MCP2140

IrDA® Standard Protocol Stack Controller With Fixed 9600 Baud Communication Rate

Features

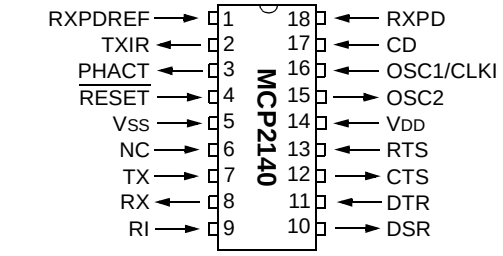
- Implements the IrDA® standard, including:
  - IrLAP
  - IrLMP
  - IAS
  - TinyTP
  - IrCOMM (9-wire “cooked” service class)
- Provides IrDA standard physical signal layer support including:
  - Bidirectional communication
  - CRC implementation
  - Fixed Data communication rate of 9600 baud
- Includes UART-to-IrDA standard encoder/decoder functionality:
  - Easily interfaces with industry standard UARTs and infrared transceivers
- UART interface for connecting to Data Communications Equipment (DCE) or Data Terminal Equipment (DTE) systems
- Transmit/Receive formats (bit width) supported:
  - 1.63 µs
- Hardware UART Support:
  - 9.6 kbaud baud rate
  - 29 Byte Data Buffer Size
- Infrared Supported:
  - 9.6 kbaud baud rate
  - 64 Byte Data Packet Size
- Operates as Secondary Device
- Automatic Low Power mode
  - < 60 µA when no IR activity present (PHACT = L)

CMOS Technology

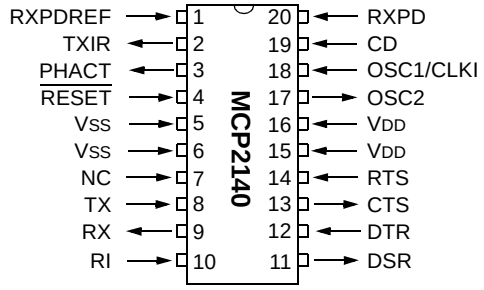
- Low power, high-speed CMOS technology
- Fully static design
- Low voltage operation
- Industrial temperature range
- Low power consumption
  - < 1 mA @ 3.0V, 7.3728 MHz (typical)

Package Types

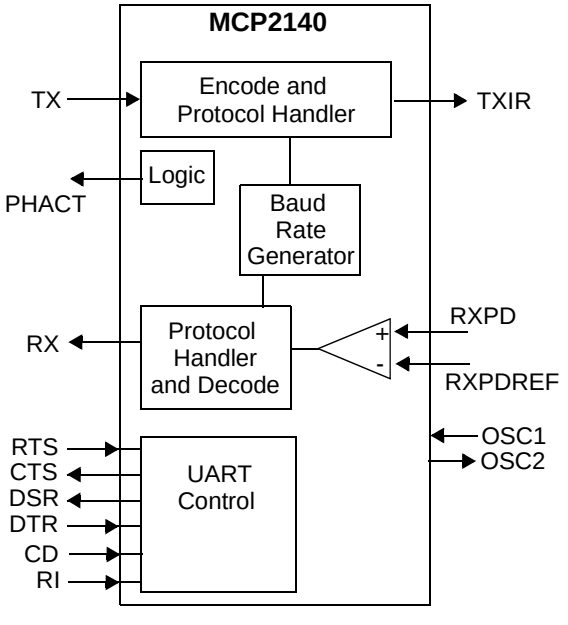
PDIP, SOIC



SSOP



Block Diagram



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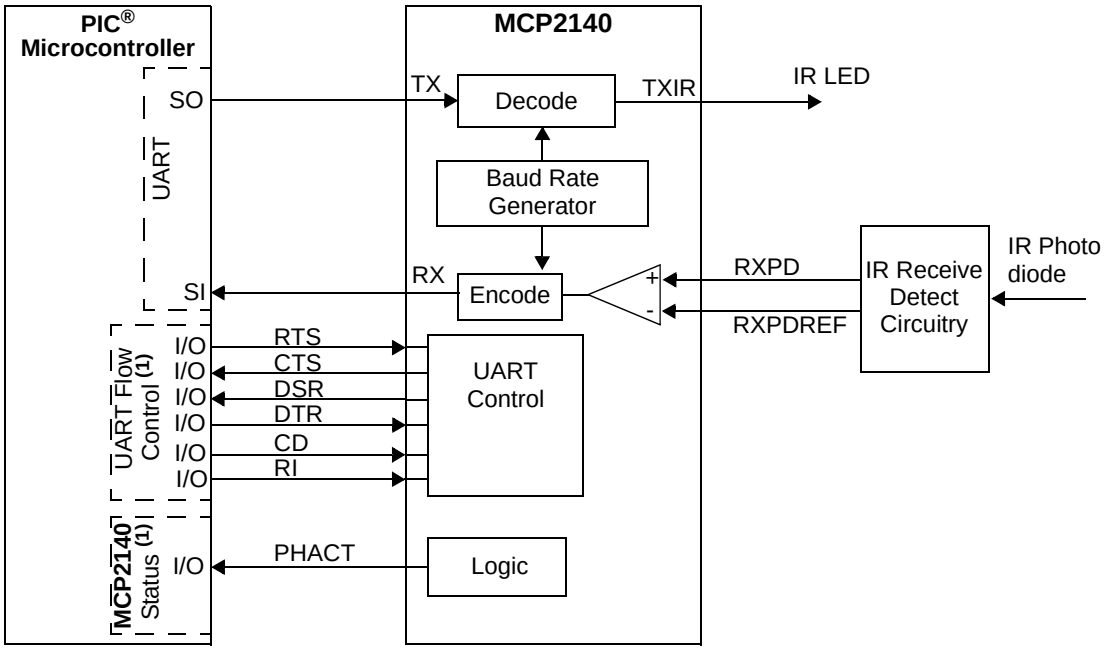
MCP2140 System Block Diagram



Note 1: Not all microcontroller I/O pins are required to be connected to the MCP2140.

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1.0 DEVICE OVERVIEW

The MCP2140 is a cost-effective, low pin count (18-pin), easy-to-use device for implementing IrDA standard wireless connectivity. The MCP2140 provides support for the IrDA standard protocol “stack”, bit encoding/decoding and low cost, discrete IR receiver circuitry.

The serial and IR interface baud rates are fixed at 9600 baud. The serial interface and IR interface baud rates are dependent on the device frequency, but IrDA standard operation requires a device frequency of 7.3728 MHz.

The MCP2140 will specify to the Primary Device the IR baud rate during the Discover phase.

The MCP2140 can operate in Data Communication Equipment (DCE) and Data Terminal Equipment (DTE) applications, and sits between a UART and an infrared optical transceiver.

The MCP2140 encodes an asynchronous serial data stream, converting each data bit to the corresponding infrared (IR) formatted pulse. IR pulses received are decoded and then handled by the protocol handler state machine. The protocol handler sends the appropriate data bytes to the Host Controller in UART-formatted serial data.

The MCP2140 supports “point-to-point” applications, that is, one Primary device and one Secondary device. The MCP2140 operates as a Secondary device and does not support “multi-point” applications.

Sending data using IR light requires some hardware and the use of specialized communication protocols. These protocol and hardware requirements are described, in detail, by the IrDA standard specifications. The encoding/decoding functionality of the MCP2140 is designed to be compatible with the physical layer component of the IrDA standard. This part of the standard is often referred to as “IrPHY”.

The complete IrDA standard specification is available for download from the IrDA website at www.IrDA.org.

1.1 Applications

The MCP2140 Infrared Communications Controller, supporting the IrDA standard, provides embedded system designers the easiest way to implement IrDA standard wireless connectivity. Figure 1-1 shows a typical application block diagram, while Table 1-2 shows the pin definitions.

TABLE 1-1: OVERVIEW OF FEATURES

Features	MCP2140
Serial Communications	UART, IR
Baud Rate Selection	Fixed
Low Power Mode	Yes
Resets (and Delays)	$\overline{\text{RESET}}$, POR (PWRT and OST)
Packages	18-pin DIP, SOIC, 20-pin SSOP

Infrared communication is a wireless, two-way data connection using infrared light generated by low-cost transceiver signaling technology. This provides reliable communication between two devices.

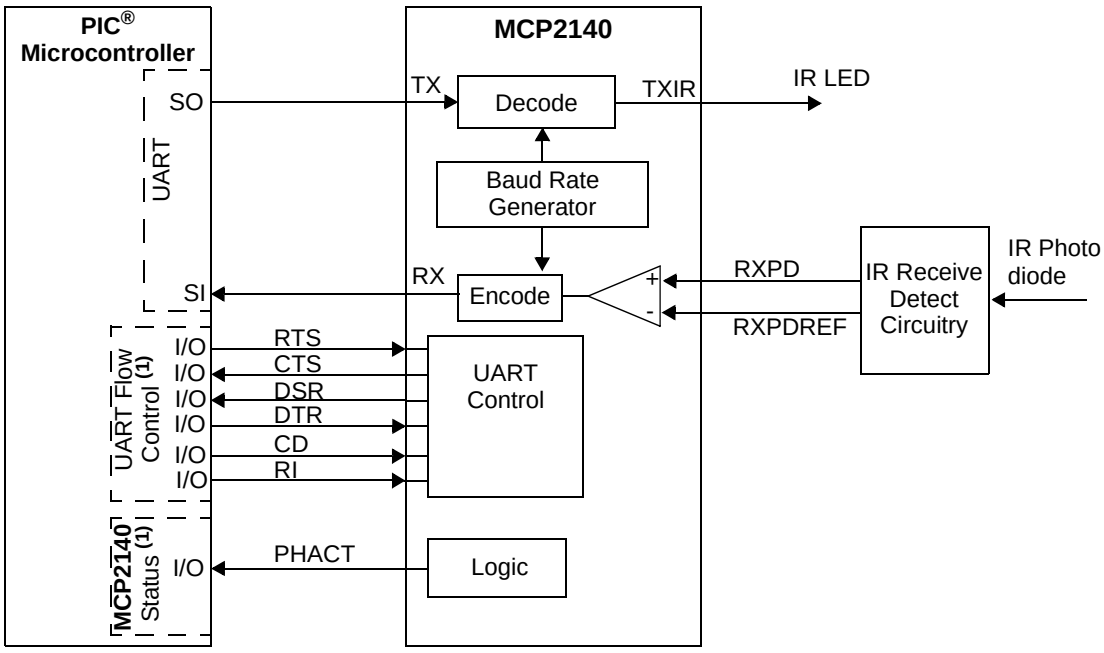
Infrared technology offers:

- Universal standard for connecting portable computing devices
- Easy, effortless implementation
- Economical alternative to other connectivity solutions
- Reliable, high-speed connections
- Safe to use in any environment (can even be used during air travel)
- Eliminates the hassle of cables
- Allows PCs and other electronic devices (such as PDAs, cell phones, etc.) to communicate with each other
- Enhances mobility by allowing users to easily connect

The MCP2140 allows the easy addition of IrDA standard wireless connectivity to any embedded application that uses serial data. Figure 1-1 shows typical implementation of the MCP2140 in an embedded system.

The IrDA protocol for printer support is not included in the IrCOMM 9-wire “cooked” service class.

FIGURE 1-1: SYSTEM BLOCK DIAGRAM



Note 1: Not all microcontroller I/O pins are required to be connected to the MCP2140.

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TABLE 1-2: MCP2140 PIN DESCRIPTION NORMAL OPERATION (DCE)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	SOIC	SSOP			
RXPDREF	1	1	1	I	A	IR Receive Photo Detect Diode reference voltage. This voltage will typically be in the range of $V_{DD}/2$.
TXIR	2	2	2	O	—	Asynchronous transmit to IrDA transceiver.
PHACT	3	3	3	OC	—	Protocol Handler Active. Indicates the state of the MCP2140 Protocol Handler. This output is an open collector, so an external pull-up resistor may be required. 1 = Protocol Handler is in the Discovery or NRM state 0 = Protocol Handler is in NDM state or the MCP2140 is in Low Power mode
$\overline{\text{RESET}}$	4	4	4	I	ST	Resets the Device
V_{SS}	5	5	5, 6	—	P	Ground reference for logic and I/O pins
NC	6	6	7	I	—	No connect
TX	7	7	8	I	TTL	Asynchronous receive; from Host Controller UART
RX	8	8	9	O	—	Asynchronous transmit; to Host Controller UART
RI	9	9	10	I	TTL	Ring Indicator. The state of this bit is communicated to the IrDA Primary Device. 1 = No Ring Indicate Present 0 = Ring Indicate Present
DSR	10	10	11	O	—	Data Set Ready. Indicates that the MCP2140 has established a valid IrDA link with a Primary Device(1). This signal is locally emulated and not related to the DTR bit of the IrDA Primary Device. 1 = An IR link has not been established (No IR Link) 0 = An IR link has been established (IR Link)
DTR	11	11	12	I	TTL	Data Terminal Ready. Indicates that the Embedded device connected to the MCP2140 is ready for IR data. The state of this bit is communicated to the IrDA Primary Device via the IrDA DSR bit carried by IrCOMM. 1 = Embedded device not ready 0 = Embedded device ready
CTS	12	12	13	O	—	Clear to Send. Indicates that the MCP2140 is ready to receive data from the Host Controller. This signal is locally emulated and not related to the CTS/RTS bit of the IrDA Primary Device. 1 = Host Controller should not send data 0 = Host Controller may send data

Legend: TTL = TTL compatible input; ST = Schmitt Trigger input with CMOS levels
A = Analog; P = Power
CMOS = CMOS compatible input; OC = Open collector output
I = Input; O = Output

1: The state of the DTR output pin does not reflect the state of the DTR bit of the IrDA Primary Device.

TABLE 1-2: MCP2140 PIN DESCRIPTION NORMAL OPERATION (DCE) (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	SOIC	SSOP			
RTS	13	13	14	I	TTL	Request to Send. Indicates that a Host Controller is ready to receive data from the MCP2140. This signal is locally emulated and not related to the CTS/RTS bit of the IrDA Primary device. 1 = Host Controller not ready to receive data 0 = Host Controller ready to receive data
VDD	14	14	15, 16	—	P	Positive supply for logic and I/O pins.
OSC2	15	15	17	O	—	Oscillator crystal output.
OSC1/CLKIN	16	16	18	I	CMOS	Oscillator crystal input/external clock source input.
CD	17	17	19	I	ST	Carrier Detect. The state of this bit is communicated to the IrDA Primary device via the IrDA CD bit. 1 = No Carrier Present 0 = Carrier Present
RXPD	18	18	20	I	A	IR RX Photo Detect Diode input. This input signal is required to be a pulse to indicate an IR bit. When the amplitude of the signal crosses the amplitude threshold set by the RXPDREF pin, the IR bit is detected. The pulse has minimum and maximum requirements as specified in Parameter IR131A.

Legend: TTL = TTL compatible input; ST = Schmitt Trigger input with CMOS levels; A = Analog; P = Power; CMOS = CMOS compatible input; OC = Open collector output; I = Input; O = Output

1: The state of the DTR output pin does not reflect the state of the DTR bit of the IrDA Primary Device.

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2.0 DEVICE OPERATION

The MCP2140 serial interface and IR baud rates are fixed at 9600 baud, given a 7.3728 MHz device clock.

2.1 Power-Up

Any time the device is powered up (Parameter D003), the Power-Up Timer delay (Parameter 33) occurs, followed by an Oscillator Start-up Timer (OST) delay (Parameter 32). Once these delays complete, communication with the device may be initiated. This communication is from both the infrared transceiver's side and the controller's UART interface.

2.2 Device Reset

The MCP2140 is forced into the reset state when the $\overline{\text{RESET}}$ pin is in the low state. Once the $\overline{\text{RESET}}$ pin is brought to a high state, the Device Reset sequence occurs. Once the sequence completes, functional operation begins.

2.3 Device Clocks

The MCP2140 requires a clock source to operate. This clock source is used to establish the device timing, including the device "Bit Clock".

2.3.1 CLOCK SOURCE

The clock source can be supplied by one of the following:

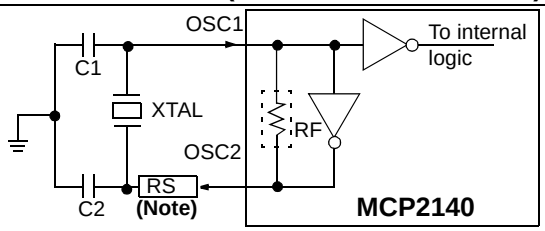
- Crystal
- Resonator
- External clock

The frequency of this clock source must be 7.3728 MHz (electrical specification Parameter 1A) for device communication at 9600 baud.

2.3.1.1 Crystal Oscillator / Ceramic Resonators

A crystal or ceramic resonator can be connected to the OSC1 and OSC2 pins to establish oscillation (Figure 2-1). The MCP2140 oscillator design requires the use of a parallel-cut crystal. Use of a series of cut crystals may give a frequency outside of the crystal manufacturers specifications.

FIGURE 2-1: CRYSTAL OPERATION (CERAMIC RESONATOR)



See Table 2-1 and Table 2-2 for recommended values of C1 and C2.

Note: A series resistor may be required for AT strip cut crystals.

TABLE 2-1: CAPACITOR SELECTION FOR CERAMIC RESONATORS

Freq	OSC1 (C1)	OSC2 (C2)
7.3728 MHz	10 - 22 pF	10 - 22 pF

Note: Higher capacitance increases the stability of the oscillator, but also increases the start-up time. These values are for design guidance only. Since each resonator has its own characteristics, the user should consult the resonator manufacturer for appropriate values of external components.

TABLE 2-2: CAPACITOR SELECTION FOR CRYSTAL OSCILLATOR

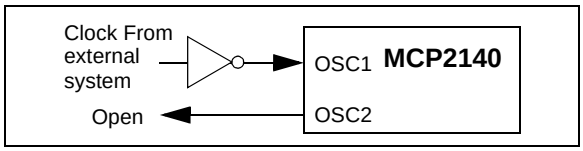
Freq	OSC1 (C1)	OSC2 (C2)
7.3728 MHz	15 - 30 pF	15 - 30 pF

Note: Higher capacitance increases the stability of the oscillator but also increases the start-up time. These values are for design guidance only. RS may be required to avoid overdriving crystals with low drive level specification. Since each crystal has its own characteristics, the user should consult the crystal manufacturer for appropriate values of external components.

2.3.1.2 External Clock

For applications where a clock is already available elsewhere, users may directly drive the MCP2140 provided that this external clock source meets the AC/DC timing requirements listed in Section 4.3, "Timing Diagrams and Specifications". Figure 2-2 shows how an external clock circuit should be configured.

FIGURE 2-2: EXTERNAL CLOCK



2.3.2 BIT CLOCK

The device crystal is used to derive the communication bit clock (BITCLK). There are 16 BITCLKs for each bit time. The BITCLKs are used for the generation of the start bit and the eight data bits. The stop bit uses the BITCLK when the data is transmitted (not for reception).

This clock is a fixed-frequency and has minimal variation in frequency (specified by the crystal manufacturer).

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2.4 Host UART Interface

The Host UART interface communicates with the Host Controller. This interface has eight signals associated with it: TX, RX, RTS, CTS, DSR, DTR, CD and RI. Several of these signals are locally generated (not passed over the IR interface). The Host UART is a half-duplex interface, meaning that the system is either transmitting or receiving, but not both simultaneously.

Note 1: The MCP2140 generates several non-data signals locally.

2: The MCP2140 emulates a 3-wire serial connection (TXD, RXD and GND). The transceiver's Transmit Data (TXD), Receive Data (RXD) signals, and the state of the CD. RI and DTR input pins are carried back and forth to the Primary device.

3: The RTS and CTS signals are local emulations.

2.4.1 BAUD RATE

The baud rate for the MCP2140 serial port (the TX and RX pins) is fixed at 9600 baud when the device frequency is 7.3728 MHz.

2.4.2 TRANSMITTING

When the controller sends serial data to the MCP2140, the controller's baud rate is required to match the baud rate of the MCP2140's serial port.

2.4.3 RECEIVING

When the controller receives serial data from the MCP2140, the controller's baud rate is required to match the baud rate of the MCP2140's serial port.

2.4.4 HARDWARE HANDSHAKING

There are three Host UART signals used to control the handshaking operation between the Host Controller and the MCP2140. They are:

- DSR
- RTS
- CTS

2.4.4.1 DSR

The DSR signal is used to indicate that a link has been established between the MCP2140 and the Primary Device. Please refer to Section 2.14, "How Devices Connect", for information on how devices connect.

2.4.4.2 RTS

The RTS signal indicates to the MCP2140 that the Host Controller is ready to receive serial data. Once an IR data packet has been received, the RTS signal will be low for the received data to be transferred to the Host Controller. If the RTS signal remains high, an IR link timeout will occur and the MCP2140 will disconnect from the Primary Device.

2.4.4.3 CTS

The MCP2140 generates the CTS signal locally due to buffer limitations.

The MCP2140 uses a 64-byte buffer for incoming data from the IR Host. Another 29-byte buffer is provided to buffer data from the UART serial port. The MCP2140 can handle IR data and Host UART serial port data simultaneously. A hardware handshaking pin (CTS) is provided to inhibit the Host Controller from sending serial data when the Host UART buffer is not available (Figure 2-3). Figure 2-4 shows a flow chart for Host UART flow control using the CTS signal.

Note: When the CTS output signal goes high, the UART FIFO will store up to 6 bytes. This is to allow devices that have a slow response time to a change on the CTS signal time to stop sending additional data (such as a modem).

FIGURE 2-3: HOST UART CTS SIGNAL AND THE RECEIVE BUFFER

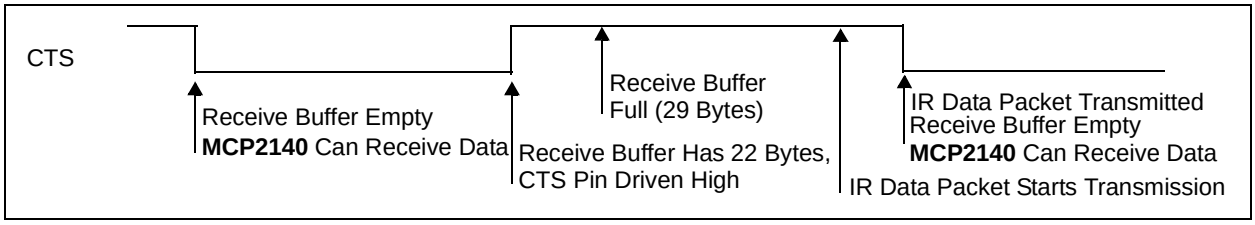
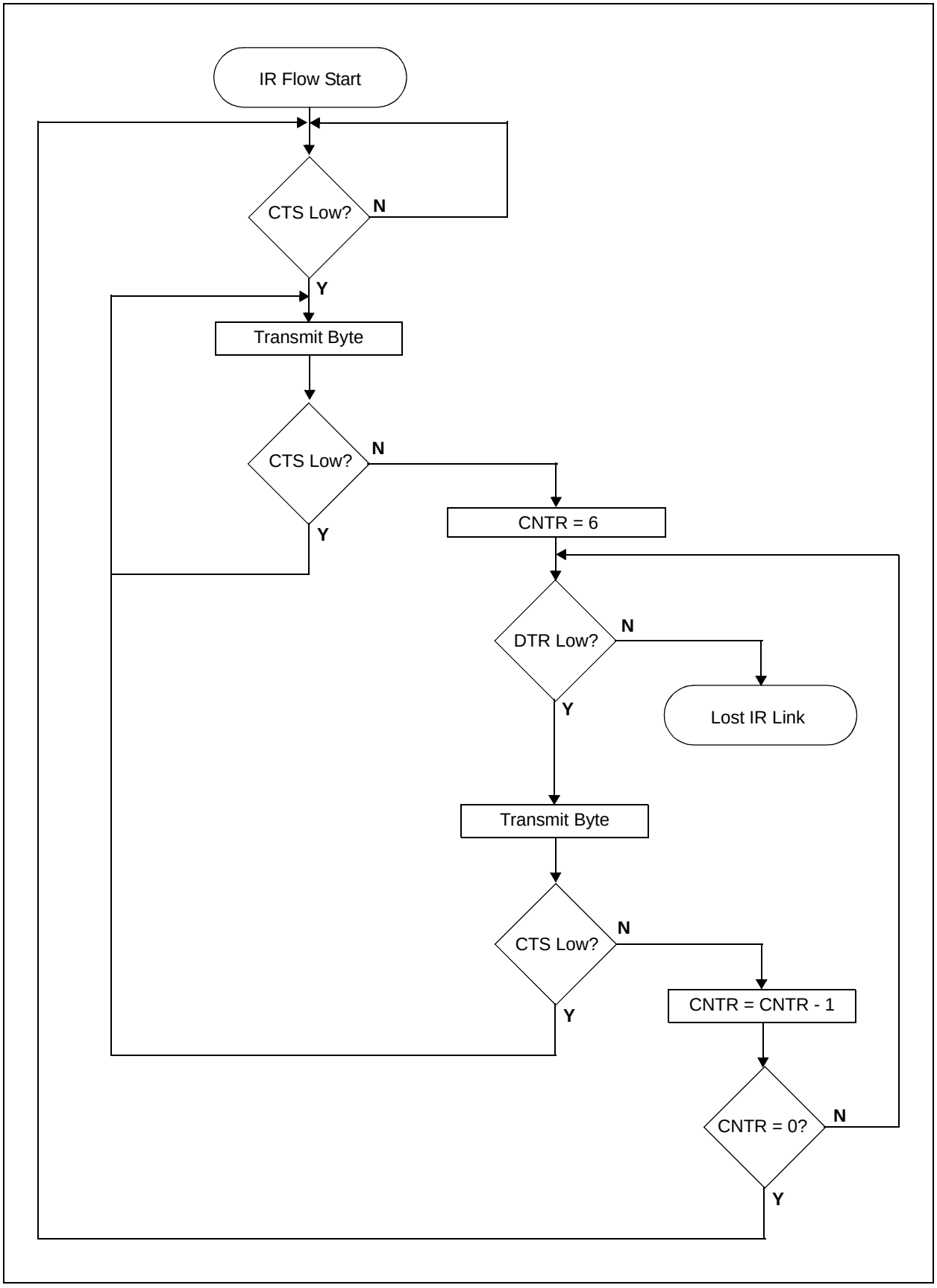


FIGURE 2-4: HOST UART CTS FLOW CONTROL FLOWCHART



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2.5 Encoder/Decoder

The encoder converts the UART format data into the IrDA Standard format data and the decoder converts IrDA Standard format data into UART format data.

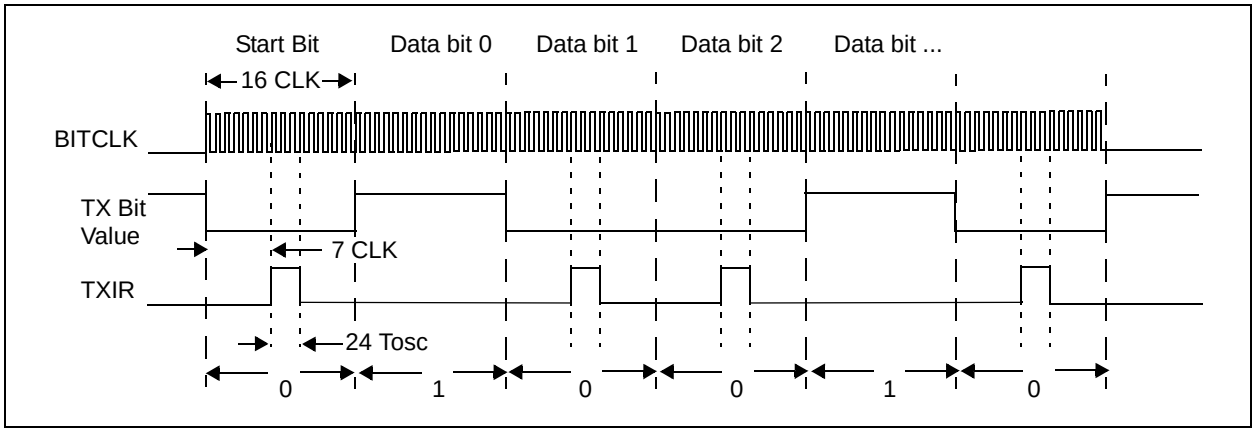
2.5.1 ENCODER (MODULATION)

The data that the MCP2140 UART received (on the TX pin) that needs to be transmitted (on the TXIR pin) will need to be modulated. This modulated signal drives the IR transceiver module. Figure 2-5 shows the encoding of the modulated signal.

Note:	The signal on the TXIR pin does not actually line up in time with the bit value that was transmitted on the TX pin, as shown in Figure 2-5. The TX bit value is shown to represent the value to be transmitted on the TXIR pin.

Each bit time is comprised of 16-bit clocks. If the value to be transmitted (as determined by the TX pin) is a logic-low, the TXIR pin will output a low level for 7-bit clock cycles, a logic high level for 3-bit clock cycles or a minimum of 1.6 µsec (see Parameter IR121). The remaining 6-bit clock cycles will be low. If the value to transmit is a logic-high, the TXIR pin will output a low level for the entire 16-bit clock cycles.

FIGURE 2-5: ENCODING



2.5.2 DECODER (DEMODULATION)

The modulated signal (data) from the IR transceiver module (on RXIR pin) needs to be demodulated to form the received data (on RX pin). Once demodulation of the data byte occurs, the data that is received is transmitted by the MCP2140 UART (on the RX pin). Figure 2-6 shows the decoding of the modulated signal.

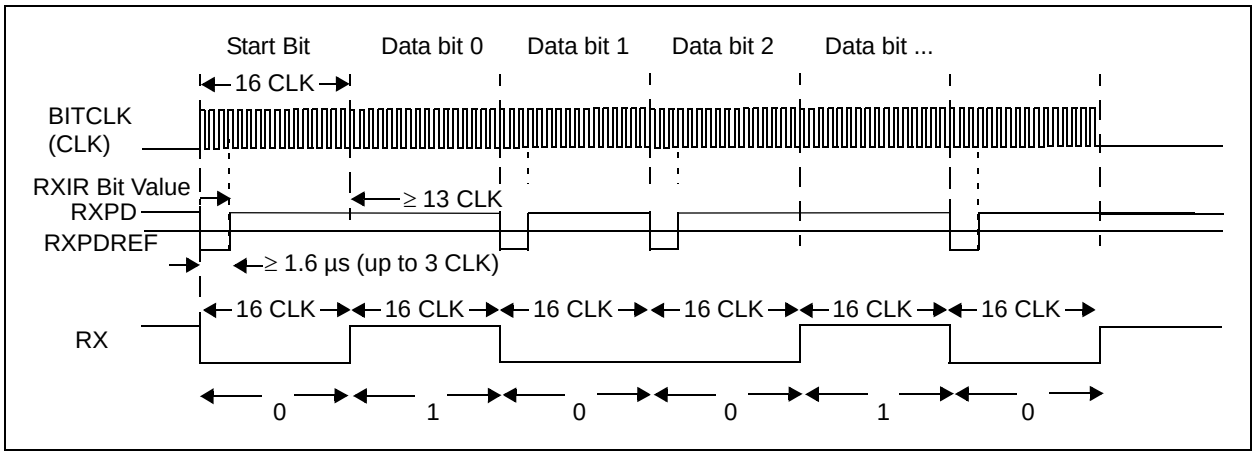
Note:	The signal on the RX pin does not actually line up in time with the bit value that was received on the RXIR pin, as shown in Figure 2-6. The RXIR bit value is shown to represent the value to be transmitted on the RX pin.

Each bit time is comprised of 16-bit clocks. If the value to be received is a logic-low, the RXIR pin will be a low level for the first 3-bit clock cycles, or a minimum of 1.6 µs. The remaining 13-bit clock cycles (or difference up to the 16-bit clock time) will be high. If the value to be received is a logic-high, the RXIR pin will be a high level for the entire 16-bit clock cycles. The level on the RX pin will be in the appropriate state for the entire 16 clock cycles.

2.6 IR Port Baud Rate

The baud rate for the MCP2140 IR port (the TXIR and RXIR pins) is fixed at the default rate of 9600 baud. The Primary device will be informed of this parameter during NDM. The Host UART baud rate and the IR port baud rate are the same.

FIGURE 2-6: DECODING



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2.7 IrDA DATA PROTOCOLS SUPPORTED BY MCP2140

The MCP2140 supports these required IrDA standard protocols:

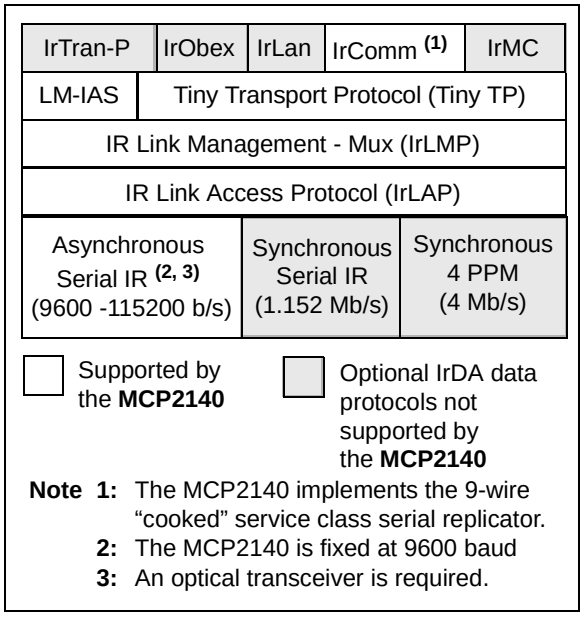
- Physical Signaling Layer (PHY)
- Link Access Protocol (IrLAP)
- Link Management Protocol/Information Access Service (IrLMP/IAS)

The MCP2140 also supports some of the optional protocols for IrDA standard data. The optional protocols implemented by the MCP2140 are:

- Tiny TP
- IrCOMM

Figure 2-7 shows the IrDA data protocol stack and those components implemented by the MCP2140.

FIGURE 2-7: IrDA DATA - PROTOCOL STACKS



Note 1: The MCP2140 implements the 9-wire "cooked" service class serial replicator.
2: The MCP2140 is fixed at 9600 baud
3: An optical transceiver is required.

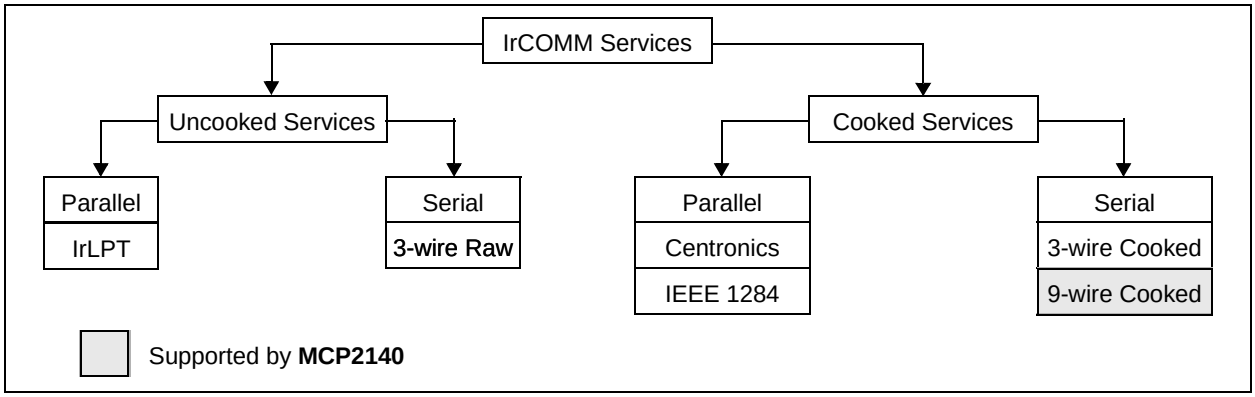
2.7.1 IRCOMM

IrCOMM provides the method to support serial and parallel port emulation. This is useful for legacy COM applications, such as printers and modem devices.

The IrCOMM standard is a syntax that allows the Primary device to consider the Secondary device a serial device. IrCOMM allows for emulation of serial or parallel (printer) connections of various capabilities. The MCP2140 supports the 9-wire "cooked" service class of IrCOMM. Other service classes supported by IrCOMM are shown in Figure 2-8.

The IrDA protocol for printer support is not included in the IrCOMM 9-wire "cooked" service class.

FIGURE 2-8: IRCOMM SERVICE CLASSES



2.8 Minimizing Power

During IR communication between a Primary Device and the MCP2140, the MCP2140 is in an operational mode. In this mode, the MCP2140 consumes the operational current (Parameter D010).

For many applications, the time that IR communication is occurring is a small percentage of the applications operational time. The ability for the IR controller to be in a low power mode during this time will save on the applications power consumption. The MCP2140 will automatically enter a low power mode once IR activity has stopped and will return to operational mode once IR activity is detected on the RXPD and RXPDREF pins.

Another way to minimize system power is to use an I/O pin of the Host Controller to enable power to the IR circuity

2.8.1 AUTOMATIC LOW POWER MODE

The Automatic Low Power mode allows the system to achieve the lowest possible operating current.

When the IR link has been “closed”, the protocol handler state machine returns to the Normal Disconnect Mode (NDM). During NDM, if no IR activity occurs for about 10 seconds, the device is disabled and enters into Low Power mode. In this mode, the device oscillator is shut down and the PHACT pin will be low (Parameter D010A).

Table 2-3 shows the MCP2140 current. These are specified in Parameter D010 and Parameter D010A.

TABLE 2-3: DEVICE MAXIMUM OPERATING CURRENT

Mode	Current	Comment
PHACT = H	2.2 mA	IR communications is occurring.
PHACT = L	60 µA	No IR communications.

Note: Additional system current is from the Receiver/Transmitter circuitry.

2.8.2 RETURNING TO DEVICE OPERATION

The device will exit the Low Power mode when the RXPD pin voltage crosses the REPDREF pin reference voltage.

A device reset will also cause the MCP2140 to exit Low Power mode. After device initialization, if no IR activity occurs for about 10 seconds, the device is disabled and returns into the Low Power mode.

Note: For proper operation, the device oscillator must be within oscillator specification in the time frame specified in Parameter IR140.

2.9 PHACT Signal

The PHACT signal indicates that the MCP2140 Protocol Handler is active. This output pin is an open collector, so when interfacing to the Host Controller, a pull-up resistor is required.

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2.10 Buffers and Throughput

The IR data rate of the MCP2140 is fixed at 9.6 kbaud. The actual throughput will be less due to several factors. The most significant factors are under the control of the developer. One factor beyond the control of the designer is the overhead associated with the IrDA standard. A throughput example is shown in Table 2-4.

Figure 2-9 shows the CTS waveform, what the state of the buffers can be and the operation of the Host UART and IR interfaces.

Figure 2-10 shows the screen-capture of a Host Controller transmitting 240 bytes. Data is not transmitted after CTS goes high (so only a maximum of 23 bytes of the 29 byte buffer are utilized). Between data packets, the CTS time can vary, depending on the Primary Device (see blue circled CTS pulse in Figure 2-10).

TABLE 2-4: THROUGHPUT

Bytes Transferred (3)	Bytes/ CTS Low	Time (S)	Effective Baud Rate
240	23 (max) (1)	0.810133	2962 (1)
240	29	0.6500	3692 (2)

Note 1: Measured from Figure 2-10.
2: Interpolated from Figure 2-10.
3: 10 bits transferred for each byte.

Note: IrDA throughput is based on many factors associated with characteristics of the Primary and Secondary devices. These characteristics may cause your throughput to be more or less than is shown in Table 2-4.

FIGURE 2-9: HOST UART RECEIVE BUFFER AND CTS WAVEFORM

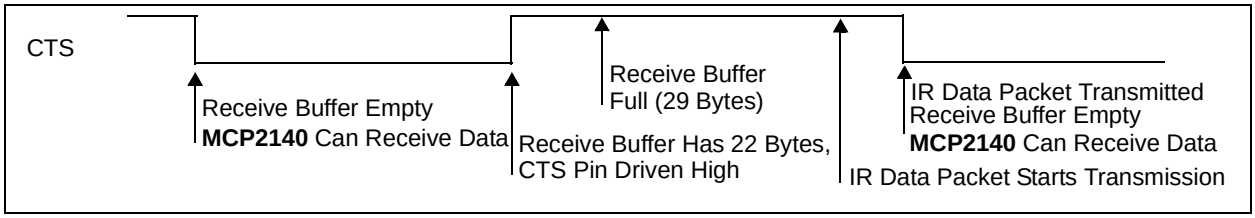
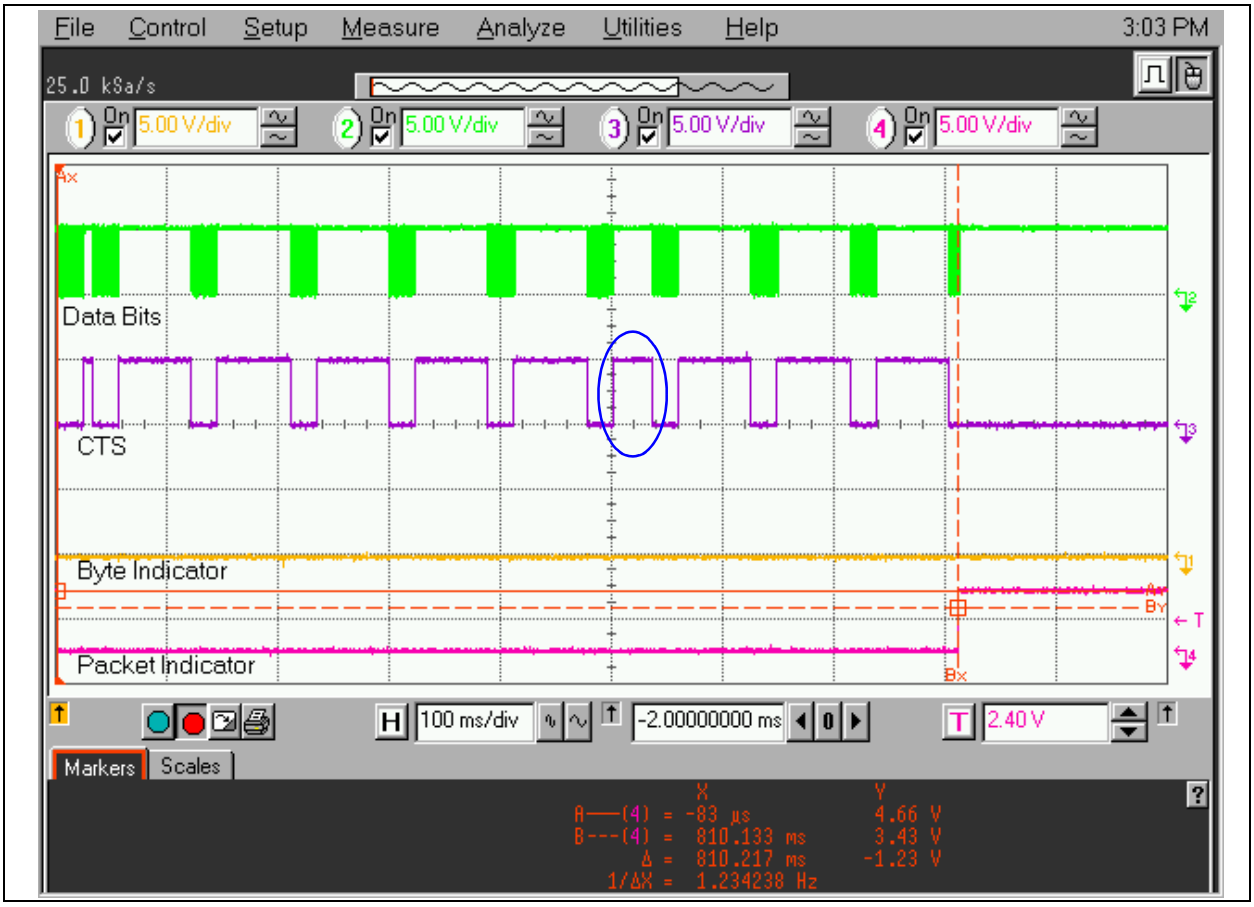


FIGURE 2-10: HOST CONTROLLER TRANSMISSION OF A 240 BYTE PACKET



2.10.1 IMPROVING THROUGHPUT

Actual maximum throughput is dependent on several factors, including:

- Characteristics of the Primary device
- Characteristics of the MCP2140
- IrDA standard protocol overhead

The IrDA standard specifies how the data is passed between the Primary device and Secondary device. In IrCOMM, an additional 8 bytes are used by the protocol for each packet transfer.

The most significant factor in data throughput is how well the data frames are filled. If only 1 byte is sent at a time, the throughput overhead of the IrCOMM protocol is 89% (see Table 2-5). The best way to maximize throughput is to align the amounts of data with the receive buffer (IR and Host UART) packet size of the MCP2140.

Then there is the delay between when data packets are sent and received. See Figure 2-10 for an example of this delay (look at CTS signal falling edges). In this screen capture, a Palm™ m105 is receiving a 240-byte string of data from the MCP2140. When the CTS signal goes high, the Host Controller stops sending data (23 bytes per CTS low-time). The CTS falling edge to CTS falling edge is approximately 90 ms (typical). This CTS high-time affects the total data throughput. The CTS high-time will be dependant on the characteristics of the Primary device.

TABLE 2-5: IRCOMM OVERHEAD %

MCP2140	Data Packet Size (Bytes)	IrCOMM Overhead (Bytes)	IrCOMM Overhead % (1)	Comment
IR Receive	64	8	11 %	**Note 2**
	1	8	89 %	
Host UART Receive	29	8	22 %	**Note 3**
	23	8	26 %	**Note 4**
	1	8	89 %	

Note 1: Overhead % = Overhead/(Overhead + Data).

2: The maximum number of bytes of the IR Receive buffer.

3: The maximum number of bytes of the Host UART Receive buffer.

4: The CTS signal is driven high at 23 byte.

2.10.1.1 From the Primary Device

The MCP2140 uses a fixed IR Receiver data block size of 64 bytes.

The minimum size frame the Primary device can respond with is 6 bytes.

2.10.1.2 From the MCP2140

The MCP2140 uses a fixed Host UART Receiver data block size of 29 bytes.

2.11 Turnaround Latency

An IR link can be compared to a one-wire data connection. The IR transceiver can transmit or receive, but not both at the same time. A delay of one bit time is recommended between the time a byte is received and another byte is transmitted.

2.12 Device ID

The MCP2140 has a fixed Device ID. This Device ID is “MCP2140 xx”, with the xx indicating the silicon revision of the device.

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2.13 Optical Interface

The MCP2140 requires an infrared transceiver for the optical interface. This transceiver can be a single-chip solution (integrated) or be implemented with discrete devices.

2.13.1 DISCRETE TRANSCEIVER SOLUTION

The MCP2140 was designed to use a discrete implementation that allows the lowest system power consumption as well as a low cost implementation.

Figure 2-12 shows a typical discrete optical transceiver circuit.

FIGURE 2-11: CIRCUIT FOR A DISCRETE OPTICAL TRANSCEIVER

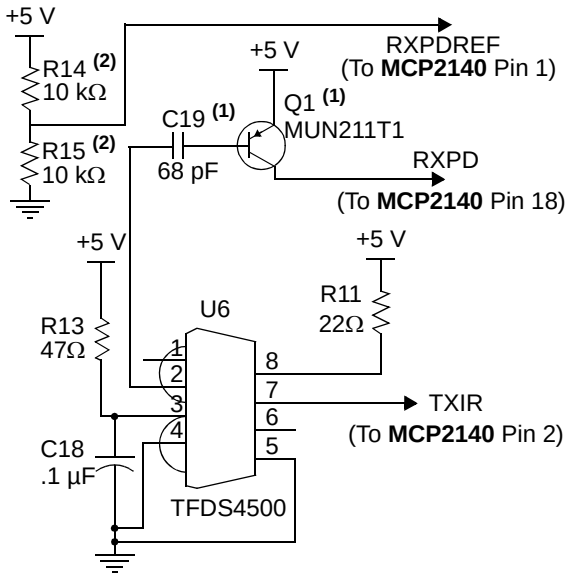
This figure will be available in Revision B of the MCP2140 data sheet. Please conact the Microchip factory via email (tech.support@microchip.com) for additional information.

Care must be taken in the design and layout of the photo-detect circuit, due to the small signals that are being detected and their sensitivity to noise.

2.13.2 INTEGRATED TRANSCEIVER

The MCP2140 was designed to use a discrete implementation that allows the lowest system power consumption and a low cost implementation (see Section 2.13.1, “Discrete Transceiver Solution”). It is possible to use an integrated optical transceiver solution, with the addition of four components. Two components are required to condition the input signal to ensure that the RXIR pulse width is not greater than 1.5 µs (see Parameter IR131A). The other two components are required to set the RXIR signal trip point (typically VDD/2). Figure 2-12 shows an example MCP2140 optical transceiver circuit, using a Vishay®/ Temic TFDS4500.

FIGURE 2-12: CIRCUIT FOR AN INTEGRATED OPTICAL TRANSCEIVER



Note 1: These components are used to control the width of the TFDS4500 RXD output signal. Q1 is a digital transistor, which includes the bias resistors.

2: These components are used to set the reference voltage that the RXPD signal needs to cross to “detect” a bit.

Table 2-6 shows a list of common manufacturers of integrated optical transceivers.

2.14 How The MCP2140 Connects

When two devices, implementing the IrDA standard feature, establish a connection using the IrCOMM protocol, the process is analogous to connecting two devices with serial ports using a cable. This is referred to as a “point-to-point” connection. This connection is limited to half-duplex operation because the IR transceiver cannot transmit and receive at the same time. The purpose of the IrDA standard protocol is to allow this half-duplex link to emulate, as much as possible, a full-duplex connection. In general, this is done by dividing the data into “packets”, or groups of data. These packets can be sent back and forth, when needed, without risk of collision. The rules of how and when these packets are sent constitute the IrDA standard protocol. The MCP2140 supports elements of this IrDA standard protocol to communicate with other IrDA standard compatible devices.

When a wired connection is used, the assumption is made that both sides have the same communications parameters and features. A wired connection has no need to identify the other connector because it is assumed that the connectors are properly connected. According to the IrDA standard, a connection process has been defined to identify other IrDA standard compatible devices and establish a communication link. There are three steps that these two devices go through to make this connection. They are:

- Normal Disconnect Mode (NDM)
- Discovery Mode
- Normal Connect Mode (NCM)

Figure 2-13 shows the connection sequence.

2.14.1 NORMAL DISCONNECT MODE (NDM)

When two IrDA standard compatible devices come into range, they must first recognize each other. The basis of this process is that one device has some task to accomplish and the other device has a resource needed to accomplish this task. One device is referred to as a Primary device while the other is referred to as a Secondary device. The distinction between Primary device and Secondary device is important because it is the responsibility of the Primary device to provide the mechanism to recognize other devices. So the Primary device must first poll for nearby IrDA standard compatible devices and, during this polling, the default baud rate of 9600 baud is used by both devices.

For example, if you want to print from an IrDA-equipped laptop to an IrDA-equipped printer, utilizing the IrDA standard feature, you would first bring your laptop in range of the printer. In this case, the laptop is the one that has something to do and the printer has the resource to do it. Thus, the laptop is called the Primary device and the printer is the Secondary device. Some data-capable cellphones have IrDA standard infrared ports. If you used such a cell phone with a Personal Digital Assistant (PDA), the PDA that supports the IrDA standard feature would be the Primary device and the cell phone would be the Secondary device.

When a Primary device polls for another device, a nearby Secondary device may respond. When a Secondary device responds, the two devices are defined to be in the Normal Disconnect Mode (NDM) state. NDM is established by the Primary device broadcasting a packet and waiting for a response. These broadcast packets are numbered. Usually, 6 or 8 packets are sent. The first packet is number 0, while the last packet is usually numbered 5 or 7. Once all the packets are sent, the Primary device sends an ID packet, which is not numbered.

The Secondary device waits for these packets and then responds to one of the packets. The packet responds to determine the “timeslot” to be used by the Secondary device. For example, if the Secondary device responds after packet number 2, the Secondary device will use timeslot 2. If the Secondary device responds after packet number 0, the Secondary device will use timeslot 0. This mechanism allows the Primary device to recognize as many nearby devices as there are timeslots. The Primary device will continue to generate timeslots and the Secondary device should continue to respond, even if there’s nothing to do.

Note 1: The MCP2140 can only be used to implement a Secondary device.

2: The MCP2140 supports a system with only one Secondary device having exclusive use of the IrDA standard infrared link (known as “point-to-point” communication).

3: The MCP2140 always responds to packet number 0. This means that the MCP2140 will always use timeslot 0.

4: If another Secondary device is nearby, the Primary device may fail to recognize the MCP2140, or the Primary device may not recognize either of the devices.

During NDM, the MCP2140 handles all responses to the Primary device (Figure 2-13) without any communication with the Host Controller. The Host Controller is inhibited by the CTS signal of the MCP2140 from sending data to the MCP2140.

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2.14.2 DISCOVERY MODE

Discovery mode allows the Primary device to determine the capabilities of the MCP2140 (Secondary device). Discovery mode is entered once the MCP2140 (Secondary device) has sent a XID response to the Primary device and the Primary device has completed sending the XIDs and a Broadcast ID. If this sequence is not completed, a Primary and Secondary device can stay in NDM indefinitely.

When the Primary device has something to do, it initiates Discovery, which has two parts. They are:

- Link initialization
- Resource determination

The first step is for the Primary and Secondary devices to determine, and then adjust to, each other's hardware capabilities. These capabilities are parameters like:

- Data rate
- Turnaround time
- Number of packets without a response
- How long to wait before disconnecting

Both the Primary and Secondary devices begin communications at 9600 baud, the default baud rate. The Primary device sends its parameters and the Secondary device responds with its parameters. For example, if the Primary device supports all data rates up to 115.2 kbaud and the Secondary device only supports 9.6 kbaud, the link will be established at 9.6 kbaud.

Note:	The MCP2140 is limited to a data rate of 9.6 kbaud.

Once the hardware parameters are established, the Primary device must determine if the Secondary device has the resources it requires. If the Primary device has a job to print, it must know if it's talking to a printer, and not a modem or other device. This determination is made using the Information Access Service (IAS). The job of the Secondary device is to respond to IAS queries made by the Primary device. The Primary device must ask a series of questions like:

- What is the name of your service?
- What is the address of this service?
- What are the capabilities of this device?

When all the Primary device's questions are answered, the Primary device can access the service provided by the Secondary device.

During Discovery mode, the MCP2140 handles all responses to the Primary device (see Figure 2-13) without any communication with the Host Controller. The Host Controller is inhibited by the CTS signal of the MCP2140 from sending data to the MCP2140.

2.14.3 NORMAL CONNECT MODE (NCM)

Once discovery has been completed, the Primary device and MCP2140 (Secondary device) can freely exchange data.

The MCP2140 uses a hardware handshake to stop the local serial port from sending data when the MCP2140 Host UART Receiving buffer is full..

Note:	Data loss will result if this hardware handshake is not observed.

Both the Primary device and the MCP2140 (Secondary device) check to make sure that data packets are received by the other without errors. Even when data is not required to be sent, the Primary and Secondary devices will still exchange packets to ensure that the connection hasn't, unexpectedly, been dropped. When the Primary device has finished, it transmits the "close link" command to the MCP2140 (Secondary device). The MCP2140 will confirm the "close link" command and both the Primary device and the MCP2140 (Secondary device) will revert to the NDM state.

Note:	If the NCM mode is unexpectedly terminated for any reason (including the Primary device not issuing a close link command), the MCP2140 will revert to the NDM state approximately 10 seconds after the last frame has been received.

It is the responsibility of the Host Controller program to understand the meaning of the data received and how the program should respond to it. It's just as if the data were being received by the Host Controller from a UART.

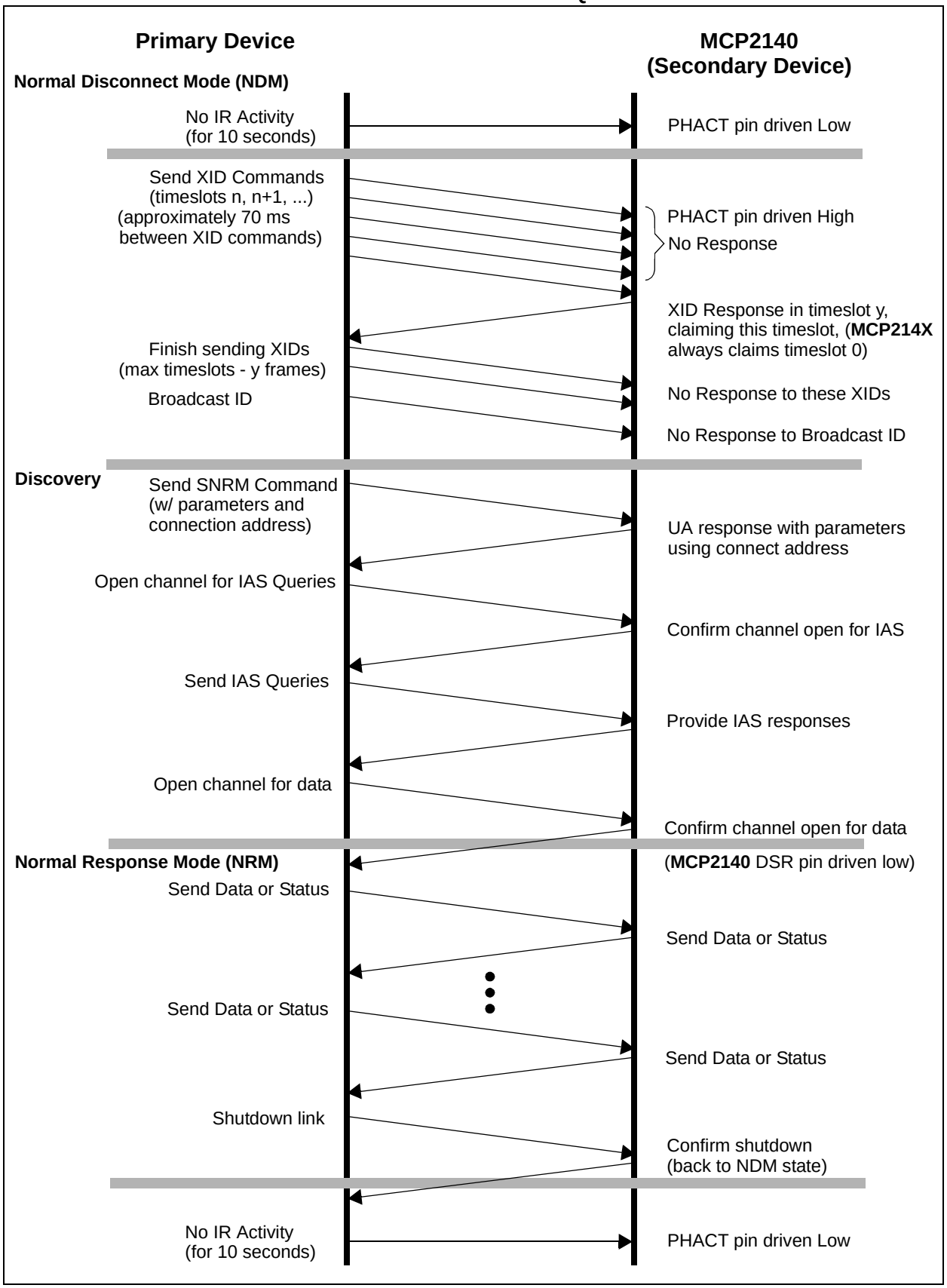
2.14.3.1 Primary Device Notification

The MCP2140 identifies itself to the Primary device as a modem.

Note:	The MCP2140 identifies itself as a modem to ensure that it is identified as a serial device with a limited amount of memory.

However, the MCP2140 is not a modem, and the non-data circuits are not handled in a modem fashion.

FIGURE 2-13: HIGH LEVEL MCP2140 CONNECTION SEQUENCE



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2.15 References

The IrDA Standards download page can be found at:

http://www.irda.org/standards/specifications

Some common manufacturers of optical transceivers are shown in Table 2-6.

TABLE 2-6: COMMON OPTICAL TRANSCEIVER MANUFACTURERS

Company	Company Web Site Address
Sharp®	www.sharpsma.com
Infineon®	www.infineon.com
Agilent®	www.agilent.com
Vishay®/Temic	www.vishay.com
Rohm	www.rohm.com

NOTES:

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3.0 DEVELOPMENT TOOLS

An MCP2140 Demo/Development board is planned.

Please check with the Microchip Technology Inc. web site (www.microchip.com) or your local Microchip sales office for product availability.

NOTES:

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4.0 ELECTRICAL CHARACTERISTICS

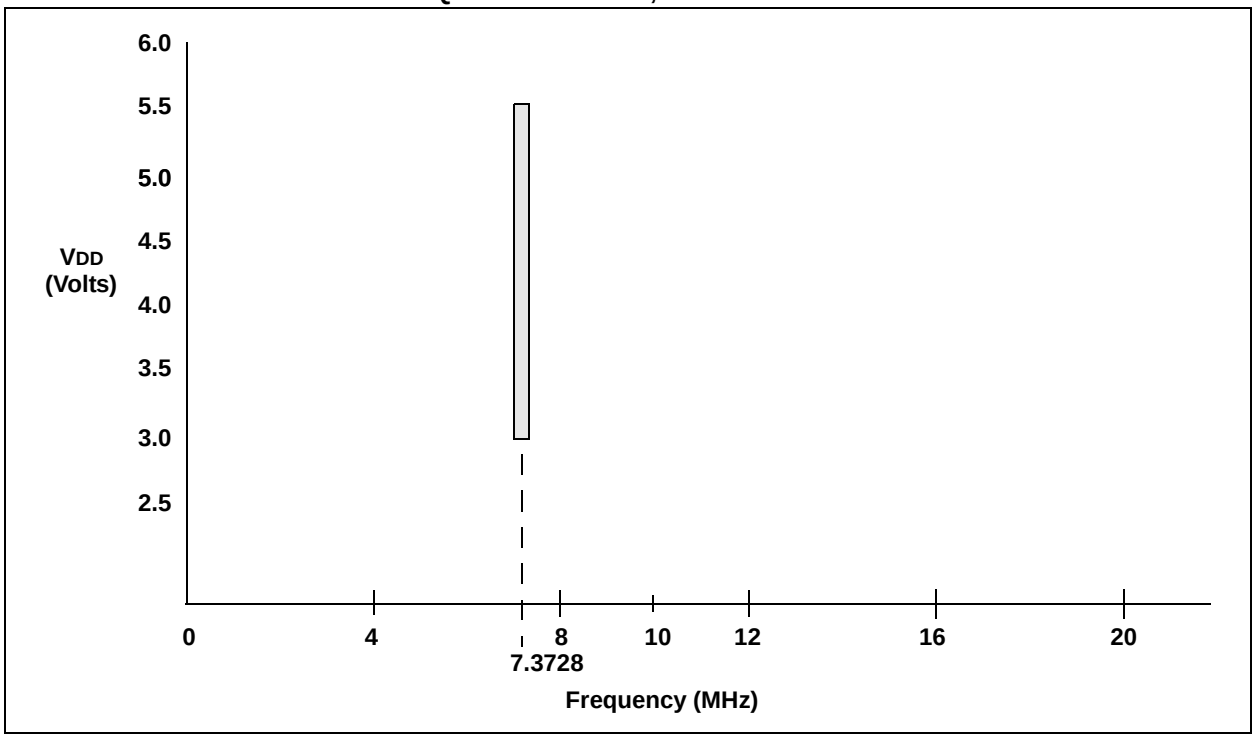
Absolute Maximum Ratings†

Ambient Temperature under bias ..... –40°C to +125°C
Storage Temperature ..... –65°C to +150°C
Voltage on V_{DD} with respect to V_{SS} ..... -0.3V to +7.5V
Voltage on $\overline{RESET}$ with respect to V_{SS} ..... -0.3V to +14V
Voltage on all other pins with respect to V_{SS} ..... –0.3V to (V_{DD} + 0.3V)
Total Power Dissipation **(1)** 1W
Max. Current out of V_{SS} pin ..... 300 mA
Max. Current into V_{DD} pin ..... 250 mA
Input Clamp Current, I_{IK} (V_I < 0 or V_I > V_{DD}) ..... ±20 mA
Output Clamp Current, I_{OK} (V_0 < 0 or V_0 > V_{DD}) ..... ±20 mA
Max. Output Current sunk by any Output pin ..... 25 mA
Max. Output Current sourced by any Output pin ..... 25 mA

Note 1: Power Dissipation is calculated as follows: $P_{DIS} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD}-V_{OH}) \times I_{OH}\} + \sum(V_{OL} \times I_{OL})$

†**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.

FIGURE 4-1: VOLTAGE-FREQUENCY GRAPH, -40°C ≤ TA ≤ +85°C



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4.1 DC Characteristics

DC Specifications			Electrical Characteristics: Standard Operating Conditions (unless otherwise specified) Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial)				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
D001	VDD	Supply Voltage	3.0	—	5.5	V	See **Figure 4-1**
D002	VDR	RAM Data Retention Voltage (2)	2.0	—	—	V	Device Oscillator/Clock stopped
D003	VPOR	VDD Start Voltage to ensure Power-on Reset	—	VSS	—	V	
D004	SVDD	VDD Rise Rate to ensure Power-on Reset	0.05	—	—	V/ms	
D010	IDD	Supply Current (3, 4)	—	—	2.2	mA	VDD = 3.0V, PHACT = H
D010A			—	25	60	µA	VDD = 3.0V, PHACT = L

Note 1: Data in the Typical (“Typ”) column is based on characterization results at 25°C. This data is for design guidance only and is not tested.

2: This is the limit to which VDD can be lowered without losing RAM data.

3: When the device is in IR communication (PHACT pin is high), supply current is mainly a function of the operating voltage and frequency. Pin loading, pin rate and temperature have an impact on the current consumption.The test conditions for all IDD measurements are made when device is:
OSC1 = external square wave, from rail-to-rail; all input pins pulled to VSS, RXIR = VDD, $\overline{\text{RESET}}$ = VDD;

4: When the device is in low power mode (PHACT pin is low), current is measured with all input pins tied to VDD or VSS and the output pins driving a high or low level into infinite impedance.

4.1 DC Characteristics (Continued)

DC Specifications			Electrical Characteristics: Standard Operating Conditions (unless otherwise specified) Operating temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating voltage VDD range as described in DC spec Section 4.1.				
Param No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
		Input Low Voltage					
	VIL	Input pins					
D030		with TTL buffer	VSS	—	0.8V	V	4.5V ≤ VDD ≤ 5.5V
D030A		(TX, RI, DTR, RTS, and CD)	VSS	—	0.15 VDD	V	otherwise
D032		$\overline{\text{RESET}}$	VSS	—	0.2 VDD	V	
D033		OSC1	VSS	—	0.3 VDD	V	
		Input High Voltage					
	VIH	Input pins		—			
D040		with TTL buffer	2.0	—	VDD	V	4.5V ≤ VDD ≤ 5.5V
D040A		(TX, RI, DTR, RTS, and CD)	0.25 VDD + 0.8	—	VDD	V	otherwise
D042		$\overline{\text{RESET}}$	0.8 VDD	—	VDD	V	
D043		OSC1	0.7 VDD	—	VDD	V	
		Input Leakage Current (Notes 1, 2)					
D060	IIL	Input pins	—	—	±1	µA	VSS ≤ VPIN ≤ VDD, pin at high-impedance.
D061		$\overline{\text{RESET}}$	—	—	±5	µA	VSS ≤ VPIN ≤ VDD
D063		OSC1	—	—	±5	µA	VSS ≤ VPIN ≤ VDD
		Output Low Voltage					
D080	VOL	TXIR, RX, DSR, and CTS pins	—	—	0.6	V	IOL = 8.5 mA, VDD = 4.5V
D083		OSC2	—	—	0.6	V	IOL = 1.6 mA, VDD = 4.5V
		Output High Voltage (Note 2)					
D090	VOH	TXIR, RX, DSR, and CTS pins	VDD - 0.7	—	—	V	IOH = -3.0 mA, VDD = 4.5V
D092		OSC2	VDD - 0.7	—	—	V	IOH = -1.3 mA, VDD = 4.5V
		Capacitive Loading Specs on Output Pins					
D100	COSC2	OSC2 pin	—	—	15	pF	When external clock is used to drive OSC1.
D101	CIO	All Input or Output pins	—	—	50	pF	

Note 1: The leakage current on the $\overline{\text{RESET}}$ pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.

2: Negative current is defined as coming out of the pin.

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4.2 Timing Parameter Symbology and Load Conditions

The timing parameter symbols have been created following one of the following formats:

4.2.1 TIMING CONDITIONS

The temperature and voltages specified in Table 4-2 apply to all timing specifications, unless otherwise noted. Figure 4-2 specifies the load conditions for the timing specifications.

TABLE 4-1: SYMBOLOGY

1. TppS2ppS

T			
F	Frequency	T	Time
E	Error		

Lowercase letters (pp) and their meanings:

pp			
io	Input or Output pin	osc	Oscillator
rx	Receive	tx	Transmit
bitclk	RX/TX BITCLK	RST	Reset
drt	Device Reset Timer		

Uppercase letters and their meanings:

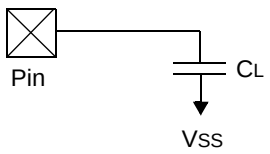
S			
F	Fall	P	Period
H	High	R	Rise
I	Invalid (high-impedance)	V	Valid
L	Low	Z	High-impedance

2. TppS

TABLE 4-2: AC TEMPERATURE AND VOLTAGE SPECIFICATIONS

AC Specifications	**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise stated):** Operating temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating voltage VDD range as described in DC spec Section 4.1.

FIGURE 4-2: LOAD CONDITIONS FOR DEVICE TIMING SPECIFICATIONS



CL = 50 pF for all pins except OSC2
15 pF for OSC2 when external clock is used to drive OSC1

4.3 Timing Diagrams and Specifications

FIGURE 4-3: EXTERNAL CLOCK TIMING

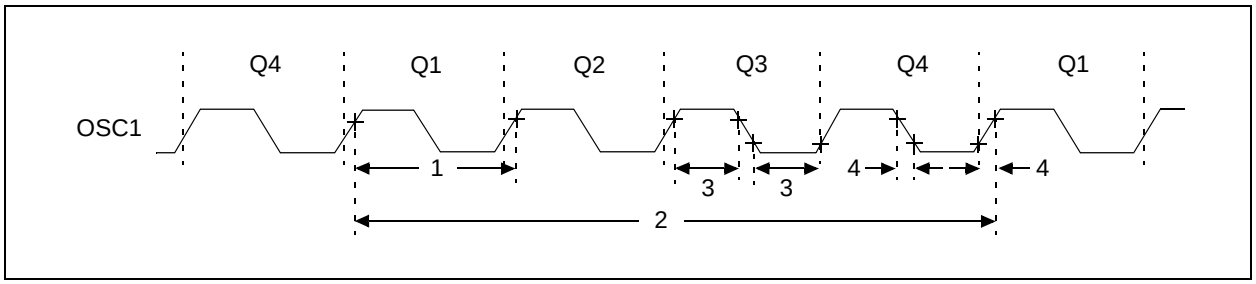


TABLE 4-3: EXTERNAL CLOCK TIMING REQUIREMENTS

AC Specifications			Electrical Characteristics: Standard Operating Conditions (unless otherwise specified): Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
1	TOSC	External CLKIN Period (2, 3) Oscillator Period (2)	90.422 90.422 90.422	— — —	90.422 — 90.422	ns ns ns	Device Operation Low Power mode (PHACT drive Low)
1A	FOSC	External CLKIN Frequency (2, 3) Oscillator Frequency (2)	7.3728 7.3728	7.3728 —	7.3728 7.3728	MHz MHz	
1B	FERR	Error in Frequency	—	—	± 0.01	%	
1C	ECLK	External Clock Error	—	—	± 0.01	%	
4	TosR, TosF	Clock in (OSC1) Rise or Fall Time	—	—	15	ns	

Note 1: Data in the Typical (“Typ”) column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

2: All specified values are based on oscillator characterization data under standard operating conditions. Exceeding these specified limits may result in unstable oscillator operation and/or higher than expected current consumption. When an external clock input is used, the “max” cycle time limit is “DC” (no clock) for all devices.

3: A duty cycle of no more than 60% (High time/Low time or Low time/High time) is recommended for external clock inputs.

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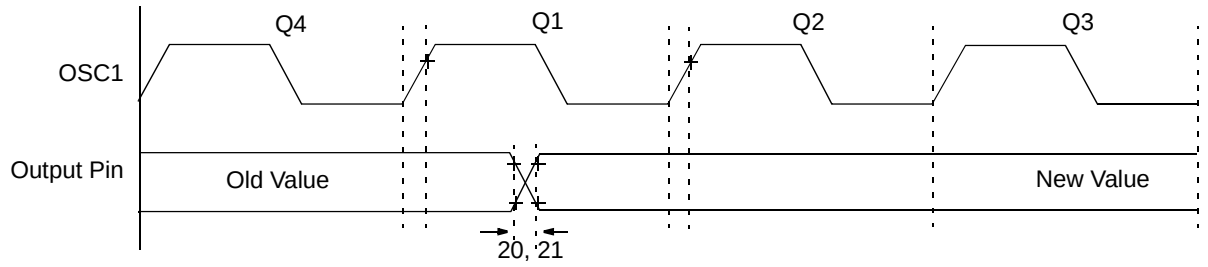
FIGURE 4-4: OUTPUT WAVEFORM



Note: Refer to Figure 4-2 for load conditions.

TABLE 4-4: OUTPUT TIMING REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
20	ToR	RX and TXIR pin rise time (2)	—	10	40	ns	
21	ToF	RX and TXIR pin fall time (2)	—	10	40	ns	

Note 1: Data in the Typical (“Typ”) column is at 5V, 25°C unless otherwise stated.

2: See Figure 4-2 for loading conditions.

FIGURE 4-5: $\overline{\text{RESET}}$ AND DEVICE RESET TIMING

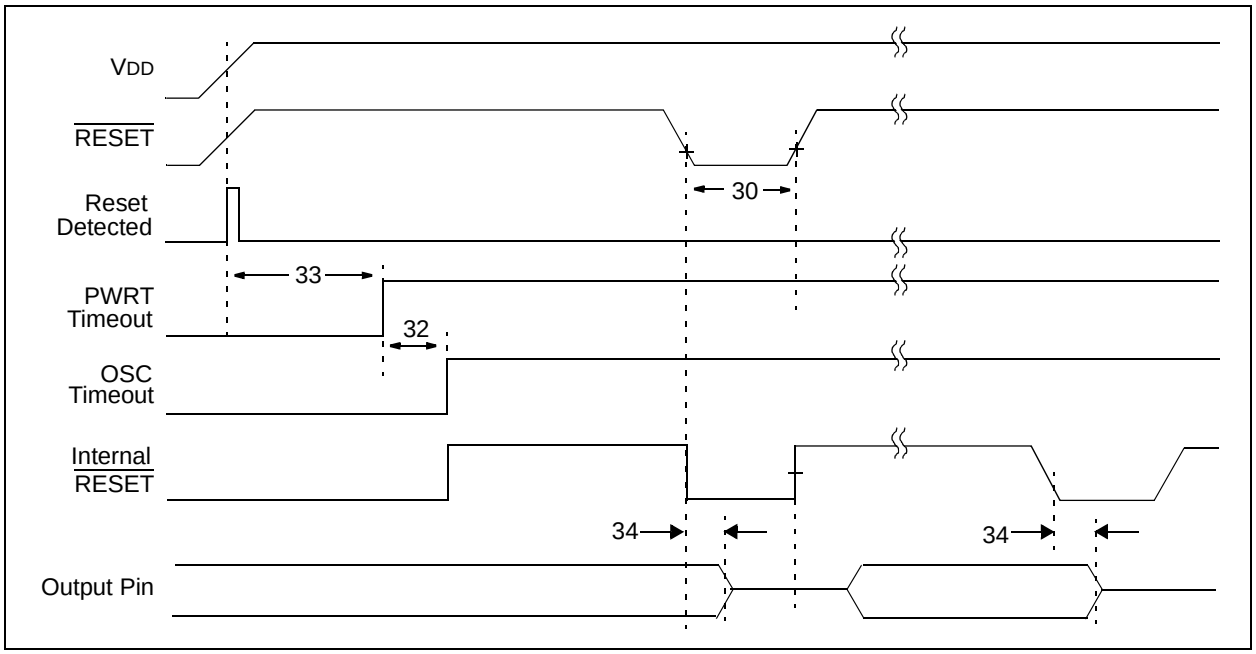


TABLE 4-5: $\overline{\text{RESET}}$ AND DEVICE RESET REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
30	TRSTL	$\overline{\text{RESET}}$ Pulse Width (low)	2000	—	—	ns	VDD = 5.0V
32	TOST	Oscillator Start-up Timer Period	1024	—	1024	TOSC	
33	TPWRT	Power up Timer Period	28	72	132	ms	VDD = 5.0V
34	TIOZ	Output High-impedance from $\overline{\text{RESET}}$ Low or device Reset	—	—	2	µs	

Note 1: Data in the Typical (“Typ”) column is at 5V, 25°C unless otherwise stated.

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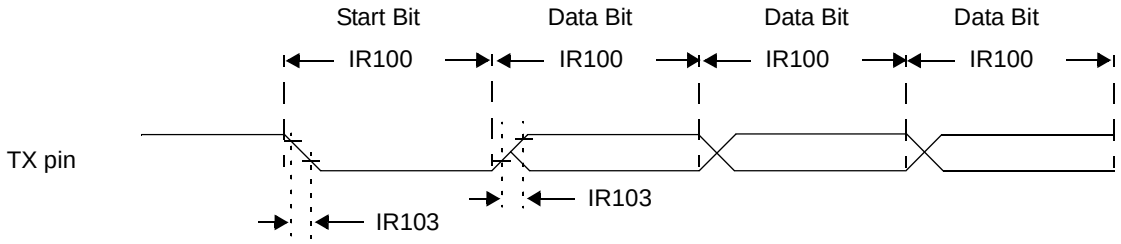
FIGURE 4-6: UART ASYNCHRONOUS TRANSMISSION WAVEFORM



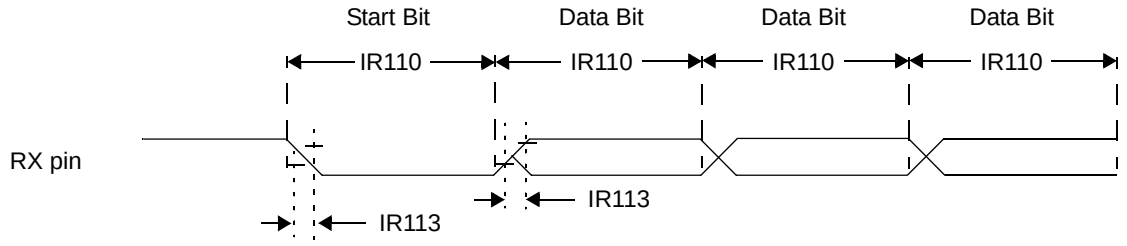
Note: Refer to Figure 4-2 for load conditions.

TABLE 4-6: UART ASYNCHRONOUS TRANSMISSION REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
IR100	TTXBIT	Transmit Baud rate	768	—	768	TOSC	BAUD2:BAUD0 = 00
IR101	ETXBIT	Transmit (TX pin) Baud rate Error (into MCP2140)	—	—	±2	%	
IR102	ETXIRBIT	Transmit (TXIR pin) Baud rate Error (out of MCP2140) (1)	—	—	±1	%	
IR103	TTXRF	TX pin rise time and fall time	—	—	25	ns	

Note 1: This error is not additive to IR101 parameter.

FIGURE 4-7: UART ASYNCHRONOUS RECEIVE TIMING



Note: Refer to Figure 4-2 for load conditions.

TABLE 4-7: UART ASYNCHRONOUS RECEIVE REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85×C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
IR110	TRXBIT	Receive Baud Rate	768	—	768	TOSC	BAUD2:BAUD0 = 00
IR111	ERXBIT	Receive (RXPD and RXPDREF pin detection) Baud rate Error (into MCP2140)	—	—	±1	%	
IR112	ERXBIT	Receive (RX pin) Baud rate Error (out of MCP2140) (1)	—	—	±1	%	
IR113	TTXRF	RX pin rise time and fall time	—	—	25	ns	

Note 1: This error is not additive to the IR111 parameter.

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FIGURE 4-8: TXIR WAVEFORMS

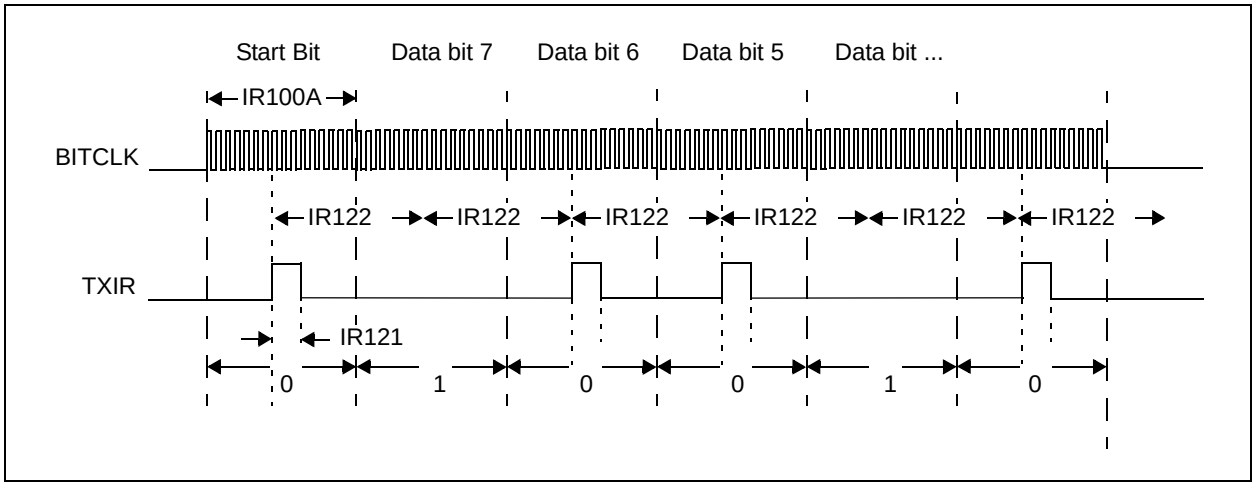

TABLE 4-8: TXIR REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
IR100A	TTXIRBIT	Transmit Baud Rate	768	—	768	TOSC	BAUD = 9600
IR121	TTXIRPW	TXIR pulse width	24	—	24	TOSC	
IR122	TTXIRP	TXIR bit period (1)	—	16	—	TBITCLK	

Note 1: TBITCLK = TTXBIT/16.

FIGURE 4-9: RXPD/RXPDREF WAVEFORMS

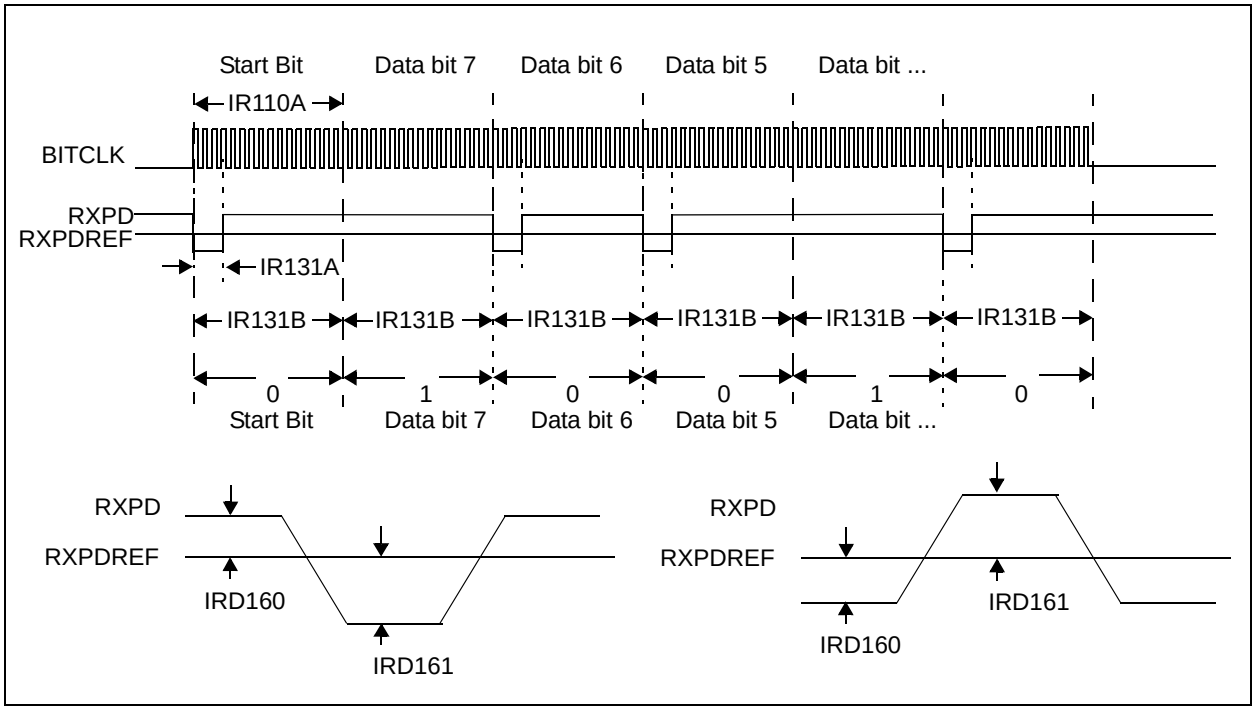

TABLE 4-9: RXPD/RXPDREF REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
IR110A	TRXPDBIT	Receive Baud Rate	768	—	768	TOSC	BAUD = 9600
IR131A	TRXPDPW	RXPD pulse width	0.01	—	1.5	µs	
IR132	TRXPDP	RXPD/RXPDREF bit period (1)	—	16	—	TBITCLK	
IRD060	VRXPDDΔ	Quiescent Delta Voltage between RXPD and RXPDREF	20	—	—	mV	
IRD061	VRXPDE	IR Pulse Detect Delta Voltage (RXPD to RXPDREF)	30	—	—	mV	RXPD signal must cross RXPDREF signal level
IR133	TRESP	Response Time (2)	—	—	400 *	ns	

* These parameters characterized but not tested.

Note 1: TBITCLK = TRXBIT/16.

2: Response time measured with RXPDREF at (VDD - 1.5V)/2, while RXPD transitions from VSS to VDD.

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FIGURE 4-10: LOW POWER WAVEFORM

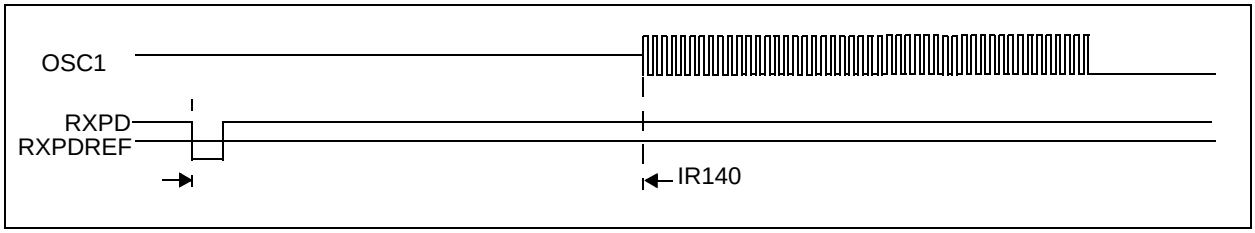

TABLE 4-10: LOW POWER REQUIREMENTS

AC Specifications			**Electrical Characteristics:** **Standard Operating Conditions (unless otherwise specified):** Operating Temperature: -40°C ≤ TA ≤ +85°C (industrial) Operating Voltage VDD range is described in Section 4.1				
Param. No.	**Sym**	**Characteristic**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
IR140	TRXPD2OSC	RXPD pulse edge to valid device oscillator (1)	—	—	4	ms	

Note 1: At 9600 Baud, 4 ms is 4 bytes (of the 11 byte repeated SOF character). This allows the MCP2140 to recognize a SOF character and properly receive the IR packet.

NOTES:

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5.0 DC AND AC CHARACTERISTICS GRAPHS AND TABLES

Not available at this time.

NOTES:

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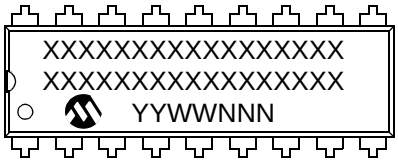
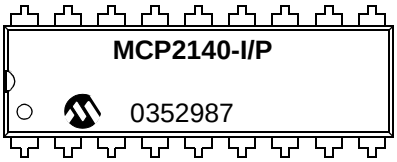
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

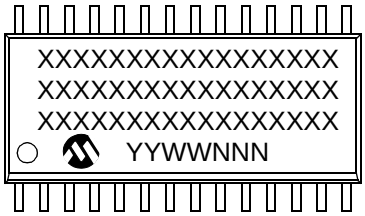
18-Lead PDIP (300 mil)



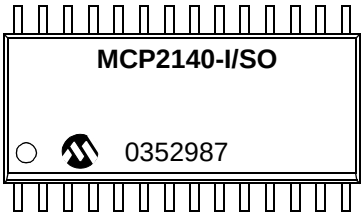
Example:



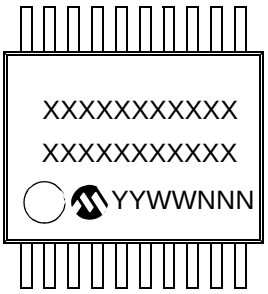
18-Lead SOIC (300 mil)



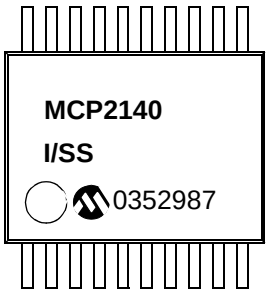
Example:



20-Lead SSOP (209 mil, 5.30 mm)



Example:

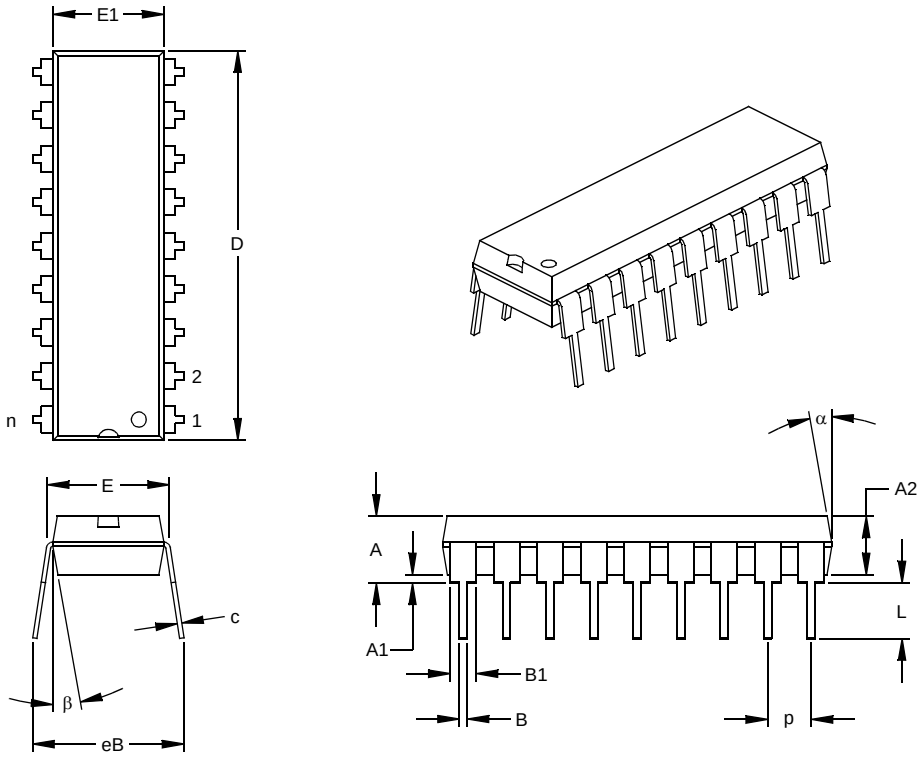


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free 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.

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

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



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		18			18	
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	.890	.898	.905	22.61	22.80	22.99
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. C04-007

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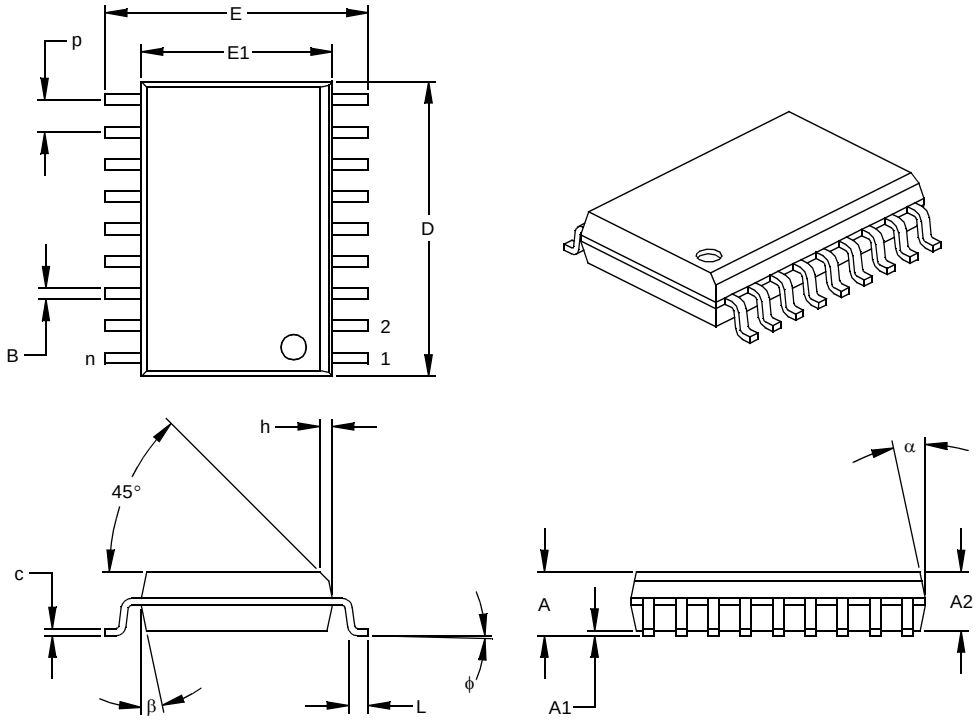
18-Lead Plastic Small Outline (SO) – Wide, 300 mil (SOIC)

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



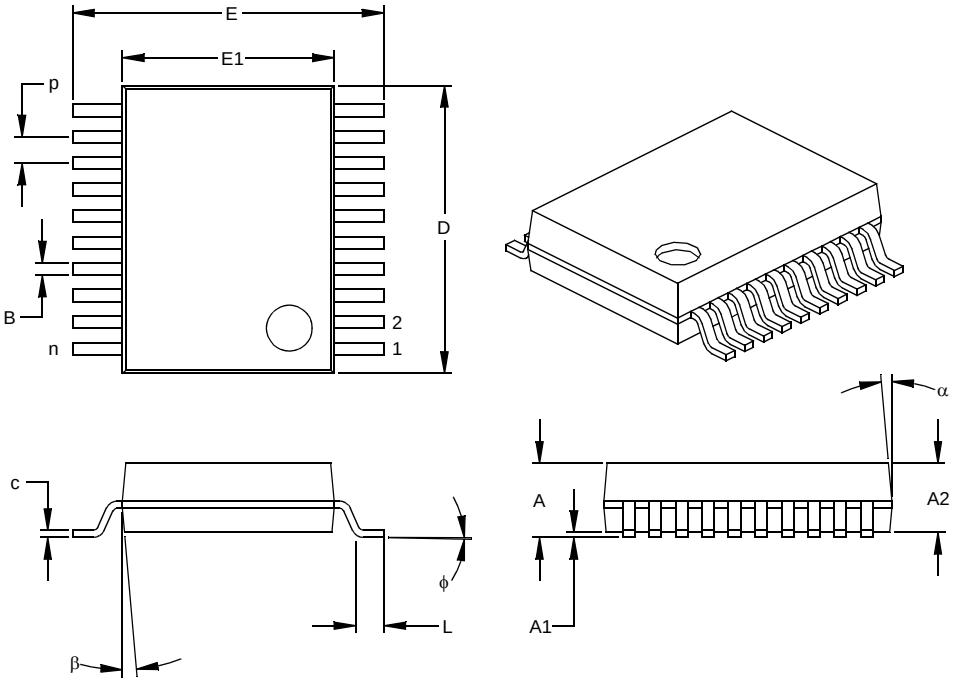
Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		18			18	
Pitch	p		.050			1.27	
Overall Height	A	.093	.099	.104	2.36	2.50	2.64
Molded Package Thickness	A2	.088	.091	.094	2.24	2.31	2.39
Standoff §	A1	.004	.008	.012	0.10	0.20	0.30
Overall Width	E	.394	.407	.420	10.01	10.34	10.67
Molded Package Width	E1	.291	.295	.299	7.39	7.49	7.59
Overall Length	D	.446	.454	.462	11.33	11.53	11.73
Chamfer Distance	h	.010	.020	.029	0.25	0.50	0.74
Foot Length	L	.016	.033	.050	0.41	0.84	1.27
Foot Angle	ϕ	0	4	8	0	4	8
Lead Thickness	c	.009	.011	.012	0.23	0.27	0.30
Lead Width	B	.014	.017	.020	0.36	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-013
Drawing No. C04-051

20-Lead Plastic Shrink Small Outline (SS) – 209 mil, 5.30 mm (SSOP)

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



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		20			20	
Pitch	p		.026			0.65	
Overall Height	A	.068	.073	.078	1.73	1.85	1.98
Molded Package Thickness	A2	.064	.068	.072	1.63	1.73	1.83
Standoff §	A1	.002	.006	.010	0.05	0.15	0.25
Overall Width	E	.299	.309	.322	7.59	7.85	8.18
Molded Package Width	E1	.201	.207	.212	5.11	5.25	5.38
Overall Length	D	.278	.284	.289	7.06	7.20	7.34
Foot Length	L	.022	.030	.037	0.56	0.75	0.94
Lead Thickness	c	.004	.007	.010	0.10	0.18	0.25
Foot Angle	ϕ	0	4	8	0.00	101.60	203.20
Lead Width	B	.010	.013	.015	0.25	0.32	0.38
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* 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: MO-150
Drawing No. C04-072

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APPENDIX A: REVISION HISTORY

Revision A

- This is a new data sheet

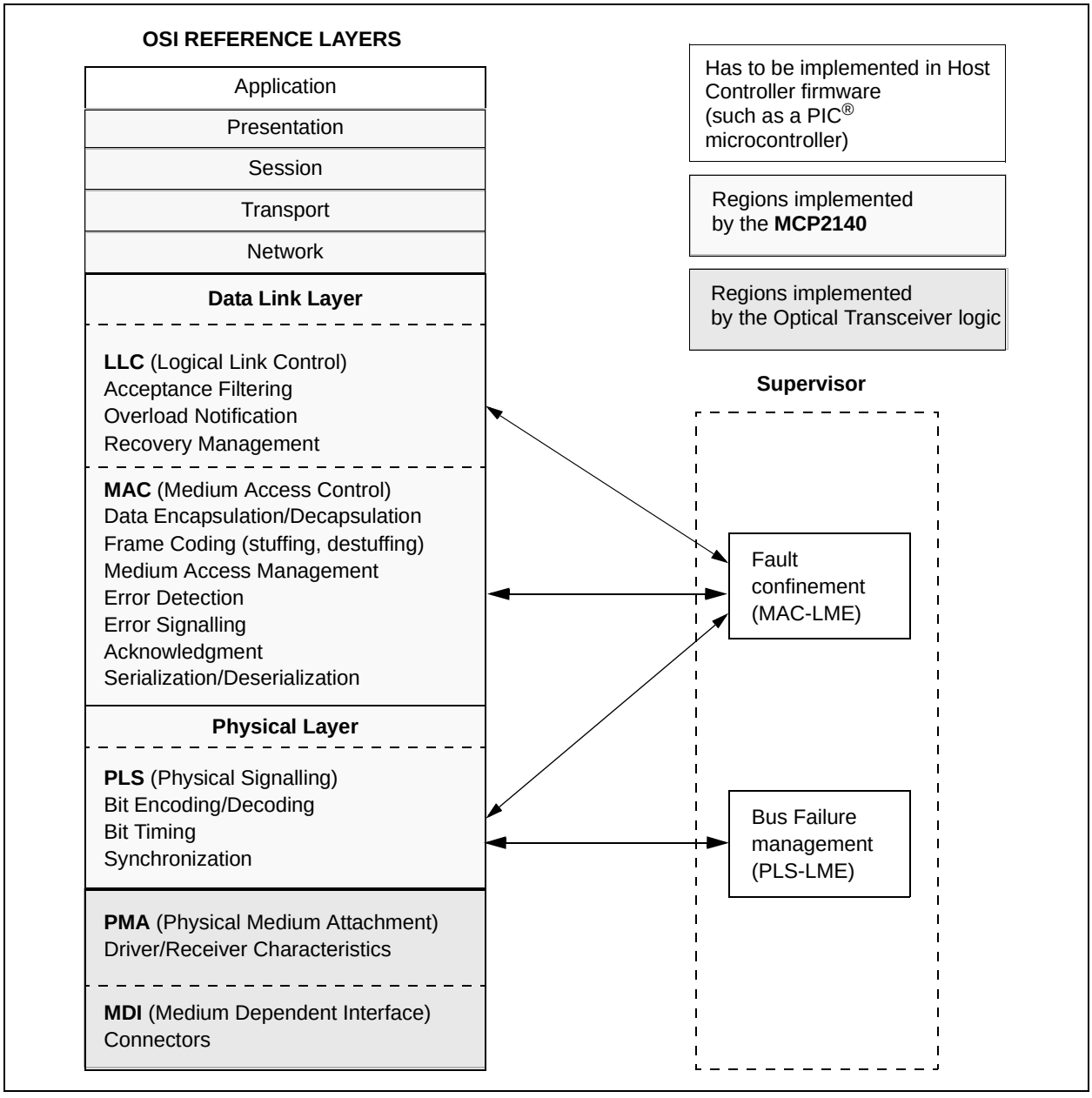
Revision B (November 2012)

Added a note to each package outline drawing.

APPENDIX B: NETWORK LAYERING REFERENCE MODEL

Figure B-1 shows the ISO Network Layering Reference Model. The shaded areas are implemented by the MCP2140, while the cross-hatched area is implemented by an infrared transceiver. The unshaded areas should be implemented by the Host Controller.

FIGURE B-1: ISO REFERENCE LAYER MODEL



The IrDA Standard specifies the following protocols:

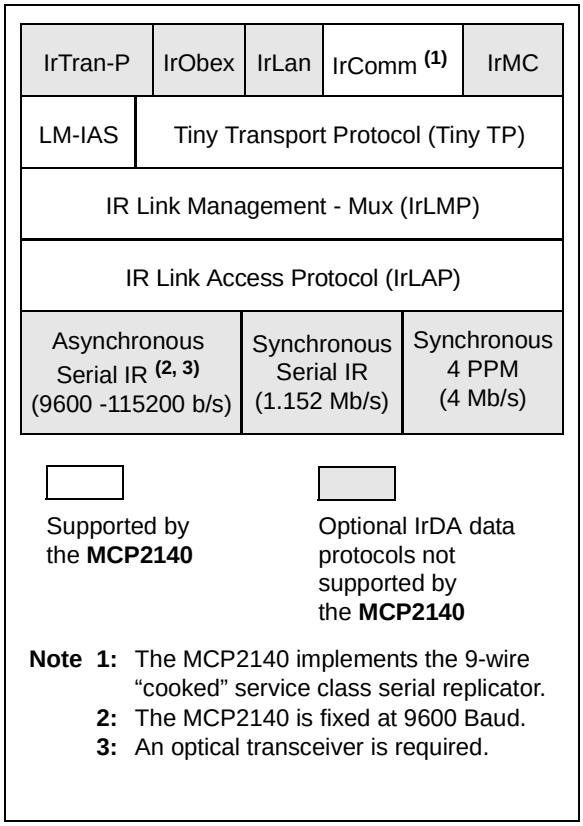
- Physical Signaling Layer (PHY)
- Link Access Protocol (IrLAP)
- Link Management Protocol/Information Access Service (IrLMP/IAS)

The IrDA data lists optional protocols. They are:

- Tiny TP
- IrTran-P
- IrOBEX
- IrLAN
- IrCOMM
- IrMC
- IrDA Lite

Figure B-2 shows the IrDA data protocol stack and which components are implemented by the MCP2140.

FIGURE B-2: IRDA DATA - PROTOCOL STACKS



Note 1: The MCP2140 implements the 9-wire "cooked" service class serial replicator.
2: The MCP2140 is fixed at 9600 Baud.
3: An optical transceiver is required.

B.1 IrDA STANDARD DATA PROTOCOLS SUPPORTED BY MCP2140

The MCP2140 supports these required IrDA standard protocols:

- Physical Signaling Layer (PHY)
- Link Access Protocol (IrLAP)
- Link Management Protocol/Information Access Service (IrLMP/IAS)

The MCP2140 also supports some of the optional protocols for IrDA data. The optional protocols that the MCP2140 implements are:

- Tiny TP
- IrCOMM

B.1.1 PHYSICAL SIGNAL LAYER (PHY)

The MCP2140 provides the following Physical Signal Layer specification support:

- Bidirectional communication
- Data Packets are protected by a CRC
  - 16-bit CRC for speeds up to 115.2 kbaud

Note: MCP2140 supports 9600 Baud only.

- Data Communication Rate
  - 9600 baud minimum data rate (with primary speed/cost steps of 115.2 kbaud

Note: MCP2140 supports 9600 Baud only.

The following Physical Layer Specification is dependant on the optical transceiver logic used in the application. The specification states:

- Communication Range, which sets the end user expectation for discovery, recognition and performance.
  - Continuous operation from contact to at least 1 meter (typically 2 meters can be reached)
  - A low power specification reduces the objective for operation from contact to at least 20 cm (low power and low power) or 30 cm (low power and standard power)

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B.1.2 IrLAP

The IrLAP protocol provides:

- Management of communication processes on the link between devices
- A device-to-device connection for the reliable, ordered transfer of data
- Device discover procedures
- Hidden node handling. 115.2 kbaud

Note: Not supported by MCP2140.

Figure B-3 identifies the key parts and hierarchy of the IrDA protocols. The bottom layer is the Physical layer, IrPHY. This is the part that converts the serial data to and from pulses of IR light. IR transceivers can't transmit and receive at the same time. The receiver has to wait for the transmitter to finish sending. This is sometimes referred to as a "Half-Duplex" connection. The IR Link Access Protocol (IrLAP) provides the structure for packets (or "frames") of data to emulate data that would normally be free to stream back and forth.

FIGURE B-3: IrDA STANDARD PROTOCOL LAYERS

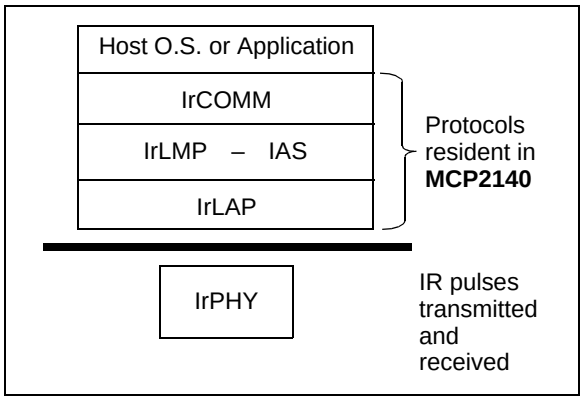


Figure B-4 shows how the IrLAP frame is organized. The frame is preceded by some number of Beginning of Frame characters (BOFs). The value of the BOF is generally 0xC0, but 0xFF may be used if the last BOF character is a 0xC0. The purpose of multiple BOFs is to give the other station some warning that a frame is coming.

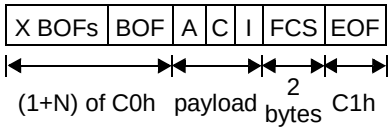
The IrLAP frame begins with an address byte ("A" field), then a control byte ("C" field). The control byte is used to differentiate between different types of frames and is also used to count frames. Frames can carry status, data or commands. The IrLAP protocol has a command syntax of it's own. These commands are part of the control byte. Lastly, IrLAP frames carry data. This data is the information (or "I") field. The integrity of the frame is ensured with a 16-bit CRC, referred to as the Frame Check Sequence (FCS). The 16-bit CRC value is transmitted LSB first. The end of the frame is marked with an EOF character, which is always a 0xC1. The frame structure described here is used for all versions of IrDA protocols used for serial wire replacement for speeds up to 115.2 kbaud.

Note 1: The MCP2140 only supports communication baud rate of 9600 baud.

2: Another IrDA standard that is entering into general usage is IR Object Exchange (IrOBEX). This standard is not used for serial connection emulation.

3: IrDA communication standards faster than 115.2 kbaud use a different CRC method and physical layer.

FIGURE B-4: IrLAP FRAME



In addition to defining the frame structure, IrLAP provides the "housekeeping" functions of opening, closing and maintaining connections. The critical parameters that determine the performance of the link are part of this function. These parameters control how many BOFs are used, identify the speed of the link, how fast either party may change from receiving to transmitting, etc. IrLAP has the responsibility of negotiating these parameters to the highest common set so that both sides can communicate as quickly and reliably as possible.

B.1.3 IrLMP

The IrLMP protocol provides:

- Multiplexing of the IrLAP layer. This allows multiple channels above an IrLAP connection.
- Protocol and service discovery. This is accomplished via the Information Access Service (IAS).

When two devices that contain the IrDA standard feature are connected, there is generally one device that has something to do and the other device that has the resource to do it. For example, a laptop may have a job to print and an IrDA standard compatible printer has the resources to print it. In IrDA standard terminology, the laptop is a Primary device and the printer is the Secondary device. When these two devices connect, the Primary device must determine the capabilities of the Secondary device to determine if the Secondary device is capable of doing the job. This determination is made by the Primary device asking the Secondary device a series of questions. Depending on the answers to these questions, the Primary device may or may not elect to connect to the Secondary device.

The queries from the Primary device are carried to the Secondary device using IrLMP. The responses to these queries can be found in the Information Access Service (IAS) of the Secondary device. The IAS is a list of the resources of the Secondary device. The Primary device compares the IAS responses with its requirements and then makes the decision if a connection should be made.

B.1.4 LINK MANAGEMENT - INFORMATION ACCESS SERVICE (LM-IAS)

Each LM-IAS entity maintains an information database to provide:

- Information on services for other devices that contain the IrDA standard feature (Discovery)
- Information on services for the device itself
- Remote accessing of another device's information base

This is required so that clients on a remote device can find configuration information needed to access a service.

B.1.5 TINY TP

Tiny TP provides the flow control on IrLMP connections. An optional service of Segmentation and Reassembly can be handled.

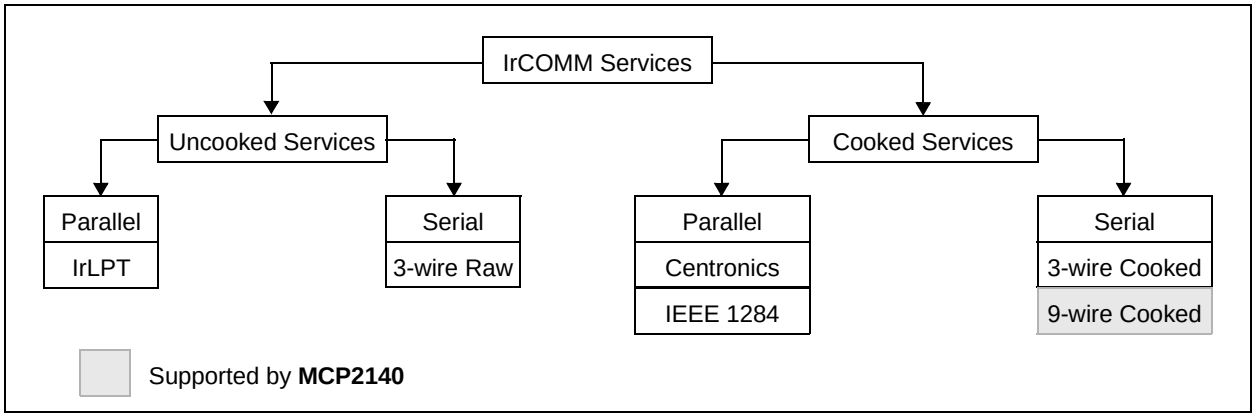
B.1.6 IRCOMM

IrCOMM provides the method to support serial and parallel port emulation. This is useful for legacy COM applications, such as printers and modem devices.

The IrCOMM standard is a syntax that allows the Primary device to consider the Secondary device a serial device. IrCOMM allows for emulation of serial or parallel (printer) connections of various capabilities.

Note:	The MCP2140 supports the 9-wire "cooked" service class of IrCOMM. Other service classes supported by IrCOMM are shown in Figure B-5.

FIGURE B-5: IRCOMM SERVICE CLASSES



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B.1.7 OTHER OPTIONAL IrDA DATA PROTOCOLS

Other IrDA data protocols have been developed to specific application requirements. These IrDA data protocols are briefly described in the following subsections. For additional information, please refer to the IrDA web site **(www.IrDA.org)**.

B.1.7.1 IrTran-P

IrTran-P provides the protocol to exchange images with digital image capture devices/cameras.

Note:	Not supported by MCP2140.

B.1.7.2 IrOBEX

IrOBEX provides OBject EXchange services. This is similar to HTTP.

Note:	Not supported by MCP2140.

B.1.7.3 IrLAN

IrLAN describes a protocol to support IR wireless access to a Local Area Network (LAN).

Note:	Not supported by MCP2140.

B.1.7.4 IrMC

IrMC describes how mobile telephony and communication devices can exchange information. This information includes phone book, calender and message data.

Also how call control and real-time voice are handled (RTCON).

Note:	Not supported by MCP2140.

B.1.7.5 IrDA Lite

IrDA Lite describes how to reduce the application code requirements, while maintaining compatibility with the full implementation.

Note:	Not supported by MCP2140.

APPENDIX C: HOW DEVICES CONNECT

When two devices implementing the IrDA standard feature establish a connection using the IrCOMM protocol, the process is analogous to connecting two devices with serial ports using a cable. This is referred to as a “point-to-point” connection. This connection is limited to half-duplex operation because the IR transceiver cannot transmit and receive at the same time. The purpose of the IrDA protocols is to allow this half-duplex link to emulate, as much as possible, a full-duplex connection. In general, this is done by dividing the data into “packets”, or groups of data. These packets can then be sent back and forth, when needed, without risk of collision. The rules of how and when these packets are sent constitute the IrDA protocols.

When a wired connection is used, the assumption is made that both sides have the same communications parameters and features. A wired connection has no need to identify the other connector because it is assumed that the connectors are properly connected. In the IrDA standard, a connection process has been defined to identify other IrDA compatible devices and establish a communication link. There are three steps that these two devices go through to make this connection. They are:

- Normal Disconnect Mode (NDM)
- Discovery Mode
- Normal Connect Mode (NCM)

Figure C-1 shows the connection sequence.

C.1 Normal Disconnect Mode (NDM)

When two IrDA standard compatible devices come into range they must first recognize each other. The basis of this process is that one device has some task to accomplish and the other device has a resource needed to accomplish this task. One device is referred to as a Primary device and the other is referred to as a Secondary device. This distinction between Primary device and Secondary device is important. It is the responsibility of the Primary device to provide the mechanism to recognize other devices. So the Primary device must first poll for nearby IrDA standard compatible devices. During this polling, the default baud rate of 9600 baud is used by both devices.

For example, if you want to print from an IrDA equipped laptop to an IrDA printer, utilizing the IrDA standard feature, you would first bring your laptop in range of the printer. In this case, the laptop is the one that has something to do and the printer has the resource to do it. The laptop is called the Primary device and the printer is the Secondary device. Some data-capable cell phones have IrDA standard infrared ports. If you used such a cell phone with a Personal Digital Assistant (PDA), the PDA that supports the IrDA standard feature would be the Primary device and the cell phone would be the Secondary device.

When a Primary device polls for another device, a nearby Secondary device may respond. When a Secondary device responds, the two devices are defined to be in the Normal Disconnect Mode (NDM) state. NDM is established by the Primary device broadcasting a packet and waiting for a response. These broadcast packets are numbered. Usually 6 or 8 packets are sent. The first packet is number 0, the last packet is usually number 5 or 7. Once all the packets are sent, the Primary device sends an ID packet, which is not numbered.

The Secondary device waits for these packets and then responds to one of the packets. The packet responds to determines the “timeslot” to be used by the Secondary device. For example, if the Secondary device responds after packet number 2, then the Secondary device will use timeslot 2. If the Secondary device responds after packet number 0, then the Secondary device will use timeslot 0. This mechanism allows the Primary device to recognize as many nearby devices as there are timeslots. The Primary device will continue to generate timeslots and the Secondary device should continue to respond, even if there’s nothing to do.

Note 1: The MCP2140 can only be used to implement a Secondary device.

2: The MCP2140 supports a system with only one Secondary device having exclusive use of the IrDA standard infrared link (known as “point-to-point” communication).

3: The MCP2140 always responds to packet number 2. This means that the MCP2140 will always use timeslot 2.

4: If another Secondary device is nearby, the Primary device may fail to recognize the MCP2140, or the Primary device may not recognize either of the devices.

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C.2 Discovery Mode

Discovery mode allows the Primary device to determine the capabilities of the MCP2140 (Secondary device). Discovery mode is entered once the MCP2140 (Secondary device) has sent an XID response to the Primary device and the Primary device has completed sending the XIDs and then sends a Broadcast ID. If this sequence is not completed, then a Primary and Secondary device can stay in NDM indefinitely.

When the Primary device has something to do, it initiates Discovery. Discovery has two parts. They are:

- Link initialization
- Resource determination

The first step is for the Primary and Secondary devices to determine, and then adjust to, each other's hardware capabilities. These capabilities are parameters like:

- Data rate
- Turn around time
- Number of packets without a response
- How long to wait before disconnecting

Both the Primary and Secondary device begin communications at 9600 baud, which is the default baud rate. The Primary device sends its parameters, then the Secondary device responds with its parameters. For example, if the Primary supports all data rates up to 115.2 kbaud and the Secondary device only supports 9.6 kbaud, the link will be established at 9.6 kbaud.

Note:	The MCP2140 is limited to a data rate of 9.6 kbaud.

Once the hardware parameters are established, the Primary device must determine if the Secondary device has the resources it requires. If the Primary device has a job to print, then it must know if it's talking to a printer, not a modem or other device. This determination is made using the Information Access Service (IAS). The job of the Secondary device is to respond to IAS queries made by the Primary device. The Primary device must ask a series of questions like:

- What is the name of your service?
- What is the address of this service?
- What are the capabilities of this device?

When all the Primary device's questions are answered, the Primary device can access the service provided by the Secondary device.

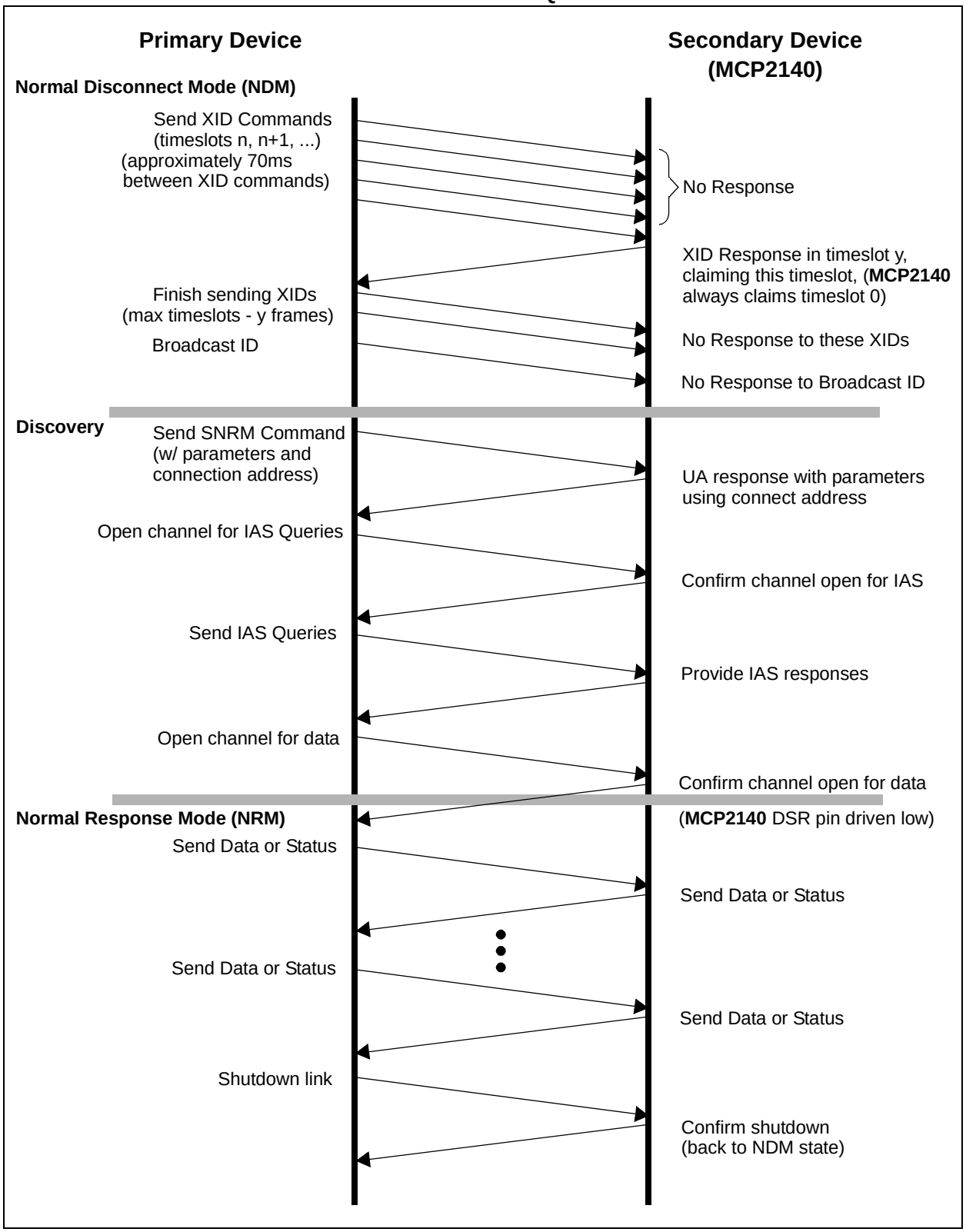
C.3 Normal Connect Mode (NCM)

Once discovery has been completed, the Primary device and Secondary device can freely exchange data.

Both the Primary device and the Secondary device check to make sure that data packets are received by the other without errors. Even when data is required to be sent, the Primary and Secondary devices will still exchange packets to ensure that the connection hasn't, unexpectedly, been dropped. When the Primary device has finished, it then transmits the close link command to the Secondary device. The Secondary device will confirm the close link command and both the Primary device and the Secondary device will revert to the NDM state.

Note:	If the NCM mode is unexpectedly terminated for any reason (including the Primary device not issuing a close link command), the Secondary device will revert to the NDM state after a time delay (after the last frame has been received).

FIGURE C-1: HIGH LEVEL IRCOMM CONNECTION SEQUENCE



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APPENDIX D: DB-9 PIN INFORMATION

Table D-1 shows the DB-9 pin information and the direction of the MCP2140 signals. The MCP2140 is designed for use in Data Communications Equipment (DCE) applications.

TABLE D-1: DB-9 SIGNAL INFORMATION

DB-9 Pin No.	Signal	Direction	Comment
1	CD	HC → MCP2140	Carrier Detect
2	RX	MCP2140 → HC	Received Data
3	TX	HC → MCP2140	Transmit Data
4	DTR	HC → MCP2140	Data Terminal Ready
5	GND	—	Ground
6	DSR	MCP2140 → HC	Data Set Ready
7	RTS	HC → MCP2140	Request to Send
8	CTS	MCP2140 → HC	Clear to Send
9	RI	HC → MCP2140	Ring Indicator

Legend: HC = Host Controller

APPENDIX E: KNOW PRIMARY DEVICE COMPATIBILITY ISSUES

Table E-1 show the known issues of Primary Devices interfacing to the MCP2140.

TABLE E-1: PRIMARY DEVICE ISSUES

Primary Device	Operating System	Issue	Result
HP Jornada 720	HPC Pro/Windows CE™ 3.0 (Pocket PC)	Jornada 720 transmits 0xFF (not 0xC0) for extra SOF (Start-of-Frame) characters during NDM.	MCP2140 will not connect to the Jornada 720.
Personal Computers	Windows® 2000 (do not have list of which versions)	The operating system will reset if an IR device ID of “null” is received.	MCP2140 will not connect to the PC

NOTES:

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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	/XX
Device	Temperature Range	Package

Device	MCP2140:		Infrared Communications Controller
	MCP2140T:		Infrared Communications Controller (Tape and Reel)
Temperature Range	I	=	-40°C to +85°C
Package	P	=	Plastic DIP (300 mil, Body), 18-lead
	SO	=	Plastic SOIC (300 mil, Body), 18-lead
	SS	=	Plastic SSOP (209 mil, Body), 20-lead

Examples:

a) MCP2140-I/P = Industrial Temp., PDIP packaging

b) MCP2140-I/SO = Industrial Temp., SOIC package

c) MCP2140T-I/SS = Tape and Reel, Industrial Temp., SSOP package

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

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ISBN: 9781620767429

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