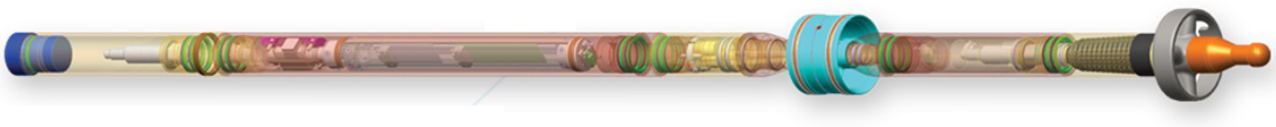
EXTREME™ ENGINEERING

XEM™



OPERATIONS MANUAL

CHAPTER 2 SPECIFICATIONS

REV A: 2013 July9

XFLD-0002

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1. OVERVIEW

The XEM is an electromagnetic (EM) telemetry system offering Inclination / Azimuth, full MWD, Gamma-ray logging, and Borehole / Annular Pressure While Drilling (PWD).

Additional aspects of the XEM tool are listed below:

- XEM is capable of high data rates.
- XEM can be used for Survey On Command (SOC) applications.
- XEM requires no mechanical adjustments associated with a pulser or extensions. Upon arrival to the job location, the tool needs only to be built, programmed, and loaded into the BHA.
- XEM is non-retrievable.
- XEM basic services are Directional Survey Service (DSS), Directional Logging Service (DLS), and other possible services include Perform Drilling Mechanics.
- XEM has no LCM restrictions.
- XEM can operate up to 300℉.
- XEM signal strength is limited by depth, formation resistivity, and electrical noise factors.
- XEM does not transmit when no vibration is detected, which saves battery life.
- XEM can incorporate programmable frames.
- XEM can have different configurations downlinked to it.

This section covers the description and specifications of the Down hole and Surface Equipment needed to run an XEM job.

2. DOWNHOLE EQUIPMENT

The XEM down-hole system consists of electronics probes mounted in the center bore of the XEM Gap Sub and nonmagnetic drill collar (NMDC). The battery probe, transmitter probe, and antenna probe are required for transmission of the telemetry signal to the surface.

The D&I probe and/or gamma probe are/is installed to provide additional data, as requested by the client. In addition, the antenna probe is equipped with dual pressure gauges, and can provide bore and annular pressure for underbalanced drilling. The dual pressure gauges provide a configurable safety means to prevent EM signal transmission from occurring at the surface. This section details the major XEM down-hole components.

1.1. DPG DUAL PRESSURE GAUGE

Figure 1: Dual Pressure Gauge Probe

PRIMARY FUNCTIONS

- Provides the electrical gap for transmitting the signal.
- Provides the mechanical strength to fixture all the probes.
- Contains gauges that measure bore, annular, and differential pressures.
- Provides the primary safety to prevent unwanted EM transmission at the surface of the rig.

FUNCTIONAL ELEMENTS

- Spearpoint: used for installing and removing the tool.
- Landing Spider: used to fix the location of all the probes in the Gap Sub and the NMDC; to control the toolface relative to the outside scribe of the Gap Sub; for transmitting the signal through to the top half of the Gap Sub.
- Gap Joint: isolates the top portion of the DPG probe from the rest of the tool string.
- Rotatable Connector (ROTC) Joint: used to program the tool string from the top.
- Grounding Spider: used for transmitting the signal through to the bottom half of the Gap Sub; for sealing the pathway from the annular port in the Gap Sub to the transducer body.
- Transducer Body: houses the bore and annular pressure gauges.

- DPG Electronics Bay: houses the DPG board that processes the dual pressure gauge signals; houses the XBUS communication board.
- Axial Shock Absorber: protects the electronics bay from the high axial shocks (centralizers in the tool are used to protect from lateral shocks).
- Down hole ROTC: mechanically and electronically joins the DPG probe to the transmitter probe.

1.2. TRANSMITTER

Figure 2: Transmitter Probe

PRIMARY FUNCTIONS

- Controls the transmission of the signal to surface.
- Includes the Flow Switch to sense flow on and flow off.
- Stores the downhole data from all probes except the battery probe.

FUNCTIONAL ELEMENTS

- Uphole ROTC: mechanically and electrically joins the transmitter probe to the DPG probe.
- Bay 2: communicates power consumption to Bay 1; generates a transmission signal.
- Bay 1: detects “Pumps on/off”; controls all communications; holds configuration files and operational history; measures downhole temperatures.
- Axial Shock Absorber: protects the electronics bays (Bay 1 and Bay 2) from high axial and rotation shock and vibration.
- Downhole ROTC: mechanically and electrically joins the DPG probe to the transmitter probe.

1.3. DIRECTIONAL PROBE

Figure 3: Directional Probe

PRIMARY FUNCTION

- Provides all directional information for the tool string.

FUNCTIONAL ELEMENTS

- Uphole ROTC: mechanically and electrically joins the directional probe to other probes.
- XBUS Board: controls communication of the directional data to the transmitter probe.
- Directional Module: determines directional measurements based on magnetic and gravitational readings.
- Axial Shock Absorber: protects the Directional Module and electronics from high axial and rotation shock and vibration.
- Downhole ROTC: mechanically and electrically joins the directional probe to other probes.

1.4. GAMMA RAY

Figure 4: Gamma Probe

PRIMARY FUNCTION

- Provides the gamma radiation counts for the tool string.

FUNCTIONAL ELEMENTS

- Uphole ROTC: mechanically and electrically joins the gamma probe to other probes.
- XBUS Board: controls communication of gamma data to the transmitter probe.
- Axial Shock Absorber: protects the Gamma Module and electronics from high axial and rotation shock and vibration.
- Downhole ROTC: mechanically and electrically joins the gamma probe to other probes.
- Gamma Module: detects variances in subsurface gamma radiation.

1.5. GAP SUB

Figure 5: Gap Sub

PRIMARY FUNCTION

- Isolates each side of the EM differential signal from the other side.
- Fixes the tool string in place within the NMDC.
- Allows for the reading of annular pressure.
- Gives the high-side offset (toolface) reference.

FUNCTIONAL ELEMENTS

- Gap Joint: for electrically isolating EM+ and EM- signals from each other.
- Bottom End: for housing the Landing Key.
- Landing Key: for locking the tool in place within the Gap Sub by mating with the landing spider of the DPG probe.
- Top End: for housing the Annular Pressure Port.
- Annular Pressure Port: for allowing the DPG probe to measure the annular pressure, which is generally used for safety settings and to monitor under-balanced drilling conditions.
- Hard Banding (raised bands of metal, one pair on each half of the Gap Sub): for protecting the Gap Sub from excess wear damage.

3. SURFACE EQUIPMENT

The XEM system's surface equipment is comprised of a grounding antenna and BOP connection, which receive the telemetry from the XEM down hole tool, and a telemetry receiver and remote terminal, which are installed in the doghouse and are used to decode and display the telemetry information.

The remote terminal also functions as a communication hub to transmit telemetry data. There are two types of remote terminals: the Azonix and XRT. This section details the major XEM surface components.

3.1. AZONIX TERMINAL

The XEM system's surface equipment is comprised of a grounding antenna and BOP connection, which receive the telemetry from the XEM down hole tool, and a telemetry receiver and remote terminal, which are installed in the doghouse and are used to decode and display the telemetry information.

The remote terminal also functions as a communication hub to transmit telemetry data. There are two types of remote terminals: the Azonix and XRT. This section details the major XEM surface components.

Figure 6 Azonix Terminal

PRIMARY FUNCTIONS

- Runs XEM Rx (XEM Receiver) software.
- Decodes information sent from Telemetry Receiver.
- Provides interactive visual display for directional driller.
- Communicates with computer networks for troubleshooting and remote monitoring.
- In addition to operating as a Remote Terminal like the XRT, the Azonix can be used as a Rig Floor Display (RFD).

FUNCTIONAL ELEMENTS

- Ruggedized laptop (included inside): runs all decoding and communication software.
- Touch Screen: used to control the laptop monitor.
- Router (included inside): communicates between the Laptop and external Ethernet devices.
- EM Rx Decoding Software: translates information received by the telemetry receiver into visually displayed data.

AZONIX CONNECTION PORTS

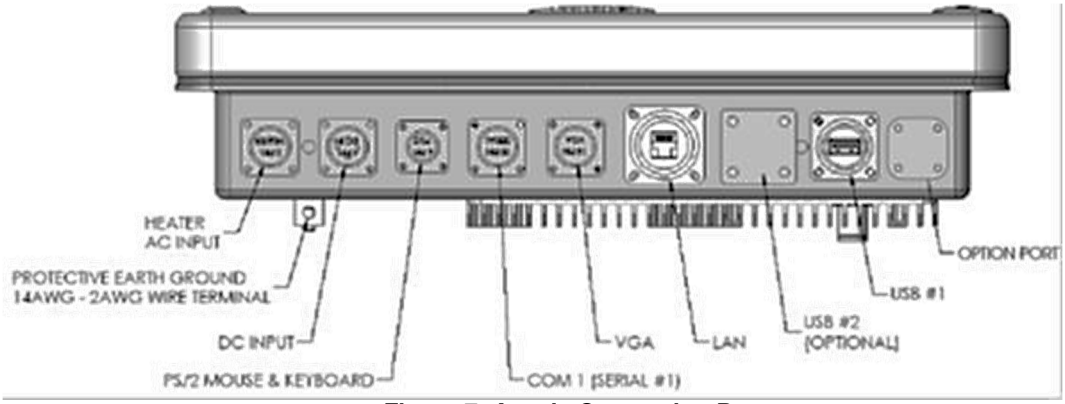


Figure 7: Azonix Connection Ports

- Power: connects to AC wall outlet.
- WIFI: ANT port, Cable and antenna from MRO.
- Telemetry Receiver (TR): Connect to USB1 or laptop on Azonix, 22CABL0104-02.
- USB (hub, mouse, keyboard, etc.): USB2, Standard Type A Male USB Cable.
- LAN: connects to LAN port on Azonix, Standard RJ45 Ethernet Cable.
- WITS: Connect to COM port or 33ADPT0001 on Azonix, use 07CABL0114-1.

CABLES

- X-EM 2m 120V AC Power Cable (22CABL0037-A).
- 20ft Azonix WITS Cable (22CABL0114-A).

- 10ft USB to CIR8P (cable mount PT06A-12-8P) Cable (22CABL0104-A).

CERTIFICATIONS

The Azonix Barracuda complies with the certifications below:

- EMC Directive – 2004/108/EC
- Low Voltage Directive – 2006/95/EC
- ATEX Directive - 94/9/EC
- Standards to which Conformity is declared:-
- LVD: EN61010 -1:2001
- EMC EN61326 -1:2006
- ATEX : EN60079-0:2009 EN60079-15 :2010
- North America: Class1 Zone 2 AEx nA II T3 IP56
- EUROPE / ATEX: exnA II T3 GC

3.2. EXTREME REMOTE TERMINAL

The Extreme Remote Terminal (XRT) is used to display and communicate data to the Command Center. The XRT is ruggedized and weather-proof, and can be used in most surface rig environments. This part will no longer be ordered, and will be replaced by the Azonix Terminal.

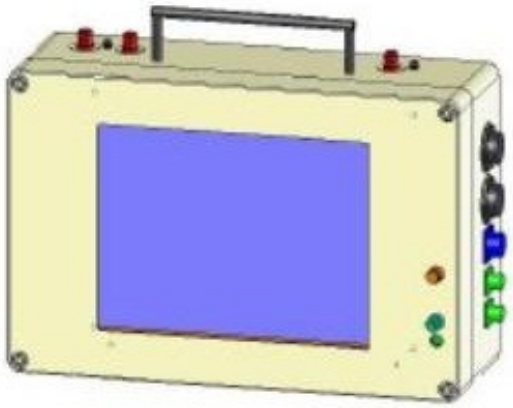


Figure 8: Remote Terminal

PRIMARY FUNCTIONS

- Runs EM Rx (XEM Receiver) software.
- Decodes information sent from Telemetry Receiver.
- Provides an interactive visual display for the directional driller.
- Communicates with computer networks for troubleshooting and remote monitoring.

FUNCTIONAL ELEMENTS

- Laptop: runs all decoding and communication software.
- Touch Screen: used to control the laptop monitor.
- Router: communicates between the Laptop and external Ethernet devices.
- EM Rx Decoding Software: translates information received by the telemetry receiver into visually displayed data.

CONNECTORS

- LAN: connects to one of four LAN inputs on the router.
- WAN: connects to the WAN input on the router.
- USB/POWER: connects directly to the Telemetry Receiver Laptop Connector.
- USB: connects one of the laptop USB ports to a mouse, keyboard, etc. (requires special cable).

POWER SOURCE

The XRT receives 15VDC power from the TR.

3.3. EXTREME TELEMETRY RECEIVER

Figure 9: Telemetry Receiver

PRIMARY FUNCTION

- Powers the tool in Test Mode.
- Powers the XRT.
- Receives raw signals from the BOP and grounding antenna.
- Sends digitized data to the Azonix or XRT.

FUNCTIONAL ELEMENTS

- [2] Power Supplies: takes in 120V AC; puts out the required voltages for laptop power, tool testing, and internal circuitry.
- Internal Circuitry: receives the raw signals from the BOP and antennae; cleans, amplifies, and digitizes the signal, which is then decoded by the EM Rx software.

CONNECTORS

- ANT: for using low-noise cabling to connect to the antennae.
- BOP: for using low-noise cable to connect to the BOP.
- HH ROTC: for connecting the Telemetry Receiver to the tool string for bank testing.
- 120VAC: receives the AC power input.
- Laptop: connects to the Universal Remote Terminal Box.
- Remote Connectivity Kit.

POWER SOURCE

The TR receives AC 100V 50Hz power from a wall socket.

3.4. REMOTE CONNECTIVITY KIT

PRIMARY FUNCTION

The Remote Connectivity Kit provides networking for the remote terminal as well as enabling communication with an external network.

FUNCTIONAL ELEMENTS

- Frequency: Channel 11 of the WiFi 2.4GHz band
- Wattage/Input: 120VAC, 0.5A, 50-60Hz
- Power level: 18 dBm EIRP
- Antenna:
    - Standard: 2.4GHz 7dBi omnidirectional
    - High-gain: 2.4GHz 8dBi omnidirectional
- Networking:
    - 802.3 LAN
    - 802.11b/g
    - WLAN (WiFi)

- Security:
  - SPI
  - WPA2
  - WEP
  - MAC Filtering
- Environmental/Operating Temperature: 0 to 40℃
- Traffic Management WiFi Access Point with DHCP server

PLACEMENT

(Refer to 07-OPDC-0020-B).

1. Connect the feed from the Satellite Modem to the “Internet” port of the Host Router.
2. Attach the magnetic mount antennas supplied into the two ports on the back of the host router.
3. Run them outside the shack so the Host Router will have the best potential for signal strength when connecting to the Client Router. Ensure the same for the Client Router (Remote Terminal) antennas.
4. Cycle the power on the host router so that all settings take affect by disconnecting its power source for at least 10 seconds then reconnecting it.

PASON EDR

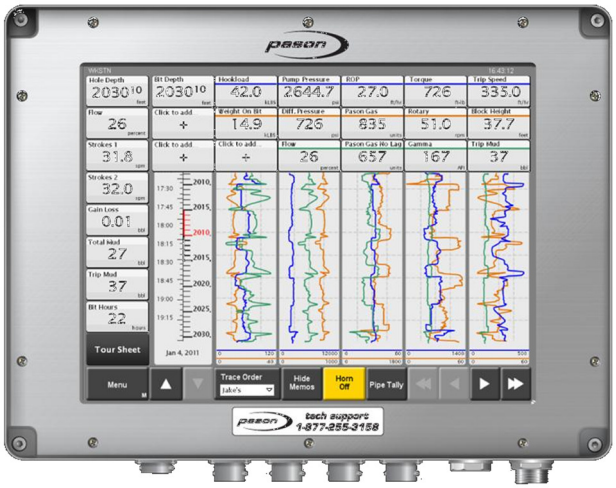


Figure 10: Pason Electronic Drilling Recorder

PRIMARY FUNCTIONS

The Pason Electronic Drilling Recorder (EDR) can use WITS to communicate directly with Extreme surface equipment, and vice versa. Using WITS communication, data can be sent or received from the PASON EDR. The Pason cannot be used independently for decoding XEM signals.

Figure 11: Pason Connection Equipment

4. SPECIFICATIONS

This section provides specifications for down hole equipment

4.1. ENVIRONMENT SPECIFICATION

Environment				
Description	**4.75"**	**6.50"**	**8.00"**	**11.00"**
Rotation**	200 RPM Typical			
Shock	1000 g, ½ msec, ½ Sine Shock			
Vibration	30 g, 30-500 Hz			
Maximum Operating Pressure	15,000 psi			
Maximum Operation Temperature	150°C (300°F)			
Minimum Storage / Transportation Temperature	-40°C (-40°F)			
Maximum Sand Content by Volume	2%			
Maximum LCM Content	No Limits			
Maximum Axial Load: (Compression)	100,000 lbs.	200,000 lbs.	300,000 lbs.	600,000 lbs.
Maximum Axial Load: (Tension)	500,000 lbs.	1,000,000 lbs.	1,200,000 lbs.	3,000,000 lbs.
Max. Dog Leg Severity Rotating: **Slick Collars**	15°/30m	10°/30m	8°/30m	5°/30m
Max. Dog Leg Severity Rotating: **Flex Collars**	25°/30m	15°/30m	13°/30m	8°/30m
Recommended Maximum Flow Rate[1]	317 GPM	528 GPM	1056 GPM 900 GPM	1500 GPM
Recommended Collar Bores	$2^{11}/_{16}$" ID Collar	$2^{13}/_{16}$" ID Collar	3 ½" ID Collar 3 ¼" ID Collar	4" ID Collar

Table 1 Environment Specification

1. The Maximum flow rates have been specified taking into consideration the fluid velocities that may create a higher probability of washout on the spiders/centralizers and the Gap Sub. Additional flow may not necessarily create failures such as jamming issues seen in Pulse tools.

A. EQUIPMENT SPECIFICATION

Equipment				
Description	**4.75"**	**6.50"**	**8.00"**	**11.00"**
Gap Sub ID	2.688 ±0.005"	2.813 ±0.005"	3.500 ±0.002"	4.000 ± 0.000" 0.0002"
Gap Sub OD	4.750 ±0.025"	6.500 ±0.025"	8.000 ±0.025"	10.800"
Gap Sub OD With Hard Banding	4.825 ±0.025"	6.575 ±0.025"	No Hard Banding	No Hard Banding
Connections	NC 38 (3 ½ IF)	NC 46 (4 ½ XH) NC 50 (4 ½ IF)	6 ⅝ Regular	API NC77
Connection Makeup Torque (Torque value for NC 50)	9,400 ft. lbs.	23,000 ft. lbs.	39 000 ft. lbs.	100,000 ft lbs.
Torsional Strength of Gap at 150℃	10,000 ft. lbs.	20,000 ft. lbs.	55,000 ft. lbs.	Tested to 100,000 ft lbs. at RT
Gap Sub Overall Length	44.2"			
Gap Sub Re-Cut Length	6.50" Pin End & 4.75" Box		5.50" Pin End & 4.75" Box End	6.50" Both Ends
Flex Collar Requirements	4.00" Flex Sections Min. ⅔ Total Length (20' of 31') Collars Above and Below Gap Sub		5.625" Flex Sections Min. ⅔Total Length (20' of 31') Collars Above and Below Gap Sub	6.00" Flex Sections Min. ⅔Total Length (20' of 31') Collars Above and Below Gap Sub
Tool Length (Probe Dependant)	Min. 234" & Max. 365"			
Max. Tool Weight (without collar)	270 lbs.	430 lbs.	610 lbs.	960 lbs.

Table 2 Equipment Specification

B. PRESSURE DROP CALCULATION

Pressure drop is computed as a function of flow and mud weight using the Equation below:

$$\text{Pressure Drop (psi)} = MW \times flow^2 / C$$

Where: MW is Mud Density in lbm/gal, Flow is gpm, and C is the Pressure Drop Constant (see table below).

Tool Size / Collar ID	Pressure Drop Constant	
	Constant With Gamma	Constant Without Gamma
4.75" Collar ID= $2\frac{11}{16}$"	7400	8500
6.50" Collar ID= $2\frac{13}{16}$"	12700	14700
8.00" Collar ID = 3.25"	46100	53300
8.00" Collar ID = 3.50"	75000	86600
11.00" Collar ID = 4"	191300	220300

Table 3 Pressure Drop specifications

For additional sizes of collars, please contact Sustaining at XPTC.

C. DIRECTION AND INCLINATION SPECIFICATIONS

Accuracy	
Azimuth (Latitude < ±55°)	±0.3°
Tool face (Roll)	±0.1°
Inclination	±0.1°
Continuous Inclination	± 0.1 Degrees at 30° Inclination (to be confirmed)
Temperature	
Operating Temperature Range	Options: 0 – 150°C (32 to 300°F)
Storage Temperature Range	-55° to +160°C (-67 to 320°F)
Power	
Input Voltage Range	+11V to +30V
Current Draw	70 ma @ 15V
Physical	
Outside Diameter (O.D.)	1.375" (35mm)
Length	15.5" (394mm)
Weight	1.5 lbs. (681g)
Environmental Performance	
Shock	1000 G 1ms half sine wave
Vibration	20G rms 5-1000Hz

Table 4 D&I Inclination specifications

D. GAMMA RAY SPECIFICATIONS

Gamma Ray Tool Specifications	NGT-T NGT-TX Without Barrel	NGT-EX
Application	Geosteering	Geosteering
Diameter (OD)	1.36"	
Length (make up)	13.6", 11.6" (TX)"	
Weight	1.7 lb.	
End Connectors	MDM 15-Pin	
Material	Aluminum Alloy	
Pressure	NR	
Typical Sensitivity	2.2 CPS/API	
Accuracy	±2% @ 300℉ / 150℃ ±5% @ 350℉ / 175℃	
Maximum API Range @ 5% error	5000 API	
Thin-Bed Resolution (8″ hole diameter, at 50% points)	6.8"	8.8″
Operating Temperature	-77 to +350℉ / -60 To 176℃	-77 to +350℉ -60 to +176℃
Survival Temperature (reduced accuracy)	400℉ / 204℃	400℉ / 204℃
Max Heat/Cool rate	5℉ / Minute -15℃ / Minute	5℉./Minute -15℃ / Minute
Vibration (3 axis) 50-1000 Hz Random spectrum	20 G.	20 G.
Shock (Z-axis)	500 G., 0.5 mS.	500 G., 0.5 mS.
Shock (X / Y-axis)	1000 G., 0.5mS.	1000 G., 0.5mS.
Input Voltage	17-48 Volts	17-48 Volts
Input Current (decreases with increasing voltage)	11-8 mA (9 mA at 28 volts)	11-8 mA (9 mA at 28 volts)
Maximum Voltage	50 Volts	50 Volts
Negative Pulse	+5V to GND 5 uS fixed width	+5V to GND 5 uS fixed width

Table 5 Gamma Specifications

E. SHOCK & VIBRATION

Shock	3-Axis measurements, ±500G
Resolution	1G minimum
RPM	Max 400RPM, 5% Precision
Memory	8MB on-board memory to store log data
Max Working Temperature	302℉/ 150℃
Logging Time Duration	10 Days minimum
Tool Length	58.65"
Tool Diameter	1.75"

Table 6 Shock & vibration specifications

F. ANNULAR & BORE PRESSURE

Accuracy			
	Low Pressure (20 psi)	**Mid Pressure (10kpsi)**	**High Pressure (20kpsi)**
Room Temp (25℃)	±7 psi	±7 psi	±15 psi
Mid Temp (80℃)	±15 psi	±7 psi	±7 psi
High Temp (150℃)	±20 psi	±10 psi	±7 psi
Min Pressure	14 psi		
Max Pressure	15000 psi	Max Pressure	15000 psi
Accuracy	±10 psi	Accuracy	±10 psi
Resolution	1 psi	Resolution	1 psi

Table 7 Annular and Bore pressure specifications

G. DPG PRESSURE SENSOR

DPG Pressure Sensor Specifications	
	Accuracy
Lower Range (0-10kpsi)	0.25% Full Scale = 20kpsi/400 = 50 psi
Upper Range (10-20kpsi)	0.50% Full Scale = 20kpsi/200 = 100 psi
Pressure Sensor Output	45 μV/psi

Table 8 DPG Pressure Sensor

H. BATTERY PROBE

Two types of batteries are available for different drilling applications:

1. Lithium Battery for Normal Drilling (mud-based) applications
2. Alkaline Batteries for Air Drilling Applications

MAXIMUM VOLTAGE	
Lithium	15V
Alkaline	16.5V

Table 9 Battery Probe

A minimum of two different packs are used in a tool, with one pack at a time powering the tool. The tool switches from one battery to another based on the following:

- Help Voltage
  - Lithium: when voltage drops to: 10 V
  - Alkaline: when voltage drops to = 8.5 V
- Help Current = 2 Amps

  *In this condition, both batteries supply power to the tool.

Protection Voltage:

- Lithium = 8 V
- Alkaline = 7 V

*In this condition, power is switched from one battery to the other.

I. LITHIUM BATTERY PACK SPECIFICATIONS

Each lithium battery contains 8 cells per pack. The specifications below are applicable to both 150℃ and 165℃ packs. Most New batteries are rated for 165C. There may still be batteries rated for 150℃ .

8 CELL LITHIUM BATTERY PACK	
Number of Cells	Total of 8 cells 4 cells connected in Series in 1 string, 2 strings per pack in parallel
Voltage	3.67 V per cell
PACK SPECIFICATIONS	
Length of Pack	43.99”
Pack Diameter	1.43”
Operating Temperature	0℃ to 150℃ /165℃
Open circuit Voltage (25℃)	14.68V
Rated Capacity	**50.5 Ah (150℃) ***

Table 10 Lithium battery Pack

The Rated capacity is based on practical experience.

*165℃ LITHIUM BATTERY CELL**

The specifications below are a high-temperature option.

CELL SPECIFICATIONS	
Open circuit voltage (25℃)	3.67V
Rated Discharge Current	200 mA
Rated Capacity	29 Ah
Maximum Continuous Current	550 mA
Cell Diameter (nominal)	31.75 mm (1.25")
Cell Length (nominal)	125.1 mm (4.93")
Cell Weight	210 g
Lithium Weight	8.4 g
Self-Discharge	2% per year at 25℃
Operating Temperature	-40℃ to +165℃ / -40℉ TO +329℉
Theoretical Rated Capacity	29Ah (165℃)

Table 11 165DegC cell specifications

J. ALKALINE BATTERY CELL

The specifications below relate to the alkaline cells which, due to the high shock and vibration are used in air drilling.

CELL SPECIFICATIONS	
Configuration	D-Cell
Nominal Voltage	1.5V
Operating Temperature Range	-20℃ to +54℃
Typical Weight	141 Grams
PACK SPECIFICATIONS	
Configuration	2 Parallel Stack of 10 Series Cells
Cell Nominal Voltage	15V
Operating Temperature Range	-20℃ to +54℃ (-4℉ to +130℉)
Typical Weight	3.08 kg (6.8 lbs.)
Capacity	30 Ah*

Table 12 Alkaline Battery cell specifications

*The capacity of alkaline batteries varies according to the following: temperature, current draw, and peak current. The listed value for capacity is an approximated number based on the usable capacity found during field trials and lab testing.

The list below summarizes general alkaline battery performance at certain temperatures:

- Ideal performance from an alkaline battery is achieved at 45℃ (113℉)
- At 20℃ (68℉), only about 75% of ideal battery life will be achieved
- At 0℃ (32℉), only about 25% of ideal battery life will be achieved
- Below -20℃ (-4℉), essentially no capacity will be achieved

BATTERY AMP HOUR CALCULATION

Battery Amp Hours are currently estimated to establish the life of the battery using the formula below:

(Transmitting time) x (SC) x (ML) x 24 + 1.5 = Ahrs/day

Where: SC= Scale Current, ML = Measured Load, Transmitting Time: When a tool is ON.

K. BATTERY USAGE TIME

ENVIRONMENT	XEM	XPULSE
Surface		
Deep Sleep	0.3 Ahrs/Day	0.6 Ahrs/Day
Non Deep Sleep (bank)	1.5–2 Ahrs/Day	1.5–2 Ahrs/Day
Downhole		
Oil Based Mud	4–10 Ahrs/Day	3–6 Ahrs/Day
Water Based Mud	4–70 Ahrs/Day	3–6 Ahrs/Day
Air/Mist	3–8 Ahrs/Day	N/A

L. SURVEY INFORMATION

A Survey is taken 30 seconds after the Pumps are switched off. This is followed through by a Survey Frame shown below. Survey information is user-configurable, but generally includes the following:

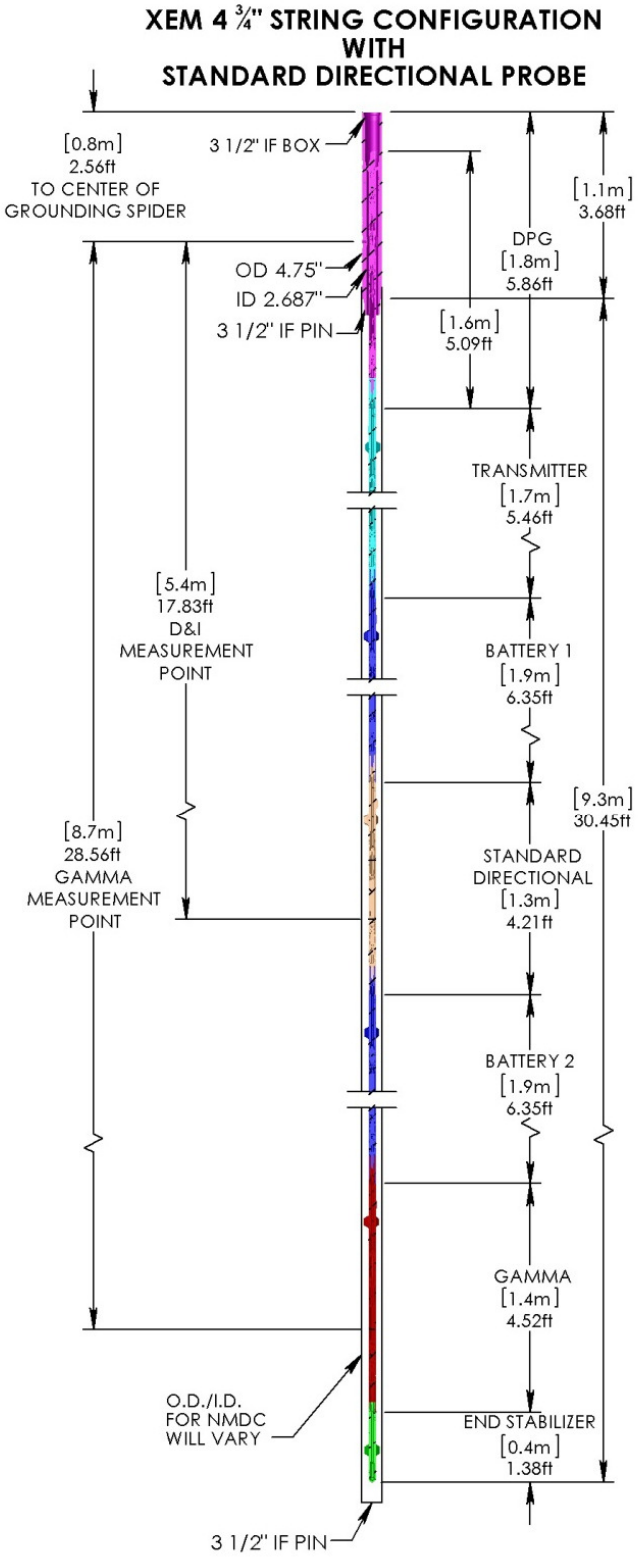
Directional Information	Inclination, Azimuth, Tool Face It is possible to send either the down hole computed values or the 6 axis raw sensor values which will compute the Surveys
Survey Quality Information	Gravity Total, Magnetic Total, DIP Angle, Tool Face
Tool Functionality Information	E-Mag Signal information, Scale Current, Measured Load Current, Battery Ampere Hours Remaining, Battery Voltage
Bore Hole Information	Temperature, Annular Pressure, Bore Hole Pressure

M. DATA INFORMATION

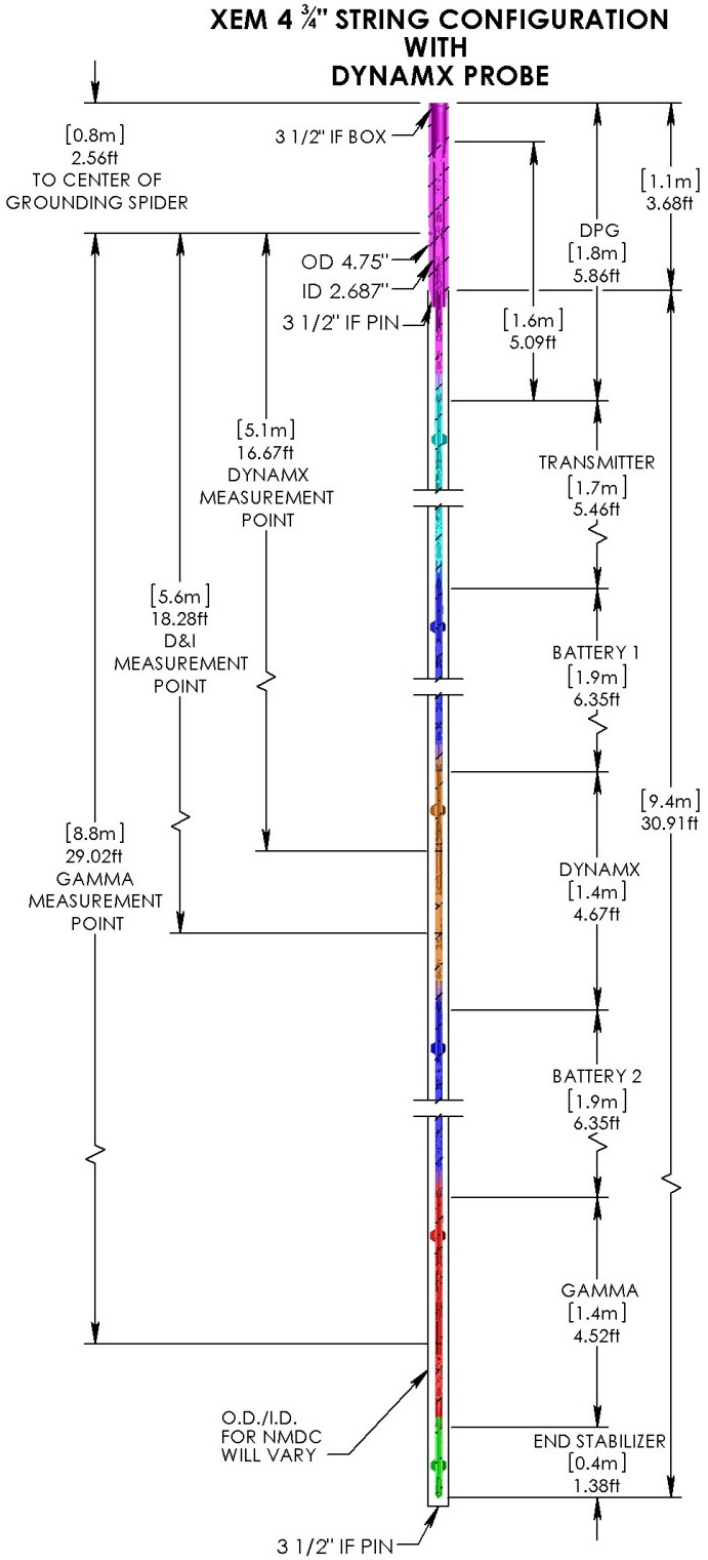
Directional Information	Tool Face: Gravity and Magnetic. (The threshold between Gravity and Magnetic Tool Face can be set by the user in the Configuration file)
Continuous Inclination	The accuracy of Continuous Inclination improves above 15° Inclination.
Formation Evaluation	• Gamma Ray Counts / Second Averaged (can be converted to API units) • The acquisition and averaging time can be configured • Annular Pressure, Bore Pressure, and Differential Pressure • Bore Temperature
Drilling Dynamics	• Shock Lateral Total, Shock Lateral Maximum • Shock Axial Total, Shock Axial Maximum • Shock Stick Slip Level, Shock Lateral Level • RPM

NOTE: continuous azimuth is not accurate when oriented along the North/South axis. The duration for the data to be sent up-hole depends on the number of bits and the location of the data within the frame. If the data is required at a quicker rate, the frequency may be increased as [Table 4]. If the quality of the signal needs to be improved, a lower frequency may be used. Each piece of data is protected by error correction/detection bits.

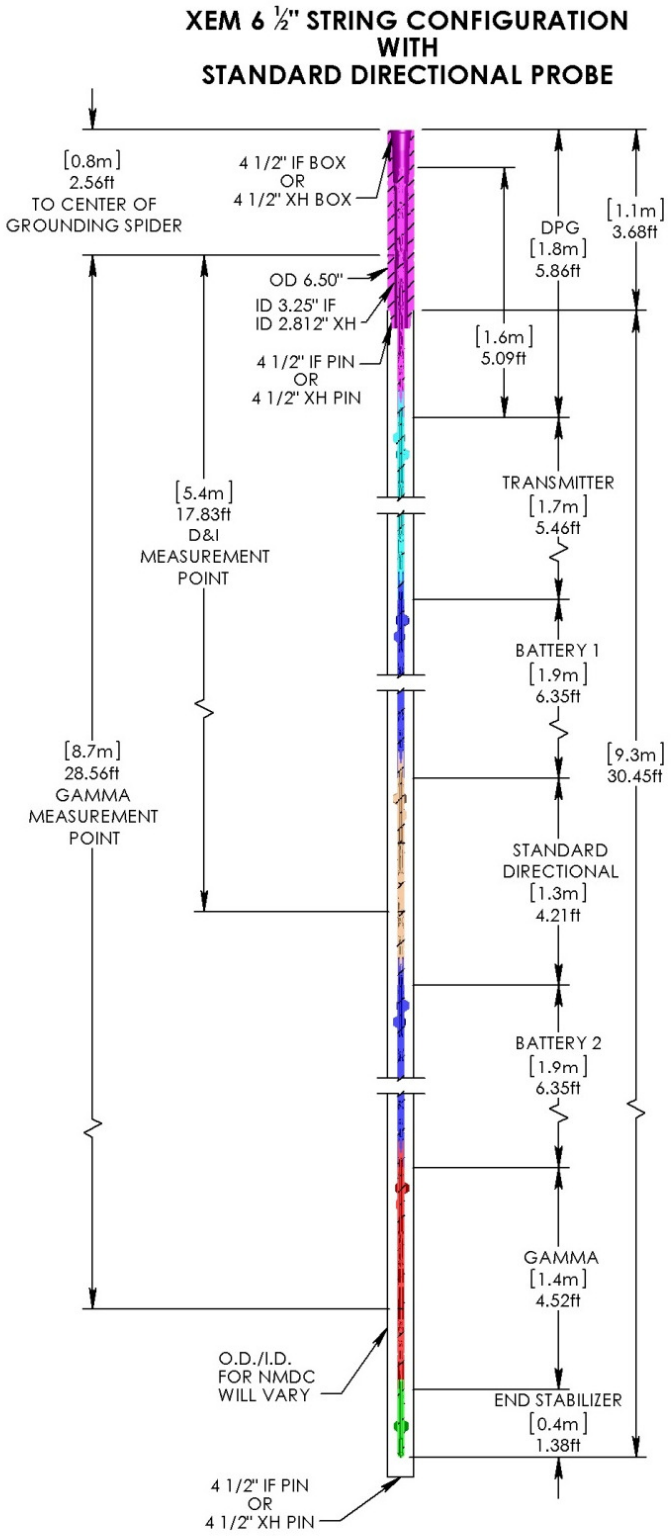
5. TOOL SKETCH

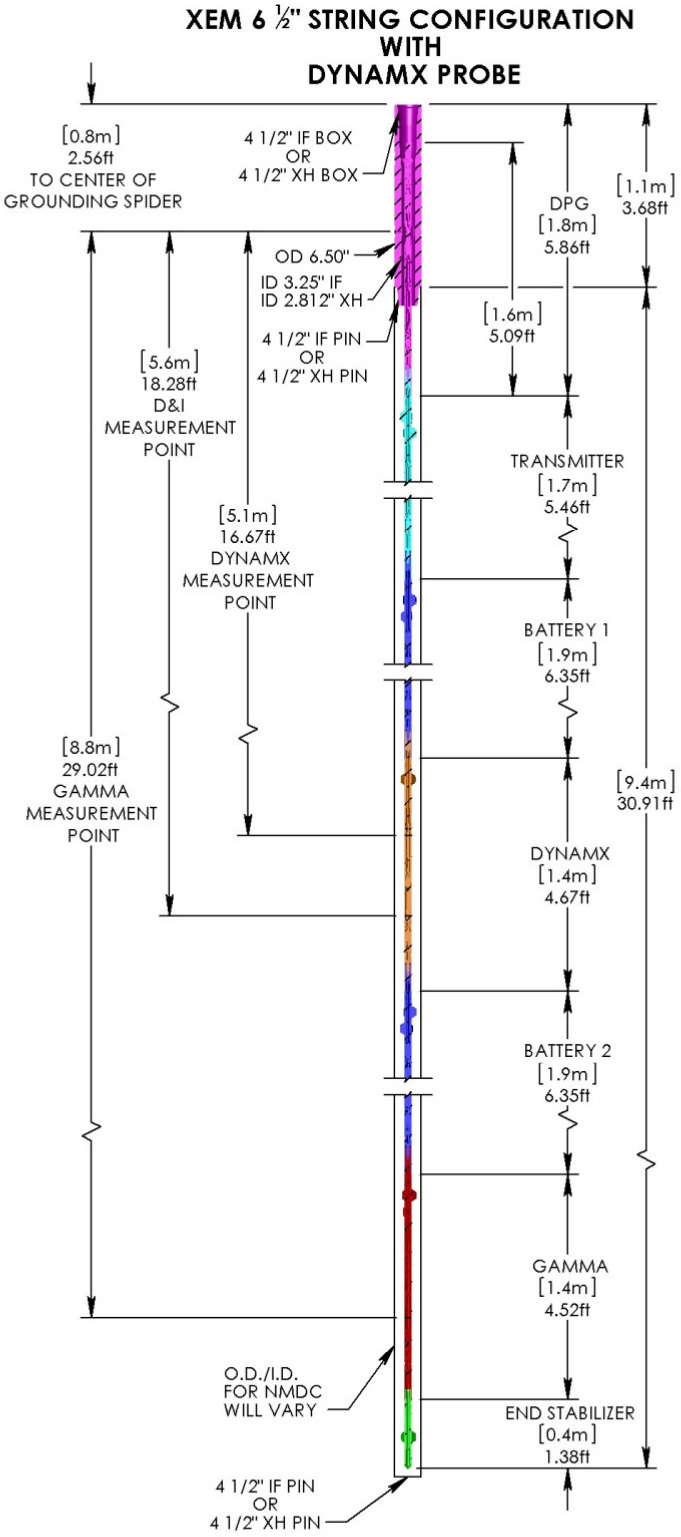


MAKE UP TORQUE FOR PIN AND BOX: 23,000 FT-LBS



MAKE UP TORQUE FOR PIN AND BOX: 23,000 FT-LBS





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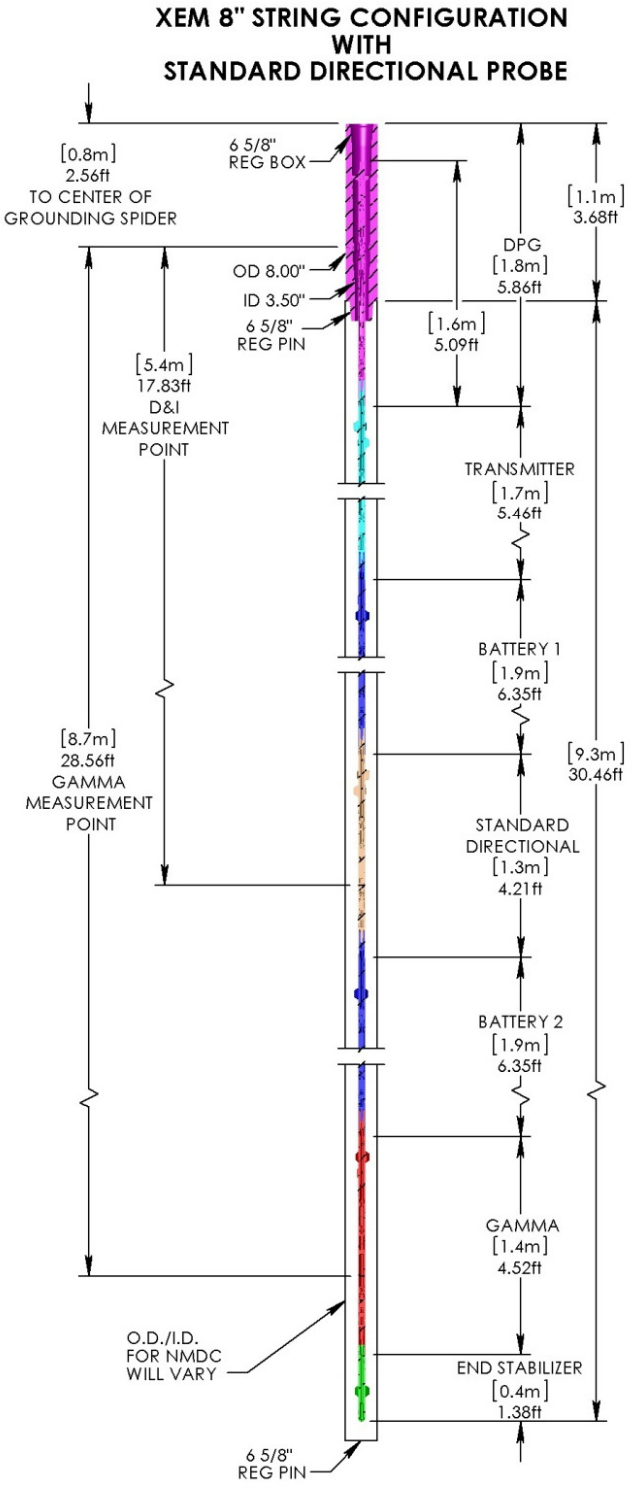
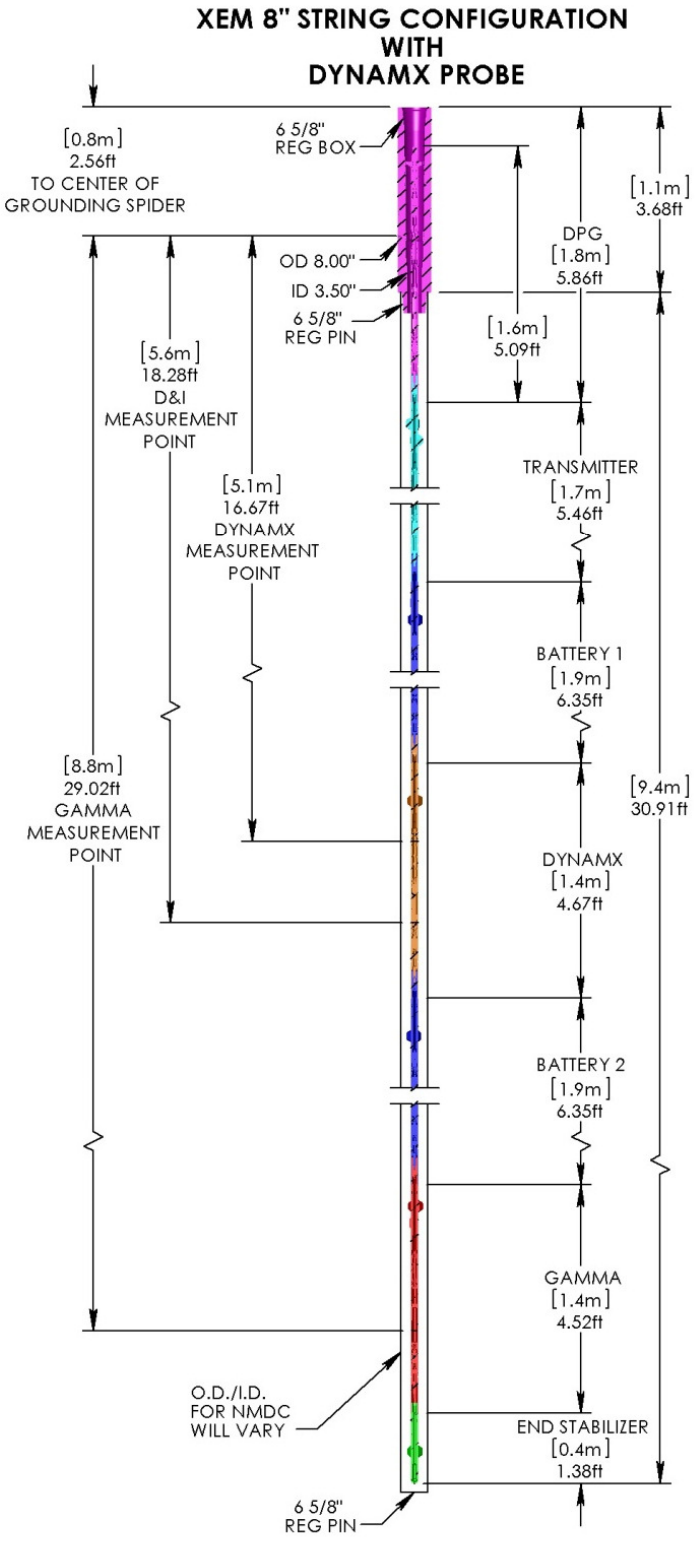


MAKE UP TORQUE FOR PIN AND BOX: 23,000 FT-LBS



MAKE UP TORQUE FOR PIN AND BOX: 23,000 FT-LBS