

Tucson Amateur Packet Radio
METCON 1 Assembly Manual
Hardware Revision 2
Firmware Revision 1.06

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INTRODUCTION

The TAPR METCON (telemetry and control) device is a packet applications tool for remote monitoring and control. When completed, it should deliver years of high-performance service.

This kit contains all parts and components necessary to populate the METCON-1 Rev 2 printed circuit (PC) board for eight (8) input and four (4) output channels. An optional parts pack consisting of relays and connectors may be purchased to populate the other four (4) output channels. There is no cabinet, case or power supply included or available from TAPR at this time.

To operate METCON, a source of +12-volts DC at 300 mA is required. In addition, to test METCON, you will need a computer or terminal with an RS-232 serial interface, a DC voltmeter and some insulated wire.

Please follow the directions in this manual carefully. It has been revised based on feedback from numerous builders.

Don't forget to carefully inspect the carton in which this kit came for any last-minute additions/corrections to the instructions provided in this manual.

As always, if you find errors or have questions or suggestions for this kit, please write the TAPR office at PO Box 12925, Tucson, AZ, 85732.

If you exercise care, construction of this kit should take you from two (2) to six (6) hours, depending on your experience.

So, clear off your workbench, warm up your soldering iron, and enjoy!

PARTS LIST

Sort the parts into egg cartons, muffin tins or other compartmented containers as you inventory them. Check off the part in the () space provided as you locate and verify it against this list.

Capacitors

Ceramic, Monolithic

<input type="checkbox"/> 0233 pF	330 or 33J	MONO-330
<input type="checkbox"/> 200.01 uF	103	MONO-103

Electrolytic, Radial lead

<input type="checkbox"/> 0610 uF	106	RAD16V-106
<input type="checkbox"/> 01100 uF	107	RAD25V-107

Connectors

<input type="checkbox"/> 032 pin male header	HDR-02M
<input type="checkbox"/> 017 pin male header	HDR-07M
<input type="checkbox"/> 012-position wire-clamp	RDI2SV
<input type="checkbox"/> 043-position wire-clamp	RDI3SV
<input type="checkbox"/> 024-position wire-clamp	RDI4SV
<input type="checkbox"/> 01DE9P 9-pin Right Angle PC Mount	DE9P-RPC
<input type="checkbox"/> 01DE9S 9-pin cable type	DE9S

Diodes

<input type="checkbox"/> 011N4002	1N4002
<input type="checkbox"/> 051N4148	1N4148

ICs

ICs are inserted in anti-static foam. Please do not remove them until they are called out in the construction steps that follow.

ICs often contain many numbers, and the "core" number may have a prefix and/or a suffix. A 74HC14, for example, may be marked MC74HC14P or SN74HC14N.

() 012595 O.C. Buffer	2595
() 0274HC14 Schmitt Trigger	74HC14
() 0174HC151 Multiplexer	74HC151
() 017805 Regulator	LM7805CT
() 0187C51 Processor, Plastic	87C51-OTP
() 019306, 93C06, 9346 or 93C46 EEPROM	93C06
() 01MAX232, TSC232 or DS1228 Converter	MAX232

Relays

() 04SPST Reed, 12-volt coil	RLx-001
-------------------------------	---------

Resistors

1/4 Watt, 5% Carbon Film

() 011K ohm	(brown-black-red-gold)	CFR1/4-102
() 012.2K ohm	(red-red-red-gold)	CFR1/4-222
() 084.7K ohm	(yellow-violet-red-gold)	CFR1/4-472
() 0310K ohm	(brown-black-orange-gold)	CFR1/4-103
() 08100K ohm	(brown-black-yellow-gold)	CFR1/4-104

SIP Network

() 022.2K, 6-pin 2.2K or 222	SIP6C-222
-------------------------------	-----------

IC Sockets

() 0108 pin	DIPS-08
() 0214 pin	DIPS-14
() 0216 pin	DIPS-16
() 0118 pin	DIPS-18
() 0140 pin	DIPS-40

Miscellaneous

- () 0111.0592 MHz Crystal XTAL-11.0592
- () 01TO220 style Heat Sink
- () 014-40 machine screw
- () 014-40 hex nut
- () 014-40 lockwasher
- () 01push-on jumper
- () 01METCON1 PCB Board, Rev 2
- () 01Assembly Manual
- () 01Operations Manual

Parts for Optional Four-Channel Output Expansion

- () 024-position wire-clamp RDI4SV
- () 04SPST Reed Relay, 12-volt coil RLx-001
- () 041N4148 Diode 1N4148

CONSTRUCTION

Note that the PC board is has two trace sides with plated-through holes joining them. This means that you must use a temperature-controlled soldering iron, fine 60/40 or 63/37 rosin core solder and painstaking care when making each and every joint. The reward will be a superior device of excellent reliability. The alternative will most likely be erratic operation.

In addition to the soldering iron and solder, you will need small flush or semi-flush cutting pliers and small-tipped long nosed pliers. A magnifying glass may prove helpful to identify the values of the small components. A lead-bending jig will help maintain a neat appearance for the resistors and other axial leaded parts.

Pay careful attention to the directions that follow. Keep the tip of your soldering iron bright and clean, wiping it frequently on a wet rag or sponge. Make solder joints carefully, but swiftly. Prolonged heat on a PC board pad can be as disastrous as too much heat, and ruining this PC board can be expensive! Two to three seconds should be enough time to apply heat to any joint.

IC SOCKETS

Check the PC board to make sure that the exposed, tinned pads are clean and shiny. If they are not, scrub the board lightly with a household cleanser (such as Ajax or Comet), rinse in fresh, clean water then dry with a soft towel.

() PC board clean.

Component installation will generally proceed from left to right and top to bottom of the PC board when the board is held so that the silkscreen legend "METCON-1" is right-reading at the upper right of the PC board.

You may find it helpful to refer to the parts layout sheet provided with this kit for clarification when installing parts as you construct your METCON unit.

NOTE: IC sockets are polarized. The end nearer pin 1 is marked with a notch, a beveled corner, or the numeral "1" embossed in the plastic body of the socket. The PC board silkscreen is marked with a notch at the pin 1 end.

When installing an IC socket, be sure all pins are through the PC board, then tack solder a diagonally opposite pair of pins. Double check that the socket is flush against the PC board surface and that all pins are through, then solder the remaining pins. Finally, re-solder the original two tack-soldered pins.

Install the following IC sockets:

- U1 16 pin
- U2 14 pin
- U3 14 pin
- U4 08 pin
- U5 40 pin
- U7 16 pin
- U8 18 pin

Solder connections should appear bright and shiny, with a concave fillet between the PC board pad and the socket pin. Grey, grainy-looking joints, round solder blobs or pads not completely and evenly covered with solder will result in an unreliable joint. Such joints should be re-soldered, using a good grade of rosin-core flux to ensure the joint is clean and that the solder adheres.

Now, double check the solder connections you have made.

- Solder joints OK.

Take this opportunity to verify that there are no leftover IC sockets.

- No IC sockets remaining.

Now, once again inspect each of the solder connections, preferably with a magnifying glass. We cannot over-emphasize the importance of these connections.

() All solder joints inspected and look great to me!

RESISTORS

Resistors used in this kit are in two forms: discrete, axial-leaded resistors and single-in-line (SIP) resistor packs or networks.

Due to space limitations and other conflicts, all resistor locations on the PC board may not have the identifier (such as R38) printed on the board. The parts layout sheet at the end of this manual will identify the locations of all resistors, however, so continue to pay close attention to the manual and the PC board.

Discrete resistors have color-coded bands denoting their value. The color code will be given in each step to aid you in identifying the value. If you have any doubt about a resistor's value, we suggest you measure it with an ohmmeter before you install it. We have tried to limit the number of different values, but it is better to be careful than to try and remove and re-install a resistor on a plated-through-hole PC board!

When installing discrete resistors, bend the leads and then insert the resistor so that its body is flush with the PC board surface. (A lead-bending jig may help for neatest appearance. Resistor leads are on 0.5" (12.7 mm) centers.) Then bend the leads slightly to secure the part in place. After placing a number of resistors, you will be instructed to solder the leads and clip the excess lead lengths. At that time a count of solder joints will be given as an aid to ensure you didn't overlook a lead or two.

Sometimes resistors are supplied between two strips of tape. These parts are best removed from the tape by cutting them rather than by pulling them out. This prevents the tape adhesive from getting into the PC board holes and possibly degrading solderability.

The SIP network has the value printed on the body of the part. A 2200 ohm network might be identified with the number series "222" or "2.2K". Again, be sure of the component before you solder it on the board.

To install the SIP, tack solder the two end pins, verify the part is properly seated on the PC board, then solder the remaining pins. Next, re-solder

the two tack-soldered end pins and inspect the solder connections before proceeding on to the next SIP.

Finally, note that the SIP network is polarized. There is one pin to which the various internal resistors have a common connection. This end of the network is marked with a dot or square or bar. This is pin 1. Pin 1 on the PC board is identified with a square pad. There is no other identification on the PC board. We will point out the orientation of pin 1 in the step that calls out the part. Again, be very careful -- a reversed network can be a difficult problem to troubleshoot.

Install the following parts:

SIP Networks

- | | | | |
|-----|------|-------------|-----------------------------|
| () | SIP1 | 2.2K or 222 | 6 pin Pin 1 right, above J1 |
| () | SIP2 | 2.2K or 222 | 6 pin Pin 1 right, below J1 |

Discrete Resistors

- | | | | |
|-----|-----|-------------------------------------|---------------------------|
| () | R1 | 100K | (brown-black-yellow-gold) |
| () | R2 | 100K | (brown-black-yellow-gold) |
| () | R3 | 100K | (brown-black-yellow-gold) |
| () | R4 | 100K | (brown-black-yellow-gold) |
| () | R5 | 100K | (brown-black-yellow-gold) |
| () | R6 | 100K | (brown-black-yellow-gold) |
| () | R7 | 100K | (brown-black-yellow-gold) |
| () | R8 | 100K | (brown-black-yellow-gold) |
| () | | Solder and clip sixteen (16) leads. | |
| () | R9 | 4.7K | (yellow-violet-red-gold) |
| () | R10 | 4.7K | (yellow-violet-red-gold) |
| () | R11 | 4.7K | (yellow-violet-red-gold) |

- () R12 4.7K (yellow-violet-red-gold)
- () R13 4.7K (yellow-violet-red-gold)
- () R14 4.7K (yellow-violet-red-gold)

- () Solder and clip twelve (12) leads.

- () R15 10K (brown-black-orange-gold)
- () R16 1K (brown-black-red-gold) NOT D2!
- () R17 10K (brown-black-orange-gold)
- () R18 10K (brown-black-orange-gold)
- () R19 4.7K (yellow-violet-red-gold)
- () R20 4.7K (yellow-violet-red-gold)

- () Solder and clip twelve (12) leads.

- () R21 2.2K (red-red-red-gold)

- () Solder and clip two (2) leads.

You should have no SIP networks remaining and no discrete resistors left.

- () No SIP networks remaining.
- () No discrete resistors remaining.

Now, once again carefully inspect the board for any poor solder joints, and correct any that you find.

- () All solder connections look simply wonderful!

CAPACITORS

The next components to be installed are capacitors. These come in ceramic monolithic radial-leaded devices which are non-polarized, and electrolytic radial-leaded devices which are polarity sensitive. You will first install the ceramic, non-polarized parts.

Ceramic Capacitors

These parts should sit on the PC board and parallel with it. As with the discrete resistors, you will be instructed when to solder, so just install and bend leads until then.

NOTE: Capacitors C1-C8 should only be installed if you have a confirmed RFI problem on inputs INPO-INP7. Under no circumstances (RFI or not) should they be installed on inputs that will be used for frequency or pulse counters.

Install the following parts:

- () C9 0.01 μ F (103)
- () C10 0.01 μ F (103)
- () C11 0.01 μ F (103)
- () C12 0.01 μ F (103)
- () C13 0.01 μ F (103)
- () C15 33 pF (330)
- () C16 33 pF (330)
- () C18 0.01 μ F (103)

() Solder and clip sixteen (16) leads.

- () C19 0.01 μ F (103)
- () C20 0.01 μ F (103)
- () C25 0.01 μ F (103)
- () C26 0.01 μ F (103)
- () C27 0.01 μ F (103)
- () C28 0.01 μ F (103)

() Solder and clip twelve (12) leads.

You should have no ceramic capacitors remaining except up to eight (8) 0.01 μ F parts not installed at C1 through C8.

() All ceramic capacitors have been used except as noted.

Now, once again carefully inspect the board for any poor solder joints, and correct any that you find.

() All solder connections look wonderful!

Polarized Capacitors

The next group of components you will install are the polarized capacitors. These may be aluminum electrolytic or tantalum types.

Electrolytic capacitors are cylindrical with radial leads (meaning both leads come out one end). The negative lead is usually marked with a black band filled with minus signs. In addition, this lead is usually shorter than the positive one.

Tantalum capacitors, in addition to having incredibly small, hard to read print, mark the positive lead with little plus signs on one side of the part. Tantalums are usually a sort-of teardrop shape.

The PC board silkscreen is marked with a plus (+) sign near the positive lead. The positive lead pad is square.

Be sure to get the positive lead in the square pad, no matter which type of part you are installing, and press the body of the part firmly against the surface of the PC board before soldering.

Install the following parts:

- () C14 10 uF(106)plus to the left
- () C17 100 uF (107)plus to the left

- () Solder and clip four (4) leads.

- () C21 10 uF(106)plus to the left
- () C22 10 uF(106)plus to the left
- () C23 10 uF(106)plus to the left
- () C24 10 uF(106)plus to the left
- () C29 10 uF(106)plus to the left

- () Solder and clip ten (10) leads.

REMAINING COMPONENTS

You will now be instructed to install the remaining parts on the PC board. Some of these parts are polarized, so continue to pay careful attention to the directions.

Headers

The single-row headers are used to form expansion connectors or to allow jumper selection of various operational configurations.

When soldering a header to the PC board, hold it against the board with your finger while you tack-solder a pin to the board (small headers) or a pin at each end of the header (longer headers).

NOTE: Do not solder the pin(s) which you are holding with your finger! The pins quickly get very hot and you may injure yourself!

After you tack-solder the header in place, inspect it for mechanical placement and appearance. It should sit firmly against the surface of the PC board and rise perpendicularly from it. If it doesn't, re-heat the tacked joint (s) and re-position the part until you are satisfied with it. Then solder the remaining pins. Finally, re-solder the tack-soldered connection(s).

Install the following parts:

- () P1 07-pin single-row header
- () RST 02-pin single-row header
- () SYS 02-pin single-row header
- () DCD 02-pin single-row header

() Inspect the solder connections and repair any that aren't perfect.

Voltage Regulator

The voltage regulator is in a three-lead plastic-bodied case. This regulator is for positive five volts, needed by the microcomputer and other chips in METCON.

The regulator should match up with the silkscreen outline. First, place the regulator on the PC board, lining up the mounting hole on the metal tab of the regulator with the hole in the PC board. Note the location of the lead holes on the PC board. Remove the regulator, and bend the three (3) leads so they will pass through the PC board holes provided. Then, place the regulator on the heat sink and attach it to the heat sink and PC board with a 4-40 machine screw, lockwasher and nut. The nut should be on the component side of the board.

() U6 7805

() Solder and clip three (3) leads.

Crystal

The crystal is in a metal can and it contains a somewhat fragile wafer of quartz. It should be mounted with its large side against the PC board with the leads bent up then arched downwards. Place the crystal on the board, then solder and clip the two leads.

() Y1 11.0592 MHz

Diodes

Diodes are polarity sensitive. The cathode is marked on the PC board silkscreen with a band at one end. The diode similarly has a band at the cathode end. The cathode lead also has a square pad on the PC board.

The two diode types used in METCON are similar in appearance, but very different in characteristics and application. Match the part number of the diode to the callout before soldering.

As with the resistors, holes are on 0.5" (12.7 mm) centers.

Install the following parts:

- D1 1N4002 (cathode left)
- D2 1N4148 (cathode left)

- Solder and clip four (4) leads.

Save the clipped leads from D1 for use as test points later.

- D3 1N4148 (cathode left)
- D4 1N4148 (cathode left)
- D5 1N4148 (cathode left)
- D6 1N4148 (cathode left)
- D7 1N4148 (cathode left) PART OF 4-CHANNEL OUTPUT OPTION
- D8 1N4148 (cathode left) PART OF 4-CHANNEL OUTPUT OPTION
- D9 1N4148 (cathode left) PART OF 4-CHANNEL OUTPUT OPTION
- D10 1N4148 (cathode left) PART OF 4-CHANNEL OUTPUT OPTION

- Solder and clip eight/sixteen (8/16) leads.

Relays

Metcon uses SPST normally open reed relays for controlling outputs. These relays have three (3) pins at one end and a single (1) pin at the other end. Match the relay to the silkscreen outline, then solder each one in place before proceeding to the next.

Install the following parts:

- K1 SPST Reed Relay
- K2 SPST Reed Relay
- K3 SPST Reed Relay
- K4 SPST Reed Relay
- K5 SPST Reed Relay PART OF 4-CHANNEL OUTPUT OPTION
- K6 SPST Reed Relay PART OF 4-CHANNEL OUTPUT OPTION
- K7 SPST Reed Relay PART OF 4-CHANNEL OUTPUT OPTION
- K8 SPST Reed Relay PART OF 4-CHANNEL OUTPUT OPTION

- Clip sixteen/thirty-two (16/32) leads.

There should be no remaining relays.

() All relays installed.

Connectors

METCON uses wire-clamp connectors and a DE9P serial port connector.

The wire-clamp connectors should be mounted flush to the PC board surface with the wire-entry ports to the outside edge.

J1 consists of four (4) each three-pin wire-clamp connectors. Line up the body of the connector with the silkscreen outline. The labels "INx" and "GND" should be plainly visible after the connector is positioned. You will only use 1/2 of the provided holes in the PC board -- the pattern on the board will accept a number of styles of connectors from a variety of sources, so don't worry about the empty holes!

Solder the pins on each connector before proceeding to the next one.

Install the following connectors:

- | | | | |
|-----|----|-------------|-------|
| () | J1 | IN0/GND/IN1 | 3-pin |
| () | | IN2/GND/IN3 | 3-pin |
| () | | IN4/GND/IN5 | 3-pin |
| () | | IN6/GND/IN7 | 3-pin |
| () | J2 | Power | 2-pin |

The DE9P connector mounts with the mating portion of the connector hanging over the PC board top edge. It is held in place with its soldered leads. If the connector has a pair of solderable mounting pins, the pins may need to be compressed before insertion.

() P2 RS232 DE9P

Test points are provided for checking the power supply as well as providing convenient places to clip test leads when troubleshooting METCON. Test points are made by forming a cut off lead from D1 around a 1/8" (3mm) drill bit, then placing the resulting loop of wire through the

two holes in the PC board provided. The loop of wire then serves as the test point or grounding point for an oscilloscope probe or other test device. The loop should protrude about 1/4" (6mm) from the surface of the PC board.

Solder the wires and clip them as you install each test point.

- () GND test point - loop
- () +5V test point - loop
- () TP1 test point - frequency counter

J3 consists of two (optionally four) (2 or 4) each four-pin wire-clamp connectors. The notes for J1, above, apply.

Install the following connectors:

- () J2 OUT0/OUT1 4-pin
- () OUT2/OUT3 4-pin
- () OUT4/OUT5 4-pin PART OF 4-CHANNEL OUTPUT OPTION
- () OUT6/OUT7 4-pin PART OF 4-CHANNEL OUTPUT OPTION

You should have no remaining connectors or other PC mounted components.

You have completed all soldering operations on the PC board. At this point, you should take a break for at least five or ten minutes and relax.

Now that you are back, you need to perform a careful inspection of the PC board. You will be checking the back of the PC board for good solder joints. We know you have already grown bored with this, but it is very important.

You also need to carefully inspect the top of the board in case some solder accidentally found its way through the holes and flowed to cause a short circuit somewhere. Or, perhaps a component got damaged while work was proceeding elsewhere on the board. It is better to find and fix all such problems now.

- () This board is inspected and looks good.

You should have one (1) push-on jumper and seven (7) ICs in addition to any 0.01 uF caps noted previously.

() Correct parts remaining.

TESTING

It is now time to apply power to your unit and check its basic operation. You will need a 12-volt DC power supply as well as several pieces of wire to insert in the wire clamp connectors.

A number of commands will be issued to METCON. These commands are explained in the METCON SYSTEM MANUAL ; in this manual, please type them exactly as they appear. What you type is underlined. What METCON responds with is bold .

() Apply power at J2, carefully observing polarity.

() Measure the voltage between the GND and +5V test points. The voltage should measure between +4.7 and +5.3 VDC. Do not proceed until the voltage measures between these limits .

() Remove power and, observing polarity and anti-static precautions, install the following ICs:

() U174HC151

() U274HC14

() U374HC14

() U49306/9346

() U587C51

() U7MAX232/TSC232/DS1228

() U82595

() Wire up an RS232 connector and attach METCON to a serial port on your computer. Use the DE9S 9-pin connector provided.

DE9S METCON	DB25S PC	DE9S AT	DB25P TNC	FUNCTION
5	7	5	7	GND
2	3	2	2	TXD FM METCON
3	2	3	3	RXD TO METCON
4			20	DTR FM METCON
1			8	DCD TO METCON

() If your computer or TNC doesn't provide DCD, you must place a temporary short at the DCD location on METCON.

() Turn on your computer, load the terminal emulator program and set the computer's serial port for 1200 bps, 7 bits, even parity.

() Place a jumper at the SYS location on METCON.

() Apply power to METCON. You should see a sign-on message similar to the following:

```
METCON-1 921031-1.06
Copyright (c) 1991-1992 T.A.P.R. All Rights Reserved.
Checksum: 0x72E4
```

```
-A- ??? EEPROM ERROR ???
```

() There may be additional lines of information sent from METCON to your computer. Ignore them for now.

() Type
=AEW<CR>

where <CR> means to press the <RETURN> or <ENTER> key on your computer's keyboard.

METCON will respond with

-A- EEPROM WRITE/READ OK

() Cycle power off then on (or briefly short the RST jumper) and the sign-on should appear without the EEPROM error message.

Congratulations! You have just verified the basic operation of the METCON-1 power supply, microcomputer, serial I/O and EEPROM subsystems.

The next tests will check the input circuitry at the J1 DIGITAL INPUT connector.

To perform these tests, prepare a length of insulated hookup wire. Use a wire of 3" to 6" in length (7.5 to 15 cm) with about 1/2" (1.2 cm) of insulation removed from each end.

As before, what you type to the computer will be underlined and METCON's response will be bold .

() Wire prepared.

()Type =ary09<CR> and you should see -A- 09-255 FF 1111 1111 .

For the next eight steps, if the METCON response isn't as indicated, then the input channel you are testing has a problem. Isolate and repair it before proceeding.

NOTE :METCON may take up to one (1) second to record an input change. If you don't get the response you expected from METCON, wait one (1) or more seconds, then try again.

()Using the wire, jumper IN0 and GND at J1 , then type =ary09<CR> and you should see -A- 09-254 FE 1111 1110 .

()Move the jumper to IN1 and GND at J1 , type =ary09<CR> and you should see -A- 09-253 FD 1111 1101 .

() Move the jumper to IN2 and GND at J1 , type =ary09<CR> and you should see -A- 09-251 FB 1111 1011 .

() Move the jumper to IN3 and GND at J1 , type =ary09<CR> and you should see -A- 09-247 F7 1111 0111 .

() Move the jumper to IN4 and GND at J1 , type =ary09<CR> and you should see -A- 09-239 EF 1110 1111 .

() Move the jumper to IN5 and GND at J1 , type =ary09<CR> and you should see -A- 09-223 DF 1101 1111 .

() Move the jumper to IN6 and GND at J1 , type =ary09<CR> and you should see -A- 09-191 BF 1011 1111 .

() Move the jumper to IN7 and GND at J1 , type =ary09<CR> and you should see -A- 09-127 7F 0111 1111 .

() Remove the jumper at J1 , then type =ary09<CR> and you should see -A- 09-255 FF 1111 1111 .

At this point, you can be sure all the input circuits are working properly.

The frequency counters will be checked next.

NOTE :METCON may take up to eight (8) seconds to record a frequency count. If you don't get the response you expect from METCON, wait eight (8) or more seconds, then try again.

() Using the jumper wire from the preceding tests, connect it between IN0 at J1 and test point TP1 .

NOTE:TP1 provides a 20 Hz square wave output whenever METCON is running. This buffered output is capable of driving all eight (8) inputs of J1 simultaneously.

() After a pause of at least eight seconds, type =amap<cr> and you should see a response something like the following:

-A- MEMORY DISPLAY

```
    P6    P5    P4    P2    P0
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 OUT
(08 07 06 05 04)
0000 0000 0000 0000 0000 0000 0000 0000 1111 1110 IN
(0D 0C 0B 0A 09)
0000 0000 0000 0000 0000 0000 0000 0000 1111 1111 CHG
(12 11 10 0F 0E)
```

```
    7    6    5    4    3    2    1    0
00000 00000 00000 00000 00000 00000 00000 00020 F/P
CTRS (21/22-13/14)
```

```
    7    6    5    4    3    2    1    0
255 255 255 255 255 255 255 255 ADC (2A-23)
```

-A- MEMORY DISPLAY COMPLETE

() Note the reading of 00020 under section 0 of the line ending "F/P CTRS (21/22-13/14)". If the reading is other than 20, wait at least eight (8) seconds, then type =amap<cr> and it should read 00020.

() Continue testing the remaining inputs by moving the jumper to IN1 then typing =amap<cr>, then IN2 and so forth. The line labelled "F/P CTRS (21/22-13/14)" should display "20" at the location corresponding to the input channel (section "0" for IN0 , etc.).

The next tests will check the operation of the relays. For this you will need to prepare eight (optionally sixteen)(8 or 16) pieces of hookup wire at least 8" (20 cm) and preferably about 12" (30 cm) long. Strip the ends as previously directed.

() Eight (or sixteen) wires prepared.

These wires will be placed between the RELAY OUT connector (J3) and the DIGITAL IN connector (J1).

() Clamp a wire at one of the OTO connections of J3 . Clamp the other end of this wire at IN0 of J1 .

()Clamp a wire at one of the OT1 connections of J3 . Clamp the other end of this wire at IN1 of J1 .

()Clamp two (2) wires at the GND connection of J1 between IN0 and IN1 .

()Clamp a free end from one of these wires to the remaining OT0 connection at J3 .

()Clamp the other free end to the remaining OT1 connection at J3 .

()Clamp a wire at one of the OT2 connections of J3 . Clamp the other end of this wire at IN2 of J1 .

()Clamp a wire at one of the OT3 connections of J3 . Clamp the other end of this wire at IN3 of J1 .

()Clamp two (2) wires at the GND connection of J1 between IN2 and IN3 .

()Clamp a free end from one of these wires to the remaining OT2 connection at J3 .

()Clamp the other free end to the remaining OT3 connection at J3 .

NOTE: The next ten (10) steps are only to be performed if you have installed the 4-channel output option.

()Clamp a wire at one of the OT4 connections of J3 . Clamp the other end of this wire at IN4 of J1 .

()Clamp a wire at one of the OT5 connections of J3 . Clamp the other end of this wire at IN5 of J1 .

()Clamp two (2) wires at the GND connection of J1 between IN4 and IN5 .

()Clamp a free end from one of these wires to the remaining OT4 connection at J3 .

()Clamp the other free end to the remaining OT5 connection at J3 .

()Clamp a wire at one of the OT6 connections of J3 . Clamp the other end of this wire at IN6 of J1 .

()Clamp a wire at one of the OT7 connections of J3 . Clamp the other end of this wire at IN7 of J1 .

()Clamp two (2) wires at the GND connection of J1 between IN6 and IN7 .

()Clamp a free end from one of these wires to the remaining OT6 connection at J3 .

()Clamp the other free end to the remaining OT7 connection at J3 .

Please double-check your wiring. You have connected the relay outputs to the digital inputs. The internal current source for each input will be shunted to ground when the corresponding relay is closed. This will enable you to test each relay output with your known-working digital inputs.

() Wiring double checked.

()Type =awy05ff<CR> and note the response of -A- 05-255 FF 1111 1111 .

()Enter =ary09<CR> and you will see -A- 09-000 00 0000 0000 if you have eight relays installed, or -A- 09-240 F0 1111 0000 if you have four relays installed.

This indicates that all four (4) or eight (8) relays have closed their contacts. If your response is different, it may mean that one or more relays are malfunctioning. Double check the wiring once more. If the response still isn't right, the relay is probably suspect.

()Enter =awy0501<CR> and you will see -A- 05-001 01 0000 0001 .

() Now type =ary09<CR> and look for a response of -A- 09-254 FE 1111 1110 . This verifies K1.

() Enter =awy0502<CR> and you will see -A- 05-002 02 0000 0010 .

() Then type =ary09<CR> and look for -A- 09-253 FD 1111 1101 . K2 is now checked.

() Type =awy0504<CR> and expect -A- 05-004 04 0000 0100 .

() Next type =ary09<CR> and look for -A- 09-251 FB 1111 1011 . K3 is verified.

() Type =awy0508<CR> and expect -A- 05-008 08 0000 1000 .

() Now type =ary09<CR> and look for -A- 09-247 F7 1111 0111 . K4 is OK.

NOTE: Perform the following eight (8) steps only if you have the 4-Channel Output Expansion Option installed.

() Enter =awy0510<CR> and you will get -A- 05-016 10 0001 0000 .

() Then type =ary09<CR> and look for -A- 09-239 EF 1110 1111 . This verifies K5.

() Now enter =awy0520<CR> and get -A- 05-032 20 0010 0000 .

() Then enter =ary09<CR> and look for -A- 09-223 DF 1101 1111 . K6 is OK.

() Enter =awy0540<CR> and you will get -A- 05-064 40 0100 0000 .

() Then type =ary09<CR> and look for -A- 09-191 BF 1011 1111 . This verifies K7.

() Now enter =awy0580<CR> and get -A- 05-128 80 1000 0000 .

() Then enter =ary09<CR> and look for -A- 09-127 7F 0111 1111 . K8 is OK.

All units perform the next two steps.

() Now enter =awy0500<CR> and get -A- 05-000 00 0000 0000 .

() Finally, type =ary09<CR> and look for -A- 09-255 FF 1111 1111 .

All the relay outputs have now been checked.

() Remove the jumper wires from connectors J1 and J2.

() Remove power from your METCON-1 kit.

() Disconnect your computer from METCON-1.

This completes initial checkout of your METCON-1 unit. Proceed to the METCON SYSTEM MANUAL for further information.