FB420-PTO Ver 2.0 Shaft Speed Sensor
(w/ Special 8x-16x-32x Speed, Pulse-Train Output)

Description:

Electro-Sensor's FB420-PTO (Pulse-Train-Output) is a shaft speed sensor that provides a Pulse-Train-Output signal directly proportional to the rotational speed of a monitored shaft.
The FB420-PTO has a 4-digit LCD display that is used for calibration and for trouble-shooting. The LCD can display:

- '% of MAX_INPUT_RPM' from '000.0' to '999.9.' %,
- or 'Input-RPM' from '0.000' to '1000.' ("Err8" beyond 1,000 RPM),
- or the simulated 'Output-RPM' from 0.000' to '9999.'

This FB420-PTO does NOT have the standard FB420's Relay Output nor the 4-20 mA Output, but instead has a Pulse-Train-Output circuit available at terminal block TB2-2.
This Pulse-Train-Output can be programmed to run at 8-times, 16-times, or 32-times, the rotating target's input speed frequency. Thus, for example, if programmed for an **8 PPR** rotating target, and for an 8x-Output, then the Pulse-Train-Output simulates a 64 PPR target.
This Pulse-Train-Output circuit at TB2-2 is pulled-up to the same external Voltage supplied to TB1-1 with the supply-return at TB1-3. This external supply can be anywhere from +12Vdc to +15 Vdc. The end-user's monitoring device may have its own Pullup resistor on its input port, but the FB420-PTO also has a 4.7 KΩ resistor to 'Pullup' the Pulse-Train-Output to the same voltage as supplied at TB1-1 when the FB420-PTO's internal NPN transistor output turns OFF.

FB420-PTO 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).

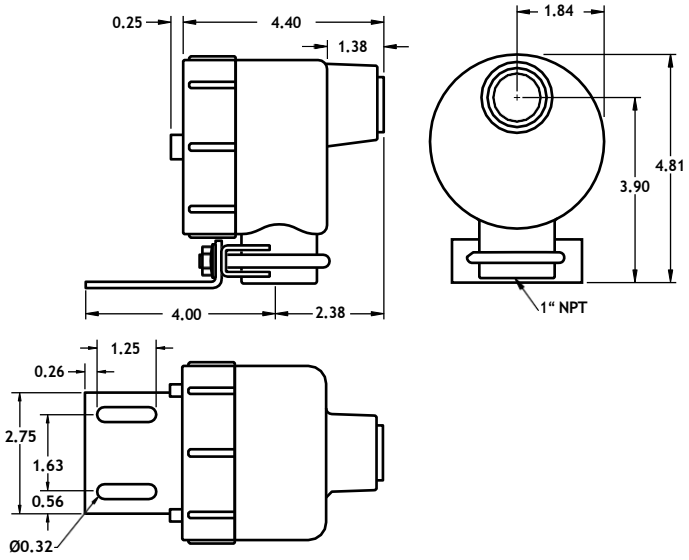

Figure 1: FB420 Dimensions w/Bracket and U-Clamp

Figure 2: FB420-PTO Front-View

Electrical connections

This FB420-PTO's electrical connections are as follows:

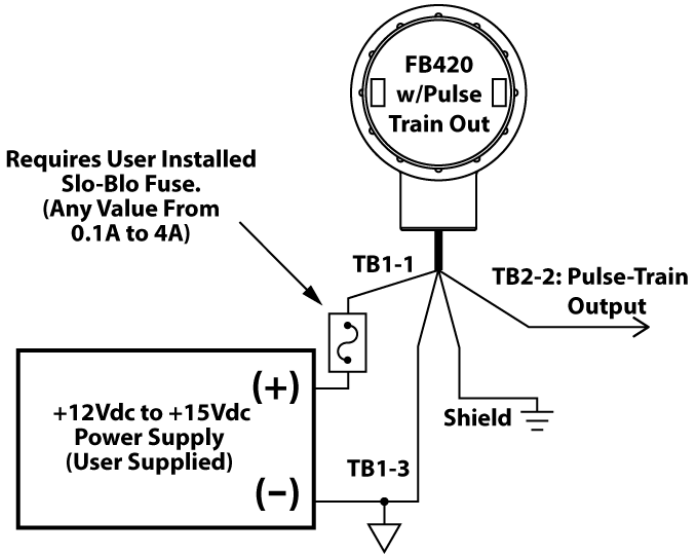

Figure 3:

- Connect the shield wire to the earth ground (if used).

- Connect TB1-1 to the user supplied +12 to +15 Vdc terminal.
- NO-Connection at TB1-2 (not used in the FB420-PTO).
- Connect TB1-3 to the user supplied (-) terminal.

- NO-Connection at TB2-1 (not used in the FB420-PTO).
- Connect TB**2**-2 (the Pulse-Train-Output) to the user's Signal Input terminal. The Pulse-Train-Output at TB**2**-2, is with respect to the DC ground at TB**1**-3.
- NO-Connection at TB2-3 (not used in the FB420-PTO).

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990-003402 Revision C

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.

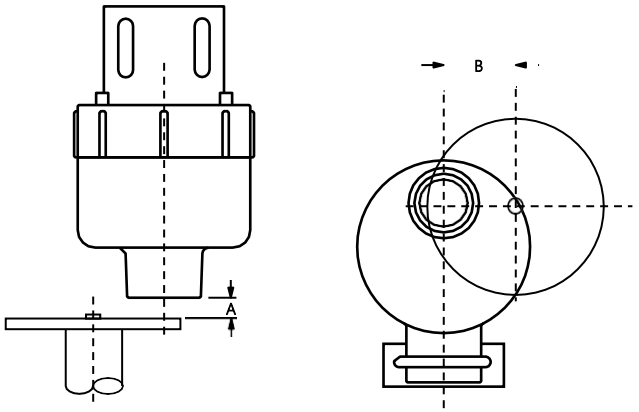

Figure 4a: FB420-PTO with 255 Pulser Disc

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

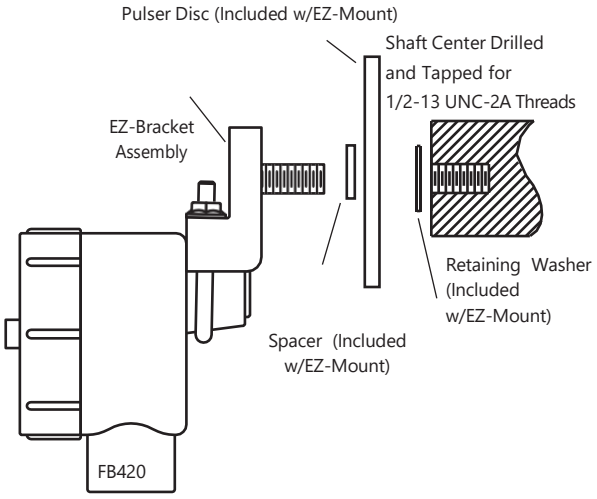

Figure 4b: FB420-PTO with EZ-Mount Bracket

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.

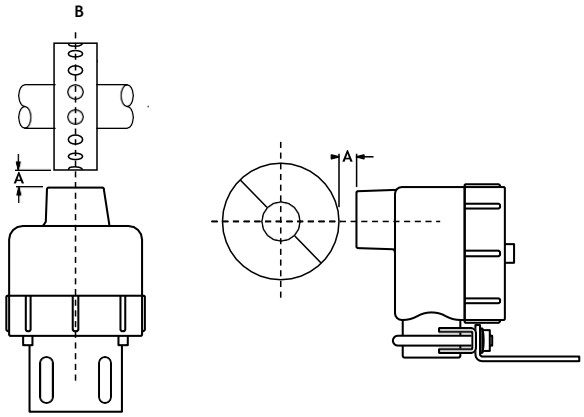

Figure 4c: FB420-PTO with Pulser Wrap

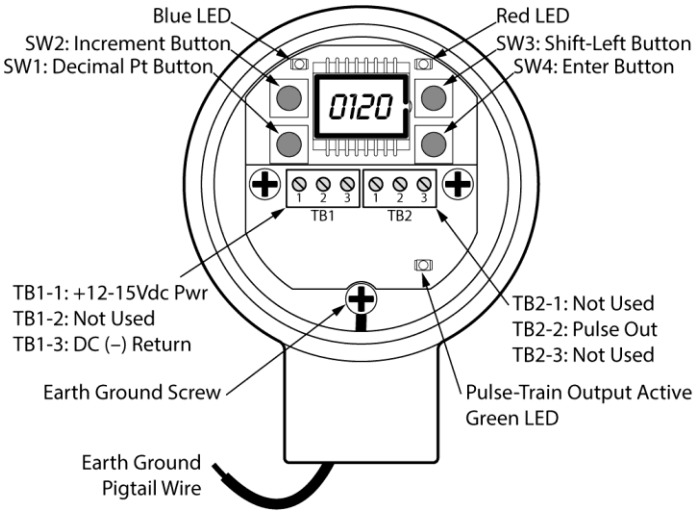

Figure 5: FB420-PTO Rear-View (Cover Removed). Showing the Power Terminal TB1, the Pulse-Train Output Terminal TB2, the push-buttons SW1, SW2, SW3, SW4, the Green LED for 'Pulse-Train-Output Active', the Blue LED for 'Loss-of-Fdbk', the Red LED, the Earth Ground Screw, and the Earth Ground Green Pigtail Wire.

Pin #	TB1 Function	TB2 Function
1	+12 to +15 VDC Power In	Not used.
2	Not used.	Pulse-Train Output. Note: Output can sink 25 mA.
3	DC (-) Return	Not used.

List of Variables

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_INPUT_RPM.	Slowest programmed Input-RPM value (usually 0 RPM).	0000 to "97.5% of Var03".	decpt tied to Var03	0000	
03	MAX_INPUT_RPM	Fastest programmed Input-RPM value.	0.000 to 9999.	User selectable.	0200	
04	Pulse-Train-Output Select.	8x speed = 0001, 16x speed= 0002, 32x speed = 0003.	0001. to 0003.	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.	0.7.0.1.	
11	Test Mode Select. (When in the Var11 test-mode, the LCD shows special icons of "VAR", "OUT%", and "RATE", in the LCD corners).	Description Run in Normal Mode or Test Mode: 0000 = Run in Normal Mode. 0001 = LCD Test mode: • Cycle LCD with digits "0.0.0.0." thru "9.9.9.9.". • The Pulse-Train-Output is disabled during this Test Mode.	0000. to 0001.	Fixed at XXXX.	0000	
---	---	---	---	---	---	---
14	Hour Meter.	Counts-up for Speed above **Cut-off.**	0000 to 9999	Fixed at XXXX.	0000	
Note:	Vars 05, 06, 07, 08, 09, 12, and 13 are Reserved.		---	---	0000	---

Continued, on next page

The FB420-PTO has two modes of operation:

Normal Mode:

This mode indicates the target's speed. The LCD display shows the shaft speed in '% of MAX_INPUT_RPM', 'Input-RPM', or 'Output-RPM' 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 '%', 'Input-RPM', or 'Output-RPM'.

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

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_INPUT_RPM variable, and it is changed using the digit selection Shift-Left button (SW3) to select the decimal point position while inside Var03_MAX_INPUT_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-PTO is now back in Normal Mode.
- When in Program Mode, if 1 minute's time passes with NO buttons being pressed, then the FB420-PTO 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.
- In Program Mode the Pulse-Train-Output remains 'live'.

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

- Remove the +12 to +15 VDC power.
- Press and hold the Shift-Left button (SW3).
- Apply the +12 to +15 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 +12 to +15 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.

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

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

LCD Display Messages	• meanings, • affects, • how to clear them if necessary (troubleshooting)
Err0	**Programming Warning (Pulse-Output is OFF):** • Var02_MIN_INPUT_RPM is greater than '97.5% of Var03_MAX_INPUT_RPM'. • The **Pulse-Train-Output** signal is locked 'HI', until **Err0** is cleared. • Verify Var02_MIN_INPUT_RPM and Var03_MAX_INPUT_RPM and modify if needed.
Err1	**Programming Warning (Pulse-Output is 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 **Pulse-Train-Output** signal is locked 'HI', until **Err1** is cleared. • Verify Var01_PPR and Var03_MAX_INPUT_RPM and modify if needed.
Err2	**Programming Warning (Pulse-Output is OFF):** • The FB420's programmed MaxHz is below the minimum allowed 0.5 Hz: (MaxHz < 0.5). • The **Pulse-Train-Output** signal is locked 'HI', until **Err2** is cleared. • Verify Var01_PPR and Var03_MAX_INPUT_RPM and modify if needed.
Err3	**Operating Warning (Pulse-Output is OFF):** • Assuming an "Err8" event has not happened first. • 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 **Pulse-Train-Output** signal is locked 'HI' during an **Err3**. • Verify Var01_PPR and Var03_MAX_INPUT_RPM and modify if needed. • Or reduce speed or use target with less PPR.
Err4	**Operating Warning (Pulse-Output is OFF):** • Assuming an "Err8" event has not happened first. • 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 **Pulse-Train-Output** signal is locked 'HI' during an **Err4**. • Verify Var01_PPR and Var03_MAX_INPUT_RPM and modify if needed. • Or reduce speed or use target with less PPR.
Err7	**Operating Warning (Pulse-Output is OFF):** • Input Speed is too SLOW for the Pulse-Train-Output feature, this is at about 1 Hz input speed. • The **Pulse-Train-Output** signal is locked 'HI', until **Err7** is cleared.
Err8	**Operating Warning (Pulse-Output is OFF):** • Input Speed is too FAST for the Pulse-Train-Output feature (i.e., Input-RPM is above 1,000). • The **Pulse-Train-Output** signal is locked 'HI', until **Err8** is cleared. • Note: Depending on the **Var01 PPR** value and the **Var04 Pulse-Train-Output Select** value, a 1000 RPM Input may, or may not, be achievable. (See table **in Specification** section).
St0P	**Operating Warning (Pulse-Output is OFF):** • 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 **Pulse-Train-Output** signal is locked 'HI' during this message.

Flashing XXXX w/ RATE icon	**Operating Warning (Pulse-Output is unaffected):**
	• The FB420 is displaying the Output speed in 'RPM', but the Input speed is either:
	  • above the Var03_MAX_INPUT_RPM,
	  • or then below the Var02_MIN_INPUT_RPM.
	• The **Pulse-Train-Output** signal is 'Live' during this warning.

Flashing "xxx.x" w/ OUT% icon	**Operating Warning (Pulse-Output is unaffected):** • The FB420 is displaying the Input speed in xxx.x '%', but speed is above the Var03_MAX_INPUT_RPM (i.e., this means the speed is more than 100.0%). • The **Pulse-Train-Output** signal is 'Live' during this warning.
Flashing "000.0" w/ OUT% icon	**Operating Warning (Pulse-Output is unaffected):** • The FB420 is displaying the Input speed in xxx.x '%', but speed is below the Var02_MIN_INPUT_RPM (i.e., this means the speed is less than 000.0%). • The **Pulse-Train-Output** signal is 'Live' during this warning.
Flashing XXXX (no icon)	**Operating Warning (Pulse-Output is unaffected):** • The FB420 is displaying the Input speed in 'XXXX' 'RPM', but the speed is above the Var03_MAX_INPUT_RPM speed. • The **Pulse-Train-Output** signal is 'Live' during this warning.
Flashing "0000" (no icon)	**Operating Warning (Pulse-Output is unaffected):** • The FB420 is displaying the Input speed in 'RPM', but the speed is below the Var02_MIN_INPUT_RPM speed. • The **Pulse-Train-Output** signal is 'Live' during this warning.
Flashing "9999" (no icon)	**Operating Warning (Pulse-Output is unaffected):** • Assuming an "Err8" event has not happened first. • The FB420 is displaying the Input speed in 'RPM', but the speed is above the LCD's '9999' capability. • The **Pulse-Train-Output** signal is 'Live' during this warning.

FB420-PTO General Specifications:

Input Power	Input Current	Fuse Type
REQUIRES USER Supplied +12 to +15 VDC Power Supply.	Max of 55mA.	**REQUIRES USER INSTALLED** External Slo-Blo Fuse, (any value 0.1A to 4A).

Input Signal	Parameters
Sensor Targets	Alternating Magnets: (ex: 16 Magnets = 8 PPR)
Range of Operation: (examples of maximum shaft Input speeds usable, per **Var01 PPR** value and **Var04 Pulse-Train-Output Select** value).	**8 PPR:** all three output speeds (8x, 16x, 32x) are usable up to 1000 RPM input speed. **16 PPR**: all three output speeds are usable up to 700 RPM input speed. **32 PPR**: all three output speeds are usable up to 350 RPM input speed. **Note**: Shaft Input RPM's exceeding these limits will disable the FB420 device. Remove the +Vdc power, then re-apply the +Vdc power to re-enable the FB420-PTO.
Gap distance	1/4 inch +/- 1/8 inch.

Pulse-Train-Output Signal	Parameters
Type	**NON-Electrically Isolated Pulse-Train-Output circuit at Terminal Block TB2-2.** Note: Internal to the FB420-PTO, the Pulse-Train-Output has a 4.7k-ohm resistor to 'pull-up' the signal to the same voltage as present at TB1-1, when the FB420-PTO's internal NPN transistor output turns OFF. Hence, the **TB2-2 Pulse-Train-Output** signal is with respect to the DC ground terminal at **TB1-3.**
TB2-1	No connection.
TB2-2	Pulse-Train-Output. (NPN transistor). Note: This output can sink 25 mA.
TB2-3	No connection.
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-PTO is 2300 ft.

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_INPUT_RPM value (Var02)

The MIN_INPUT_RPM value sets the slowest programmed RPM value. The MIN_INPUT_RPM value can be anywhere from 0000 RPM** up to 097.5% of Var03 MAX_INPUT_RPM, with the decimal point locked in the same position as Var03.
**Note: If Var02 = 0000 RPM, then the corresponding cut-off speed is either 0.1 Hz or 0.5 Hz, as per the 'MaxHz' value.
Note: See LCD message "**Err0**" regarding Var02.

MAX_INPUT_RPM value (Var03)

The MAX_INPUT_RPM value sets the Fastest programmed RPM value.
Note: See LCD messages "**Err0**" through "**Err4**" regarding Var03.

Pulse-Train-Output Selection (Var04)

This selection sets the Pulse-Train-Output as an 8x, or 16x, or a 32x, speed output. The choices are:

- A "0001" = an 8x-Pulse-Train-Output. (1 pulse in: 8 pulses out).
- A "0002" = a 16x-Pulse-Train-Output. (1 pulse in: 16 pulses out).
- A "0003" = a 32x-Pulse-Train-Output. (1 pulse in: 32 pulses out).

(Var05, Var06, Var07, Var08, Var09, Var12, Var13)

Not applicable.

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)

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.

Resolution of the LCD's RPM value: For best resolution, the FB420-PTO automatically selects from one of four internal operating ranges as per the programmed 'MaxHz' value. The ranges are:

- If 'MaxHz' is between 0.5 Hz and 9.999 Hz, then the internal operating range = 0.1 Hz to 9.999 Hz. **Cut-off** to "STOP" < 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. **Cut-off** to "STOP" < 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. **Cut-off** to "STOP" < 0.5 Hz.
- If 'MaxHz' is between 0.5 Hz and 9999. Hz, then the internal operating range = 0.5 Hz to 9999. Hz. **Cut-off** to "STOP" < 0.5 Hz.

This allows the FB420-PTO to use the smallest frequency range to cover the application, thus improving resolution.

The LCD's RPM value: The Var03_MAX_INPUT_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**).

Loss of Feedback Alert (the Blue LED):

If feedback pulses are lost when running, the FB420-PTO waits an amount of time equal to "(1/real-time-frequency) + another 12.5% of that" before it locks the **Pulse-Train-Output** 'LO' and ramps the LCD down towards "St0P". During this time the Loss-of-Fdbk Blue LED turns-ON.
Once "St0P" appears on the LCD, then the **Pulse-Train-Output** is locked 'HI' for the normal "St0P" case.

Note: Specifications subject to change without notice.