PSoCEval User Guide and Example Projects

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TABLE OF CONTENTS

Introduction to the PsoCEval 3
What Comes with my PSoCEval? 4
PSoCEval Power Supply Options.............................6
Introduction to MiniProg 7
Specifications for MiniProg 9
Operating Changes to the PsoCEval 9

Introduction to Example Projects............................10
Example #1 ADC Conversion and LCD Display 11
Example #2 Blink an LED..16
Example #3 Output a SINE Wave...19
Example #4 Dynamically Re-configure a PWM 24
Example #5 Combine PWMs using Output Logic 29

Cypress Support 32

INTRODUCTION TO PSOCEVAL

Welcome to the new exciting world of the PSoCEval!

PSoCEval allows you to evaluate what PSoC has to offer. The board includes an LCD module, potentiometer, LEDs, and plenty of breadboard space. This user guide includes five different example projects that can be used with the PSoCEval board. The MiniProg can program both the PSoC on your PSoCEval board or on a proto board you might build using a five-pin header.

The example projects can answer your questions. Want to see how PSoC can talk with an LCD? Hook up the LCD module and output your sensor's data. Curious how PSoC's dynamic re-configuration is reshaping how designers do business? Switch back and forth between different types of PWMs. Test both the digital and analog resources of our system-on-a-chip in your application.

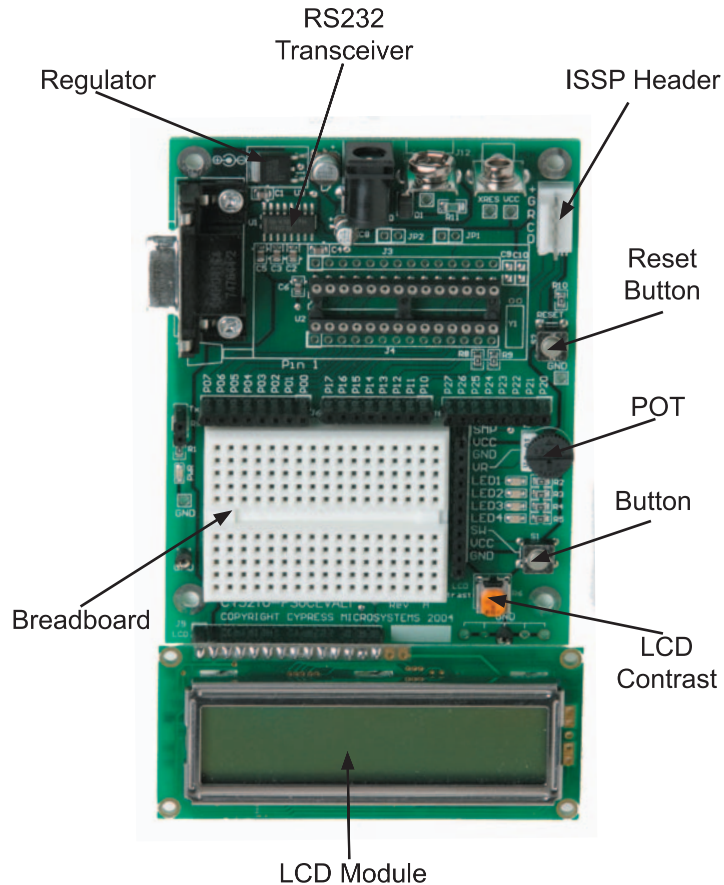
Use PSoCEval to gain insight into how the PSoC's breadth of flexibility and functionality can work for you!

WHAT COMES WITH MY PSOCEVAL?

Please confirm that your kit includes the following items:

- PSoCEval Evaluation Board
- MiniProg Programmer
- LCD Module
- CY8C29466-24PXI 28-Pin DIP Sample
- PSoC Designer CD
- USB Cable
- Wire Pack
- User Guide

For additional technical information a schematic is available online at www.cypress.com/ >> Developer Kits.



PSOCEVAL POWER SUPPLY OPTIONS

The following are PSoCEval power supply options:

1. Powered by the MiniProg unit.
2. Powered by a 9-12V DC wall transformer with positive tip barrel plug and a 100 mA or higher rating. Recommended model is CUI Inc., EPAS-101W-12.
3. Powered by a 9V battery connected to battery terminals.
4. Powered from the ICE pod in socket.

Only one of the power supplies should be used at a time. Do not use a power supply that is less than 9V or exceeds 12V.

INTRODUCTION TO MINIPROG

The Cypress MicroSystems MiniProg gives you the ability to program PSoC parts quickly and easily.

It is small and compact, and connects to your PC using the provided USB 2.0 cable.

During prototyping, the MiniProg can be used as an in-system serial programmer (ISSP) to program PSoC devices on your PCB. (See Application Notes AN2014 and AN2026 available online at www.cypress.com for more details.)

For production purposes, it is recommended that you use the CY3207ISSP programmer or a third-party production programmer.

Once the MiniProg is connected, you can use PSoC Programmer software to program. (This free software can either be launched from within PSoC Designer or run as a stand alone program.)

SPECIFICATIONS FOR MINIPROG

The operating temperature of the MiniProg is from 0° C to 50° C.

Always plug the USB cable into the MiniProg before attaching it to the five-pin header on the board.

When using an ISSP adapter cable with MiniProg, keep the length under six inches to avoid signal integrity issues.

When using MiniProg, the LEDs blink at a variable rate to track connection status. The green LED near the USB connector turns on after MiniProg is plugged into the computer and configured by the OS. If MiniProg cannot find the correct driver in the system, this LED will not turn on. After the device has been configured, the LED stays on at about a 4-Hz blink rate. This changes during programming, where the blink duty cycle increases.

The red LED at the bottom turns on when the MiniProg powers the part. The LED is off when power is provided by the target board.

OPERATING CHANGES TO THE PSOCEVAL

To use an external 32 kHz crystal oscillator, R8 and R9 on the PSoCEval board must be removed. C9 and C10 must be added, with values determined by the type of feedback desired. It is recommended that you use unbalanced feedback, with C9 at 12 pF and C10 at 100 pF. (See Application Note AN2027 online at www.cypress.com for complete details.)

To use PSoCEval at 3.3V, two parts will need to be swapped on the board: the regulator and the RS232 transceiver, shown in Figure 1. Suitable replacements or their equivalents are as follows:

Regulator:
TI UA78M33CKTPR
(Digikey 296-13425-1-ND)

RS232 Transceiver:
Maxim MAC3232CSE
(Digikey MAX3232CSE-ND)

INTRODUCTION TO EXAMPLE PROJECTS

Four Example Projects are described in the following sections. Each section is organized as follows:

Project Name: PSoC Designer project name.

Purpose: Overview of the project.

Implementation: Describes the funtionality.

Connections: Pin connections to wire up the PSoCEval board. Pictures are included to help you verify your wiring for each project.

Example Code (*main.asm*): Code to run the project.

The example projects are available in PSoC Designer. To use them, open PSoC Designer and browse to select the correct file. The example projects are found in …\Program Files\Cypress MicroSystems\ PSoC Designer\Examples. Choose the chip type you desire and open the project's .soc file (CY8C29x66 comes with the PSoCEval board).

When using the MiniEval programmer, do not use the "Connect" and "Download" buttons in PSoC Designer. Theys are for use with an In-Circuit Emulator (ICE).

EXAMPLE PROJECT #1 ADC CONVERSION AND LCD DISPLAY

Project Name: **ASM_Example_ADC_UART_LCD**

Purpose: To demonstrate the 12-bit incremental ADC by measuring the voltage of the potentiometer, transmitting the conversion result out the UART, and displaying it on the LCD.

Implementation: This project enables the LCD, UART and ADCINC12, and then goes into an endless loop.

In the loop, the ADC status (as it monitors the potentiometer) is checked. If the ADC has completed a conversion, the result is placed in "iResult" and the HEX value is transmitted out the serial port and displayed on the LCD as ASCII text.

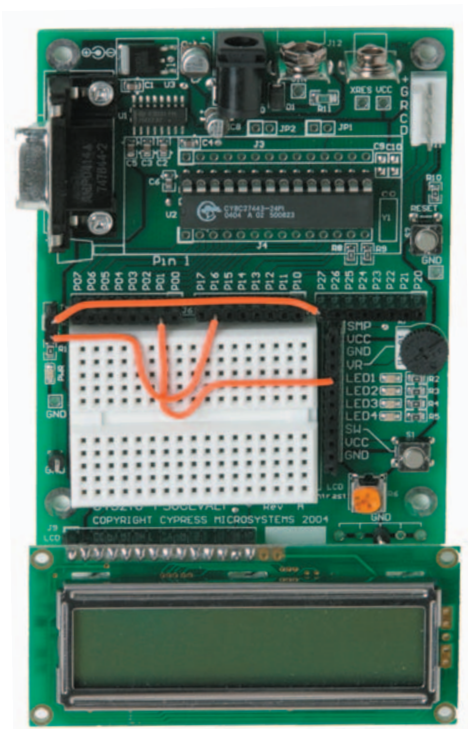
The clock divider VC1 provides a sample clock of 3 MHz to the ADCINC12, resulting in a sample rate of 180 samples per second.

The clock divider VC3 generates the baud clock for the UART by dividing 24 MHz by 156.

The UART internally divides VC3 by 8, resulting in a baud rate of 19,200 bps.

Connections:

P01 -> VR = ADC Input (0-Vdd)
P16 -> RX = Serial RX
P27 -> TX = Serial TX



Example Code (main.asm):

```
// include m8c specific declarations
include “m8c.inc”
// include User Module API specific declarations
include “psocapi.inc”

export  _main:

// inform assembler that variables follow
area    bss(RAM)
// ADC result variable
iResult:     blk 2
// inform assembler that program code follows
area    text(ROM,REL)

_main:
    mov   A, UART_PARITY_NONE
    // Enable UART
    lcall UART_1_Start

    mov   A, >sRomString1
    mov   X, <sRomString1
    // Display example string
    lcall UART_1_CPutString
    lcall UART_1_PutCRLF
    mov   A, PGA_1_MEDPOWER
    // Turn on PGA power
    lcall PGA_1_Start
    mov   A, ADCINC12_1_MEDPOWER
    // Turn on ADC power
    lcall ADCINC12_1_Start
```

```
    mov   A, 0
    // Sample forever
    lcall ADCINC12_1_GetSamples
    // Init the LCD
    lcall LCD_1_Start
    // row
    mov   A, 0

    // column
    mov   X, 0
    lcall LCD_1_Position
    mov   A, >sRomString2
    mov   X, <sRomString2

    // Display string
    lcall LCD_1_PrCString

    // Enable Global interrupts
    M8C_EnableGInt
loop:
    // If conversion complete....
    lcall ADCINC12_1_fIsDataAvailable
    jz    loop

    // Get result, convert to unsigned and clear flag
    lcall ADCINC12_1_iGetData
    mov   [iResult+1], A
    mov   [iResult+0], X
    // add 0x0800 to result
    add   [iResult+0], 0x08
    lcall ADCINC12_1_ClearFlag

    mov   A, [iResult+1]
    mov   X, [iResult+0]
```



```
    // Print result to UART
    lcall UART_1_PutSHexInt
    // Tack on a CR and LF
    lcall UART_1_PutCRLF

    // row
    mov   A, 1

    // column
    mov   X, 0
    // display result in hex
    lcall LCD_1_Position
    mov   A, [iResult+1]
    mov   X, [iResult+0]
    lcall LCD_1_PrHexInt

    jmp   loop

area    lit

sRomString1:
DS "Example ADC_UART_LCD"
db 00h

sRomString2:
DS "PSoC LCD"
db 00h

area    text
```

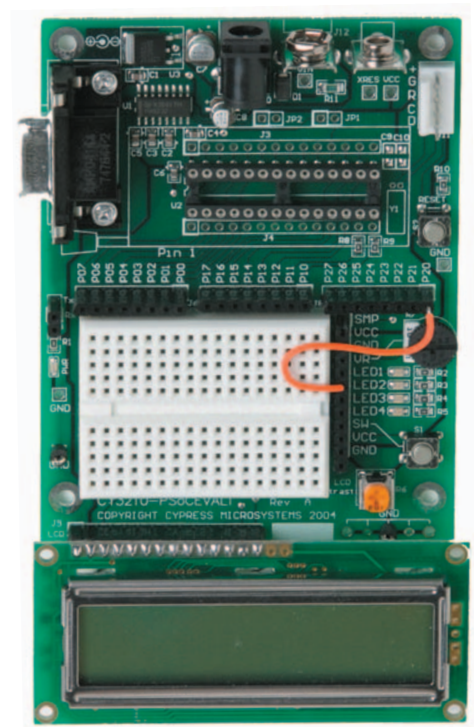
EXAMPLE PROJECT #2 BLINK AN LED

Project Name: **ASM_Example_Blink_LED**

Purpose: To demonstrate blinking an LED at a varying duty cycle using a hardware PWM.

Implementation: The clock dividers VC1, VC2, and VC3 are used to divide the 24 MHz system clock by 16, 16 and 256, respectively. The resulting 366 Hz clock is used as the input to an 8-bit PWM. This in turn produces an LED blink period of 1.4 Hz.

Connections:
P20 -> LED1



Example Code (main.asm):

```
// include m8c specific declarations
include "m8c.inc"
// include User Module API specific declarations
include "psocapi.inc"
export  _main:

_main:
    // Enable PWM
    lcall   PWM8_1_Start
    lcall   PWM8_1_EnableInt

    // Enable Global interrupts
    M8C_EnableGInt
loop:
    jmp         loop
```

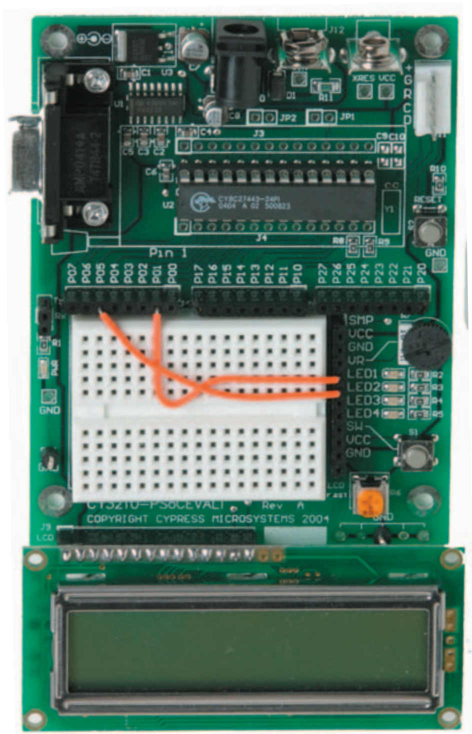

EXAMPLE PROJECT #3 OUTPUT A SINE WAVE

Project Name: **ASM_Example_DAC_ADC**

Purpose: To demonstrate a PSoC project that outputs a SINE wave using a 6-bit DAC. The SINE wave period is based on the current ADC value of the potentiometer.

Implementation: This project uses a 64-entry SINE look-up table to generate values used to update a 6-bit DAC. An 8-bit counter is utilized to generate an interrupt at the DAC update rate (1/64 SINE wave period). By adjusting the counter period, the DAC frequency and the resulting SINE frequency may be modified. The counter period is reloaded with the current ADC conversion value. The ADC input voltage may be between 0 and Vdd volts depending on the potentiometer. At higher frequencies, SINE wave jitter may be observed due to the large timing impact of a one-count change in the ADC conversion.

Connections:
P01 -> VR = ADC Input (0-Vdd)
P05 -> LED1 -> Scope = DAC Output (0-Vdd)



Example Code (main.asm):

```
// include m8c specific declarations
include “m8c.inc”
// include User Module API specific declarations
include “psocapi.inc”

export   _main
export   bADCvalue
export   bTablePos
export   SINtable

// inform assembler that variables follow
area     bss(RAM)

// Store ADC value for debug watch variable
bADCvalue:    blk 1

// Stores last table position index
bTablePos:    blk 1

// inform assembler that program code follows
area     text(ROM,REL)
_main:
    // starts DAC value update counter
    lcall Counter8_1_Start
    lcall Counter8_1_EnableInt
// Turn on PGA power
    mov    A, PGA_1_MEDPOWER
    lcall PGA_1_Start

    // Turn on DAC power
    mov    A, DAC6_1_HIGHPOWER
```

```
    lcall DAC6_1_Start
    // Turn on ADC power
    mov   A, DELSIG8_1_HIGHPOWER
    lcall DELSIG8_1_Start
    lcall DELSIG8_1_StartAD

    // Enable Global interrupts
    M8C_EnableGInt

loop:
    // if ADC conversion complete then.....
    lcall DELSIG8_1_fIsDataAvailable
    jz    loop
    // get ADC result and convert to offset binary
    lcall DELSIG8_1_cGetDataClearFlag
    add   A, 0x80
    // store value for debug watch variable
    mov   [bADCvalue], A

    // counter period less then 0x03 is invalid
    cmp   A, 0x03
    // excessive interrupt servicing
    jnc     LoadCounter
    mov   A, 0x03
```



```
LoadCounter:
    // update DAC update rate
    lcall Counter8_1_WritePeriod
    jmp   loop

area lit


// 64 entry SINE look-up table
SINEtable:
db  31, 33, 36, 39, 41, 44, 46, 49, 51, 53, 55, 56, 58,
59, 59
db  60, 60, 60, 59, 59, 58, 56, 55, 53, 51, 49, 47, 44,
42, 39
db  36, 33, 31, 28, 25, 22, 19, 16, 13, 11, 9, 7, 5, 3,
2, 1, 0
db  0, 0, 0, 1, 2, 3, 4, 6, 7, 10, 12, 14, 17, 20, 23,
26, 29

area text
```

EXAMPLE PROJECT #4 DYNAMICALLY RE-CONFIGURE A PWM

Project Name: **ASM_Example_Dynamic_PWM_PRS**

Purpose: To demonstrate PSoC's dynamic re-configuration capability by switching a digital block between a PWM8 and a PRS8 (Pseudo Random Sequence). This example project also demonstrates the advantages of using a PRS to generate a pulse width. A benefit of the PRS is that it does not generate the strong frequency harmonics of an equivalent PWM.

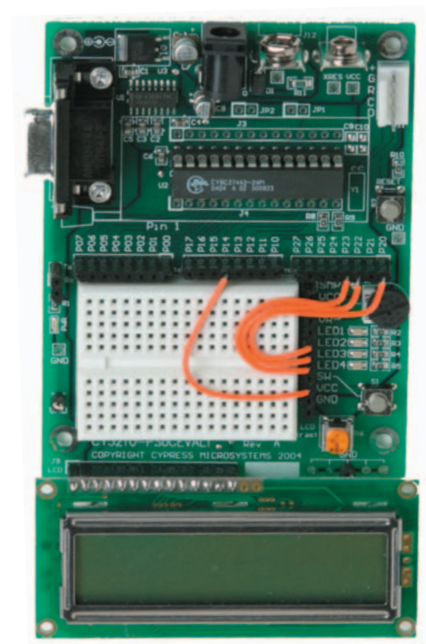
Implementation: The clock dividers VC1, VC2, and VC3 are used to divide the 24 MHz system clock by 16, 16, and 128, respectively. The resulting 732 Hz clock becomes the input to an 8-bit Counter User Module in the base configuration (this is the first configuration in PSoC Designer).

If the SW button connected on the PSoCEval board is released, configuration PWM_config is loaded and a period of two is loaded into the counter.
If the button is pressed and held, configuration PRS_config is loaded and a period of 128 is loaded into the counter.

The PWM configuration contains a standard 8-bit PWM with a duty cycle of 50%. Both the pulse width and terminal count outputs are displayed on LEDs.

The PRS configuration contains a PRS with pulse density (analogous to pulse width) and shifted bit stream output on LEDs.

Connections:
P14 -> SW   = User Button
P20 -> LED1 = PWM Pulse Width or PRS Pulse Density
P22 -> LED2 = PWM Terminal Count
P23 -> LED3 = PRS Bit Stream



Example Code (main.asm):

```
// include m8c specific declarations
include "m8c.inc"
// include User Module API specific declarations
include "psocapi.inc"
export  _main:

_main:
    // configure port pins
    and   reg[PRT1DR], ~0x10
    mov   reg[PRT2DR], 0x00

    // start clock generator
    lcall Counter8_1_Start

    // load PRS configuration
    lcall LoadConfig_PRS_Config
    jmp   PWM
PRS:
    // stop and unload PWM configuration
    lcall PWM8_1_Stop
    lcall UnloadConfig_PWM_Config
    // then load PRS config
    lcall LoadConfig_PRS_Config

    // update clock divider, don't wait for period
     reload
    lcall Counter8_1_Stop
```



```
    mov   A, 0x7F
    lcall Counter8_1_WritePeriod
    lcall Counter8_1_Start
    // configure and start PRS
    mov   A, 0x01
    lcall PRS8_1_WriteSeed
    mov   A, 0xB8
    lcall PRS8_1_WritePolynomial
    lcall PRS8_1_Start
    // load compare value, must be loaded after PRS is
     started
    mov   reg[PRS8_1_SEED_REG], 0x7F

PRSloop:
    // wait for button release
    tst   reg[PRT1DR], 0x10
    jnz   PRSloop
    // simple debounce
    tst   reg[PRT1DR], 0x10
    jnz   PRSloop
    jmp   PWM

PWM:
    // stop and unload PRS configuration
    lcall PRS8_1_Stop
    lcall UnloadConfig_PRS_Config
    // then load PWM config
    lcall LoadConfig_PWM_Config
    // update clock divider, don't wait for period
     reload
    lcall Counter8_1_Stop
```

```
    mov   A, 0x01
    lcall Counter8_1_WritePeriod
    lcall Counter8_1_Start

    // configure and start PWM
    mov   A, 0xFF
    lcall PWM8_1_WritePeriod
    mov   A, 0x7F
    lcall PWM8_1_WritePulseWidth
    // enable PWM
    lcall PWM8_1_Start

PWMloop:
    // wait for button release
    tst   reg[PRT1DR], 0x10
    jz    PWMloop
    // simple debounce
    tst   reg[PRT1DR], 0x10
    jz    PWMloop
    jmp   PRS
```

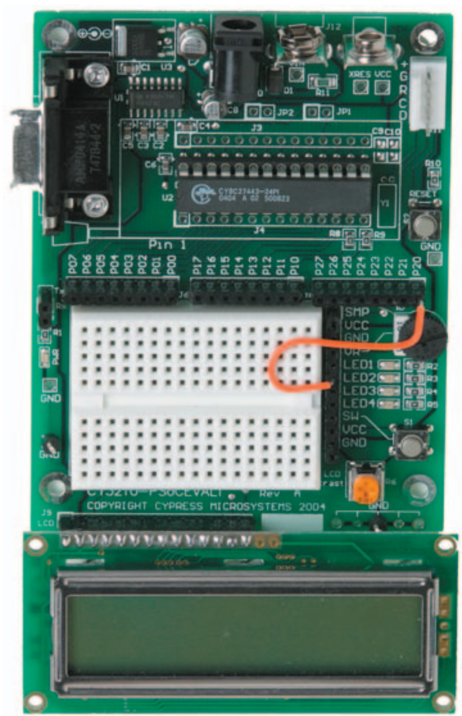

EXAMPLE PROJECT #5 COMBINING PWMS USING OUTPUT LOGIC

Project Name: **ASM_Example_LED_Logic**

Purpose: To demonstrate a PSoC project designed to blink an LED using the output of two PWMs. The outputs are combined using an AND gate in an output bus logic block. This logical combination results in a beat frequency of 1.4 Hz.

Implementation: The clock dividers VC1 and VC2 are used to divide the 24 MHz system clock by 16 and 16, respectively. The resulting 93.37 kHz clock becomes the input to the two 8-bit PWM User Modules with respective periods of 256 and 255. This produces the LED beat frequency of 1.4 Hz.

Connections:
P20 -> LED1



Example Code (main.asm):

```
// include m8c specific declarations
include “m8c.inc”

// include User Module API specific declarations
include “psocapi.inc”

export  _main:

_main:
    // Enable PWM1
    lcall PWM8_1_Start
    // Enable PWM2
    lcall PWM8_2_Start

loop:
    jmp   loop
```

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