<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Crown Block</td>
<td>Measure weight on drill line via cable tension. Load cells: 41, RM.</td>
</tr>
<tr>
<td>B Power Generation Unit</td>
<td>Measure oil, water, and hydraulic fluid pressure. Pressure sensors: FP2000, MLH, IP IS, PK2, PK3, SPT. Emergency shutdown switches for ESD: WOI.</td>
</tr>
<tr>
<td>C Accumulator Unit</td>
<td>Control/monitor operations actively. MICRO SWITCH basic switches: BZ, VT, V15W, SX. MICRO SWITCH toggle switches: TL, NT, TS, TW, ET, AT. Key, rotary, and e-stop switches: custom Limitless™ operator interface: WOI.</td>
</tr>
<tr>
<td>D Drilling Cab</td>
<td>Measure torque, weight/position while guiding pipe into position. Load cells: 41, RM. MICRO SWITCH switches: BX, LSX.</td>
</tr>
<tr>
<td>E Rig Hydraulics Lift</td>
<td>Measure torque while attaching pipe using hydraulic pressure or load measurements. Load cells: 41, RM. Pressure sensors: FP2000, IP IS.</td>
</tr>
<tr>
<td>F Drawworks</td>
<td>Measure torque, load/weight/position while guiding pipe into position. Load cells: 41, RM. MICRO SWITCH switches: BX, LSX.</td>
</tr>
<tr>
<td>G Iron Roughneck</td>
<td>Measure torque/rotating movement to ensure right amount of force is applied. Torque sensors: custom.</td>
</tr>
<tr>
<td>I Top Drive</td>
<td>Measure weight on the drill line via cable tension. Load cells: 41, RM. Pressure sensors: FP2000, IP IS.</td>
</tr>
<tr>
<td>J Mud Return Line</td>
<td>Measure valve position/choke valves. MICRO SWITCH hazardous area switch: CK, VPK.</td>
</tr>
<tr>
<td>K Mud Shaker</td>
<td>Measure drilling mud pressure to monitor and control mud flow. Wing Union sensors: 434, 435, 437.</td>
</tr>
<tr>
<td>L Mud Cleaner</td>
<td>Measure pressure and flow of mud media. Wing Union sensors: 434, 435, 437. On/off or emergency start/stop applications. Limitless™ operator interface: WOI.</td>
</tr>
<tr>
<td>M Mud Pump</td>
<td>Measure direct and indirect loads. Canister load cells: MP8, 3130, 3136, 3127.</td>
</tr>
<tr>
<td>N Fluid Manifold</td>
<td>Monitor ECD pressure via hydraulic volumetric or pressure behind the piston (“pinch offs”). Pressure sensors: A-105, TJE.</td>
</tr>
<tr>
<td>Q Drill Bit</td>
<td>Measure pressure or differential pressure at high temperature and pressure ranges. Pressure sensors: S.</td>
</tr>
</tbody>
</table>
Sensors and Switches in Oil Rig Applications

Pressure Sensors

FP2000 Series
- All-welded stainless steel construction
- Gage, absolute, barometric, vacuum, differential pressure
- Range: 0 to 1000 psi
- Accuracy range of 0.1% or 0.25%
- Intrinsically safe options available

MLH Series
- All metal wetted parts for use in severe fluid applications
- No internal elastomeric seals mean no o-ring compatibility issues
- Range: 50 psi to 8000 psi (inclusion)
- Accuracy: ±0.25% FS FSL
- Rated IP65 or better for protection from harsh environments

IP 5 IS Series
- Rugged, all-welded stainless steel and Hastelloy® wetted parts for durability
- Compatible with a wide variety of media
- Range: 7 bar to 350 bar, 1.1 psi to 50,000 psi
- Accuracy: ±0.15%, ±0.25% FS FSL
- Fully configurable

PK2 and PK3 Series
- Cost effective, highly configurable and highly-durable
- Compatible with a wide variety of harsh media
- Broad compensated temperature range with industry-leading Total Error Band
- Range: 1 bar to 6 bar, 100 MPa to 667 kPa (PK2)
- Range: 1 bar to 46 bar, 115 psi to 667 psi (PK3)
- Accuracy: ±0.25% FS FSL, TE ±2% FS FSL (-40°F to 125°F) (-40°C to 257°F)

597 Series
- Rugged stainless steel in a small size package
- Absolute, gage, sealed gage, vacuum gage
- Range: 0 to 600 psig, 0 to 40 psi;
- Accuracy: ±0.25%
- Reliable semiconductor technology, NEMA 4X design
- Calibrated and temperature compensated

Model TJE
- Rugged, all-welded, stainless steel construction
- Built for applications requiring high accuracy and temperature stability
- Unique “true gage” design hermetically sealed against atmospheric contamination
- Range: 1 psi to 600 psig (pressure), 50 psid to 750 psid (differential)
- Intrinsically safe available

Super TJE Series
- Ultra precision pressure sensors with an accuracy of ±0.05% or better
- Dual gage heads for pressure fitting for easy bulkhead mounting
- Explosion proof

Model 5
- Rugged, high-frequency stainless steel
- Extremely small size, fits into tight spaces
- Range: 10 psig to 15,000 psig
- Operating temperature range: -54°C to 149°C [-65°F to 300°F]
- Accuracy: ±0.05%

Model A-105
- Rugged, utilized stainless steel design with heavy sidewalls
- Thin diaphragm design able to measure low pressures
- High pressure head mount with minimum dead space
- Can be used in corrosive fluid environments
- Range: 10 psig to 15,000 psig
- Operating temperature range: -20°C to 120°C [-4°F to 248°F]
- Accuracy: ±0.1%

Models 434, 435, 437 Wing Union Pressure Sensors
- Rugged design with a UNF 1/4-50 or NACE-compliant inconel 718 wetted parts
- Build to provide durability with abrasive or corrosive media
- Accuracy: ±0.25% FS FSL, Model 437S (high accuracy), or ±0.2% FS FSL (Model 434, 437) standard accuracy
- Wide pressure range 100 to 4377 psi for use with more viscous media
- Compatible with WECD, 1502, 2002, 2002; intrinsically safe option available
- Protective cage option (Model 434A, 437A)

Torque Shafts

Custom Torque Shaft
- Modified design for hard top drive shafts to measure torque
- Strain-gauge the complex large shafts found in top drives
- Calibrating torque levels required on a top drive
- Modify/adapt the calibration rig flanges to the custom flanges on a top drive shaft

Operator Controls

Rotary Switches
- 3- and 6-position options
- May be engineered with lever or knob actuator
- Integral connectors (Mini-con 28D and Sumitomo)
- Environmentally sealed design

e-Stop Switches
- Provides positive contact closure and opening when the switch is operated
- Environmentally sealed design (IP67 sealing)
- UV-resistant knob for outdoor use
- Knob available in variety of colors

MICRO SWITCH Toggle Switches (Sealed and Unsealed), TL, NL, TS, TW, ET, AT Series
- Broad product range meets a variety of electrical and load requirements
- Sealed models built to withstand harsh, wet, dust, dirty, and dirty environments
- 2 or 3 position, momentary and/or maintained action; 1-, 2- or 4-pole circuits
- NWS (integrated wire termination system) for ease of assembly & maintainability

Load Cells

Model 431
- Rugged, low profile pancake style
- All-welded stainless steel with double diaphragm load range: 5 lbs to 5000 lbs; Accuracy ±0.1%
- Low sensitivity to extraneous loads
- Intrinsically safe option available

Model 439
- Rod and in-line tension load cell
- Rugged design with stainless steel, all-welded construction
- Load ranges from 200 lb to 200,000 lb; ±0.22% to ±0.29%
- Low sensitivity to extraneous loads

Model MPB
- High capacity load measurements in a small size load cell
- Rugged stainless steel construction
- Load ranges from 15,000 lbs to 2,000,000 lbs
- Accuracy: ±0.25% full scale

Model 3130
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges of 150,000 lbs to 1,000,000 lbs
- Accuracy: ±0.30% full scale

Model 3156
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges of 25,000 lbs to 150,000 lbs
- Accuracy: ±0.30% full scale

Model 3127
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges up to 2,000,000 lbs
- Accuracy: ±0.30% full scale

MICRO SWITCH Basic Switches

MICRO SWITCH Premium Large Basic Switches, BZ Series
- Available as a world-wide licensed version
- Best suited for high-cost-of-failure applications
- Designed for 100K operations at full load or 10MK for mechanical-life
- Current ratings from 1A to 25A
- UL/CSA, CE, ENEC approvals

MICRO SWITCH Premium V-Basic Switches, V7 Series
- Available as a world-wide licensed version
- Best suited for high-cost-of-failure applications
- Designed for 100K operations at full load or 10MK for mechanical-life
- Current ratings from 0.1A to 25A
- UL/CSA, ENEC approvals

MICRO SWITCH Watertight Miniature Switches, V15S Series
- Miniature-sized switch designed for harsh-duty, wash down areas
- Rugged, highly accurate machine control for turning circuits on and off
- Compact, lightweight, and aesthetically
- UL, cUL, ENEC, CQC approvals

MICRO SWITCH Limit Switches

MICRO SWITCH Hazardous Area Switches, BX and LSX Series
- Extremely resistant to extraneous indoor or outdoor locations
- Superior reliability and repeatability
- Explosion-proof design with flame path to contain and cost escaping hot gases
- O-ring seals render switches weather-proof, water-tight, dust-tight
- UL, CSA (BX, LSX Series) ATEX, IECX, NEPSI, European approvals (BX Series)

MICRO SWITCH Hazardous Area Switches, CX Series
- Hazardous atmosphere output options
- Built to withstand harsh conditions
- Superior reliability and repeatability
- Rugged, not in-circuit to withstand back-of-circuit, counter-clockwise, or both-way operation
- IP66, NEMA 4, 4X, 6, 6P, 13 sealing
- UL, CSA, ATEX, IECX approvals

MICRO SWITCH Hazardous Area Valve Position Indicator, VPX Series
- Certified for ATEX, IECX, CE, and CUS specifications for global applications
- Fire-proof aluminum housing and various sealing (NEMA 4X, 6, 6P, 13)
- Versions available in both snap-action switches and intrinsically safe inductive proximity switches
- Versions of the VPX with proximity switches carry an Intrinsically Safe (IS) rating

MICRO SWITCH Hazardous Area Switches, EX Series
- Designed for hazardous indoor or outdoor locations
- Superior reliability and repeatability
- Smallest UL-listed housings available for use in hazardous locations
- O-ring seals render switches weather-proof, water-tight, dust-tight
- UL, CSA, ATEX, IECX approvals

MICRO SWITCH Heavy-Duty Limit Switches, HDLS Series
- Three series offer rugged, die-cast body and epoxy coating
- Board-soldered head design for use during body-to-body retention
- Multiple mounting and actuator options
- UL, CSA, CE, CCC approvals

Limitless™ Wireless Solutions

Limitless™ Wireless Operator Interface, WDI Series
- Enables operator indication from locations where wiring is too costly or not possible
- Flexible operator type options (push button, rotary or key switch, etc.)
- Reduces installation/maintenance costs with no wires, conduit, connectors, etc.
- Eliminates issues with wire connection integrity on moving equipment

Limitless™ Wireless Non-Contact Switches, WLS Series
- MICRO SWITCH HDLS heritage combined with the latest wireless technology
- Enables precision sensing detection where wiring is an issue or not feasible
- Reduces installation/maintenance costs due to no wires, conduit, connectors, etc.
- Eliminates wire connection integrity issues on moving equipment

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