

METCRAXII “Mote” Hints

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The Wisard ‘motes’ come in 3 flavors for MetcraxII: Soil/Rad-XbeeWireless data sampling; Serial-Forwarding for crater barometer/csat’s; Power Monitor. The basic command sets are shown below:

METCRAXII Mote Default Settings:

If the ‘einit’ command is used, the project defaults are reprogrammed into the eeprom which controls operating parameters.

Low Battery Voltage Monitor:	disabled (vm=0).
GPS:	disabled on the serial forwarding motes in crater (2baro’s and 2csats) rad/soil gps sync rate=2hours (gr=7200), timeout=1min (gto=60), failed retry rate=30min (gfr=1800)
Primary Output Port	pp=radio (pp=1)
Message Output	wisard mode (mp=0) messages
Local Data Storage	disabled (fsr=0)
Sampling Mode	Self-Timed (md=0)...Don’t change this!
BAUD Rates	38400bps,n81 = Rad/Soil Motes 9600bps,n81 = Serial Forwarding Motes

LED Indicators

- Startup: 3-Blinks: either Green=Xbee output, or Red=Serial output. Also have solid yellow and orange. The green blinks can be hard to see because the heartbeat begins during the startup.
7-Blinks Red/Green indicating the mote is configured and sampling begins.
Comment messages are sent to the DSM indicating the operating conditions.
- Normal Operation:
- Green: HeartBeat - Toggles on-off 1/sec with RTCC (RealTime Clock Calendar) interrupt
 - Red: Sample Taken and message sent to output: ~ every 5seconds, but depends upon ‘dr’
 - Yellow: GPS has been turned on and a message being received from it.
 - Orange: Command input being received. This goes out when a ‘cr’ is received, so it can happen fairly fast.
- Watchdog Reboot:
- This is bad and usually appears as a *continual* ‘Startup’ condition
It usually happens during a Sampling Period when the Red comes on and stays on followed by the ‘Startup.’

Usually this means one of the I2C sensors is not responding properly. Try unplugging one or more sensors.

How-To Command/Interact with a Specific V2.4 Soil/Rad Xbee Radio Motes:

By default all commands are sent by a base station radio to all remotes. You can address a specific mote only by one of two ways:

- 1) Don't Do This!: Reprogram the base Xbee radio (or equivalent) to only talk with your target.
- 2) Do This: #xxcmd where xx=moteID, and 'cmd' is one of the above commands.
For example: '#17dr' or '#2xb=pl' or '#4eeupdate'

FLR: >rs 2 ids = 1,2,17
NEAR: >rs 1 ids = 3,8,10
FAR: >rs 2 ids = 4,22
Unless they're changed!

METCRAXII: Rad/Soil Mote Commands V2.4:

<p>Note: Cnds with '=' option can be reset with a new value</p> <p>Note: All values are stored in eeprom and reloaded at runtime. If you change one or more and then 'eupdate' they will be used both immediately and at any reboot. Exceptions are rxb,hb,st,jd and 'on/off'</p>		
Sampling Rates:	'dr' 'dr=' 'sp' 'sp=' 'sn' 'sn=' 'sx' 'sx='	Data Sampling rate in seconds Power message skip count = dr*value Serial# message skip count = dr*value XbeeStatus message skip count Skipcount 0=Disabled, 1=Every Message
Operating Modes	'md' 'md=' 'id' 'id=' 'mp' 'mp=' 'pp' 'pp=' cache cache=	0=Self-Timed Mode (Default)1=Xbee-Sleep MoteID Output: 0=Wisard, 1=DSM printable,2=Ascii Primary Output Port: 0=rs232, 1=xbee Show/Set message caching count
Local File	fsON/OFF fsr fsr=	Rate in seconds to cycle (ie flush) local storage fil. fsr=0 disables local data storage
Batt Monitor	'vm' 'vm=' 'vl' 'vl=' 'vh' 'vh=' 'vs' 'vs='	vm=1 MonitoringON, vm=0 OFF vl=7000 Turn MoteOps off at 7vdc vh=12300 Turn back on at 12.3vdc when off 'sleep seconds' before re-testing
EEPROM	'eecfg' 'eupdate' 'einit' 'eload'	report current operating settings write eeprom with current settings initialize default settings read/load existing eeprom contents
Xbee Radio:	'xb=' 'xr' 'xr=' 'hb' 'xs' 'rxb' 'xhdl', 'xbch', 'xbid' 'x' 'bst', 'xbstp' 'xv'	Send specific command to xbee: such as 'xb=pl' for power. To reprogram a new value ex: 'xb=pl2' or 'xb=d112345678' Xbee automatic reset rate unless 'hb' heart-beat rcvd Xbee status Reset Xbee dl=destination, ch=chan: values setup in eeprom st=wake time (7D0=2sec) sp=sleep time(12C=3sec) Do This to Confirm/Reprogram xbee with above values
GPS/Timing:	'gpsON/OFF' 'gr' 'gr=' 'gto' 'gto=' 'gfr' 'gfr=' 'gnl' 'gnl=' 'st' 'st=' 'jd' 'jd=' 'bf' 'bf=' 'ba' 'ba='	How often 'gpsON' to set Date/Time (secs) Timeout Seconds if no lock acquired Retry Wait time (secs) if no lock #of sequential valid messages to confirm lock Show/Set time of day 'hhmmss' Show/Set Julian date Special use: Bresenham Freq. (~800000) Adjust value
	'?'	Print command list
Red-Button Use, or	'reset' 'reboot'	Or Power Cycle!
White-Button Use	1 2	scan for any attached I2C sensors Toggle Output port between radio/Console
LEDs	Startup Normal Ops Command ingest GPS WhiteButton	Normally 3 blinks of either: green-led=output is radio, red=output is console; then 7 quick blinks before boot (sometimes other leds come on and when xbee is the output there is a delay period before 'boot') 1-sec green led heart-beat, and red led blink at the 'data-rate' Orange led (above pic) comes on when a command is being ingested from the 'base radio' or the console which-ever is active, and goes out upon command <cr> termination. Yellow led (under microSD)blinks when message received and blinks several times when it syncs, then goes out. Org blinks for # of presses, then if swapping output ports the green or red will blink 3 times.

METCRAXII: Serial Forwarding Mote:

<p>Note: Cnds with '=' option can be reset with a new value</p> <p>Note: All values are stored in eeprom and reloaded at runtime. Thus if you change one or more and then 'eupdate' they will be used both immediately and at any reboot. Exceptions are rxb,hb and 'on/off'</p> <p>NOTE: by default ALL MOTE COMMANDS ARE DISABLED and it is in 'pass-through' mode. Thus when you connect, you'll be talking with the serial sensor itself. To enable these commands use the hidden escape: 'esc-esc-esc' to toggle the command-mode on/off.</p>		
Sampling Rates:	'dr' 'dr=' 'sp' 'sp=' 'sx' 'sx='	Data Sampling rate in seconds Power message skip count = dr*value XbeeStatus message skip count Skipcount 0=Disabled, 1=Every Message
Operating Modes	'id' 'id=' 'mp' 'mp=' 'pp' 'pp=' 'delay' 'delay='	MoteID Output: 0=Wisard, 1=DSM printable,2=Ascii Primary Output Port: 0=rs232, 1=xbee Seconds of delay before starting up. This was done to allow the sensor and bluetooth radio to boot before forwarding chars begins
Local File	fsON/OFF fsr fsr=	Any questions...? Rate in seconds to cycle (ie flush) local storage file
EEPROM	'eefg' 'eupdate' 'einit' 'eload'	report current operating settings write eeprom with current settings initialize default settings read/load existing eeprom contents
Xbee Radio:	'xb=' 'xr' 'xr=' 'xs' 'rxb' 'bradio'	Send specific command to xbee: such as 'xb=pl' for power. To reprogram a new xbee value ex: 'xb=pl2' or 'xb=d112345678' Xbee automatic reset rate unless 'hb' rcvd Report Xbee status Reset Xbee immediately Special Use Only while using Console Port!: passthrough directly to the radio. You then need to do the timing, special '+++ 'atxx' etc.
GPS / Timing:	gpsON/OFF gr gr= gto gto= gfr gfr= gnl gnl=	Any questions...? How often 'gpsON' to set Date/Time (secs) Timeout Seconds if no lock acquired Retry Wait time (secs) if no lock #of sequential valid messages to confirm lock
	'?' 'reset' 'reboot'	Print command list reset cpu
White-Button Usage	1 2 3	scan for any attache I2C sensors (limited use for forwarder!) Toggle Output port between radio/Console Tobble Fake Message Simulator On/Off (so you don't need a sensor attached to try out the radio link)
LEDs	Startup Normal Ops Command ingest GPS	A long series of 1-sec blinks will last for the 'delay' time mentioned above. Then 'roughly' 7 blinks and the 1-sec green led heart-beat, and red led blink at the 'data-rate' when sampling occurs (yes the forwarder is taking power readings at 'dr') Orange led (above pic) comes on when a command is being ingested from the 'base radio' or the console which-ever is active, and goes out upon command <cr> termination. Yellow led (under microSD)

Because the Serial Forwarding Motes in MetcraxII are BlueTooth based radios, to talk with them individually, the command '#' prefix shown above is superfluous. Instead the interaction is entirely up to the DSM virtual serial port connection. For that you must know what the friendly name of its BT-radio. With the DSM / Nidas software running, and logged into the DSM:

>rserial btsp: name This must be a known name in the config and in the radio.

METCRAXII: Power Monitor Note:

The Power Monitor Board designed and built in 2013 was based upon a PIC18F2520, the same as used on the original Version 1 motes. For convenience the initial implementation of the command set was similar to V1 Motes, not the V2.4 soil/rad devices.

Note: Cmds with '=' option can be reset with a new value		
Sampling Rates:	'dr' 'dr=' 'sx' 'sx='	Data Sampling rate in seconds XbeeStatus message skip count If skipcount=0 Disabled If skipcount=1 Every msg (ie no sensor data)
Operating Modes	'id' 'id=' 'mp' 'mp=' 'pp' 'pp=' 'mt' 'mx'	MoteID Output: 0=Wisard, 1=Ascii Primary Output Port: 0=rs232, 1=xbee Self-Timed Mode (Default) Xbee-Sleep Mode BEWARE: unlike version2+ once in xbee mode you can't hit the button, only power cycle and/or use a properly setup xbee 'base'
Calibration Offset/Gain Settings	'vbg' 'vbg=' 'vbo' 'vbo=' 'ilg' 'ilg=' 'ilo' 'ilo=' 'ilt' 'ilt=' 'ipvg' 'ipvg=' 'ipvo' 'ipvo=' 'ipvt' 'ipvt='	Battery Voltage circuit Gain, Offset Load Current circuit Gain, Offset, Temperature Coefficient Charging Current circuit Gain, Offset, Temperature Coefficient
EEPROM	'ew' 'ei' 'er'	write eeprom with current settings initialize default settings read eeprom contents
Xbee Radio:	'xb=' 'xr' 'xr=' 'hb' 'xs' 'rxb'	Send command to xbee: 'xb=pl' for power Xbee automatic reset rate unless 'hb' rcvd Send Xbee a 'heart-beat' Report Xbee status Reset Xbee immediately
Timing:	'st' 'st=' 'jd' 'jd=' 'bf' 'bf=' 'ba' 'ba='	Show/Set time of day 'hhmmss' Show/Set Julian date Special use: Bresenham Freq. (~8000000) and Adjust value
	'?' 'reset' 'reboot'	Print command list reset cpu

These motes in METCRAXII were initially setup with a wired link into a DSM port and are mounted in the battery boxes. They can be swapped over to Xbee radios by removing the rs232 module and swapping in a xbee radio pre-programmed to work with the base radio it will be interacting with.

FAR: >rs 7
NEAR: >rs 17 (low) >rs 18 (up)
RIM: >rs 14 (low) >rs 16 (up)
FLR: >rs 8

HOW-TO: Change Mote Xbee Radio's

If a radio goes bad, or more likely a mote/xbee need to be swapped in to a different BASE-Xbee receiver, then the xbee radio must be either swapped in or have its settings changed. In either case you need to know the Base Radio's values (labeled on the box):

- 1) Serial number, low number: 'sl' in the base xbee, used in the 'dl' setting of the client xbee.
- 2) Channel number: 'ch'
- 3) Node ID: 'id'

All other parameters should be ready to go in our radios. The base broadcasts to all clients 'dl=0000' and the clients send messages to the base radio 'dl=xxxxxxxx'.

If the radio is ok but the mote is bad: you can remove the xbee from the old mote and put it in the new one. If you do that the default eeprom 'radio settings' in the mote will probably be different but that is ok because the radio will already be setup correctly; just don't use the 'xv' command!

Otherwise if you putting in a new mote with new radio (ie moving it) then you need to change the xbee and mote settings. This can be awkwardly done over the air but the best is to use the mote console port:

- 1) Connect console cable between Mote-PC. Start serial comm program (minicom,procomm,rserial):
38400bps = Rad/Soil Motes, 9600bps=SerialForwardingMote
- 2) Power Up Mote You should see 3 short green blinks indicating stdio is going to the xbee port.
- 3) 2x White Button Toggles stdio to the console port. You should see 2 quick org. blinks indicating it saw the 2 button presses.
- 4) md=2 If using minicom/procomm. This puts the mote in plain text mode so you can see the output. In rserial the md=0 'wisard' mode is ok/best.
- 5) xbdl=xxxxxxxx where 'xxxxxxxx' is the BaseRadio's low serial number (hex)
- 6) xbid=x where 'x' is the BaseRadio's id.
- 7) xbch=xx where 'xx' is the BaseRadio's channel number (hex)
- 8) xv The mote will reprogram the xbee radio with the above numbers and give you a status report.
- 9) id=xx Do this for the DSM inject if you're swapping in a new mote. You must know the old mote number. The alternative when swapping is to change the dsm's 'xml' for the new id, and all the associated adjustments in base, etc.
- 9) md=0 puts the mote in wisard output mode. If you leave the md=2 (or 1) then the next command will cause it to boot in the wrong mode and cause dsm problems.
- 9) eeupdate This stores the above values in the mote's eeprom.
- 10) reboot Or press reboot button, or cycle power to restart with the new setting
- 11) Check the settings/results and that the dsm is still getting data, etc.

The xbee radio settings can be adjusted or viewed also by using the command 'xb=yyy' including 'over the air.' Be careful not to change one of the 3 values above over the air or else you will lose radio contact.

Some examples

- 1) xb=pl shows xbee's power level
- 2) xb=pl2 changes xbee's power level.
- 3) sx reports various xbee status values
- 4) xb=sl shows xbee's serial number
- 5) xb=dl shows xbee's destination serial number
- 6) xb=xxxxxxxx changes xbee's destination destination serial number (you can shoot yourself in the foot if using this over the air).

Xbee Digi-Mesh Commands (XB24-DM)

VR	Version #	We typically have been using 8062 , but it is not the latest
WR	WRITE Parameters to NV	
FR	Software RESET	
AC	APPLY CHANGES	Should happen also by getting out of command mode
CN	EXIT COMMAND Mode	
Networking Commands:		
CH=C	Operating Channel	0x0B-0x1A
RR=A	Mac Retries	
MT=3	Multi-Transmit	Set/read number of additional broadcast retransmissions. All broadcast packets are transmitted MT+1 times to ensure it is received.
BH=0	Broadcast Radius	Set/Read the transmission radius for broadcast data transmissions. Set to 0 for maximum radius. If BH is set greater than NH then the value of NH is used.
MR=1	Mesh Retries	Set/read maximum number of network packet delivery attempts. If MR is non-zero, packets sent will request a network acknowledgement, and can be resent up to MR times if no acknowledgements are received.
NH=7	Network Hops	Set/read maximum number of hops across the network. This number doesn't limit # of hops; rather, it is used to calculate maximum network traversal time and must be set the same on all nodes in the network.
NN=3	Network Delay Slots	Set/read the maximum number of delay slots before rebroadcasting a network packet.
CE=0	Coordinator Enable	Set/read the network type. End Device won't propagate broadcasts and won't become an intermediate node on a route. 0=standard router 2=end device
DH=13A200	Destination High-Addr	
DL=40561BA5	Low-Addr	
NI=	Node Identifier	
NT=82	Node Discovery Backoff	
DD=50000	Device Type Identifier	Set/read the device type identifier value. This can be used to differentiate multiple XBee-based products
NO=0	Node Discovery Options	Sets the node discovery options register. Options include 0x01 - Append DD value to end of node discovery, 0x02 - Return devices own ND response first.
EE=0	Encryption Enable	
KY	AES Encryption Key	
BD=3	Baud Rate	
NB=0	Parity	
RO=3	Packetization Timeout	0-0xFF. Set/read number of inter-character-times of no input required before transmission begins. Set to zero to transmit characters as they arrive instead of buffering them into one RF packet. (ie 9600bps~= 1mS/char: FF=256mS Important to set this high enough to avoid 'multi-packeting' of wizard messages if interrupts cause a comms delay!!! 15 ~= 15mS
D7=1	DIO7 Cfg	
D6=0	DIO6 Cfg	
FT=BE	Flow Control Threshold	
AP=0	API Interfacing	0=Disable, 1=Enable Packet mode API formats frames into packets from the RF link to the serial port. It expects serial port packets to be formatted and transmits as a packet over the RF link.
A0	API Enable	Packet mode API receive format. Zigbee explicit formats include endpoints, cluster IDs, and profile ID's in API packet type 0x91.
D0=0 ... D4=0	AD/DIO Configuration	0=input unmonitored, 3Digital Input monitored, 4/5=Digital Output low/high
D5=1	..	1=Enable LED Associate on PIN15
P0=1	..	
P1=0	..	
M0=0	PWM0 Duty Cycle	
M1=0	PWM1 Duty Cycle	
LT=0	LED BlinkTime	
RP=20	RSSI PWM Timer	
PR=1FFF	Pull-Up Resistor Enable	
CT=64	Cmdmd Mode Timeout	2-0x28F (100mS) (0x64 = 10sec = Default)
GT=3E8	Guard Time	1-0xCE4 (1mS) Needed both before/after going 'command mode' (1sec=Default)
CC=2B	Command Seq. Char.	For entering Cmd Mode (Default = '+++')
PL=0	Power Level	0=-8dbm, 1=-4dbm, 2=-2dbm, 3=0dbm, 4=+2dbm. See also boost mode to raise by 1db
Sleep Commands:		
NOTE: Base-Station MUST HAVE Setup: SM=7 (Sleep Support), SO=1 (Preferred Coordinator)		
WH	Wake Host Delay	Set/read the time the module will delay before sending serial data out the UART or taking IO samples after waking from sleep. This can be used to give a sleeping host processor sufficient time to power up after the module asserts the ON_SLEEP line.
SO=2	Sleep Options	Bitfield of options for a sleep compatible node. Bit 0 - Preferred Sleep Coord. Setting this bit will cause a sleep compatible node to always act as sleep coordinator. Bit 1 - Non-Sleep Coord. will cause a node to never act as a sleep coordinator. Bit 2 - Enable API sleep status messages. Bit 3 - Disable automatic wakeup for missed synchs. Bit 4 - Disable seniority based on node type. ie value 1= preferred coordinator
SM=0	Sleep Mode Setting	Normal mode is always awake. Cyclic mode sleeps for SP time and wakes for ST time. Sleep Support mode is always awake but can effectively communicate with SM8 nodes. 0=Normal 1=Pin Sleep Mode (Pin9: high=Off, low=Awake) 4= Async Cyclic Sleep 5= Async Cyclic Sleep w/ Pin wakeup (high-to-low pin9) 7=Sync. Sleep Support 8=Sync Sleep (SP,ST)

ST=7D0	Wake Time	Minimum wake time is a function of SP, NN, NH, and platform dependent values. Value will be raised automatically to a valid value when SP, NN, NH are increased. Maximum value is an hour (or 0x36ee80 ms). 0x45-36EE80 HEX (1mS each) 1s = 3E8 2s = 7D0 (Default) 3s=bb8 5s = 1388, 10s = 2710 30s = 7530 60s= EA60
SP=C8	Sleep Period	In cyclic mode, node will sleep with CTS disabled for the sleep time interval, then wake for the wake time interval. 0x1-15F900 HEX (4hours) (10mS each) (Default=2s) 1s=64 2s=C8 3s=12C 4s=190 5s=1F4 7s=26c 8s=320 10s=3E8 28s=AF0 30s=BB8 57s=1644 58s=16A8 60s=1770
Diagnostic Commands		
DB	Last Pkt RSSI	Read the RSSI of the last received packet.
VR	Firmware version	
HV	Hardw version	
ER	Rcv Error Count	RF Errors: Reads the number of times the receiver detected a CRC or length error. Maxes out 0xffff. USEFUL parameter to monitor.
GD	Rcv Good Count	Good packets. Reads the number of good frames with valid MAC headers that are received on the RF interface. Maxes out at 0xffff USEFUL parameter to monitor.
TR	Delivery Failure Count	Transmission Errors. Reads the number of MAC frames that exhaust MAC retries without ever receiving MAC –ack message from the adjacent node. Maxes at 0xffff. USEFUL parameter to monitor: maybe a good reason to reset?
SQ	Missed Sleep Sync Count	Read number of sleep cycles in which a sleep synch has not been received
CK	Config. Code	
NP	Max.# of RF payload byte	Read the maximum number of RF payload bytes that can be sent in a single RF transmission. USEFUL parameter to monitor.
MS	Missed Synch Messages	Read the number of sleep/wake cycles since the node received a synch message.
Sleep – Diagnostic Commands		
SS	Sleep Status	Bitfield of sleep status bits. See product manual for full description. Bit 0 - Is network awake? Bit 1 - Is sleep coordinator? Bit 2 - Ever received synch? Bit 3 - RX synch this cycle? Bit 4 - Overriding synch pending? Bit 5 - Nomination Requested? (All other bits are reserved and should be ignored)
MS	Missed Synch Messages	Read the number of sleep/wake cycles since the node received a synch message.
OS=C8	Operating Sleep Time	Read the current network sleep time that this node is synchronized to, in units of 10 milliseconds. If this node has not been synched then OS will return the value of SP.
OW	Operating Wake Time	Read the current network wake time that this node is synchronized to, in units of milliseconds. If this node has not been synched then OW will return the value of ST.