PICMASTER™ Support of Microsoft® Windows™ DDE

The PICMASTER system supports Windows Dynamic Data Exchange (DDE). This feature allows the contents of the trace buffer to be transferred to other windows applications such as Microsoft Excel™. This feature is invaluable to control systems designers who would like to plot real-time data to debug and fine tune an application. This application note will show how to set this up and graph system data.

THE TRACE BUFFER

The PICMASTER contains a 8K x 40 bit trace buffer. The fields within this buffer are broken up into three categories:

(1)	Current Address of instruction	16-Bits	(**ADDRESS**)
(2)	Data/Opcode Field	16-Bits	(**DATA**)
(3)	External Logic Analyzer inputs	8-Bits	(**EXT**)
		40-Bits	

Any instruction can be optionally traced or not traced; the trace for each instruction is enabled by the "T" field on the far left column of the program memory dump window. To set up the trace buffer, do the following:

1. Select the ***SETUP->TRACE SETTINGS*** window option to set up a range of addresses to be traced. These ranges are selecting specific memory addresses that will be traced if these instructions are executed. Individual instructions can also be trace enabled / disabled with the ***SHIFT+RIGHT_MOUSE*** button
2. Open the trace window by selecting the ***WATCH->TRACE MEMORY*** menu selection.
3. Click the ***RUN*** button after opening the Run box with the ***RUN->RUN BOX*** menu selection.
4. The processor will now run. At a later time you may hit the ***HALT*** button from the Run Box.
5. You will see the trace buffer fill with instructions and data if those instructions were executed and trace enabled. If you do not see any instructions in the trace buffer, check the Trace Settings in (1) and look for loops or deadlock situations that would prevent your program from executing these instructions.

Note: PICMASTER must be running and the trace buffer open with data displaying in order to use DDE for other Windows applications (such as Microsoft Excel as described in the next section).

SETTING UP EXCEL

After starting Excel with a blank spread sheet, select 100 rows in the first column by pressing the left mouse button and holding it down to drag across all cells. Next Type the following string in the box:

=PICMASTR|'c:\path\test.hex'!'data 0 99'

and hit ***CNTRL+SHIFT+ENTER***

The format for this command is as follows:

=PICMASTR|'<***hex_file***>'!'<***string***> <***start_address***> <***end_address***>'

- <***hex_file***> represents the full path and filename of the object code file that you have downloaded to program memory. This string must match what is displayed in the PICMASTER window handle at the top of the PICMASTER window.
- <***string***> defines the group of values that you want to look at in the trace buffer. The following are the three groups of trace information:
- **ADDRESS** for opcode address (16-bits Real-time data)
- **DATA** for the opcode coding itself (16-bits Real-time data)
- **EXT** for the external logic probes (8-bits Real-time data)

EXAMPLE 1: TRACE BUFFER DATA

Trace Buffer Address		Program Memory Address	Instruction Opcode (12,14,16 bit)	Address Label	Instruction	Comments
0	:	711	425		bcf porta,0x1	;Toggle Clock
1	:	712	525	BIT3	bsf porta,0x1	
2	:	713	305		rrf porta,W	;Clock in data
3	:	714	36F		rlf 0xF	

- **RAM** for the current state of any file registers (8-bits, ***Not*** Real-time)
- **PROG** The current state of program memory (16-bits, ***Not*** Real-time)
- <***start_address***> specifies starting address location in the trace buffer to be transferred
- <***end_address***> specifies the ending address location in the trace buffer.

Note: Generally, the <***end_address***> must be greater than the <***start_address***> and the difference equal to the number of cells selected in Excel.

Hit ***SHIFT-CTL-ENTER*** and the data/opcode field values show up in the excel cells. You can now create hex values or strip off the literal encoding with formulas written for Excel.

MOVING LIVE DATA INTO THE TRACE BUFFER

Many applications would like to show trends in register values over time as the application runs real-time. For example, if the microcontroller software is using a file register **SPEED** to show the current shaft speed of a motor that the controller was controlling, the designer may want to capture the motor speed VS time when the controller is running in real-time. This can be accomplished with three different methods, two of which work with the PIC16CXX and PIC16C5X family, and all three work with the PIC17C42.

Method 1: Lookup Table (PIC16C5X, PIC16CXX, PIC17C42)

At the end of your code, add a look-up table that returns the literal value that is passed to it. This value can then be traced in the trace buffer through the DATA field and the data value stripped from the opcode. The lookup table that is added would look like the following:

```
    .                        ; Here is your code that calculates SPEED
    .
    MOVF   SPEED,W           ; Place the current value of the SPEED register into W
    CALL   TRACE_REG         ; Call TRACE_REG so the opcode is stored in trace buffer
    .
    .
           ORG (600-3)       ; This address must have bit 9 as a zero in 16C5X
    TRACE_REG                ; and must always have the ADDWF PC on address XX00h
           BTFSC    STATUS,Z ; Skip to Decrement if not zero
.T..       RETLW    0        ; if zero, return zero
           DECF     SPEED,W  ; Compensate for table offset
           ADDWF    PC       ; Jump into lookup table and return same value as W-1
.T..       RETLW    1        ; Return 1
.T..       RETLW    2        ; Return 2
.T..       RETLW    3        ; Return 3
.T..       .                 ; There are 250 RETURN instructions here -
.T..       .                 ; RETLW 4 through RETLW 0FDh
.T..       RETLW    0FEh     ; Return FE
.T..       RETLW    0FFh     ; Return FF
```

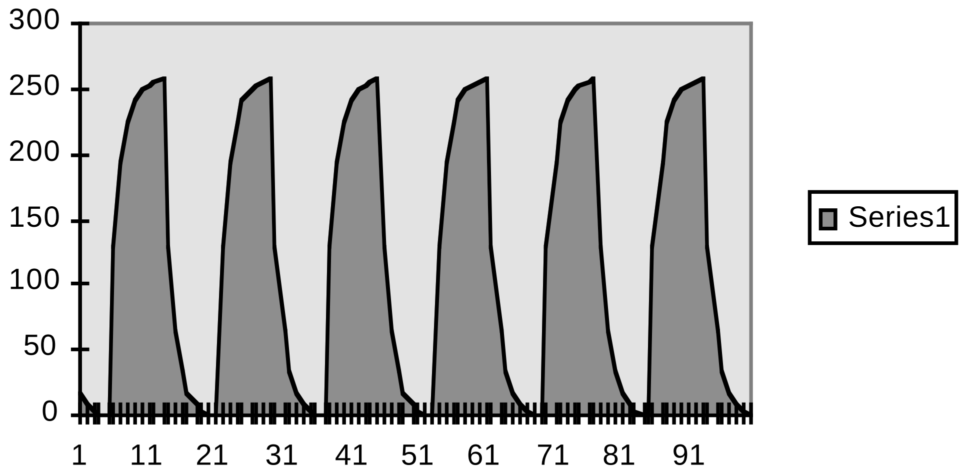
Note*:* Since the **RETLW** instruction takes two cycles and the next instruction is prefetched, the trace buffer will contain two sequential values for every value that is traced with this method. The user can strip this intervening value out with the spread sheet.

Method 2: Using the Logic Analyzer external inputs (PIC16C5X, PIC16CXX, PIC17C42).

Connect the eight logic analyzer inputs TRC<7:0> to a currently unused digital output port of the PIC16/17. Set the port direction of this port to OUTPUT and when you want to look at a value, simply move the value to the port and set the trace bit on the second instruction following the move instruction. The following example shows this:

```
    .                   ; Code Initialization
    CLRW                ; Place 0 into W register
    OPTION   Port_B     ; Make all Port B pins outputs to feed variable state data to logic inputs
    .                   ; Use MOVWF DDRB instruction in place of OPTION for 17C42
    .
    .                   ; Place where Speed variable is modified and needs to be traced
    MOVF     SPEED,W    ; Place Speed value into W register
    MOVWF    Port_B     ; Place value into Port B
    .                   ; Execute normal instruction
.T..         .          ; Trace second instruction after Port B move to capture current value
```

FIGURE 1: EXCEL SPREADSHEET EXAMPLE OF REAL-TIME PSEUDO-SINE WAVE GENERATOR



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Method 3: Using TBLWRT instruction to modify program memory (PIC17C42 only)

The PIC17C42 supports table lookup and writing features that are not supported on the PIC16CXX family. The emulator supports write operations to program memory using the TBLWRT instruction. To capture real-time RAM data, the user simply sets up the table pointers to an unused portion of program memory space and loads the current register value into the table latch. Next the user issues the TBLWRT instructiono load the data into the least significant byte of the word used for trace. A simple call to this location with the trace bit set will capture the data. The following example shows this:

ANALYSIS OF VARIOUS METHODS

Method 1 requires an additional 259 words of code space at the end of memory but does not require any external port pin connections. Method 2 requires an 8-bit port connection to the external logic input pins but does not require any additional code space. Additionally, Method 2 does not have an intervening sequential address that occurs from the two cycle RETLW instruction used in Method 1 and Method 3.

Method 3 does not require the additional code of Method 1 or the port connections of Method 2, but this is only supported on the PIC17C42.

```
      MOVLW  TRACE_HIGH    ; PlaceTRACE_LOCATION MSB into W
      MOVWF  TBLPTRH       ; Move TRACE_LOCATION MSB into Table pointer HIGH
      MOVLW  TRACE_LOW     ; Place TRACT_LOCATION LSB into W
      MOVWF  TBLPTRL       ; Move TRACE_LOCATION LSB into Table pointer LOW
      TLWT   1,0B6h        ; Place RETLW opcode MSB into Table Latch High
      TABLWT 0,0,SPEED     ; Place SPEED value into Table Latch low and write to mem
      CALL   TRACE_LOCATION; Now Call to trace the value
      .
      .
TRACE_LOCATION
.T..  RETLW  XX            ; The data in XX with reflect current SPEED value
```

CONCLUSION

Although there is no straight forward method to do this, it is practical to trace real-time file register data with the PICMASTER trace buffer.

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Note the following details of the code protection feature on PICmicro® MCUs.

- The PICmicro family meets the specifications contained in the Microchip Data Sheet.
- Microchip believes that its family of PICmicro microcontrollers is one of the most secure products of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the PICmicro microcontroller in a manner outside the operating specifications contained in the data sheet. The person doing so may be engaged in theft of intellectual property.
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