MSI Linear Variable Displacement Transducer (LVDT) and Slide Valve Position Signal Conditioning Module

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1. About this Publication

These instructions have been prepared according to the following standards:

- BS EN ISO 11442: Technical product documentation. Document management;
- BS EN ISO 12100: Safety of machinery - General principles for design - Risk assessment and risk reduction;
- BS EN 62023: Structuring of technical information and documentation;
- BS EN 82079-1: Preparation of instructions for use. Structuring, content and presentation. General principles and detailed requirements.

1.1. Safety Warnings and Symbols

The system of safety warnings and symbols is based on:

- BS EN ISO 7010: Graphical symbols. Safety colours and safety signs. Registered safety signs;
- BS EN 82079-1: Preparation of instructions for use. Structuring, content and presentation. General principles and detailed requirements.

⚠ DANGER

This indicates a hazard with a high level of risk, which if not avoided, will result in death or serious injury if instructions, including recommended precautions, are not followed.

⚠ WARNING

This indicates a hazard with a medium level of risk, which if not avoided, will result in death or serious injury if instructions, including recommended precautions, are not followed. In addition, there is a high risk of damage to the component, product or process.

⚠ CAUTION

This indicates a hazard with a low level of risk, which if not avoided, will result in minor or moderate injury if instructions, including recommended precautions, are not followed. In addition, there is a potential risk of damage to the component, product or process.

NOTE: Draws attention to important additional information.

1.2. Units of Measurement

Quantities are expressed in SI units or SI derived units; refer to J & E Hall International Standard JEH-ES-02 Guide to the International System of Units (SI).

1.3. Terminology

Terminology, abbreviations and acronyms are those currently in use throughout the refrigeration and air conditioning industry; refer to J & E Hall International Standard JEH-ES-01 Definition of Terms and Acronyms Used in the Refrigeration Industry.

1.4. Additional Copies

Obtain additional copies of these instructions from J & E Hall International; go to www.jehall.com.

2. Application

The Linear Variable Displacement Transducer (LVDT) provides a continuous 4 to 20 mA slide valve position signal between minimum load and maximum load. The LVDT operates on the principle of using a coil (inductance element) to produce an electrical output proportional to the displacement of a separate movable indicator rod.

The LVDT electronics module is outside the pressure envelope of the compressor, eliminating any possibility of refrigerant leakage and allowing the module to be easily renewed in the event of failure.

⚠ CAUTION

The LVDT contains electronic components, which are susceptible to the interference from mobile phones, portable radios or other devices which emit electromagnetic radiation. Such items must not be operated adjacent to the LVDT assembly.

Five different designs of LVDT have been fitted to the HallScrew compressor:

- Prior to August 2004: LVDT or NLVDT;
- After August 2004 until February 2008: HB LVDT, refer to publication 2-206 HB LVDT;
- After February 2008: old design MSI LVDT with metal electronics housing;
- After June 2016: new design MSI LVDT with plastic electronics housing.

3. Description

From February 2008, HallScrew compressors are supplied with the MSI LVDT which replaces the HB LVDT previously fitted.

The MSI LVDT is a drop-in replacement for the HB LVDT. Adaptors, spacers etc., are not required. A special MSI LVDT version is not required for ATEX applications; refer to 6.2 MSI LVDT for ATEX Applications.

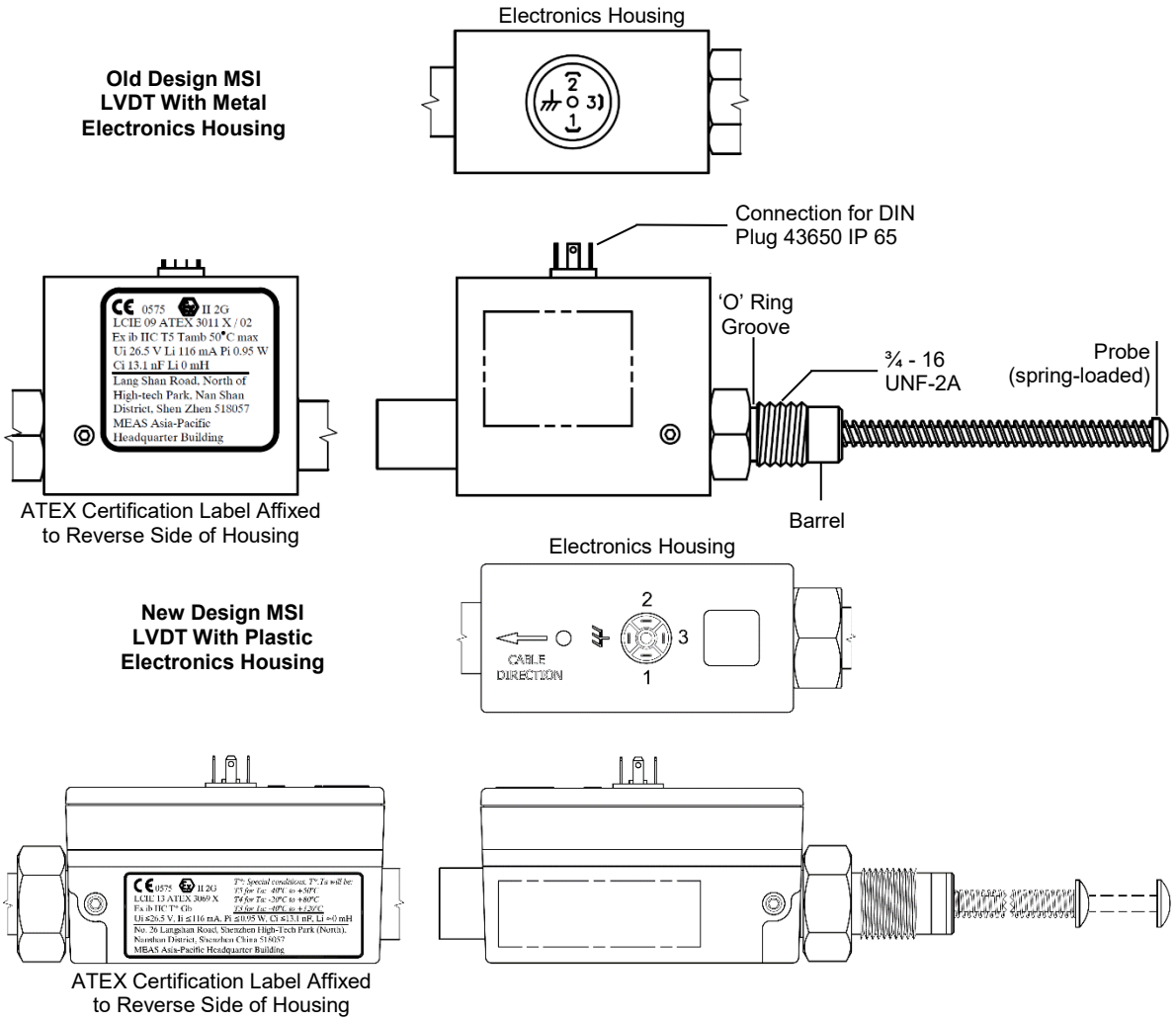
The MSI LVDT is only available without calibration, this must be done on the controller. However, a Pepperl & Fuchs signal conditioning module is available for applications where this is not possible; refer to 5. Pepperl & Fuchs Signal Conditioning Module KFU8-USC-1.D

HallScrew compressors fitted with the LVDT or NLVDT can be converted to the MSI LVDT by purchasing the appropriate kit of parts; refer 6.3 LVDT or NLVDT to MSI LVDT Conversion Kit.

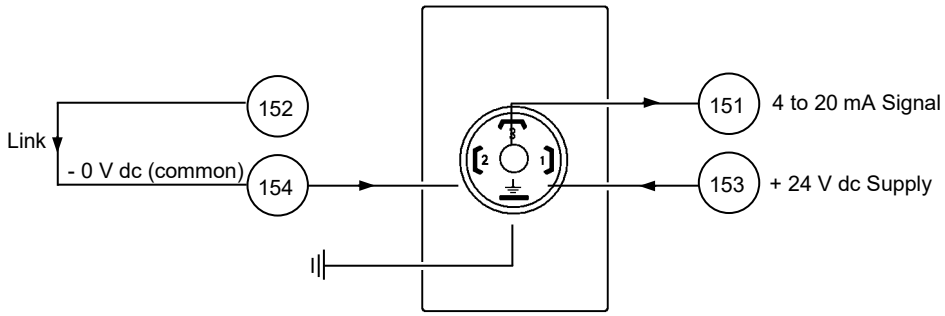
4. Technical Data

Parameter	Details
Linearity	Better than ± 1 % of full scale operation
Output	4 to 20 mA, load maximum 500 Ω @ 24 V dc
Supply	12 to 28 V dc
Response Time	Better than 2 seconds
Operating Temp Range (Electronics Assembly)	-40.0 °C to +50.0 °C ambient
Coefficient of Sensitivity	0.05 % per °C maximum
Vibration	IEC 68-2-6
Pressure	100 bar maximum from ‘O’ ring towards probe

Table 1 Technical Data



Wiring Connections to Fridgewatch 2000 and 2100 Controllers



Wiring Connections to Fridgewatch 4000 and 4100 Controllers

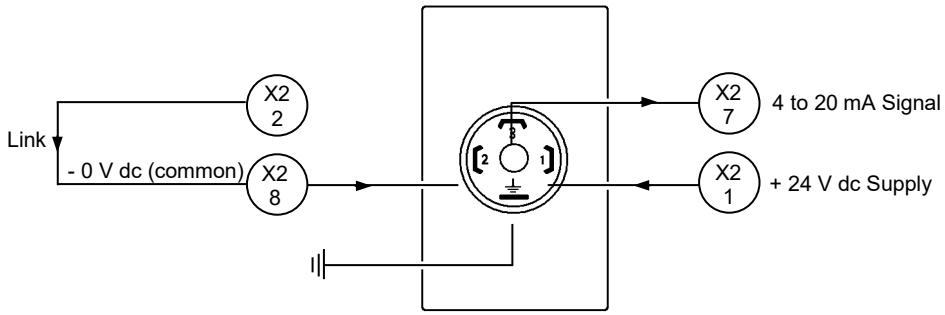


Fig 1 MSI LVDT

5. Pepperl & Fuchs Signal Conditioning Module KFU8-USC-1.D

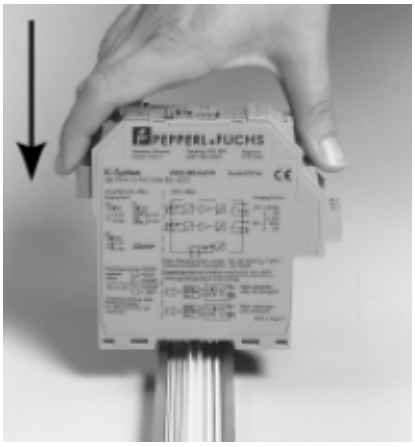
The module is suitable for DIN rail mounting; refer to Fig 2.

DANGER

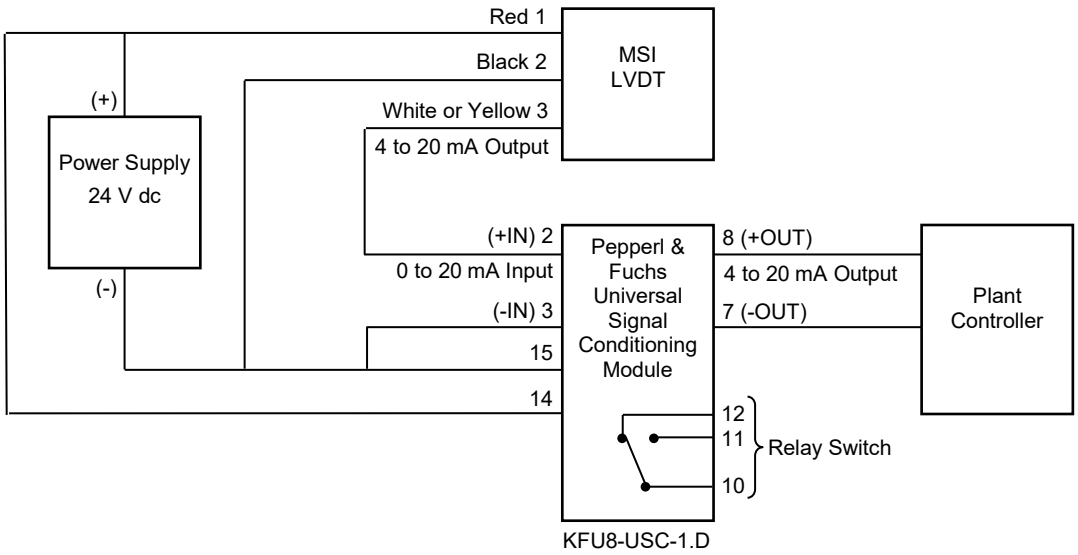
The signal conditioning module is not ATEX certified for use in hazardous areas (explosion proof). Although the module can be used with the standard MSI LVDT which is ATEX approved, the module MUST be located in a safe area.

The method of 4 to 20 mA signal calibration using the signal conditioning module is described in 5.1 Basic Set up for 4 mA and 20 mA Output Values at Minimum and Maximum Slide Valve Positions.

Pepperl & Fuchs Module KFU8-USC-1.D
Part Number 2848-601



Suitable for DIN Rail Mounting



Wiring for MSI LVDT and Pepperl & Fuchs Universal Signal Conditioning Module

Fig 2 Signal Conditioning Module

5.1. Basic Set up for 4 mA and 20 mA Output Values at Minimum and Maximum Slide Valve Positions

Refer to Table 2.

The KFU8-USC-1.D module can be used simply to calibrate the output from the MSI LVDT to provide 4 mA and 20 mA signals, at the compressor minimum and maximum slide valve positions respectively, by following the instructions in Table 2.

Setting the 'Start Value' (at minimum load) and setting the 'End Value' (at maximum load) are independent processes.

The End Value setting can be made at any time after the Start Value setting.

The values can be reset at any time.

If necessary, the unit can be reset to the factory settings by following the instructions in the Pepperl & Fuchs manual included with the unit.

5.1.1. Setting the Display to Read 0 at Minimum Load and 100 at Maximum Load

Refer to Table 3.

This procedure is optional and not necessary for the basic calibration of the signal from the MSI LVDT, however it is useful for setting a slide valve position for the relay switch.

It also provides a visual display of the slide position as if it were a percentage value.

> **NOTE: Although '%' is a unit option in the module, this cannot be used as the units for this application because it has a pre-programmed function which does not allow the required 'Factor' to be set up (also 'mA' cannot be used as a unit because this is the same as the input units). It is therefore recommended that 'I' is used for the units; this allows the 'Zero' and 'Factor' to be set to give the 0 to 100 numerical values required even though the actual unit is not meaningful.**

Unless the 'units' are reconfigured, the value displayed on the module is always the actual **input value** in mA from the LVDT.

This is not particularly meaningful for the user.

To set the relay switch trip point, the value must be in the units displayed, so if not reconfigured, this would need to be calculated from the input mA for a given slide valve position.

It is therefore easier to set the trip point if the display reads 0 at minimum load and 100 at maximum load, then the switch point trip value can be set as if it were a percentage slide valve position.

5.1.2. Setting the Relay Switch Value

Refer to Table 4.

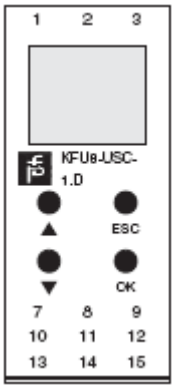
Once the display units have been reconfigured to 'I' and the display values at minimum and maximum load slide positions are 0 and 100 respectively, the switch (Trip) point can be set as a value as if it were a percentage.

The 'Hysteresis' value can also be set as equivalent to a percentage.

Depending on how it is required for the switch hysteresis to operate with rising and falling values, the module can be configured accordingly; refer to the note at the bottom of Table 4.

This is also demonstrated fully in the Pepperl & Fuchs manual included with the unit.

KFU8-USC-1.D



Display

Slide Valve Position	Action	Input		Output	
		Display	Comment	Value	Comment
Minimum load	Record value displayed on unit	6.235 mA	For example	6.235 mA	Start
	Press buttons on Display:				
	ESC + OK (together)	Unit			
	▼	Input			
	▼	Output			
	OK	Relay			
	▼	Analogue Out			
	OK	Characteristic			
	OK	0 to 20 mA	'Flashing'		
	▼	4 to 20 mA NE4	'Flashing'	6.235 mA	
	OK	4 to 20 mA NE4	Set (saved)	9.0 mA	Temporary value
	ESC	Characteristic			
	▼	Start Value			
	OK	Numeric			
	▼	Teach In			
	OK	6.235 mA	'Flashing'	9.0 mA	
	OK	6.235 mA	Start value saved	4 mA	Minimum load set
	ESC	Teach In			
	ESC	Start Value			
	ESC	Analogue Out			
	ESC	Output			
Minimum load	ESC	6.235 mA	Default screen	4 mA	

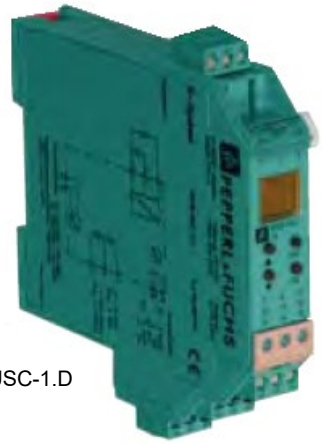
Table 2 Basic Set up for 4 mA and 20 mA Output Values at Minimum and Maximum Slide Valve Positions

Slide Valve Position	Action	Input		Output	
		Display	Comment	Value	Comment
Maximum load	Record value displayed on unit	15.76 mA	For example	15.1mA	Temporary value
	Press buttons on Display				
	ESC + OK (together)	Unit			
	▼	Input			
	▼	Output			
	OK	Relay			
	▼	Analogue Out			
	OK	Characteristic			
	▼	Start Value			
	▼	End Vlaue			
	OK	Numeric			
	▼	Teach In			
	OK	15.76 mA	'Flashing'	15.1 mA	
	OK	15.76 mA	End value saved	20 mA	Maximum load set
	ESC	Teach In			
	ESC	End Value			
	ESC	Analogue Out			
	ESC	Output			
Maximum load	ESC	15.76 mA	Default screen	20 mA	Finish
Minimum load		6.235 mA		4 mA	

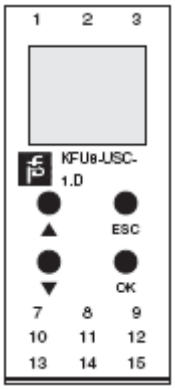
NOTE: Setting the 'Start Value' (at minimum load) and setting the 'End Value' (at maximum load) are independent processes. The End Value setting can be made at any time after the Start value setting.

Table 2 (continued) Basic Set up for 4 mA and 20 mA Output Values at Minimum and Maximum Slide Valve Positions

This procedure is optional but recommended for easy set up of the relay switch point (if used); refer to Table 4



KFU8-USC-1.D



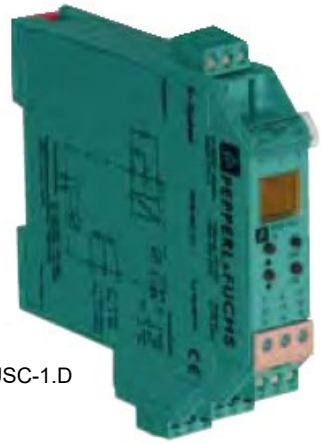
Display

Slide Valve Position	Action	Input		Output Value
		Display	Comment	
[1]Min load		6.235 mA	For example	4 mA
	Press the following buttons			
	ESC+OK (together)	Unit		
	OK	mA	'Flashing'	
	▼	[2]%	'Flashing'	
	▼	[2]I	'Flashing'	
	OK	[2]I	Unit set	
	ESC	Unit		
	▼	Input		
	OK	Type		
	▼	Zero		
	OK	4.000	'Flashing'	
	▲ ▼	6.23 mA	Set value = min load input value	
	OK	6.23 mA	Zero set	
	ESC	Zero		
	▼	Factor		
	OK	1.000	'Flashing'	
	▲ ▼	10.49	Set value = 100/(15.765 - 6.235)	
	OK	10.49	Multiplying factor set	
	ESC	Factor		
	ESC	Input		
Min load	ESC	0.000	% slide valve setting	4 mA
Max load		100.0	% slide valve setting	20 mA

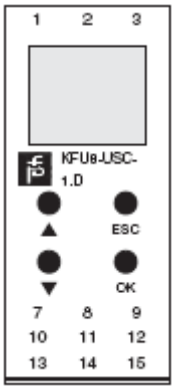
[1]Operation can be done with the slide valve in any position.
[2]The unit of % cannot be chosen for this application because of the special functionality given to it inbuilt in the unit (for example, if % is chosen as the unit then the required Factor cannot be set). Therefore it is suggested that 'I' is chosen as the unit for simplicity although it must be recognised that for this application the unit does not any real meaning, i.e. the value is dimensionless or can be interpreted as a percentage value.

Table 3 Setting the Display to Read 0 at Minimum Load and 100 at Maximum Load

Set the display to read 0 at minimum load and 100 at maximum load before setting the relay switch value



KFU8-USC-1.D



Display

Slide Valve Position	Action	Input		Output Value
		Display	Comment	
[1]Min load		0.000	For example	4 mA
	Press the following buttons			
	ESC + OK (together)	Unit		
	▼	Input		
	▼	Output		
	OK	Relay		
	OK	[2]MIN/MAX	Default set to MIN	
	▼	Trip		
	OK	102.4	For example ‘Flashing’	
	▲▼	70.00	Set value (for example) ‘Flashing’	
	OK	70.00	Trip value set	
	ESC	Trip		
	▼	Hysteresis		
	OK	20.98	For example ‘Flashing’	
	▲▼	2.000	Set value (for example) ‘Flashing’	
	OK	2.000	Hysteresis value set	
	ESC	Hysteresis		
	ESC	Relay		
	ESC	Output		
Min load	ESC	0.000		4 mA

[1]Operation can be done with the slide valve in any position.
[2]MIN setting will make/break switch at Trip value when value is falling. When value is rising, the switch will break/make at the Trip value + Hysteresis value. MAX setting will make/break switch at Trip value when value is rising. When value is falling, the switch will break/make at the Trip value – Hysteresis value; refer to pages 18 and 19 of the Pepperl & Fuchs manual included with the unit.

Table 4 Setting the Relay Switch Value

6. Part Numbers

Obtain spare parts from the address below:

J & E Hall International
Hansard Gate,
West Meadows,
Derby,
DE21 6JN
England

Telephone: +44 (0) 1332-253400
Fax: +44 (0) 1332-371061
Email: spares@jehall.co.uk
Website: www.jehall.com

6.1. MSI LVDT Old and New Designs

A new design of MSI LVDT was introduced in June 2016.

The old and new designs have the same operating characteristics and are physically identical except that:

- The new design MSI LVDT has a plastic electronics housing rather than the metal housing used in the old design; refer to Fig 1;
- The new design MSI LVDT has been issued with a new ATEX certificate; refer to 6.2 MSI LVDT for ATEX Applications.

The new design is a drop-in replacement for the old, however, the new electronics housing will not fit onto the old barrel.

Hence, when replacing an old design MSI LVDT with the new, the complete assembly must be replaced.

6.2. MSI LVDT for ATEX Applications

A special MSI LVDT version is not required for ATEX applications.

The standard MSI LVDT is ATEX approved, intrinsically safe with classification Ex ib IIC T5 (Ta <= 50 °C) thereby satisfying the minimum requirement for operation on equipment classified as Group II category 2.

- ATEX Certificate:

  Old design MSI LVDT: LCIE 09 ATEX 3011 X.

  New design MSI LVDT: 13 ATEX 3069 X.

The old and new designs of MSI LVDT are physically identical, only the ATEX certification has changed; refer to Table 5 for details.

HallScrew Compressor	MSI LVDT Design		Part Number
	Old Design MSI LVDT: ATEX Certificate LCIE 09 ATEX 3011 X	New Design MSI LVDT: ATEX Certificate 13 ATEX 3069 X	
HS 3100 series	73350007-000	73350007-001	N05390008
HS 3200 series			
HS 4200 series	73350002-000	73350002-001	N05390007
HSO 2024	73350003-000	73350003-001	N05390009
HSO 2028	73350004-000	73350004-001	N05390010
HSO 5200 V_R series			
HSO 2031	73350005-000	73350005-001	N05390011
HSO 2035	73350006-000	73350006-001	N05390012
HSO 6200 V_R series			
'O' ring 31.5 ID x 3.0 – MSI LVDT connector to discharge end cover			N14060228
Pepperl & Fuchs signal conditioning module KFU8-USC-1.D			N05250068

Table 5 MSI LVDT Part Numbers

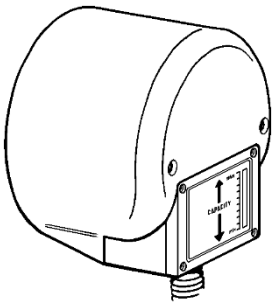
6.3. LVDT or NLVDT to MSI LVDT Conversion Kit

HallScrew HSO 2018 to HSO 2035 compressors fitted with an LVDT or NLVDT can be converted to the MSI LVDT by purchasing the appropriate kit of parts; refer to Table 6.

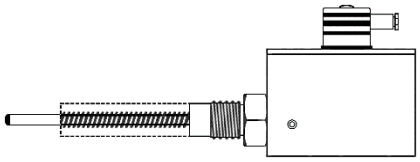
The kit includes:

- MSI LVDT;
- Pepperl & Fuchs signal conditioning module KFU8-USC-1.D;
- Capacity control piston (compatible with the MSI LVDT);
- Gaskets, ‘O’ rings and lockwashers;
- Comprehensive instructions.

Convert from LVDT or NLVDT



to MSI LVDT



HallScrew Compressor	Conversion Kit
HSO 2018	N05390025
HSO 2020	N05390026
HSO 2022	N05390027
HSO 2024	N05390028
HSO 2028	N05390030
HSO 2031	N05390029
HSO 2035	N05390031

Table 6 LVDT or NLVDT to MSI LVDT Conversion Kits