User's Manual for COP8-EVAL-HI01

Evaluation Board for National Semiconductor's COP8™ Microcontrollers

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National Semiconductor™

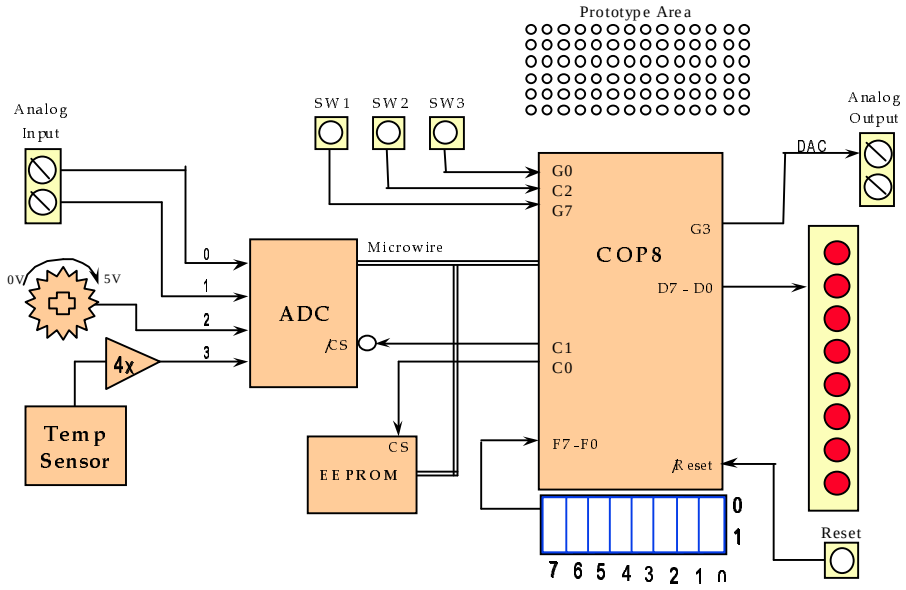
COP8-EVAL-HI01 User's Manual

Introduction:
Hilton Incorporated's COP8-EVAL-HI01 provides the Design Engineer with a low cost, proven, hardware platform for developing applications with National Semiconductor's COP8[tm] family of low cost, 8 bit, One Time Programmable (OTP) Microcontrollers. COP8-EVAL-HI01 also serves as a target environment for software code development and execution. COP8-EVAL-HI01 allows the user to execute COP8 code at full system speed, and utilize some of National's peripherals, without designing any hardware.

COP8-EVAL-HI01 Features

- R/C Oscillator with Halt Mode Support
- EEPROM
- PWM output
- Four Analog Input Channels
- Three User Pushbuttons
- Temperature Sensor
- User Accessible General Purpose OpAmp
- User Accessible Voltage Source
- Digital I/O's
- Eight display LED's
- Eight User Input Switches
- Prototype area

Block Diagram



Clocking Options

COP8-EVAL-HI01 includes a factory installed R/C Oscillator circuit. When the COP8 is driven by an R/C, the Halt Power Saving Mode can be implemented. Pushbutton #1, labeled as "SW1", can be used to bring the COP8 out of the Halt state.

Alternately, the COP8-EVAL-HI01 support's the Crystal Oscillator option. Refer to the appropriate COP8 datasheet, for values of R20, R21, C12, C13, and XT1. This would demonstrates the highest performance clocking option.

COP8Sax parts have an R/C that is internal to the microcontroller, which is fully supported by the COP8-EVAL-HI01. To utilize this feature, remove C12, C13, C2, XT1, R10, R20, R21.

EEPROM

COP8-EVAL-HI01 includes the National Semiconductor NM93C86AN, EEPROM. This allows 16,384 bits of non-volatile memory. The user can organize this memory as 1024 16-bit registers, or 2048 8-bit registers, by setting Jumper #JP1. Default configuration is 2048 x 8. EEPROM communicates to the COP8 via the three wire serial interface. Please refer to the datasheet for the NM93C86AN for details. If you are familiar with MICROWIRE, then all you need to know, is that the Chip Select for the EEPROM, is Port Pin C0. When C0 is High (C0=1), the EEPROM will be selected. Note: Make sure that bit C1 is kept High, as it is the Chip Select for another Microwire device, the Analog-to-Digital converter.

One Analog (PWM) Output

Terminal Block #2, provides access to the TIO line, after it has passed through an R/C filter. The user may wish to change the values of R14, C4, and C9; to better suite their specific needs. Default values are sufficient to demonstrate the Pulse Width Modulated (PWM) capabilities of the COP8.

If the designer wishes to use the TIO line as an input, Jumper #JP3, should be placed between pins 2 & 3. TIO is now available in the prototype area. Refer to the schematic of the COP8-EVAL-HI01.

Four Analog Input Channels

COP8-EVAL-HI01 utilizes National Semiconductor's ADC08234; 8 bit serial output, Analog-to-Digital Converter, with Four Channel Multiplexer. Channels #1 & #2, are provided for the user at Terminal Block #1. Channel #3, is connected to the potentiometer; R13. Channel #4, is connected to the output of an Op Amp, providing four times gain for the Temperature Sensor (LM35).

Three User Pushbuttons

Input switches are provided, to allow customer software to read push button inputs. These "Normally Open" pushbuttons provide a "1" to their appropriate input pins. When depressed, they provide a "0." Be certain that your software configures these pins as inputs.

SW1 connects to Port Pin G7, can be used for general purpose, or to demonstrate HALT mode. SW2 connects to the C2. SW3 connects to G0, can be used for general purpose, or to produce an interrupt.

Temperature Sensor

COP8-EVAL-HI01 uses National Semiconductor's LM35, thermal transducer, providing voltage output proportional to ambient temperature. This voltage passes through a gain stage, and finally is fed to Analog Input Channel #4.

User Accessible General Purpose Operational Amplifier

COP8-EVAL-HI01 uses National Semiconductor's LM6482AIN, CMOS Dual Rail-to-Rail Operational Amplifier. One amplifier provides gain for the temperature sensor. Connections for the second amplifier; Output, In+, In-; are provided for the prototype area. Please refer to datasheet for the LM6482 for details.

User Accessible Voltage Source

R13, 10k potentiometer, provides voltages from 0 to 5 Volts. The "output", or wiper voltage is the input to Channel #3, of the ADC.

Digital I/O's

All 40 pins, of the COP8, are readily accessible at the prototype area for design expansion. Care needs to be taken, because many of these are used elsewhere on the PCB. The user may choose to "depopulate" areas of the COP8-EVAL-HI01, to meet special needs. Refer to the schematic for the COP8-EVAL-HI01.

Eleven spare I/O lines are dedicated to the prototype area. These come directly from the COP8. These are L0-L7, G1, G2, C3.

Eight display LED's

COP8-EVAL-HI01 drives eight LED's directly, to allow visual inspection of Port D. When a Port Pin is pulled Low, an LED will light.

Eight User Input Switches

COP8-EVAL-HI01 includes SW5, an eight position DIP Switch. Each switch has an individual pull-up resistor. When switch is open, in the "Off" state, the Port Pin will be pulled high. To avoid confusion, the PCB is marked to indicate that when the switch is physically opened, a logical "1" appears at the input pin, implying the "On" state.

Prototype area

Over 10 square inches of 0.10" x 0.10" spaced holes, allow users to implement additional circuitry, not provide by the above features of the COP8-EVAL-HI01. Solderless breadboard (Radio Shack #111-#276-175 or similar) can also be accommodated. The four mounting holes are provided for that purpose.

Jumper Settings

There are five, Three-Position jumpers on COP8-EVAL-HI01, labeled "JP1" through "JP5." The default settings for all jumper blocks, is with the shunt between pins #1 and #2.

JP1 - EEPROM Organization
Default position organizes the EEPROM as 8 bit wide data. Jumper shunt to Pins #2 and #3, forces organization by 16.

JP2 - Reference Voltage for Analog-to-Digital Converter
Default position sets the ADC voltage reference to 5.0 Volts. Each of 256 steps, of the ADC output, is approximately 20mV. Moving the shunt between pins #2 and #3, the reference voltage is 2.5 Volts. Each step is then valued at 10mV.

JP3 - TIO (Timer Input/Output) Selection
Default position sets TIO as an output, connected through R14, C4, C9. These passive components filter the output. For digital output, from TB2, remove C4 & C9, and replace R14 with a wire jumper.

To use TIO for input, move shunt between pins #2 & #3. Connect G3 (TIO) at the prototype area. For digital input at Terminal Block #2 (TB2), remove C4 & C9, and replace R14 with a wire jumper. Refer to the schematic for details.

JP4 - Clocking Options, R/C or Crystal
In the default setting, COP8-EVAL-HI01 uses the R/C circuit. When using the Crystal Oscillator, move the shunt between pins #2 and #3. This will disconnect SW1 from G7. To utilize SW1, while using a crystal, refer to the schematic. SW1 can be connected to an unused input.

JP5 - COP8 ICC
VCC is connected to the COP8, through JP5. Completely remove the shunt, and place an Ammeter between Pins #1 and #2. You can now measure how much current (ICC) that the COP8 is drawing.

Jumper	Default (1&2)	Option (2&3)
JP1 - EEPROM Organization	2048 x 8	1024 x 16
JP2 - Voltage Reference	5.0V	2.5V
JP3 - TIO Selection	Output	Input
JP4 - Clocking Options	R/C	Crystal
JP5 - COP8 ICC	Normal	Open

Developing Applications using COP8-EVAL-HI01

Introduction

Many applications can be designed, tested, and demonstrated using the COP8-EVAL-HI01 Board without any additional hardware. This section provides the designer with detailed information, necessary to utilize the peripherals on COP8-EVAL-HI01. Refer to the schematic, included in the Appendix. Please refer to the appropriate datasheets for all components utilized.

DIP Switches - Eight User Input Switches

SW5 provides an eight position DIP Switch. These switches are mapped to Port F. Each switch is pulled up, through a pull up resistor, and shorted to Ground when closed. (Depending on which COP8 devices you are using, R2 may not be needed.) This implies that when a switch is in the "open" position, the corresponding Port pin will be pulled "high." The silk-screen on the PCB indicates a "1" or "0" to avoid confusion. The "Off" marking is physically on the switch, which again, denotes a "1" at the Port pin. Be certain to configure this Port as an Input.

Eight display LED's

These LED's are connected to Port D. COP8-EVAL-HI01 drives these eight LED's directly, to allow visual indication of the independent states of this Port. When a Port pin is pulled Low, an LED will light. When writing software, be certain to configure this Port as an Output.

Pushbuttons

COP8-EVAL-HI01 includes four User Pushbuttons. Each pushbutton is normally-open, and pulled "high." When pressed, the corresponding Port pin is driven "low."

SW1 is an Input to Port Pin G7. This is also the Halt Pin. Note: If you populate the Crystal Clocking option, SW1 must be disabled via jumper JP4. (Refer to Jumper Settings.) However, SW1 can be rewired to the prototype area. When demonstrating "Halt Mode", SW1 holds the pin "high", and is driven "low" when pressed.

SW2 is an Input to Port Pin C2. Be certain that software initializes this pin as an Input.

SW3 is an Input to Port Pin G0. Be certain that software initializes this pin as an Input..

SW4 is used to RESET the COP8.

Microwire Peripherals

COP8-EVAL-HI01 hosts two peripherals on the Microwire bus, as well as additional peripherals that may be designed in the Prototype Area. Most important, are the Chip Select lines for the Analog-to-Digital Converter (ADC) and the EEPROM. If these are both enabled at the same time, communication will not occur. Chip select for the ADC, is Port Pin C1, active low. Chip select for the EEPROM, is Port Pin C0, active high. User software must be certain to configure these port pins as Outputs, and guarantee that they are not both "active" at the same time. It is recommended that both peripherals remain disabled, until they are required for communication. This will ensure proper operation.

Please refer to the datasheet for the ADC08234 for specifics of the Microwire interface. The connections to the multiplexer are as follows:

Channel 1 is User Input 1, found on terminal block TB1.
Channel 2 is User Input 2, found on terminal block TB1.

Channel 3 is fed from the wiper of potentiometer, R13, also marked as IN3 on the PCB. This voltage can vary from 0 to 5 volts. The reference voltage to the ADC can be changed to 2.5 Volts, by utilizing JP2.

Channel 4 is used to read the Temperature sensor, LM35. The sensor output is 10mV/C. This output is amplified, by a gain of 4, through U5, providing 40mV/°C. With VREF (the reference at the ADC) set to 5 Volts, each step of 256 is about 20mV. This means that each count of the ADC corresponds to 0.5 C. Moving the jumper to 2.5 Volt reference, set each step to 0.25 C.

Timer Input & Output

When used as an Output, this pin generates Pulse Width Modulated (PWM) waveforms. When used as an Input, this pin can be used for Capture Mode, or Timer Input Mode. JP3 determines the use of this Port Pin, G3.

With JP3 in the default position, G3 is used as an output, to generate PWM. This waveform is passed through an R/C filter, to generate an analog voltage between GND and VCC. The user may wish to change the values of R14, C4, and C9; to better suite their specific needs. Default values should be sufficient to demonstrate the Pulse Width Modulated (PWM) capabilities of the COP8. The filtered output can be found at terminal block 2, marked TB2.

If the designer wishes to use the TIO line as an input, Jumper #JP3, should be placed between pins 2 & 3. Connection to TIO, must be made in the prototype area. Do not connect the input to TB2. If you refer to the schematic, in the Appendix, you will see the R/C filter at TB2. COP8-EVAL-HI01 can easily be modified to accommodate TB2 for use as an input, by removing the capacitors (C4, C9), shorting R14, and leaving JP3 in the default position (between pins #1 & #2).

User Accessible General purpose OpAmp

COP8-EVAL-HI01 uses National Semiconductor's LM6482AIN, CMOS Dual Rail-to-Rail Operational Amplifier. One amplifier provides gain for the temperature sensor. The second amplifier is provided as a spare for the design engineer. Pins for the Op Amp; Output, In+, In-; are clearly labeled on the Printed Circuit Board (PCB). Connect wires from these pins, to the prototype area, if you need a single Op Amp. Please refer to datasheet for the LM6482 for detailed specifications.

Digital I/O's

Eleven spare I/O lines are dedicated to the prototype area. These come directly from the COP8. These are L0-L7, G1, G2, C3. Using these I/O pins in the prototype area will maintain compatibility with DEMO software, that may exist for the COP8-EVAL-HI01. All 40 pins, of the COP8, are easily accessible at the prototype area, for design expansion. Care needs to be taken, because many of these are used elsewhere on the PCB. The user may choose to "depopulate" areas of the COP8-EVAL-HI01, to meet special needs. Refer to the schematic for Port Pin Assignments.

Prototype area

Over 10 square inches of 0.10” x 0.10” spaced holes, allow users to implement additional circuitry, not provide by the above features of the COP8-EVAL-HI01. A solderless breadboard (Radio Shack #111-#276-175 or similar) can also be accommodated, by the four mounting holes provided .