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# APPROVAL REPORT

## PAK-BOX MK2 TYPE PB1 AND PB2 CONTROL ASSEMBLIES FOR HAZARDOUS (CLASSIFIED) LOCATIONS

### Prepared for:

**Rotork Controls Ltd.  
Brassmill Lane  
Bath BA13JQ  
England**

**Project ID. 3D7A5.AE  
Class 3615  
Date: October 24, 2001**

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**PAK-BOX MK2 Type PB1 and PB2 Control Assemblies  
FOR  
HAZARDOUS (CLASSIFIED) LOCATIONS  
October 24, 2001**

from

**Rotork Controls Ltd.  
Brassmill Lane  
Bath BA13JQ  
England**

**I INTRODUCTION**

1.1 Rotork Controls Ltd. (manufacturer) requested Factory Mutual Research Approval of the PAK-BOX MK2 Type PB1 and PB2 Control Assemblies as explosionproof for Class I, Division 1, Group C and D; dust-ignitionproof for Class II, Division 1, Groups E, F and G hazardous (classified) locations, indoors and outdoors (NEMA 4 and 6). Examination and testing of PAK-BOX MK2 Type PB1 and PB2 Control Assembly was conducted by SIRA Certification Service based on inter-laboratory agreement with Factory Mutual Research.

1.2 This Report may be reproduced only in its entirety and without modification.

1.3 **Standards:**

<b>Title</b>	<b>Class Number</b>	<b>Date</b>
Electrical Equipment for Use in Hazardous (Classified) Locations, General Requirements	3600	November 1998
Explosionproof Electrical Equipment	3615	March 1989
Electrical and Electronic Test, Measuring and Process Control Equipment	3810 (Including Supplement #1)	March 1989 (July 1995)
Enclosures for Electrical Equipment	ANSI/NEMA 250	1991

1.4 **Listings:** The product will appear in the Factory Mutual Research Approval Guide as follows:

**PAK-BOX MK2 Type PB1 and PB2 Control Assemblies**  
XP//I/CD/T4 Ta = 70°C; DIP//II/EFG/T4 Ta = 70°C; Type 4 and 6.

Note: Pak-Box MK2 Type PB1 and PB2 are provided with the following non-model code options such as conduit hole position and size (Maximum of 20 each 3/4" NPT and 4 each 1 1/2" NPT) and fixings (no brackets, wall brackets or pipe brackets). In addition the Pak-Box MK2 Type PB2 is provided with a non-model code voltage option of 110Vac or 230Vac.

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## II DESCRIPTION

- 2.1 General - The explosionproof enclosure used for both the Pak-Box MK2 Type PB1 and Type PB2 control assemblies consists of a base and bolt on cover constructed of cast aluminum. The cover connects to the base via a spigot type joint and is secured with four screws. The base can be supplied with a maximum of 24 conduit entries (20 each 3/4"NPT and 4 each 1 1/2"NPT). These units are stand alone units that can be pole or wall mounted for use with a Rotork Actuator or other suitably rated electrical equipment.
- 2.2 PAK-BOX MK2 Type PB1 Control Assembly - The PAK-BOX MK2 Type PB1 Control Assembly contains a disconnect switch and control terminals mounted in one cast aluminum enclosure as described in Section 2.1. The cover of this enclosure forms a cylindrical joint with the actuator shaft which passes through the cover to the switch handle assembly. The switch unit rated at up to 600VAC and 25A, is connected so that when turned it will interrupt power to the Rotork actuator or other suitably rated electrical equipment.
- 2.3 PAK-BOX MK2 Type PB2 Control Assembly - The PAK-BOX MK2 Type PB2 Control Assembly is comprised of one main explosionproof enclosure and one control explosionproof enclosure. The PAK-BOX MK2 Type PB2 Control Assembly main enclosure is similar to the enclosure used for the Type PB1 Control Assembly and described in Section 2.1. This main enclosure consists of control terminals that convey power to the Field Control Unit in the attached control explosionproof enclosure. The control explosionproof enclosure is bolted onto, and forms a flamepath with, the top wall of the PAK-BOX MK2 Type PB2 Control Assembly main enclosure. The control enclosure contains the Field control Unit which controls and monitors communication with the interconnected actuator. Cabling between the two enclosures is accomplished through a bushing constructed of resin compound, mounted in the intercompartmental wall. These two explosionproof enclosures bolted together are the PAK-BOX MK2 Type PB2 Control Assembly. This assembly like the PAK-BOX MK2 Type PB1 Control Assembly can be either pole mounted or wall mounted.

## III EXAMINATIONS AND TESTS

The attached SIRA Test Report No. R51G4958E, describe the examination and testing that SIRA performed towards Factory Mutual Research Approval of the PAK-BOX MK2 Type PB1 and PB2 Control Assembly. A review of the SIRA report found that examination and testing of the PAK-BOX MK2 Type PB1 and PB2 Control Assembly to be satisfactory for Factory Mutual Research Approval.

All data is on file at Factory Mutual Research along with other documents and correspondence applicable to this program. The following satisfactory examination and tests for the PAK-BOX MK2 Type PB1 and PB2 Control Assembly were abstracted from the SIRA report and from the Manufacturer's design documentation that Factory Mutual Research controls.

- Explosionproof examination and testing for Class 1, Division 1, Groups C and D hazardous (classified) locations in an ambient temperature of 70°C with a temperature code designation of T4.
- Dust-ignitionproof examination and testing for Class II, Division 1, Groups E, F and G hazardous (classified) locations in an ambient temperature of 70°C with a temperature code designation of T4.
- Environmental NEMA Type 4 and 6 examination and testing.
- Examination and testing to verify protection against injury and shock.

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**IV MARKING**

The PAK-BOX MK2 Type PB1 and PB2 Control Assemblies are provided with the information specified on drawing 41777-03 permanently marked with stainless steel labels permanently attached to each unit by stainless steel drive screws.

**V REMARKS**

Installations shall comply with the relevant requirements of the latest edition of the National Electrical Code (ANSI/NFPA 70), and the manufacturer's installation instructions.

**VI FACILITIES AND PROCEDURES AUDIT**

Rotork Controls Ltd design and manufacturing facilities located in Bath, England is subject to the Factory Mutual Research follow-up audit program. The facilities and quality control procedures have been found to be satisfactory to manufacture product identical to that tested and Approved.

**VII MANUFACTURERS RESPONSIBILITIES**

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

7.2 On 100% of production, the manufacturer shall inspect for the presence of the protective ground terminal on the PAK-BOX MK2 Type PB1 and PB2 Control Assembly.

7.3 On 100% of production, the PAK-BOX MK2 Type PB1 and PB2 Control Assembly will be dielectric tested. The power input connections shall withstand for one minute, with no insulation breakdown, the application of 2300 Vac with respect to the secondary circuits. The power input connections shall withstand the a shall withstand for one minute, with no insulation breakdown, the application of 1350 Vac with respect to the protective ground terminal

**WARNING:** The dielectric test required may present a hazard og injury to personnel and/or property and should only be performed under controlled conditions, and by persons knowledgeable of the potential hazards of such testing to minimize the likelihood of shock and/or fire.

7.4 On 100% of production, the PAK-BOX MK2 Type PB1 and PB2 Control Assemblies will be Hydrostatic Pressure tested to a pressure of three times the maximum ignition test pressure of 190psi (1310kPa), or 570psi (3930kPa) for a period of one minute. After the successful completion of the Hydrostatic Pressure test, the PAK-BOX MK2 Type PB1 and PB2 Control Assemblies will have their flamepath gap dimensionally verified to be unaffected by the Hydrostatic Pressure test by a calibrated tool against Rotork drawing #AD1024-03.

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**VIII DOCUMENTATION**

The following documentation is applicable to this equipment and is on file at Factory Mutual Research under Factory Mutual Research J.I. No. 3D7A5.AE. 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. The Approved Product - Revision Report, Factory Mutual Research Form 797, shall be forwarded to Factory Mutual Research as notice of proposed changes.

<b>Drawing No</b>	<b>Drawing Title</b>	<b>Revision</b>
1014-329	TRANSORMER SPECIFICATIONS, PB2	06-24-92
41664-01	TRANSFORMER ASSEMBLY, PB2	01
41777-03	NAMEPLATE	03
AD1012-01	SCHEMATIC, PB2	01
AD1024-03	ASSY, PB1, SHEET1 OF 2	03
AD1024-03	ASSY, PB2, SHEET 2 OF 2	03
WD07288-02	CIRCUIT DIAGRAM, PB2	02
WD07298-03	CIRCUIT DIAGRAM, PB1	03
AD1161-01	MK2 PAK-BOX CONDUIT ENTRY DETAILS/SHEET 1 OF 2	01
AD1161-01	MK2 PAK-BOX CONDUIT ENTRY DETAILS/SHEET 2 OF 2	01
552	INSTRUCTION MANUAL	10/15/01
P130	PROCESS INSTRUCTION	1

**IX CONCLUSION**

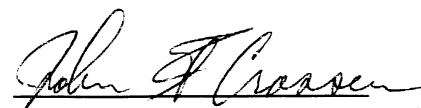
The PAK-BOX MK2 Type PB1 and PB2 Control Assemblies described in this report meet Factory Mutual Research Approval requirements. Approval is effective when the Approval Agreement is signed and received by Factory Mutual Research.

**EXAMINATION AND TESTING BY:** Steven Otty, Sira Certification Service.

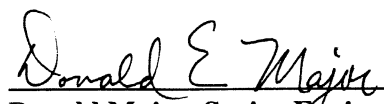
**EXAMINATION BY:** John F. Crossen, Factory Mutual Research

**ATTACHMENTS:** SIRA Test Report No. R51G4958E Dated October, 2001.  
Nameplate Drawing # 41777-03  
Publication #S160E  
Publication #S161E

**REPORT BY:**

  
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**ASSESSMENT REPORT**

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Date: October 2001

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**Mk2 Pak-Box**

**Rotork Controls Limited**  
**J.I. 3D7A5.AE**

**Report No: R51G4958E**  
**Commercially in Confidence**

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# ASSESSMENT REPORT

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## 1 INTRODUCTION

This report has been re-issued as R51G4958E to correct and clarify test parameters.

**Carried out by SCS on behalf of:** Rotork Controls Limited  
 Brassmill Lane  
 Bath  
 BA1 3JQ  
 UK

**Equipment:** Mk 2 Pak-Box

**FM number:** J.I. 3D7A5.AE

**Tests Conducted Between:** March 1998 and August 2001

Unless otherwise stated, all test and measurements are recorded in ST&C laboratory note book no: 51G4958.

Rotork Controls Limited requested approval of the apparatus listed in section 1.2 to be in compliance with the applicable requirements of the following standards:

Title	Author/Number	Date
Electrical Equipment for use in Hazardous (Classified) Locations – General Requirements	FM3600	Nov 1998
Explosionproof Electrical Requirements – General Requirements	FM3615	1989
Electrical and Electronic Test, Measuring and Process Control Equipment.	FM 3810	1989
Enclosures for Electrical Equipment.	NEMA 250	1988
Safety Standards for Electrical and Electronic Test, Measuring, Control and Related Equipment	ANSI/ISA – S82.01	1994

The equipment being designated explosion proof for Class I, Div. 1, Groups C and D and Class II, Div 1 Groups E, F and G, indoor and outdoor (NEMA Type 4, 6) hazardous (classified) locations.

Factory Mutual Global job identification number J.I 3D7A5.AE.

This report refers to the performance of the test samples when tested against the agreed programme. It does not imply that any other samples or products necessarily comply with the requirements of the test programme. In addition, whilst this report may be freely reproduced as a complete document, it may not be abstracted.

## 2 DESCRIPTION

The Mk2 Pak-Box Enclosure has two design Options:

**The PB1 Enclosure** is rated at up to 600 V and comprises a cast aluminium alloy case with a bolt-on cover forming an explosionproof enclosure. The unit contains a switch assembly, the actuator shaft of which passes through the cover, and termination facilities. The case/cover joint is optionally machined for the fitting of an 'O' ring seal. The switch unit is rated at up to 600 V and 25 A for UL and additionally complies with IEC 947-3 .The power terminals comply with UL 24-6 AWG and rated at up to 600 V and 35 A each.

Up to 24 apertures are provided in the side walls of the enclosure for the fitting of suitably dimensioned and certified cable entry components.

**The PB2 Enclosure** is rated at up to 250 V maximum and utilises the same case as the PB1 but with the switch arrangement substituted by up to 35 rail mounted suitably certified terminal assemblies, additionally complying with UL 28-16 AWG, with a maximum terminal resistance of 1.7 mΩ per terminal. The actuator shaft aperture is omitted and the cover left solid at this position. The case/cover 'O' ring seal is mandatory in this variant. The terminals are rated at up to 600 V, 10 A each.

An explosionproof control enclosure is bolted to, and forms a flamepath with, the top wall of the enclosure. The enclosure contains control and monitoring circuitry. Cabling between the two enclosures is via an aperture in the intercompartmental wall. Optionally fitted with a spigot fitting multi-core bushing. The main/control enclosure joint is coated with a non-setting sealing compound.

## 3 SAMPLES

The following samples were received for assessment and test purposes:

<b>Samples received</b>	<b>Quantity</b>	<b>Sample number</b>	<b>Date received</b>
Pak-Box (PB2)	1	Mk 2/#1	04 Mar 98
Pak-Box (PB1)	1	Mk 2/#2	04 Mar 98
Cable bushings	2	Mk 2/#3 & #4	04 Mar 98
Modified Pak-Box (PB2)	1	Mk 2/#4	01 Sep 98
Modified Pak-Box (PB2)	1	Mk 2/#5	16 Dec 98

Assessment and tests conducted between January 1999 and March 2000

## 4 MARKING

The label carries the following information:

The manufacturer's identifications:	Rotork
A unique serial number:	####
The type identification:	Mk 2 Pak-Box
The type of protection concerned:	Explosionproof – FM 3615
The class, division and group rating:	Class I, Div. 1, Groups C and D Class II, Div 1 Groups E, F and G
Maximum operating temperature (referred to as XX°C ambient):	T4 (tamb = 70°C)
Precautionary information:	"to prevent ignition of hazardous atmospheres, do not remove cover whilst circuits are live" or equivalent wording. " Warning – potentially hot surface"
The FM logo:	
Warning label:	"Torque cover bolts to 21 lbf/ft max" "use conductors rated at 97°C or better"
The equipment rating:	XXXX (as applicable)
The enclosure rating:	NEMA 4, 6

## 5 ASSESSMENTS, EXAMINATIONS AND TESTS

### 5.1 Materials

The housing and covers were manufactured from aluminium alloy containing less than 6% magnesium by weight. It is considered that the material is not chemically reactive with any other materials with which it may be installed.

The optional bushing is filled with resin compound, Robnorganic EL 116F. However, as the equipment was tested without the bushing fitted, further evidence of design and material compliance was not required.

### 5.2 Explosionproof joints

Approximate internal free volumes:	Main chamber (PB1 & PB2)	– 7920 cm <sup>2</sup>
	Electronics chamber (PB2)	– 1233 cm <sup>2</sup>

### 5.2.1 Joint parameters

Joint	Type of Joint	Design Parameters	Measured Parameters
Main chamber cover/case (PB1 & PB2)	Flange	12.5mm path length (excluding 'O' ring seal). Max gap 0.08 mm	Gap increased to 0.12 mm for safety factor testing.
Actuator shaft/cover (PB1)	Cylindrical	25 mm path length. Max gap 0.13 mm	25 mm reduced to 18.75 mm for safety factor testing. Gap = 0.10 mm.
Electronics cover/case (PB2)	Flange	12.5 mm path length Max gap 0.08 mm	Gap increased to 0.12 mm for safety factor testing.
Conduit openings (PB1 & PB2)	Threaded	Up to 4 off 1½" NPT or Up to 20 off ¾" NPT	4 off 1½" NPT in LH wall 20 off ¾" NPT in RH wall

Note:

- a The equipment was tested without the bushing fitted and therefore this is disregarded in respect of flamepaths.
- b The electronics cover/case joint was not coated with the sealing compound.

### 5.2.2 Joint Security

Joint	Design securing method	Examined securing method
Main chamber cover/case (PB1) & PB2)	12 off M8 screws – grade 12.9 min	Sufficient depth of hole and clearances around holes provided.
Actuator shaft/cover (PB1)	Circlip	Adequate engagement of clip
Electronics cover/case (PB2)	6 off M8 screws – grade 12.9 min	Sufficient depth of hole and clearances around holes provided.
Conduit openings (PB1 & PB2)	Approved entries declared	Not required to be fitted on sample.

## 5.3 Mechanical Strength

### 5.3.1 Drop Tests

As this equipment was considered fixed apparatus, the drop tests prescribed in 5.1.1 of FM 3600 were waived.

### **5.3.2 Impact Tests**

Both chambers of the PB2 enclosure were subjected to impact tests exceeding the requirements of 5.1.2 of FM 3600. Impacts of 7 J were applied at various locations using 25 mm spherical steel tipped weight.

Surface marking only was noted with no further damage or deformation evident as a result of the tests.

### **5.3.3 Thermal Shock**

Both chambers of the PB2 enclosure were subjected to tests for resistance to thermal shock, as required by clause 5.1.3 of FM 3600. The unit was heated to 155°C (which exceeded the maximum surface temperature determined under test) and a cloth saturated in water at 10°C was applied to the external surfaces. The test was repeated five times.

No visible damage or deformation was evident as a result of the tests.

## **5.4 Non-metallic parts of the enclosure (PB2)**

Because the bushing was not fitted during testing the bushing seal non-metallic material was not subjected to testing or verification.

The electronics enclosure cover/case joint was sealed by means of the addition of a non-setting compound to the flanges. It was confirmed that, when the compound was fitted, the maximum joint gap remained in compliance with Tables C and D of FM 3615. The manufacturer confirmed that, once assembled, it was not intended that the electronics enclosure should be opened during installation of servicing.

## **5.5 Joint Securing Fasteners**

### **5.5.1 Design Parameters**

The main cover of both the PB1 and PB2 was secured by 12 off M8 screws and the electronics cover by 6 off M8 screws. It was noted that the fixing holes did not pass through the walls of the enclosure and at least  $\frac{1}{8}$ " (3.2 mm) of material remained at the base of each hole.

### **5.5.2 Fixings Torque Test**

Two of the cover fixings were tightened until damage occurred or the maximum specified torque of the screw was reached. The enclosure threads became damaged at 21 lb/ft (60 Nm) which is below the specified torque of the screws. Therefore a suitable warning label shall be fitted to the equipment.

## **5.6 Conduit openings**

### **5.6.1 Design parameters**

20 off  $\frac{3}{4}$ " NPT and 4 off  $1\frac{1}{2}$ " NPT conduit openings were provided into the main chamber.

## 5.6.2 Conduit Torque tests

One of each size of opening was subjected to a conduit torque test as required by clause 4.2 of FM 3615. A suitably threaded steel plug was screwed into the opening and tightened to the figures in the following table. The plug was then removed and the opening inspected for evidence of damage.

Entry Size	Torque lb/ft (Nm)	Results
¾" NPT	67 (90)	No damage to thread noted.
1. ½" NPT	83 (113)	No damage to thread noted.

## 5.7 Gaskets and sealing

The gaskets fitted in the main cover/case joint (PB1 & PB2) were neoprene 'O' ring seals. The seals were applied as supplements to and not a part of, the flamepath portion of the joints, as required by clause 3.3.5 of FM 3615. The prescribed joint dimensions were un-effected by their inclusion.

The electronics enclosure cover/case joint (PB2) was sealed by means of the addition of a non-setting compound to the flanges. It was confirmed that, when the compound was fitted, the maximum joint gap remained in compliance with Tables C and D of FM 3615. The manufacturer confirmed that, once assembled, it was not intended that the electronics enclosure should be opened during installation of servicing.

## 5.8 Environmental tests

The equipment was subjected to the tests required for NEMA 4 rated enclosures, as defined in NEMA 250:1991. The equipment tested was the PB2 enclosure fitted with a PB1 main cover, such that all optional joints were tested.

### 5.8.1 Ingress protection

The equipment was subjected to the hosedown test required by clause 6.7 of NEMA 250. The equipment was subjected to a stream of water from a 1 inch diameter nozzle at a flow rate in excess of 246 litres/minute. The water was directed from different directions from a distance of between 10 and 12 feet for a duration of five minutes. At the end of the test duration the covers were removed and the equipment examined for evidence of ingress of water into the enclosure.

No ingress of water was evident as a result of the test an, as such, shows compliance with NEMA 4.

The equipment was further subjected to tests for ingress protection level IP 68 as defined by EN 60529 (IEC 529). The immersion (X8) depth was 2m for a duration of 8 hours. With no ingress of water observed. The dust test was for a duration of 8 hours with no ingress of dust observed. From Appendix A of NEMA 250, it is considered that this shows compliance with the requirements NEMA 6 and that the equipment is 'dust tight'.

## 5.8.2 Icing and corrosion tests

Icing tests, defined in clause 6.6 of NEMA 250, were waived, as any build up of ice was not considered to be a threat to the integrity of the enclosure.

The equipment was constructed of LM 25 aluminium to BS 1490 and, as such, has a known corrosion resistance in excess of that required by clause 6.9.1 of NEMA 250. It was considered that further testing was not required.

This can be considered as an adequate indication of compliance with NEMA 4 and 6 requirements.

## 5.9 Thermal tests

The PB2 variant was tested as this was considered to dissipate the maximum power. The maximum ratings were determined as:

Enclosure	Voltage (V)	Power (kW)
Main Enclosure – PB2 version	550 ac	338.25
<b>Electronics chamber</b>		
Externally switched circuits	30 dc	0.06
Control circuits	24 dc	0.0005

The sample unit was tested by inducing maximum power dissipation + 10% and measuring the internal and external surfaces at a number of points. The power was removed when the temperature had stabilised, however temperature monitoring continued until internal temperatures and thermal lag had been accounted for.

The following temperatures were determined:

The maximum external surface temperature rise was measured at the centre of the main cover and was 12 K.

adjusted for a 70°C ambient and adding a 5 K safety factor = 87.0°C

The maximum internal surface temperature rise was measured inside the terminal cable bunch and was 21.3 K

adjusted for a 70°C ambient and adding a 5 K safety factor = 96.3°C

A dust blanket test was not applied as it was considered that this would not effect the T4 rating of the equipment.

The following labels shall be fitted:

“use conductors rated at 96.3°C or better” or equivalent wording, should be fitted close to the connection point in accordance with clause 9.4 of ANSI/ISA-S82.01.

“Warning – hot surfaces” or equivalent wording, should be fitted close to the actuator handle in accordance with Table 3 of ANSI/ISA-S82.01.

## 5.10 Ignition tests

As the rated ambient was 70°C, Safety factor Ignition tests were carried out as required by clause 4.4 of FM 3615. Tests were carried out in an ambient temperature of (70°C + 20°C =) 90°C in accordance with clause 4.3 of FM 3615.

Tests were carried out on the PB2 enclosure fitted with the PB1 main cover and with the cable bushing between the two chambers removed.

The sample was prepared as follows:

- ◆ Removal of the 'O' rings
- ◆ Flange joint shimmed to at least 50% of the design gap
- ◆ Actuator shaft spigot joint reduced to 75% of design width and shaft machined to give a diametrical clearance of at least 50% of the design clearance.
- ◆ The internal contents of the PB2 variant were fitted, these being considered to be the worst case.
- ◆ Any sealant between the control case flanges was removed.

Tests were carried out with 18", 5', 10" or 15" lengths of steel conduit fitted – ten tests in each configuration. The test mixture was Ethylene (representative of Group C gasses) ranging in concentrations from 4.4 % to 9.9 % by volume in air. Ignition was initiated by a high voltage spark, located at the centre of the chamber.

Ignition internal to the housing did not result in propagation to an identical mixture surrounding the housing during any of the tests, nor was any permanent deformation of the housing observed. The maximum ignition pressure developed was 9.9 bar (144 psi). Adjusted for a minimum ambient of -40°C this becomes 13.1 bar 190 psi).

Note: test results for a -40°C ambient were carried out at laboratory ambient and the adjusted results are derived from experimental data contained CANMET Research Document "an investigation of the effect of low ambient temperature upon explosive atmospheres" by G. Lobay dated September 1977.

## 5.11 Hydrostatic Tests

The same sample tested in 5.10 was subjected to a hydrostatic test, as required by clause 4.5 of FM 3615. A pressure equal to at least 39.3 bar (570 psi), this being 3X the reference pressure, was applied for at least one minute.

No damage or deformation was noted as a result of the tests.



## 5.12 Protection from Electric Shocks

The following tests verify the protection afforded by the product against electric shock.

### 5.12.1 Accessibility

The NEMA 4 enclosure is considered to endow protection to the internal components such that no part of the hazardous live or non-hazardous live circuitry is considered accessible.

### 5.12.2 Creepage and Clearance and dielectric tests

#### 5.12.2.1 Primary Circuit

The primary circuit comprises either a switch unit (PB1) and/or terminal assemblies (PB2), which are considered to be hazardous live. The following parameters were determined:

Maximum working voltage PB1 – 600 V ac  
 Maximum working voltage PB2 – 250 V ac  
 Pollution Degree PB1 & PB2 – 2  
 Over-voltage Category PB1 – III  
 Over-voltage Category PB2 – II

Clearances have been adjusted for a maximum altitude of 3000m (x 1.14, in accordance with clause D.19 of ANSI/ISA S82.01).

Item	Insulation Type	Min Clearance (mm)	Min Creepage (mm)	Method of compliance
Switch unit (PB1) - from Table D.6.	Basic (material Group I)	(1.14 x 5.5 =) 6.27	5.5	Unit is UL approved (No. 164864) and declared as complying with IEC 947-3.
Terminal (PB1 & PB2) – from Table D.6.	Basic (material Group I)	(1.14 x 5.5 =) 6.27	5.5	Units are UL approved (No. E 45 172) Terminals comply with IEC 60998.
Transformer Terminals (PB2) – from Table D.4.	Air	(1.14 x 1.5 =) 1.71	1.5	Confirmed by measurement of samples

The primary circuit of the PB1 enclosure was subjected to dielectric tests as below:

Test Between:	Table	Voltage (rms) applied for one minute	Observations
Phase L1 to earth	D.6	3250	No breakdown
Phase L1 to Phase L2 through switch and wiring	D.6	3250	No breakdown
Phase L1 to Phase L3 through switch and wiring	D.6	3250	No breakdown
Phase L2 to earth	D.6	3250	No breakdown
Phase L2 to Phase L3 through switch and wiring	D.6	3250	No breakdown
Phase L3 to earth	D.6	3250	No breakdown

### 5.12.2.2 Secondary Circuit

The electronics enclosure (PB2) contained circuitry rated at a maximum voltage of 20 V ac and therefore is not considered to be hazardous live, as defined by clause 6.3.1 of ANSI/ISA S82.01.

### 5.12.3 Assessment of Fault Conditions

The only fault condition was failure of the transformer in the PB2 enclosure, allowing primary voltage (250V) to appear in the secondary circuit – see 5.12.2.4.

#### 5.12.3.1 Transformer Tests and Assessments

Whilst the circuit contained fuses, these were not considered to provide adequate current limiting. Therefore the transformer was subjected to the tests required by clause 14 of ANSI/ISA S82.01.

#### 5.12.3.2 Short Circuit Tests

A sample transformer was loaded on each winding and the voltage of each monitored. Each secondary winding was short circuited in turn and any resultant change in voltage noted as required by clause 14.7.1 of ANSI/ISA S82.01.

In each case there was no significant increase in the voltage.

The sample failed after approximately 15 minutes. However the mode of failure was such that there was no increase in secondary voltage.

The maximum temperature rise recorded on the transformer surface was 20.9 K.

The sample was subsequently subjected to dielectric tests as below:

<b>Test Between:</b>	<b>Table</b>	<b>Voltage (rms) applied for one minute</b>	<b>Observations</b>
Primary (a) to chassis	D.4	1350	No breakdown
Primary (b) to chassis	D.4	1350	No breakdown
Primary (a) to primary (b)	D.10	2300	No breakdown
Primary to secondaries (3 tests)	D.10	2300	No breakdown

### 5.12.3.3 Overload and Dielectric Tests

A sample of the transformer was subjected to overload tests. The primary fuse was rated at 0.5 A and it was determined that this would pass 0.85A maximum over a one hour period. Resistors were connected to each of the secondary windings in turn such that the maximum current was achieved. Each winding was tested for a duration of one hour and the temperatures monitored, as required by clause 14.7.2 of ANSI/ISA S82.01.

The sample was subsequently subjected to dielectric tests as below:

<b>Test Between:</b>	<b>Table</b>	<b>Voltage (rms) applied for one minute</b>	<b>Observations</b>
Primary (a) to chassis	D.4	1350.	No breakdown
Primary (b) to chassis	D.4	1350	No breakdown
Primary (a) to primary (b)	D.10	2300	No breakdown
Primary to secondaries (3 tests)	D.10	2300	No breakdown

### 5.12.3.4 Physical Examination

The transformer was subsequently sectioned and visually examined. No evidence of damage due to the overload test was noted.

### 5.12.4 Protective Grounding

Internal and external grounding facilities are provided and are appropriately marked. The terminals are constructed of steel and are considered to comply with the requirements of clause 6.11.2 of ANSI/ISA S82.01.

## 5.13 Assessment of dust requirements

The temperature tests at section 5.9 and consequent T4 classification is considered to apply to Class II dust atmospheres.

The ingress protection tests at section 5.8.1 are considered to prove the equipment to be 'dust tight' and hence maintain the pollution degree declared.

## 6 DOCUMENTATION

The samples submitted for certification complied with the documents listed below. It was verified that these documents give a full and accurate description of those aspects of the equipment relating to compliance with the relevant certification standards.

Drawing no:	Sheets	Issue	Date	Title
AD1024-1-03	1 of 1	03	11 Jul 01	Mk 2 Pak Box for FM Approval
AD1024-2-03	1 of 1	03	11 Jul 01	Mk 2 Pak Box for FM Approval
41777-03	1 of 1	03	09 Jul 01	Nameplate Pak-Box Mk 2
AD1012-01	1 of 1	01	14 Oct 99	Pak Scan Schematic

## 7 ROUTINE TESTS

The mains circuit of each unit shall be tested according to Annex K of ANSI/ISA-S82.01:1994 at a voltage of at least 1350 V. No breakdown or repeated flashover shall occur as a result of the tests.

## 8 CONCLUSION

The Mk 2 Pak-Box enclosure (PB1 & PB2), as indicated by the results of this report, complies with the appropriate requirements of FM 3600 and FM 3615 and classes 4 and 6 to NEMA 250:1991. The equipment meets the flame propagation requirements of Groups C & D gasses. In addition, the equipment is considered to show compliance with the requirements for protection against electric shock of ANSI/ISA-S82.01-1994.

Material STAINLESS STEEL 24SWG  
 Specification BS1449 PT.2 315S16  
 AISI TYPE 316

Drawing Number 41777-03

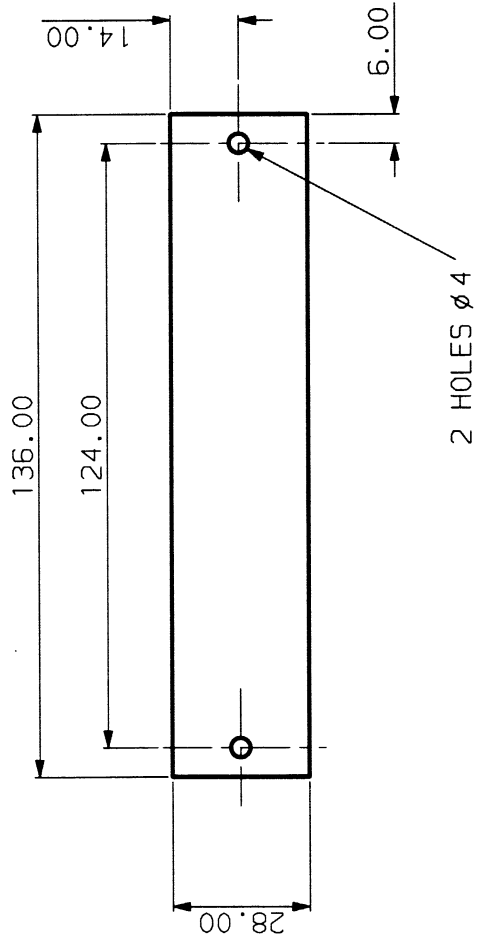
Scale 1:1

Issue	Modifications	EC0109
01	First Issue.	
02	Voltage/Hz & I <sub>max</sub> added. P.West 091000	
03	Temp.Code was T6. Ambient Temp.Note added. P.West 090701 <b>EC1053</b>	

**rotork** Rotork Controls Ltd.  
 Bath, England  
 Explosionproof - FK3615  
 Class II Division 1 Group E,F & G  
 Approved Temp.Code T4, NEA, 4.5, 158°F, 70°C  
 Made in England  
 Warning: Potentially hot surfaces. Use conductors rated at 97" or better.  
 Seal all conduits within 18 inches. Torque cover bolts to 21lb.ft.(29Nm)Max.

Part type:  Part no.:   
 Serial number:  Hz:  I<sub>max</sub>:

241777-03



STAINLESS STEEL LETTERING  
 ON MATT BLACK BACKGROUND

See drawing No.AD1024 for stamping details.

Title NAMEPLATE  
 MK2 PAK-BOX.  
 Drawn P.WEST Date 071299  
 Checked K.SWEET  
 Similar to Drg.  
 Used on PAK-BOX MK2 No. off 1  
 Job No. 1  
 Assembly Drg No. 38837  
 Group/Module No. 00-26-2PB  
 Parent/Parts List PS

Drawing Number 41777-03

**Pakscan**  
**Mains and Loop Isolator Unit**  
**Pakbox Mounted (FLP-PB1)**

**rotork**

Publication: S160E  
Date of issue: 02/99  
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**GENERAL DESCRIPTION**

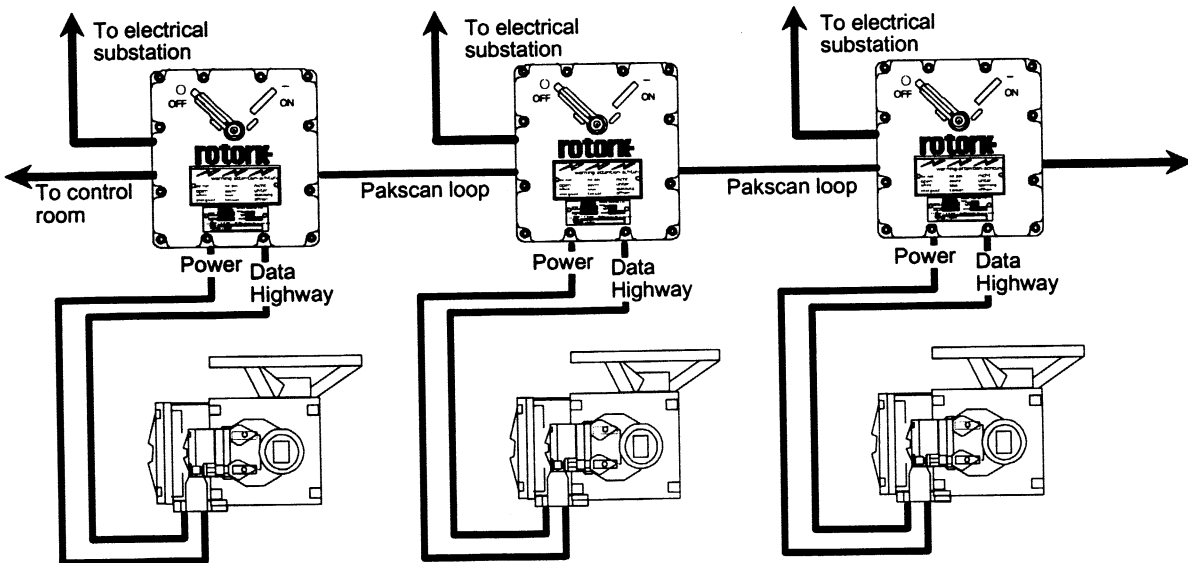
The FLP-PB1 has been designed for use with electric actuators requiring isolation of power and looped data highway connections without disturbing the continuity of the data highway. It is ideally suited to use on the Pakscan 2 wire system where maintaining loop continuity is important when an actuator is out of service.

The action of turning the isolator handle to the "off" position simultaneously isolates the power and data highway from the actuator while bridging the data highway to maintain loop continuity. Suitable for use on any data highway the FLP-PB1 ensures system integrity at all times.

A padlocking facility is provided for securing the isolator handle in either the "on" or "off" position to further increase plant safety.

The FLP-PB1 is manufactured in cast aluminium and includes fixtures for use in mounting the Pakbox on either a wall or pipe bracket. Cable gland access is allowed for on three sides and the maximum cable gland size permitted is 40 mm.

The FLP-PB1 assembly is certified for use in a Hazardous area and may therefore be placed close to the actuator.



**Fig 1: Schematic details**

**Pakscan**  
**Mains and Loop Isolator Unit**  
**Pakbox Mounted (FLP-PB1)**

**rotork**

Publication: S160E  
 Date of issue: 02/99  
 Page 2 of 4

**MECHANICAL DESCRIPTION**

**Enclosure**

Cast aluminium (BS1490, LM 25 ) with Rotork standard grey paint finish, BS4800-00A13, suitable for wall mounting using fixing plates or alternately with clamps for 2" pipe mounting. Weatherproof to IEC 529, IP68.

**Approvals**

Hazardous area approval to EC directive 94/9/EC EN50018 EExd. IIBT4.

**Alternative Approvals**

Factory Mutual approval:

Class 1 - Groups C and D division 1 locations according to NEC Article 500.

CSA Hazardous approval:

Class 1 - Group C & D

Class 2 - Group E, F & G

**Power Isolator**

Load Break Switch Rating

AC-3	230/240V	5.5kW
	400/415V	11kW
	500V	15kW
	690V	11kW

UL and CSA approved

**Data Highway Switching Contacts**

Make before break to ensure continuity of the data highway.

Contact material: Nickel Silver

Minimum ratings: 10 mA min or 17 V min

**Terminals**

TS35 DIN rail mounted cage clamp terminals:

Power - 6 off to accept 0.2 to 16mm<sup>2</sup> conductors,

Control - 8 off to accept 0.08 to 1.5mm<sup>2</sup> conductors.

Earth - 2 off internal to accept 0.2 to 16mm<sup>2</sup> conductors and 1 off external 6mm diameter tapped hole.

TS35 DIN rail mounted screw terminals:

Switched Supply – 3 off to accept 6 to 10mm<sup>2</sup> stranded or solid conductors

**Conduit entries**

A,B,C, & D = 4 off max. 40mm, 1.5" ASA/NPT or PG29

E to Y = 20 off max 20mm, 0.75" ASA/NPT or PG13.5.

See installation drawings overleaf for cable entry locations according to size

**Environmental specification**

Operating temperature, -30° to +70°C

Storage temperature, -50° to +85°C

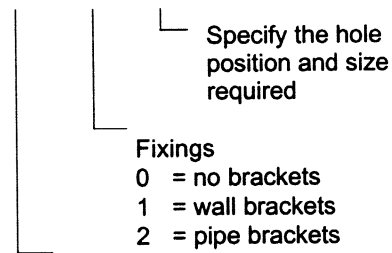
Humidity, 5% to 95% R.H. non-condensing

Vibration, 0.75g (0.5Hz to 300Hz)

**Ordering Details**

With all orders it is necessary to specify the enclosure approval required, the FLP-PB1 mounting arrangement and the conduit entry holes to be drilled together with their size. Five holes are included in the basic price and additional holes are extra.

**FLP - PB1 - XXX - X - XXXXX**



**Certification**

xd = EExd

xde = EExde

Example:

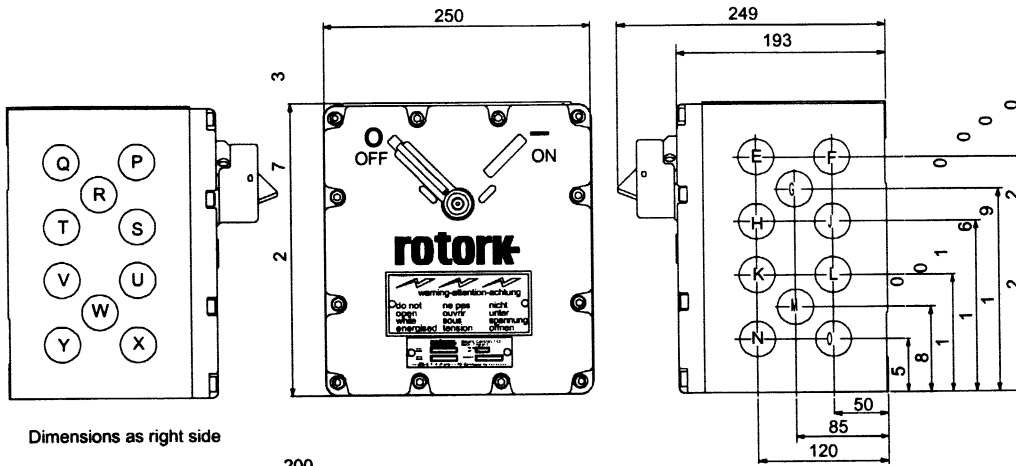
FLP-PB1- xd - 1 - A 20, B 20, C 15, N 15, P 15

EExd certified, supplied with wall brackets, holes drilled for conduits - A and B 20 mm, C N and P 15 mm.

**Pakscan**  
**Mains and Loop Isolator Unit**  
**Pakbox Mounted (FLP-PB1)**

**rotork**

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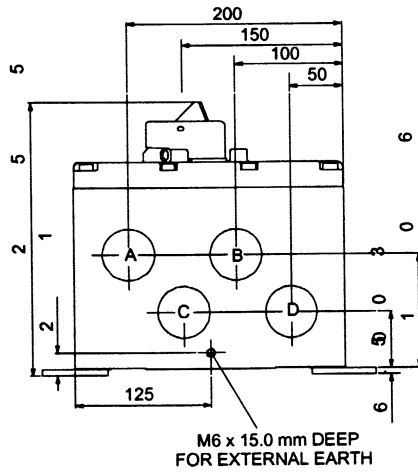


Dimensions as right side

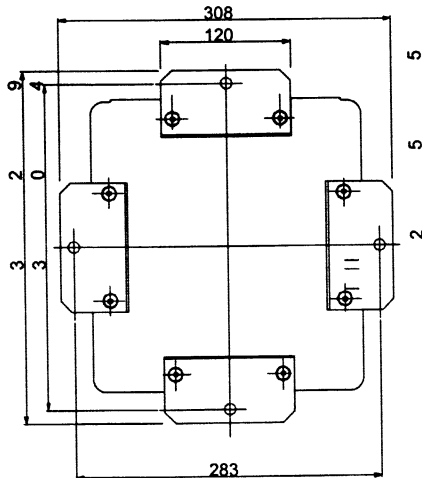
MAXIMUM CONDUIT ENTRY SIZES

LOCATION	mm	ASA/NPT	PG
A,B,C,D.	40.00	1.5"	29
E,F,G,H,J, K,L,M,N,O, P,Q,R,S,T, U,V,W,X,Y.	20.00	0.75"	13.5

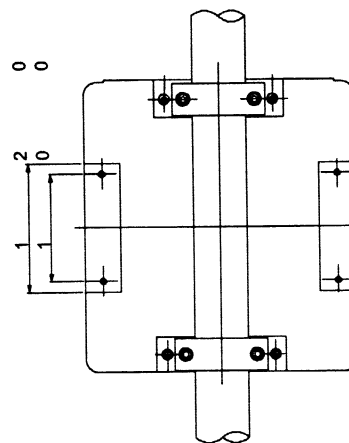
**Fig 2: Dimensional details**



M6 x 15.0 mm DEEP  
 FOR EXTERNAL EARTH



**WALL MOUNTING**  
 2 OR 4 OFF BRACKETS 39983  
 SUITABLE FOR USE WITH 10 mm Dia. FASTENERS.



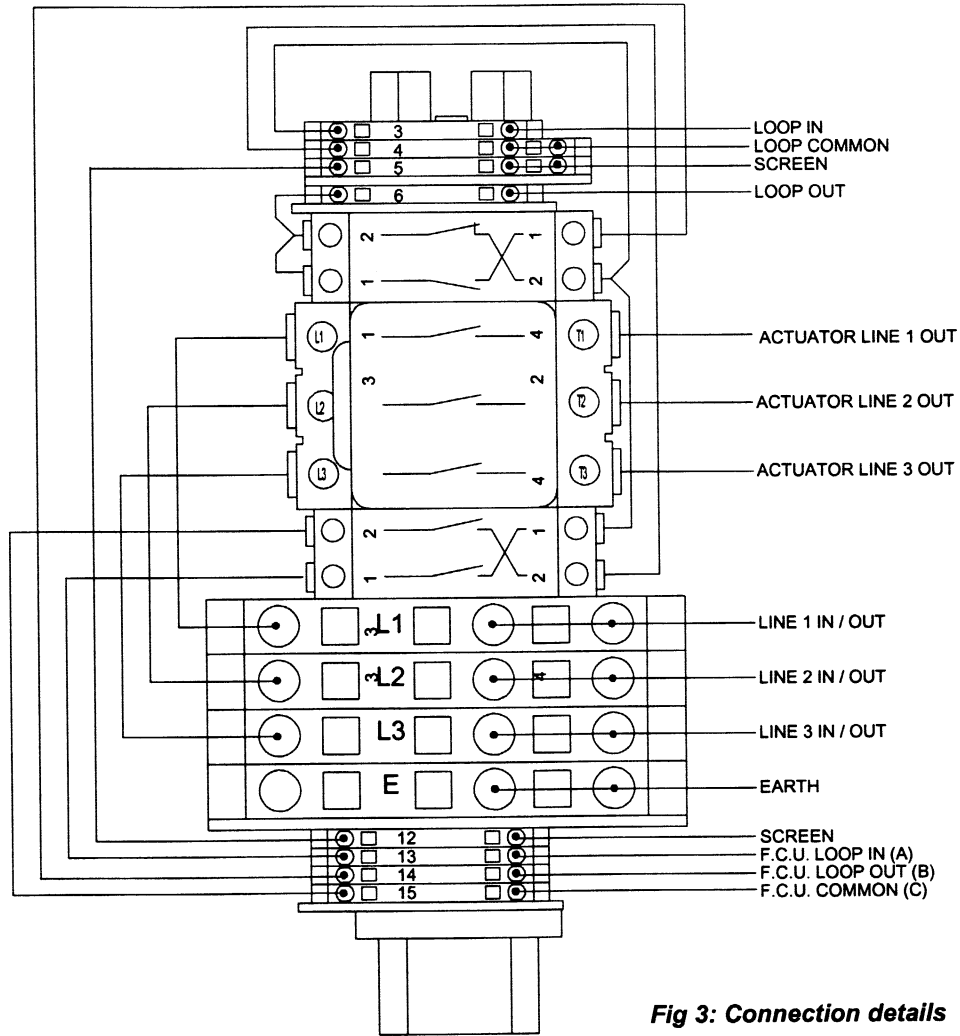
**PIPE MOUNTING**  
 STAUFF GROUP 6 CLAMPS  
 SUITABLE FOR USE WITH 1.75" TO 2.0" Dia PIPE.



**Pakscan**  
**Mains and Loop Isolator Unit**  
**Pakbox Mounted (FLP-PB1)**

**rotork**

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 Page 4 of 4



**Fig 3: Connection details**

**rotork**

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 ROTORK CONTROLS LTD  
 telephone Bath (01225) 733200  
 telefax (01225) 333467  
 e-mail mail@rotork.co.uk

USA head office  
 ROTORK CONTROLS INC  
 telephone Rochester (716) 328 1550  
 telefax (716) 328 5848  
 e-mail info@rotork.com

<http://www.rotork.com>

As we are continually developing our products,  
 their design is subject to change without notice.

The name Rotork is a registered trade mark

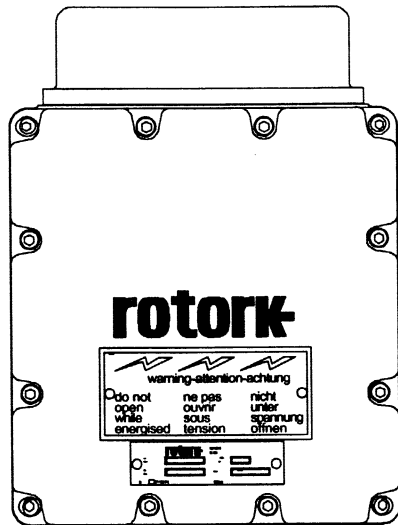
	telephone	telefax		telephone	telefax
AUSTRALIA Ballarat	(053) 381 566	(053) 381 570	KOREA (South) Seoul	(02) 565 4803	(02) 565 4802
CANADA Calgary	(403) 569 9455	(403) 569 9414	MALAYSIA	(03) 519 3093	(03) 519 30998
CANADA Toronto	(905) 602 5665	(905) 602 5669	NETHERLANDS	(010) 414 6911	(010) 414 4750
CHINA Shanghai	(021) 627 7680	(021) 627 7681	RUSSIA Moscow	(503) 2349125	(503) 2349125
CHINA (N and Central)	(10) 646 21617	(10) 646 20713	SAUDI ARABIA	(03) 833 0702	(03) 833 9369
CHINA Beijing	(10) 646 21617	(10) 646 20713	SINGAPORE	457 1233	457 6011
FRANCE Paris	(01) 43111550	(01) 48354254	SOUTH AFRICA	(11) 453 9741	(11) 453 9894
GERMANY Hilden	(02103) 54098	(02103) 54090	SPAIN Bilbao	(94) 676 6011	(94) 676 6018
HONG KONG, S.China	2520 2390	2528 9746	THAILAND bangkok	(02) 272 7165	(02) 272 7167
INDIA Chennai	(044) 625 8494	(044) 625 7108	USA Houston	(713) 782 5888	(713) 782 8524
INDONESIA Jakarta	(21) 580 6764	(21) 581 2757	USA West Coast	(707) 769 4880	(707) 769 4880
ITALY Milan	(02) 457 03300	(02) 457 03301	VENEZUELA Caracas	(02) 263 6533	(014) 250 822

# Pakscan

## General Purpose Field Control Unit Pakbox Mounted (FLP-PB2)

# rotork

Publication: S161E  
Date of issue: 02/99  
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### GENERAL DESCRIPTION

The Pakscan General Purpose Field Control Unit (GPFUC) provides a means of controlling actuators, pumps, motors, solenoid valves, mixers, etc., as well as interfacing digital and analogue information between field process devices and a Pakscan two wire control system. By using a Pakbox FLP-PB2 housing the GPFUC can be field mounted in a Hazardous areas and may be placed close to the device being controlled.

The FLP-PB2 enclosure is manufactured in cast aluminium and includes fixtures for use in mounting the Pakbox on either a wall or pipe bracket. Cable gland access is allowed for on three sides.

The Pakscan GPFUC is sealed in a separate compartment to the equipment terminals to ensure that during installation and operation no moisture can affect the electronic components.

### PERFORMANCE SPECIFICATION

#### Pakscan 2 -Wire Interface

Baud Rate	2400, 1200, 600, 300 or 110
Current	20 mA
Conductors	screened twisted pair

#### 8 off Digital Inputs

Isolation	mutual galvanic isolation
Input Voltage	active 18V < Vi < 38V inactive -0.5V < Vi < 2V
Pulse input	Input 1
Pulse width	> 20mS
I/P power supply	internal 24V at 20 mA max

#### 4 off Digital Outputs

Contacts	changeover
Operation	fleeting or maintained (normally de-energised)
Voltage range	up to 120V
Max load	60W, 125VA, (max 1 A)
Life	10 <sup>7</sup> operations at 5W load

#### 2 off Analogue Inputs

Range	0 to 5V, or 4 to 20 mA
Resolution	1.2mV
Thermal stability	100 ppm/°C

#### 1 off Analogue Output

Voltage range	0 to 5V
Resolution	1.2mV
Thermal stability	100 ppm/°C
Load resistance	>1 kOhm

#### Electrical Supply

Supply	110V ac +/-20% or 230V ac +10%/-20%, (47-63 Hz)
--------	--

### I/O DESCRIPTION

#### General Purpose Mode

4 off digital outputs, each with one independently addressable C/O contact rated at 60W, 125VA, (max 1A). All contacts can be either fleeting, (300mS), or maintained (requiring an energise and de-energise command).

1 off analogue output, 0 - 5V, with 1.2mV resolution, i.e. 12 bit accuracy.

8 off independent digital inputs, each requiring a volt free input. Each input can be configured to

# **Pakscan IIE**

## **General Purpose Field Control Unit**

### **Pakbox Mounted (FLP-PB2)**

**rotork**

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invert the incoming signal. (Input D1 also acts as a pulse counter, up to 9999, provided that the pulse is greater than 20mS).

The state of the output relays and their action (fleeting or maintained) is reported as are status bits relating to the field unit itself.

2 off analogue inputs sharing a common return, either 4 - 20mA or 0 - 5V, reported as a value between 0% and 100%. Both inputs must be the same, i.e. voltage or current. For voltage inputs JP1 and JP2 must be removed. The default setting is for current inputs with JP1 and JP2 fitted.

#### **Alarms**

POWR - Reset (on restoration of power)  
WDOG - Watchdog failure  
MEMF - Memory failure  
COMMS - Communication failure

#### **Actuator Mode**

Digital control  
Open, Stop, Close, ESD, (ESD option is not available on all actuator types)

Position control  
Over range 0% to 100%, (not available on all actuator types)

Digital feedback  
The field unit reports the following status bits, (some of the options are not available on all actuator types):  
OAS - open limit switch  
CAS - closed limit switch  
STOP - motor stopped  
MRUN - motor running  
MRO - motor running in open direction  
MRC - motor running in closed direction  
EXT - status of an external digital signal, (only available when position control is **not** used).  
Further status bits relating to the field unit are also reported, i.e. loopback on, new alarm and alarm.

Analogue feedback  
Valve position over range 0% to 100%, (not available on all actuator types)

Alarms  
POWR- power on reset (on restoration of power)  
WDOG - watchdog failure

MEMF - memory failure  
COMMS - communication failure  
CNA - local control selected  
MREL - monitor relay tripped  
THERM - thermostat tripped  
LSTOP - local stop selected  
(some or all of the above may not be available depending on actuator type).

#### **Derived alarms**

SFAIL - motor start or stop failure  
VOBS - valve obstruction detected, torque tripped  
VJAM - valve stuck detected, torque tripped  
MOP - valve moved to open limit manually  
MCL - valve moved to closed limit manually  
MOPG - valve moved from closed limit manually  
MCLG - valve moved from open limit manually  
EOT - motor running at end of travel  
(some or all of the above may not be available depending on actuator type).

## **MECHANICAL DESCRIPTION**

#### **Enclosure**

Cast aluminium (BS1490, LM25 ) with Rotork standard grey paint finish, BS4800-00A13, suitable for wall mounting using fixing plates or alternately with clamps for 2" pipe mounting. Weatherproof to IEC 529, IP68.

#### **Approvals**

Hazardous area approval to EC directive 94/9/EC EN50018 EExd. IIBT4.

#### **Alternative Approvals**

Increase safety terminations EN50019EExde  
Factory Mutual approval:  
Class 1 - Groups C and D division 1 locations according to NEC Article 500.  
CSA Hazardous approval:  
Class 1 - Group C & D  
Class 2 - Group E, F & G

#### **Terminals**

TS35 DIN rail mounted cage clamp terminals suitable for up to 1.5mm<sup>2</sup> conductors for power and signals. Double terminations are provided for power supply, earth & loop connections. An external 6mm tapped hole is also provided for earthing purposes.

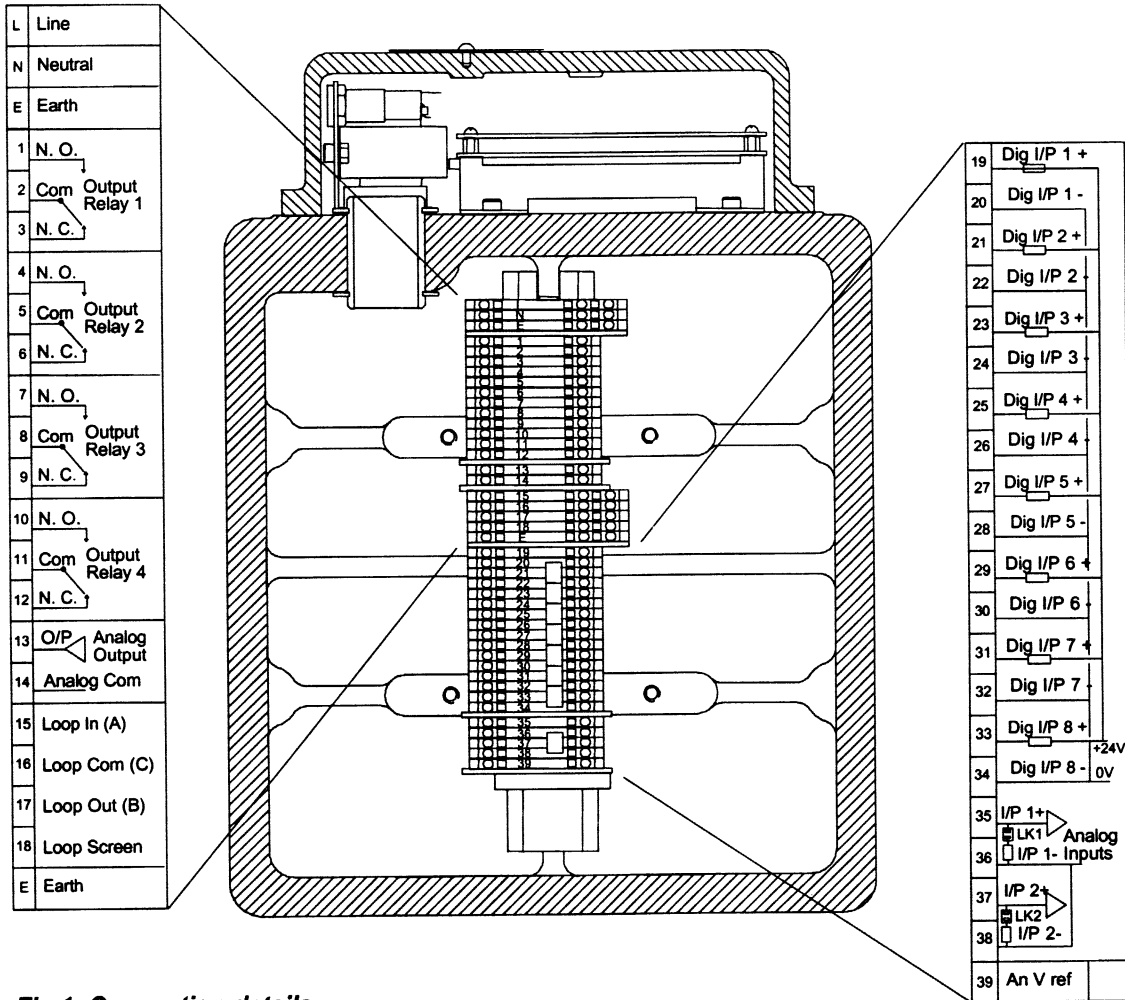
# Pakscan IIE

## General Purpose Field Control Unit

### Pakbox Mounted (PB2-FLP)

# rotork

Publication: S161E  
Date of issue: 02/99  
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**Fig 1: Connection details**

# rotork

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telefax (716) 328 5848  
e-mail info@rotork.com

<http://www.rotork.com>

As we are continually developing our products, their design is subject to change without notice.

The name Rotork is a registered trade mark

	telephone	telefax		telephone	telefax
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INDONESIA Jakarta	(21) 580 6764	(21) 581 2757	USA West Coast	(707) 769 4880	(707) 769 4880
ITALY Milan	(02) 457 03300	(02) 457 03301	VENEZUELA Caracas	(02) 263 6533	(014) 250 822