

## Electrical Feedthrough System (EFS) for Horizontal Subsea Wellhead Completions

Teledyne D.G.O'Brien offers an advanced, high-reliability subsea wellhead single-channel electrical feedthrough system for use in intelligent completions with permanent downhole instrumentation. The connection system is designed for long-term reliability in demanding subsea and downhole environments with sour well (H2S) conditions, as well as with aggressive production and packer fluids.

Teledyne D.G.O'Brien has completed extensive system, component and material qualifications, and continues to analyze failure modes and effects (FMEA). Our goal is not to simply qualify a design, but to determine its limits and set them ever higher as demands continue to rise. (Refer to the Summary of Testing below for more detail.)

One of the key technologies that distinguishes DGO from our competition is glass-to-metal sealing. Our integral glass-ceramic seal barriers withstand continuous, extreme high pressure, high temperature exposure in excess of 22,500 psig (155 MPa) and 400 F (204 C). These glass seal barriers provide burst pressures exceeding 40,000 psig (276 MPa). The inorganic materials used provide an inherently stable structure that exhibits no degradation attributed to continuous HPHT exposure in aggressive media.

Teledyne D.G.O'Brien provides support services in line with the level of our technology. Call or write for details about product support, training, field service and custom designs.

### Key Features:

- Underwater, wetmateable connections
- Glass-to-metal seal pressure barriers
- Pressure compensated system
- Modular design to suit varying installation envelopes
- Interchangeable with hydraulic couplers
- Standard Ø1/4" (6.35mm) DHG Control Line interface
- Simple, quick, secure, reliable Downhole Gauge connector rig terminations

- Dual barrier philosophy throughout:
  - Primary metal seals
  - Secondary elastomer seals
  - Rig-testable interface seals
- API 6A, 16D & 17D compliant
  - HH Material class (sour service)
  - Exceeds U Temperature class
  - Product Specification Level 3 – PSL 3
  - Performance Requirement Level 2 – PR2
- NACE MR0175 compliant

### Specifications:

#### Environmental

Pressure, rating	15,000psig/103MPa
Pressure, test	17,500psig/121MPa
Temperature, rating	0°F to 302°F
	-18°C to 150°C
Storage temperature	0°F to 120°F
	-18°C to 49°C
Deployment depth	10,000ft/3000m
Mating durability	100 cycles min.
Service life	25 years

#### Mechanical (maximums)

Axial misalignment	±.062" (±1.57mm)
Angular misalignment	±0.5°
Radial misalignment	±.03" (.76mm)
Actuation speed	5in/sec (12.5mm/sec)

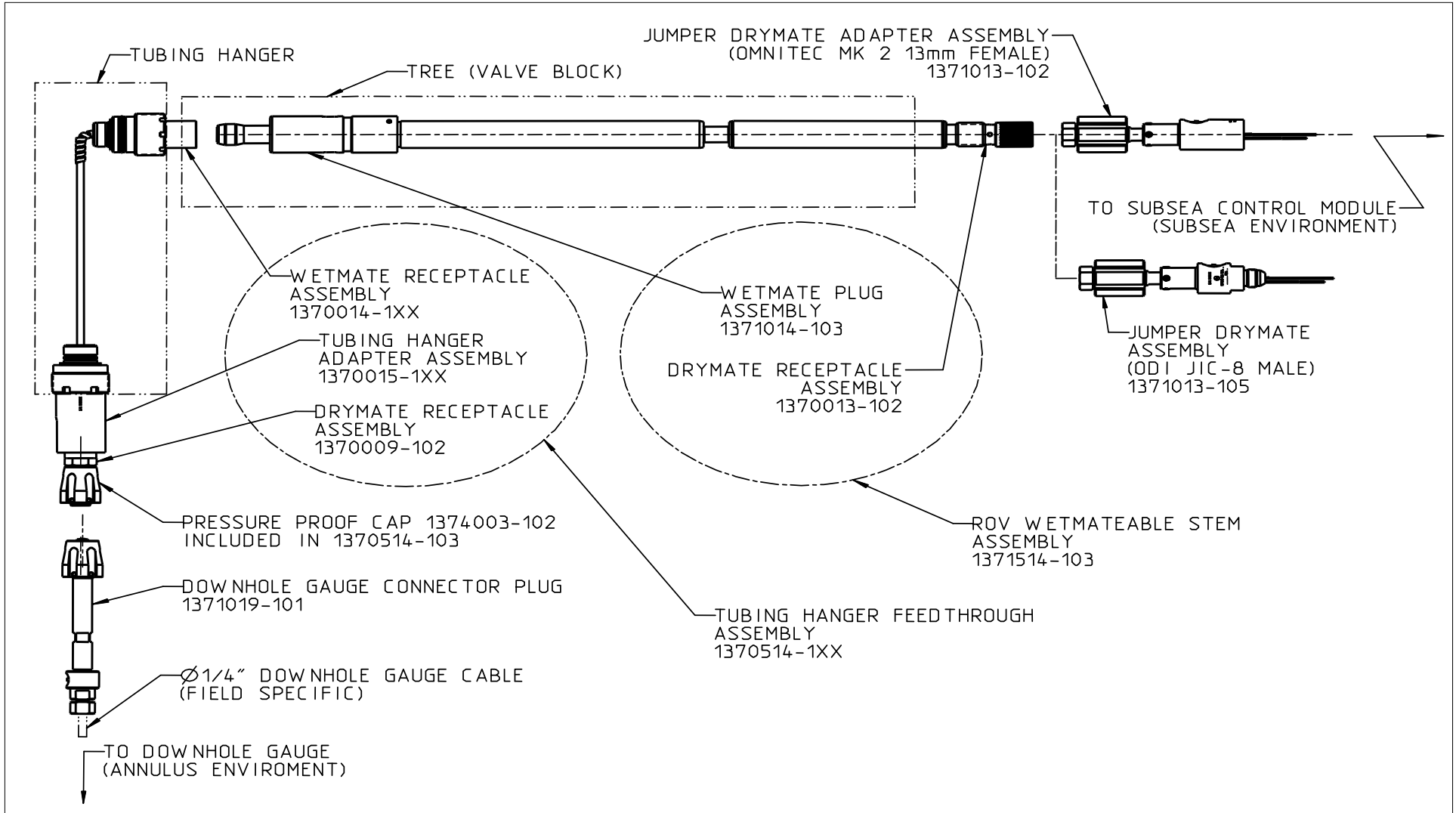
#### Electrical

Number of circuits	one
Voltage rating, working	600 VDC
Voltage, test	2400 VDC
Current rating, working	2.0 A
Insulation resistance	> 1GΩ 1kVDC (20°C)
Contact resistance	< 30mΩ
Shell resistance	< 10mΩ

#### Materials

Load bearing	Inconel 718 (UNS N07718)
	<i>alternate materials are readily accommodated</i>
Metal seals	Inconel 718, Ag-plated
Dielectric insulators	PEEK
Elastomers	FKM and HNBR
Electrical contacts	Au-plated BeCu

### System Configuration – Horizontal Tree Electrical Feedthrough System



Summary of Electrical Feedthrough System Qualification Testing	
Function	Test Type
Electrical	<p><b>Contact resistance</b> &lt; 30mΩ at 2A (per contact pair)</p> <p><b>Shell continuity</b></p> <p><b>Insulation resistance</b> &gt; 1GΩ at 1000VDC (system)</p> <p><b>Proof voltage (DWV)</b> - 2400VDC</p>
Mechanical	<p><b>Pressure testing</b> - Internal: 17,500psig - External: 7,500psig</p> <p><b>Helium leak test</b> &lt; 1 x 10<sup>-6</sup> cc/sec</p> <p><b>Maximum misalignment mating test</b> - ±.030" radial, ±.062" axial (longitudinal), ±0.5° angular</p>
Turbid mating cycling	<b>Wetmating test</b> > 100 mating cycles at 5,000psig in simulated silty seawater (2 to 500µm particle size) at 36°±3°F (2°±2°C).
Flooded connector capability	<b>Flooded connector cable termination test</b> - primary barrier failure, exposed to 10,000psig and 250°F for 7-day period (continuous).
Environmental stress tests	<p><b>Thermal shock:</b> 3 cycles from 160° to 36°F (immersion), followed by 3 cycles from -20° to 36°F (immersion).</p> <p><b>Mechanical shock:</b> 11ms half-sine period at 30g; 3 shocks in 2 orthogonal axes.</p> <p><b>Vibration:</b> 5 to 150 to 5Hz double sweep, 5 to 25 ±2mm displacement, 25 to 150Hz at 5g.</p> <p><b>API 6A, Appendix F PR2 cyclic testing:</b> Mated system functional test exposed to 3 cycles including 0 to 15,000psig cycling combined with 0 to 302°F cycling.</p>
Material compatibility	<b>Wetmate cycles</b> - immersed in control fluid (Transaqua HT), glycol, ethanol, methanol, MEG, xylene, kerosene, corrosion inhibitor.

Summary of Minimum Factory Acceptance Test Requirements	
Function	Test Type
Electrical	<p>Insulation resistance &gt; 1GΩ at 500VDC (system) &gt; 10GΩ at 500VDC (component)</p> <p>Proof voltage (DWV) - 2400VDC (component &amp; system)</p>
Mechanical	<p>Pressure testing -</p> <p>Glass sealed subassemblies:</p> <ul style="list-style-type: none"> <li>- Internal: 17,500psig x 5 cycles x 5 minutes</li> <li>- External: 7,500psig x 5 cycles x 5 minutes</li> </ul> <p>Top level assemblies: 15,000psig x 5 cycles x 5 minutes</p> <p>Helium leak test &lt; 1 x 10<sup>-6</sup> cm<sup>3</sup>/sec (<i>glass seals always &lt; 1 x 10<sup>-8</sup> cm<sup>3</sup>/sec</i>)</p>
Quality conformance	<p>Tolerance checks</p> <p>Interface checks</p> <p>Verification of marking</p> <p>Quality assurance checklists</p> <p>Packaging and preservation</p>

## Logistical Support:

Successful wellhead feedthrough system operation depends on proper termination and installation. Teledyne D.G.O'Brien, Inc. offers factory training and certification of customer field service technicians to support this requirement. In addition, DGO can provide comprehensive world-wide service capability with a fully-trained DGO field integration team to support product installation both onshore and offshore. We have extensive field service history in the GOM, North Sea (UK & NCS), West Africa and Brazil. All the necessary tools, test equipment and spare parts are utilized by experienced, highly trained field technicians.

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## System Part Numbers:

10k EH5 Stem Assembly	1371514-103
10k Tubing Hanger Feedthrough Assembly <i>(P/N dependant on Tubing Hanger length)</i>	1370514-10X
15k EH5 Stem Assembly	1371516-101
15k Tubing Hanger Feedthrough Assembly	1370516-101
Downhole Gauge Plug Kit	1371019-101
Subsea Jumper Plug Kit <i>(P/N dependant on hose system used)</i>	1371013-10X
Onshore Installation Logistical Support: Installation Procedure IM-1099-4 with QC Installation Certificate	
Installation Tool Kit	1379002-101
Installation Spares Kit	1379002-201
Offshore Installation Logistical Support: Installation Procedure IM-1099-5 with QC Installation Certificate	
Installation Tool Kit	1379007-101
Installation Spares Kit	1379007-201
Test Connector Kit	1379006-101
Pressure Test Kit	913-512-101

Comprehensive customer training available

24-hour technical support

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