Model PT420

Frequency Converter

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Notice

Proprietary Notice

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SAFETY INSTRUCTIONS

The following instructions must be observed.

- Every effort has been made to design and manufacture this instrument to be safe for its intended use. A hazardous situation may occur if this instrument is not used for its intended purpose or is used incorrectly. Please note operating instructions provided in this manual.
- The instrument must be installed, operated, and maintained by personnel who have been properly trained. Personnel must read and understand this manual prior to installation and/or operation of the instrument.
- The manufacturer assumes no liability for damage caused by incorrect use of the instrument or for modifications or changes made to the instrument.
- The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

Les instructions suivantes doivent être respectées.

- Tous les efforts ont été faits pour concevoir et fabriquer cet instrument est sans danger pour son utilisation prévue. Une situation dangereuse peut se produire si cet instrument n'est pas utilisé conformément à sa destination ou est mal utilisé. S'il vous plaît respecter les instructions fournies dans ce manuel.
- L'appareil doit être installé, utilisé et entretenu par du personnel ayant reçu une formation adéquate. Le personnel doit lire et comprendre ce manuel avant l'installation et / ou le fonctionnement de l'instrument.
- Le fabricant décline toute responsabilité pour les dommages causés par une utilisation incorrecte de l'instrument ou de modifications ou de changements apportés à l'instrument.
- La sécurité de tout système intégrant l'équipement est de la responsabilité de l'assembleur du système.

Technical Improvements

Turbines Incorporated may modify the technical data herein without notice.

Table of Contents

Description

The PT420 Frequency Converter is a microcontroller based rate/totalizer designed for both, Liquid and Gas Applications. The unit has PC programming and monitoring capability through a RS-232/USB type data link and it also offers the option to set the minimum and maximum flow rate thresholds through two on board pairs of switches and LED indicators. The two selectable PT420 inputs accept sine and square wave signals generated by passive and, respectively, active magnetic pickup coil probes. Computations include calculation of liquid flowrate in Pulses per Second based on the turbine pulse rate and in Gallons per Minute based on the predetermined turbine k-factor. An internal 20 point linearizer allows linearization of typically non-linear turbines-flowrate curve and to increase the range of repeatable points outside the normal linear range. Outputs include 4-20mA Current Loop, Factored Pulse Output, Voltage Output and RS-232 data link.

Features

- 2-20 point linearizer
- 4-20mA Current Loop or DC external powered operation
- Pulse input supports sine and square type signals from pickup coils probes
- All features/configuration settings are field programmable through a hyperlink terminal window implemented on a RS-232 connected PC or laptop
- Field programmable Minimum and maximum flowrate via two on board switches
- Flowrate monitoring and pulse totalizer through a hyperlink terminal window implemented on a RS-232 connected laptop
- Concurrent multiple outputs include 4-20mA Current Loop, Factored Pulse and 0-5/10V Voltage
- Built-in test system for 4-20mA and 0-5/10V testing
- Error reporting and warning system
- Non-resettable "Grand" totalizer

Specifications

❖ **Programming and Monitoring Options via PC Displayed Hyperlink Terminal Window**

  ➢ *Flowrate Monitoring*

  - 6 digit when expressed in Pulses per Second
  - Decimal locations: 0.01 to 9999.99
  - 6 digit when expressed in Gallons per Minute
  - Decimal locations: 0.01 to 9999.99
  - Accuracy: ±0.1% of reading value

  ➢ *Pulses and Gallons Totalizer*

  - 11 digit for pulse counting
  - Decimal locations: 0 to 99,999,999,999
  - Accuracy: ± 1 pulse
  - 11 digit for gallons counting
  - Decimal locations: 0.001 to 9,999,999,999.9
  - Accuracy: ± 0.001Gallon to ±1Gallon, K factor dependent

❖ **Manual Programming Options**

  ➢ *Field selectable of minimum and maximum flowrate via two on board switches*
  ➢ *Programming error indicated by on board LEDs*

❖ **Power Supply**

  ➢ 4-20mA Loop powered

  - Maximum supply voltage: 36V
  - Operational supply voltage: 6.5 to 30 VDC
  - Reverse polarity protected
  - Max Current: 25mA

  ➢ DC powered

  - Maximum supply voltage: 36 VDC
  - Operational supply voltage: 5.5 to 30 VDC (7 to 30V for 0/5V Voltage output option and 12 to 30V for 0/10V Voltage output option)
  - Reverse polarity protected
  - Max supply current: 3.9mA (Factored rate pulse output ON and no external loads attached)

❖ **K-Factor range**

  ➢ Pulses per Gallon: 0.00001 to 999,999

❖ **Signal Input (sine and square wave)**

  ➢ Frequency: 1Hz-10kHz
  ➢ Impedance: 10k ohms
  ➢ Sensitivity(Sine):   50mV-24Vpp

  ➢ Sensitivity(Square):   3.6-24V (50% duty cycle)
❖ **Engineering Unit Conversions**

  ➢ Pre-programmed units: Gallons

❖ **Compensation**

  ➢ Linearizer table 2 to 20 points

❖ **Time Base**

  ➢ Rates can be displayed per second or minute

❖ **Outputs**

  ➢ *Factored Pulse (based on input pulses or calculated Gallons)*

    ▪ Input frequency range: 1Hz to 10KHz
    ▪ Pulse Output Divider: 0.01, 0.1, 1, 10, 100, 1000, & custom
    ▪ Pulses width variable or fixed: 2, 5, 10, 50, 100, 250, 500ms, & custom
    ▪ Accuracy: ±1 pulse
    ▪ Pulses acquiring interval: 1 sec
    ▪ Output update interval: 1 sec
    ▪ Pulse shape: square wave, 50% duty cycle
    ▪ Pulse amplitude: 4 to 29V, proportional to supply voltage
    ▪ Minimum load resistance: 1KΩ
    ▪ Short circuit protection and recovery

  ➢ *Factored Rate current (based on input pulses or calculated Gallons)*

    ▪ Input frequency range: 5Hz to 6KHz
    ▪ Current range: 4 to 20mA
    ▪ Accuracy: 0.1% of reading at 25°C , 0.25% over temperature
    ▪ Response time: 0.2 sec min (at 5Hz input frequency)
    ▪ Scalable low and high programmable
    ▪ Current Loop error detect and shut down

  ➢ *Factored Rate voltage (based on input pulses or calculated Gallons)*

    ▪ Input frequency range: 5Hz to 6KHz
    ▪ Voltage range: 0 to 5V or 0 to 10V
    ▪ Accuracy: 0.25% of FSR at 25 °C, 0.5% over temperature
    ▪ Accuracy (special order):   0.1% of FSR at 25 °C, 0.25% of FSR over temperature
    ▪ Response time: 0.2 sec min (at 5Hz input frequency)
    ▪ Minimum load resistance: 10KΩ
    ▪ Scalable low and high programmable
    ▪ Short circuit protection and recovery

  ➢ DC Output Voltage

    ▪ Maximum output voltage: 35V
    ▪ Operational output voltage: 4.5V to 29V, proportional to supply voltage
    ▪ Max Current: 20mA
    ▪ Short circuit protection

❖ **Compliance**

- ➤ Pollution Degree: 2
- ➤ Overvoltage Category: I
- ➤ Altitude: 2000 m max

❖ **Environmental**

- ➤ Operating: -40 to 65°C (-40 to 150°F)
- ➤ Storage: -40 to 85°C (-40 to 185°F)

❖ **Enclosure**

- ➤ Cast Aluminum (copper-free)
- ➤ Epoxy Powder Coat
- ➤ Enclosure rating NEMA 3, 4, 4X
- ➤ Class I, Division 1 and 2, Groups B, C, D
- ➤ Class II, Division 1 and 2, Groups E, F, G
- ➤ Class 1, Zone 1 and 2, IIA, IIB

❖ **Other features**

- ➤ EEPROM parameter storage
- ➤ Programming and monitoring via a PC displayed Hyperlink Terminal Window
- ➤ Field programmable Minimum and Maximum flowrate via two on board switches
- ➤ Secondary storage location for parameters and linearizer table

Dimensional

Wiring

All of the PT420 connections with the external devices are made through two removable connectors. To access the connectors, remove the face cover of the unit and observe connectors TB1 and TB2 on the PT420 circuit board. The wiring for monitoring and programming PT420 is made through J1 connector, placed on the same circuit board.

Wiring Guidelines

Turbines Incorporated recommends the following practices be followed:
- All wires connected to the unit should be shielded
- To help avoid ground loops and unexpected behavior, it is recommended that the opposite end of any cable shield is left unconnected (the end opposite the PT420)
- Care should be taken to ensure no part of any wire is not fully inserted into a connector to avoid shorting other circuitry on the mounting board
- Shields should not cover more than one set of signal wires at a time
- Supply wires should be 30AWG minim

Maintenance and Service

The only user serviceable parts of the PT420 are TB1, TB2 and J1 connectors. When servicing or programming the PT420, take care when opening the cover of the unit that any internal signal or power wires are not strained or pulled.

Enclosure

In order to maintain enclosure ratings the following torque specs must be followed:

Item	Torque
1" NPT fitting	2.5 turns past hand tight
Enclosure Cover	1/8-1/4 turn past hand tight

Connections

The connections are listed on the rear of the PT420 board. For clarification, the connections are shown below for each one of the three PT420 connectors (see **Figure 1**).

TB1	
1	SINE +/PULSE +
2	SINE –
3	+ Vcc_OUT
4	GRND/SHIELD

Where:

— SINE + and SINE – represent the differential input from a passive magnetic pickup coil
— PULSE + is the single input from an active magnetic pickup coil
— +Vcc_OUT is the optional voltage output for supplying an active magnetic pickup coil

TB2	
1	LOOP +/+Vcc_INPUT
2	LOOP –
3	VOUT
4	POUT
5	GND/SHIELD

Where:

 — LOOP + and LOOP – are the inputs for 4-20mA current loop
 — + Vcc_INPUT is the single input for external DC supply
 — VOUT is the factored voltage output
 — POUT is the factored pulse output

J1	
1	GND
2	RS232_CTS
3	+5V_RS232
4	RS232_TXD
5	RS232_RXD
6	RS232_RTS

Where:

 — RS232_CTS and RS232_RTS are RS232 control signals
 — RS232_TXD and RS232_RXD are RS232 data signals
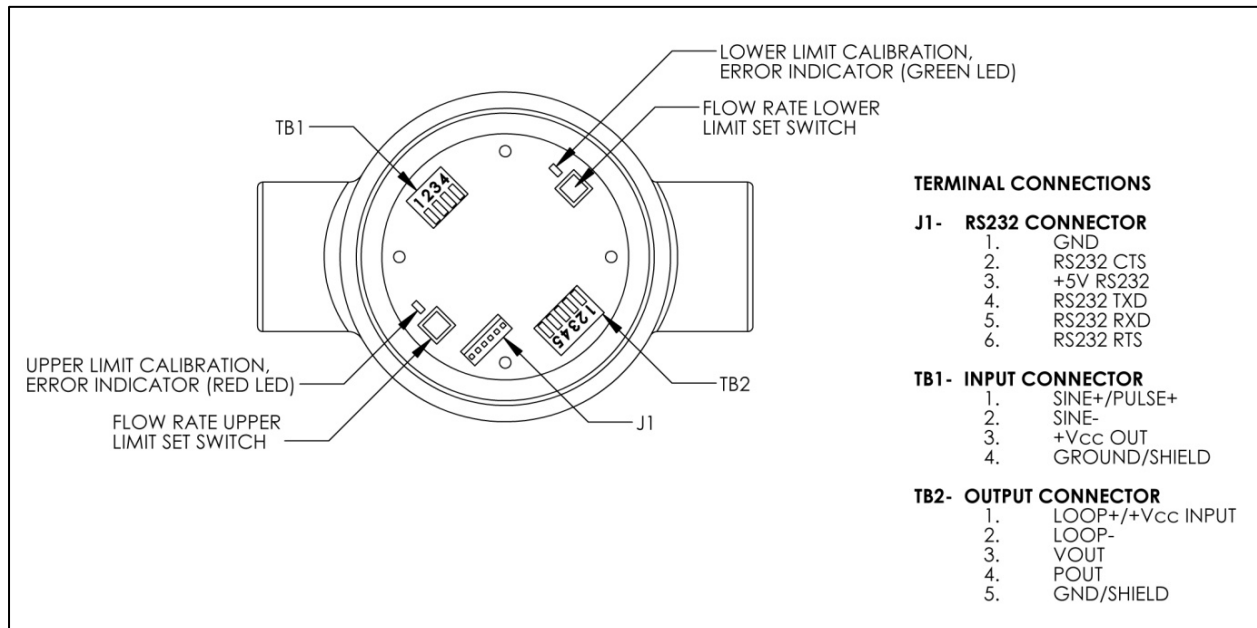 — + 5V_RS232 is the 5Vcc voltage input from RS232/USB cable

Figure 1. PT420 Connection Diagram

PT420 wiring

The PT420 supports connections with a variety of external devices: passive and active magnetic pickup coil, 4-20mA Current Loop receiver, DC power supply, Voltage indicator, Pulse Counter and PC or laptop for bench or infield monitoring/programming. A block diagram illustrating the PT420 connection to the external devices is illustrated below in **Figure 2**.
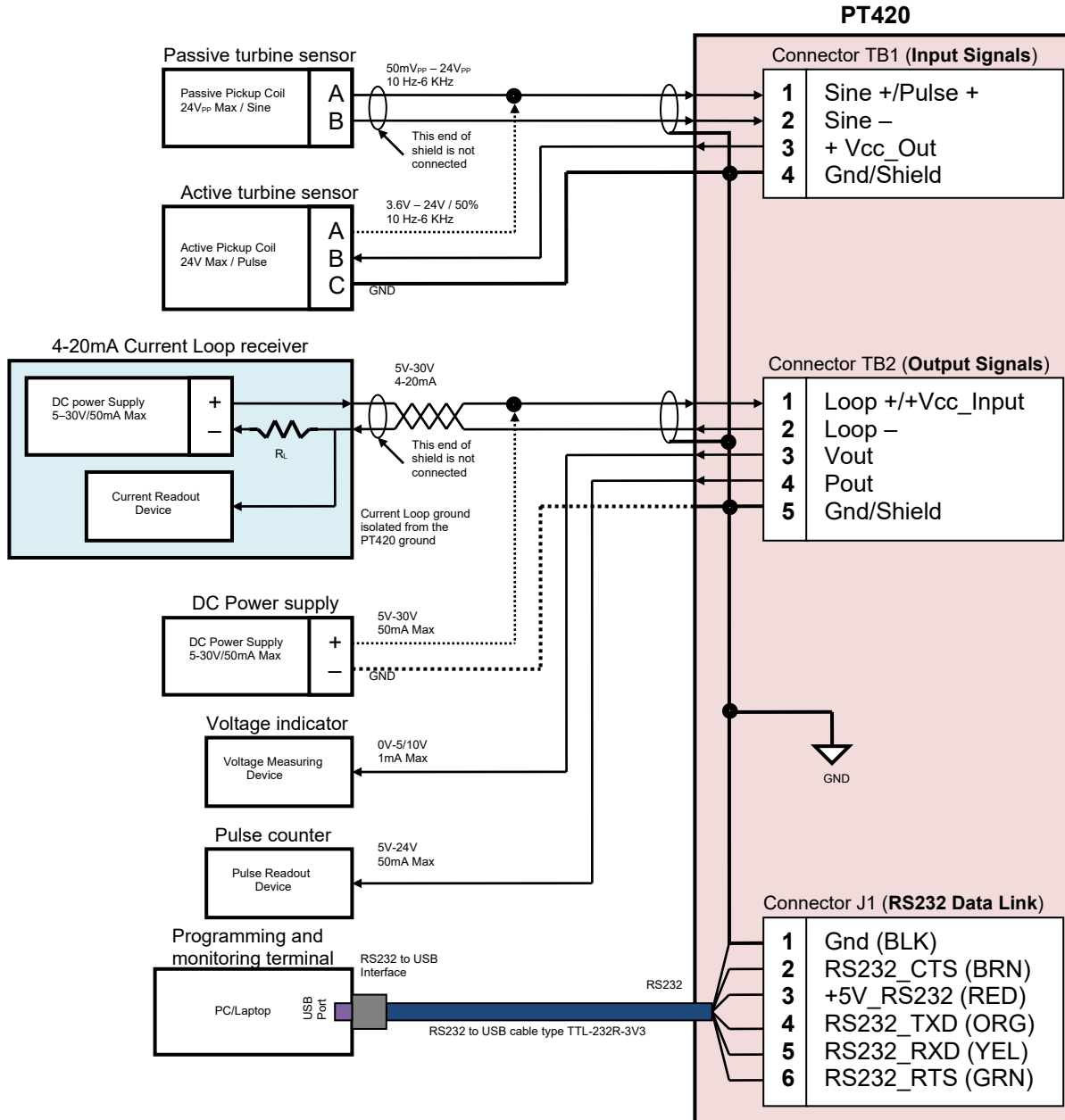
PT420

Connector TB1 (Input Signals)

1	Sine +/Pulse +
2	Sine –
3	+ Vcc_Out
4	Gnd/Shield

Passive turbine sensor

Passive Pickup Coil
24V$_{PP}$ Max / Sine

A
B

50mV$_{PP}$ – 24V$_{PP}$
10 Hz-6 KHz

This end of shield is not connected

Active turbine sensor

Active Pickup Coil
24V Max / Pulse

A
B
C

3.6V – 24V / 50%
10 Hz-6 KHz

GND

Connector TB2 (Output Signals)

1	Loop +/+Vcc_Input
2	Loop –
3	Vout
4	Pout
5	Gnd/Shield

4-20mA Current Loop receiver

DC power Supply
5–30V/50mA Max

+
–

R$_L$

Current Readout Device

5V-30V
4-20mA

This end of shield is not connected

Current Loop ground isolated from the PT420 ground

DC Power supply

DC Power Supply
5-30V/50mA Max

+
–

5V-30V
50mA Max

GND

GND

Voltage indicator

Voltage Measuring Device

0V-5/10V
1mA Max

Pulse counter

Pulse Readout Device

5V-24V
50mA Max

Programming and monitoring terminal

PC/Laptop

USB Port

RS232 to USB Interface

RS232

RS232 to USB cable type TTL-232R-3V3

Connector J1 (RS232 Data Link)

1	Gnd (BLK)
2	RS232_CTS (BRN)
3	+5V_RS232 (RED)
4	RS232_TXD (ORG)
5	RS232_RXD (YEL)
6	RS232_RTS (GRN)

Fig 2. PT420 typical wiring diagram

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Wiring Examples

Below are wiring diagrams showing the specific connection of each external device with PT420.

Turbine Sensor

The turbine sensor provides the PT420 with a sinusoidal signal generated by a passive magnetic pickup coil or pulses generated by an active magnetic pickup coil.

PT420 is able to detect sinusoidal signals with $50mV_{PP}$ – $24V_{PP}$ amplitude and 10 Hz – 6 KHz frequency and pulses with 3.6V – 15V amplitude in the same frequency range.

The active magnetic pickup coil can be powered from an external DC power supply with a voltage of 4.3V- 24V or, optionally, by the PT420 itself with a voltage of 4.3V- 24V and a maximum current of 1mA. The various configurations for connecting the turbine sensor to the PT420 are illustrated below in **Figures 3,4&5**.

Notes:
For the IS version of the PT420 an IS certified magnetic pickup coil must be used. A Class 2 or Limited Energy Source in accordance with CSA 61010-1-12 must be used with an Active magnetic pickup coil.
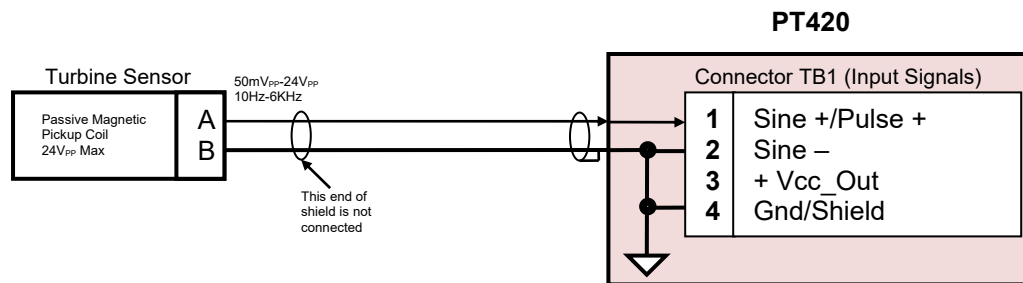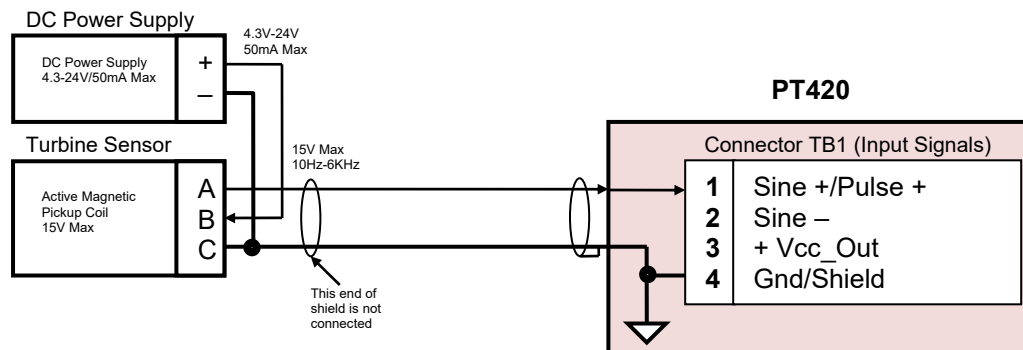

Fig 3. Passive magnetic pickup coil input wiring.

Fig 4. Wiring of an active magnetic pickup coil supplied by an external DC power supply.
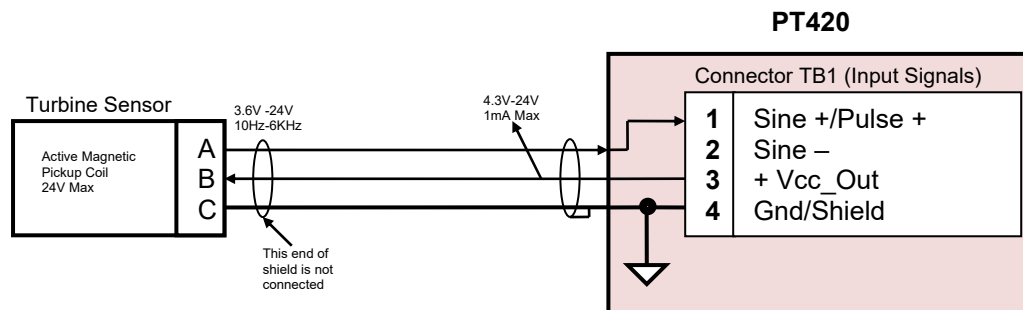

Fig 5. Wiring of an active magnetic pickup coil supplied by PT420.

4-20mA Current Loop Receiver

The 4-20mA current loop supplies 5V - 30V to the PT420 which in turn provides a 4mA to 20mA output current proportional to the measured flow rate. The two main components of the Current Loop receiver illustrated below in **Figure 6** are a DC power supply and a current readout device. These two components of the Current Loop receiver, although shown together, can also be implemented as two separate units. The R_L resistor also may be included or not in the Current Readout device. The 4-20mA Current Loop receiver is connected to the PT420 through pair of twisted conductors and the current delivered by its DC power supply is limited to a maximum of 50mA. Test circuit is illustrated below in **Figure7**.

<u>**Notes:**</u>
In order to assure the Current Loop proper operation The Current Loop receiver ground has to be insulated/floating with regard to the PT420 ground.
Current Loop power to be supplied by a Class 2 or Limited Energy Source in accordance with CSA 61010-1-12
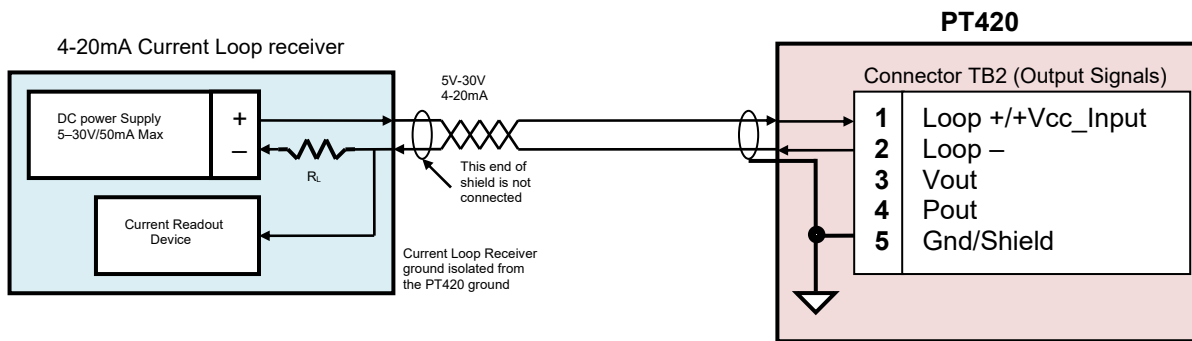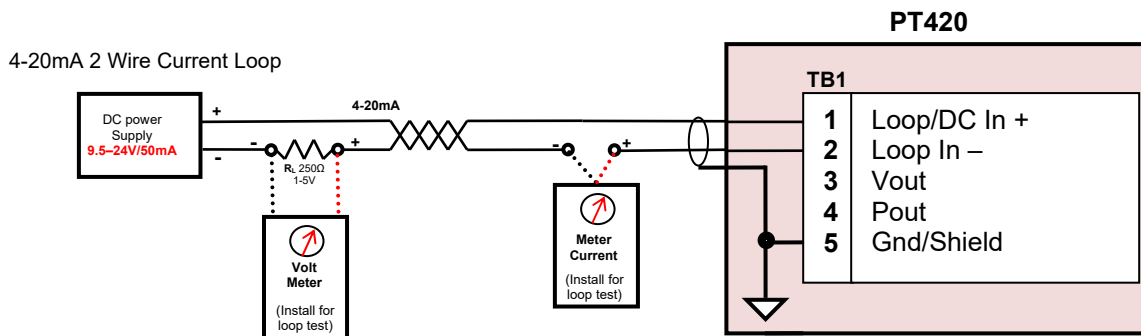

Fig 6. 4-20mA Current Loop output wiring.

Fig 7 4-20mA 2 Wire Current Loop output test configuration.

External DC Power Supply

PT420 can be supplied from an external DC power supply capable to deliver 5V to 30V and a maximum current of 50mA.

Notes:
When supplying the PT420 from an external DC power supply the *4-20mA Current Loop circuit is disabled*.
External power to be supplied by a Class 2 or Limited Energy Source in accordance with CSA 61010-1-12
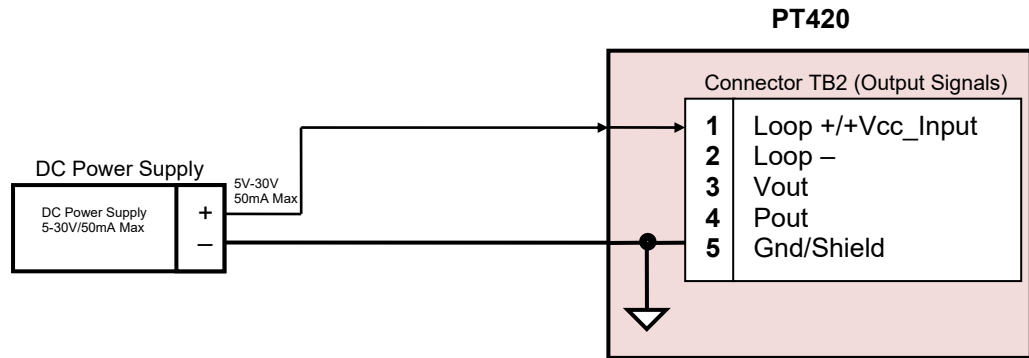

Fig-8. External DC power supply wiring.

Voltage indicator

Similar to 4-20mA current loop PT420 provides a 0-5V or 0-10V output voltage proportional with the measured flowrate.
The configuration used for connecting the voltage indicator to the PT420 is illustrated below in **Figure 9**.

Note:
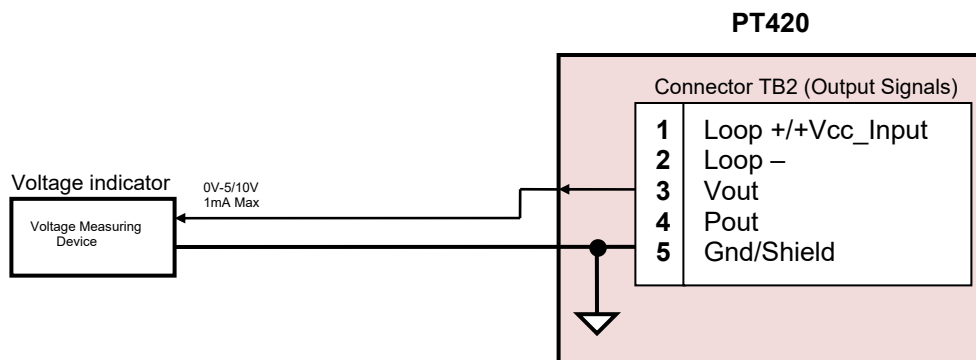For IS version of the PT420 a IS certified voltage indicator must be employed.

Fig 9. Voltage Indicator Wiring.

Pulse Counter

The pulse counter detects and accumulates the factored pulses received from the PT420 pulse output. The rate of factored pulses created by PT420 is based on the flow rate information received from the turbine sensor and a user-defined volume per pulse ratio. PT420 pulse output is short circuit protected and produces pulses with a maximum rating of 30V and 50mA.
The connection configuration for the pulse counter to the PT420 is illustrated next page in **Figure 10**.
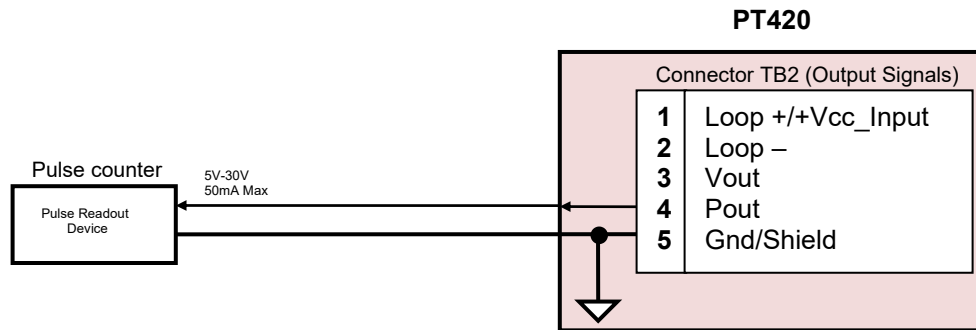

PT420

	Connector TB2 (Output Signals)
1	Loop +/+Vcc_Input
2	Loop –
3	Vout
4	Pout
5	Gnd/Shield

Pulse counter   5V-30V 50mA Max

Pulse Readout Device

Fig 10. Pulse counter wiring.

Note:
For IS version of the PT420 an IS certified pulse counter must be employed.

Programming and Monitoring Terminal

To assure its control, PT420 is provided with an RS232 data link for communicating with a PC/Laptop which, in this case, serves as a programming and monitoring device. An RS232 to USB converter cable can be used to connect the two devices for allowing the usage of the more common USB port when communicating with a PC/Laptop. The programming and monitoring functions are part of a menu included in a hyperlink terminal window displayed on the PC/Laptop screen.
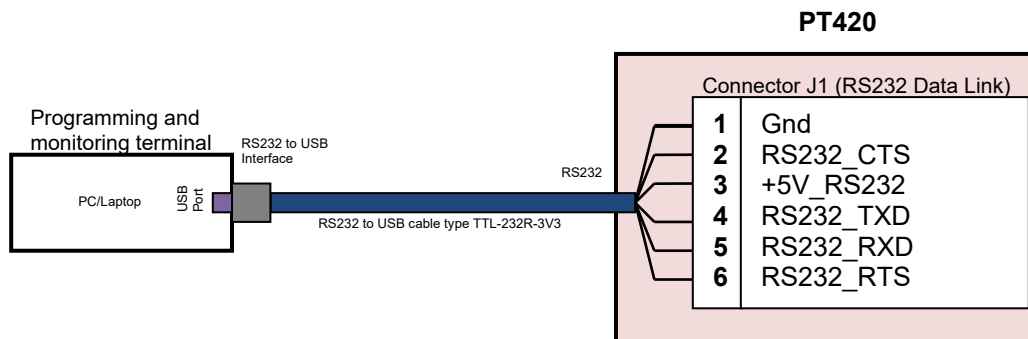The wiring between the two devices is illustrated below in **Figure 11**.

PT420

	Connector J1 (RS232 Data Link)
1	Gnd
2	RS232_CTS
3	+5V_RS232
4	RS232_TXD
5	RS232_RXD
6	RS232_RTS

Programming and monitoring terminal

PC/Laptop   USB Port

RS232 to USB Interface

RS232 to USB cable type TTL-232R-3V3

RS232

Fig 11. PT420 connection to a PC/Laptop device.

Note:
To assure normal operation of the 4-20mA Current Loop when using the RS232 data link, correct voltage must be supplied to the 4-20mA inputs (TB2 pins 1&2), then attach RS232 to USB cable to J1.

Caution:
For an IS certified PT420 installed in a hazardous location, all field wiring must conform to wiring methods for explosion-proof installations as defined by the National Electric Code in United States or by the Canadian Electric Code in Canada. Other International, State and local wiring codes may also apply.

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Operation Overview

Details of the operation of the PT420 can be found in this section.

Flow Calculations

Calculation for uncompensated flow rate:

FlowRate = Fin / KFactor

Calculation for uncompensated flow total:

FlowTotal = PulseInSUm / KFactor

Grand total is calculated independently from total.

Linearization

Linearization, as it pertains to the PT420, is the selection and interpolation of a K-Factor from a table of calibrated values based on frequency. Whenever a new frequency is detected, the unit will look up adjacent frequency values in the linearizer table and calculate a K-Factor (using linear interpolation). If the frequency value is below the lowest frequency in the table, then the linearizer uses the lowest point in the table. If the frequency value is above the highest point in the table, then the linearizer continues to use the K-Factor from the highest point in the table.

Units of Measure

All unit of measure calculations are based on the conversion of the desired unit of measure to the system units of measure, in this case Gallons, calculated from the input pulses and based on a calibrated average or linearized K-factor. The main units of measure are Gallons for totals and Gallons/minute for flowrate. Additionally PT420 can express totals in pulses and the flowrate in pulses/second.

4-20mA Current Loop

PT420 has a 4-20mA Current Loop feature which provides an output current proportional with the current flow rate and whose minimum and maximum limits represent a set of preprogrammed minimum and maximum flowrate values within the range of the flowmeter. Typically, the minimum programmed flowrate is the flowrate that will produce a 4mA output current and the maximum programmed flowrate is the flowrate producing a 20mA output current. Consequently, a current flowrate between these two limits will produce on output current conform to the following formula:

Iout = ((Imax – Imin) / (FRmax – Frmin)) * (FRcurr – FRmin) + Imin   where,

Iout – Output current at the current flowrate
Imin – Minimum output current (4mA)
Imax – Maximum output current (20mA)
FRmin – Minimum flowrate
FRmax – Maximum flowrate
FRcurr – Current flowrate

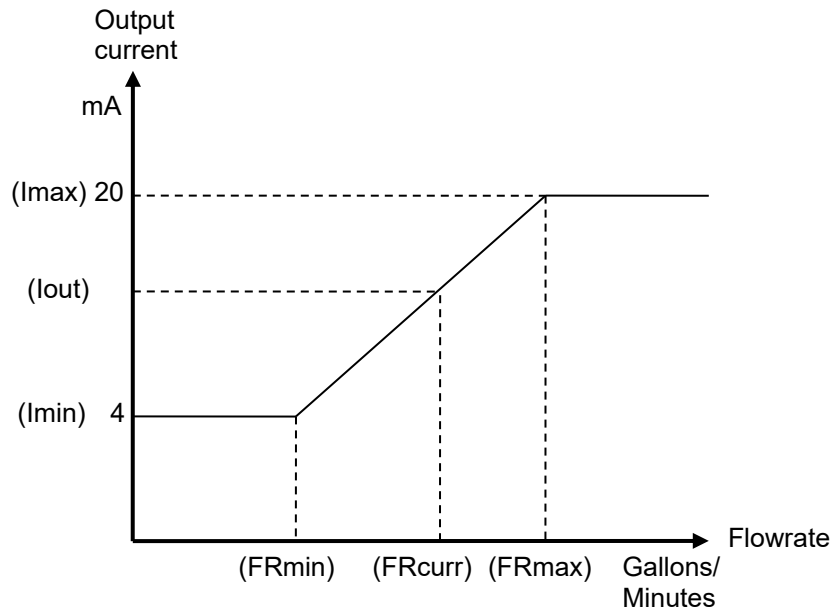The 4-20mA Loop output current dependency of the PT420 flowrate is illustrated next page in **Figure 12**.

Fig 12. 4-20mA Loop output current versus PT420 flowrate

Note:
The 4-20mA Loop output current is capped for flowrate values outside their selected minimum and maximum limits, as it is illustrated in the above diagram.

To assure normal operation of the 4-20mA Current Loop when using the RS232 data link, the RS232 to USB cable must be attached to J1 connector after the correct voltage is supplied at the 4-20mA inputs of PT420 (TB2 pins 1&2).

Voltage Output

Similar to 4-20mA feature PT420 provides an output voltage that represents the current flowrate and whose minimum and maximum limits represent a set of preprogrammed minimum and maximum flowrate values. In this case, the minimum programmed flowrate will produce an 0V output voltage while the maximum programmed flowrate will produce a selectable 5V or 10V output voltage.
The formula governing the relationship between the output voltage and the current flowrate is shown below:

$$Vout = (Vmax / (FRmax - FRmin)) * (FRcurr - FRmin) \quad where,$$

Vout – Output voltage at the current flowrate
Vmax – Maximum output voltage (5/10V)
FRmin – Minimum flowrate
FRmax – Maximum flowrate
FRcurr – Current flowrate

The output voltage dependency of the current flowrate is illustrated next page in **Figure 13**.
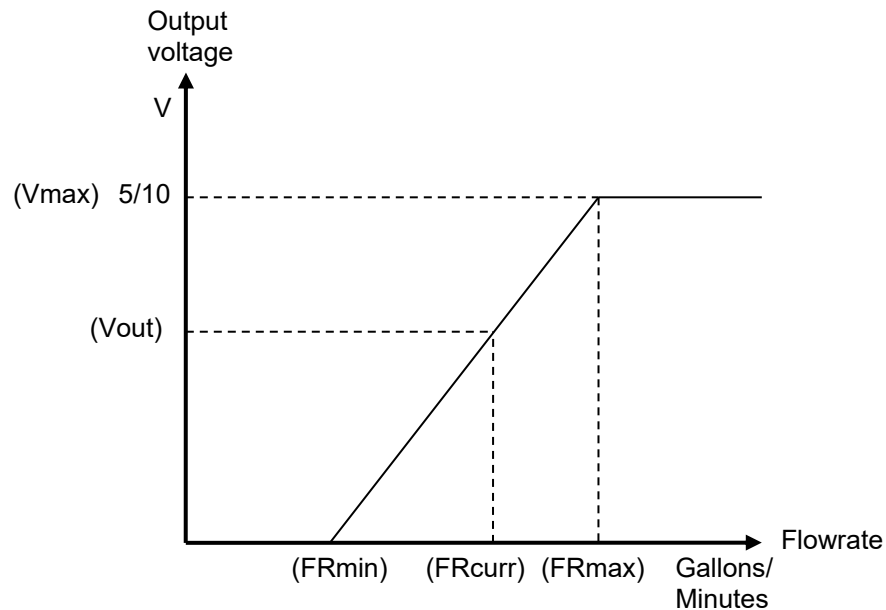
Fig 13. Output voltage versus PT420 flowrate

Note:

The output voltage is capped for flowrate values outside their selected minimum and maximum limits, as it is illustrated in the above diagram.

Pulse Output

This PT420 output allows an external pulse counter type device to measure the amount of fluid passing through a pipe in a certain circumstances or period of time by providing, through a push-pull type driver, a factored pulse with adjustable width. To calculate the number of outputted pulses in a certain time interval the unit subtracts the previous grand totalizer value from the last updated grand totalizer value and divides the result by a user defined pulse divider value (set in the setup menu). Because the divider is allowed to be smaller than 1, the pulse divider can be made to be a multiplier. For PT420 the time interval between two consecutive totalizer updates is 1 second, implying that the number of pulses outputted by PT420 in an every given second between two totalizer updates represent the number of pulses accumulated in the totalizer in the previous one second interval between two totalizer updates. Here is the formula that is used:

Pout = (LUTPulses – PUTPulses) / PD   where,

Pout – The number of pulses outputted in a certain time interval
LUTPulses – Last updated totalizer pulses
PUTPulses – Previous updated totalizer pulses
PD – Pulse divider

Pulse duration is the number of milliseconds the pulse is active and, for PT420, represents half of the pulse period (PT420 generates 50% duty cycle output pulses). This will need to be small enough that all of the pulses that need to be outputted in the 1 second time interval have time to complete, but large

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enough that the receiving equipment can still detect them. To calculate the maximum pulse duration the following formula can be used:

Pdur max = PD / ((OutputPulses/second)*2)

Example: If the maximum flowrate through a pipe is expected to produce in the PT420 totalizer   an accumulation of 300 pulses in every one second interval between two consecutive updates and the Pulse Output Divider is set to 10, then the maximum allowed pulse duration is:

Pdur max = 10 / ((300)*2) = 16.6 mS

Note:

One pulse outputted by PT420 in a one second time interval is indicating that:

(totalizer accumulated pulses in the previous one second time interval / PD) = 1

For example, if the pulses accumulated in the totalizer are calculated based on a K-factor value of 1 pulse /gal, then 1 pulse in the grand totalizer represents 1 gallon. Additionally, if the pulse divider PD is set to 10, then a pulse outputted by PT420 in the one second time interval between two grand totalizer updates represents 10 gallons of fluid, as it is illustrated below in **Figure 14**.
It is worth noting that PT420 takes into account the fraction of Gallons not accounted in a one second time interval and adds them to the next one second time interval for assuring the accuracy of the total pulses counted in a period of time or, equivalently, the total volume measured in that same period. Also one needs to consider that this method of measuring the volume, being based on counting the PT420 factored output pulses, has an inherent error of 1 pulse. Considering the above example in this case this would translate in a maximum error of 10 Gallons.
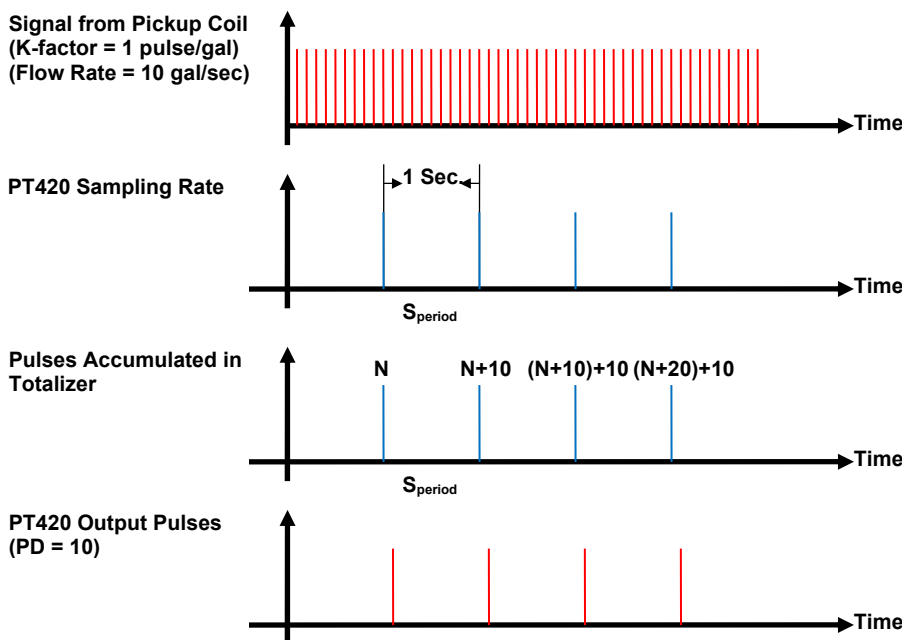

Fig 14. Output pulses produced by PT420 assuming that frequency = 10 pulses/sec, K-factor = 1 pulses/gal and divider factor = 10; one output pulse represents 10 gallons.

Note:

For cases when the pulse output system is in danger to be overloaded and, consequently, lose pulses, PT420 offers the option to add these extra pulses to the first period with fewer pulses, avoiding the potential errors due to the possible unaccounted pulses during the periods of pick flowrate. An overloaded pulse output can also be caused by the incorrect setting or estimation of the pulse width and divider values or flowrate range and the K-factor values (for example choosing a pulse width too wide for the number of pulses being asked to be outputted per second). It is therefore the duty of the PT420 operator to adjust and estimate these factors of influence correctly, as for example, reducing the Pulse Width, increasing the Pulse Divider, etc, for assuring an accurate pulse output counting.

Reset

The PT420 has two totalizers, the Batch total and the Grand total. The Batch total is resettable while the Grand total is not resettable. Their operation is controlled through the hyperlink terminal window displayed on a PT420 connected PC/Laptop device, as it will be in more detail explained later in the "PT420 Configuration and Operation" section of this manual.

Power

The PT420 can receive power from three sources:
- External 4-20 mA loop source
- External Vdc source
- PC/Laptop when in programming/monitoring mode

Notes:
— When PT420 is supplied from an external 4-20mA loop source the ground of the 4-20mA loop source needs to be isolated from the PT420 ground and any other devices having a common ground with it.
— When PT420 is supplied from an external 4-20mA loop source and the voltage output and/or pulse output are enabled or the +VCC_OUT is used, the total PT420 total consumption has to be below 4mA for assuring the 4mA lower limit of the 4-20mA current loop range
— When an external Vdc source is used for supplying PT420 and the 0-5/10V voltage output is selected the value of the external source has to be at least 1V higher than the desired voltage output for assuring the 5/10Vupper limit of the 0-5/10V output voltage range; if the external source is provided by a 4-20mA loop, beside the condition of having its ground isolated from PT420 ground, the voltage of the external 4-20mA loop source, less the voltage dropped on the external loop load, has to meet the same requirement regarding the desired output voltage; the same conditions for both sources, external Vcc and 4-20mA loop, occur for the pulse output regarding its maximum desired amplitude

PT420 Configuration and Operation

PT420 can be connected to a PC/Laptop device through a RS232 to USB converter cable, as it is described in the previous "Programming and Monitoring Terminal" paragraph and **Fig 11**. This method allows the user to manipulate various aspects of the flowmeter configuration and operation through a PC/laptop keyboard and a hyperlink terminal window.
Also, an alternate, limited option to set the lower and upper flowrate for calibrating 4-20mA Loop it is possible through the two pairs of momentary switches and LED's existent on the PT420 electronic board. These two methods are in more detail explained further.

Configuration and Operation via Hyperlink Terminal Window

Once a communication is established with PT420 the following self-explanatory menu appears in the hyperlink terminal window displayed on the connected PC/Laptop:

I - Monitor and set flow inputs and calibrate ranges
K - K-factor and linearizer
L - Manually set flow input limits
P - Print configuration and status
S - Select input source
4 - Configure 4-20mA output
U - Configure pulse output
V - Configure voltage output
Q - Exit to main program
Z - Board test and calibration

The Menu consists of several items that allow the user to manipulate aspects of the PT420's operation. The Menu items are accessed by pressing the corresponding letters and numbers on the PC/Laptop keyboard. A brief description of the Submenus and their components is presented below.

I - Monitor and set flow inputs and calibrate ranges

This Menu item has two components: one is responsible for setting the flowrate lower and upper limits and resetting the batch totals to zero and the other one allows the flow rate monitoring, in pulses per second, Hz, and gallons per minute, GPM, and units counting in pulses and gallons.
By pressing the letter **I** key on the keyboard the following self-explanatory Submenu items shows up:

R - reset batch totals to zero.
L - set flow rate GPM as lower limit of flow rate.
H - set flow rate GPM as upper limit of flow rate.
X - set turbine rate Hz as low range of turbine rate.
Y - set turbine rate Hz as high range of turbine rate.
S - store lower and upper limit settings.
D - toggle ratio display between GPM and turbine rate limits.
ESC - return to main menu.

```
 Total |  Total | -- Flow Rate --      | Calculated
Pulses | Gallons |     Hz     GPM Ratio | K-Factor
-------+---------|----------------------+-----------
 10158   1015.80    999.98 5999.86 1.000     10
```

Notes:
The totals in this Submenu are referring to the batch totals and can be reset to zero by pressing R key. Gallons are calculated based on the previous introduced K-factors values, average or from linearization table when higher measurement accuracy is desired.

K - K-factor and linearizer

This Menu item is responsible for allowing the user to select between using an average K-factor or a linearizing table for translating in gallons the input pulses received by PT420 from turbine and also set the calibrated K-factor values
By pressing the letter **K** key on the keyboard the following self-explanatory Submenu items shows up:

Using average K-Factor.
K-Factor =   10.00000
K-Factor and Linearizer settings
L - Use Linearizer table for K-Factor
F - Use K-Factor instead of table
K - Set average K-Factor
T - Set Linearizer table values
ESC - Main Menu

By further pressing the **K** key the following Submenu appear, allowing the setting of the average K-factor:

Current K-Factor is   10.00000
Type the new K-Factor.
Press ENTER to finish editing.
Press ESC to abort editing

If the **T** key is pressed the following Submenu appear, allowing the setting of the linearization table values:

0123456789ABCDEFGHIJ - select table entry.
You will be prompted for frequency then K-Factor.
S - sort and save the table.
ESC - discard unsaved changes and return to K-Factor menu.

Note:
The K-factor values are obtained from the calibration sheet of the turbine the PT420 is supposed to use in a given application.

<div align="center">

L - Manually set flow input limits

</div>

This Menu item allows the setting of the minimum and maximum flowrate limits in pulses per second, Hz, or gallons per minute, GPM.
By pressing the letter **L** key on the keyboard the following self-explanatory Submenu items shows up:

Flow rate min   10.00 GPM
Flow rate max   100.00 GPM
Turbine rate min 100.00 Hz
Turbine rate max 1000.00 Hz
Manual limit entry
0 - Enter minimum flow rate in GPM
1 - Enter maximum flow rate in GPM
X - Enter minimum flow rate in Hz
Y - Enter maximum flow rate in Hz
ESC - Main Menu

<div align="center">

P - Print configuration and status

</div>

This Menu item allows an overview of the PT420 configuration and the present status of various parameters as well as the value of the batch and grand totals and the time elapsed from the moment the PT420 was the first time powered.
By pressing the letter **P** key on the keyboard the following self-explanatory Submenu items shows up:

Using average K-Factor.
K-Factor =   10.00000

Pulse output is enabled.
The pulse output is computed from gallons measured after K-Factor.
The pulse divider ratio is   1.0000
The pulse width is fixed at 1 ms.
Excess pulses are carried over to the next 1 second interval

Voltage output range is 0.0 to 10.0 volts.

Voltage output is generated from turbine pulse rate
Voltage trim values are   +0, -309.

4-20mA loop output is generated from turbine pulse rate
Uptime   21481
Age of backup 17092
Grand totals:
Pulses   5142
Gallons   514.20000
Batch totals:
Pulses   5142
Gallons   514.20000

S - Select input source

This Menu item allows the selection of the source providing the PT420 input pulses, passive magnetic pickup coil or active magnetic pickup coil producing square wave pulses.
By pressing the letter S key on the keyboard the following self-explanatory Submenu items shows up:

Input Source
C - Use magnetic pickup coil
P - Use square wave pulse input
ESC - Main Men

4 - Configure 4-20mA output

This Menu item allows the configuration of the 4-20mA Loop current output.
By pressing the letter 4 key on the keyboard the following self-explanatory Submenu items shows up:

4-20mA loop output is generated from turbine pulse rate
4-20mA Current Output
G - Use flow rate GPM for 4-20mA output
P - Use turbine pulse rate for 4-20mA output
ESC - Main Menu

Note:
The 4-20mA Loop current output can be generated based on turbine pulses per second, Hz, or gallons per minute, GPM, calculated after applying the K-factor to the received turbine pulses.

U - Configure pulse output

This Menu item allows the activation and configuration of the Pulse output.
By pressing the letter **U** key on the keyboard the following self-explanatory Submenu items shows up:

Pulse output is enabled.
The pulse output is computed from gallons measured after K-Factor.
The pulse divider ratio is 1.0000
The pulse width is fixed at 1 ms.
Excess pulses are carried over to the next 1 second interval
Pulse Output
D - Disable pulse output
E - Enable pulse output
N - Disable pulse overflow carry
O - Enable pulse overflow carry
L - Use input pulse count for pulse output
G - Use UOM (gallons) for pulse output
P - Set pulse width
R - Set pulse divider ratio
V - Set variable width pulse output
W - Set fixed width pulse output
ESC - Main Menu

V - Configure voltage output

This Menu item allows the configuration of the Voltage output.
By pressing the letter **V** key on the keyboard the following self-explanatory Submenu items shows up:

Voltage output range is 0.0 to 10.0 volts.

Voltage output is generated from turbine pulse rate
Voltage trim values are +0, -309.
Voltage Output
1 - Set voltage range to 0 .. 10 Volts
5 - Set voltage range to 0 .. 5 Volts
G - Use flow rate GPM for voltage output
P - Use turbine pulse rate for voltage output
ESC - Main Menu

Q - Exit to main program

This Menu item allows the return to the main program.

Z - Board test and calibration

This Menu item allows the calibration of the Voltage output and it displays the status of the two pairs of the on board switches and LED's.
By pressing the letter **Z** key on the keyboard the following self-explanatory Submenu items shows up:

Board Test Menu
4 - Manually set 4-20 output

V - Manually set voltage output
T - Trim voltage output calibration
I - test front panel I/O
ESC - Main Menu

By further pressing **T** key of this Submenu, the Submenu allowing the calibration of the Output voltage appears:

[- trim by -1.
] - trim by +1.
{ - trim by -10.
} - trim by +10.
0 - trim for 0 volt output.
1 - trim for 10 volt output.
5 - trim for 5 volt output.
S - store the trim value.
ESC - return to main menu.
The same trim is applied (with scaling) to 5 and 10 volt outputs.
A separate trim is applied to 0 volt output.

Lower | | Upper
 Trim | @V | Trim
------+----+------
  +0   10   -309

Alternately, by pressing **I** key of this **Z** Submenu, the status of the two pairs of on board switches and LED's is displayed:

1 - toggle S1 LED.
2 - toggle S2 LED.
ESC - return to main menu.

  BUTTONS | LEDS
 S1 | S2 | S1 | S2
TOP | BOTTOM | RED | GREEN
----+--------+-----+------
 1   1   1   1

Notes:
This Submenu also allows the ON/OFF toggling of the two on board LED's for testing their normal operation.

Submenus 4 and V of the Z submenu are not yet implemented, being reserved for further developments of this product

Configuration and Operation via on board switches

In addition to the use of the hyperlink terminal window to program its configuration, the PT420 provides the user an alternative method to set the lower and upper flowrate limits through the pair of momentary switches and LED's placed on the PT420 electronic board. This method offers additional operational flexibility by allowing the user to adjust the PT420 flowrate limits based on the changes typically occurring in the field.
On the following page, the **Figure 15** logic diagram illustrates the sequence of actions required to set the PT420 lower and upper flowrate limits when using this method (also see **Figure 1**).
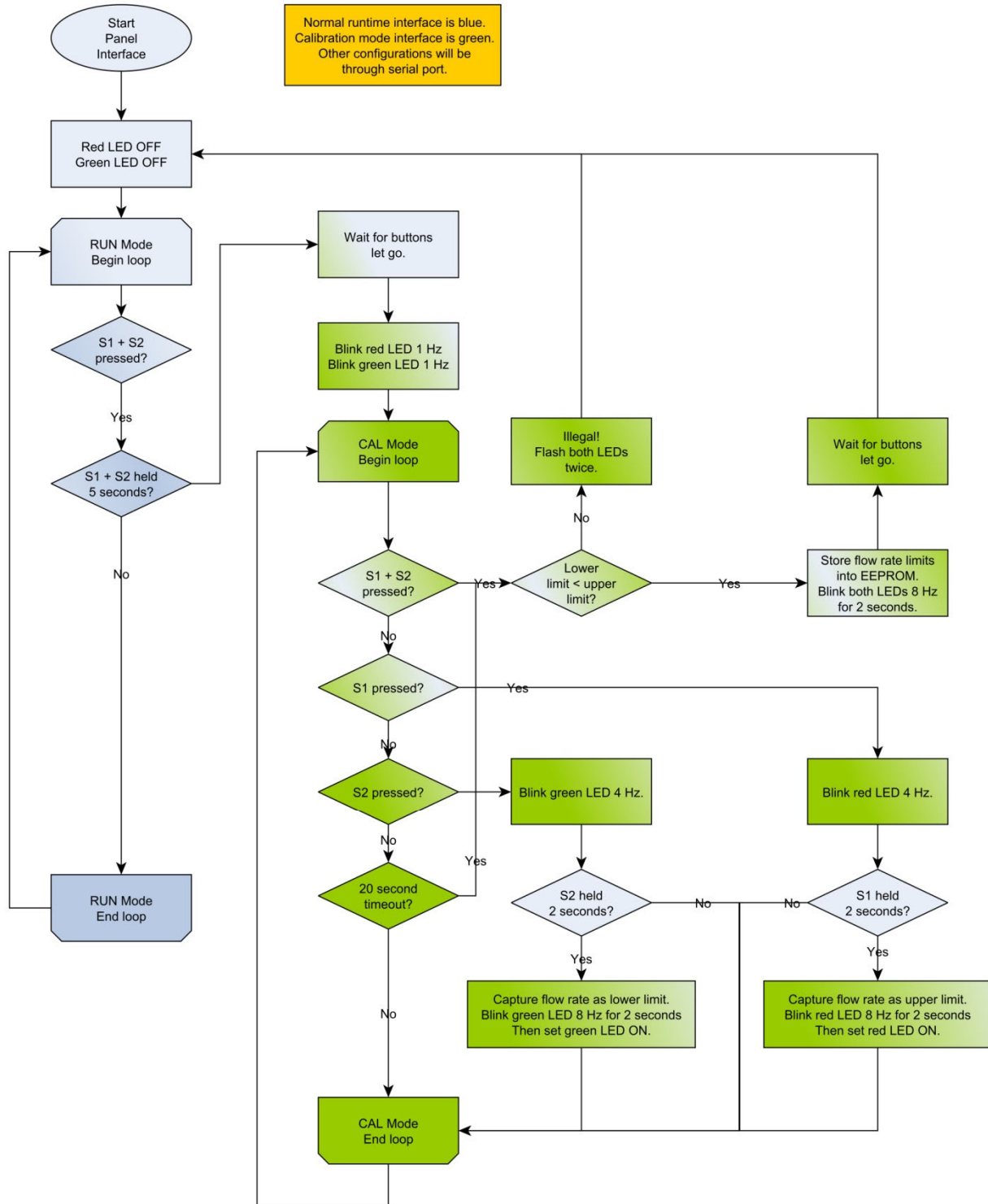
Fig 15. Flowchart illustrating the sequence of actions required to set the PT420 lower and upper flowrate limits when using its on board switches and LED's.

Based on this flowchart the following steps have to be taken in order to set the low and upper limits defining the range of the flow rates to be transmitted:

1. Uncover the PT420 enclosure to access the electronic board mounted inside
2. Identify the switches S1 and S2 placed on the electronic board
3. Adjust the flow rate to the value corresponding to the lower limit to be set
4. Press simultaneously S1 and S2 for 5 seconds
5. Release them and observe both, the red and green LED's placed next to S1, respective S2 blinking simultaneously at 1Hz; this indicates that PT420 is ready to proceed to the next phase of the set up process, the calibration mode; if this step is not perform properly the programming has to return repeat step 4
6. Press S2 and observe the green LED blinking at 4Hz
7. Held S2 for 2 seconds to capture the present adjusted flow rate as the lower limit and observe the green LED blinking at 8Hz for 2 seconds and then turning ON continuously; if S2 is not held for 2 seconds the program has to return to step 6 again for allowing a new try to capture the flow rate lower limit
8. Adjust the flow rate to the value corresponding to the upper limit to be set
9. Press S1 and observe the red LED blinking at 4Hz
10. Held S1 for 2 seconds to capture the present adjusted flow rate as the upper limit and observe the red LED blinking at 8Hz for 2 seconds and then turning ON continuously; if S2 is not held for 2 seconds the program has to return to step 6 again for allowing a new try to capture the flow rate upper limit
11. Press simultaneously S1 and S2 and release them for storing the flow rate lower and upper limits in the PT420 memory and observe both LED's blinking at 8Hz for 2 second to confirm that the programming of the lower and upper flow rate limits was successfully finished; if, by mistake, the flow rate lower and upper limits captured in the previous steps don't meet the condition that the lower limit is smaller than the upper limit the storage in the PT420 memory is canceled and both LED's flash twice indicating an illegal operation

Note:

If after step 6 nor S1 or S2 are pressed for a period longer than 20 seconds the entire programming procedure has to be restart from step 4.

Document Revision History

Revision	Description	Date
	Initial Release of PT420 User Manual	

Turbines, Inc.™