

# EM Downlinker SOP



## Revision History

Revision & Date		Description	CR/CN	Approvals
B	9-12-19	Downlinker SOP	N/A	Originator: Jack Rader Reviewed By: Approved By:

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# 1 Overview

The XEM Downlinker is a system that makes downlinks faster and more accurate during drilling operations. The Downhole Downlink Receiver (DDR) contains an additional DPG electronics bay and an additional surface box that work together to transmit and receive downlink commands.



**Danger**

**Potential Severity: Major**

**Potential Loss: Assets, Personnel**

**Hazard Category: Electrical**

Downlinker is a high voltage device and is extremely dangerous. All safety precautions related to high voltage must be followed to avoid injury and/or damage to surface and downhole equipment. Use caution with the electrode output when the box is powered on. The Downlinker box must always be installed inside of a zone 2 environment to prevent potential explosion due to spark.

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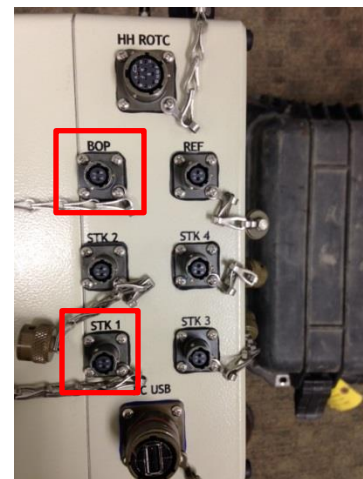
## 2 System Setup

### 2.1 Surface Setup

- A) Set the Downlinker, XM4/XTR, and Azonix/Laversab boxes in a dry, uncluttered area.
- B) Using a Type A male to male USB cable connect the Downlinker to the Azonix box. One end will plug into the USB port on the Downlinker and the other end will plug into one of the USB connections on the Azonix box or a USB hub.

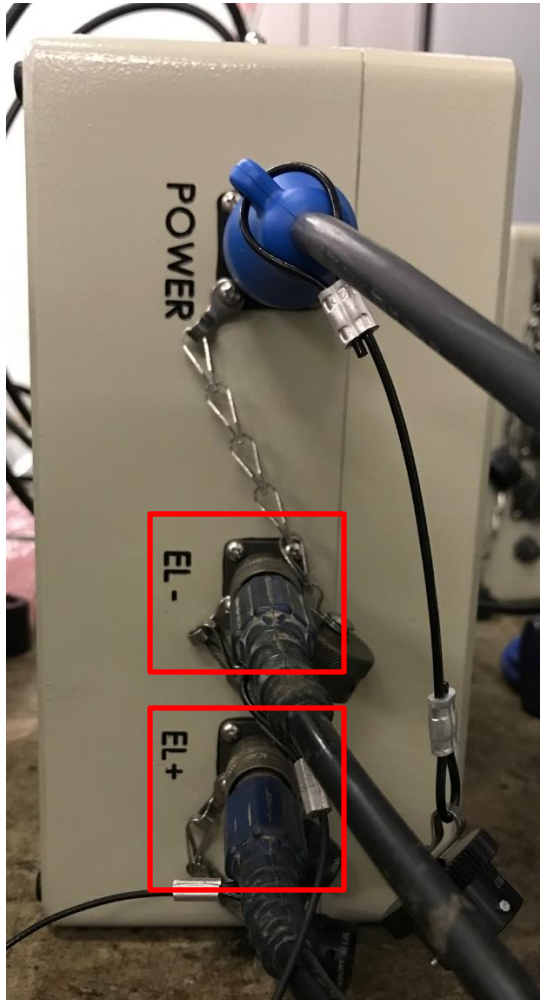


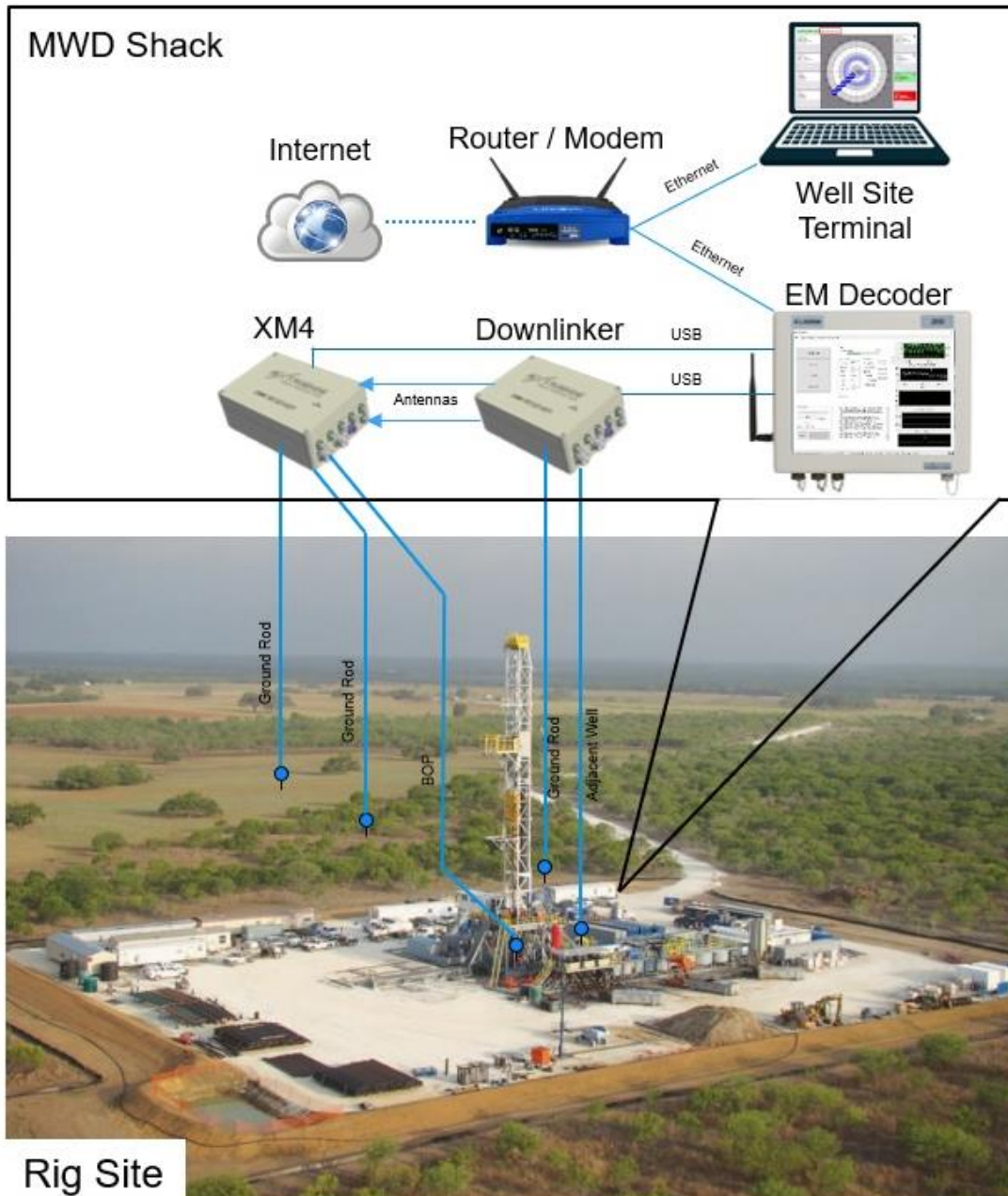
- C) Connect 22CABL0037 to the POWER port on the Downlinker and other end into a power source.
- D) Using BOP/ANT test cables (22CABL0063), connect the Downlinker to the XM4 by attaching the cables to the XM4+ and XM4- ports on the Downlinker to the BOP and STK1 ports on the XM4.



- E) Using cables 22CABL0058, 22CABL0033, 22CABL0056, or 22CABL0057, connect to the BOP, a stake, or offset well using the EL+ and EL- ports on the Downlinker.

**NOTE: If using ProXimity. Connect to the downhole antenna and the wellhead that contains the ProXimity antenna for best results.**





F) The image above portrays a standard surface system using the EM downlinker with an XM4 receiver. If the lines that the downlinker are using are successfully decoding tool signal, then it is highly probably that the downlinks sent will be seen by the MWD tool downhole.

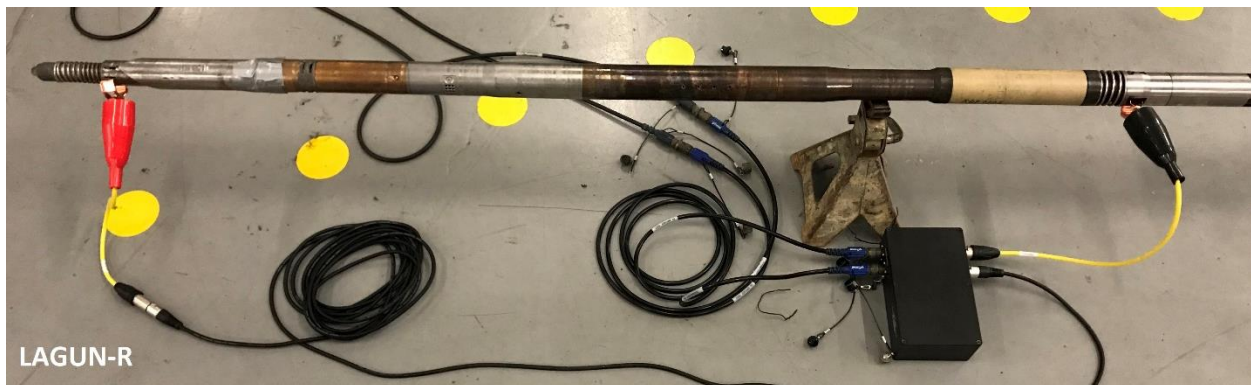


## 2.2 Bank Testing

- A) For standard bank testing the modified blue box with standard antenna cables or black downlinker box with the yellow wired clamps can be used by connecting it to the EL+ and EL- ports of the Downlinker using the BOP/ANT test cables (22CABLE0063). The use of 25m or 100m BOP/ANT extensions cables (22CABLE33/58) can be necessary to span the distance between the two.
- B) The modified blue box (as pictured below) has internal changes that allow it to be used with a downlinker. Several visual changes have been made to differentiate this blue box.
  - 1. "DOWNLINKER ENABLED" sticker now on the top
  - 2. Red "To Spider" terminals on the end
  - 3. "DOWNLINKER ENABLED" etched onto the bottom side



- C) Connect the leads to the upper gap and lower gap ports on the black box. Extensions will be necessary if testing a duel telemetry probe.
- D) Connect the upper gap cable to the spearpoint, landing spider, or pulser.
- E) Connect the lower gap cable below the gap joint on the grounding spider or gap probe

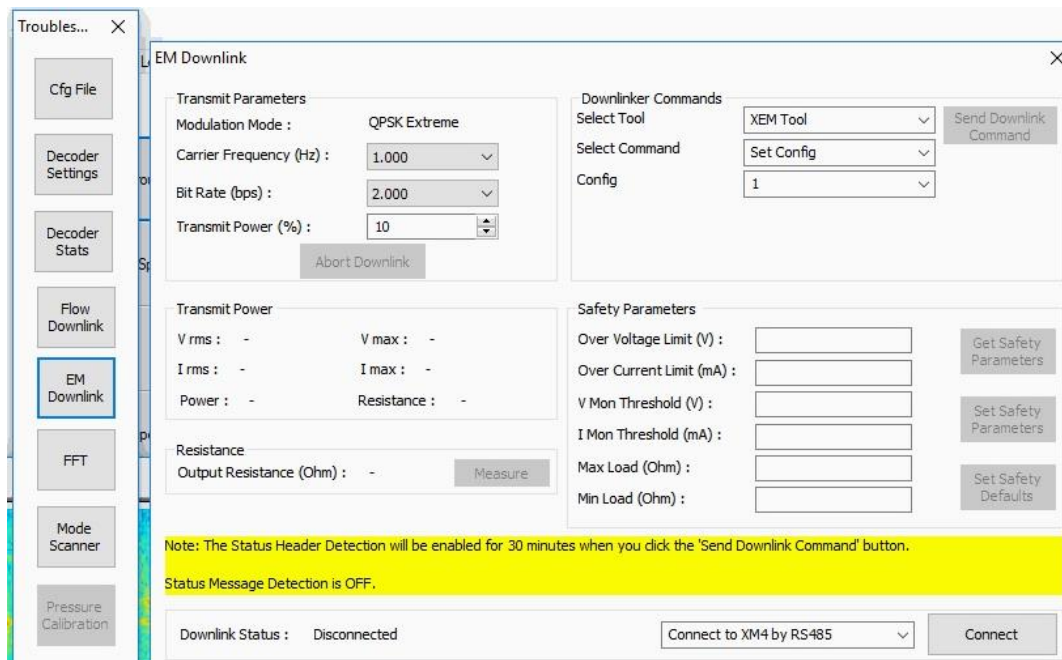


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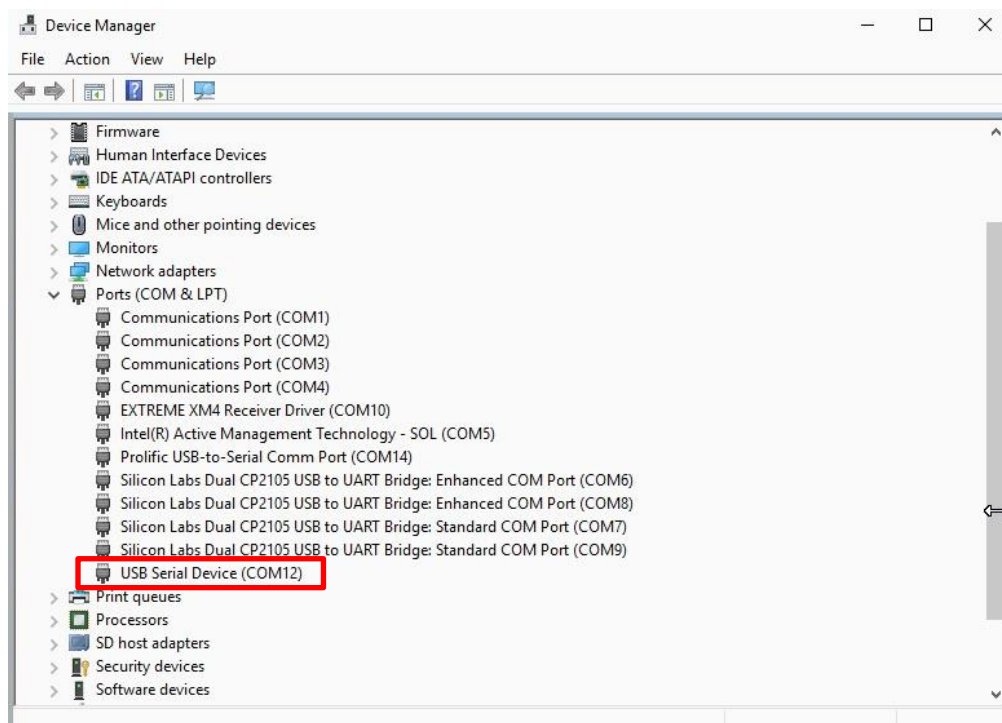
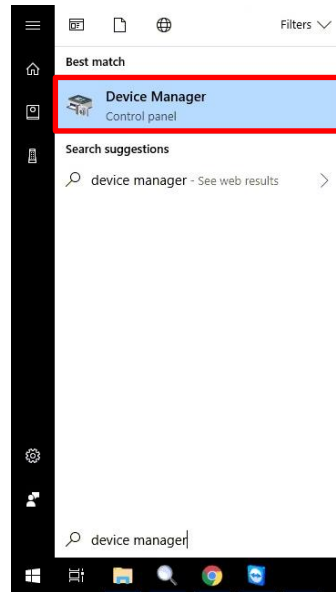
F) Open EM or XM4 surface software.

G) On the Data tab select the troubleshooting button in the upper left of the window and select the EM Downlink button.



H) Next to the Connect button in the lower right. Select “Connect to PC by USB” and select which port the Downlinker is occupying. The port being used by the downlinker can be found via Windows Device Manger. Open the Device Manager by selecting the windows button in the lower left and typing in “device manager”.





- 1) Expand the menu for Ports (COM & LPT). “Downlinker” will be visible in Windows 7 or “USB Serial Device” in Windows 10. The downlinker may appear to not have the proper driver installed if it is plugged in while the power to the downlinker is off. If this occurs, unplug the downlinker from the Azonix/Laversab. Power the Downlinker on. Plug the USB back into the Azonix Laversab.

Downlink Status : Disconnected    COM12    Connect to PC by USB    Connect

J) Once correct port is chosen, select the connect button in the lower right.

**NOTE: The button will change to disconnect and status will change to Idle if the downlinker has successfully connected.**

Downlink Status : Idle    COM12    Connect to PC by USB    Disconnect

K) Select "Get Safety Parameters". The current values will populate after this.

Safety Parameters

Over Voltage Limit (V) :	<input type="text"/>	Get Safety Parameters
Over Current Limit (mA) :	<input type="text"/>	Set Safety Parameters
V Mon Threshold (V) :	<input type="text"/>	Set Safety Parameters
I Mon Threshold (mA) :	<input type="text"/>	Set Safety Parameters
Max Load (Ohm) :	<input type="text"/>	Set Safety Defaults
Min Load (Ohm) :	<input type="text"/>	

L) Select "Set Safety Defaults" button to set all values to the default safety settings.

Safety Parameters

Over Voltage Limit (V) :	158	Get Safety Parameters
Over Current Limit (mA) :	3500	Set Safety Parameters
V Mon Threshold (V) :	50	Set Safety Parameters
I Mon Threshold (mA) :	100	Set Safety Parameters
Max Load (Ohm) :	600	Set Safety Defaults
Min Load (Ohm) :	5	

**NOTE: Do not change V Mon Threshold and I Mon Threshold without direct instruction from the engineering group.**

M) Setting the transmit parameters.

- Modulation Mode set to QPSK.
- Carrier Frequency set to 4.0.
- Bit Rate set to 4.
- Transmit Power set to 10%.

Transmit Parameters

Modulation Mode : QPSK Extreme

Carrier Frequency (Hz) : 4.000

Bit Rate (bps) : 4.000

Transmit Power (%) : 10

Abort Downlink

**NOTE: The Carrier Frequency and Bit Rate must match the settings in the XEM DDR probe. This can be found by accessing the DDR node from Live Tool Comm or referencing the pre-run report from XDirect.**



XDTM

**Pre-run MWD Report**

SW Version:13.6.23 - 2.0.0.567 (2.0.0.567)

**MWD Tool Health Check**

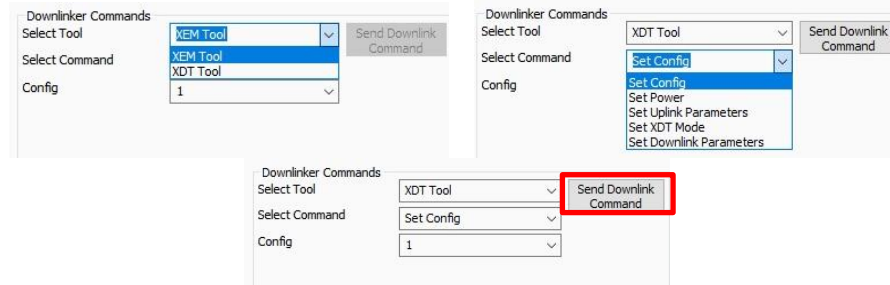
Probe XMCU (DDR)  
 FW Version 1.0.0.1  
 Hours 0.0

#	Name	Result Value	Range	Unit	Result Type
1	DDR Listening Bit Rate (bps)	4.0	0.5-8.5	bps	Pass
2	DDR Listening Frequency (Hz)	4.00	0.25-12.5	Hz	Pass

- N) Cycle the flow on and off using a vibrator or the Live Tool Comm inside of XDirect to transmit a survey.

**NOTE: These next steps must be initiated immediately after the survey is finished. The DDR will go into a listening mode as soon as the survey completes transmission and will continue to listen until the tool starts sending signal again or the tool is reset.**

- O) Return to the EM Downlink Utility. Select the tool that is being used. XEM for DDR probes and XDT for duel telemetry probes. Continue to the “Select Tool” dropdown menu. For testing select, “Set Config”. Select a different configuration than what is currently loaded. Once settings are correct select the “Send Downlink Command”.

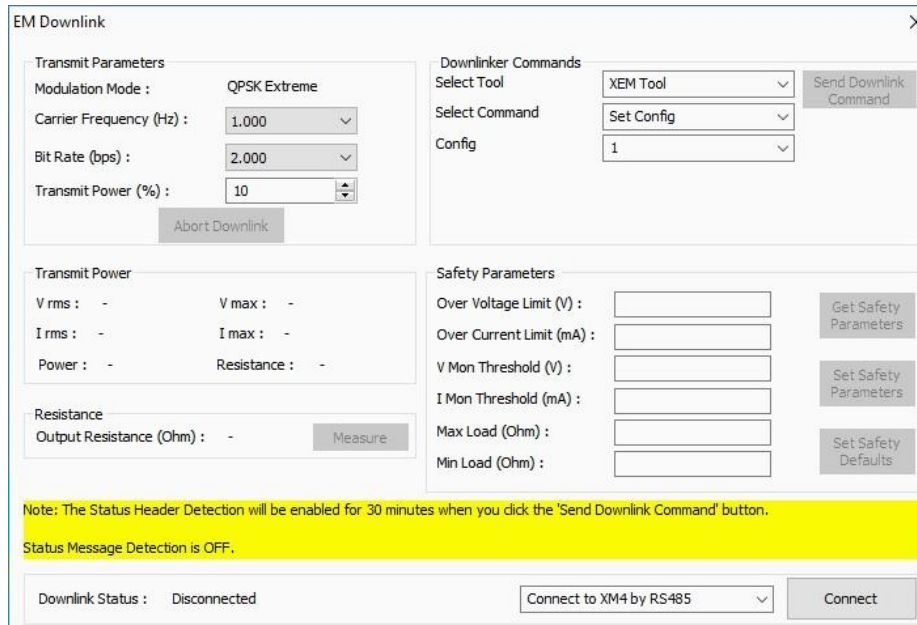


- P) A successful downlink can be observed in the XEM receiver software. A status header will come from the XEM tool and the surface software will produce a pop-up window showing the tool has changed.
- Q) Close the EM Downlinker Utility and manually change the configuration in the surface software to decode the EM signal in the new configuration.

### 3 Downhole Operation

#### 3.1 Downlinking

- A) Launch the EM Downlink Utility from within the RX surface software on the PC connected to the Downlinker box. If necessary, refer to pages 7-8 for instruction on connecting to the downlinker.



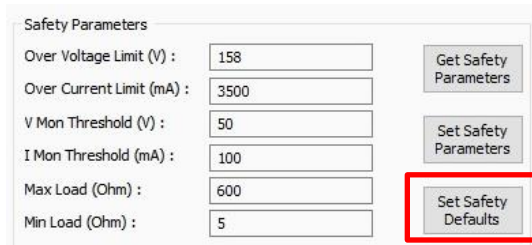
**NOTE: The button will change to disconnect and the Downlink status to Idle once the downlinker has successfully connected to the software.**

- B) Select the “Measure” button to populate the Formation Resistance ( $R_f$ ) from the Output resistance (Ohm). Optimal resistance measurements should read between 15 and 100 ohms. Resistance above 450 ohms may result in an error and the inability to send downlinks.





R) Select “Set Safety Defaults” button to set all values to the default safety settings.

C) The screenshot shows a 'Safety Parameters' window with six input fields and three buttons. The fields are: Over Voltage Limit (V) with value 158, Over Current Limit (mA) with value 3500, V Mon Threshold (V) with value 50, I Mon Threshold (mA) with value 100, Max Load (Ohm) with value 600, and Min Load (Ohm) with value 5. The buttons are 'Get Safety Parameters' (top), 'Set Safety Parameters' (middle), and 'Set Safety Defaults' (bottom, highlighted with a red box).

**NOTE: Do not change V Mon Threshold and I Mon Threshold without direct instruction from the engineering group.**

D) Setting Safety Parameters

1) Setting the Over Voltage Limit (V)

i. If  $R_f \leq 37.5$  Ohms, then: Over Voltage Limit =  $R_f * 4.2$

ii. If  $R_f > 37.5$  Ohms, then: Over Voltage Limit = 158

2) Setting the Over Current Limit (mA)

i. If  $R_f \leq 37.5$  Ohms, then: Over Current Limit = 4200

ii. If  $R_f > 37.5$  Ohms, then: Over Current Limit =  $157,500 / R_f$

E) Set the transmit parameters.

a. Modulation Mode set to QPSK.

b. Carrier Frequency set to 4.0.

c. Bit Rate set to 4.0.

d. Setting Transmit Power (%).

i. If  $R_f \leq 37.5$  Ohms, then: Transmit Power =  $R_f * 2.22$

ii. If  $R_f > 37.5$  Ohms, then: Transmit Power = 84

**NOTE: The Carrier Frequency and Bit Rate must match the settings in the XEM DDR probe. This can be found by accessing the DDR node from Live Tool Comm or referencing the pre-run report from XDirect.**



XDTM

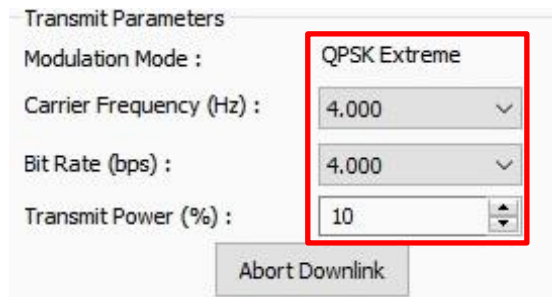
**Pre-run MWD Report**

SW Version:13.6.23 - 2.0.0.567 (2.0.0.567)

**MWD Tool Health Check**

Probe XMCU (DDR)  
 FW Version 1.0.0.1  
 Hours 0.0

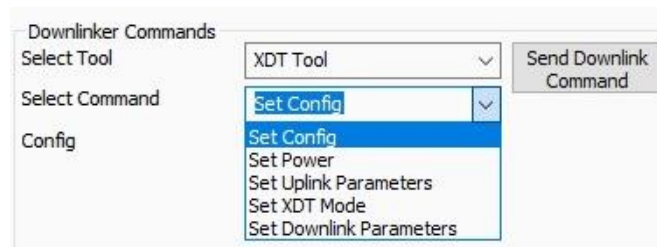
#	Name	Result Value	Range	Unit	Result Type
1	DDR Listening Bit Rate (bps)	4.0	0.5-8.5	bps	Pass
2	DDR Listening Frequency (Hz)	4.00	0.25-12.5	Hz	Pass



F) If the tool is currently not transmitting cycle the flow on and off to transmit a survey.

**NOTE: These next steps must be initiated immediately after the survey is finished. The DDR will go into a listening mode as soon as the survey completes transmission and will continue to listen until the tool starts sending signal or the tool is reset.**

G) Return to the EM Downlink Utility. There are three Downlinker Commands that can be selected with XEM and \*Five with XDT (duel telemetry). Only one of these downlinks can be completed at a time.



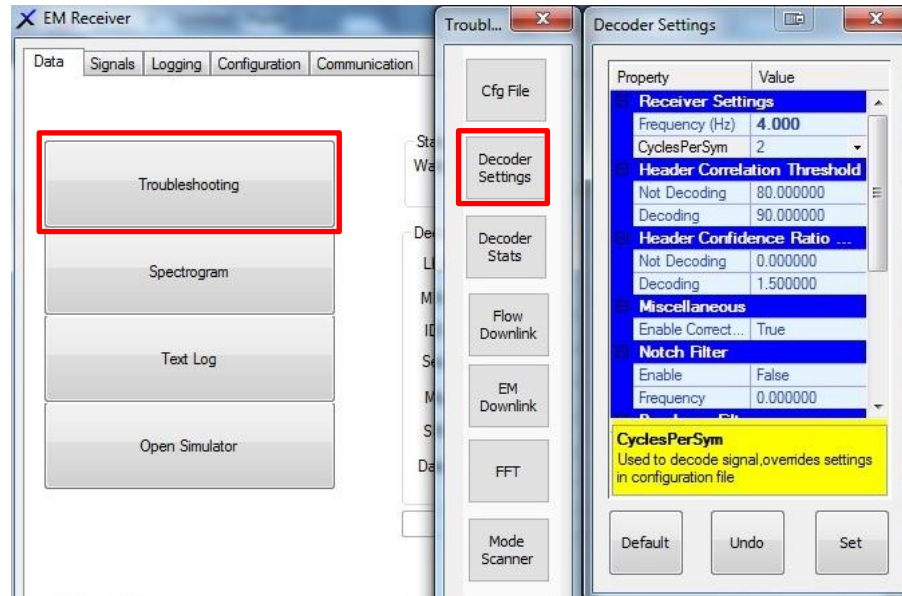
1) Set Config: User can select a configuration number between 1 and 8. This command will reset the tool.

- 2) Set Target Current/\*Power: User can select any standard target current between 0.1 and 5 amps or standard power between 0.3 and 20 watts. This command will not reset the tool.
- 3) Set Uplink Parameters: User can select frequency and cycles per symbol together. This command will reset the tool.
- 4) \*Set XDT Mode: User can set several modes in the dual telemetry tool. These commands will reset the tool.
  - i. EM Mode – The tool is in EM tool mode
  - ii. Pulse Mode – The tool is in pulse tool mode
  - iii. MP with EM Survey – Pulse mode with EM surveys on connection
  - iv. MP with EM & MP Survey – Pulse mode with EM surveys on connection and pulse surveys post connection
  - v. Trip Out Sleep – Turns tool off. The tool will wake up when a new mode downlink is received from the downlinker.
  - vi. Trip Out with RM Survey – Tool stops transmitting but continues to record surveys
- 5) \*Set Downlink Parameters: User can change the listening frequency within a standard range the tool uses for EM downlinks. This command will reset the tool.

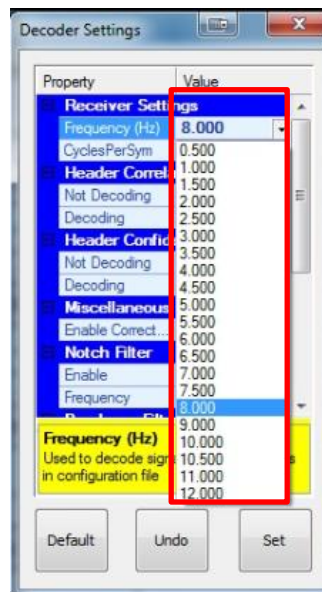
**NOTE: If any alarm is triggered during the downlink, the downlink process will stop. The “Abort Downlink” button will change to “Reset Alarm”. The user must select the “Reset Alarm” button and decrease the Transmit Power (%) before sending the next downlink command.**

- H) A successful downlink can be observed in the XEM receiver software. A status header will come from the XEM tool and the box will produce a pop-up window showing the tool has changed. If “Set Power” is used the downlink can be seen on the next Target Current uplink transmission from the toolstring. The decoded DDR count can also be monitored for an increase. This is a rolling count of how many times the DDR node has decoded EM downlinks successfully. Inside of the decoded log files or real time decoding details will be “DDR: DDR\_RX\_MSG\_CNTRE = (number)”. This number will not reset and will increase 1 unit for every downlink received.
- I) Follow the steps below if “Set Uplink Parameters” was used to change the tools transmission frequency.

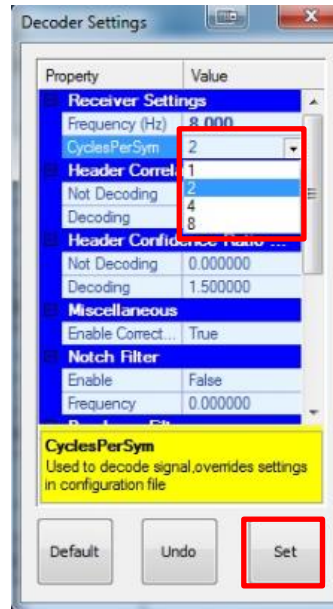
- 1) Select the Troubleshooting button.
- 2) Select the Decoder Settings button.



- 3) Select the Frequency (Hz) dropdown and select the frequency that was downlinked to.



- 4) Select the CyclesPerSym dropdown and select the Cycles Per Symbol downlinked to. Select set.



- J) Turn flow on to see if the tool is decoding properly. If frequency was changed the spectrogram can be consulted to see if the tool's signal was also changed. If signal is not decoding, follow steps F through J again.