GE Grid Solutions

Kelman TRANSFIX™-family Installation Manual

Transformer Oil
Dissolved Gas and Moisture Monitor
Contents

1 Introduction ................................................................................................................... 5
  1.1 Product Overview ..................................................................................................... 5
  1.2 Manual Scope .......................................................................................................... 6
2 Safety ............................................................................................................................ 7
  2.1 Symbols .................................................................................................................... 7
  2.2 Warnings .................................................................................................................. 7
3 Requirements ................................................................................................................ 9
  3.1 Pre-installation ........................................................................................................ 9
  3.2 Handling & Storage ................................................................................................. 9
4 Technical Specification ............................................................................................... 10
5 Compliance ................................................................................................................... 11
6 Transformer Criteria ..................................................................................................... 12
7 Mounting ...................................................................................................................... 13
8 Plumbing ...................................................................................................................... 15
  8.1 Transformer Valves ................................................................................................. 16
    8.1.1 Fill Valve ........................................................................................................... 16
    8.1.2 Drain Valve ...................................................................................................... 16
    8.1.3 Ancillary Valves .............................................................................................. 16
    8.1.4 Cooling Loop Valves ...................................................................................... 17
  8.2 Supply & Return Valves ........................................................................................... 17
    8.2.1 Oil Supply ....................................................................................................... 17
    8.2.2 Oil Return ....................................................................................................... 18
  8.3 Tubing ...................................................................................................................... 18
    8.3.1 Fitting Requirements ...................................................................................... 20
    8.3.2 Fitting Instructions .......................................................................................... 22
    8.3.3 Connection to Oil Supply Valve ..................................................................... 22
    8.3.4 Connection to Oil Return Valve ..................................................................... 23
9 Power ........................................................................................................................... 26
  9.1 Connections ............................................................................................................ 26
  9.2 Cold Start ................................................................................................................ 28
  9.3 Battery ..................................................................................................................... 28
10 Electronics ................................................................................................................ 30
  10.1 System Board ........................................................................................................ 30

Warnings ......................................................................................................................... 17

Symbols .............................................................................................................................. 7

Manual Scope .................................................................................................................... 7

Installation .......................................................................................................................... 7

Connection to Oil Return Valve ........................................................................................ 17

Connection to Oil Supply Valve ....................................................................................... 17

Fitting Requirements ....................................................................................................... 18

Fill Valve .......................................................................................................................... 16

Drain Valve ...................................................................................................................... 16

Ancillary Valves ................................................................................................................ 16

Cooling Loop Valves ....................................................................................................... 17

Oil Supply ......................................................................................................................... 17

Oil Return ......................................................................................................................... 18

Tubing ............................................................................................................................... 18

Connection to Oil Supply Valve ....................................................................................... 22

Connection to Oil Return Valve ....................................................................................... 23

Fitting Instructions .......................................................................................................... 22

System Board .................................................................................................................. 30
10.2 Alarm Connections ........................................................................................................... 30
10.3 Accessory Power ............................................................................................................. 31
10.4 External Sensors ............................................................................................................ 31
11 Communications .............................................................................................................. 32
11.1 Electromagnetic Compatibility (EMC) requirements .................................................... 33
Appendix A Installation Tools and Supplies ........................................................................... 34
Appendix B Customer Checklist ............................................................................................ 35
Appendix C Installation Record ............................................................................................... 36
Appendix D Tubing Specification and Ordering Details ......................................................... 40
Appendix E Dielectric fittings ............................................................................................... 43
Appendix F Product Dimensions ........................................................................................... 45
Appendix G Mounting Stand Dimensions ............................................................................. 48
Appendix H Footprint Dimensions ....................................................................................... 50
Appendix I System Board ...................................................................................................... 51
Appendix J Heat Trace Cable ................................................................................................. 54
Contact & Copyright Details ................................................................................................. 55

**Table of Figures**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8—1</td>
<td>Schematic representation of an installation</td>
<td>15</td>
</tr>
<tr>
<td>8—2</td>
<td>Examples of possible line configurations (three of many)</td>
<td>15</td>
</tr>
<tr>
<td>8—3</td>
<td>Transformer Valve locations</td>
<td>16</td>
</tr>
<tr>
<td>8—4</td>
<td>TRANSFIX 1.6 connections - bottom view</td>
<td>20</td>
</tr>
<tr>
<td>8—5</td>
<td>MULTITRANS connections - bottom view</td>
<td>21</td>
</tr>
<tr>
<td>8—6</td>
<td>TAPTRANS connections - bottom view</td>
<td>21</td>
</tr>
<tr>
<td>8—7</td>
<td>Fitting body and tubing</td>
<td>22</td>
</tr>
<tr>
<td>8—8</td>
<td>Nut at 6 o'clock position</td>
<td>22</td>
</tr>
<tr>
<td>8—9</td>
<td>Nut at 9 o'clock position</td>
<td>22</td>
</tr>
<tr>
<td>8—10</td>
<td>Bleed assembly on flange-type oil return valve</td>
<td>23</td>
</tr>
<tr>
<td>8—11</td>
<td>Flange example</td>
<td>24</td>
</tr>
<tr>
<td>8—12</td>
<td>Return Assembly kit</td>
<td>24</td>
</tr>
<tr>
<td>8—13</td>
<td>Bleed assembly on threaded-type oil return valve</td>
<td>25</td>
</tr>
<tr>
<td>9—1</td>
<td>Location of mains supply</td>
<td>27</td>
</tr>
<tr>
<td>9—2</td>
<td>Protective cover</td>
<td>27</td>
</tr>
<tr>
<td>9—3</td>
<td>Earth terminal on bottom of enclosure</td>
<td>28</td>
</tr>
<tr>
<td>9—4</td>
<td>Voltage selector switch</td>
<td>28</td>
</tr>
<tr>
<td>9—5</td>
<td>Coin cell battery</td>
<td>29</td>
</tr>
<tr>
<td>10—1</td>
<td>Accessory power points for 12 V and 24 V</td>
<td>31</td>
</tr>
<tr>
<td>11—1</td>
<td>Ferrite placement on RS-485</td>
<td>33</td>
</tr>
</tbody>
</table>
Figure F—1: TRANSFIX 1.6 dimensions .................................................................................. 45
Figure F—2: TAPTRANS dimensions .................................................................................. 46
Figure F—3: MULTITRANS dimensions ............................................................................... 47
Figure G—1: TRANSFIX 1.6 & MULTITRANS mounting stand dimensions – top, front & side ........................................................................... 48
Figure G—2: TAPTRANS mounting stand dimensions – top, front & side ......................... 49
Figure H—1: TRANSFIX 1.6 & MULTITRANS footprint dimensions .................................. 50
Figure H—2: TAPTRANS footprint dimensions .................................................................. 50
Figure I—1: System board ................................................................................................... 51
Figure I—2: RS-232 & RS-485 connections ....................................................................... 53

List of Tables

Table 4—1: Technical specification ...................................................................................... 10
Table 5—1: Type tests ........................................................................................................ 11
Table 11—1: Product communications channels .................................................................. 32
Table I—1: List of terminals ................................................................................................ 52
1 INTRODUCTION

1.1 Product Overview

The TRANSFIX™ family of products (herein referred to as the product, meaning the TRANSFIX 1.6, MULTITRANS and TAPTRANS) are on-line DGA (Dissolved Gas Analysis) systems for transformer diagnostics. The products measure the following key fault gases in the transformer oil: hydrogen, methane, ethane, ethylene, carbon monoxide, carbon dioxide and acetylene. In addition they also measure oxygen, nitrogen as well as moisture in the oil and the transformer load current. Such data provides insight on transformer condition criteria, such as developing faults, paper degradation and electrical arcing. Once installed, operation is straightforward. All results are stored within the product, but can be downloaded to a PC for analysis.

In addition, the MULTITRANS has the facility to measure oil from three separate oil tanks, for example, three transformer tanks operating in a single phase bank. The TAPTRANS has the facility to measure oil from the transformer main tank and on-load tap changer (OLTC), including both the separate diverter tank and selector tank where one exists.

The key features and characteristics are summarised as follows:

- Utilises dynamic headspace sampling to extract target gases from the oil sample.
- No consumables, such as carrier gases are required.
- Accurate results are available as often as once per hour.
- Minimal maintenance.
- Uses highly accurate and stable Photo-acoustic Spectrographic technology.
- Fully embedded microprocessor with non-volatile internal memory storage for 10,000 records.
- Stainless steel outdoor-rated IP55 enclosure connected to the transformer by robust stainless steel tubing.
- All gas sensing is carried out internally – no external gas sensors.
- Transformer load tracking is available.
- Six user-configurable relay contacts based on absolute gas and moisture values.
- Two user-configurable sunlight-visible LED arrays on the exterior of the enclosure – one red for alarm, one yellow for caution.
- Two standard sunlight-visible LED arrays – green for power, blue for service.
- Communication options include: Ethernet, RS-232, Cellular modem (GSM/GPRS), PSTN modem, RS-485 and Fibre Optic. Other options may be available on request.
- Internal USB connection provided for commissioning and service, or local data download.
1.2 Manual Scope

This manual details the installation requirements and procedure, including important pre-installation tasks to be considered when planning and preparing for the installation. It examines mounting, plumbing, power, electronics and communications — including tools, supplies and items to purchase. Differences between the products are always qualified by the use of the respective product name and operational details can be found in the respective product user guides. This manual must be read in its entirety prior to installation so as to prepare the site and obtain the necessary equipment. Refer to the appendices for details and record site details in the Installation Record (see Appendix C).
2 SAFETY

2.1 Symbols

General Warning or Caution. Refer to the Installation Manual / User Guide to prevent injury or damage to equipment.

Electrical Hazard. Risk of electric shock.

Primary Protective Earth connection.

Hot surfaces may be present.

2.2 Warnings

⚠️ The minimum ambient temperature for installation and service activities is −10 °C.

⚠️ If the equipment is installed or used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

⚠️ If working at height, third parties must have received appropriate training for working at height prior to work commencing. This includes, but is not limited to “Working at height training”.

⚠️ If working at a height greater than 4 feet or at a height greater than that stipulated by national or site regulatory requirements, it is the responsibility of the installer to ensure that planned work complies with those requirements.

⚠️ The installer shall also ensure that any third-party equipment, such as an approved platform, scaffold or lift is suitable and safe before commencing work. Ladders or improvised platforms do not meet GE service engineer requirements.

⚡ Once installed, the product may have more than one source of supply. Disconnect all supplies at their source before accessing the cabinet for servicing. Follow the site lockout-tagout (LOTO) procedure.
Only GE-trained and certified personnel may commission GE products. Commissioning tasks include making any connections and/or performing any work within the enclosure, or performing tasks such as purging the oil circuit between the transformer and the product, and/or all first start-up procedures relating to equipment or firmware/software.
3 REQUIREMENTS

3.1 Pre-installation

Ensure that the mains selection switch in the product is set to the relevant voltage range. The product can be safely connected to an energised or non-energised transformer. However, if installation personnel are required to work in an energised environment they must be made aware of this prior to work commencing and must observe all health and safety practices, especially when working with conductive materials such as stainless steel installation tubing. If either of the oil supply or return valves to be utilised brings personnel within restricted approach boundaries then the transformer must be de-energised and isolated before such work is performed.

To ensure success, careful planning and proper execution of the tasks outlined in this manual are essential. In addition, the GE Customer Service Centre representative will need specific information in order to provide recommendations for a trouble-free installation. If GE is to perform the installation, the installation will not be scheduled until all pre-installation tasks outlined in this manual are complete (as performed by the customer and GE).

The appendices to this manual contain additional information, such as drawings, forms and checklists that need to be reviewed and completed prior to the installation. This relates to materials and facilities that need to be ordered, acquired and in place well in advance of the scheduled installation date. Confirmation of this needs to reach GE as soon as possible, at a minimum four weeks prior to the installation date, unless prior arrangements have been made with the installation group. This aids in planning and supporting the installation thereby ensuring a trouble-free commissioning process.

3.2 Handling & Storage

For short-term storage (defined as less than one week), it is acceptable to store the products in the open air, provided that they are protected from wet weather and direct sunlight by a suitable customer-supplied waterproof covering and also provided that the outside temperature does not exceed 45 °C or fall below 0 °C. For storage periods exceeding one week, customers are requested to store the product in a fully enclosed building that is free from damp and extremes in ambient temperature (defined as above 30 °C or below 2 °C).

Note: TAPTRANS packages do not include a mounting stand top section, so are unsuitable for stacking.

Note: Customers are fully responsible for ensuring that stacked pallets are stable and, if necessary, providing additional external support. Damage incurred as a result of poor customer handling or storage will not be covered under the GE warranty.
4 TECHNICAL SPECIFICATION

The product meets the following technical specification as listed in Table 4—1.

Table 4—1: Technical specification

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE/MEETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAS MEASURED</td>
<td>MEASUREMENT RANGE (ppm) and accuracy</td>
</tr>
<tr>
<td>Hydrogen (H₂)</td>
<td>5 – 5,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>2 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Ethane (C₂H₆)</td>
<td>2 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Ethylene (C₂H₄)</td>
<td>2 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Acetylene (C₂H₂)</td>
<td>0.5 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>2 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>20 – 50,000 Accuracy ± 5% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>100 – 50,000 Accuracy ± 10% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>10,000 – 100,000 ppm Accuracy ± 15% or ± LDL (whichever is greater) *1</td>
</tr>
<tr>
<td>Moisture (H₂O)</td>
<td>0 – 100% RS (given in ppm)</td>
</tr>
<tr>
<td>ENVIRONMENTAL</td>
<td></td>
</tr>
<tr>
<td>External temperature range</td>
<td>−40 °C to 55 °C</td>
</tr>
<tr>
<td>Oil temperature range</td>
<td>−20 °C to 120 °C</td>
</tr>
<tr>
<td>Altitude</td>
<td>Up to 2000 m</td>
</tr>
<tr>
<td>Atmospheric pressure</td>
<td>Up to 1050 mbar</td>
</tr>
<tr>
<td>Operating humidity</td>
<td>10 – 95% RH non-condensing</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IP55</td>
</tr>
<tr>
<td>Weight</td>
<td>72 kg (159 lb) TRANSFIX 1.6</td>
</tr>
<tr>
<td></td>
<td>88 kg (194 lb) TAPTRANS</td>
</tr>
<tr>
<td></td>
<td>76.5 kg (169 lb) MULTITRANS</td>
</tr>
<tr>
<td>POWER REQUIREMENTS</td>
<td>110 / 230 V AC *3 (factory set), 50/60 Hz, 8 A Max</td>
</tr>
<tr>
<td>Single phase Alarm Relays: NO and NC provided</td>
<td>3 A 250 V AC, 150 mA 300 V DC*4, 200 mA 125 V DC, 3 A 30 V DC</td>
</tr>
<tr>
<td>Fuses *5</td>
<td>10 A 500 V (Cooper Bussmann BAF), 10×38 mm</td>
</tr>
<tr>
<td>MEASUREMENT FREQUENCY</td>
<td>Variable – Once per hour to once every 4 weeks</td>
</tr>
</tbody>
</table>

*1 Note: Accuracy quoted is the accuracy of detectors during calibration; gas-in-oil measurement accuracy may also be affected by sampling and/or oil type.

*2 Note: Based on testing carried out using VOLTESSO™ 35 mineral oil over a ¼ in. pipe run of 10 metres or less from oil supply or return valve to product connection point, and on transformer oil supply valve volumes of 200ml or less. For oil temperatures colder than −20 °C, GE recommends the use of heat trace cabling on piping.

*3 Note: Voltage ranges:

<table>
<thead>
<tr>
<th>Set Voltage (V AC)</th>
<th>Minimum I/P Voltage (V AC)</th>
<th>Maximum I/P Voltage (V AC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>100</td>
<td>121</td>
</tr>
<tr>
<td>230</td>
<td>207</td>
<td>253</td>
</tr>
</tbody>
</table>

*4 Note: Maximum DC breaking capacity for a resistive load.

*5 Note: Use only the approved and recommended fuse to ensure continued fire protection and compliance.
## 5 COMPLIANCE

The product meets the following type tests as listed in Table 5—1:

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard</th>
<th>Class/Level</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMC Emissions – EN 61326-1:2006</strong></td>
<td>CISPR 11</td>
<td>A</td>
<td>Radiated &amp; Conducted Emissions</td>
</tr>
<tr>
<td></td>
<td>FCC Part 15</td>
<td>A</td>
<td>Radiated &amp; Conducted Emissions</td>
</tr>
<tr>
<td></td>
<td>EN 61000-3-2</td>
<td>A</td>
<td>Harmonic Current Emissions Limits</td>
</tr>
<tr>
<td><strong>EMC Immunity – EN 61326-1:2006</strong></td>
<td>EN 61000-4-2</td>
<td>IV</td>
<td>Electrostatic Discharge</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-3</td>
<td>III</td>
<td>Electromagnetic Field Immunity</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-4</td>
<td>III</td>
<td>Electrical Fast Transients</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-5</td>
<td>III</td>
<td>Surge Immunity</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-6</td>
<td>III</td>
<td>Conducted RF Immunity</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-8</td>
<td>IV &amp; V</td>
<td>Magnetic Field Immunity</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-9</td>
<td>X</td>
<td>Pulsed Magnetic Field Immunity</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-10</td>
<td>X</td>
<td>Damped Oscillatory Magnetic Field Immunity</td>
</tr>
<tr>
<td></td>
<td>EN 61000-4-11</td>
<td>III</td>
<td>Voltage Dips &amp; Interruptions</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-12</td>
<td>X 2.5 kV &amp; 1kV</td>
<td>Oscillatory Wave</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-18</td>
<td>X</td>
<td>Damped Oscillatory Wave</td>
</tr>
<tr>
<td></td>
<td>EN 61000-3-3</td>
<td>Pst 10 min, Plt 120 min</td>
<td>Voltage fluctuations &amp; flicker</td>
</tr>
<tr>
<td></td>
<td>EN 60255-5</td>
<td>5 kV, 2 kV &amp; 500 V DC</td>
<td>Impulse, Dielectric &amp; Insulation resistance testing</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>IEC 60068-2-1</td>
<td>−40 °C</td>
<td>Cold</td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-2</td>
<td>55 °C</td>
<td>Dry Heat</td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-6</td>
<td>10 – 150 Hz, 0.5 g operation 10 – 150 Hz, 0.5 g endurance</td>
<td>Vibration</td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-30</td>
<td>55 °C, 95% RH</td>
<td>Damp Heat</td>
</tr>
<tr>
<td></td>
<td>EN 60529</td>
<td>IP55</td>
<td>Degree of Protection</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>IEC 61010-1</td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>EN 61010-1</td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>UL 61010-1</td>
<td></td>
<td>2012</td>
</tr>
</tbody>
</table>
6 TRANSFORMER CRITERIA

The transformer shall meet the following criteria:

- The transformer contains mineral type oils (paraffinic or naphthenic) that meet the requirements of IEC 60296, BS EN 60296, VDE 0370 or ASTM D 3487.
- The transformer oil must be certified PCB free.
- The temperature of the oil at the outlet valve of the transformer should not fall below –20 °C nor exceed 120 °C.
- The transformer oil is at atmospheric pressure or above (see points below).
- There are separate supply and return valves available for connection.
- The condition of the transformer supply and return valves must allow a secure long-term connection to the product. The valve size should measure at least 15 mm (½ in.) in diameter.
- The ambient temperature in the area where the product resides should not fall below –40 °C nor exceed 55 °C.

⚠️ If the transformer is nitrogen blanketed, check the pressure/vacuum gauge. If the pressure is positive, then the product can be installed. If the pressure is negative, a vacuum exists within the transformer. Air will be drawn into the transformer when a valve is opened. Air bubbles could be damaging to the transformer if the transformer is energised.

⚠️ **Do not** install the product on an energised transformer that is under vacuum.

⚠️ Dielectric fittings are a safety measure to prevent circulating currents from flowing in the tubing circuits whenever a transformer is not grounded to the same point as the monitoring product. Customers should consult with their local tubing supplier to source suitable dielectric fittings if required.
7 MOUNTING

Depending on requirements and the installation environment, the product can be mounted on a separate standalone mounting stand (recommended) or direct mounted to the body of a transformer. When considering where and how to mount the product, observe the following points to ensure an appropriate mounting configuration:

⚠️ The location for the product shall allow easy access to the transformer oil supply and return valves, so that tubing runs can be kept to a minimum, particularly in case of extreme temperature. The supply and return tubing runs between each transformer valve and the product connection point should not exceed 30 m (98 ft) in length, or 60 m (196 ft) in total length for the complete oil circuit. Note: This avoids putting stress on the internal pump and also reduces the possibility of oil cavitation.

⚠️ If the recommended GE mounting stand is not purchased, a structurally sound weather-resistant mounting that supports the 80 kg (177 lb) of the TRANSFIX 1.6 / MULTITRANS, or the 90 kg (199 lb) of the TAPTRANS must be available (see Appendix G for dimensions). It must also be designed to be securely fastened to a flat mounting surface. Additional reinforcement and/or dampening may be necessary if local conditions (environmental or otherwise) could expose the product to potential external forces or vibration.

⚠️ The product must be mounted on a flat surface within 5 degrees of plumb and level on both axes, which is capable of supporting the combined weight of the product and its mounting stand. (See Appendix G and Appendix H.)

⚠️ If a new concrete pad is required, GE recommends that it be at least 61 cm (24 in.) wide by 122 cm (48 in.) long and 9 cm (3 ½ in.) thick with a #3 (10 mm) steel reinforcing bar around the perimeter. (Earth bonded as per local or site practice and code.)

⚠️ The product must not be mounted where it could interfere with the regular maintenance of the transformer.

⚠️ The product must not be mounted where it could interfere with the airflow of the transformer’s cooling system.

⚠️ At least 100 cm (3.3 ft) must be kept clear of the Peltier cooler. The airflow to the vent areas on the bottom and sides of the product must not be blocked or restricted in any way. See Appendix Figure F—1.

⚠️ At least 75 cm (2.5 ft) must be kept clear directly in front of the product. The front door of the product opens for access during installation, maintenance and operation.

⚠️ It is acceptable to mount the product to the body of a transformer, which is exhibiting normal operational levels of vibration, provided that
- care is taken to ensure a level and secure mounting configuration;
- the product is mounted within 5 degrees of plumb and level on both axes;
- the product is mounted in such a way as to support the total weight of the product;
- the product is mounted to an area of the tank body with minimum vibration, such as close to a corner or the stiffeners;
- guidance on inlet and outlet oil supply lengths and configuration is followed.

If mounting to the body of a transformer, GE's recommendation is to do so with the top half of the GE-supplied mounting stand. If there is concern about extreme vibration on a transformer, GE strongly advises against mounting the product to the body of a transformer. Furthermore, should damage occur to the product that is attributable to the mounting arrangement and/or excessive transformer vibration, such damage will not be covered under warranty. Care should be taken at all times to ensure that damage does not occur to the transformer or the product during installation.

⚠️ The chosen location should take account of the potential requirement for testing an onsite water deluge system (if applicable), such that the product is not located in the direct line of water jets. While the product provides IP55-level water spray protection, a water deluge system could exceed IP55 thresholds depending on the location, pressure and direction of the water jets. See the relevant product User Guide for further recommendations around testing a water deluge system.
8 PLUMBING

The product removes oil from the transformer, extracts the gases, analyses the gases and then returns the oil to the transformer. The locations from which the oil is removed and to which it is returned are important for the accurate analysis of the gases (see Figure 8–1 and Figure 8–2).

Figure 8–1: Schematic representation of an installation

The oil is removed from one valve of the transformer (the supply valve) and returned via another (the return valve). The location of the supply valve should produce an oil sample that is a well-mixed representation of the transformer oil. The following pages contain points to consider when choosing where to connect the oil circuit from the transformer to the product.

Figure 8–2: Examples of possible line configurations (three of many)
8.1 Transformer Valves

The possible valve locations of a transformer are shown in Figure 8—3.

8.1.1 Fill Valve

If the transformer is nitrogen blanketed, the fill valve or any other valve at the top of the transformer should not be used as an oil supply valve because there is no guarantee that there will always be oil at this position. However, it is acceptable to return oil through this valve.

8.1.2 Drain Valve

The drain valve may be used as an oil supply or oil return valve. However, it is particularly useful to return the oil to the transformer through this valve because it is near ground level, providing an easily accessible point to bleed the air from the oil lines during the installation.

8.1.3 Ancillary Valves

Some transformers have an array of ancillary valves and ports. These valves can be a good choice to connect the product to the transformer, although it is important to know how these valves route inside the transformer.
Ensure that the valve chosen to return oil is not internally piped to another location within the transformer, such as the headspace or the internal windings.

8.1.4 Cooling Loop Valves

The product should only be supplied with oil from a cooling loop valve if there are no other valves available. Note: If oil has to be taken from an oil-forced cooling loop, the oil supply valve must be located on the high pressure side of the oil pump.

Do not return oil to the cooling loop unless it is absolutely clear that the cooling is not directed flow and that there are no other alternative valves in which to connect the product.

8.2 Supply & Return Valves

All transformers have different valve configurations. The transformer supply and return valves should be assessed for durability to ensure that a reliable connection can be made. The valve size should measure at least 15 mm (½ in.) in diameter. These valves will need to be adapted to ¼ in. female NPT fittings to properly fit the ¼ in. NPT male fittings on the product. When choosing how to prepare the oil supply and return valves, consider these points:

8.2.1 Oil Supply

- Oil is typically taken from a valve midway up on the transformer or from an active cooling loop. Note: If oil has to be taken from an oil-forced cooling loop, the oil supply valve must be located on the high pressure side of the oil pump. It is necessary to ensure that the oil is taken from a location where the oil is well mixed and in the active flow of transformer oil. The oil temperature at this location should not exceed 120 °C or be lower than −20 °C.
- The distance between the oil supply valve and oil return valve should be at least 30 cm (12 in.) to prevent mixing of the de-gassed oil with the transformer oil being sampled.
- Fittings must be provided to adapt the oil supply valve to a ¼ in. female NPT fitting using fittings and adaptors made from stainless steel, brass or black iron.

Do not use galvanised steel, copper or plastic fittings as these materials can negatively affect the gas concentrations in the sample line.

- If the oil supply valve is located more than 1.82 m (6 ft) above the base of the transformer, it is recommended that an additional ¼ in. ball valve be placed in the oil supply line within easy reach while standing, and in an easily accessible and
visible location. This valve can be used to conveniently shut off the oil supply, if required.

8.2.2 Oil Return

- Oil is typically returned to a valve lower on the transformer, such as the transformer drain valve.

⚠️ **Do not** return the oil to a location that leads directly to a critical location within the transformer, such as a cooling loop designed for directed cooling.

- Oil returning to the transformer must be via the ‘Return Assembly’ provided in the product installation kit. This assembly incorporates a check valve, a ball valve and a port that facilitates bleeding the system of air during the installation process. The bleed port must be oriented up so that air can be drawn from it. The assembly can be reconfigured to fit the transformer valve and adaptor, but must first be adapted from a ¼ in. female NPT fitting.

- If the oil return valve is located more than 1.82 m (6 ft) above the base of the transformer, it is recommended that an additional ¼ in. ball valve be placed in the oil return line within easy reach while standing, and in an easily accessible and visible location. This valve can be used to conveniently shut off the oil return, if required.

- It is important to ensure that the configuration of the Return Assembly eliminates any pre-existing air pockets. This is achieved by the use of a Tee on the return valve with the bleed port facing upwards. To reduce the possibility of air pockets behind the flange, the position of the ¼ in. NPT hole must be drilled near to the top of the flange offset from the centre (see Figure 8—11).

Note: An optional manual oil sampling arrangement can be fitted to the oil inlet on the base of the product. For more information, contact the GE Customer Service Centre.

8.3 Tubing

Stainless steel tubing is used to connect the product to the transformer. The amount of tubing required is based on the location of the product in relation to the valves on the transformer.

⚠️ **Stainless steel is the only material that should be used** – the use of any other tubing material would invalidate the results of the analysis and void the warranty of the product. (See Appendix D for a full description of the tubing.)

It is also recommended that each section of tubing between the transformer and the product be installed as one continuous piece, and to use as few fittings as possible to reduce restriction and minimise the risk of oil leaks.
Note: Products, such as MULTITRANS, that are connected to more than one transformer must have suitable dielectric fittings placed in-line with the tubing and installed close to the product (see Appendix E for more details).

Consider these points when choosing where to route the tubing and estimating how much tubing is required:

- The route must not interfere with the regular maintenance of the transformer. The tubing shall not be routed so that it could be stepped on, tripped over or damaged by activities near the transformer.
- The route shall be selected to allow the tubing to be secured to existing structures. It is important that the tubing be adequately secured to the structure of the transformer or ancillary structure with appropriate mounting hardware and fasteners. (Swagelok or Ham-Let offer several options for mounting and securing tubing.)
- When measuring the routes chosen for the tubing between the product and the transformer oil supply and return valves – corners, bends and other obstacles may add to the overall length and must therefore be taken in to consideration.
- The rigid tubing is typically supplied in 6 m (20 ft) lengths (see Appendix D). If the length of either tubing path exceeds 6 m (20 ft), ¼ in. stainless steel compression unions will need to be provided along with the additional tubing. The required amount of tubing, in accordance with the specification in Appendix D, must be on site on the day of the installation.
- Bending the rigid tubing is a complicated procedure and if there is a change to the proposed route during the installation it could require extra tubing. For this reason, it is advisable to order at least 20% more tubing than the initial required estimate.
- Flexible tubing is also available, but is more expensive than rigid tubing, and must be ordered in custom lengths.
- If the supplied shut-off valves are mounted to transformer valves that are 1.82 m (6 ft) or more above the ground, an additional ¼ in. stainless steel compression ball valve should be installed on the ¼ in. tubing at an easy to reach and visible location. This valve should be located not more than 1.82 m (6 ft) above the ground. This will facilitate turning off the oil flow, if needed, without having to climb to reach the valve. One additional ¼ in. stainless steel compression ball valve is included in the product installation kit.

⚠️ If the oil temperature can fall below –20 °C, a heat trace may be fitted to the oil pipe to increase the oil temperature before it enters the product. Note: The heat trace shall need to be powered externally and be installed in accordance with the manufacturer's instructions and local wiring regulations.
8.3.1 Fitting Requirements

Figure 8—4 to Figure 8—6 shows the bottom plate connection points for each product. The stainless steel tubing should be fitted between the transformer and the product as follows, ensuring that:

- The supply line is connected to the OIL IN port (this is the bulkhead fitting at the bottom of the product that is located closest to the right-hand-side when viewed from the front). This line will route to the transformer supply valve.
- The return line is connected to the OIL OUT port (this is the bulkhead fitting at the bottom of the product that is located closest to the left-hand side when viewed from the front). This line will route to the Return Assembly on the transformer valve.
- All stainless steel tubing is clean and de-burred before attaching the tube fittings.
- All tubing is properly secured to the transformer or other suitable non-vibrating structures.
- All tube fittings are sufficiently tight and tightened as per the fitting instructions below (also outlined in the relevant Swagelok or Ham-Let documentation).

Figure 8—4: TRANSFIX 1.6 connections - bottom view

A. Oil-out  
B. Oil-in  
C. Manual sampling port  
D. Ambient temperature sensor  
E. Power-in (gland)  
F. M8 earth connection point
Figure 8—5: MULTITRANS connections - bottom view

A. Manual sampling port  
B. Oil-out ports (circuits 1, 2, 3)  
C. Oil-in ports (circuits 1, 2, 3) with filters  
D. Power cable gland  
E. Ambient temperature sensor  
F. Communications cables gland  
G. M8 earth connection point

Figure 8—6: TAPTRANS connections - bottom view

A. Out “C” selector  
B. Out “A” main  
C. Manual DGA “A/C”  
D. In “C” selector  
E. Manual DGA “B”  
F. In “A” main  
I. M8 earth connection point  
J. Ambient temperature sensor  
K. Out “B” diverter  
L. In “B” diverter
8.3.2 Fitting Instructions

1. Insert one end of the tubing into the Swagelok or Ham-Let fitting body as shown in Figure 8—7.

![Figure 8—7: Fitting body and tubing](image)

2. Ensure that the tubing rests firmly on the shoulder of the fitting body and that the nut is finger-tight.

3. Mark the nut with a fine-tipped permanent marker at the 6 o’clock position as shown in Figure 8—8.

![Figure 8—8: Nut at 6 o’clock position](image)

4. While holding the fitting body steady, tighten the nut 1 and a 1/4 turns to the 9 o’clock position as shown in Figure 8—9.

![Figure 8—9: Nut at 9 o’clock position](image)

⚠️ Do not use any type of thread sealant on compression-type tube fittings.

⚠️ Do not open the valves on the transformer or the stainless steel tubing. This is performed by GE-trained and certified personnel during the commissioning phase to prevent air bubbles from entering the transformer.

8.3.3 Connection to Oil Supply Valve

Oil is typically taken from a valve midway up on the transformer or from an active cooling loop (see Section 8.1 for information on valve selection). Oil must be taken from a location where the oil is well mixed and in the active flow of the transformer oil. The temperature of the oil at this location should not exceed 120 °C or be lower than –20 °C. Note: The distance from the oil return valve should be at least 30 cm (12 in.).

These points must be observed when connecting to the oil supply valve:

- Locate the valve on the transformer chosen for the oil supply line. Identify the items needed to adapt the oil supply valve to a ¼ in. female NPT fitting. Select fittings and adaptors made from stainless steel, brass or black iron.
Do not use galvanised steel, copper or plastic fittings as these materials can negatively affect the gas concentrations in the sample line.

- All pipe fittings should be tight and all threaded pipe fittings tightly wrapped with PTFE tape with a light coating of PTFE paste or other quality pipe thread sealant applied over the taped male threads to prevent leaks. Both of these items are included in the product installation kit. Note: GE recommends two wraps of PTFE tape or three wraps for large pipe fittings.

8.3.4 Connection to Oil Return Valve

Oil is typically returned to a valve lower on the transformer, such as the transformer drain valve. Note: The distance from the oil supply valve should be at least 30 cm (12 in.).

Do not return the oil into a high pressure area on the transformer, such as a cooling loop.

The following points must be observed when connecting to the oil return valve (see Section 8.1 for information on valve selection):

- The return line to the transformer must be via the Return Assembly (see Figure 8—10 to Figure 8—12). This assembly incorporates a check valve and port that facilitates bleeding the system of air during the installation process. The bleed port must be oriented up so that air can be drawn from the top. The assembly can be reconfigured to fit the transformer valve and adaptor. This assembly must be adapted from a ¼ in. female NPT fitting to the valve on the transformer.
- If a flange-type valve is to be used to return the oil and the flange is drilled and tapped to a ¼ in. female NPT fitting, then the drilled hole should be offset to the top of the internal valve diameter to prevent an air pocket from being trapped behind the flange (see Figure 8—11).

![Figure 8—11: Flange example](image)

Figure 8—12 depicts the Return Assembly kit.

![Figure 8—12: Return Assembly kit](image)

- All pipe fittings should be tight and all threaded pipe fittings tightly wrapped with PTFE tape with a light coating of PTFE paste or other quality pipe thread sealant applied over the taped male threads to prevent leaks. Both of these items are included in the product installation kit. **Note: GE recommends two wraps of PTFE tape or three wraps for large pipe fittings.**
Figure 8—13 depicts the proper arrangement of the Return Assembly.

Figure 8—13: Bleed assembly on threaded-type oil return valve
9 POWER

This section outlines the power requirements, electrical connections and related aspects that must be observed.

⚠️ The product contains a power supply that can accommodate 110 V AC (100-121 V AC) or 230 V AC (207-253 V AC), 50/60 Hz single phase factory set and draws 8 amps maximum.

⚠️ The power source must be rated to either 110 V AC (100-121 V AC) or 230 V AC (207-253 V AC), 50/60 Hz. A 10 to 15 amp circuit meeting these requirements must be available for the product at the time of installation. Installation must be done in accordance with local wiring regulations.

⚠️ Ensure that the mains selection switch in the product is set to the relevant voltage range.

⚠️ Ensure that the mains power of the product is connected to a circuit that is continually on to ensure its continuous operation.

Disconnection is through an external switch or circuit breaker that must be installed on the mains supply line near the product. The switch or breaker shall be rated at 10 A minimum 250 V AC minimum.

⚠️ The switch or breaker shall be approved to IEC60947-1 or IEC60947-3 and installed in accordance with local wiring regulations. The switch or breaker shall be identified as the disconnect device for the product and should be located where it is visible from the product and easily accessible.

⚠️ Before commencing any work, ensure that the ON/OFF switch is in the OFF position and that the product is disconnected from the mains supply via the external switch or circuit breaker.

9.1 Connections

All wires and cables leading to or from the product are made through four conduit connectors on the base of the product. The mains wiring routes through the 25 mm conduit connector, while wiring for communications and sensors route through the other conduit connectors.

⚠️ Unused conduit connectors shall be sealed. Conduit connectors may be replaced, if necessary. Terminal connections are provided on the System board for terminating the communication and sensor wires and cables.

Section 8.3.1 depicts the location of the various cable glands and connection points of each product.
The power supply terminals for the mains supply and the modular fuse holder are shown in Figure 9—1. The protective cover for the AC connection block is shown in Figure 9—2. The protective cover is a safety feature designed to protect the connection block from a buildup of dust.

To ensure a safe connection to the power supply, follow these steps:

1. Disconnect the power supply to the product at the external switch or circuit breaker before accessing internal components.
2. Open the front panel on the right-hand-side of the product by turning the ¼-turn fasteners anticlockwise.
3. Route the mains supply cable through the 25 mm cable gland on the bottom of the product.
4. The outer sheath of the mains supply cable shall continue into the equipment as far as possible, so that reinforced insulation is maintained between the operator and the mains supply.
5. The mains supply shall be connected so that the protective earth wire is the last wire to take the strain and break free in the event of the cord being pulled.
6. Tighten the cable gland to secure the cable and fit the protective cover shown in Figure 9—2 over the AC connection block.
7. The product has an M8 earth stud located on the bottom of the enclosure on the right-hand side. To ensure continued safety and EMC compliance, this must be connected to earth ground in accordance with local wiring regulations and using at least 6 mm² (10 AWG) wiring (see Figure 9—3).
Ensure that the selector switch for the heater supply voltage is set to the correct supply voltage, either 110 V or 230 V as shown in Figure 9—4. The switch is situated on the circuit board on the back wall of the enclosure.

If heat trace is to be used, please refer to Appendix J.

### 9.2 Cold Start

If the product is powered up in cold conditions (less than −10 °C), the product initiates the following cold-start sequence before a measurement can commence. The internal heater in zone 1 automatically switches on to increase the internal temperature to within the PGA operational temperature range. The system does not fully power up until the working temperature in zone 1 reaches −10 °C, after which the system becomes operational. Lights for the system power supplies are situated on the circuit board at the rear. See the relevant product user guide for more details.

Note: Once the DC power supply resumes, the internal temperature of the product may take several hours to reach working temperature before a measurement cycle commences.

### 9.3 Battery

The product uses a non-rechargeable lithium coin cell battery (Panasonic CR2450 3 V 620 mAh) as shown in Figure 9—5. In the event that the battery needs to be replaced, data from the product must be backed up. Failure to do so may result in historical data loss.
The following steps describe how to change the battery:

1. Back up the product data – contact your GE representative.
2. Open the inner door to locate the battery on the System board (see Figure 9—5).
3. Slide the battery out of its housing.
4. Replace with a new Panasonic CR2450 3 V 620 mAh coin cell.
5. Close the inner door.

There is a danger of a new battery exploding if installed incorrectly.

Dispose of the used battery in accordance with local regulations — not in a fire or with household waste. Contact your local waste disposal agency for the address of the nearest battery deposit site. Perchlorate material — special handling may apply. See: [www.dtsc.ca.gov/hazardouswaste/perchlorate/](http://www.dtsc.ca.gov/hazardouswaste/perchlorate/)
10 ELECTRONICS

10.1 System Board

The product provides connections for the alarms, PSTN, serial communications and transformer load sensor. These screw terminal connections are located on the System board at the back of the front panel (see Appendix I). Communications modules and optional analogue inputs are also located here. All cabling, communications and sensor wiring that lead into or out of the product are made through the two left-hand-side 20 mm cable glands on the bottom. There are also cable tie bases on the inner side of the front panel for securing the cables.

⚠️ Note: After the product has been in operation, components may get hot within the inner compartments and inside the front panel. Care should be taken that all items have cooled sufficiently before carrying out any work.

10.2 Alarm Connections

The product has eight relays — a service relay, a watchdog relay and six user-configurable caution and alarm relays, and four front-panel LEDs. Relay outputs are located along the terminal strip on the System board (see Appendix I). Three connections are provided to each relay: NO (Normally Open), NC (Normally Closed), and COM (Common). Each alarm relay can handle a maximum of 3 A at 250 V AC, 150 mA at 300 V DC, 200 mA at 125 V DC or 3 A at 30 V DC (see Appendix I).

- Service relay — notifies the user of an error condition.
  - The blue LED illuminates if internal error checking detects an error condition. If after the next measurement run, there are no error conditions present, the blue LED switches off.

- Watchdog relay — notifies the user of power to the product.
  - The green LED illuminates when the product is connected to the mains power and is powered on.

- Relays 2-7 — notify the user when a user-configurable caution and/or alarm threshold is reached.
  - The yellow (caution) or red (alarm) LED illuminates when a caution or alarm state arises respectively. If after the next measurement run, no caution or alarm states exist, the respective LEDs(s) switch off. Use the TransConnect software to set alarm and caution limits for many different combinations of results. (See the TransConnect User Guide for more information).
10.3 Accessory Power

There are additional power points to connect +12 V DC or +24 V DC at 0.7 A accessories, such as wireless modems or protocol converters. These are available on the AC board on the back wall of the enclosure as shown in Figure 10—1.

![Figure 10—1: Accessory power points for 12 V and 24 V](image)

10.4 External Sensors

A transformer load sensor is provided in the product installation kit to measure and record the transformer load. The transformer load sensor is a split core current sensor that can be installed unobtrusively around a CT line receiving a feed from the main bushing secondary wiring (usually located within the marshalling / control cabinet of the transformer).

It should be possible to locate a suitable current transformer with a 0 A – 5 A secondary circuit on which to mount the sensor. The sensor is supplied with 2.5 m (100 in.) of cable and may be spliced to the required length to connect to the product with up to a total of 10 m (33 ft) of 20 AWG twisted pair cable. Longer cable lengths are possible depending upon the quality of the cable. The load sensor connects to the bottom two terminals on the left-hand side of the System board – terminals 33 and 34 (see Appendix I).
11 COMMUNICATIONS

Various communication options are available for the product. These include:

- A USB slave connection — allows serial communications with an external computer. This connection is available on the panel inside the product.
- An Ethernet connection (using the MODBUS/TCP protocol). This connection is available on the circuit board inside the inner door.
- Up to two further communications channels. However, if a DNP3 module is fitted (one maximum) this limits the available communication channels to one.

The product supports simultaneous communication on several channels – up to three masters over Ethernet, and one master on each of the serial connections (including the USB connection) as listed in Table 11—1.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Carrier</th>
<th>MODBUS/RTU</th>
<th>MODBUS/TCP</th>
<th>MODBUS/ASCII</th>
<th>DNP3.0</th>
<th>IEC61850</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td>USB</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel A*</td>
<td>RS-232 Isolated</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel A*</td>
<td>RS-485 2-wire</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel A*</td>
<td>RS-485 4-wire</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel A*</td>
<td>PSTN</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel A*</td>
<td>GSM/GPRS</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel A*</td>
<td>CDMA</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel B</td>
<td>RS-232 Isolated</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel B</td>
<td>RS-485 2-wire</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel B</td>
<td>RS-485 4-wire</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Channel B</td>
<td>PSTN</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel B</td>
<td>GSM/GPRS</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channel B</td>
<td>CDMA</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Ethernet</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DNP3</td>
<td>Ethernet</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: Channel A is disabled when DNP3 over Ethernet is selected.

The options listed above are available at the time of printing – other options may become available. (Contact the GE Customer Service Centre for further information.)
11.1 Electromagnetic Compatibility (EMC) requirements

⚠️ To ensure continued EMC compliance, a Wurth 74271221S ferrite as shown in Figure 11—1 (supplied as part of the COMMS kit) must be fitted to make connection with an RS-232 and/or RS-485 module using connector P1. The communications cable must be looped twice through the ferrite as shown in Figure 11—1.

Figure 11—1: Ferrite placement on RS-485
Appendix A  Installation Tools and Supplies

The tools and supplies for a product installation are listed below. If GE performs the installation, the GE installation engineer will provide these items:

A.1  GE-supplied Items

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>9/16 in. Combination wrench (must be imperial 9/16 in.)</td>
</tr>
<tr>
<td>1</td>
<td>30 cm (12 in.) Adjustable wrench</td>
</tr>
<tr>
<td>1</td>
<td>35 – 40 cm (14 in.) Pipe wrench</td>
</tr>
<tr>
<td>1</td>
<td>1/8 flat blade screwdriver</td>
</tr>
<tr>
<td>1</td>
<td>¼ in. flat blade screwdriver</td>
</tr>
<tr>
<td>1</td>
<td>#2 Phillips screwdriver</td>
</tr>
<tr>
<td>1</td>
<td>¼ in. Tubing bender</td>
</tr>
<tr>
<td>1</td>
<td>¼ in. Tubing cutter</td>
</tr>
<tr>
<td>1</td>
<td>Non-metallic tape measure</td>
</tr>
<tr>
<td>1</td>
<td>Level capable of indicating plumb and level within 5 degrees</td>
</tr>
<tr>
<td>1</td>
<td>Permanent marker (fine tip)</td>
</tr>
<tr>
<td>1</td>
<td>22 – 14 Gauge wire cutter/stripper</td>
</tr>
<tr>
<td>1</td>
<td>Small diagonal cutting pliers</td>
</tr>
<tr>
<td>1</td>
<td>Quality vacuum pump with approximately 3 ft of clear ¼ in. tubing fitted with a ¼ in. compression fitting at the end of the tubing</td>
</tr>
<tr>
<td>1 roll</td>
<td>12 mm (½ in.) width PTFE pipe-sealing tape or PTFE pipe compound</td>
</tr>
<tr>
<td>25</td>
<td>30 cm (12 in.) Nylon UV-resistant cable ties</td>
</tr>
<tr>
<td>1 bag</td>
<td>¼ in. tubing P clamps</td>
</tr>
<tr>
<td>1</td>
<td>Laptop computer for commissioning the product and running the TRANS.COM software for downloading and interpreting the results of the gas analysis. Minimum specification: Windows® 2000 or Windows® XP operating system, PII 400 MHz processor, 128 MB of RAM and 1.2 GB hard drive space, 28.8 Kbps modem or faster and USB 1.1 or faster.</td>
</tr>
</tbody>
</table>

A.2  Customer-supplied Items

The following tools and supplies are needed on site to secure the mounting stand (if used), tighten the 2 in. pipe fittings (if used) and complete the installation. GE is unable to bring the following items due to size and weight restrictions, so the customer should provide them.

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12 mm (½ in.) capacity hammer drill with 9.5 mm (3/8 in.) masonry bit</td>
</tr>
<tr>
<td>1</td>
<td>36 in. pipe wrench if large fittings are used to provide oil to the product</td>
</tr>
<tr>
<td>1</td>
<td>Scaffolding, lift or approved platform to obtain access to valves (if needed)</td>
</tr>
<tr>
<td>1</td>
<td>Suitable vessel to collect at least 4 litres of waste oil during the commissioning process</td>
</tr>
<tr>
<td>1</td>
<td>Absorbent cloths</td>
</tr>
<tr>
<td>12</td>
<td>M8 threaded fasteners with a recommended minimum length of 80 mm for the concrete pad</td>
</tr>
</tbody>
</table>
Appendix B  Customer Checklist

The following checklist details items that the customer must acquire prior to the installation:

- Prepared, flat mounting surface
- Parts to fabricate a mounting stand (if the product mounting stand has not been purchased)—see Section 7.
- Required number of stainless steel tubing lengths of 6 m (20 ft) each (see Section 8.3).
- Fittings to adapt the transformer supply valve to a ¼ in. female NPT fitting (see Section 8.2).
- Fittings to adapt the transformer return valve to a ¼ in. female NPT fitting (see Section 8.2).
- ¼ in. compression ball valve, if required (see Section 8.3).
- ¼ in. stainless steel compression unions (if the length of either tubing path exceeds 6 m (20 ft) — see Section 8.3.
- Communications option tested and located at the installation site (see Section 11).
- Circuit capable of 110 V AC (100-121 V AC) or 230 V AC (207-253 V AC), 50/60 Hz with suitable overcurrent protection as per local regulations (see Section 9). If heat trace cable is used, the current capability of the circuit must be sufficient for both the product and the heat trace cable.
- Wiring and/or conduit for connection between the terminals within the product and to the external switch or circuit breaker. This must be performed by a suitably qualified electrician in accordance with local wiring regulations (see Section 9.1).
- Tools and supplies needed to complete the installation (see Appendix A).
Appendix C  Installation Record

C.1 Customer Contact and Site Details

Company:
Address:
City, State and Postcode (Zip):
Country:
Phone:

Installation Site Name:
Site Address:
City, State:
Postcode (Zip):
Country:

Primary Corporate Contact:
Name: Title: 
Address:
City, State and Postcode (Zip):
Country:
Phone: Mobile:
Email address:
Secondary Contact Name: Mobile: 

Primary Site Contact:
Name: Title: 
Address:
City, State and Postcode (Zip):
Country:
Phone: Mobile:
Email address:
Secondary Contact Name: Mobile: 

Site Map
Please attach a detailed map or GPS coordinates on how to locate the site.
C.2  Transformer Details

Make: __________________________  Year: _______  Years in Service: ______
Type:
  Conservator ☐  Nitrogen Blanketed ☐  Other: ___________________
  MVA Rating: ________________________________
  CT ratio: ________________________________
  Condition of Desiccant: ________________________________

Attach several photos showing the transformer and surrounding area ☐
Attach all available DGA data ☐
Total Dissolved Gas: ___________ ppm (sum of all measured gases)
Please describe (or attach separately) details of any major maintenance actions, such as a rebuild, vacuum degassing or filtering etc.

C.2.1  Transformer Oil

Oil Capacity: ____________ (in gallons) ____________ (in litres)
Manufacturer: _______________  Type: __________________
Certified PCB free:  Yes ☐  No ☐
Temperature range at oil supply valve:  High _____ °C  Low _____ °C
Temperature range at oil return valve:  High _____ °C  Low _____ °C

C.2.2  Transformer Nitrogen Blanket (if applicable)

How frequently does the nitrogen bottle need to be changed?
______________________Years _____________Months
Headspace Pressure: ______________ psi (kPa, bar)
C.3  Pre-Installation Photographs

It is recommended that photographs of the installation site be taken in advance of the installation in order to properly assess the site, aid in planning the installation and contribute to the Short Duration Safety Plan. The following areas should be photographed:

C.3.1  Valves / Plumbing:
- Proposed Supply valve location
- Proposed Return valve location
- Alternative Supply valve location
- Alternative Return valve location
- Secondary Shut-Off valve location (if needed)
- Oil supply & return routing (the ¼ in. stainless steel tubing)

C.3.2  Proposed Product location:
- Overview from front
- Overview from left side
- Overview from back
- Overview from right side

C.3.3  Proposed Cable routing and connection locations:
- Communication cable routing (include terminations)
- Power cable routing (include terminations)

C.3.4  Transformer:
- Nameplate photo
- Oil temperature gauge
- Oil level gauge
- Control panel with door open
- Overview of each side
- Cooling loop(s)
- Conservator with close-ups of gauges
- Pumps
- Desiccant
- Nitrogen Cylinder / Regulator gauges (if transformer is nitrogen-blanketed) (both Output & Cylinder psig)
C.3.5 Additional Photographs:

- Any additional devices used in conjunction with the installation, such as junction boxes, telephone line sharing devices, alternative communication devices etc.
- Overall site photos
- Any other useful photos
Appendix D  Tubing Specification and Ordering Details

D.1 Specifications

Rigid Tubing  г\t¼ in. OD × 0.035 in. wall T316 seamless stainless steel tubing (6.35 mm OD × 0.889 mm wall) (ASTM A269 / A213).

Flexible Hose  г\t¼ in. ID low pressure, 316 stainless steel braid over stainless steel metal flexible hose with welded ¼ in. compression fittings on each end.

D.2 Order Information (E.g. Swagelok)

Rigid Tubing  Rigid tubing can be ordered from Swagelok in advance of the installation. For example, a 20 foot length would have part number SS-T4-S-035-20 (see the Swagelok website www.swagelok.com or your local Swagelok representative).

Flexible Hose  Flexible hose can be ordered from Swagelok, but must be ordered in custom lengths well in advance of the installation. For example, a custom 8 meter FL series hose would have part number SS FL4TA4TA4-800 (specified in centimetres) (see the Swagelok website www.swagelok.com or your local Swagelok representative).

⚠️ Do not use copper tubing (See Section D.6).

D.3 Tubing Unions

Tubing Unions connect two pieces of the above ¼ in. tubing together. GE recommend:

- Swagelok: SS-400-6 Stainless Union, ¼ in. OD
- Ham-Let: 762L SS 1/4 Stainless Union, ¼ in. OD

D.4 Shut-Off Valve

If the oil supply or return valve is located more than 6 ft (1.82 m) above the base of the transformer, use a Swagelok tube fitting (SS-4P4T Stainless Plug Valve, ¼ in.) or a Ham-Let tube fitting (H800MSSL Stainless Plug Valve, ¼ in.) as directed in this procedure.
D.5 6 mm Tubing Adaptors

If ¼ in. tubing is not available, 6 mm stainless steel tubing may be used, but the maximum tubing run may be reduced, and ¼ in. to 6 mm tubing adaptors must be used. Consult with the GE Customer Service Centre. The adaptors should be Swagelok (SS-6M0-R-4 Stainless Reducer, 6 mm OD – ¼ in. OD) or Ham-Let (767LT SS Stainless Reducer, 6 mm OD – ¼ in. OD). At least eight of these are required for the installation.

⚠️ Do not use 6 mm tubing without the above adaptors. To do so would void the warranty.

D.6 Tubing Material

⚠️ Stainless steel is the only material that should be used. The use of any other tubing material will cause reliability issues or inaccurate results and void the warranty of the product. GE does not support the use of copper tubing for the installation of its transformer analysis products. The reasons for this are outlined below.

D.6.1 Flow Rate

The solid seamless stainless steel tubing that GE specifies is 316 Stainless Steel, 1/4 in. OD with a 0.035 in. thick wall. Most 1/4 in. copper tubing has a greater wall thickness which reduces the flow rate rendering it too fragile to place in the field. Bends in standard soft copper tubing crush and deform more easily, which can reduce the flow rate than would otherwise be the case with properly bent stainless steel tubing.

D.6.2 Connection reliability and physical damage

GE has two overriding primary design and installation principles:

⚠️ Never let oil out of the customer's transformer during operation.
⚠️ Never let air into the customer's transformer during operation.

Copper tubing, in general, is too soft to create a reliable long term seal at the connections in the vibratory environment of a transformer; the connections will eventually leak. The softness of copper tubing also make it prone to damage after the installation; it can easily get kinked, pinched and even torn from the connection by maintenance and service activities near the transformer.
D.6.3  Compounds in the transformer oil that react with copper

Transformer oils contain compounds that can react with copper. One notable compound is Acetylene which reacts with copper to form copper acetylide. This creates two related problems:

- ⚠️ Copper acetylide is a highly explosive compound and for regulatory and health and safety reasons, our equipment or installations cannot create these compounds.
- The reaction changes the chemical makeup of the oil before it reaches the sensor in the product. This causes the product to measure acetylene and possibly other gasses inaccurately.

Although a transformer already contains copper, GE diagnostic and monitoring equipment is designed to accurately measure the gasses in the oil of the transformer without affecting that oil.

⚠️ GE will not guarantee or perform warranty work on a product that has been installed using copper tubing or any other tubing, other than stainless steel, as specified above.
TRANSFIX-family products that are to be connected to more than one transformer, such as the MULTITRANS, must have suitable dielectric fittings placed in-line with the tubing and installed close to the product. Dielectric fittings provide electrical isolation and prevent circulating currents from flowing in the tubing circuits. Both Swagelok and Ham-Let offer dielectric fittings.

Details of the Swagelok dielectric fittings:

**Features**
- Metal components are machined from 316 stainless steel for use in rugged environments.
- Molded thermoplastic insulation with excellent electrical, chemical, and ultraviolet resistance and low water absorption maintains dielectric strength and integrity over a wide range of operating and climatic conditions.
- Gaugeable Swagelok® tube fitting or tapered pipe thread end connections (NPT/BSP) provide direct connection to tubing or piping system.

**Materials**
- **Body**: 316 stainless steel
- **Insulators**: Polyamide-imide
- **Quad Seal**: 70 durometer fluorocarbon FKM
- **Backup Ring**: Virgin PTFE

**Technical Data**
- **Electrical Resistance of Insulators at 70°F (20°C)**:
  \[ 10 \times 10^6 \Omega \text{ at } 10 \text{ V (dc)} \]
- **Pressure Rating**: 5000 psig (344 bar)
- **Temperature Rating**: –40 to 200°F (–40 to 93°C)

**Ordering Information and Dimensions**

<table>
<thead>
<tr>
<th>End Connections</th>
<th>Tube Size</th>
<th>Pipe Size</th>
<th>Ordering Number</th>
<th>Dimensions, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swagelok tube fittings</td>
<td>1/4 in.</td>
<td>–</td>
<td>SS-4-DE-6</td>
<td>A: 3.77 (95.8), B: 2.57 (65.3), C: 0.60 (15.2), E: 0.19 (4.8), F: 1/2, Fx: 9/16</td>
</tr>
<tr>
<td></td>
<td>3/8 in.</td>
<td>–</td>
<td>SS-6-DE-6</td>
<td>A: 3.92 (99.5), B: 2.59 (65.8), C: 0.65 (16.5), F: 5/8, Fx: 13/16, G: 11/16</td>
</tr>
<tr>
<td></td>
<td>1/2 in.</td>
<td>–</td>
<td>SS-8-DE-8</td>
<td>A: 4.17 (106), B: 2.37 (60.2), C: 0.90 (22.9), F: 13/16, Fx: 7/8, G: 11/16</td>
</tr>
<tr>
<td></td>
<td>12 mm</td>
<td>–</td>
<td>SS-12-MDE-6</td>
<td>A: 4.23 (107), B: 2.43 (61.7), E: 0.28 (7.1), F: 5/8, Fx: 7/8, G: 11/16</td>
</tr>
<tr>
<td>Swagelok tube fitting male NPT</td>
<td>3/8 in.</td>
<td>1/4 in.</td>
<td>SS-6-DE-1-4</td>
<td>A: 3.73 (94.7), B: 0.65 (16.8), F: 5/8, Fx: 7/8, G: 11/16</td>
</tr>
</tbody>
</table>

Dimensions shown with Swagelok nuts finger-tight. Dimensions are for reference only and are subject to change.

**Caution**: Do not disassemble the insulating connection. It must not be broken or used as a disconnection point.
Details of the Ham-Let dielectric fittings:

**HAM-LET DIELECTRIC FITTINGS**

Dielectric fittings are designed to insulate subsystems from electrical current, voltages and static charges.

**MATERIALS OF CONSTRUCTION:**
2. Insulators: Polyamide-Imide.
3. O-Ring: Viton 70 Durometer.
4. Ring: PTFE.

**WORKING CONDITIONS:**
1. Pressure rating: 5000 psi
2. Temperature rating: -40°C to 93°C (-40°F to 200°F).
3. Electrical resistance at 20°C -25°C (68°F-77°F): 10x10Ω at 50V DC.

**TUBE (INCH) TO TUBE (INCH)**

<table>
<thead>
<tr>
<th>Ordering Information</th>
<th>A</th>
<th>Tube O.D.</th>
<th>D</th>
<th>W</th>
<th>Wa</th>
<th>Wa</th>
<th>M</th>
<th>I</th>
<th>N</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inch</td>
<td></td>
<td>Inch</td>
<td>Inch</td>
<td>Inch</td>
<td>Inch</td>
<td>Inch</td>
<td>Inch</td>
<td>Inch</td>
</tr>
<tr>
<td>762L 1/4 Dielectric</td>
<td>1/4</td>
<td>6.36</td>
<td>1.0</td>
<td>4.9</td>
<td>13/16</td>
<td>20/60</td>
<td>1/2</td>
<td>12.70</td>
<td>2.67</td>
<td>65.90</td>
</tr>
<tr>
<td>762L 3/8 Dielectric</td>
<td>3/8</td>
<td>9.52</td>
<td>0.28</td>
<td>7.10</td>
<td>13/16</td>
<td>20/60</td>
<td>5/8</td>
<td>15.90</td>
<td>2.59</td>
<td>65.00</td>
</tr>
<tr>
<td>762L 1/2 Dielectric</td>
<td>1/2</td>
<td>12.70</td>
<td>0.28</td>
<td>7.10</td>
<td>13/16</td>
<td>20/60</td>
<td>13/16</td>
<td>20/60</td>
<td>2.37</td>
<td>60.20</td>
</tr>
</tbody>
</table>

**TUBE (METRIC) TO TUBE (METRIC)**

<table>
<thead>
<tr>
<th>Ordering Information</th>
<th>A</th>
<th>Tube O.D.</th>
<th>D</th>
<th>W</th>
<th>Wa</th>
<th>Wa</th>
<th>M</th>
<th>I</th>
<th>N</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mm</td>
<td></td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>760L12 mm Dielectric</td>
<td>120.0</td>
<td>7.10</td>
<td>22.0</td>
<td>22.0</td>
<td>81.70</td>
<td>22.60</td>
<td>87.10</td>
<td>107.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assembly Instructions for Dielectric Fitting**

1. Hold hex. A (Back-Up) and tighten nut A according to Let-Lok assembly instructions (see Let-Lok catalogue for more information).
2. Hold hex. B (Back-Up) and tighten nut B according to the Let-Lok assembly instructions.

**CAUTION:** DO NOT LOOSEN the INSULATION NUT and DO NOT USE it as a BACK UP HECK.

**Notes:**
1. If end connection is Taper Pipe Thread - apply pipe sealant on thread and use hex A or B as wrenching or as Back Up hex.
2. For additional types of and connection, please contact your authorized Ham-Let representative.

**Warning! For Your Safety**
The system designer and user have the sole responsibility to select products suitable for their special application requirements and to ensure the proper installation, operation and maintenance of the product. Please consider application details, material compatibility and product ratings when making your selection. Improper selection or use of products can cause property damage or personal injury.
Appendix F  Product Dimensions

Figure F—1 shows the TRANSFIX 1.6 dimensions. The TRANSFIX 1.6 weighs 72 kg (159 lb). All dimensions are in millimetres (mm). Tolerance is ±5 mm.

Figure F—1: TRANSFIX 1.6 dimensions
Figure F—2 shows the TAPTRANS dimensions. The TAPTRANS weighs 88 kg (194 lb). All dimensions are in millimetres (mm). Tolerance is ± 5 mm.
Figure F–3 shows the MULTITRANS dimensions. The MULTITRANS weighs 76.5 kg (169 lb). All dimensions are in millimetres (mm). Tolerance is ± 5 mm.
Appendix G  Mounting Stand Dimensions

Figure G—1 shows the TRANSFIX 1.6 and MULTITRANS mounting stand dimensions with the product mounted. The mounting stand weighs 20 kg (45 lb). All dimensions are in millimetres (mm). Tolerance is ±5 mm.

Figure G—1: TRANSFIX 1.6 & MULTITRANS mounting stand dimensions – top, front & side
Figure G–2 shows the TAPTRANS mounting stand dimensions with the product mounted. The mounting stand weighs 16 kg (36 lb). All dimensions are in millimetres (mm). Tolerance is ±5 mm.

Figure G–2: TAPTRANS mounting stand dimensions – top, front & side
Appendix H  Footprint Dimensions

Figure H—1 shows the TRANSFIX 1.6 and MULTITRANS footprint dimensions. All dimensions are in millimetres (mm). Tolerance is ± 5 mm.

Figure H—1: TRANSFIX 1.6 & MULTITRANS footprint dimensions

Figure H—2 shows the TAPTRANS footprint dimensions. All dimensions are in millimetres (mm). Tolerance is ± 5 mm.

Figure H—2: TAPTRANS footprint dimensions
Appendix I  System Board

Figure I—1 shows the product System board. A description of each terminal is provided in Table I—1.
Table I–1: List of terminals

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>PSTN Interface</strong></td>
</tr>
<tr>
<td>1</td>
<td>TIP</td>
<td>PSTN interface</td>
</tr>
<tr>
<td>2</td>
<td>RING</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Digital outputs</strong></td>
</tr>
<tr>
<td>3</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>COM</td>
<td>Service Alarm</td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NO</td>
<td>Watchdog Alarm</td>
</tr>
<tr>
<td>7</td>
<td>COM</td>
<td>Note: The default condition is NO when the product is powered on.</td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>COM</td>
<td>Relay 2</td>
</tr>
<tr>
<td>11</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>COM</td>
<td>Relay 3</td>
</tr>
<tr>
<td>14</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>NO</td>
<td>Relay 4</td>
</tr>
<tr>
<td>16</td>
<td>COM</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>NO</td>
<td>Relay 5</td>
</tr>
<tr>
<td>19</td>
<td>COM</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>NO</td>
<td>Relay 6</td>
</tr>
<tr>
<td>22</td>
<td>COM</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>NO</td>
<td>Relay 7</td>
</tr>
<tr>
<td>25</td>
<td>COM</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Digital Inputs</strong></td>
</tr>
<tr>
<td>27</td>
<td>DIG IN 1+</td>
<td>Digital Input channel 1, positive</td>
</tr>
<tr>
<td>28</td>
<td>DIG IN 1-</td>
<td>Digital Input channel 1, negative</td>
</tr>
<tr>
<td>29</td>
<td>DIG IN 2+</td>
<td>Digital Input channel 2, positive</td>
</tr>
<tr>
<td>30</td>
<td>DIG IN 2-</td>
<td>Digital Input channel 2, negative</td>
</tr>
<tr>
<td>31</td>
<td>DIG IN 3+</td>
<td>Digital Input channel 3, positive</td>
</tr>
<tr>
<td>32</td>
<td>DIG IN 3-</td>
<td>Digital Input channel 3, negative</td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Analog Inputs</strong></td>
</tr>
<tr>
<td>33</td>
<td>ANALOG IN A</td>
<td>Analog input - Load sensor, positive</td>
</tr>
<tr>
<td>34</td>
<td>ANALOG IN B</td>
<td>Analog input - Load sensor, negative</td>
</tr>
<tr>
<td>Spacer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I.1 Optional communications modules

Figure I–2 illustrates the connections for the RS-232 and RS-485 connections, including DNP3.
Appendix J  Heat Trace Cable

It is recommended that heat trace cable be used on the tubing, if the oil temperature in the tubing can reach temperatures below −20 °C.

The customer is responsible for supplying the heat trace cable, which must be installed by a qualified electrician. GE Service Personnel are available to advise the customer and work with the company’s electrician to install the heat trace cable.

J.1 Installation Requirements

- Installation of heat trace cable must be done by a qualified electrician familiar with local wiring regulations.
- The heat trace cable selected shall have all necessary safety approvals required by local wiring regulations. The heat trace cable rating shall be suitable for the voltage of the power source, the temperature rating required, and the size of tubing it is to be installed on.
- Heat trace cable must be installed in accordance with the manufacturer’s instructions and local wiring regulations. Particular attention should be paid to requirements for circuit protection and power supply.
- The heat trace cable shall be controlled by a thermostat to prevent continuous operation.