AI-TEK Tachometers

Principles of Operation

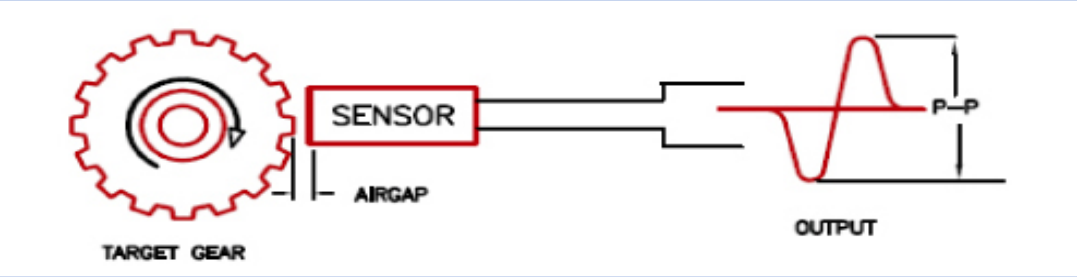
AI-TEK Instruments, LLC • 152 Knotter Drive, P.O. Box 748 • Cheshire, CT USA 06410
Tel: 203-271-6000 • Fax: 203-271-6200
www.aitekinstruments.com

AI-TEK Sensor Training

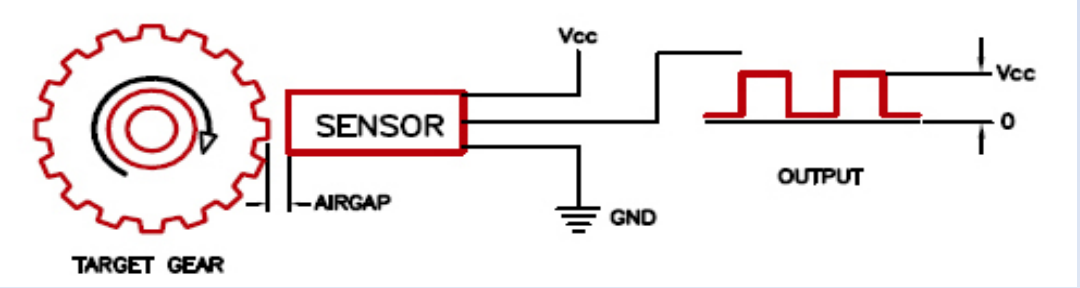
- Speed sensors bridge the gap between the mechanical and electrical world. They produce a frequency proportional to the speed of the target.

- AI-Tek offers ***two*** basic sensor technologies that can be used in a large variety of applications.

  - Variable Reluctance (Passive)



  - Hall Effect (Active)



Tachometry Products

Tachometers are highly configurable instruments that provide measuring, monitoring and control to critical equipment by directly "reading" speed sensor signals, and converting those signals into units and functions that are relevant to the user.

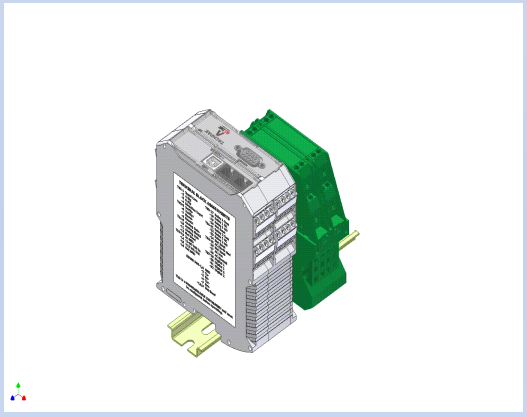
TACHTROL 10 and 30

Panel mounted tachometer

- LCD Display
- AC/DC Power
- 2 Mechanical Relays
- USB
- Infrared Remote Compatible
- Remote Display Compatible
- *Utility RS485 (TACHTROL 30)*
- *Analog Output (TACHTROL 30)*
- *2 Solid State relays (TACHTROL 30)*

- Programmed by either front panel or via computer using TACHLINK software

TACHPAK 10 and 30



DIN rail mounted tachometer

- AC/DC Power
- 2 Mechanical Relays
- USB
- Remote Display Compatible
- *Utility RS485 (TACHPAK 30)*
- *Analog Output (TACHPAK 30)*
- *2 Solid State relays (TACHPAK 30)*

- Programmed by computer using TACHLINK software or in combination with TACHTROL PLUS.

TACHTROL PLUS

Panel mounted digital meter

- Multiplex up to 8 displays with TACHTROL/TACHPAK tachometers
- Powered by tachometer instrument through RJ11 connection
- Infrared remote compatible
- Use as hub for additional remote displays
- Use as pendant for programming TACHPAK 10 & 30

TACHPAK &TACHTROL Features

Features

- **Programable** - Every tachometer is shipped with ***"Tachlink"*** software.

- **2 Sensor Inputs** - Both ***Tachpak*** and ***Tachtrol*** models can take (2) sensor inputs.

- **Mathematic Function** - Both ***Tachpak*** and ***Tachtrol*** models have a selectable list of equations that will allow the tachometer to use the (2) inputs and display a result. (i.e. compare two sensor inputs for mixing materials).

- **Both AC & DC Voltage input** – Every Tachpak and Tachtrol is capable of 80-264VAC and 12-30VDC

- **Analog Output** - Both the ***Tachpak*** and ***Tachtrol 30*** has selectable analog output, 0-20, 4-20 or -20-20mA

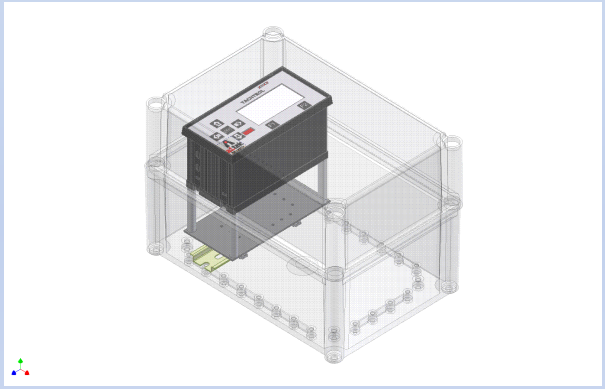
- **Relays**
  - Both ***Tachpak*** and ***Tachtrol*** models have (2) programable Mechanical relays (10A@125/250VAC)
  - Both ***Tachpak*** and ***Tachtrol 30 (only)*** have both (2) Mechanical and (2) digital relays (400ma@ 60VAC/VDC)

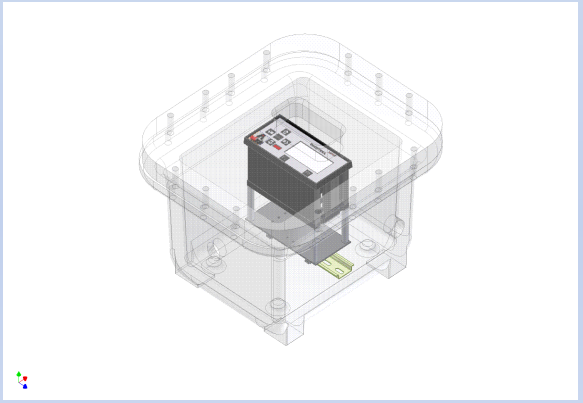
- **Plotting -** Included is the option to plot an output (i.e. sensor A or B or equation). This feature is only available when using the Tachlink software and a computer.

TACHPAK & TACHTROL®

Enclosure Mounting Options Tachtrol & Tachtrol Plus

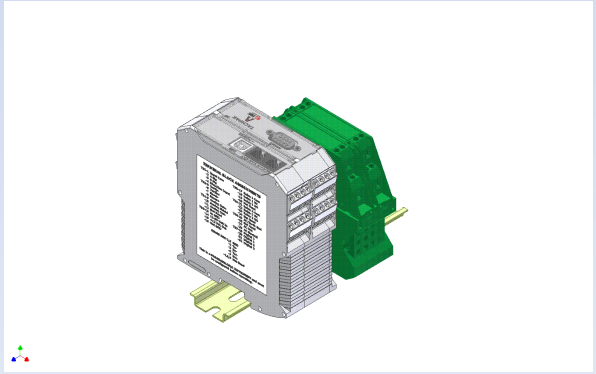
PANEL MOUNT	NEMA 4X	UL/ATEX X-PROOF

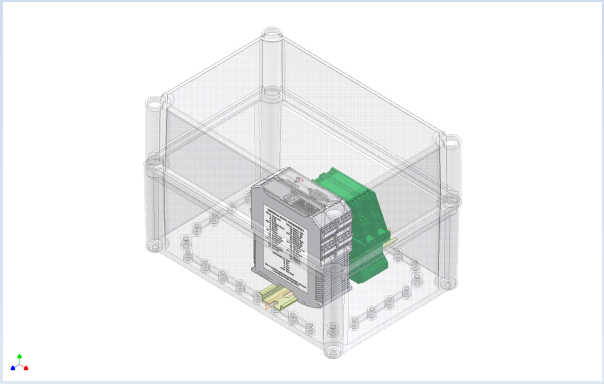


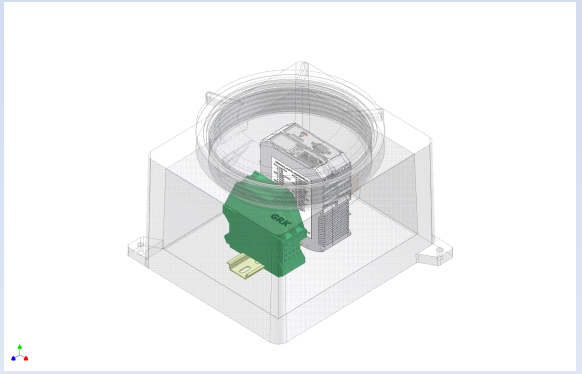


Enclosure Mounting Options Tachpak

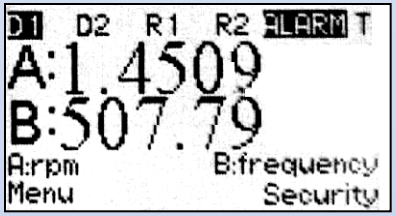
DIN Rail Mount	NEMA 4X	UL/ATEX X-PROOF

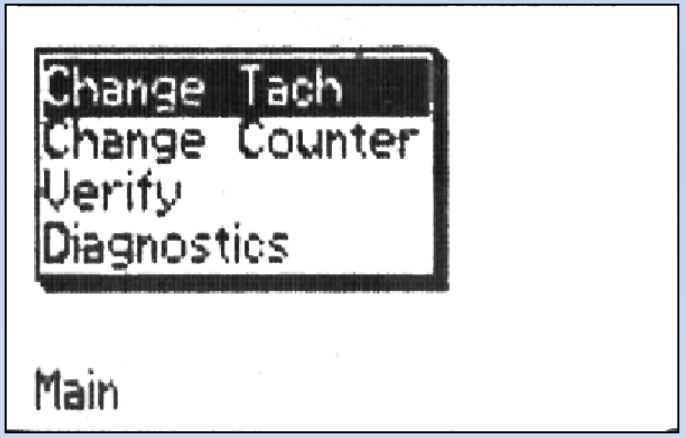


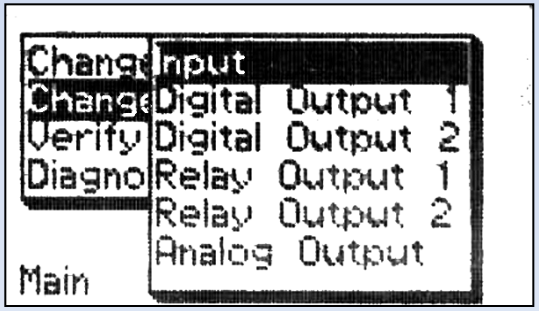




TACHTROL® Front Panel Programming







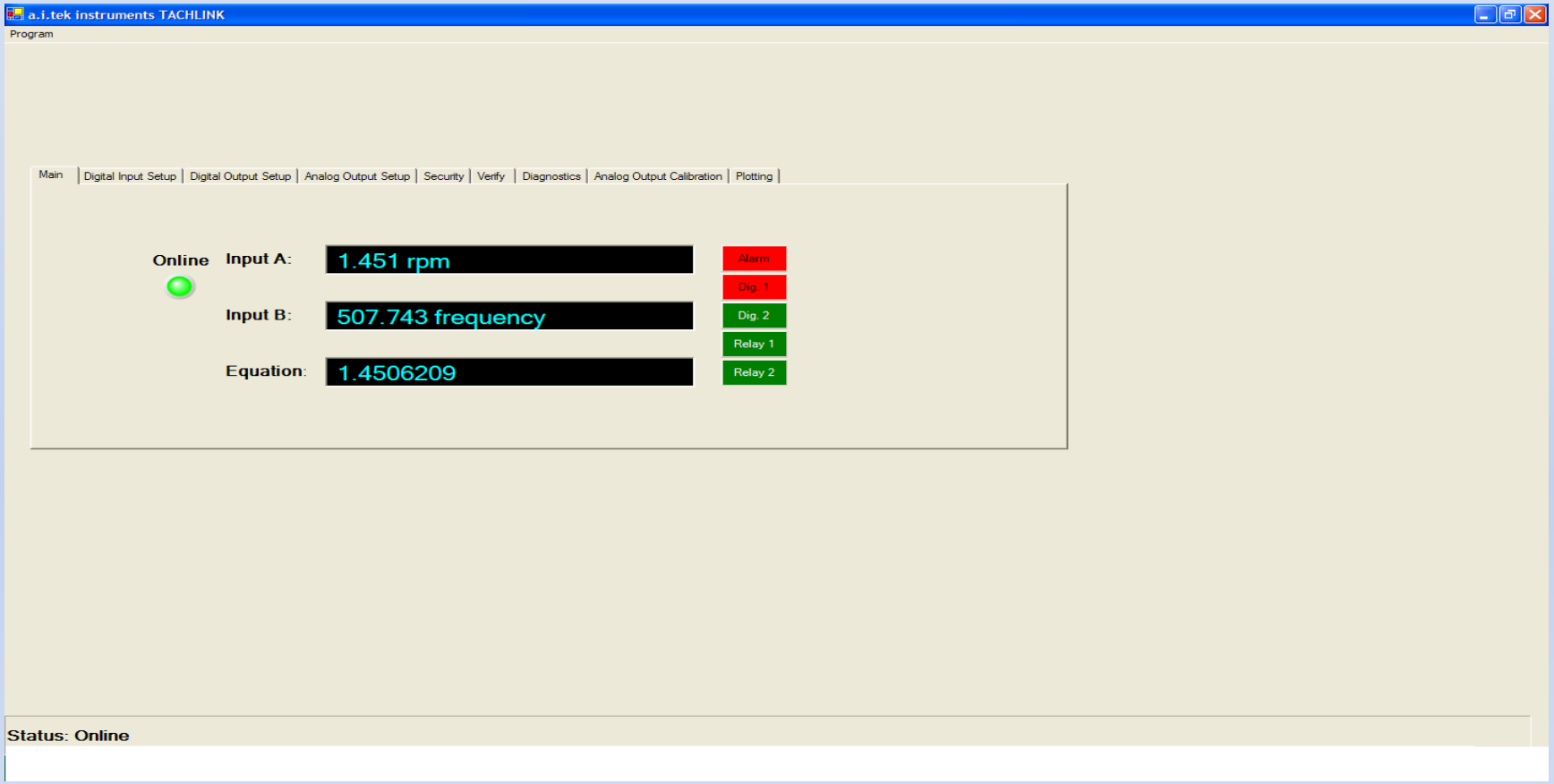
TACHTROL 10 and 30 can be programmed through the integrated display/membrane panel.

TACHPAK 10 and 30 can also be programmed in the same manner with the addition of a TACHTROL plus remote display.

In either case programming is accomplished by navigating through a series of nested menus

TACHTROL tachometers embedded in explosion proof or NEMA 4X enclosures can be programmed by making use of an IR link to allow full front panel control via a hand-held remote

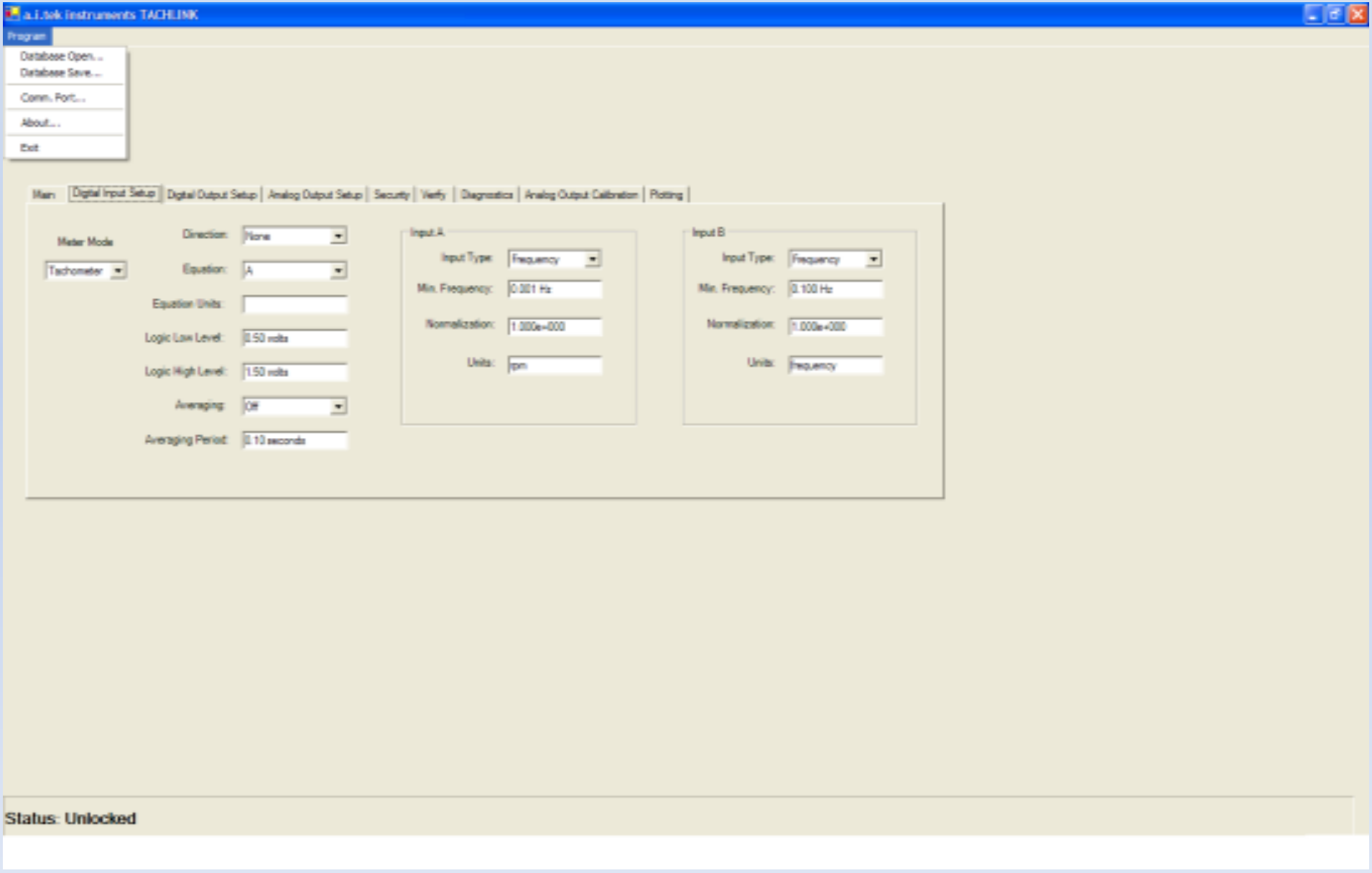
What is TACHLINK ®



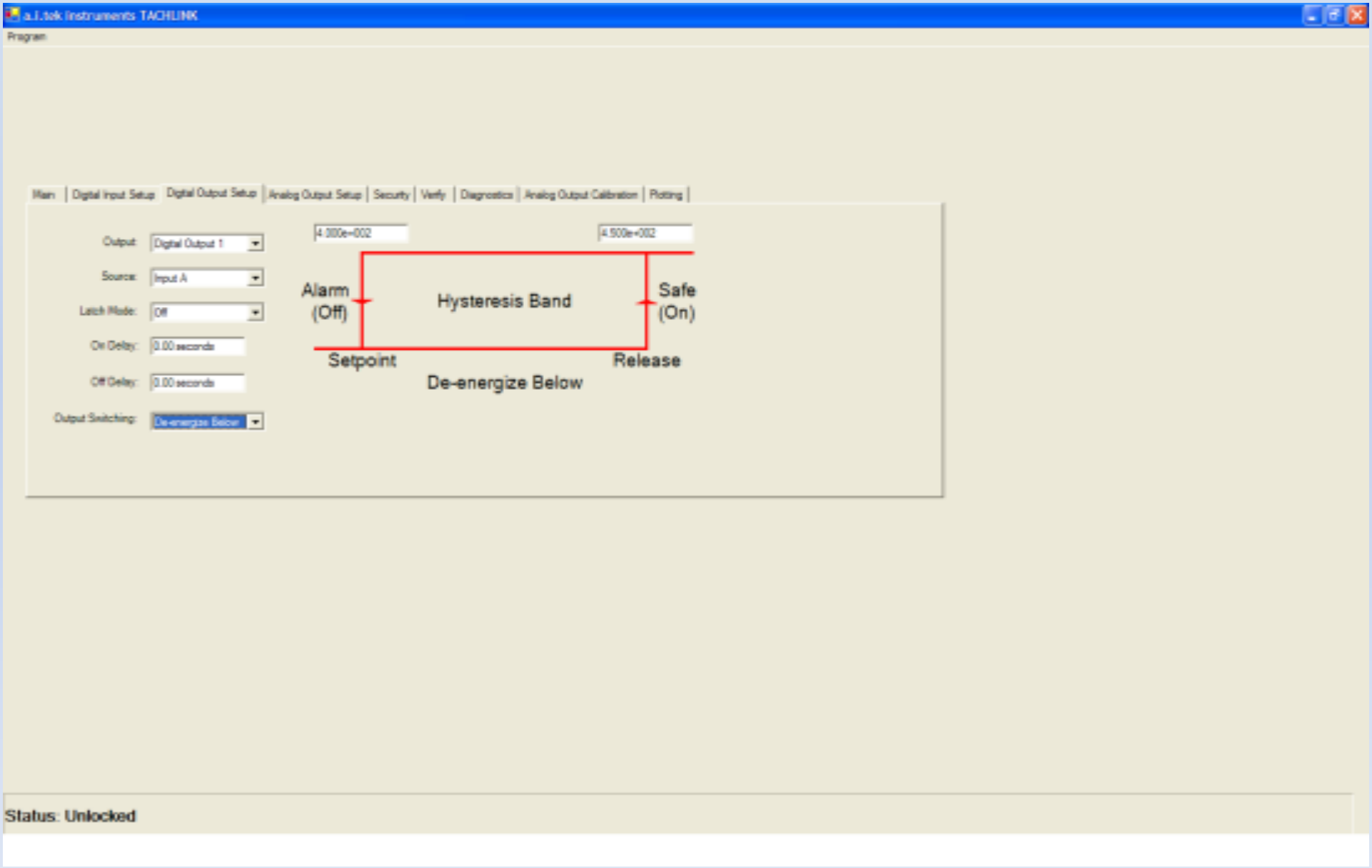
PC / Windows-based GUI (Graphical User Interface)

- Custom software allows the user to program all configurable attributes of TACHPAK and TACHTROL by PC via a USB2.0 or RS485 connection.
- PC can be used to display data, perform security functions, diagnostics, analog output calibration and real-time data logging.

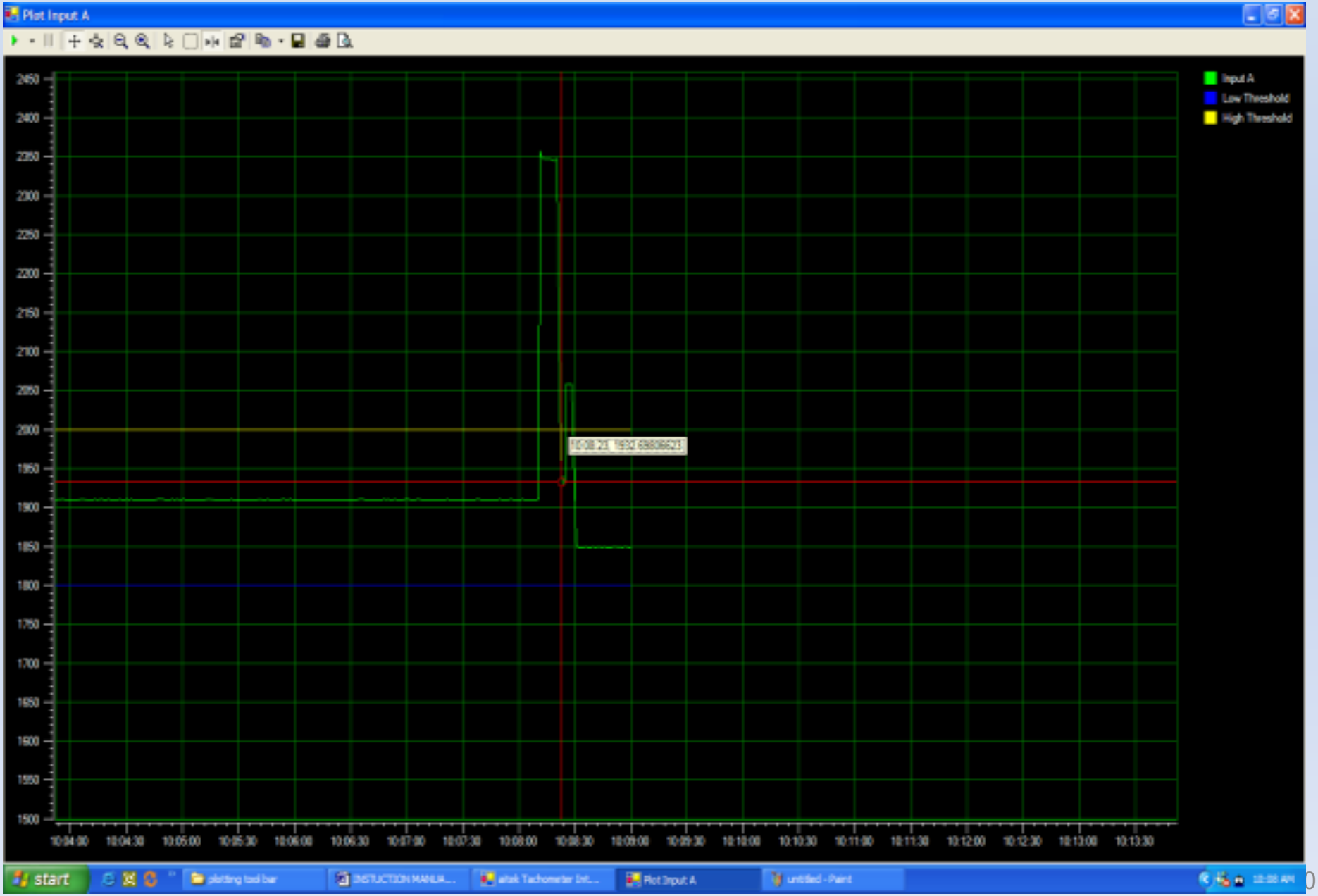
Programming Parameters



Relay Setup


a.i.tek Instruments TACHLINK
Program
Main
Digital Input Setup
Digital Output Setup
Analog Output Setup
Security
Verify
Diagnostics
Analog Output Calibration
Plotting
Output:
Digital Output 1
Source:
Input A
Latch Mode:
Off
On Delay:
0.00 seconds
Off Delay:
0.00 seconds
Output Switching:
De-energize Below
4.300e+002
4.500e+002
Alarm
(Off)
Hysteresis Band
Safe
(On)
Setpoint
Release
De-energize Below
Status: Unlocked

Plotting Capability



Quick Start Guide & Tips For A Typical Installation

a.i.tek instruments

- Install TACHLINK. Follow software installation guide in top of box.
- Connect tachometer per manual; power, input signal, relay, Analog out, USB or RS485
- Launch TACHLINK
- **Digital Input Tab**
  - Select appropriate Com Port from Program menu (USB typically); check for "online" status
  - No need to fill in all fields. Unit comes with defaults. **Use starter data bases** (**database open**)
  - Set **Logic Levels** appropriate to sensor. Active sensors can probably use defaults, Passive sensors may require changes with low speeds, high air gaps.
  - **Minimum Frequency:** Point at which tachometer interprets speed as zero.
  - To read RPM, **Normalization** = 60 ÷ number of teeth
  - **Important!! Normalization x Minimum Frequency = value assigned to output**
  - **Important!! No "Zeros"**
  - **Units** = RPM
- **Digital Output Setup Tab**
  - Select desired **Output** (D1, D2, R1, R2) & **Source** (A, B, Equation, Off)
  - Enter **Safe** (Off) and **Alarm** (On) setpoints
- **Analog Output Setup Tab**
  - Select **Source**, **Range** / Enter **Min** & **Max Value (No "Zeros")**
- **Analog Output Calibration Tab**
  - ***Do not touch unless you wish to calibrate!!! Clicking "START" wipes out all AO calibration constants!!! If you start you must finish!!! Refer to manual.***

Tachometer Configurations

New Generation Tachometer Configuration Chart

	AC Voltage 80-264 vac	DC Voltage 12-30 vdc	Utility RS485	USB / TACHLINK Compatible	Analog Output	Mechanical Relays (2)	Solid State Relays (2)	Infrared Remote Compatible**	Panel Mount	DIN Rail Mount	NEMA 4X	Explosion Proof / ATEX
TACHPAK 10												
T77510-10	X	X		X		X				X		
T77510-40	X	X		X		X					X	
T77510-70	X	X		X		X						X
TACHPAK 30												
T77530-10	X	X	X	X	X	X	X			X		
T77530-40	X	X	X	X	X	X	X				X	
T77530-70	X	X	X	X	X	X	X					X
TACHTROL 10												
T77610-10	X	X		X		X		X	X			
T77610-40	X	X		X		X		X			X	
T77610-70	X	X		X		X		X				X
TACHTROL 30												
T77630-10	X	X	X	X	X	X	X	X	X			
T77630-40	X	X	X	X	X	X	X	X			X	
T77630-70	X	X	X	X	X	X	X	X				X
TACHTROL plus	TACHTROL plus is a remote display only. It is used to provide display and programming functions. Up to 8 displays can be connected to a single tachometer.***											
T77810-10								X	X			
T77810-40								X			X	
T77810-70								X				X

Tachometer Cross Reference Data

New Generation Tachometer
CROSS REFERENCE

NEW	OLD
TACHPAK 10	**TACHPAK 1**
T77510-10 80-264Vac, 12-30 Vdc, Standard	T77130-11 120 Vac / 24Vdc, Standard
	T77130-12 240 Vac / 24Vdc, Standard
T77510-40 80-264Vac, 12-30 Vdc, NEMA 4X	T77130-41 120 Vac / 24Vdc, NEMA 4X
	T77130-42 240 Vac / 24Vdc, NEMA 4X
T77510-70 80-264Vac, 12-30 Vdc, Explosion Proof	T77130-71 120 Vac / 24Vdc, Explosion Proof
	T77130-72 240 Vac / 24Vdc, Explosion Proof
TACHPAK 30	**TACHPAK 3**
T77530-10 80-264Vac, 12-30 Vdc, Standard	T77430-11 120 Vac / 24Vdc, Standard
	T77430-12 240 Vac / 24Vdc, Standard
T77530-40 80-264Vac, 12-30 Vdc, NEMA 4X	T77430-41 120 Vac / 24Vdc, NEMA 4X
	T77430-42 240 Vac / 24Vdc, NEMA 4X
T77530-70 80-264Vac, 12-30 Vdc, Explosion Proof	T77430-71 120 Vac / 24Vdc, Explosion Proof
	T77430-72 240 Vac / 24Vdc, Explosion Proof
TACHTROL 30	**TACHTROL 3**
No Cross Reference offered.	T77310-01 120 Vac / 24Vdc, Less enclosure
	T77310-02 240 Vac / 24Vdc, Less enclosure
T77630-10 80-264Vac, 12-30 Vdc, Standard	T77310-11 120 Vac / 24Vdc, Standard panel mount
	T77310-12 240 Vac / 24Vdc, Standard panel mount
No Cross Reference offered. Use T77630-40 for closest match.	T77310-21 120 Vac / 24Vdc, Splash prf panel mnt
	T77310-22 240 Vac / 24Vdc, Splash prf panel mnt
T77630-40 80-264Vac, 12-30 Vdc, NEMA 4X	T77310-41 120 Vac / 24Vdc, NEMA 4X
	T77310-42 240 Vac / 24Vdc, NEMA 4X
T77630-70 80-264Vac, 12-30 Vdc, Explosion Proof	T77310-71 120 Vac / 24Vdc, Explosion Proof
	T77310-72 240 Vac / 24Vdc, Explosion Proof
TACHTROL 10	**TACHTROL 2**
T77610-10 80-264Vac, 12-30 Vdc, Standard	T77220-11, 12
T77610-40 80-264Vac, 12-30 Vdc, NEMA 4X	T77220-41,42
T77610-70 80-264Vac, 12-30 Vdc, Explosion Proof	T77220-71, 72
TACHTROL plus	**Analog Panel Meter**
T77810-10 Standard	M77650-1XX-XXX, Model 210
T77810-40 NEMA 4X	Same as above in NEMA 4X Enclosure
T77810-70 Explosion Proof	M77650-111, -112, -XXXX EX. Proof Enclosure

Tachtrol 20

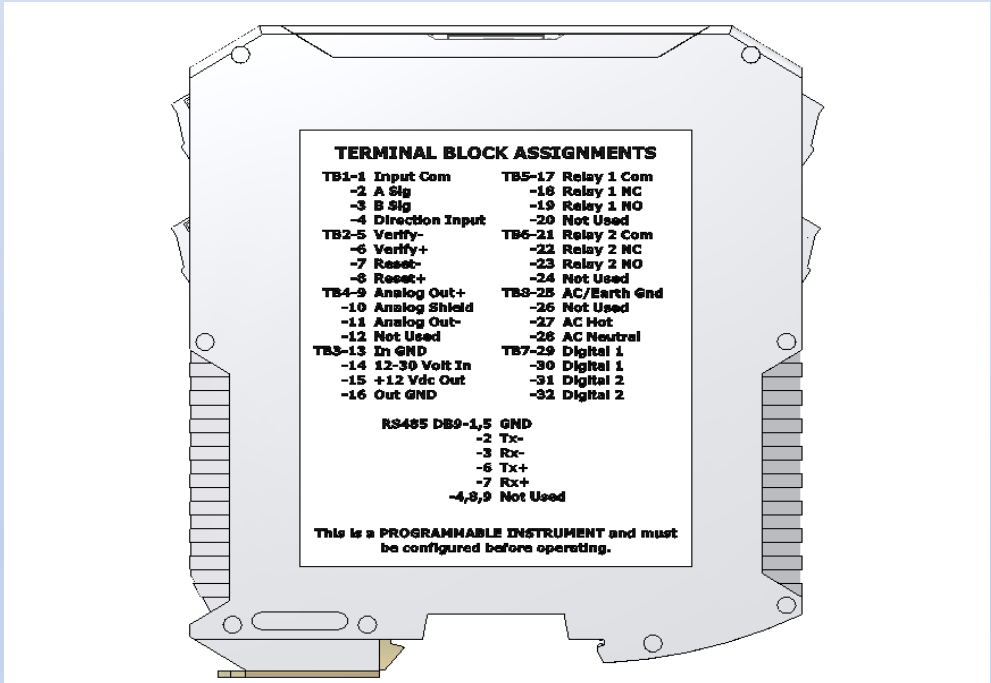
New Product

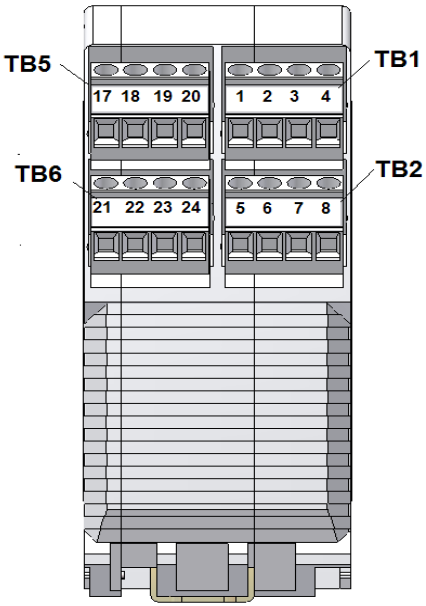
- 6 Digit red LED display
- Input rates up to 25 KHz
- Single Channel Input
- Simple DIP Switch Set-up
- Programmable decimal points
- Programmable scaling/updates
- NEMA 4X front panel

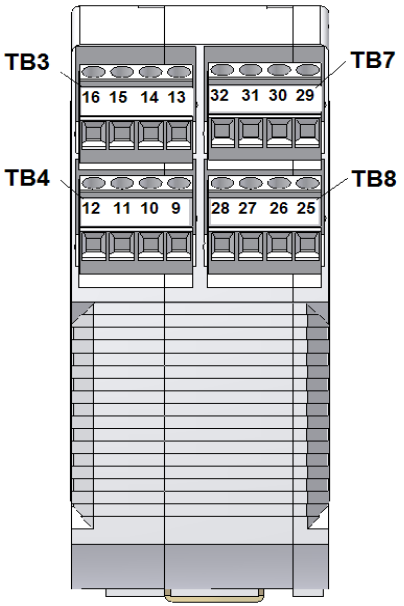
Tachometer Application - TACHPAK

TACHPAK

SIDE VIEWS



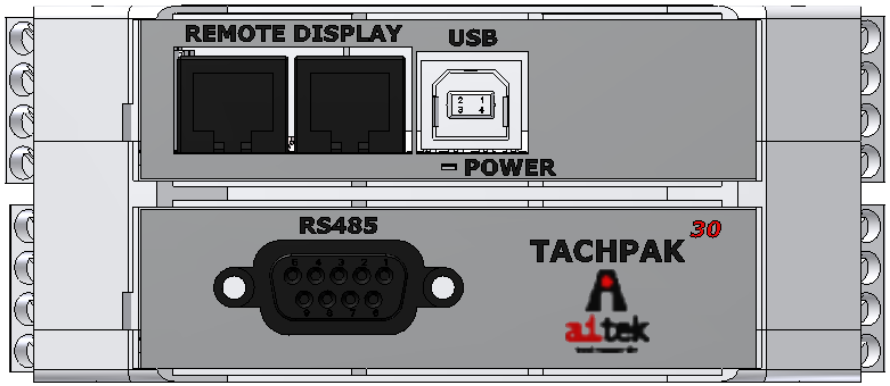




Tachometer Application - TACHPAK

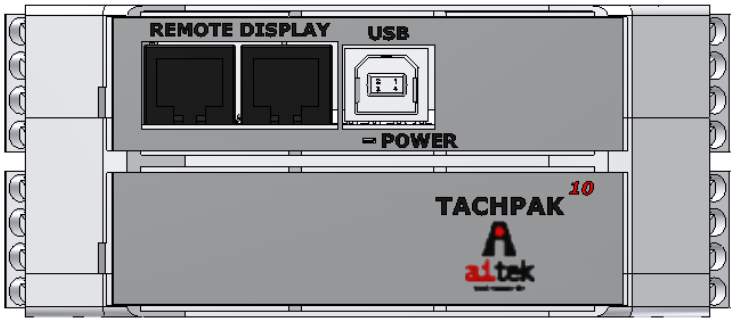
TACHPAK 30

TOP VIEW



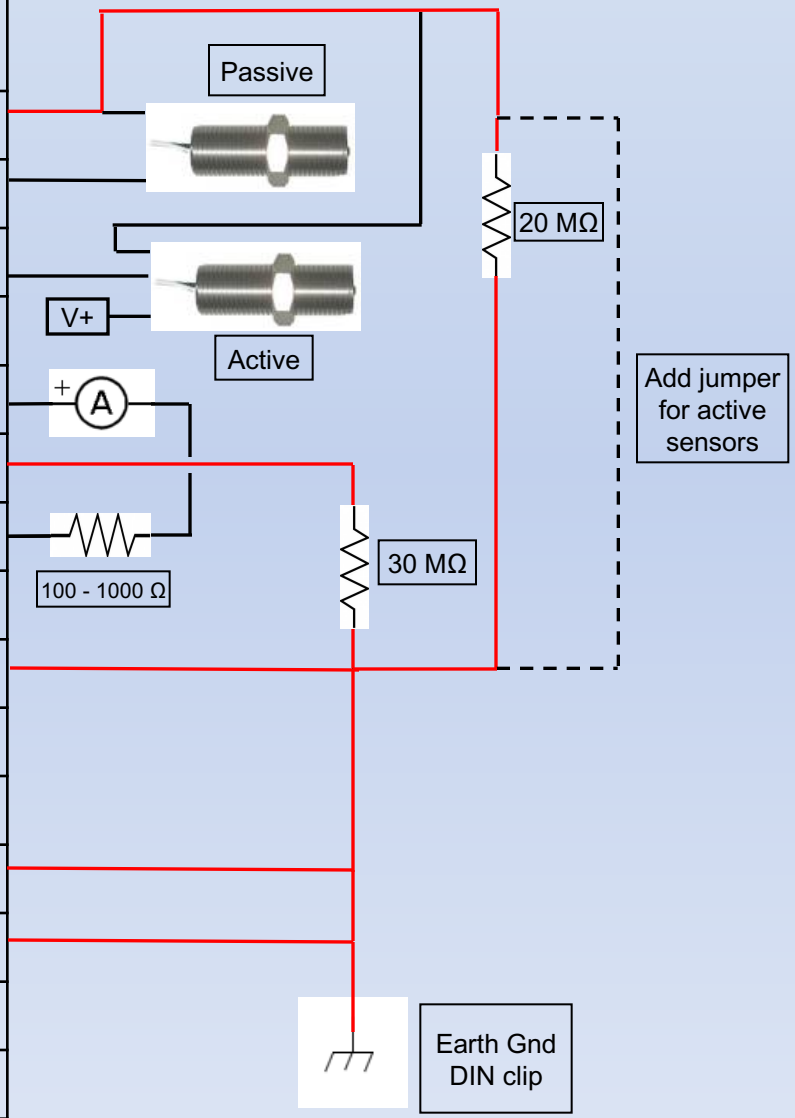
TACHPAK 10

TOP VIEW



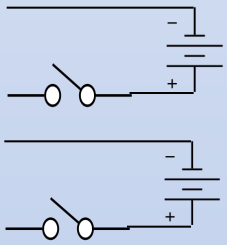
Tachometer Application – TACHPAK Connections

Terminal Block	Pin #	TACHPAK 10	TACHPAK 30
TB1	1	Input Com	Input Com
	2	A Sig	A Sig
	3	B Sig	B Sig
	4	Direction Input	Direction Input
TB4	9	Not Available	Analog Out +
	10	Not Available	Analog Shield
	11	Not Available	Analog Out -
	12	Not Available	Not Used
TB3	13	In GND	In GND
	14	12-30 Volt In	12-30 Volt In
	15	+12 Vdc Out	+12 Vdc Out
	16	Out GND	Out GND
TB8	25	AC/Earth Gnd	AC/Earth Gnd
	26	Not Used	Not Used
	27	AC Hot	AC Hot
	28	AC Neutral	AC Neutral

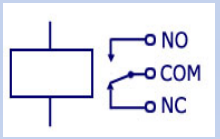


Tachometer Application – TACHPAK Connections

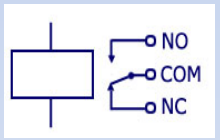
Terminal Block	Pin #	TACHPAK 10	TACHPAK 30
TB2	5	Verify -	Verify -
	6	Verify +	Verify +
	7	Reset -	Reset -
	8	Reset +	Reset +
TB5	17	Relay 1 Com	Relay 1 Com
	18	Relay 1 N.C.	Relay 1 N.C.
	19	Relay 1 N.O.	Relay 1 N.O.
	20	Not Used	Not Used
TB6	21	Relay 2 Com	Relay 2 Com
	22	Relay 2 N.C.	Relay 2 N.C.
	23	Relay 2 N.O.	Relay 2 N.O.
	24	Not Used	Not Used
TB7	29	Not Available	Digital 1 (no polarity)
	30	Not Available	Digital 1 (no polarity)
	31	Not Available	Digital 2 (no polarity)
	32	Not Available	Digital 2 (no polarity)

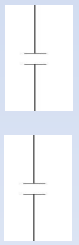


3.5 – 30Vdc



10A @
125/250Vac





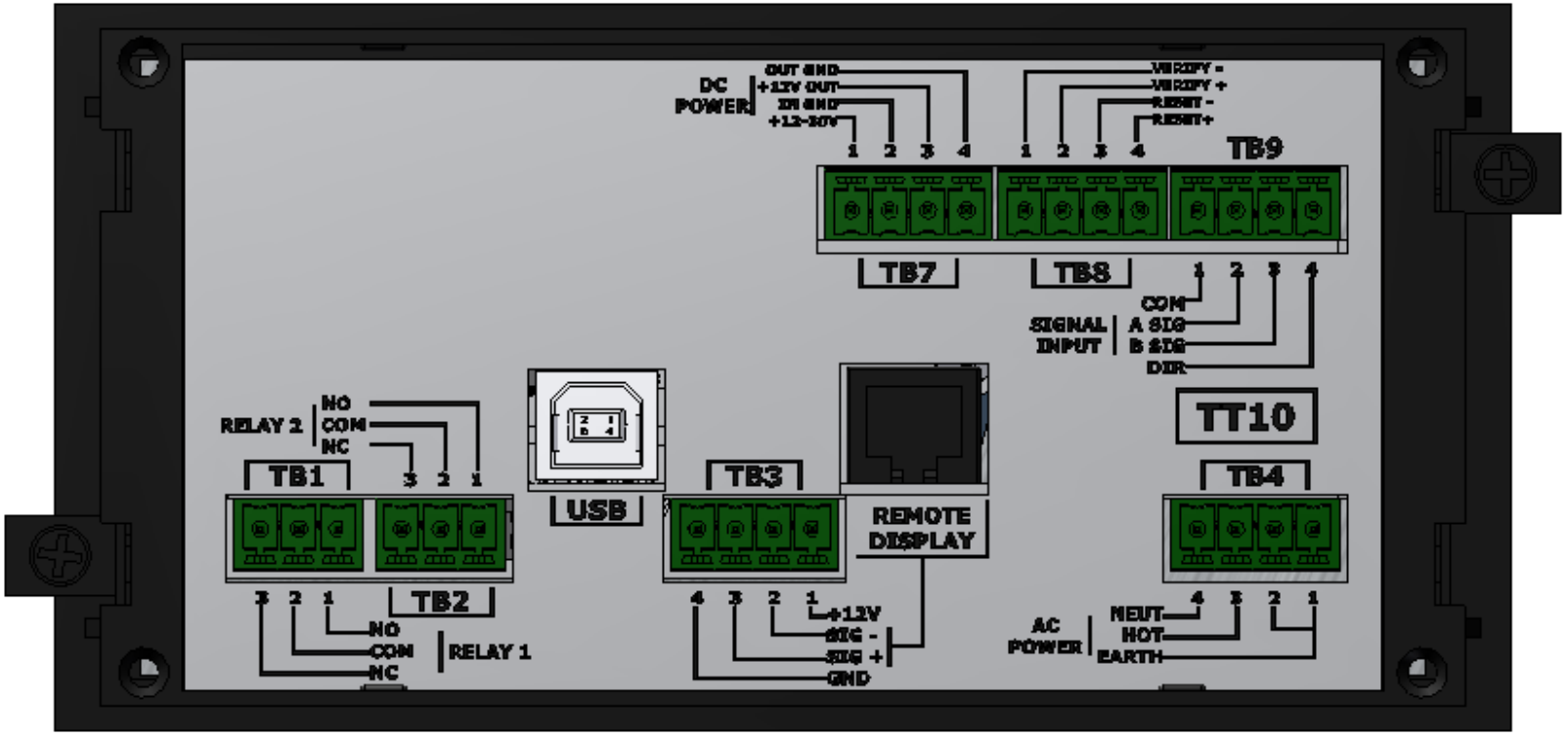
0.4A @
60Vac / dc

Tachometer Application – TACHTROL

TACHTROL 30
FRONT PANEL
VIEW

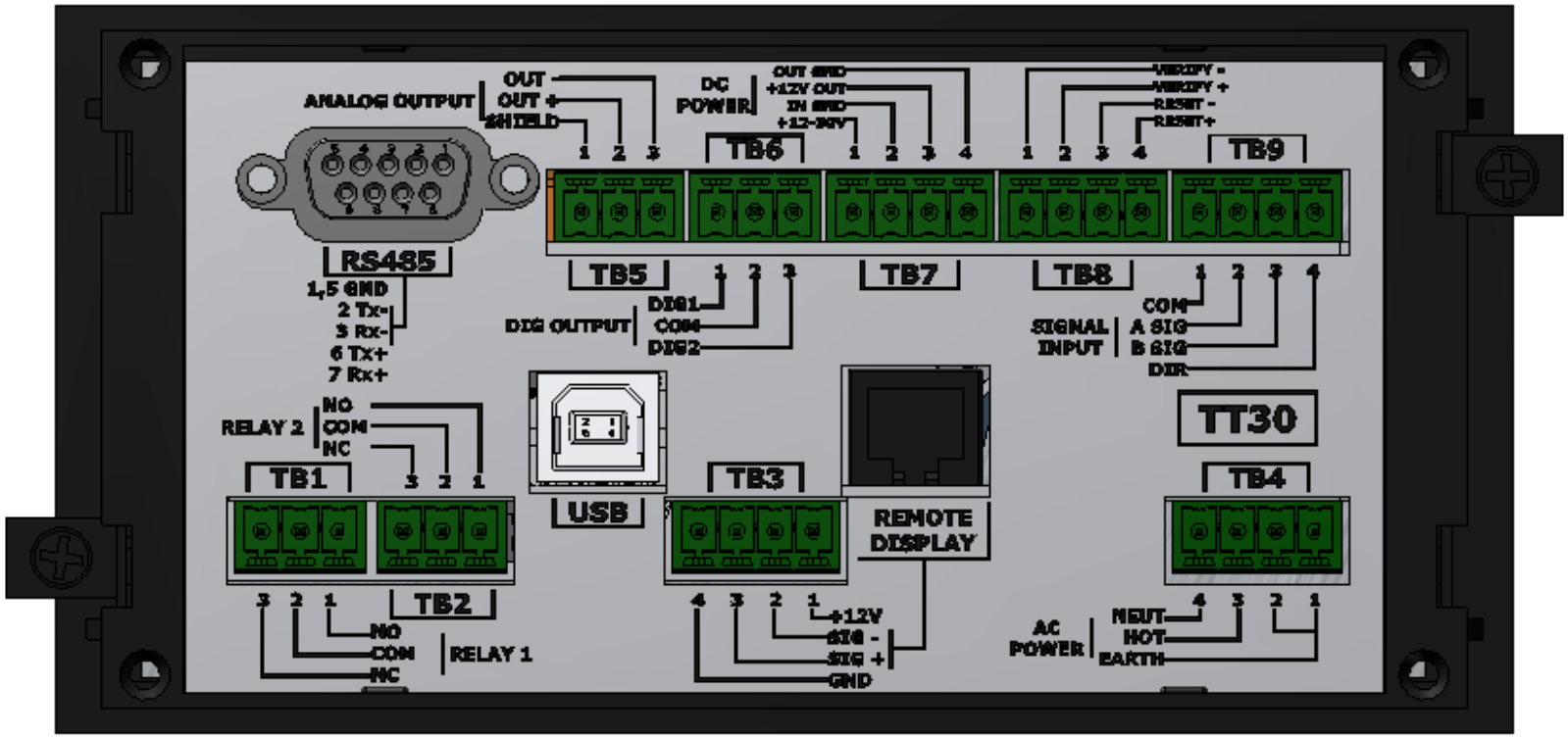
Tachometer Application – TACHTROL

TACHTROL 10
REAR PANEL VIEW



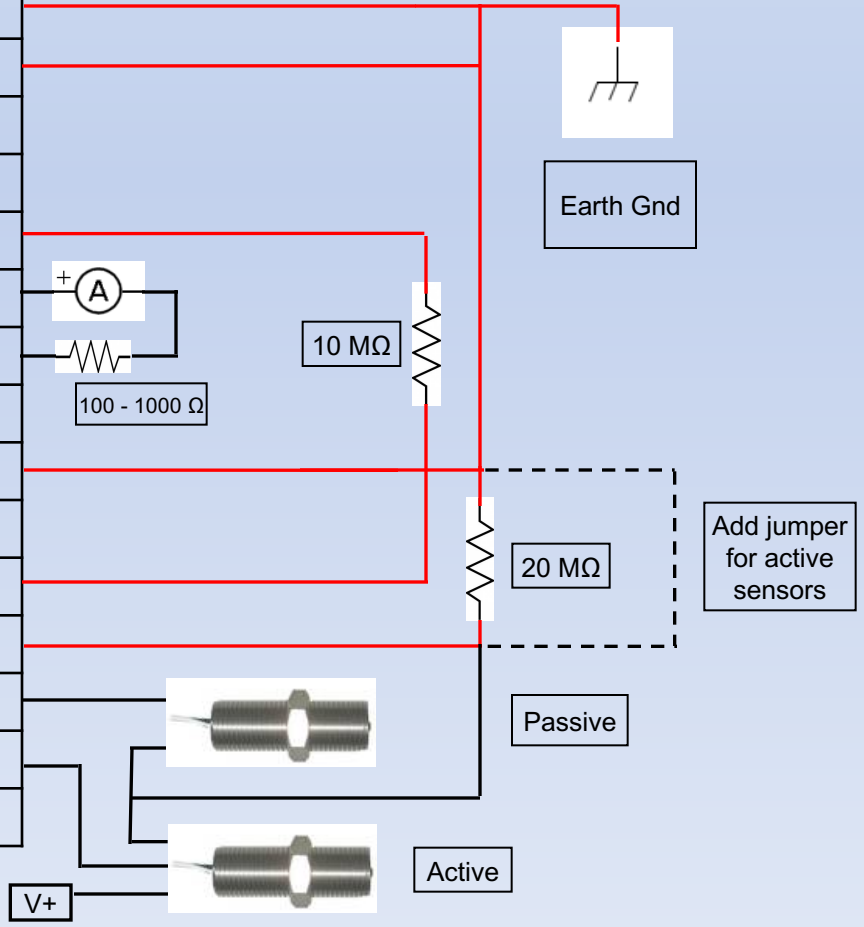
Tachometer Application – TACHTROL

TACHTROL 30
REAR PANEL VIEW



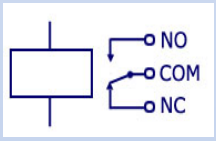
Tachometer Application – TACHTROL Connections

Terminal Block	Pin #	TACHTROL 10	TACHTROL 30
TB3 Remote Display	1	+12vdc Out	+12vdc Out
	2	Sig -	Sig -
	3	Sig +	Sig +
	4	Gnd	Gnd
TB4	1	AC/Earth Gnd	AC/Earth Gnd
	2	AC/Earth Gnd	AC/Earth Gnd
	3	AC Hot	AC Hot
	4	AC Neutral	AC Neutral
TB5	1	Not Available	Analog Shield
	2	Not Available	Analog Out +
	3	Not Available	Analog Out -
TB7	1	12-30 Volt In	12-30 Volt In
	2	In GND	In GND
	3	+12 Vdc Out	+12 Vdc Out
	4	Out GND	Out GND
TB9	1	Input Com	Input Com
	2	A Sig	A Sig
	3	B Sig	B Sig
	4	Direction Input	Direction Input

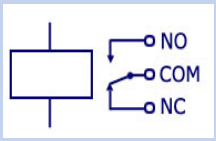


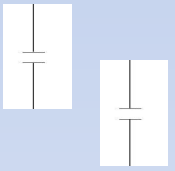
Tachometer Application – TACHTROL Connections

Terminal Block	Pin #	TACHTROL 10	TACHTROL 30
TB1	1	Relay 1 N.O.	Relay 1 N.O.
	2	Relay 1 Com	Relay 1 Com
	3	Relay 1 N.C.	Relay 1 N.C.
TB2	1	Relay 2 N.O.	Relay 2 N.O.
	2	Relay 2 Com	Relay 2 Com
	3	Relay 2 N.C.	Relay 2 N.C.
TB6	1	Not Available	Digital 1
	2	Not Available	Dig Com
	3	Not Available	Digital 2
TB8	1	Verify -	Verify -
	2	Verify +	Verify +
	3	Reset -	Reset -
	4	Reset +	Reset +

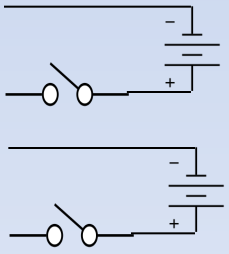


10A @ 125/250Vac





0.4A @ 60Vac / dc



3.5 – 30Vdc

Tachometer Application

Installation and wiring guidelines

•Avoid water, heat, humidity, and dust or provide a suitable enclosure to protect it from these elements.

•Locate the instrument away from sources of electrical noise.

•Use a grounded metal enclosure to protect the instrument from radiated electrical noise and other magnetic influences.

•Separate low voltage signal and control wiring from switching and power wiring.

•Signal and control wiring should be in twisted pairs. Lines for magnetic pick-ups and other frequency output devices should be run in separate shielded cables.

•Avoid use of commutators or slip rings to transmit low-level signals.

•Connect all shield segments in series, then to the appropriate connection on the tachometer or to an approved earth ground nearest the instrument.

•Provide a power source that is free of electrical noise and power interruption.

Tachometer Application - Troubleshooting guide

	Problem description	Resolution
1	Tachometer is not recognized by computer when connected via USB	USB drivers not installed. Under **Control panel** > **Add Hardware** > start **Add New Hardware Wizard** > follow prompts and **TACHLINK Installation Guide** found in shipping carton. Follow "W XP & 2000 Installation" whitepaper @ www.aitekinstruments.com/literature
2	Tachometer will not communicate with TACHLINK	1. See item 1. Also check under **Control panel** > **Add or Remove Software**. Make sure **Microsoft ® .NET 1.1 Framework** is installed. 2. Multiple versions may cause TACHLINK communication problems. Consult your IT department.
3	TACHLINK will not install on Windows 7 computer	TACHLINK is designed to install on Windows 2000 and XP and in most cases W7. TACHLINK will only run on 32 bit systems – not 64 bit. Follow "W7 Installation" whitepaper @ www.aitekinstruments.com/literature
4	Tachometer loses communication through TACHLINK after power loss.	Re-establish link by re-launching **TACHLINK** or return to **Program** menu and re-select appropriate **Comm. Port** from **Program** menu.
5	TACHTROL display reads "Display is Offline"	From front panel **Security (F2)** > **Display Address** > set to any number other than 0. **Consult manual / follow "Offline" whitepaper @** www.aitekinstruments.com/literature
6	Program Changes not saved.	Return to **Main tab / Main screen** and answer **YES** if you wish to save changes. Changes to constants may need to be re-entered.
7	After power is lost or cycled off/on relays do not reflect correct state.	1. Cycle speed through Alarm (On) and Safe (Off) hysteresis band. 2. Under Security tab / menu click on Alarm Reset (TACHLINK or front panel). 3. Connect a logic pulse from switch, relay or other source to Reset input terminals.
8.	Analog output does not change with speed, is "stuck" at full scale or is behaving erratically.	Recalibrate in **TACHLINK** > **Analog Output Calibration** > **Start.** Consult manual / follow "AO Cal" White paper @ www.aitekinstruments.com/literature
9	Analog output shows some value of output after speed has dropped below AO minimum value.	1. Min frequency x Normalization = the lowest speed the tachometer interprets. 2. If Normalization must be a large number, select Min Frequency to be as small as possible. 3. Attempt recalibration per Troubleshooting step # 7.
10	Cannot access analog output or solid state relays on TACHPAK or TACHTROL 30	Wrong database installed. Reload using T30 starter database. Consult manual / follow "DB Correction" whitepaper @ www.aitekinstruments.com/literature

Tachometer Application Example (Basic)

Application Definition:

A customer has a pump shaft that spins from 1000 to 2000 rpm. A 4”, 30 tooth, 8 diametral pitch target is mounted to the shaft. The user wants to set the tachometer to alarm if the shaft speed drops below 1000 rpm and reset once the speed returns to 1100 rpm. 0-20 mA analog output must be set for 900 to 2100 rpm. A passive sensor is being used and is known to produce 3Vp-p (1.5 Vpk). No display is required.

Follow the Quick start guide with these additions: Use TACHPAK30 (T77530-10)

Calculate logic levels at approx 20% & 80% of peak: Logic low ≈ 0.3V, Logic high ≈ 1.2V

Calculate normalization for RPM = 60 ÷ # teeth = 60 ÷ 30 = 2

Change only the constants listed below. Use exponential notation with front panel

Digital Input Setup

Logic low level = 0.3V

Logic high level = 1.2V

Input A

Normalization = 2

Units = RPM

Digital Output Setup

Optional:Output D1, D2, R2;
Source = OFF

Output R1 Source = Input A

Alarm (ON) = 1000

Safe (OFF) = 1100

Output switching = Energize Below

Analog Output Setup

Range = 0 To 20 mA

Min. Value = 1100

Max. Value = 2100

Tachometer Application

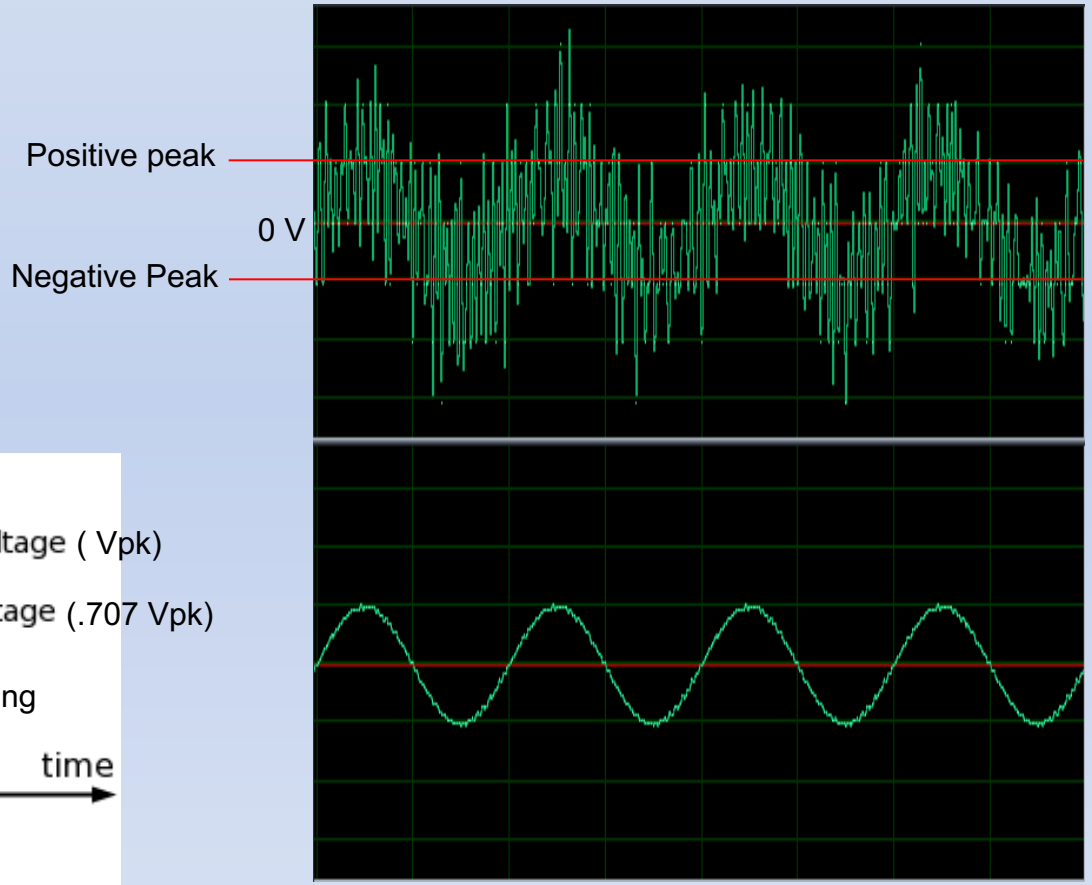
Logic Thresholds – Passive (VR) Sensor Output - Sine Wave

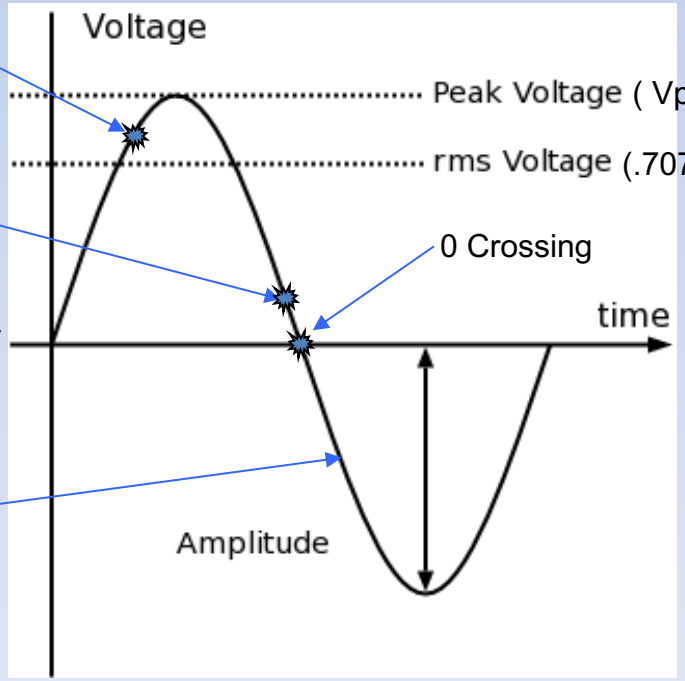
Logic thresholds:

Define a viable sensor pulse

Use to create filter to reject noise

LHL – LLL = Noise Margin





Logic High Level
70 – 80% Vpk

Logic Low Level:
20 – 30% Vpk

Tach disregards negative part of cycle

Tachometer Application

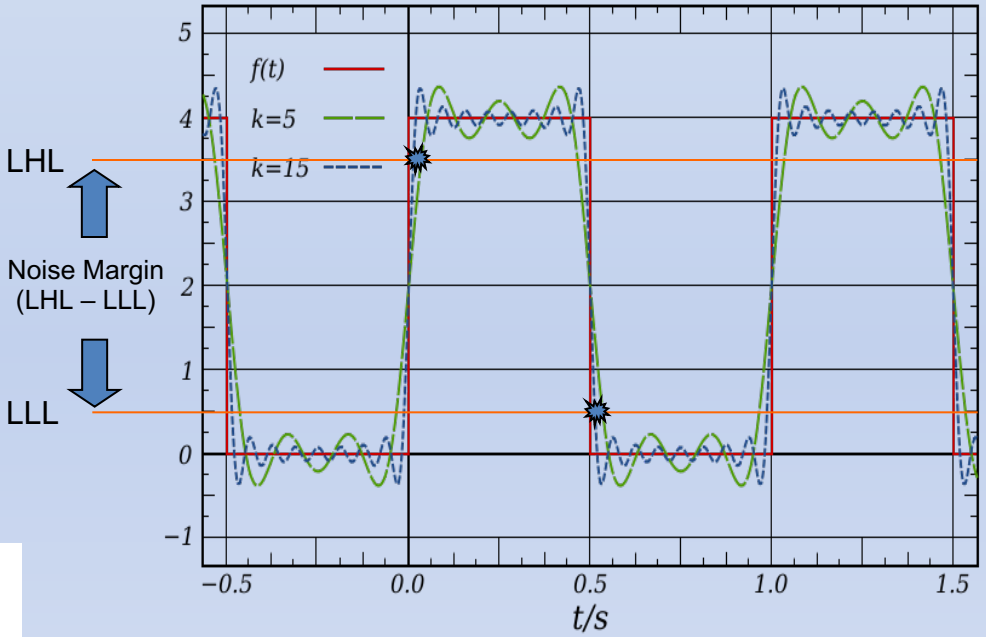
Logic Thresholds – Active (Hall Effect) Sensor Output - Square Wave

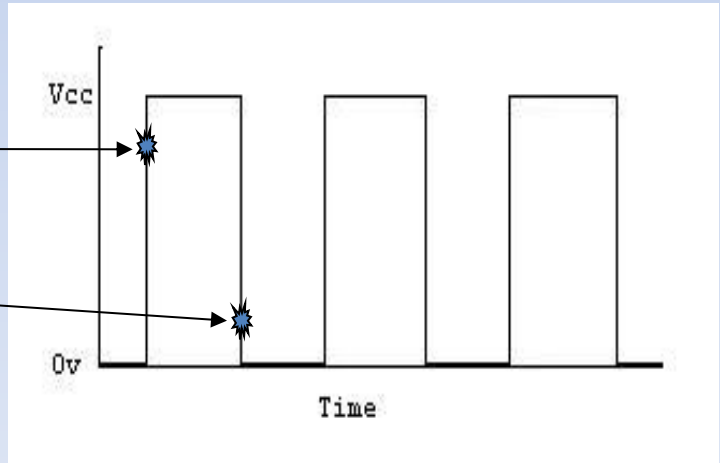
Logic thresholds:

Define a viable sensor pulse

Use to create filter to reject noise

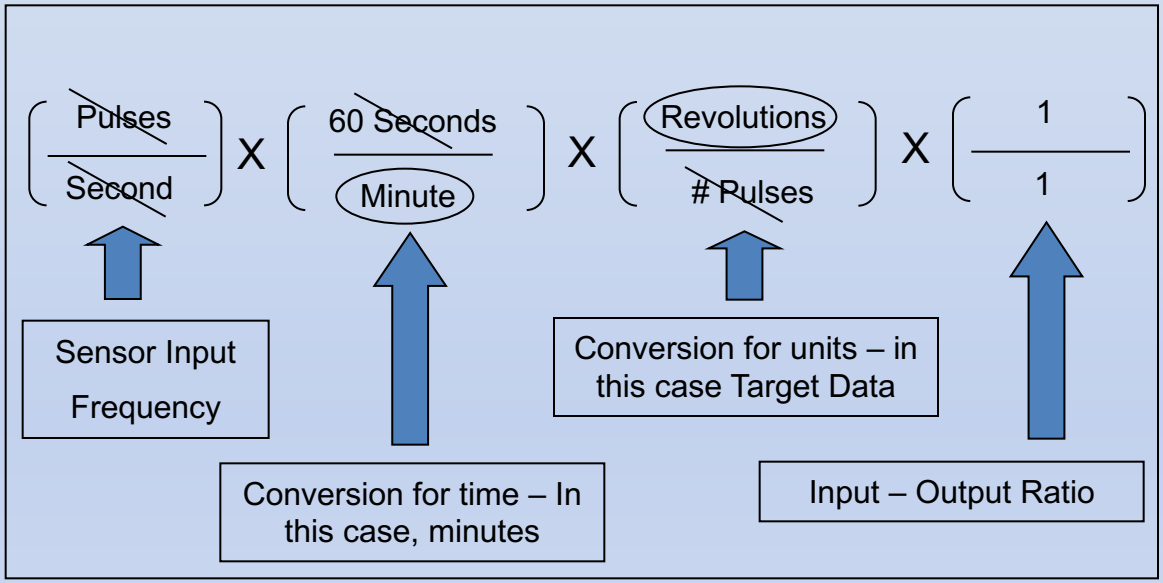
LHL – LLL = Noise Margin





Tachometer Application

Normalization



Converts the input frequency into units useful to the user

RPM, Gallons Per Hour, Feet Per Minute, etc

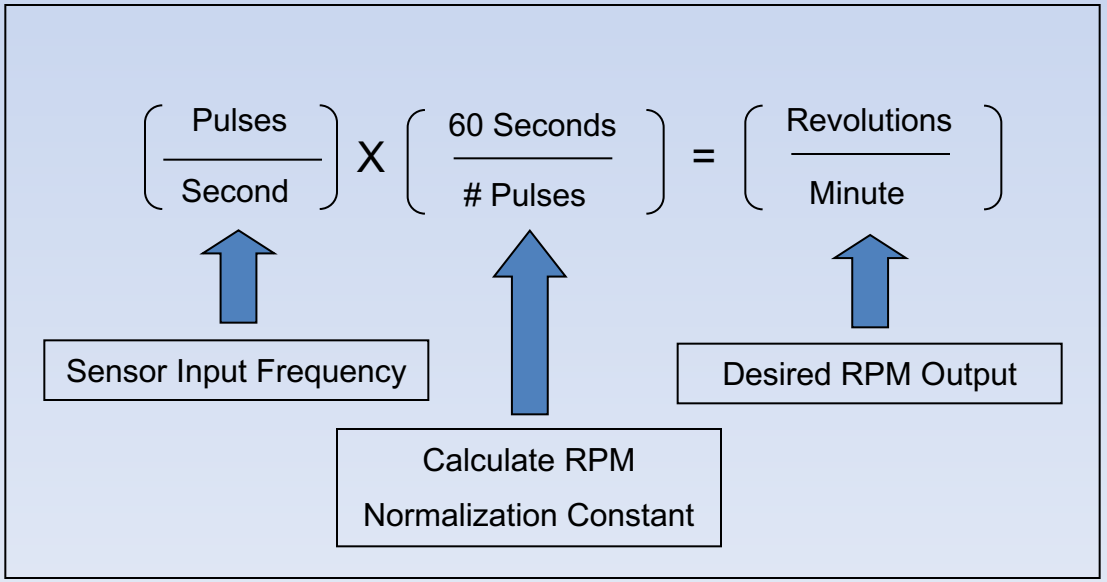
95% of applications are RPM -

N = (60 / #Teeth on target)

-Or-

N = Display Value / Input Frequ.

Re-arrange Terms



Tachometer Application Example (Complex)

AI-TEK Tachometers can be used for more complex functions.

Under the **Digital Input Setup** tab:

Select Counter to track number of events that occur

Use math functions under **Equation** to calculate:

1/A , **1/B** = time

A-B, B-A, A+B = sum or difference in speed between 2 sensors

AxB, A/B, B/A = product and ratio between 2 sensors

(A-B)/A x 100, (B-A)/A x 100 = % difference (% slip)

Use Normalization to convert incoming sensor frequency to units useful to the customer

RPM = 60 ÷ number of teeth on target

Calculate normalization to read linear displacement in inches for a 94 tooth target mounted to a lead-screw shaft on a linear table that moves 1” per 1000 revolutions

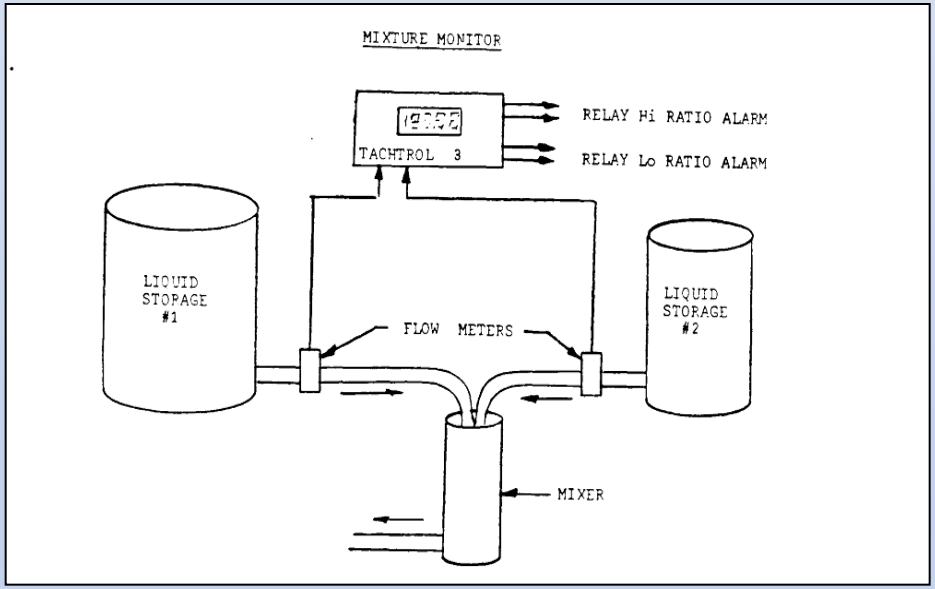
(94 pulses/rev) x (1000 revs/inch) = 94,000 pulses/inch

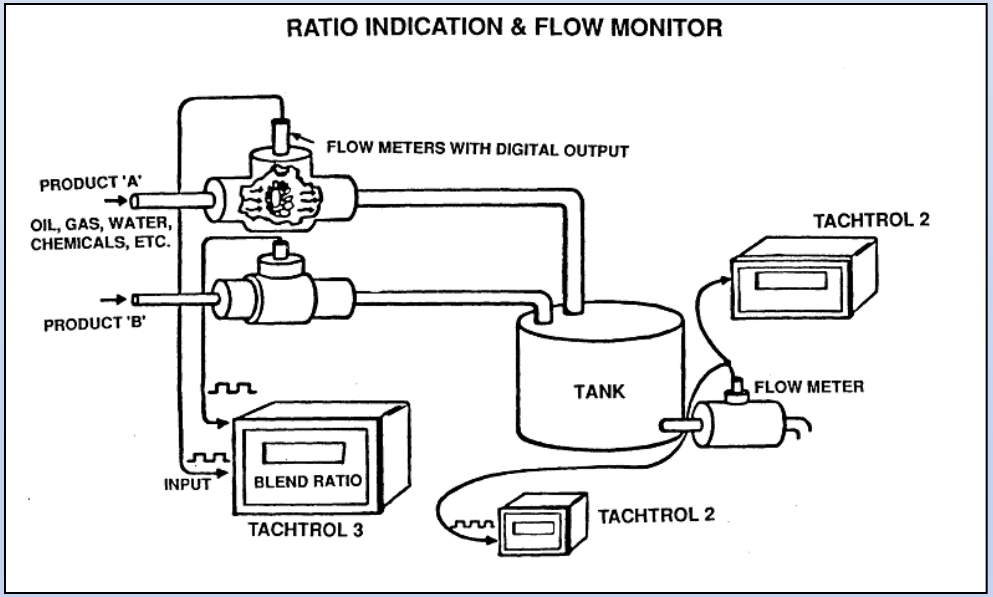
To show displacement (inches) = 1/94,000 inches/pulse

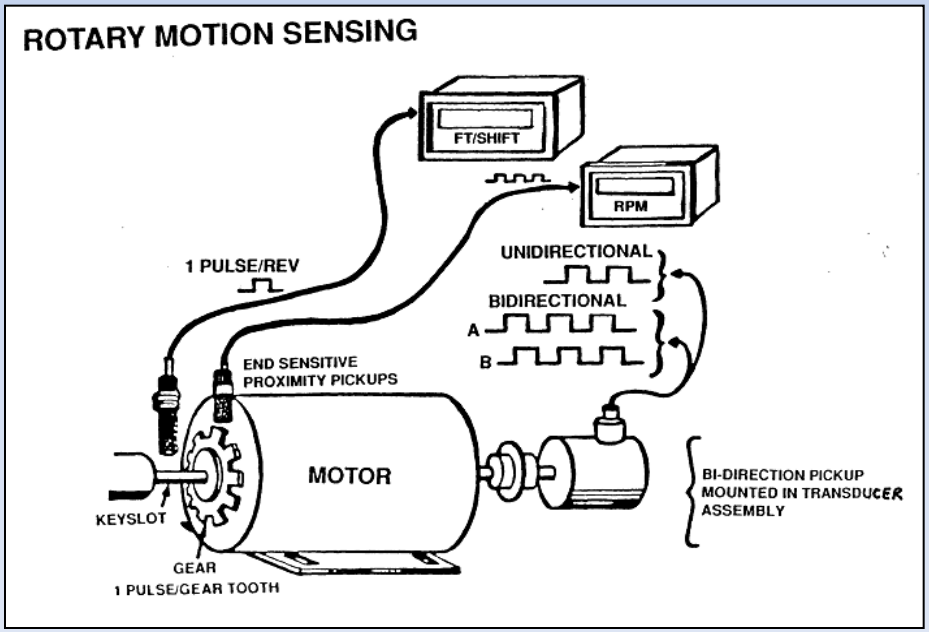
Enter 0.00001064 (1.064e-005) inches/pulse into normalization

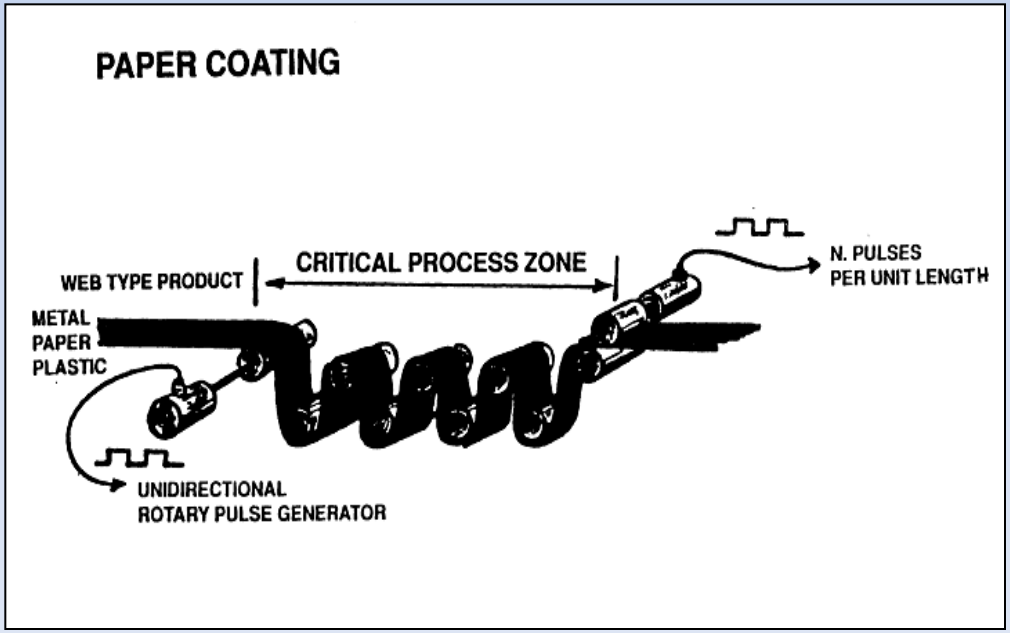
Set tachometer to counter mode

Tachometer/Sensor Applications

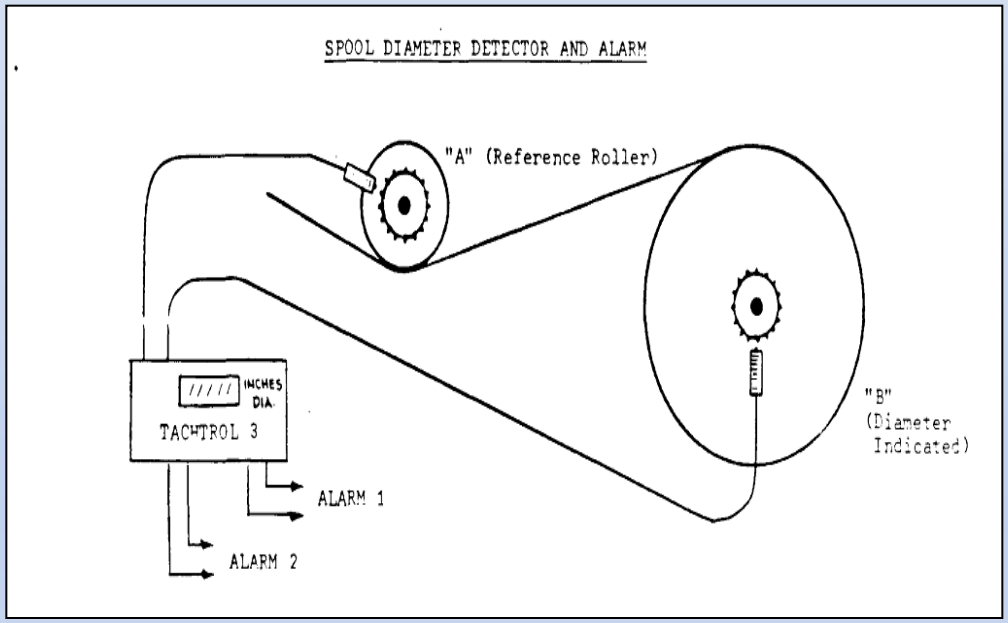


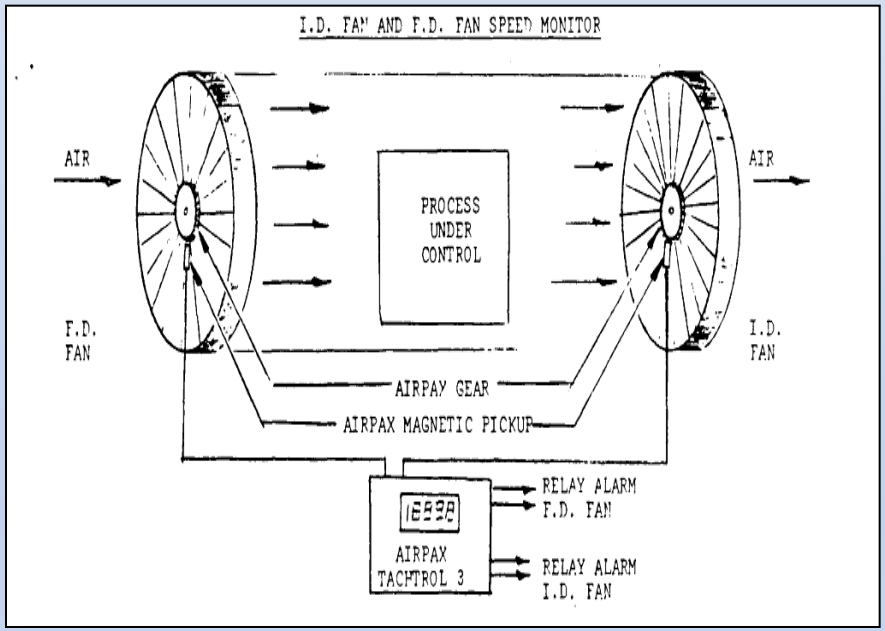


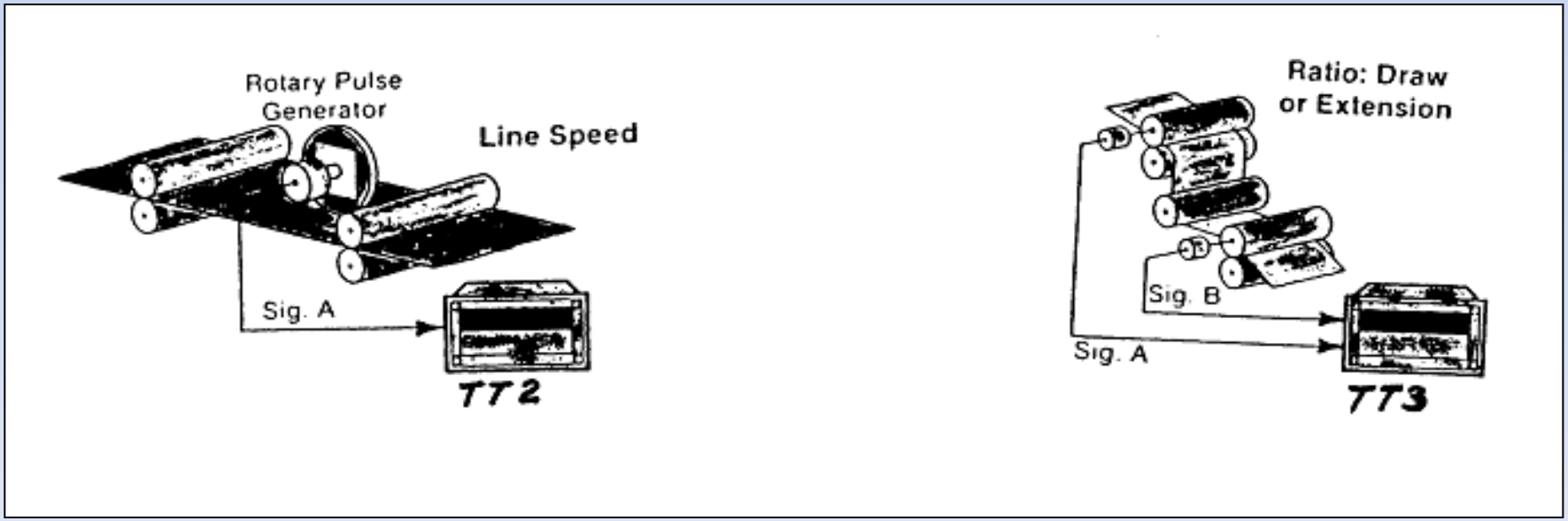




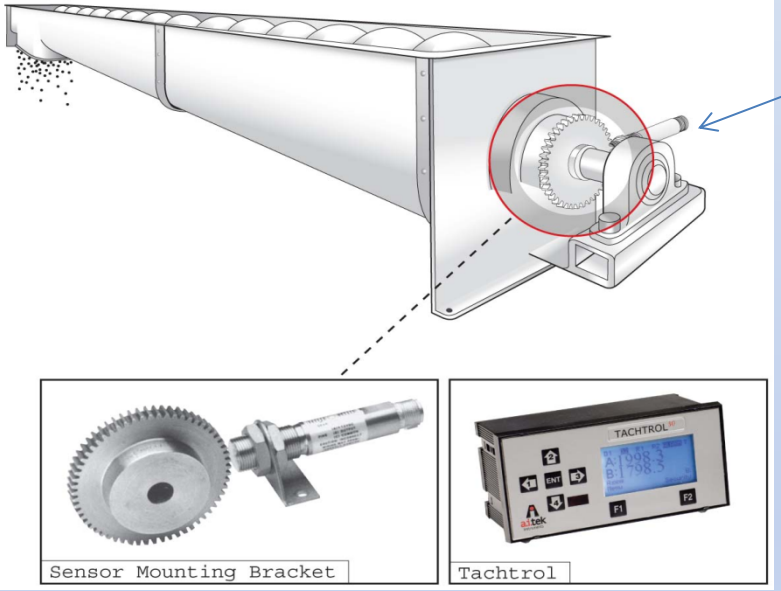
Tachometer/Sensor Applications





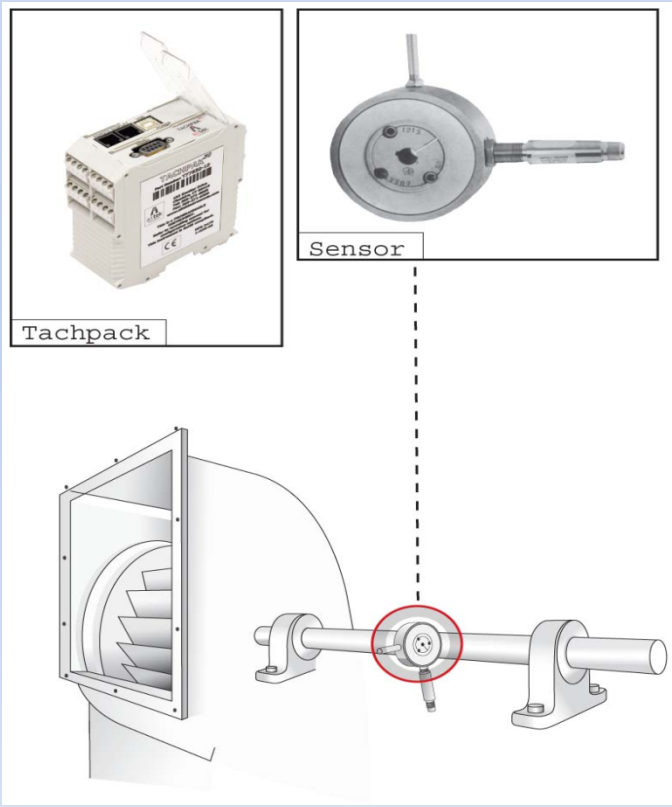


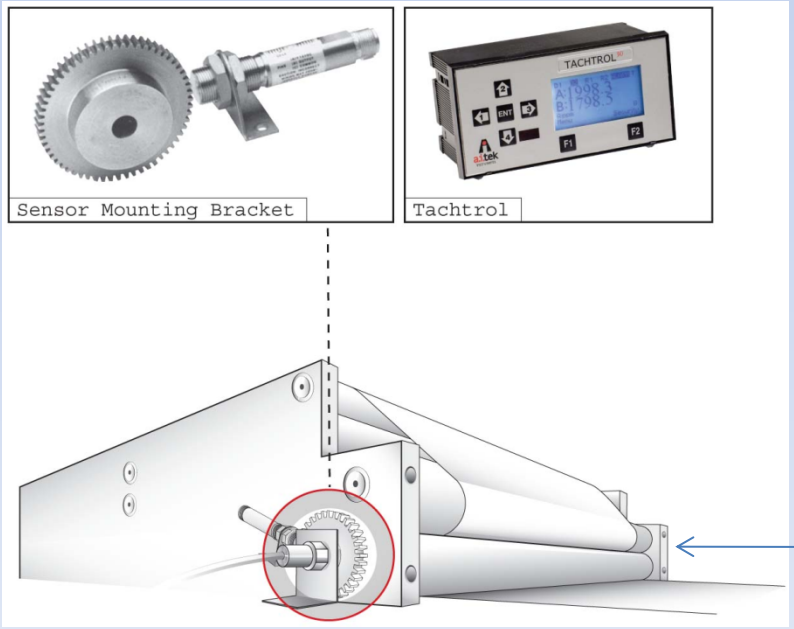
Tachometer/Sensor Applications



Detecting speed on screw conveyors

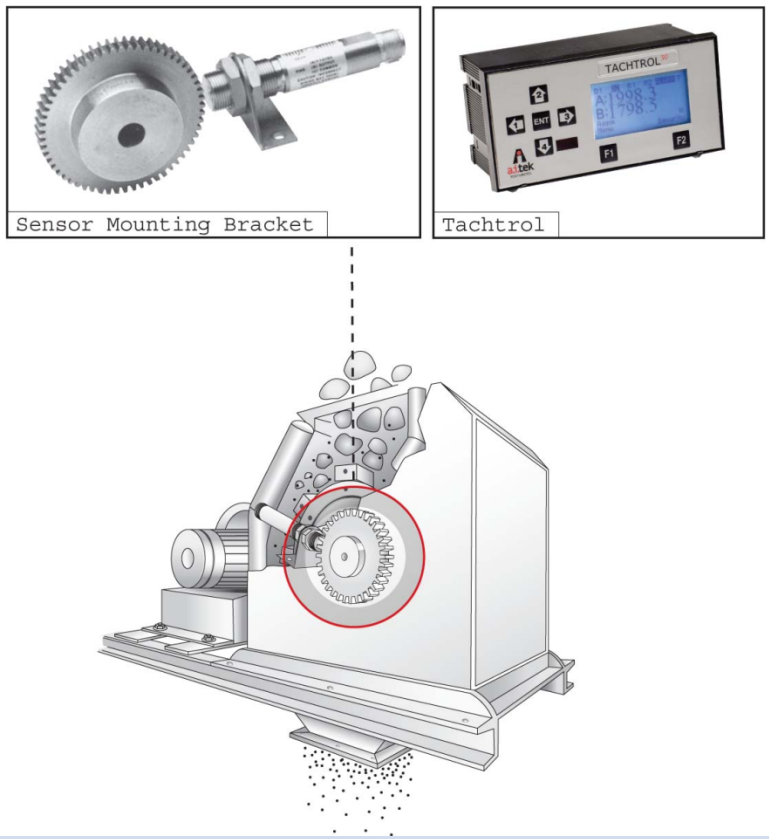
Detecting over-speed, under-speed or stoppage of fans and blowers



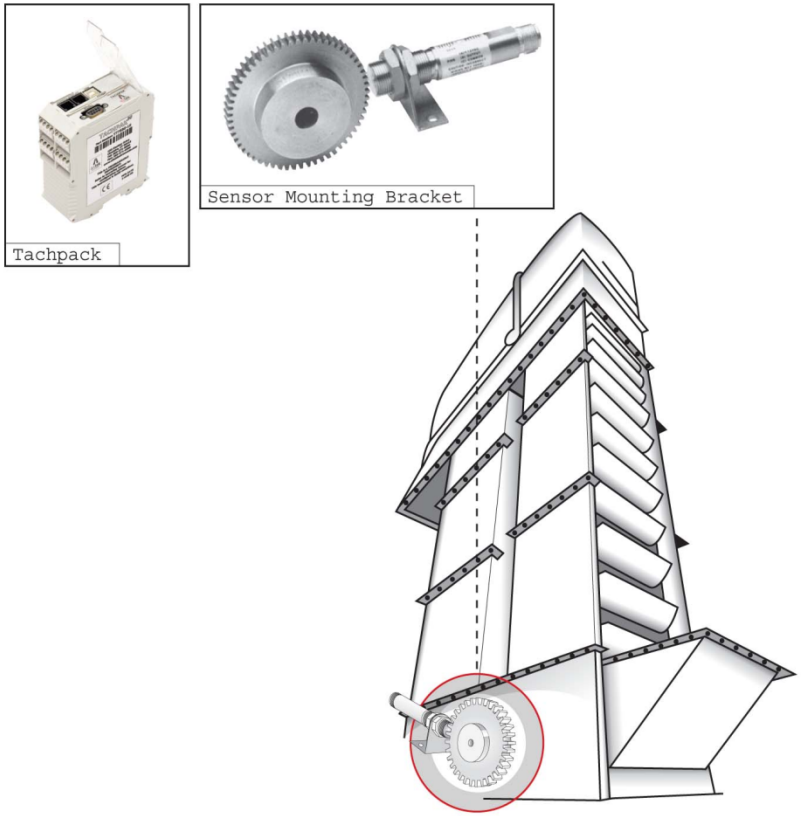


Monitoring web press

Tachometer/Sensor Applications

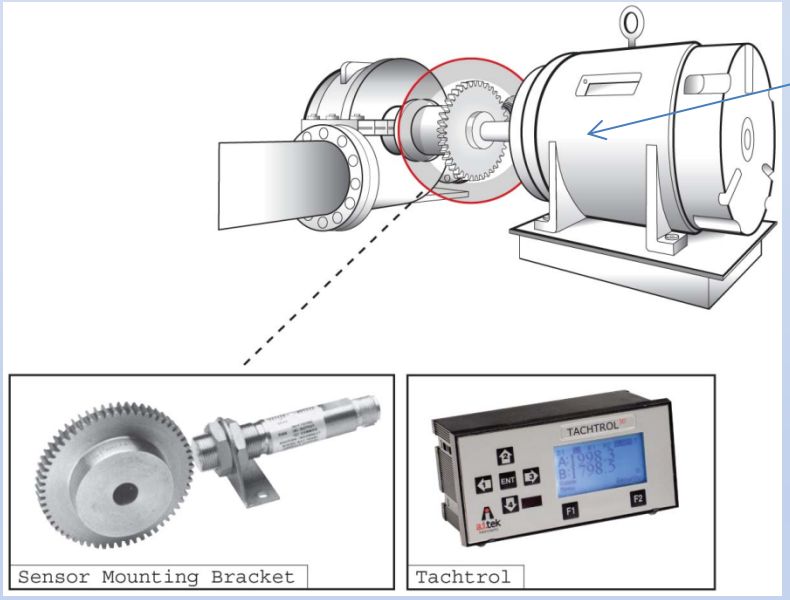


Monitoring hammer mill speed



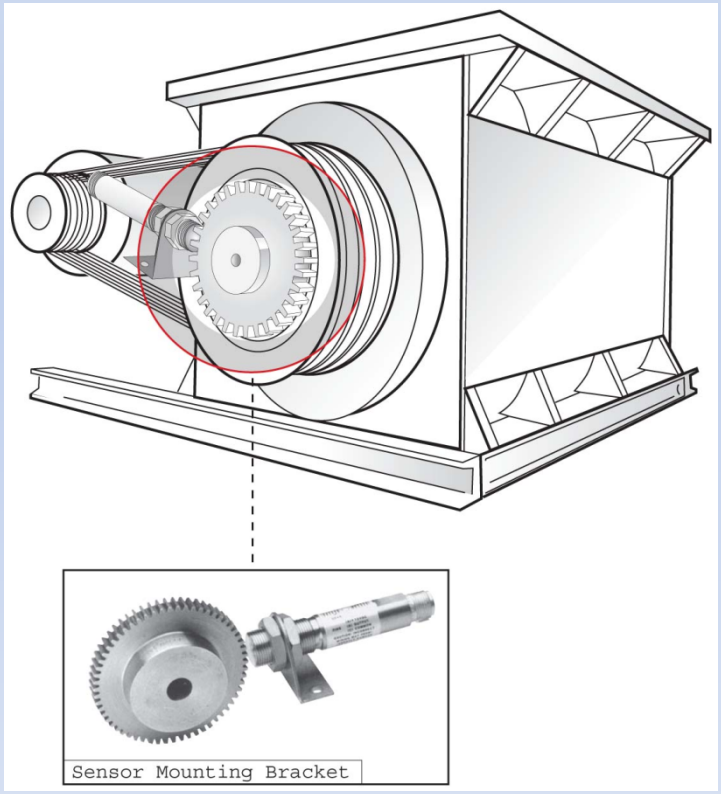
Monitoring shaft speed slowdown or belt slippage of a bucket conveyor

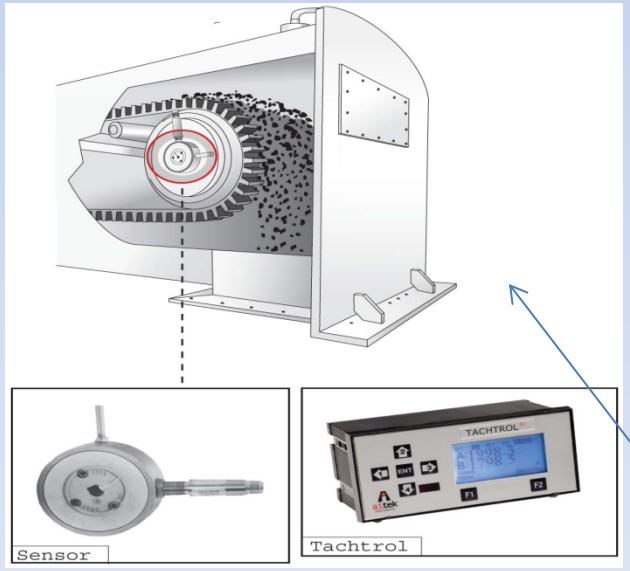
Tachometer/Sensor Applications



Pump application monitoring for reverse rotation or jam

Monitoring speed of a rotary air lock





Monitoring shaft speed and coal feed on volumetric coal feeder

AI-Tek Sensor Training
Key Sensor Selection Criteria

Target Info

Outside Dia. _____ # of Teeth (or holes) ____ Diametral Pitch (#T+2/OD in.)or module _____
Material _____

Mounting and Data needed

Max speed measured _____ Min. speed measured ____ Surface spd(OD* Π * RPM/60)
Max. ___ Min. ___

Air gap Max. _____ Min, _____ Min Output Voltage(Vp-p) _____Active Signal Type NPN PNP
Load on Sensor(ohms) _____ Thread size _____ length ____

Environment

Temperature _____ Atmosphere (air, oil, steam, pressure etc…) _____
Certification UL ____ FM ____ ATEX____ Termination (connector, cable, wire leads) _____
Other _____

Sales Detail

Volume/year _____ Target price_____ Due Date _____ Competition _____

Common Conversions

Formulas

f = RPM x PPR/60=ss x PPR/ Π x D

f = UPM x PPU/60 = UPH x PPU/3600

RPM = 60 x f/PPR = 60 x ss / Π x D

PPR = (D x DP)-2 = 60 x f/RPM

PPR = f x Π x D/ss

ss =RPM x Π x D/60=f x Π x D/PPR

D = (PPR +2)/DP = ss x PPR/f x Π

DP = (PPR +2)/D = 25.4/M

M = 25.4/DP = 25.4 x D/(PPR+2)

Definitions

f = frequency in Hz or cycles per second (cps)

RPM = rotary speed in revolution per minute

PPR = pulses per revolution or # of gear teeth

PPU = pulses per unit measure

Π = pi, 3.14

UPM = unit measure per minute

UPH = unit measure per hour

ss = surface speed in inches per second (ips)

D = outside diameter of target in inches

DP = diametral pitch, # teeth in 1 inch of pitch diameter

M = metric module, pitch diameter in mm divided by # of gear teeth