FB420 Ver 2.0 Shaft Speed Sensor (Standard Model)

Description:

Electro-Sensor's FB420 Ver2.0 is a shaft speed sensor that provides a 4-20 mA signal that is directly proportional to the rotational speed of a monitored shaft.
Since both the 4 mA and 20 mA calibration points are programmable the user can also, if desired, operate the FB420 Ver2.0 with the 4 mA offset from 0 RPM.

The FB420 Ver2.0 has a 4-digit LCD display that is used for calibration and for trouble-shooting. The LCD can display:

- '% of MAX_RPM' from '000.0' to '999.9.' %,
- or the 'RPM' from '0.000' to '9999.',
- or the 'Output Signal' from '04.00' to '20.00' mA.

The FB420 Ver2.0 has one relay that can be programmed as either an Overspeed or Underspeed alarm, or as Unused.

The FB420 Ver2.0 has **a Speed_Trim_Down** test feature, activated by holding down the DECPT button to simulate a speed slowdown. The user can use this feature to simulate the speed dropping to below the (Underspeed) Relay Setpt, at which the Relay will go into the de-energized 'Alarm' state.

FB420 Ver2.0 (hereafter FB420) Installation:

The FB420 needs a rotating target installed on the application's drive-shaft, etc. A typical rotating target is a 255 Pulser Disc (sold separately, with or without an optional EZ-Mount bracket), or an optional custom-made Pulser Wrap (also sold separately).
(See Figure's 4a, 4b, and 4c).

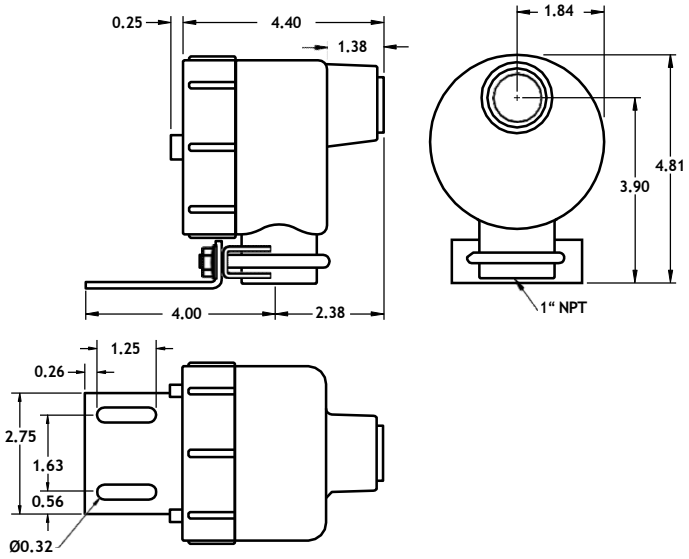

Figure 1: FB420 Dimensions w/Bracket and U-Clamp

Figure 2: FB420 Front-View

Electrical connections

The FB420's electrical connections are as follows:

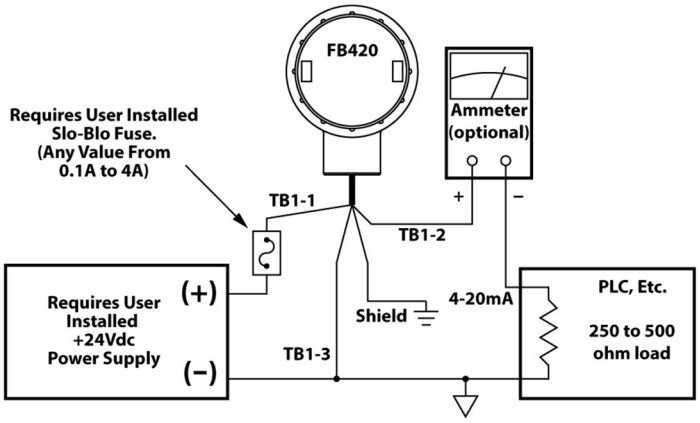

Figure 3:

- Connect the shield wire to the earth ground (if used).
- Connect TB1-1 to the power-supply (+24 Vdc) terminal.
- Connect TB1-2 to a resistive load of 250 Ω to 500 Ω, (usually this load is internal to a PLC, etc.).
- Connect TB1-3 to the power-supply (-) terminal.

Note: TB1-2 is the 4-20 mA DC output line.
The other side of the 250 Ω to 500 Ω load must be connected to the power-supply (-) terminal.

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Pulser Disc (sold separately):

The end of the shaft to be monitored must be center drilled to a depth of 1/2–inch with a #21 drill and tapped for a 10-32 UNF. After applying Loctite™ or a similar adhesive on the threads to keep the pulser disc tight, the pulser disc should be attached, decal side out with the supplied 10-32UNF machine screw and lock washer. Dimension (A) is 1/4 inch +/- 1/8 inch.
The center-line (white circular line) of the magnets (B) must align with the center of the sensing head as the Pulser Disc rotates.

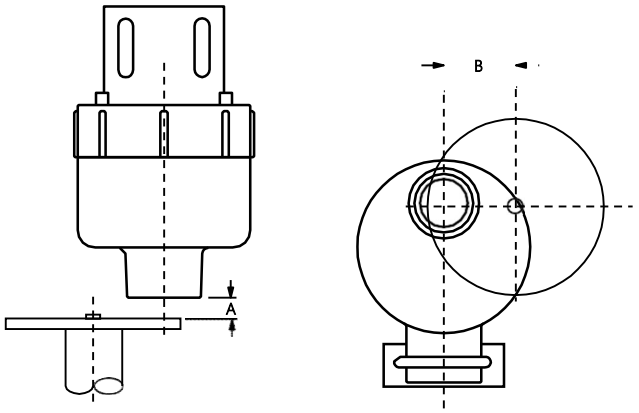

Figure 4a: FB420 with 255 Pulser Disc

EZ-Mount Bracket with Pulser Disc (Option sold separately). (See EZ-Mount Bracket documentation for more details, doc # ES100).

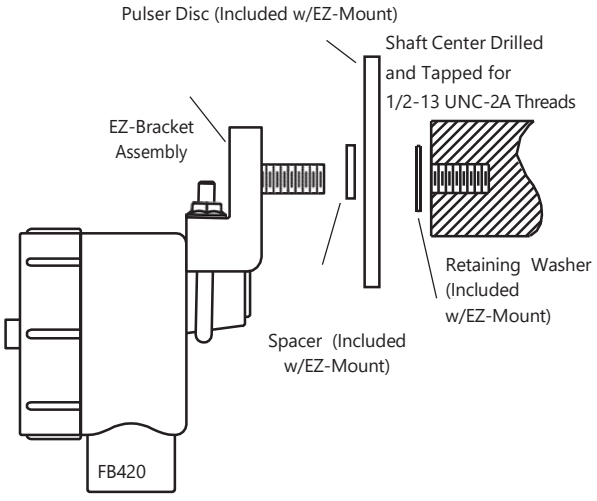

Figure 4b: FB420 with EZ-Mount Bracket

Pulser Wrap (Option sold separately):

Pulser wraps are custom manufactured to fit the shaft they will be mounted on. When the wrap is shipped, four Allen-head cap screws hold the two halves of the wrap together. These screws must be removed so the wrap is in two halves. Place the halves around the shaft, reinsert the screws and torque them evenly to 5 foot-pounds. Dimension (A) is 1/4 inch +/- 1/8 inch.
The center-line of the magnets (B) must align with the center of the sensing head as the Pulser Wrap rotates.

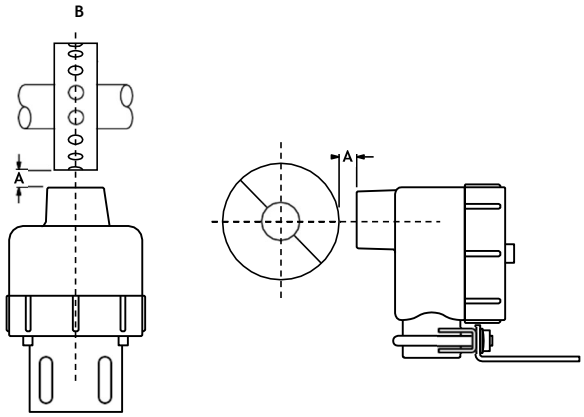

Figure 4c: FB420 with Pulser Wrap

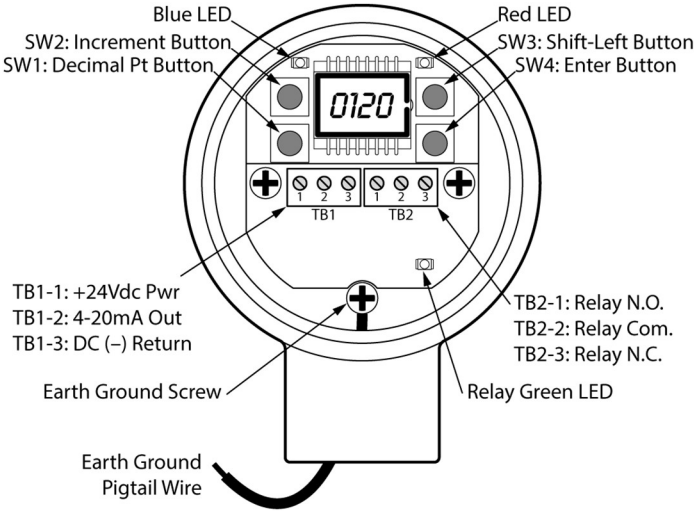

Figure 5: FB420 Rear-View (Cover Removed). Showing the Power / Signal Terminal TB1, the Relay Terminal TB2, the push-buttons SW1, SW2, SW3, SW4, the Green LED for 'Relay Energized', the Blue LED for 'Loss-of-Fdbk', the Red LED for 'Open-Circuit' in the 4-20 mA Output Signal path, the Earth Ground Screw, and the Earth Ground Green Pigtail Wire.

Pin #	TB1 Function	TB2 Function
1	+24 VDC Power In	Relay Normally Open Contact
2	4-20 mA Output	Relay Common Contact
3	DC (-) Return	Relay Normally Closed Contact

List of Variables (An '*' indicates a 'critical' UserVar, that when changed results in an internal MaxHz recalculation).

VAR	Mnemonic	Description	Range	Decimal Place	Default	User's Value
01*	Pulses Per Rev	Pulses per revolution of target	0001. to 9999.	Fixed at XXXX.	0008	
02*	Min_RPM	RPM value corresponding to 4 mA	0000 to "97.5% of Var03"	decpt tied to Var03	0000	
03*	Max_RPM	RPM value corresponding to 20 mA	0.000 to 9999.	User selectable	0200	
04*	Relay Function Select	Unused = 0000, Over-speed = 0001, Under-speed = 0002	0000. to 0002.	Fixed at XXXX.	0000	
05*	Relay Set-point RPM	Relay alarm trip point in RPM	0000 to 9999	decpt tied to Var03	0100	
06	Relay Set-point Delay	Alarm event 'wait' time in seconds	0000. to 0030.	Fixed at XXXX.	0001	
10	Software ID	(Read Only) Version and Revision	0.0.0.0 to 9.9.9.9	X.X.X.X.	0.3.0.3.	
14	Hour Meter	Counts-up for Speed above **Cut-off**	0000 to 9999	Fixed at XXXX.	0000	
15	One Rev Averaging Select	Disable = 0000, Enable = 0001	0000. to 0001.	Fixed at XXXX.	0001	
Note:	Vars 07, 08, 09, 12, and 13 are Reserved for Future		---	---	0000	---

VAR	Mnemonic	Description Run in Normal Mode or Test Mode: **Warning! Tests "0002", "0004", and "0005" will ENERGIZE the Relay.** **Make sure any Motor, etc., controlled by the Relay is safe for operation.**	Range	Decimal Place	Default
11	Test Mode Select (When in any of the Var11 test-modes, the LCD shows special icons of "VAR", "OUT%", and "RATE", in the LCD corners).	0000 = Run in Normal Mode. 0001 = LCD Test mode: • Cycle LCD with digits "0.0.0.0." thru "9.9.9.9.". • The Relay is locked OFF, and the 4-20 mA Output is locked at 4 mA. 0002 = Relay Test mode: • Pressing INCRement button toggles Relay state. • LCD = "0000" for Relay OFF. • LCD = "0001" for Relay ON. • The 4-20 mA Output is locked at 4 mA. 0003 = 4-20 mA Output Test mode: • 4-20 mA Output scrolls in 2 mA steps, "04.00" thru "20.00" mA. • LCD increments in unison with 4-20 mA Output. • The Relay is locked OFF. 0004 = Simulate Underspeed Relay RPM Setpt Test mode: • **This test can be done even if Real Fdbk Speed is 0 in the background**. • Test begins with LCD showing **UserVar05_Relay_RPM_Setpt value + 10% more RPM**, with Relay in the de-energized Alarm state. • Hold-in INCRment button for 5 secs to turn-ON Relay to begin test. • The 4-20 mA Output Signal now becomes active per the Simulated Speed. • Repeatably pressing INCRment button walks-down RPM value on LCD. • Once LCD is walked-down to below **UserVar05_Relay_RPM_Setpt** then Relay goes into de-energized Alarm state. • Hold-in INCRment button for 5 secs to turn-ON Relay to test again. *(See p.4-6 for similar Normal Running Mode "Speed_Trim_Down" test feature).* 0005 = Simulate Overspeed Relay RPM Setpt Test mode: • **This test can be done even if Real Fdbk Speed is 0 in the background**. • Test begins with LCD showing **UserVar05_Relay_RPM_Setpt value - 10% less RPM**, with Relay in the de-energized Alarm state. • Hold-in INCRment button for 5 secs to turn-ON Relay to begin test. • The 4-20 mA Output Signal now becomes active per the Simulated Speed. • Repeatably pressing INCRment button walks-up RPM value on the LCD. • Once LCD is walked-up to above **UserVar05_Relay_RPM_Setpt** then Relay goes into de-energized Alarm state. • Hold-in INCRment button for 5 secs to turn-ON Relay to test again. *For Var11 options 0004 & 0005, if the Relay has been turned-ON by the test, if any of the 'critical' UserVars' are changed, then this automatically 'RESETs' the Relay Test and the 4-20 mA Output.	0000 to 0005	Fixed at XXXX.	0000

The FB420 has two modes of operation:

Normal Mode:

This mode indicates the target's speed via the 4-20 mA output signal. The LCD display shows the shaft speed in '% of MAX_ RPM', 'RPMs', or as a 'mA' value (04.00 to 20.00 mA). The relay energizes or de-energizes as per the RPM set-point value. 'Normal Mode' is indicated by the absence of the "VAR" icon in the lower left corner of the display.

Toggling the view in Normal Mode:

Press the SW2 Increment button to toggle the LCD between displaying the speed value in '%', 'RPM', or in 'mA'.

- When displaying '% of MAX_RPM' values the LCD shows the "OUT%" icon in the upper right corner.
- When displaying 'RPM' values the LCD does not show any special icons in the corners of the display.
- When displaying 'mA' values the LCD shows the "RATE" icon in the lower right corner.

Normal Mode's Speed_Trim_Down test feature:

While operating in Normal Mode and displaying a non-zero Speed (LCD showing speed in units of %, RPM, or mA), press and hold-in the DECPT button (SW1) for more than 2 seconds to activate the Speed_Trim_Down feature.

Continue to hold-in the DECPT button continuously to engage the test feature. The simulated speed will start to decrease, and the LCD will show the decreased speed accordingly (whether in %, RPM, or mA). Also, during the Speed_Trim_Down test the 4-20 mA output signal will decrease accordingly. During the Speed_Trim_Down test the speed can be trimmed-down all the way to 1% of the actual real-time running speed. However, once the simulated speed drops to below the Relay Setpoint RPM value, then the Relay will de-energize immediately (if it has been programmed for the Underspeed function).

If during the Speed_Trim_Down test, the DECPT Button is released (or any of the other 3 buttons are simultaneously pressed during the test), then the simulated speed holds its Trimmed value for 5 seconds, before returning to NO Trim.

Program Mode:

This mode allows the user to change the variables. The LCD display shows the present active variable or its value. 'Program Mode' is indicated by the presence of the "VAR" icon in the lower left corner of the display. Programming is accomplished by utilizing the four pushbuttons: the DECPT button (SW1), the Increment button (SW2), the Shift-Left button (SW3), and the Enter button (SW4). (See Fig. 5 for locations of SW1 thru SW4).

To enter the Program Mode:

- Press the Enter button (SW4). The "VAR" icon will display and the 4 digits will show "Pr01".
- Press the Increment button (SW2) repeatedly until you get to the variable you want to change.

  Note: There are 14 user variables, Pr01 through Pr14 (not all user variables are used).
- Press the Enter button (SW4) to access desired variable.
- While in that variable you must use the Increment button (SW2) to change the active digit (flashing digit). Then use the Shift-Left button (SW3) to move left to select the next digit, and so on.

  Note: The only variable where the actual DECPT position can be changed is in the Var03_MAX_RPM variable, and it is changed using the digit selection Shift-Left button (SW3) to select the decimal point position while inside Var03_MAX_RPM. Once the decimal point is flashing, then press the DECPT button (SW1) to set desired decimal point position.
- Press the Enter button (SW4) to save the variable's value and to step back to the "PrXX" variable selection level.
- When you are done with that variable you will see "PrXX, the 'XX' being the variable you just programmed.
- To step to the next variable use the Increment button (SW2). To exit the Program Mode, repeatedly press the Increment button (SW2) until the "VAR" icon disappears. OR, do a 'Quick-bailout' from the UserVar "PrXX" list by pressing the DECPT button (SW1). The FB420 is now back in the normal mode.
- When in Program Mode, if 1 minute's time passes with NO buttons being pressed, then the FB420 does an 'Auto-bailout' and automatically exits the Program Mode.

  If an 'Auto-bailout' happens while displaying a variable's value, then NO new changes are saved to that variable.
- When in Program Mode the 4-20 mA is locked at 12 mA (this was also in the old FB420 but was NOT mentioned).

Resetting the FB420's variables to Factory-Defaults:
Method 1, (aka, the "Power-up" Method):

- Remove the +24 VDC power.
- Press and hold the Shift-Left button (SW3).
- Apply the +24 VDC power.
- When the LCD shows "rESE", release the button.
- The user variables are then automatically reset to the Factory-Default values.

Method 2, (aka, the "On-The-Fly" Method):

- While maintaining the +24 VDC power.
- Press and hold the Shift-Left button (SW3) for 5 to 6 seconds
- When the LCD shows "rESE", release the button.
- The user variables are then automatically reset to the Factory-Default values.

The 4-20 mA Output "Open-Circuit" Alert (the Red LED):

If the 4-20 mA Output at TB1-2 is NOT connected to a proper load, or if connected to too-high of a resistance (significantly above 500 ohms), then a small Red LED on the PCB lights-up as a Warning.

'Program-Mode' or 'Test-Mode' Alert (flash the Blue and Red LEDs in unison):

When the FB420 is NOT in Normal Mode (but in Program Mode or a Var11 Test-Mode), then the 4-20 mA open-circuit Red LED will blink in unison with the Loss-of-Fdbk Blue LED, as an indication the FB420 is NOT fully monitoring and alarming for Real-Speed.

LCD Display Messages	• meanings, • affects, • how to clear them if necessary (troubleshooting)
Err0	**Programming Warning (Relay set to OFF):** • Var02_MIN_RPM is greater than 97.5% of Var03_MAX_RPM. • The output signal is 12 mA, and the relay is in the de-energized 'alarm' state until **Err0** is cleared. • Verify Var02_MIN_RPM and Var03_MAX_RPM, and modify if needed.
Err1	**Programming Warning (Relay set to OFF):** • The FB420's programmed MaxHz is above the maximum allowed 9999 Hz: (MaxHz > 9999). **MaxHz = Var01_PPR * Var03_MAX_RPM / 60.** • **Or an internal variable based on Var01, Var03 is too large**. • The output signal is 12 mA, and the relay is in the de-energized 'alarm' state until **Err1** is cleared. • Verify Var01_PPR and Var03_MAX_RPM, and modify if needed.
Err2	**Programming Warning (Relay set to OFF):** • The FB420's programmed MaxHz is below the minimum allowed 0.5 Hz: (MaxHz < 0.5). • The output signal is 12 mA, and the relay is in the de-energized 'alarm' state until **Err2** is cleared. • Verify Var01_PPR and Var03_MAX_RPM, and modify if needed.
Err3	**Operating Warning (Relay unaffected):** • The system is running at a speed above the FB420's absolute maximum rating of 9999 Hz (i.e., above 9999 Hz + a safety margin). • The output signal is 20 mA during an **Err3**. • Verify Var01_PPR and Var03_MAX_RPM, and modify if needed. • Or reduce speed or use target with less PPR.
Err4	**Operating Warning (Relay unaffected):** • The system is running at a speed well above (7x) the FB420's internal range as set by the MaxHz value. (Note: The FB420 automatically chooses the best range in which to operate, as per the MaxHz value. The ranges are: 0 to 9.999 Hz, 0 to 99.99 Hz, 0 to 999.9 Hz, or 0 to 9999 Hz). • The output signal is 20 mA during an **Err4**. • Verify Var01_PPR and Var03_MAX_RPM, and modify if needed. • Or reduce speed or use target with less PPR.
Err5	**Programming Warning (Relay set to OFF):** • The Relay Setpt is above a speed of 10,000 Hz. • Or, the Relay Setpt is too large resulting in an internal variable overflow. • The output signal is 12 mA, and the relay is in the de-energized 'alarm' state until **Err5** is cleared. • Verify Var05_Relay_Setpt and modify if needed.
St0P	**Operating Warning (Relay unaffected):** • The monitored shaft is stopped. • Or, the FB420 is gapped too far from the Disc or the Wrap. • Or, the Disc or Wrap is damaged. • Or, the FB420 is damaged. • The output signal is 4 mA during this message.
Flashing "20.00" w/ RATE icon	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in 'mA', but the speed is above the Var03_MAX_RPM. • The output signal is 20 mA during this warning.
Flashing "04.00" w/ RATE icon	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in 'mA', but the speed is below the Var02_MIN_RPM. • The output signal is 4 mA during this warning.
Flashing "xxx.x" w/ OUT% icon	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in xxx.x '%', but the speed is above the Var03_MAX_RPM speed (i.e., this means the speed is more than 100.0%). • The output signal is 20 mA during this warning.
Flashing "000.0" w/ OUT% icon	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in xxx.x '%', but the speed is below the Var02_MIN_RPM speed (i.e., this means the speed is less than 000.0%). • The output signal is 4 mA during this warning.
Flashing XXXX (no icon)	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in 'XXXX' 'RPM', but the speed is above the Var03_MAX_RPM speed. • The output signal is 20 mA during this warning.
Flashing "0000" (no icon)	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in 'RPM', but the speed is below the Var02_MIN_RPM speed. • The output signal is 4 mA during this warning.
Flashing "9999" (no icon)	**Operating Warning (Relay unaffected):** • The FB420 is displaying the speed in 'RPM', but the speed is above the LCD's '9999' capability. • The output signal is 20 mA during this warning.

FB420 General Specifications:

Input Power	Input Current	Fuse Type
REQUIRES USER INSTALLED +24 VDC ±10% Power Supply	Max of 55mA, (this with Max_Hz input, and 20mA Output Signal, and Relay Energized).	**REQUIRES USER INSTALLED** External Slo-Blo Fuse, (any value from 0.1A to 4A).
Input Signal	**Parameters**	
Sensor Targets	Alternating Magnets: (ex: 16 Magnets = 8 PPR)	
Range of Operation	Overall = 0.1 to 9999 Hz. (With 8 PPR = 0.75 to 9999 RPM*. *Note: LCD can only display up to 9999).	
Gap distance	1/4 inch +/- 1/8 inch.	

FB420 General Specifications (continued on next page):

FB420 General Specifications (cont):

Analog Output Signal	Parameters
Type	4-20 mA, with programmable end-points: (4 mA @ user's Min RPM) (20 mA @ user's Max RPM)
4-20 mA Accuracy	±0.3% FSR
4-20 mA Resolution	Depends on calibration, but can be a best of 0.001 mA per increment.
Required impedance	4-20 mA output needs a 250 to 500 Ω load
Max signal distance	Using a 3-conductor cable with 17.5 Ω /1000 ft. per conductor, the maximum length of cable usable with the FB420 is: • 3800 ft. when not using the Relay • 2300 ft. when using the Relay

Relay Output Data	Parameters
Number Available	1 SPDT Form C
Relay Contact Rating	5 Amp @ 30 Vdc 5 Amp @ 250 Vac
Relay Functions	The 'alarm' state is relay de-energized: • Unused, • Over-speed, • Under-speed,

Physical/Environment	Parameters
c UL us LISTED Class I, Div 1, Group C, D Class II Groups E, F, G UL File: E249019 CE	
Additional Rating	NEMA 4X, Gasket Provided
Operating Temp	-40ºC to +65ºC (-40ºF to +149ºF)
Storage Temperature	-40ºC to +80ºC (-40ºF to +176ºF)
Humidity	0% to 90% non-condensing

Definitions:

Pulse Per Rev (Var01)

The Pulse Per Rev value, or PPR, is the number of pulses generated per revolution of the magnetic target mounted on the rotating shaft.
Note: See LCD messages "**Err1**" through "**Err4**" regarding Var01.

MIN RPM value (Var02)

The MIN_RPM value sets the speed corresponding to an output of 4 mA. The MIN_RPM value can be anywhere from 0000 RPM** up to 097.5% of Var03 MAX_RPM, with the decimal point locked in the same position as Var03.
**Note: If Var02 = 0000 RPM, then the corresponding 4 mA speed is either 0.1 Hz or 0.5 Hz, as per the 'MaxHz' value.
Note: See LCD message "**Err0**" regarding Var02.

MAX RPM value (Var03)

The MAX_RPM value sets the speed corresponding to 20 mA output.
Note: See LCD messages "**Err0**" through "**Err4**" regarding Var03.

Relay Function Selection (Var04)

The Relay Function Select value determines how the relay responds.
The choices are:

- Unused (0000),
- Over-speed (0001),
- Under-speed (0002).

Relay RPM Set-point value (Var05)

The Relay RPM Set-point value programs the trip point for the relay. The relay drops when the RPM set-point value is passed (i.e., goes into the de-energized 'alarm' state, with the Relay Green LED = OFF).
See LCD message "**Err5**" regarding Var05.

Note: There is a 6.25% hysterisis for pulling-in the relay (i.e., returning to the energized 'non-alarm' state, with the Relay Green LED = ON).

- For under-speed operation it means the shaft speed must be 6.25% faster than the set-point to pull-in (i.e. re-energize relay).
- For over-speed it means the shaft speed must be 6.25% slower than the set-point to pull-in (i.e. re-energize relay).
  Note: See Figure 5 showing the location of the Relay Green LED.

Relay Set Point Delay (Var06)

The Relay Set Point Delay determines how many seconds an 'alarm' event condition must exist before de-energizing the Relay.

- At least a '0001' second delay recommended if using the Relay.

Software Identification (Var10)

During power-up the LCD first shows the software ID in the "X.X.X.X." format, where the first two digits are the version number, and the last two digits are the revision number. This information is also found in Var10.

Test-Modes (Var11)

Various Test-Modes are found in Var11. (See UserVar list on page 3).

Hour Meter (Var14)

The Hour Meter increments once per Hour for Speed above "**Cut-off**" (and when NOT in Program Mode).
Hour Meter counts-up from value entered in Var14, and caps at "9999".
Clear Hour Meter manually by entering "0000" into Var14.
Hour Meter also clears to "0000" via a Factory-Default RESET.

One Rev Averaging Select (Var15)

The One Rev Averaging Select value is used to Enable or Disable the one revolution averaging function used in the FB420 to average out variations in machine rotation or magnet target spacing. This averaging creates a smoother 4-20 mA output and Relay operation.

Most applications use Var15 = 0001 which enables the one revolution averaging function.
Very slow speed applications that have a maximum feedback frequency near 0.5 Hz will have faster response times by setting Var15 = 0000, which turns off the One Rev Averaging function and updates the 4-20 mA output and Relay operation on a pulse-by-pulse basis. This provides the fastest response time to changes in machine speed.

Since there is no speed averaging when Var15 = 0000, the 4-20 mA output will change at each input pulse in very slow speed applications. Based on machine rotation or magnet targets, this change could be ± 5% on each pulse. Setpoints for the Relay operation or 4-20 mA output should be at least 15% different from the normal operating speed to avoid jitter in control system operation.

The following formula is used to convert "RPM" into "Hz":

Hz = (RPM * PPR) / 60.

From this formula we see that for very low RPM applications a higher PPR target needs to be used to get the Pulse-Train-Signal to a fast enough value (i.e., to at least 0.5 Hz) to be workable with the FB420.

Example: Machine shaft rotating at 0.5 RPM max speed (which is the same as 1 Rev in 120 seconds) with an FB420 sensing a 60 pulse/rev magnet wrap on it. (Note: In this example the 60 PPR wrap is needed to achieve at least 0.5 Hz when at 0.5 RPM).

- Setting Var15 = 0000 Disables the One Rev Averaging, so the 4-20 mA output and Relay operation is updated every pulse of the wrap.
  - In this example there are 60 pulses in 1 rev, and at 0.5 RPM this is 30 pulses in 1 minute, which is 1 pulse in 2 seconds, so the response time is theoretically 2 seconds (i.e., need 2 seconds to detect the 1-pulse during a speed change).
  - Hence in this example, if the speed changes while running near 0.5 RPM, it takes about 2 seconds before a new speed is indicated on the LCD, in the 4-20 mA Output Signal, and in the Relay response if the Var05_Set-point_RPM and Var06_Set-point_Delay requirements have been met.

- Setting Var15 = 0001 Enables the One Rev Averaging, so the 4-20 mA output and Relay operation is updated every revolution of the shaft:
  - In this example there are 60 pulses in 1 rev, and at 0.5 RPM this is 30 pulses in 1 minute, which is 60 pulses in 2 minutes, so the response time is theoretically 2 minutes (i.e., need 2 minutes to detect the 1-full-rev of 60 pulses during a speed change).
  - However, depending on exactly when that last full-rev of pulses comes-in, determines if the FB420 takes a 1-step change to the new speed value, or takes a multi-step change. Here is why it varies:
    - Assume the FB420 was at internal pulse count # 45 (out of 60 pulses per rev in this example) when the motor-speed changes.
    - **If the motor-speed changes within 12.5% of its previous speed** (either up or down), the FB420 sees this as a minor change, and does not respond until internal pulse count # 60 (a full-rev) is reached.
    - At that point the FB420 calculates the One-Rev speed using "60 pulses / the time-span for those 60 pulses", and a speed change is indicated, but it may not be the final actual speed.
    - At this point the internal pulse count is reset to #0, and another revolution of pulses begins counting from # 0 to # 60.
    - The next time the FB420 indicates a new speed is when the internal pulse count reaches 60 again. In this example at 60 PPR and about 0.5 RPM, this takes about another 2 minutes.
    - Hence in this example, the entire process to track and calculate the final speed may take 2 to 4 minutes (i.e., 1 to 2 full-revs of pulses) before stabilizing in the LCD, in the 4-20 mA Output Signal, and in the Relay response if the Var05_Set-point_RPM and Var06_Set-point_Delay requirements have been met.
    - **The user most likely will find this very slow response unacceptable. This slow response is why UserVar15 exists to allow the user the option to Disable the One Rev Averaging.**
    - However, **if the motor-speed changes beyond 12.5% of its previous speed** (either up or down), then the FB420 overrides the One Rev Averaging algorithm and responds after it detects the 1-pulse speed change (in this example it responds in about 2 seconds).

Note: When Var15 is set to turn off the One Rev Averaging function, the user sees any pulse-to-pulse fluctuations in the LCD display, the 4-20 mA output, and the Relay operation due to variation in the machine rotation and magnet target spacing.

Note: Custom-made Pulser Wraps can be made for different PPR needs. However, the more common Pulser Wraps have 8 PPR (16 magnets), 16 PPR (32 magnets), or 32 PPR (64 magnets).

Here are some examples of how slow the user's application can be when used with each of these common PPR Pulser Wraps AND still meet the requirement of getting a signal of at least 0.5 Hz at the fastest speed and at least 0.1 Hz signal at the slowest speed. Plugging the PPR value and the 0.5 Hz and 0.1 Hz values into the formula stated above, we get the following:

With an 8 PPR (16 magnet) Pulser Wrap, the application must have:
- a maximum speed no less than 3.75 RPM,
- a minimum speed no less than 0.75 RPM, not counting 'Stop".

With a 16 PPR (32 magnet) Pulser Wrap, the application must have:
- a maximum speed no less than 1.875 RPM,
- a minimum speed no less than 0.375 RPM, not counting 'Stop".

With a 32 PPR (64 magnet) Pulser Wrap, the application must have:
- a maximum speed no less than 0.938 RPM,
- a minimum speed no less than 0.188 RPM, not counting 'Stop".

Resolution (of the 4-20 mA signal, description / effects of the Cut-Off levels, and LCD's RPM value)

The 4-20 mA signal: For best resolution of the 4-20 mA output, the FB420 automatically selects from one of four internal operating ranges as per the programmed 'MaxHz' value.

The internal operating ranges and the corresponding Cut-off levels are:
- If 'MaxHz' is between 0.5 Hz and 9.999 Hz, then the internal operating range = **0.1 Hz** to **9.999 Hz**, and where **Cut-off** to "STOP" happens when speed drops below **0.1** Hz.
- If 'MaxHz' is between 0.5 Hz and 99.99 Hz, then the internal operating range = **0.1 Hz** to **99.99 Hz**, and where **Cut-off** to "STOP" happens when speed drops below **0.1** Hz.
- If 'MaxHz' is between 0.5 Hz and 999.9 Hz, then the internal operating range = **0.5 Hz** to **999.9 Hz**, and where **Cut-off** to "STOP" happens when speed drops below **0.5** Hz.
- If 'MaxHz' is between 0.5 Hz and 9999. Hz, then the internal operating range = **0.5 Hz** to **9999. Hz**, and where **Cut-off** to "STOP" happens when speed drops below **0.5** Hz.

This allows the FB420 to use the smallest frequency range to cover the application, thus improving resolution. Then depending on the programmed MIN_RPM and MAX_RPM values, the resulting 4-20 mA resolution can be as tight as 0.001 mA per increment.

The LCD's RPM value: The Var03_MAX_RPM's decimal point position affects the resolution of the LCD displayed RPM value. For best resolution of the displayed RPM value, program Var03 with the greatest number of decimal places possible (**XXXX.** to **X.XXX**). Note: Var03 Decimal pt position has no effect on the 4-20 mA resolution.

Loss of Feedback Alert (the Blue LED):

If feedback pulses are lost when running, the FB420 waits an amount of time equal to "twice the time-span between the last 2 received pulses" before it begins to cascade the 4-20 mA output down towards 4 mA, and the LCD down towards "St0P". During this time the Loss-of-Fdbk Blue LED turns-ON.

Note: Specifications subject to change without notice.