FLOWSERVE

USER INSTRUCTIONS

Flowserve KW941
Pump Power Monitor™

Pump Power Monitor for protection against both under load and over load conditions.

PCN= = 71569285 – 02-12 (E) (incorporates PM-200 & PM-201)
Original instructions.

Installation
Operation
Maintenance

These instructions must be read prior to installing, operating, using and maintaining this equipment.

Experience In Motion

CONTENTS

1 INTRODUCTION AND SAFETY

1.1 General

These instructions must always be kept close to the product's operating location or directly with the product.

Flowserve products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilizing sophisticated quality techniques and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

These instructions must be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met. Failure to follow and apply the present user instructions is considered to be misuse. Personal injury, product damage, delay or failure caused by misuse are not covered by the Flowserve warranty.

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals.

To confirm the Approvals applying and if the product is CE marked, check the product identification label and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

Information in these User Instructions is believed to be complete and reliable. However, in spite of all of the efforts of Flowserve Corporation to provide comprehensive instructions, good engineering and safety practice should always be used.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organizations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorized Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by the Flowserve warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

1.5 Duty conditions

This product has been selected to meet the specifications of your purchase order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.

The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the part number.

If the conditions of service on your purchase order are going to be changed (for example supply voltage or frequency) it is requested that the user seeks the written agreement of Flowserve before start up.

1.6 Safety

1.6.1 Summary of safety markings

These User Instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

This symbol indicates electrical safety instructions where non-compliance will involve a high risk to personal safety or the loss of life.


This symbol indicates safety instructions where non-compliance would affect personal safety and could result in loss of life.


This symbol indicates “hazardous and toxic substances” safety instructions where non-compliance would affect personal safety and could result in loss of life.

This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.


This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.


This symbol is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure the cloth is damp. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

This sign is not a safety symbol but indicates an important instruction in the assembly process.

1.6.2 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may contact the manufacturer/supplier to provide applicable training/technical support.

Always coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

1.6.3 Safety action

This is a summary of conditions and actions to help prevent injury to personnel and damage to the environment and to equipment.

NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER. LOCK OUT THE POWER SUPPLY.

Dangerous voltages are present in motor control panels and circuits. INSTALLATION MUST BE PERFORMED BY QUALIFIED PERSONNEL!

Improper installation or operation can cause damage to the unit and can result in an unprotected pump or nuisance tripping of the pump.

The current transformer/toroid secondary leads must always be shorted together or connected to an appropriate measuring device to provide a suitable burden whenever the primary circuit is energized. Operation of a current transformer/toroid with an open secondary will result in hazardous voltages and destruction of the device!

1.7 Nameplate and safety labels

1.7.1 Safety labels

1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation. Any shortage and/or damage must be reported immediately to Flowserve Pump Division and must be received in writing within ten days of receipt of the equipment. Later claims cannot be accepted.

Check all crates, boxes or wrappings for any accessories or spare parts that may be packed separately from the equipment or attached to side walls of the box or equipment.

Note: The current senor (toroid) is shipped inside the KW941 underneath the wiring compartment cover.

2.2 Handling

The KW941 Power Monitor is small and light so handling and mounting are easy. The unit weighs approximately 2.3 kg (5 lbs).

2.3 Storage

CAUTION Store the pump in a clean, dry location away from vibration. If kept in its original packaging and protected from excessive environmental effects like continuous high humidity or corrosive gases the shelf life would be decades.

2.4 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and in accordance with local regulations. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current local regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.

Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current local regulations at all times.

3 DESCRIPTION

3.1 Configurations

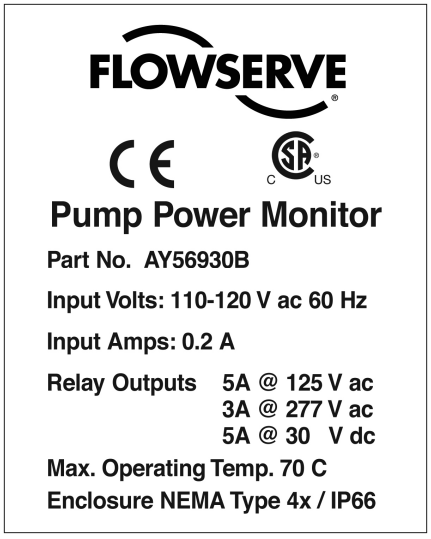
The KW941 Pump Power Monitor provides a power measurement, display and trip-point system to detect and protect against both UNDERLOAD and OVERLOAD conditions. The KW941 monitors MOTOR POWER by sensing both VOLTAGE and CURRENT. By factoring in motor efficiency, the KW941 can be scaled to display PUMP POWER. The adjustable trip-points can be set using power information provided by the Flowserve Pros+ software for Flowserve pumps.

The KW941 consists of a current sensor and a Display/Control module. The sensor, through which one motor power lead passes, normally is located inside the motor starter panel and provides a sample of motor current to the Display/Control module. A voltage sample is provided by a control voltage transformer (not supplied) located between two of the three motor power phases. The Display/ Control module (located outside the starter panel) processes the current and voltage sample information, contains the LED display, alarm relays, and provides operator interface.
Three models of the KW941 Power Monitor are available based upon the supply voltage at the customer's site. The part numbers are listed below:

AY56930B = 110-120v, 60Hz
AY56930C = 220-240v, 50Hz
AY56930D = 220-240v, 60Hz

3.2 Nomenclature

3.2.1 Product Identification Label



3.2.2 Abbreviations

TS = terminal strip
TS1 = terminal strip screw position #1
Jp = jumper
NO = normally open
NC = normally closed
FS = full scale (power)
CR = control relay
MOL = motor overload

3.3 Design of major parts

3.3.1 Enclosure

- Material: polycarbonate, with see-through cover.
- Protection rating: NEMA 4X / IP66. Use only certified liquid-tight access hole fittings/conduit hubs to maintain enclosure protection rating.
- Overall dimensions: 182 mm W x 180 mm L x 90 mm H (7.17"W x 7.09"L x 3.54"H).
- Mounting hole spacing: 167 mm W x 173 mm H (6.57"W x 6.81"H).
- Mounting screws: 4 mm (#8), quantity of four.
- Enclosure can be drilled, sawed or punched for wiring access holes.

CAUTION Do not damage the internal components of the KW941 unit while making access holes.

3.3.2 Power Requirements

- 110 Vac Model (110/115/120 nominal Vac), 60 HZ @ 0.100 amps
- 220 Vac Models (220/230/240 nominal Vac), 50/60 HZ @ 0.05 amps
- Fuse: (Internal to TS1 #2 VAC connection, not user accessible.)
  - For 110 Vac Models: 200 mA, 125 Vac, Slo Blo, 5 x 20 mm
  - For 220 Vac Models: 100 mA, 250 Vac, Slo Blo, 5 x 20 mm

Note: Power to the KW941 is supplied by a (customer-supplied) control voltage transformer connected between two of the three motor power supply phases. Power may be supplied by an existing appropriately connected transformer with adequate capacity. Consult area codes/regulations for transformer fusing and grounding requirements.

Fusing of the control voltage transformer primary and/or secondary circuit supplying power to the KW941 may be required. Please consult local area electrical codes/regulations.

- Control Voltage Transformer: (Not Supplied) Rating: 15 VA (Volt Amps) or greater.
- Power On/Off Switch: (Not Supplied)

Note: No On/Off switch is provided with the KW941. It is intended to be On (operational) whenever power is supplied to the motor starter control circuits, whether or not the motor is running, so that it can be set up prior to starting the equipment and provide protection on startup. The transformer supplying power to the KW941 is normally installed ahead of the motor starter contactor but after the starter power disconnect switch, so that power can be turned off with the disconnect switch. If required, the control transformer circuit supplying power to the KW941 can be switched.

3.3.3 Wiring and Grounding

- Maximum TS1 connection wire size: #14 AWG.
- Use wire with adequate insulation and current carrying capability for the application.
- Terminal TS1 #1 is internally connected to the KW941's metal chassis. Connect this point to earth ground.
- Use of metallic conduits will require bonding between the conduits.

DANGER PLEASE FOLLOW ALL AREA ELECTRICAL CODES/REGULATIONS!

3.3.4 Full Scale Range

- 0.7 to 112 KW (1 to 150 HP) @ 460 Vac, 50/60 Hz three phase power with the supplied current sensor (toroid).
- Contact Flowserve Engineering for higher power capabilities (to 999 hp with auxiliary current sensor) and for special applications.

3.3.5 Current Sensor (also known as a toroid or current transformer)

- 200 amp (primary), current sensing toroid
- 12" #24 AWG leads
- Max lead extension length = 30.5 m (100 feet).
- O.D: 51 mm (2.0 in.)
- I.D.: 18 mm (0.7in.) – this limits the maximum wire size that can go through current sensor.
- Ht.: 20 mm (0.8 in.)

3.3.6 Alarm Output Relay Contacts

5 amps @ 125 VAC
3 amps @ 277 VAC
5 amps @ 30 VDC

3.3.7 Analog Output

- 4 to 20 milliamp source, proportional to full scale.
- Maximum loop load resistance = 600 Ohms.

3.3.8 Digital Display

- 3 digit, 0.6" high, seven segment, red LED.
- Displays 0.0 to 999

3.3.9 Timers

- Start-Up Delay Timer: Adjustable 0 to 999 seconds.
- Trip Delay Timers: Adjustable 0 to 999 seconds.

3.3.10 Remote Reset

- Momentary external mechanical or solid state switch to conduct < 200 microamps DC between "RESET +" and "RESET -" terminals.
- Reset input specifications (for use with solid state logic switch resets)
  - For NORMAL operation: +2 to +5 VDC between reset terminals
  - For RESET: -0.3 to +0.8 VDC between reset terminals (minimum pulse width 20 milliseconds).

3.4 Performance and operation limits

Operating Temperature: -40 to 70 ℃ (-40 to 158 ℉) .

Effective toroid power limit = 112 KW (150 HP)

Note: Power monitoring using only the supplied current sensor is limited by its 200 amp current limit and the size of the motor lead that can fit through the toroid's internal diameter (18 mm (0.7 in.)).

Use of a second current transformer in series with the supplied toroid can allow the KW941 to monitor power levels up to 745 KW (999 HP).

Supply voltage should not exceed 230 Vac at 50 Hz or the internal fuse may blow.

Unbalanced power line/load conditions will affect power readings.

The motor efficiency value used during initial setup (Section 4 Installation) affects the KW941 power reading displayed.

4 INSTALLATION

DANGER Dangerous voltages are present in motor control panels/circuits. Make sure power is off and locked out during installation.
INSTALLATION MUST BE PERFORMED BY QUALIFIED PERSONNEL!

The KW941 Pump Power Monitor and its current sensing toroid must not be installed in a potentially explosive atmosphere.

It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity of the equipment, wiring or any connected devices. If in any doubt, contact Flowserve for advice.

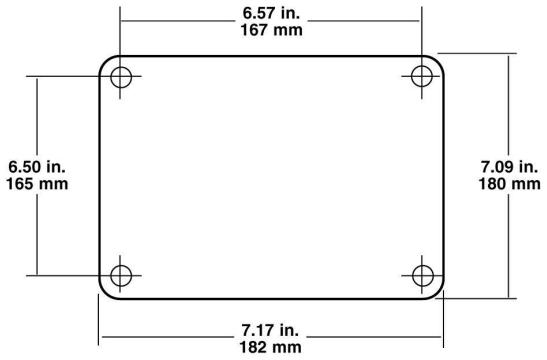
Note: The Flowserve KW941 Pump Power Monitor has a CE Mark approval for EMC and Low Voltage Directive Compliance.

4.1 Location

The KW941 Display/Control module can be mounted on the outside of the motor starter panel or a nearby wall or structure. Use the four corner mounting screw holes located below the see - through front cover screws. Refer to Figure 4.1 for mounting dimensions.

The KW941 Display/Control module can be located up to 30.5 m (100 ft.) from the motor lead that must run through the current sensor (toroid). This is the length limit for extending the toroid leads.

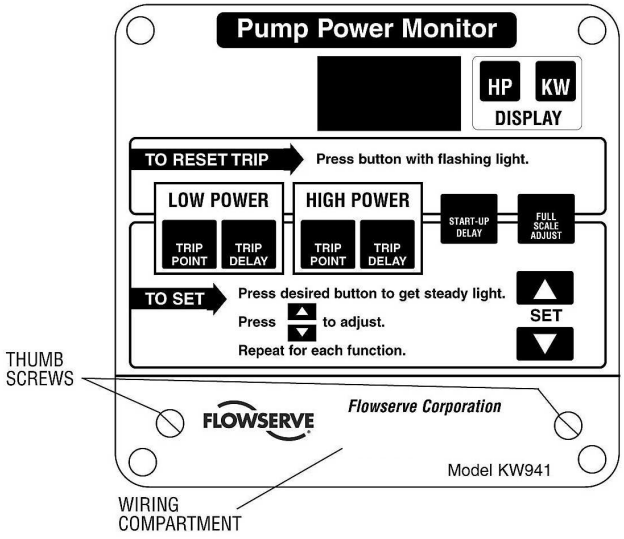
Figure 4.1



4.2 Electrical connections

Connections are made in the wiring compartment, accessible by removing the separate cover plate on the lower portion of the KW941. Loosen the two thumbscrews to remove the cover plate (see Figure 4.2).

Figure 4.2



Entry for wiring/conduit is made by drilling, sawing or punching the required hole(s) into the wiring compartment area. Use caution when making access holes to prevent damage to the internal components.

The following information is required for installation:
1) Motor Nameplate Full Load Power
2) Motor Nameplate Voltage and Hertz (Hz)
3) Control Volts (110 or 220/240 VAC) from transformer between motor power phases.
4) Motor efficiency.

Record this information on the worksheet provided in Section 8 of this manual.

4.2.1 Control Voltage

Refer to the product identification label on the outside of the KW941 enclosure for the selected factory preset VAC and HZ options (110/120 or 220/240 VAC, 50 or 60 HZ).

CAUTION **Never move jumpers when power is on! It can damage the unit.**

The Control Voltage (110 or 220/240 VAC) is required to power the KW941 as well as to provide a voltage sample for power computation.

Note: **The voltage (VAC) MUST be obtained from a voltage transformer connected between two phases of the three phase motor power leads.**

If a control voltage transformer (with at least 15 VA capacity) is already present between two phases, it can be used to supply the voltage. Otherwise, a suitable transformer must be installed.

In the case of a 220/240 VAC three phase motor, the voltage (VAC) can be obtained directly across two of the phases, provided that the Display/Control module is set for 220/240 VAC voltage operation.

The control voltage is connected to the KW941 Display/Control module using properly sized wires in an appropriate conduit. Wire the control voltage (VAC) to the KW941 terminal strip (TS1) as shown in Figure 4.3. Table 4.1 describes the function of each of the terminal strip positions.

Figure 4.3

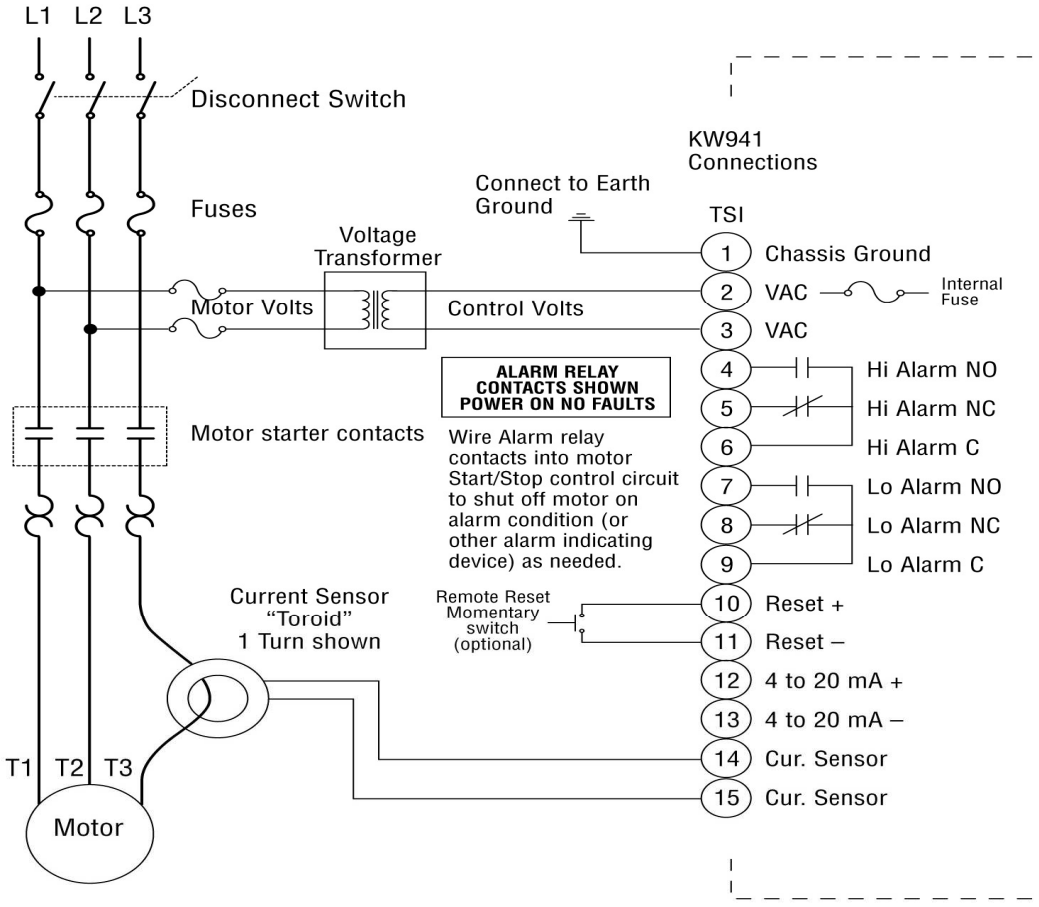


Table 4.1 Display/Control Unit Connection Terminals (TS1)

Screw #	Description	Notes
1	Ground	Safety ground to connect units metal frame to earth ground
2	VAC Input	AC control voltage, 110 VAC from control voltage transformer (220/240 VAC optional)
3	VAC Input	AC control voltage, 110 VAC from control voltage transformer (220/240 VAC optional)
4	Hi Alarm NO	The normally open (power on, not tripped) Hi Alarm relay contact between TS1 screw # 4 and # 6. This contact will be closed upon a Hi Alarm condition or loss of control voltage.
5	Hi Alarm NC	The normally closed (power on, not tripped) Hi Alarm relay contact between TS1 screw # 5 and # 6. This contact will open upon a Hi Alarm condition or loss of control voltage.
6	Hi Alarm common	The common screw # for the HI Alarm relay contacts.
7	Lo Alarm NO	The normally open (power on, not tripped) LO Alarm relay contact between TS1 screw # 7 and # 9. This contact will close upon a LO Alarm condition or loss of control voltage.
8	Lo Alarm NC	The normally closed (power on, not tripped) LO Alarm relay contact between TS1 screw # 8 and # 9. This contact will open upon a LO Alarm condition or loss of control voltage.
9	Lo Alarm common	The common screw # for the LO Alarm relay contacts.
10	Reset +	Remote reset terminal. A momentary contact between TS1 # 10 and # 11 will reset the alarm relay contacts.
11	Reset -	Remote reset terminal. A momentary contact between TS1 # 10 and # 11 will reset the alarm relay contacts.
12	4-20 mA +	Positive connection for the 4-20 mA output function (optional).
13	4-20 mA -	Negative connection for the 4-20 mA output function (optional).
14	Current Sensor Input	Current sensing toroid lead connection.
15	Current Sensor Input	Current sensing toroid lead connection.

4.2.2 Current Sensor Set Up

Note: The current senor (toroid) is shipped inside the KW941 underneath the wiring compartment cover.

⚠ CAUTION NEVER MOVE JUMPERS WHEN POWER IS ON!

When properly installed, the current sensing toroid (see figure 4.4) normally is located inside the motor starter panel with one of the three phase motor power leads passing through its center one or more times. The sensor's output leads are then connected to the KW941 Display/Control module using an appropriate conduit. ***Figure 4.4***

To install the current sensor:

1) Determine the required KW941 Full Scale Power (FS) by calculating your motor's required INPUT Power:

2) $$Input\_Power = \frac{Motor\_Nameplate\_Power}{Motor\_Efficiency}$$

EXAMPLE:

$$Input\_Power = \frac{10HP}{0.91} = 10.98 \text{ HP}$$

3) Locate your motor voltage in Table 4.2 by reading down the Motor Volts column.
4) Read <u>across</u> the table row identified by your motor voltage to locate the smallest KW941 Full Scale Power value that is greater than or equal to the motor's Input Power found in step 1. This will be the KW941 Full Scale Power (FS). Record this value on the configuration worksheet in Section 8 of this manual.
If the motor's Input Power exceeds the FS values listed in Table 4.2, use Table 4.3.

Note: Using a FS value larger than required will result in decreased sensitivity.

5) Determine the number of "turns" required by the motor power lead through the toroid inner diameter. Read *up* the table column from the selected Full Scale Power (FS) found in step 3. The number of turns shown in that column header is the required number of passes the motor power lead must make through the current sensing toroid. Record the number of turns on the installation and configuration worksheet in Section 8 of this manual.
6) Loop the motor power lead the required number of turns through the toroid. **THIS LEAD MUST NOT BE EITHER OF THE LEADS USED FOR THE CONTROL VOLTAGE TRANSFORMER.** Turns are counted by the number of times the motor lead passes through the toroid center. See Figure 4.3 for an example of one turn through the current sensing toroid. If the motor power lead is too large to obtain the required number of turns, select the next larger KW941 Full Scale Power (FS) and its corresponding number of turns. The smallest possible FS at the required motor voltage will give best results.
7) Connect the two leads coming from the current sensing toroid to the KW941 TS1 (# 14 and # 15) as shown in Figure 4.3 and described in Table 4.1. If extension leads are needed, use 24 AWG or larger wire up to 30.5 m (100 ft.) long.

Table 4.2

KW941 Full Scale Power "FS" (Jp5 set to X10 Range)										
Motor	Power @ 1 turn		Power @ 2 turns		Power @ 3 Turns		Power @ 4 turns		Power @ 5 Turns	
Volts	KW	HP	KW	HP	KW	HP	KW	HP	KW	HP
575	14.0	18.8	7.0	9.4	4.7	6.3	3.5	4.7	2.8	3.8
460	11.2	15.0	5.6	7.5	3.7	5.0	2.8	3.8	2.2	3.0
415	10.0	13.5	5.0	6.8	3.4	4.5	2.5	3.4	2.0	2.7
400	9.7	13.0	4.8	6.5	3.2	4.3	2.5	3.3	1.9	2.6
380	9.2	12.4	4.6	6.2	3.0	4.1	2.3	3.1	1.8	2.5
230	5.6	7.5	2.8	3.8	1.8	2.5	1.4	1.9	1.1	1.5
208	5.0	6.8	2.5	3.4	1.7	2.3	1.3	1.7	1.0	1.4

Table 4.3

KW941 Full Scale Power "FS" (Jp5 set to X1 Range -- Default)						
Motor	Power @ 1 turn		Power @ 2 turns		Power @ 3 turns	
Volts	KW	HP	KW	HP	KW	HP
575	140	188	69.9	93.8	46.6	62.5
460	112	150	55.9	75.0	37.3	50.0
415	101	135	50.4	67.7	33.6	45.1
400	96.9	130	48.6	65.2	32.4	43.5
380	92.5	124	46.2	62.0	30.8	41.3
230	55.9	75.0	27.9	37.5	18.6	25.0
208	50.5	67.8	25.3	33.9	16.8	22.6

For motor voltages not listed in Table 4.2 or 4.3, calculate Full Scale Power as follows:

a) For 110 VAC KW941 models

$$FSP2 = FSP1 \times \frac{V_M}{4 \times V_C}$$

b) For 220/240 VAC KW941 models

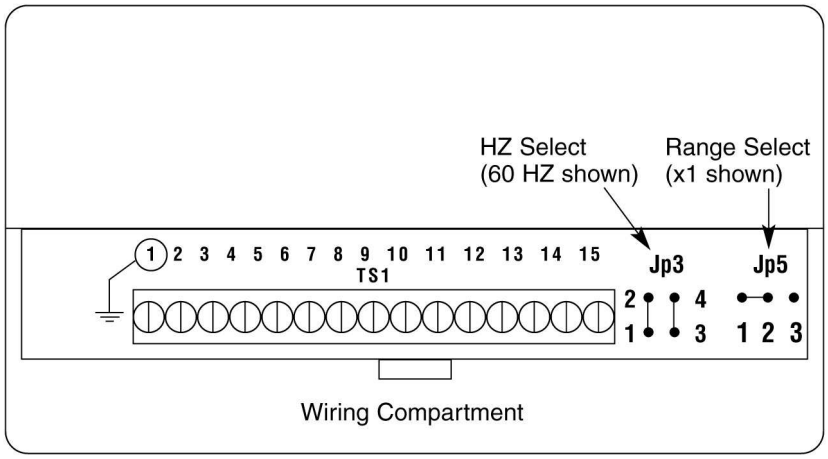
$$FSP2 = FSP1 \times \frac{V_M}{2 \times V_C}$$

FSP1 = FS Power @ 460 VAC from Table 4.2 or 4.3
V_M = motor voltage
V_C = control voltage (110 or 220/240 VAC)

Note: Control voltage is the voltage to the KW941 VAC terminals (# 2 and # 3). This voltage normally is the output voltage of the control transformer in the motor starter and must be 110/115/120 or 220/230/240 VAC.

For applications with motor nameplates above 150 HP (112 KW) @ 460 VAC, if the motor lead does not fit through the supplied current sensor, or if custom full scale settings are desired, contact your nearest Flowserve sales representative or distributor.

Figure 4.5



4.2.3 Jumper Settings

Note: By default, Jumper Jp5 connections are pins # 1 to # 2 (see Figure 4.5 and Table 4.4) which is the "X1" range. This range is used for motors over 11.2 KW (15 HP).

For smaller motors, the jumper Jp5 may need to be moved to pins # 2 and # 3, which is the "X10" range. Review Tables 4.2 and 4.3 for setting the ranges for a given Full Scale Power (FS).

⚠ CAUTION **Never move jumpers when power is on!**

Table 4.4

Hz Selection (Jp3)	
Hz	Connect Pins
50	3 to 4
60	1 to 2 and 3 to 4

Range Select (Jp5)	
Range	Connect Pins
X1	1 to 2 (Default)
X10	2 to 3

4.2.4 Alarm Relays

Use of a surge suppressor is recommended when switching highly inductive loads such as a magnetic motor starter coil.

In case of an alarm condition, alarm relay contacts can be connected into the pump start/stop control circuit in order to shut down the pump. Refer to Figure 4.3 and Table 4.1 for alarm relay connections. Relays are shown powered up, not tripped. The relays may also be used for audible or visual alarms.

4.2.5 4-20 Milliamp Output

The output provides 4-20 milliamps proportional to the KW941 full scale power. An external load of up to 600 Ohms can provide remote indication or input to another device. The load is connected across TS1 # 12 (4-20 mA +) and TS1 # 13 (4-20 mA -) as identified in Figure 4.3.

5 SETUP AND OPERATION

CAUTION ***These operations must be carried out by fully qualified personnel.***

The normal startup/reset sequence begins when power is supplied to the KW941. The display will flash "888" and the front panel LEDs will also flash. The software revision number will then be displayed briefly before the display returns to "0". The display and front panel LEDs should be constant when this sequence is complete.

Once installed and powered, set the control values for the KW941 using the front panel Function buttons and the up and down (↕) SET buttons. A button is activated by pressing the slightly raised front panel label area containing the desired function. Setup should be performed prior to start-up of the pump with power applied to the KW941.

Setup is accomplished by performing the following steps to set various control values:

1) Select the power display mode, i.e. HP or KW.
2) Set the Full Scale Adjust value.
3) Set the Start-Up Delay timer value.
4) Set the Low Power Trip Point value.
5) Set the Low Power Trip Delay timer.
6) Set the High Power Trip Point value.
7) Set the High Power Trip Delay timer

We recommend that the setup information be recorded on the Installation/ Setup Configuration Worksheet form.

Function Adjustments
Select the appropriate function button to adjust functions. A red LED on the button will illuminate indicating the function is active. The function can then be adjusted by pressing the -↕ SET arrow buttons to obtain the necessary display value.

Pressing the HP or KW display button after pressing another function button will cause the function adjust button LED to go out and return the KW941 to normal operation.

If no button is pressed within 15 seconds after a function button has been pressed, the function adjust button LED will go out and the KW941 will return to normal operation.

5.1 Display Mode – Power Units Selection

The KW941 can display power in either HP (horsepower) or KW (Kilowatts). Select the desired display units by depressing the HP or KW button. The red LED will illuminate for the selected units.

The KW941 can be set up and operated in either mode. Conversion between units is automatic when display units are changed.

5.2 Full Scale Adjust

The KW941 can be scaled to display power to the motor or power to the pump. The preferred setup is pump power.

5.2.1 To display PUMP POWER

1) Calculate the Full Scale Adjustment setting (FSA) by multiplying the Full Scale (FS) Power obtained from Table #4 or 4a, (HP or KW) times the motor efficiency factor in decimal format. Record the FSA on the installation/setup worksheet.

   Example: Motor Volts = 460 VAC, Full Scale power from Table #4 = 3.8 HP, and motor efficiency = .93 (93%).

   FSA = 3.8 HP X 0.93 = 3.5 HP
   or
   FSA = 2.8 KW X 0.93 = 2.6 KW

2) Depress the Full Scale Adjust button. The LED on the button will illuminate, indicating that the Full Scale Adjust function is active.

3) Press the -↕ SET arrows to obtain the Full Scale Adjust setting on the display.

4) Press the HP or KW display mode button to return to normal operation or any other function button to activate that function's adjustment feature.

   The display will now indicate power to the pump in the selected units.

5.2.2 To display MOTOR POWER

1) Obtain the Full Scale power (HP or KW) from Table #4. This will be the Full Scale Adjust setting (FSA).
   Example: Full Scale power = 3.8 HP.
   FSA = 3.8 HP
   or
   FSA = 2.8 KW

2) Depress the Full Scale Adjust button. The LED on the button will illuminate, indicating that the Full Scale Adjust function is active.

3) Press the ↕ SET arrows to obtain the Full Scale Adjust setting on the display.
4) Press the HP or KW display mode button to return to normal operation or any other function button to activate that function's adjustment feature.

The display will now indicate power to the motor in the selected units.

Note: Unbalanced power line load conditions will affect power readings.

5.3 Alarms

The KW941 provides LOW POWER (UNDERLOAD) and HIGH POWER (OVERLOAD) alarm relays. When wired into the pump's motor starter circuit, the alarm relays can trip out the pump motor during UNDERLOAD or OVERLOAD conditions. The alarms are disabled for an adjustable period of time during motor start-up (Start-Up Delay) to permit the pump to reach normal operation.

The following information describes how to set up the Start-Up Delay timer and alarms.

5.3.1 Start-Up Delay

The start-up delay is the amount of time in seconds (0-999) that must expire after the pump motor has been started and before the High Power and Low Power functions become active.

5.3.1.1 Operation

When the pump is started, the START-UP DELAY LED will flash for the set period of time and then go out.

5.3.1.2 Setting the START UP DELAY

1) Press the START-UP DELAY button. The Start-Up Delay LED will illuminate and the display will show the timer value in seconds.
2) Adjust the value by pressing the ↕ SET arrow buttons to obtain the desired time (0-999 seconds) on the display. It is recommended that the delay be set to the minimum time required to obtain a normal pump start-up (usually less than 5 seconds). Excessive delays leave the pump un-protected which may result in damage to the pump or motor.
3) Press the desired display mode HP or KW button to turn off the Start-Up Delay LED and return to normal operation (or any other function button to activate that function's adjustment feature).

5.3.2 Low Power Alarm

The Low Power Trip Point is the minimum power level necessary to prevent the Low Power Alarm relay from tripping. The normal state of the Low Power Trip Point LED is off.

5.3.2.1 Operation

If a low power trip has occurred, the Low Power Trip Point LED will blink and the Low Power Alarm Relay will trip if the Low Power Trip Delay timer has expired.

The Low Power Trip Delay is the amount of time in seconds (0-999) that must expire before the Low Power Alarm Relay will trip. The timer is activated when the power level has fallen below the Low Power Trip Point setting. The normal state of the Low Power Trip Delay LED is off.

When the power level has fallen below the Low Power Trip Point setting, the Low Power Trip Delay LED will blink. If the power level increases above the trip point setting before the delay timer value times out, the blinking LED will then go out and the unit returns to normal operation. If the power level remains below the trip point longer than the delay timer setting, the Low Power Trip Relay is activated. The blinking Trip Delay LED will go out and the Trip Point LED will blink alerting the operator to the problem.

To reset, press the Low Power Trip Point function button (or use the remote reset feature). This will cause the Low Power Trip Point LED to go out and its alarm relay to be reset. The pump may be restarted after resetting the alarm, however, it is strongly recommended that you investigate the cause of the alarm.

5.3.2.2 Setting the Low Power Trip Point

1) Pressing this function button will cause its LED to illuminate. The current setting for the Low Power Trip Point is displayed.
2) Press the ↕ SET arrow buttons to adjust the setting.
3) After the trip point is set, press the HP or KW button to return to normal operation (or any other function button to activate that function's adjustment feature).

Note: Flowserve recommends the Low Power Trip Point be set at the pump's power level for its minimum continuous flow. This power level is provided by Flowserve via the PC based pump selection program (PROS+). If the information is not readily available, contact your Flowserve sales representative or local distributor. You may also obtain a copy of the PROS+ program for in-plant use.

5.3.2.3 Setting the Low Power Trip Delay

1) Press the Low Power Trip Delay button. The Trip Delay LED will illuminate indicating the function is active. The current delay value in seconds (0 to 999) will be displayed.
2) Press the ↕ SET buttons to display the desired value.
3) Press the HP or KW button to turn off the function's LED and return to normal operation (or any other function button to activate that function's adjustment feature).

Note: The delay time value should be set to accommodate normal process fluctuations (usually 5 seconds or less). Excessive delays allow the pump to operate at low power (low flow) conditions which may result in damage to the pump.

5.3.3 High Power Alarm

The High Power Trip Point is the power level that, if exceeded, will cause the High Power Alarm relay to trip after the High Power Trip Delay has expired. The normal state of the high power trip point LED is off.

5.3.3.1 Operation

If a high power trip has occurred, the High Power Trip Point LED will blink and the High Power Alarm Relay will trip if the High Power Trip Delay timer has expired.

The High Power Trip Delay is the amount of time in seconds (0-999) that must expire before the high power alarm relay will trip. The timer is activated when the power level increases above the High Power Trip Point setting. The normal state of the High Power Trip Delay LED is off.

When the power level increases above the High Power Trip Point setting, the High Power Trip Delay LED will blink. If the power level decreases below the trip point setting before the delay timer value times out, the blinking LED will then go out and the unit returns to normal operation. If the power level remains above the trip point longer than the delay timer setting, the high power relay trips. The blinking Trip Delay LED will go out and the Trip Point LED will blink.

To reset, press the High Power Trip Point function button (or use the remote reset feature). This will cause the High Power Trip Point LED to go out and its alarm relay to be reset. The pump may be restarted after resetting the alarm, however, it is strongly recommended that you investigate the cause of the alarm.

5.3.3.2 Setting the High Power Trip Point

1) Pressing this function button will cause its LED to illuminate. The current setting for the High Power Trip Point is displayed.
2) Press the ↕ SET arrow buttons to adjust the setting.
3) After the trip point is set, press the HP or KW button to return to normal operation (or any other function button to activate that function's adjustment feature).

Note: Flowserve recommends the High Power Trip Point be set at one of the following levels:

a) The end of curve power shown on the pump performance curve.
b) The maximum rated power of the motor.
c) The power rating of the magnetic coupling of a mag drive or canned motor pump motor.

The High Power Trip Point setting is usually determined by the lowest value of the above three conditions, however, specific pumping applications may benefit from lower setting. For additional information, contact your Flowserve sales representative or local distributor.

5.3.3.3 Setting the High Power Trip Delay

1) Press the High Power Trip Delay button. The Trip Delay LED will illuminate indicating the function is active. The current delay value in seconds (0 to 999) will be displayed.
2) Press the ↕ SET buttons to display the desired value.
3) Press the HP or KW button to turn off the function's LED and return to normal operation (or any other function button to activate that function's adjustment feature).

Note: The delay time value should be set to accommodate normal process fluctuations (usually 2 seconds or less). Excessive delays allow the pump to operate at high power conditions which may result in damage to the pump or motor.

5.3.4 Resetting Alarms

Alarms, indicated by a blinking Low Power or High Power Trip Point LED, can be reset by any of three methods.

a) MANUAL: Press Trip Button with the flashing LED.
b) REMOTE: Momentary contact closure between Reset + and Reset - on TS1. See specifications for contact requirements.
c) AUTOMATIC: In automatic reset mode, an alarm condition will cause the selected alarm relay(s) to remain in the tripped state for 10 seconds before automatically resetting.

5.3.5 Activating Automatic Reset Mode

1) Press and hold the TRIP DELAY button until the TRIP DELAY displayed value is flashing. This indicates that the unit is now in automatic mode.
2) Press the HP or KW button to return to normal operating mode.

5.3.6 De-activating Automatic Reset Mode

1) To return to manual alarm reset operation press and hold the TRIP DELAY button until the TRIP DELAY display value stops flashing.
2) Press the HP or KW button to return to normal operating mode.

5.4 Demo Mode

Using the Demo Mode can be helpful in verifying whether or not the alarm contacts are functional. Varying the simulated input power in Demo Mode will permit simulated alarm conditions causing the alarm relay(s) to trip. This will enable verification of the alarm contact wiring/wiring logic into the motor start/stop circuit.

Changing time delays and setpoints, then successfully causing alarm relays to trip while in Demo Mode may indicate that a problem is due to external causes such as wiring errors, misapplication, or improper setup.

To enter the Demo Mode:

- press the "HP" button, and then the UP (↑) setting arrow on the front panel consecutively. The "HP" LED will blink indicating that the Demo Mode is operational.
- Repeat this sequence to exit the Demo Mode.
- Use the UP (↑) and DOWN (↓) setting arrows to change the readout to simulate a motor load. The display will increase or decrease as the arrow buttons are pressed. Moving the load above the High Power Trip Point or below the Low Power Trip Point will activate the alarm contacts (after Trip Delay has expired).
- The Startup Delay may need to be extended to move the simulated load between the Trip Points.

5.5 Current Sensor Field Replacement

The current sensor (toroid) can be replaced in the field if required, but it must be calibrated to the KW941 using the following procedure.

With the current sensor connected to the KW941 and power to the unit but the motor not running (no current through the lead going thru the sensor):

1. Press and hold in the “KW” button until the display changes, a number will be displayed.
2. Release the “KW” button and immediately press and release the up arrow “SET” button.
3. The display will return to zero and the sensor will be calibrated for that unit. Select the desired display units. The unit is now ready for normal operation.

6 MAINTENANCE

The KW941 Pump Power Monitor should not require any routine maintenance outside of wiping down the front cover occasionally.

⚠ It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Before restarting the machine, the relevant instructions listed in section 5, Setup and Operation must be observed.

Place a warning sign on the starting device: ***"Machine under repair: do not start"***.

With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning sign on the fuse box or main switch:
"Machine under repair: do not connect".

6.1 Spare parts

No spare parts are needed. The internal fuse is not meant to be accessed by the customer per CE requirements. The current sensor (toroid) is robust, but the leads can be broken off if handled roughly. Contact your local Flowserve sales representative to order a new toroid if the leads are damaged. Follow the procedure in Section 5.5 to calibrate the new toroid to the KW941 unit.

6.2 Tools required

A flat blade screwdriver, wire cutter, and wire stripper are all that should be required to work on the wiring going to the KW941 Pump Power Monitor once it is installed.

7 FAULTS: CAUSES AND REMEDIES

Troubleshooting
The purpose of this guide is to supply general information on how to troubleshoot problems related to startup and operation of the KW941 Pump Power Monitor. It is intended only as a guide and cannot cover every situation. If a problem exists that is not covered by one of the examples, then contact a Flowserve Sales Engineer or Distributor/Representative for assistance.

General Guidelines

- The KW941 Pump Power Monitor is intended for use on fixed frequency, steady, non-pulsating loads. The unit is not intended for use with variable frequency drives.
- When troubleshooting, never swap electronics from one unit to another. This will cause operational problems and void any warranty claim.
- It is often helpful to isolate the monitor to determine if the cause of a problem is internal to the KW941 or a part of the external wiring system. By removing all connections except for the voltage and current sensing toroid, the problem can normally be isolated to either the monitor itself or to the external wiring.
- Each KW941 has an internal "DEMO MODE" which can be helpful in verifying the correct function of the unit. See Section 5.4 for instructions on how to use this mode.
- Typical writing configurations for utilizing alarm relays are shown in Section 8 as Figures 8.1 and 8.2 for reference.

FAULT SYMPTOM

Unit will not power up (i.e., no lights)	Display locks up or all LEDs continuously flashing	Power readings higher than expected	Power readings lower than expected	Power readings drifting or inconsistent	Non-zero reading when equipment not running	Power reading flashing	Unit repeats startup/reset cycle when motor is tripped due to alarm, or when the motor is started	Monitor will not shut off motor	Cannot start motor	PROBABLE CAUSES	POSSIBLE REMEDIES
●										No AC power to unit.	Check for proper voltage supply to terminals # 2 and # 3.
●										Voltage supply different than unit rating.	Verify supply voltage is the same as unit rating (110V or 220V).
●										Unit held in reset mode (closed switch/contact at remote reset terminals # 10 and # 11).	Use normally open switch/contact for remote reset.
●										Internal fault.	Return unit through the sales representative to supplier for evaluation and repair.
	●									Corrupted memory or internal fault.	Reset unit (power off/on) to clear the fault. If normal operation is not seen, return the unit through the sales representative to supplier for evaluation and repair.
		●								Equipment operating at higher than expected load.	1. Verify equipment operating conditions are at designed levels. 2. Check equipment for abnormal operation (e.g., excessive mechanical rubbing).
		●								Incorrect KW941 installation/setup.	1. Verify correct number of turns of motor power lead through current sensing toroid. 2. Verify correct Full Scale Adjustment setting. 3. Verify correct Full Scale Range is selected (X1 or X10). 4. Verify correct frequency is selected (50 Hz or 60 Hz).
		●								Current sensing toroid on wrong motor lead.	Verify current sample is not taken from either of the lead from which the voltage sample is taken.
		●								Incorrect voltage sample.	Verify voltage sample taken from two phases supplying a three-phase motor.
			●							Equipment operating at lower than expected load.	1. Verify equipment operating conditions are at designed levels. 2. On mag drive pumps, check for magnet decoupling. 3. Check for closed valve or other flow restriction. 4. Check motor to pump coupling.
			●							Incorrect KW941 installation/setup.	1. Verify correct number of turns of motor power lead through current sensing toroid. 2. Verify correct Full Scale Adjustment setting. 3. Verify correct Full Scale Range is selected (X1 or X10). 4. Verify correct frequency is selected (50 Hz or 60 Hz).
			●							Current sensing toroid on wrong motor lead.	Verify current sample is not taken from either of the lead from which the voltage sample is taken.
			●							Incorrect voltage sample.	Verify voltage sample taken from two phases supplying a three-phase motor.
			●							Current sensing toroid leads too long.	Limit lead length to 30.5 m (100 ft.).
				●						Equipment load fluctuating.	Verify equipment operating conditions are at designed levels.
				●						Current sensing toroid on wrong motor lead.	Verify current sample is not taken from either of the lead from which the voltage sample is taken.

FAULT SYMPTOM

Unit will not power up (i.e., no lights)										
⇓	Display locks up or all LEDs continuously flashing									
	⇓	Power readings higher than expected								
		⇓	Power readings lower than expected							
			⇓	Power readings drifting or inconsistent						
				⇓	Non-zero reading when equipment not running					
					⇓	Power reading flashing				
						⇓	Unit repeats startup/reset cycle when motor is tripped due to alarm, or when the motor is started			
							⇓	Monitor will not shut off motor		
								⇓	Cannot start motor	
									⇓	**PROBABLE CAUSES** / **POSSIBLE REMEDIES**
				●						Incorrect voltage sample. — Verify voltage sample taken from two phases supplying a three-phase motor.
				●						Poor or open connection from current sensing toroid leads to terminals # 14 and # 15. — Check connections.
				●						Current input circuit damaged because of overload from selecting the wrong Full Scale Range (X10 instead of X1) or having too many turns through the toroid. — Return unit through the sales representative to supplier for evaluation and repair.
				●						Wrong input voltage frequency setting. — Verify correct frequency is selected (50 Hz or 60 Hz) per jumper Jp3.
					●					Wrong current sensing toroid used with unit. — Verify that the sensor being used is the same one shipped with the unit. If it is not, see section 5.5 for the calibration procedure.
					●					Other load exists on terminal # 14 and # 15 or on the leads of the toroid. — Eliminate all connection except those for the KW941.
						●				Over-range condition. — 1. Verify equipment operating conditions are at designed levels. 2. Verify correct installation/setup (see “power readings higher or lower than expected”).
							●			Electrical interference caused by KW941 relay contacts switching too large or unsuppressed load. — 1. Verify load is within relay ratings. 2. Add arc suppression device to motor starting coil. 3. Use interposing relay (a separate relay switched by the KW941 relay) to switch load. See schematic in Figure 8.2.
							●			Nearby equipment causing interference. — Relocate the KW941 unit.
							●			Improper application of remote reset. — Use normally open switch/contact for remote reset.
							●			Interference picked up by reset leads. — 1. Relocate the leads. 2. Use twisted shielded pair for reset leads.
								●		Incorrect alarm inputs. — Check equipment performance characteristics to determine appropriate set points.
								●		Alarm contact not wired, or improperly wired into motor start/stop circuit. — Verify proper wiring of alarm contacts into motor start/stop circuit.
									●	KW941 not powered. — Check voltage supply to unit.
									●	KW941 tripped due to previous alarm condition. — Check equipment for cause of alarm. Reset unit using manual, remote, or auto reset features.
									●	Internal fault not allowing contacts to close. — Reset unit (power off/on) to clear the fault. If normal operation is not seen, return the unit through the sales representative to supplier for evaluation and repair.
									●	Alarm contacts wired improperly into motor start/stop circuit. — Verify proper wiring of alarm contacts into motor start/stop circuit.

8 PARTS LIST AND DRAWINGS

Installation / Setup Configuration Worksheet

Pump/Equipment Identification _____
Location KW941 _____
Model / Part Number _____
Serial Number _____

Motor Data

Motor Nameplate Full Load Power	_____	KW HP
Motor Nameplate Voltage	_____	Volts
Motor Nameplate Frequency	_____	Hertz (HZ)
Control Voltage from Transformer	_____	110 V or 220/240 V

Motor Efficiency = $\frac{Motor\_Efficiency\_\%}{100}$ _____

Calculate: Input Power = $\frac{Full\_Load\_Power}{MotorEfficiency}$ _____

Current Sensor

Full Scale Power (FS) [Table 4.2 or 4.3]	_____	KW HP
Number of Turns through Toroid [Table 4.2 or 4.3]	_____	Turns

Display Settings

Units	_____	KW or HP
Full Scale Power (FS) [from Table 4.2 or 4.3]	_____	KW HP
Calculate: Full Scale Adjust = Full Scale (FS) x Motor Efficiency	_____	KW HP
Start-up Delay	_____	Seconds
Low Power Trip Point	_____	KW HP
Low Power Trip Delay	_____	Seconds
High Power Trip Point	_____	KW HP
High Power Trip Delay	_____	Seconds

Fault Reset Method

Local (from keypad) _____
Remote (TS1) _____
Automatic _____

Figure 8.1
Schematic showing wiring arrangement used to shut off motor in case of HIGH or LOW Alarm and provide 120 VAC to alarm indicators or other devices.

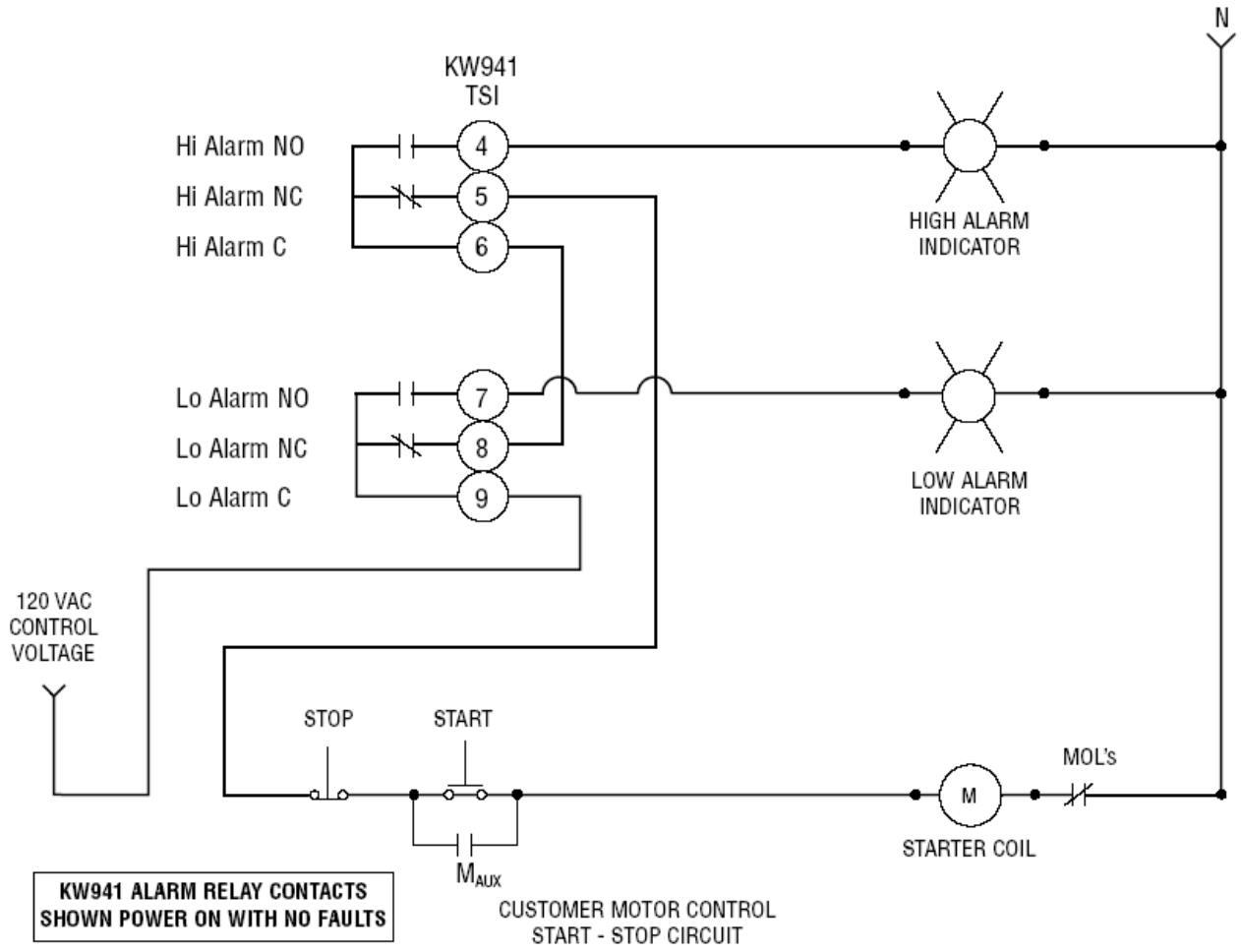
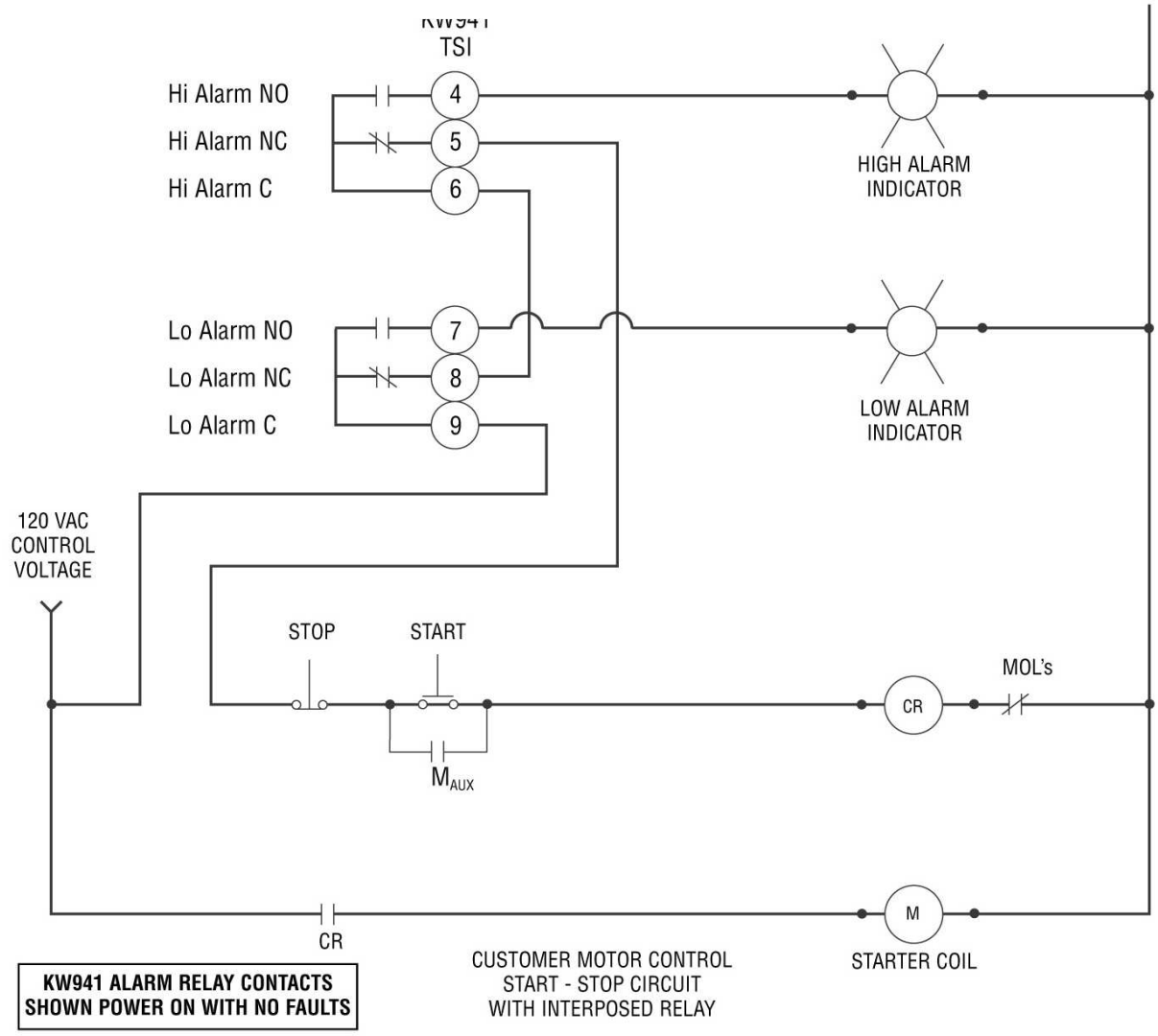


Figure 8.2:
Schematic showing wiring arrangement used to shut off motor in case of HIGH or LOW Alarm and provide 120 VAC to alarm indicators or other devices (interposed relay).



9 CERTIFICATION

Certificates, determined from the contract requirements, are provided with these instructions where applicable. Examples are certificates for CE marking and ATEX marking etc. If required, copies of other certificates sent separately to the Purchaser should be obtained from Purchaser for retention with these User Instructions.

Statement on ATEX Compliance

The KW941 Pump Power Monitor must not be installed in a potentially explosive atmosphere, but is compliant with Ignition Prevention Level 1 in EN 13463-6 and so it can provide protection, by control of ignition source 'b', of equipment of classification Category 2 and 3, which is operating in a potentially explosive atmosphere, (Zones -- 1, 21, 2 and 22). The KW941 is not ATEX marked as an independent device.

If the KW941 is used to monitor and alarm but not automatically shut down, it shall still not be used in a potentially explosive atmosphere, but there is no restriction on its use with equipment in the potentially explosive atmosphere.

If the KW941 is purchased separately to a Flowserve pump/motor set, the user is responsible for the risk assessment of the complete equipment.

The Flowserve KW941 Pump Power Monitor has the following approvals:

The KW941 carries a CSA Certificate of Compliance to Canadian and U.S. standards, Certificate Number: LR 108009-1, dated 2007/08/09. Details are as follows:

Products:
Class 3211 07 - Industrial Control Equipment - Miscellaneous Apparatus
Class 3211 87 - Industrial Control equipment - Miscellaneous Apparatus - CERTIFIED TO U.S. STANDARDS

Applicable requirements:
CAN/CSA-C22.2 No. 14-05 - Industrial Control Equipment
CAN/CSA-C22.2 No. 94-M91 - Special Purpose Enclosures
UL Std No. 508 - Industrial Control Equipment

The "C" and "US" indicators next to the CSA Mark signifies that the product was tested to applicable ANSI/UL and CSA Standards, for use in the U.S. and Canada.

In addition to the CSA Certification, theKW941 also carries an EC-Declaration of Conformity:

Article 10.1 of the Directive 89/336/EEC (EMC-Directive) in accordance with the following standards or standardized documents:

EN 55 011:1991 Gr. 1 Kl.A Emission EMA
EN 61 000-3-2:1995 EMA Harmonics
EN 61 000-3-3:1995 EMA, Voltage Fluctuations
EN 50 082-2:1995 Immunity EMB

Appendix III of the Directive 73/23/EEC (Low Voltage Directive)
IEC 1010-1:90 +A1:92 +A2:95

Test Reports of TUV Rheinland, Product Safety GmbH, 51101 Cologne, Germany
No. P9612 781 E01 (EMC Test report)
No. E 9712536 E02 (Low Voltage Directive test report)

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary user instructions

Supplementary instructions such as for using the KW941 Power Monitor for applications over 112 KW (150 hp) or further clarification on how to use the 4-20 mA output are available. Have your local sales representative contact Flowserve Engineering to discuss your needs and get copies of the supplementary instructions.

10.2 Change Notes

If any changes, agreed with Flowserve Pump Division, are made to the product after it is supplied, a record of the details should be maintained with these User Instructions.

Your Flowserve factory contact:

Flowserve Pump Division
3900 Cook Boulevard
Chesapeake, VA 23323-1626 USA
Telephone +1 757 485 8000
Fax +1 757 485 8149

Flowserve Pumps
Flowserve GB Limited
Lowfield Works, Balderton
Newark, Notts NG24 3BU
United Kingdom

Telephone (24 hours): +44 1636 494 600
Sales & Admin Fax: +44 1636 705 991
Repair & Service Fax: +44 1636 494 833

Email: newarksales@flowserve.com

Your local Flowserve representative:

To find your local Flowserve representative please use the Sales Support Locator System found at www.flowserve.com

FLOWSERVE REGIONAL SALES OFFICES:

USA and Canada
Flowserve Corporation
5215 North O'Connor Blvd.,
Suite 2300
Irving, Texas 75039-5421, USA
Telephone +1 972 443 6500
Fax +1 972 443 6800

Europe, Middle East, Africa
Flowserve FSG – Italy
Worthing S.r.l.
Via Rossini 90/92
20033 Desio (Milan), Italy
Telephone +39 0362 6121
Fax +39 0362 628 882

Latin America and Caribbean
Flowserve Corporation
6840 Wynnwood Lane
Houston, Texas 77008, USA
Telephone +1 713 803 4434
Fax +1 713 803 4497

Asia Pacific
Flowserve Pte. Ltd
10 Tuas Loop
Singapore 637345
Telephone +65 6771 0600
Fax +65 6862 2329