RE46C803 Carbon Monoxide Detector Companion IC

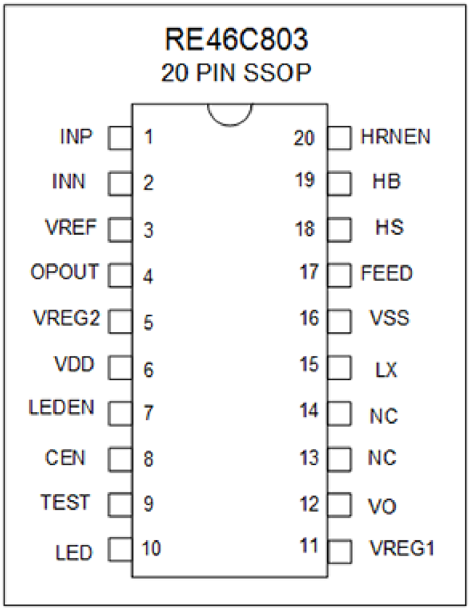
Features

- Low Quiescent Current
- Operation from 3V
- 1.8V Regulated Voltage for CO Detection
- 3.3V Regulated Voltage for Microcontroller Operation in Boost Mode
- 9V Boost Converter
- Horn Driver
- LED Driver
- Internal Operational Amplifier
  - Rail-to-Rail Input and Output
  - 10 KHz Gain Bandwidth Product
  - Unity Gain Stable

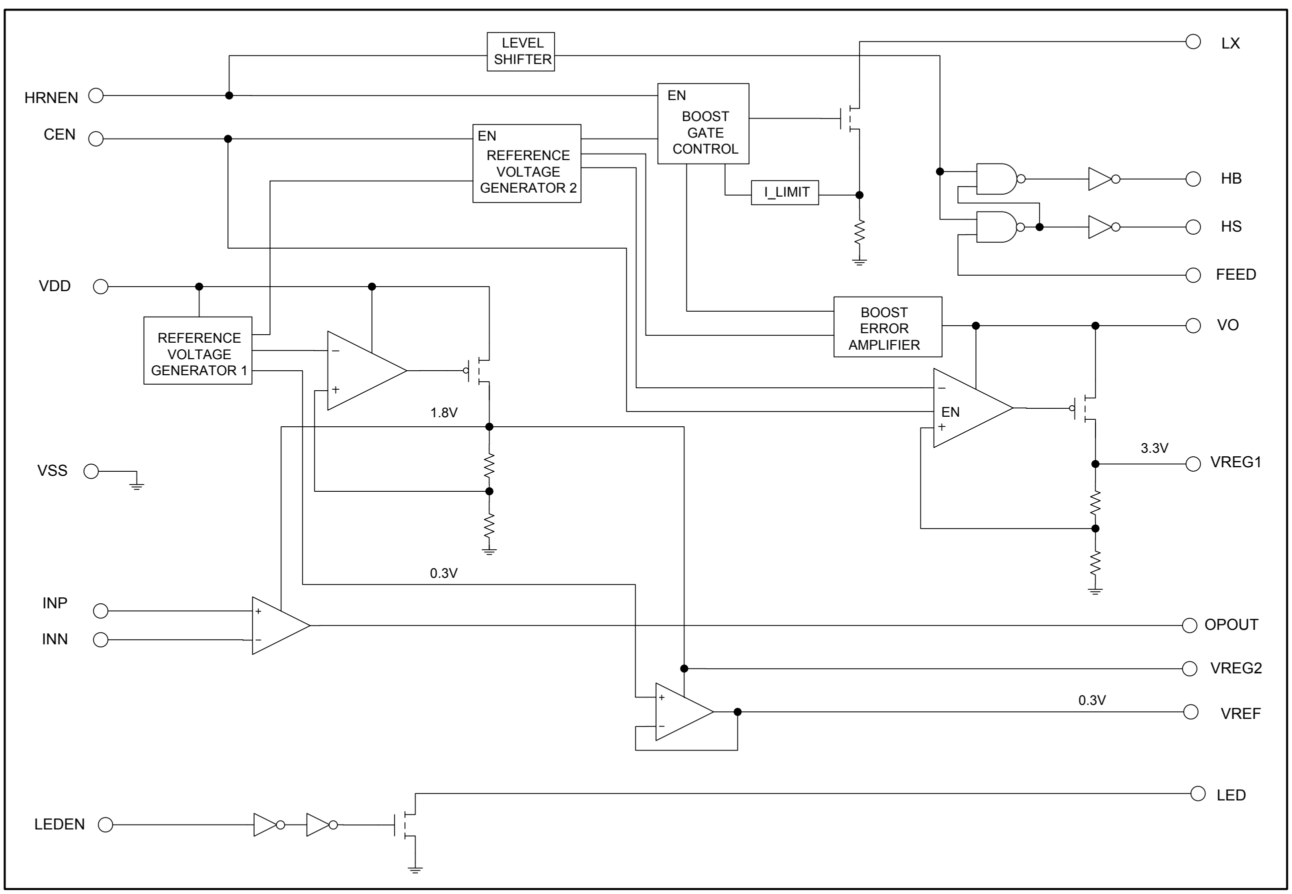
Description

The RE46C803 is a low-voltage, low-power CMOS carbon monoxide detector companion IC. The RE46C803 provides all of the analog, interface, and power regulation functions for a microcontroller-based CO or toxic gas detector. It is intended for use in 3V battery applications. It features a boost converter and horn driver circuit suitable for driving a piezoelectric horn, a 3.3V regulator for microcontroller voltage regulation, an LED driver and an operational amplifier.

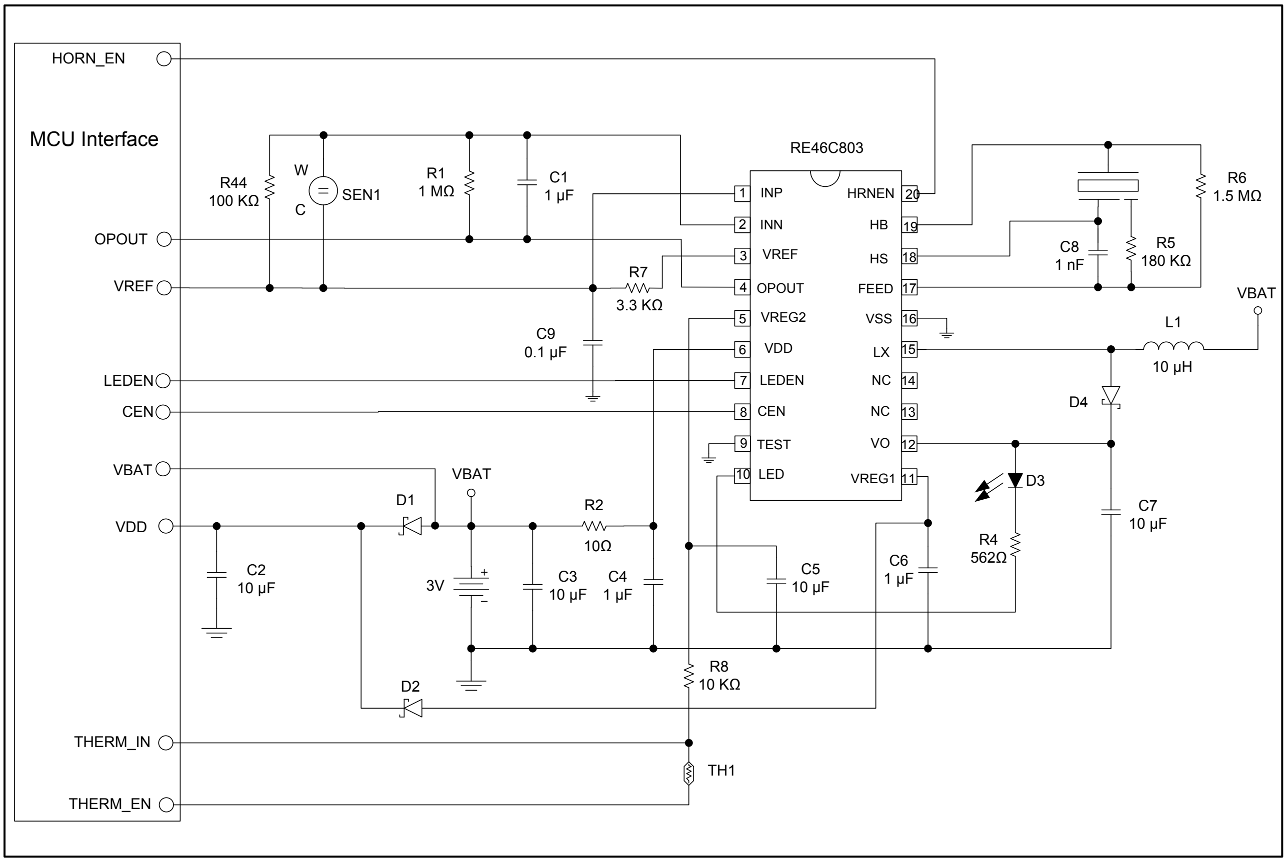
Package Type



Functional Block Diagram



Typical Applications



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1. Electrical Characteristics

1.1 Absolute Maximum Ratings

V_{DD}	5V
V_O, LX, LED	15V
INP, INN Input Voltage Range	–0.3 to VDD + 0.3V
CEN	V_{IN2} = –0.3 to VO + 0.3V
FEED Input Voltage Range	V_{INFD} = –10 to +22V
LEDEN, HRNEN Input Voltage Range	–0.3V to 7V
Input Current Except FEED	I_{IN} = 10 mA
Output Current VREF	I_{REF} = 20 mA
Output Current OPOUT	I_{OPO} = 20 mA
Sink Current I_{LED}	I_{LED} = 50 mA
Output Current I_{HS}, I_{HB}	I_{HS} = I_{HB} = 75 mA
Source Current I_{REG1}	I_{REG1} = 50 mA
Source Current I_{REG2}	I_{REG2} = 30 mA
Operating Temperature	T_A = –10 to +60℃
Storage Temperature	T_{STG} = –55 to +125℃
Maximum Junction Temperature	T_J = +150℃

Note: Stresses beyond those listed under "Absolute 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 beyond those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 1-1. DC Characteristics

Electrical Specifications: Unless otherwise specified, all parameters apply at –10°C ≤ T_A ≤ +60°C, V_{DD} = 3V, V_O = 10V, V_{SS} = 0V, C_{reg1} = 1 μF, C_{reg2} = 10 μF, C_{vo} = 10 μF, (Note 1) (Note 2) (Note 3)

Parameters	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	6	2	—	3.6	V	Operating
Standby Supply Current	I_{DDSTBY}	6	—	2.2	3.5	μA	CEN = VSS ,Inputs low; No loads, Boost Regulator not running
Standby I_{VO}	I_{VOSTBY}	12	—	—	100	nA	CEN = VSS ,Inputs low; No loads, Boost Regulator not running

Parameters	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Quiescent I_{DD}	I_{DDQ}	6	—	33	52	µA	CEN = VDD, Inputs low, No loads, LX = 0.5V
Quiescent I_{VO}	I_{VOQ}	12	—	—	69	µA	CEN = VDD, Inputs low, No loads, LX = 0.5V
Input Leakage Low	I_{IL}	1, 7, 8, 20	—	—	–100	nA	INP, LEDEN, CEN, HRNEN Inputs $V_{in} = V_{SS}$
	I_{ILOP}	2	—	—	–200	pA	INN input, $V_{in} = V_{SS}$
	I_{ILF}	17	—	-15	–50	µA	FEED = -10V, VO = 14V
Input Leakage High	I_{IH}	1, 7, 8, 20	—	—	100	nA	INP,LEDEN, CEN, HRNEN Inputs, V_{DD} = 3.6V, V_{in} = 3.6V
	I_{IHOP}	2	—	—	200	pA	INN input, V_{DD} = 3.6V, V_{in} = 3.6V
	I_{IHF}	17	—	20	50	µA	FEED = +22V, VO = 14V
Output Off Leakage High	I_{IHOZ}	10, 15	—	—	1	µA	LEDEN = VSS, CEN = VSS, VO = LED = LX = 14V
Input Voltage Low	V_{IL1}	7, 8, 20	—	—	1	V	LEDEN, CEN, HRNEN Inputs
	V_{ILF}	17	—	—	3	V	FEED Input
Input Voltage High	V_{IH1}	7, 8, 20	V_{DD} - 0.7	—	—	V	LEDEN, CEN, HRNEN Inputs
	V_{IHF}	17	7	—	—	V	FEED Input
Output Voltage Low	V_{OL1}	18, 19	—	0.3	0.5	V	HS or HB, I_{out} = 16 mA, CEN = VSS, HRNEN = VSS
	V_{OL2}	10	—	0.3	0.5	V	LED, I_{out} = 10 mA, CEN = VDD, LEDEN = VDD
Boost Output Voltage	V_{OH}	18, 19	9.5	9.7	—	V	HS or HB, I_{out} = -16 mA, CEN = VDD, HRNEN = VDD
Output Voltage High	V_{VO}	12	8.2	9	9.8	V	CEN = VDD, I_{out} = 10 mA, Boost Regulator running
Boost Efficiency	V_{EFF}	—	—	85	—	%	CEN=VDD I_{out}=10mA
VREG Voltage	V_{REG1}	11	3.2	3.3	3.4	V	I_{out} < 10 mA, CEN = VDD
	V_{REG2}	5	1.76	1.8	1.84	V	I_{out} < 5 mA

Parameters	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
VREG Load Regulation	V_{REGLD1}	11	—	15	25	mV	I_{out} = 0 to 20 mA, CEN = VDD
	V_{REGLD2}	5	—	20	40	mV	I_{out} = 0 to 5 mA
Dropout Voltage	V_{DO}	5	0.15	—	—	V	I_{out} = 5 mA
Reference Voltage	V_{REF}	3	—	300	—	mV	Operating
Operational amplifier							
Input Offset Voltage	V_{OS}	1, 2, 4	–3	—	3	mV	V_{CM} = 0.3V
Input Offset Voltage	V_{OS2}	1, 2, 4	–1	—	1	mV	T_A = +25°C, V_{CM} = 0.3V
Common-Mode Rejection Range	V_{CMR}	1, 2, 4	VSS	—	VREG2	V	
Common-Mode Rejection Ratio	CMRR	1, 2, 4	—	86	—	dB	V_{CM} = 0V to V_{REG2}
DC Open-Loop Gain (large signal)	AOL	1, 2, 4	—	115	—	dB	R_L = 50 kΩ, V_{REG2} = 1.8V, V_{CM} = 0.3V, V_{OUT} = 0.3V to V_{REG2} –0.3V
Maximum Output Voltage Swing	V_{OLOP}, V_{OHOP}	4	VSS + 10	—	VREG2 – 10	mV	R_L = 50 kΩ, 0.5V input overdrive
Output Short Circuit Current	I_{SC}	4	—	20	—	mA	

Note:

1. Wherever a specific VO value is listed under test conditions, the VO is forced externally with the inductor disconnected and the Boost converter is NOT running.
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.

Table 1-2. AC Characteristics

Electrical Specifications: Unless otherwise specified, all parameters apply at $-10°C \le T_A \le +60°C$, V_{DD} = 3V, V_O = 10V, V_{SS} = 0V, C_{reg1} = 1 µF, C_{reg2} = 10 µF, C_{vo} = 10 µF, (Note 1) (Note 2) (Note 3)

Parameters	Sym.	Test Pin	Min.	Typ.	Max.	Units	Conditions
Operational Amplifier AC Response							
Gain Bandwidth Product	GBWP	1, 2, 4	—	10	—	kHz	
Slew Rate	SR	1, 2, 4	—	3	—	V/ms	
Phase margin	PM	1, 2, 4	—	65	—	°	G = +1V/V
Operational Amplifier Noise							
Input Voltage Noise	Eni	1, 2	—	5	—	µVP - P	f = 0.1 Hz to 10 KHz
Input Voltage Noise Density	eni	1, 2	—	170	—	nV/√Hz	f = 1 KHz
Input Current Noise Density	ini	1, 2	—	0.6	—	fA/√Hz	f = 1 KHz

Note:

1. Wherever a specific VO value is listed under test conditions, the VO is forced externally with the inductor disconnected and the Boost converter is NOT running.
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.

Table 1-3. Thermal Specifications

Parameters	Sym.	Min.	Typ.	Max.	Units	Test Conditions
Temperature Ranges						
Operating Temperature Range	T_A	-10	—	+60	°C	
Storage Temperature Range	T_{STG}	-55	—	+125	°C	
Thermal Package Resistances						
Thermal Resistance, 20L-SSOP	θ_{JA}	—	87	—	°C/W	

2. Pin Description

The description of the pins are listed in Table 2-1

Table 2-1. Pin Function Table

RE46C803 SSOP	Pin Name	Description
1	INP	Noninverting input of the operational amplifier.
2	INN	Inverting input of the operational amplifier.
3	VREF	Voltage reference for CO biasing and detection circuitry.
4	OPOUT	Output of the operational amplifier.
5	VREG2	Regulated output voltage. Nominal output is 1.8V.
6	VDD	Connect to a 3V battery through this pin.
7	LEDEN	Logic input used to enable the LED driver.
8	CEN	Connect to the microcontroller to start the boost mode.
9	TEST	Connect to VSS
10	LED	Open drain NMOS output used to drive a visible LED.
11	VREG1	Regulated output voltage. Nominal output is 3.3V.
12	VO	Regulated output voltage. Nominal output is 9.0V.
13	NC	Not Connected
14	NC	Not Connected
15	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.
16	VSS	Connect to the negative supply voltage.
17	FEED	Usually connected to the feedback electrode of the piezoelectric horn through a resistor. If not used, this pin must be connected to VSS.
18	HS	HS is a complementary output to HB and connects to the ceramic electrode (M) of the piezoelectric transducer.
19	HB	This pin is connected to the metal electrode (G) of a piezoelectric transducer.
20	HRNEN	Logic input to control the operation of the horn driver.

3. Device Description

3.1 Introduction

The RE46C803 provides the necessary analog functions to build a microcontroller-based CO or toxic gas detector. This includes an operational amplifier and a reference voltage for the electrochemical sensor, a 1.8V regulator that powers the CO detection circuitry or other circuitry such as a thermal sensor, a 3.3V voltage regulator for the microcontroller in alarm, a LED driver, a horn driver and a 9V boost regulator. The RE46C803 provides a simple means for the microcontroller to control the operation of the CO detector and provides the necessary signaling functions during an alarm condition.

3.2 CO Sensor Circuit

The RE46C803 provides a low offset operational amplifier and a voltage reference (VREF) for a two terminal CO or toxic gas sensor. The unity gain stable operational amplifier is powered by the internal regulator VREG2. The operational amplifier provides rail-to-rail inputs and output. The operational amplifier output is monitored by the microcontroller to determine the CO concentration. This uncommitted operational amplifier can be used for other purposes, such as temperature sensing.

3.3 Power Control System

RE46C803 is intended to operate in a 3V battery condition. In standby mode, RE46C803 is powered by the 3V battery through the VDD pin. The voltage on VDD powers the 1.8V voltage regulator VREG2. The 1.8V voltage regulator, in turn, powers the low offset operational amplifier, the reference voltage VREF circuit for CO detection, and other circuits, such as external temperature sensing. In standby mode the boost regulator and the 3.3V voltage regulator is disabled. This keeps the power consumption of RE46C803 to a minimum.

The boost mode is initiated by the microcontroller through the CEN pin. The microcontroller first drives the CEN pin to a high level. This enables the boost regulator and the 3.3V regulator. The microcontroller then drives either HRNEN or LEDEN to a high level. HRNEN asserted high starts sounding the horn alarm. LEDEN asserted high provides load current in battery test or acts as an alarm indicator.

3.4 Boost Regulator

The boost regulator is a fixed off-time boost converter with peak current limiting. The boost regulator is disabled in standby mode and enabled in boost mode. In boost operation, the peak current is nominally 0.8A. The boost regulator provides a nominal 9V on the VO pin. In normal operation, the boost regulator can only be enabled with CEN asserted high. This feature allows VO to reach high boost level before enabling LEDEN or HRNEN.

3.5 Voltage Regulators

There are two voltage regulators in RE46C803.

The low-dropout, low-current 1.8V voltage regulator provides a nominal 1.8V output at the VREG2 pin. The regulator nominal quiescent current is 1 µA. Internally, the 1.8V regulator provides power to the essential CO detection circuit, the low offset operational amplifier and the reference voltage VREF. Externally, the 1.8V regulator can be used as a reference to the microcontroller, or as the supply for circuit such as for temperature sensing. The 1.8V regulator will source current up to 5 mA, but the current sinking capability is typically under 1 µA. The 1.8V regulator is always active and is powered by the battery through the VDD pin.

The 3.3V voltage regulator is only enabled in boost mode with CEN asserted high. It provides a nominal 3.3 V output at the VREG1 pin. The 3.3V regulator can be used to power the microcontroller in boost mode. When enabled, this regulator will source current up to 20 mA, but the current sinking capability is typically under 1 µA. The 3.3V voltage regulator is powered from the VO pin.

3.6 LED Driver

The LED drive circuit provides power to an LED which can be used as a visual indicator by the system. The LED drive circuit can also be used as part of a battery check function. The CEN must be driven high before enabling LED driver. When LEDEN is asserted high The LED will load the VO output and the microcontroller can monitor the battery operation under load. The load current is set by the resistor in series with the LED.

3.7 Horn Driver

The horn driver drives a standard three terminal piezo horn connected to the pins HB, HS, and FEED. The alarm is sounded by having the microcontroller drive HRNEN pin with required horn modulation pattern. The horn operation requiresRE46C803 operate in boost mode. CEN must be driven high before enabling horn driver. This insures 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.

4. Application Notes

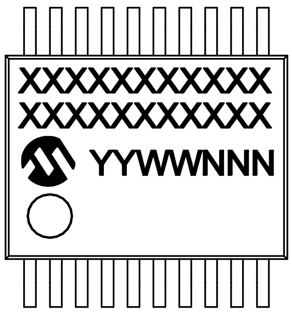
4.1 Boost Regulator

The boost regulator in High-Boost 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 VSS 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 regulator switching cycle. The Schottky diode and inductor should be specified with a maximum operating current of 1.2A or higher. The boost capacitor should have a low ESR.

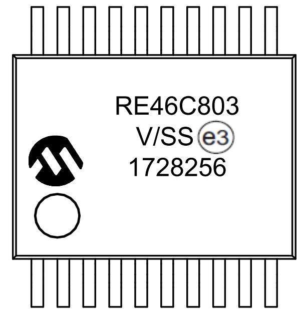
5. Packaging Information

5.1 Marking Information

20-Lead SSOP



Example



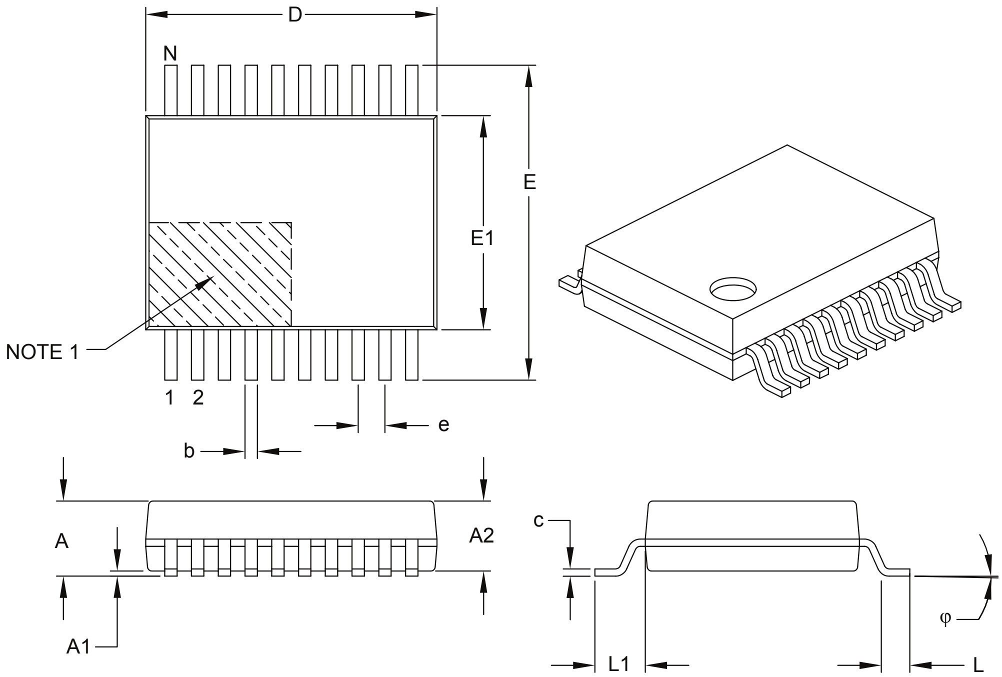
Legend:

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	JEDEC® designator for Matte Tin (Sn)
*	This package is RoHS compliant. The 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.

20-Lead Plastic Shrink Small Outline (SS) – 5.30 mm Body [SSOP]

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	20		
Pitch	e	0.65 BSC		
Overall Height	A	–	–	2.00
Molded Package Thickness	A2	1.65	1.75	1.85
Standoff	A1	0.05	–	–
Overall Width	E	7.40	7.80	8.20
Molded Package Width	E1	5.00	5.30	5.60
Overall Length	D	6.90	7.20	7.50
Foot Length	L	0.55	0.75	0.95
Footprint	L1	1.25 REF		
Lead Thickness	c	0.09	–	0.25
Foot Angle	φ	0°	4°	8°
Lead Width	b	0.22	–	0.38

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.20 mm per side.
3. 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 C04-072B

20-Lead Plastic Shrink Small Outline (SS) - 5.30 mm Body [SSOP]

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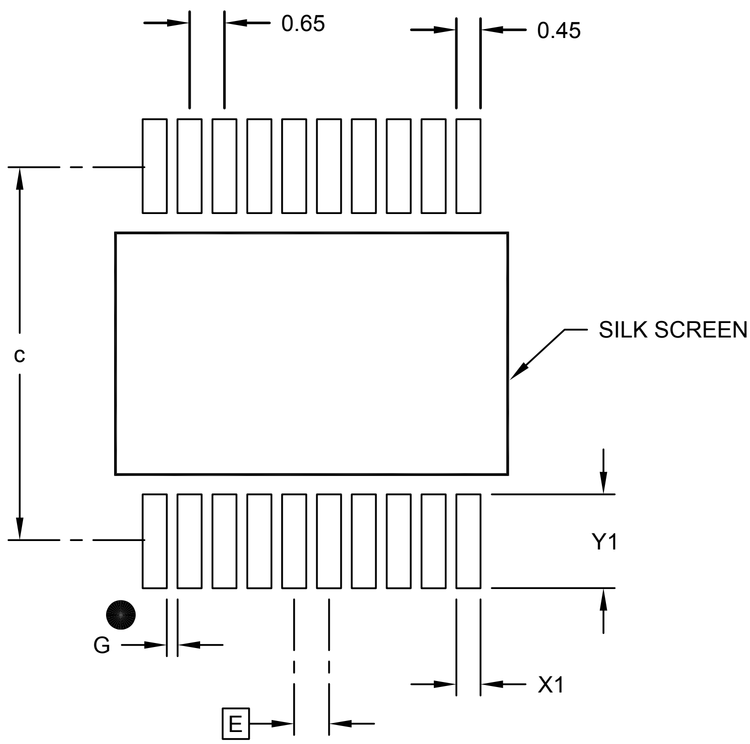

RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Contact Pad Spacing	C		7.20	
Contact Pad Width (X20)	X1			0.45
Contact Pad Length (X20)	Y1			1.75
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2072B

6. Revision History

Revision A (August 2017)
Original Release of this Document.

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PART NO.	[X][1]	XX	X
Device	Tape and Reel	Package	Number of pins

Device:	RE46C803SS20: CMOS Carbon Monoxide Detector Companion	
Tape & Reel Option:	Blank	= Tube
	T	= Tape & Reel
Package	SS	= Package Plastic Shrink Small Outline
Number of pins	20	

Examples:

- RE46C803SS20: 20-pin SSOP package
- RE46C803SS20T: Tape and Reel, 20-pin SSOP package

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