Table of Contents

I. Introduction

STACKTACH is a single-input industrial tachometer that measures the rate of events. Using various sensors, STACKTACH can measure events as simple as the speed of a rotating shaft, the rate at which paper passes through a press, or as diverse as the rate at which liquid flows through a pump.

1.1 Overview

STACKTACH's microcomputer uses a scheme of data acquisition called adaptive period averaging, a unique frequency measuring method in which the number of periods averaged changes with the frequency to obtain optimal accuracy. At input frequencies of 100 Hz and above, the outputs are updated every 30 milliseconds.

The input signal is a repetitive signal that is proportional to the event you want to measure. The STACKTACH measures the rate in terms of Hertz (pulses per second) and then outputs an analog signal or relay function. Both functions are programmable to meet your specific application via a separate programming pendant.

STACKTACH provides two scaleable output types:

- 0-20/4-20 mA DC analog output
- One Form C (SPDT) relay setpoint

To set up STACKTACH, first determine how each output should behave in your application, then enter the setup information as six "constants" through the STACKTACH's programming pendant (See Section 4.) The constants are stored in STACKTACH's electrically alterable read-only memory (EAROM). They can be viewed and altered individually in much the same way you set a digital watch.

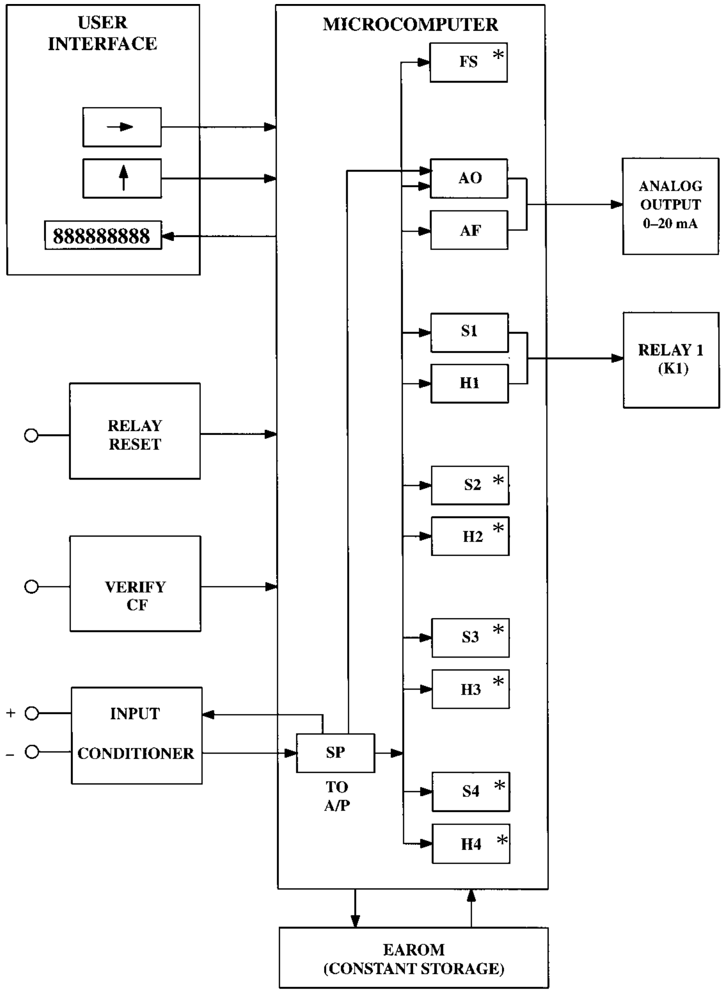


Figure 1. Operation Flow Diagram
** Constant not used in this intrument.*

To put STACKTACH into operation, complete the following steps:

1. Mount STACKTACH — See Section 3.2
2. Install and connect the appropriate output wiring. — See Section 3.4.2
3. Install and connect the speed sensor — See Sections 3.3, 3.5.1 & 3.5.2
4. Install and connect the power wiring — See Section 3.5.3
5. Enter the constants into STACKTACH — See Section 6

This manual describes all five steps.

NOTE

Note: By connecting temporary power wiring, STACKTACH can be powered up and programmed prior to mounting it on the application.

1.2 Tools

You will need the following tool to perform the procedures described in this manual:

Straight blade screwdriver, 1/8" (3.8mm) or smaller.

1.3 Notes and Cautions

This manual uses the following conventions:

NOTE

Note: provides an explanation or amplification.

CAUTION

Caution: advises you risk damaging your equipment if you do not heed instructions.

DANGER

Danger: advises you risk danger to personal health if you do not follow instructions carefully.

1.4 Where to Go for Help

For technical support and programming assistance on this product, please contact your area distributor. To locate the distributor closest to you, please call:

(800) 576 - 6308

Fax: (714) 751 - 0213

E-Mail: thien@flw.com

2. Unpacking Instructions

To ensure safe transit every STACKTACH is thoroughly tested and carefully packed before leaving the plant. Responsibility for its safe delivery was assumed by the carrier upon acceptance of the shipment. Claims for loss or damage sustained in transit must be made to the carrier.

2.1 Package Contents

STACKTACH is shipped in a single carton that contains:

- one STACKTACH
- one instruction manual

NOTE

Note: Electrical and mounting hardware are not supplied.

2.2 Unpacking

CAUTION

CAUTION: STACKTACH is a precision instrument. Although it is designed to withstand the rigors of industrial use, excessive physical shock or vibration can damage it. Handle it carefully. Do not drop or subject it to physical extremes exceeding those specified in Section 7.1.4.

1. Place the carton on a level surface in a well-lighted area and open the top.
2. Carefully lift out STACKTACH and the packing material.
3. Remove the packing material.
4. Remove the instruction manual from the carton.
5. Inspect your STACKTACH for concealed damage.

3. Mounting and Wiring Procedures

3.1 Installation and Wiring Guidelines

Adhere to these guidelines when installing your instrument:

1. Locate STACKTACH away from sources of water, humidity, heat, and dust; or provide a suitable enclosure to protect it from these elements.

2. Separate low voltage signal and control wiring from switching and power wiring. Plan cabinet and panel wiring so that the power and relay wiring are dressed to one side and low level signals dressed to the other side. Plan wiring to maintain separation at entry to and egress from the enclosure.

3. Signal and control wiring should be at a minimum run in twisted pairs. Lines for magnetic pick-ups, pulse type outputs and other frequency devices should be run in separate shielded cables.

4. Try not to use commutators or slip rings to transmit low level signals. Should this be absolutely necessary, ensure that the point of contact is maintained and clean at all times. Refer questions about this type of application to your local distributor.

5. Connect the shields of shielded cables so that no current flows in the shield by first connecting all of the shields in series then to the shield terminal #3. Do not ground the shield at any point other than the instrument. If equipped with a metal enclosure, connect the enclosure to an earth ground.

6. DC power supplies sourcing the tachometer should operate within the limits provided in the instrument's specifications. Applications involving battery chargers should be avoided unless isolation can be provided between the charger system and STACKTACH.

   In the event DC power is not available, please contact your area distributor for an AC-DC power supply.

3.2 Mounting STACKTACH

Locate the STACKTACH enclosure to allow for proper clearances as shown in the figure below.

Unit is designed to mount on a 35mm DIN Rail.

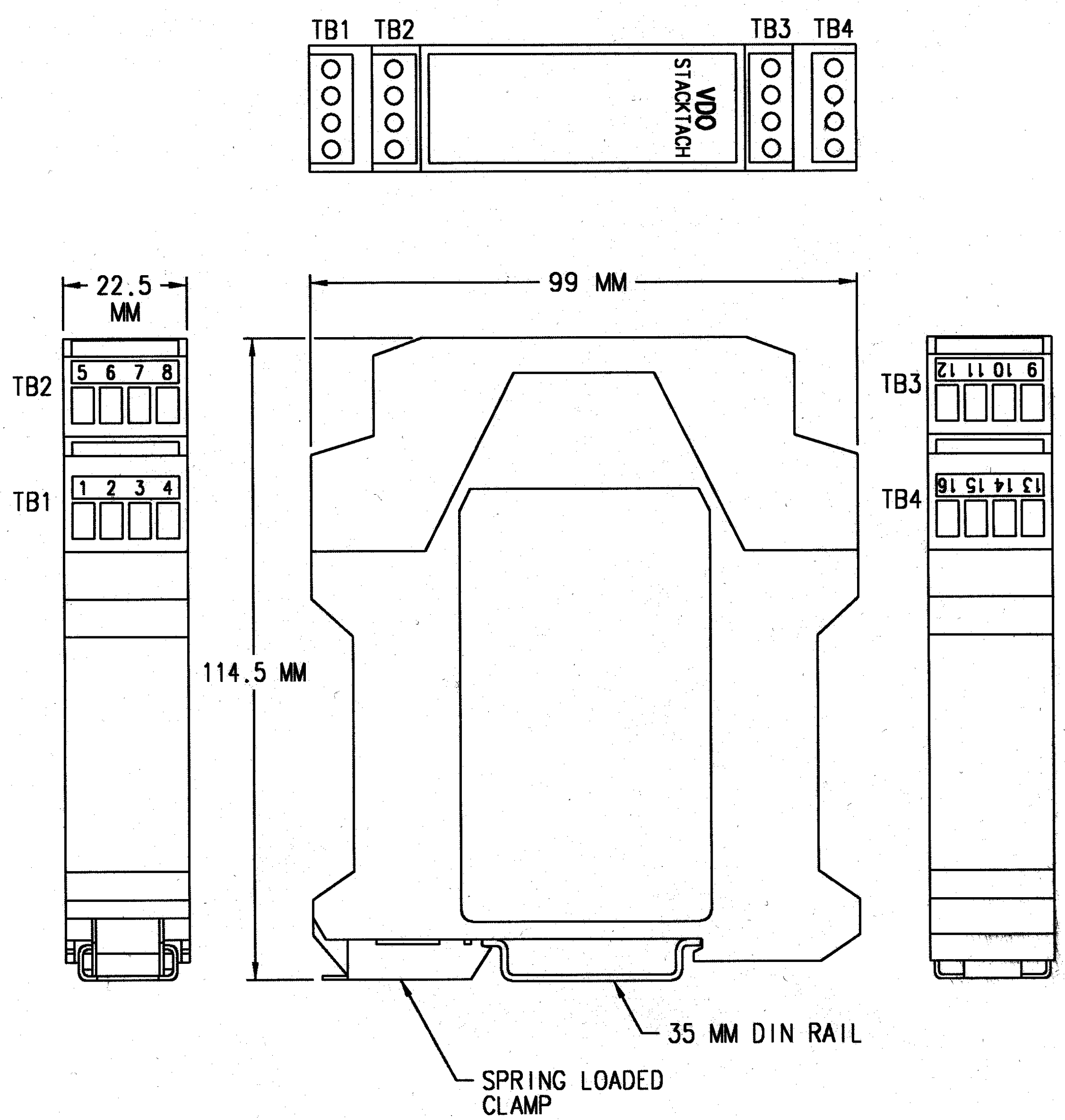


Figure 2. STACKTACH on DIN Rail.

3.3 Mounting Speed Sensor

The sensor should be secured in a rigid mount. Normal machine vibration should not affect the accuracy of the instrument; however, any relative motion between the sensor and the target can produce an extraneous pulse. A loose sensor or vibrating mount that causes the sensor to move towards and away from the target may potentially produce unwanted signals measured by the tachometer.

3.3.1 Using Through-hole Mount

Use two jam nuts and feeler gauge to position sensors at the proper airgap and orientation. Secure in position.

3.3.2 Using a Threaded Opening

CAUTION

CAUTION: Disconnect all power and lockout machinery.

1. While looking through mounting hole, rotate target manually until a tooth or high point is directly under opening.

2. Thread sensor in (CW) until it lightly contacts the highest point of the target.

3. Back sensor out (CCW) a partial rotation to approximate desired airgap as defined by sensor requirement. Reference Infomation:

1 revolution of 5/8-18 thread	=	.056" airgap
1 revolution of 3/4-20 thread	=	.050" airgap

a.) If unit is an active sensor, orientation flat(s) or notch must be aligned to gear tooth. Only two points * of rotation will give a functional signal.

b.) When mounting an active sensor in this method, if first alignment point is less than 1/4 of a rotation, it is suggested using next alignment point at an additional 1/2 turn.

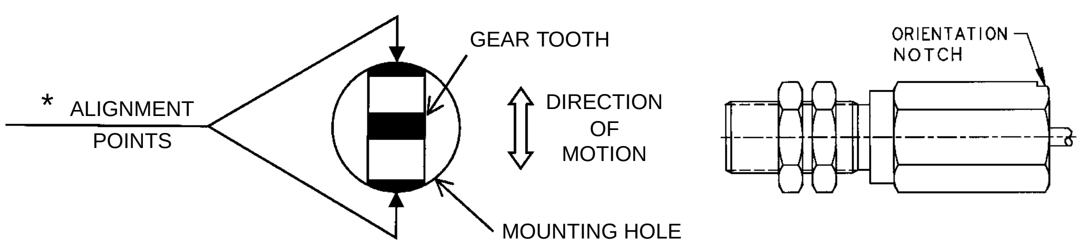


Figure 3. Sensor Mounting & Orientation in Threaded Opening

4. Once in position use jam nut to secure sensor.

CAUTION

CAUTION: Do not overtighten the jam nut(s).

CAUTION

CAUTION: At no time in its revolution should the target touch the sensor or damage to the sensor will occur.

3.4 Wiring Connections

Electrical connections are made to the four terminal blocks on the STACKTACH. The terminal blocks provide connections for DC power, output relay wiring, sensor connections, analog output, reset and calibrate functions.

3.4.1 Accessing the Terminal Blocks

* Push in both sides and pull up. Enclosure will open 39 mm (≈1.5") upward to expose pendant connection for programmming. Terminal blocks become more accessible. Each terminal block can also be removed by prying with a screwdriver. Return each block when finished with connections → .

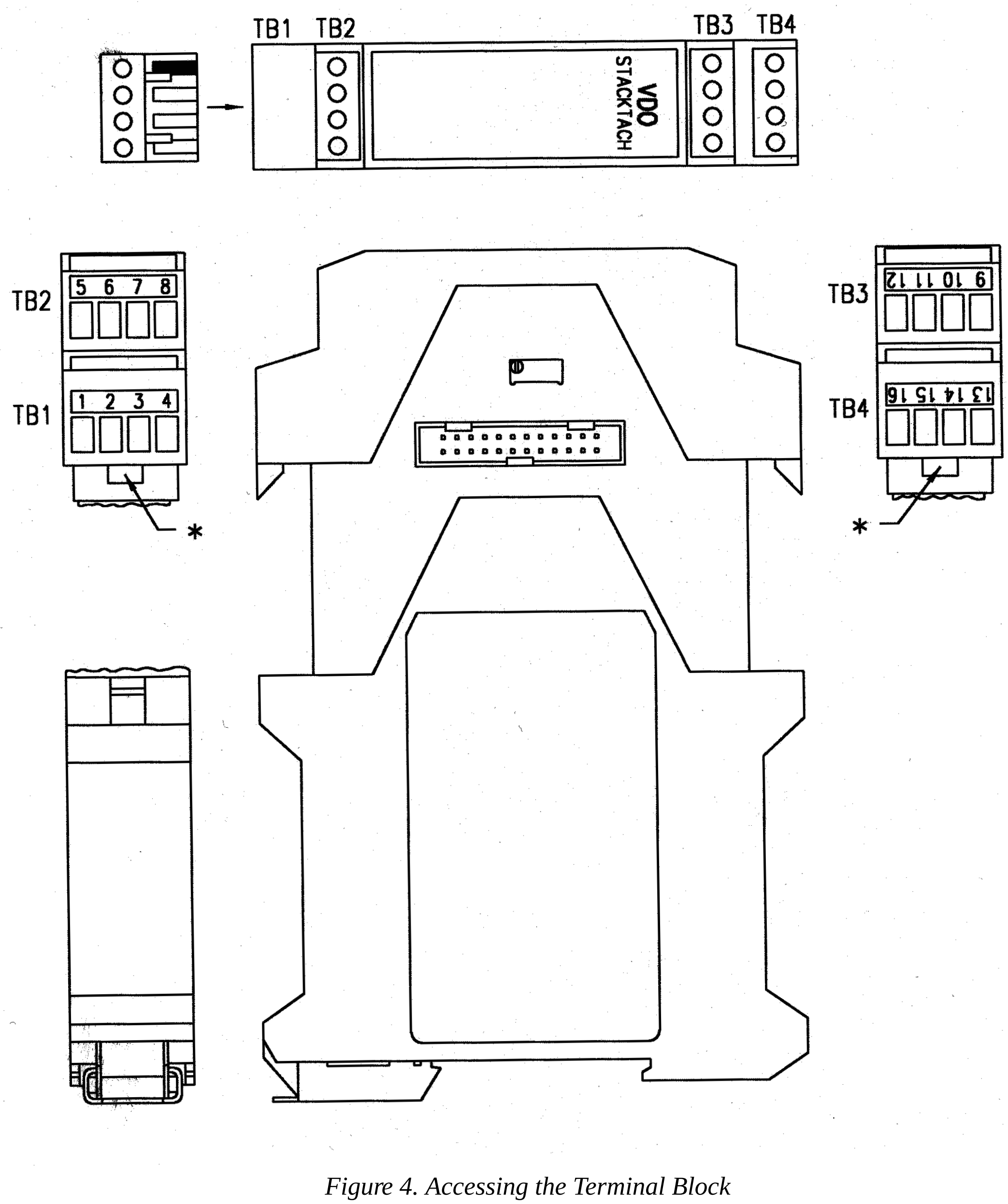


Figure 4. Accessing the Terminal Block

3.4.2 Terminal Block Assignments (T77410-10)

The terminal block assignments are shown below.

Terminal Block #	Terminal	Description
TB1	1	Input Signal +
TB1	2	Input Signal -
TB1	3	Shield
TB1	4	+12 Vdc Output (50 mA max.)
TB2	5	0-20/4-20 mA Analog Output (+)
TB2	6	0-20/4-20 mA Analog Output (-)
TB2	7	Verify/Calibrate (when connected to +12 Vdc)
TB2	8	Digital Common
TB3	9	Digital Common
TB3	10	+24 Vdc Input
TB3	11	Relay Reset (when connected to Digital Common)
TB3	12	Earth
TB4	13	K1 Common
TB4	14	No Connection (not used)
TB4	15	K1 Normally Closed
TB4	16	K1 Normally Open

CAUTION

CAUTION: Signal leads between the sensor and STACKTACH should be shielded twisted pair with insulation over the shielding. This will provide effective noise shielding and is recommended for all sensor, analog output, and meter output cables. Nevertheless, do not run signal leads near noise sources such as switches and power lines that carry large currents.

Connect shields at the instrument end only. Trim the shield at the sensor end and insulate it to prevent any electrical contact with the conduit or other grounds, if sensor is <u>not</u> made by AI-tek/Airpax.

3.5 Types of Speed Sensors

STACKTACH is designed to operate with standard Airpax sensors. For applications using irregular discontinuities as targets consult Airpax Product Catalog (#13000) or your local distributor.

The type of speed sensor used with STACKTACH depends on the speed of the application being monitored. Passive (non-powered) speed sensors that produce a signal in the form of an analog sine wave can be used with STACKTACH in most applications. Low-speed applications require active (powered) zero-velocity speed sensors that produce a signal in the form of a digital square wave. You will have to tell STACKTACH what type of signal it will be receiving as described in Sections 3.5.1 and 3.5.2.

If you are using another manufacturer's speed sensor, follow their recommended installation procedures.

3.5.1 Connecting a Passive Sensor

These connections are for a passive sensor producing a zero-crossing analog sine wave.

Connect the sensor as shown in the diagram below.

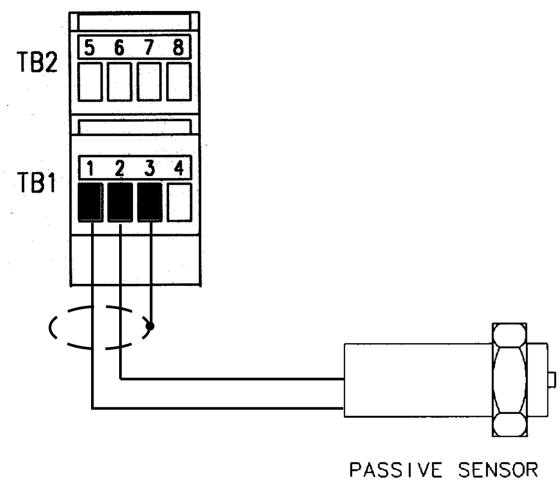


Figure 5. Passive Sensor Connection

NOTE

> *Note: Be sure to enter a "P" for passive in the special constant (SP) when you enter the constants. (See Section 5.5.1.)*

3.5.2 Connecting an Active Sensor

These connections are for an active sensor producing a ground-referenced digital square wave. Other active or TTL sensors should be connected the same way.

Connect the sensor as shown in the diagram below.

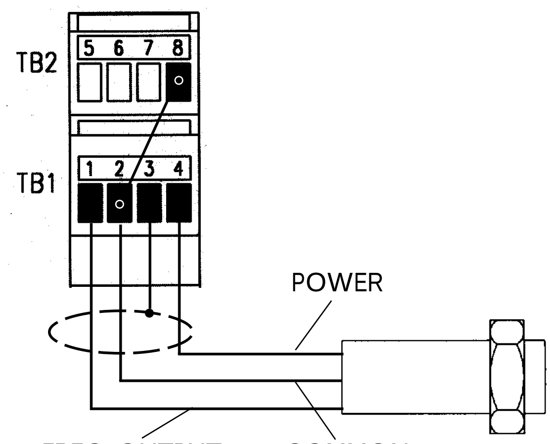


Figure 6. Active Sensor Connection

NOTE

Note: Be sure to enter an "A" for active in the special constant (SP) when you enter the constants. (See Section 5.5.1.) Also make sure to connect 2 and 8 with jumper.

3.5.3 Verification Circuit

You can set up the optional verification circuit at this time according to the wiring diagram below. Closing this S.P.S.T. external switch (not supplied) will turn off the incoming frequency signal and will generate an internal verify frequency signal equal to "CF" value. Opening the switch will return the STACKTACH to tach mode.

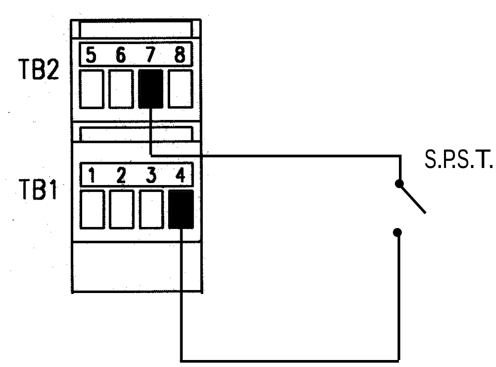


Figure 7. Verify / Calibrate Connection

3.5.4 Relay Reset Circuit

If the "L" latching mode is used with K1 relay, you will need an external Momentary, Normally Open, S.P.S.T. switch. Closing the switch will reset the latched relay.

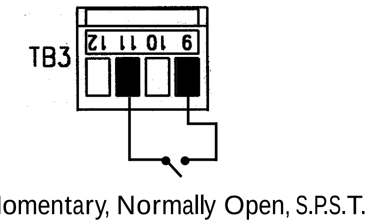


Figure 8. Relay Reset

3.5.5 Connecting the DC Power Supply

CAUTION

CAUTION: Do not exceed the maximum supply voltage to STACKTACH as specified in Section 7.1.1.

DANGER

DANGER: 24Vdc normally does not represent a threat to personal safety. However, care should be exercised while working with the power source. Do not touch or place objects in the power supply area when power is being applied to the STACKTACH. If STACKTACH has already been connected to a power source, disconnect it before proceeding. Proper lockout procedures should be observed.

Wire power from Airpax power supply T77410-120AC or T77410-230AC or from another +24 Vdc supply.

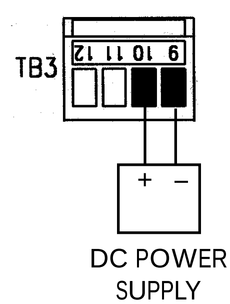
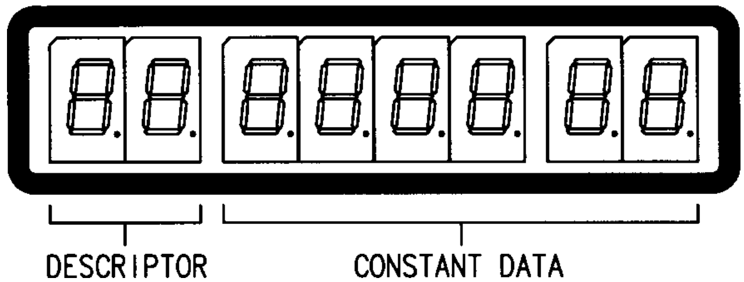


Figure 9. DC Power Connection

4. Programming Pendant

The programming pendant is an optional accessory that permits programming of the STACKTACH. The pendant provides a means of interface to the user, and its controls consist of two pushbuttons and an eight character LED display used to show and modify the constants. The general layout of the display is shown below.



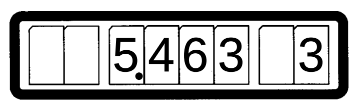
Modify the values of the constants using the up arrow and right arrow keys.

The digits appearing in the display vary according to the descriptor being displayed. The location of the cursor is shown by the blinking digit or digits.

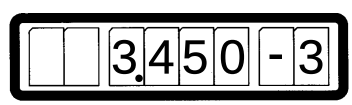
4.1 Scientific Notation

Before entering frequency values into STACKTACH, convert them to scientific notation and round them to four digits. Enter only the four most significant digits and the exponent. To convert a number to scientific notation, you express it as a decimal value with one significant digit to the left of the decimal point, multiplied by a power of 10. The exponent of 10 is the number of places the decimal point has been offset to the left (positive) or right (negative). For example, in scientific notation:

$5463 = 5.463 \times 10^{3}$

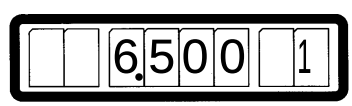


$0.00345 = 3.450 \times 10^{-3}$

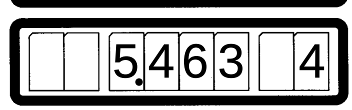


To round a number to four digits, add the necessary number of zeros to bring it up to four digits, or round off to reduce it to four digits. The following examples illustrate this:

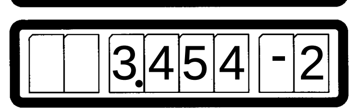
$65 = 6.5 \times 10$ 6.500×10^{1}



$54627 = 5.4627 \times 10^{4}$ 5.463×10^{4}



$0.034538 = 3.4538 \times 10^{-2}$ 3.454×10^{-2}



5.0 Characteristics of Operation

5.1 The Constants

The constants and their descriptors are listed below in the order they appear in the display, with standard constant as set at the factory.

Constant	Descriptor	Std. Constant
Meter Full Scale Frequency	F S ⊗	*
Analog Zero Scale Frequency	A 0 ⊗	0.0 0 0 ○ 0
Analog Full Scale Frequency	A F ⊗	3.0 0 0 ○ 4
Calibrate Frequency (verify)	C F ⊗	3.0 0 0 ○ 4
Setpoint 1 Frequency	S 1 ⊗	5.0 0 0 ○ 3
Setpoint 1 Hysteresis and Type	H 1 ⊗	E A h 1 0.0
Setpoint 2 Frequency	S 2 ⊗	*
Setpoint 2 Hysteresis and Type	H 2 ⊗	*
Setpoint 3 Frequency	S 3 ⊗	*
Setpoint 3 Hysteresis and Type	H 3 ⊗	*
Setpoint 4 Frequency	S 4 ⊗	*
Setpoint 4 Hysteresis and Type	H 4 ⊗	*
Special	S P ⊗	0 ⊗ P ⊗ 1.0

* Not used on STACKTACH even though values are shown on descriptor.

5.2 Constant Descriptions

To control the operation of STACKTACH, you will determine, enter, and store values for 5 operational constants and one calibration constant in memory.

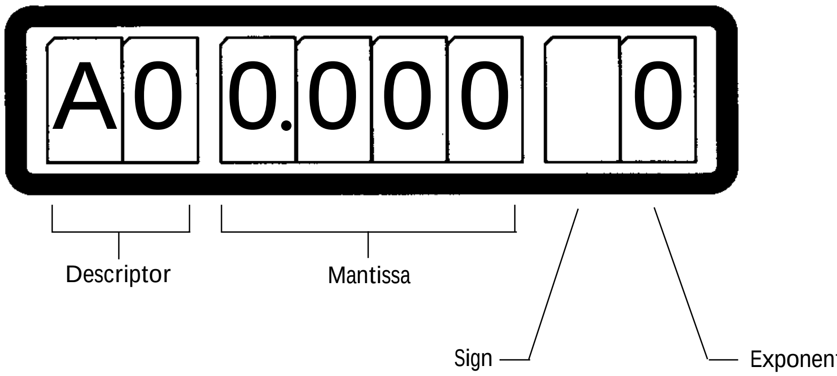
This chapter describes each of the constants in detail and gives procedures and examples for determining the value of each constant. Section 6 describes how to enter and store the constants in STACKTACH.

NOTE

Note: Values for the constants are entered in scientific notation. If you are unfamiliar with scientific notation, see Section 4.1 for directions.

5.3 Analog Zero Scale Frequency (A0)

5.3.1 Display Format for Analog Zero Scale Frequency



5.3.2 Determining Analog Zero Scale Input Frequency

The analog output from STACKTACH is a proportional current source of either 0 to 20 mA or 4 to 20 mA that can be used to drive industrial devices such as recorders, meters, controllers and instruments operated by a current loop. You must determine the frequency at which the analog output delivers the minimum (zero scale) and maximum (20 mA) current.

NOTE

Note: Values for the constants are entered in scientific notation. If you are unfamiliar with scientific notation, see Section 4.1 for directions.

To determine the analog output zero scale frequency, use the frequency formula below to determine the frequency at which the analog output will deliver the zero scale current value.

$$\textbf{\textit{FREQUENCY}} = \frac{\text{RPM x PPR}}{60}$$

Record this value on the setup sheet and enter it in the Analog Zero Scale Frequency Constant (A0). Section 6 describes how to enter constants.

To specify the zero scale current value, enter either 0 or 4 in the Special Constant (SP). (See Section 5.6.1.)

Sample application. You are using a STACKTACH to sense the speed of a gear with 48 teeth. At the desired analog zero scale frequency, the gear is turning at 500 rpm. The formula is:

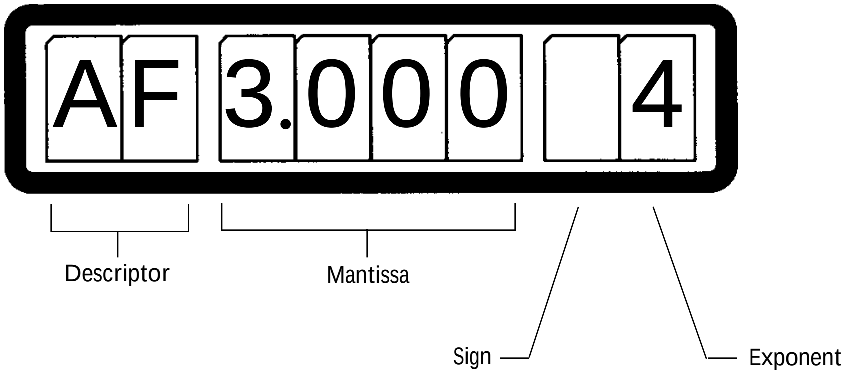
$$\textbf{\textit{FREQUENCY}} = \frac{\text{RPM x PPR}}{60} = \frac{500 \text{ x } 48}{60} = \textbf{\textit{400 Hz}}$$

Convert to scientific notation, round to four digits, and record on the setup sheet:

400 Hz = 4.000×10^{2}

5.4 Analog Full Scale Frequency (AF)

5.4.1 Display Format for Analog Full Scale Frequency



5.4.2 Determining Analog Full Scale Input Frequency

Use the frequency formula below to determine the frequency at which the analog output will deliver 20 mA.

$$\textbf{\textit{FREQUENCY}} = \frac{\text{RPM x PPR}}{60}$$

Convert the result to scientific notation and record it on the setup sheet.

NOTE

Note: You can invert the scale by making the zero scale value larger than the full scale value.

NOTE

Note: The 0-20 mA can be converted into a 0-5 VDC or 0-10 VDC signal by placing a scaling resistor across the input of the receiving instrument. The parallel combination of the scaling resistor and the input resistance of the instrument must equal 250 ohms for 0-5 VDC or 500 ohms for 0-10 VDC.

Sample application. You are monitoring a 60 Hz power line and want to use the analog output to drive a recorder that will record fluctuations in the frequency of the power line. Your area of concern is the frequency around 60 Hz.

If you set the analog zero scale at 1 Hz and the full scale at 60 Hz, the span of the scale (the difference between the full scale value and the zero scale value) would be so small that fluctuations around 60 Hz would be difficult to observe. To create an expanded scale that magnifies the portion of the frequency scale you are concerned with, you might set the Analog Zero Scale Frequency (A0) to 57 Hz, and the Analog Full Scale Frequency (AF) to 63 Hz.

NOTE

Note: The span of the analog output (the difference between AF and AO) should not be expanded beyond .05 ($\frac{1}{20}$) of the full scale value (AF). To check this relationship, use the following formula:

$$\frac{AF - AO}{AF} \geq .05$$

In the power line example, the full scale value is 63 Hz, so the span of the expanded analog scale must be greater than or equal to 3.15 Hz (63 x .05).The expanded scale in the example is 6 Hz wide, which is acceptable. However, a 59 Hz zero scale value and a 61 Hz full scale value produce a span of only 2 Hz, which would be unacceptable.

Since the power line frequencies in this example are already in Hz, you simply convert them to scientific notation, round to four digits, and record them:

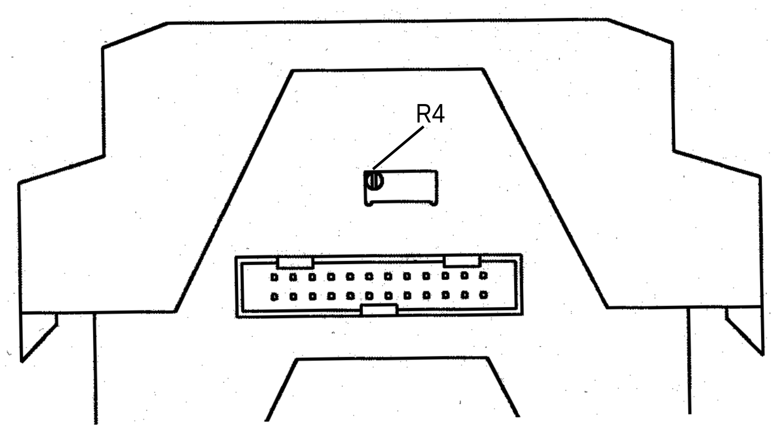
- Analog zero scale frequency = 5.700×10^1
- Analog full scale frequency = 6.300×10^1

NOTE

Note: With expanded scales, the greater the magnification of the scale, the greater the magnification of mechanical irregularities such as machine jitter.

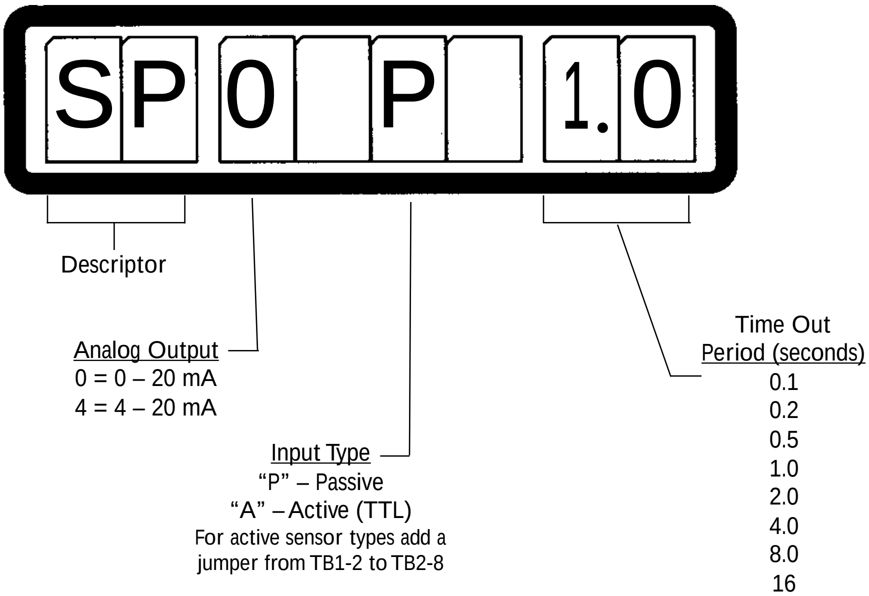
5.4.3 Analog Output Full Scale Adjusting Potentiometer (R4)

- Located above pendant connector, accurately set at factory
- Requires no calibration
- May be adjusted by inputting an accurate frequency signal equal to the "AF" value and by adjusting R4=20.0 mA, using a calibrated current (mA) meter



5.5 Special Constant (SP)

5.5.1 Display Format for Special Constant (SP)



The special constant is used to set the following parameters:

- The zero scale value expressed in milliamperes delivered by the analog output (either 0 mA or 4 mA). See Section 5.3.2.
- The input type (passive or active). See Sections 3.5.1 and 3.5.2.
- The lowest measured frequency (time-out period) See Section 5.5.2.

5.5.2 Lowest Measured Frequency (time-out)

This parameter sets the amount of time required to recognize that the process is stopped. You must choose one of the eight periods listed in the table below and enter the corresponding time-out period in the special constant. (See Section 6.) This is the amount of time STACKTACH will wait to end the data acquisition.

NOTE

Note: You should not pick a time out period that is lower than is required by the application, because this period is the amount of time required to indicate zero speed.

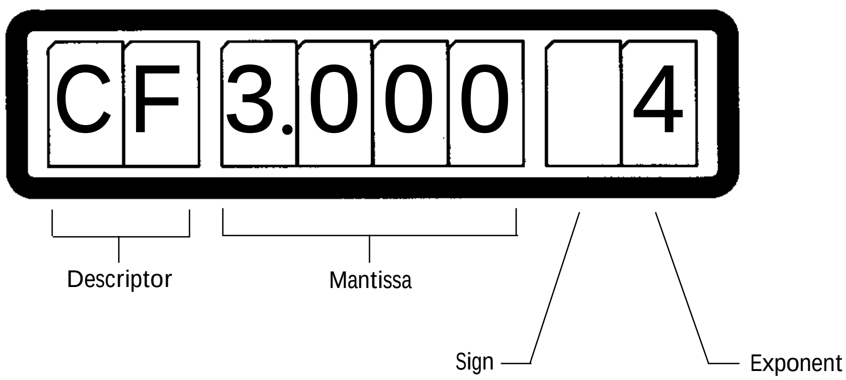
Lowest Frequency Measured	Time-out Period
10.0000 Hz	0.1
5.0000 Hz	0.2
2.0000 Hz	0.5
1.0000 Hz	1.0
.5000 Hz	2.0
.2500 Hz	4.0
.1250 Hz	8.0
.0625 Hz	16

NOTE

Note: Generally the relationship between the highest frequency measured and the lowest should be about 1000 to 1. If the highest frequency you are measuring is 5000, then you might choose 5 as the lowest measured frequency and enter 0.2 in the special constant. However, an appropriate time-out is entirely application dependent. Refer questions to your local distributor.

5.6 Calibrate Frequency (CF) / Verify

5.6.1 Display Format for Calibrate Frequency



This constant is used to verify the operation of the instrument and the behavior of the outputs. When 12 VDC is applied to the verify input, STACKTACH behaves as if the value entered in CF were the input frequency.

Use CF to:

1. Test the setpoints by making the verify value slightly larger than the setpoint and seeing if the relay trips.
2. Calibrate the output of the analog functions.
3. Test devices connected to the analog output such as a meter, chart recorder, or alarm.

CAUTION

CAUTION: When CF is active, the CF value overrides the input frequency for the duration of the applied CF signal. During this time, STACKTACH is not monitoring the process.

5.7 Setpoint Classifications

The STACKTACH has one relay setpoint (S1). A setpoint is a value of input frequency that causes a relay to change state (energize or de-energize). A setpoint value is expressed in Hertz (number of cycles per second). There are several different types of relay behavior available, and they are divided into two major classifications, Failsafe and Non-failsafe.

5.7.1 Failsafe Setpoint

Failsafe refers to a mode of operation where loss of power to STACKTACH will result in an alarm condition at the relay contacts. ***Alarm condition*** is defined as the relay state that signals a fault to auxiliary or support equipment. This type of relay behavior should be used in applications where loss of speed control cannot be tolerated or will result in a hazardous condition to personnel or monitored equipment.

5.7.2 Non-failsafe Setpoint

Non-failsafe refers to a mode of operation where loss of power to STACKTACH will not result in an alarm condition at the relay contacts. ***Alarm condition*** is defined as the relay state that signals a fault to auxiliary or support equipment. This type of relay behavior should only be used in applications where loss of speed control will not result in a hazardous condition to personnel or monitored equipment.

5.8 Setpoint Categories

Both failsafe and non-failsafe setpoints have two categories of setpoint operation, overspeed and underspeed.

5.8.1 Overspeed setpoint

Overspeed setpoints are used where control of a condition involving excess speed is required.

5.8.2 Underspeed setpoint

Underspeed setpoints are used where control of a condition involving too low a speed is required.

5.8.3 Illustrations of setpoint types

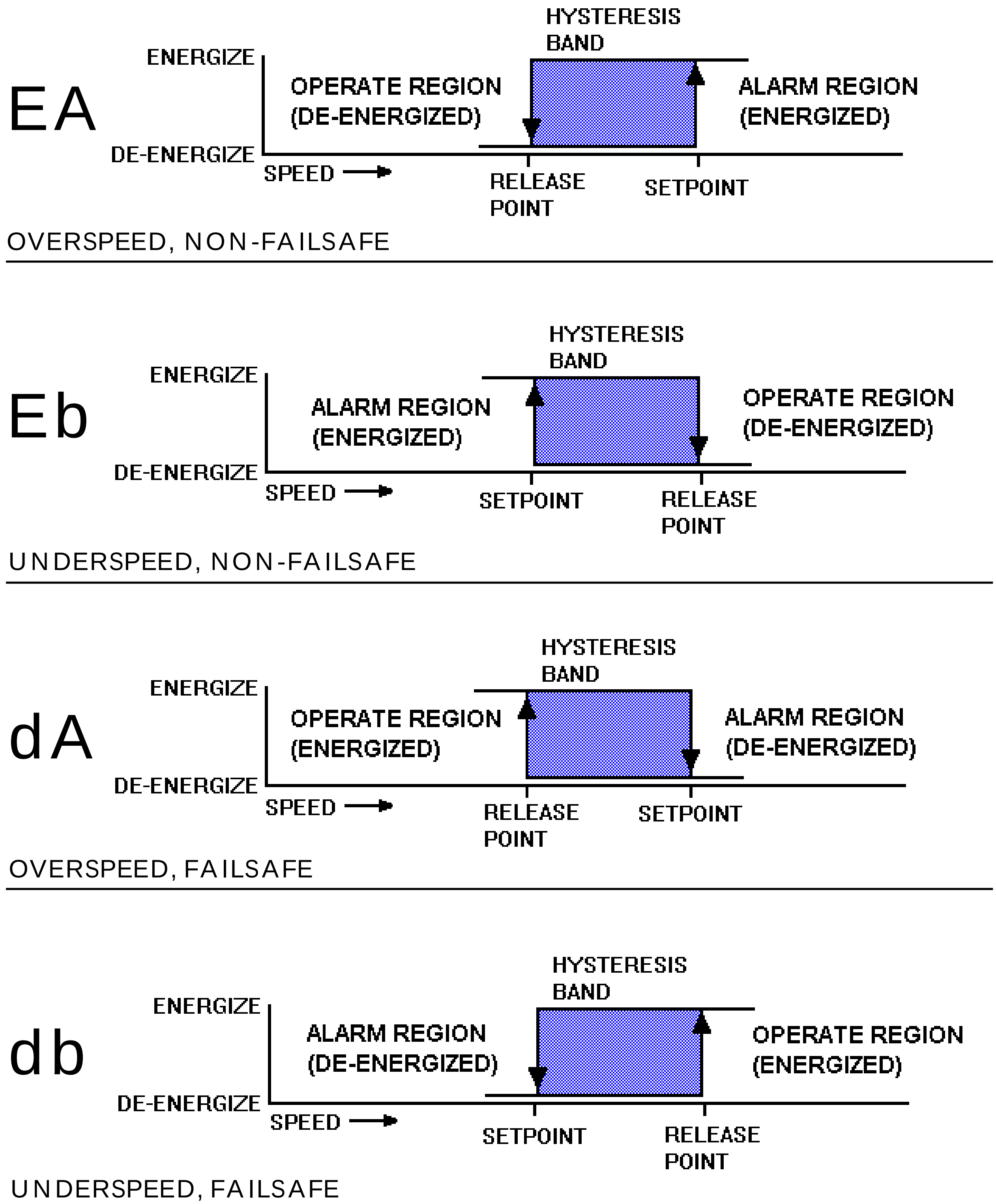
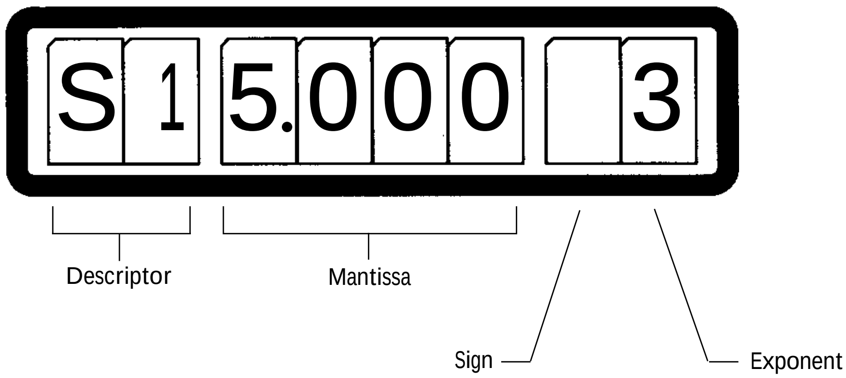


Figure 13. Setpoint Types

5.9 Setpoint types

STACKTACH has four setpoint types available to its relay using the terms previously defined. They are described in the following paragraphs.

5.9.1 Display Format for Setpoint Frequency (S1)



5.9.2 EA (Energize Above setpoint)

This setpoint type should be used in applications where non-failsafe control of an overspeed condition is desired. Operation of this type is as follows (Refer to the setpoint illustrations in Section 5.8.3.):

- If the monitored application is operating at a speed below the setpoint, the relay is de-energized.
- If speed increases beyond the setpoint value, the setpoint enters the alarm condition and energizes the relay.
- The relay will remain energized until the speed decreases to a value below the reset point of the hysteresis band at which point the relay is de-energized.

The reset point of a relay is determined by the hysteresis type and magnitude as configured in the hysteresis constant for that relay. For information on hysteresis refer to Section 5.11.

5.9.3 Eb (Energize below setpoint)

This setpoint type should be used in applications where non-failsafe control of an underspeed condition is desired. Operation of this type is as follows (Refer to setpoint illustrations in Section 5.8.3.):

- If operating at a speed above the setpoint, the relay is de-energized.
- If speed decreases below the setpoint value, the setpoint enters the alarm condition and energizes the relay.
- The relay will remain energized until the speed increases to a value above the reset point of the hysteresis band at which point the relay is de-energized.

The reset point of a relay is determined by the hysteresis type and magnitude as configured in the hysteresis constant for that relay. For information on hysteresis refer to Section 5.11.

5.9.4 dA (de-energize Above setpoint)

This setpoint type should be used in applications where failsafe control of an overspeed condition is desired. Operation of this type is as follows (Refer to setpoint illustrations in Section 5.8.3.):

- If operating at a speed below the setpoint, the relay is energized.
- If speed increases beyond the setpoint value, the setpoint enters the alarm condition and de-energizes the relay.
- The relay will remain de-energized until the speed decreases to a value below the reset point of the hysteresis band at which point the relay is energized.

The reset point of a relay is determined by the hysteresis type and magnitude as configured in the hysteresis constant for that relay. For information on hysteresis refer to Section 5.11.

5.9.5 db (de-energize below setpoint)

This setpoint type should be used in applications where failsafe control of an underspeed condition is desired. Operation of this type is as follows (Refer to setpoint illustrations in Section 5.8.3.):

- If operating at a speed above the setpoint, the relay is energized.
- If speed decreases below the setpoint value, the setpoint enters the alarm condition and de-energizes the relay.
- The relay will remain de-energized until the speed increases to a value above the reset point of the hysteresis band at which point the relay is energized.

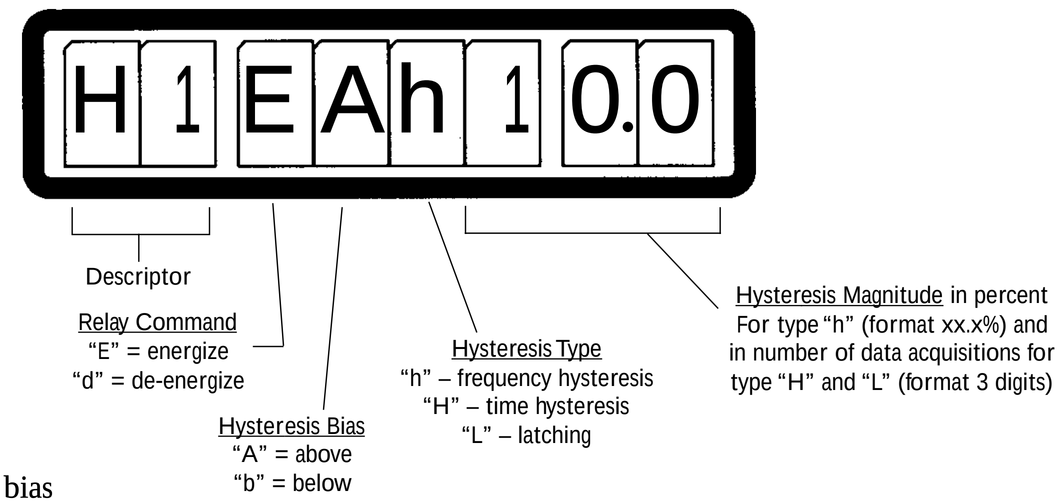
The reset point of a relay is determined by the hysteresis type and magnitude as configured in the hysteresis constant for that relay. For information on hysteresis refer to Section 5.11.

5.10 Hysteresis

The function of hysteresis in setpoint relays is to provide a ***dead band*** that will prevent premature release of a relay in the alarm condition. Airpax tachometers provide a great deal of flexibility in the configuration of hysteresis behaviors or types. With each hysteresis type, the magnitude of the hystersis band, as well as the events necessary to permit the release of a tripped setpoint, can be defined. The setpoint has associated with it a hysteresis constant (H1). It is the configuration of this constant that determines the hysteresis behavior of the setpoint.

The hysteresis constant must be set to control the behavior of each relay setpoint in your application. The hysteresis constant contains information that determines three characteristics of operation for each relay: bias, type and magnitude.

5.10.1 Display Format for Hysteresis and Type Constants (H1)



5.10.2 Hysteresis bias

The most important property of hysteresis is its bias relative to the setpoint value. It comes into effect either above or below the setpoint value. Overspeed setpoints have the hysteresis band located below the setpoint value to allow the setpoint to trip (alarm) at the prescribed value as speed increases, and to permit release of the setpoint when speed decreases to a safe level. Underspeed setpoints have the hysteresis band located above the setpoint value to allow the setpoint to trip (alarm) at the prescribed value as speed decreases, and to permit release of the setpoint when the speed increases to a safe level. Refer to the illustrations in figure 5.8.3.

5.10.3 Hysteresis magnitude

Magnitude defines the size of the dead band. The means used to describe it vary according to the type of hysteresis being applied to the setpoint.

5.10.4 Hysteresis types

STACKTACH has three types of hysteresis available to each relay setpoint:

- frequency domain hysteresis
- time domain hysteresis
- Latching relay with delay

They are described in detail on the following pages.

5.11 Frequency domain hysteresis (h)

Frequency domain hysteresis uses a percentage of the setpoint value to calculate the reset point of a relay in the alarm condition.

5.11.1 Example: Frequency domain hysteresis

A setpoint is programmed as follows:

- setpoint configuration: EA (energize above setpoint)
- setpoint value: 1000 Hz
- hysteresis type: h
- hysteresis value: 10.0%.

The hysteresis band would be 100 Hz wide (1000 x .100). The setpoint would energize the relay (alarm) if the speed was equal to or greater than 1000 Hz, and de-energize the relay (reset point) when the speed decreased to 900 Hz or less. This type of hysteresis is the most common due to its ease of use.

5.12 Time domain hysteresis (H)

Time domain hysteresis uses intervals of time (data acquisitions) in combination with the incoming frequency to calculate the reset point of a relay in the alarm condition. The magnitude of H type hysteresis is expressed as the number of consecutive data acquisitions not in violation of the setpoint.

To calculate the data acquisition time:	Example
1. Choose the setpoint frequency and delay time.	20 Hz 5 sec.
2. Multiply the input frequency by .03. If the result is not a whole number, round it to the next higher whole number.	20 x .03 = .6 .6 → 1
3. Multiply the result by the reciprocal of the input frequency.	$1 \times \frac{1}{20} = .05$
4. The result represents the time of one data acquisition.	.05 seconds
5. Number of data acquisitions is the delay time (sec.) divided by one data acquisition time (sec.).	5 ÷ .05 = 100
6. Time delay is specified as 0 to 999 data acquisitions.	You enter 100 as the hysteresis value portion of the constant.

> **NOTE**
>
> *Note: If the input frequency is not steady, the data acquisition time will vary in proportion to the input frequency.*

5.12.1 Example: Time domain hysteresis

A setpoint is programmed as follows:

- setpoint configuration: EA (energize above setpoint)
- setpoint value: 1000 Hz
- hysteresis type: H
- hysteresis value: 010 (10 data acquisitions)

The hysteresis band would be 10 data acquisitions wide. The setpoint would energize the relay (alarm) if the speed was equal to or greater than 1000 Hz, and de-energize the relay (reset point) once the tachometer recognized 10 consecutive data acquisitions below 1000 Hz. The time interval for a data acquisition is dynamic due to the advanced scheme of adaptive period averaging employed by Airpax tachometers. For information on data acquisition times, see Section 5.12.

5.13 Delayed Trip or Latching Relay (L)

Type L hysteresis has two modes of relay operation.

1. Delayed trip (when hysteresis value is greater than 000)
2. Latching (when hysteresis value is equal to 000)

5.13.1 Delayed Trip

Type L hysteresis has the capability to delay a setpoint trip. The length of the delay is controlled by specifying the number of consecutive data acquisitions in violation of the setpoint. Once the tachometer detects that the prescribed number of consecutive data acquisitions have violated the setpoint, the relay will change state. The time interval for a data acquisition is dynamic due to the advanced scheme of adaptive period averaging employed by Airpax tachometers. For information on data acquisition times, see Section 5.12. When using the delayed trip function, the setpoint will remain in the alarm condition until the following conditions are met:

The input frequency returns to "operate" (non-alarm) region **AND** the relay reset (TB3-11) is connected to digital common (TB3-9).

OR

The instrument has timed-out.

5.13.2 Latching Relay

Type L hysteresis also has the capability to latch a relay in the alarm state. Once the tachometer detects that the input frequency has violated the setpoint, the relay will change state. The time interval must be set to zero to activate the latching function. When using the latching function, the setpoint will remain in the alarm condition until the following conditions have been met:

1. The input frequency must have returned to a non-alarm value.
2. The relay reset input must have received the proper input to reset the relay. On loss of power the relay will also reset.

For information on connecting the relay reset input, see Section 3.5.4.

5.13.3 Example: Delayed Trip

A setpoint is programmed as follows:

- setpoint configuration: EA (energize above setpoint)
- setpoint value: 1000 Hz
- hysteresis type: L
- hysteresis value: 010 (10 data acquisitions)

The setpoint would energize the relay (alarm) if the speed were equal to or greater than 1000 Hz for 10 consecutive data acquisitions. It would remain energized indefinitely (latched) until the following conditions are met:

The input frequency decreases below 1000 Hz **AND** the relay reset (TB3-11) is connected to digital common (TB3-9).

OR

The instrument has timed-out.

5.13.4 Example: Latching

A setpoint is programmed as follows:

- setpoint configuration: EA (energize above setpoint)
- setpoint value: 1000 Hz
- hysteresis type: L
- hysteresis value: 000 (no data acquisitions)

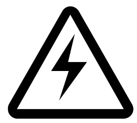
The setpoint would energize the relay (alarm) if the speed were equal to or greater than 1000 Hz for zero data acquisition. The relay would remain energized indefinitely (latched) until the following two conditions are met:

The input frequency decreases to below 1000 Hz and the relay reset (TB3-11) is connected to digital common (TB3-9).

6. Entering the Constants

6.1 Connecting the Programming Pendant to the STACKTACH

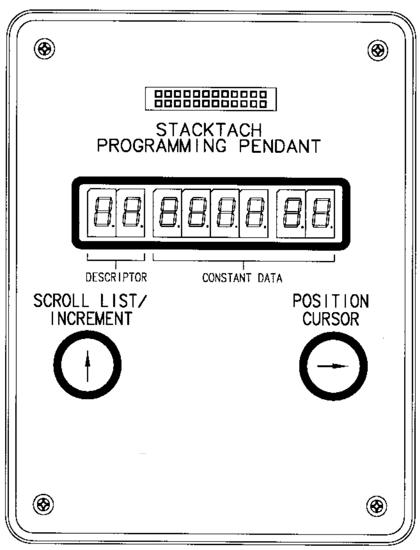
Using a 1/8" screwdriver, depress latches, open module, and connect cable. Note cable connector is polarized.


CAUTION

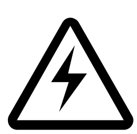
CAUTION: 24Vdc power must be ***ON*** *in order to program the unit per section 3.5.5. Turn 24Vdc power on after connecting pendant.*

3. Using the keyed connector at the end of the programming pendant's cable, insert connector into mating programming port.

6.2 Entering the Constants Into Each Channel of the STACKTACH



1. Press the up arrow key  twice to enter program mode.The cursor (the blinking characters) will be located on the descriptor of the second constant(A).


CAUTION

CAUTION: STACKTACH is not monitoring the application while you are entering constants.

2. Press the right arrow key to move the cursor to the first digit.
3. Press the up arrow key until the desired value is displayed.

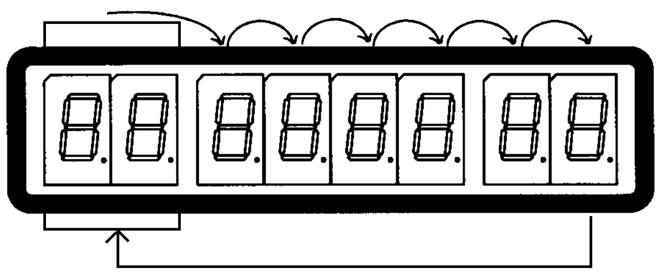
NOTE

Note: Repeatedly pressing the up arrow key will cause the display to cycle through all the available values for that digit and wrap back to the starting value.

4. Press the right arrow key to move the cursor to the next digit.
5. Press the up arrow to set it to the desired value.
6. Continue to set the remaining digits this way. When you are setting a sign, the display will toggle back and forth between blank for positive, and "-" for negative. Likewise, when you are setting other digits that have only two values, the display will toggle back and forth between those two values.
7. When the last digit has been set, press the right arrow key to move the cursor back to the descriptor.

NOTE

Note: When the cursor is located on the right-most character, pressing the right arrow key causes the cursor to wrap around to the left-most character(s) as shown below. Each arrow represents one press of the right arrow key .



8. Press the up arrow key to increment the display to the next descriptor.
9. Use the right arrow and up arrow keys to set its values in the manner just described.
10. Continue this process until all the constants have been set.
11. After the last constant has been set, press the right arrow key to move the cursor to the descriptor on the display.
12. Press the up arrow key until the word "store" is displayed.

13. Press the right arrow key (→). The display will go blank, indicating that the constants have been stored.

NOTE

> *Note: You must complete the above step in order for the constants you have entered to take effect. If you power down STACKTACH before you complete this step, the constants you have entered will be lost.*

14. Remove pendant from 1st channel and plug it into second channel (if unit has a second channel).

15. Proceed to program 2nd channel through step 13.

16. Remove pendant and replace external cover.

NOTE

> *Note: We suggest you keep a summary sheet (provided on page 38 of this manual) of your programmed constants so that you may refer back to these values if someone changes your original constants.*

7. Reference

7.1 Specifications

7.1.1 Power Supply

Models T77410-10:

24 VDC (24-30 VDC), standard (600 ohm analog load) or 7 watts maximum

7.1.2 Signal Input

Type:
Active or passive pickup determined by software settings (jumper required for active pickups)
AC Input (sine wave):
Input impedance = 2000 ohms
Sensitivity @ 1 kHz = 250 mVrms
Max. voltage input = 25 Vrms
Pulse Input (TTL-compatible):
Input impedance = 2000 ohms
Min. pulse width = 10 µs
Logic 0 = V in < .5 V
Logic 1 = V in > 1.5 V
(+12 VDC @ 70 mA supplied for powered sensors)
Frequency Range:
Upper limit 30 kHz
Lower limit is software selectable from .0625 Hz to 10 Hz

7.1.3 Outputs

Analog Output:
Selectable from 0 to 20 mA or 4 to 20 mA ±.5%. True current, 600 ohm maximum loop resistance
Full scale and zero scale selectable from 0 Hz to 30 kHz
Relay outputs:
One SPDT relay, rated 6 amps @ 28 VDC or 300 VAC, 170 W or 1800 VA
Frequency hysteresis selectable from 0.0% to 99.9%, or latching with remote reset
Relay logic and type selectable
Time hysteresis selectable 000 to 999 data acquisitions or latching with delay of 000 to 999 data acquisitions
+12 VDC for powered sensors - 50 mA max
Response time:
50 msec updates above 100 Hz
See Auto Reset with delay for updates between 20 and 100 Hz, one cycle below 20 Hz

7.1.4 Environmental

Temperature:
-10º to 55ºC (14º to 131ºF) (operating)
-40º to 80ºC (-40º to 176ºF) (storage)
Vibration:
Tested to IEC 68-2-6, 10-150 Hz, 2g
Shock:
Tested to IEC 68-2-27, 50g Half Sine
Electromagnetic Compatibility:
The tachometer shall function to the requirements of the EC Council Directive 89/336/EEC, the EMC Directive as defined by:
Immunity per EN 50082-2 1995
EN61000-4-2: ESD 1995: ±8kV Air Discharge, ±4k/V Direct Discharge
ENV61000-4-3 Radiated Immunity: 10V/m, 80MHz-1 GHz
ENV50204 RF Electromagnetic Field Pulsed 1995: 10V/m, 900 MHz
EN61000-4-4; EFT 1995: 2Kv
ENV50141: Conducted Immunity 1993: 10V Conducted Noise, 150kHz-80 MHz
Emission per EN50081-2 1995
EN55011: Radiated Emissions 1998: Class B
Enclosure:
IP 40
Humidity:
Tested to IEC 654-1, IEC 68-2-3 90% Humidity
Constant Storage:
Retained in EAROM and may be altered 1,000,000 times
Electrical References:
DC power is referenced to digital common. Analog output is refered to analog output common. Passive inputs are balanced. Active pickup inputs are referenced to circuit common. Form C relay contacts are isolated.

7.2 Glossary

active sensor • a powered, zero-velocity sensor that produces an output in the form of a digital square wave.

adaptive period averaging • a unique frequency measuring method in which the number of periods averaged changes with the frequency to obtain optimal accuracy.

alarm condition • the relay state that signals a fault to auxiliary or support equipment.

analog output • the 0-20 or 4-20 milliampere proportional output produced by STACKTACH that can be used for driving industrial devices such as recorders, meters, controllers and instruments operated by a current loop.

constant • one of 13 different codes and their associated variables that control STACKTACH's operation.

cursor • the flashing digits or characters in STACKTACH's internal LED display.

de-energize • when a relay has no electrical power applied to its coil.

delay • used with latching hysteresis to postpone, by a specified number of consecutive data acquisitions that violate the setpoint, the relay's change of state into an alarm condition.

earom • STACKTACH's Electrically Alterable Read-Only Memory where the constants are stored.

energize • when a relay has electrical power applied to its coil.

failsafe • a mode of operation where loss of power to STACKTACH will result in an alarm condition at the relay contacts.

frequency domain hysteresis • a type of hysteresis which uses a percentage of the setpoint value to determine the magnitude of the dead band.

hysteresis • the dead band associated with each setpoint which determines the release point of a relay in alarm. The purpose of hysteresis is to prevent relay chatter about the setpoint value and/or to ensure that the process has returned to a safe condition before releasing an alarmed setpoint. The hysteresis band can be specified by type and magnitude for each setpoint by the user.

hysteresis bias • the location of the hysteresis relative to the setpoint, above or below.

hysteresis constant • a setpoint parameter that determines the bias, magnitude, and type of hysteresis.

hysteresis magnitude • the size of the dead band created by the hysteresis parameters, described either by a percentage of the setpoint value or a number of consecutive, non-alarm data acquisitions.

latching • a mode of setpoint operation that requires it to be reset from the alarm condition by an external event.

meter output • the 0-1 milliampere proportional output produced by STACKTACH that can be used to drive an analog meter.

non-failsafe • a mode of operation where loss of power to STACKTACH will not result in an alarm condition at the relay contacts.

overspeed • a category of setpoint that is used where control of a condition involving excess speed is required.

passive sensor • a non-powered sensor that produces an output in the form of an analog sine wave.

reset point - the point determined by the hysteresis parameters at which a relay changes state to the non-alarm condition (energize or de-energize).

scientific notation • a means of describing a number as a mantissa (significant digits) and exponent (power of ten). STACKTACH uses only the four most-significant digits in the mantissa. For example the number 123,456 would be expressed as 1.234 x 105.

setpoint • a value of input frequency that causes a relay to change state to the alarm condition (energize or de-energize).

store • the concluding operation when setting constants, causing them to be retained in STACKTACH's EAROM.

time domain hysteresis • a type of hysteresis which uses a specified number of data acquisitions to determine the magnitude of the dead band.

time-out • the amount of time required for STACKTACH to indicate zero speed.

underspeed • a category of setpoint that is used where control of a condition involving too low a speed is required.

7.3 Target Variable Conversions

$$f = \frac{RPM \times PPR}{60} = \frac{ss \times PPR}{\pi \times D}$$

$$f = \frac{UPM \times PPU}{60} = \frac{UPH \times PPU}{3600}$$

$$ss = \frac{RPM \times \pi \times D}{60} = \frac{f \times \pi \times D}{PPR}$$

$$RPM = \frac{60 \times f}{PPR} = \frac{60 \times ss}{\pi \times D}$$

$$D = \frac{(PPR + 2)}{DP} = \frac{ss \times PPR}{f \times \pi}$$

$$DP = \frac{(PPR + 2)}{D} = \frac{25.4}{M}$$

$$M = \frac{25.4}{DP} = \frac{25.4 \times D}{(PPR + 2)}$$

$$PPR = (D \times DP) - 2 = \frac{60xf}{RPM} = \frac{f \times \pi \times D}{ss}$$

Definitions:

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

ss = surface speed in inches per second (ips)

RPM = rotary speed in revolution per minute

PPR = pulses per revolution or number of gear teeth

D = outside diameter of target (gear) in inches

π = 3.14

UPM = unit measure per minute

UPH = unit measure per hour

PPU = pulses per unit measure

DP = diametral pitch = number of teeth in 1 inch pitch diameter

M = metric module = pitch diameter in mm ÷ number of gear teeth

Warranty and Return Shipments Statement

The materials ordered and agreed to be furnished by Seller are warranted against defect of material or workmanship for a period of (1) year from the date of shipment, or for their rated life (whichever period ends first). Seller's obligation under the warranty is limited to repair or replacement, in Seller's option, of the defective material at Seller's factory (point of shipment) and does not extend to equipment other than of Seller's factory (point of shipment) and does not extend to equipment other than of Seller's manufacture. The warranty shall not apply to any product or part which has been subject to misuse, negligence, accident, or attempted or unauthorized repair or modification. All return shipments must be factory authorized prior to shipment, and shipment will be at buyer's expense. The only statutory warranties applicable to the materials are warranties of title and that the materials will be merchantable and, if manufactured to Buyer's specifications, that the said items conform to such specifications. UNLESS EXPRESSLY STATED ON THE FACE HEREOF, NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE IS TO BE IMPLIED, NOR ARE ANY OTHER WARRANTIES WHICH EXTEND BEYOND THOSE STATED HEREIN. SELLER'S SOLE LIABILITY FOR DEFECTS OR BREACH OF WARRANTY SHALL BE REPLACEMENT OF THE MATERIALS INVOLVED, AND IN NO EVENT WILL THE SELLER BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES. FAILURE TO TEST, INSPECT AND MAKE CLAIMS FOR BREACH OF WARRANTY WITHIN REASONABLE PERIODS SHALL BE CONCLUSIVE EVIDENCE THAT THE MERCHANDISE SHIPPED IS SATISFACTORY IN ALL RESPECTS AND SUPPLIED IN ACCORDANCE WITH ORDERED SPECIFICATIONS.

LIMITATION OF LIABILITY: (a) SELLER DOES NOT UNDER ANY CIRCUMSTANCES, WHETHER AS A RESULT OF BREACH OF CONTRACT, BREACH OF WARRANTY, TORT OR OTHERWISE BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, SPECIAL OR EXEMPLARY DAMAGES, including, but not limited to, loss of profits or revenues, loss of use of or damage to any associated equipment , cost of capital, cost of substitute products, facilities or services, downtime costs, or claims of Buyer's customers. (b) SELLER'S LIABILITY ON ANY CLAIM OF ANY KIND FOR ANY LOSS OF DAMAGE ARISING OUT OF, RESULTING FROM, OR CONCERNING ANY ASPECT OF THIS AGREEMENT OR FROM THE PRODUCTS OR SERVICES FURNISHED HEREUNDER SHALL NOT EXCEED THE PRICE OF THE SPECIFIC ORDER OR SHIPMENT WHICH GIVES RISE TO THE CLAIM.

Notice Regarding Damage

These units were carefully packed in compliance with carrier regulations and thoroughly inspected before leaving our delivery plant. Responsibility for their safe delivery was assumed by the carrier upon acceptance of the shipment. Claims for loss or damage sustained in transit must, therefore, be made upon the carrier.

Concealed Loss or Damage

Concealed loss or damage means loss or damage which does not become apparent until the merchandise has been unpacked. The contents may be damaged in transit due to rough handling even through the package may not show external damage. When damage is discovered upon unpacking, make a request for inspection by the carrier's agent. Then file a claim with the carrier since such damage is the carrier's responsibility.

Visible Loss or Damage

Any external evidence of loss or damage must be noted on the freight bill or express receipt and signed by the carrier's agent. Failure to properly describe evidence of loss or damage may result in the carrier refusing to honor a claim. We definitely are not responsible for any damage incurred while merchandise is in transit. The transportation company will settle promptly all claims as they are insured and their rates cover this cost. Any correspondence in regard to loss or damage must be accompanied by a copy of the carrier's report.

Index

Recorded Stored Constants

Descriptor	Section	Constant
FS		Ⓕ Ⓢ ⊗ Not Used
AO	5.3.1	Ⓐ ⓪ ⊗ ◯.◯ ◯ ◯ ◯ ◯
AF	5.4.1	Ⓐ Ⓕ ⊗ ◯.◯ ◯ ◯ ◯ ◯
CF	5.6.1	Ⓒ Ⓕ ⊗ ◯.◯ ◯ ◯ ◯ ◯
S1	5.9.1	Ⓢ ① ⊗ ◯.◯ ◯ ◯ ◯ ◯
H1	5.10.1	Ⓗ ① ⊗ ◯ ◯ ◯ ◯ ◯ ◯
S2		Ⓢ ② ⊗ Not Used
H2		Ⓗ ② ⊗ Not Used
S3		Ⓢ ③ ⊗ Not Used
H3		Ⓗ ③ ⊗ Not Used
S4		Ⓢ ④ ⊗ Not Used
H4		Ⓗ ④ ⊗ Not Used
SP	5.5.1	Ⓢ Ⓟ ⊗ ◯ ⊗ ◯ ⊗ ◯ ◯

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