Prime Horizontal

www.primehorizontal.com

Stop drilling in the dark, step into the light with GyroTrack

Prime Horizontal

Utility Line Survey Services

GyroTrack is a versatile and unique multi-purpose utility line and pipeline mapping system. With a proven track record on virtually every continent, this multi-diameter system provides the most accurate results on pipeline location.

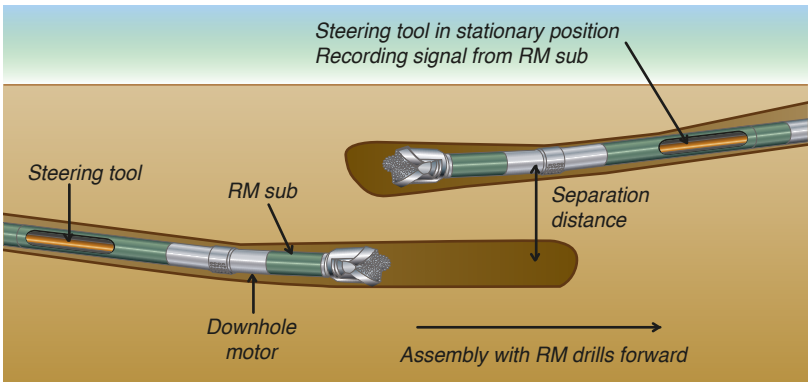
A unique system of interchangeable, centralizing wheel units gives the GyroTrack an operational range of ID 90 mm (3.5”) to ID 1200 mm (48”). Whether the conduit is made of steel, concrete, PE or PVC, this mapping system will improve the location of any HDD conduit.

The GyroTrack tool with its centralization, may be pulled either by a hand operated wireline or a mechanical winch. In certain cases, the tool may be pumped through the product line.

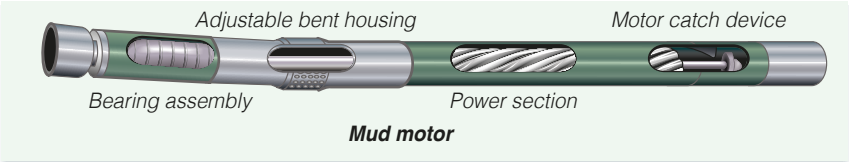
Contents

Company Profile

First and foremost, Prime Horizontal is a service company whether it is providing steering services for HDD projects or selling steering tool systems or drilling equipment, mud motors, specialized rock reamers, hole openers or other specialized products to enhance the quality of the drilling operation.



Since its start in 1998 as a consultancy specializing in providing HDD guidance services, the HDD industry has changed and Prime Horizontal has changed along with it, in fact, some of its efforts have prompted the changes that have occurred. Since 1998, more specialized approaches with the ParaTrack magnetic guidance system have been created in order to focus on more significant projects, many of which could not be done effectively with then current HDD guidance technology.



The growth of underground intersect drilling developed by Prime Horizontal is but one example of this. Many contractors said this couldn't be done, but Prime did it.

Now since many drilling company customers have become generally able to handle their own guidance operations, Prime Horizontal continues to search for ways to continue to be relevant to its customer base. Several examples of its recent product developments are the development of rig data recording with its ProData product and its recent addition of the GyroTrack system for post survey measurement and archival storage of hole location. Prime recently embarked on its mud motor development program and is now in the process of introducing its mud motors to the market. Australia is going through a boom time in the production of coal bed methane (CBM) and Prime Horizontal's RMRS system is being used for drilling the CBM production holes.


GyroTrack

Another example of Prime's technology extension to other drilling areas is its development of the MicroCoil magnetic source used to guide the placement of parallel freeze holes with an accuracy of ± several centimeters for the freeze hole drilling of tunnel bores in soft formations to avoid hole collapse or to close off fracture channels in hard, highly fractured formations to avoid communication of drilling fluids to the surface.

One of our largest growth areas has been the provision of drilling tools and related products to complement the service side of its business. Prime Horizontal routinely provides the individual rotary tools that make up drilling assemblies both for pilot hole drilling hole opening, and product line installation. We sell and support ParaTrack guidance systems and Mud Motors are now sold and supported, including training for their use. To complement sales of its mud motors, mobile break-out units are provided for maintenance and repair of mud motors in-country, and in some cases on site.

Prime Horizontal hasn't stopped here. The first decade of the 21st century has seen rapid expansion of its services worldwide. Fully staffed offices are located in The United States, in The Netherlands, in Australia, in Brazil and in India. More offices are on the way as experienced, indigenous personnel and companies are found with whom Prime Horizontal wants to grow.

In support of its customers in every country, experienced and professional steering engineers are employed. With its emphasis being on international service, English, German, Dutch, Portuguese, Indian, Romanian and Spanish-speaking field engineers located around the world, are routinely provided and field engineers who are fluent in many other languages, like Eastern European languages.

So, Prime Horizontal is a company characterized by its growth, both in its geographical distribution and demographics as well as in its tool kit of services and products. Even so, Prime has not outgrown itself. Its size is maintained that can be afforded and its technical capabilities are not allowed to slide down the slippery slope of promising more than can be delivered. That is why our customers return time and time again.

Company Profile

Services/Tooling summary

HDD applications with ParaTrack

Horizontal Crossings with ParaTrack
- Use surface or underground guidewire installation.
- Deploy as loop or single cable.
- Handle extreme local magnetic interference with ease.
- Use proprietary ParaTrack-2 steering tool.

Parallel Drilling
- Use ParaTrack-2.
- Use surface or underground guidewire installation with centers from 0.5 m. to more than 80 m.
- Use proprietary **Rotating Magnet Source** in first borehole.
- Handles extreme local magnetic variations with ease.

Tunnel Excavation
- Use ParaTrack-2.
- Use underground guidewire installation with centers from 0.3 m. to more than 10 m.
- Use new proprietary **Micro-Coil Magnetic Source** for extreme precision.

Vertical Underground Intersects
- Use ParaTrack-2.
- Use Rotating Magnet Source or MGT.
- Use for **Coal Bed Methane** projects.
- Use for drilling air and vent shafts in mines.

Horizontal Underground Intersects
- Use ParaTrack-2.
- Use surface or underground guidewire installation.
- Use proprietary **Rotating Magnet Source** in vicinity of intersect.
- Use proprietary **AC Beacon magnetic source** for long reach intercept drilling.
- Use for drilling from casing to casing.
- Use for long reach crossings.

Shore Approaches
- Use ParaTrack-2.
- Use proprietary **AC Beacon magnetic source**.
- Use from beach or river bank to more than 100 meter range.
- Use for drilling from casing to casing.
- Use for long distance crossings.

'TO BE THE LEADER ON GUIDANCE SERVICES, PRODUCTS, & SOLUTIONS, THAT ENABLE OUR CUSTOMERS TO ACHIEVE THEIR GOALS & OBJECTIVES'

– Prime Horizontal's Vision Statement

Guidance Equipment

- **ParaTrack-2 Steering Tools**
  – New generation steering tools with AC magnetic field tracking
- **ParaTrack-2 Steering Tools with PWD Option**
  – Adds measurement of pilot hole and drill pipe annulus with the Pressure while Drilling (PWD) Sub
- **Conventional Steering Tools**
  – Two different makes for sale or rental for jobs where ParaTrack service is not required

Drilling Equipment

- **Rock Bits**
  – Premium and discount rock bits in stock
  – 2 7/8" up to 12 ¼" TCI or Mill tooth
- **Jetting Assemblies**
  – Custom jetting assemblies for alluvial formations
  – 3 ½" OD to 8" OD from 3m to 9m in Length
- **Non Magnetic Drill Collars**
  – Sizes from 2 3/8" OD through 8" OD
- **Substitutes**
  – Over 200 Orienting and Cross-Overs available
- **Non Mag Drill Collars**
  3 ½" OD to 8" OD from 3m to 9m in Length
- **Mud motors**
  An assorted range of Motors 2 7/8" to 8"
- **Lo Torque & Jumbo Lo Torque Hole Openers**

Mud Motor

- **Rock Reamers**
- **Centralisers**
  16" to 50" Hole sizes
- **Crossovers**
  An assortment of crossover subs, Firestick, Ditchwitch, Full Hole, from 2 7/8" Reg and IF to 7 5/8" Reg

Rock Reamers™

Hole Openers - Project Capable from 6 in. to 64 in.
Lo Torque Hole Openers
- TCI & Milled Tooth Inventory

Lo Torque Hole Opener

Bi-directional Rock Reamer™

The Rock Reamer™ adds a new dimension to hole opening technology combining the best ideas for ease of use and rock cutting techniques. The replaceable arm design allows field interchangeability of cutters to reduce the number of parts on location at one time. Different size arms allow hole sizes to be optimized to the best plan for both hole cleaning purposes and product line size. Milled Tooth and TCI Insert Cutters and arms are available in 2" increments cutting from a 6" pilot hole all the way to 60".

Company Profile

Innovations

Magnetic Sources with ParaTrack

ParaTrack-2 uses selectable magnetic sources to fit the requirements of the most exacting HDD or CBM project, and it is the only HDD steering system on the market designed for guidance with AC electromagnetic field sources.
The signal to electromagnetic noise ratio is much better for AC magnetic fields than for DC magnetic fields which allows better tracking accuracy at deeper depths and in noisy magnetic environments. The use of AC fields has also spurred the development of an entire suite of different magnetic sources by Prime Horizontal and Vector Magnetics used for different HDD applications, each source having different specifications of accuracy and precision. It is not uncommon for the same HDD project to use several different magnetic sources, depending on the geometry and precision requirements of the project.

Guidewire Magnetic Source

For many crossing projects, a guidewire is deployed all the way from entry to exit, either on the surface or on the sea bottom, through which is passed a DC electromagnetic field (ParaTrack-1) or an AC electromagnetic field (ParaTrack-2) to enable pilot hole tracking accurately along its length. The guidewire may be deployed as a single wire or as a closed loop for better precision. The continuous tracking reduces the probability of pull-backs, sidetracks and corrections.

AC Beacon

The AC Beacon is used primarily for shore approaches and long crossings. The AC beacon provides accurate positioning up to 100 meters so installing a beacon periodically along a traverse allows the use of shorter guidewires.

Rotating Magnet Sub and Axial Magnet Sub

The Rotating Magnet (RM) Sub uses cylindrical magnets in a spinning sub to produce an extremely high resolution AC magnetic field which is used to complete underground intersects both for the HDD crossing market and for the coal bed methane production market. The Axial Magnet Sub is similar to the RM sub except it uses rare earth magnets in a different configuration in the sub. As an intersection is approached, the magnetic source is switched from a guidewire to the rotating magnet to guide all the way to the intersection point. Its precision is a matter of several centimeters.

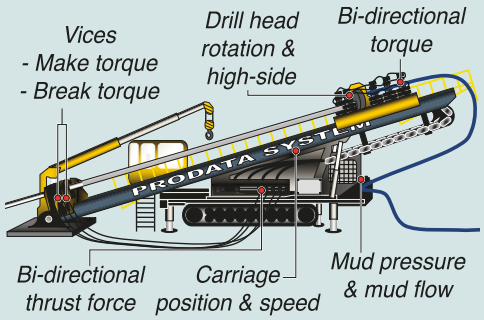
Rotating Magnet Sub

MicroCoil

The MicroCoil is a closed 50 meter loop deployed inside a pilot hole with a very small separation between the two long coil axes. It is used for close proximity parallel drilling when centimeter accuracy is required and where other sources cannot meet the required precision. The MicroCoil was originally developed for guiding the drilling of closely parallel freeze drilling pilot holes in the Naples Metro project and was later used in the Hallandsas Rail Tunnel project in Sweden.

Pressure Measurement While Drilling (PWD)

In addition to magnetic guidance, ParaTrack-2 optionally includes a Pressure while Drilling (PWD) sub to measure the pilot hole annulus and the internal pipe pressure at the steering tool. By monitoring the pilot hole annulus pressure, the driller can significantly limit environmental damage caused by formation fractures.



ProData

Whether you operate a single horizontal directional rig or a fleet of rigs, you want to keep your investment working for you 24/7, and you don't like breakdown surprises.

You need Prime Horizontal's ProData System.

The ProData system uses wireless GPRS and satellite to link measured drilling parameters on HDD drilling rigs as shown in inset to a central and secure database. Real time and historical data are accessed remotely by personnel both on and offsite. The primary data and automatic daily reports from ProData give a clear overview of current, past and future projects for analysis.

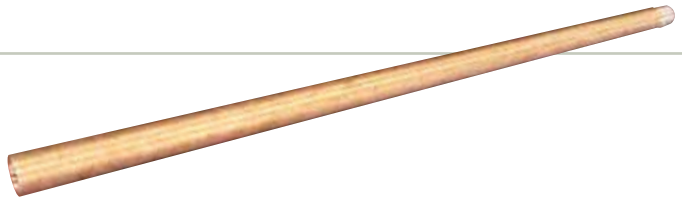
Downhole Motors

Prime Horizontal's Mud motor (or Drilling Motor) is a Progressive Cavity Positive Displacement Pump (PCPD) placed in the Drill string to provide power to the bit while drilling by using the drilling mud to create eccentric motion in the power section of the motor. The Mud Motor uses different rotor and stator configurations to provide greater horsepower for the desired drilling operation, as the eccentric motion in the power section is transferred as concentric power to the drill bit. The rotation rate of the bit is proportional to the volumetric flow rate of drilling mud through the motor and normal rotation rates are from 60 rpm, to over 150 rpm.

GyroTrack

GyroTrack is a multi-purpose pipeline mapping system. With a proven track record on virtually every continent, this multi-diameter system has easy handling features and provides the most accurate results on pipeline location. A unique system of exchangeable centralizing wheel units gives GyroTrack an operational range of ID 90 mm (3.5") to ID 1200 mm (48"). GyroTrak is at home in steel, concrete, PE or PVC pipes.

It is pulled by a hand operated wireline or a mechanical winch. Data are uploaded to the office through GPRS after survey data integrity is checked.
An immediate on site Survey Report is optionally provided that includes a 3D pipeline profile, Bend radius report per customer defined intervals, Inclination analysis, Job specification and Job locations. Output data can be exported to open platform formats for seamless integration in common GIS platforms such as AutoCAD, Excel, MicroStation or Text.



ParaTrack-2

ParaTrack is an underground tracking system with unique up to date capabilities. This offers considerably more flexibility in coil positionand dimensions than older magnetic guidance systems. ParaTrack's surface deployment will normally be along centreline with a return cable placed well offline, where its signal is nominal.

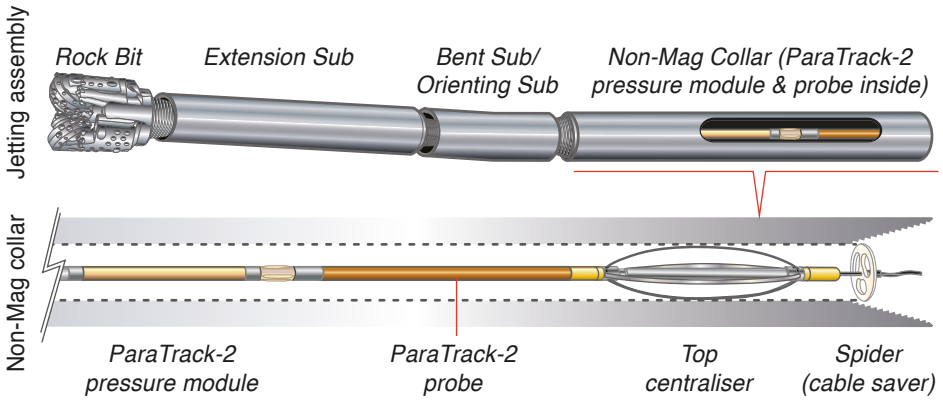
The ParaTrack Advantage

- Can be set up as a single cable from entry to exit
- Can range against other pipelines in certain circumstances
- Can use alternative magnetic sources in order for technical guidance solutions to be tailored to each job:
  - Rotating magnetic sub
  - Single centerline cable
  - MGT Source
  - AC Beacon
- Can measure annulus and internal pipe pressure
- Has positively guided large 110 degree curves
- Has guided a number of pilot holes in magnetic environments where it was not possible for other systems
- Guided a number of parallel crossings where center to center spacing was of paramount importance
- Has positively guided underground intersects from each side

In specific circumstances, the centreline cable may be earthed on each side of the crossing, negating the need for a return path and its significant loss of time.

ParaTrack can be deployed underground in an offset parallel borehole and earthed thus creating a known magnetic field to use for guidance. Each pilot hole thereafter will use the same original bore location as the base line. Parallel bores may now be drilled with confidence, all the way from entry to exit.

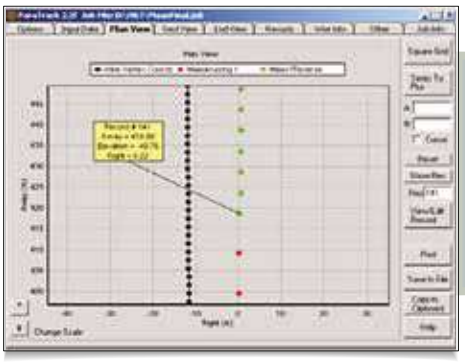
ParaTrack is the only tracking system able to utilise many different magnetic sources. Not only can we use guide wires on surface or underground, we also utilise the AC Beacon, a Rotating Magnet tool and MGT tool. One or a combination of these choices will fit the exact needs of most crossings.



ParaTrack, a DC or AC secondary locating system, has been operated in the HDD market by Prime Horizontal since 1999.

Primarily developed as an underground parallel drilling locating system, it's use has been enhanced by development of the Rotating Magnet (RM) Sub and lately by inclusion of Pressure while Drilling (PWD) gauges measuring not only the pilot hole annulus but also the internal pipe pressure
at the steering tool.

The addition of non-wire based magnetic sources allows better approach accuracy for intersecting another bore by developing a known magnetic field down hole essentially to act as a target for final intersect drilling.

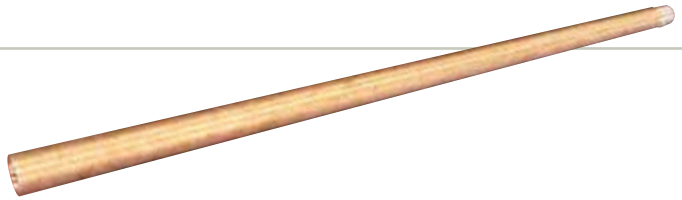


Reading on screen

By measuring the pilot hole annulus pressure, the driller has much better control of down hole pressures to limit the incidence of formation fractures causing environmental damage.

ParaTrack operations gives HDD operators the confidence to plan and execute the most challenging drilled crossings in the market.

Guidance



Shock mounted triaxial accelerometers and magnetometers, temperature sensor and digitising circuitry contained in 1.750 in. dia. x 55 in. long beryllium copper pressure barrel. Telemetry and power via single conductor wire line.

ParaTrack-2 pressure module

ParaTrack-2 probe

LCD driller's display

LCD Digital Display with Operator Selectable Screens

RS232 Communications

Wireless or Wired for Ease of Operation

Pressure Module

Length: 600 mm (24")

Drill Pipe annulus gauge: 350 bar (5000 psi)

Pilot hole annulus gauge: 35 bar (500 psi)

Orienting pressure sub: 600 mm (24")

Specifications

Temperature Rating: 85°C (185˚F)

Pressure Rating: 1200 bar (17400 psi)

Sensor Accuracy:

Inclination: ± 0.1°

Azimuth: ± 0.3°

Tool face: ± 0.5°

OD: 450 mm (1.75")

Length: 1405 mm (55")

Maximum Wire line Length: 5000 m (16000 ft)

Interface unit

Small footprint Probe Power Supply and interface between probe, laptop and driller's display.
Face controls mounted in front while all wire connections are side mounted for ease of hook up and worktop organization.

Input: 85-265 VAC 50-60 HZ

Output: 48VDC, 50 mA—1000 mA

Power Fused on Input and Output

Analog Amperage Display

Connection for secondary laptop used as drillers display

Connection for existing driller's display

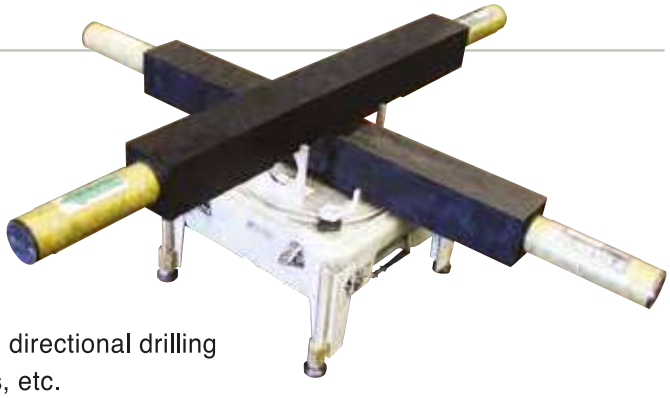
Guide wire supply

Small footprint guide wire supply for location on top of the interface unit in the control cab or on the exit side to power the guide wire.

Unit Input: 85-265 VAC 50-60 HZ

Unit Output: 3 or 6 Amps p-p max.

AC Beacon



The Beacon Tracker is a two solenoid AC system for tracking the directional drilling of cable and pipeline boreholes under rivers, buildings, highways, etc.
The precise drill bit location and drilling direction are measured with 300ft/100m range.

The AC Beacon Advantage

- Can be used without a surface guidewire
- Can be used to complement existing guidance methods
- When installed at the edge of a water source, will give guidance information up to 100 meters offshore
- Can be installed inside buildings while drilling underneath
- Has assisted the establishment of the Initial Line Azimuth for drilling away from an entry guidewire
- Has positively guided large 110 degree curves
- Has guided entire crossings without use of a surface cable
- Has benchmarked crossings under golf courses
- Determines drilling positions under buildings

Wire wound steel core solenoids mounted on a two degree of freedom table. The table doubles as a transport case holding the electronics, table legs and controls. A 12 VDC deep discharge battery can handle an all day operation and recharge in the evenings.

The solenoid stack is installed on or offset to the centerline. It is oriented to a known azimuth, normally the line azimuth, and leveled using bubble levels provided.

Remote actuation of the AC Beacon is accomplished from the laptop keyboard by clicking a button on the software screen causing a tone to be generated through a radio left at the ac solenoid location.

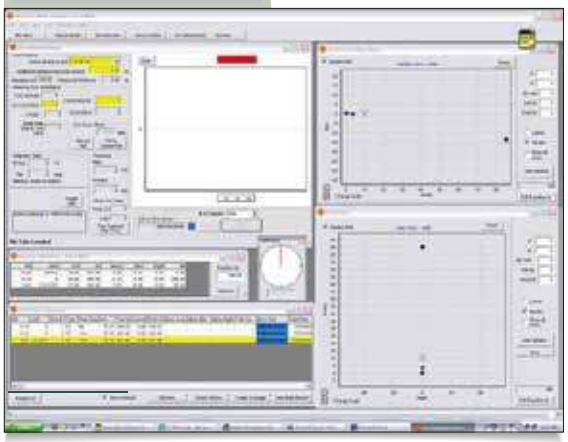
After actuation, data is saved on the main ParaTrack-2 screen and the tracking algorithm used to determine elevation, left/right position and a confirmed away distance from entry.

To date, the AC Beacon has been used more than a 100 meters offshore where normal coil layout is impossible. The Beacon has been deployed on golf courses where unsightly surface cables were prohibited. We have mobilized the AC Beacon in order to locate the drilling path accurately before crossing the exit side coastline to ensure accuracy and limit the real possibility of damage.

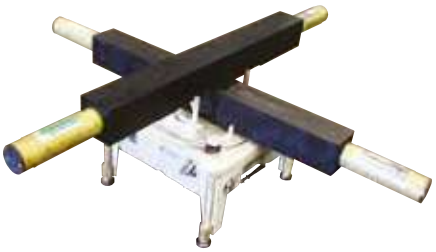
Outfalls are a major planned use of the AC Beacon where surface wires are difficult to install in the surf zone and inaccurate where unseen.

In conjunction with other tracking methods, the AC Beacon will assist long reach intercept drilling by ensuring the two approaching bores are within tolerance of each other to ensure no pullbacks.

Reading on screen



Guidance



Shock mounted triaxial accelerometers and magnetometers, temperature sensor and digitising circuitry contained in 1.750 in. dia. x 55.3 in. long beryllium copper pressure barrel. Telemetry and power via single conductor wire line.

Specifications

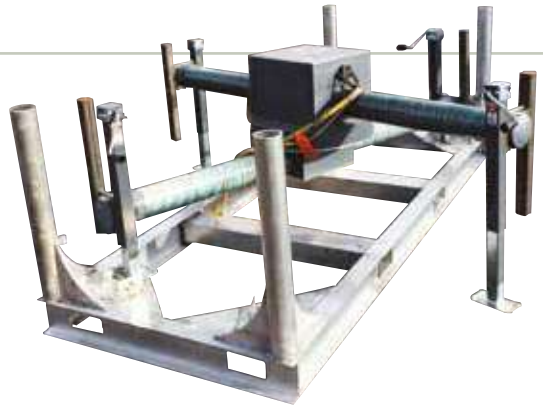
Solenoid length: 50 inches (2 per system)
Solenoid weight: 62 lbs. (2 per system)
Input voltage: 12 VDC, 7 Amps (typical small automotive type battery)
Excitation frequency: between 2 and 3 Hz.
Compass interference: none
Radio interference: N/A
FCC regulation: N/A
Maximum Range: 100 meters
Precision: Away, Elevation and Right +/- 2% of BTS to Probe distance
Drilling Azimuth Determination (relative to solenoid axis) : +/- 1 degree
Remote or manual activation Survey time: 20 seconds

Temperature Rating: 85°C (185° F)
Pressure Rating: 1200 bar (17400 psi)
Sensor Accuracy:
Inclination: ± 0.1°
Azimuth: ± 0.4°
Tool face: ± 0.5°
Length: 1256 mm (49”) Maximum
Wire line Length: 5000 meters (16000 ft)

Operation guide

1. Hand carry the support stand, the solenoids and the battery shown to a surveyed surface location.
2. Adjust the telescoping legs to level the solenoids.
3. Rotate the solenoids to a surveyed direction using the telescope and freely rotating solenoid table included in the support stand.
4. Start a survey manually at the solenoid site or with a telephone touch tone transmitted by a walkie talkie.
5. The left/right, away and elevation coordinates of the drill bit and the azimuth of drilling are computed and displayed 20 seconds after the start of a survey. The magnetic fields of the beacon are measured with a steering tool near the bit.

Large Field Beacon



LFB Advantages

- Increased Range
- Radio Controlled
- Operating parameters transmitted wirelessly & automatically
- Single unit packed for easy shipment

The Large Field Beacon (LFB) is a larger version of the standard Beacon Tracker System providing increased detection range.

It operates under the same principles as the standard BTS, and uses the same software interface for operation. Unlike a standard BTS, however, it requires a mechanical lift to deploy, a 6kW generator to power, and it uses large solenoids and a different electronics control box.

Once an LFB is set up, its location & direction needs to be surveyed accurately and entered into RivCross. This provides the known location from which all steering decisions are made. LFB has the option to be generally operated remotely using a radio modem kit, which allows two-way communication without needing to connect the LFB directly to the computer running RivCross, or manually.

Overview of project using Big Beacon

Overview, Aberdeen, Hong Kong

The Big Beacon consists of:

- Skid with inbuilt solenoids attached on a rotary table
- 4 adjustable leveling feet
  - 4 c-clamps for the feet
  - 4 Cords to secure the feet to the Beacons
- Power supply
- Radio modem kit for remotely triggering Beacon

Specifications

Solenoid Length:	92” x 92” (2.3 x 2.3 m) deployed [92” by 30” (2.3 x 0.7 m) stowed]
Weight:	1540 lbs (700 kg)
Ships (on its own skid):	Skid weight 200 lbs (90 kg)
Setup Area Required:	A flat, level, magnetically clean surface, 98.5” x 98.5” (2.5 x 2.5m) or larger
Input voltage:	11.5 - 12v
Power Supplies:	90-240v AC, 50-60hz. 15 amps, 6kW generator OK
Maximum range:	1300 ft (400 meters)
Precision:	Away, Elevation, and Right +/- 2% of LFB to Probe distance
Drilling Azimuth Determination (relative to solenoid axis):	+/- 1°
Remote or manual activation Survey time:	20 seconds
Compass Interference:	None
Radio Interference:	None
FCC Regulation:	None

HDD Intersect Services

Horizontal Intersect Drilling

Casing to Casing

- Restricted Entry/Exit positions
- Gravel formation
- Intersect Casing direction or along the borehole

Environmental

- If hole cleaning or formation conditions require a lower annular pressure (monitored by Pressure While Drilling) than has been estimated over the length of the bore, it can be significantly reduced by drilling from both sides.

Torque & Drag Relief

- For various reasons, there are instances where it appears impossible to punch out. In some situations a relief bore from the opposite side can relieve the push and torque values allowing completion of the hole.

While 'Casing to Casing' intersects generated the first opportunity to succesfully prove intersect techniques and technologies. Prime Horizontal was the pioneer of this technology.

We have now completed over 60 successful intersects using multiple magnetic sources for guidance.

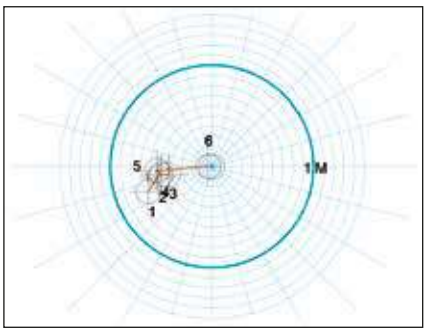
Each source gives us additional capabilities to ensure a first time success.

Longest Intersect: 3935m with 14" product pipe.

Shortest Intersect: 350 m.

Largest Intersect: 1100m with 48" product pipe.

Smallest product pipe diameter: 4".



Intercept vector plot

AM & RM subs accuracy

RM &AM Subs	2 7/8" OD—9 1/2" OD
RM & AM Accuracy	5cm at <3m depending on S/N Ratio

Benchmark in use

Various Magnetic Sources

ParaTrack-2 Axial Magnet sub

The AM sub is generally utilised in soft formation/ jetting. Where tracking systems enables a close proximity for the first range as distance is limited to 5m.

Applications include close spaced boreholes, freeze drilling, & tunneling projects.

AM Final Approach	Up to 5m

Axial Magnet Sub

ParaTrack-2 Rotating Magnet sub

Rotating Magnet Sub

The RM sub is generally utilised in harder formations & longer crossings & where the surface tracking systems are limited. Ideal for long crossings under a large body of water or obstruction, where coil or beacon cannot be utilised.

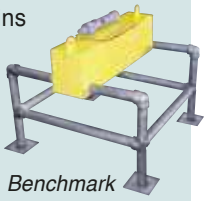
RM Initial Approach	Up to 70m

Benchmark

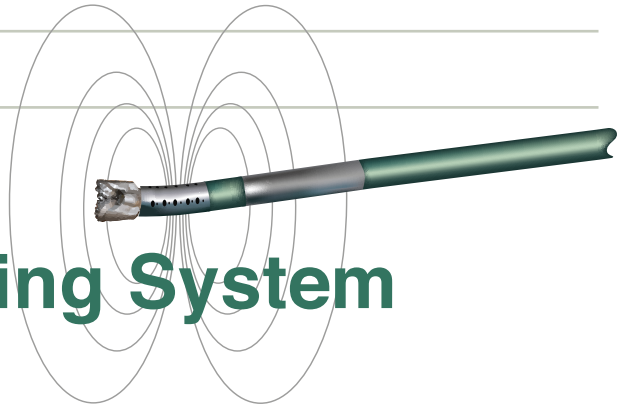
The Benchmark is used for under river Intersects. It is deployed by positioning 3 Benchmarks on the riverbed over the drill line.

Stand Footprint	915mm x 915mm
Box	1041mm x 203mm x 280mm
Weight	125kg
Materials	Non magnetic stainless steel

Omni-directional acoustical actuator
Operation time per actuation: 15mins
30 day reserve to first actuation
Signal strength accuracy to -50m
160 hour operating time reserve
100m water depth maximum.



Benchmark



Rotating Magnet Ranging System

RMRS

The HDD RMRS System and the production of Coal Bed Methane

In recent years, the production of coal bed methane (CBM) with a combination of vertical and horizontal wells has become cost effective, especially when used with HDD methodologies. See our FAQ #9 for a discussion of Coal Bed Methane and our FAQ #10 for a discussion of Drilling for CBM.

Accurate horizontal to vertical well intersections

The Rotating Magnet Ranging System (RMRS) system as supplied by Prime Horizontal is a cutting edge magnetic downhole ranging system for use in Vertical/Horizontal and Horizontal/Horizontal well intersects. When being used for a Vertical/Horizontal well intersect the particular advantage it has over other technologies is the ability to locate the drill bit up to 60m before the intersect point has been reached. This enables the necessary changes in direction to be made before reaching the intersect point and increasing significantly the possibilities of a successful intersect on the first attempt.

All other current downhole ranging technologies rely on the use of a pass-by, in which the downhole assembly in the horizontal well must be drilled past the vertical well to locate it. Once the horizontal well has been located it must then be pulled back and sidetracked for a second attempt, causing lost time, and possibly introduce hole quality issues. Being able to range directly to the bit significantly increases the possibility of a first attempt intersect. Success rates for first time CBM intersects run at around 90%.

The signal can be detected from 50-60 m away and a corrected vertical target location can be calculated. This technique is different from the technique using a single wire conventional HDD source, where the steering tool is located in the vertical well, because the rotating magnet at the bit is the source and the steering tool is located in the horizontal well. The steering tool works independently of the MWD system used in the drill string. The rotating magnet has minimal effect on the magnet field of the MWD tool as it is located far behind the motor with adequate spacing. If the directional driller has concerns about the interference then a full BHA roll test can be performed to calculate the BHA flux.

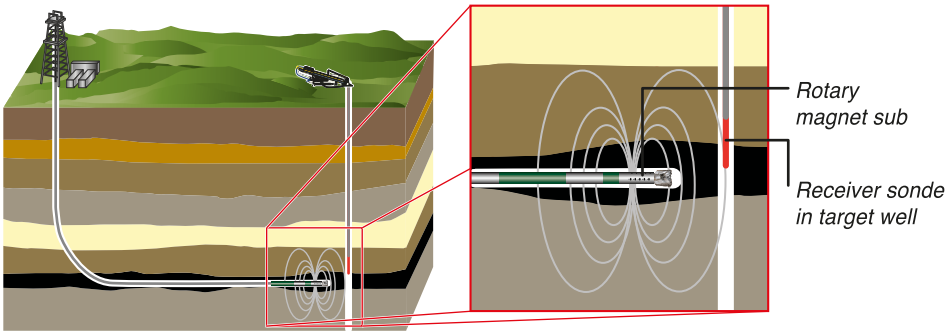


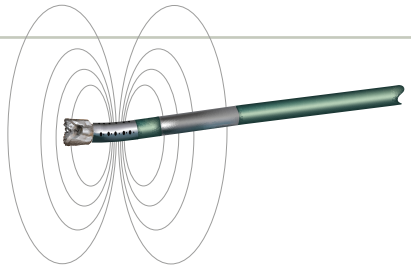
Figure 1-RMRS. A horizontal drill with the RMRS sub approaching a vertical hole containing the steering tool for magnetic ranging.

Smart tools, precise and efficient operations, proven results

Prime Horizontal's RMRS system is unique in its design and its ranging precision. It uses Prime Horizontal's RM or AM sub, near-bit subs that have a number of magnets aligned in the sides of the sub. When the bit spins, the magnets create an AC magnetic field which can be detected from a reasonable distance to allow correction of the trajectory for vertical well intersection without doing an initial ranging pass by as required by all other technologies. This geometry is diagrammatically shown in Figure 1-RMRS and the RMRS sub is shown in Figure 2-RMRS.

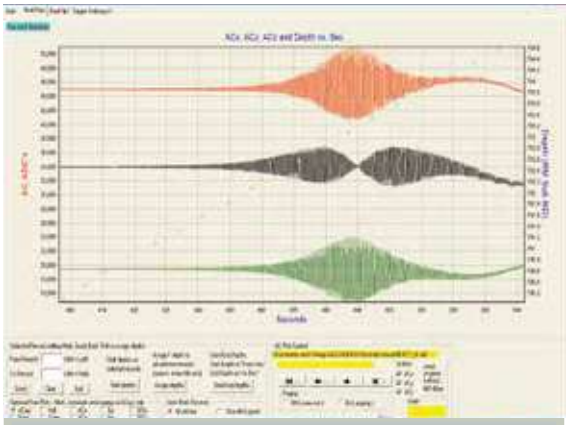
The RMRS sub is located just behind the bit in this picture of a conventional, cantilever drilling rig. You can see the eight slots that contain the bar magnets. When the bit spins, the spinning magnets create the AC magnetic field.

Guidance



Rotating Magnet Ranging System Advantages

- Ability to reduce costs associated with drilling and intersecting vertical wells
- Intelligent ranging tool – can steer to the target from distances of 70m
- Can intersect well cavities of 4” and greater
- Slim tool will fit in casing from 2 7/8 and greater – assembly diameter is 1¾”
- Modular vertical well tool, can be assembled slick or with centralisers when required
- Simplicity with different MWD systems – no data is required from the MWD tool, can work with EM or Mud Pulse tools
- Captures data while drilling, no need to shut down pumps to collect data
- Can work to any depth without complications from wireline loop resistance
- Potential to intersect vertical wells without having to pass by and sidetrack
- Uses AC Active Magnetic Ranging technology, works in formations with existing magnetic distortions
- Prime Horizontal is an experienced company in intersection technology in vertical and horizontal wells.

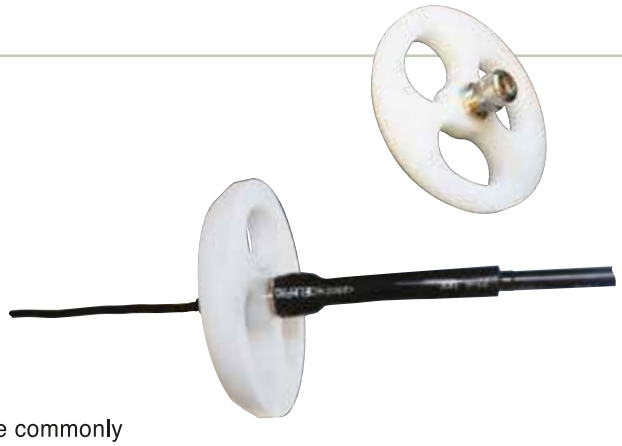


Shown are 3-component magnetic data from the rotatin magnet sub. These data are analyzed for range and azimuth information for a single “shot.”

RMRS specifications

Nominal tool OD	44.45mm (1.75")
Minimum target well ID	50.8-22.2mm (2-7/8")
Sonde length	1.4m (55.12")
Weight bar length	1.2m (3.9')
Centraliser length	0.4m (1.3') each
Typical length of assembly	**3.4m (11.2')**
Magnet bit sub connections	2-3/8" Reg and up
Operating temperature range	85°C (185°F)
Max operating pressure	1034 bar (15000 psi)
Accuracy 0-15m	5%
Accuracy 15-25m	5%
Accuracy beyond 25m	5%
Max operating range	70m (229.7')

Cable Saver



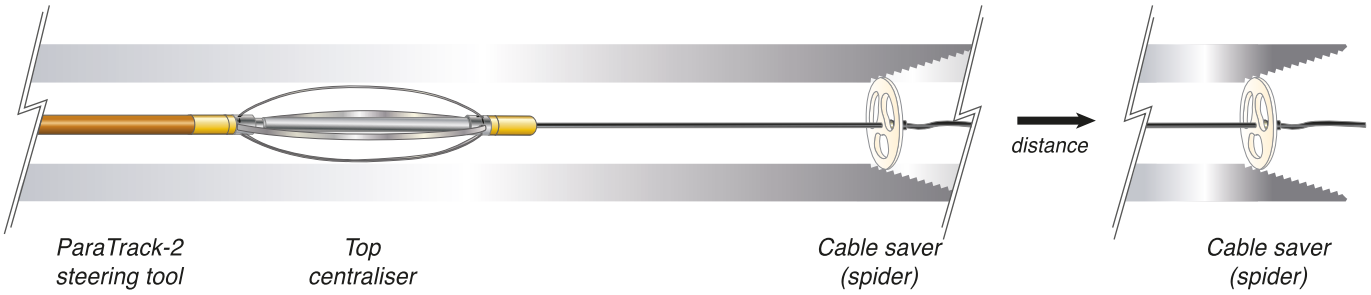
The Cable Saver Advantage

- Reduces possible short circuits/cable breaks
- Reduces tripping due to reduced cable breaks
- Should a break occur, tripping is only necessary to the spider below the break
- Increases overall confidence on long and difficult crossing

Cable savers or 'Spiders' as they are commonly known, are used in the horizontal drilling industry during the pilot hole drilling procedure. Typically a wire is installed through the drill string to allow communication with the steering tool, located behind the BHA.

During long drillings or crossings where a high mud flow and pressure are present in the drill string. It is recommended to place a spider at the first connection behind the steering tool and at regular intervals thereafter.

The first spider prevents any slack or stretch from coming into contact with the sharp centraliser blades of the steering tool hence preventing eventual short circuits. After a predetermined interval the next spider is positioned on the wire prior to a wire connection being made and any slack pulled out before the Spider is clamped to the wire and allowed to rest in the bottom of the box connection.



Cable saver specifications

Sizes available	Material
2 7/8" IF	Epradur Multilene (Abrasion resistance, Water absorption resistance)
3 1/2" IF	**Minimum operational temperature:** -50˚C
4 1/2" IF	**Maximum operational temperature:** 80˚C
6 5/8" FH	**Tensile strength at yield**
5 1/2" FH	20 N/mm^2
6 5/8" Reg	

** Spiders only fit in standard shouldered API connections and not suitable in double shouldered connections*

Cable saver (spider) as situated in the box of the pipe

MicroCoil©

The MicroCoil© enables accurate ranging in situations where it is not feasible to deploy surface ranging or standard underground ranging techniques. For example, when drilling in freeze hole or ground consolidation applications.
The MicroCoil© is installed inside a "blind hole" (i.e., a borehole which does not exit on the surface) which can then be used to range to when drilling parallel boreholes.

The MicroCoil© Advantage

Can:

- be installed inside a blind borehole and used for accurate parallel tracking
- be used in one of the parallel boreholes
- be used in a sacrificial borehole within a radius
- be used between two vertical bore series to create side walls
- be used vertically and horizontally

Has:

- been deployed inside train tunnels
- positively guided more than 170 bores to date of a 400 bore project
- achieved bore hole rate of three 50 meter bores per working day
- reduced or eliminated cases of inaccurate bores causing redrill, additional or replacements bores
- created opportunity for contractor to increase the length of bores thereby increasing production time and achieving significant cost savings

Since the accuracy of the wire placement on a narrow plastic pipe is extremely important, this pipe has been accurately grooved in an engineering shop to avoid assembly problems.
After assembly it is inserted into the sacrificial bore as shown below.

ParaTrack-2 MicroCoil© specifications

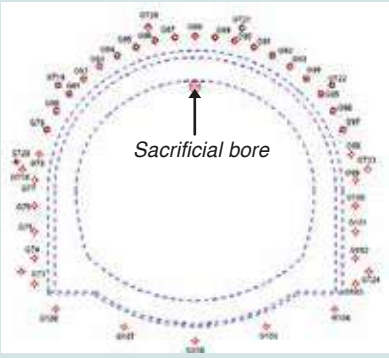
Shock mounted triaxial accelerometers and magnetometers, temperature sensor and digitising circuitry contained in 1.750" diameter x 55.3" long beryllium copper pressure barrel. Telemetry and power via single conductor wire line.

Temperature Rating	85°C (185°F)
Pressure Rating	1200 bar (17404 psi)
Sensor Accuracy	
Inclination	± 0.1°
Azimuth	± 0.4°
Tool face	± 0.5°
Length	1256 mm (49")
Maximum Wire line Length	5000 m (16000')

MicroCoil©

Narrow coil, accurately wound axially on a stiff plastic pipe. Wire size and length determined on the planned application.

Wire	Insulated 0.75– 2.5 mmsq stranded
Plastic pipe	Minimum 55mm diameter
Length	Minimum 20m
Accuracy	±5cm possible in 5 m depending on S/N ratio



The MicroCoil©, made on site from readily available materials, is usually deployed inside a sacrificial bore in the centre of the object or planned bore gemetry. The sacrificial bore must be drilled and surveyed accurately in order for it to be used to guide the rest of the bores using the MicroCoil©.

Mud Motor

Prime Horizontal Mud motor advantages

- Easy to set adjustable bent housing:
  - 0-3 degrees on motors larger than 3 3/4"
  - 0-4 degrees on 3 3/4" motors
- Motor catch device (sizes larger than 3 3/4")
- Variety of lobe configurations
- Mud lubricated bearing assembly
- In-house maintenance
- Low flow high torque power sections
- Short radius drilling motors
- Time/date of usage reporting

Based on the reverse Moineau pump principle Prime Horizontal positive displacement motors deliver predictable torque and RPM directly to the bit. With a full range of motor diameters from 3 3/4" up to 8".

These versatile motors can be configured to meet drilling requirements for steerability, build rates, torque, bit speed, flow rate and string rotation.

A variety of configurations are available for steerable drilling and long, medium and short radius drilling.

The choice of Prime Horizontal power sections (stator/rotor) determine the bit speed and torque output of the motor.

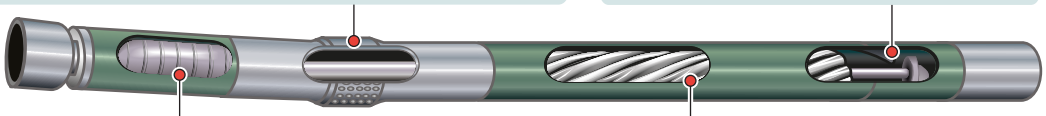
Generally the motors are classified as low to medium speed, and within each category a wide range of power sections are available.

Adjustable bent housing

The adjustable bent housing is available in 0°-3° settings (with a 0°-4° on 3 ¾" motors). The housing is easily adjustable and allows the operator to reset angles on the rig, eliminating the need to change assemblies or motors. Always follow the specifications for proper torquing of the assembly.

Motor catch device

The motor catch device prevents leaving the motor downhole in the unlikely situation of a motor connection failure. The catch device reduces the chance for possible fishing operations.

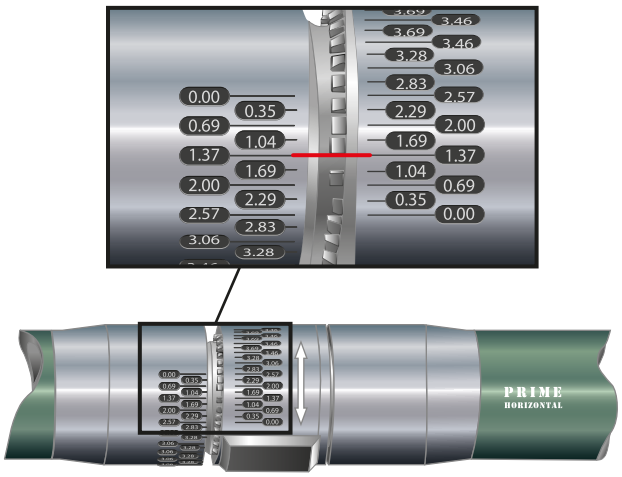


Bearing assembly

Each motor comes equipped with a specially designed thrust bearing stack for axial loading and radial bearings to support radial loading.
A small percentage of the drilling fluids (5% - 7%) bypasses the bearings to cool and lubricate the thrust and radial bearings. The remaining drilling fluid exits through the nozzle ports of the drill bit.

Power section

The power section is made up of a lobed rotor that fits inside a elastomer lined housing (stator). The rotor has one less lobe than the stator, creating a continuously sealing chamber. Drilling fluid is forced through the motor, thereby turning the rotor and generating torque. The lower the speed (higher number of lobes), the more torque is provided, and vice versa.



Adjustable section

9/10 lobe – (Low speed motor feature High Torque output, which is ideal for use in steerable applications.)

5/6 lobe – (Medium speed motor increase rate of penetration while maximizing the bit life, primarily in long interval drilling.)

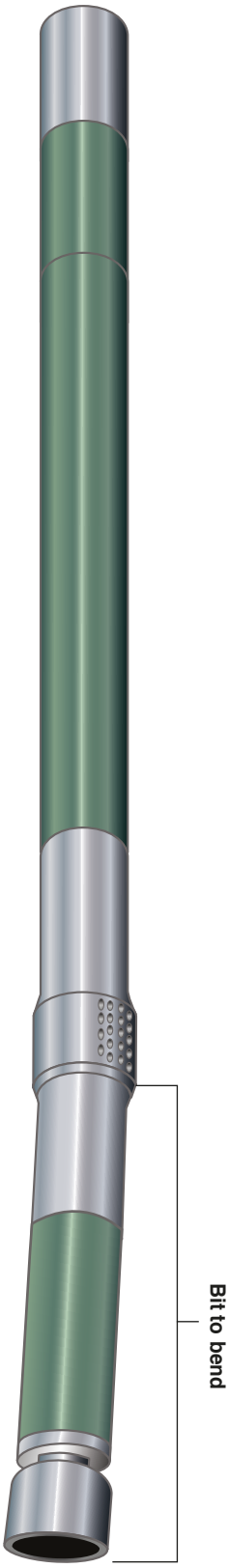
4/5 lobe – (Medium speed motor increase rate of penetration while maximizing the bit life, primarily in long interval drilling.)

Lobe configurations in stock
• 3 1/8" - 5/6 lobe 3.0 stage
• 3 3/4" - 5/6 lobe 3.0 stage
• 3 3/4" - 5/6 lobe 3.8 stage
• 3 3/4" - 9/10 lobe 3.0 stage
• 3 3/4" - 9/10 lobe 4.0 stage
• 4 3/4" - 4/5 lobe 3.5 stage
• 4 3/4" - 5/6 lobe 3.0 stage
• 4 3/4" - 9/10 lobe 4.0 stage
• 6 3/4" - 4/5 lobe 4.8 stage
• 6 3/4" - 9/10 lobe 4.0 stage
• 7 3/4" - 9/10 lobe 4.0 stage
• 8" - 6/7 lobe 4.0 stage
• 8" - 9/10 lobe 4.0 stage

** For other configurations and sizes, please contact our DownHole representative.*

Mud Motors – **3 3/4"**

Drilling motors – Technical data

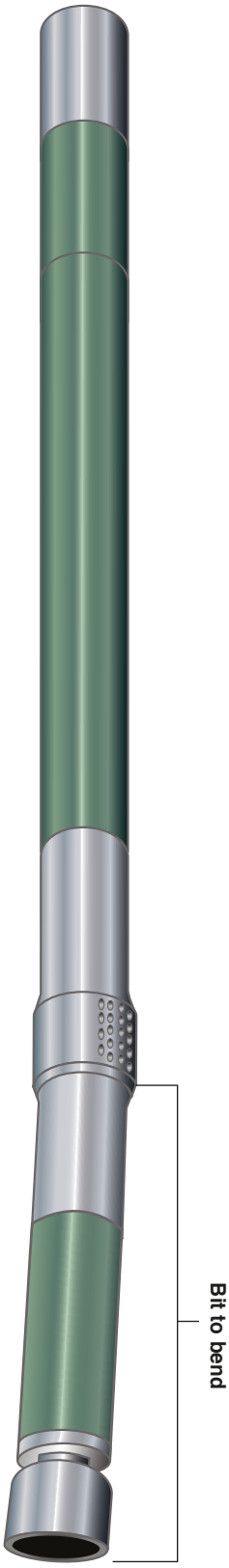


3 3/4"	5/6 lobe 3.0 stage		5/6 lobe 3.8 stage	
Motor specifications	**(PH-375-560-30)**		**(PH-375-560-38)**	
	Imperial	Metric	Imperial	Metric
Tool OD	3 3/4"	95 mm	3 3/4"	95 mm
Weight	348 lbs	125 kg	276 lbs	125 kg
Length	12.4 ft	3.8 m	12.5 ft	3.8 m
Lobe configuration	5/6 lobe		5/6 lobe	
Number of stages	3.0 stage		3.8 stage	
Bit speed	100 - 260 rpm		90 - 360 rpm	
Flow rate	80 - 190 gpm	303 - 719 lpm	40 - 160 gpm	150 - 600 lpm
Maximum torque	627 ft-lbs	850 Nm	574 ft-lbs	780 Nm
Maximum power	32 hp	24 kW	37 hp	28 kW
Bit to bend	46"	1,168 mm	45"	1,147 mm
Maximum rec. diff. pressure	450 psi	31 bar	460 psi	32 bar
Maximum WOB	12,000 lbs	5,443 kg	11,000 lbs	5,000 kg
Maximum pull to re-run motor	70,000 lbs	31,751 kg	55,000 lbs	25,000 kg
Top connection (box)	2 7/8" reg.		2 7/8" reg.	
Bit connection (box)	2 7/8" reg.		2 7/8" reg.	

3 3/4"	9/10 lobe 3.0 stage		9/10 lobe 4.0 stage	
Motor specifications	**(PH-375-910-30)**		**(PH-375-910-40)**	
	Imperial	Metric	Imperial	Metric
Tool OD	3 3/4"	95 mm	3 3/4"	95 mm
Weight	264 lbs	120 kg	379 lbs	172 kg
Length	10.5 ft	3.2 m	12.4 ft	3.79 m
Lobe configuration	9/10 lobe		9/10 lobe	
Number of stages	3.0 stage		4.0 stage	
Bit speed	125 - 317 rpm		50 - 150 rpm	
Flow rate	60 - 120 gpm	227 - 454 lpm	60 - 140 gpm	227 - 530 lpm
Maximum torque	457 ft-lbs	644 Nm	1,069 ft-lbs	1,450 Nm
Maximum power	18.6 hp	14 kW	63 hp	47 kW
Bit to bend	39"	965 mm	46"	1,168 mm
Maximum rec. diff. pressure	642 psi	44 bar	600 psi	41 bar
Maximum WOB	12,000 lbs	5,443 kg	12,000 lbs	5,443 kg
Maximum pull to re-run motor	67,500 lbs	30,617 kg	70,000 lbs	31,751 kg
Top connection (box)	2 3/8" reg.		2 7/8" reg.	
Bit connection (box)	2 3 /8" reg.		2 7/8" reg.	

Mud Motors – **4 3/4" & 6 3/4"**

Drilling motors – Technical data

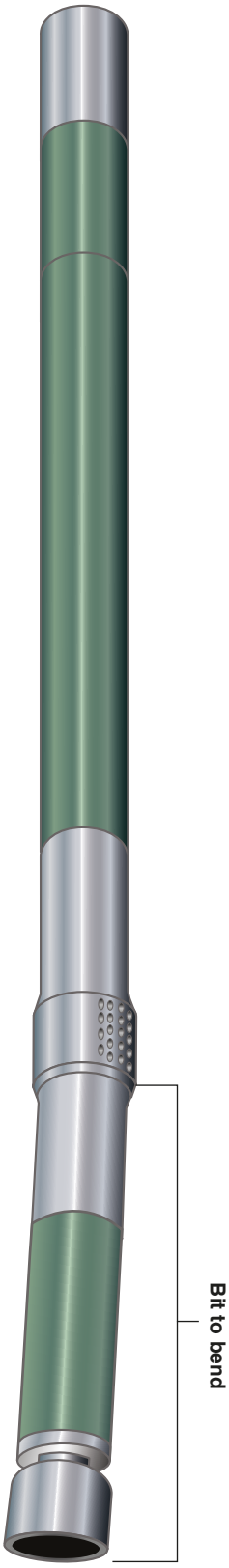


4 3/4"	5/6 lobe 3.0 stage		9/10 lobe 4.0 stage	
Motor specifications	**(PH-475-560-30)**		**(PH-475-910-40)**	
	Imperial	Metric	Imperial	Metric
Tool OD	4.75"	120 mm	4.75"	120 mm
Weight	873lbs	396 kg	1,100 lbs	499 kg
Length	16.7 ft	508 cm	22.3 ft	680 cm
Lobe configuration	5/6 lobe		9/10 lobe	
Number of stages	3.0 stage		4.0 stage	
Bit speed	70 - 175 rpm		70 - 175 rpm	
Flow rate	100 - 250 gpm	379 - 946 l/min	100 - 250 gpm	379 - 946 l/min
Maximum torque	1,586 ft-lbs	2,150 Nm	1,881 ft-lbs	2,550 Nm
Maximum power	76 hp	57 kW	103 hp	77 kW
Bit to bend	46"	1,168 mm	46"	1,168 mm
Maximum rec. diff. pressure	1,500 psi	103 bar	1,500 psi	103 bar
Maximum WOB	25,000 lbs	11,340 kg	25,000 lbs	11,340 kg
Maximum pull to re-run motor	100,000 lbs	45,359 kg	100,000 lbs	45,359 kg
Top connection (box)	3 1/2" IF 3 1/2" reg.		3 1/2" IF 3 1/2" reg.	
Bit connection (box)	3 1/2" reg.		3 1/2" reg.	

6 3/4"	4/5 lobe 4.8 stage		9/10 lobe 4.0 stage	
Motor specifications	**(PH-675-450-48)**		**(PH-675-910-40)**	
	Imperial	Metric	Imperial	Metric
Tool OD	6 3/4"	172 mm	6.75"	172 mm
Weight	1,940 lbs	880 kg	2,135 lbs	968 kg
Length	22.7 ft	692 cm	22.9 ft	700 cm
Lobe configuration	4/5 lobe		9/10 lobe	
Number of stages	4.8 stage		4.0 stage	
Bit speed	150 - 300 rpm		50 - 180 rpm	
Flow rate	303 - 600 gpm	1,150 - 2,270 l/min	250 - 600 gpm	946 - 2271 l/min
Maximum torque	3,355 ft-lbs	4,550 Nm	3,950 ft-lbs	5,355 Nm
Maximum power	162 hp	121 kW	105 hp	78 kW
Bit to bend	77.5"	1,969 mm	76"	1,930 mm
Maximum rec. diff. pressure	580 psi	40 bar	600 psi	41 bar
Maximum WOB	66,000 lbs	30,000 kg	75,000 lbs	34,019 kg
Maximum pull to re-run motor	198,000 lbs	90,000 kg	225,000 lbs	102,058 kg
Top connection (box)	4 1/2" IF		4 1/2" IF 4 1/2" reg.	
Bit connection (box)	4 1/2" reg.		4 1/2" reg.	

Mud Motors – **7 3/4" & 8"**

Drilling motors – Technical data



7 3/4" — **9/10 lobe 4.0 stage**

Motor specifications	**(PH-775-910-40)**	
	Imperial	Metric
Tool OD	7.75"	197 mm
Weight	2,668 lbs	1,210 kg
Length	23.6 ft	720 cm
Lobe configuration	9/10 lobe	
Number of stages	4.0 stage	
Bit speed	80 - 180 rpm	
Flow rate	300 - 900 gpm	1,135 - 3,407 l/min
Maximum torque	14,800 ft-lbs	20,000 Nm
Maximum power	383 hp	286 kW
Bit to bend	86"	2,179 mm
Maximum rec. diff. pressure	800 psi	55 bar
Maximum WOB	80,000 lbs	36,287 kg
Maximum pull to re-run motor	275,000 lbs	124,737 kg
Top connection (box)	6 5/8" reg.	
Bit connection (box)	6 5/8" reg.	

8" — **6/7 lobe 4.0 stage**

Motor specifications	**(PH-800-670-40)**	
	Imperial	Metric
Tool OD	8"	203 mm
Weight	3,196 lbs	1,450 kg
Length	23.3 ft	710 cm
Lobe configuration	6/7 lobe	
Number of stages	4.0 stage	
Bit speed	80 - 240 rpm	
Flow rate	290 - 900 gpm	1,100 - 3,400 l/min
Maximum torque	4,905 ft-lbs	6,650 Nm
Maximum power	208 hp	153 kW
Bit to bend	90"	2,305 mm
Maximum rec. diff. pressure	478 psi	33 bar
Maximum WOB	80,000 lbs	36,287 kg
Maximum pull to re-run motor	275,000 lbs	124,737 kg
Top connection (box)	6 5/8" reg.	
Bit connection (box)	6 5/8" reg.	

Drill bits

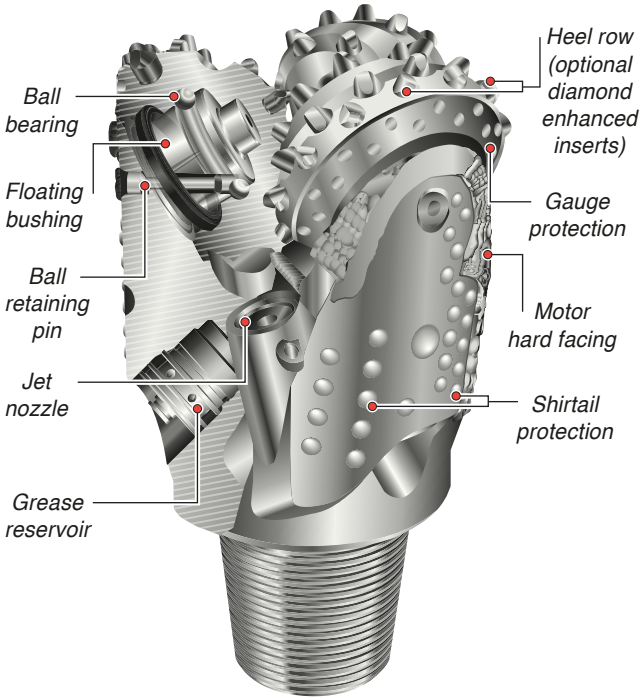
Since the early 1900's when the first roller cone tri-cone rock bits were patented, these tools have proven to provide the best all-around cutters for drilling rock, from soft formations all the way to extremely hard formations. While most cutting technologies have been attempted, their uses have proven too limited to specific rock formations, and the tri-cone roller cone rock bit remains the bit of choice for the wide range of applications encountered in HDD horizontal drilling projects.

All the major bit manufacturing companies have developed bits for specialized applications during the past 20 years, but these developments generally have focused on vertical drilling applications rather than horizontal drilling applications.

Prime Horizontal has chosen to work with a small group of bit suppliers who consistently provide bits tailored to the wear characteristics of horizontal drilling. Prime Horizontal sells bits with extra heavy gauge protection and the bit suppliers add these options to the bits they sell. In certain circumstances additional options are asked for, such as diamond impregnated coatings on the shirt-tails to extended jet nozzles for softer formation jet bits.

It is important to understand the type of formation intended to be drilled so an accurate recommendation can be made as to which type of bit would be best for a specific project. For example, there are 8 different grades of roller cones, denoting softer formations all the way to the hardest. Within each grade, there are another four different sub-grades of each. And finally, within each of the sub-grades, there are many additional options from changing up the type of bearing in use based on formation expectations.

Clients are asked to supply the compressive strengths of the formations and the type of formations to be drilled so Prime Horizontal can make appropriate recommendations on which drill bits to use.



IADC coding	
First digit	1, 2 and 3 designate Steel tooth bits with 1 for soft, 2 for medium and 3 for hard formations. 4, 5, 6, 7 and 8 designate Tungsten carbide insert bits for varying formation hardness with 4 the softest and 8 the hardest.
Second digit	1, 2, 3 and 4 are a further breakdown of formation with 1 the softest and 4 the hardest.
Third digit	This digit will classify the bit according to bearing/seal type and special gauge wear protection as follows: 1. Standard open bearing roller bit 2. Standard open bearing roller bit for air drilling only 3. Standard open bearing roller bit with gauge protection which is defined as carbide inserts in the heel of the cone 4. Ball & roller sealed bearing bit 5. Roller sealed bearing bit with carbide inserts in the heel of the cone 6. Journal sealed bearing bit. 7. Journal sealed bearing bit with carbide inserts in the heel of the cone.

Shock Tool

Shock Tool Features & Advantage

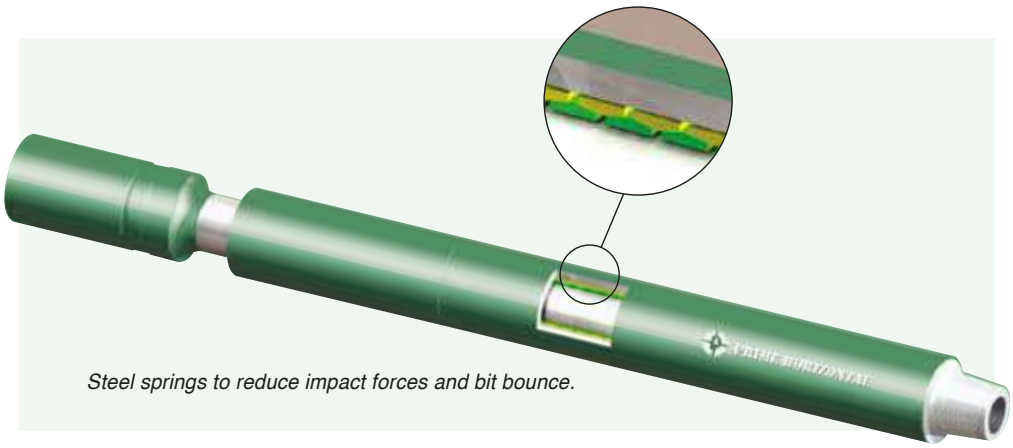
The use of Prime Horizontal's Shock Tooling will increase your bit life and protect your drill string.

- Vibration Dampening Device should limit damage to down-hole electronic tooling
- Spring Stack compensates for fluctuation in bit weight requirements
- Absorbs both natural and induced vibrations
- Longer bit life by eliminating unusual vibration wear patterns on bit
- Self-lubricated for prolonged life
- Double sealed thread joints and pistons

The Prime Horizontal Shock Tool is a simple drilling enhancement tool designed to reduce bit bounce and impact forces. Reducing bit bounce will increase formation contact and therefore increase the rate of penetration. Reducing impact forces will increase drilling motor and bit life.

The Prime Horizontal Shock Tool has a relatively soft spring rate and linear travel that will function effectively in a wide range of weight on bits. Because the Prime Horizontal Shock Tool does not rely on internal hydraulic fluid and valves it operates consistently in a wide range of temperatures.

As the name implies the tool is a linear shock absorber that uses unique load dampening steel springs to reduce impact forces and bit bounce. The drilling torque is transmitted through a heavy duty spline. The Prime Horizontal Shock Tool is the ultimate in mechanical simplicity for reliable performance in a wide range of drilling conditions.



Steel springs to reduce impact forces and bit bounce.

Shock Tool

	Model Number	Outside Diameter	Internal Diameter	Tool Length	Torque Capability	Tensile Yield Load	Spring Rate	Max – Min Working Compression Load	Tool Weight
Metric	ST 475	127 mm	50.8 mm	320 cm	51,521 nm	181,437 kg	321.44 kg/mm	22,679 – 2,721 kg	240 kg
	ST 650	165 mm	50.8 mm	198 cm	88,128 nm	290,299 kg	392.87 kg/mm	18,143 – 3,628 kg	254 kg
	ST 800	203 mm	71.1 mm	219 cm	176,256 nm	351,534 kg	607.17 kg/mm	31,751 – 4,535 kg	415 kg
Imperial	ST 475	5.0 in	2.00 in	10.5 ft	38,000 ft-lbs	400,000 lbs	18,000 lbs/in	50,0000 – 6,000 lbs	530 lbs
	ST 650	6.5 in	2.00 in	6.5 ft	65,000 ft-lbs	640,000 lbs	22,000 lbs/in	40,000 – 8,000 lbs	560 lbs
	ST 800	8.0 in	2.80 in	7.2 ft	130,000 ft-lbs	775,000 lbs	34,000 lbs/in	70,000 – 10,000 lbs	915 lbs

PWD sub

Pressure While Drilling

Pressure While Drilling (PWD) with ParaTrack-2

In conjunction with a Pressure Module and a Pressure While Drilling (PWD) Orienting Sub, the ParaTrack-2 system tool is used to measure downhole pressure. It gives real-time measurements of mud pressure both inside the drill pipe and in the annulus just behind the drill bit. Pressure measurements are taken behind the bit when jetting. When using a mud motor the pressure is measured directly behind the mud motor.

Pressure Module

The Paratrack-2 tool must be the PWD enhanced version to allow the connection of the Pressure Module as shown in Figure 1.

Figure 1: The Pressure Module

Pressure Module Specifications

Length	600mm
Drillpipe annulus gauge	350 bar full scale
Pilot hole annulus gauge	35 bar full scale

Pressure While Drilling (PWD) / orienting sub

The pressure module has a grease-filled access port in its side for measurement of the pipe pressure and another grease-filled access port at the bottom which allows transport of pressure from the specialized Pressure While Drilling (PWD) / orienting sub as shown in Figure 2. The PWD sub uses a grease-filled access port to transport pressure measured from the outside of the PWD sub to the Pressure Module. The Pressure Module then sends the pressure data up the wire line to the interface box and computer located at the top of the hole.

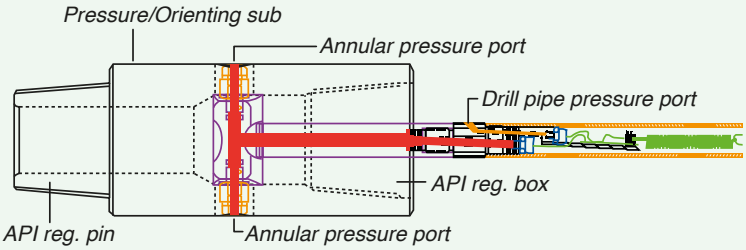


Figure 2: The Pressure While Drilling (PWD) / Orienting Sub showing the attached Pressure Module.

The pressure data is monitored and stored by the standard RivCross software used with the Paratrack-2 system. The pressure can be viewed in real time. It is also stored for later use. The software allows easy graphical representations of pressure variations with time, an example of which is shown in Figure 3. Alarms can also be set in the software and will trigger if pressure limits are exceeded during drilling.

Because it is capable of giving a rapid indication of an increase in downhole pressure, the measurement of pressure while drilling is an effective technique to reduce the risk of bentonite (drilling mud) breakout during the drilling process. It can also help ensure that a drilled hole is kept clean and free of blockages, thus reducing operational risks.

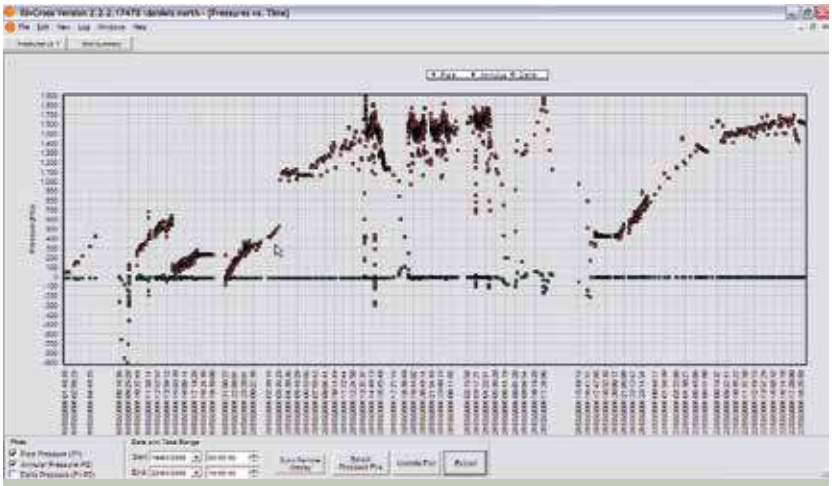


Figure 3: An example of a post-job PWD drilling chart

Rock Reamer

Imperial sizes

Rock reamer specifications

Body				Cutters			
Body	Min pilot hole	Connections	No of cutters	Opening range			
RR4	4 1/2"	2 7/8" IF B x B	3	8 1/2"	10"	12"	-
				AA	BB	CC	DD
RR6	6 1/4"	3 1/2" IF B x B	3	12"	14"	16"	18"

Body				Cutters					
				Opening range					
Body	Min pilot hole	Connections	No of cutters	A	B	C	D	E	F
RR8	8 1/2"	4 1/2" IF B x B	3	16"	18"	20"	22"	24"	26"
RR17	17 1/2"	7 5/8" Reg. B x B	3, 4	24"	26"	28"	30"	32"	34"
RR26	26"	7 5/8" Reg. B x B	3, 5	32"	34"	36"	38"	40"	42"
RR36	36"	7 5/8" Reg. B x B	3, 4, 5	42"	44"	46"	48"	50"	52"
RR42	42"	7 5/8" Reg. B x B	4, 5, 7	48"	50"	52"	54"	56"	58"
RR48	48"	7 5/8" Reg. B x B	4, 5, 7	54"	56"	58"	60"	62"	64"

** Thread connections mentioned are in standard sizes. Other connections are available upon request.*

Cutter specifications

Milled Tooth

Alluvial formations, clays, soft rock.
3–21 Mpa (500–3,000 PSI) compressive strength formations.

Formation types: Sandstone, shale, mudstone, clays, gravels and conglomerate.

Teeth are milled directly from the hard cone steel and tungsten hardfacing applied on the trailing edge to maintain sharpness of the blade. TCI gauge row MT cutters available on special order.

TCI Chisel

Medium rock
21–103 Mpa (3,000–15,000 PSI) compressive strength rock.

Formation types: Limestone, sandstone and shale.

TCI teeth are aggressive conical shaped for aggressive penetration rates in medium type rock.

TCI Type 5

Medium – hard rock
83–172 Mpa (12,000–25,000 PSI) compressive strength formations.

Formation types: Granite, marble, and dolomite.

TCI teeth have moderate extensions. Gage area has all dome type cutters to maximize cutter gauge life.

TCI Type 7

Hard rock
172–310 Mpa (25,000–45,000 PSI) compressive strength formations.

Formation types: Quartz, Basalt and Quartzite.

TCI teeth are all hemispherical shape, providing a longer cutter life in extremely hard rock.

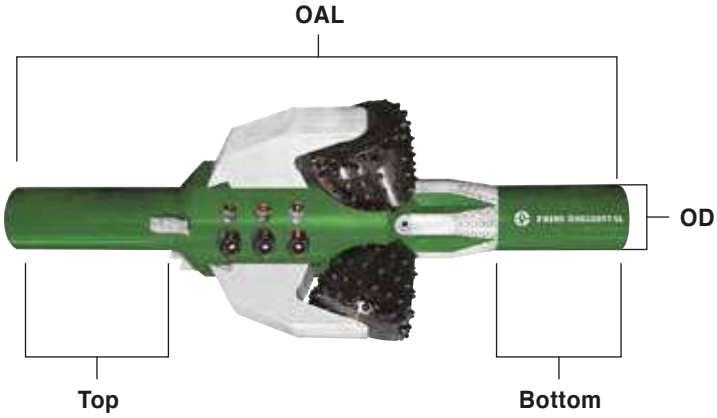
Body, cutter and arm weights – *in lbs*

Body	**RR4** – 135	**RR6** – 346	**RR8** – 730	**RR17** – 1915	**RR26** – 2669	**RR36** – 3900	**RR42** – 4739	**RR48**

Body	R4-8.5	R4-10	R4-12	R6-12	R6-14	R6-16	R6-18	R6-20	A	B	C	D	E	F
MT	4.0	7.9	11.9	15.0	22.9	30.9	41.0	56.0	31.7	46.7	63.5	79.4	101.2	127.0
TCI	6.0	9.9	15.9	20.9	29.8	41.7	55.0	73.0	40.8	60.6	78.5	99.2	125.0	153.9
FRA	5.1	7.1	9.0	19.8	23.8	27.8	35.0	37.0	50.4	54.7	67.5	73.4	87.3	100.3

** Weight in lbs per cutter*

Operating specifications– Imperial sizes



					Mill Tooth		TCI					
Tool series	Pilot hole	Thread B x B	No. of cutters	Opening size	WOB (000's lbs)	RPM's	WOB (000's lbs)	RPM's	Body OD (in)	OAL*	Top*	Bottom*
RR4	4 1/2"	2 7/8" IF	3	8 1/2" – 12"	7.7 – 9.9	50 – 80	7.7 – 12.1	40 – 80	3 1/2"	41.5"	15.0"	12"
RR6	6 1/4"	3 1/2" IF	3	12" – 18"	9.9 – 15.4	40 – 100	15.4 – 19.8	35 – 80	4 3/4"	52.0"	12.0"	15"
RR8	8 1/2"	4 1/2" IF	3	16" – 26"	15.4 – 19.8	40 – 80	19.8 – 39.7	35 – 70	6 1/2"	61.0"	12.5"	16"
RR17	17 1/2"	7 5/8" Reg.	3	24" – 24"	15.4 – 25.4	40 – 65	19.8 – 39.7	40 – 65	9 1/2"	64.5"	12.0"	14"
RR26	26"	7 5/8" Reg.	3	32" – 42"	15.4 – 29.8	35 – 60	19.8 – 49.6	35 – 55	9 1/2"	64.5"	12.0"	12"
RR36	36"	7 5/8" Reg.	4	42" – 52"	15.4 – 29.8	35 – 55	19.8 – 49.6	35 – 50	9 1/2"	64.5"	12.0"	12"
RR42	42"	7 5/8" Reg.	4	48" – 58"	15.4 – 29.8	35 – 50	19.8 – 49.6	30 – 45	9 1/2"	64.5"	12.0"	12"
RR48	48"	7 5/8" Reg.	5	54" – 64"	15.4 – 35.3	35 – 45	19.8 – 59.5	25 – 40	9 1/2"	64.5"	12.0"	12"

• Lengths apply for new bodies only.

The suggested weights and RPM's are only a recommended guide.Weights and RPM's should be adjusted to maximum penetration rates modified by expected cutter life. They will vary with formation and rig power. Recommended weights assume minimum pilot hole sizes. As the cutting shoulder is reduced, less weight is needed.

Tips:

- *Softer formations will normally respond to lighter weights and higher RPM's. Harder formations require more weight and slower RPM's*
- *Adjust weight and RPM to achieve optimum torque. Avoid uneven rotation of hole opener.*
- *Use sufficient fluid volume to obtain optimum hole cleaning.*
- *Proper centralisation will enhance tool performance and increase downhole life.*

Lo Torque Hole Opener

Imperial sizes

LT hole opener specifications

Body				Cutters			
Body	Min pilot hole	Connections	No of cutters	Opening range			
LT2	2 1/2"	2" IF P x B	3	6"			
LT4	4 1/2"	2 7/8" IF P x B	3	8"	10"	12"	
LT6	6 1/2"	3 1/2" IF P x B	3	12"	14"	16"	
				A	B	C	D
LT8	8 1/2"	4 1/2" IF P x B	3	16"	18"	20"	22"
LT16	16"	7 5/8" Reg. P x B	3	24"	26"	28"	30"
LT24	24"	7 5/8" Reg. P x B	4	32"	34"	36"	38"
LT32	32"	7 5/8" Reg. P x B	4	40"	42"	44"	46"
LT40	40"	7 5/8" Reg. P x B	4	48"	50"	52"	54"
LT48	48"	7 5/8" Reg. P x B	5	56"	58"	60"	62"

** Thread connections mentioned are in standard sizes. Other connections are available upon request.*

Cutter specifications

Milled Tooth

Alluvial formations, clays, soft rock.
3–21 Mpa (500–3,000 PSI) compressive strength formations.
Formation types: Sandstone, shale, mudstone, clays, gravels and conglomerate.
Teeth are milled directly from the hard cone steel and tungsten hardfacing applied on the trailing edge to maintain sharpness of the blade. TCI gage row MT cutters available on special order.

TYPE 5 (IADC)

Medium rock
41–103 Mpa (6,000 - 15,000 PSI) compressive strength rock
Formation types: Limestone, sandstone, and shale.
TCI teeth are aggressive conical shaped for aggressive penetration rates in medium type rock.

TYPE 7 (IADC)

Medium – hard rock
83–172 Mpa (12,000 - 25,000 PSI) compressive strength rock
Formation Types: Granite, marble, and dolomite.
TCI teeth have moderate extensions.
Gage area has all dome type cutters to maximize cutter gage life.

TYPE 8 (IADC)

Hard rock
172–310 Mpa (25,000 - 45,000 PSI) compressive strength rock
Formation Types: Quartz, basalt, and quartzite.
TCI teeth are all hemispherical shape, providing a longer cutter life in extremely hard rock.

Lo-Torque Hole Opener Cutters to match the formation hardness of your bore.
The Lo-Torque Tungsten Carbide Cutter types now range from medium to extremely hard rock formations. Close attention to insert material composition of gage, inner row and base areas of the cutters optimizes their performance in the wide range of rock conditions encountered in horizontal drilling.

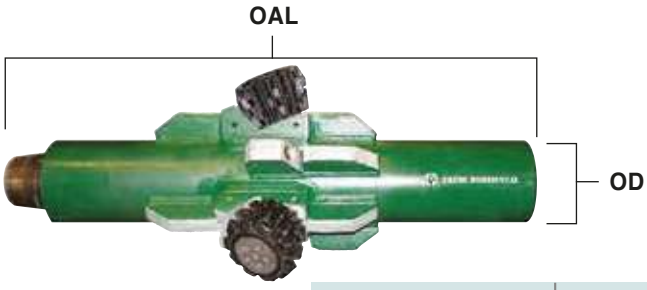
Body and cutter weights – *in lbs*

Body	**LT2** – 32	**LT4** – 112	**LT6** – 267	**LT8** – 480	**LT16** – 1188	**LT24** – 1952	**LT32**– 2712	**LT40** – 3200	**LT48** – 3407

Body	LT2	LT4			LT6			LT8				LT16				LT24				LT32				LT40				LT48			
	2"	8"	10"	12"	12"	14"	16"	16"	18"	20"	22"	24"	26"	28"	30"	32"	34"	36"	38"	40"	42"	44"	46"	48"	50"	52"	54"	56"	58"	60"	62"
MT	3	4	8	12	15	23	31	32	47	64	84	32	47	64	84	32	47	64	84	32	47	64	84	32	47	64	84	32	47	64	84
TCI	3	6	10	16	21	30	42	41	61	79	100	41	61	79	100	41	61	79	100	41	61	79	100	41	61	79	100	41	61	79	100

** Weight in lbs per cutter*

Operating specifications– Imperial sizes



						Mill Tooth		TCI			
Body type	Pilot hole	Body thread P x B	No. of cutters	cutter series	Opening size	WOB (000's lbs)	RPM's	WOB (000's lbs)	RPM's	Body OD	OAL*
LT2	2 1/2"	2" IF	3		6"	3 – 7	50 – 80	3 – 7	30 – 60	2.5"	15"
LT4	4 1/2"	2 7/8" IF	3		8" – 12"	8 – 10	50 – 90	10 – 12	40 – 80	3.5"	26"
LT6	6 1/2"	3 1/2" IF	3		12" – 16"	10 – 15	40 – 100	15 – 20	35 – 90	4.5"	31"
LT8	8 1/2"	4 1/2" IF	3	A	16"	15 – 20	40 – 100	20 – 40	35 – 90	6.5"	36"
				B	18"	15 – 20	40 – 90	20 – 40	35 – 80		
				C	20"	15 – 20	40 – 80	20 – 40	35 – 80		
				D	22"	15 – 20	40 – 75	20 – 40	35 – 70		
LT16	16"	7 5/8" Reg.	3	A	24"	15 – 25	40 – 75	20 – 40	35 – 70	9.5"	42"
				B	26"	15 – 25	40 – 75	20 – 40	35 – 70		
				C	28"	15 – 25	40 – 75	20 – 40	35 – 70		
				D	30"	15 – 25	40 – 65	20 – 40	35 – 60		
LT24	24"	7 5/8" Reg.	4	A	32"	15 – 30	35 – 60	20 – 50	35 – 55	9.5"	42"
				B	34"	15 – 30	35 – 60	20 – 50	35 – 55		
				C	36"	15 – 30	35 – 60	20 – 50	35 – 55		
				D	38"	15 – 30	35 – 60	20 – 50	35 – 55		
LT32	32"	7 5/8" Reg.	4	A	40"	15 – 30	35 – 55	20 – 50	35 – 50	9.5"	42"
				B	42"	15 – 30	35 – 55	20 – 50	35 – 50		
				C	44"	15 – 30	35 – 55	20 – 50	35 – 50		
				D	46"	15 – 30	35 – 55	20 – 50	35 – 50		
LT40	40"	7 5/8" Reg.	4	A	48"	15 – 30	35 – 50	20 – 50	30 – 45	9.5"	42"
				B	50"	15 – 30	35 – 50	20 – 50	30 – 45		
				C	52"	15 – 30	35 – 50	20 – 50	30 – 45		
				D	54"	15 – 30	35 – 50	20 – 50	30 – 45		
LT48	48"	7 5/8" Reg.	5	A	56"	15 – 35	35 – 45	20 – 60	25 – 40	9.5"	42"
				B	58"	15 – 35	35 – 45	20 – 60	25 – 40		
				C	60"	15 – 35	35 – 45	20 – 60	25 – 40		
				D	62"	15 – 35	35 – 45	20 – 60	25 – 40		

• Lengths apply for new bodies only.

Tips:

- *Softer formations will normally respond to lighter weights and higher RPM's. Harder formations require more weight and slower RPM's*
- *Adjust weight and RPM to achieve optimum torque. Avoid uneven rotation of hole opener.*
- *Use sufficient fluid volume to obtain optimum hole cleaning.*
- *Proper centralisation will enhance tool performance and increase downhole life.*

The suggested weights and RPM's are only a recommended guide. Weights and RPM's should be adjusted to maximum penetration rates. They will vary with formation and rig power. Recommended weights assume minimum pilot hole sizes. As the cutting shoulder is reduced, less weight is needed.

GyroTrack

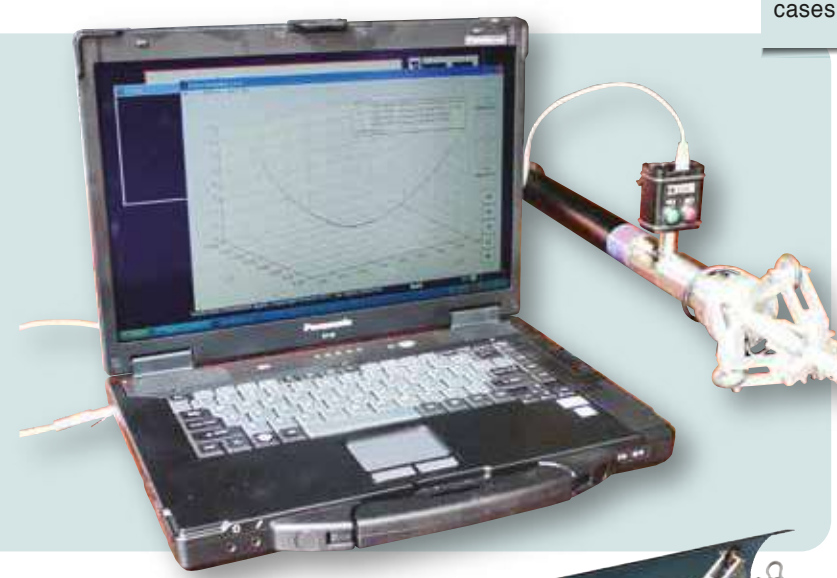
Pipeline survey services

Taking advantage of more than 10 years experience as a leading field service company to the HDD market, Prime Horizontal offers post installation pipeline surveying using gyroscope technology.
With unrivalled customer service, fast reaction times, a flexible approach to client requirements and offices on four continents, Prime Horizontal offers this service worldwide using the field proven GyroTrack platform.

GyroTrack is a versatile and unique multi-purpose pipeline mapping system. With a proven track record on virtually every continent, this multi-diameter system provides the most accurate results on pipeline location.

A unique system of exchangeable centralizing wheel units gives the GyroTrack an operational range of ID90mm (3.5”) to ID1200 (48”). Whether the pipeline is made of steel, concrete, HDPE or PVC, this mapping system will improve any HDD implementation procedure.

The GyroTrack tool with centralization, may be pulled either by a hand operated wireline or a mechanical winch. In certain cases, the tool may be pumped through the product line.



GyroTrack positioned in pipe

Interchangeable centralizers

Data Monitoring / Measurement

1 Data collection

GyroTrack operation is enabled after insertion into the end of the product line. Once physical location measurements are made, GyroTrack is pulled through the line at a predetermined rate, usually 1 to 1.5 m/sec.

After GyroTrack arrives at the other end of the product line, it is reversed and pulled back obtaining a second, confirming, set of data.

2 Data processing

Captured data is immediately checked on site to ensure data collection limits and quality control targets have been met. After confirmation, the data can be uploaded to the office through GPRS.
An immediate on site Survey Report can be provided at this time. The report would include the following attributes.

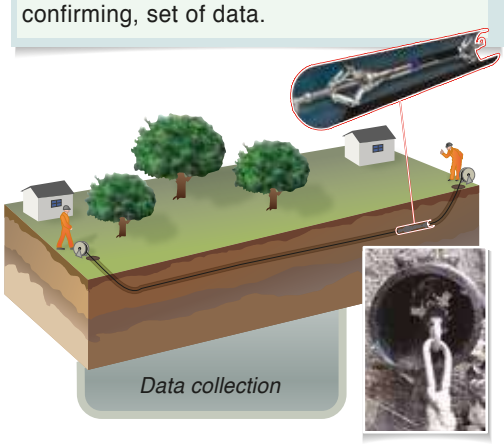
- 3D pipeline profile
- Bend radius report per customer defined intervals
- Inclination analysis
- Job specification
- Job locations

3 Data transfer to GIS

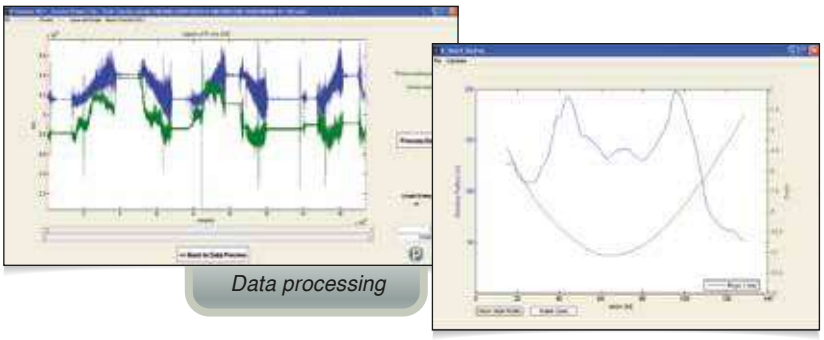
Output data can be exported to open platform formats for seamless integration in common GIS platforms such as:

- AutoCAD
- Excel
- MicroStation
- Text

A final report will be produced after office quality control of the survey.



Data collection



Data processing

GyroTrack specifications

Diameter	3.5"/90 mm to 32"/800 mm	36"/900 mm	48"/1200 mm
Operational ID range	Fully variable in range	36"/900 mm	48"/1200 mm
System length	44"/108 cm to 67"/170 cm	47"/1200 mm	40"/1000 mm
Minimum bending radius	15'/4500 mm to 2.2'/700 mm	2D	2D
System weight	3 kg to 8 kg	22kg	25kg
Logging rate	800hz		
Calibrated Accuracy	15cm in XYZ over a 500m distance between Way Points**		
Battery autonomy	> 3 hours		

*** Accuracies subject to many environmental factors and are more closely defined within each Post Job Report. Specifications may change without prior notice.*

There's a new arm to our tree...

Prime Horizontal

We are proud to announce the launch of MudVis

Prime Horizontal's MudVis samples your stock or mixing tank bentonite at regular preset intervals and tells you about your mud mixture.

Viscosity and specific gravity values are logged in the processing unit and available real time for display on the unit and various handheld devices, ready for data analysis.

MudVis complements your mud mixing system and helps you monitor and control the quality and efficient use of your drilling fluid.

Allows you to react quickly to changing soil conditions, reducing your carbon footprint.

... it's good to go green

primehorizontal.com

MudVis: Automated Mud Viscosity Logging System

MudVis Advantages

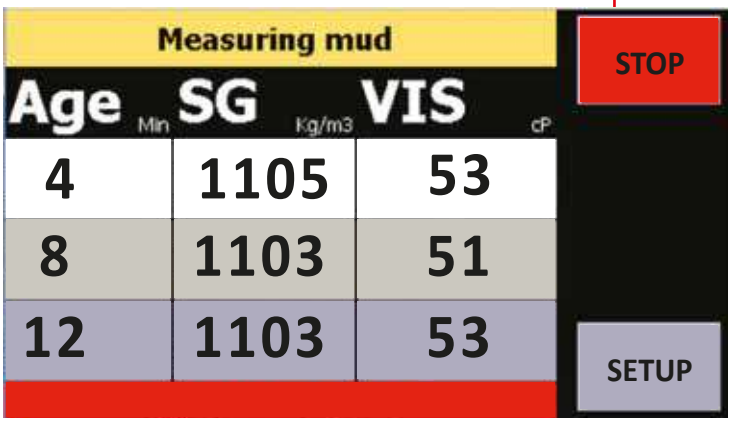
- Real-time automated Viscosity measurements assists the Mud Engineer during the mixing process
- Easy tracking of mud weight throughout the drilling & reaming process
- Generates mud mixing data for reports
- Data download via WiFi for logging, reporting and analysis purposes
- Monitoring is accessible via WiFi from around the drill site from laptops, smartphones and tablets
- User friendly self calibrating/ cleaning, low maintenance system
- Exterior mounted alarm system
- Ability to react quickly to changing soil conditions

MudVis is an automated mud viscosity and specific gravity measuring and logging system.

Designed specifically for the HDD industry, MudVis samples your stock; or mixing tank bentonite at regular preset intervals (varying from 4 to 10 minutes).

The viscosity and specific gravity values are logged in the processing unit, displayed on a sunlight viewable LCD screen, on Wifi enabled laptops, smartphones, and tablets for easy viewing at a glance.

Complements the mud mixing system by providing real time viscosity values during mud mixing.



Readout of results on the sunlight viewable display screen displaying: Timing, Specific Gravity and Viscosity

Data logging snapshot of mud measurement viewed on a mobile device

Specifications

Weight (dry)	30 kg (66 lb)
Power	110/220v mains supply
Mud pump	12 m (40 ft) max, 200 l/min
Viscosity units	MFs or Centipoise
Specific gravity units	kg/m³ (lb/ft³)
Measurement frequency	Reading at preset intervals [from 4 minutes on (adjustable)]
Accuracy SG / VIS	+/- 1.5%
WiFi capability	With app for real time readings
Mud viscosity	Up to 100 MFs
Dimensions of box (lwh)	30 x 46 x 57 cm (12 x 18 x 22 in)

Smart Pulling Head

The Smart Pulling Head is an intelligent pulling head for high density polyethylene (HDPE) pipelines from 160 mm to 315 mm capable of measuring and transmitting pull force and down-hole mud pressure in real time.

Pull force up to 30 tons and mud pressure up to 400 bar are measured directly at the pulling head and displayed to the rig operator in real time during the pipe pulling process.

The system requires no physical access or wire connections in the drill string, measured data is transmitted using a cable installed inside the product line and then wirelessly sent to the simple touch-screen driller's display at the rig, avoiding downtime when pulling pipe. The display unit can be connected to a laptop to store digital data for later reference and in the future will wirelessly communicate with the Prime Horizontal ProData System.

There is no limitation on the depth of boreholes or the length of boreholes making this a flexible solution for measuring pull force and pressure while pulling any suitable HDPE pipe installed with HDD technology.

Smart Pulling Head Apparatus

1

The Pulling Head is an industry standard Polyethylene pull head, modified specifically for the purpose of measuring down hole force and annular borehole pressures. The standard system can measure up to 30 tons of pull force and 400 bar of pressure.

The standard system is available for PE (Polyethylene) pipe sizes from 160mm (SDR 11) up to 315mm diameter. Larger PE diameters are also available.

2

The tail pipe data handler is the electronic unit which is installed in the tail end of the product pipe. It's purpose is to receive the measured data from the Pull Head via a cable running through the product pipe.

Once the data has been received by the handler it transmits the data via radio frequency to the display unit located with the driller.

3

The Pull Head Driller Display Unit is a touch screen display. It receives information collected by the tail pipe data handler via radio frequency. The measured outputs are then displayed for the driller to see. The output allows the driller to initialize the system by calibrating the sensor output to 'zero' prior to beginning the pipe installation. It is also possible to change the pressure reading from Bar to PSI by applying the appropriate scale factor.

The system is designed to integrate with the Prime ProData system, if available, The two systems will wirelessly see each other and the data will automatically be recorded and saved to the ProData servers.

Data Monitoring / Measurement

Pre-requisites

1. **Laid down pipe:** The pipeline must be laid out in a straight run and not on a roll. Typically we are concerned with force and pressure measurements on pipelines longer than 200m. Normally such a length dictates that the pipeline be built up from sections of pipe up to 10m in length. The product pipeline is by default laid out in a straight line, sometimes on a series of rollers. There can be exceptions to this, usually cramped inner city projects where there is no other option than to weld two rolls together as the pipeline is pulled into the ground.

2. **Hot Plate welder:** It is required that a hot plate welder be present on site. This is the same system used to weld the pipeline sections together. The pulling head is fused in the same way as the pipe sections to the head of the pipeline, it is the clients responsibility to provide this service.

3. **Pull line installed:** In order for the pulling head to deliver its measurements to the surface a communication cable is installed through the length of the pipe, connecting the Pull Head with the data handler. It is the responsibility of the client to provide a pull line to facilitate the installation of the communication cable.

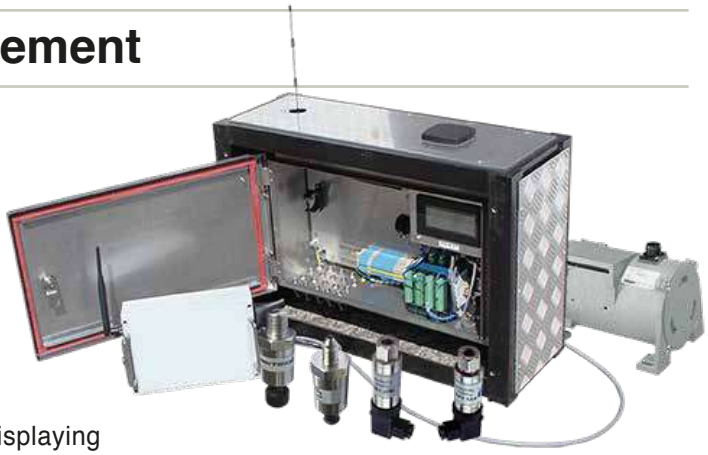
Specifications

Available for sizes PE pipe	160mm (6.2") [SDR11] - 315mm (12.4")*
Pulling force	Up to 30 tons
Annular pressure range	0–100 bar (1450 psi)
Transmission range	2.5km (1.5miles) [distance doubled with repeater]
Battery autonomy	8 hours**
Temperature range of downhole sensors	-20 – 60˚C (-4–140˚F)
Measurement frequency	Every 3 seconds

** Larger PE diameters are also available*

*** If more than 8 hours is required then a back up battery pack will be provided to give a further 8 hours of measurements.*

Data Monitoring / Measurement



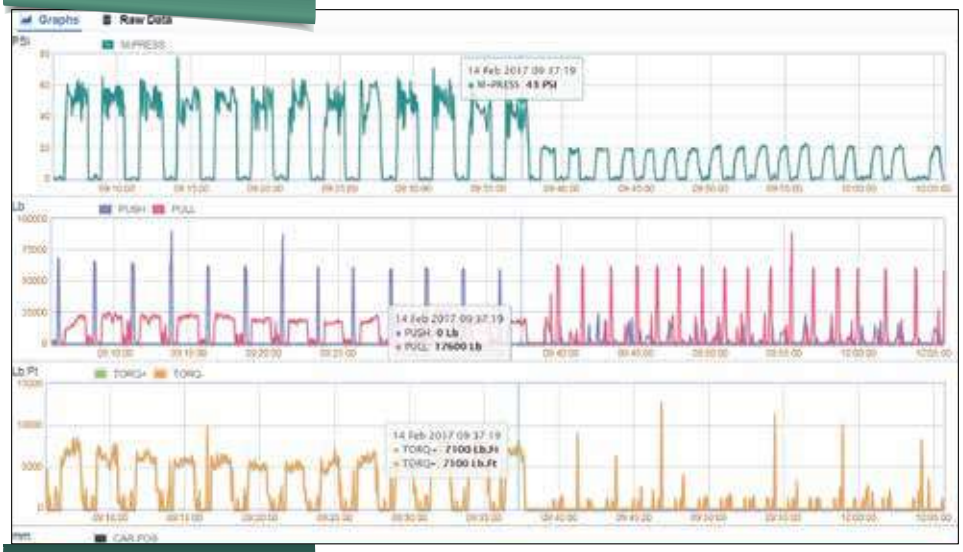
ProData

ProData is a system for measuring drilling parameters and displaying them locally at the rig site or in a remote office location via the cell network.

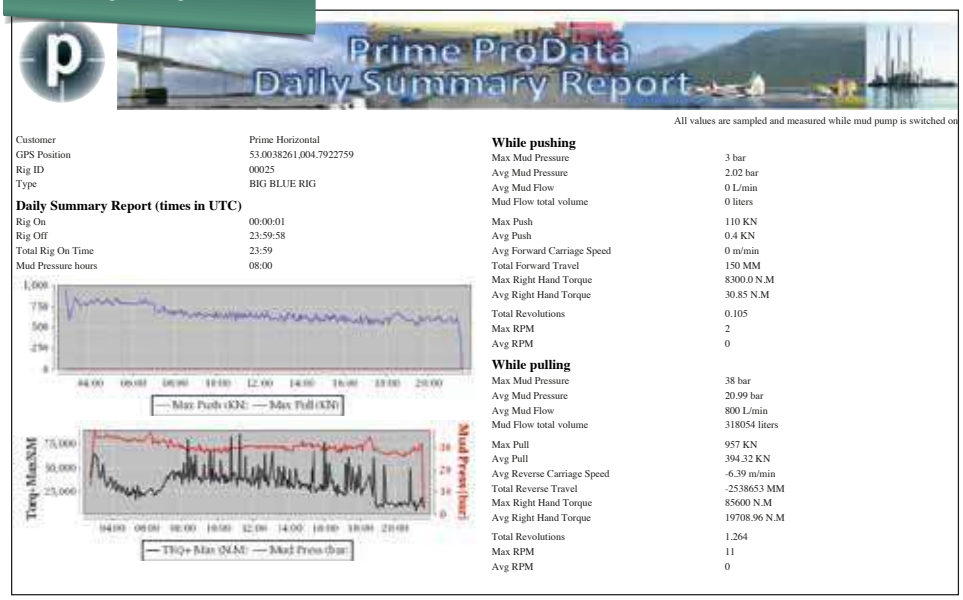
ProData Benefits

- Daily reports give concise overview of drilling activities
- In depth analysis of the drilling operation
- Reduced downtime
- Reduced broken pipe and stuck in hole problems
- High and low pre-set alarms of all measured drilling parameters
- User defineable 3rd party access
- Real time graphical representations of drilling parameters logged every 3 seconds
- Increased tooling life
- Data archive on site and off site
- Multiple operations oversight from one location
- Facilitates decision making
- Savings in supervisory man hours on the drill site

Data Display



Daily Report



Prime ProData
Daily Summary Report

All values are sampled and measured while mud pump is switched on

Customer	Prime Horizontal
GPS Position	53.0038261,004.7922759
Rig ID	00025
Type	BIG BLUE RIG

Daily Summary Report (times in UTC)

Rig On	00:00:01
Rig Off	23:59:58
Total Rig On Time	23:59
Mud Pressure hours	08:00

While pushing

Max Mud Pressure	3 bar
Avg Mud Pressure	2.02 bar
Avg Mud Flow	0 L/min
Mud Flow total volume	0 liters
Max Push	110 KN
Avg Push	0.4 KN
Avg Forward Carriage Speed	0 m/min
Total Forward Travel	150 MM
Max Right Hand Torque	8300.0 N.M
Avg Right Hand Torque	30.85 N.M
Total Revolutions	0.105
Max RPM	2
Avg RPM	0

While pulling

Max Mud Pressure	38 bar
Avg Mud Pressure	20.99 bar
Avg Mud Flow	800 L/min
Mud Flow total volume	318054 liters
Max Pull	957 KN
Avg Pull	394.32 KN
Avg Reverse Carriage Speed	-6.39 m/min
Total Reverse Travel	-2538653 MM
Max Right Hand Torque	85600 N.M
Avg Right Hand Torque	19708.96 N.M
Total Revolutions	1.264
Max RPM	11
Avg RPM	0

Data Monitoring / Measurement

The ProData System Features

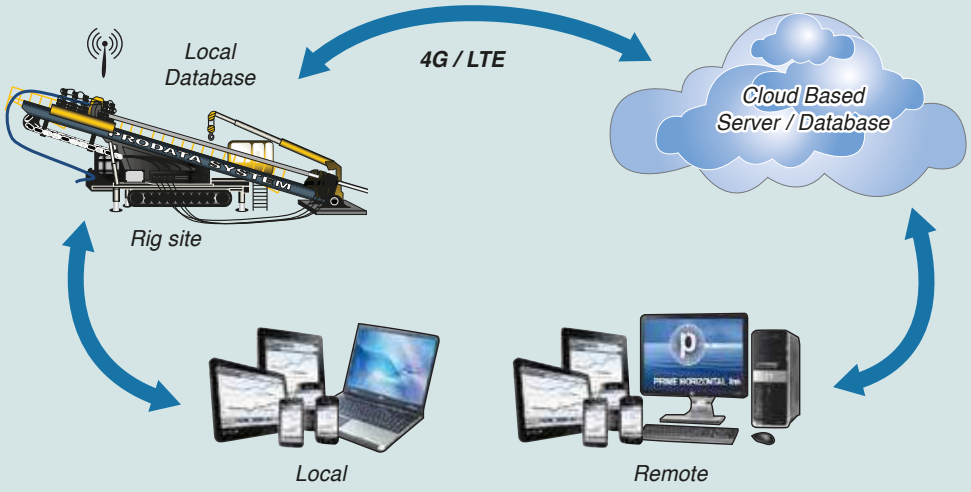
- Retrofit existing drill rigs or install on new drill rigs
- Suitable for installation on drill rigs from 12 to 600 tons
- Use of field proven and internationally certified sensors
- Use of modular design for adding new data packages, such as steering data, mud weight & viscosity data or Downhole Pressure & Gravity information
- GPS Position tracking
- Use of wireless technology to avoid using cables at the drill site
- Ruggedized to withstand vibration and ingress to minimum IP67
- Automatic data transfer to local and cloud-based user portal
- Security with password access for each rig and each client
- Capability of multiple users per client with client definable user permissions.
- Viewable on any device, any time, anywhere.

ProData System

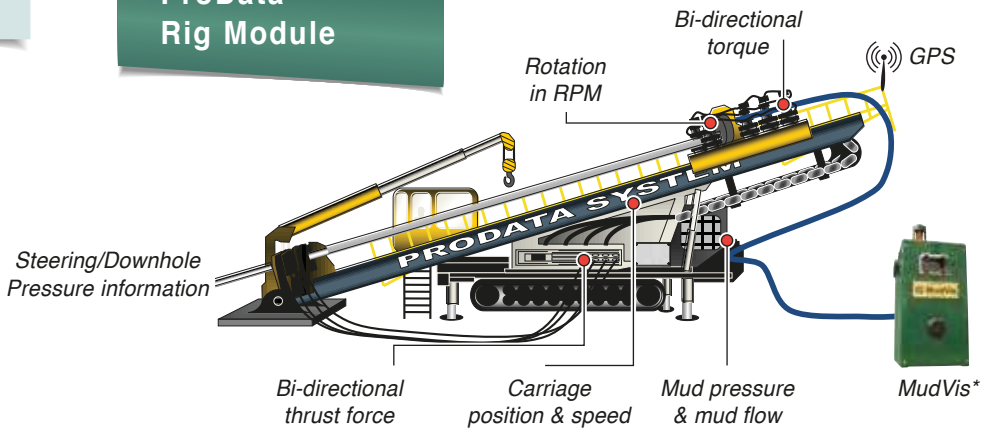
The ProData system automatically gathers, stores and transmits it modular suite of HDD rig site data to an on-site database (Local). The data is also transmitted via the cell network to the Prime Horizontal cloud-based database (Remote).

Both remote and local database archives make all logged data available for on-demand access by means of the intuitive and user-friendly client access portals.

Through these portals the customer gains access to either historical or “live” data (near real time) from one of the two Prime web servers.

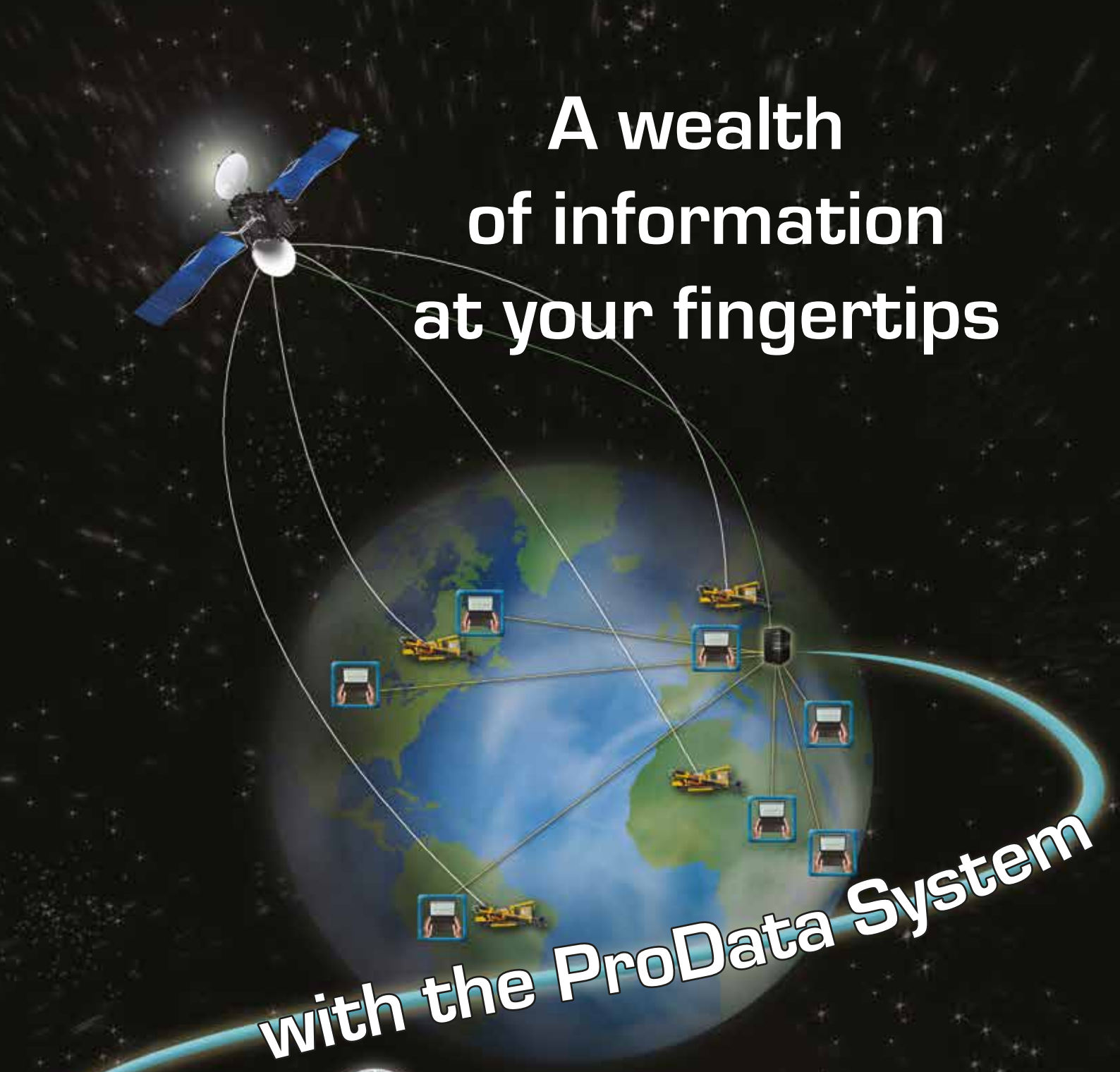


ProData Rig Module



* Denotes non-standard component

A wealth of information at your fingertips



with the ProData System

Prime Horizontal
ProData System

ProData is Prime Horizontal's system that measures and logs drilling parameters in real time for monitoring a HDD drilling operation. Measuring and logging the drilling data help the onsite driller discover possible drilling problems before they occur and help offsite drilling management monitor the effectiveness of their drilling rig utilization.

Rig data, including make/break torques on the vices, bi-directional torque on the drill pipe, bi-directional thrust force, drill head rotation & high side, carriage position and speed, mud pressure & mud flow rate, are logged in real time typically at a 3 second time interval.

Data from the ProData Rig module are automatically transmitted from the rig site by GPRS to a Prime Horizontal database server where the data are copied to a second physical location for security and made available for on-demand access by the customer via a confidential and proprietary Prime Horizontal Data Portal through which the offsite customer gains access to both historical and live data. The Portal uses Google Maps to track the physical locations of customer rigs throughout the duration of a project as well as between projects.

Prime Horizontal

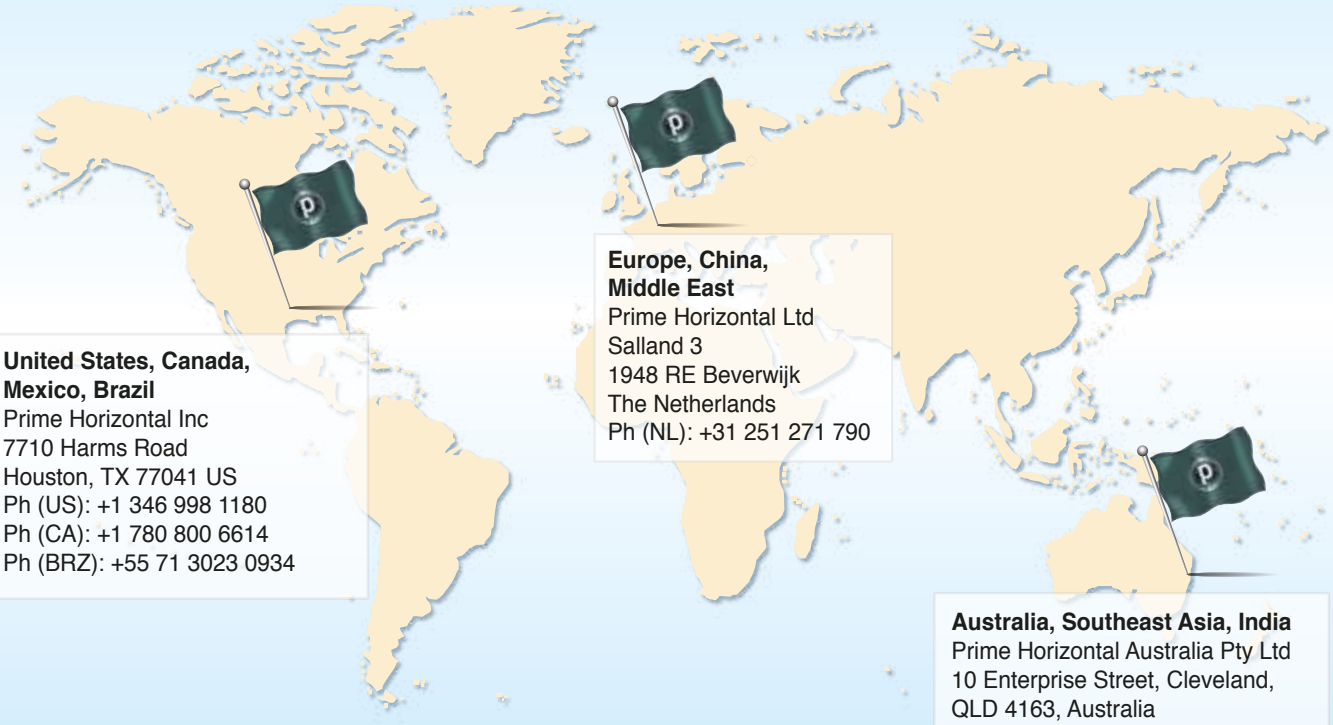
Innovation & Experience

Creating confidence from entry to exit

Prime Horizontal's Global Offices

Prime Horizontal has been a primary driver of advances in the ParaTrack system of magnetic guidance for many new applications and remains the primary user of ParaTrack. As a result, Prime Horizontal is considered one of the foremost authorities on the use of the ParaTrack system in HDD applications.

We would like to continue to be involved with your upcoming projects, so when we can be of assistance please get in touch.



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