# Pilot Wire

# User Manual

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# 1. ABSTRACT

The function of a Pilot wire relay is to ensure that at all times the bonding resistance between a flameproof socket outlet and mobile machine being supplied is within the specified limit.

The ProBeck Pilot wire relay can be operated in three modes namely

1. Local start with standard diode (16F120 P/N 700042)

2. Remote start with an additional known resistor is series shorted by the start button the drop in measured pilot wire resistance and then the recovery is interpreted as a start signal (The actual earth bond resistance value is calculated by subtracting the value of the resistor in parallel with the start button)

3. The Smart pilot node used in the market by a number of manufactures. This node typically combines the remote start option with the additional feature of using the unused portion of the of the bi polar pilot pulse waveform (the negative portion of the waveform is shorted by the pilot diode) to power a MCU in the node which in turn is able to superimpose a pulse waveform on the remaining positive portion of the waveform. This pulse train is measured by the main pilot relay to identify the device being connected, having done so the protection setting are transferred to the protection relay to protect the connected load. Additional feature is that the Pilot relay can superimpose a pulse train on the waveform to program new setting or configure a node

Additional features added to the pilot relay active in all three modes is on every start request be it local, remote or from the ProBeck relay will test the integrity and functionality of the ProBeck Pilot relay
The following tests are performed and results stored in a time and date stamped 1000 event, 1000 fault record nonvolatile memory buffer

1. Start request. Log source of start signal location ( Local, remote, ProBeck IPS relay)
2. Short circuit pilot
3. Open circuit pilot
4. Confirm pilot conductor loop resistance is within specification
5. Allow output contactor to be energized

If the ProBeck pilot is used with the ProBeck relay additional tests are performed by the ProBeck relay namely

1. PEC conductor measurement through 1100 volt mains through power transformer windings to star point through NER to earth ( Provisional patent registered)
2. Insulation lockout test < 20 Kilo ohms
3. Earth Leakage test 0,200 amp Io set at 0.100 amp
4. Pilot relay test
    a. On start request
    b. Short circuit pilot
    c. Open circuit pilot
    d. Confirm pilot conductor loop resistance is within specification
    e. Allow output contactor to be energized

# 2. SPECIFICATIONS

## 2.1 Technical Specifications of Pilot wire

| | | |
|---|---|---|
| General Data | Mounting Position | • Next to ProBeck-IPS on right. |
| | Allowed Ambient Temperature | • Operation : 0 ºC to +60 ºC |
| | Humidity | • < 87% |
| Pilot Resistor | Pilot remote start signal | • 30 Ohm Model<br>• 100 Ohm Model |
| | Pilot local start signal | • 4 to 20 Ohm |
| Pilot Diode | Test Diode used | • 16F120 P/N 700042 |
| Indication Lights | Healthy LED | • Resistance value of Pilot conduct to PEC earth is in range. |
| | Run LED | • Output contactor clear to energize. |
| | Pilot Open LED | • Pilot loop resistance to high. |
| | Pilot Short LED | • Pilot diode short circuited |
| | Pilot Wire Test LED | • Manual test request. |
| | Pilot Local Run LED | • Local start request (must be latched) |
| | Pilot Remote LED<br>(Start signal source selection) | • Remote is selected when LED is on.<br>• Local is selected when LED is off. |
| Relays | Ratings | • 6Amps at 250Vac.<br>• 6Amps at 30Vdc. |
| | Healthy Relay | • Resistance value of Pilot conduct to PEC earth is in range. |
| | Run Relay | • Output contactor clear to energize. |
| | Pilot Open Relay | • Pilot loop resistance to high. |
| | Pilot Short Relay | • Pilot diode short circuited |
| | Barrier | • Relays are separated from other terminals by 50mm barrier. |
| Inputs | Ratings | • 24Vdc infallible supply only. |
| | Input Resistance | • 100kOhm at 1Watt |
| | Pilot Wire Test | • Manual test request. |
| | Pilot Local Run | • Local start request (must be latched) |
| | Pilot Remote | • Remote is selected when LED is on.<br>• Local is selected when LED is off. |
| Power | Infallible Power Supply | • 24 Vdc. |
| | Consumption | • 200mA. |

# 3. FUNCTIONAL DESCRIPTION

The Pilot wire can be broken down into the following function blocks:

- Micro-Controller
- ProBeck Interface.
- Pilot wire signal.
- Light Emitting Diodes (LED).
- Relays.

Micro-Controller – Is the core of the system. The micro-controller ensures that the operation of the Pilot wire gets executed. The micro-controller will monitor the pilot wire signal act according to logic.

ProBeck Interface – Is the communication bus between the ProBeck and Pilot wire. With the ProBeck interface it is possible for the two micro-controllers ProBeck and Pilot wire to exchange data.

Pilot wire signal – Generates a 24V 20 hertz signal to detect that the ground loop is intact and not shorted. Pilot signal also can be used to detect a remote start and stop.

Light Emitting Diodes – Allows the Pilot wire to indicate conditions to the operator.

Relays – Allows the ProBeck Pilot wire to switch potential free contacts for indication lamps or output contactor.

## 3.1 Output Relay Functionality

| Relay | Description |
|---|---|
| Healthy Relay | Will be energized as long as the Pilot wire system is functional and healthy. As soon as a trip condition is active the healthy relay will then de-energize. |
| Run Relay | Will energize after a start command is received and the pre-start test was successful. A trip or stop will de-energize the relay. |
| Pilot Open Relay | Will energize in the event that the pilot wire loop is open circuit.<br>When the fault is cleared the relay will then de-energize.<br>Failure on prestart test will require manual or remote ProBeck-IPS relay reset. |
| Pilot Short Relay | Will energize in the event that the pilot is short circuit.<br>When the fault is cleared the relay will then de-energize.<br>Failure on prestart test will require manual or remote ProBeck-IPS relay reset. |

# 4. OPERATING INSTRUCTIONS

## 4.1 Getting Started

### 4.1.1 Remote Start Configuration

Following connection must be done for a remote configuration:

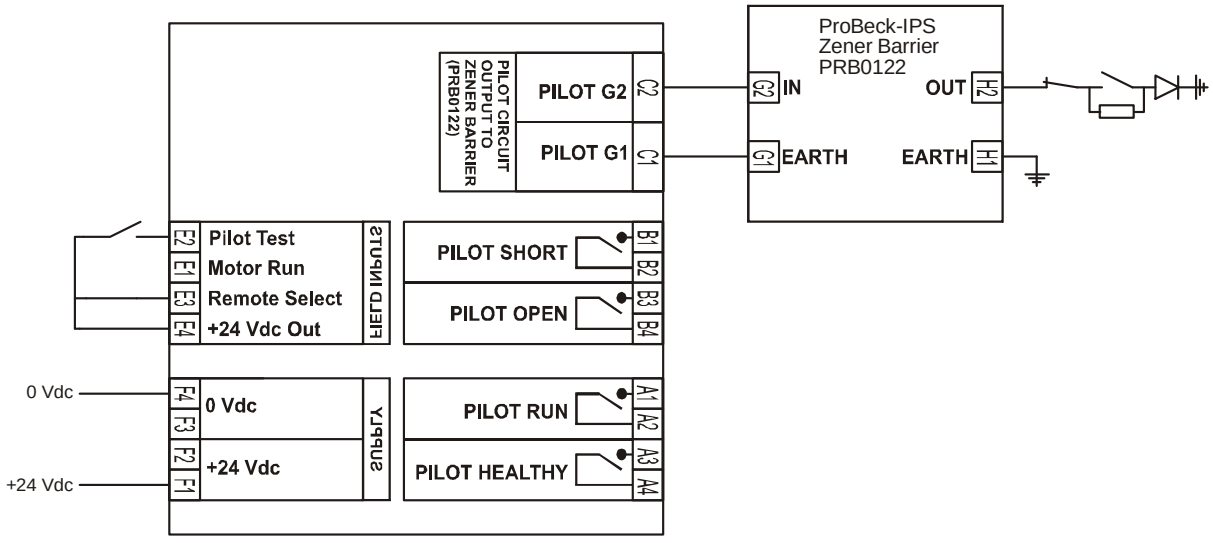
The remote input must be taken High (Active)

A 30 Ohm or 100 Ohm 1W (Depending on the model) must be used to give the signal through that the connection is healthy with the pilot diode.

When the signal drops below 20 Ohm the pilot relay will see that as a start condition. After the circuit test is passed the run contactor will then be energized. This will allow then a signal that can start the motor.

When a start signal was present the pilot will remember the start. This will allow the event record to record a stop rather than an open circuit fault. But if the circuit remains open for longer than 3 seconds then an open circuit trip will get recorded in the fault and event record.

In the event that the pre-start test failing then the respected contactor of the fault will be energized and the healthy and run contactor will be de-energized. Checking the wire connection and cycling the power of the pilot wire can clear the fault.



### 4.1.2 Local Start Configuration

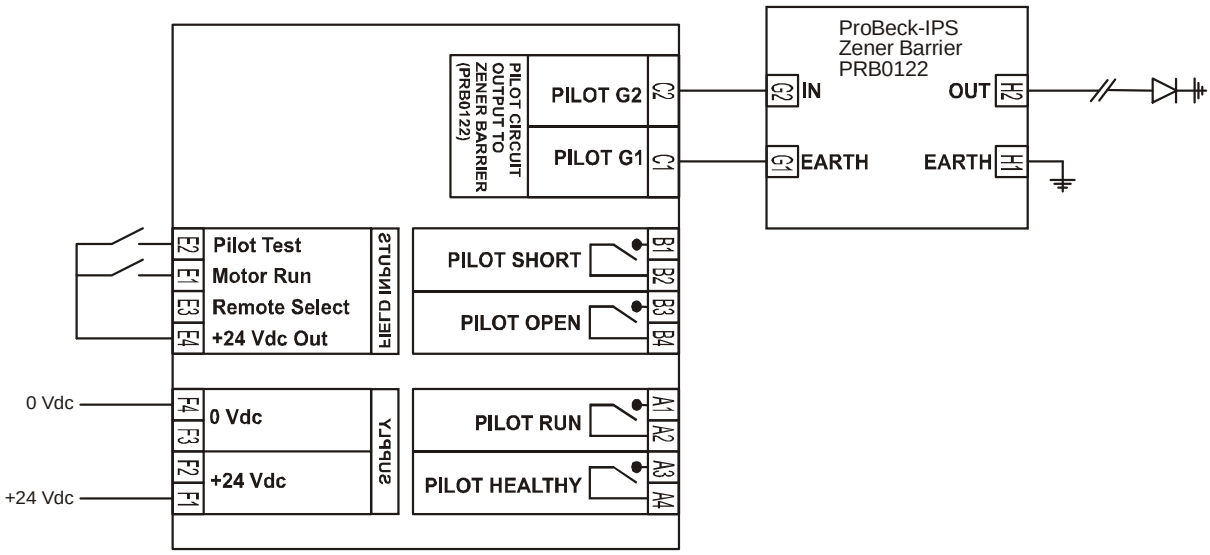
Following connection must be done for a remote configuration:

No resistor is used with the pilot diode.

The remote input must not be active (energized)

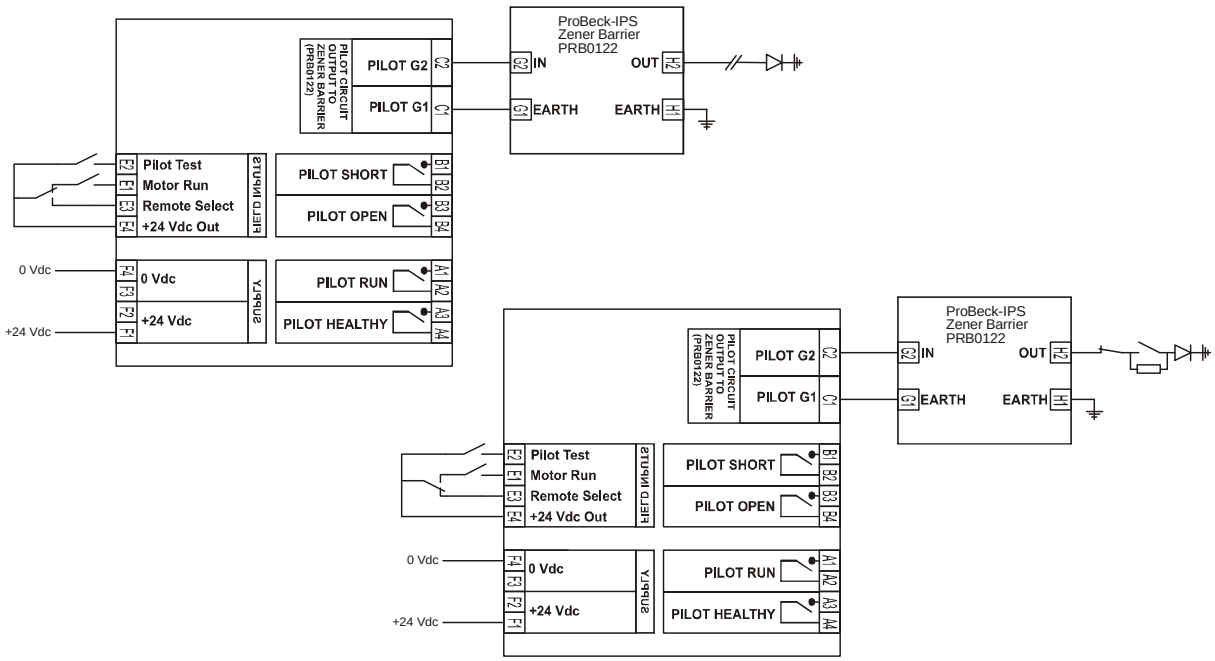
Start signal can be received by making the run input high. The start signal must be retained in order to keep the run contactor closed.

In the event that the pre-start test failing then the respected contactor of the fault will be energized and the healthy and run contactor will be de-energized. Checking the wire connection and cycling the power of the pilot wire can clear the fault.



### 4.1.3 Local And Remote Configuration

A local and a remote configuration can be achieved by using the following wiring diagram. Make sure that the correct diode and resistor configuration is placed before powering MCC.




### 4.1.4 Pilot Wire Integrated With ProBeck-IPS Protection And Control Relay

The Pilot wire can be connected to the ProBeck-IPS relay as a remote or local configuration.

When the Pilot wire receives a valid start signal the P

Start from pilot.

- Pilot receives a start command depend if selected remote or local.
- Local selection through input (E1 – Pilot Start Local)
- Remote Resistor must be below 20 Ohm to execute a test sequence.
    - Open pilot.
    - Short pilot
- Pilot wire will the inform the ProBeck-IPS that a start was received and the

pilot passed its test.

- Request ProBeck-IPS to start the ProBeck-IPS test sequence.
  - PEC conductor measurement through 1100 volt mains through power transformer windings to star point through NER to earth ( Provisional patent registered)
  - Insulation lockout test < 20 Kilo ohms
  - Earth Leakage test 0,200 amp Io set at 0.100 amp

- ProBeck-IPS starts and indicates to the Pilot Wire that it can also pull in its “RUN” contactor.
- Should button jam (Latch) on next stop healthy state will not be restored.
- If at any point a test fails the test sequence will get aborted.

Start from ProBeck-IPS

If the ProBeck pilot is used with the ProBeck relay additional tests are performed by the ProBeck relay namely

1. PEC conductor measurement through 1100 volt mains through power transformer windings to star point through NER to earth ( Provisional patent registered)
2. Insulation lockout test < 20 Kilo ohms
3. Earth Leakage test 0,200 amp Io set at 0.100 amp
4. The above test gets done with aid of the ProBeck IO expander module (PBRXXXXX).

| Relay | Input Signals |
|---|---|
| Relay 1 | PreStartWarnF |
| Relay 2 | SOP1- |
| Relay 3 | Zero (0) |
| Relay 4 | Zero (0) |
| External Relay 5 | Test_ELLO |
| External Relay 6 | Test_EL |
| External Relay 7 | VacuumFail_tf |
| External Relay 8 | Test_Sys_Earth |

| Input | Description | Relay | Description |
|---|---|---|---|
| Input 01 | Remote | Relay 1 | Main |
| Input 02 | Forward | Relay 2 | Forward |
| Input 03 | Reverse | Relay 3 | Reverse |
| Input 04 | C/B On | Relay 4 | MCCB |
| Input 05 | Reset | Relay 5 | Test EL |
| Input 06 | Stop | Relay 6 | Test ISLO |
| Input 07 | Start | Relay 7 | Inservice |
| Input 08 | Input 8 | Relay 8 | Relay 8 |
| Input 09 | Input 9 | | |
| Input 10 | Input 10 | | |
| Input 11 | Input 11 | | |
| Input 12 | Input 12 | | |
| Input 13 | Input 13 | | |
| Input 14 | Input 14 | | |
| Input 15 | Input 15 | | |

5. Pilot relay test
    a. On start request
    b. Short circuit pilot
    c. Open circuit pilot
    d. Confirm pilot conductor loop resistance is within specification
    e. Allow output contactor to be energized

## 4.2 Pilot Wire Test

Integrity test will always execute a

- pilot wire loop resistance open circuit
- pilot wire diode short circuit
- pilot wire loop resistance within specified value

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The test is carried out during the following conditions:

- Power up.
- Remote start.
- Local start.
- ProBeck-IPS start.
- Test button was pressed.

Trip relays are not energized during a test sequence which yields a healthy result. Should a faulty condition be detected the respective trip relay will be energized

This allows for testing of a operational circuit without causing a nuisance trip but allows one to confirm that all circuits are functional and healthy

## 4.3 Pilot Faults

1000 faults are stored into the pilot with time and date stamping.

The faults can be assessed with aid of the Pilot wire front end.

Faults can be cleared with aid of the Pilot wire frontend.

## 4.4 Pilot Events

1000 events are stored into the pilot with time and date stamping.

The events can be assessed with aid of the Pilot wire front end.

Event records can only be cleared by the factory.

## 4.5 Pilot Reset

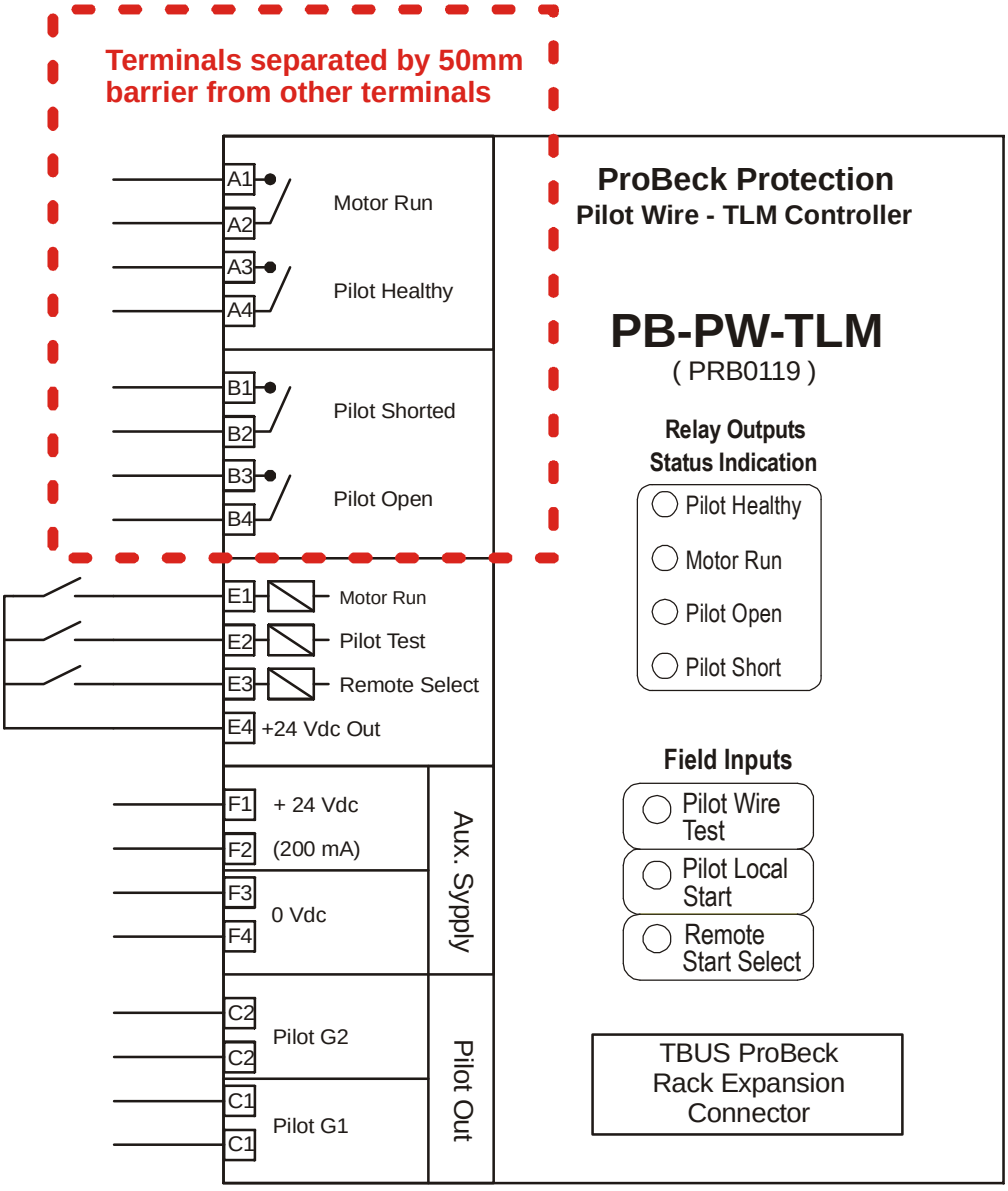
When the pilot resistor value is within the resistor limit then the pilot will auto reset.

If the is connected to the ProBeck-IPS relay and the ProBeck-IPS has a trip condition the Pilot will also become unhealthy till the ProBeck-IPS relay’s fault is cleared.

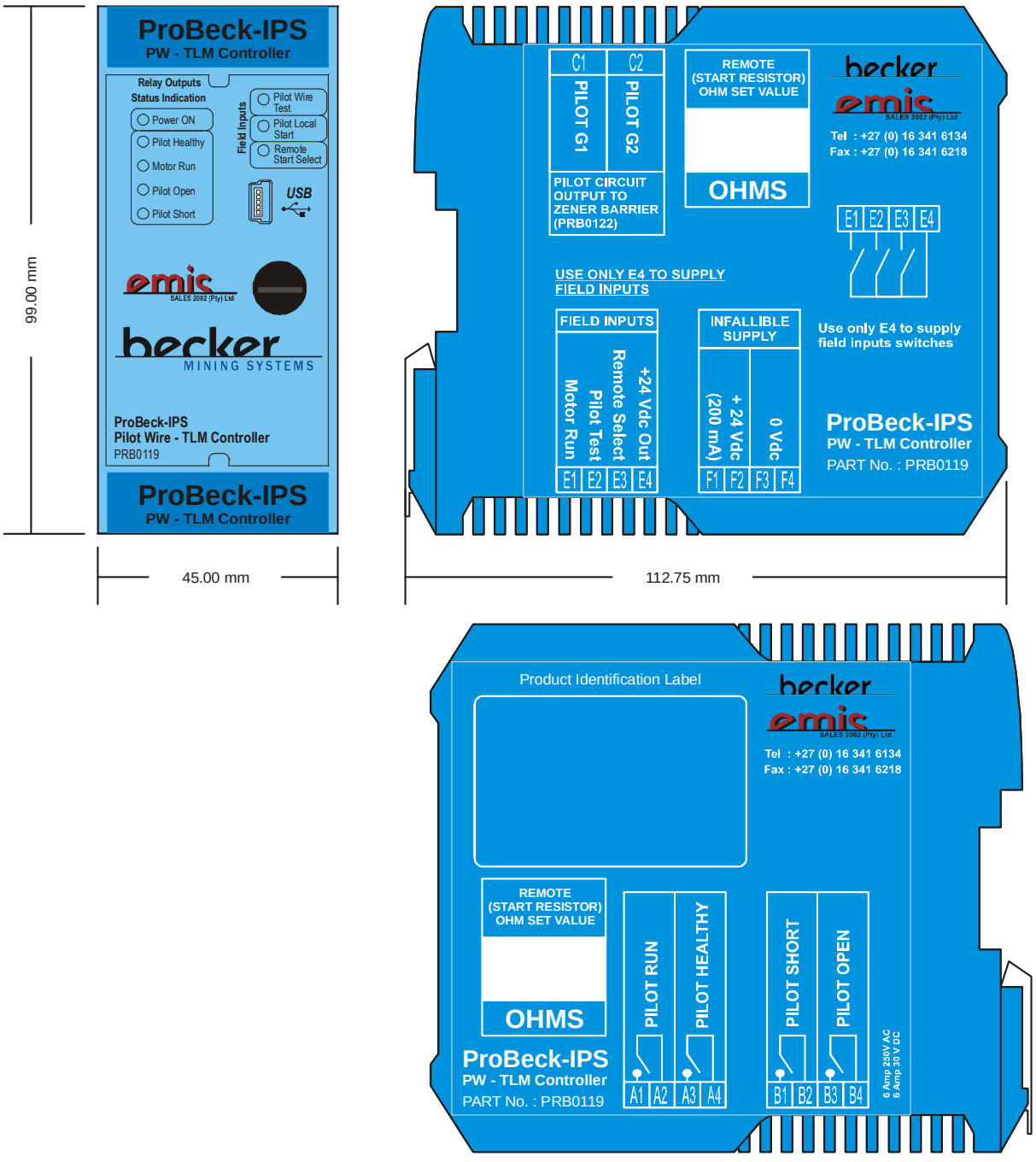
Only fault that will not reset is when the Pilot wire module has failed the startup test. This will require the Pilot wire module to be power cycled.

# 5. DIAGRAMS

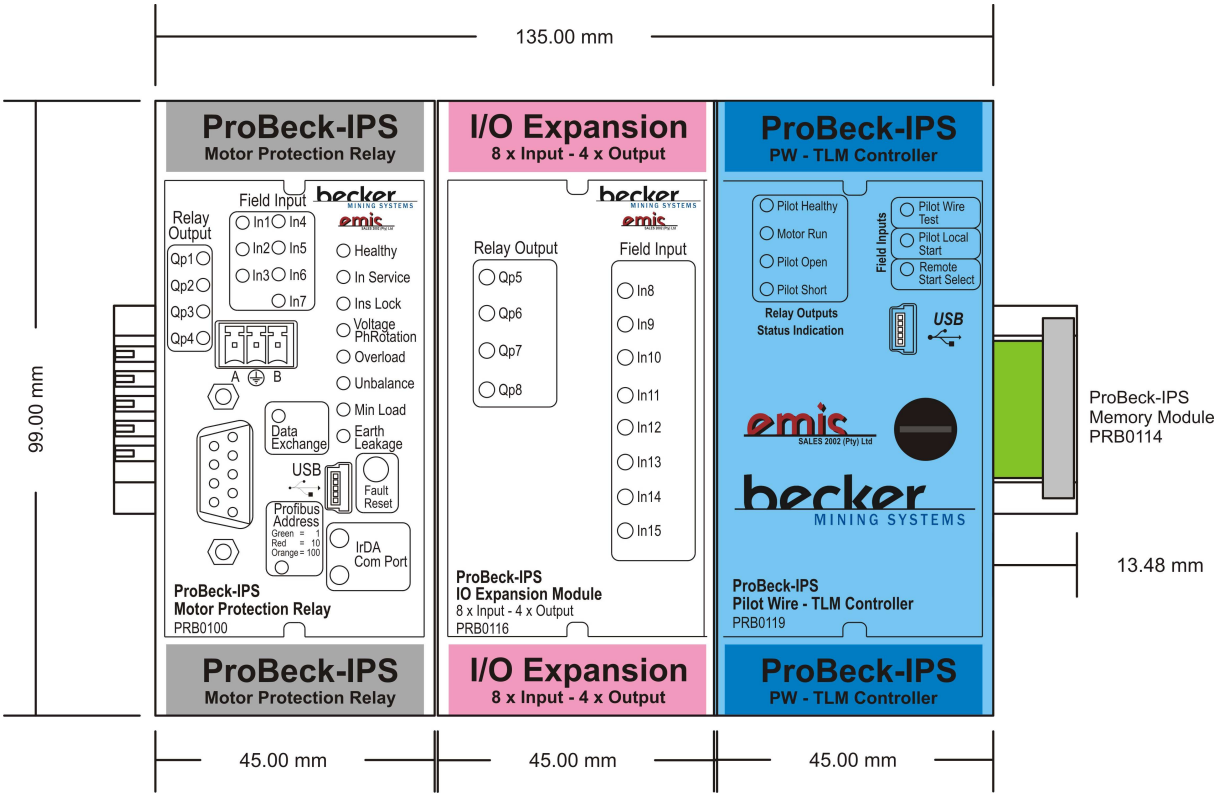
## 5.1 Block Diagram of Pilot wire



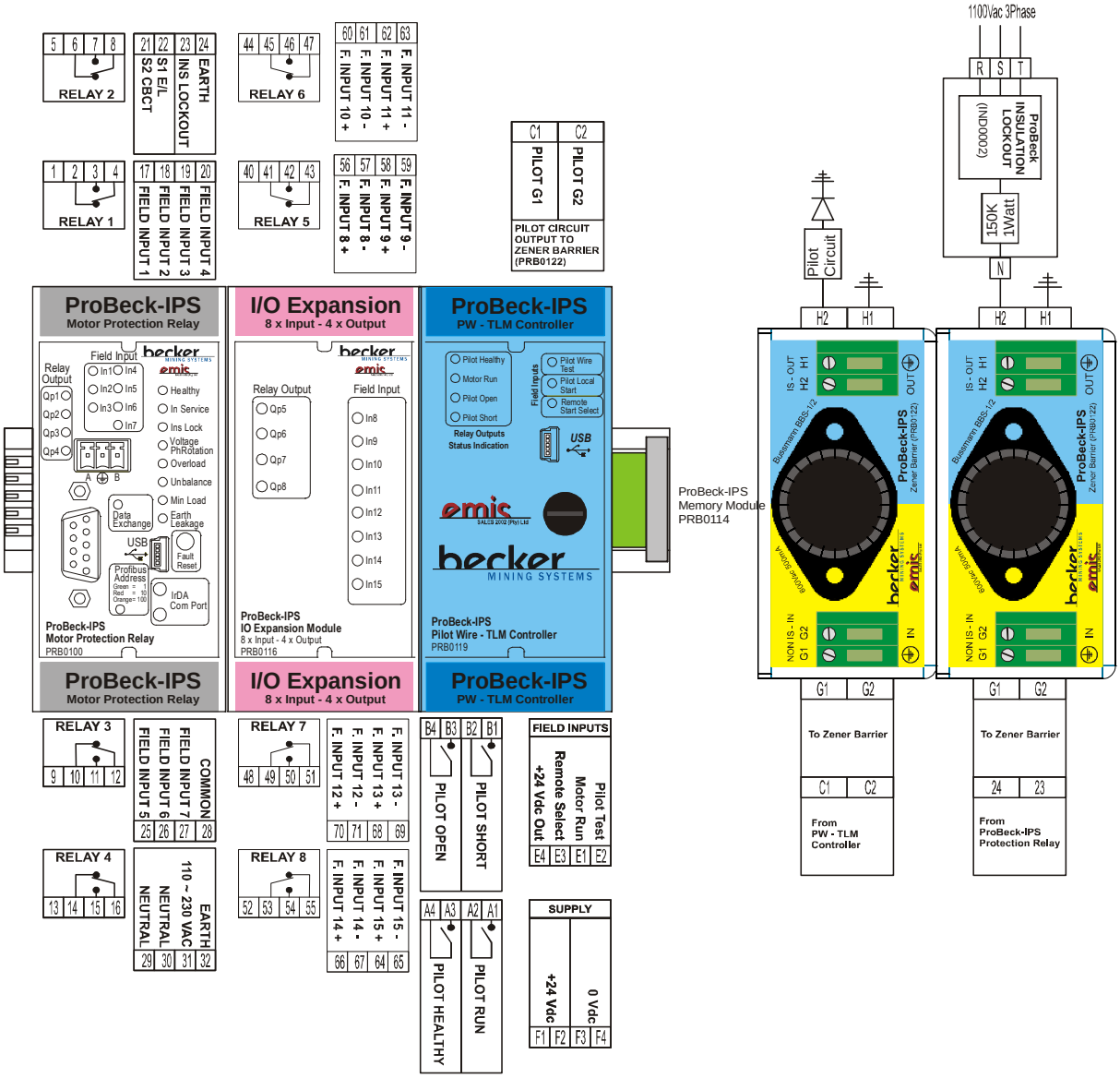
## 5.2 Pilot Dimensional Drawing

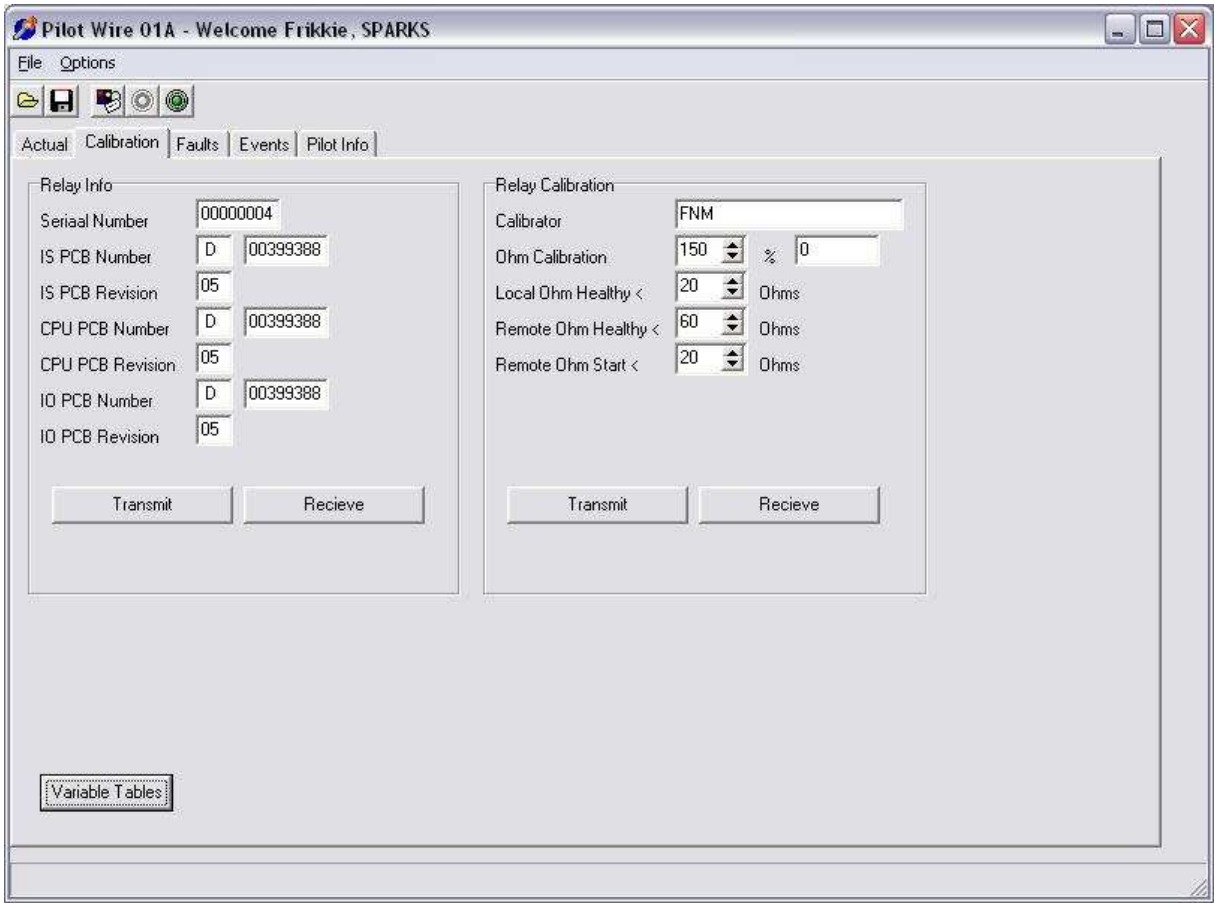


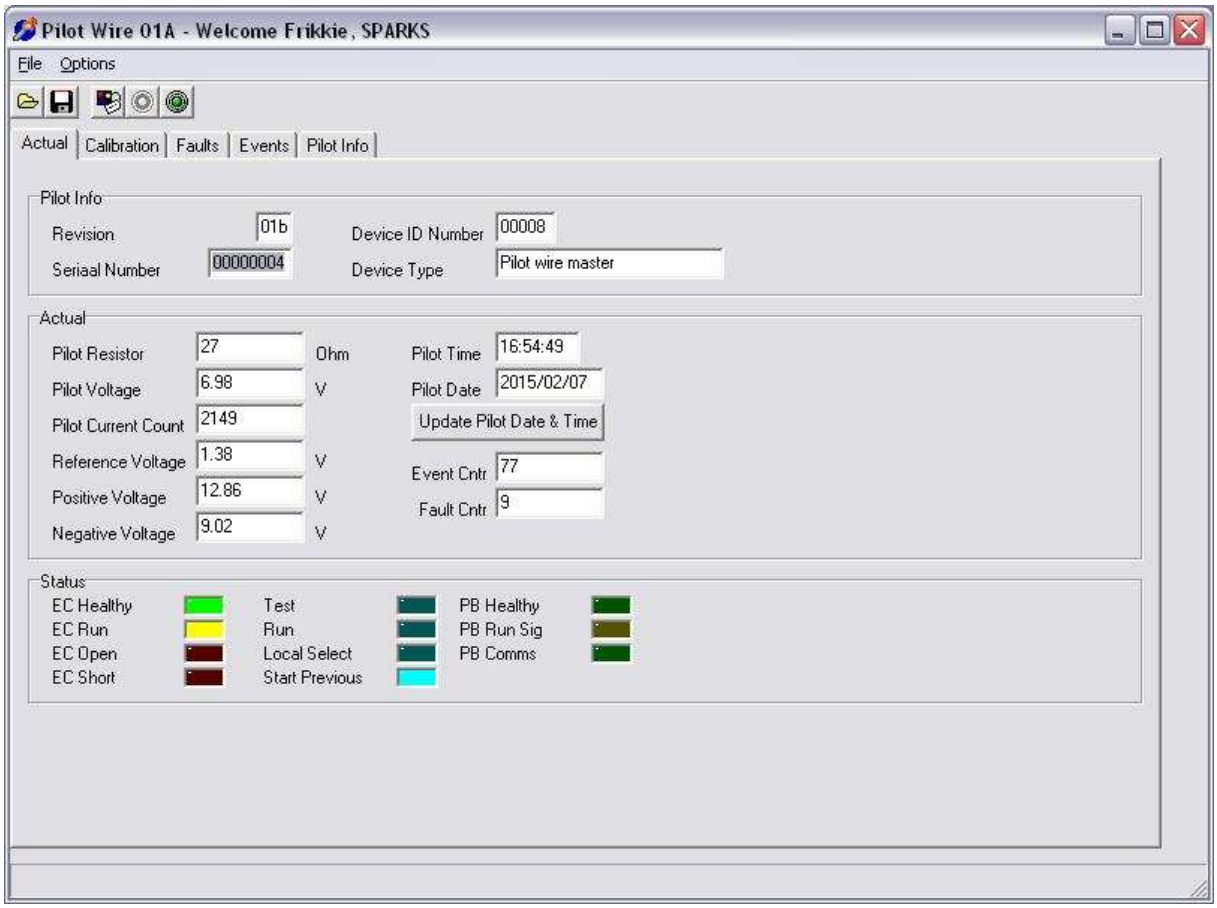
## *5.3 Pilot Wire Connected With ProBeck-IPS*

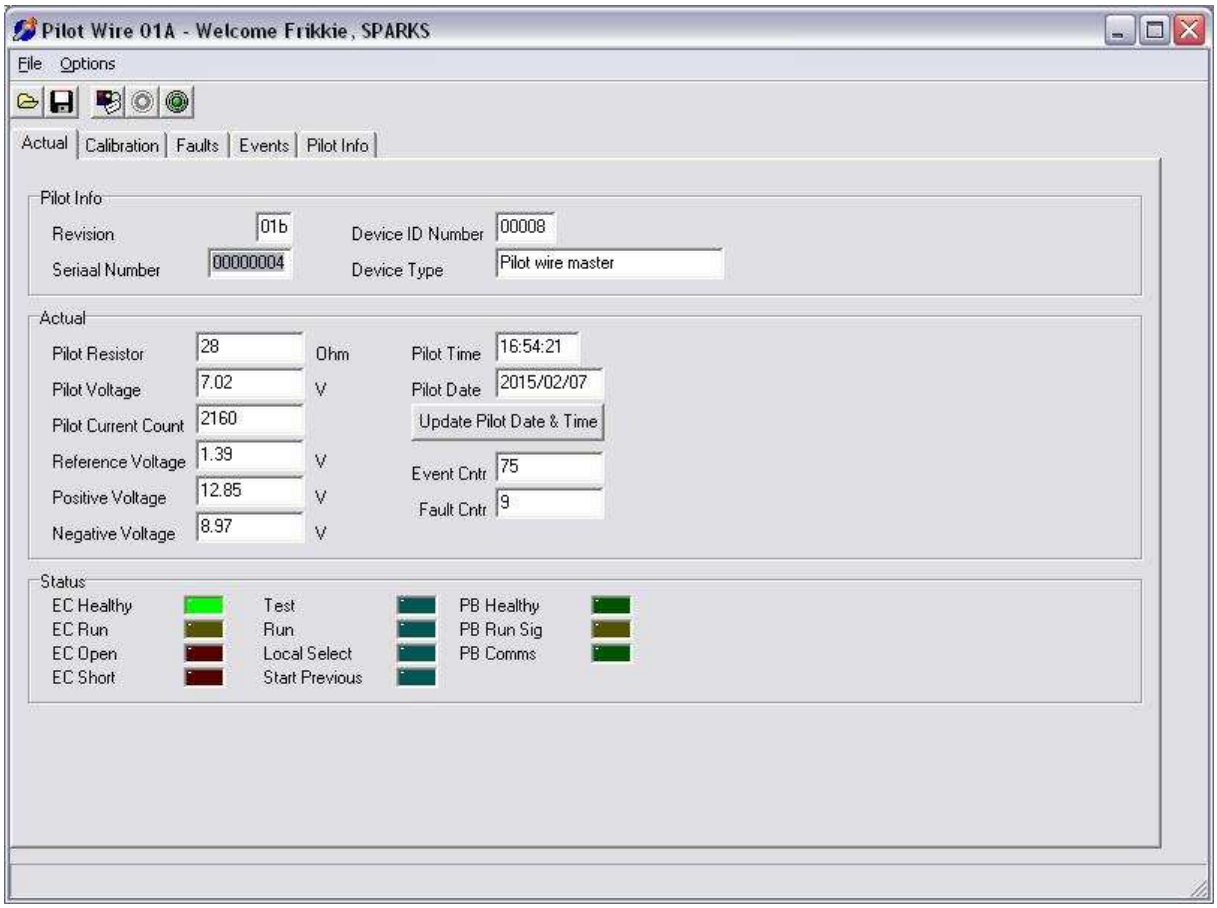


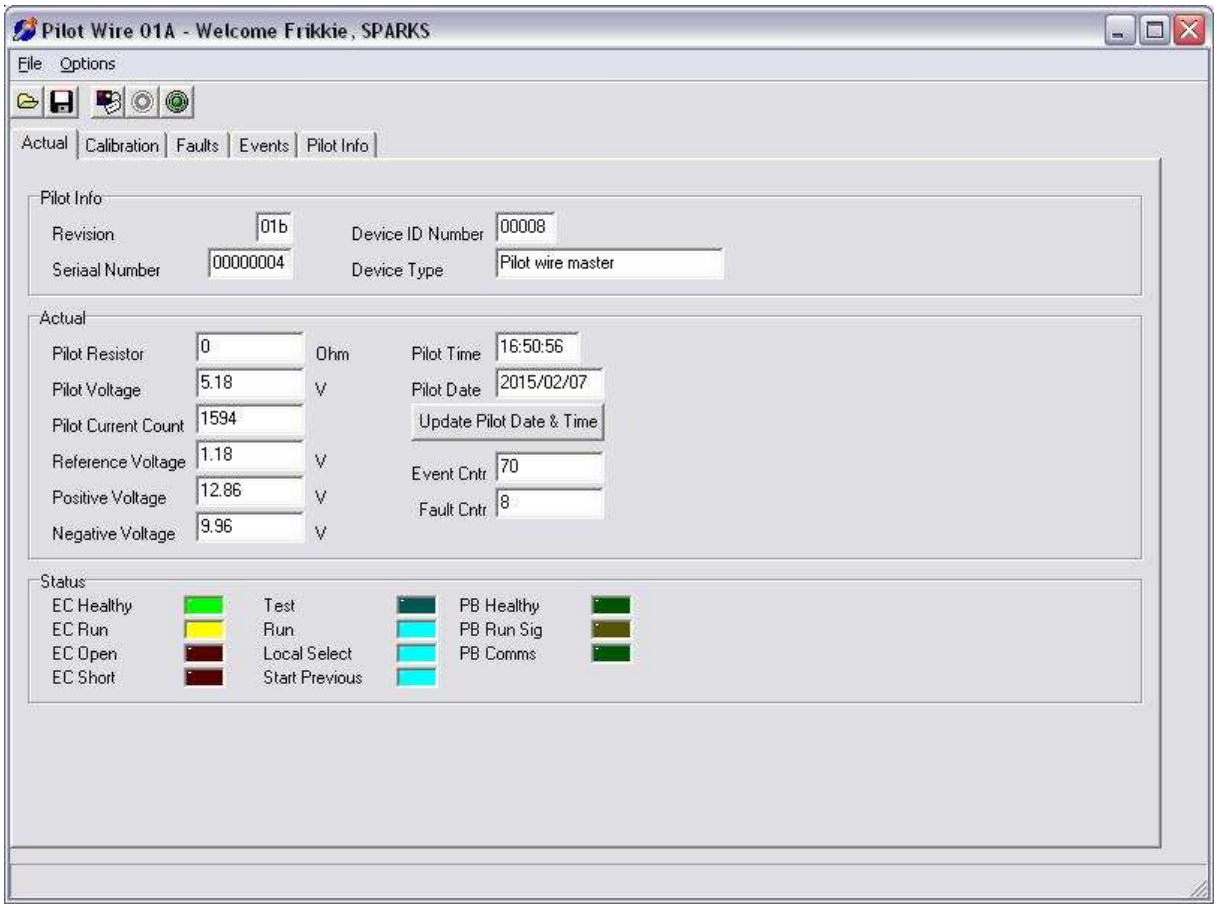
## *5.4 Pilot Wire And ProBeck-IPS Terminal Descriptions*

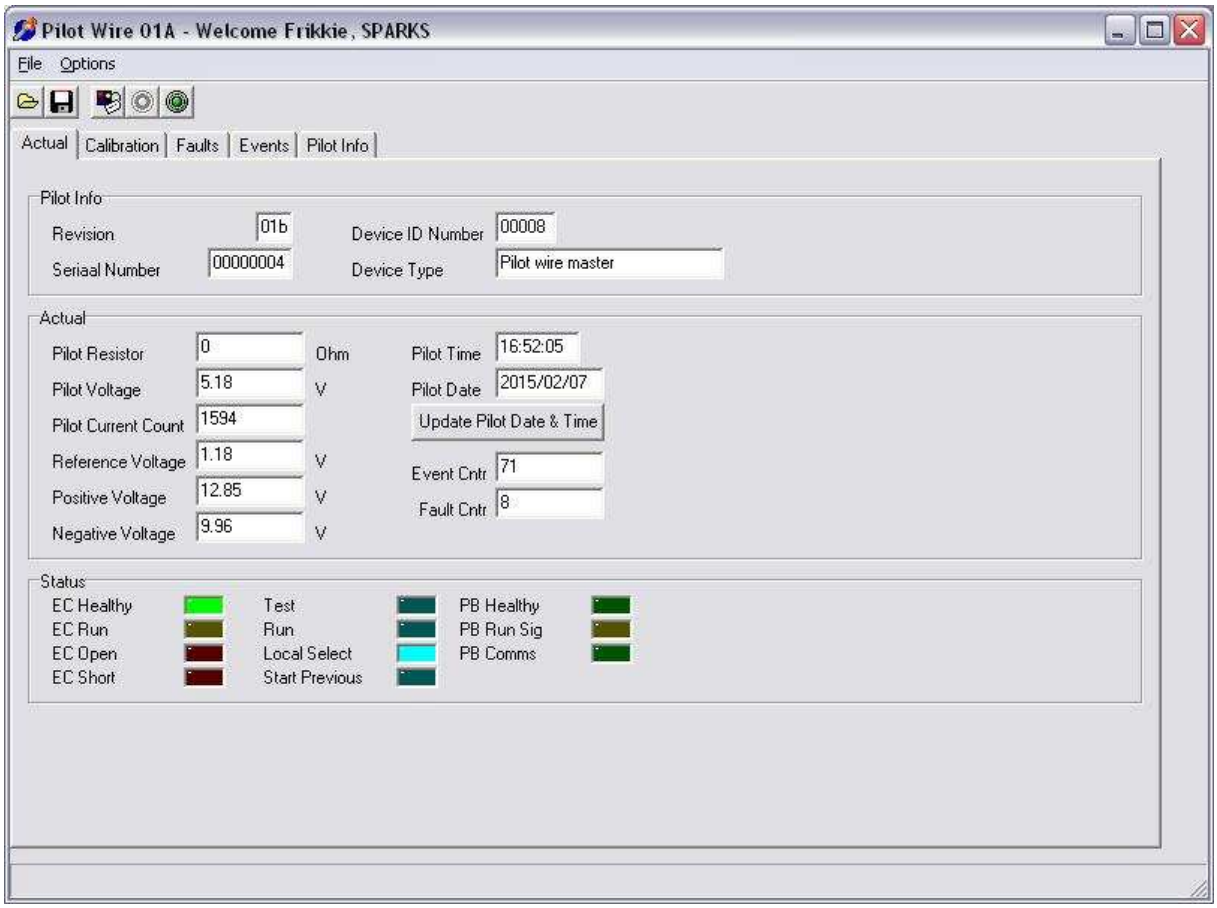



Pilot Wire 01A - Welcome Frikkie, SPARKS
File Options
Actual Calibration Faults Events Pilot Info
Relay Info
Seriaal Number 00000004
IS PCB Number D 00399388
IS PCB Revision 05
CPU PCB Number D 00399388
CPU PCB Revision 05
IO PCB Number D 00399388
IO PCB Revision 05
Transmit Recieve
Relay Calibration
Calibrator FNM
Ohm Calibration 150 % 0
Local Ohm Healthy < 20 Ohms
Remote Ohm Healthy < 60 Ohms
Remote Ohm Start < 20 Ohms
Transmit Recieve
Variable Tables


Pilot Wire 01A - Welcome Frikkie, SPARKS
File Options
Actual Calibration Faults Events Pilot Info
Pilot Info
Revision 01b
Seriaal Number 00000004
Device ID Number 00008
Device Type Pilot wire master
Actual
Pilot Resistor 27 Ohm
Pilot Voltage 6.98 V
Pilot Current Count 2149
Reference Voltage 1.38 V
Positive Voltage 12.86 V
Negative Voltage 9.02 V
Pilot Time 16:54:49
Pilot Date 2015/02/07
Update Pilot Date & Time
Event Cntr 77
Fault Cntr 9
Status
EC Healthy
EC Run
EC Open
EC Short
Test
Run
Local Select
Start Previous
PB Healthy
PB Run Sig
PB Comms


Pilot Wire 01A - Welcome Frikkie, SPARKS
File Options
Actual Calibration Faults Events Pilot Info
Pilot Info
Revision 01b
Seriaal Number 00000004
Device ID Number 00008
Device Type Pilot wire master
Actual
Pilot Resistor 28 Ohm
Pilot Voltage 7.02 V
Pilot Current Count 2160
Reference Voltage 1.39 V
Positive Voltage 12.85 V
Negative Voltage 8.97 V
Pilot Time 16:54:21
Pilot Date 2015/02/07
Update Pilot Date & Time
Event Cntr 75
Fault Cntr 9
Status
EC Healthy
EC Run
EC Open
EC Short
Test
Run
Local Select
Start Previous
PB Healthy
PB Run Sig
PB Comms


Pilot Wire 01A - Welcome Frikkie, SPARKS
File Options
Actual Calibration Faults Events Pilot Info
Pilot Info
Revision 01b
Seriaal Number 00000004
Device ID Number 00008
Device Type Pilot wire master
Actual
Pilot Resistor 0 Ohm
Pilot Voltage 5.18 V
Pilot Current Count 1594
Reference Voltage 1.18 V
Positive Voltage 12.86 V
Negative Voltage 9.96 V
Pilot Time 16:50:56
Pilot Date 2015/02/07
Update Pilot Date & Time
Event Cntr 70
Fault Cntr 8
Status
EC Healthy
EC Run
EC Open
EC Short
Test
Run
Local Select
Start Previous
PB Healthy
PB Run Sig
PB Comms


Pilot Wire 01A - Welcome Frikkie, SPARKS
File Options
Actual Calibration Faults Events Pilot Info
Pilot Info
Revision 01b
Seriaal Number 00000004
Device ID Number 00008
Device Type Pilot wire master
Actual
Pilot Resistor 0 Ohm
Pilot Voltage 5.18 V
Pilot Current Count 1594
Reference Voltage 1.18 V
Positive Voltage 12.85 V
Negative Voltage 9.96 V
Pilot Time 16:52:05
Pilot Date 2015/02/07
Update Pilot Date & Time
Event Cntr 71
Fault Cntr 8
Status
EC Healthy
EC Run
EC Open
EC Short
Test
Run
Local Select
Start Previous
PB Healthy
PB Run Sig
PB Comms