

MCRF250

Contactless Programmable Passive RFID Device With Anti-Collision

FEATURES

- Anti-collision feature to resolve multiple tags in the same RF field
- · Read-only data transmission
- 96 or 128 bits of One-Time Programmable (OTP) user memory (also supports 48 and 64-bit protocols)
- Operates up to 150 kHz
- On-chip rectifier and voltage regulator
- Low power operation
- Factory programming and device serialization available
- Encoding options:
 - NRZ Direct, Differential Biphase, Manchester Biphase, Biphase IDI
- Modulation options:
 - FSK, Direct, PSK (change on data change), PSK (change at the beginning of a one)
- · Contactless programmable after encapsulation

DESCRIPTION

This device is a Radio Frequency Identification (RFID) tag that provides a variety of operating modes. The device is powered by an external RF transmitter (reader) through inductive coupling. When in the reader field, the device will transmit the contents of its memory array by damping (modulating) the incoming RF signal. A reader is able to detect the damping 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.

BLOCK DIAGRAM

APPLICATION



The MCRF250 is equipped with an anti-collision feature that allows multiple tags in the same field to be read simultaneously. This revolutionary feature eliminates the issue of data corruption due to simultaneous transmissions from multiple tags.

The user memory array of this device can be programmed contactlessly after encapsulation. This allows the user to keep encapsulated blank tags in stock for on-demand personalization. The tags can then be programmed with data as they are needed.

These devices are available in die form or packaged in SOIC, PDIP or COB modules. The encoding, modulation, frequency, and bit rate options are specified by the customer and programmed by Microchip Technology Inc. prior to shipment. Array programming and serialization (SQTP) can also be arranged upon request. See TB023 (page 23) for more information.



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 pads50 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: PAD FUNCTION TABLE

Name	Function
VA,VB	Coil connection
NC	No connection, test pad

TABLE 1-2: AC AND DC CHARACTERISTICS

All parameters apply across the speci- fied operating ranges unless otherwise noted.	Industrial (I): Tamb = -40°C to +85°C									
Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions				
Clock frequency	FCLK	100	_	150	kHz					
Contactless programming time	Twc		2		S	128-bit array				
Data retention		200	_	_	Years	25°C				
Coil current (Dynamic)	ICD		50		μA					
Operating current	IDD		2		μA					
Turn-on-voltage (Dynamic)	VAVB	10	-	_	Vpp					
for modulation	Vcc	2	—	—	VDC					

FIGURE 1-1: DIE PLOT



TABLE 1-3: RFID PAD COORDINATES (MICRONS)

	Pass Ope	ivation nings		
Pad Name	Pad Width	Pad Height	Pad Center X	Pad Center Y
VA	90.0	90.0	427.50	-734.17
Vв	90.0	90.0	-408.60	-734.17

Note 1: All coordinates are referenced from the center of the die.

2: Die size 1.1215 mm x 1.7384 mm.

FIGURE 1-2: PIN DIAGRAM



2.0 FUNCTIONAL DESCRIPTION

The RF section generates all the analog functions needed by the transponder. These include rectification of the carrier, on-chip regulation of VPP (programming voltage), and VDD (operating voltage), as well as high voltage clamping to prevent excessive voltage from being applied to the device. This section generates a system clock from the interrogator carrier frequency, detects carrier interrupts and modulates the tuned LC antenna for transmission to the interrogator. The chip detects a power up condition and resets the transponder when sufficient voltage develops.

2.1 <u>Rectifier – AC Clamp</u>

The AC voltage induced by the tuned LC circuit is full wave rectified. This unregulated voltage is used as the DC supply voltage for the rest of the chip. The peak voltage on the tuned circuit is clamped by the internal circuitry to a safe level to prevent damage to the IC. This voltage is adjusted during programming to allow sufficient programming voltage to the EEPROM.

2.2 Coil Load Modulation

The MCRF250 communicates by shunting a transistor across the tuned LC circuit, which modulates the received RF field.

2.3 <u>VDD Regulator</u>

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

2.4 VPP Regulator

This regulates a programming voltage during the programming mode. The voltage is switched into the EEPROM array to perform block erasure of the memory as well as single bit programming during both contact and contactless programming. During reading this voltage is level shifted down and kept below the programming voltages to insure that the part is not inadvertently programmed.

2.5 <u>Clock Generator</u>

This circuit generates a clock with a frequency equal to the interrogator frequency. This clock is used to derive all timing in the device, including the baud rate, modulation rate, and programming rate.

2.6 IRQ Detector

This circuitry detects an interrupt in the continuous electromagnetic field of the interrogator. An IRQ (interrupt request) is defined as the absence of the electromagnetic field for a specific number of clock cycles. Detection of an IRQ will trigger the device to enter the Anti-collision mode. This mode is discussed in detail in Section 5.0.

2.7 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 VDD regulator to allow correct operation. The reset trip points are set such that sufficient voltage across VDD has developed which allows for correct clocking of the logic for reading of the EEPROM and configuration data, and correct modulation.

2.8 Modulation Logic

This logic acts upon the serial data being read from the EEPROM and performs two operations on the data. The logic first encodes the data according to the configuration bits CB6 and CB7. The data can be sent out direct to the modulation logic or encoded biphase_s (differential), biphase_I (manchester) or idi (manchester).

The encoded data is then either passed NRZ Direct out to modulate the coil, or FSK modulated, or PSK modulated with phase changes on the change of data, or PSK with phase changes on the bit edge of a one. Configuration bits CB8 and CB9 determine the modulation option. CB10 is used if the PSK option has been selected and determines whether the return carrier rate is FCLK/2 or FCLK/4.

3.0 CONFIGURATIONLOGIC

3.1 Control Bit Register

The configuration register determines the operational parameters of the device. The configuration register can not be programmed contactlessly; it is programmed during wafer probe at the Microchip factory. CB11 is always a one; CB12 is set when successful contact or contactless programming of the data array has been completed. Once CB12 is set, programming and erasing of the device is disabled. Figure 3-1 contains a description of the control register bit functions.

3.2 Organization

The configuration bit register directly controls logic blocks, which generate the baud rate, memory size, encoded data, and modulated data. This register also contains bits which lock the data array.

3.3 Baud Rate Timing

The chip will access data at a baud rate determined by bits CB2, CB3, CB4, and CB5 of the configuration register. CB2, CB3, and CB4 determine the return data rate (CACLK). The default rate of FCLK/128 is used for contact and contactless programming. Once the array is successfully programmed, the lock bit CB12 is set. When the lock bit is set, programming and erasing the device becomes permanently disabled. The configuration register has no effect on device timing or modulation until after the EEPROM data array is programmed. If CB2 is set to a one and CB5 is set to a one, the 1.5 bit SYNC word option is enabled.

3.4 <u>Column and Row Decoder Logic and</u> <u>Bit Counter</u>

The column and row decoders address the EEPROM array at the CACLK rate and generate a serial data stream for modulation. This data stream can be up to 128 bits in length. The size of the 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 data is then encoded by the modulation logic. The data length during contactless programming is 128 bits.

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.

FIGL	JRE 3-'	1: C	ONFIG	URA	TION	REC	SIST	ΓER														
	CB12C	B11 CE	310 CB9	CB8	CB7	CB6	CB	5 CB4	C	B3 CI	B2	CB1	Т									
					-			- I-	-					ARR	AY SIZ	ZE						
					<u> </u>			L			_			CB1 = 1: 128-bit user array								
														CB1 = 0: 96-bit user array								
														TIMIN	IG							
														CB2	CB3	CB4	Rate					
														0	0	0	MOD128					
														0	0	1	MOD100					
														0	1	0	MOD80					
														0	1	1	MOD32					
														1	0	0	MOD64					
														1	0	1	MOD50					
														1	1	0	MOD40					
																	MODIO	I				
							L							<u>51NC</u>	WO1	<u>KD</u> ait sync	word on ab	lo				
														CB5 =	0: 1.5-k	bit sync	word disab	le				
														DATA	ENC		G					
														CB6 =	0; CB7	= 0 nrz	_I (direct)					
														CB6 =	0; CB7	= 1 bipl	hase_s (diff	erential)				
														CB6 =	1; CB7	= 0 bipi = 1 (No	nase_I (mai	nchester)				
															т, СВ7 П П АТ							
														CB8 =	0 CB9	= 0 FSI	$\sqrt{0} = \frac{10}{8} = 1$	/10				
														CB8 =	0; CB9	= 1 Dire	ect	,				
														CB8 =	1; CB9	= 0 psk	_1					
														(phase	chang	e on ch	ange of dat	a)				
														(nhase	CB9	= 1 psk e at ber	 ninning of a	one				
														DEK			יים אוויוויק ו ∩וו	one				
														CB10 =	: 1 clk/4	carrier						
														CB10 =	0 clk/2	carrier						
														(REA	D ON	LY)						
														CB11 =	1							
														ARR/	Y LO	CK B	IT (REA	D ONLY)				
1														CB12 =	0 arra	y not lo	cked	•				
														CB12 =	arra	y is lock	ked					

4.0 MODES OF OPERATION

The device has two basic modes of operation: Native Mode and Read Mode.

4.1 Native Mode

In native mode, the MCRF250 will have an unprogrammed array and will be in the default mode for contactless programming (default baud rate FCLK/128, FSK, NRZ_direct).

4.2 Read Mode

The second mode is a read mode after the contactless or contact programming has been completed and for the rest of the lifetime of the device. The lock bit CB12 will be set, and the transponder will have the ability to transmit when powered and enter the anti-collision algorithm.



FIGURE 4-1: TYPICAL APPLICATION CIRCUIT

5.0 ANTI-COLLISION

The anti-collision feature is enabled when the array is locked. In this mode, the MCRF250 has the ability to stop transmitting when a collision has occurred. The device will begin transmitting again when its internal anti-collision algorithm indicates that it is time to do so.

Multiple tags can enter the same reader field and be read by the reader in a short period of time. The reader must provide "gaps" (RF field off) at proper timing intervals as shown in Figure 5-1 in order to inform the MCRF250 of collisions, and to sequence from one tag to another.

FIGURE 5-1: ANTI-COLLISION FLOWCHART



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MCRF250 PRODUCT IDENTIFICATION SYSTEM

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





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9/8/98

Microchip received ISO 9001 Quality System certification for its worldwide headquarters, design, and wafer fabrication facilities in January, 1997. Our field-programmable PICmicro™ 8bit MCUs, Serial EEPROMs, related specialty memory products and development systems conform to the stringent quality standards of the International Standard Organization (ISO).

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