Introduction

This paper outlines the hardware for the METCON-1 module. Refer to the TAPR METCON OPERATIONS GUIDE for information about what METCON-1 can do and how you can control it.

Circuit Description

Microcomputer

IC1 (87C51) is the microcomputer that runs METCON-1. Y1, C2 and C3 provide the clock frequency of 11.0592 MHz. C4, an optional variable capacitor, can be installed to net the crystal exactly onto frequency to ensure that the Time-Of-Day clock is accurate.

R1, C1, R2 and D1 form the reset circuit. This circuit provides power up reset as well as a reset anytime a short is placed on the optional P2 plug.

P3, a shorting plug connected to the pulled up interrupt 0 signal, is used to signal IC1 that the user wants SYSTEM ADMINISTRATOR privileges. When this plug is open, users are restricted from reading and writing the restricted area of the user's memory. The interrupt function of this pin is disabled; it functions as a simple bit input port.

The METCON-1 firmware allows the user to configure Port-0 and Port-2 as input or output, on a bit by bit basis. The default is that Port-0 is used for inputs and Port-2 is used for outputs.

METCON-1 hardware is configured to use these defaults. However, if you wanted to, you could configure METCON-1 to have 16 bits of output, 16 bits of input, or any combinations thereof.

An additional note about Port-0 is that this port, unlike the other 8051 ports, doesn't include internal pull-ups. So, if Port-0 is used for output, there must be an external pull-up for Port-0 if the external circuit doesn't source current to the 8051.

Port-1 and Port-3 are configured for special purposes and cannot be changed by the user. Port-1 is used to control the VTF multiplexer, the EEPROM and an optional outboard A/D converter. Port-3 is used for serial port (RXD, TXD, WR, RD), VTF input (T0), and system administrator switch (INT0).

Serial Port

IC2 (MAX232) provides RS-232-like drivers and receivers for the serial port. IC2 includes an oscillator, voltage doubler and inverter to generate +/- 10 VDC for the RS-232 output drivers. The RS-232 level signals from IC2 are connected to P1.

Sensor Inputs

Sensor input signals are applied to METCON-1 via J1. The connectors are optional. Some users may want to solder their sensor wires directly to the board for a cost savings or better reliability. However, soldering will be less convenient.

Each line is pulled up to +5 volts by 2.2K ohm resistors within SIP1, a single 8-pin SIP package.

Each signal passes through a 100K resistor before being applied to the input of IC3 (74HC14). The purpose of the 100K resistors is to protect IC3 from damage during overvoltage input conditions. Capacitors from the inputs of IC3 to ground are provided to improve immunity to Radio Frequency Interference (RFI). These capacitors are omitted from channels that will act as frequency counters.

The output signals from IC3 pass through a 4.7K resistor before going to Port-0 of IC1. The purpose of the 4.7K resistors is to protect IC1 in case the user has inadvertently configured IC1 to have Port-0 as outputs. The 4.7K resisters limit the current flow into IC1 to less than 1.5 mA during this condition.

The sensor inputs connected to J1 should not source current of their own. METCON-1 should be the only source of current flow through the sensor signal.

The inputs on J1 can either be dry switch contacts or the outputs of opto-isolators.

Frequency Counter

METCON-1 includes a frequency counter to measure the frequency from voltage-to-frequency converters. The same input buffers that provide signals to Port-0 of IC1 are also sampled in round-robin fashion to measure frequency.

IC4 is a multiplexer used to select the current input to be measured for VTF applications.

Interrupt firmware within IC1 causes it to select a new sensor input every second and measure the number of transitions on that input for almost exactly one second (about 10 uSec of the 1 second is used for changing the multiplexer address). The number of transitions during that 1 second period is the frequency. That value is then written to memory for the user to read and the next multiplexer address is selected.

Relay Outputs

Port-2 is connected to IC5 (7407) which drives relays directly. The diodes across the relays are used as "snubbers" to ensure that the voltage kick generated by a relay

when it's de-energized doesn't damage IC5 or other signals on the power bus.

Power

Input power of +8 to +15 volts is applied to J4.

C15 is used for RFI filtering. D1 protects from reversed power without forcing an external fuse to blow every time reverse power is applied. C16 provides a bulk filter capacity to help smooth out any ripple or perturbations of the power source.

IC7 (LM340-5 or LM7805) provides a regulated +5-volt power source for the ICs on METCON-1. C17 through C20 provide filtering of the +5-volt power bus.

Non-volatile Memory

IC6 (9306 or 9346) is a 256-bit EEPROM in an 8-pin package and is used for non-volatile memory. IC6, when installed, can be used to save the current system options and relay output settings. Following a reset or power-on, if the EEPROM is present and the data is correct (protected by checksum) the EEPROM data will be used to initialize the METCON-1 module.

Analog-to-Digital Converter Interface

An eight channel ADC0838 Analog-to-Digital Converter (ADC) can be connected to METCON-1 via P4. Each of the eight channels are sampled in round-robin fashion and the 8 bit value is stored into memory for the user to read.

Unlike the VTF inputs that are interrupt driven on a very accurate schedule, the A/D inputs are part of the "polled loop". Typically, one channel is sampled every 100 mSec. That means that it takes 800 mSec for all eight channels to be sampled (or about once a second). The firmware assumes that the ADC is always present and will try to access it, even if it isn't in the circuit.

If the ADC module is not connected to P4 then the values at the A/D memory addresses are undefined, but no damage will occur to METCON.

Notes

If a binary digital input is used as a frequency counter input then this RFI bypass capacitor must be removed from the circuit. Otherwise, signals above several hundred Hertz will be inaccurately counted.

This document was written by Paul Newland, AD7I, and edited into its present format by Brian Kassel, W5VBO, and Lyle Johnson, WA7GXD.