METCON

A SIMPLE TELEMETRY AND TELECONTROL SYSTEM

Operations Guide

(Ver 990321-0.04

0   TESTING ISSUES

Here's a quick list of what should work, not work, etc for the development version of METCON-2 firmware dated 981210.

0.1   WHAT SHOULD WORK

- Basic Bit Read, Bit Write, Memory Map Display, Clock, Fast upload and download, SYSADM switch on standard input port bit 7, login, logout, password stuff, RS-232 signals, auto logout with DCD, new buad rate option command, new mode option command, watch dog timer.

0.2   WHAT DOESN'T YET WORK

- Alarm set comamnd
- Command to electronically power down the system (and power up from RTC interrupt)

0.3   WHAT HAS BEEN IMPLEMENTED BUT NOT TESTED

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0.4   STUFF TO ADD/CHANGE IN DOCUMENT

- Add feature to set, clear, display to have it also work with just one digit, so that it's a quick address to the first port.

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- Say something about what/when to save parameters to EEPROM, do so in examples for security settings
- For all references to RS-232 cable/connector reference 9 pin and 25 pin connectors.

1 INTRODUCTION

This document outlines METCON a telemetry and control system. METCON[1] allows a user, via a serial port, read and control external electrical signals. This paper outlines the operator's guide for METCON-2. A companion paper outlines the system hardware. METCON-2 is a system composing at least two PC boards, the TUC52 CPU board and the METCON-2 interface board. METCON-2 is the replacement for TAPR's original METCON system (now called METCON-1). For the remainder of this document the term METCON refers to METCON-2 and METCON-1 will refer to the original METCON-1 system.

At it's most basic operation METCON can enable or disable 8 current sink outputs and read 8 binary inputs (switches and other slowly changing on/off devices). Additional METCON-2 features include time-of-day clock stamping of all messages from METCON, automatic system status display every 15 minutes (or every minute for testing), automatic display of input status whenever a state change occurs for any binary input. Advanced features include a frequency counter for each of the 8 binary input channels (0 to 10 kHz with 1 Hz resolution), an accumulating pulse counter for each of the 8 binary input channels (alternative function to the frequency counter), an 8 pin dip EEPROM to save parameters other than default conditions and an interface to an external eight channel Analog-to-Digital Converter (ADC) board.

METCON is designed to be connected to a PC via either direct hardwire connection, through a dialup (or nailed up) telephone modem, or via a packet radio link.

1.1 EXAMPLE APPLICATIONS

Telemetry is the ability to read sensors from a remote location. For example, imagine a repeater site on a mountain top. The control operator of the repeater might be interested in knowing if the A/C power is on or off, the float voltage of the battery backup system, the temperature inside the building or inside the power amplifier compartment, and perhaps the status of a motion detector in the shack to see if intruders are, or have in the past, gained entry into the building.

Tele-command (or control) is the ability to control devices at remote location. Citing the example above, suppose that the A/C power at the repeater is off and the battery float voltage has dipping toward low levels. The control operator might want to switch to low transmit power to save batteries. This would be an example of control.

One way of controlling such functions is through a commercial repeater controller. Another would be to use a packet radio system to communicate with a METCON module located at the remote site.

1.2 VERY QUICK START

If you just want to plug it in and see if it's working, then do the following. Start up a terminal emulator at 1200 bps on your PC. Connect your PC to the DCE connector on METCON. Carefully remove the 8 pin EEPROM (typically a PCF8582) from the TUC52 board at IC 10, thus ensuring the system will use default parameters. Apply a short from standard input 7 to ground (from TB3-9 to TB3-10) to enable System Administrator mode. Apply power to the METCON system. You should see a sign-on message and some EEPROM error messages. Connect a shorting shunt to H23 on the METCON board. Type the command "=AWB0471 {ent}" on the keyboard[2]. This will cause the output on Port 4, bit 7 to go active (low). You will now see that the METCON's LED is on. Type the command "=AWB0470 {ent}" on the keyboard

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[1] METCON is a contraction of teleMETry and teleCONtrol.

[2] {ent} means press the Enter key on the PC keyboard, in ASCII it's a CR

and you will now see that the LED is off. If you got this far turn off the power, reinstall the EEPROM and continue reading the manual.

1.3   A GOOD SUGGESTION

Most all the data you need should be in this document. Save yourself some time. Get a highlighter pen and use it while reading the rest of the document, marking the items that seem of interest to you. All the info you may need should be in this document. If not, let us know and we will update it.

2 METCON FUNCTIONS AND FEATURES

The METCON system consists of a TUC52 CPU module which is comprised by an 8032 CPU, ROM, RAM and two 82C55 parallel I/O ports. The microcomputer includes a UART[3] serial port that's connected a PC via your communications link (wire cable, land-line modem, packet radio modem). Once your packet station is connected to the remote system you can send and receive data with METCON. When you give METCON a command you are either writing to a locations in METCON's memory map or reading and reporting a location from METCON's memory map. You do not read and/or write directly to METCON's ports. Instead, as a background process, METCON's firmware moves portions of the memory map to the output ports and moves data from the input ports to portions of the memory map that you can read. Simple single line commands are used to read and/or write METCON's memory map. The user, by reading from and writing to METCON's memory map, controls METCON functions.

METCON in the basic form as 8 binary outputs and 8 binary inputs. These are provided via the first 82c55 on the TUC52 board.

2.1 CURRENT SINK OUTPUTS

The 8 binary outputs come from port A on the first 82c55 of TUC-52 . These outputs pass through open collector drivers that can safely drive loads that provide an open circuit voltage of up to 20 volts and draw no more than 100 mA when active. There are plans for a MULRLY (multiple relay) board that will provide form C contacts (SPDT) from 8 relays that can be easily connected to the METCON-2 interface board. This MULRLY board does not exist at this time.

2.2 DRY CONTACT INPUTS

The 8 binary inputs are provided by port B on the first 82c55 of TUC-52. These inputs are pulled to plus 5 via a 2.2 K ohm resistor plus they pass through a 100 K ohm resistor before then passing through in inverter and then on to the 82c55 B port. Because of this resistor network at the input, the allowable input range of voltage is +20 VDC to –20 VDC with a "high/low" switching threshold of about 2.5 VDC. Additionally, because of the 2.2 K ohm pull up resistor, dry contact switches to ground can be connected directly to the METCON-2 input circuits. Loop current is provided by METCON, the only thing you need to add is a switch or other binary sensor. These sensors could include magnetic reed switches, motion detectors, etc. Many sensors are available from many sources[4].

2.3 FREQUENCY COUNTER

Each of the above described binary inputs are also multiplexed to a timer on TUC-52 that is configured as a frequency counter. Each input is "monitored" by the frequency counter for 1 full second and the resulting count is stored at a particular location in the memory map. At the en of the monitor period that input is ignored by the frequency counter for 7 seconds while the other remaining 7 inputs are monitored. The the first channel will again be monitored, and so on, round-robin fashion. The primary use of this frequency counter feature is to montor the output of voltage-to-frequency (VTF) converters. VTF converters offer several advantages over Analog-to-Digital Converters (ADC). One advantage of VTF is that the signal to be measured can be converted to a frequency at the source. The audio signal (0 to 10 kHz) can then be transmitted over wires (or radio for that matter) to the METCON module where the

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[3] UART stands for Universal Asynchronous Receiver and Transmitter

[4] Sources for magnetic reed switches include MOUSER ELECTRONICS (800-346-6873) and RADIO SHACK.

frequency is captured and stored in memory for remote access. Additionally, the signal can be passed through a simple opto-isolator to provide a large voltage isolation capability between the signal source and the METCON module. The digital 5 volt square wave signal from a VTF module has high noise immunity from induced voltage hum. There could be up to 0.5 VACrms of 60 Hz hum on the line but the "digital" frequency counter on METCON won't respond to signals less than 2 volts peak-to-peak. Also, it's unlikely that external noise induced into the wires would convert a 2360 Hz signal to 2130 Hz. However, the analogous situation for Analog-to-Digital Conversion doesn't fair so well. Consider the likelyhood of transmitting a 0.236 VDC signal down a 500 foot run of telephone wire and having a digital voltmeter at the other end read a stable 0.236 volts? Probably not good; especially when the air conditioning compressor motor starts up, or the refrigerator starts up, or ... well you get the idea. The down-side of VTF is that typically you don't get as many updates per unit time as you would with ADC. However, the METCON system isn't designed to take 50 samples per second. Since it can only acquire and transmit a few samples per second ADC offers few advantages over VTF.

2.4   CUMULATIVE PULSE COUNTER

METCON can be configured, on a per input basis, to disable the frequency counter and instead enable an accumulating pulse counter. This can be advantageous in some applications.

Some transducers, such as a dripping rain gauge, require the telemetry unit to count the total number of pulses over a long duration of time. The frequency counter inputs are not suitable for this function for two reasons. First, the frequency is measured only 1 second out of every 8 seconds. The user can not safely assume that the number of pulses received during the other 7 seconds is simply 7 times the number of pulses received during the one second observation period. Second, the frequency measured can not be reported to the host frequently enough so that every measurement is captured. Consequently, flag bits have been added, that when set, will cause the frequency counter operation on a particular input channel to be suspended and an accumulating pulse count substituted in its place.

When a pulse counter flag for a particular channel is set, the frequency counter operation for that channel is inoperative. Instead, the input is sampled every 20 milliseconds. If a transition from high to low is detected between consecutive samples, the frequency counter register is incremented by one. This is a totalized count. To reset the counter the pulse counter flag for that input must be cleared so that the frequency counter becomes operative again for that input. Within 8 seconds the frequency counter function will zero the counter (assuming the frequency at the input is less than 1 Hz). Because the pulse count input is sampled, any pulse that doesn't exceed 20 ms in duration (high or low) may not be registered.

2.5   ANALOG-TO-DIGITAL CONVERTER (ADC)

For most users VTF systems will meet there needs for measurement of analog signals. However, there are some advantages of using an Analog-to-Digital Converter (ADC) so METCON is programmed to accept signals from a National Semiconductor ADC0838C Integrated Circuit (IC). TAPR has an ADC module available that uses this part..

2.6   CLOCK

METCON provides a battery backed time of day clock that is used to provide time stamps on all messages. Additionally, the clock can be used to set an alarm to power up METCON at some future time.

2.7   SERIAL EXPANSION I/O

There are serial expansion boards proposed for METCON that can provide an additional 32 binary inputs and 32 binary outputs. That functionality has not yet been provided for the system.

3   CONNECTING METCON TO YOUR PC FOR INITIAL TESTING

Need to ensure that

1. Correct Rom is installed on TUC52.
2. Correct headers are installed on TUC52, METCON2
3. Connect METCON-2 to PC running terminal emulator like figure shown below

Pull in data from section 1.2
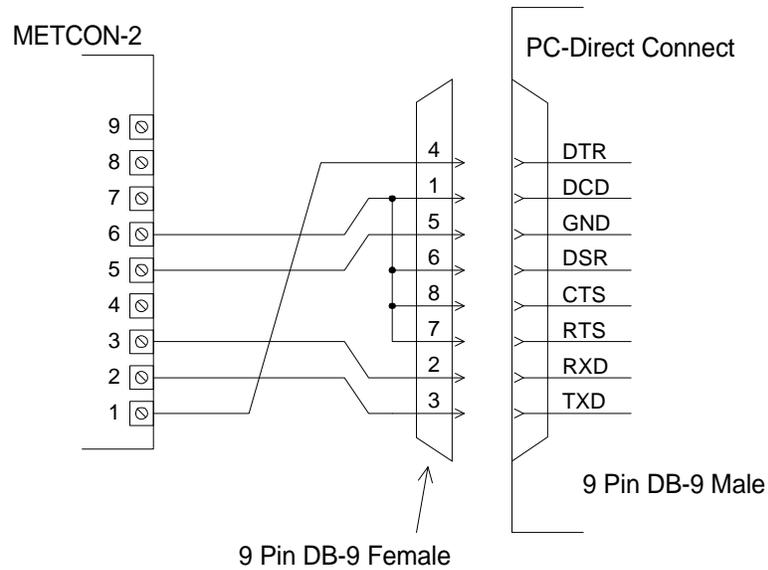
4   USER INTERFACE

METCON provides a simple command structure to allow the operator to read and write areas of memory where METCON port information is stored. Reads can take place on a bit, byte or word basis. Word reads are done with checks to ensure that the data is not mis-phased because of interrupt processing. Writes can be done using a bit or byte mode. Writes can take place on a bit or byte basis. There is no word write mode.

4.1   COMMAND STRUCTURE

Commands must begin on a newline (i.e., followed by an ASCII CR character). They must begin with an equal sign (=) as the first character on the line. Immediately following the equal sign is a single character that represents the station address[5]. The default value for station address is "A". Immediately following the station address is the command character. The remainder of the command line can vary depending on the nature of the command. The table below shows the various commands available.

4.2   COMMAND SUMMARY – BIT CONTROL

Memory Map Read/Write Bit, Byte & Word Comands

```
=sRBaab    READ STN s, ADDRESS aa, BIT b           Read Bit
=sWBaab    WRITE STN s, ADDRESS aa, BIT b          Write Bit
=sRYaa     READ STN s, ADDRESS aa,                 Read Byte
=sWYaadd   WRITE STN s, ADDRESS aa, DATA BYTE dd   Write Byte
=sRWaa     READ WORD OF STN s, ADDRESS aa          Read Word

Quick Commands, Reserved for future implementation

=sDb       DISPLAY STN s, ADDRESS 09, BIT          Bit Display
=sSb       SET STN s, ADDRESS 04, BIT b            Bit Set to 1
=sCb       CLEAR STN s, ADDRESS 04, BIT b          Bit Clear to zero
```

4.3   COMMAND SUMMARY – GLOBAL FUNCTIONS

```
=sM          SHOW CURRENT FORMATTED MEMORY MAP DISPLAY OF STN s
=sV          SHOW CURRENT VERSION AND SIGNON MESSAGE OF STN s
=sZ          ZAP ALL CHANGE INPUTS FLAGS BACK TO ZERO OF STN s
=sEW         WRITE STATUS AND OUTPUT MEMORY TO EEPROM
=sER         READ STATUS AND OUTPUT VALUE FROM EEPROM
=sED         SET DEFAULT STATUS AND OUTPUT VALUES
=sLIxxxxxx   LOGIN USING PASSWORD xxxxxx (XXXXXX IS SIX HEX CHARS)
=sLO         LOGOUT
=sT          READ/SET TIME-STAMP CLOCK


Reserved for future implementation

=sA          READ/SET ALARM CLOCK
```

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[5] The station address values can range from "a" to "z". The use of a station address allows several METCON units to share one communications channel via a simple "wired-OR" via diodes of their RS-232 transmit lines. Since each station can be configured to speak only when spoken to, this is a simple way to add more I/O capacity to a particular site (or allow for redundancy).

```
        *** is this below correct?   Should be =sEW???
        =sSAVE          SAVE RESTRICTED MEM and OUTPUT USER MEM TO EEPROM
```

4.4   COMMAND ARGUMENTS AND VALUES

Addresses (aa) and bit positions (b) are always in hex (base 16). Output is always in base 10 followed by base 16 followed by base 2. Word reads are always protected from phasing errors (an example of a phasing error is when an interrupt routine updates a RAM memory address at the same time a non-interrupt routine is reading the same address).

4.5   COMMAND EXAMPLES

To set TX Port 4 bit 3 to active, enter the command
        =awb0431 <enter>   ; put station A bit address 04:3 to value 1

To read RX Port 5 bit 6, enter the command
        =arb096 <enter>   ; get and show station A bit addres 09:6

4.6   INVERTED SYSTEM

> **NOTE:**   **METCON-2 is an ACTIVE LOW system. Thus, when you turn something on by setting an output bit to "1", the electrical output actually goes LOW. Additionally, when a mechanical switch is connected to a binary input of METCON, when the switch is CLOSED the input goes LOW, an inverter on the METCON board causes the signal to be high at the into to the TUC52 82c55 input and MECON will report that port as being in state "1". So you SET a bit to enable the output (which will be LOW, current sink to ground) and you CLEAR a bit to disable the output (which will be FLOATING, no current flow). When you display an input bit that shows "1" that means the input is LOW and/or there is current flowing through the external mechanical switch. An input that displays as "0" has no current flowing through the external mechanical switch and the input will be at +5VDC.**

4.7   COMMON COMMANDS

For most METCON users, there are only three common commands: MAP, Time Clock, Quick Set, Quick Clear and Quick Display

4.7.1   Map Display

Perhaps the command of most interest is the MAP command. This command causes a formatted version
of the memory map using binary or decimal output, where appropriate The MAP command can be
abbreviated to just "m", so for station A the command is "=AM". The output is shown below.

```
=am {ent}
-A- 981211/0843/44/FRI ::  MAP DISPLAY BEGIN

ADC-TYPE    ADC-CFG     PUL1/FCTR   STAT0
0000 0000   0000 0000   0000 0000   0000 0000   SYSTEM (03 02 01 00)

TX-S3       TX-S2       TX-S1       TX-S0       TX-P4/A
0000 0000   0000 0000   0000 0000   0000 0000   0001 0001   TX     (08 07 06 05 04)

RX-S3       RX-S2       RX-S1       RX-S0       RX-P5/B
0000 0000   0000 0000   0000 0000   0000 0000   1111 1100   RX     (0D 0C 0B 0A 09)
0000 0000   0000 0000   0000 0000   0000 0000   1111 1100   RX-CHG (12 11 10 0F 0E)
---- ----   ---- ----   ---- ----   ---- ----   ---- ----
7654 3210   7654 3210   7654 3210   7654 3210   7654 3210

7     6     5     4     3     2     1     0
00000 01207 00000 00000 01207 00000 00000 00000 F/P CTRS (H:L  22:21--14:13)
00000 00000 00000 00000 00000 00000 00000 00064 ADC REGS (H:L  32:31--24:23)

-A- 981211/0843/45/FRI ::   MAP DISPLAY COMPLETE
```

The output can be considered in groups of lines. The first line group is simply the station address,
Time, and a lable "Map Display Begin".

The second line group shows the system status flags that the user may control. The bit ordering is always
right to left (just like the significance of digits on any cash register receipt), with bit 0 on the right and bit
7 on the left, as well as low digit on the right and high digit on the left. The first byte (on the right) is
labeled STATUS. You need to refer to later parts of this document to see what each bit controls. The
second byte labeled PUL1/FCTR. A one in a particular bit position of this byte changes the function of the
associated frequency counter to an accumulating pulse counter (more on this later). The third byte is
labeled ADC-CFG. This controls the configuration of the optional Analog to Digital Converter. The
fourth byte is labeled ADC-TYPE. This selects which type of ADC module is connected to METCON.
Note that for each data value on a line there is a corresponding memory map address shown on the far
right. These serve as reminders to tell you where a particular byte is located should you want to use the
byte/bit write commands to change it.

The third line group shows the status of the binary outputs. The memory map has been designed to
provide for up to 5 output ports (of 8 bits each) but only one is provided with the basic METCON system,
and that's the one on the right, TX-P4/A. The other ports (TX-S1, TX-S2, TX-S3, TX-S4) are optional
ports provided by serial expansion boards.

The fourth group shows the status of the binary input ports. Again, the port TX-P5/B is provided with the
basic METCON system. The first data line is the input data while the second data line indicates if the
input data has changed since the last time the change flags were cleared. The last line is simply an index
to help you determine the bit labeling within the above data bytes.

The fifth data group shows the values last sampled from the Frequency Counter (or Accumulating Pulse
Counters) and the ADC inputs. Realize that when an input is in frequency counter mode the value is only
updated once every 8 seconds in round-robin fashion. The Accumulating Pulse Counters are effectively
instantaneous and the ADC inputs are updated about twice every second, but again in round-robin fashion.

You can effectively "watch the system" by repeatedly issuing MAP commands.

4.7.2   TIME-STAMP CLOCK

All command responses may include a time stamp (this option is controlled by a system configuration bit).

The command to read or set the time is "=sTx", where "s" is the station address, and x is a character string of length 0 to 6. To just read the clock don't enter anything following the T. That will cause the clock report the current time of day.

To set the clock to the current year, month, and day enter "=sTyymmdd <RET>" where "yy" is last two digits of the current year; where "mm" is the two digits of the current month; where "dd" is the two digits of the current day. The string "yymmdd" must have six characters -- use zeros where necessary.

To set the clock to the current hour and minute enter "=sThhmm <RET>" where "hh" is the two digits of the current hour; where "mm" is the two digits of the current minute. The string "hhmm" must have four characters -- use zeros where necessary.

To set the clock to the current second enter "=sTss <RET>" where "ss" is the two digits of the current second. The string "ss" must have two characters -- use zeros where necessary.

To set the clock to the current day-of-the-week enter "=sTd <RET>" where "d" is a single numeric symbol for the day-of-the-week (Sun = 1, Mon = 2, Tue = 3, Wed = 4, Thu = 5, Fri = 6, Sat = 7 are the only allowed values).

As with most clocks, the clock on TUC52, the METCON controller, will drift a bit over time. Under normal living conditions, the clock should adjustable to provide an error of no more than ± 15 seconds per month. It's a simple process to synchronize the TUC52/METCON clock to a reference clock. When the reference clock approaches a new second enter the command

      =sT0   but don't yet press the <enter> key

When the reference clock reaches a new minute, then press the <enter> key. Now the seconds are correct but the minutes may or may not be right. Look at the time reported by METCON. If the METCON time needs to be advanced by one minute enter

      =sT+ <enter>

if, instead, the METCON time needs to be retarded by one minute enter

      =sT- <enter>

If the time still isn't right then reload a whole new time value.

4.7.3   Quick Commands: Set, Clear, Display

RESERVED – NOT YET WORKING

You can use the quick commands to set or clear bits on the primary output port or to display the value of the primary input port.

The quick command are as follows

=sSb <enter>	sets TX/P4 bit "b" to active (low output)
=sCb <enter>	clears TX/P4 bit "b" to inactive (high output)
=sDb <enter>	displays the value of RX/P5, 1 means input active (low)

5   MEMORY MAP

METCON operates in a pretty simple manner. A section of RAM within the TUC52 processor board is divided into two arrays of memory: restricted and open. The user can always read or write to all of the open data area. When the SYSTEM ADMINISTRATOR switch contacts (port P5 bit 7 is used as the System Administrator switch input) are open (inactive) the user can <u>not</u> access the restricted data memory. When the SYSTEM ADMINISTRATOR contacts are closed (active, port P5 bit 7 is low) the user can read from and write to any address within the restricted memory.

Both sections of memory (restricted and open) appear to be a linear array of bytes and that each memory byte contains 8 bits (labeled 0 through 7). User open memory extends from address 00 to 30 while the restricted memory extends from F8 through FF (hex). See Figure 1 for a pictorial of the memory.

Yadr	Bit Position							
	7	6	5	4	3	2	1	0
00	x	x	x	x	x	x	x	x
01	x	x	x	x	x	x	x	x
02	x	x	x	x	x	x	x	x
03	x	x	x	x	x	x	x	x

Figure 1: A section of memory

An address can point to a particular byte or a particular bit within a particular byte. The notation Yadr:NN is used to indicate a byte address of NN (hex) and the action taken with regard to that address (read or write) will be on a byte basis (8 bits at once). The notation Badr:NNB is used to indicate a bit address where NN (hex) indicates the particular byte the bit lies within and B (0-7) is the particular bit within that byte and that the action taken with regard to that address will be on a bit basis (one bit).

Below is a listing of the bytes within the Restricted Area. Data in the Restricted area are typically those data that if inadvertently changed may cause the system to be unusable.

Restricted Addresses		
Yadr	**Name**	**Description**
FA	RSTAT0	Restricted Status Byte 0
FB	RSTAT1	Restricted Status Byte 1
FC	PSWD0	Login Password First Byte
FD	PSWD1	Login Password Middle Byte
FE	PSWD2	Login Password Last Byte
FF	STNADR	Station Address Byte

In general, any flag that if set the wrong way could cause the system to be uncontrollable has been moved to restricted memory. As part of that change the global ACHG flag has been changed to a byte mask (byte address FB) that is applied to all input bits. If a bit of the ACHGMSK is set high, then any change on input ports in the same bit position will cause an INPUT STATUS CHANGE message with time-stamp to be generated. Any input that generates a frequent periodic signal (like a VTF board) should NEVER have the corresponding ACHGMSK bit set to 1. Doing so will cause METCON to generate message after message and it will ignore the serial input because it's too busy dealing with the serial output port.

Below is a listing of the bytes within the Open Area. Data in the Open area are typically those data that if inadvertently changed would not render the system unusable..

User Addresses – Status		
Yadr	**Name**	**Description**
00	STAT0	System Status Flags
01	PULFRQ	Pulse Ctr / Freq Ctr Select
02	ADCCFG	ADC Config
03	ADCTYP	ADC Type

User Addresses – Input/Output		
Yadr	**Name**	**Description**
04	TX-P4/A	Memory Image for Output Port TX-P4/A
05	TX-S0	Memory Image for Output Port TX-S0
06	TX-S1	Memory Image for Output Port TX-S1
07	TX-S2	Memory Image for Output Port TX-S
08	TX-S3	Memory Image for Output Port TX-S3
09	RX-P5/B	Memory Image for Input Port RX-P5/B
0A	RX-S0	Memory Image for Input Port RX-S0
0B	RX-S1	Memory Image for Input Port RX-S1
0C	RX-S2	Memory Image for Input Port RX-S2
0D	RX-S3	Memory Image for Input Port RX-S3
0E	RCH-P5/B	Change Flags for Input Port RX-P5/B
0F	RCH-S0	Change Flags for Input Port RX-S0
10	RCH-S1	Change Flags for Input Port RX-S1
11	RCH-S2	Change Flags for Input Port RX-S2
12	RCH-S3	Change Flags for Input Port RX-S3

User Addresses -- Frequency, Pulse Counters)		
Yadr	**Name**	**Description**
13	CCN0L	LS Byte of Counter Channel 0
14	CCN0H	MS Byte of Counter Channel 0
15	CCN1L	LS Byte of Counter Channel 1
16	CCN1H	MS Byte of Counter Channel 1
17	CCN2L	LS Byte of Counter Channel 2
18	CCN2L	MS Byte of Counter Channel 2
19	CCN3L	LS Byte of Counter Channel 3
1A	CCN3H	MS Byte of Counter Channel 3
1B	CCN4L	LS Byte of Counter Channel 4
1C	CCN4H	MS Byte of Counter Channel 4
1D	CCN5L	LS Byte of Counter Channel 5
1E	CCN5H	MS Byte of Counter Channel 5
1F	CCN6L	LS Byte of Counter Channel 6
20	CCN6H	MS Byte of Counter Channel 6
21	CCN7L	LS Byte of Counter Channel 7
22	CCN7H	MS Byte of Counter Channel 7

User Addresses -- Frequency, Pulse Counters)		
Yadr	**Name**	**Description**
23	ADCH0L	Analog to Digital Conv Ch 0 Low
24	ADCH0H	Analog to Digital Conv Ch 0 High
25	ADCH1L	Analog to Digital Conv Ch 1 Low
26	ADCH1H	Analog to Digital Conv Ch 1 High
27	ADCH2L	Analog to Digital Conv Ch 2 Low
28	ADCH2H	Analog to Digital Conv Ch 2 High
29	ADCH3L	Analog to Digital Conv Ch 3 Low
2A	ADCH3H	Analog to Digital Conv Ch 3 High
2B	ADCH4L	Analog to Digital Conv Ch 4 Low
2C	ADCH4H	Analog to Digital Conv Ch 4 High
2D	ADCH5L	Analog to Digital Conv Ch 5 Low
2E	ADCH5H	Analog to Digital Conv Ch 5 High
2F	ADCH6L	Analog to Digital Conv Ch 6 Low
30	ADCH6H	Analog to Digital Conv Ch 6 High
31	ADCH7L	Analog to Digital Conv Ch 7 Low
32	ADCH7H	Analog to Digital Conv Ch 7 High

6   SYSTEM CONTROLS BITS

There are several sets of control bits in Restricted memory and the lower portion of Open memory. These all have special purposes. Many of these bits can be thought of as "switches": set a bit high and METCON behaves one particular way, set a bit low and METCON behaves a different way. Below is a description of each control bit and the address to use to read the value or change the state of the value. NOTE: You will not be able to access the Restricted Memory unless you have enable METCON as System Administrator. You set METCON to be System Administrator by forcing input 7 on RX-P5/B to a low (grounded) state.

6.1   RESTRICTED MEMORY CONTROL BIT DETAILS

SPS0 Badr:F90 SPS1 Badr:F91 SPS2 Badr:F92	SPS2, SPS1 and SPS0 are used to determine baud rate on the serial port. The baudrates for the following bit vector values are as follows. 210 Baud Rate 000 -- 110 bps 001 -- 300 bps 010 -- 1200 bps 011 -- 2400 bps 100 -- 4800 bps 101 -- 9600 bps 110 -- 19200 bps* 111 -- 83400 bps* Default value is 010 for 1200 bps (temporarily 101 for 9600). * METCON may not be able to accept data at full speed at this rate.
AONLI Badr:F93	AONLI (Auto Output when Not Logged In) determines if METCON will output auto display and auto change messages when the user is not logged in. When ADNLI=0 auto messages will not be sent to the serial port, they will be discarded instead. When ADNLI=1 auto messages will be sent to the serial port even if the user is not logged in. This can be useful if a system is desired where users do not login, they can not change values but they can get the auto display messages. Default value is 0.
ADISCON Badr:F94	ADISCON (Automatic DISCONnection) determines if METCON will automatically disconnect the user from Packet or Dial-Up Modem connections if he or she fails to LOGIN successfully 4 or less tries within 60 seconds of DCD going active (connection established). The disconnect routine generates an error message, then a 10 second delay, followed by three "control C" characters (packet radio attention signal), then a 2 second delay, followed by an ASCII "D" character (packet disconnect) then an ASCII CR and LF, followed by a 5 second delay, then a 5 second BREAK signal on the TXD lead of the RS-232 connector (telephone modem disconnect signal), followed by a 5 second delay before normal processing begins. Default value is 0.
NECHO Badr:F95	NECHO (No ECHO of input) determines if METCON will echo input it receives on the serial port to the output. This is useful when a human communicates to METCON over a direct connect cable or a land line modem. Set this bit to 1 to disable echo. Disable echo is usually desired for packet radio operation.. Default value is 0.

NLF
Badr:F96

NLF (No Line Feeds on output) determines if METCON will follow every transmitted carraige return with a line feed character. Including line feeds is useful when a human communicates to METCON over a direct connect cable or a land line modem. Set this bit to 1 to disable line feeds. Disable Line Feeds is usually desired for packet radio operation. Default value is 0.

INVI
Badr:FA0

INVI (Inverted Input) provides a way to have an active HIGH input system to the TUC52 82c55 input port. Typically, METCON is an active LOW system, where a low input is inverted by inverters on METCON before passing to the TUC52 system, and the firmware reports that input as being in state "1". Set INVI to "1" to have an active high input system at the METCON input terminal. Default value is 0.

NINVO
Badr:FA1

NII (No Inverted Output) provides a way to have an active HIGH output system. Typically, METCON is an active LOW system, where an output bit set to "1" will cause the hardware output to go low. Set NIO to "1" to have an active low system. Default value is 0.

Reserved
Yadr:FA

Reserved

ACHGMSK
Yadr:FB

ACHGMSK (Automatic Change reporting MaSK) is a mask that's applied to the change bits of each input. Those bits set high will allow the corresponding input channel on RX-P5/B to automatically generate a status change message when that feature is enabled. Ensure that for any input that expected to frequently change input states (i.e, more than more four times in a minute) that the corresponding bit in the ACHGMSK is set to zero.. Default value is FFH.

PSWD0
Yadr:FC

PSWD0 (PaSsWord 0) is the first byte the user must enter to login to METCON. This byte can be considered a 2 character hex value or a 2 digit packed BCD value. If PSWD0 is programmed to 00 then user LOGIN is not needed. The user is considered to always be logged in. Default value is 12H.

PSWD1
Yadr:FD

PSWD1 (PaSsWord 1) is the second byte the user must enter to login to METCON. This byte can be considered a 2 character hex value or a 2 digit packed BCD value. Default value is 34H.

PSWD2
Yadr:FE

PSWD2 (PaSsWord 2) is the third byte the user must enter to login to METCON. This byte can be considered a 2 character hex value or a 2 digit packed BCD value. Default value is 56H.

STNARR
Yadr:FF

The byte STNADR (STatioN ADdRess) is used to program what station will be needed to address this METCON module. This address is in restricted user memory. It can only be read or written then the SYSTEM ADMINISTRATOR plug is shorted. Default value is 41H (Ascii "A").

6.2 USER MEMORY BIT DETAILS

The User Memory is broken down into two parts: Configuration and I/O. The Configuration is area is composed of three components: General, Counters and A/D Converter.

6.2.1 General User Configuration Bits

AD1
Badr:000

AD1 (Auto Display 1 minute). The AD1 bit causes automatic display of the memory map once every minute. When the AD1 bit is 1 METCON operates as though the user has given a MAP command once every minute, when the time of day clock's seconds equals 00. Setting the AD1 bit to 0 will disable this function. Causing MAP outputs to be transmitted every minute on packet is not advised. It could clog communications for everyone on a heavily used channel. Use this only for wire-line systems or for diagnostics. Default value is 0.

AD15
Badr:001

AD15 (Auto Display 15 minutes). The AD15 bit causes automatic display of the memory map once every 15 minutes. When the AD15 bit is 1 METCON operates as though the user has given a MAP command once every 15 minutes, at 00, 15, 30 and 45 minutes after the hour. Setting the AD15 bit to 0 will disable this function. Default value is 0

FSR
Badr:002

FSR (Fast Sample Rate). When the FSR bit is 1 METCON samples the binary inputs at a rate of 10 times a second. When the FSR bit is 0 METCON sample the binary inputs at a rate of once a second. Default value is 0.

AFLU
Badr:003

AFLU (Auto Fast Load Up). When the AFLU bit is 1 whenever METCON would normally generate an Auto Display MAP output, it will instead generate a Fast Load Up output. This is useful when another computer is monitoring the METCON system instead of a human. Default value is 0.

TSAR
Badr:004

TSAR (Time Stamp All Responses. When the TSAR bit is 1 METCON will include a stime stamp on all responses from the METCON system.. Default value is 0.

6.2.2   Frequency Counter or Pulse Counter Configuration Bits

PULCTR0
Badr:010

PULCTR0 (Pulse Counter 0) determines if METCON will consider alternate function for INPUT-0 to be a frequency counter input or an accumulating pulse counter input. When PULCTR0 is 0 the alternate function for INPUT-0 will be a frequency counter input. When PULCTR0 is 1 the alternate function for INPUT-0 will be an accumulating pulse counter input. Default value of PULCTR0 is 0 (i.e., frequency counter input).

PULCTR1
Badr:011

PULCTR0 (Pulse Counter 0) determines if METCON will consider alternate function for INPUT-0 to be a frequency counter input or an accumulating pulse counter input. When PULCTR0 is 0 the alternate function for INPUT-0 will be a frequency counter input. When PULCTR0 is 1 the alternate function for INPUT-0 will be an accumulating pulse counter input. Default value of PULCTR0 is 0 (i.e., frequency counter input).

PULCTR2
Badr:012

PULCTR0 (Pulse Counter 0) determines if METCON will consider alternate function for INPUT-0 to be a frequency counter input or an accumulating pulse counter input. When PULCTR0 is 0 the alternate function for INPUT-0 will be a frequency counter input. When PULCTR0 is 1 the alternate function for INPUT-0 will be an accumulating pulse counter input. Default value of PULCTR0 is 0 (i.e., frequency counter input).

PULCTR3
Badr:013

PULCTR3 (Pulse Counter 3) determines if METCON will consider alternate function for INPUT-3 to be a frequency counter input or an accumulating pulse counter input. When PULCTR3 is 0 the alternate function for INPUT-3 will be a frequency counter input. When PULCTR3 is 1 the alternate function for INPUT-3 will be an accumulating pulse counter input. Default value of PULCTR3 is 0 (i.e., frequency counter input).

PULCTR4
Badr:014

PULCTR4 (Pulse Counter 4) determines if METCON will consider alternate function for INPUT-4 to be a frequency counter input or an accumulating pulse counter input. When PULCTR4 is 0 the alternate function for INPUT-4 will be a frequency counter input. When PULCTR4 is 1 the alternate function for INPUT-4 will be an accumulating pulse counter input. Default value of PULCTR4 is 0 (i.e., frequency counter input).

PULCTR5
Badr:015

PULCTR5 (Pulse Counter 0) determines if METCON will consider alternate function for INPUT-5 to be a frequency counter input or an accumulating pulse counter input. When PULCTR5 is 0 the alternate function for INPUT-5 will be a frequency counter input. When PULCTR5 is 1 the alternate function for INPUT-5 will be an accumulating pulse counter input. Default value of PULCTR5 is 0 (i.e., frequency counter input).

PULCTR6
Badr:016

PULCTR6 (Pulse Counter 6) determines if METCON will consider alternate function for INPUT-6 to be a frequency counter input or an accumulating pulse counter input. When PULCTR6 is 0 the alternate function for INPUT-6 will be a frequency counter input. When PULCTR6 is 1 the alternate function for INPUT-6 will be an accumulating pulse counter input. Default value of PULCTR6 is 0 (i.e., frequency counter input).

PULCTR7
Badr:017

PULCTR7 (Pulse Counter 7) determines if METCON will consider alternate function for INPUT-7 to be a frequency counter input or an accumulating pulse counter input. When PULCTR7 is 0 the alternate function for INPUT-7 will be a frequency counter input. When PULCTR7 is 1 the alternate function for INPUT-7 will be an accumulating pulse counter input. Default value of PULCTR7 is 0 (i.e., frequency counter input).

6.2.3   Analog To Digital Converter Configuration Bits

ADCTYPE
Yadr:02

ADCTYPE (Analog to Digital Converter TYPE). This is a reserved configuration byte. It will be used in the future if the METCON system supports more than one type of ADC device. Default value of ADCTYPE is 0.

ADC01B
Badr:030

When the ADC01B (ADC Channels 0 & 1 Balanced) bit is 1 METCON will consider ADC inputs 0 and 1 as a balanced pair. When the ADC01B bit is 0 METCON will consider ADC inputs 0 and 1 as separate positive single ended inputs measured relative to the COMMON input. The value of ADC01R has no effect when ADC01B is 0. Default value of ADC01B is 0.

ADC01R
Badr:031

When the ADC01R (ADC Channels 0 & 1 Reversed) bit is 1 (and ADC01B is set to 1) METCON will consider ADC input 0 as the negative input and input 1 as the positive input of a balanced pair. When the ADC01R bit is 1 (and ADC01B is set to 1) METCON will consider ADC input 0 as the positive input and input 1 as the negative input of a balanced pair. When ADC01B is set to 1 channels 0 and 1 are single ended at ADC01R has no effect. Default value of ADC01R is 0.

ADC23B
Badr:032

When the ADC23B (ADC Channels 2 & 3 Balanced) bit is 1 METCON will consider ADC inputs 2 and 3 as a balanced pair. When the ADC23B bit is 0 METCON will consider ADC inputs 2 and 3 as separate positive single ended inputs measured relative to the COMMON input. The value of ADC23R has no effect when ADC23B is 0. Default value of ADC23B is 0.

ADC23R
Badr:033

When the ADC23R (ADC Channels 2 & 3 Reversed) bit is 1 (and ADC23B is set to 1) METCON will consider ADC input 2 as the negative input and input 3 as the positive input of a balanced pair. When the ADC23R bit is 1 (and ADC23B is set to 1) METCON will consider ADC input 2 as the positive input and input 3 as the negative input of a balanced pair. When ADC23B is set to 1 channels 2 and 3 are single ended at ADC23R has no effect. Default value of ADC23R is 0.

ADC45B
Badr:034

When the ADC23R (ADC Channels 2 & 3 Reversed) bit is 1 (and ADC23B is set to 1) METCON will consider ADC input 2 as the negative input and input 3 as the positive input of a balanced pair. When the ADC23R bit is 1 (and ADC23B is set to 1) METCON will consider ADC input 2 as the positive input and input 3 as the negative input of a balanced pair. When ADC23B is set to 1 channels 2 and 3 are single ended at ADC23R has no effect. Default value of ADC23R is 0.

ADC45R
Badr:035

When the ADC45R (ADC Channels 4 & 5 Reversed) bit is 1 (and ADC45B is set to 1) METCON will consider ADC input 4 as the negative input and input 5 as the positive input of a balanced pair. When the ADC45R bit is 1 (and ADC45B is set to 1) METCON will consider ADC input 4 as the positive input and input 5 as the negative input of a balanced pair. When ADC45B is set to 1 channels 4 and 5 are single ended at ADC45R has no effect. Default value of ADC45R is 0.

ADC67B
Badr:036

When the ADC45R (ADC Channels 4 & 5 Reversed) bit is 1 (and ADC45B is set to 1) METCON will consider ADC input 4 as the negative input and input 5 as the positive input of a balanced pair. When the ADC45R bit is 1 (and ADC45B is set to 1) METCON will consider ADC input 4 as the positive input and input 5 as the negative input of a balanced pair. When ADC45B is set to 1 channels 4 and 5 are single ended at ADC45R has no effect. Default value of ADC45R is 0.

ADC67R
Badr:037

When the ADC67R (ADC Channels 6 & 7 Reversed) bit is 1 (and ADC67B is set to 1) METCON will consider ADC input 6 as the negative input and input 7 as the positive input of a balanced pair. When the ADC67R bit is 1 (and ADC67B is set to 1) METCON will consider ADC input 6 as the positive input and input 7 as the negative input of a balanced pair. When ADC67B is set to 1 channels 6 and 7 are single ended at ADC67R has no effect. Default value of ADC67R is 0.

6.2.4   User I/O Memory

The memory locations used for general input and output are not further detailed, beyond that shown in the tables in Section 4, the memory map. However, some general comments about data representing non-binary input values are as follows. All frequency counter, accumulating pulse counter, and analog to digital data are stored as 16 bit unsigned integers. The integers are stored as words which are broken down into two bytes, high and low and these values are stored as shown in the tables in section 4.

7   COMPUTER UPLOAD/DOWNLOAD

Most of the commands for METCON are designed for a human user. However, probably the best use for METCON is where it feeds information to a PC with graphics and presents a "picture" of METCON's inputs on the display. The user could then get a clearer picture of what METCON is sensing and controlling. Yet, the commands designed for humans are not the best choice for a computer to use when communicating with METCON. That's where the "fast upload" and "fast download" come into play.

7.1   FAST LOAD DOWN

The FLD (Fast Load Down) command is used to send information to METCON. To do a down load the host computer would send to METCON the command "=sFD {ent}" where "s" is the station address. METCON is now waiting for data from the host computer.

The format of the expected data is simple, but screwy. Bytes are sent to METCON starting at user open memory address 0 and working upward (a computer can't download to restricted memory, it must use the byte write, bit write or bit set and bit clear commands). Each byte is represented as four hex characters. The first two characters must be the same and they represent the upper nibble of the byte. The following two characters must be the same and they represent the lower nibble. There is no checksum for a Fast Load Down command. The checking is done by the double transmission of each nibble. The double nibble technique is needed to ensure that only correct data is loaded into the user memory. To end the download just send a CR (or any other non-hex character). METCON will respond with an address marker and the number of bytes stored.

An example of downloading to the open memory status locations looks like the following:

                    =afd
                    001155aa22cc33ff {RET}
                    -A- FLOADED BYTES = 04

The use of four hex characters per byte is wasteful but this is the method used in METCON-1 because there was no extra RAM space to use as an input buffer. We have retained this somewhat strange operation in order to be compatible with software that was designed to control the original METCON-1 system. The double nibble checking scheme is somewhat wasteful but you really shouldn't be downloading more than 8 bytes. The first four bytes downloaded are open user memory status stuff and the following four bytes are output data. No sense in writing beyond that because METCON will overwrite that data the next time it gets inputs from the port, inputs from the frequency counter or from the analog-to-digital converter

If there is sufficient demand we can add a supplementary way of downloading that is more conventional.

7.2   FAST LOAD UP

The FLD (Fast Load Up) command is used to get information from METCON. To do an up load the host computer would send to METCON the command "=sFUn {RET}" where "s" is the station address and "n" is the block of data to be sent. METCON will respond with a string of bytes represented as pairs of hex chars. The bytes are sent from lowest memory first and work their way upward through the memory map. When bytes are transmitted, the first character represents the high nibble and the following character represents the low nibble. The last byte of the string is a checksum that is the 8 bit sum of all previous

bytes PLUS the number of bytes. Additionally, to help the host find the begining and end of the data the hex characters are enclosed in parenthsis (like this).

An example of uploading memory block 4 looks like the following:

```
=afu4  {RET}
-A- (BB783D0000003DBB70)
```

The blocks of memory are partitioned as follows:

0.   Adresses 00H through 30H inclusive for a total of 49 bytes plus checksum. This represents all of the user open memory.

1.   Adresses 00H through 08H inclusive for a total of 9 bytes plus checksum. This represents the user open memory status bytes plus the output bytes.

2.   Adresses 09H through 12H inclusive for a total of 10 bytes plus checksum. This represents the input port image and input change flag bytes. Input port 0 image is sent first and input change flags for port S3 are sent last.

3.   Adresses 13H through 22H inclusive for a total of 16 bytes plus checksum. This represents the frequency counter or accumulating pulse counter results. Port 5 (82C55 B) input 0 is sent first and port 5 (82C55 B) input 7 is sent last.

4.   Adresses 23H through 30H inclusive for a total of 16 bytes plus checksum. This represents the analog-to-digital converter inputs. Channel 0 LSByte data is sent first and channel 7 MSByte data is sent last

8   COMMUNICATING WITH METCON

The user communicates with METCON via the serial port. Commands are entered in a line oriented format and METCON responds with information in response to the command. There are three major ways that the user can connect his or her terminal to METCON: (1) direct connection through a cable, (2) dial up (or private line) modem connection via the telephone network, or (3) radio modems (like amateur packet radio, HF PACTOR, or even AMTOR). Depending on what method is used to connect the terminal to METCON the user will want to select different system options (linefeed on/off, echo on/off, terminal speed, etc.).

8.1   DIRECT CONNECTION

The direct connection is simple. Simply use a RS-232 cable to connect to METCON's DTE interface. When using direct connection ensure that ECHO is selected and that NLF is zero (i.e., line feeds enabled).

8.2   TELEPHONE MODEM CONNECTION

When METCON is connected to the terminal via a telephone modem (like a Bell 212A) the modem should be configured for autoanswer. METCON should be configured for ECHO on and NLF zero. The cable between the modem and METCON should a standard RS-232 cable.

8.3   RADIO CONNECTION

When METCON is connected to the terminal via Packet Radio or AMTOR METCON should be configured for ECHO off and NLF on. Additionally, the radio modem should be set to ECHO OFF. The cable between the modem and METCON should a standard RS-232 cable.

8.3.1   USE TRANSPARENT MODE

When METCON is connected to a TNC for packet radio operation, the user may choose to set the TNC to either CONVERSE or TRANSPARENT mode. There is a potential problem with CONVERSE mode that deals with having METCON stall the TNC because of half completed input. Always use TRANSPARENT mode unless there is a strong, compelling reason to do otherwise. CONVERSE is fine for a quick test but if you are putting something up on a mountain top or any other inaccessible place, then use TRANSPARENT. Only the TNC connected to METCON needs to be in TRANSPARENT mode. It doesn't matter what mode the connecting station's TNC is using.

8.4   SERIAL PORT

The user communicates with METCON via the serial port. The serial port is configured as an 8 bit start/stop UART[6]. On the input side the most significant bit can either be set high or low (METCON will strip out this bit). On the output side METCON will always set the most significant bit high so that it looks like an additional stop bit. METCON defaults to 1200 bps but the user can configure it for 300, 1200, 2400 or 9600 bps operation. These values can be stored in the EEPROM so that they will be effective after a power failure. METCON uses two control leads as part of the serial port. The first is DCD (Data Carrier Detect or Receive Signal Detect) that's on pin 8 of the 25 conductor RS-232 cable. This is a signal from the modem to METCON. METCON includes a pull up resistor so if the cable

---

[6] Footnote

doesn't include this lead METCON will consider the signal defaulted to ACTIVE. METCON uses DCD to tell it when a connection has been established or concluded. METCON uses this information to automatically LOG OUT a user the connection is dropped (NOT YET WORKING IN SOFTWARE). The second control signal is DTR (Data Terminal Ready). This signal is pin 20 of the RS-232 cable and METCON uses it to tell the telephone modem when METCON wants to terminate a telephone connection. METCON will do this if the user doesn't LOGIN with 60 seconds of a connection or if the user enters the wrong password three times, which ever comes first (NOT YET WORKING IN SOFTWARE). When METCON wants to terminate a connection to does several things to ensure that it will work for all devices. First, it makes the DTR lead inactive for 2 seconds, then it sends a break character for 2 seconds, then it sends ^C D CR, then it sends ^C R CR (others to be added as needed) (NOT YET WORKING IN SOFTWARE, MAY NEED TO HAVE CONFIGURATION BITS TO PROGRAM THE SPECIFIC MODE OF DISCONNECT INSTEAD OF JUST DOING THEM ALL).

8.4.1   DCD MUST BE ACTIVE

The DCD input to METCON must be ACTIVE (more positive than +3 volts) for any communications to take place on the serial port. When using a TNC-2 or telephone modem, DCD should be provided by the TNC-2 or telephone modem on pin 8 of its RS-232 connector. For those times when you do not have a good DCD source you can install a shorting plug on Jxx (labled DCD on silk). This will make \sn's microcomputer think that DCD is stuck on all the time. Although many applications can get by with having DCD stuck on do not do so if you want any security features (like password or authentication security). When DCD goes inactive METCON will sense this and LOGOUT the user. Also, if someone connects, DCD will go active. METCON uses this signal for AUTOMATIC DISCONNECT.

9   SECURITY

This sections discusses various issues about system access control.

9.1   AUTOMATIC DISCONNECT

Automatic disconnect is useful when operating with packet radio or dial-up modem. When a user connects to METCON when Automatic Disconnect (ADISCON) is active, the user has 4 tries within 60 seconds to LOGIN successfully (the RS-232 DCD signal is used to start this counting and timing). If the operator fails to LOGIN within the allotted number of tries and time period, the connection is dropped via break and control D.

9.2   LOGIN SECURITY

There are three kinds of login security: NO security, authentication security and password security. METCON is defaulted to use password security with a PSWD (password) value of "123456". METCON uses the first byte of PSWD to determine which kind of security is desired.

9.2.1   NO SECURITY

If the first byte of the PSWD (adr FC) is 00 (zero) then no security is used. LOGIN status follows the DCD input: when DCD is active the user is automatically LOGGED IN; when DCD is NOT active the user it automatically LOGGED OUT. This is used for direct hard-wire connections where "bad guy" attacks are not expected.

9.2.2   AUTHENTICATION SECURITY

If the first byte of PSWD (adr FC) is hex value FF then authentication security is selected. Authentication is used when the communications link is NOT private (and perhaps shared) such as Amateur Radio packet data systems. METCON uses the last four bytes of PSWD for the SEED for the authentication table (don't use 0000) Once a value has been stored in PSWD the system administrator enters a command to tell METCON to output an authentication table. This table is given to all authorized users. When any user wants to LOGIN he or she must ask METCON for a CHALLENGE (or enter a dummy LOGIN command and get the CHALLENGE from the error message). The data that METCON responds with is used as an index into the private table. The results of the user's manual lookup into the private table are given to METCON as part of the LOGIN command.

EXAMPLE OF AUTHENTICATION

```
                                ; first, install shorting plug at Jxx (labled SYS on
                                ; silk) to flag to METCON that you are System
          Administrator.
                                ; now the PSWD values can be changed.  a value of
                                ; 1234 will be used as the SEED.
          =aed                  ; get default values
          =awyfcff              ; write FF into PSWD0 (Yadr FC)
          -A- FC-FF   FF   1111 1111  ; METCON confirmation
          =aryfd12              ; write 12 into PSWD1 (Yadr FD)
          -A- FD-12   12   0001 0010  ; METCON confirmation
          =awyfe34              ; write 34 into PSWD2 (Yadr FE)
          -A- FE-34   34   0011 0100  ; METCON confirmation
          =ala                  ; ask METCON to print authentication table
                                ; capture data to file and print for
                                ; later use.  keep table private

          SEED: FF1234


               00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
               -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
          00: F4 C9 78 AA C8 78 29 29 C6 78 29 F4 58 7F C8 F4
          10: C9 F4 48 78 95 AA 58 7F 9A 95 AA 8A 68 EC F8 C9
          20: 88 4A 88 49 DA DA F8 AA 4A AA 1F 14 FD 98 49 98
          30: 7F C8 68 14 B8 68 7C 58 58 7F CB 68 88 4A 88 49
          40: 2A 68 98 49 58 7F CB 68 88 4A 88 49 49 98 4A AA
          50: 7F C8 78 98 7C 98 68 58 CB 68 B8 6B 88 68 58 7F
          60: 74 F1 F8 C6 C8 C8 C8 66 66 81 74 76 4A AA 00 68
          70: 6B 98 49 98 7F CB 68 2A 4A 88 49 58 98 4A AA 88
          80: D9 B5 DA D9 58 D4 5F DA A3 CA C8 6F DA A3 DA DA
          90: DA D9 B5 DA E8 58 D4 7C DA 43 FB 4F FB 4F 68 CA
          A0: 98 68 AA 1F F4 D3 1F F8 68 AA 88 68 D2 1F F8 98
          B0: D3 1F F8 F4 AA 88 68 F4 7B DA D9 B5 0F AA 58 D4
          C0: CA F4 D3 AA D0 AA 34 D2 34 FD CA F4 DA D9 CE AA
          D0: D4 DA D9 D0 7E AA DA D9 1F 79 DA DA 14 1F F8 AA
          E0: 34 AE CA 99 E1 CA 99 AA AA 1F 14 34 1F 50 08 CF
          F0: 68 AA 6D AA 18 C4 6D A4 D7 6D A4 5D 7D A4 4B 08


                                ; now, remove shorting plug at Jxx (labled SYS on
                                ; silk) to flag to METCON that you are no longer
                                ; System Administrator.
                                ; whenever SYS is shorted METCON automatically logs
                                ; you in so you need to log out.
          =alo                  ; user LOGOUT command
          -A- LOGGED OUT        ; METCON says user is logged out

                                ; assume new user has connected to METCON
          =alc                  ; ask station A to issue LOGIN Challenge
          -A- CHAL: DC A3 2A    ; METCON provides challenge, use each
                                ; value as index into private table.  respond
                                ; with value of each entry instead of 6 character
                                ; password for LOGIN
```

```
                        =al141f2a                 LOGIN with value 141f2a (last byte wrong)
                        -A- !!! ERROR, USER MUST LOGIN !!!        ; METCON error message, followed by
                        -A- CHAL: A1 B8 8F        ; new challenge, look up data in private table
                        =al687bda                 ; LOGIN with value 687bda (correct lookup)
                        -A- LOGGED IN             ; METCON says user is logged in
                                                  ; do any commands, when finished need to LOGOUT
                        =alo                      ; user LOGOUT command
                        -A- LOGGED OUT            ; METCON says user is logged out
                                                  ; completes authentication login example
```

9.2.3   PASSWORD SECURITY

If the first byte of the PSWD (adr FC) isn't zero and isn't hex value FF then password security is selected. Password security is used when the communications link IS private such as when using a dial-up modem. METCON uses the all six bytes of PSWD for the user password. Of course, the first two characters can't be FF and they can't be 00. That's the only restriction on passwords other than they must consist of hex characters. When a user wants to LOGIN he or she provides the 6 character password as part of the LOGIN command.

EXAMPLE OF PASSWORD

```
                                           ; first, install shorting plug at Jxx (labled SYS on
                                           ; silk) to flag to METCON that you are System
                 Administrator.
                                           ; now the PSWD values can be changed.  A password of
                                           ; 654321 will be used.
                 =aed                      ; get default values
                 =awyfc65                  ; write 65 into PSWD0 (adr FC)
                 -A- FC-65  65  0110 0101  ; METCON confirmation
                 =awyfd43                  ; write 34 into PSWD1 (adr FD)
                 -A- FD-43  43  0100 0011  ; METCON confirmation
                 =awyfe21                  ; write 12 into PSWD2 (adr FE)
                 -A- FE-21  21  0010 0001  ; METCON confirmation
                                           ; now, remove shorting plug at Jxx (labled SYS on
                                           ; silk) to flag to METCON that you are no longer
                                           ; System Administrator.
                                           ; whenever SYS is shorted METCON automatically logs
                                           ; you in so you need to log out.
                 =alo                      ; user LOGOUT command
                 -A- LOGGED OUT            ; METCON says user is logged out
                                           ; assume new user has connected to METCON
                 =ali123456                ; LOGIN with wrong password (order reversed)
                 -A- !!! ERROR, USER MUST LOGIN !!!        ; METCON error message, followed by
                 -A- CHAL: A1 B8 8F        ; new challenge, ignore because password in effect
                 =ali654321                ; LOGIN with value 654321 (correct)
                 -A- LOGGED IN             ; METCON says user is logged in
                                           ; do any commands, when finished need to LOGOUT
                 =alo                      ; user LOGOUT command
                 -A- LOGGED OUT            ; METCON says user is logged out
                                           ; completes password login example
```

9.3   LOGIN/LOGOUT STATUS

Although there isn't a command to tell you if you are LOGGED IN or not, there's a simple test that will give you that answer. If you give a command that looks at a User Open Address (=ARY00, read byte 00) the response will tell you if you are LOGGED IN or not. If you get data from this command then you are LOGGED IN. If you get an error message then you are LOGGED OUT.

The same thing can be done to see if you are system administrator. Give a command that looks at a User Restricted Address (=ARYFF, read byte FF) the response will tell you if you are System Administrator or not. If you get data from this command then you ARE System Administrator. If you get an error message then you are NOT System Administrator.

10   OTHER CONSIDERATIONS OR PROBLEMS

At power up METCON defaults to conditions that are useful to the novice user. If no EEPROM is installed or it doesn't have a correct checksum, METCON configures P0 for inputs, P2 outputs, serial port for 1200 bps, echo on, station address is set to "A" and all ADC inputs are single ended. If the EEPROM is installed and it does past the checksum test then the restricted memory and output ports are loaded with data from the EEPROM.

As explained briefly above, the user controls METCON by reading and writing the values in the user memory. This can be done by reading or writing one bit at a time (bit commands), by reading or writing 8 bits at a time from or to a single address (byte commands), or by reading 16 bits at once from two consecutive address (word command).

10.1   GOOFY START UP

Sometimes, the first time you power up METCON, especially after changing from one version of firmware to another, METCON might send repetitive copies of it's sign-on message and never accept a command. If you have this problem, remove power from METCON and then remove the 8 pin EEPROM part from it's socket. Then power up METCON and everything should be OK. Carefully install the EEPROM in its socket (yes, with the power on) and then give the EEPROM write command ("=AEW"). Remove and reapply power; METCON should now give you one sign-on message and then accept your commands. Change any needed SYSTEM FLAGS and again write to the EEPROM. Your problems should now be over.

———ooOoo———