

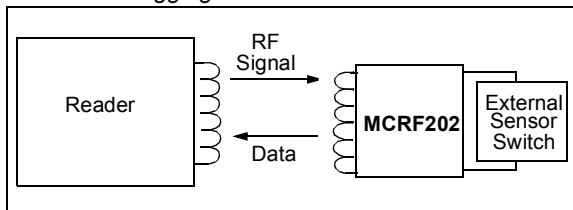
## Passive RFID Device with Sensor Input

### Features

- External sensor input
- Data polarity changes with sensor input condition
- Read only data transmission
- 96- or 128-bits of factory programming user memory (also supports 48 and 64-bit protocols)
- Operates up to 400 kHz carrier frequency
- Low-power operation
- Modulation options:
  - ASK, FSK, PSK
- Data Encoding options:
  - NRZ Direct, Differential Biphase, Manchester Biphase
- Die, Wafer, PDIP, or SOIC package option
- Factory programming and device serialization

### Applications

- Insect control
- Industrial tagging



### Package Type

PDIP/SOIC			
VA	1	8	VB
NC	2	7	NC
TEST	3	6	Vss
SENSOR	4	5	Vcc

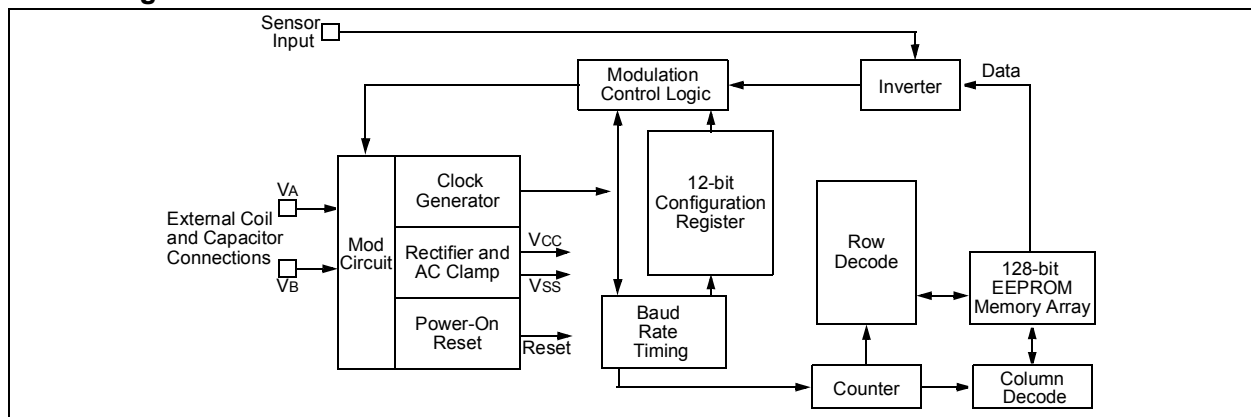
### Description

The MCRF202 is a passive Radio Frequency Identification (RFID) device that provides an RF interface for reading the contents of a user memory array. This device is specially designed to detect the logic state of an external sensor, and alters its data transmissions, based on the condition of the sensor input. The device outputs a normal bit data stream if the sensor input has a logic '1' state, but outputs an inverted data stream for a logic '0' state. In this way, the reader can monitor the state (condition) of the external sensor input by detecting whether the data from the device is a normal or inverted data stream.

The device is powered by rectifying the incoming RF carrier signal that is transmitted from the reader. When the device develops sufficient DC voltage, it transmits the contents of its memory array by modulating the incoming RF carrier signal. The reader is able to detect the modulation and decodes the data being transmitted. Code length, modulation option, encoding option, and bit rate are set at the factory to fit the needs of particular applications.

The MCRF202 is available in die, wafer, PDIP and SOIC packages. The encoding, modulation, bit rate options, and data fields are specified by the customer and programmed by Microchip Technology Inc. prior to shipment. See TB023 for more information on factory serialization (SQTP™).

### Block Diagram



# MCRF202

## 1.0 ELECTRICAL CHARACTERISTICS

### 1.1 Maximum Ratings\*

Storage temperature ..... - 65°C to +150°C

Ambient temp. with power applied ..... -40°C to +125°C

Maximum current into coil pads.....50 mA

**\*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 those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**TABLE 1-1: AC AND DC CHARACTERISTICS**

All parameters apply across the specified operating ranges unless otherwise noted.		Industrial (I): TAMB = -40°C to +85°C				
Parameter	Sym	Min	Typ	Max	Units	Conditions
Clock frequency	FCLK	100	—	400	kHz	
Data retention		200	—	—	Years	25°C
Coil current (Dynamic)	ICD	—	50	—	μA	
Operating current with no Vcc load	IDD	—	5	—	μA	Vcc = 2V No load to Vcc pad
Operating current with Vcc load	IDL	—	10	—	μA	Vcc = 2V Vcc load through switch to sensor
Turn-on-voltage (Dynamic) for modulation	VAVB	10	—	—	VPP	
	VCC	2	—	—	VDC	
Input Capacitance	CIN	—	2	—	pF	Between VA and VB
SENSOR pull-down	RS	400	800	1200	kΩ	
SENSOR trigger threshold	VS	0.5	1.0	1.5	V	

## 2.0 FUNCTIONAL DESCRIPTION

The device contains three major building blocks. They are RF front-end and sensor input, configuration and control logic, and memory sections. The Block Diagram is shown on page 1.

### 2.1 RF Front-End and Sensor Input

The RF front-end of the device includes circuits for rectification of the carrier,  $V_{DD}$  (operating voltage), and high-voltage clamping to prevent excessive voltage from being applied to the device. This section also generates a system clock from the incoming carrier signal and modulates the carrier signal to transmit data to the reader.

#### 2.1.1 RECTIFIER – AC CLAMP

The AC voltage generated by the external tuned LC circuit is full wave rectified. This unregulated voltage is used as the maximum DC supply voltage for the rest of the device and for the  $V_{CC}$  supply to the external sensor or switch. Any excessive voltage on the tuned circuit is clamped by the internal circuitry to a safe level to prevent damage to the IC.

#### 2.1.2 MODULATION CIRCUIT

The MCRF202 sends the encoded data to the reader by AM-modulating the coil voltage across the tuned LC circuit. A modulation transistor is placed between the antenna coil pads ( $V_A$  and  $V_B$ ). The transistor turns on and off based on the modulation signal. As a result, the amplitude of the antenna coil voltage varies with the modulation signal. See Figure 2-1 for details.

#### 2.1.3 $V_{CC}$ REGULATOR

The device generates a DC supply voltage from the unregulated coil voltage.

#### 2.1.4 CLOCK GENERATOR

This circuit generates a clock based on the carrier frequency from the reader. This clock is used to derive all timing in the MCRF202, including the baud rate and modulation rate.

#### 2.1.5 POWER-ON RESET

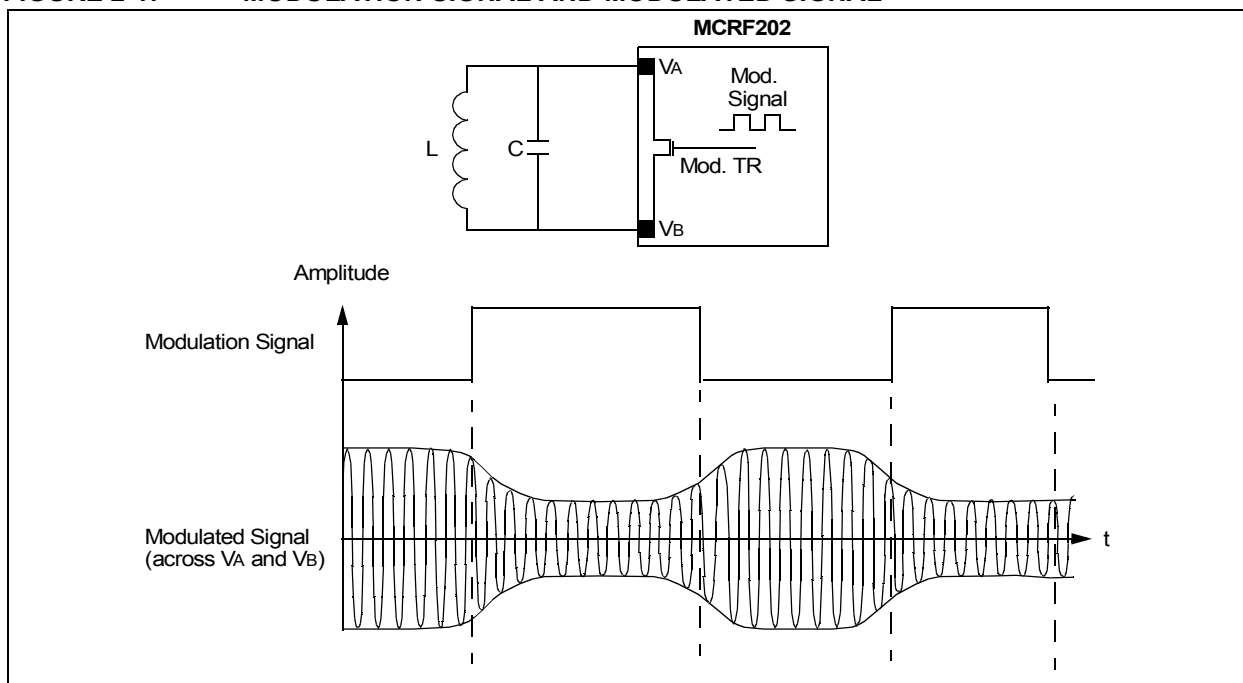
This circuit generates a power-on reset when the tag first enters the interrogator field. The reset releases when sufficient power has developed on the  $V_{DD}$  regulator to allow correct operation.

#### 2.1.6 SENSOR INPUT AND DATA INVERTER

The SENSOR input responds to logic high or logic low voltages to drive the internal inverter on or off. A logic high results in normal tag operation; a logic low at SENSOR input activates an inverter, which inverts the entire data stream prior to modulation.

The SENSOR input has an internal pull-down resistor of 800 k $\Omega$  (typical). See Figure 2-4 for application details.

**FIGURE 2-1: MODULATION SIGNAL AND MODULATED SIGNAL**



## 2.2 Configuration Register and Control Logic

The configuration register determines the operational parameters of the device. It directly controls logic blocks which generate the baud rate, memory size, encoded data, modulation protocol, etc. CB11 is always a zero. Once the array is successfully programmed at the factory, the lock bit CB12 is set. When the lock bit is set, programming and erasing the device becomes permanently disabled. Table 2-1 contains a description of the control register bit functions.

### 2.2.1 BAUD RATE TIMING OPTION

The chip will access data at a baud rate determined by bits CB2, CB3, and CB4 of the configuration register. For example, MOD32 (CB2 = 0, CB3 = 1, CB4 = 1) has 32 RF cycles per bit. This gives the data rate of 4 kHz for the RF carrier frequency of 128 kHz.

### 2.2.2 DATA ENCODING OPTION

This logic acts upon the serial data being read from the EEPROM. The logic encodes the data according to the configuration bits CB6 and CB7. CB6 and CB7 determine the data encoding method. The available choices are:

- Non-return to zero-level (NRZ\_L)
- Biphase\_S (Differential)
- Biphase\_L (Manchester)
- Inverted Manchester

### 2.2.3 MODULATION OPTION

CB8 and CB9 determine the modulation protocol of the encoded data. The available choices are:

- ASK
- FSK
- PSK\_1
- PSK\_2

When ASK (direct) option is chosen, the encoded data is fed into the modulation transistor without change.

When FSK option is chosen, the encoded data is represented by:

- a. Sets of 10 RF carrier cycles (first 5 cycles → higher amplitude, the last 5 cycles → lower amplitude) for logic “high” level.
- b. Sets of 8 RF carrier cycles (first 4 cycles → higher amplitude, the last 4 cycles → lower amplitude) for logic “low” level.

For example, FSK signal for MOD40 is represented:

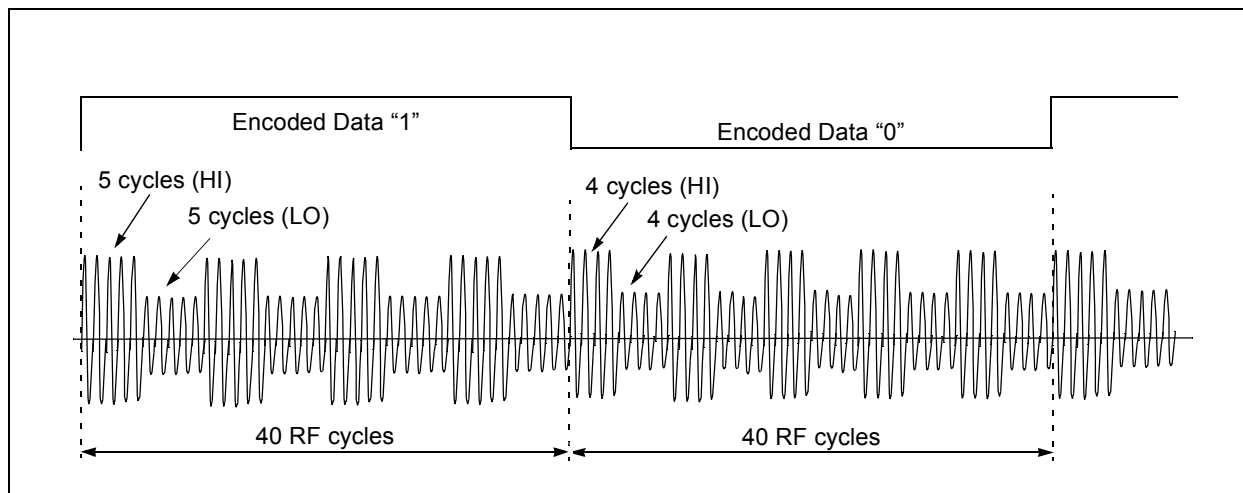
- a. 4 sets of 10 RF carrier cycles for data ‘1’.
- b. 5 sets of 8 RF carrier cycles for data ‘0’.

Refer to Figure 2-2 for the FSK signal with MOD40 option.

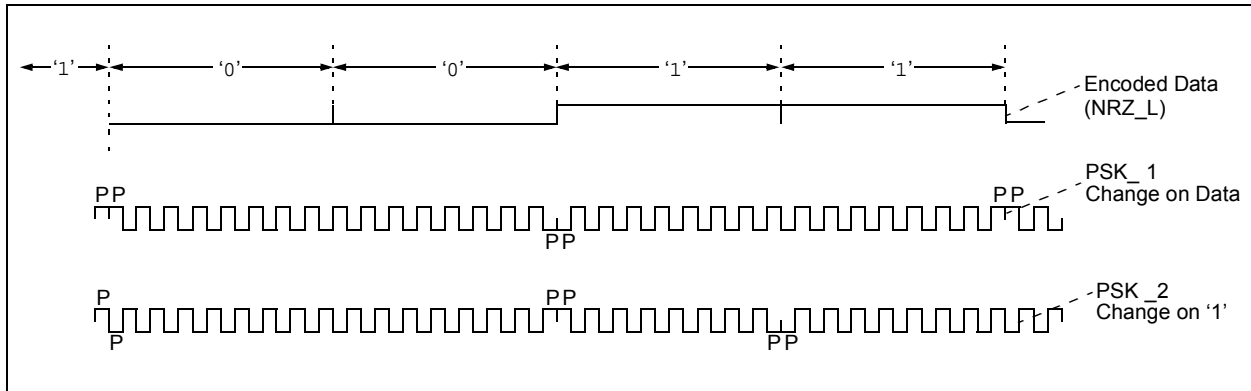
The PSK\_1 represents change in the phase of the modulation signal at the change of the encoded data. For example, the phase changes when the encoded data is changed from ‘1’ to ‘0’, or from ‘0’ to ‘1’.

The PSK\_2 represents change in the phase at the change on ‘1’. For example, the phase changes when the encoded data is changed from ‘0’ to ‘1’, or from ‘1’ to ‘1’.

**FIGURE 2-2: ENCODED DATA AND FSK OUTPUT SIGNAL FOR MOD40 OPTION**



**FIGURE 2-3: PSK DATA MODULATION**



## 2.2.4 MEMORY ARRAY LOCK BIT (CB12)

The CB12 bit must be a '1' for a factory programmed device.

## 2.3 Memory Section

The device has 128 bits of one-time-programmable (OTP) memory. The user can choose 96 or 128 bits by selecting the CB1 bit in the configuration register. See Table 2-1 for more details.

### 2.3.1 COLUMN AND ROW DECODER LOGIC AND BIT COUNTER

The column and row decoders address the EEPROM array at the clock rate and generate a serial data stream for modulation. This data stream can be up to 128 bits in length. The size of the data stream is user programmable with CB1 and can be set to 96 or 128 bits. Data lengths of 48 and 64 bits are available by programming the data twice in the array, end-to-end.

The column and row decoders route the proper voltage to the array for programming and reading. In the programming modes, each individual bit is addressed serially from bit 1 to bit 128.

## 2.4 Examples of Configuration Settings

### EXAMPLE 2-1: "88D" Configuration

The "88D" (hex) configuration is interpreted as follows:

CB12                      CB1  
"88D" → 1000-1000-1101

Referring to Table 2-1, the "88D" configuration represents:

Modulation = PSK\_1  
PSK rate = rf/2  
Data encoding = NRZ\_L (direct)  
Baud rate = rf/32 = MOD32  
Memory size: 128 bits  
Programmed device

### EXAMPLE 2-2: "80A" Configuration

The "80A" (hex) configuration is interpreted as follows:

CB12                      CB1  
"80A" → 1000-0000-1010

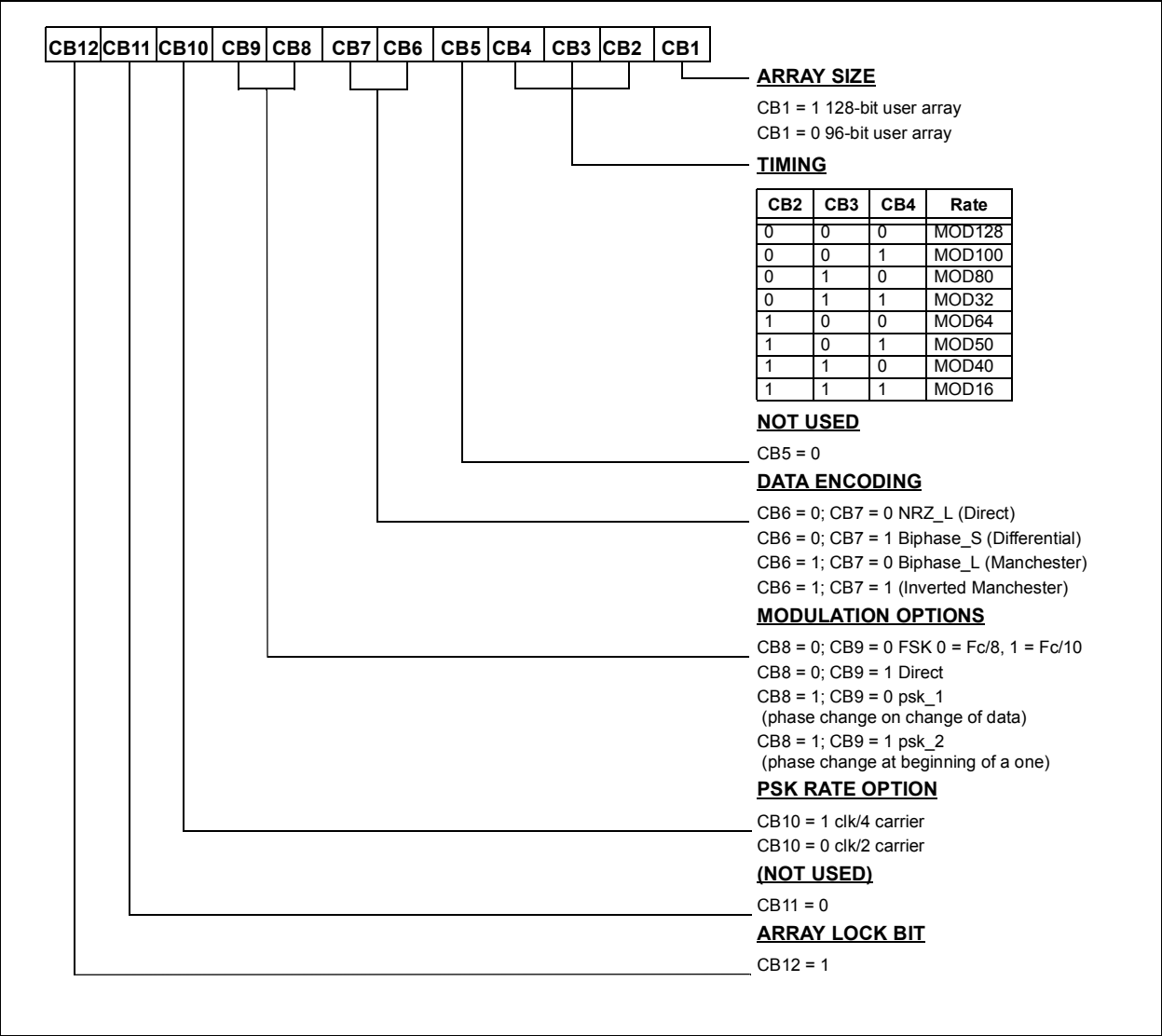
The MSB corresponds to CB12 and the LSB corresponds to CB1 of the configuration register. Therefore, we have:

CB12=1	CB11=0	CB10=0	CB9=0
CB8=0	CB7=0	CB6=0	CB5=0
CB4=1	CB3=0	CB2=1	CB1=0

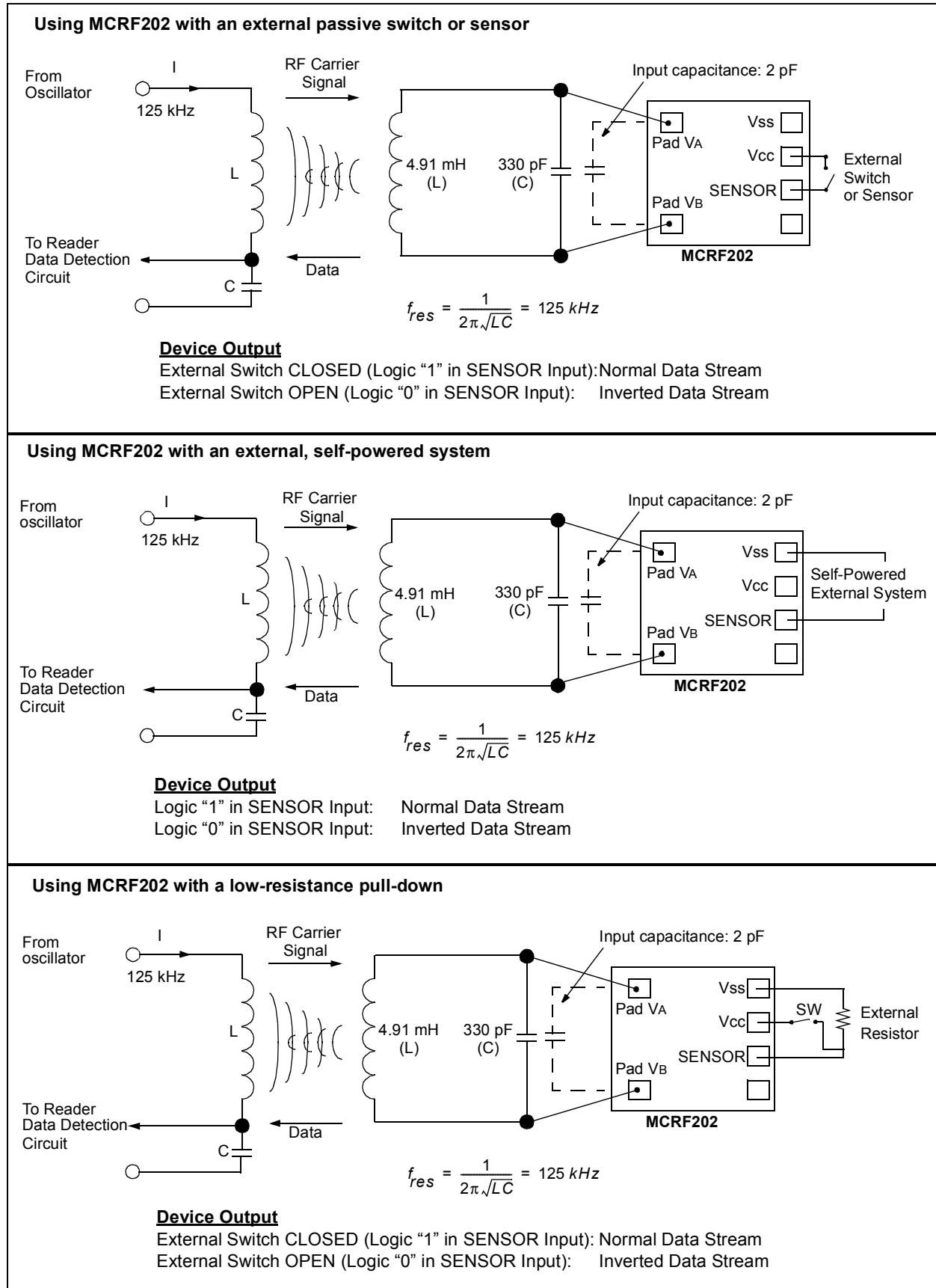
Referring to Table 2-1, the "80A" configuration represents:

Programmed device, FSK protocol, NRZ\_L (direct) encoding, MOD50 (baud rate = rf/50), 96 bits.

TABLE 2-1: CONFIGURATION REGISTER



**FIGURE 2-4: TYPICAL APPLICATION CIRCUITS**



3.0 MECHANICAL SPECIFICATIONS FOR DIE AND WAFER

FIGURE 3-1: DIE PLOT

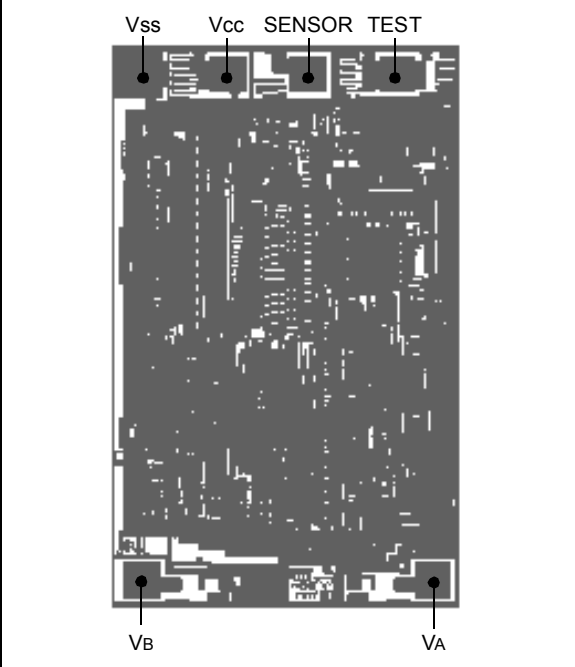


TABLE 3-1: PAD COORDINATES (μM)

Pad Name	Passivation Openings		Pad Center X	Pad Center Y
	Pad Width	Pad Height		
VA	90.0	90.0	427.50	-734.17
VB	90.0	90.0	-408.60	-734.17
Vss	105.3	112.5	-417.60	722.47
Vcc	90.0	90.0	-164.70	723.82
SENSOR	90.0	90.0	69.30	723.82
TEST	90.0	90.0	325.35	723.82

**Note 1:** All coordinates are referenced from the center of the die.  
**2:** Die size: 1.1215 mm x 1.7384 mm.

TABLE 3-2: PAD FUNCTION TABLE

Name	Function
VA, VB	Coil and capacitor connections
Vss	Device ground
Vcc	DC supply out from device
SENSOR	Sensor input
TEST	Do Not Connect, Test pin



**TABLE 3-3: DIE MECHANICAL DIMENSIONS**

Specifications	Min	Typ	Max	Unit	Comments
Bond pad opening	— —	3.5 x 3.5 89 x 89	— —	mil μm	Note 1, Note 2
Die backgrind thickness	— —	7 177.8	— —	mil μm	Sawed 6" wafer on frame (option = WF) <b>Note 3</b>
	— —	11 279.4	— —	mil μm	Unsawed wafer (option = W) <b>Note 3</b>
Die backgrind thickness tolerance	— —	— —	±1 ±25.4	mil μm	Note 4
Die passivation thickness (multilayer)	—	0.9050	—	μm	Note 5
Die Size:					
Die size X*Y before saw (step size)	—	44.15 x 68.44	—	mil	—
Die size X*Y after saw	—	42.58 x 66.87	—	mil	—

- Note 1:** The bond pad size is that of the passivation opening. The metal overlaps the bond pad passivation by at least 0.1 mil.
- 2:** Metal Pad Composition is 98.5% Aluminum with 1% Si and 0.5% Cu.
- 3:** As the die thickness decreases, susceptibility to cracking increases. It is recommended that the die be as thick as the application will allow.
- 4:** This specification is not tested. For design guidance only.
- 5:** The Die Passivation thickness can vary by device depending on the mask set used:
- Layer 1: Oxide (undoped oxide 0.135 μm)
  - Layer 2: PSG (doped oxide, 0.43 μm)
  - Layer 3: Oxynitride (top layer, 0.34 μm)
- 6:** The conversion rate is 25.4 μm/mil.

**Notice:** Extreme care is urged in the handling and assembly of die products since they are susceptible to mechanical and electrostatic damage.

**TABLE 3-4: WAFER MECHANICAL SPECIFICATIONS**

Specifications	Min	Typ	Max	Unit	Comments
Wafer Diameter	—	6	—	inch	150 mm
Die separation line width	—	80	—	μm	
Dies per wafer	—	8,000	—	die	
Batch size	—	24	—	wafer	

## 4.0 FAILED DIE IDENTIFICATION

Every die on the wafer is electrically tested according to the datasheet specifications and visually inspected to detect any mechanical damage such as mechanical cracks and scratches.

Any failed die in the test or visual inspection is identified by black colored inking. Therefore, any die covered with black ink should not be used.

The ink dot specification:

- Ink dot size: minimum 20  $\mu\text{m}$  x 20  $\mu\text{m}$
- Position: central third of die
- Color: black

## 5.0 WAFER DELIVERY DOCUMENTATION

Each wafer container is marked with the following information:

- Microchip Technology Inc. MP Code
- Lot Number
- Total number of wafer in the container
- Total number of good dice in the container
- Average die per wafer (DPW)
- Scribe number of wafer with number of good dice.

## 6.0 NOTICE ON DIE AND WAFER HANDLING

The device is very susceptible to Electro-Static Discharge (ESD). ESD can cause critical damage to the device. Special attention is needed during the handling process.

Any ultraviolet (UV) light can erase the memory cell contents of an unpackaged device. Fluorescent lights and sun light can also erase the memory cell although it takes more time than UV lamps. Therefore, keep any unpackaged devices out of UV light and also avoid direct exposure from strong fluorescent lights and sun light.

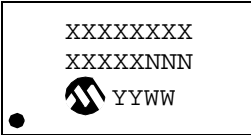
Certain integrated circuit (IC) manufacturing, chip-on-board (COB) and tag assembly operations may use UV light. Operations such as backgrind, de-tape, certain cleaning operations, epoxy or glue cure should be done without exposing the die surface to UV light.

Using x-ray for die inspection will not harm the die, nor erase memory cell contents.

## 7.0 PACKAGING INFORMATION

### 7.1 Package Marking Information

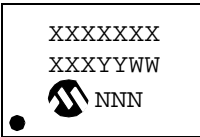
8-Lead PDIP (300 mil)



Example:



8-Lead SOIC (150 mil)



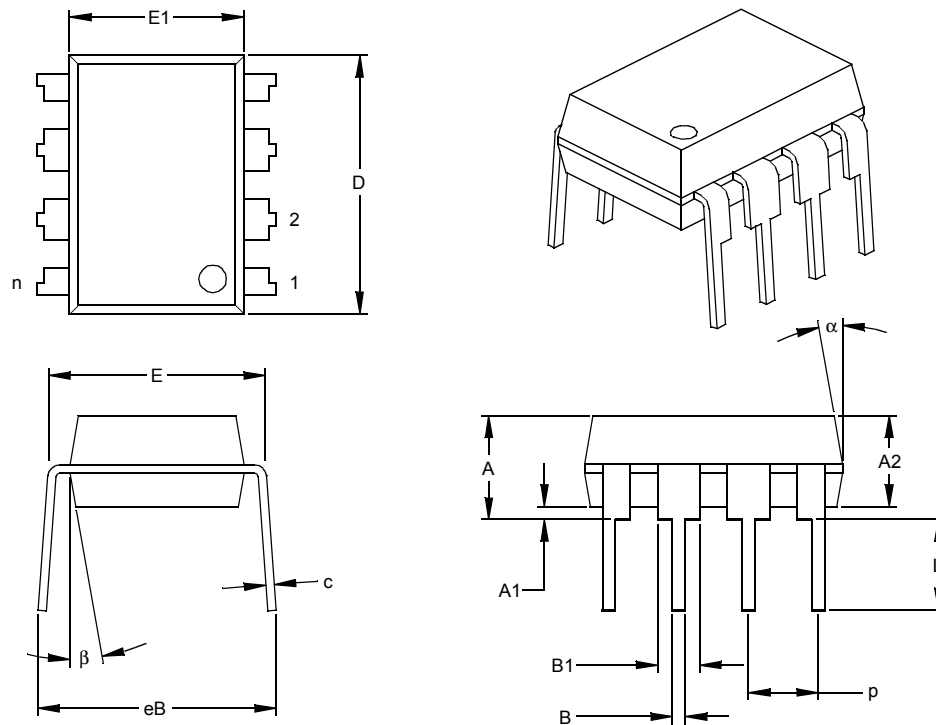
Example:



<b>Legend:</b>	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
<b>Note:</b>	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.	

\* Standard OTP marking consists of Microchip part number, year code, week code, and traceability code.

## 8-Lead Plastic Dual In-line (P) – 300 mil (PDIP)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.360	.373	.385	9.14	9.46	9.78
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing	§ eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

\* Controlling Parameter

§ Significant Characteristic

### Notes:

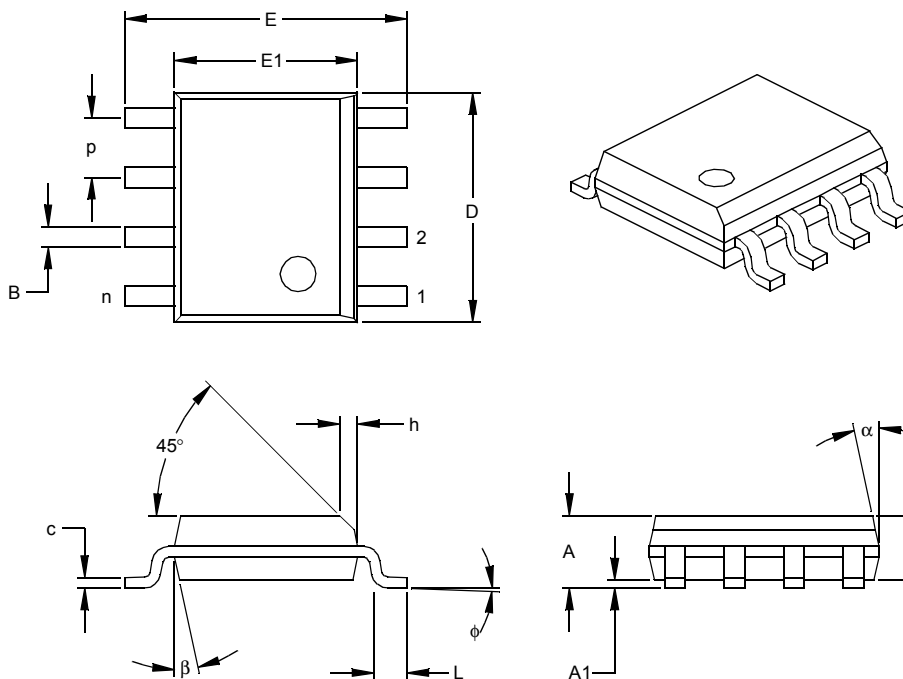
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-001

Drawing No. C04-018

# MCRF202

## 8-Lead Plastic Small Outline (SN) – Narrow, 150 mil (SOIC)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.050			1.27	
Overall Height	A	.053	.061	.069	1.35	1.55	1.75
Molded Package Thickness	A2	.052	.056	.061	1.32	1.42	1.55
Standoff §	A1	.004	.007	.010	0.10	0.18	0.25
Overall Width	E	.228	.237	.244	5.79	6.02	6.20
Molded Package Width	E1	.146	.154	.157	3.71	3.91	3.99
Overall Length	D	.189	.193	.197	4.80	4.90	5.00
Chamfer Distance	h	.010	.015	.020	0.25	0.38	0.51
Foot Length	L	.019	.025	.030	0.48	0.62	0.76
Foot Angle	φ	0	4	8	0	4	8
Lead Thickness	c	.008	.009	.010	0.20	0.23	0.25
Lead Width	B	.013	.017	.020	0.33	0.42	0.51
Mold Draft Angle Top	α	0	12	15	0	12	15
Mold Draft Angle Bottom	β	0	12	15	0	12	15

\* Controlling Parameter

§ Significant Characteristic

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-012

Drawing No. C04-057

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The file transfer site is available by using an FTP service to connect to:

**<ftp://ftp.microchip.com>**

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- Conferences for products, Development Systems, technical information and more
- Listing of seminars and events

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Would you like a reply? \_\_\_\_Y \_\_\_\_N

Device: **MCRF202**

Literature Number: **DS21308D**

Questions:

1. What are the best features of this document?

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3. Do you find the organization of this data sheet easy to follow? If not, why?

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4. What additions to the data sheet do you think would enhance the structure and subject?

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5. What deletions from the data sheet could be made without affecting the overall usefulness?

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6. Is there any incorrect or misleading information (what and where)?

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8. How would you improve our software, systems, and silicon products?

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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.

<u>PART NO.</u>	<u>-X</u>	<u>/XXX</u>	<u>XXX</u>
Device	Temperature Range	Package	Configuration
<div>Device: MCRF202 = 125 kHz MicroID tag with Sensor input, 96/128-bit</div> <div>Temperature Range: I = -40°C to +85°C</div> <div>Package:<div>WF = Sawed wafer on frame (7 mil backgrind)</div><div>W = Wafer (11 mil backgrind)</div><div>S = Dice in wafer pack (11 mil backgrind)</div><div>WFB = Sawed, Bumped wafer on frame (11 mil backgrind)</div><div>WB = Bumped wafer (11 mil backgrind)</div><div>SB = Bumped die in wafer pack (11 mil backgrind)</div><div>SN = Plastic SOIC (150 mil body) 8-lead</div><div>P = Plastic DIP (300 mil body) 8-lead</div></div> <div>Configuration: SQTP Customer Identifier. Assigned during the SQTP (factory programming) approval process. Always Qxx where xx is an integer used to track customer data files.</div>			

Examples:

a) MCRF202-I/WQ99 = 125 kHz, industrial temperature, wafer package, factory programmed, sensor input, "Q99" sample customer code.

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2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site ([www.microchip.com](http://www.microchip.com))

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

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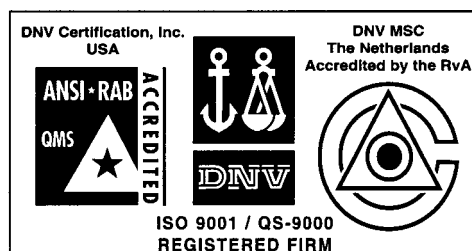
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## WORLDWIDE SALES AND SERVICE

### AMERICAS

#### Corporate Office

2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 480-792-7200 Fax: 480-792-7277  
Technical Support: 480-792-7627  
Web Address: <http://www.microchip.com>

#### Rocky Mountain

2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 480-792-7966 Fax: 480-792-7456

#### Atlanta

500 Sugar Mill Road, Suite 200B  
Atlanta, GA 30350  
Tel: 770-640-0034 Fax: 770-640-0307

#### Boston

2 Lan Drive, Suite 120  
Westford, MA 01886  
Tel: 781-692-3848 Fax: 978-692-3821

#### Chicago

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Itasca, IL 60143  
Tel: 630-285-0071 Fax: 630-285-0075

#### Dallas

4570 Westgrove Drive, Suite 160  
Addison, TX 75001  
Tel: 972-818-7423 Fax: 972-818-2924

#### Detroit

Tri-Atria Office Building  
32255 Northwestern Highway, Suite 190  
Farmington Hills, MI 48334  
Tel: 248-538-2250 Fax: 248-538-2260

#### Kokomo

2767 S. Albright Road  
Kokomo, Indiana 46902  
Tel: 765-864-8360 Fax: 765-864-8387

#### Los Angeles

18201 Von Karman, Suite 1090  
Irvine, CA 92612  
Tel: 949-263-1888 Fax: 949-263-1338

#### New York

150 Motor Parkway, Suite 202  
Hauppauge, NY 11788  
Tel: 631-273-5305 Fax: 631-273-5335

#### San Jose

Microchip Technology Inc.  
2107 North First Street, Suite 590  
San Jose, CA 95131  
Tel: 408-436-7950 Fax: 408-436-7955

#### Toronto

6285 Northam Drive, Suite 108  
Mississauga, Ontario L4V 1X5, Canada  
Tel: 905-673-0699 Fax: 905-673-6509

### ASIA/PACIFIC

#### Australia

Microchip Technology Australia Pty Ltd  
Suite 22, 41 Rawson Street  
Epping 2121, NSW  
Australia  
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

#### China - Beijing

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Beijing Liaison Office  
Unit 915  
Bei Hai Wan Tai Bldg.  
No. 6 Chaoyangmen Beidajie  
Beijing, 100027, No. China  
Tel: 86-10-85282100 Fax: 86-10-85282104

#### China - Chengdu

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Chengdu Liaison Office  
Rm. 2401, 24th Floor,  
Ming Xing Financial Tower  
No. 88 TIDU Street  
Chengdu 610016, China  
Tel: 86-28-6766200 Fax: 86-28-6766599

#### China - Fuzhou

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Fuzhou Liaison Office  
Unit 28F, World Trade Plaza  
No. 71 Wusi Road  
Fuzhou 350001, China  
Tel: 86-591-7503506 Fax: 86-591-7503521

#### China - Shanghai

Microchip Technology Consulting (Shanghai)  
Co., Ltd.  
Room 701, Bldg. B  
Far East International Plaza  
No. 317 Xian Xia Road  
Shanghai, 200051  
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

#### China - Shenzhen

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Shenzhen Liaison Office  
Rm. 1315, 13/F, Shenzhen Kerry Centre,  
Renminnan Lu  
Shenzhen 518001, China  
Tel: 86-755-2350361 Fax: 86-755-2366086

#### Hong Kong

Microchip Technology Hongkong Ltd.  
Unit 901-6, Tower 2, Metroplaza  
223 Hing Fong Road  
Kwai Fong, N.T., Hong Kong  
Tel: 852-2401-1200 Fax: 852-2401-3431

#### India

Microchip Technology Inc.  
India Liaison Office  
Divyasree Chambers  
1 Floor, Wing A (A3/A4)  
No. 11, O'Shaughnessy Road  
Bangalore, 560 025, India  
Tel: 91-80-2290061 Fax: 91-80-2290062

### Japan

Microchip Technology Japan K.K.  
Benex S-1 6F  
3-18-20, Shinyokohama  
Kohoku-Ku, Yokohama-shi  
Kanagawa, 222-0033, Japan  
Tel: 81-45-471-6166 Fax: 81-45-471-6122

### Korea

Microchip Technology Korea  
168-1, Youngbo Bldg. 3 Floor  
Samsung-Dong, Kangnam-Ku  
Seoul, Korea 135-882  
Tel: 82-2-554-7200 Fax: 82-2-558-5934

### Singapore

Microchip Technology Singapore Pte Ltd.  
200 Middle Road  
#07-02 Prime Centre  
Singapore, 188980  
Tel: 65-334-8870 Fax: 65-334-8850

### Taiwan

Microchip Technology Taiwan  
11F-3, No. 207  
Tung Hua North Road  
Taipei, 105, Taiwan  
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

### EUROPE

#### Denmark

Microchip Technology Nordic ApS  
Regus Business Centre  
Lautrup hof 1-3  
Ballerup DK-2750 Denmark  
Tel: 45 4420 9895 Fax: 45 4420 9910

#### France

Microchip Technology SARL  
Parc d'Activite du Moulin de Massy  
43 Rue du Saule Trappu  
Batiment A - 1er Etage  
91300 Massy, France  
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

#### Germany

Microchip Technology GmbH  
Gustav-Heinemann Ring 125  
D-81739 Munich, Germany  
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

#### Italy

Microchip Technology SRL  
Centro Direzionale Colleoni  
Palazzo Taurus 1 V. Le Colleoni 1  
20041 Agrate Brianza  
Milan, Italy  
Tel: 39-039-65791-1 Fax: 39-039-6899883

#### United Kingdom

Arizona Microchip Technology Ltd.  
505 Eskdale Road  
Winnersh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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