DEFT 3a TACHOMETER

USER'S MANUAL

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INTRODUCTION

The Deft-3a tachometer precisely and rapidly converts the quadrature signal from an optical encoder to an accurate, noise free analog output signal for control or monitoring purpose. The unit can detect direction of motion and converts the input frequency signal (DC to 100 kHz) to industry standard unipolar 0 to 10 volt DC or 4-20 mA analog outputs as well as bipolar output for reverse detection.

Advanced technology, innovative design of the receiver section and use of a sophisticated quadrature signal filter allow the Deft-3a tachometer to be placed at long distances from the encoder while maintaining excellent noise immunity in a harsh industrial environment. The use of a highly integrated frequency to voltage conversion stage followed by a proprietary adaptive filter provides a very fast response time (<15 ms) while keeping the low output ripple at an absolute minimum (<20 mV @ 1 Hz, <3 mV @ 300 Hz).

High precision components are used throughout the Deft-3a tachometer to insure a highly linear output with excellent temperature stability over the extended industrial range (-25°C to 85°C).

The Deft-3a tachometer is a permanently mounted field unit customized to user specifications.

DESCRIPTION

The Deft-3a tachometer system is composed of two parts: an optical encoder (provided by others) and a tachometer module.

Recommended Encoder: Optical Encoder with Quadrature Outputs

This type of encoder transmits two square wave signals whose frequencies are proportional to the encoder shaft rotational velocity. The two signals are in quadrature (out of phase by 90°), which enables digital filtering of the input signal and detection of the direction of rotation.

The encoder should use line driver outputs and have a minimum of 2000 PPR (Pulse Per Revolution) for maximum performance. It should also be sealed for rain and spray.

Use of the a proper coupling between the encoder and the monitored equipment shaft and precise alignment of the encoder shaft are extremely important. The tachometer output signal will be degraded due to precession noise and the encoder bearing may fail if proper care is not applied during the encoder mounting.

CDI can procure suitable encoders and couplings on request, or can provide detailed specification for direct procurement by the client.

A typical encoder suitable for use with the CDI tachometer is the following model:

Dynapar HSD25 (IP67 rated)
Model number HSD25 3600 7461 - 02
- Hollow shaft on one side
- Sealed
- 3600ppr
- ½" bore
- Slotted tether
- Differential outputs
- 5-26Vin, 5-26Vout, -40° to 100°C
- 7 pin connector plus mating connector
- Stainless Steel housing (-02)

Tachometer Module:

The tachometer module converts the square wave frequency signals to an analog output signal (+/-10 VDC or 4-20 mA).

The tachometer module consists of several stages; an input signal processing stage, an input filter stage, a pre-scaling stage, a converter stage, an output filter stage, and finally an output signal processing stage.

The input signal processing stage is opto-isolated from the other stages and can be configured for current loop (line receiver) or voltage inputs (from voltage or open collector sources).

The input filter stage includes a specialized digital quadrature filter that allow the Deft-3a tachometer to be placed at long distances from the encoder while maintaining excellent noise immunity in a harsh industrial environment.

The pre-scaling stage consists of a digital multiplier/divider module that allows the input frequency to be scaled to the base frequency range of the converter module (4-8 kHz full scale). The scaling options range from divide by 16 to multiply by 4.

The converter stage consists of a highly integrated and very accurate frequency to voltage conversion module. The full scale frequency of this stage can be adjusted between 4 kHz and 8 kHz with the span adjustment.

The output filter stage consists of a proprietary adaptive filter module designed to minimize output ripple while maximizing response time at any input frequency.

The output signal processing stage can be configured for unipolar current loop (4-20mA), bipolar current (12 to 4mA, 12 to 20mA) or voltage outputs (0-10 VDC or +/- 10 VDC).

Several power options and several analog output options are available as described below.

Power options:

The tachometer module requires 24VDC power.

In typical applications, a 5V encoder is used which is powered from the tachometer module internal 5 VDC bus isolated.
For complete isolation from the internal board, use a 24V encoder. In this case, jumpers J1 and J2 and J18 and 19 must be removed internally and J3 and J4 must be installed to supply power to the front end receiver and encoder. Jumpers 18 and 19 bypass current limiting resistors to allow higher current through the opto-isolation for 5V operation. J18 and 19 must be removed for 24V encoder operation so that the optical isolation LED is not subjected to excessive current.

Analog Output Options:

Several options are available for the analog output signal:

- 0-10 Volt unipolar
- +/- 10 Volt bipolar (negative voltage in reverse direction)
- 4-20 mA unipolar
- 12 – 4ma, 12 – 20mA bipolar

Status LED’s:

The Deft-3a tachometer is equipped with two diagnostic LED’s located on the faceplate:

- Power - 24 VDC power and 5V internal power.
- Direction - Green: forward
- Red: reverse

Digital Outputs:

The Deft-3a tachometer can be equipped with two optional relays with adjustable trip threshold.

- Over speed
- Auxiliary – Under speed or Reverse Detection

SPECIFICATIONS

Input Signal

Type	Quadrature
Maximum Frequency	100kHz
Full Scale Frequency	1-100 kHz (with pre-scaling)
Base Frequency	4 - 8 kHz
Pre-Scaling Range Settings	x4, x2, x1, /2, /4, /8, /16 (DIP switch selectable)
Input Impedance	2kΩ
Sensitivity	1 volt
Max. Differential Voltage	30 volt
Isolation	1500 volt (requires Isolated Encoder Power)

Distance to Encoder (with line driver outputs, 8830 or equivalent)

Maximum Distance At 100 kHz	1000 feet
Maximum Distance At 50 kHz	3000 feet

Analog Output

Standard output	0-10 volt Unipolar into 5 kΩ
Optional outputs	±10 volt Bipolar into 5 kΩ
	4-20 mA Unipolar or Bipolar into 500 Ω
Span Adjustment	50-100% of Full Scale
Response Time (0-90% fs)	10 ms (>8 kHz), 15 ms (<8 kHz)
Output Ripple	<20 mV at 1 Hz, <3 mV above 300 Hz
Non-Linearity	0.005% of Full Scale Typical
Temperature Drift	0.01% per °C Typical

Power

Standard Power	18-30 VDC at 200 mA

Encoder Power

Standard Power	5 VDC at 150 mA
Optional Isolated Power	24 VDC at 150 mA

Digital Outputs (optional)

Over speed Relay	0-100% Full Scale
Auxiliary Relay	0-100% Full Scale
Relay Specifications	SPDT, 2 amp DC, 0.6 amp AC

General

Temperature Range	-25 to +85°C
Enclosure	DIN rail mounted Aluminum
Connectors	Phoenix® Mini Combicron, 3.81mm pitch

Figure1: DEFT3a Mechanical Layout (mm)

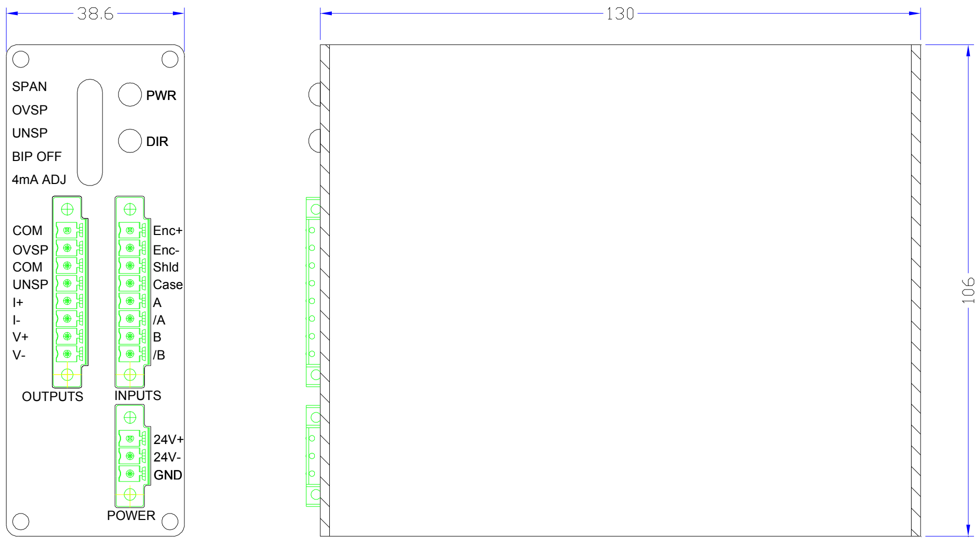
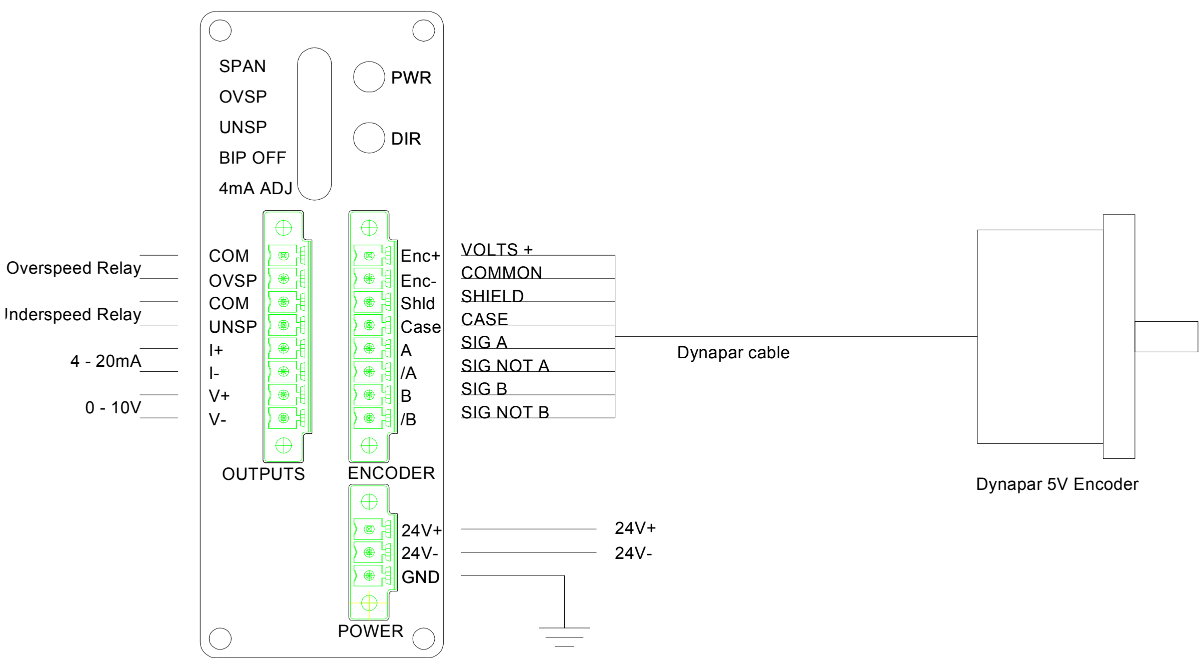


Figure 2: Typical Wiring Diagram with Internal encoder power



Note:
- The DEFT3a has different wiring than the DEFT3 and different terminal blocks.
- The encoder shield should be connected on the tachometer side only, but the 4-20 mA shield should be connected on the PLC side only.

Configuration Calculations

Pre-Scaling:

- The pre-scaling stage should be set to bring the full scale input frequency within the base frequency range of 4-8 kHz.

For instance, for a full scale input frequency of 1.5 kHz, the pre-scaling should be set to multiply by 4 (X4) for a scaled frequency of 6kHz.

- Similarly, with a full scale input frequency of 14 kHz, the pre-scaling should be set to divide by 2 (/2) for a scaled frequency of 7kHz.
- The span adjustment is then used to adjust the current output.

Configuration

- A common configuration is for a 4-20 mA unipolar output with a full-scale output of 133% of the nominal operating speed. As a result, the output is 4.0 mA when stopped and 16.0 mA at 100% operating speed. This calibration scheme enables over speed detection.
- Your tachometer will come set to 20mA at an integer multiple of 1kHz appropriate for your installation. You may change this with the DIP switches and the SPAN adjustment.

Nominal Frequency (Hz) = Shaft RPM * Encoder PPR / 60

- The relationship between current output (mA), input frequency, and calibration frequency is as follows:

$$\text{Iout (mA)} = 4.0\text{ mA} + 16 * \frac{\text{Input Frequency}}{\text{Full Scale Freq}}$$

- For example, with a full scale frequency of 5 kHz and an input frequency of 2 kHz, the output current is:

Iout = 4.0 mA + (16 *(2.0 / 5.0)) = 10.4mA

Single Ended Input: If your encoder signal is only one signal (3 wire operation) remove jumper 11.

Caution, ESD danger: Opening the case and touching the circuit board will damage the DEFT3a from static shock. The power must be off and the technician must be grounded with a wrist strap connected to ground before opening.

Encoder power:

Caution: Failure to set the proper jumpers for encoder power will destroy the tachometer.

The jumpers can be accessed by removing the front plate, the enclosure can remain on the DIN rail.

For 5V encoders, power can be provided by the DEFT3a 5V internal supply: Jumpers 1 and 2 in. Also jumpers 18 and 19 in to bypass current limiting resistors to the opto-isolators.

For 24V externally powered encoders, power can be provided by the 24V supplying the DEFT3a: jumpers 3, 4 in, 1,2 out. Jumpers 18 and 19 out to allow current limiting to the opto-isolators.

Top Board – with power supplies and LEDs

5V Encoder	**24V Encoder**
Jpr 1,2 IN	Jpr 1,2 OUT
Jpr 3,4 OUT	Jpr 3,4 IN
Jpr 18,19 IN	Jpr 18,19 OUT

Bottom Board – with adjustment potentiometers

Encoder Input		**Auxiliary Relay** (newer versions only)	
Differential:	Jpr 11 IN	Under speed:	**JP** 1,3 IN
Single:	Jpr 11 OUT	Direction:	**JP** 2,4 IN

Note difference between **Jpr** and **JP**, different jumpers!

ADJUSTMENTS

Basic Adjustments

Use the Tachometer Calibrator to simulate an encoder. The calibrator outputs a quadrature signal at exact, discrete frequencies. Use the installed encoder cable to verify cable connections as well.
With the shaft stopped, turn the P6 potentiometer “4mA Adj” (accessed by removing backplate) to read 4.0 mA at the “Iout” output signal.

Start the system and run it at full speed (100%). Use P1 “SPAN” to adjust for the desired output.

DIP Switch Setting

The DIP switches are accessed by removing the back plate however, the Direction switch can be accessed by a hole without removing the back plate.

Switches 1 to 3 are used to set the signal pre-scaling parameters. The input frequency must be scaled to match the base frequency range of the tachometer (4-8 kHz).

Switch 5 sets the direction of motion. It should be set so that the direction LED is green when forward and red when running reversed.

Switch 6 is used to disable the digital quadrature filter. This option is provided for compatibility with older system, and should only be used when a non-quadrature encoder is used. Should be Off if a quadrature signal.

DEFT 3a DIP Switch Settings

FREQUENCY PRE-SCALE			
SETTING	SW1	SW2	SW3
X4	ON	ON	ON
X2	OFF	ON	ON
X1	ON	OFF	ON
/2	OFF	OFF	ON
/4	ON	ON	OFF
/8	OFF	ON	OFF
/16	ON	OFF	OFF

SW4		(for future use)
SW5	ON	CLOCKWISE FORWARD
	OFF	CCW FORWARD
SW6	ON	NO QUADRATURE FILTER
	OFF	QUADRATURE FILTER (normal position)

REPAIR and HELP

Faulty tachometers can be returned to CDI for diagnostics and repair. Please indicate what the symptoms were when the tachometer was replaced. Return address for Conveyor Dynamics, Inc:

Attn: Instrumentation Engineer
Conveyor Dynamics
1111 West Holly
Suite A
Bellingham, WA 98225

Phone:	360-671-2200
Fax::	360-671-8450
Email	cdi@conveyor-dynamics.com