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DF77

**PULSE INPUTS MODULE
WITH PROVER SUPPORT**



DF77 – PULSE INPUTS MODULE WITH PROVER SUPPORT

Introduction

The DF77 is a module with 10 pulse and frequency inputs, divided in 5 isolated groups, provided with prover support. It is ideal to applications of flow measurement and totalization, such as, turbines or positive displacement meters.

DF77 is an A Level pulse totalizer module that has 10 independent totalizers of 16 bits operating in single pulses or 5 totalizers operating in dual pulses. It is in compliance with the main Brazilian and international standards regarding pulse transmission reliability and volumetric meter proving with pulsed output.

It is used together with FC302. This manual describes basic characteristics, common to all the applications.

For specific information about configuration and operation, please, refer to the AuditFlow's manual.

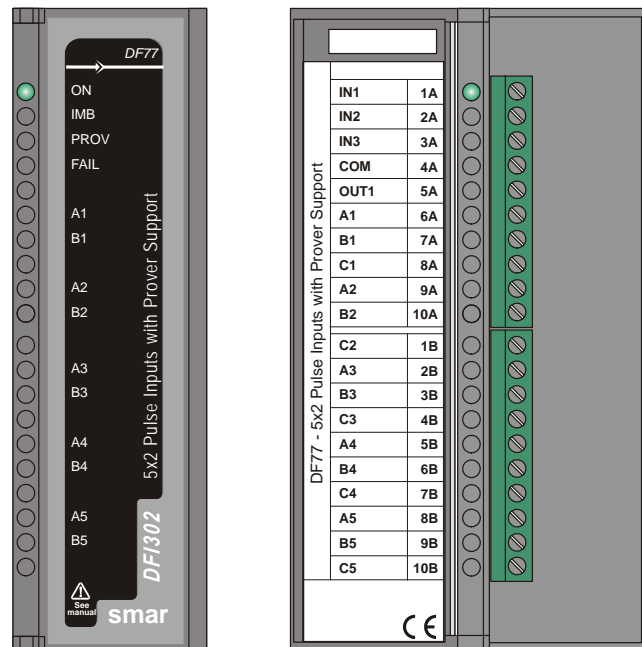


Figure 1 - Pulse Inputs Module with Prover Support: DF77

Part Number

DF77 – 5 x 2 Pulse Inputs Module with Prover Support

WARNINGS



ATTENTION

This equipment has Electrostatic Discharge (ESD) sensitive components. Do not open the module while it is powered or without the appropriate ESD protection. Otherwise, the circuits can be damaged permanently.

NOTE

It is important to install and configure all measurement system components correctly. It is also important to check the installation to make sure there are no noise sources. The automatic error detection and correction implemented in the DF77 helps the flow computer to reduce the measurement uncertainty only in untypical conditions. This equipment does not guarantee the system functionality in precarious installation conditions, with noise or meter problems. Frequent maintenances are extremely important.

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DF77 – PULSE INPUTS MODULE WITH PROVER SUPPORT

Overview

Standards Compliance

- ANP/INMETRO Regulation number 1 and number 64.
- API MPMS 4.6: Proving Systems - Pulse Interpolation.
- API MPMS 5.5: Metering - Fidelity and Security of Flow Measurement Pulsed-Data Transmission Systems.
- ISO 6551: Petroleum Liquids and Gases - Fidelity and security of dynamic measurement - Cabled transmission of electric and or electronic pulsed data.
- ISO 7278-3: Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters - Part 3: Pulse interpolation techniques.

Features

The DF77 has 10 inputs for counting the pulses and average frequency measurement with 0.01% accuracy. The DF77 has features that make it ideal for applications of flow measurement and pulse totalization.

“A level” pulse totalizers (API 5.5 and ISO 6551). The totalizers provide the accumulated total from the last CPU reading. The CPU is responsible for maintaining the totalization for larger periods of time.

Use of advanced programmable logic technology to guarantee reliable and accurate operation, with specific hardware for critical functions.

10 independent 16-bit totalizers operating in single pulse mode or 5 independent totalizers operating in dual pulse mode.

The totalizers reading is done simultaneously in each CPU cycle with the counters synchronized. In the AuditFlow (FC302) system, this feature is important for Master Meter (MM) proving where the totalization value for the meter in prove and the MM must be obtained in same instant.

On the dual pulse mode, the DF77 automatically detects and corrects level A errors related to^{*}:

- Coincident pulses.
- Sequence error.
- Phase difference error.
- Missing pulses.
- Additional pulses.
- Coincident pulses, phase errors, sequence errors and additional pulses errors are automatically ignored in the totalization, being computed by counters that are individual for each type of error, which are available in the CPU transducer block.
- Detected missing pulses are automatically counted.
- If one of the signals is lost, the totalization will continue only with the remaining signal, without error detection and correction.

The prover support includes:

Connection to any prover that detects the beginning and the end of the calibrated section (compact, U type, etc).

Open-drain output controlled by the flow computer (FC302) to start proving.

Dual chronometry implementation for pulse interpolation, with counters operating at 50MHz providing excellent resolution.

Proving does not interfere in the totalization, since it is executed by independent, specific hardware.

^{*} The configuration of this mode depends on the CPU used. Refer to the CPU's manual for further details.

Description of the Front Panel LEDs

| LED | Status | Description |
|--------------------|--------------------|--|
| ON | Green ON | The module is powered; the HOT SWAP circuit is operating correctly and the FPGA initialization sequence was successful. |
| | Red ON | The module is powered via IMB (+5V), but the FPGA initialization sequence was not successful. The FPGA may not have been programmed yet. It may have some internal problem. |
| | OFF | There is no power on the IMB or the HOT SWAP circuit failed. |
| IMB | Green ON | The CPU is scanning the module with acceptable periodicity. |
| | Red ON or blinking | The CPU is not scanning the module with acceptable periodicity |
| PROV | Blue ON | Proving is being executed. |
| | OFF | There is no proving being executed. |
| FAIL | Red ON | Hardware failure, the CPU and/or the power supply indicate failure in the IMB (HC block missing, power failure). |
| | OFF | No hardware failure. |
| A1...A5 B1...B5 | Green ON | The corresponding input is continuously receiving the pulse train with frequency within the configured range with configuration <code>FREQ_LOWER_RANGE</code> and <code>FREQ_UPPER_RANGE</code> of PIP block. |
| | Green blinking | The input is receiving the pulse train with frequency out of the lower and upper range limits configured in the CPU transducer block, or there is too much noise. The sign frequency is among the following limits: $5\text{Hz} < f < \text{FREQ_LOWER_RANGE}$ or $\text{FREQ_UPPER_RANGE} < f < 25\text{kHz}$. |
| | Red ON | There has been a signal failure or the measured frequency is out of the maximum limits of the equipment (5Hz-25kHz) or the duty cycle is smaller than 15% of the corresponding period to the configured value in <code>FREQ_UPPER_RANGE</code> . |
| | OFF | The corresponding input is disabled by the configuration in the CPU transducer block. |

Table 1 – Front Panel LEDs

I/O Circuits

The figure below shows the block diagram of the I/O circuits to facilitate the connection of the pulse transmitters, preamplifiers and external interfaces.

DF77 - 5x2 Pulse Inputs with Prover Support

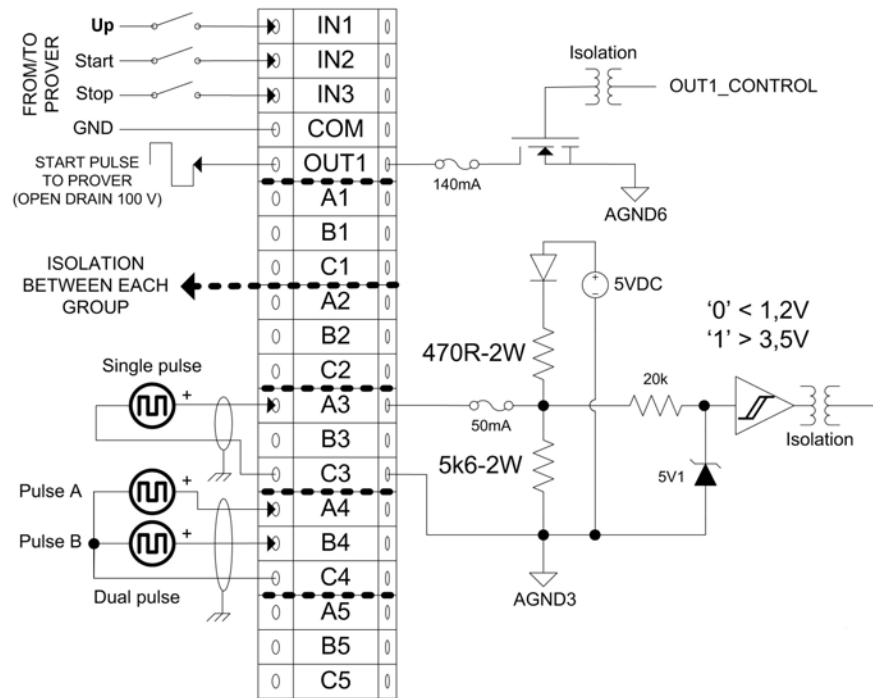


Figure 2 – I/O Internal Circuits

Installation

The DF77 was developed using the most recent technology and must be installed and operated carefully in order to obtain the best results. The complete reading and understanding of this manual is fundamental to obtain the best results.



ATTENTION

This equipment has Electrostatic Discharge (ESD) sensitive components. Do not open the module while it is powered or without the appropriate ESD protection. Otherwise, the circuits can be damaged permanently.

Things the user should never do:

Start the installation before reading and understanding this manual. In case of doubts, please, contact our technical support.

Expose or touch the electronic circuits when the module is powered.

Touch any internal part without ESD protection (wrist trap, ionizers, etc) and appropriate grounding. This item also applies to the front terminal.

Insert metallic objects inside the module when it is powered.

Connect the signal cable's shield in more than one point.

Operate the system without appropriate grounding (< 20 Ohms).

Operate the equipment in constant noise conditions in the AC network, as well as in pulse signals or housing and grounding.

Install signal cables in the same conduit of the power cables.

Use signal cables without the shield correctly grounded.

Start the system operation without validating the installation and the pulse totalization devices, according to the recommendations in this manual.

Start the system operation without validating the installation and the proving devices, according to the recommendations in this manual.

Things the user should always do:

Read the manual carefully before installing and operating the system. This step prevents damages and installation delays.

Use quality grounding system (< 20 Ohms) in the installation, connecting cables with appropriate measures and isolation.

Use shielded twisted pair cables to connect the signals from the field to the module.

Connect the cable loop to one single point, preferably on the base of the mounting panel, preserving the loop in the input of the front module. Isolate the cable terminal with a thermal shrinking tube to protect the loop.

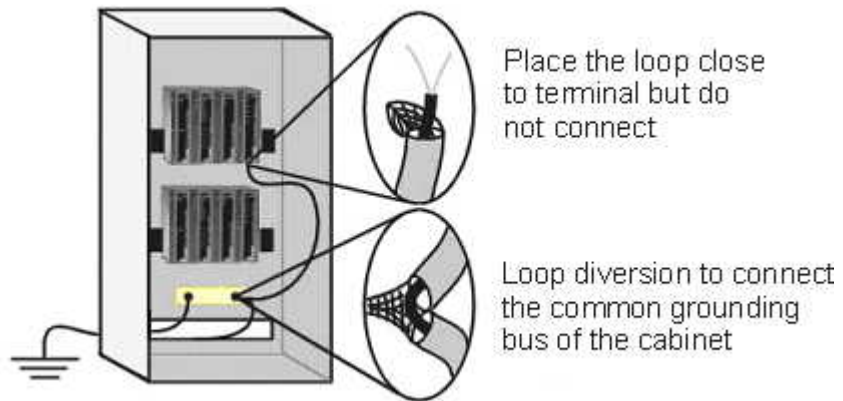


Figure 3 - Suggestion of Connection of the Cables Shield in the Panel Grounding

Pulse transmitter's connection

The DF77 module can be used with different meter types with pulsed output. The only condition is that the generated pulses amplitude, frequency and duty cycle within the module's operation limits:

Frequency: 5Hz to 25kHz.

Amplitude: $V_{0max}=1V$ and $V_{1min}=4,3V$, where the transition levels are: '0' < 1,2V and '1' > 3,5V.

Duty cycle: 15% to 85% of period FREQ_UPPER_RANGE configured in the transducer block.
Refer to CPU's manual for more details.

Using preamplifiers

The DF77 pulse inputs are not developed for small signal sensors, such as magnetic pick-ups, inductive sensors, variable reluctance, etc. If the flow meter uses this type of sensor, a proper preamplifier must be installed between the sensor and the module, according to the following figure:

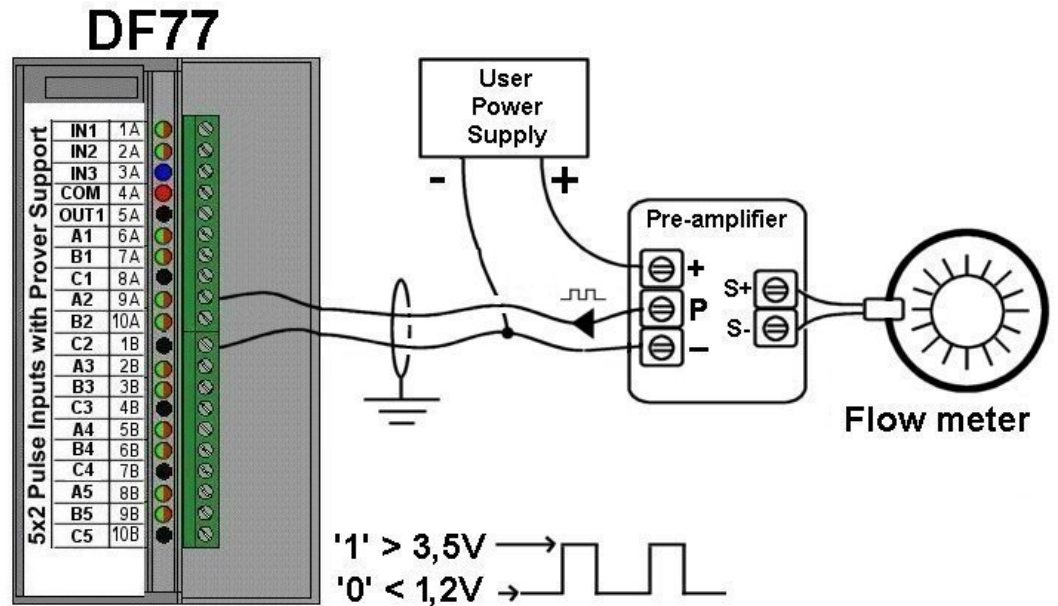


Figure 4 – Single Signal Connected to the A2 Pulse Input

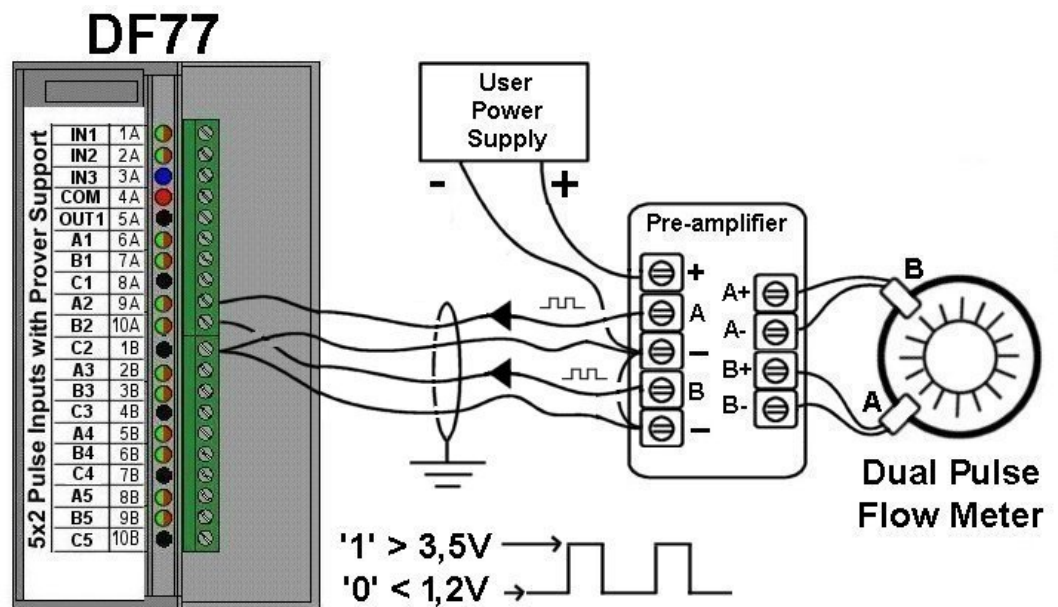


Figure 5 – Dual Signal Connected to Group 2 (A2 and B2 Inputs)

IMPORTANT

In the dual pulse example above, it is extremely important to observe the pulse sequence A B and configure the correct phase difference in the DF77 transducer block (usually 90°). The group should also be configured to operate in the dual signal check mode. In case there is a lot of variation in the phase difference among the pulses it may be necessary to increase the tolerance in the phase difference verification for a correct totalization. Refer to the CPU's manual for more details.

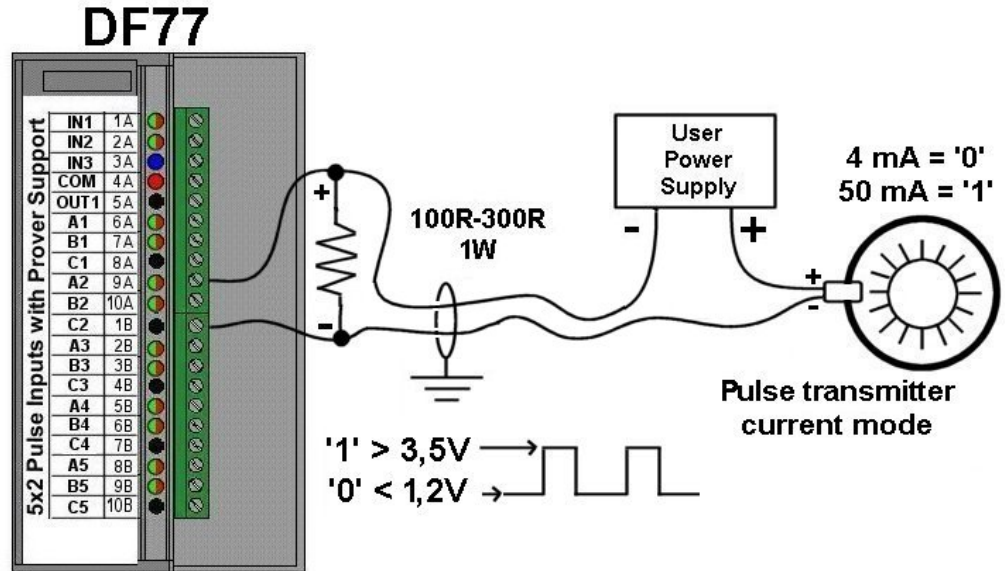


Figure 6 – Connecting the Current Pulse Generator

Prover Connections

The DF77 allows the FC302 to operate with a large variety of provers, from conventional ones, such as the U-type, to compact provers. The following figures show how to connect the DF77 to the most common types of provers. It is important to observe that there is no standard for provers, and therefore the following figure should only be used as a reference. It is recommended to consult the specific prover documentation before the installation.

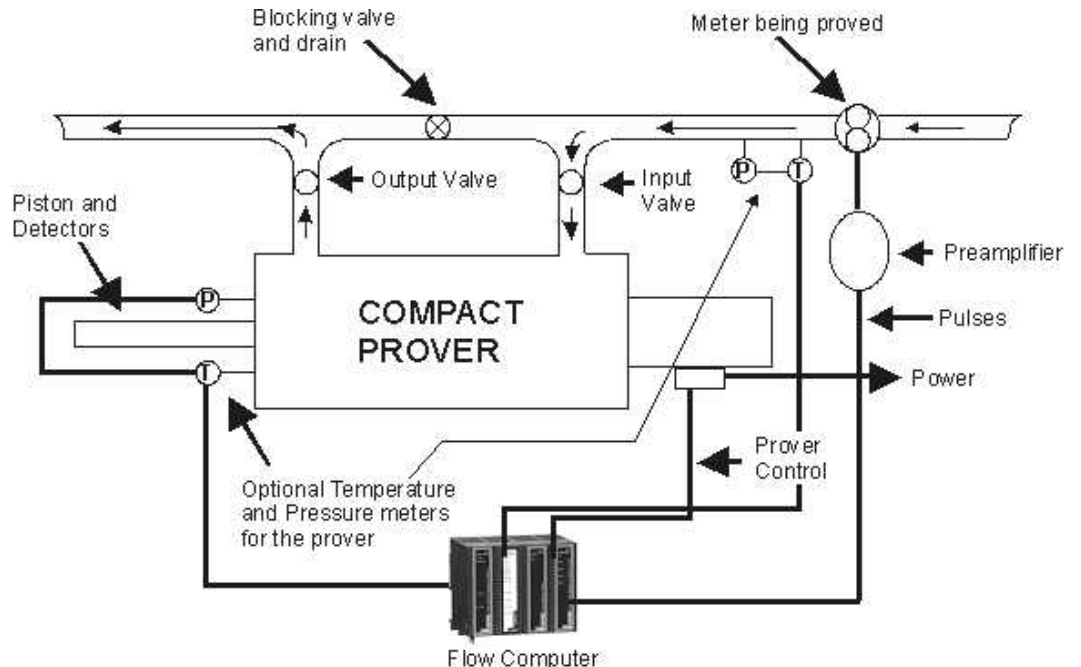


Figure 7 – Typical Installation for Prover and Flow Computer

General connection for provers

The DF77 operates with compact provers or provers with a large volume, such as the U-type. The figure below shows an example of a general connection. There are independent signal interfaces for each detector or a single signal for 2 detectors.

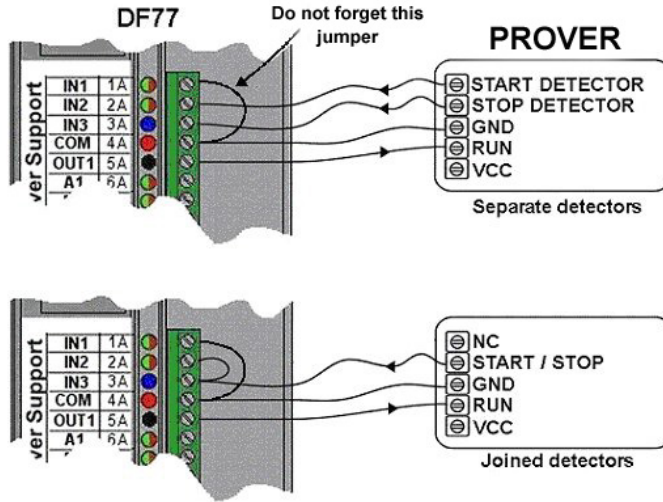


Figure 8 – General Connection for Provers

Connecting the Calibron Syncrotrak compact prover

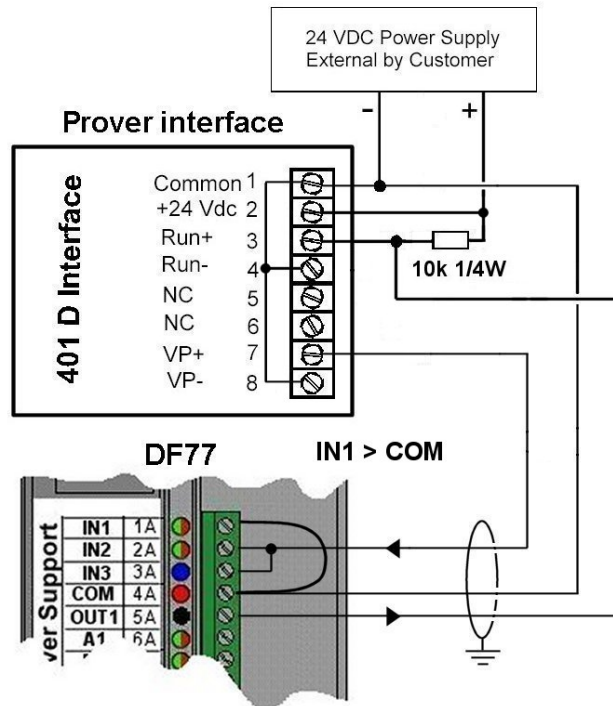


Figure 9 – Connecting the Calibron Syncrotrak Compact Prover

Connecting the Brooks compact prover

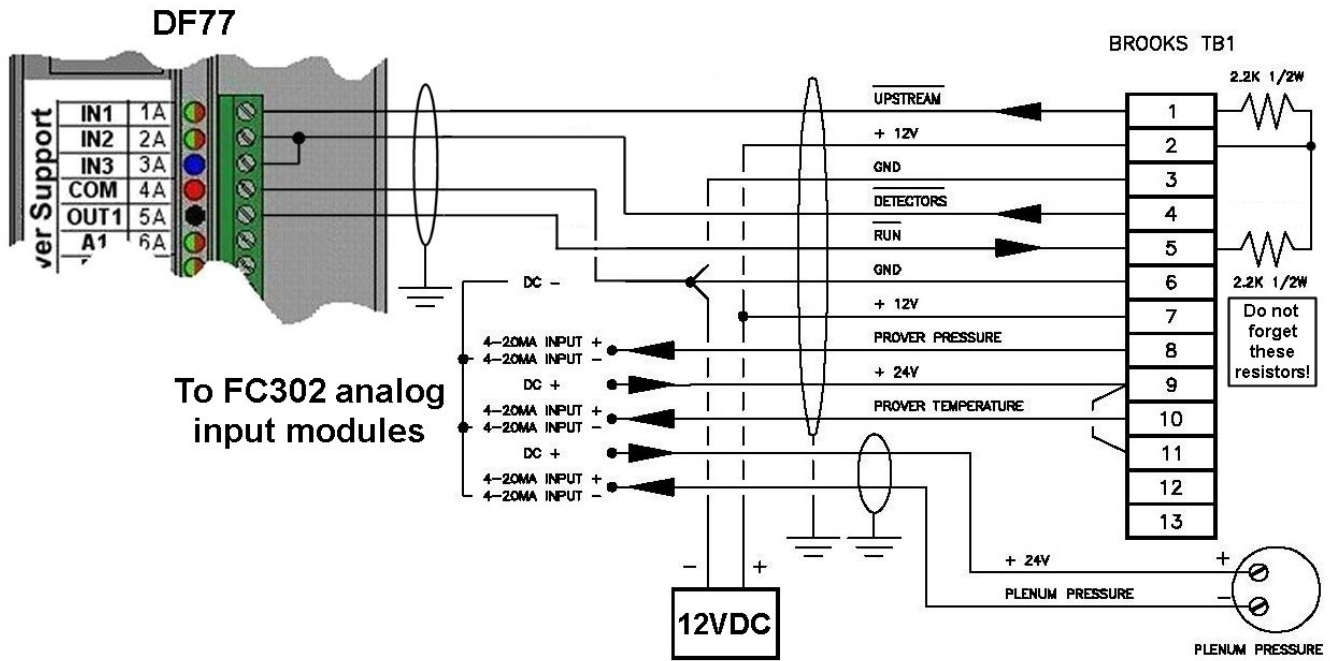


Figure 10 – Connecting the Brooks Compact Prover

Connecting the Master Meter

The DF77 also supports the proving for Master Meter (MM). The MM operation is the same of any other meter. This means that all filter mechanisms, error detection and correction are applied to the MM. It was defined that group 5 should be used for the MM connection. However, any input or group of inputs can be used once the FC302 blocks are configured correctly. The MM must be carefully installed, as the production meters. Refer to FC302's manual for more details.

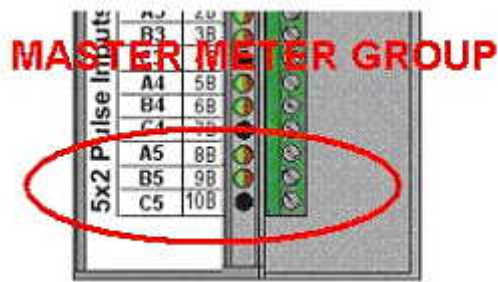


Figure 11 – Connecting the Master Meter

Installation in Hazardous Areas

The DF77 cannot be directly connected to devices located in hazardous areas. One of the ways to do this installation is using intrinsic safety barriers.

Pulse signals installation

Pulse inputs (A1, B1 ... A5, B5) should use digital repeater barriers. The barrier's output should match DF77 input levels: "0" < 1.2V and "1" > 3.5V. Additionally, barrier's response time should be sufficient to work in the operation frequency range of the pulse transmitter (for example: response of 10 ms, frequency up to 100 Hz). See the following example which uses SENSE KD-11/Ex barrier:

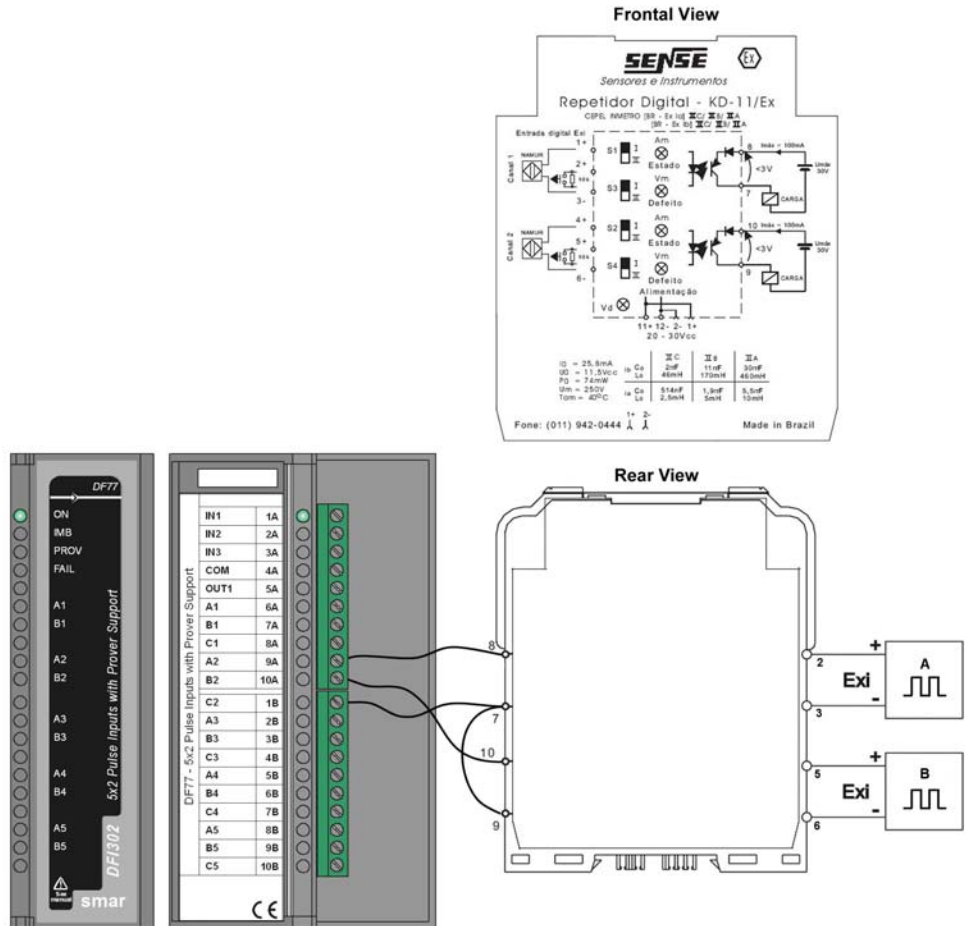


Figure 12 – Pulse Inputs' Installation in Hazardous Areas

Interface to volumetric prover

Discrete inputs (IN1, IN2, and IN3) should use digital repeater barriers provided the same restrictions for the pulse inputs. OUT1 output should use a digital drive barrier .OUT1 is OPEN DRAIN, which assures a voltage drop in the output less than 1V (100mA@100V maximum). Use a 10k 1/4W resistor as pull-up for 24VDC operation. See the example, in the figure below, for the SENSE KD-572T/Ex barrier:

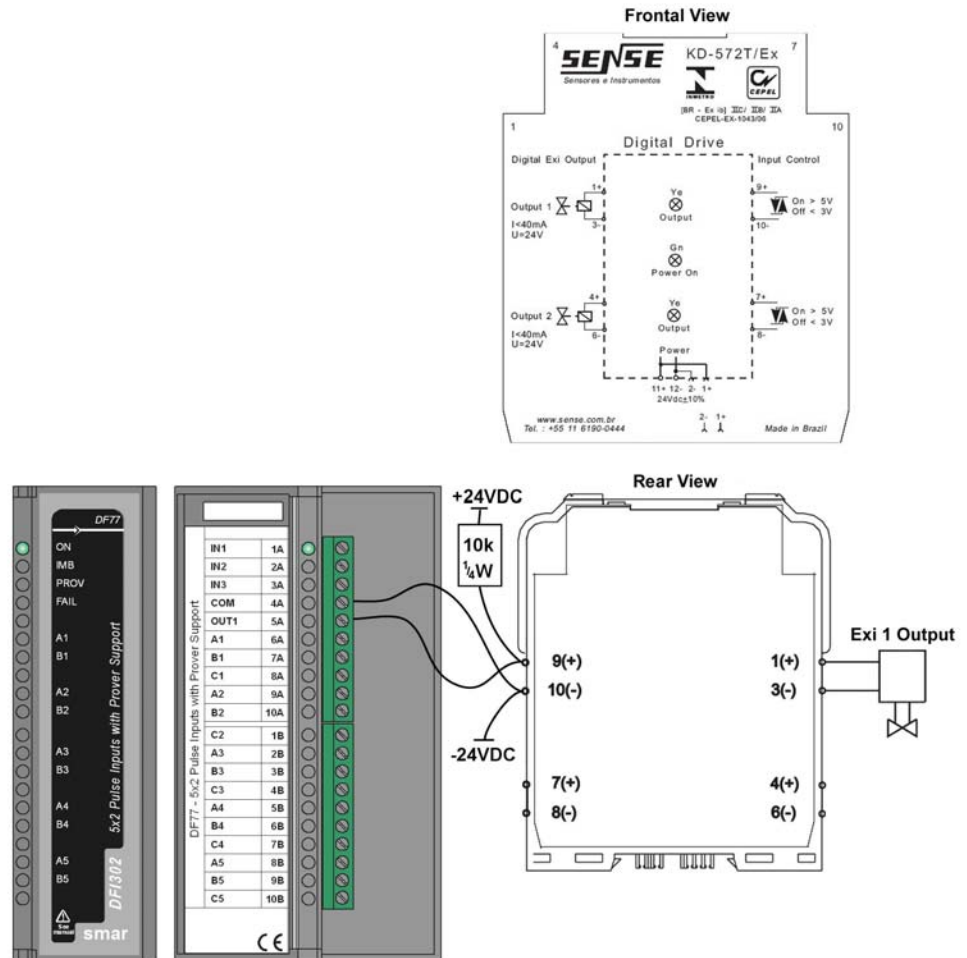


Figure 13 – Interface with Volumetric Prover in Hazardous Areas

Example of connection for Calibron Syncrotrak prover with barriers

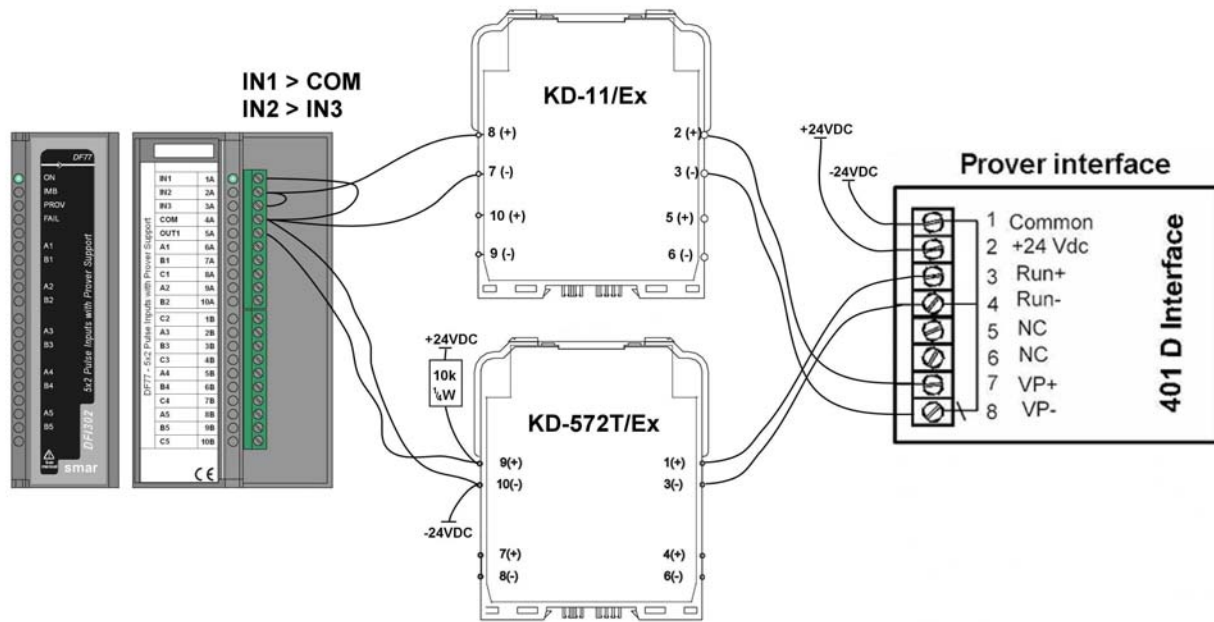


Figure 14 – Calibron Syncrotrak Prover in Hazardous Areas

IMPORTANT

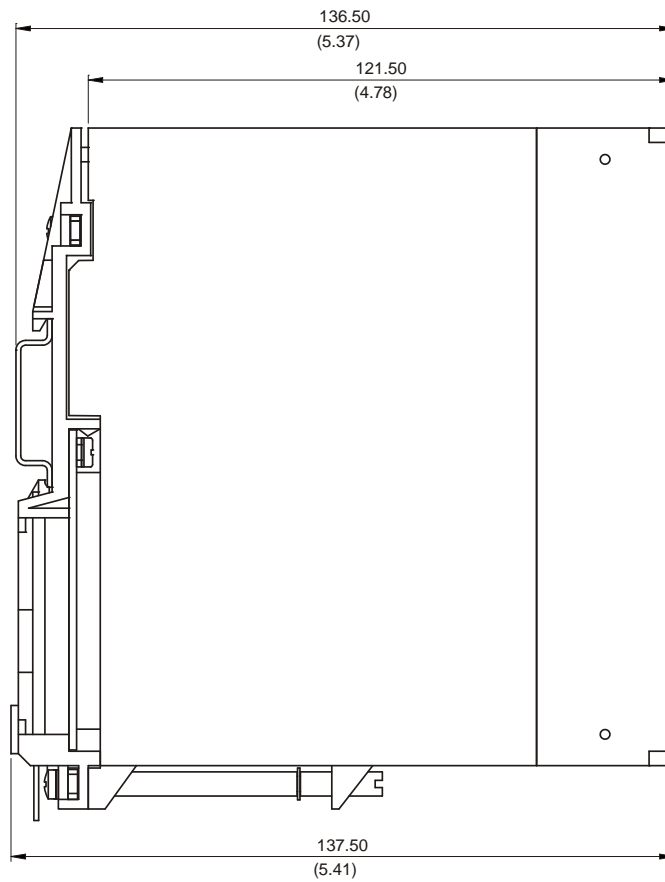
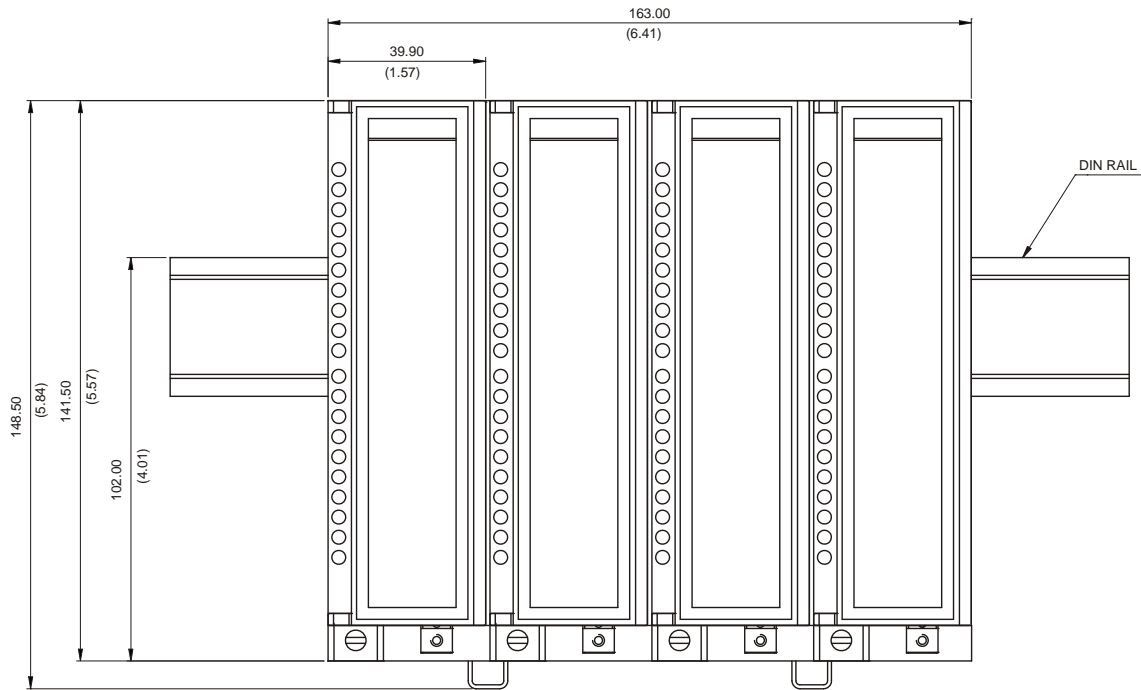
The 24 VDC power supply for the 401D interface have to be isolated from the barriers' power supply and from the power supply of the safe side (DF77).

Technical Specifications

| Technical Specifications | |
|--|--|
| Number of inputs | 10 of pulse and frequency (groups 1 to 5) and 3 discrete (group 6). |
| Number of outputs | 1 <i>open-drain</i> , 100 mA @ 100 V. |
| Isolated groups | 6 (2x5 pulses and frequency, 3+1 discrete). |
| Operation frequency | 5 Hz to 25 kHz, duty cycle from 12.5% to 87.5%. |
| Voltage input | -30 to +60 VAC/VDC. |
| Schmitt-trigger in all inputs | Logic level '0' < 1.2V and logic level '1' > 3.5V. "Digital debouncing" eliminates the need of installing external capacitors. |
| Wave forms | Square, pulse, sinusoidal, triangular and trapezoidal. |
| Input pull-up | 490 Ω for +5 VDC internal isolated. |
| Input impedance | 5.6 k Ω . |
| Protections | Resettable polymeric fusel in all field signals. Protection against ESD and surges. |
| Isolation | 500 Vrms among the groups. 500 Vrms among the groups and the IMB. |
| Interface with CPU | IMB, <i>hot-swappable</i> , module_ID = 77. |
| Power supply and consumption | 3W @+5VDC 5% via IMB, maximum ripple of 50 mVpp. 600 mA in regime, 1A during 1ms on power-up. |
| Digital pulse filter | In all inputs, with cut width of T/8 of <code>FREQ_UPPER_RANGE</code> configured individually to each input. |
| Low-pass filter | All inputs, cut frequency -3 dB @ 75 kHz. |
| Operation environment | 0 °C to 60 °C, 5% to 90% non-condensed relative humidity. |
| Storage environment | -25 °C to 80 °C, 5% to 90% non-condensed relative humidity. |
| Indicator LEDs | ON : bicolor, indicates module is powered and operating. IMB : bicolor, indicates active CPU scan. PROV : blue, prove is being executed. FAIL : red, indicates hardware failure in the IMB or in the module. A1...B5 : bicolor, indicates the status of each pulse input. |
| Pulse Counters | 16-bit, provide the accumulated total since the last scanning cycle. |
| Average frequency accuracy | 0.01%, 32 bits of resolution. |
| Dual pulse fidelity | "A level" in compliance with API 5.5 and ISO 6551 standards, with automatic error detection and correction to: coincident pulses, phase errors, sequence errors, counting errors, false pulses and missing pulses. |
| Interface for volumetric prover | Accept the most common prover types: conventional, U and compacts, in compliance with API 4 and ISO 7278 standards. |
| Operation Modes | 10 inputs SINGLE PULSE or 5 groups DUAL PULSE, with 4 for production measurement and 1 for MASTER METER. |
| Dimensions and Weight | Dimensions (HxWxD): 141.50 (5.57) x 39.90 (1.57) x 137.50 (5.41) Net Weight: 300 g. With package: 350 g. |

Dimensions

Dimensions are in mm (inches).



Troubleshooting

| Problem | Solution |
|--|--|
| <p>The pulse input LED is always red.</p> <p>The input LED is blinking between red and green.</p> | <p>Verify if there is pulse signal and if it is compatible with the voltage specification and input frequency.</p> <p>Check if the logical levels '0' and '1' are in allowed voltage range: '0' < 1.2V and '1' > 3.5V.</p> <p>The cable can be broken or have some bad contact. Check the electrical connections in the meter, preamplifiers and terminal blocks.</p> <p>Verify the polarity of the connection.</p> <p>Verify the I.S. barriers, if there is any.</p> <p>Verify if the frontal terminal block is well fit.</p> <p>In case there are additional protections, verify if they are in good conditions.</p> |
| <p>The IMB LED is red or blinking.</p> | <p>Verify if the CPU is configured with an I/O scanning cycle of less than 1 second.</p> <p>Check the CPU configuration and the rack address.</p> |
| <p>The pulse input LED is off.</p> | <p>The corresponding input has been disabled. Verify the CPU configuration.</p> |
| <p>The pulse input LED is blinking green.</p> | <p>The input frequency is out of the configured range. Change the configuration in the transducer block in order to correspond to the pulse generator range.</p> <p>The configured range is out of the application frequency range. Change the CPU configuration.</p> |
| <p>The ON LED is red or blinking.</p> | <p>Some problem has occurred in the power supply. Verify the power supply.</p> <p>Some internal problem may have occurred in the module. Turn off the module, and then turn it on. In case the problem persists, send it to the technical support.</p> |
| <p>The FAIL LED is on or blinking.</p> | <p>Turn off and on the module. If the problem persists, send the module to the technical support.</p> <p>The CPU's configuration may have a problem (HC block missing, for example).</p> <p>The IMB power supply is indicating failure. Verify the power supply and possibly other modules on the rack.</p> |
| <p>There isn't pulse counting.</p> | <p>Verify in the CPU's configuration if the configured operation mode of the input or of the groups is correct.</p> <p>Verify if the input corresponding LED is green. Otherwise, check if the pulses are being generated (amplitude, frequency, duty cycle etc).</p> |
| <p>The pulse totalization seems to be wrong.</p> <p>There is loss of pulses.</p> <p>The showed frequency is incorrect.</p> | <p>Observe if the cable shield is installed and grounded correctly.</p> <p>Verify in the CPU's configuration if the configured operation mode of the input or of the groups is correct: single or dual pulse.</p> <p>Verify if the frequency is within the configured operation range.</p> <p>If in dual pulse mode, verify the phase difference of the meter and the one configured at the CPU.</p> <p>Check the connections to see if there is bad contact and if the frontal terminal block is well fit.</p> <p>If the mode is dual pulse, make sure that the connection order of the pulse signals A and B is correct. Try to exchange A and B.</p> <p>Try to increase the tolerance of the phase difference in the CPU's configuration, because the signal can be very irregular.</p> |
| <p>The PROV blue LED does not switch on when the CPU requests the proving.</p> | <p>Verify the CPU's configuration and the rack address.</p> |
| <p>The proving operations do not complete with success.</p> | <p>Check the connections with the prover or Master Meter according to the installation instructions of this manual.</p> <p>Observe if the cable shield is installed and grounded correctly.</p> <p>Verify if the output for prover starting is connected and polarized correctly (you may need to add external resistors. Check prover documentation).</p> <p>Check the voltage levels and frequency of all inputs.</p> <p>Verify if the process is stable (temperature, pressure, flow, etc).</p> <p>Observe if there is noise source during the proving (motors, inverters, etc.)</p> |