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APLISENS PEM-1000 Electromagnetic Flowmeter Pulse Output Interfacing

APLISENS PEM-1000 Electromagnetic Flowmeter Pulse Output Interfacing User Manual

Contents

APLISENS PEM-1000 Electromagnetic Flowmeter Pulse Output Interfacing

Product Information

Specifications

- **Product Name:** PEM-1000 Electromagnetic Flowmeter
- **Manufacturer:** APLISENS S.A.
- **Model Number:** EN.IO.OWI.PEM.1000
- **Output:** Pulse Output

Product Usage Instructions

Introduction
This manual guides interfacing the pulse output of the PEM-1000 flowmeter with external input circuits and configuring the output. The output can also function in frequency mode without any hardware changes.

Electrical Connections
The pulse output terminals (5, 6) are located in the rear chamber of the flowmeter's case. The output is a galvanically isolated, passive optocoupler-like circuit with overcurrent protection and a diode bridge for polarity connection.

Interfacing the Pulse Output
There are three basic cases for interfacing the pulse output:

1. Discrete inputs with moderate detection threshold or current detection
2. Passive discrete inputs with low detection thresholds intended for NPN drive
3. Low voltage, active discrete inputs intended for the open collector or reed contacts only

Connecting External Inputs with Polarization Circuit
For inputs without a polarization circuit, an external power supply is required. Ensure a 24 V source is available for certain circuits.

Interfacing Passive Inputs with Low Detection Threshold
Passive inputs with low detection thresholds are suitable for NPN outputs but require a simple interfacing circuit to work in PNP mode.

FAQ

- **Q: What is the maximum operating voltage for passive inputs with a low detection threshold?**

  A: The maximum operating voltage is about 30 V, with a threshold voltage of approximately 1 V.

INTRODUCTION

This manual covers typical scenarios of interfacing the pulse output of the PEM-1000 flowmeter to various types of external input circuits and the configuration of the output. Please note, that the output can also be used in frequency mode, with no hardware differences. For the simplicity of this document, the output will be called "pulse output", regardless of the configuration.

This manual assumes that the user has basic skills in operating the flowmeter, such as navigating the menu and entering numerical values using the local keyboard.

ELECTRICAL CONNECTIONS

The pulse output terminals (5, 6) are accessible in the rear chamber of the flowmeter's case as shown in the picture below:
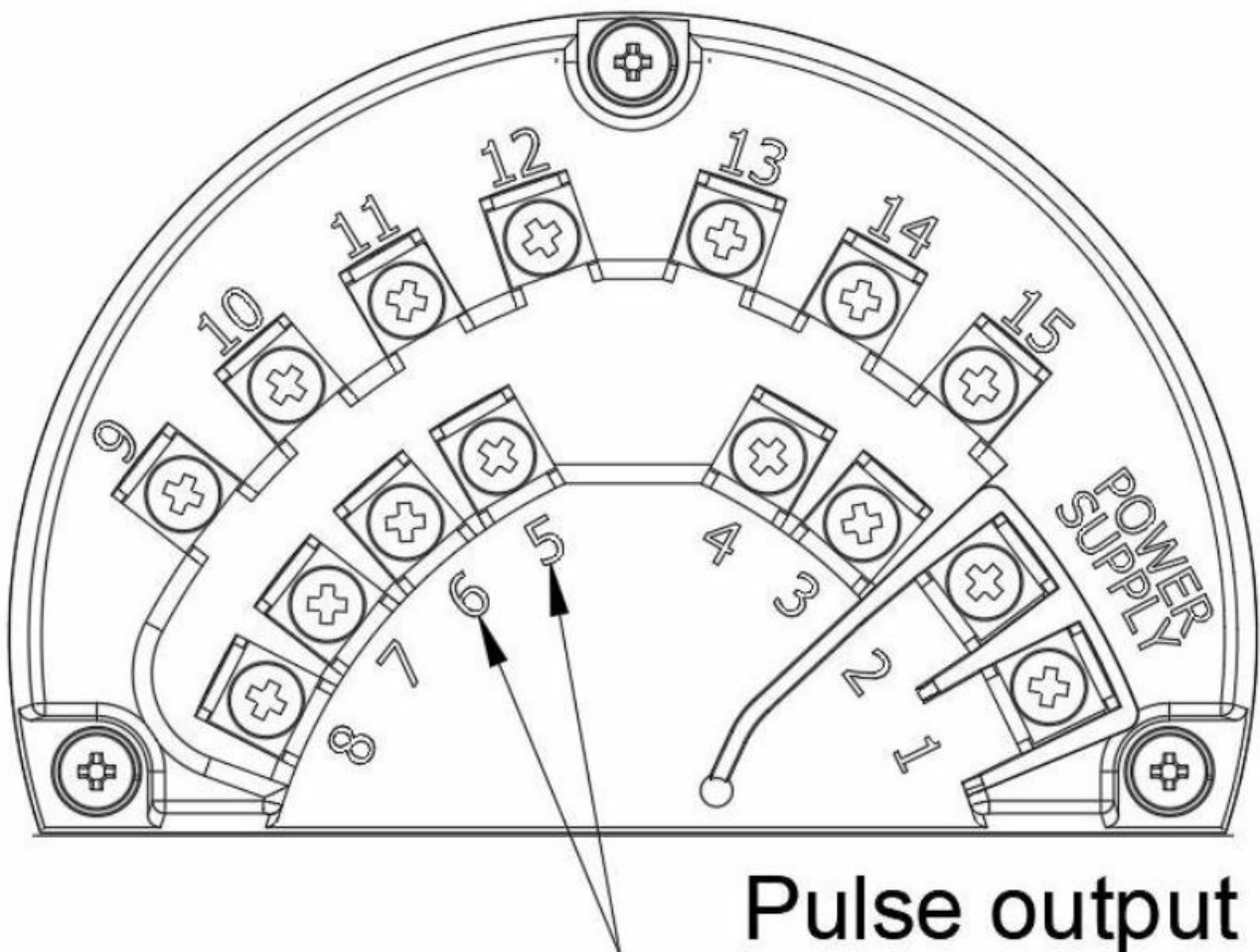
Figure 1. The pulse output terminals

- The internal structure of the output will be explained, to avoid problems with interfacing with external circuits of the PLCs, test rig counters, pulse counters, etc.
- The pulse output is a galvanically isolated, passive optocoupler-like circuit, equipped with additional over-current protection and a diode bridge, to allow any polarity connection. The simplified schematics of this output are as follows:
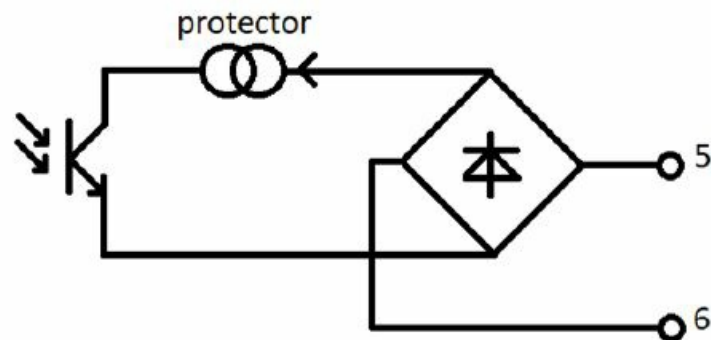

Figure 2. Simplified schematics of the pulse output

The protector circuit is a low voltage drop passive current source with a current limit of about 20 mA. Connecting (mistakenly) low impedance voltage source to the output is not destructible, thanks to this pro-tection. The guaranteed output current of the output is 10 mA. The most important feature of the above circuit is a voltage drop of about 1-1,5 V at the terminals 5-6. This voltage drop is higher than the on-state voltage drop of standard open-collector optocoupler or relay output, which negatively affects interfacing to external circuits requiring low voltage drop output.

There are three basic cases of interfacing the pulse output with an external input circuit:

- discrete inputs with moderate detection threshold or current detection,
- passive discrete inputs with a low detection threshold (~0,7 V) intended for NPN drive,
- low voltage, active discrete inputs intended for the open collector or reed (relay) contacts only.

Inputs with moderate detection threshold are typically active current sources with current detection circuits or voltage type inputs, optionally with active polarization network powered internally from voltages not less than 5 V. Typical examples of those inputs are digital inputs circuits of PLC controllers, test rigs' input circuits, galvanically isolated interfaces and so on. Typical threshold voltages lie in the range of 5-20 V with significant hysteresis. The typical threshold current is about 1-5 mA. Inputs with polarization circuits can be directly interfaced with the pulse output. See the drawing below:
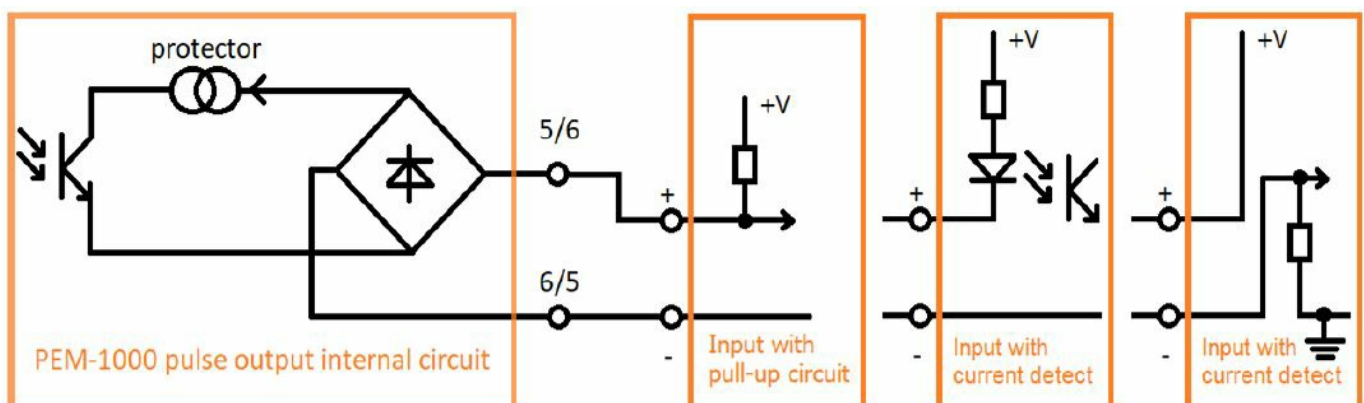

Figure 3. Connecting the external inputs with the polarization circuit

Inputs without polarization circuits should be interfaced with the help of an external power supply. See drawing below:
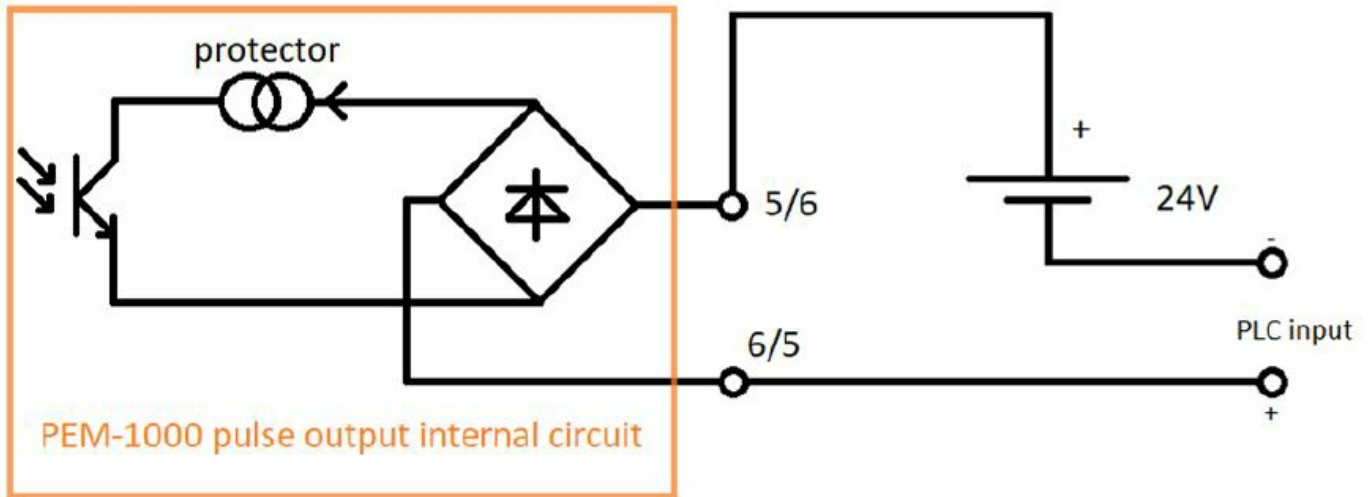

Figure 4. Connecting of the external inputs without polarization circuit

Please note, that some of the proposed circuits may require a power supply of about 24 V. It could be any accessible 24 V source, e.g. local 24 V mains, power supply of the low voltage version of the flowmeter, etc., due to galvanic insulation on the flowmeter's side. Also, typical industrial-grade PSU can be used, advisably as small as possible, because the current drawn by these circuits is very small. Passive inputs with low detection thresholds are typically intended to be driven by an NPN output. Their maximum operating voltage is about 30 V, but the threshold voltage is about 1 V. Those circuits cannot be directly interfaced with the pulse output of the flowmeter, but can be used in "PNP" mode. A simple interfacing circuit resolves this issue. See the drawing below:
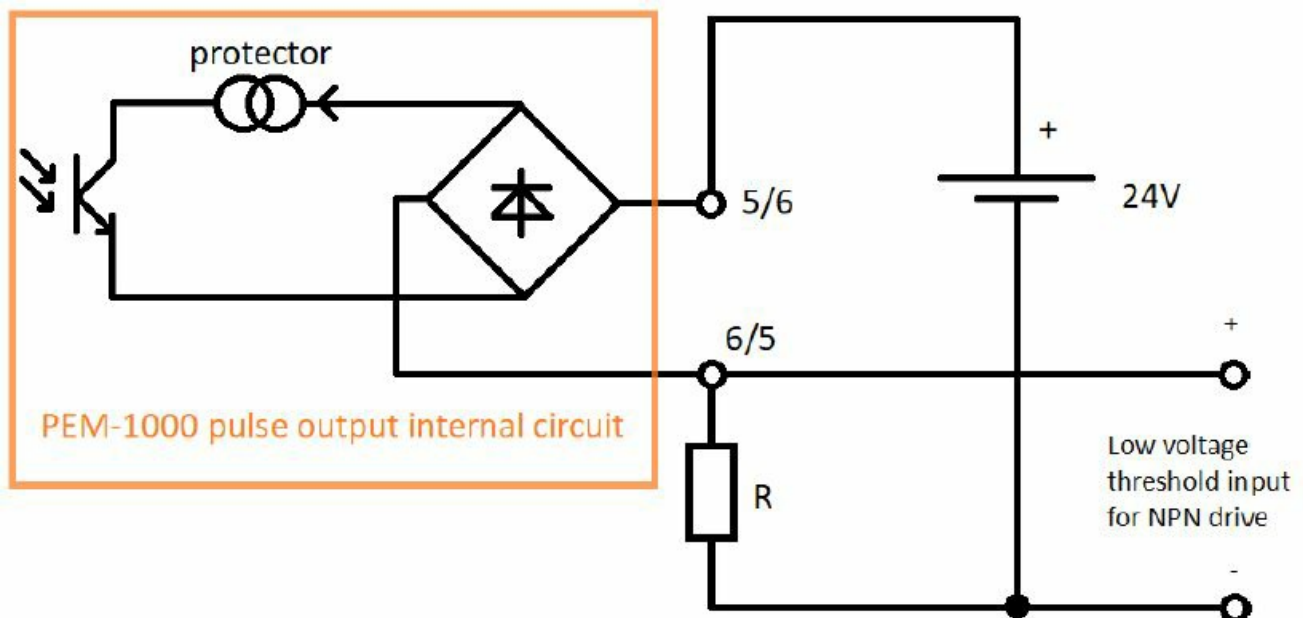

Figure 5. Connecting the passive input with a low detection threshold for the NPN drive

The value of Resistor is not critical, it should be anywhere in the range 2,2-22 kΩ. The higher the resistance, the smaller the current drawing from the power supply, but also the lower the noise immunity of the circuit. The most troublesome are low-power, low-voltage active digital inputs intended only for potential-free contacts such as relay, reed, or open collector ones. Typical examples of those inputs are low-power devices such as LCD pulse counters, heat meters, or other devices based on low-voltage logic. In this case, the following circuit should be used:
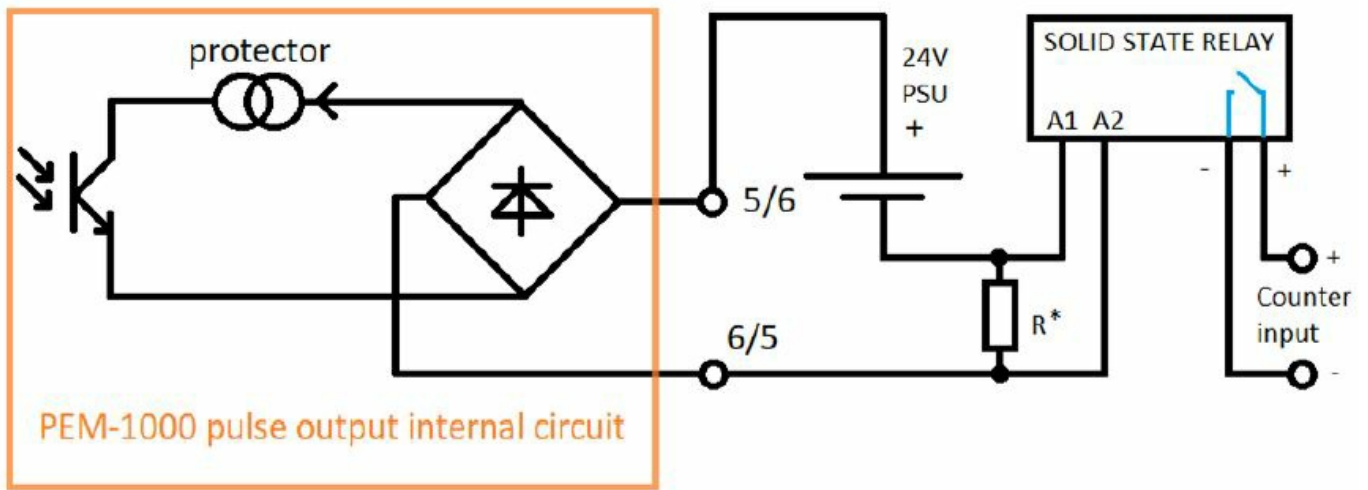
Figure 6. Connecting of the low-voltage active discrete inputs intended for potential-free contacts

The circuit uses a solid state relay (SSR). For this task only versions with low on-state voltage drop, low output leakage current, and low minimum working current are suitable because input circuits of low voltage devices typically source currents in the range of 1-2 mA, and detection threshold voltage is less than 1 V. ELCO SSR20-524C is well suited for this task. The parameters of this device are shown in the table below:

Table 1. Main parameters of the ELCO SSR20-524C

Parameter	Load voltage	Output voltage drop (ON state)	Off-state leakage current	Minimum working current (ON state)	Input voltage range	Input current
Value	0-35 V DC	300 mV	10 µA	1 mA	10-32 V DC	3,2-13 mA

Resistor R is optional in this circuit (used only for high-sensitivity SSRs). Any equivalent SSR of similar parameters can be used. Please note, that this SSR has polarized output and non-polarized input. Observe polarities for equivalent parts. For a complete part list of this circuit see ➔ Appendix A. Part list for output interface circuit for reed contact inputs. For SSR equivalents see ➔ Appendix B. SSR equivalents.

Some versions of low-power low-voltage digital inputs cannot be driven even by an SSR relay because of extremely low driving current (in the range of µAmperes) together with low detection threshold and high input impedance. Typical examples of those inputs are battery-powered low-power devices, such as LCD counters and energy meters (e.g. Zenner multidata series). Fortunately, these inputs can often be controlled by an active low-voltage source. Driving these inputs requires a slight modification of the PNP schematic:
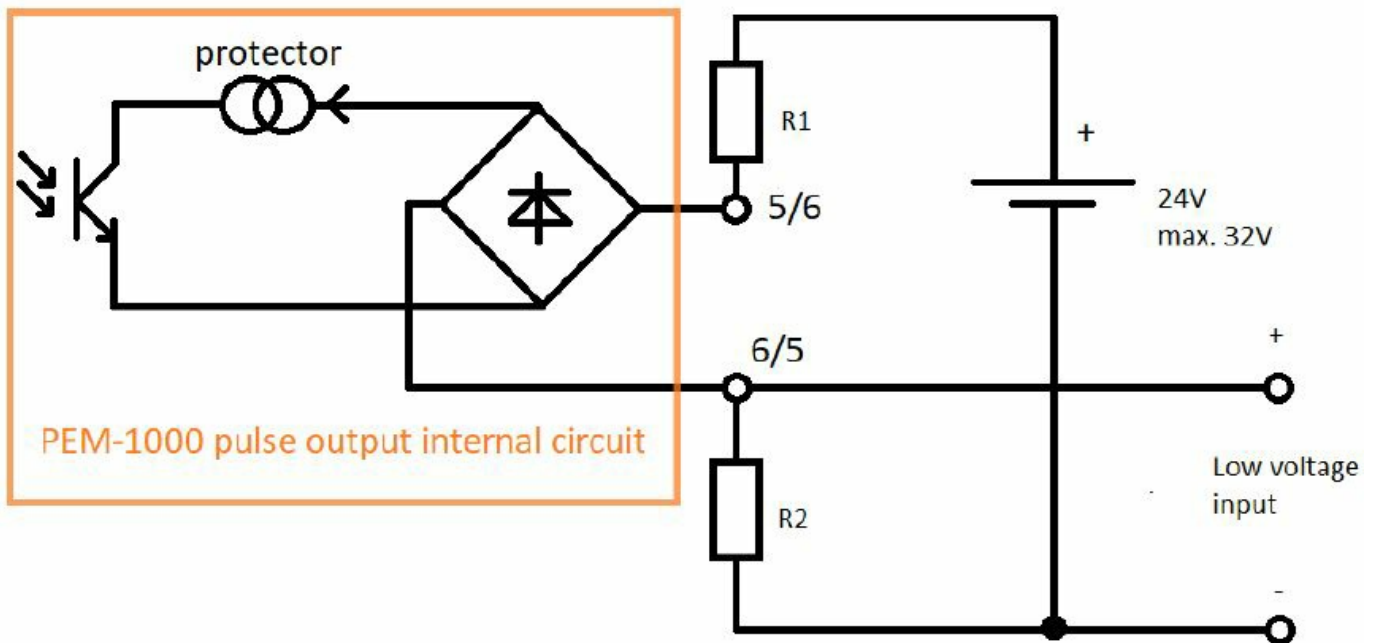
Figure 7. Connecting the discrete inputs with extremely low driving current (in the range of microamperes)

Resistors R1 and R2 form a voltage divider protecting input circuits against an excessive voltage from a 24 V source when pulse output is active. For maximum input voltage of low-voltage input of 3,6 V, resistor values should be: R1 = 12 kΩ, R2 = 1,5 kΩ for 24 V power supply, providing it is not exceed 32 V. Power supply units of other voltages can be used, then the values of the resistors must be calculated according to the power supply voltage and voltage limits of the input circuit. See ➜ Appendix C. Low volt-age active driver calculations for calculations for other cases.

CONFIGURATION OF THE PULSE OUTPUT

The pulse output of the flowmeter must be properly configured to achieve the best resolution and avoid errors stemming from too high a pulse frequency. The most important parameters are pulse length and volume per pulse. These parameters are self-explanatory – for each complete volume unit of "volume per pulse" one pulse of chosen length is issued. Please note, that the PEM-1000 flowmeter uses a "volume per pulse" approach, but some flowmeters or pulse detection devices use a "pulses per volume" approach, those parameters are reciprocals of each other. That is why using round numbers as a volume per pulse parameter (or checking its reciprocal) is recommended.
The theoretical maximum instantaneous pulse frequency for pulse output is 500 Hz because the shortest pulis of 1 ms and the shortest gap is also of 1 ms. Such high frequencies should be avoided because of the risk of pulse loss in case of a temporary flow rate peak. Also, SSR frequency limits and external circuit frequency limits apply. Theoretical limits for volume per pulse value and pulse length result from the formula below:

$$\frac{Q_{MAX}}{volume\ per\ pulse\ [m^3] \cdot 3600} < \frac{1000}{pulse\ time\ [ms] + 1}$$

where QMAX – maximum flow rate [m3/h].

Setting proper values of pulse output parameters requires some margins. That is why optimal output frequency for 100% of the range should be no greater than about 200 Hz for 1 ms pulses. The pulse length should be set to satisfy the detection capabilities of external circuits. Practical values fit in the range of 1 ms (fast inputs) – 100 ms (very slow inputs). The value used should be as low as possible becausethe it limits maximum achievable frequency. thelonger pthe ulse length, the lower the maximum theoretical frequency, for 10 ms pulses it drops to ~90 Hz.

The typical configuration of pulse output is as follows:

- Menu → Configuration → Outputs → Pulse output → On/Off = ON
- Menu → Configuration → Outputs → Pulse output → Mode = PULSE
- Menu → Configuration → Outputs → Pulse output → Pulse → Pulse time = 1[ms] (see notes above)
- Menu → Configuration → Outputs → Pulse output → Pulse → Mode = POSITIVE
- Menu → Configuration → Outputs → Pulse output → Pulse → Polar = POSITIVE
- Menu → Configuration → Outputs → Pulse output → Pulse → Volume/imp. = see explanation above.

Please note, that the filtering setting "for pulse output" ("Menu → Configuration → Filtering → for Pulse out") regards the frequency mode of the output. There is no filtering available for pulse output in pulse mode, because of the self-averaging and high-precision nature of this mode of operation.

HISTORY OF REVISIONS

Revision No.	Document revision	Description of changes
-	01.A.001/2024.02	First version of the document. Prepared by DBFD, DR.

Part list for output interface circuit for reed contact inputs

Description	Manufacturer	Part number	Notes
SSR	ELCO	SSR20-524C	
SSR socket	Relpol	GZ80	
PSU 24V	Meanwell	HDR-15-24	

SSR equivalents

Please note, that the equivalent of the SSR used in the interface circuit should be chosen with great care, most of the SSRs do not meet the requirements of low-power, low-voltage input circuits. SSRs based on thyristor/triacs or bipolar transistors with reverse polarity protection may not be usable due to their elevated voltage drop or minimum load current values. The following parts were chosen, according to their catalog specifications, but were not tested in the field. All of them are the SPST-NO version, which is also the most popular. The packaging of these parts may not be compatible, please use relevant sockets for TH35 rail mounting.

| Crydom DRA-CN024D24, 500Hz max. or CN024D24 (PCB mount mini version)						
Parameter	Load voltage	Output voltage drop (ON state)	Off-state leakage current	Minimum working current (ON state)	Input voltage range	Input current
Value	0-24 V DC	400 mV	1 µA	1 mA	15-30 V DC	5,6-11,2 mA 4,3-8,6 mA*

*) for CN024D24 PCB mount mini-SIP version

Phoenix contact OV-24DC/60DC/4 - 2982647, 100Hz max.						
Parameter	Load voltage	Output voltage drop (ON state)	Off-state leakage current	Minimum working current (ON state)	Input voltage range	Input current
Value	0-24 V DC	400 mV	1 µA	1 mA	4,25-32 V DC	5,6-11,2 mA

IDEC RV8S-L-D24-D24 or RV8S-S-D24-D24						
Parameter	Load voltage	Output voltage drop (ON state)	Off-state leakage current	Minimum working current (ON state)	Input voltage range	Input current
Value	0-24 V DC	400 mV	1 µA	1 mA	19,6-30 V DC	not listed

Low voltage active driver calculations

Some low-voltage digital inputs can be driven by an active voltage source, providing that the maximum input voltage is not exceeded. Schematic of the connections is as follows:
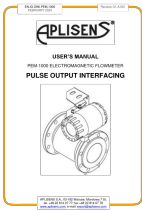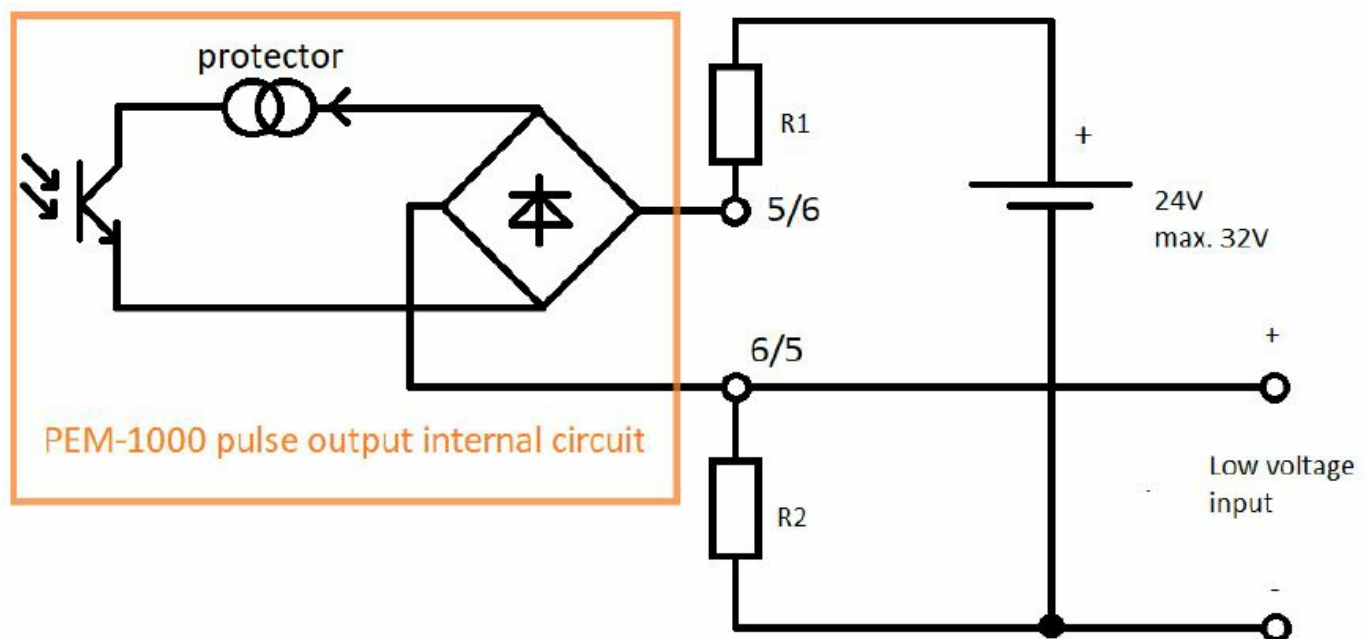

Resistors R1 and R2 form a voltage divider limiting the maximum output voltage of the driver. Calculations of values of this resistor for some typical cases are as follows (E series values are used, recommended tolerance is 1%):

Power supply voltage	Maximum input voltage	R1	R2
24 V (max. 32 V)	3,6 V	12 kΩ	1,5 kΩ
24 V (max. 32 V)	3,3 V	24 kΩ	2,7 kΩ
24 V (max. 32 V)	5 V	12 kΩ	2,2 kΩ
12 V (max. 16 V)	3,6 V	5,1 kΩ	1,5 kΩ
12 V (max. 16 V)	3,3 V	5,6 kΩ	1,5 kΩ
12 V (max. 16 V)	5 V	4,7 kΩ	2,2 kΩ

For other values of these parameters, follow the formula below:

$$max.\ power\ supply\ voltage \cdot \frac{R2}{R1 + R2} \leq max.\ input\ voltage$$

Documents / Resources

APLISENS PEM-1000 Electromagnetic Flowmeter Pulse Output Interfacing [pdf] User Manual
PEM-1000 Electromagnetic Flowmeter Pulse Output Interfacing, PEM-1000, Electromagnetic Flowmeter Pulse Output Interfacing, Flowmeter Pulse Output Interfacing, Pulse Output Interfacing, Output Interfacing

References

- ᑭ **Aplisens S.A. is one of the leading manufacturers of high quality process instrumentation.**
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