AN927

Data Throughput and the MCP215X

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INTRODUCTION

Throughput is based on many factors, some of which are determined by the Secondary Device (host controller + MCP215X) and others that are determined by the Primary Device.

This application note discusses techniques that will improve the data transfer throughput between an IrDA® standard Primary Device and embedded system and-focus on what techniques can be used on the interface between the host controller and the MCP215X. The embedded system (Secondary Device) uses a MCP215X device for the IrDA® standard communication (IrCOMM 9-wire "cooked" service class). Figure 1 shows a typical IrDA standard system.

All timing measurements and screen captures in this application note are performed using a Palm™ Tungsten™ T2 PDA as the Primary Device. Using a different Primary Device may yield different results.

Data Transfers

Data Transfers can be broken down into three classes:

1. Data downloading
2. Data uploading
3. Bidirectional

In many typical systems, the majority of data will travel either in one direction or the other. That is, the majority of data will be transmitted (downloaded) from the Primary Device (PDA) to the Secondary Device (embedded system), or will be transmitted (uploaded) from the Secondary Device (embedded system) to the Primary Device (PDA).

Typical downloading application examples include:

- Embedded system configuration programming
- Embedded system firmware update

The data throughput during downloading cannot be controlled by the embedded system's host controller. In this case, the data throughput is primarily determined by the characteristics of the Primary Device and the hardware characteristics of the MCP215X. The hardware characteristics of the MCP215X requires the CRC generation timing and parsing of the incoming IR Frame.

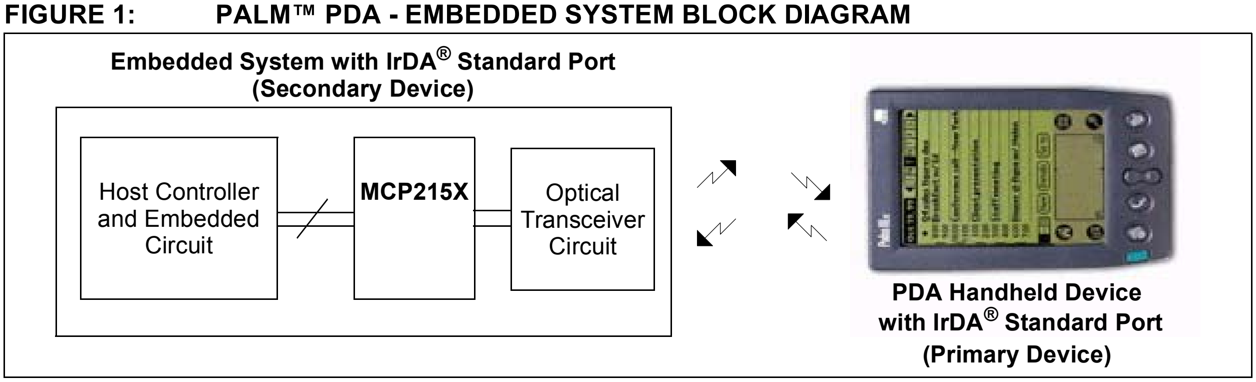
Typical uploading application examples include:

- Data loggers
- Diagnostic ports

During upload, the host controller firmware can have a significant impact on the data throughput.

In cases where small amounts of data are passed between devices and require user interface input, IR throughput requirements are minimized due to the human interface. An example of this would be when the PDA sends some codes to the embedded system, which then responds to the codes. The PDA operator then needs to determine what to do next based on this response. So the actual data throughput is not really an issue.

FIGURE 1: PALM™ PDA - EMBEDDED SYSTEM BLOCK DIAGRAM



MCP215X Host UART Interface and Receive Buffer

The MCP215X receive buffer is 64 bytes. The host UART also has a two-byte buffer. The limited size of the receive buffer requires that the host controller firmware takes care not to overflow the receive buffer. The MCP215X host UART interface includes signals to indicate to the host controller when data can be sent.

The MCP215X host UART interface includes eight signals (TX, RX, CTS, RTS, CD, RI, DTR and DSR). The number of signals implemented in the embedded system is dependent on the requirements of the application. For more information, please refer to Application Note 858, "Interfacing the MCP215X to a Host Controller", DS00858. In this application note, we will focus on three signals: the TX pin, the RX pin and the CTS pin. The CTS pin is an output signal from the MCP215X that indicates when the host controller can transfer data to the MCP215X. The MCP215X implements a windowed technique for receiving data. Once the CTS pin has a high-to-low transition, a 22 ms timer starts. The CTS pin will then be forced high when:

- the 22 ms timer ends, and
- the MCP215X receive buffer has received 60 bytes.

When the CTS pin is driven high due to the host receive buffer having received 60 bytes, the Receive Data window is still open (see Figure 3). Remember that the receive buffer is 64 bytes, so the Receive Data window will not be closed until either:

- the 22 ms timer has completed, or
- the MCP215X receive buffer has received 64 bytes.

Once the Receive Data window has been closed, the data in the host UART receive buffer will be processed for transmission on the TXIR pin.

Table 1 shows the minimum time to transmit 64 bytes at a given baud rate. This requires that there be no byte-to-byte spacing.

Table 2 shows how many bytes may be transferred on the host controller's TX pin in 22 ms for a given baud rate. For baud rates 38400 and above, it is very easy to transmit the 64 bytes within the 22 ms Receive Data window. For baud rates 19200 and below, it is not possible to transmit 64 bytes within the 22 ms Receive Data window.

TABLE 1: TIME TO TRANSFER 64 BYTES (BACK TO BACK)

Baud Rate	Time (ms)	Comment
9600	66.7 (1)	> 22 ms Receive Data window
19200	33.4 (1)	> 22 ms Receive Data window
38400	16.7	
57600	11.2	
115200	5.6	

Note 1: The Receive Data window time-out causes the CTS pin to be forced high and the MCP215X to process the data packet that has been loaded into the receive buffer.

TABLE 2: BYTES TRANSFERRED AT GIVEN BAUD RATES

Baud Rate	Bytes Transferred in 22 ms	Comment
9600	22 (1, 2)	Host UART receive buffer NOT filled
19200	43 (1, 2)	Host UART receive buffer NOT filled
38400	85 (3)	> Host UART receive buffer
57600	127 (3)	> Host UART receive buffer
115200	254 (3)	> Host UART receive buffer

Note 1: The Receive Data window time-out causes the CTS pin to be forced high and the MCP215X to process the data packet that has been loaded into the receive buffer.

2: Any byte that is being transmitted when the MCP215X CTS signal goes high will be received.

3: The CTS signal will go high when the receive buffer receives 60 bytes or the Receive Data window time-out occurs. The MCP215X will start processing the data packet when 64 bytes have been received. The host controller MUST NOT send more than 64 bytes for each CTS window (or data may be lost).

CTS STATE AND THE RECEIVE BUFFER

Once a link has been established, the level (high, low) of the CTS pin is influenced by the state of the MCP215X host UART receive buffer.

Figure 2 shows the operation of the CTS pin with respect to the 22 ms Receive Data window and the number of bytes that have been received into the host UART receive buffer. This illustrates a situation when the host UART baud rate is either 9600 baud or 19200 baud. This can also occur at higher baud rates, if the host controller is not "streaming" the data quickly. Figure 5 shows the CTS-to-CTS timing that occurs in this case.

Figure 3 shows when the host controller transfers at least 60 bytes in this CTS window, but does not reach the 64-byte receive buffer limit. So the data is only processed when the Receive Data window closes. CTS-to-CTS timing will be slightly longer than what is shown in Figure 5 due to the additional data that is processed and transmitted on TXIR.

Figure 4 illustrates a situation where the host controller is "streaming" the data quickly and the baud rate is 38400, 57600 or 115200. Once the 64 data bytes have been received by the MCP215X, the data is processed and then transmitted on the TXIR pin. Therefore, for the greatest data throughput, a host UART baud rate of 115200 is recommended. Figure 6 also shows the CTS-to-CTS timing (30.567 ms) that occurs in this case (64 bytes after falling edge of CTS). Figure 5 shows the CTS-to-CTS timing (40.417 ms) that occured when the receive buffer was not filled (40 bytes while CTS is low). So the transfer time of 40 bytes per CTS low takes about 10 ms longer than does 64 bytes transferred after CTS falling edge.

The CTS signal was designed to go high once 60 bytes were received so that a host controller with a transmit FIFO of 4 bytes (or less) could interface to the MCP215X.

To demonstrate the effects of the host controller firmware on throughput from a Secondary Device to a Primary Device (S $\rightarrow$ P), two programs have been implemented that use different techniques for transmitting data with respect to the CTS signal.

The techniques used in these programs are:

1. Transmit data while the CTS pin is low (see Figure 3).
2. Transmits 64 bytes with minimal byte-to-byte spacing (see Figure 4 and Figure 6) after the falling edge of the CTS signal.

FIGURE 2: CTS WAVEFORM FOR < 60 BYTES INTO UART RECEIVE FIFO

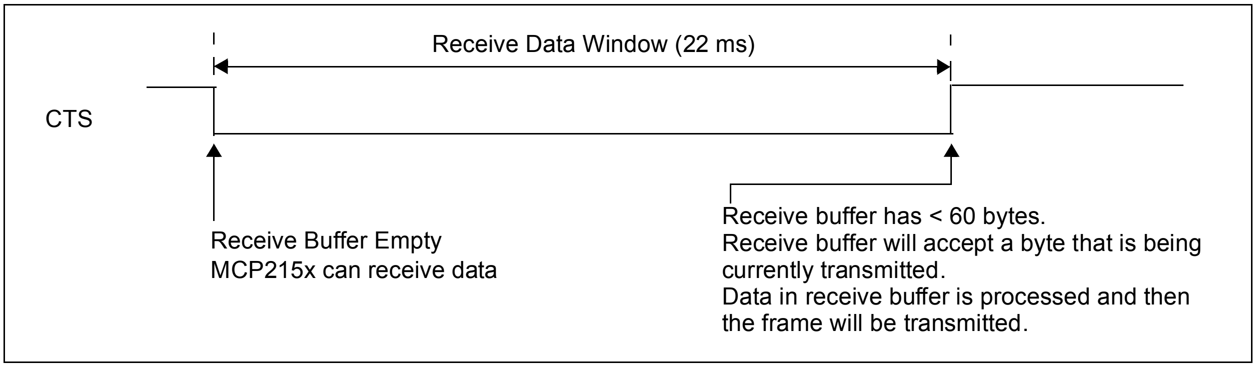


FIGURE 3: CTS WAVEFORM FOR BETWEEN 60 AND 64 BYTES INTO UART RECEIVE FIFO

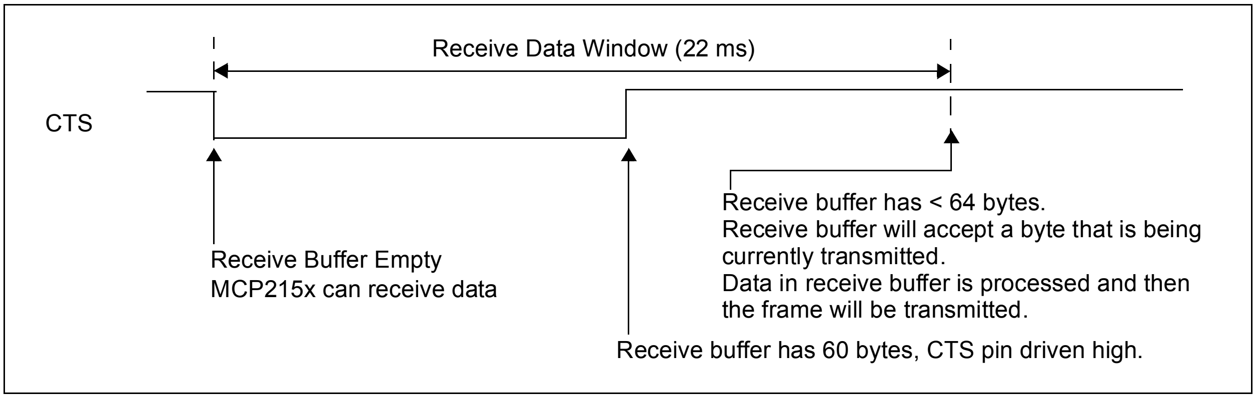


FIGURE 4: CTS WAVEFORM FOR 64 BYTES INTO UART RECEIVE FIFO

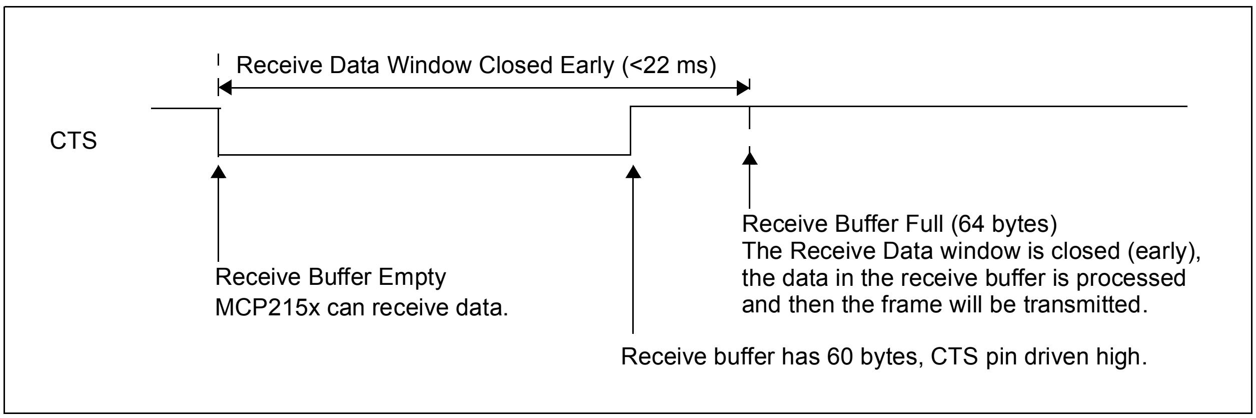


FIGURE 5: CTS TO CTS WHEN MCP215X RECEIVE BUFFER IS NOT FILLED (40 BYTES)

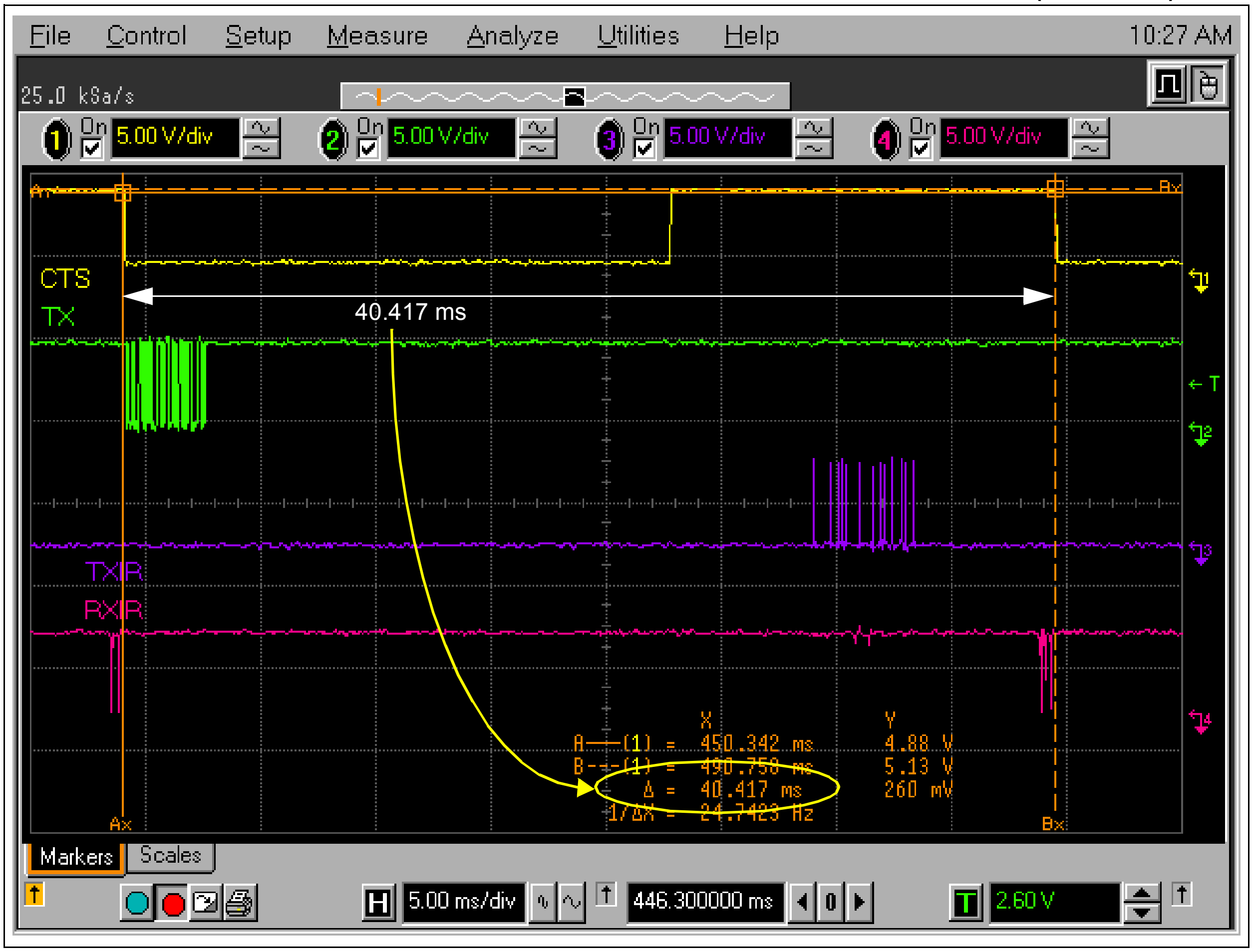


FIGURE 6: CTS TO CTS WHEN MCP215X RECEIVE BUFFER IS FILLED (64 BYTES)

MCP215X Data Processing

After the Receive Data window has closed, the MCP215X will process the data in the receive buffer to generate the CRC and construct the transmit frame.

When the host controller fills the 64-byte receive buffer, this processing time is from TX to TXIR (see Figure 7).

When the host controller does not fill the 64-byte receive buffer, the processing time starts at the end of the 22 ms timer and ends at TXIR (see Figure 8). This extends the time measured from TX to TXIR.

Table 3 shows the delta time of the Receive Data window when 64 bytes are transmitted by the host controller (which forces the Receive Data window closed). Table 3 also illustrates when 63 bytes are transmitted by the host controller (so the Receive Data window is closed after the 22 ms time-out).

When the host UART is at 115200 baud, the host controller could transmit 64 bytes in approximately 5.6 ms. So, for a transmission of 64 bytes, the data processing begins at about 5.6 ms after the CTS falling edge. For a transmission of 63 bytes, the data processing begins at approximately 22 ms after the CTS falling edge. Since the processing time will be approximately the same between 63 and 64 bytes, the transmission of that one extra byte can save about 16.4 ms from the time the activity on TX ends to the activity on TXIR begins.

Table 4 gives the times, between the end of activity on TX to the beginning of activity on TXIR, that were measured in Figure 7 and Figure 8.

Figure 7 shows the timings when 64 bytes are transmitted after the falling edge of the CTS signal.

Figure 8 shows the timings when data is transmitted while the CTS signal is low. The MCP215X will force the CTS signal high after the receive buffer has 60 bytes. So, depending on how quickly the host controller is testing the CTS signal before transmitting the data, the MCP215X receive buffer will have either 60 or 61 data bytes in the transmitted packet.

TABLE 3: RECEIVE DATA WINDOW TIMES

Baud Rate	64 Byte TX Receive Data Window (ms)	63 Byte TX Receive Data Window (ms)	∆ Receive Data Window Time (22 ms - TX Time)
38400	16.7	22	5.3 ms
57600	11.2	22	10.8 ms
115200	5.6	22	16.4 ms

TABLE 4: MCP215X TO PALM TUNGSTEN T2 PDA TIMINGS: TX TO TXIR (MEASURED)

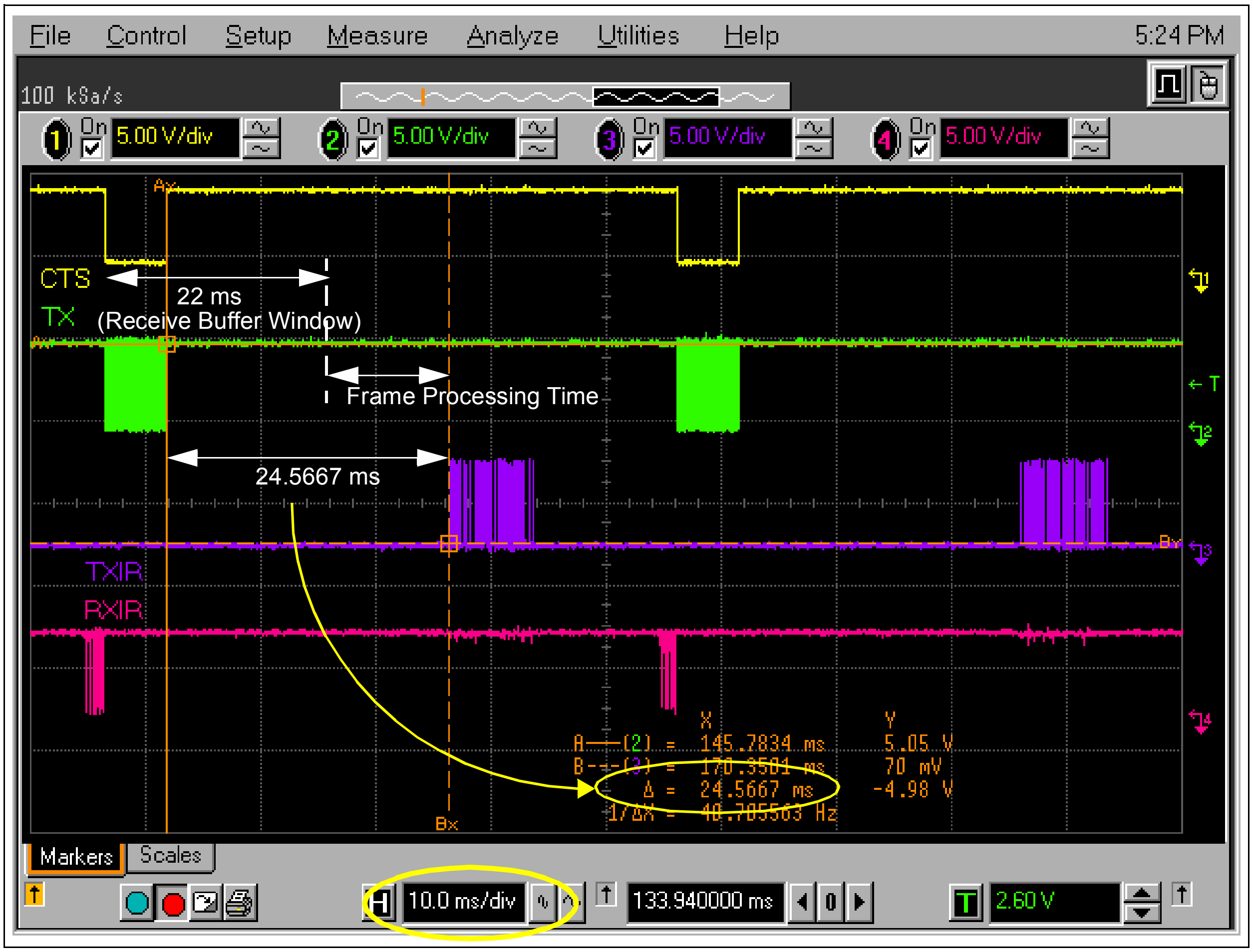
Timing	Condition	Figure #	Time (ms)	Comments
TX to TXIR	Transmit 64 Bytes after CTS Falling Edge	Figure 7	6.15	Figure at **5** ms/div. **(Note 1)**
	Transmit while CTS Low (Receive buffer loaded with 60 or 61 bytes)	Figure 8	24.57	Figure at **10** ms/div. **(Note 2)**

Note 1: Data packet processing starts once the 64th byte has been received (in MCP215X receive buffer).

2: Data packet processing starts once the MCP215X Receive Data window timer times-out (22 ms).

FIGURE 7: TX TO TXIR TIME FOR 64 BYTE DATA TRANSMISSION PER CTS

FIGURE 8: TX TO TXIR TIME FOR DATA TRANSMISSION WHILE CTS IS LOW



Primary Device Response Time

Once the last bit has been transmitted on TXIR, the MCP215X waits for a response from the Primary Device. Since this response time also affects the data throughput, whatever can be done to minimize this response time from the Primary Device will increase the data throughput. Figure 9 and Figure 10 show response times from the end of TXIR to the beginning of RXIR for the Palm™ Tungsten™ T2 running the 215xDemo program from Application Note 888, "Programming the Palm OS® for Embedded IR Applications", DS00888. These times will vary from capture-to-capture due to the asynchronous nature of the communication and PDA operation.

Table 5 shows the times that were measured in Figure 9 and Figure 10.

TABLE 5: MCP215X TO PALM TUNGSTEN T2 PDA TIMINGS: TXIR TO RXIR (MEASURED)

Timing	Condition	Figure #	Time (ms)	Comments
TXIR to RXIR	Transmit 64 Bytes after CTS Falling Edge	Figure 9	9.32	Figure at **5** ms/div **(Note 1)**
	Transmit while CTS low (Receive buffer loaded with 60 or 61 bytes)	Figure 10	11.1	Figure at **10** ms/div **(Note 1)**

Note 1: The TXIR to RXIR delay time is determined by the characteristics of the Primary Device.

FIGURE 9: TXIR TO RXIR TIME FOR 64 BYTE DATA TRANSMISSION PER CTS

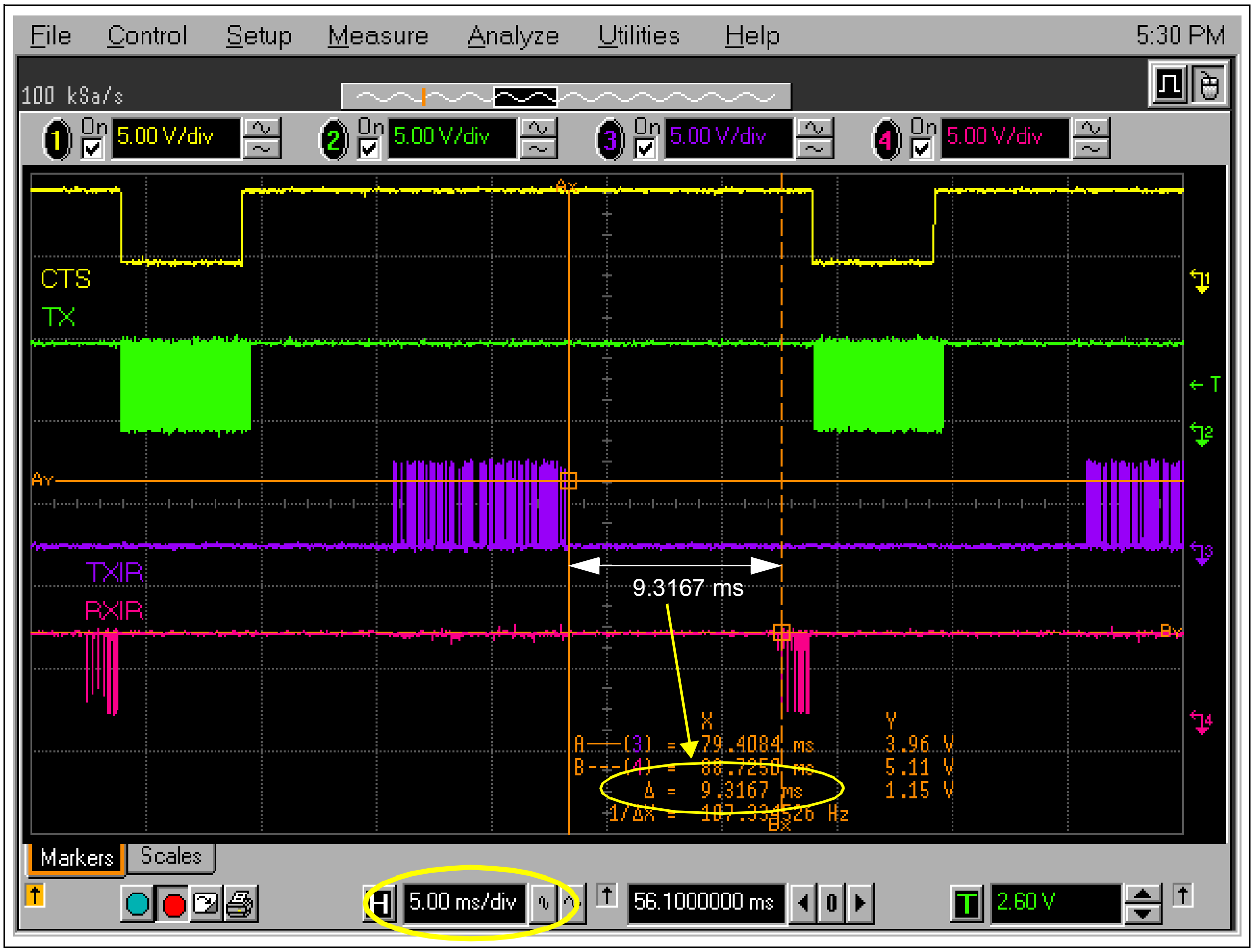
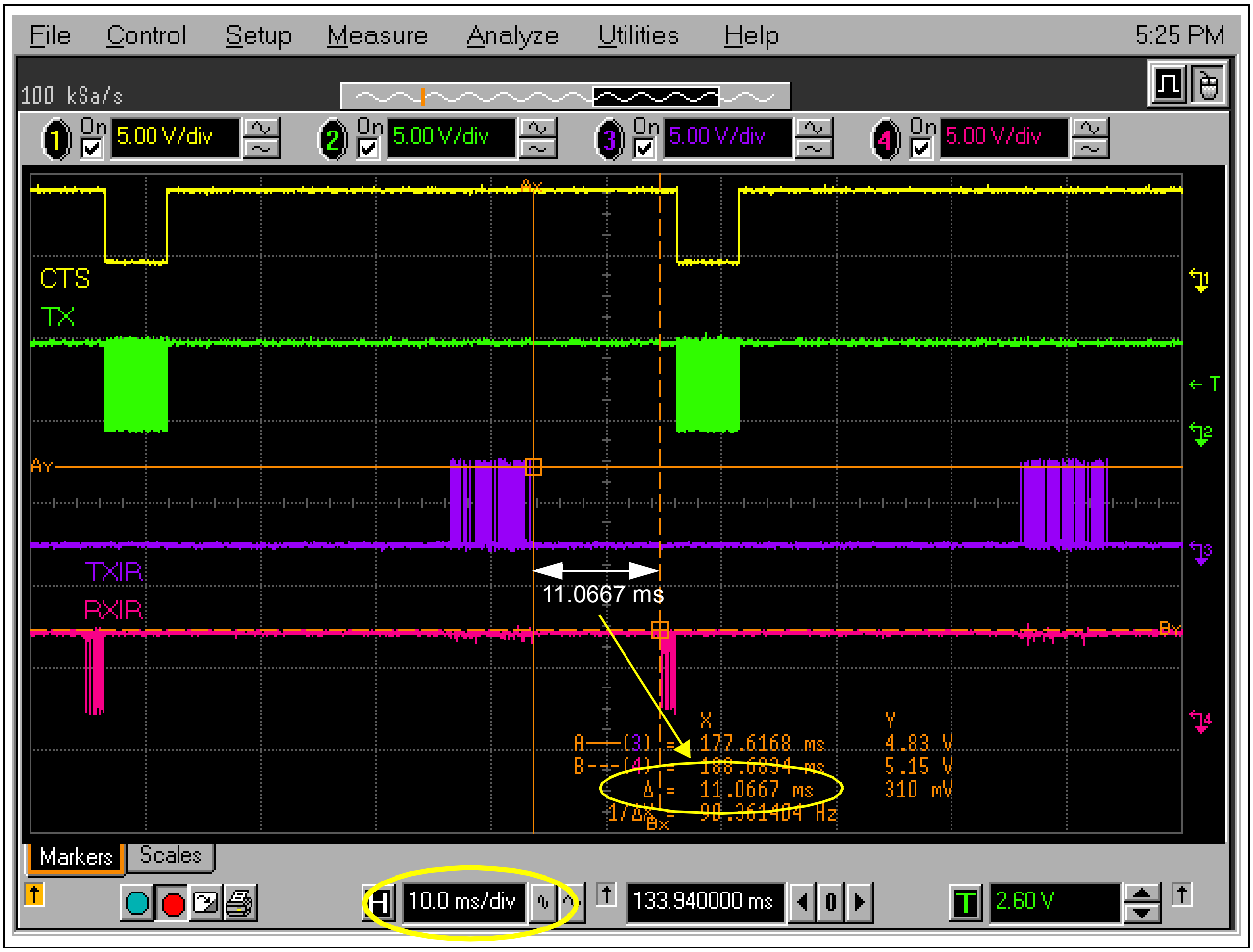


FIGURE 10: TXIR TO RXIR TIME FOR DATA TRANSMISSION WHILE CTS IS LOW



Measured Data Throughput

An Agilent® 54825A oscilloscope was used to capture the data transfer of 1000 bytes from the Secondary Device to the Primary Device (S → P). This 4-channel scope allowed the CTS, TX, TXIR and RXIR signals to be monitored.

The data throughput time was measured at the host controller TX pin. The time measurement started at the first transmitted bit on the TX pin (a Start bit) to the last data bit on the TX pin (actually, the last '0' bit in the data). Given the data that was transmitted, there are no more than 2 bits of error (a data '1' bit plus the Stop bit). The Primary Device used was a Palm Tungsten T2 PDA, while the embedded system (Secondary Device) was an internal Microchip demo board.

Appendix C: "Oscilloscope Screen Captures - MCP215X Rev C" and **Appendix D: "Oscilloscope Screen Captures - MCP215X Rev B"** show the captured waveform for the transfer of 1000 bytes from the embedded system to the Primary Device.

Figure C-1 shows an oscilloscope screen capture of a 1000-byte transfer from a host controller to the Primary Device, where the host controller transmits 64 bytes of data when it detects the falling edge of CTS. Notice the time from the falling edge of CTS pin to the activity on the TXIR pin.

Figure C-2 shows an oscilloscope screen capture for a 1000 byte transfer from a host controller to the Primary Device, where the host controller only transmits data when the CTS signal is low. The time from the falling edge of the CTS pin to the activity on the TXIR pin is much longer in this case, since the data is not processed until the 22 ms Receive Data window is closed. This, then, adds a delay from the time the host controller stops sending data until the MCP2150 starts to process the data.

Figure D-1 and Figure D-2 show the same screen captures, except Rev B of the MCP2150 was used. You will notice that Rev C of the MCP2150 has improved throughput when 64 bytes are transmitted after each CTS falling edge.

Table 6 shows the transfer times of 1000 bytes from the embedded system to the Primary Device (Palm Tungsten T2). These times were measured from the oscilloscope screen captures (see **Appendix C: "Oscilloscope Screen Captures - MCP215X Rev C"** and **Appendix D: "Oscilloscope Screen Captures - MCP215X Rev B"**).

Table 7 takes the times shown in Table 6 and converts them to the approximate data throughput. The host controller program is shown in **Appendix B: "PIC16F877 Source Code"**.

TABLE 6: 1000 BYTES TRANSFER TIME (NOTE 1)

Host Controller to MCP215X Technique	MCP2150		Units
	Rev C (6)	Rev B (6)	
Transfer 64 Bytes after CTS falling edge (S → P)	454 (2)	755 (4)	ms
Transfer Bytes while CTS is low (S → P)	803 (3)	802 (5)	ms

Note 1: Transfer time is dependent on many factors, including the characteristics of the Primary Device. These measurements were taken using a Palm Tungsten T2 PDA. Due to the asynchronous nature of communication, these times can vary from transfer to transfer. Use of a different Primary Device may also lead to different transfer times.

2: See Figure C-1.

3: See Figure C-2.

4: See Figure D-1.

5: See Figure D-2.

6: Appendix B of the MCP215X Device Errata (DS80139) describes how to determine the revision of the device.

TABLE 7: THROUGHPUT

Host Controller to MCP215X Technique	Theoretical(1) (115200 bit/sec)	MCP2150		Units(1)
		Rev C	Rev B	
Constant Streaming (2) (No IrDA standard IrCOMM protocol overhead)	11,520	—	—	Bytes/sec
Transfer 64 Bytes after CTS falling edge (S → P)	—	2200	1324	Bytes/sec
Transfer Bytes while CTS is low (S → P)	—	1245	1246	Bytes/sec

Note 1: Each 8-bit data byte also includes a Start bit and a Stop bit. So 8 bits of data requires a transfer of 10 bits.

2: This would be the transfer rate for a constant stream of data using an encoder/decoder (such as the MCP2120).

Test System Overview

EMBEDDED SYSTEM HARDWARE

The embedded system is a board that contains a PIC16F877 as the host controller, a MCP215X device and an integrated transceiver. The board is an internal Microchip demo board.

EMBEDDED SYSTEM (HOST CONTROLLER) FIRMWARE

To demonstrate the effects of the host controller firmware on throughput from a Secondary Device to a Primary Device, two programs have been implemented. The PIC16F877 firmware program (in **Appendix B: "PIC16F877 Source Code"**) uses conditional assembly to select between these two programs. The value of the **TXMode** constant determines which program to assemble. A variable called "`TableCNTR`" determines how many times to transmit the 250-byte table.

These programs are:

1. Transmit data while the CTS pin is low (TXMode = H'`0`').
2. Transmits 64 bytes with minimal byte-to-byte spacing (as shown in Figure 4) after the falling edge of the CTS signal (TXMode = H'`1`').

In Program #1, the Receive Data window only closes once the 22 ms timer has completed (as shown in Figure 3).

In Program #2, the Receive Data window closes once the 64th byte has been received by the MCP215X (as shown in Figure 4 and Figure 6).

PRIMARY DEVICE

Table 8 shows the characteristics of the Primary Device used, as well as the application program on the Primary Device.

TABLE 8: PALM SYSTEM SETUP

Item	Product	Comment
Manufacturer:	Palm™	
Model:	Tungsten™ T2	
O.S. Version:	5.2.1	
Software Application	MCP215xDemo	From Application Note 888

SUMMARY

The data throughput to communicate from a Secondary Device to a Primary Device can be substantially improved when the host UART receive buffer is filled as quickly as possible. This forces the MCP215X device to process the 64-byte data packet and start transmitting this packet on the TXIR pin.

The data throughput from a Primary Device to a Secondary Device cannot be greatly affected by firmware techniques of the embedded system's host controller.

Use of different Primary Devices will also affect the data throughput performance. Anything that can be done on the Primary Device side to reduce the TXIR-to-RXIR response time will also increase throughput.

NOTES:

APPENDIX A: PIC16F877 FIRMWARE CODE DESCRIPTION

The “215x Tput V001.ASM” application firmware has two main conditional assembly switch constants. These are:

1. “`MCP215X`”, and
2. “`TXMode`”.

The “`MCP215X`” constant selects which MCP21XX device to assemble for, while the “`TXMode`” constant selects the in which the host controller will transmit data to the MCP215X. This allows one file to be used for four different configurations.

The host controller timings (such as the UART) are based on a 20 MHz device frequency.

APPENDIX B: PIC16F877 SOURCE CODE

FIGURE B-1: “215X TPUT V001.ASM” - PAGE 1

```
        LIST    C=132
        include P16F877.inc
        ERRORLEVEL -302
;
;*******************************************************************************
;
;                        Software License Agreement
;
;  The software supplied herewith by Microchip Technology Incorporated
;  (the "Company") is intended and supplied to you, the Companyís
;  customer, for use solely and exclusively with products manufactured
;  by the Company.
;
;  The software is owned by the Company and/or its supplier, and is
;  protected under applicable copyright laws. All rights are reserved.
;  Any use in violation of the foregoing restrictions may subject the
;  user to criminal sanctions under applicable laws, as well as to
;  civil liability for the breach of the terms and conditions of this
;  license.
;
;  THIS SOFTWARE IS PROVIDED IN AN "AS IS" CONDITION. NO WARRANTIES,
;  WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED
;  TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A
;  PARTICULAR PURPOSE APPLY TO THIS SOFTWARE. THE COMPANY SHALL NOT,
;  IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL OR
;  CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
;
;******************************************************************************
;******************************************************************************
;
; SELECT THE MCP215x Device to interface (Host UART Signals) to.
;    This code supports the MCP2155 and MCP2150.  The conditional assembly is
;    defined here.  The allowable choices in this version are 50h, 55h or 40h
;
;MCP215X       equu     H'40'   ; assemble for MCP2140 (same as Flow Control as MCP2155)
;MCP215X       equ     H'55'   ; assemble for MCP2155
MCP215X       equ     H'50'   ; assemble for MCP2150
;
;TXMode        equ     H'1'    ; assemble for Transfer 64 Bytes per CTS falling Edge
TXMode        equ     H'0'    ; assemble for Transfer while CTS is Low
;
;
```


FIGURE B-2: “215X TPUT V001.ASM” - PAGE 2

```
; The use of these Assembler Directives is to verify that a valid target
; product was selected for the Firmware generation. If not, an ERROR MESSAGE
; will be generated.
;
        if ( MCP215X != H'55' && MCP215X != H'50' && MCP215X != H'40' )
           error "MCP21xx Device Selected NOT VALID"
        endif
;
        if ( TXMode != H'1' && TXMode != H'0' )
           error "Data Transfer Mode Selected NOT VALID"
        endif
    if MCP215X==H'50'           ;
           messg "MCP2150 has been Selected"
    endif
;
    if MCP215X==H'55'           ;
           messg "MCP2155 has been Selected"
    endif
;
    if MCP215X==H'40'           ;
           messg "MCP2140 has been Selected"
    endif
;
    if TXMode==H'0'           ;
           messg "Data Transfer Mode is while CTS is low"
    endif
;
    if TXMode==H'1'           ;
           messg "Data Transfer Mode is 64 Bytes after CTS Falling Edge"
    endif
;
;*******************************************************************************
; Revision History
;  1.00 03/15/04  S -> P configured to do multiple of 250 byte transmissions.
;                 This allows data throughput to be analysed and to ensure that
;                 no bytes are "lost" when sending a continuous stream of data
;                 This program can be assembled for one of 2 modes of host controller
;                 to MCP215x communication:
;                 1. Send 64 bytes on each CTS falling edge
;                 2. Send data bytes while CTS is low
;*******************************************************************************
; MCP2150 Developer's Board with PICDEM-2 Demo Board Demo
;    PIC16F877 code to interface to MCP215x Controller
;    Program resets MCP215x and waits for "IR connection"
;    Once a connection is established, the host controller
;    monitors the CTS signal (for a Low) to sends a stream
;    of bytes.
;    Once the table has completed being transmitted, the
;    program "stops" (that is the program loops forever)
;
; NOTE: The MCP2150 Developer's Board requires that the RESET pin of the
;       MCP215x device be disconnected from the MCP2150 Developer Board
;       circuitry and connected to the specified I/O pin of the PIC16F877
;       device on the PICDEM(tm)-2 Demo Board
;
; PICDEM-2 Requirements
;    Device:           PIC16F877
;    Clock Frequency:  20.00 MHz
;    UART:             User-Defined Baud
;
; MCP215x Requirements
;    Clock Frequency:  11.0952 MHz
```

FIGURE B-3: "215X TPUT V001.ASM" - PAGE 3

```
; PIC16F877 PORT Functions
;    PORTA
;      Function         ---   ---   SW2   SW3  LCDRS LCDRW LCDE  XferStr
;      TRIS Direction   ---   ---    I     I     O     O     O     O
;      Initial value    ---   ---   ---   ---    H     H     H     H
;
;*** PORTB (For MCP2150)
;***   Function      PktStr ByteStr RI    CD   LCDD7 LCDD6 LCDD5 LCDD4
;***   TRIS Direction    O     O     I     I    I/O   I/O   I/O   I/O
;***   Initial value     H     L    ---   ---    H     H     H     H
;
;*** PORTB (For MCP2155/MCP2140)
;***   Function      PktStr ByteStr RI    CD   LCDD7 LCDD6 LCDD5 LCDD4
;***   TRIS Direction    O     O     O     O    I/O   I/O   I/O   I/O
;***   Initial value     H     H     H     H     H     H     H     H
;
;    PORTC
;      Function         RX    TX    NA    NA    NA    DTR   DSR RST215X
;      TRIS Direction    I     I     O     O     O     O     I     O
;      Initial value    ---   ---    H     H     H     H    ---    H
;
;    PORTD
;      Function         LED7  LED6  LED5  LED4  LED3  LED2  LED1  LED0
;      Function        BAUD1 BAUD0  NA    NA    NA    NA    NA    NA
;      TRIS Direction    O     O     O     O     O     O     O     O
;      Initial value     H     H     H     H     H     H     H     H
;
;    PORTE
;      Function         ---   ---   ---   ---   ---   NA    CTS   RTS
;      TRIS Direction   ---   ---   ---   ---   ---    O     O     O
;      Initial value    ---   ---   ---   ---   ---    H     H     H
;
;******************************************************************************


#define reset   H'00'           ; Reset vector
;******************************************************************************
;       Configuration Bits
   __CONFIG _CP_OFF & _PWRTE_ON & _HS_OSC & _WDT_OFF & _LVP_OFF
       __IDLOCS H'0010'
;******************************************************************************
;       PORT Bits
;
#define rxd     PORTC, 7        ; input,  serial data from MCP215x
#define txd     PORTC, 6        ; output  UART overrides TRIS bit,
                                ;         serial data to MCP215x
#define cts     PORTE, 1        ; input,  MCP215x is ready to receive data
#define rts     PORTE, 0        ; output, PIC16F877 (host controller) is ready
                                ;         to receive data. At RESET,
                                ;         Low for pgm mode, High for normal
#define dtr     PORTC, 2        ; output, force high or low (LOW). At RESET,
                                ;         High for pgm mode, Low for normal
#define dsr     PORTC, 1        ; input,  Indicates MCP2150 has completed
                                ;         Reset, or
                                ;         Indicates MCP2155 has established
                                ;         a valid link,
                                ;         high for no link, low for link
```

FIGURE B-4: "215X TPUT V001.ASM" - PAGE 4

```
#define cd      PORTB, 4        ; input,  Indicates MCP2150 has established
                                ;         a valid link,
                                ;         high for link, low for no link; or
                                ; output, The MCP2155 communicates this value
                                ;         is to the Primary Device.
                                ;         For this application, this signal
                                ;         (CD) can be static
#define ri      PORTB, 5        ; input,  MCP2150 - Driven high
                                ; output, MCP2155 - This value is communicated
                                ;         to the Primary Device.
                                ;         For this application, this signal
                                ;         (RI) can be static
#define rst215x PORTC,0         ; output, used to reset the MCP2155
                                ;         high for normal operation, low to
                                ;         RESET device
#define en      PORTE, 2        ; output, used to enable MCP215x
                                ;         High for enable, Low for disable
#define baud1   PORTD, 7        ; output
#define baud0   PORTD, 6        ; output, 11 = 115200
                                ;         10 =  57600
                                ;         01 =  19200
                                ;         00 =   9600
                                ;
#define XferStrobe PORTA, 0     ; Output,
                                ;    Used in Program 2 to indicate Start
                                ;    and Stop of Receiving Data
                                ;    Used in Program 3 to indicate Start
                                ;    and Stop of Transmitting Data
#define ByteStrobe PORTB, 6     ; Output, Used in Program 2 and 3 to
                                ;    indicate Byte Count
#definePacketStrobe PORTB, 7   ; Output, Packet Strobe signal
;
#define sw2     PORTA, 5
SW2     EQU     5
#define sw3     PORTA, 4
SW3     EQU     4
;
;
; PORTA, PORTC, PORTD, and PORTE Data Direction values
;
ddra    equu    B'00110000'     ; Data Direction for PORTA
ddrc    equ     B'11000010'     ; Data Direction for PORTC
ddrd    equ     B'00000000'     ; Data Direction for PORTD
ddre    equ     B'00000010'     ; Data Direction for PORTE
;
;***
;*** Conditional assembly on PORTB, PORTC, and PORTE Data Direction values
;*** for Host UART
;***
    if MCP215X==H'50'           ;
ddrb    equ     B'00110000'     ; CD and RI are INPUTs
    endif
;
    if (MCP215X==H'55' || MCP215X==H'40')          ;
ddrb    equ     B'00000000'     ; CD and RI are OUTPUTs
    endif
;
cfgopt  equ     B'11001000'     ; option reg setup
;
```

FIGURE B-5: "215X TPUT V001.ASM" - PAGE 5

```
;******************************************************************************
;
; Additional Conditional Assembly Flags
;
;******************************************************************************
;
ICD     EQU     1        ; When ICD is TRUE, Address 0x00
                         ; must be a NOP and RB7:RB6 are used
                         ; by the ICD module (override TRIS
                         ; settings).
TermEmulator  EQU  1     ; When the PDA uses a Terminal Emulator program
;
;******************************************************************************
;       Constants
;
; Host UART Data Rate/BRG Value (BRGH = 1)
;                 SPBRG Value
;    Baud Rate    @ 20MHz
;    9600         D'129'
;    19200         D'64'
;    57600         D'21'
;   115200         D'10'
;
;                     SPBRG Value
B9600at20MHz    EQU    D'129'
B19200at20MHz   EQU    D'64'
B57600at20MHz   EQU    D'21'
B115200at20MHz  EQU    D'10'
;
;******************************************************************************
;       Registers
;
    cblock    H'20'
        delreg          ; register for timing delays & scratchpad
        MENUCNTR        ; Pointer to the Menu character to send
        MENUBYTES       ; This is the # of bytes in the MENU
        hostdata        ; Host Data to Transmit
        BYTERX          ; Received Byte on UART
        RXBufferSize    ; The size of the MCP215x Host UART Receive Buffer
                        ; LCD variables
        RXTableTXCount  ; The counter for the number of times the 256-byte
                        ; table is transmitted
                        ; (250-byte table + 6 extra characters)
        B256CNTR        ; Counter to display on PORTD how many times the 256-byte
                        ; table is transmitted
        ERRCNT
        COUNTER
        delay
        ptr_pos
        ptr_count
        SodaCNTR
        CandyCNTR
        hundreds        ; 8-bit to 3-Digit conversion, Hundreds place
        tens            ;     Tens place
        REMAINDER       ;     Ones place
        temp3
        temp2
        temp1
        temp
        temp_wr
        temp_rd
    endc
```

FIGURE B-6: "215X TPUT V001.ASM" - PAGE 6

```
;******************************************************************************
        org     H'00'         ; use 00h as reset vector
    if ICD
        NOP                   ; Use of the ICD requires the first
    endif                     ;   instruction to be a NOP

        goto    START
;
;
;******************************************************************************
;       Start Routine
;       Initialization is done here
;       (Ports, Option Register, and UART).
;       Option Register has:
;            RBPU disabled,
;            RB0 on Rising Edge,
;            TMR0 Clock Source internal
;            T0CKI inc on L-to-H
;            Prescaler assigned to WDT
;            WDT = 1:1
;******************************************************************************
STARTclrf    STATUS          ; Bank 0
        movlw   0xFF            ; Force PORTs to display High when configured
        movwf   PORTA           ;    as Output
        movwf   PORTB           ;
        movwf   PORTC           ;
        movwf   PORTD           ;
        movwf   PORTE           ;

        bsf     STATUS, RP0     ; Bank 1
        movlw   ddra
        movwf   TRISA           ; Configure PORTA
        movlw   ddrb
        movwf   TRISB           ; Configure PORTB
        movlw   ddrc
        movwf   TRISC           ; Configure PORTC
        movlw   ddrd
        movwf   TRISD           ; Configure PORTD
        movlw   ddre
        movwf   TRISE           ; Configure PORTE
;
        movlw   cfgopt          ; setup option reg
        movwf   OPTION_REG

        MOVLW   0x0E            ; Configure A/D Module so that RA0 is Analog,
        MOVWF   ADCON1          ; ALL other pins Digital; Result is Left-Justified
```

FIGURE B-7: "215X TPUT V001.ASM" - PAGE 7

```
;  Initialize UART
;      BRGH = 1
;      8-bit
;      TX Enabled
;      Async. Operation
;      Continuous receive
;  Enable UART
;  Write value (0xFF) to PORTB
;     (ICD uses RB7:RB6, so with ICD 0x3F will be displayed)
;
        movlw   0x24            ; BRGH = 1, 8-bit, TX Enabled, Async.
        movwf   TXSTA           ;
    if (MCP215X==H'55' || MCP215X==H'50')          ;
        movlw   B115200at20MHz  ;
    endif
    if (MCP215X==H'40')         ;
        movlw   B9600at20MHz    ;
    endif
        movwf   SPBRG           ;
        clrf    STATUS          ; Bank 0
        movlw   0x90            ; Enable serial port, continuous receive
        movwf   RCSTA           ;
;
        clrf    PORTD           ; clear outputs (Display on LEDs)

        MOVLW   B'10000001'     ; Configure A/D Module so that RA0 is Selected,
        MOVWF   ADCON1          ; A/D clock is /32, and A/D is ON.
;
; Initialize MCP215x Flow Control signals,
; Reset MCP215x,
;       BAUD1:BAUD0         Baud Rate
;           0 0                9600
;           0 1               19200
;           1 0               57600
;           1 1              115200
;
; Delay for 1us,
; then release Reset
;
RESET215X
        bsf     en              ; enable MCP215x
        bsf     baud1           ;
        bsf     baud0           ; 11 = 115200
        bcf     dtr             ; dtr low is the normal mode for the MCP215x

        bcf     rst215x         ; Reset the MCP215x
        nop                     ; Delay to ensure MCP215x RESET pin is
        nop                     ;    deteceted (driven) low
        nop
        nop
        nop
        bsf     rst215x         ; Release the MCP215x from RESET
;
; MCP215x requires 2000 Tosc (at 11.0592MHz = 180 us)
; delay before the device initialization should be
; complete
;
        movlw   H'FF'           ;
        call    DELAY
        BSF     XferStrobe      ; Output, Default High
        BCF     ByteStrobe      ; Output, Default Low
        BSF     PacketStrobe    ; Output, Default High
```

FIGURE B-8: "215X TPUT V001.ASM" - PAGE 8

```
;**************** STANDARD CODE MENU SELECTION *******************
;
; The following delay is done only on the MCP2150, since the MCP2150 has a
; signal (DSR) which is used to indicate if the MCP2150 has completed RESET.
; There is no corresponding signal on the MCP2155.
;

    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
;
; Has MCP2150 completed initialization?,
; if not continue to wait
;
WAIT2150                        ; Now test the state of the DSR pin
        btfss   dsr
        goto    WAIT2150        ; NO, wait more time
        goto    MAIN            ; YES, continue
;
    endif                       ; End of Conditional Assemble for MCP2150



;******************************************************************************
;  Main Routine - MCP215x Has completed initialization
;
; Wait for MCP215x to establish a link.
; Indicate to MCP215x to Send byte that established link
; Wait for byte to be received by PIC16F877
; (while waiting, test to ensure link is still present)
; Read Byte and display on PORTB
; Call Subroutine which Transmits entire Table of Data
; Then Loop forever.
;
;******************************************************************************
;
MAIN
WaitForSW2SW3
        CLRF    STATUS          ; Bank 0
;
;
;******************************************************************************
```

FIGURE B-9: "215X TPUT V001.ASM" - PAGE 9

```
;******************************************************************************
;  Program3 Routine - Transmit a Table of 256 bytes a LoopCounter number
;                     of times. The transmissions starts after receiving a
;                     character from an IrDA(r) standard Primary device. Data starts
;                     transmitting when the CTS signal goes low and stops
;                     transmitting that data packet when either:
;                     1. CTS goes high
;                     2. 64 bytes have been transmitted
;                     The transmit mode is determined by user input (SW2/SW3)
;
; Wait for MCP215x to establish a link.
; Indicate to MCP215x to Send byte that established link
; Wait for byte to be received by PIC16F877
; (while waiting, test to ensure link is still present)
; Read Byte and display on PORTB
; Clear Timer to measure the time to send data.
; Start Timer
; Call Subroutine which Transmits entire Table of Data
; Stop Timer and display bytes/time on LCD
; Then Loop forever.
;
;******************************************************************************
;
#define      TableCNTR   D'4'   ; Send 250 Byte Table this # of times
Program3
        BSF     XferStrobe      ; Set the Stobe High, can trigger Oscilliscope when
                                ;    XferStrobe goes Low.
        BCF     ByteStrobe      ; Set the Stobe Low, can trigger Oscilliscope when
                                ;    ByteStrobe goes High.
                                ;
```

FIGURE B-10: “215X TPUT V001.ASM” - PAGE 10

```
    if TXMode==H'1'             ; assemble for Transfer 64 Bytes per CTS falling Edge
;
;******************************************************************************
;
; This code sends the data as 64 byte blocks after the a falling edge
; has been detected on the CTS signal
;
;******************************************************************************
;
Xfer64Byte
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
P3X64WAITCD
        btfsc   cd              ; Has the MCP2150 made a link?
        goto    P3X64WAITCD     ; NO, wait for a link to be established
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
P3X64WAITDSR
        btfsc   dsr             ; Has the MCP2155/MCP2140 made a link?
        goto    P3X64WAITDSR    ; NO, wait for a link to be established
        bcf     cd              ;*** Light the CD LED to show that DSR was low
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        bcf     rts             ; YES, Host can receive the "Dummy" byte
                                ;
P3X64RXWAIT1                    ; The program will wait here before sending
                                ;   the "data" out. This is because to
                                ;   create a link, many devices (PDAs)
                                ;   must transmit at least one data byte.
        btfsc   PIR1, RCIF      ; Has a byte been received yet?
        goto    P3X64GOTBYTE1   ; YES
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
        btfsc   cd              ; NO, so test if MCP2150 link still active?
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')    ; Conditional Assemble for MCP2155/MCP2140
        btfsc   dsr             ; NO, so test if MCP2155/MCP2140 link still active?
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    MAIN            ;     NO, Link was lost, so start over
        goto    P3X64RXWAIT1    ;     YES, Have not received a byte yet
P3X64GOTBYTE1
        movf    RCREG, W        ; Get byte into W register and this clears
                                ;   the RCIF flag. Link is established,
        movwf   PORTD           ;   display on PORTB then send bytes
;
        call    SENDX64DATA     ; Send the MENU character string
;
        GOTO    Program3        ;
;
;
```

FIGURE B-11: "215X TPUT V001.ASM" - PAGE 11

```
; Send String (MENU) routine
;
; This routine Transmits the String (MENU) Data to the MCP215x
; The First byte of the String (Menu) is the length of the Data
;        MENUCNTR is pointer into Table MENU to get the Table lookup data
;        MENUBYTES contains the number of bytes of the String (MENU) still to
;        be transmitted. hostdata contains the value returned from MENU, to
;        be transmitted
;
; Determine if PIC16F877 can transmit UART data (monitor CTS signal)
; After Calling Serial Send Routine, decrement the number of bytes to send
; Test to see if still more bytes to send.
;
;   CTS Window 22ms.
;      Baud Rate     Max Bytes Transferred
;        9600            23
;       19200            46
;       57600           134    Exceeds MCP215x Buffer Size of 64 Bytes -
;                              Ensure only 64 bytes are sent during MCP215x
;                              Transmit Window
;      115200           276    Exceeds MCP215x Buffer Size of 64 Bytes -
;                              Ensure only 64 bytes are sent during MCP215x
;                              Transmit Window
;
SENDX64DATA                     ; Send until Buffer is full
        MOVLW   TableCNTR       ; Send 256 Byte Table this # of times
        MOVWF   RXTableTXCount  ;  1x =   250 Bytes
                                ;  4x =  1000 Bytes
                                ;  8x =  2000 Bytes
                                ; 10x =  2500 Bytes
        CLRF    B256CNTR        ; # of Tables Transmitted
;
SENDX64DataLoop                   ; Send until Buffer is full
        clrf    MENUCNTR          ; MENU Counter = 0
        call    MENU              ; Get next byte of data from the MENU Data Table
        movwf   MENUBYTES         ; This is the # of bytes in the MENU
                                  ;   (Menu size must be > 1, MENUBYTES = 0 --> 256 )
        INCF    B256CNTR, F       ; Increment the # of Tables Transmitted
;
MENUX64LOOPRXBufLoad
        MOVLW   0x40              ; Load 64 into the Counter RXBufferSize
        MOVWF   RXBufferSize      ;
;
    if (MCP215X==H'55' || MCP215X==H'50')          ;
X64CTSWait1
        BTFSS   cts               ; Wait for CTS to be High
        GOTO    X64CTSWait1       ; (need to ensure that we detect CTS falling edge)
    endif
;
X64CTSWait2
        btfsc   cts               ; Wait for CTS to be Low
        goto    X64CTSWait2       ; (waiting to detect CTS falling edge)
;
        MOVF    B256CNTR, W       ; Load value into PORTD
        MOVWF   PORTD             ;
MENUX64LOOP1
        incf    MENUCNTR, F       ; Point to next location in the MENU
        call    MENU              ; Get next byte of data from the MENU Data Table
        movwf   hostdata          ; Store this byte in register "hostdata"
;
```

FIGURE B-12: "215X TPUT V001.ASM" - PAGE 12

```
P3X64MENULP1
    if MCP215X==H'50'               ; Conditional Assemble for MCP2150
        btfsc   cd                  ; Is the link still active?
    endif                           ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
        btfsc   dsr                 ; Is the link still active?
    endif                           ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    RESET215X           ; NO, link closed for unknown reason,
                                    ;    RESET MCP215x
        BCF     XferStrobe          ; 240 Byte Strobe
        call    SERSNDX64           ; YES, Send the Data Byte
;
;
        DECFSZ  MENUBYTES, F        ; Decrement the number of available bytes
                                    ; If MENUBYTES = 0, The complete MENU has been sent
        GOTO    TestRXBufSize       ; MENUBYTES != 0, need to check RX Buffer Size
;
TestTXTableCNTR                     ; MENUBYTES = 0, Do we need to send the table some more?
        DECFSZ  RXTableTXCount, F ; If the counter != 0, then we need to send the
                                    ;   MENU table some more times,
                                    ;   but lets check RX Buffer Size
        GOTO    LoadNextTableX64  ; TestRXBufSize != 0, more tables to send
        BSF     XferStrobe          ; TestRXBufSize = 0, Close Data Transmit Strobe
        RETURN                      ; Back to Program3 loop (S->P Transmission)
;
;
LoadNextTableX64
        clrf    MENUCNTR            ; MENU Counter = 0
        call    MENU                ; Get next byte of data from the MENU Data Table
        movwf   MENUBYTES           ; This is the # of bytes in the MENU
                                    ;   (Menu size must be > 1, MENUBYTES = 0 --> 256 )
        INCF    B256CNTR, F         ;
;
TestRXBufSize
        DECFSZ  RXBufferSize, F     ; Is RX Buffer Full for this window?
        GOTO    MENUX64LOOP1        ; NO, More of the MENU needs to be sent
;TestLP1 GOTO    TestLP1            ; YES, wait for next CTS low for more of the MENU to be sent
        GOTO    MENUX64LOOPRXBufLoad  ; YES, wait for next CTS low for more of the MENU to be sent
;
;
```

FIGURE B-13: "215X TPUT V001.ASM" - PAGE 13

```
; Serial Send Routine
; This routine uses the uart to send a single data byte to
; the MCP215x with hardware handshake.
; Data is passed in register called "hostdata"
;
; Wait for UART to be ready for next byte to be loaded
; Ensure the MCP215x can still receive data (test CTS signal)
; Load data to send Data, then return
;
;
SERSNDX64
        bsf     STATUS, RP0     ; Bank 1
SERSLPX64
        btfss   TXSTA, TRMT     ; check if UART ready
        goto    SERSLPX64       ; not ready, wait
        bcf     STATUS, RP0     ; Bank 0
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
SERS1X64
        btfsc   cd              ; Is the link still active?
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')  ; Conditional Assemble for MCP2155/MCP2140
SERS1X64
        btfsc   dsr             ; Is the link still active?
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    RESET215X       ; NO, link closed for unknown reason,
                                ;    RESET MCP215x
        movf    hostdata,w      ; get the byte to send
        movwf   TXREG           ; send the byte
        BSF     ByteStrobe      ; Byte is sent - Start Strobe
        NOP                     ; Some High Time (easier to count)
        NOP
        NOP
        NOP
        NOP
        NOP
        NOP
        BCF     ByteStrobe      ; end of Strobe
        RETURN
;
    endif
;
```

FIGURE B-14: "215X TPUT V001.ASM" - PAGE 14

```
    if TXMode==H'0'             ; assemble for Transfer while CTS is Low
;
;******************************************************************************
;
; This code sends the data as while the CTS signalis Low. This does not
; give optimum data throughput, since the Receive Data window is not
; forced closed by having 64 bytes in the MCP215x Host UART Receive Buffer
;
;******************************************************************************
;
XferCTSHigh
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
P3CTSWAITCD
        btfsc   cd              ; Has the MCP2150 made a link?
        goto    P3CTSWAITCD     ; NO, wait for a link to be established
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
P3CTSWAITDSR
        btfsc   dsr             ; Has the MCP2155/MCP2140 made a link?
        goto    P3CTSWAITDSR    ; NO, wait for a link to be established
        bcf     cd              ;*** Light the CD LED to show that DSR was low
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        bcf     rts             ; YES, Host can receive the "Dummy" byte
P3CTSRXWAIT1
        btfsc   PIR1, RCIF      ; Has a byte been received yet?
        goto    P3CTSGOTBYTE1   ; YES
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
        btfsc   cd              ; NO, so test if MCP2150 link still active?
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
        btfsc   dsr             ; NO, so test if MCP2155/MCP2140 link still active?
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    MAIN            ;     NO, Link was lost, so start over
        goto    P3CTSRXWAIT1    ;     YES, Have not received a byte yet
P3CTSGOTBYTE1
        movf    RCREG, W        ; Get byte into W register and this clears
                                ;   the RCIF flag. Link is established,
        movwf   PORTD           ;   display on PORTB then send bytes
;
        call    SENDCTSDATA     ; Send the MENU character string
;
;
;
        GOTO    Program3        ; Program Completed transmission of
                                ;   characters, Start Program 3 over to
                                ;   see if want to transmit again
;
```

FIGURE B-15: "215X TPUT V001.ASM" - PAGE 15

```
; Send String (MENU) routine
;
; This routine Transmits the String (MENU) Data to the MCP215x
; The First byte of the String (Menu) is the length of the Data
;        MENUCNTR is pointer into Table MENU to get the Table lookup data
;        MENUBYTES contains the number of bytes of the String (MENU) still to
;        be transmitted. hostdata contains the value returned from MENU, to
;        be transmitted
;
; Determine if PIC16F877 can transmit UART data (monitor CTS signal)
; After Calling Serial Send Routine, decrement the number of bytes to send
; Test to see if still more bytes to send.
;
;   CTS Window 22ms.
;      Baud Rate     Max Bytes Transferred
;        9600           23
;       19200           46
;       57600          134    Exceeds MCP215x Buffer Size of 64 Bytes -
;                             Ensure only 64 bytes are sent during MCP215x
;                             Transmit Window
;      115200          276    Exceeds MCP215x Buffer Size of 64 Bytes -
;                             Ensure only 64 bytes are sent during MCP215x
;                             Transmit Window
;
SENDCTSDATA                   ; Send until CTS is High
        MOVLW   TableCNTR      ; Send 256 Byte Table this # of times
        MOVWF   RXTableTXCount ;  1x =   250 Bytes
                              ;  4x =  1000 Bytes
                              ;  8x =  2000 Bytes
                              ; 10x =  2500 Bytes
        CLRF    B256CNTR       ; # of Tables Transmitted
;
SENDCTSDataLoop               ; Send until Buffer is full
        clrf    MENUCNTR       ; MENU Counter = 0
        call    MENU           ; Get next byte of data from the MENU Data Table
        movwf   MENUBYTES      ; This is the # of bytes in the MENU
                              ;   (Menu size must be > 1, MENUBYTES = 0 --> 256 )
        INCF    B256CNTR, F    ; Increment the # of Tables Transmitted
;
    if (MCP215X==H'55' || MCP215X==H'50')          ;
CTSWait1
        BTFSS   cts               ; Wait for CTS to be High
        GOTO    CTSWait1          ; (need to ensure that we detect CTS falling edge)
    endif
CTSWait2
        btfsc   cts               ; Wait for CTS to be Low
        goto    CTSWait2          ; (waiting to detect CTS falling edge)
;
        MOVF    B256CNTR, W       ; Load value into PORTD
        MOVWF   PORTD             ;
;
```


FIGURE B-16: "215X TPUT V001.ASM" - PAGE 16

```
MENUCTSLOOP1
        incf    MENUCNTR, F    ; Point to next location in the MENU
        call    MENU           ; Get next byte of data from the MENU Data Table
        movwf   hostdata       ; Store this byte in register "hostdata"
;
P3CTSMENULP1
    if MCP215X==H'50'          ; Conditional Assemble for MCP2150
        btfsc   cd             ; Is the link still active?
    endif                      ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
        btfsc   dsr            ; Is the link still active?
    endif                      ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    RESET215X      ; NO, link closed for unknown reason,
                               ;    RESET MCP215x
        btfsc   cts            ; YES, Can the Host can send Data?
        goto    P3CTSMENULP1   ; NO, wait for MCP215x to be ready for data
;
        BCF     XferStrobe
;
        call    SERSNDCTS      ; YES, Send the Data Byte
;
        DECFSZ  MENUBYTES, F   ; Decrement the number of available bytes
        goto    MENUCTSLOOP1   ; More of the MENU needs to be sent been sent

        DECFSZ  RXTableTXCount, F   ; MENUBYTES = 0, Decrement the Transmit
                                    ;    Table (MENU) Counter
        goto    LoadNextTableCTS    ; MENU needs to be sent out again
;
        BSF     XferStrobe     ; MENUBYTES = 0 and RXTableTXCount = 0,
                               ;    All Data Bytes have been transmitted
;
        RETURN                  ; Back to main loop
;
LoadNextTableCTS
        clrf    MENUCNTR          ; MENU Counter = 0
        call    MENU              ; Get next byte of data from the MENU Data Table
        movwf   MENUBYTES         ; This is the # of bytes in the MENU
                                  ;   (Menu size must be > 1, MENUBYTES = 0 --> 256 )
        INCF    B256CNTR, F       ;
;
        GOTO    MENUCTSLOOP1      ; NO, More of the MENU needs to be sent
;
;
```

FIGURE B-17: "215X TPUT V001.ASM" - PAGE 17

```
; Serial Send Routine
; This routine uses the uart to send a single data byte to
; the MCP215x with hardware handshake.
; Data is passed in register called "hostdata"
;
; Wait for UART to be ready for next byte to be loaded
; Ensure the MCP215x can still receive data (test CTS signal)
; Load data to send Data, then return
;
SERSNDCTS
        bsf     STATUS, RP0     ; Bank 1
SERSLPCTS
        btfss   TXSTA, TRMT     ; check if UART ready
        goto    SERSLPCTS       ; not ready, wait
        bcf     STATUS, RP0     ; Bank 0
;
    if MCP215X==H'50'           ; Conditional Assemble for MCP2150
SERS1CTS
        btfsc   cd              ; Is the link still active?
    endif                       ; End of Conditional Assemble for MCP2150
;
    if (MCP215X==H'55' || MCP215X==H'40')   ; Conditional Assemble for MCP2155/MCP2140
SERS1CTS
        btfsc   dsr             ; Is the link still active?
    endif                       ; End of Conditional Assemble for MCP2155/MCP2140
;
        goto    RESET215X       ; NO, link closed for unknown reason,
                                ;    RESET MCP215x
        btfsc   cts             ; YES, check the printer handshake
        goto    SERS1CTS        ; if CTS=1 then do not print
        movf    hostdata,w      ; get the byte to send
        movwf   TXREG           ; send the byte
        BSF     ByteStrobe      ; Byte is sent - Start Strobe
        NOP                     ; Some High Time (easier to count)
        NOP
        NOP
        NOP
        NOP
        NOP
        NOP
        BCF     ByteStrobe      ; end of Strobe
        RETURN
;
    endif
;
;******************************************************************************
;
;       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
;
;
;
```

FIGURE B-18: "215X TPUT V001.ASM" - PAGE 18

```
        org     H'0400'         ; use 0400h as Start of String Table Routine
;
;
;*****************************************************************************
;
;   String Table - Used in PROGRAM2 (P->S) and PROGRAM3 (S->P)
;   This table stores the MENU string, MENUCNTR is the offset.
;   The string is terminated by a null.
;
;   Caution: Do not let MENU String cross 256 word boundary
;            (that is the reason for the ORG directive)
;
;*****************************************************************************
;
MENU    movlw   HIGH (MENU)     ; Get the upper address bits where this table
        movwf   PCLATH          ;    is located and load into the PCLATH
                                ;    register
        movf    MENUCNTR, W     ; get the offset
        addwf   PCL,f           ; add the offset to PC


MENU2   DT      D'250'            ; the first byte is the byte count (0 = 256)
                                                          ; 1 Characters
        DT      "12345678", 0x0D, 0x0A                    ; 10 Characters -  10
        DT      "2BCDEFGH", 0x0D, 0x0A                    ; 10 Characters -  20
        DT      "32345678", 0x0D, 0x0A                    ; 10 Characters -  30
        DT      "4bcdefgh", 0x0D, 0x0A                    ; 10 Characters -  40
        DT      "52345678", 0x0D, 0x0A                    ; 10 Characters -  50
        DT      "6BCDEFGH", 0x0D, 0x0A                    ; 10 Characters -  60
        DT      "72345678", 0x0D, 0x0A                    ; 10 Characters -  70
        DT      "8bcdefgh", 0x0D, 0x0A                    ; 10 Characters -  80
        DT      "92345678", 0x0D, 0x0A                    ; 10 Characters -  90
        DT      "ABCDEFGH", 0x0D, 0x0A                    ; 10 Characters - 100
        DT      "B2345678", 0x0D, 0x0A                    ; 10 Characters - 110
        DT      "Cbcdefgh", 0x0D, 0x0A                    ; 10 Characters - 120
        DT      "D2345678", 0x0D, 0x0A                    ; 10 Characters - 130
        DT      "EBCDEFGH", 0x0D, 0x0A                    ; 10 Characters - 140
        DT      "F2345678", 0x0D, 0x0A                    ; 10 Characters - 150
        DT      "1bcdefgh", 0x0D, 0x0A                    ; 10 Characters - 160
        DT      "22345678", 0x0D, 0x0A                    ; 10 Characters - 170
        DT      "3BCDEFGH", 0x0D, 0x0A                    ; 10 Characters - 180
        DT      "42345678", 0x0D, 0x0A                    ; 10 Characters - 190
        DT      "5bcdefgh", 0x0D, 0x0A                    ; 10 Characters - 200
        DT      "62345678", 0x0D, 0x0A                    ; 10 Characters - 210
        DT      "7BCDEFGH", 0x0D, 0x0A                    ; 10 Characters - 220
        DT      "82345678", 0x0D, 0x0A                    ; 10 Characters - 230
        DT      "9bcdefgh", 0x0D, 0x0A                    ; 10 Characters - 240
        DT      "a2345678", 0x0D, 0x0A                    ; 10 Characters - 250

;
; NOTE:  0x0D = Carriage Return, 0x0A = Line Feed
;
;
;
;
ENDPROG NOP


    end
```

APPENDIX C: OSCILLOSCOPE SCREEN CAPTURES - MCP215X REV C

FIGURE C-1: 1000-BYTE DATA TRANSFER - TRANSMIT 64 BYTES PER CTS FALLING EDGE

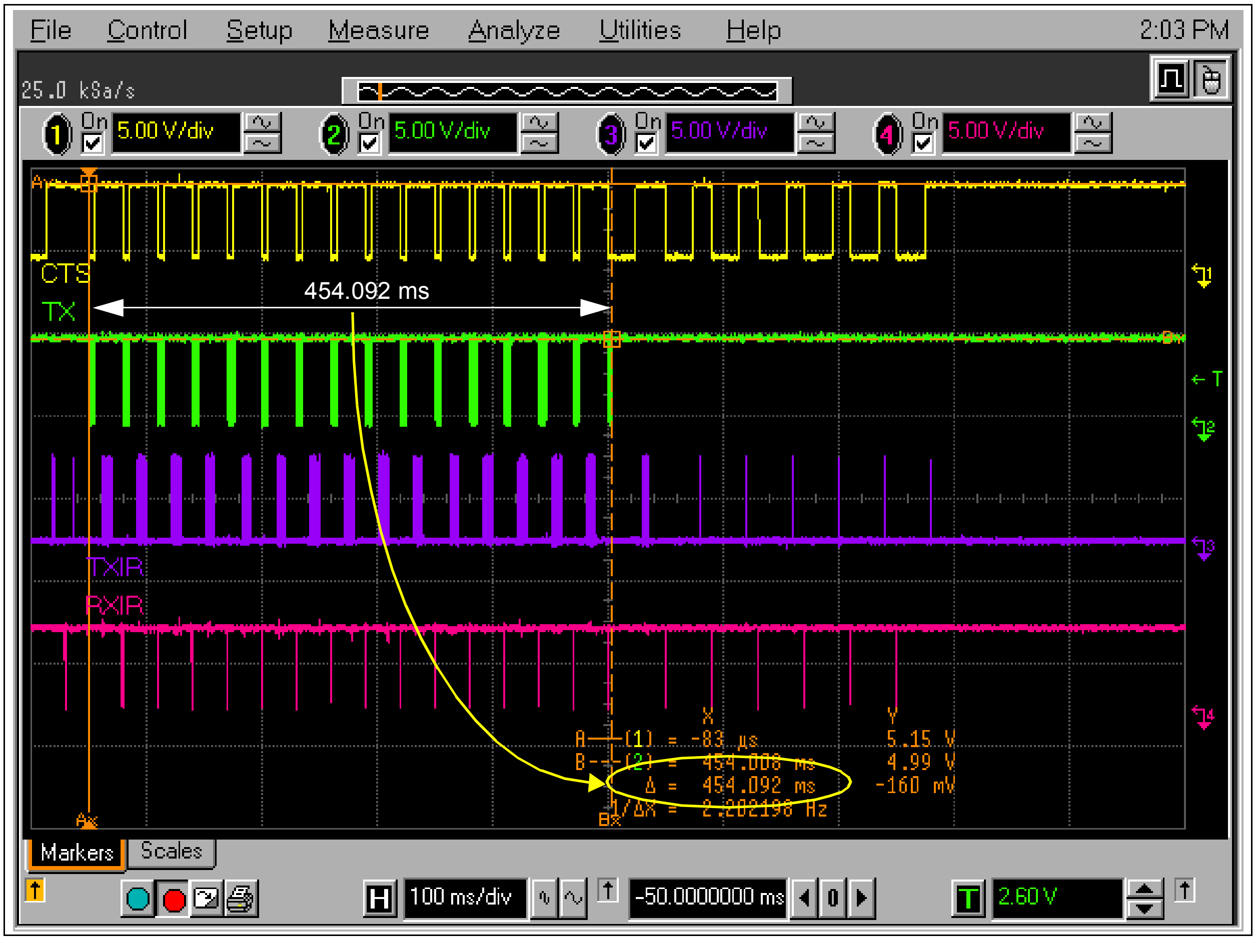
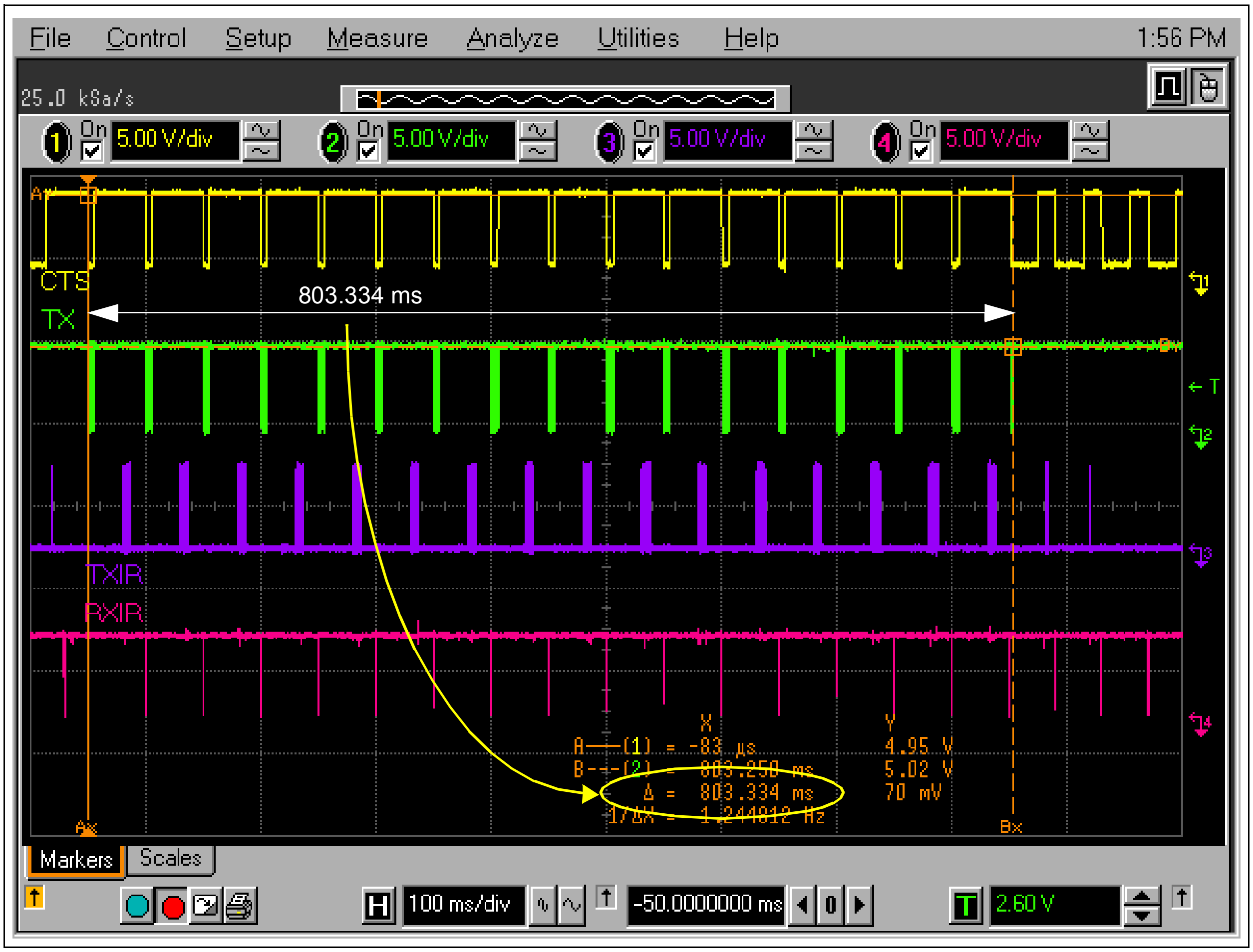


FIGURE C-2: 1000-BYTE DATA TRANSFER - TRANSMIT WHILE CTS IS LOW



APPENDIX D: OSCILLOSCOPE SCREEN CAPTURES - MCP215X REV B

FIGURE D-1: 1000-BYTE DATA TRANSFER - TRANSMIT 64 BYTES PER CTS FALLING EDGE

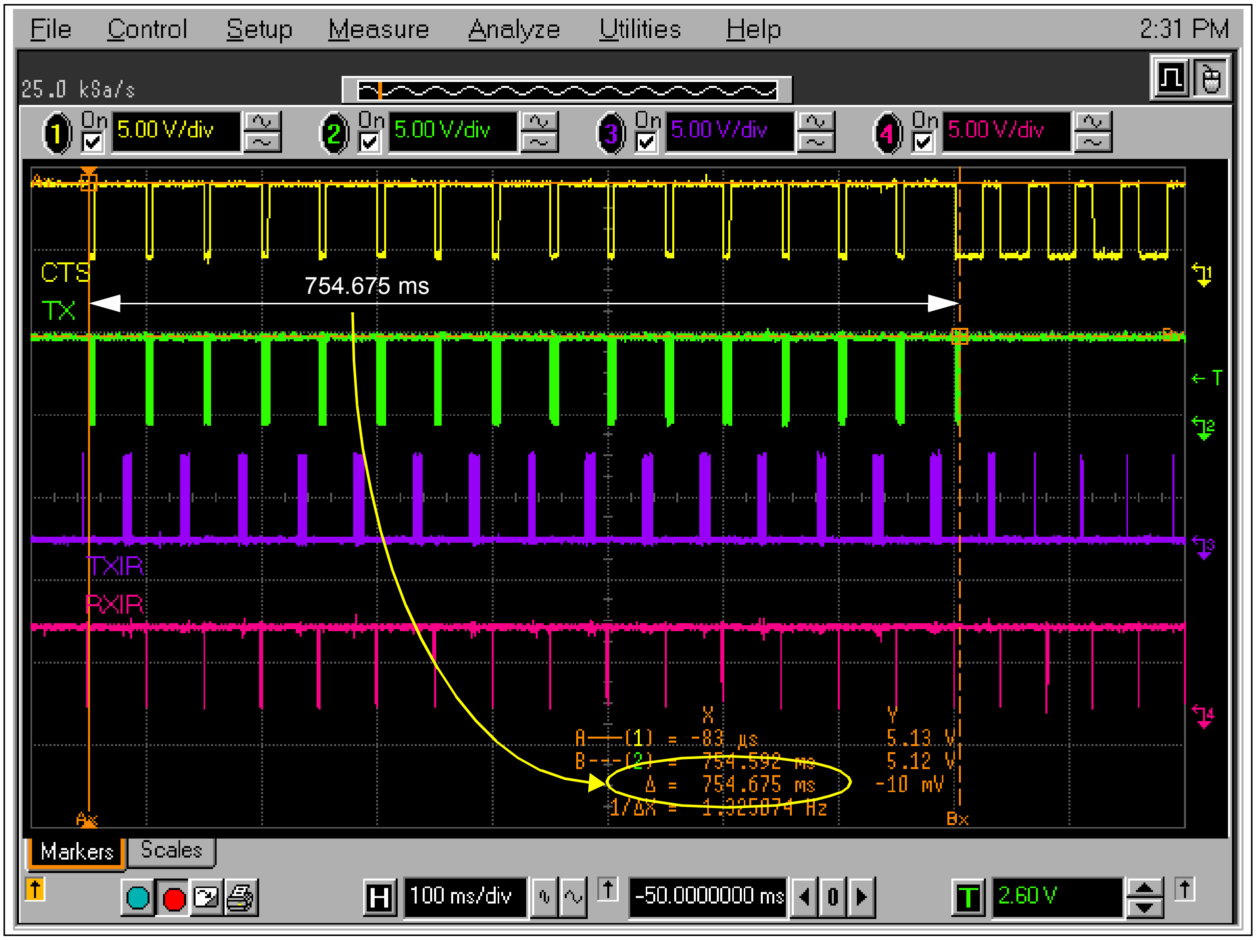
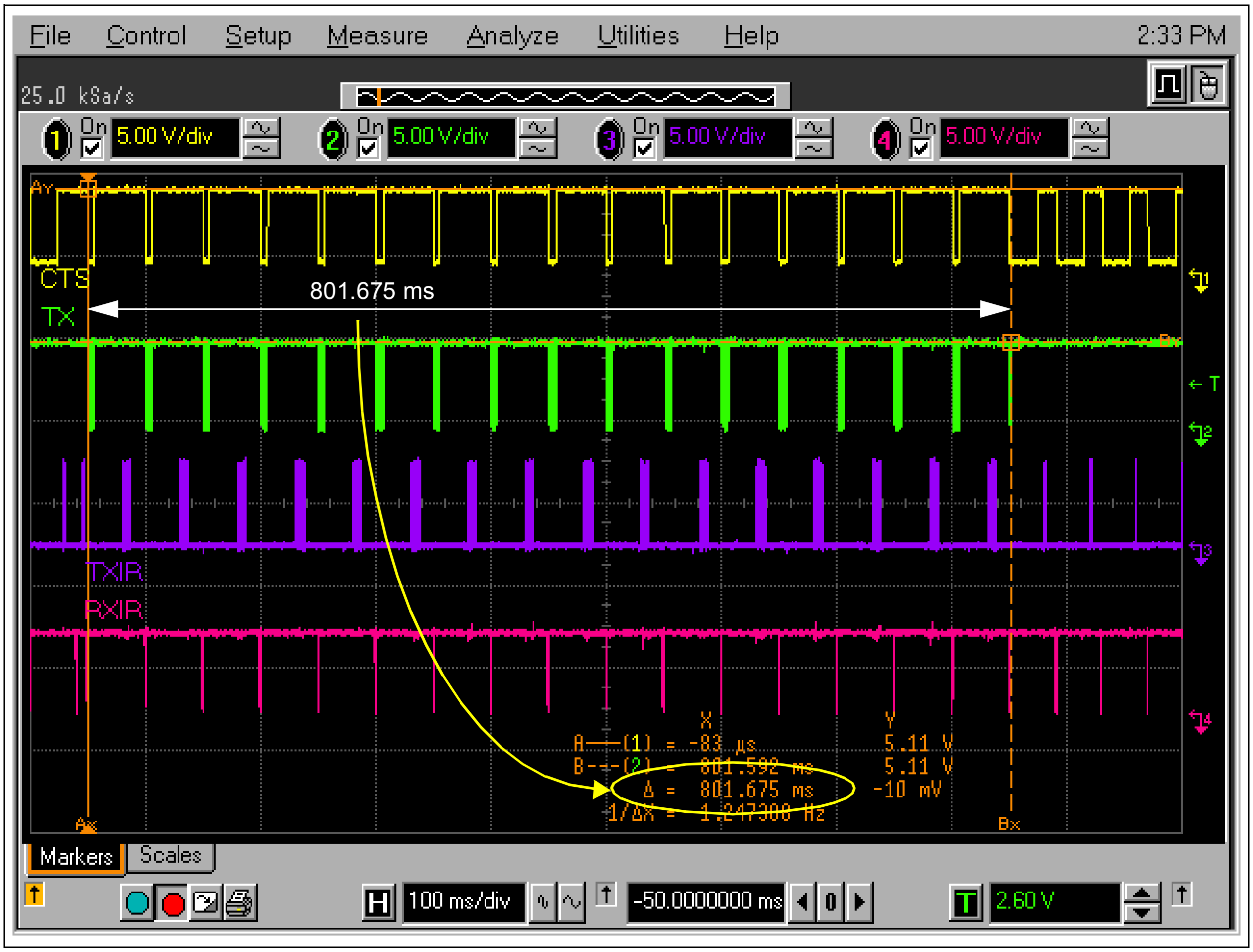


FIGURE D-2: 1000-BYTE DATA TRANSFER - TRANSMIT WHILE CTS IS LOW



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