DSC61XXB

Ultra-Small, Ultra-Low Power MEMS Oscillator

Features

- Wide Frequency Range: 3.5 kHz to 100 MHz
- Ultra-Low Power Consumption: 3 mA/1 µA (Active/Standby)
- Ultra-Small Footprints
  - 1.6 mm × 1.2 mm
  - 2.0 mm × 1.6 mm
  - 2.5 mm × 2.0 mm
- Frequency Select Input Supports Two Pre-Defined Frequencies
- High Stability: ±20 ppm, ±25 ppm, ±50 ppm
- Wide Temperature Range
  - Automotive: –40°C to +125°C
  - Ext. Industrial: –40°C to +105°C
  - Industrial: –40°C to +85°C
  - Ext. Commercial: –20° to +70°C
- Excellent Shock and Vibration Immunity
  - Qualified to MIL-STD-883
- High Reliability
  - 20x Better MTF Than Quartz Oscillators
- Supply Range of 1.71V to 3.63V
- Short Sample Lead Time: <2 weeks
- Lead Free & RoHS Compliant
- Automotive Version Available: DSA61xxB

Applications

- Low Power/Portable Applications: IoT, Embedded/Smart Devices
- Consumer: Home Healthcare, Fitness Devices, Home Automation
- Industrial: Building/Factory Automation, Surveillance Camera
- Automotive (Please Refer to the DSA61xx Family)

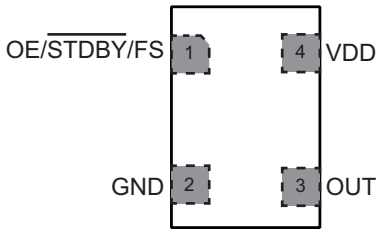
General Description

The DSC61xxB family of MEMS oscillators combines the industry leading low power consumption and ultra-small packages with exceptional frequency stability and jitter performance over temperature. The single-output DSC61xxB MEMS oscillators are excellent choices for use as clock references in small, battery-powered devices such as wearable and Internet of Things (IoT) devices in which small size, low power consumption, and long-term reliability are paramount.

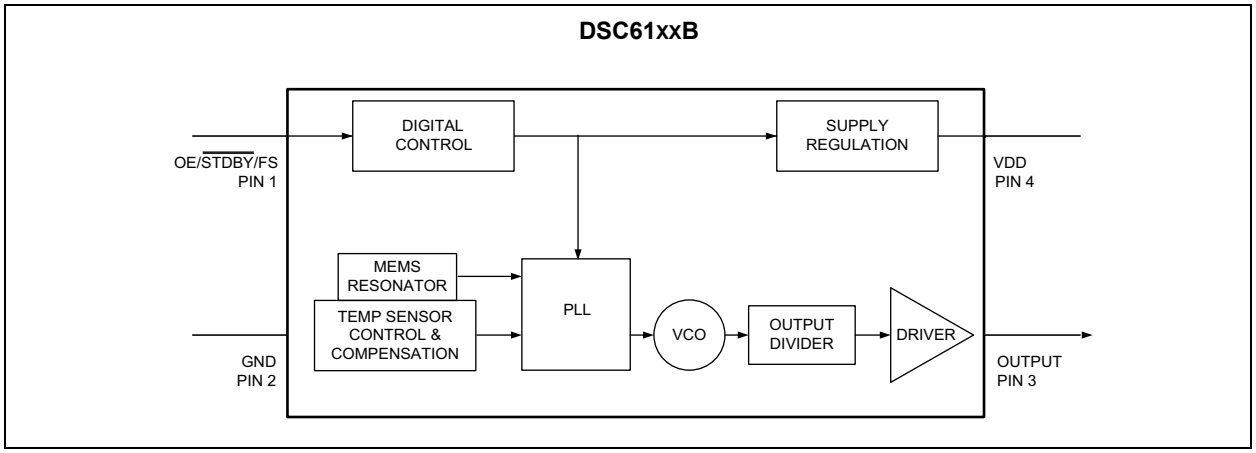
The DSC61xxB family is available in ultra-small 1.6 mm x 1.2 mm, 2.0 mm x 1.6 mm, and 2.5 mm x 2.0 mm packages. These packages are “drop-in” replacements for standard 4-pin CMOS quartz crystal oscillators. The Automotive Grade AEC-Q100 qualified option is also available for this device.

Package Types

DSC61xxB
2.5 mm x 2.0 mm VLGA
2.0 mm x 1.6 mm VFLGA
1.6 mm x 1.2 mm VFLGA
(Top View)



Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Supply Voltage ..... –0.3V to +4.0V
Input Voltage (V_{IN}) ..... –0.3V to V_{DD}+0.3V
ESD Protection ..... 4 kV HBM, 400V MM, 2 kV CDM

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = 1.8V –5% to 3.3V +10%, T_A = –40°C to +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	1.71	—	3.63	V	Note 1
Power Supply Ramp	t_{PU}	0.1	—	100	ms	Note 8
Active Supply Current	I_{DD}	—	3.0	—	mA	f_{OUT} = 27 MHz, V_{DD} = 1.8V, No Load
Standby Supply Current	I_{STBY}	—	1	—	µA	V_{DD} = 1.8/2.5V, Note 2
		—	1.5	—		V_{DD} = 3.3V, Note 2
Output Duty Cycle	SYM	45	—	55	%	—
Frequency	f_0	0.0035	—	100	MHz	—
Frequency Stability	Δf	—	—	±20 ±25 ±50	ppm	All temp ranges, Note 3
Aging	Δf	—	—	±5	ppm	1st year @ 25°C
		—	—	±1		Per year after first year
Startup Time	t_{SU}	—	—	1.5	ms	From 90% V_{DD} to valid clock output, T = 25°C
Input Logic Levels	V_{IH}	0.7 x V_{DD}	—	—	V	Input Logic High, Note 4
	V_{IL}	—	—	0.3 x V_{DD}	V	Input Logic Low, Note 4
Output Disable Time	t_{DA}	—	—	200 + 2 Periods	ns	Note 5
Output Enable Time	t_{EN}	—	—	1	µs	Note 6
Enable Pull-up Resistor	—	—	300	—	kΩ	If configured, Note 7

Note 1: Pin 4 V_{DD} should be filtered with 0.1 µF capacitor.
2: Not including current through pull-up resistor on EN pin (if configured). Higher standby current seen at >3.3V V_{DD}.
3: Includes frequency variations due to initial tolerance, temp. and power supply voltage.
4: Input waveform must be monotonic with rise/fall time < 10 ms
5: Output Disable time takes up to two periods of the output waveform + 200 ns.
6: For parts configured with OE, not Standby.
7: Output is enabled if pad is floated or not connected.
8: Time to reach 90% of target V_{DD}. Power ramp rise must be monotonic.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{DD} = 1.8V –5% to 3.3V +10%, T_A = –40°C to +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions	
Output Logic Levels	V_{OH}	0.8 x V_{DD}	—	—	V	Output Logic High, I = 3 mA, Std. Drive	
						Output Logic High, I = 6 mA, High Drive	
	V_{OL}	—	—	0.2 x V_{DD}	V	Output Logic Low, I = –3 mA, Std. Drive	
						Output Logic Low, I = –6 mA, High Drive	
Output Transition Time Rise Time/Fall Time	t_{RX}/t_{FX}	—	1	1.5	ns	DSC61x2 High Drive, 20% to 80% C_L = 15 pF	V_{DD} = 1.8V
		—	0.5	1.0	ns		V_{DD} = 2.5V/3.3V
	t_{RY}/t_{FY}	—	1.2	2.0	ns	DSC61x1 Std Drive, 20% to 80% C_L = 10 pF	V_{DD} = 1.8V
		—	0.6	1.2	ns		V_{DD} = 2.5V/3.3V
Period Jitter, RMS	J_{PER}	—	8.5	—	ps_{RMS}	f_{OUT} = 27 MHz	V_{DD} = 1.8V
		—	7	—			V_{DD} = 2.5V/3.3V
Cycle-to-Cycle Jitter (Peak)	$J_{Cy–Cy}$	—	50	70	ps	f_{OUT} = 27 MHz	V_{DD} = 1.8V
		—	35	60			V_{DD} = 2.5V/3.3V
Period Jitter (Peak-to-Peak)	J_{PP}	—	70	—	ps	f_{OUT} = 27 MHz	V_{DD} = 1.8V
		—	60	—			V_{DD} = 2.5V/3.3V

Note 1: Pin 4 V_{DD} should be filtered with 0.1 µF capacitor.

2: Not including current through pull-up resistor on EN pin (if configured). Higher standby current seen at >3.3V V_{DD}.

3: Includes frequency variations due to initial tolerance, temp. and power supply voltage.

4: Input waveform must be monotonic with rise/fall time < 10 ms

5: Output Disable time takes up to two periods of the output waveform + 200 ns.

6: For parts configured with OE, not Standby.

7: Output is enabled if pad is floated or not connected.

8: Time to reach 90% of target V_{DD}. Power ramp rise must be monotonic.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Operating Temperature	T_J	–40	—	+150	°C	—
Storage Ambient Temperature Range	T_A	–55	—	+150	°C	—
Soldering Temperature	T_S	—	+260	—	°C	40 sec. max.

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +150°C rating. Sustained junction temperatures above +150°C can impact the device reliability.

2.0 PIN DESCRIPTIONS

The DSC61xxB is a highly configurable device and can be factory programmed in many different ways to meet the customer's needs. Microchip's ClockWorks® Configurator http://clockworks.microchip.com/Timing/ must be used to choose the necessary options, create the final part number, data sheet, and order samples. The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: DSC61XXB PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1 (Note 1)	OE	Output Enable: H = Active, L = Disabled (High Impedance).
	$\overline{\text{STDBY}}$	Standby: H = Device is active, L = Device is in standby (Low Power Mode).
	FS	Frequency Select: H = Output Frequency 1, L = Output Frequency 2.
2	GND	Ground.
3	Output	Oscillator clock output.
4	VDD	Power supply: 1.71V to 3.63V.

Note 1: DSC610xB/1xB/3xB has a 300 kΩ internal pull-up resistor on pin 1. DSC614xB/5xB/7xB has no internal pull-up resistor on pin 1 and needs an external pull-up or to be driven by another chip.

An explanation of the different options listed in Table 2-1 follows.

2.1 Pin 1

This is a control pin and may be configured to fulfill one of three different functions. If not actively driven, a 10 kΩ pull-up resistor is recommended.

2.1.1 OUTPUT ENABLE (OE)

Pin 1 may be configured as OE. Oscillator output may be turned on and off according to the state of this pin.

2.1.2 $\overline{\text{STDBY}}$

Pin 1 may be configured as Standby. When the pin is low, both output buffer and PLL will be off and the device will enter a low power mode.

2.1.3 FREQUENCY SELECT (FS)

Pin 1 may be configured as FS. The output may be set to one of two pre-programmed frequencies. The output clock frequencies can only be set to either kHz or MHz. A combination of kHz and MHz cannot be set.

2.2 Pins 2 through 4

Pins 2 and 4 are the supply terminals, GND and VDD respectively. Pin 3 is the clock output, programmable to Standard and High Drive strength settings. Visit ClockWorks® Configurator to customize your device.

2.3 Output Buffer Options

The DSC61xx family is available in multiple output driver configurations.

The standard-drive (61x1) and high-drive (61x2) deliver respective output currents of greater than 3 mA and 6 mA at 20%/80% of the supply voltage. For heavy loads of 15 pF or higher, the high-drive option is recommended.

3.0 DIAGRAMS

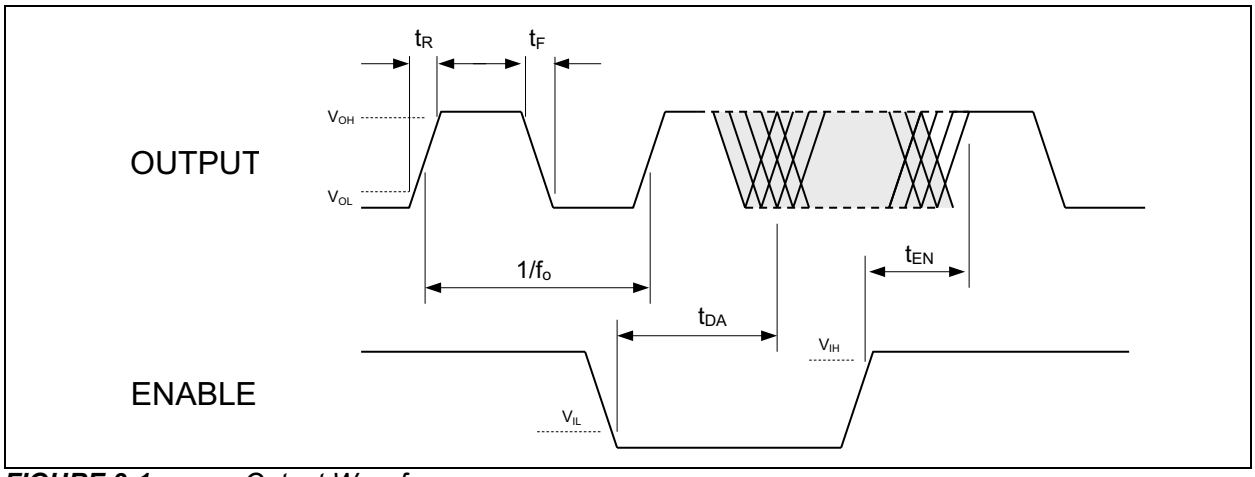


FIGURE 3-1: *Output Waveform.*

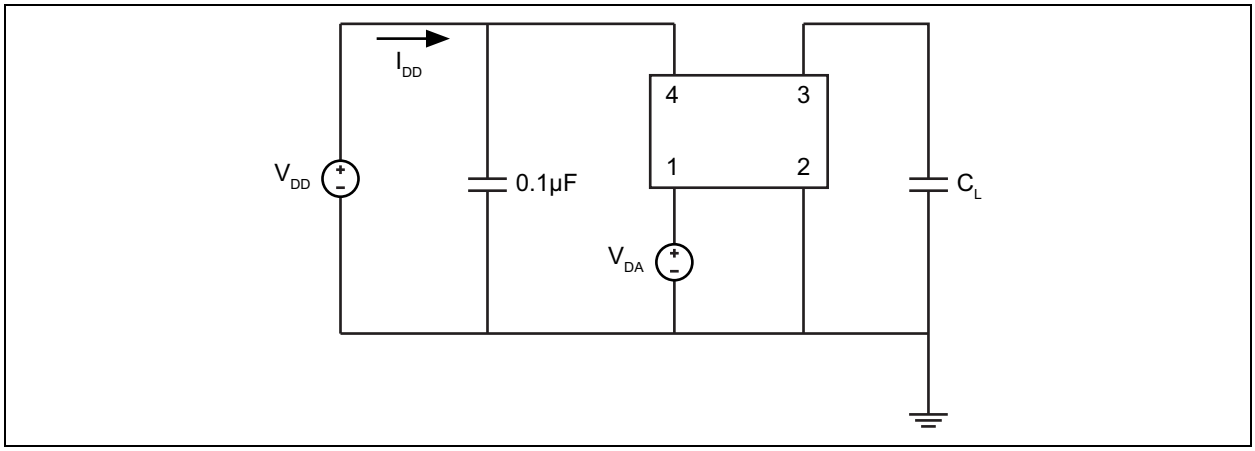


FIGURE 3-2: *Test Circuit.*

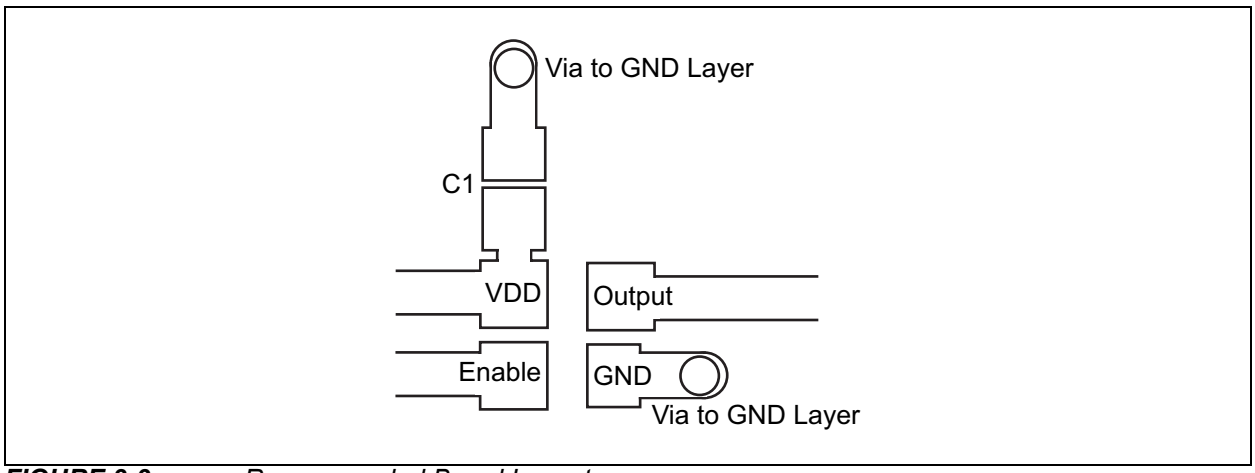


FIGURE 3-3: *Recommended Board Layout.*

4.0 SOLDER REFLOW PROFILE

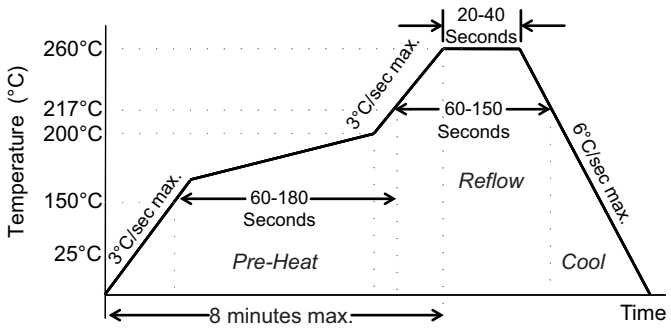


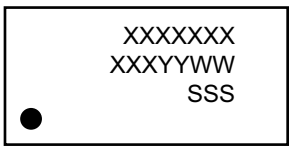
FIGURE 4-1: *Solder Reflow Profile.*

MSL 1 @ 260°C refer to JSTD-020C	
Ramp-Up Rate (200°C to Peak Temp)	3°C/sec. max.
Preheat Time 150°C to 200°C	60 to 180 sec.
Time maintained above 217°C	60 to 150 sec.
Peak Temperature	255°C to 260°C
Time within 5°C of actual Peak	20 to 40 sec.
Ramp-Down Rate	6°C/sec. max.
Time 25°C to Peak Temperature	8 minutes max.

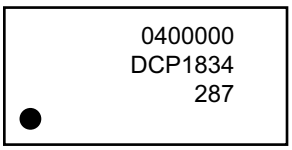
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

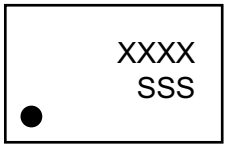
4-Lead VLGA*
2.5 x 2.0



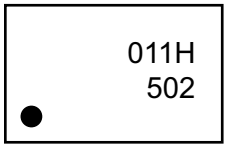
Example



4-Lead VFLGA*
2.0 x 1.6/1.6 x 1.2



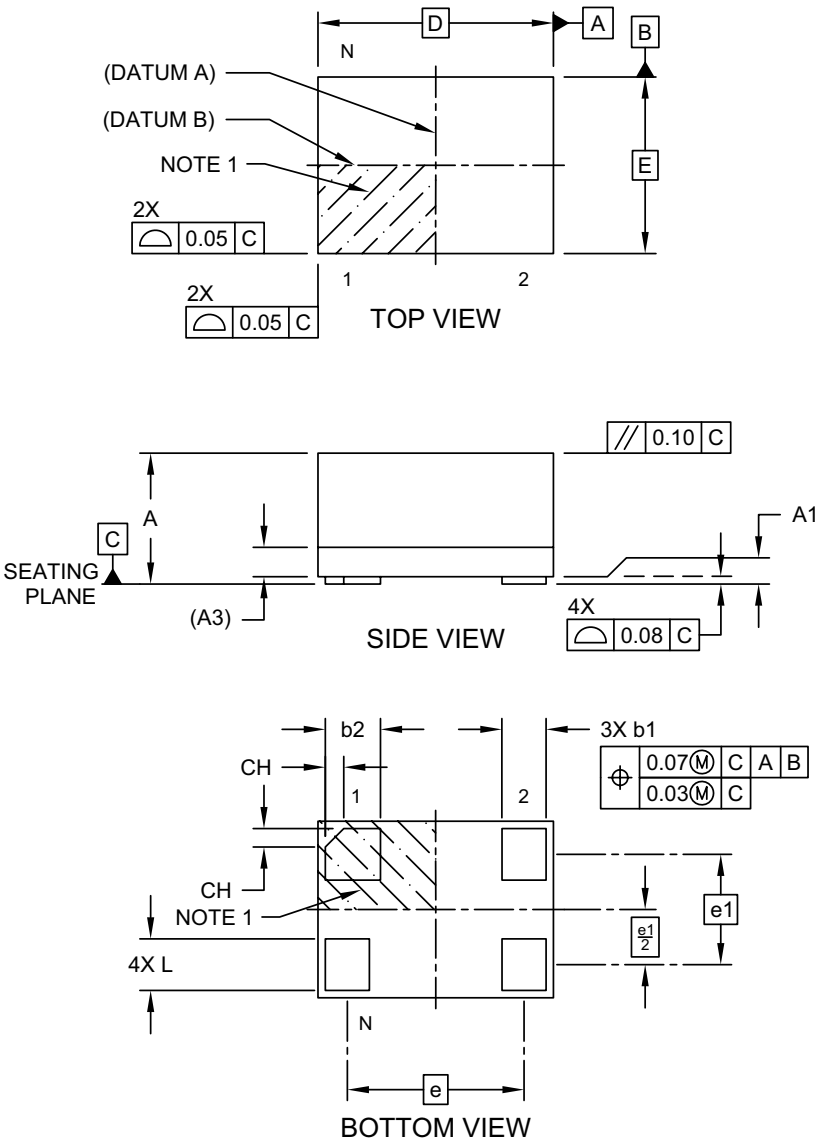
Example



Legend:	XX...X	Product code or 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’)
	SSS	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.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
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. Package may or may not include the corporate logo.	
	Underbar (_) and/or Overbar (¯) symbol may not be to scale.	

4-Lead Very Thin Fine Pitch Land Grid Array (ARA) - 1.6x1.2 mm Body [VFLGA]

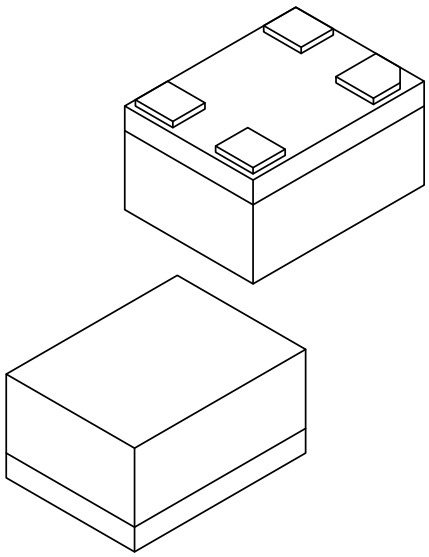
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1199A Sheet 1 of 2

4-Lead Very Thin Fine Pitch Land Grid Array (ARA) - 1.6x1.2 mm Body [VFLGA]

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 Terminals	N		4	
Terminal Pitch	e		1.20 BSC	
Terminal Pitch	e1		0.75 BSC	
Overall Height	A	0.79	0.84	0.89
Standoff	A1	0.00	0.02	0.05
Substrate Thickness (with Terminals)	A3		0.20 REF	
Overall Length	D		1.60 BSC	
Overall Width	E		1.20 BSC	
Terminal Width	b1	0.25	0.30	0.35
Terminal Width	b2	0.325	0.375	0.425
Terminal Length	L	0.30	0.35	0.40
Terminal 1 Index Chamfer	CH	-	0.125	-

Notes:

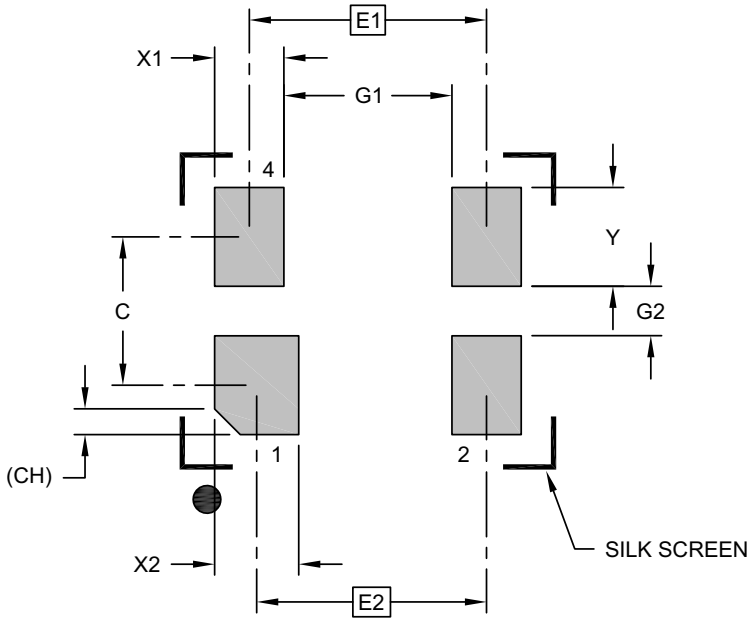
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1199A Sheet 2 of 2

4-Lead Very Thin Fine Pitch Land Grid Array (ARA) - 1.6x1.2 mm Body [VFLGA]

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	E1		1.20 BSC	
Contact Pitch	E2		1.16 BSC	
Contact Spacing	C		0.75	
Contact Width (X3)	X1			0.35
Contact Width	X2			0.43
Contact Pad Length (X6)	Y			0.50
Space Between Contacts (X4)	G1	0.85		
Space Between Contacts (X3)	G2	0.25		
Contact 1 Index Chamfer	CH		0.13 X 45° REF	

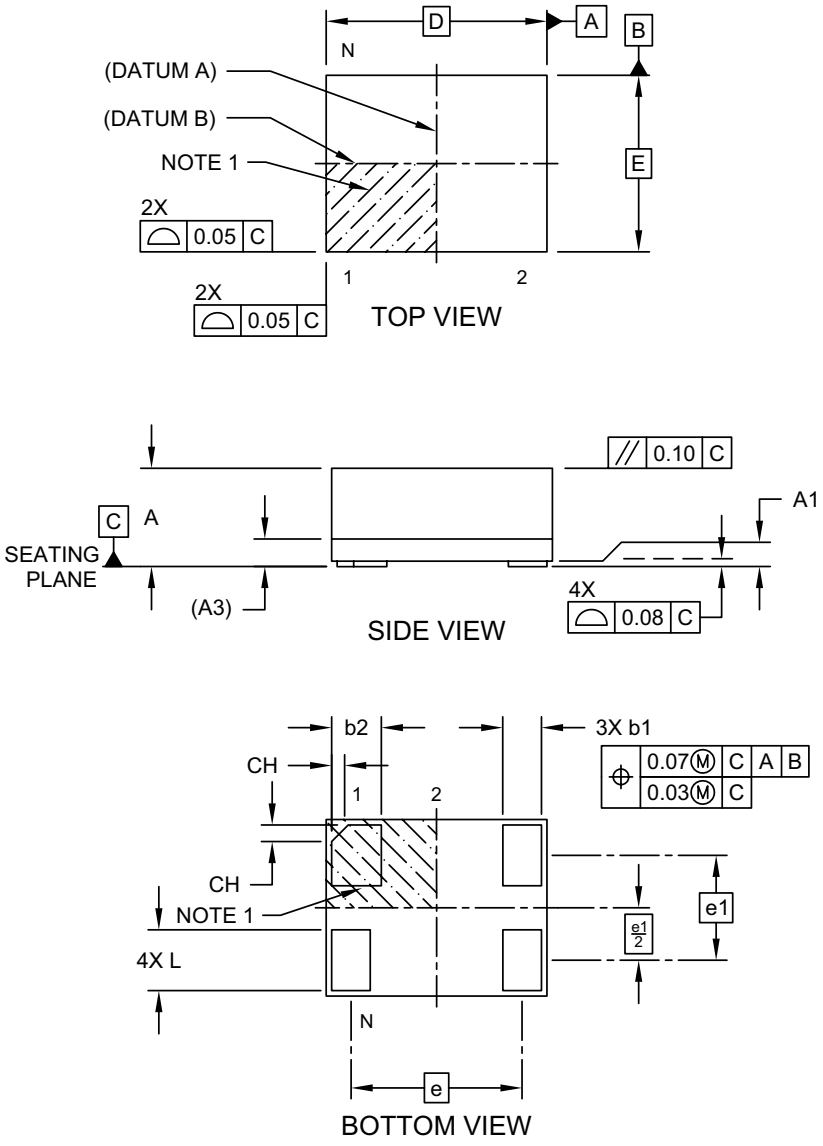
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-3199A

4-Lead Very Thin Fine Pitch Land Grid Array (ASA) - 2.0x1.6 mm Body [VFLGA]

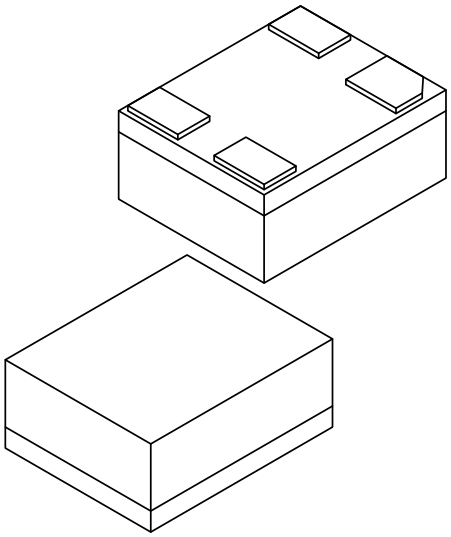
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1200A Sheet 1 of 2

4-Lead Very Thin Fine Pitch Land Grid Array (ASA) - 2.0x1.6 mm Body [VFLGA]

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 Terminals	N		6	
Terminal Pitch	e		1.55 BSC	
Terminal Pitch	e1		0.95 BSC	
Overall Height	A	0.79	0.84	0.89
Standoff	A1	0.00	0.02	0.05
Substrate Thickness (with Terminals)	A3		0.20 REF	
Overall Length	D		2.00 BSC	
Overall Width	E		1.60 BSC	
Terminal Width	b1	0.30	0.35	0.40
Terminal Width	b2	0.40	0.45	0.50
Terminal Length	L	0.50	0.55	0.60
Terminal 1 Index Chamfer	CH	-	0.15	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

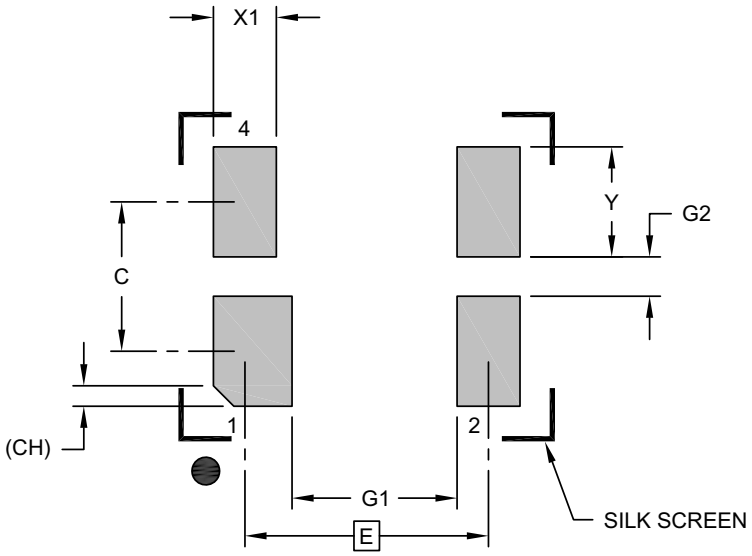
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-1200A Sheet 2 of 2

4-Lead Very Thin Fine Pitch Land Grid Array (ASA) - 2.0x1.6 mm Body [VFLGA]

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	1.55 BSC		
Contact Spacing	C		0.95	
Contact Width (X4)	X1			0.50
Contact Width (X2)	X2			0.40
Contact Pad Length (X6)	Y			0.70
Space Between Contacts (X4)	G1	1.05		
Space Between Contacts (X3)	G2	0.25		
Contact 1 Index Chamfer	CH	0.13 X 45° REF		

Notes:

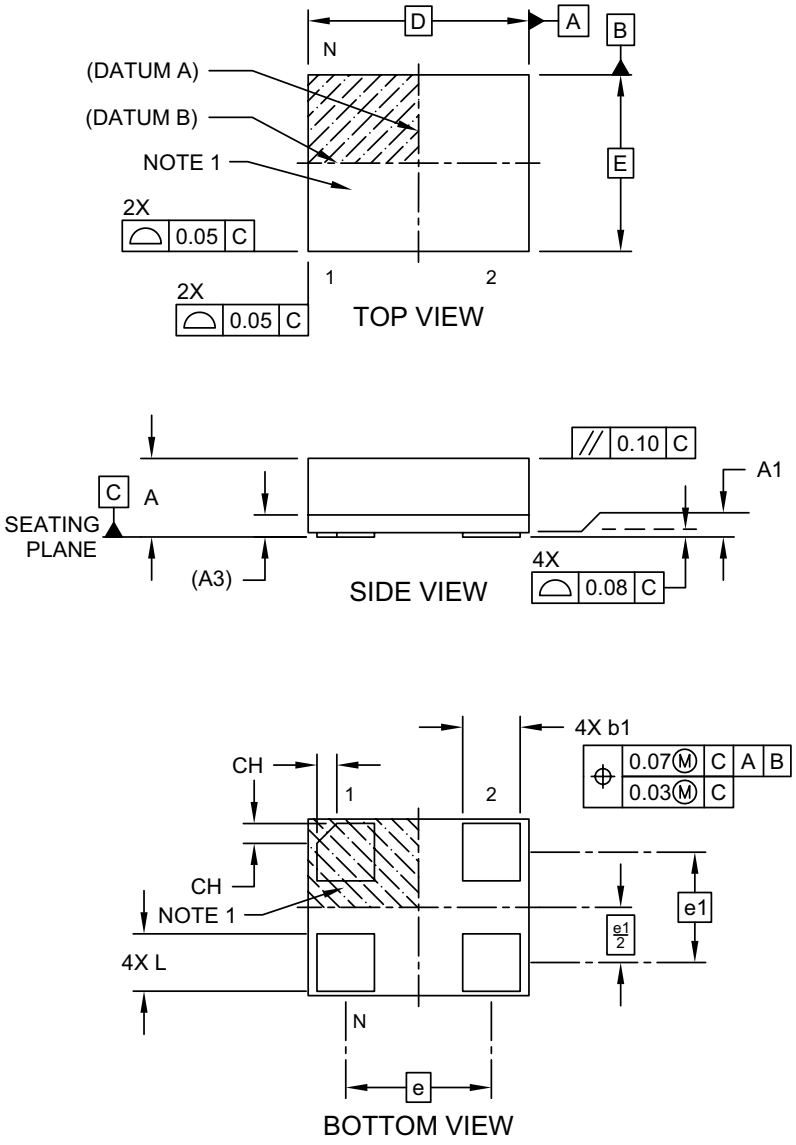
1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing C04-3200A

4-Lead Very Thin Land Grid Array (AUA) - 2.5x2.0 mm Body [VLGA]

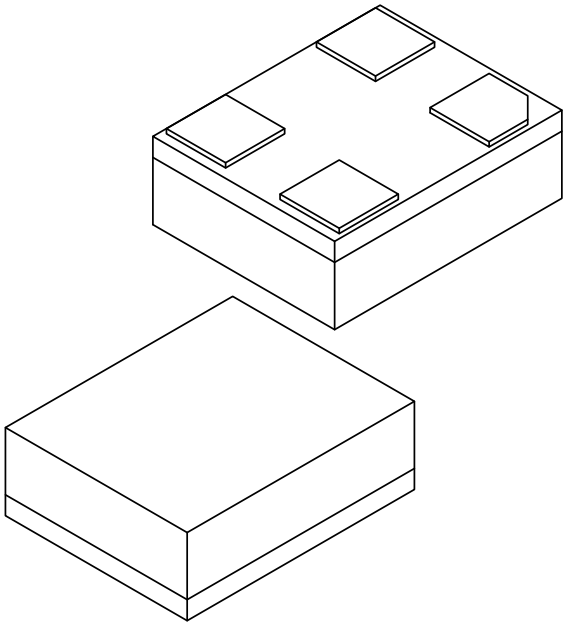
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1202A Sheet 1 of 2

4-Lead Very Thin Land Grid Array (AUA) - 2.5x2.0 mm Body [VLGA]

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 Terminals	N		4	
Terminal Pitch	e		1.65 BSC	
Terminal Pitch	e1		1.25 BSC	
Overall Height	A	0.79	0.84	0.89
Standoff	A1	0.00	0.02	0.05
Substrate Thickness (with Terminals)	A3		0.20 REF	
Overall Length	D		2.50 BSC	
Overall Width	E		2.00 BSC	
Terminal Width	b1	0.60	0.65	0.70
Terminal Length	L	0.60	0.65	0.70
Terminal 1 Index Chamfer	CH	-	0.225	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

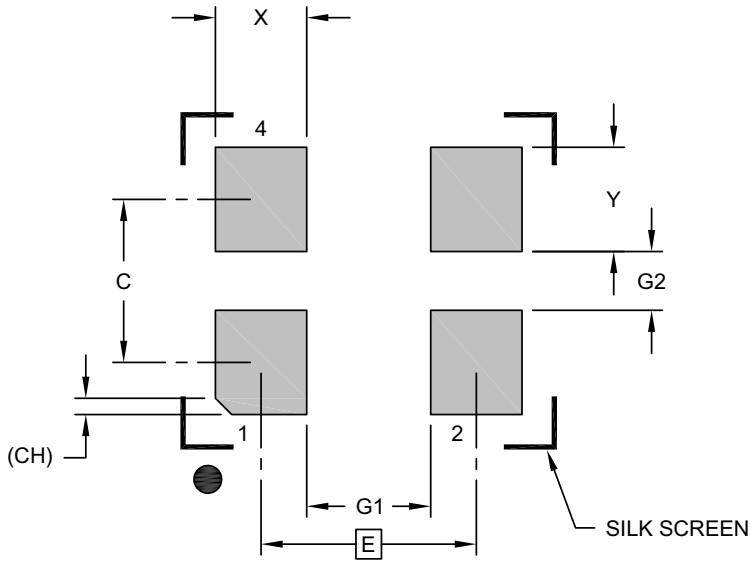
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-1202A Sheet 2 of 2

4-Lead Very Thin Land Grid Array (AUA) - 2.5x2.0 mm Body [VLGA]

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		1.65 BSC	
Contact Spacing	C		1.25	
Contact Width (X4)	X			0.70
Contact Pad Length (X6)	Y			0.80
Space Between Contacts (X4)	G1	0.95		
Space Between Contacts (X3)	G2	0.45		
Contact 1 Index Chamfer	CH		0.13 X 45° REF	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-3202A

APPENDIX A: REVISION HISTORY

Revision A (January 2019)

- Initial creation of DSC61xxB Microchip data sheet DS20006155A.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	X	X	X	X	X	X	–	XXX.XXXX	X
Device	Pin 1 Definition	Output Drive Strength	Package	Temperature Range	Frequency Stability	Revision		Frequency	Media Type

Device: DSC61: Ultra-Small, Ultra-Low Power MEMS Oscillator

Pin Definition:	Selection	Pin 1	Internal Pull-Up Register
	0	OE	Pull-up
	1	$\overline{\text{STDBY}}$	Pull-up
	2	FS	Pull-up
	4	OE	None
	5	$\overline{\text{STDBY}}$	None
	6	FS	None

Output Drive Strength: 1 Standard; 2 High

Packages:
J = 4-Lead 2.5 mm x 2.0 mm VLGA
M = 4-Lead 2.0 mm x 1.6 mm VFLGA
H = 4-Lead 1.6 mm x 1.2 mm VFLGA

Temperature Range:
A = –40°C to +125°C (Automotive)
L = –40°C to +105°C (Extended Industrial)
I = –40°C to +85°C (Industrial)
E = –20°C to +70°C (Extended Commercial)

Frequency Stability:
1 = ± 50 ppm
2 = ± 25 ppm
3 = ± 20 ppm

Revision: B = Revision B

Frequency:
xxx.xxxx = User-Defined Frequency between 001.0000 MHz and 100.0000 MHz
xxxkxxx = User-Defined Frequency between 003.500 kHz and 999.999 kHz
xxxx = Frequency configuration code when pin 1 = FS. Configure the part online through ClockWorks

Media Type:
<blank>= 140/Tube (J Package Option)
<blank>= 100/Bag (M & H Package Option)
T = 1,000/Reel
B = 3,000/Reel

Examples:

a) DSC6112JI2B-100.0000:
Ultra-Small, Ultra-Low Power MEMS Oscillator, Pin 1 = $\overline{\text{STDBY}}$ with Internal Pull-Up, High Drive Strength, 4-Lead 2.5 mm x 2.0 mm VLGA, Industrial Temperature, ±25 ppm Stability, Revision B, 100 MHz Frequency, 140/Tube

b) DSC6101HE1B-016.0000T:
Ultra-Small, Ultra-Low Power MEMS Oscillator, Pin 1 = OE with Internal Pull-Up, Standard Drive Strength, 4-Lead 1.6 mm x 1.2 mm VFLGA, Extended Commercial Temperature, ±50 ppm Stability, Revision B, 16 MHz Frequency, 1,000/Reel

c) DSC6121MI2B-005QB:
Ultra-Small, Ultra-Low Power MEMS Oscillator, Pin 1 = Freq. Select with Internal Pull-Up, Standard Drive Strength, 4-Lead 2.0 mm x 1.6 mm VFLGA, Industrial Temperature, ±25 ppm Stability, Revision B, Two Frequencies Configured through ClockWorks, 3,000/Reel

Note 1: Media Type identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with different media options.

Note 1: Please visit Microchip ClockWorks® Configurator Website to configure the part number for customized frequency. http://clockworks.microchip.com/timing/.

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.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Trademarks

ISBN: 978-1-5224-4095-6

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880- 3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-67-3636

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820