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T-238+

T-238+ Operations Manual

Introduction

The Operations Manual describes the operation and programming of the TAPR T238+. Use this manual once you have assembled and verified the basic operations of the T238+ following the instructions in the Assembly Manuals for the main board and modem board. While the assembly manual can be for any T238+ application, this operations manual is specifically for the weather application.

The Motorola MC68HC908GP32 microcontroller that comes with the T238 kit has been pre-programmed with the Dallas Semiconductor 1-Wire® APRS® Weather Station Application. If you've just finished the last steps in the T238+ Assembly Manuals, you can proceed to the Section 1, Operating the Station in this manual.

Updates and improvements for the Weather Station Application will be posted at http://www.beals5.com/wx and select downloads. You can update the program in your T238+ using the DOS utility MON08. Section 3, Updating Firmware Using MON08 explains how.

The T238+ is a general purpose microcontroller based platform that interfaces with Dallas Semiconductor's 1-Wire® products. The Weather Station Application is just one possible application that can be programmed into the T238+. Any application can be programmed into the T238+. Development tools for the Motorola MC68HC908GP32 microcontroller can be downloaded for free from the Internet. Section 4, Using the Motorola Development Tools tells you how and where.

The T238+ interfaces to the outside world via a serial connector, headers, and a MX-614-based packet modem. The T238+ has been optimized for end-user use, but a debug header P1 can be used for a full software development platform. Section 5, Connectors and Jumpers covers the various connectors, headers, and jumper settings on the T238+.

The Section 6, Applications tells you where you can find more T-238 applications.

This manual is written with respect to the Revision 1.15.4 firmware release. See Section 6 for websites and discussion groups for newer firmware and manuals.

DALLAS SEMICONDUCTOR 1-WIRE? APRS? WEATHER STATION APPLICATION

Section 1, Operating the Station

The micro you received from TAPR is pre-programmed with this weather application.

After powering up the T238+ for the first time is to setup the Dallas Semiconductor 1-Wire® Weather Station sensor.

After powering up the T238+ for the first time, you will get a message asking you to run the setup routines and you will be given the main menus. This will continue to happen until the setup routines have been run. Once you have run the setup routines, the weather station will immediately go into the data-gathering mode when powered up.

The first menu presented is always the "DISPLAY CURRENT DATA" menu. By pressing the Menu button, you can cycle through all the menu options. While displaying a menu option, pressing the Select button performs the action associated with that menu. If this is your first time powering up, you need to go through all the setup screens before selecting the "DISPLAY CURRENT DATA" option. If you are coming back after setting up your weather station earlier, you can skip the items that don't apply. The options are:

MENU TEXT	FUNCTION	WHEN TO SELECT
DISPLAY CURRENT DATA (SW Rev x.xx.xR)	Displays the current weather data.	Select last
SET ZULU/LOCAL TIME	Sets the internal clock.	Select on every restart unless you have a real-time clock.
UART/DISPLAY OPTIONS	Sets various display and function parameters.	Select on first power-up and when you want to change a parameter
SENSOR SETUP	Sets up the weather station sensors	Select on first power-up and when you change sensor units
POSITION STRING AND MODEM SETUP	Allows you to specify a position string for APRS packets as well as TNC parameters	Select on first power-up if you want a position string or have a modem.

The screens are explained below in the order you should execute them when setting up the weather station for the first time.

"Sensor Setup"

This is the menu that is used to have the T238+ (indoor unit) find the serial numbers of the various sensor units (outdoor units). This set-up process must be performed before any weather readings can be made.

Once you hit select, you will get quick instructions on what to press if you decide to detect each sensor, then you will be offered the opportunity to go detect each sensor one at a time. For each sensor, press Select to discover it, Menu to leave whatever settings were previously programmed.

Unless you are really good at reprogramming micros, you must have physical access to the sensor unit to perform many of these discoveries. For initial testing it is fine to perform this calibration routine on a bench, but eventually you will need to do this with the sensor outdoors or know its final orientation with it sitting on your bench. If you run into trouble with this, your best bet is to ask questions on the TAPR "WXSIG" email reflector.

SENSOR SETUP: TEMPERATURE

There is only one sensor ID for temperature sensors, but for historical reasons, there could be multiple temperature sensors. If the firmware detects two temperature sensors, it will need direction as to which sensor is the correct one to use. The most likely scenario for this is if you add an external temperature sensor to the 1-Wire® bus without removing the one that is inside the wind/temperature unit. This is a perfectly OK thing to do, but will require this extra step: You will get a message saying there are two temperature sensors and the IDs of both will be listed. Press the up/down buttons to put the asterisk next to the desired ID. Since in almost all cases you will be replacing an old DS1820 with a newer DS18S20, the ID with an eight in the fifth-to-last digit will be your new sensor. With the asterisk next to the correct sensor, press select.

SENSOR SETUP: WIND SPEED

If you have a rain gauge installed you will need to help the firmware pick which counter is the rain gauge and which is the wind speed sensor. You will be given the option of removing the rain gauge to identify the wind speed sensor or be presented with both counter IDs and choose. If you can remove the rain gauge, do so and tell the firmware it is removed. The firmware will pick the remaining counter as the wind speed counter. If you do not remove the rain gauge, tell the firmware give you the IDs and you can pick which is which. Press the up/down buttons to put the asterisk next to the ID of the wind speed sensor and press select.

SENSOR SETUP: WIND DIRECTION

Make sure the wind direction sensor is stationary, then press select to start. The T238+ supports two types of wind direction sensors, the original Dallas configuration and the AAG configuration.

With the Dallas sensors, you will be asked to rotate the weather vane clockwise slowly (looking from above). Almost any speed is acceptable as long as you don't go backwards. Remember that clockwise assumes the sensor is right side up (weather vane down). All eight sensors must be acquired in the correct sequence three times in a row for the calibration to be considered successful. The sensor sequence numbers are displayed as they are acquired.

Errors can and do occasionally happen during this process and this is OK. When an error occurs, the counting will start over again. Several retries is probably OK, but more than that may suggest a sensor problem

After the sequence is done, you will be ready to tell the T238 which direction North is. If you have an AAG sensor setup, this is the only thing you have to do. You will be asked to point the vane north (true north, not magnetic) and press select. This completes the wind direction sensor calibration.

SENSOR SETUP: RAIN GAUGE

You should only select this if you have a rain gauge. You were asked to remove the rain gauge for the wind speed calibration routine, so install it before running this routine if you have not done so already. The anemometer and rain gauge have the same sensor type (a counter). By removing the rain gauge for the anemometer and getting its ID, this routine goes out and finds the "other" ID.

You are asked to confirm that the rain gauge is installed. In addition to finding out the rain gauge sensor ID, this routine reads the current rain count and stores it as a reference for the "user" rain setting. Whenever you want to reset this user setting to zero, simply re-run this calibration routine.

SENSOR SETUP: HUMIDITY SENSOR

The humidity sensor shares a sensor ID with the Barometric pressure sensor. If you have both sensors installed, you will need to either tell the T238+ which sensor ID is which, or remove the humidity sensor from the 1-Wire network and the T238+ will pick the remaining sensor as the humidity sensor.

After selecting the sensor, you will be asked if you want to use the himidiy sensors temperature reading as your "main" temperature sensor. The typical answer is "no" as an idea location for a humidity sensor may not be ideal for accurate temperature measurements. If for some reason it is, select "Yes".

SENSOR SETUP: BAROMETRIC PRESSURE

You should only select this if you have a barometric pressure sensor. You were asked to remove the sensor for the humidity sensorcalibration routine, so install it before running this routine if you have not done so already. The barometric pressure sensor and humidity sensor have the same sensor type. By removing the barometric pressure sensor for the humidity sensor calibration and getting its ID, this routine goes out and finds the "other" ID for the BP sensor.

This completes the sensor setup routines. You can re-run the sequence any time you make any sensor changes. The only values that will get changes are for the sensors you select "yes" for during the calibration sequence.

"UART/Display Options"

Here is where you configure the weather station for various modes and options. Pressing select shows your first setting. With the setting displayed, pressing the up or down buttons cycles through your options. When you see the option you want, press select to set it and go on to the next option. The options are:

UART Settings:	
5-min avg (TNC-dir)	Send averaged data every 5 minutes in APRS format. Puts TNC in conversation mode. Expected data rate is 4800 baud.
5-min avg (TNC-LTP)	Send averaged data every 5 minutes in APRS format (For Kantronics KPC3+ LTP command mode) Expected data rate is 2400 baud
5-second live (Computer)	Send raw samples every 5 seconds in APRS format. Expected data rate is 9600 baud.
5-second live (Peet)	Send raw samples every 5 seconds in Peet format. Expected data rate is 2400 baud.
5-min avg (modem)	Send averaged data every 5 minutes in APRS format using the MX-614-based modem.

The UART settings are intended to select between the anticipated modes for the weather station. TNC modes average the data and send out only the averaged data every five minutes. Computer and Peet modes just send off each 5-second sample over the UART and let the computer do any data processing. For a full description on the data logging functions of the weather station see the "DATA FORMATS" section.

All modes send the data out the UART port. Selecting the modem mode also sends the data out MX-614-based modem and still sends averaged data out the UART.

When you change the data format, the baud rate is automatically set to the expected data rate listed in the table above. If you wish to over-ride this, you can do so on the baud rate menu (next menu).

In general you should use automatically selected baud rate. For most of the data formats the baud rate is part of the defined format. If you do need to select a specific baud rate you can do so with this menu.

UART Baud Rate:	
2400, 4800, 9600	Overrides default for a specific baud rate

The wind direction text is for the LCD. You can choose between the direction being shown as numeric degrees or compass points. This only affects the display, all the transmissions out the UART still use numeric degrees.

Wind Direction Text:	
Numeric Degrees	LCD shows numeric degrees for wind direction
Compass (E, N, etc)	LCD shows compass points for wind direction

You have the option of displaying your weather data in English or Metric units. This selection affects the LCD only, not the data transmitted by the UART. The data sent by the UART continues to follow the units specified by the selected protocol.

Select Units:	
English	LCD shows weather using English units (even though the English use metric now!). Transmitted data still follows units of published specification.
Metric	LCD shows weather data using metric units. Transmitted data still follows units of published specification.

"Set Zulu Date/Time"

This menu item is to set up the local time. When you press the select button you will be presented with a date and time field to set up. The date is in the form MM/DD/YY and the time is in the form HH:MM. This is important for several reasons. The main one is that the current Zulu (UTC) time is sent as part of every weather packet sent out, and weather data with the wrong time tag is in error and may be ignored by APRS display programs. For each field, use the up and down arrows to select the correct value (holding the button down will auto-repeat) and press the select button to go to the next field. After finishing the minutes field, you will be asked the current local hour.

The offset from Zulu time to local time is stored permanently. If you have a Dallas DS1994 real-time clock iButton™ installed on the 1-Wire network, you should use your computer and the Dallas software to set the time in the DS1994 to Zulu time. If the T238+ finds a DS1994 on the 1-wire network, then it will set the Zulu time to the time stored in the DS1994 and use the Zulu to local time offset to determine the local time. If you have unreliable power, or have your weather station in an inaccessible place, the DS1994 is essentially a requirement. Note that the T238+ does NOT set the DS1994 time, it only reads it.

After you are done setting the time, you are done and get returned to the main menu.

"Position String and Modem Setup"

This menu is used to enter a position string and set up the modem if you have it. The position string is only used in the TNC and modem formats and is optional. You are first asked if you want a string, and if so, you are asked to enter the string. The format is "ddmm.mmN/dddmm.mmW" (or S/E depending on where you are in the world). The cursor starts at the first digit. Press the up and down buttons to select the digit/letter you want, then press select to go on to the next character. Note that the format assumes decimal notation for the minutes, so 45 degrees, 30 minutes, 15 seconds would be entered as 4530.25.

After entering the position string, you will be prompted for Modem settings if Modem mode has been selected. You will only be prompted if you have a modem installed and have selected the Modem mode in the UART options menu.

The first entry is your callsign and SSID. Use the up and down arrows to select your callsign characters. Pressing select advances the character to be modified, pressing Menu clears any characters from the cursor to the end.

After you are done with your callsign and SSID, you will be prompted for up to two repeater Ids. Enter them in the same way you entered your callsign.

After the repeater IDs, you will be prompted for the "silence before PTT" time. This is the time the T238+ will wait for a silent channel before asserting PTT to start a packet transmission. 500ms is the default.

Next is "PTT to packet start". This is the time from when PTT is asserted to when the T238+ starts to send real data. The default of 500ms allows the radio to transmitter to "warm up" before actual data is sent. During this time, the T238+ is sending sync bytes (per the AX.25 spec)

"Display Current Data"

This menu item gathers weather data, displays it on the LCD, and sends it over the serial port. How it does all this depends on how options are selected before. While showing data, pressing the select button cycles through various display modes. These modes are:

Currently	
Temp 62°F Rain 0.00"	Current Temperature, rain past hour
Wnd WSW 2MPH G 5	Wind direction, Wind speed, Max speed last 5 mins.
RH 40%DP 45°BP29.71?	Humidity, Dew point, and Barometric pressure

Todays Stats	
Temp Hi 81 Low 61	Today's low and high temperature
Max Gust 14 MPH	Today's peak gust
Rain 0.00"	Rain since midnight

Yesterday	
Temp L 49°F H 61°F	Yesterday's low and high temperature
Wind Gust 14 MPH	Yesterday's peak gust
Rain 0.00"	Yesterday's total rain

Rain	
Today 0.00 Yest 0.00	Rain since midnight, total rain yesterday
Month 0.00 User 0.00	Rain since start of month, Rain since last calibration
Hour 0.00	Rain in last 60 minutes

Status	
06/04/00 01:59 Zulu	Current Month, day, year, hour, minute UTC
18:00 Lcl Bus:5.00V	Current local hour, Bus voltage
Smp 10/60 Bty:11.0V	Interval count , Battery Voltage

Error Counters	
Temp 000 Rain 000	Temperature CRC errors, Rain CRC errors
Wspd 000 Wdir 000	Wind speed CRC errors, Wind direction CRC errors
Humd 000 Baro 000	Humidity sensor CRC errors, BP sensor CRC errors

Debug Information	
H: v---- a---- t----	Humidity sensor raw data
AAG: -- -- -- --	AAG wind sensor raw data

For any screen, the data is updated every five seconds. If there are communications errors, the data that got corrupted will be replaced with dashes and that sensors error count will increment. Ideally, this should be rare, (maximum of about 10 per day). If it does start to happen often, you should try to see what you can do to correct the problem. The counters roll back to 0 after a count of 63

Hopefully you should NEVER see any erroneous data, all data is checked with CRCs to ensure accuracy. Note that your very first wind speed reading will be dashes as two consecutive wind speed counter readings are needed before a wind speed can be determined. This is not an error and does not increase the wind speed error counter.

Bus voltage is a measurement of the 1-wire bus voltage as it leaves the T238. There are several failure modes where this voltage can be low. If your displayed voltage is above 4.00V you should be OK. A voltage between 4V and 3.5V is marginal, and anything less than 3.5V will likely result in many errors reading data. If you have a low bus voltage your best hope is to selectively remove 1-wire devices from the bus to isolate which device is causing the problem and then repair or replace that device. The status screen also shows the voltage coming into the T238+ before the regulator. This may be handy for monitoring the battery for a solar powered station.

The Debug information screen is for showing raw data from some problematic sensors. The data displayed on this screen will likely be dynamic from version to version depending on what issues may be being discussed on the WXSIG forum.

DS1994 Real Time Clock Support

The DS1994 is an I-button device that contains both a real-time-clock and some non-volatile RAM. If a DS1994 is on the 1-wire bus during power up and the clock is programmed to be running, theT238 firmware assumes the device has the correct time and the local clock is set to match the DS1994 time. A short message is displayed during power up noting that the time was obtained from the DS1994. This is particularly handy if you experience regular power outages and do not want to reset the clock every time. The RAM is currently not used, but some data logging functions are envisioned.

When you program the DS1994 using your computer, set the time on the DS1994 to UTC. After powering up for the first time using the DS1994, re-run the set-time routine once more to set the correct local time. This saves the UTC to local time offset in permanent memory and then you should never need to set the clock manually again.

Missing Rain Gauge Support

If the rain gauge sensor is missing during power-up a short message is displayed noting the missing sensor and rain data is ignored (and error counts do not increment) until power is cycled again. This feature allows the rain gauge to be removed for the winter in the colder climates without having to recalibrate sensors to remove then re-add the sensor during the spring.

Section 2, Data Formats

The weather station currently supports sending data in two basic formats using four specific modes. Selecting which format you want is done using the "UART/DISPLAY OPTIONS" menu and selecting which format you want. They are listed below:

Selection	Recipient	Data Format
5-min averaged (TNC-dir)	TNC	APRS Format
5-min averaged (TNC-LTP)	TNC	APRS Format
5-second live (Computer)	Computer	APRS Format
5-second live (Peet)	Computer	Peet format
5-min averaged (modem)	Modem	APRS format

Note that whatever mode is selected, the data displayed on the LCD is unaffected.

5-Minute Averaged (TNC-Dir) Mode

The TNC mode is intended for just that, hooking up to a TNC. If your intentions are to hook up to a computer, you can safely ignore this section, it is pretty much for ham radio folk only. In this mode, when you start gathering data, commands are sent out to the TNC to initialize it as a weather broadcaster. The TNC is programmed for the un-attached conversation mode so that whenever a string of data is sent to the TNC, it immediately transmits it.

Except for the newer Kantronics KPC3+es, the GPS logging mode found in most newer TNCs is not used as it is not ideal for this application. (See next section for the KPC3+) The logging modes on TNCs assume that data is constantly being fed to the TNC and at the appropriate interval, the latest complete set of data received is transmitted. For GPS operations this is fine, but for weather operations averaged data is much more valuable. If the weather station transmitted averaged data every five minutes and the TNC was set up to transmit data every five minutes, when they got out of sync, the data transmitted would be nearly 10 minutes old.

> Forgive me a small soapbox: AVERAGED data is important! This is especially true for wind direction. An instantaneous wind sample at a particular moment in time is useless. If you look at wind vane on any weather station, you can see how much it varies over a period of even a few seconds, never mind five minutes. Taking a snapshot once every five minutes (like you get with all the off-the-shelf amateur weather stations) is horribly inaccurate. For this weather station we go to great lengths to figure out a good averaged wind speed that is much more representative of what the real wind direction is. We now return to the regular dispassionate manual.

In the un-attached mode, the TNC is in conversation mode all the time but not attached to any other TNC. As such, it sends the data to the UNPROTO destination you programmed into your TNC. This should be something like "APRSW via {your favorite path}". When five minutes of data have been averaged, the weather station sends the data to the TNC and it is transmitted as soon as the TNC finds an opening in the channel.

When the weather station is in TNC mode, it will try to initialize the TNC when you tell it to start displaying data. The sequence consists of flushing any pending data out of the TNC and sending four commands and a version string to the TNC. The sequence is:

^C	to make sure we are in command mode
Monitor off	to keep data from coming back into the TNC
Echo off	to also keep data from coming back into the TNC
Convers	to get into conversation mode
Wx start (x.xx.x)	broadcast the current firmware version.

If you also use the TNC for packet messages and the like, you are going to need some kind of data switch for the TNC to select between the computer and weather station. When you change over to the computer, you will need to issue two commands to get the TNC back into a computer-friendly mode. The first is a "^C" to get back to command mode and finally "echo on" to be able to see what you are typing. Setting a function key to send this script is particularly handy.

While in display mode the weather station sends out data to the TNC. The data is sent out every five minutes or 60 samples. The data consists of the averaged wind direction, speed, and temperature. The string transmitted follows the APRS weather format and looks like the following:

```
_MMDDHHMMcxxxsxxxgxxxtxxxPxxxrxxxhxxbxxxxxe
1w where
```

_	Is the character to flag weather data
MMDD	is the month and day (Zulu)
HHMM	is the hour and minute (Zulu)
cxxx	is wind direction (degrees)
sxxx	is wind speed (MPH)
gxxx	is wind gust (MPH)
txxx	is temperature (Farenheight)
Pxxx	Is rain since midnight (1/100ths of an inch)
rxxx	is rain past hour (1/100ths of an inch)
hxx	Is the relative humidity (01-99)
bxxxxx	is the Barometric Pressure
e1w	is the project identifier (Embedded, 1-wire)

With Rev 1.15.2 and later, the gust speed reported on APRS is the max speed for the past 10 minutes instead of the last five minutes. This is to meet NWS reporting requirements.

The only part of the string that may not be 100% APRS-compatible is the project identifier. The current spec does not include an option for a project such as this (choices are PIC-E, Dos, Win, Mac, and Linux). The APRS folk acknowledge this small hole in the spec and will update the spec soon. Until then I will leave the existing format.

The baud rate chosen for TNC mode is 4800 baud. This was chosen primarily because that is what most of the GPS receivers use and we wanted to be able to use the same baud rate everywhere.

5-Minute Averaged (Tnc-Ltp) Mode

This mode is very similar to the 5-Minute Averaged (TNC-dir) mode. This mode is specifically for the Kantronics KPC3+ TNCs that have a firmware revision greater than 8.2. These TNCs essentially have a second serial port that can accept input-only data while leaving the main serial port for other uses. This port was intended for a GPS input, but works just fine for the weather input as well. The data sent in this mode is identical to the direct mode in all ways except that it does not send the initialization strings, only the weather data.

5-Second Live (Computer) Mode:

In computer mode only raw (un-averaged) data is transmitted. The data is sent out every five seconds at 9600 baud. This mode is much simpler than the TNC mode as there are no special initialization commands. All the intelligence is assumed to be in the computer. The data transmitted is very similar to the APRS format used in TNC mode except the gust data is omitted. The format is as follows:

`_MMDDHHMMcxxxsxxxtxxxPxxxrxxxhxxbxxxxxe1w`
where

_	is the character to flag weather data
MMDD	is the month and day (Zulu)
HHMM	is the hour and minute (Zulu)
cxxx	is wind direction (degrees)
sxxx	is wind speed (MPH)
txxx	is temperature (Farenheight)
Pxxx	Is rain since midnight (100ths of an inch)
rxxx	is rain past hour (100ths of an inch)
hxx	Is the relative humidity (01-99)
bxxxxx	is the Barometric Pressure
e1w	Is my project identifier (Embedded, 1-wire)

DEBUG STRINGS

For both the TNC and computer modes, debug strings are added on to the end of the APRS string for debug purposes. The Peet format does not support additional data and does not support this feature. The debug string consists of a multi-byte hexadecimal string after the “e1w” identifier. The first byte is the message identifier and the subsequent bytes are the data bytes. Currently only two message types exist.

5-Minute Live (Peet) Mode:

This mode is intended to emulate a Peet weather sensor so other computer programs (and standalone displays) that expect the Peet format can accept data from this weather station. The format I intend to support is called

Header	Data
00	aa bb cc Firmware revision aa is huge rev (01 for 1.11.0) bb is major rev (0b for 1.11.0) cc is minor rev (00 for 1.11.0)
01	aa bb cc dd ee ff gg Error counters aa = Temperature error counter bb = Wind Speed error counter cc = Wind Direction error counter dd = Rain Guage error counter ee = Humidiyt sensor error counter ff = barometric pressure ee = Bus static voltage (ff=5.00V)

the “data logging mode”. This mode sends data in the following format:

`!!aaaabbbbccccddddeeeeffffgggghhhhiiiijjjjk`
`kkk` where

!!	is the header
aaaa	is wind speed (.1KPH)
bbbb	is wind direction (00-ff)
cccc	is Temperature in (.1 degrees F)
dddd	is Long term rain (---- for now)
eeee	is Barometric pressure
ffff	is indoor temperature (---- for now)
gggg	is outside humidity
hhhh	is inside humidity (---- for now)
iiii	Date (day of year)
jjjj	Time (minute of day)
kkkk	Rain since Midnight (100ths of an inch)

All data fields are 4-digit ASCII hex values. For full details on this format, consult http://www.peetbros.com and select “Serial data specs.” On that sheet, look for the “Data Logging mode” section and all will be revealed.

Section 3, Updating Firmware Using MON08

NOTE: The micro in the TAPR T238 Kit it pre-programmed. This section is needed if you are building a T238 from scratch or you have a firmware update.

There are actually two programs inside the micro. The first is a downloader that allows updating the weather station code without having to use all the Motorola tools. The second is the weather station program itself that gets loaded by the downloader. You can think of the downloader as a miniature operating system and the weather station code as an application. If you got a kit from TAPR, the micro already has both programs loaded and is ready to run. If you have a working weather station and just want to upgrade to the latest version of weather station code, you only need to download new code. If you are building this weather station from scratch or have corrupted the downloader, then you are going to need to completely reprogram the micro using the (free) Motorola development tools.

Downloading New Code:

To just update the weather station code, you can use this simpler download process. You will need two files from the website. The first file is the latest object code, a file called WX08.S19. You will also need the DOS program MON08.EXE. After downloading these two files, reboot your computer in DOS mode (not a DOS window!) and be in a directory that has both these files.

1) Power to the weather station should be off.
2) Attach a serial cable from your computer to port J4 on the weather station.
3) Press and hold down the up and down buttons.
4) With those buttons pressed, apply power to the controller
5) You should get an LCD message stating the monitor version number.
6) On your computer, enter MON08 WX08.S19 followed by 1 or 2 for your com port number.
7) The MON08 program should now program the new code into your micro.
8) When complete the weather station should automatically start to run.

The two most likely places for problems are in steps 6 and 8. If you do not get a monitor message on power-up with the up and down buttons pressed, make sure all the jumpers and connectors are in the right place. If all checks out and you still do not get the message, then the monitor may have been corrupted for some reason. If this is the case, you have no choice but to use the Motorola tools to reprogram the entire micro. The second place for problems is during the programming process. It is essential to be in DOS mode, not a DOS window for the downloader to run. If you run into problems, just try a few times. If that still doesn't work, then your only recourse is to use the Motorola tools.

The DOS downloader isn't the greatest way to download new code, but for now it is all I have. A windows-based program would be nice, but is still only a concept. I'm not a windows programmer. Any volunteers?

Section 4, Using The Motorola Development Tools

In addition to being a ready-made kit with the weather application pre-programmed into the microcontroller, all the necessary hardware is provided for the more adventurous people to develop their own applications. A list of available development tools for the MC68HC908 can be found at http://www.beals5.com/wx and selecting links. The locations of the tools tend to move, so the above link will be kept current. Free development environment is available from P&E Microsystems at http://www.pemicro.com/ics08/. Download the file "ICS08GP Software for 68HC908GP20/GP32" which contains the following programs:

WINIDE08 – Integrated Development Environment w/ Assembler
PROG08SZ – MON08 Flash/EEPROM Programmer
ICS08Z – In-Circuit Simulator
ICD08SZ – Real Time In-Circuit Debugger

If you are starting with a blank micro, wanting to do some of your own code development, or the monitor program has been corrupted somehow, you will need to use the Motorola development tools. The toolset can be found by following the 6808 link on the links page. It is a nice toolset with plenty of decent documentation. Describing the toolset is way beyond the scope of this manual, however. Here is the basic data you need: The debug port is P1.

Note that the weather station stores the serial numbers for all your sensors in flash memory. When you use the debug tools and erase the flash, you are also going to erase all your sensor calibration values too. One option you have (besides doing the calibration every time) is to use the tools to save your data and then re-program it back in later. The source-code file wireids.asm is where these IDs should be located. In that source file are instructions on how to put your IDs into that file to save you having to re-learn the IDs every time you reprogram the Flash.

Section 5, Connectors And Jumpers

This section describes all the interfaces and options for the T238+ main board and modem board.

J1: LCD Header

J1 is the header for the Liquid Crystal Display. It is mounted to the back of the main board as the LCD module is also mounted to the back of the main board. To save microcontroller pins, the interface to the LCD uses the 4-bit mode instead of the 8-bit mode, so the lower four data pins are not connected. The signals are as follows:

Pin	Function	Pin	Function
1	GND	2	+5V
3	VLC (contrast adjust)	4	Register Select
5	Read/Write	6	Enable
7	N/C	8	N/C
9	N/C	10	N/C
11	Data 4	12	Data 5
13	Data 6	14	Data 7
15	Backlight +	16	Backlight -

J2: Front Panel

Use this connector if you want to have the four switches and LED on a separate panel that is not part of the main board. The pin functions are as follows:

Pin	Function	Pin	Function
1	Up switch	2	Down Switch
3	Select switch	4	Menu Switch
5	Heartbeat LED	6	Ground
7	Ground	8	Ground
9	+5V	10	GND

J3: Expansion Header

J3 is an expansion header with all the pins unused (or slightly used) by the main board. This is where the Modem board plugs in.

Pin	Function	Pin	Function
1	Port B, bit 7	2	Port C bit 0
3	Port C bit 1	4	Port C bit 2
5	Port C bit 3	6	Port C bit 5
7	Port D bit0	8	Port D bit 1
9	Port D bit 2	10	Port D bit 3
11	Port D bit 5	12	N/C
13	32MHz Clock	14	1-Wire data
15	+5V	16	GND

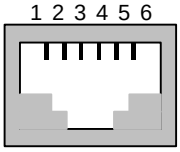
J4: Computer Data Connector

J4 is the data interface to the computer. If you want the data from the weather station to go to a computer, use this connector. You should be able to plug in a normal serial cable between this connector and your computer. Use either this header or J5, do not use both at the same time. J4 is configured as a Data Communication Equipment (DCE) serial port (i.e. modem port). Any Data Terminal Equipment (DTE) such as a computer can connect directly pin-for-pin to the port. The pin numbers are labeled on the connector. The pin functions are as follows:

Pin Number	Pin Function
1	Signal detect (N/C)
2	Tx Data out
3	Rx Data in
4	DTR (N/C)
5	GND
6	DSR (always high)
7	RTS (N/C)
8	CTS (always high)
9	Ring Indicator (N/C)

J5 and P2: 1-Wire Interface

Jack J5 is the 1-Wire interface. It is a 6-6 RJ-11. The pins on J5 are also duplicated on P2 for any special wiring needs. The pin-out of J2 is:



Looking into RJ-11 jack

Pin Number	Function
1	No-connect or +5V
2	Ground
3	Data
4	Ground
5	+5V
6	No-connect

J6: Power plug

7-15VDC, center pin positive, barrel is ground

P1: Debug Interface (Rev A board)

Pin Number	Function
1	Tx
2	Rx
3	Ground
4	IRQ
5	Clock
6	-9V

For Rev A debug support wire a DE-9s GND, Tx and Rx pins to the GND, Tx and Rx pins on P1. Drive a 9.384MHz clock source into pin 5, and Tie pin 4 to +9V. **NOTE: Due to a wiring error, -9V was wired to pin 6 instead of +9V. Do NOT use this pin!!!**

P3: Debug Interface (Rev B board)

Pin Number	Function
1	Debug Rx
2	Debug Tx
3	External Rx
4	External Tx
5	APRS Data Rx
6	ARPS Data Tx
7	+9V
8	CPU IRQ

For Rev B boards, pins 3 and 5 are shorted on the back of the board as well as pins 2 and 4. This provides "normal" operations where APRS data is routed to the DE-9 connector. If you want to use the DE-9 connector for debug purposes, cut the two traces on the back of the board and install a header in location P3. For normal operations, jumper pins 2/4 and 3/5. For debug purposes, jumper 1/3 and 2/4 for data and 7/8 to provide +9V to the CPUs IRQ pin.

P100: Modem analog interface connector

P100 on the Modem board is the analog interface to the radio. It is optimized for a radio with separate Tx Audio, Rx Audio, and a "digital" PTT signal that is at +5V for receive and 0V for transmit. For radios that combine the PTT and Tx Audio, a resistor (value specified by your radio) will need to be added between the PTT and Tx Audio pins. The pin functions are as follows:

Pin Number	Pin Function
1	GND
2	GND
3	GND
4	GND
5	GND
6	PTT (active low)
7	Rx Audio (Speaker)
8	Tx Audio (Mic)
9	+5V

Section 6, Applications

This manual covers the first application of the T-238+ board. There is nothing about the hardware that makes it a weather station nor anything that prevents you from creating your own applications. The full source code including all the drives for the 1-Wire® bus, LCD, and UART are available to help you create your own applications. As you or anyone else develops these programs, we encourage you to let TAPR know so we can add them to the list of available applications for this board.

As T-238+ programs are developed they will be displayed or linked from the TAPR Weather web site located at http://www.tapr.org/taprf/html/Fwx.html. If you've created a project and would like to display or link to it, contact TAPR at tapr@tapr.org.

T-238 is discussed on the WXSIG Special Interest Group. You can join WX SIG via the web at http://www.tapr.org/cgi-bin/lyris.pl?join=wxsig.