



Factory Mutual Research

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5W1A0.AX
(3610)

June 16, 1993

TWO WIRE TRANSMITTERS FOR HAZARDOUS LOCATIONS

from

MINCO PRODUCTS INCORPORATED
7300 COMMERCE LANE
MINNEAPOLIS, MINNESOTA 55432

I INTRODUCTION

1.1 Minco Products Incorporated requested Approval of the apparatus listed in Section 1.2 to be in compliance with the applicable requirements of the following standards:

<u>Title</u>	<u>No.</u>	<u>Issue Date</u>
Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1, Hazardous (Classified) Locations	3610	October 1988

Note: Factors applied to voltage or current

Electrical Equipment for Use in Hazardous (Classified) Locations General Requirements	3600	March 1989
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1.2 The following was evaluated as intrinsically safe with entity for use in Class I, Division 1, Group A, B, C and D indoor hazardous locations in accordance with Minco Products Drawing No. INST 704, Rev. A, and will appear in the Approval Guide as follows:

IS/I/1/ABCD - INST 704/A; Entity

Entity Parameters: $V_{max} = 35V$, $I_{max} = 150 \text{ mA}$, $C_i = 0$, $L_i = 0$

Two Wire Transmitter. Model aTTbcl d

a = Calibration code, X or blank.

b = Transmitter model 176, 190, 210, 211, 216, 220, 221, 230, 676, 710, 711 or 720.

c = One or two letter sensor element code, A through Z or AA through ZZ.

d = One or two letter temperature code, A through Z or AA through ZZ.

1.3 The transmitters listed in Section 1.2 have been previously Approved by FMRC under J.I. OT5A1.AX, 1V3A0.AX, OWOA9.AX and 5W1A0.AX as nonincendive for use in Class I, Division 2, Groups A, B, C and D indoor hazardous (classified) locations. This report supplements those previous examinations.

II DESCRIPTION

The transmitters detailed within Section 1.2 are two wire 4-20 mA temperature transmitters containing electronics encapsulated within a molded plastic housing. The models utilize the same electronic layout and differ only in the sizing of components. Application of the transmitters vary only in input type, either thermocouple or RTD, and whether the temperature range is fixed or adjustable. Each of the transmitter models utilizes a supply voltage between 8.5 to 45 VDC while generating an output of 4-20 mA over a specified temperature range.

III EXAMINATION AND TESTS

3.1 General

A representative sample of each transmitter specified in Section 1.2 was examined and tested to determine their acceptability for use in the specified hazardous locations. The examination included circuit analysis and temperature measurements as well as a review of the manufacturer's documentation and the equipments physical construction. All were satisfactory and are summarized in the following sections.

3.2 Entity Examination

3.2.1 Under "Entity" requirements, the concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such combination. The criteria for interconnection is that the voltage (V_{max}) and current (I_{max}) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal to or greater than the voltage (V_{oc} or V_t) and current (I_{sc} or I_t) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (C_i) and inductance (L_i) of the intrinsically safe apparatus, including interconnecting wiring, must be equal to or less than the capacitance (C_a) and inductance (L_a) that can safely be connected to the associated apparatus. If these criteria are met, then the combination may be connected.

3.2.2 Minco Products requested that the maximum input voltage to the transmitters be specified on the installation drawing as $V_{max} = 35V$. The maximum input current to the transmitters will also be detailed on the installation drawing as $I_{max} = 150$ mA.

3.2.3 The Model 210, 211, 710 and 711 Transmitters contain no capacitance within the circuitry. Therefore, the unprotected capacitance will be designated as $C_i = 0$.

3.2.4 The Model 176, 190, 216, 220, 221, 230, 676 and 720 transmitters contain two series redundant Type 1N4148 blocking diodes at the input. Based on the position of these components within the circuitry, the unprotected capacitance of these transmitters will be indicated as $C_i = 0$.

3.2.5 The Model 210, 211, 710 and 711 Transmitters contain no inductance within the circuitry. Therefore, the unprotected inductance will be designated as $L_i = 0$.

3.2.6 The Model 176, 190, 216, 230 and 676 transmitters contain one 33 uH coil, designated as L_1 , within the circuitry. More than two faults are required to remove circuitry that would allow the coil to become unprotected at the input. Therefore, the maximum unprotected inductance will be designated as $L_i = 0$.

3.2.7 The Model 220, 221 and 720 transmitters contain one 33 uH coil, designated as L_1 , and one transformer, designated as T_1 , within the circuitry. As in Section 3.2.5, more than two faults are required to remove circuitry that would allow the coil, L_1 , to become unprotected at the input. Additionally, parallel redundant Type Schottky rectifier diodes are placed across the windings of the transformer preventing discharge of energy onto the field wiring. Therefore, due to the configuration of the circuitry the maximum unprotected inductance will be designated as $L_i = 0$.

3.2.8 Based upon the unprotected capacitance and inductance values stated above, the maximum entity parameters will be stated as follows:

$$V_{max} = 35V, I_{max} = 150 \text{ mA}, C_i = 0, L_i = 0$$

3.2.9 A review of previous Division 2 temperature measurements taken on the external surface of the potted transmitter circuitry during their respective Approval examinations showed no appreciable rise in temperature and identification marking was not previously required. It was determined that the entity parameters requested would not affect the previous test results with faults applied to the circuitry. Therefore, temperature identification marking in accordance with the National Electrical Code is not required.

3.2.10 The outputs of the transmitters are connected only to simple apparatus devices (thermocouples and RTD's). Analysis determined that the maximum energy that may be discharged at these components, in the event of a field wiring fault, would not exceed the energy available from the associated apparatus. Therefore, no additional analysis was deemed necessary.

3.2.11 Analysis confirmed that protective components are operated within two-thirds of their ratings under normal operating conditions.

3.2.12 Creepage and clearance distances within the encapsulated circuitry of the transmitters, affecting intrinsic safety, were found to meet the maximum requirement of 1.0 mm (0.039 in.) for circuits operating up to a maximum voltage of 60V. The printed circuit boards have a maximum CTI rating of 175. No further analysis was deemed necessary.

3.3 System Examination

3.3.1 The installation drawing identified in Section 1.2 details connection of the transmitters to intrinsic safety barriers located within the nonhazardous location. Examination and tests by FMRC on these intrinsic safety barriers was previously conducted under normal and one fault conditions with a 1.5 factor and under two fault conditions with a factor of 1.0. Under these conditions the barriers are known to have intrinsically safe connections for specific group locations. Listed below are the maximum output parameters as determined by FMRC.

<u>Manufacturer/Model</u>	<u>Groups</u>	<u>1 Fault (volts/mA)</u>	<u>Ca (uF)</u>	<u>La (mH)</u>
R. Stahl Inc.				
9001/01-280-100-10	A-G	29.5/105.2	0.11	3.2
9001/51-280-091-14	A-G	28.4/89.4	0.14	4.4
9001/51-280-110-14	A-G	28.4/107.3	0.14	3.1
9002/13-280-110-00	A-G	28.4/0	0.12	1000
Measurement Technology Limited				
702+	A-G	25.1/125	0.17	2.2
706+	A-G	28.1/93	0.12	4.0
787S+	A-G			
Terminal 3		28.5/93	0.11	4.0
Terminal 4		1.2/0	1000	1000
Terminal 3-4		29.7/93.5	0.1	4.0
788+	A-G			
Terminal 3		28.1/93	0.12	4.0
Terminal 4		10.0/1889	3.0	1.0
Terminal 3-4		10.0/1889	3.0	1.0
2441	A-G	29.4/96.7	0.11	4.0
3041	A-G	28.0/93	0.13	4.0
3046B	A-G			
Terminal 5-6		28.0/3.0	0.13	4.0
Terminal 6-8		1.2/100	1000	3.75
4041	A-G	28.0/93	0.13	4.2

Pepperl + Fuchs Inc.

KHP-103/EX-1A	A-G	28.0/98	0.12	3.7
KHP-104/EX-2A	A-G			
Terminal 1-2		28.0/98	0.12	3.7
Terminal 1-3		28.0/0	0.12	1000
KHP-105/EX-2A	A-G			
Terminal 1-2		28.0/98	0.12	3.7
Terminal 1-3		28.0/98	0.12	3.7
KHZ-907/EX	A-G			
Terminals 1-4		27/109	0.16	3.0
Terminals 3-6		27/109	0.16	3.0
Terminals 14-17		27/109	0.16	3.0
Terminals 2-5		27/0	0.16	2.52
Terminals 13-18		27/0	0.16	2.52
Terminals 15-18		27/0	0.16	2.52
Terminals 1-2-3-4-5-6-13-14-17-18		27/118	0.13	2.52
KHZ-428/EX3	A-G			
Terminals 1-4		27/90	0.16	4.66
Terminals 2-5		27/90	0.16	4.66
Terminals 3-6		27/90	0.16	4.66
KHZ-487/EX3	A-G			
Terminals 1-4		27/90	0.16	4.66
Terminals 2-5		27/0	0.16	1000
Terminals 3-6		27/90	0.16	4.66
Terminals 13-16		27/0	0.16	1000
Terminals 14-17		27/90	0.16	4.66
Terminals 15-18		27/0	0.16	1000
Z130/EX	A-G	23.8/121.4	0.10	2.5
Z428/EX	A-G	26.6/88.6	0.14	4.6
Z479/EX	A-G			
Terminal 13-4		26.6/88.6	0.14	4.6
Terminal 23-4		26.6/88.6	0.14	4.6
Z487/EX	A-G			
Terminal 13-4		26.6/88.6	0.14	4.6
Terminal 23-4		26.6/0	0.14	1000

3.3.2 The parameters of the barriers listed in Section 3.3.1 are lower than those of the entity parameters listed in Section 3.2. Therefore, the barriers may be connected to the transmitters as detailed within the installation drawing referenced within Section 1.2.

IV MARKING

The following information appears on the apparatus identified in Section 1.2 and meets FMRC requirements.

- Manufacturer's name and address
- Model number and date code
- Input voltage rating and output connections
- The words, "CL I, DIV 1 & 2, GP A, B, C, D, ENTITY PER DWG NO. INST 704".
- The Factory Mutual Research Corporation mark of Approval

V REMARKS

5.1 Installation shall be in accord with the manufacturer's instructions, the National Electrical Code (ANSI/NFPA 70) and ANSI/ISA, "Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations".

5.2 Tampering and replacement with nonfactory components may adversely affect the safe use of the system.

VI FACILITIES AND PROCEDURES AUDIT

Minco Products Incorporated has design and manufacturing facilities in Minneapolis, Minnesota that are subject to follow-up audit inspections. The facilities and quality control procedures in place have been found satisfactory to manufacture product identical to that examined and tested as described herein.

VII MANUFACTURER'S RESPONSIBILITIES

7.1 Documentation that is applicable to this Approval is on file at Factory Mutual Research Corporation and listed in Documentation File, Section VIII of this report. No changes of any nature shall be made unless notice of the proposed change has been given and written authorization obtained from Factory Mutual Research Corporation. The Approved Product - Revision Report, Factory Mutual Research Corporation Form 797, shall be forwarded to Factory Mutual Research Corporation as notice of proposed changes.

7.2 For installation of the transmitters within a Division 2 hazardous (classified) location, the manufacturer shall inform the end user of details of the transmitter enclosure requirements as detailed within FMRC J.I. 0T5A1.AX, 1V3A0.AX, 0W0A9.AX and 5W1A0.AX. Further enclosure requirement details may be found in ANSI/ISA S82.01, S82.02 and S82.03 Standard.

7.3 The manufacturer shall supply copies of the installation drawings referenced in Section 1.2 with each transmitter. Copies of the installation drawings shall also be made available to the installer upon request.

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VIII DOCUMENTATION FILE

<u>Document No.</u>	<u>Revision</u>	<u>Title</u>
INST 704	A	Control Document System Approvals For Intrinsically Safe Transmitters
390-02900	B	TT176/TT676 Transmitter Assembly Drawing
390-02901	B	TT216 Transmitter Assembly Drawing
390-02902	B	TT190 Transmitter Assembly Drawing
390-02903	B	TT230 Transmitter Assembly Drawing
395-02900	B	TT176/TT190/TT216/TT230/TT676 Schematic Diagram
TT220	A	Temptran Temperature Transmitter Model TT220
TT221	A	Temptran Temperature Transmitter Model TT221
TT720	A	Temptran Temperature Transmitter Model TT720
390-04400	A	TT220/TT720 Assembly Drawing
390-04401	A	TT221 Assembly Drawing
395-04400	A	TT220/TT221/TT720 Schematic Diagram
390-04500	A	TT220/TT221/TT720 Assembly Diagram
395-04500	A	TT220/TT221/TT720 Schematic Diagram
330-60004	B	Model/Range Label Drawing
390-05800	B	TT210/TT211/TT710/TT711 Assembly Drawing
395-05800	B	TT210/TT211/TT710/TT711 Schematic Diagram

IX CONCLUSION

The apparatus described in Section 1.2 meets FMRC requirements. Approval is granted when the Approval Agreement is signed and received by FMRC.

EXAMINATION AND TESTS BY: R. H. Allen

ORIGINAL DATA: Test Notebook No. 93-304

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