Length	Y			1.50
Distance Between Pads	Gx	0.67		
Distance Between Pads	G	3.90		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2108A

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NOTES:

APPENDIX A: REVISION HISTORY

Revision E (February 2022)

- Updated the **DC Electrical Characteristics**.
- Updated Figure 4-3.

Revision D (September 2021)

- Updated the Functional Block Diagram.
- Updated **Section 1.1 "Absolute Maximum Ratings†"**.

Revision C (December 2020)

- Initial public release of this document.
- Updated **Section 1.1 "Absolute Maximum Ratings†"**.

Revision B (July 2020)

- Document not publicly released.
- Updated **Section 1.1, Absolute Maximum Ratings†** and the **DC Electrical Characteristics** table.
- Minor typographical edits.

Revision A (February 2018)

- Initial Release of this Document. (Document not publicly released.)

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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
Device	Package	Number of Pins	Tape and Reel

Device:	RE46C600	Ionization Smoke Detector Companion IC
Package:	E	= Plastic Dual In-Line - 300 mil Body, 16-Lead (PDIP)
	S	= Plastic Small Outline - Narrow, 3.90 mm Body, 16-Lead (SOIC)
Tape and Reel:	T	= Tape and Reel

Examples:

a) RE46C600E16: Ionization Smoke Detector Companion IC,16LD PDIP package

b) RE46C600S16: Ionization Smoke Detector Companion IC, 16LD SOIC package

c) RE46C600S16T: Ionization Smoke Detector Companion IC, 16LD SOIC package, Tape and Reel

NOTES:

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