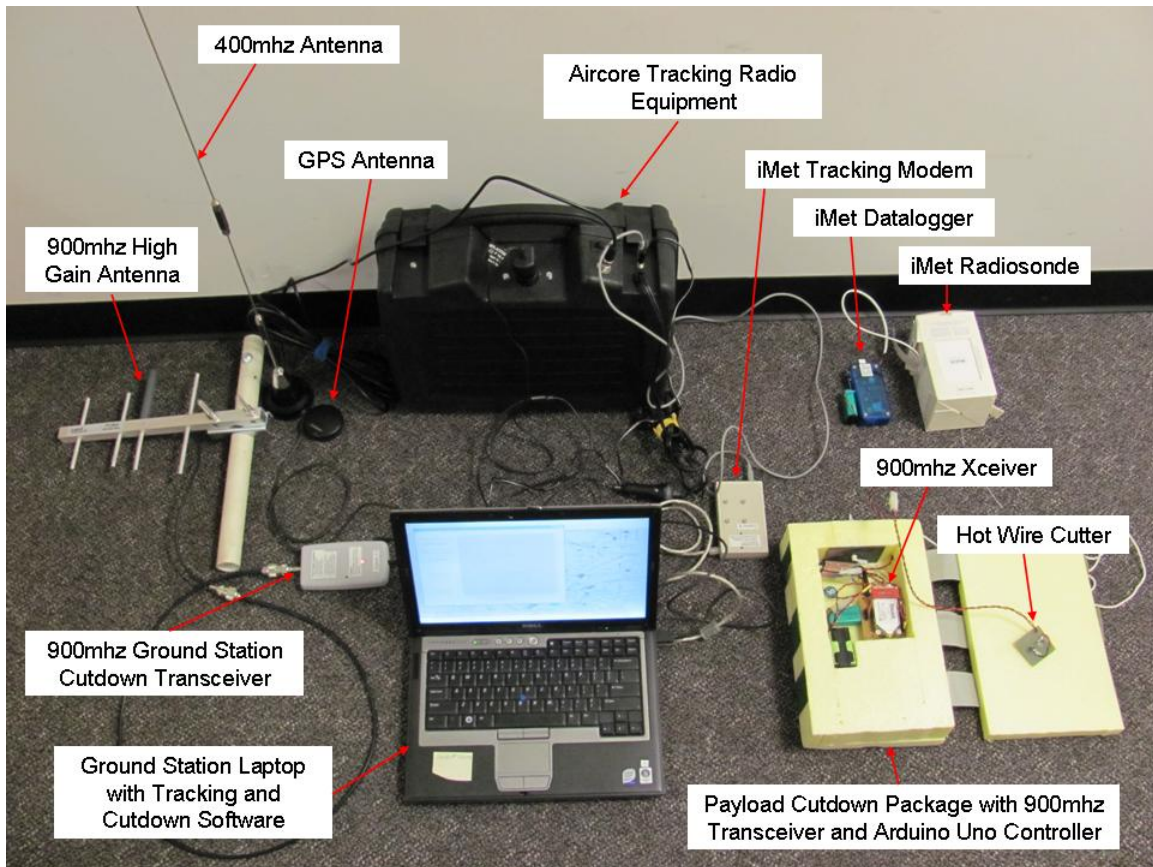# Aircore Balloon Tracking and Payload Cutdown Equipment Procedure

1. **Equipment**

   This equipment is used to track the aircore in flight and to perform a cutdown of the payload if necessary. It provides the GPS position of both the chase vehicle and the balloon payload in one mapping program for easier tracking.

   1.1. 400mhz Antenna – Attached to the Aircore Tracking Radio Equipment box via the BNC connector. It is used to receive the 402mhz radio transmission sent from the iMet radiosonde. It is a mobil magnet mount scanner antenna available from Radio Shack catalog number: 20-032 ($29.99).

   1.2. GPS Antenna – Roof magnet mount antenna for tracking the location of the chase vehicle. The GPS signal from this antenna is combined with the GPS signal received from the iMet and formatted into the $PRAVE messages used by the Global Mapper mapping program to display both the location of the Aircore balloon and the chase vehicle on one map display. The GPS Antenna is a Garmin GPS 18x PC Serial Port GPS Receiver purchased from TheGPSStore.com

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($79.95). It is powered by 12vdc via the cigarette power connector on the front of the Aircore Tracking Radio Equipment box.

1.3. 900mhz High Gain Antenna – Yagi high gain antenna attached to the 900mhz Ground Station Cutdown Transceiver on the chase vehicle. Purchased from Digi-Key part number: A09-Y8NF-ND ($60.00)

1.4. Aircore Tracking Radio Equipment – Consists of an ICOM IC-R6 scanning radio receiver set to 402mhz, 5vdc power supply for IC-R6, 12vdc battery for backup power when disconnected from vehicle power, preamp, switching relay for power, BNC connector, female 2.1mm 12vdc power plug for 900mhz Ground Station Cutdown Transceiver power, female stereo jack for modem connection, power switch, male 12vdc cigarette plug for connection to vehicle power, and female 12vdc cigarette plug for power to the GPS Antenna. The IC-R6 radio was purchased from Universal Radio, Inc ($189.95) along with a power supply ($26.95) and a BNC to SMA adapter ($5.85). The preamp was purchased from Advanced Receiver Research part number: P400-410VDG ($119.95).

1.5. iMet Tracking Modem – Demodulates the audio from the iMet radiosonde via the Aircore Tracking Radio. It receives power via the Ground Station Laptop USB port. It connects to the ATR box via the stereo audio jack. The modem card is an RTX-12OEM 1200 baud BEL 202 telemetry modem purchased from Tigertronics.com ($55.00). The modem is connected to a cannibalized USB to Serial adapter from Ultimate Solutions, Inc. The modem talks to the USB adapter via RS-232 over the connection points where the DB-9 connector was removed. It receives 5vdc power via the USB power.

1.6. iMet Datalogger – Connects to the iMet radiosonde via the 4-conductor cable on the iMet. It consists of a Logomatic (v2) datalogger with a micro SD card reader and a 9vdc battery for power. This equipment flies on the balloon payload to log iMet GPS location/time, temperature, humidity, and pressure data. The Logomatic was purchased from Sparkfun.com sku: WIG-08627 ($59.95).

1.7. iMet – Radiosonde with GPS, temperature, humidity, and pressure capabilities. It transmits a 400mhz signal to the ground station with this data. It is self powered. Purchased from InterMet Systems for less than $200. If damaged, it can be sent back to InterMet Systems and rebuilt for $75.

1.8. Payload Cutdown Package – Flies on the balloon to cut the payload down from the balloon on command from the ground station. It consists of a 900mhz transceiver, processor board, 9vdc power source, 5vdc power source, antenna, and hot wire cutter. The transceiver is a Digi XTend 900 mhz 1watt RPSMA 40 mile range transceiver purchased from Sparkfun.com sku: WRL-09411 ($184.95). The processor board is an Arduino Uno processor purchased from Sparkfun.com sku: DEV-09950 ($29.95). The antenna is a 900mhz Duck

Antenna sku: WRL-09143 ($7.95). The hot wire cutter uses a 26awg nichrome wire to burn thru the payload string.

1.9. Ground Station Laptop – Has the tracking, mapping, and cutdown software for payload tracking and recovery.

1.10.   900mhz Ground Station Cutdown Transceiver – Connects to the ground station laptop via a USB port. It transmits the cutdown command to the Payload Cutdown Package on the balloon. It consists of a transceiver, USB/UART converter, female 2.1mm 12vdc power jack, and 5vdc switching regulator for transceiver power. The transceiver is a Digi XTend 900 mhz 1watt RPSMA 40 mile range transceiver purchased from Sparkfun.com sku: WRL-09411 ($184.95). The USB/UART converter is a USB-MB5 USB to TTL(serial) converter purchased from Sparkfun.com sku: DEV-08531 ($26.95). Though the USB converter can supply up to 500ma of 5vdc power, the transceiver needs 730ma of power to operate at its maximum of 1watt output during transmission. A 1.5amp positive step-down integrated switching regulator part number: 78ST105HC from Power Trends is used to convert 12vdc to 5vdc for transceiver power. The 12vdc power is received from the Aircore Tracking Radio box.

2. Supplies

2.1. (2) New Energizer Advanced Lithium 9vdc batteries.
2.2. (4) New Energizer Advanced Lithium AA batteries.
2.3. (1) New iMet battery Part Number: 300,208
2.4. Roll of duct tape.

3. Procedure

3.1. In Lab setup before going out to the balloon launch site.

3.1.1. iMet Radiosonde Setup
3.1.1.1. Verify the iMet output data is correctly setup and saved in the iMet.
3.1.1.2. Connect the iMet Interface Box to the laptop via the USB cable.
3.1.1.3. Start hyperterminal at the correct com port for the interface box. Connection settings are: 9600-8-N-1-N
3.1.1.4. Connect power (battery or power supply) to the iMet and turn it on. After a few seconds the red LED should flash at a 1hz rate.
3.1.1.5. Connect the iMet Interface Box to the iMet data cable. Be sure the yellow iMet wire is to the "Yellow" indication on the 4-pin connector on the interface box. Verify if data is displayed on hyperterminal. If it
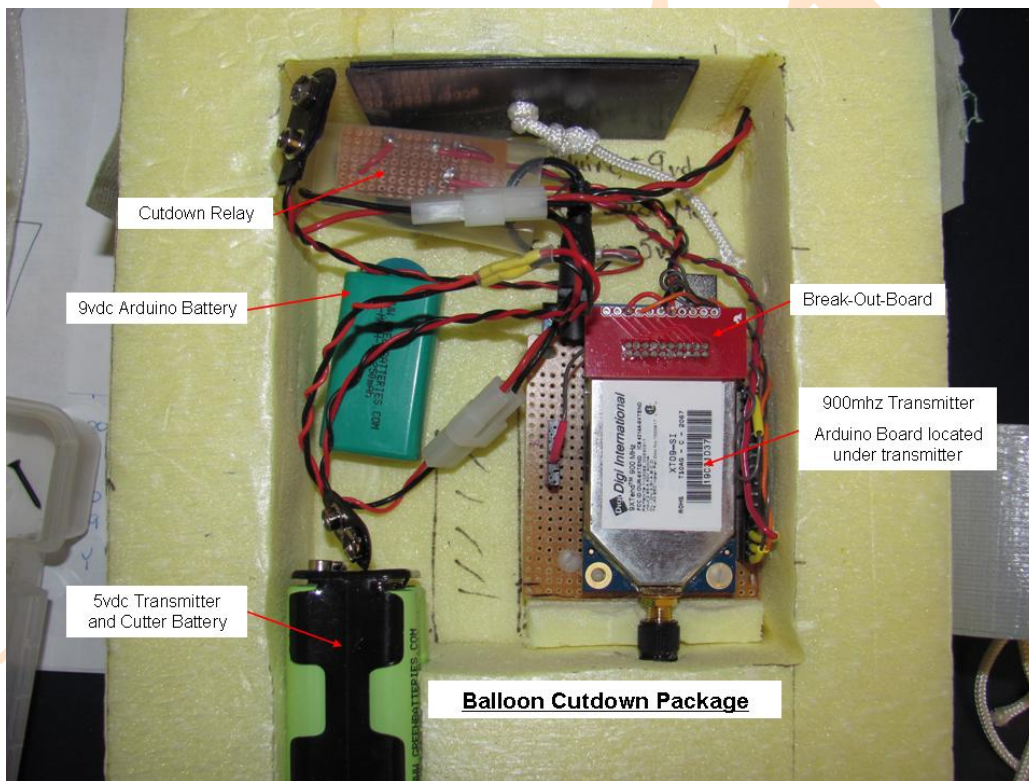
is not, type "data=on" without parenthesis and Enter. Data should be
present now. If not, verify the serial connection and try again.
3.1.1.6. Verify that the iMet transmitter is turned on by typing "txrf=on" and
press Enter.
3.1.1.7. **IMPORTANT:** If any changes are made to the iMet via
hyperterminal they must be saved before powering down. To do this
type "save" and press Enter. Then power down and back up the iMet
and verify that changes were saved.
3.1.1.8. A list of all the iMet commands are at the end of this document.

3.1.2. Payload Cutdown Package in-lab setup

Cutdown Relay

9vdc Arduino Battery

Break-Out-Board

900mhz Transmitter
Arduino Board located
under transmitter

5vdc Transmitter
and Cutter Battery

Balloon Cutdown Package

3.1.2.1. Verify that the transmitter power is set to 1watt.
3.1.2.1.1. Carefully disconnect the 900mhz transmitter break-out-board
from the 20-pin connector on the transmitter.
3.1.2.1.2. Connect the USB to Break-Out-Board Adapter to the
transmitter and to the laptop.

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USB to Break-Out-Board Adapter
For 900mhz Transmitter Programming
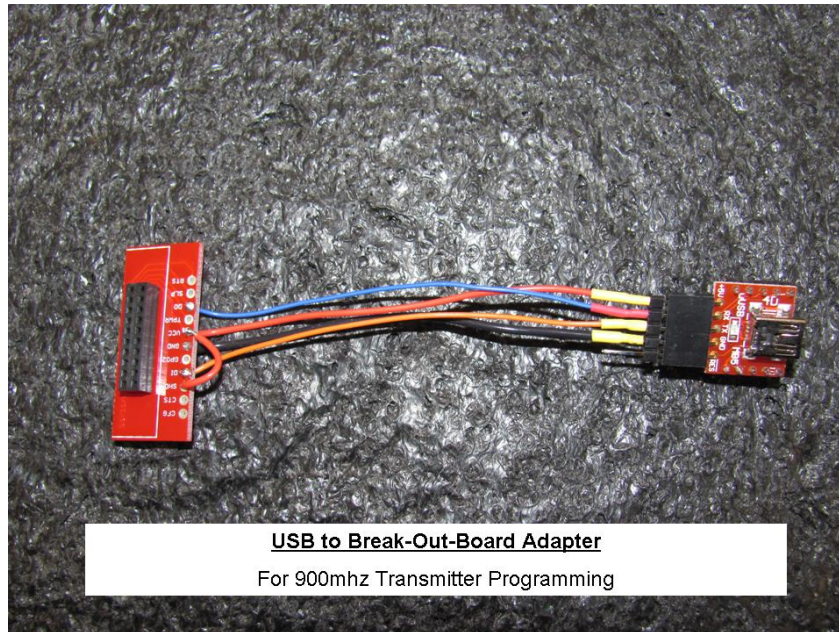
3.1.2.1.3. Start the "X-CTU" program.

3.1.2.1.4. In the "PC Settings" tab select the correct com port and verify 9600-8-N-1-N.

3.1.2.1.5. In the "Modem Configuration" tab select the "Read" button.

3.1.2.1.6. Under "Networking/Security" verify that the VID is set to 4669. Any transmitters that are expected to communicate with each other must have the same VID number.

3.1.2.1.7. Under "RF Interfacing" verify that the TX Power Level is set to 4 -1 WATT. This is the max power setting for a balloon flight. It is generally set to 0 – 1Mw for in lab testing to avoid interference cause by the transmitted RF signal.

3.1.2.1.8. In the "Modem Configuration" tab select the "Write" button to save any changes that were made.

3.1.2.1.9. When done programming, disconnect power and remove the USB to Break-Out-Board Adapter. Reconnect the B-O-B disconnected in step 3.1.2.1.1.

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3.1.3. 900mhz Ground Station Cutdown Transceiver setup

Ground Station Cutdown Transceiver

3.1.3.1. Verify that the transmitter power is set to 1watt.

    3.1.3.1.1. Connect the USB cable to the laptop.

    3.1.3.1.2. Connect 12vdc power to the power connector.

    3.1.3.1.3. Start the "X-CTU" program.

    3.1.3.1.4. In the "PC Settings" tab select the correct com port and verify 9600-8-N-1-N.

    3.1.3.1.5. In the "Modem Configuration" tab select the "Read" button.

    3.1.3.1.6. Under "Networking/Security" verify that the VID is set to 4669. Any transmitters that are expected to communicate with each other must have the same VID number.

    3.1.3.1.7. Under "RF Interfacing" verify that the TX Power Level is set to 4 -1 WATT. This is the max power setting for a balloon flight. It is generally set to 0 – 1Mw for in lab testing to avoid interference cause by the transmitted RF signal.

    3.1.3.1.8. In the "Modem Configuration" tab select the "Write" button to save any changes that were made.

3.2. Ground Station Setup.

3.2.1. Install the Aircore Tracking Radio box and connect its power cable to the vehicle's 12vdc cigarette lighter power and turn on box. Note that the box will supply 12vdc power to itself via its rechargeable battery if power is not

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received from the vehicle. This is to keep the radio operating if the vehicle is turned off for any reason and also to operate the box if it needs to be removed from the vehicle along with the 400mhz antenna and the laptop for tracking the payload on foot once the payload is on the ground.

3.2.2. Setup and turn on the laptop. A 120vac power inverter should be used to keep the laptop powered up in the vehicle. When in use, the tracking programs is generating a log file which can cause the laptop to drain its battery quickly.

3.2.3. Connect the 900mhz cutdown transceiver to an available laptop USB port.
  3.2.3.1. Verify which Com Port the USB is recognized as. This information will be needed when setting up the computer programs for communication with the balloon payload.
  3.2.3.2. Connect the 12vdc cable from the cutdown transceiver to the tracking radio box and verify that both the green and read LEDs are illuminated.

3.2.4. Connect the iMet Tracking Modem to an available laptop USB port.
  3.2.4.1. Verify which Com Port the USB is recognized as. This information will be needed when setting up the computer programs for tracking the balloon payload.
  3.2.4.2. Connect the radio audio cable to the modem from the tracking radio box. Only do this after the USB cable is connected to the laptop and there are no problems with the cursor jumping around the screen. It can cause the laptop to think the tracking modem is a Serial Ballpointer and cause problems with the computer cursor. If the cursor begins to jump around the screen, go to device manager on the laptop and uninstall the Serial Ballpointer.

3.2.5. Install GPS, 900mhz, and 400mhz antennas on the chase vehicle roof. Connect the GPS power plug to the Aircore Tracking Radio box and the serial cable to the laptop serial port. Connect the 900mhz antenna to the Ground Station Cutdown Transceiver. Connect the 400mhz antenna to the Aircore Tracking Radio BNC connector.
CAUTION: Stay further than 1 foot from the 900mhz transmit antenna whenever the transmitter is transmitting. Transmission only occurs when commanded to by the laptop.

3.2.6. At the laptop…
  3.2.6.1. Start the Virtual Serial Ports Emulator program. Once VSPE is started got to FILE and OPEN and open the file "Com4to5and14to15". This starts the virtual com ports that will be used by Global Mapper and the Skysonde Server and Client programs.
  3.2.6.2. Start the Global Mapper program select GPS and SETUP and verify the following:
    3.2.6.2.1. Format is set to NMEA.

3.2.6.2.2. Serial Port Connection is selected.

3.2.6.2.3. Port is set to COM 15.

3.2.6.2.4. Baud is set to 9600.

3.2.6.2.5. Optional: Select "Log GPS Data To Track File" to save data.

3.2.6.2.6. Select the appropriate maps for the area where the Aircore will be flying. Maps can be downloaded from libremap.org for any county in the US. Topographic maps can also be downloaded.

3.2.6.3. Start the Skysonde Server program and select the appropriate com port from step 3.2.5 above. If the iMet radiosonde is transmitting, the PTUX and GPS "LEDs" should flash at the iMet's data rate (1hz).

3.2.6.4. Start the Skysonde Client program.

3.2.6.4.1. Verify in the Ozone and Hygrometer tabs that they are unchecked.

3.2.6.4.2. Fill in data (station ID, Lat/Long, output file, serial number, etc…) as necessary.

3.2.6.4.3. In the "GPS NMEA Output" section, set the comport to Com 4 and verify that "Enable GPS NMEA Output" is checked.

3.2.6.4.4. Select the "OK" button. If the iMet radiosonde is transmitting the PTUX and GPS "LEDs" will be flashing at the iMet's data rate (1hz).

3.2.6.5. Start the Global Mapper iMet and Tracking Vehicle Program. This program was written in JustBasic software.

3.2.6.5.1. Select the "Feed GPS Info to Global Mapper" button.

3.2.6.5.2. Input a file name to save the GPS data to. This will save the $PRAVE messages that will be output to Com 14.

3.2.6.5.3. Input the com port that the vehicle GPS serial cable is connected to. Usually Com 1.

3.2.6.5.4. Input the com port that iMet GPS data is being fed from Skysonde Client. Usually Com 5.

3.2.6.5.5. In Global Mapper, verify that the Chase Vehicle location is present at the proper location on the map.

3.2.6.6. Start the Cutdown Program. This program is used to communicate with the payload cutdown package on the balloon and issue the cutdown command. This program was written in JustBasic software.

3.2.6.6.1. Input the com port where the Ground Station Cutdown Transceiver is connected (Step 3.2.4).

3.2.6.6.2. Select the "Create a LOG File" button if you want to save a text file log of actions of this program. Use the "Enter a LOG File Comment" to enter one-line comments into the log file as necessary.

3.2.6.6.3. To check communication with the payload, select the "Arduino/Aircore COMMS CHECK" button. This will send a query three times to the payload cutdown package. If comms are good, a message will be displayed from the cutdown package indicating that "ARDUINO IS ALIVE". Otherwise a message will be displayed indicating that there were no comms.

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3.2.6.6.4. Once the balloon is in flight and has reached its cutdown point, select the "!!!!! CUT DOWN AIRCORE !!!!!" button. Two prompts will be displayed asking to verify cutting down the payload. Answering "YES" to both prompts will send a message to the cutdown package and initiate the cutdown hot wire cutter on the package. This will burn thru the cord connecting the payload string to the balloon. The hot wire cutter will stay hot for 4 seconds and then the cutdown package will transmit a message indicating that cutdown has occurred and to check the iMet GPS elevation to verify that the payload is decending. If the payload is not decending, the cutdown command can be sent again. NOTE: if the cutdown message from the cutdown package is not received at the ground station that does not necessarily mean that the command was not received by the cutdown package. Always verify if the payload is descending before sending the cutdown command again.

3.3. iMet Radiosonde At-Site Setup
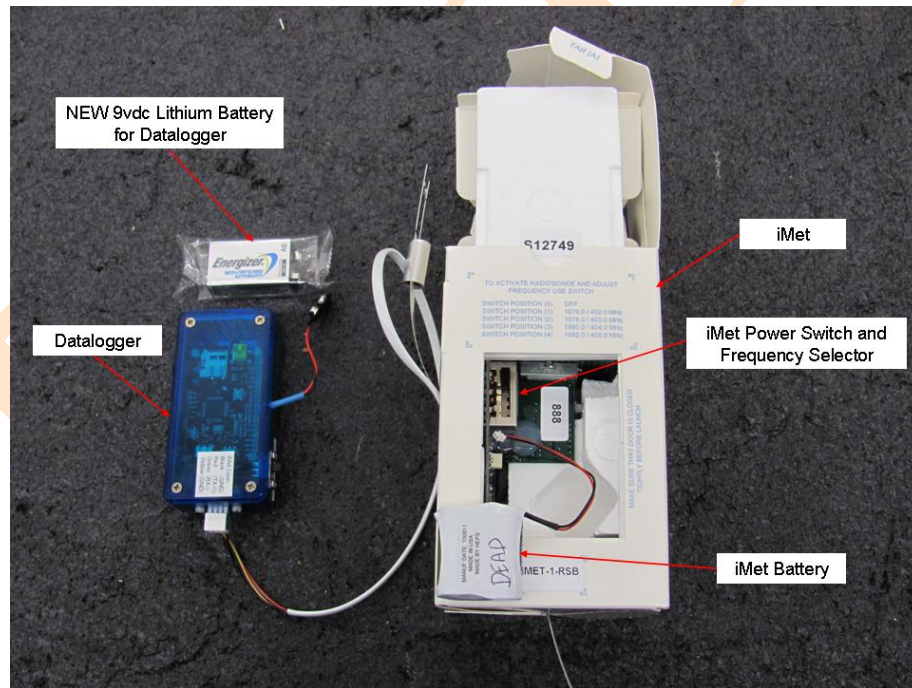
3.3.1. Install NEW iMet battery and turn on to the appropriate frequency (usually 402mhz). After a few seconds the red LED should flash at a 1hz rate.

3.3.2. Connect the iMet data cable to the 4-pin connector on the datalogger. Match the yellow wire to the "Yellow (GND)" label on the connector.

3.3.3. Connect NEW 9vdc Energizer Advanced Lithium battery to the datalogger and push the switch to the "ON" position. The datalogger will now start a

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new text file on the micro SD card and start logging any data that the iMet is outputting. Note: the battery is not needed and the power switch is set to "OFF" when downloading data from the datalogger to a laptop. The USB cable supplies power to the datalogger at that time.

3.3.4. Verify LED conditions per the instructions on the side of the datalogger.

3.3.5. Place the datalogger and battery into an appropriate Styrofoam box along with some type of small heat source (chemical hand warmer, water packet, etc…) and close and duct tape the box. Attach the box to the iMet and to the payload string as necessary.

3.3.6. At the laptop in Global Mapper, verify that the Payload location is present at the proper location on the map.

3.3.7. If not, check Skysonde Server or Client software to see if the "LED's" are blinking. If they are not then check the setup.

3.4. Payload Cutdown Package At-Site setup

CAUTION: Stay further than 1 foot from the transmitter antenna located in the bottom of the cutdown package whenever the transmitter is transmitting. The transmitter will only transmit when it is queried by the Ground Station cutdown transmitter.

Note: There are no power switches or LED indicators on the Payload Cutdown Package. Once the batteries are connected the transmitter and Arduino board are powered up and functioning.

3.4.1. Feed the payload string thru the Hot Wire Cutter as necessary.

3.4.2. Connect the power connector of the cutter to the connector on the top of the payload cutdown package.

3.4.3. Connect the 5vdc battery pack with NEW Energizer Advanced Lithium AA batteries to the transmitter power connector. **IMPORTANT:** DO NOT CONNECT A POWER SOURCE GREATER THAN 5VDC TO THIS CONNECTOR!!! It can damage the transmitter.

3.4.4. Connect a NEW Energizer Advanced Lithium 9vdc battery to the Arduino power connector.

3.4.5. Secure batteries and other equipment inside the package as appropriate and duct tape the front cover in place. Attach the package to the payload string as appropriate.

3.4.6. At the laptop, verify comms with the cutdown package. On the Cutdown Program software, select the "Arduino/Aircore COMMS CHECK" button. This will send a query three times to the payload cutdown package. If comms are good, a response message will be displayed three times from the cutdown package indicating that "ARDUINO IS ALIVE". Otherwise a message will be displayed indicating that there were no comms.

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4. **Software**

   4.1. Global Mapper version 12 or higher
   4.2. Virtual Serial Port Emulator
   4.3. Skysonde Server
   4.4. Skysonde Client
   4.5. Global Mapper iMet and Tracking Vehicle Program
   4.6. Cutdown Program

5. **Additional Information**

   5.1. iMet Radiosonde commands

ENSCI firmware for iMet radiosonde serial commands
version 1.06
date 09/06/2007

command	description	example
sid	get/set sonde id	"sid=123456789012"
pid	get/set probe id	"pid=123456789012"
sn	get/set serial number	"sn=123456789012"
txrf	on/off transmitter RF ouput	"txrf=on" or "txrf=off"
data	on/off all serial data output (PTU,STAT,GPS)	"data=on" or "data=off"
ptu	on/off serial PTU data output	"ptu=on" or "ptu=off"
stat	on/off serial status data output	"stat=on" or "stat=off"
gps	on/off serial GPS data output (RF & serial)	"gps=on" or "gps=off"
cal	get/set single cal const	"cal[0]=1.2345"
cals	read all cal const	"cals"
txmode	get/set tranmission mode	"txmode=BEL103" or

"txmode=BEL202" or "txmode=V.23"

xdata	transmit extra data	"xdata=0102030405060708090A"
hsp	get/set heater set-point	"hsp=-20"
leds	on/off on-board LEDs	"leds=on" or "leds=off"
pturr	get/set PTU report rate (sec)	"pturr=1"
gpsrr	get/set GPS report rate (sec)	"gpsrr=1"
txfreq	set tx freq for switch position(s)	"txfreq=403.5" to assign switch pos 1
		"txfreq=401.0,401.5,403,403.5" to assign all switch pos
save	save current config	"save"

6. .