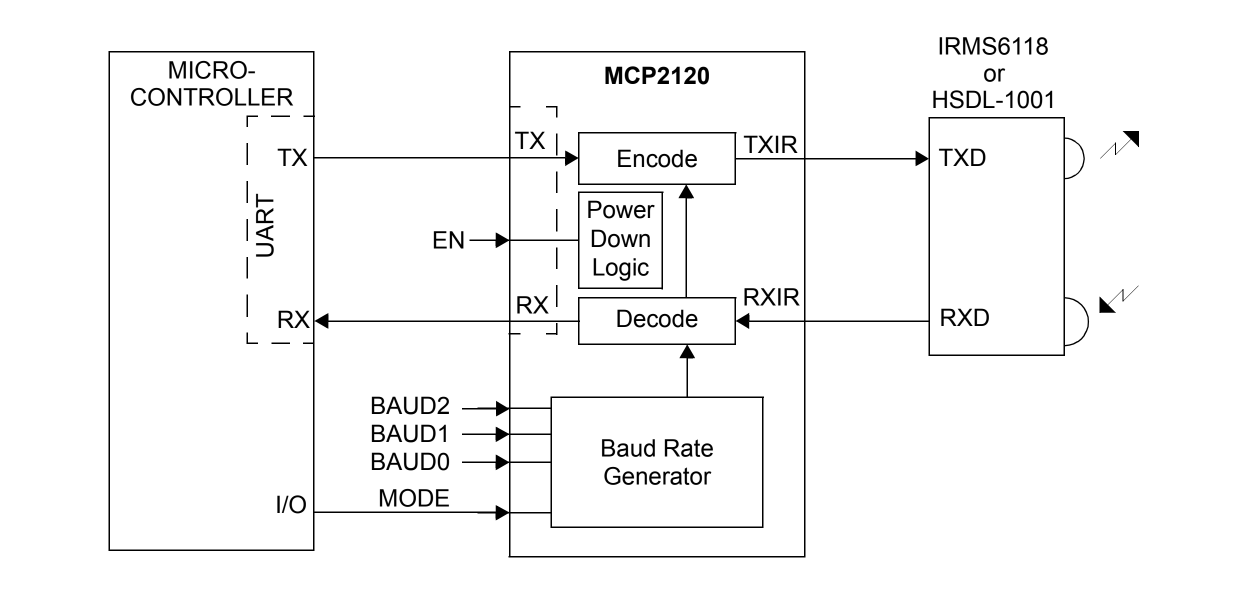
Using The MCP2120 For Infrared Communications

Author: *Steve Schlanger*
Aegis Technologies LLC.

INTRODUCTION

The MCP2120 is a cost effective and easy to use device for sending and receiving IR serial data. The MCP2120 encodes an asynchronous serial data stream, converting each data bit to the corresponding Infrared (IR) formatted pulse. IR pulses that are received are decoded into the corresponding UART formatted serial data. The MCP2120 may be used to add IR capability to any embedded application where serial data is present. The encoding/decoding function in the MCP2120 is performed as specified in the physical layer component of the IrDA® standard. This part of the standard is referred to as "IrPHY". A detailed discussion of this standard is beyond the scope of this Application Note, but a discussion regarding the encoding and decoding is in order. More detailed information is available from the IrDA website (**www.IrDA.org**). The vendor list later in this document also has weblinks to more information. Figure 1 shows typical implementation of the MCP2120 in an embedded system.

FIGURE 1: SYSTEM BLOCK DIAGRAM



IrDA is a registered trademark of the Infrared Data Association.

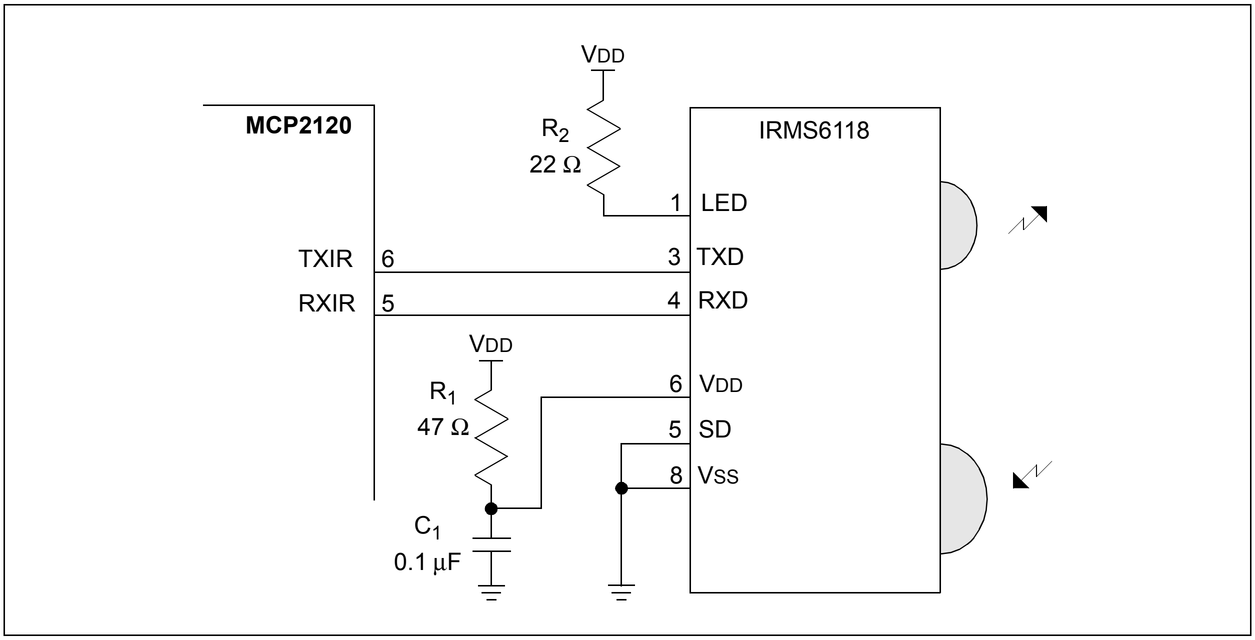
SYSTEM HARDWARE

Figure 2 shows that very few components are needed to implement an IrDA standard compatible subsystem. The IR light pulses are converted to electrical pulses by the optical transceiver. The MCP2120 is connected directly to the optical transceiver. Resistor, R_1 and capacitor, C_1 are used to decouple the power supply of the optical transceiver from the rest of the system, since some transceivers have limited tolerance for power supply noise. This circuit will reduce 10 kHz power supply ripple by about 30 dB, if a good quality tantalum capacitor is used. Resistor, R_2 is used to limit the current of the emitter LED. Most transceivers use an external resistor for this purpose. Many infrared transceivers will emit an IR pulse when the transmit pin (TXD) is high, and will indicate a bit received by setting the receive pin (RXD) low.

The output impedance of the transceiver receive circuit may be 4 kΩ or more, so the MCP2120 should be located as close to the transceiver as possible. A ground plane under the transceiver will improve electromagnetic interference (EMI) performance and reduce susceptibility to EMI.

For battery powered applications, it may be an advantage to turn off power to the MCP2120. If power is turned off completely, care should be taken so that none of the I/O pins are exposed to a signal greater than V_{SS} ± 0.6V. In some systems, it may be preferable to shut down the MCP2120 and leave other parts of the system active, thus exposing the MCP2120 to active signals while shut down. If this is the case, then the EN input pin should be used. If the EN pin (pin 6) is low, the device becomes disabled. The current consumption in this mode will be typically less than 1 µA and active I/O signals from the rest of the system do not need to be isolated from the MCP2120.

FIGURE 2: TYPICAL IrPHY CONFIGURATION



ENCODING

Figure 3 shows one-half (1st half) of an asynchronous serial byte sent by the MCP2120. Data to be transmitted is input to the MCP2120 on the TX pin (pin 12). The upper trace in Figure 3 shows a data word being sent. The first falling edge of the TX pin is the beginning of the start bit. The MCP2120 will then encode the following eight data bits according to the currently set data rate. The parameters for an IrDA standard transmission are: Start bit, eight data bits, no parity, and one stop bit.

Note 1: The sampling of the TX pin is level sensitive, not edge sensitive.

2: The MCP2120 does not indicate over-run errors. Care should be exercised to make sure the TX pin is low during the stop bit time.

3: An extended time period where TX is low (a BREAK), will result in the MCP2120 sending a string of 00h bytes as long as the TX pin is low.

The IrDA standard does not support other communication parameters. The MCP2120 has a fixed IR transmit pulse width which is equal to or greater than 1.6 µs.

Increasing Transmit Distance

The IrDA standard calls for a transmission distance of 1 m, with the emitter and received mis-aligned up to ±15 degrees. Some applications require a greater distance. This can be achieved with an increase in emitter power, a lens for the receiver, or both. Figure 4 shows how adding LEDs can be used to increase the transmission distance.

Note 1: For every doubling of distance the emitter power must be increased by a factor of 4. Thus if a transmission distance of 2 m is needed, three emitter LEDs of similar efficiency to the LED built into the transceiver, would need to be added. For 4 m distance, 15 LEDs would be need to be added.

2: Few IR LEDs are fast enough for use in IrDA standard compatible applications. The TON and TOFF for the LED device should be less than 100 ns.

The emitters used should have a wavelength centered at 875 nm. The author has used the Vishay/Temic TSSF4500 with excellent results. Typically, LEDs used in television-type remote controls have a wavelength of 950 nm and a TON and TOFF of 2 µs or more. These type of LEDs are not recommended for IrDA standard applications.

FIGURE 3: IR TRANSMISSION

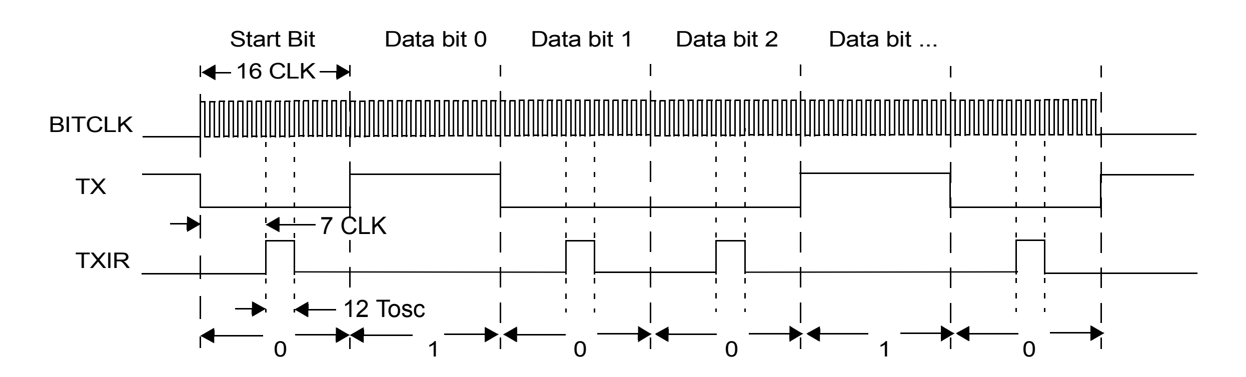
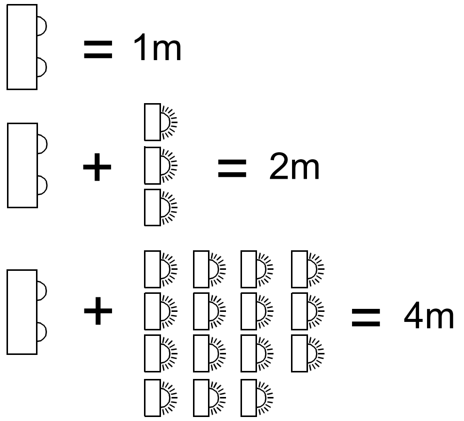


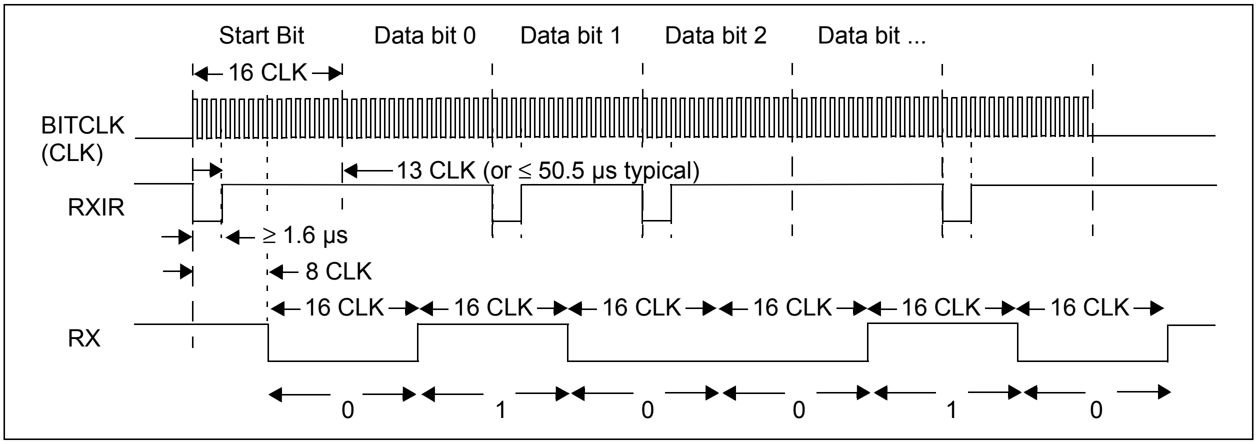
FIGURE 4: USING ADDITIONAL LEDS FOR GREATER DISTANCE



DECODING

Figure 5 shows the reception of an IR byte. Many illumination sources, such as fluorescent lamps or sun light can introduce light noise that can interfere with proper data reception. For best results, the IR transceiver should not be pointed directly at a visible light source. Also, sunlight is rich in IR light. If the ambient IR light level is too high, then the IR data source may not be sufficient to trigger the receiver. For best results, IR communications should not take place in direct sunlight.

FIGURE 5: IR DATA RECEPTION



HARDWARE DATA RATE SELECTION

The MCP2120 will encode and decode serial data at the currently selected data rate, or baud rate. The selection of this data rate is flexible and easy to use. Figure 6 shows how to use the BAUD2:BAUD0 input pins to implement hardware select mode. Jumpers or I/O signals from another controller may be used, or these inputs may be tied directly to fixed voltage levels, if the data rate does not have to change.

After the MCP2120 is reset, the BAUD2:BAUD0 input pins are sampled. If all three of these inputs are high, then software select mode is used. For any other inputs, hardware select mode is active. This setting is latched when the device is reset, either from the $\overline{\text{RESET}}$ pin or a power-on reset. After a device reset, changing the value of the BAUD2:BAUD0 pins has no effect on the device's baud rate.

From Table 1, if a 9.6 kBaud data rate is desired with the device frequency at 7.3728 MHz, the BAUD2:BAUD0 pins should all be low.

FIGURE 6: USING HARDWARE DATA RATE SELECTION

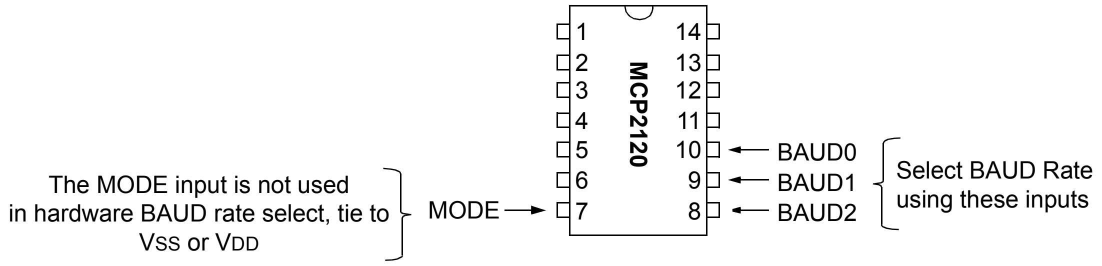


TABLE 1: HARDWARE MODE - BAUD RATE SELECTION

	Fosc Frequency (MHz)							
BAUD2:BAUD0	**0.6144** (1)	**2.000**	**3.6864**	**4.9152**	**7.3728**	**14.7456** (2)	**20.000** (2)	**Bit Rate**
000	800	2604	4800	6400	9600	19200	26042	FOSC / 768
001	1600	5208	9600	12800	19200	38400	52083	FOSC / 384
010	3200	10417	19200	25600	38400	78600	104167	FOSC / 192
011	4800	15625	28800	38400	57600	115200	156250	FOSC / 128
100	9600	31250	57600	78600	115200	230400	312500	FOSC / 64

Note 1: An external clock is recommended for frequencies below 2 MHz.

2: For frequencies above 7.5 MHz, the TXIR pulse width (MCP2120 Data Sheet, Electrical Specifications, parameter IR121) will be shorter than the 1.6 µs IrDA standard specification.

SOFTWARE DATA RATE SELECTION

Software data rate selection is intended for use with systems where switching data rates must be changed frequently or when a minimum number of connections are needed between the MCP2120 and the embedded host as shown in Figure 7. Hardware data rate selection can be implemented with three signals. Software data selection requires five signals, in addition to using the $\overline{\text{RESET}}$ pin whenever a rate change is needed. The software Baud mode is compatible with one of the IR drivers published by Microsoft® for Microsoft Windows®.

Note:	The Software Data select mode is compatible with the Microsoft CRYSTAL.VXD driver. See TB048, "Connecting the MCP2150 to the Windows Operating System" for more information.

In software baud mode, the MCP2120 differentiates between data and commands. This is controlled via the MODE pin. The command mode and data mode are summarized in Table 2. For select frequencies, the command/baud rate selected is shown in Table 3.

TABLE 2: SOFTWARE OPERATION

Mode Pin State	Operation	Echo	Transmit
0	Command	Yes	No
1	Data	No	Yes

Data sent to the MCP2120 will be encoded and transmitted via the IR transceiver. Commands are not intended to be transmitted. Commands are used to change data rates. When in command mode, the data sent to the MCP2120 will be echoed back to the embedded host.

The MODE pin is used to switch between command and data modes. When the MODE pin is low, the MCP2120 is in command mode, when the MODE pin is high, the MCP2120 is in data mode. The MODE pin is sampled during the start bit. Changing the state of the MODE pin after the start bit will have no effect. Be sure to allow for propagation delays to insure that the MODE pin is in the intended state before the start bit begins. If the MCP2120 is used with Microsoft Windows or other operating systems, the MODE pin is usually connected to the DTR signal of the host serial port. In this context, the host RTS signal is usually connected to the device reset as shown in Figure 7.

FIGURE 7: IMPLEMENTATION OF SOFTWARE DATA RATE SELECTION

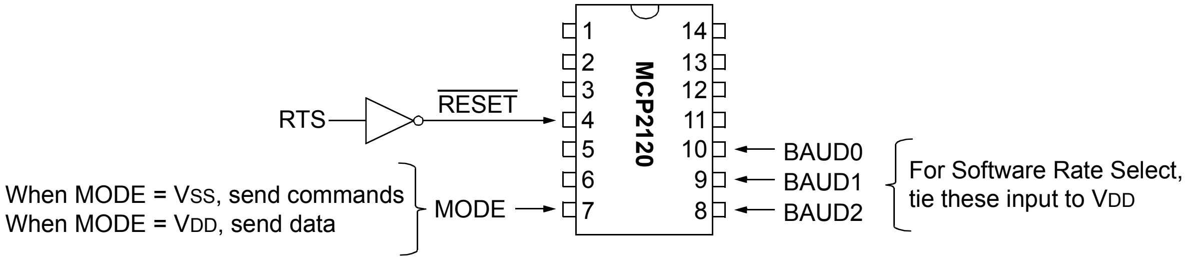

MCP2120
1
2
3
4
5
6
7
14
13
12
11
10
9
8
RTS
RESET
When MODE = VSS, send commands
When MODE = VDD, send data
MODE
BAUD0
BAUD1
BAUD2
For Software Rate Select, tie these input to VDD

TABLE 3: SOFTWARE MODE - BAUD RATE SELECTION

Hex Command [3, 4]	Fosc Frequency (MHz)							Bit Rate
	0.6144 [1]	2.000	3.6864	4.9152	7.3728	14.7456 [2]	20.000 [2]	
0x87	800	2604	4800	6400	9600	19200	26042	Fosc / 768
0x8B	1600	5208	9600	12800	19200	38400	52083	Fosc / 384
0x85	3200	10417	19200	25600	38400	78600	104167	Fosc / 192
0x83	4800	15625	28800	38400	57600	115200	156250	Fosc / 128
0x81	9600	31250	57600	78600	115200	230400	312500	Fosc / 64

Note 1: An external clock is recommended for frequencies below 2 MHz.

2: For frequencies above 7.3728 MHz, the TXIR pulse width (MCP2120 Data Sheet, Electrical Specifications, parameter IR121) will be shorter than the 1.6 µs IrDA standard specification.

3: Command 0x11 is used to change to the new baud rate.

4: All other command codes are reserved.

SOFTWARE RATE SELECT COMMANDS

Two commands are supported: the "Next Data Rate" and the "Change Data Rate". To use these commands, the MODE pin should be held low, then the one byte command codes sent. Table 4 shows these command codes.

TABLE 4: COMMAND CODES

Command Value (hex)	Description
0x87	FOSC / 768 is next data rate
0x8B	FOSC / 384 is next data rate
0x85	FOSC / 192 is next data rate
0x83	FOSC / 128 is next data rate
0x81	FOSC / 64 is next data rate
0x11	Change to new rate

To change the data rate, two bytes must be sent. The first command loads the desired data rate. The second command changes the data rate to the value previously loaded. The "Change Data Rate" command will be echoed back at the current data rate. The next byte sent/received after the "Change Data Rate" command will be received/sent, or echoed at the new data rate. The MCP2120 requires that the stop bit of the "Change Data Rate" command byte finish at the currently selected data rate. If the current data rate is 9.6 kBaud, then the required delay is 100 µs before data is sent or received. In addition, a delay of 200 µs should be used after any "Change Data Rate" command.

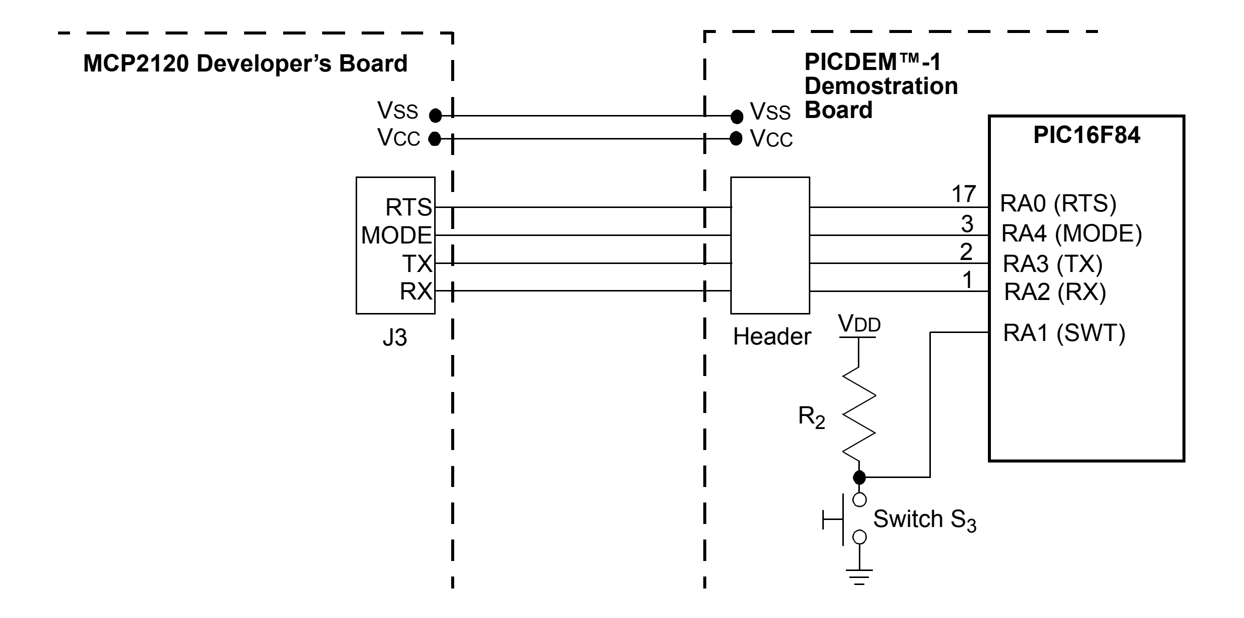
TURNAROUND LATENCY

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 suggested between the time a byte is received and another byte is transmitted.

USING THE MCP2120 DEVELOPER'S BOARD

Figure 8 shows two examples of how to use the MCP2120 with PICmicro® microcontrollers. The first example shows how wireless IR communication can be added to a minimum system using the PIC16F84. The PIC16F84 sends an IR message of "Hello World" when switch S_3 is pressed. IR bytes received by the PIC16F84 are displayed in binary form. This example uses hardware select mode and a firmware UART for the PIC16F84. Another example shows a PIC16F84 using its internal hardware UART and software select mode.

FIGURE 8: EMBEDDED IrDA STANDARD EXAMPLE



REFERENCES

The IrDA Standards download page can be found at:

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

Manufacturers of Optical Transceivers are shown in Table 5.

TABLE 5: OPTICAL TRANSCEIVER MANUFACTURERS

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

MEMORY USAGE

The PIC16F84 program that uses the Hardware Select of the baud rate (Appendix A) uses the following resources:

Program Memory:	135 words
Data Memory:	9 bytes

The PIC16F84 program that uses the Software Select of the baud rate (Appendix B) uses the following resources:

Program Memory:	163 words
Data Memory:	9 bytes

SUMMARY

The MCP2120 has a uniquely flexible combination of hardware, software, or Fosc selection of the data rate. The high integration, low power, and Windows compatibility make the MCP2120 well suited to implementing infrared solutions in consumer, industrial, automotive, and telecommunications applications.

APPENDIX A: PIC16F84 HARDWARE SELECT SOURCE CODE

EXAMPLE A-1: PIC16F84 Hardware Select Code

```
;*****************************************************************
;               MCP2120 Demo with PicDem
;               Use with PIC16F84, 3.6864Hz clock
;               Checksum=9383 (cp on)
;*****************************************************************
; Revision History
;  1.0    04/05/01    Initial Release
;
;*****************************************************************
; Notes:
; This demo code sends/receives serial data at a fixed
; data rate.  This rate can be from 9.6 to 38.4KB.  The
; bitreg delay values for the various data rates are given
; below.  The data sent is a string which is stored in a table.  The
; string is sent when the PICDEM RA1 button is pressed.
; Any bytes received are displayed on the PortB LEDs.
; This version of the code assumes that the MCP2120 is using
; hardware setup and the jumpers have been set to match the
; data rate of this code.
;*****************************************************************
    LIST   C=132
    include    P16F84.inc
#define    reset    H'00'    ;Reset vector
;*****************************************************************
;  Configuration Bits
    __CONFIG _CP_OFF & _PWRTE_ON & _XT_OSC & _WDT_OFF
    __IDLOCS H'0010'
;*****************************************************************
;  PortA Bits
;
#define    rts    porta,0    ;output, set high to reset MCP2120
#define    swt    porta,1    ;input, low when switch pressed
#define    rxd    porta,2    ;input, serial data from MCP2120
#define    txd    porta,3    ;output, serial data to MCP2120
#define    mode   porta,4    ;output, high for data mode, low for cmd mode
;
;
cfga      equu    B'00000110' ;configuration for porta
cfgb      equ    H'00'       ;portb is an output port
cfgopt    equ    B'11001000' ;option reg setup
;
```

Example A-1: PIC16F84 Hardware Select Code - Page 2

```
;*****************************************************************
;  Constants
;
bytesz    equu    D'08'        ;there are 8 bits per byte
bitval    equ     D'08'        ;data bit delay
;
;Data Rate Constants
;   Rate  cyc  Bitval
;    9.6   96   20
;   19.2   48   08
;   38.4   24   02
;
;*****************************************************************
;  Registers
;
    cblock    H'0C'
        areg                   ;GP scratchpad
        breg                   ;GP scratchpad
        bitreg                 ;storage for data bit delay
        baudreg                ;storage for baud rate
        cmdreg                 ;reg for commands
        delreg                 ;reg for timing delays & scratchpad
        bitcnt                 ;bit counter
        flags
        state                  ;reg for state counter
    endc
;
;*****************************************************************
    org      H'00'             ;use 00h as reset vector
        goto    start
;
;*****************************************************************
; String Table
; This table stores a string, breg is the offset.  The string
; is terminated by a null.
;*****************************************************************
string1 clrf    pclath         ;this routine is on page 0
        movf    breg,w         ;get the offset
        addwf   pcl,f          ;add the offset to PC
        DT      "Hello World"  ;
        DT      H'0D', H'0A'   ;the string also contains a CR+LF
        DT      H'00'          ;terminate with 00h
;
;*****************************************************************
; Delay Routine
; Each unit change of delay value changes the delay by 4 cycles.
; The delay value is passed in W.
;*****************************************************************
delay   movwf     delreg
dellp   nop
        decfsz    delreg,f
        goto      dellp
        retlw     0
;
```

Example A-1: PIC16F84 Hardware Select Code - Page 3

```
;*****************************************************************
; Transmit serial Routine
; This routine sends the areg byte to the serial port at 19.2KB
;
;*****************************************************************
txser    bcf    txd          ;begin the start bit
         nop
         nop
         nop
         nop
;
txdb    movf    bitreg,w
        call    delay
        nop
        nop
        btfsc   areg,0       ;if bit=0 then rxd=0
        goto    txdb1        ;if bit=1 then rxd=1
txdb0   nop
        nop
        bcf     txd          ;ir detected, bit=0
        rrf     areg,f       ;rotate the byte
        decfsz  bitcnt,f     ;all bits rev'd?
        goto    txdb         ;ir recv'd, toggle routine
        goto    txsp
;
txdb1   nop
        bsf     txd
        rrf     areg,f       ;rotate the byte
        decfsz  bitcnt,f     ;all bits rev'd?
        goto    txdb         ;
        goto    txsp
;
txsp    nop
        nop
        nop
        movlw   bytesz       ;delay until the end of the 8th data bit
        movwf   bitcnt
        movf    bitreg,w
        call    delay
        bsf     txd          ;8th data bit ends here
        movf    bitreg,w     ;do the stop bit delay
        call    delay
        movf    bitreg,w     ;delay beyond the stop bit to allow for slow systems
        call    delay
        retlw   0
;
;
```

Example A-1: PIC16F84 Hardware Select Code - Page 4

```
;*****************************************************************
; Receive Serial Routine
; This routine gets an incoming serial byte and stuffs it
; into areg
;*****************************************************************
rxser   nop                     ;delay from the beginning of the start bit
        nop
        nop
        nop
        nop
        nop
        nop
;
rxdb    movf     bitreg,w
        call     delay
        nop
        nop
        rrf      areg,f        ;rotate the byte
        btfsc    rxd           ;if rxd=0 then the bit=0
        goto     rxdb1         ;if rxd=1 then bit=1
rxdb0   nop
        nop
        bcf      areg,7        ;clear the bit
        decfsz   bitcnt,f      ;all bits rev'd?
        goto     rxdb          ;ir recv'd, toggle routine
        goto     rxsp
;
rxdb1   nop
        bsf      areg,7        ;set the bit
        decfsz   bitcnt,f      ;all bits rev'd?
        goto     rxdb          ;
        goto     rxsp
;
rxsp    movlw    bytesz        ;reset the bit counter
        movwf    bitcnt
        movf     bitreg,w      ;do the stop bit delay
        call     delay
        retlw    0
;
;
```

Example A-1: PIC16F84 Hardware Select Code - Page 5

```
;*****************************************************************
;  Start Routine
;  The post-reset setup is done here
;*****************************************************************
start   movlw    trisa       ;setup I/O
        movwf    fsr
        movlw    cfga
        movwf    indf
;
        movlw    trisb
        movwf    fsr
        movlw    cfgb
        movwf    indf
;
        movlw    option_reg  ;setup option reg
        movwf    fsr
        movlw    cfgopt
        movwf    indf
;
        movlw    H'00'       ;clear outputs
        movwf    portb
        bsf      txd         ;setup quiescent state
        bsf      mode
        bcf      rts
;
        movlw    bitval      ;
        movwf    bitreg
        movlw    bytesz      ;setup bit count
        movwf    bitcnt
;
        goto     main
;
;*****************************************************************
; Main Routine
;*****************************************************************
main    btfss    swt         ;check for keypress
        goto     send        ;key is pressed, send the bytes
        btfss    rxd         ;check for an incoming byte from MCP2120
        goto     getser      ;there's an incoming byte, go get it
        goto     main
;
;
```

Example A-1: PIC16F84 Hardware Select Code - Page 6

```
;****************************************************************
; Send routine
; This routine sends the data found in sndtab
;****************************************************************
send    clrf    breg           ;clear the offset
sndlp   call    string1        ;get the byte
        movwf   areg           ;save the byte
        incf    breg,f         ;increment the table pointer
        movf    areg,f         ;move the byte to test it
        btfsc   status,z       ;if z=1 then we're done
        goto    sendex         ;we're done, do the exit
        call    txser          ;send the byte in areg
        goto    sndlp
;
sendex  btfss   swt            ;check for key release
        goto    sendex         ;key is pressed, wait for release
        movlw   H'FF'          ;do a debounce delay
        call    delay
        goto    main           ;return to waiting
;
;
;****************************************************************
; Get serial routine
; This routine gets a serial byte and displays the value
; on the PICDEM portb leds.
;****************************************************************
getser  call    rxser          ;get the serial byte
        movf    areg,w         ;w = serial byte
        movwf   portb          ;move the byte to the output
        goto    main
;
;
;
     end
```

APPENDIX B: PIC16F84 SOFTWARE SELECT SOURCE CODE

EXAMPLE B-1: PIC16F84 Software Select Code

```
;*****************************************************************
;
;               MCP2120 Demo with PicDem
;               Demonstration of Software Setup Mode of the MCP2120
;               Use with PIC16F84, 3.6864Hz clock
;               Checksum=9383 (cp on)
;*****************************************************************
; Revision History
;  1.0  04/05/01  Initial Release
;
;****************************************************************
;   Notes:
;   This demo code sends/receives serial data at a changeable
;   data rate.  This code can be easily changed from 9.6 to 38.4KB.  The
;   bitreg delay values for the various data rates are given
;   below.  The data sent is a string which is stored in a table.  The
;   string is sent when the PICDEM RA1 button is pressed.
;   Any bytes received are displayed on the PortB LEDs.
;   This version of the code assumes that the MCP2120 BAUD inputs
;   have been set to software setup, BAUDx=B'111'.  NOTE: When the
;   MCP2120 powers up the optical transceiver may emit some garbage.
;   The PICDEM board should be reset with the MCLR button before
;   doing the demo.
;   This demo starts with the MCP2120 and the host (this code)
;   at 9.6KB.  When the RA1 button is pressed the MCP2120 and the
;   host change to 19.2KB and a "Hello World" message is transmitted
;   via Ir at 19.2KB.  Any data received by the MCP2120 is displayed on
;   the PICDEM PortB LEDs.  NOTE: The PICDEM serial port can be used to
;   monitor the communication between this code and the MCP2120.
;****************************************************************
        LIST    C=132
        include P16F84.inc
#define reset   H'00'        ;Reset vector
;****************************************************************
;       Configuration Bits
        __CONFIG _CP_OFF & _PWRTE_ON & _XT_OSC & _WDT_OFF
        __IDLOCS H'0010'
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 2

```
;*****************************************************************
;       PortA Bits
;
#define rts     porta,0        ;output, set high to reset MCP2120
#define swt     porta,1        ;input, low when switch pressed
#define rxd     porta,2        ;input, serial data from MCP2120
#define txd     porta,3        ;output, serial data to MCP2120
#define mode    porta,4        ;output, high for data mode, low for cmd mode
;
;
cfga    equu    B'00000110'    ;configuration for porta
cfgb    equ     H'00'          ;portb is an output port
cfgopt  equ     B'11001000'    ;option reg setup
;
;************************************************************
;       Constants
;
bytesz  equ     D'08'          ;there are 8 bits per byte
bitval  equ     D'20'          ;data bit delay
bit96   equ     D'20'
bit19   equ     D'08'
bit38   equ     D'02'
;
;
;Data Rate Constants
;       Rate    cyc     Bitval
;       9.6     96      20
;       19.2    48      08
;       38.4    24      02
;
;****************************************************************
;       Registers
;
    cblock  H'0C'
        areg                   ;GP scratchpad
        breg                   ;GP scratchpad
        bitreg                 ;storage for data bit delay
        baudreg                ;storage for baud rate
        cmdreg                 ;reg for commands
        delreg                 ;reg for timing delays & scratchpad
        bitcnt                 ;bit counter
        flags
        state                  ;reg for state counter
    endc
;
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 3

```
;****************************************************************
        org     H'00'        ;use 00h as reset vector
        goto    start
;
;
;*****************************************************************
; String Table
; This table stores a string, breg is the offset.  The string
; is terminated by a null.
;*****************************************************************
string1 clrf    pclath       ;this routine is on page 0
        movf    breg,w       ;get the offset
        addwf   pcl,f        ;add the offset to PC
        DT      "Hello World";
        DT      H'0D',H'0A'  ;the string also contains a CR+LF
        DT      H'00'        ;terminate with 00h
;
;
;*****************************************************************
;       Delay Routine
;       Each unit change of delay value changes the delay by 4 cycles.
;       The delay value is passed in W.
;*****************************************************************
delay   movwf   delreg
dellp   nop
        decfsz  delreg,f
        goto    dellp
        retlw   0
;
;
;*****************************************************************
;       Long Delay
;       This routine is used to delay past the POR time of the MCP2120.
;       The delay is 100ms.
;*****************************************************************
ldelay  movlw   D'100'       ;the inner loop is 1ms, do it 100 times
        movwf   breg         ;breg is the loop counter
ldellp  movlw   D'230'       ;delreg of 230 = 1ms
        call    delay
        decfsz  breg,f       ;more to delay?
        goto    ldellp       ;delay more
        retlw   0
;
;
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 4

```
;*****************************************************************
;   Transmit serial Routine
;   This routine sends the areg byte to the serial port at 19.2KB
;
;*****************************************************************
txser   bcf     txd            ;begin the start bit
        nop
        nop
        nop
        nop
;
txdb    movf    bitreg,w
        call    delay
        nop
        nop
        btfsc   areg,0         ;if bit=0 then rxd=0
        goto    txdb1          ;if bit=1 then rxd=1
txdb0   nop
        nop
        bcf     txd            ;ir detected, bit=0
        rrf     areg,f         ;rotate the byte
        decfsz  bitcnt,f       ;all bits rev'd?
        goto    txdb           ;ir recv'd, toggle routine
        goto    txsp
;
txdb1   nop
        bsf     txd
        rrf     areg,f         ;rotate the byte
        decfsz  bitcnt,f       ;all bits rev'd?
        goto    txdb           ;
        goto    txsp
;
txsp    nop
        nop
        nop
        movlw   bytesz         ;delay until the end of the 8th data bit
        movwf   bitcnt
        movf    bitreg,w
        call    delay
        bsf     txd            ;8th data bit ends here
        movf    bitreg,w       ;do the stop bit delay
        call    delay
        movf    bitreg,w       ;delay beyond the stop bit to allow for slow systems
        call    delay
        retlw   0
;
;
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 5

```
;****************************************************************
;  Receive Serial Routine
;  This routine gets an incoming serial byte and stuffs it
;  into areg
;****************************************************************
rxser   nop                  ;delay from the beginning of the start bit
        nop
        nop
        nop
        nop
        nop
        nop
;
rxdb    movf    bitreg,w
        call    delay
        nop
        nop
        rrf     areg,f       ;rotate the byte
        btfsc   rxd          ;if rxd=0 then the bit=0
        goto    rxdb1        ;if rxd=1 then bit=1
rxdb0   nop
        nop
        bcf     areg,7       ;clear the bit
        decfsz  bitcnt,f     ;all bits rev'd?
        goto    rxdb         ;ir recv'd, toggle routine
        goto    rxsp
;
rxdb1   nop
        bsf     areg,7       ;set the bit
        decfsz  bitcnt,f     ;all bits rev'd?
        goto    rxdb         ;
        goto    rxsp
;
rxsp    movlw   bytesz       ;reset the bit counter
        movwf   bitcnt
        movf    bitreg,w     ;do the stop bit delay
        call    delay
        retlw   0
;
;
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 6

```
;*****************************************************************
;  Start Routine
;  The post-reset setup is done here
;*****************************************************************
start   movlw   trisa          ;setup I/O
        movwf   fsr
        movlw   cfga
        movwf   indf
;
        movlw   trisb
        movwf   fsr
        movlw   cfgb
        movwf   indf
;
        movlw   option_reg     ;setup option reg
        movwf   fsr
        movlw   cfgopt
        movwf   indf
;
        movlw   H'00'          ;clear outputs
        movwf   portb
        bsf     txd            ;setup quiescent state
        bsf     mode
        bcf     rts
;
        movlw   bitval         ;
        movwf   bitreg
        movlw   bytesz         ;setup bit count
        movwf   bitcnt
;
        goto    main
;
;*****************************************************************
;       Main Routine
;*****************************************************************
main    btfss   swt            ;check for keypress
        goto    send           ;key is pressed, send the bytes
        btfss   rxd            ;check for an incoming byte from MCP2120
        goto    getser         ;there's an incoming byte, go get it
        goto    main
;
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 7

```
;****************************************************************
;  Send routine
;  This routine sends the data found in sndtab using the following
;  procedure:
;  1.) The host (this code) resets to 9.6KB
;  2.) The MCP2120 is reset, reverting to 9.6KB as well.
;  3.) The MCP2120 is placed in command mode.
;  4.) The commands are sent to change the MCP2120 to 19.2KB
;  5.) The host changes to 19.2KB.
;  6.) The test data is sent
;
; Note: The mode output is RA4 which has an open-collector structure.
;       This output is pulled up by R5 and loaded by C5 on the PICDEM
;       board.  To get around this we assume a 20us fall time and a
;       60us rise time.  These mode delays will not be needed in
;       any production production code.  The MCP2120 does not
;       require this delay.
;****************************************************************
send    movlw   bit96        ;change the host data rate to 9.6KB
        movwf   bitreg
        bsf     rts          ;assert the MCP2120 reset
        movlw   D'25'        ;do the reset for 100us
        call    delay        ;
        bcf     rts          ;release the reset
        call    ldelay       ;delay past the POR of the MCP2120
;
        bcf     mode         ;change to command mode
        movlw   D'10'        ;delay for the Mode fall time
        call    delay
        movlw   H'8B'        ;8B loads the 19.2KB rate into the MCP2120
        movwf   areg
        call    txser
        movlw   H'11'        ;11h changes the BAUD rate to the new value
        movwf   areg
        call    txser        ;send the command
        bsf     mode         ;back to data mode
        movlw   D'25'        ;delay for mode rise time
        call    delay        ;
        movlw   bit19        ;change the host data rate to 19.2KB
        movwf   bitreg
;
        clrf    breg         ;clear the offset
```

EXAMPLE B-1: PIC16F84 Software Select Code - Page 8

```
sndlp   call    string1        ;get the byte
        movwf   areg           ;save the byte
        incf    breg,f         ;increment the table pointer
        movf    areg,f         ;move the byte to test it
        btfsc   status,z       ;if z=1 then we're done
        goto    sendex         ;we're done, do the exit
        call    txser          ;send the byte in areg
        goto    sndlp
;
sendex  btfss   swt            ;check for key release
        goto    sendex         ;key is pressed, wait for release
        movlw   H'FF'          ;do a debounce delay
        call    delay
        goto    main           ;return to waiting
;
;
;****************************************************************
;  Get serial routine
;  This routine gets a serial byte and displays the value
;  on the PICDEM portb leds.
;****************************************************************
getser  call    rxser          ;get the serial byte
        movf    areg,w         ;w = serial byte
        movwf   portb          ;move the byte to the output
        goto    main
;
;
;
    end
```

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2355 West Chandler Blvd.
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Farmington Hills, MI 48334
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Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

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

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

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

ASIA/PACIFIC

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

China - Beijing
Microchip Technology Consulting (Shanghai)
Co., Ltd., Beijing Liaison Office
Unit 915
New China Hong Kong Manhattan Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

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

China - Fuzhou
Microchip Technology Consulting (Shanghai)
Co., Ltd., Fuzhou Liaison Office
Rm. 531, North Building
Fujian Foreign Trade Center Hotel
73 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7557563 Fax: 86-591-7557572

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

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

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

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

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

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

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

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

EUROPE

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

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

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

Germany - Analog
Lochhamer Strasse 13
D-82152 Martinsried, Germany
Tel: 49-89-895650-0 Fax: 49-89-895650-22

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

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

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