



BTA HAZARD MONITOR MANUAL

THIS MANUAL CONTAINS:

BTA INSTALLATION GUIDE
BTA ETHERNET – SYSWATCH CONNECTIONS
BTA USER GUIDE

SPECIAL NOTE

READ THIS ENTIRE BOOKLET
BEFORE PROCEEDING WITH
THE INSTALLATION

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BTA INSTALLATION GUIDE

DOCUMENT#: 190055

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1. INTRODUCTION

This document describes how to correctly install the *Bearing Temperature and Alignment (BTA) Hazard Monitoring System* in grain elevators and processing facilities. Conveying equipment has motors, bearings or alignment rubs are points of friction, which can ignite dust, resulting in fire or explosion. Though it was designed for agricultural applications, the BTA is useful anywhere material handling equipment is used and failure of motor, bearing or belt misalignment would cause a problem. The BTA is a tool for preventive maintenance as well as for safety.

PURPOSE OF THE BTA SYSTEM

The **B**earing **T**emperature and **A**lignment, **BTA**, system is used to continually monitor points of friction by means of thermocouple sensors. By adding the Motion Module to the Main Instrument, rotational speed sensors can also be monitored for slowdowns. The BTA is used to control warning and alarm relays that will signal when temperatures or speeds move outside limits which are programmed by the operator. The resulting alarm will alert the equipment operator of any potentially dangerous conditions.

It operates as a “Stand-Alone” system, not needing a Personal Computer or extra pieces to fully function though it can send out data and reports to other peripherals.

Conventions used in this manual:

Wherever you see a six digit number in parenthesis such as (249011), this refers to the Boone Cable Works & Electronics, Inc. part number for the item being discussed.

2. SYSTEM OVERVIEW

The System consists of the BTA Instrument, the Motion Module and one or more Auxiliary Switch Boxes. All these assemblies work together to form the BTA Instrument system. In this section we will describe their basic functions and relationships. The Instrument is equipped with an embedded processor and can scan thermocouple inputs. The BTA Instrument polls the thermocouples in a round robin manner by through the use of Auxiliary Switches. As each Auxiliary Switch is polled, the 8 thermocouples tied to that Auxiliary switch are read. The BTA Instrument can connect, one at a time, to as many as 32 separate Auxiliary Switches.

2.1. POSSIBLE CONFIGURATIONS Most systems will monitor both motion and temperature.

Figure 1 describes a simplified view of a complete system. The *BTA Instrument* is the heart of the system and will always be in the configuration. It is possible to install and operate a BTA that monitors only temperature or only motion. For one or the other, remove all *Auxiliaries* and thermocouple sensors, or delete the *Motion Module* and all that is connected to it. See following sections on Temperature Systems and Motion Systems.

2.1.1. WHERE TO INSTALL THE INSTRUMENT & MOTION MODULE

These are required to be in an ordinary location only (Non-classified). Mount on the wall of an Office, Motor Control Center Room or other Control Room preferably at eye-level.

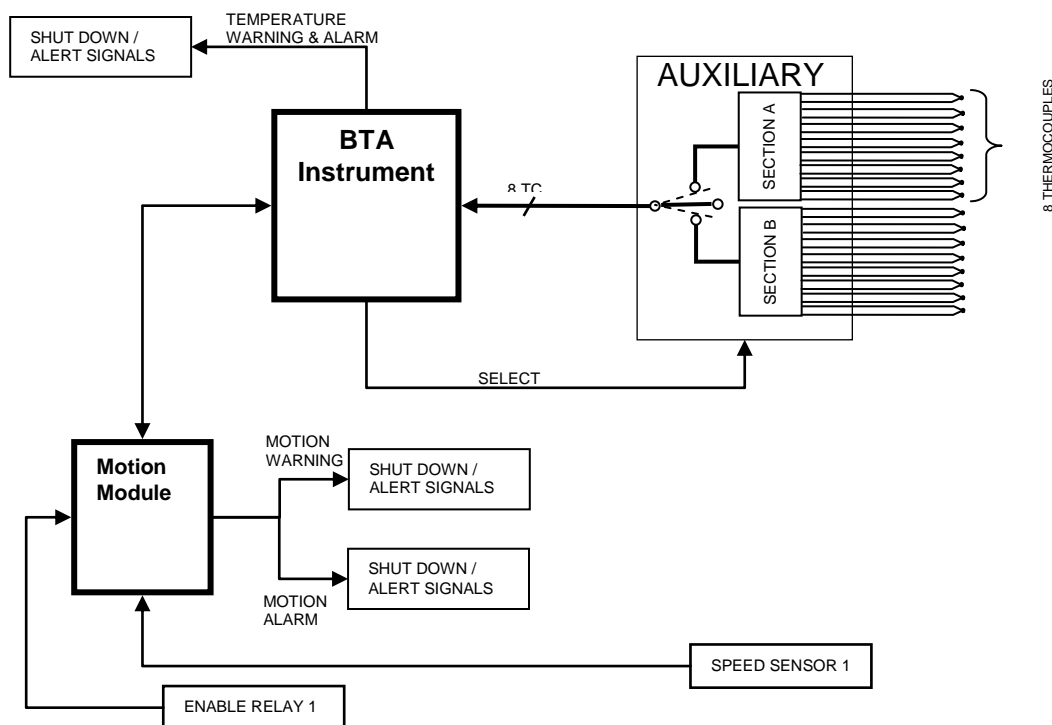


Figure1. Temperature & Motion System

3. BTA INSTRUMENT

The Instrument (401810) is essential to all types of systems. The BTA Instrument is an embedded system, based on a microprocessor that has sophisticated features to watch conveying equipment (belts, legs, drags, augers) in grain elevators and mills. Two stacking electronic circuit boards are the primary components in the Enclosure. See figures 2 & 3.

- 3.1. MPU & Auxiliary Output Board (200049) its main features: MicroController Unit, Outputs to select Auxiliaries, Input/Output Ports, Temperature Warning and Alarm Relays.
- 3.2. Thermocouple & Power Supply Circuit Board (200050) there are 8 isolated instrumentation amplifier channels that condition the thermocouples signals. Power is converted from 120Vac 60Hz line source down to three separate supplies: one +5VDC and two +15VDC. These power all the remaining assemblies in the BTA system.

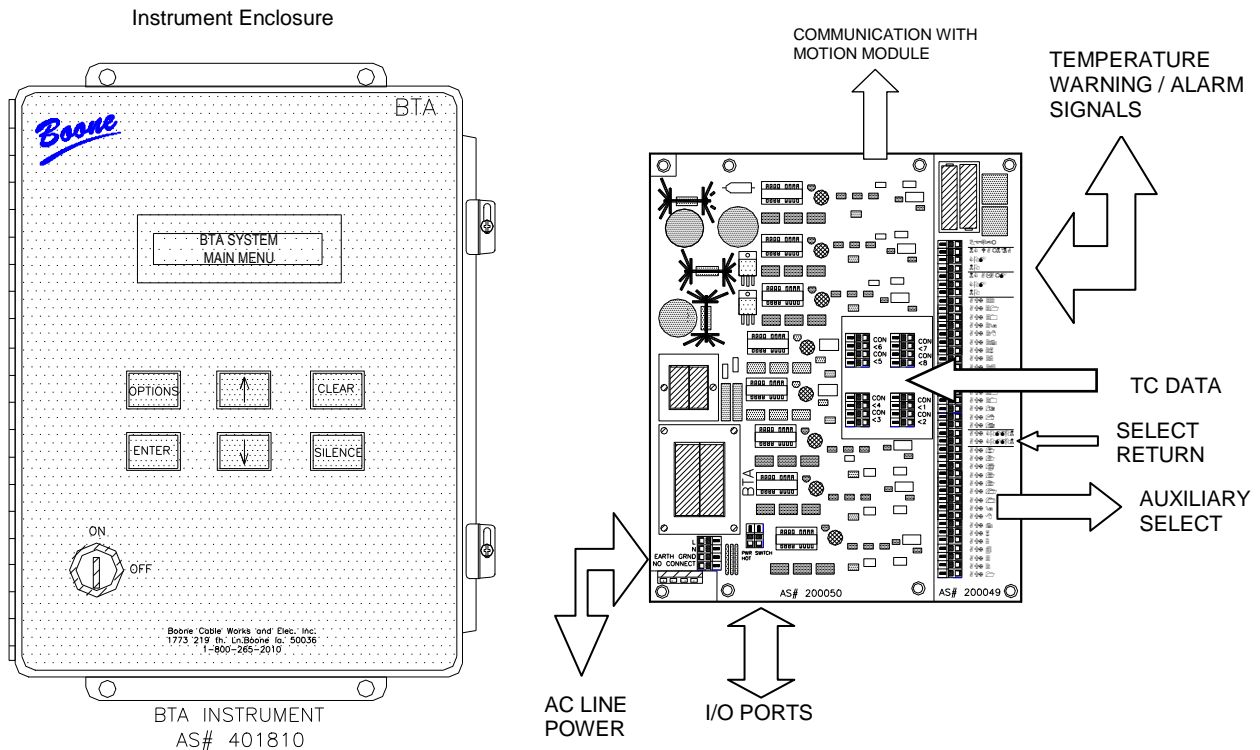


Figure 2. Main Instrument and Circuit Boards

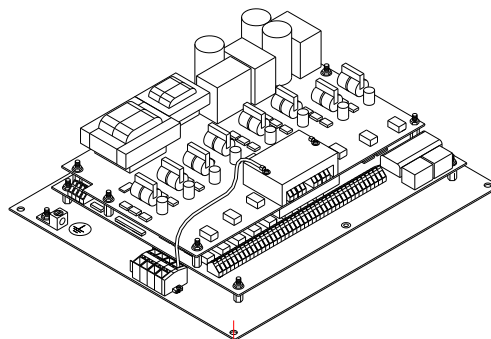


Figure 3. Circuit Boards inside Instrument

3.3. CONNECTIONS The majority of the connections should have been made at the factory to the Main Terminal Block Assembly mounted on the electrical panel supporting the circuit boards.

3.3.1. LINE POWER AC line voltage (110 – 120 VAC, 60 Hz) must be provided to the *Thermocouple and Power Supply Board* (AS# 200050) in the *BTA Instrument* enclosure. Earth Ground must be provided as well, to take advantage of Lightning and Transient protection features. Leave connections to a qualified electrician. For best results, a dedicated circuit from the supply panel plus an additional, separate EMI Ground is highly recommended. See Figure 4 below.

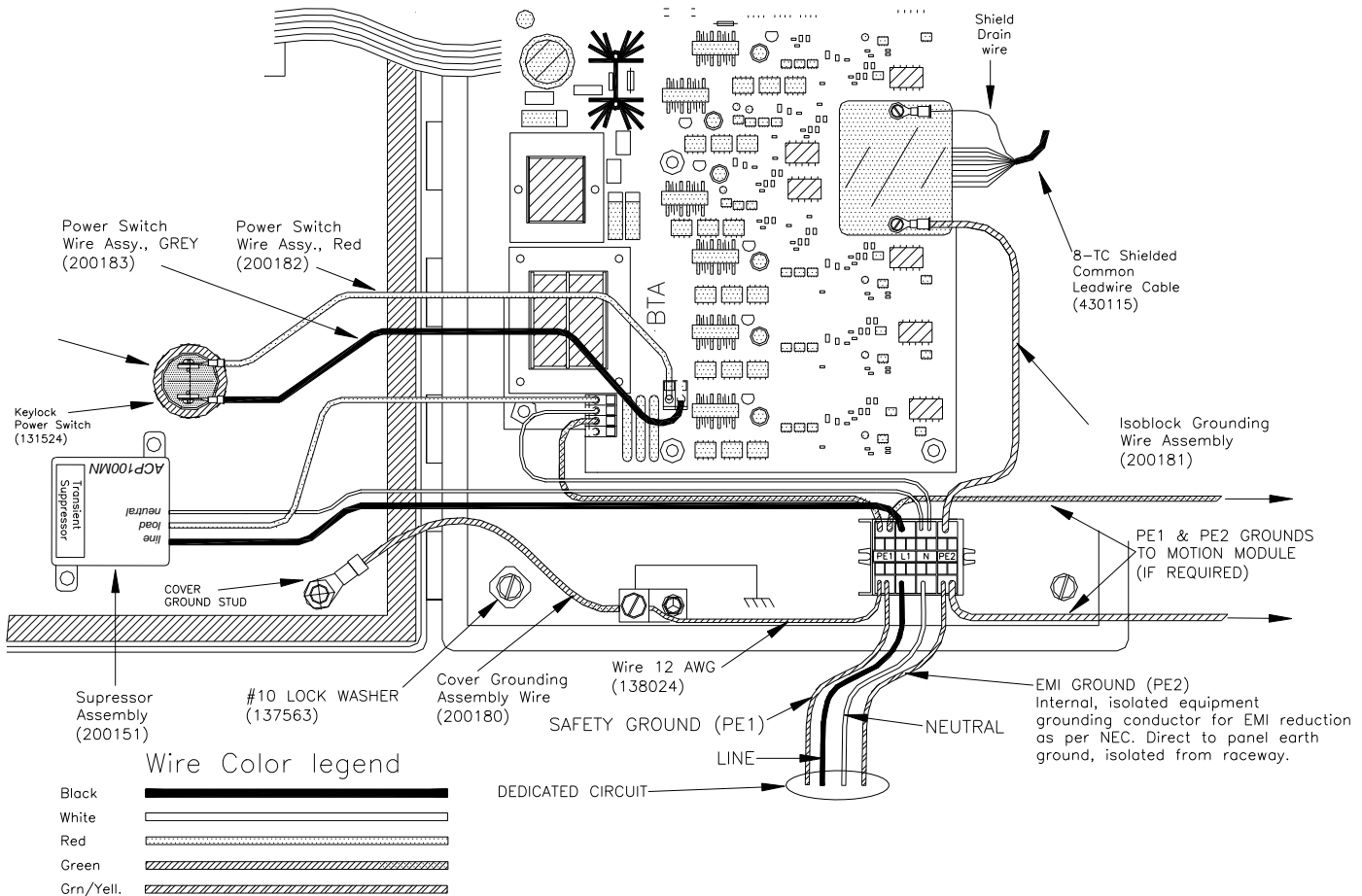


Figure 4. Power & Grounding Connections

3.3.2. GROUNDING Figure 4 shows that in addition to the standard circuit safety ground (PE1), an additional EMI ground (PE2) has been provided for. This is allowed for under the NEC for electronic equipment.

3.3.3. SHIELD TERMINATION The Isoblock Grounding Wire is part of the Lightning Shunt Circuit. It diverts destructive transients away from instrument. This is also a convenient point to ground all cable shield drain wires at one central known ground.

3.3.4. SURGE SUPPRESSION Protection from poor (dirty) power quality coming in on the line is provided with an industrial grade suppressor. Fast acting Silicon Avalanche Suppressor Diodes are superior to older types of suppression when protecting digital electronic equipment. Energy is dissipated in these SASDs between Line and Neutral.

- 3.3.5. SERIAL PORTS** The BTA can communicate with a personal computer using one of two Recommended Standards of communications protocol. See Figure 5.
- 3.3.5.1. SERIAL REPORT OF SCAN DATA** This feature streams up-to-date sensor information through the RS-232 or RS-485 serial ports to a PLC or PC. Normal output consists of an abbreviated report giving basic information such as the sensor's number location, temperature or speed, time, date, and enable/disable status. ASCII text sent and multiple baud rates are supported. Any setting or configuration changes on the BTA unit are reported out the serial port. A Boone Cable Works & Electronics BCS2000 Windows Application would be waiting to process sensor information to display it graphically.
- 3.3.5.2. RS-232** The most common serial communications interface for short distances (up to 50 feet) between one device (BTA) and one Personal Computer communications port. A true Input / Output Port made up by a dual-row header connector with 10 pins. Connection to an optional 9-pin D-Sub Male Connector can be installed. This port can be used to *Upload/Download Configuration Files*. It is necessary to use a Null Modem Cross-Over Cable instead of a standard serial cable.
- 3.3.5.3. RS-485** Another definition of serial communications interfaces which is a more industrial standard which can go longer distances and is more immune to interference. This is an optional port to be used instead of RS-232 when distances are from 50 to 3600 feet. As used in this application, an Output Port only. It is a balanced differential two-line (A= -Signal, B= +Signal) system. A 4-conductor terminal block is provided for this. Connect wires directly to block. Although RS-485 able to handle multiple drops on the line, when used with a BTA system, a single BTA can be the only drop on the line. There is no master/slave relationship from BTA to Host PC. A jumper is provided to on this board to select between the RS-485 and RS-232 devices as the source of data

- 3.3.6. PARALLEL/ PRINTER PORT** A dual-row header connector with 26 pins makes up this port. Connection to a Unidirectional Printer can be made with a standard PC Parallel Printer Cable and an optional 25-pin D-Sub Male Connector can be installed on the dual-row header.

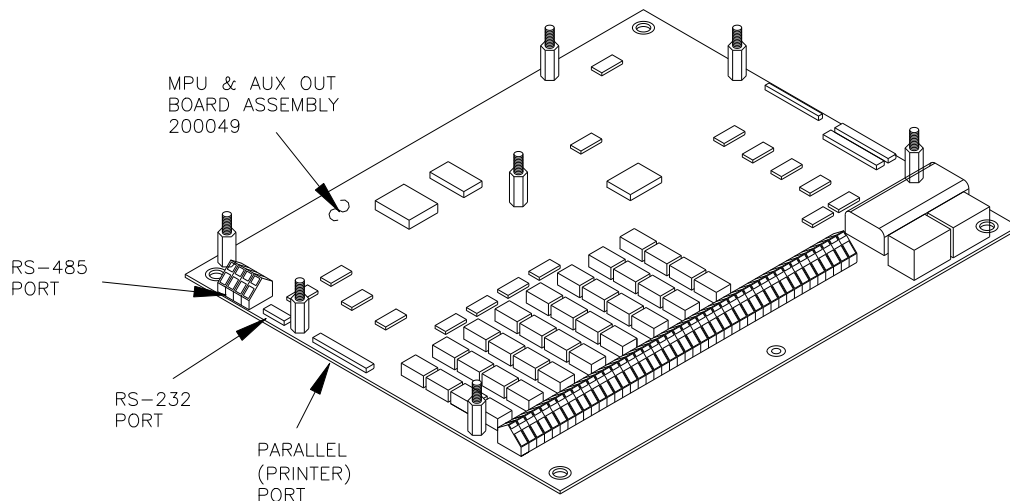


Figure 5. Serial & Parallel Ports

4. GOOD INSTALLATION PRACTICES

4.1.1.1. Keep signal and DC wires and cables in separate conduit from conduit carrying AC Line Voltage.

4.1.1.2. Use Shielded Cable for Thermocouple and Motion signals. Ground the EMI Drain wire at the Instrument end only. Any exposed Drain Wire must not contact the enclosure, conduit or any part of the raceway. Shorten or insulate with electric tape or spaghetti tube.

5. RACEWAY, BOXES, & FITTINGS

5.1. CONDUIT It is required that wiring in a hazardous location be installed in conduit. The vast majority of service problems are related to broken or rodent damaged wire. Conduit provides the mechanical protection of the cable from all but the most catastrophic events.

5.1.1. Conduit Attachment and Mounting When mounting conduit, avoid making long parallel runs in close proximity (closer than 4 to 5 inches) to high voltage runs. Separation reduces the possibility of interference from induced voltage. Conduit should be attached to a secure structure at frequent intervals and must be kept clear of moving machinery. Installation should be made in a neat and workman like manner

5.1.2. Conduit Runs Avoid making any run of conduit where the total of all of the bends between pull boxes exceeds 180°. It is usually best to keep straight runs of conduit to under 100 ft. of horizontal length between pull boxes, and even shorter if there are bends. Whenever installing conduit outside be sure to seal all threaded joints with Metal Seal or a similar product. Only use Liquidtight Flexible Metal Conduit where absolutely necessary and only in runs not to exceed 6' in length. Use box hubs with gaskets when entering the Instrument, Motion Module and all Auxiliary Boxes.

5.1.3. Shavings And Sharp Metal Edges Use Box Hubs. Ream out sharp edges created during drilling, filling and knockouts. These can scrape wire insulation and cable jackets when pulling these through the conduit, thus grounding out the exposed conductors. Vibration or thermal expansion can make these intermittent problems extremely hard to diagnose. Metal dust and shavings short out components on circuit boards.

5.1.4. CONDUIT SIZING

Common diameters for conduit used in BTA Systems are 1/2", 3/4", and 1".

The following tables have been developed to help you plan the size needed for the amount and type of cable that go through them.

5.1.4.1. 1/2" CONDUIT

ITEM	DIAMETER	AREA
18 AWG Common	.090 OD	.006362
Enable Cable	.119 OD	.011122
9-Wire Aux. Select	.160 OD	.020106
8 TC Shielded LW	.187 OD	.027465
Speed Sensor Cable	.217 OD	.036984
1/2" Conduit	.617 ID	.298992
3/4" Conduit	.830 ID	.541055
1" Conduit	1.050 ID	.865892
1 1/4" Conduit	1.395 ID	1.528403

PULLING DIFFICULTY LEGEND

A = Easy to good pulling

B = Snug but suitable for short straight runs only

C = Will fit but is not recommended

D = Do not attempt

[] = When working close to maximums it is suggested that you go to the next larger size conduit to leave room for expansion.

FORMULAS

$$A = D^2 \times .78539$$

$$\%F = \frac{A1}{A2}$$

D =Diameter of a circle.

A =The area of a circle.

A1=The total area of all conductors in the conduit.

A2=The total area of the ID of the conduit.

%F=The percentage of the conduit ID that is taken up by conductors.




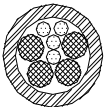



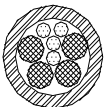
1/2" CONDUIT CABLE FILL CHART for BTA					
S P E E D & E N A B L E	1/2" Conduit				
	Speed Sensor Cable(104005)	1	2	3	4
	Enable Cable(104006)	1	2	3	4
	% Conductor Fill	16%	32%	[48%]	--
	Pulling Difficulty	A	A	B	C
S P E E D & E N A B L E + C O N T R O L	1/2" Conduit				
	1X 9-Wire Aux Sel, %Fill	34%	[50%]	--	--
	Pulling Difficulty	A	B	C	D
	2X 9-Wire Aux Sel, %Fill	41%	[57%]	--	--
	Pulling Difficulty	A	B	D	D
	3X 9-Wire Aux Sel, %Fill	48%	--	--	--
	Pulling Difficulty	A	C	D	D
	4X 9-Wire Aux Sel, %Fill	[55%]	--	--	--
	Pulling Difficulty	B	D	D	D

Table 1. 1/2" Conduit Fill

5.1.4.2. 3/4" CONDUIT

3/4" CONDUIT CABLE FILL CHART for BTA								
<ul style="list-style-type: none"> ● 18 AWG Common ⊗ Enable Cable 9-Wire Auxiliary Select Cable 8-TC Leadwire Cable Speed Sensor Cable 	S P E E D & E N A B L E	3/4" Conduit						
		Speed Sensor Cable(104005)	1	2	3	4	5	6
		Enable Cable (104006)	1	2	3	4	5	6
		% Conductor Fill	9 %	18%	27%	36%	45%	[54%]
		Pulling Difficulty	A	A	A	A	A	B
<p>PULLING DIFFICULTY LEGEND</p> <p>A = Easy to good pulling</p> <p>B = Snug but suitable for short straight runs only</p> <p>C = Will fit but is not recommended</p> <p>D = Do not attempt</p> <p>[] = When working close to maximums it is suggested that you go to the next larger size conduit to leave room for expansion.</p>	S P E E D & E N A B L E + C O N T R O L	3/4" Conduit						
		1X 9-Wire Aux Sel, %Fill	19%	28%	37%	46%	[55%]	--
		Pulling Difficulty	A	A	A	A	B	C
		2X 9-Wire Aux Sel, %Fill	23%	32%	41%	50%	--	--
		Pulling Difficulty	A	A	A	A	C	D
		3X 9-Wire Aux Sel, %Fill	27%	36%	45%	[54%]	--	--
		Pulling Difficulty	A	A	A	B	D	D
		4X 9-Wire Aux Sel, %Fill	31%	40%	49%	[58%]	--	--
		Pulling Difficulty	A	A	A	B	D	D

Table 2. 3/4" Conduit Fill

5.1.4.3. 1" CONDUIT

1" CONDUIT CABLE FILL CHART for BTA						
<ul style="list-style-type: none"> ● 18 AWG Common ⊙ Enable Cable ⊗ 9-Wire Auxiliary Select Cable ⊘ 8-TC Shielded Leadwire Cable ⊙ Speed Sensor Cable 	S P E E D & E N A B L E	1" Conduit				
		Speed Sensor Cable (104005)	4	5	6	7
		Enable Cable(104006)	4	5	6	7
		% Conductor Fill	22%	28%	34%	40%
		Pulling Difficulty	A	A	A	A
<p>PULLING DIFFICULTY LEGEND</p> <p>A = Easy to good pulling B = Snug but suitable for short straight runs only C = Will fit but is not recommended D = Do not attempt</p> <p>□ □ = When working close to maximums it is suggested that you go to the next larger size conduit to leave room for expansion.</p>	S P E E D & E N A B L E + C O N T R O L	1" Conduit				
		1X 9-Wire Aux Sel, %Fill	28%	34%	40%	46%
		Pulling Difficulty	A	A	A	B
		2X 9-Wire Aux Sel, %Fill	31%	37%	43%	[55%]
		Pulling Difficulty	A	A	A	B
		3X 9-Wire Aux Sel, %Fill	34%	40%	46%	[58%]
		Pulling Difficulty	A	A	A	B
		4X 9-Wire Aux Sel, %Fill	37%	43%	49%	[55%]
		Pulling Difficulty	A	A	A	C

Table 3. 1" Conduit Fill

5.2. CABLES SHARING RACEWAY

- 5.2.1. It is permissible to run *Auxiliary Extension Lead Wires* in the same conduit as the *Control Wire*. Please refer to the conduit-sizing tables above.
- 5.2.2. Never mix wires carrying AC Line Voltage with any BTA wire and Cable inside the same conduit. Significant AC voltage can be induced on the BTA signals such that proper operation of the BTA System is interfered with. Don't mix low voltage direct current (<50 Volts) with AC voltage 24VAC or higher

5.3. PULLING WIRE & CABLE

- 5.3.1. When pulling cables or wire into conduit, great care must be used not to nick or scrape the outer jacket or insulation which provides the main protection against moisture and abrasion.
- 5.3.2. Remove any sharp edges in conduit, hubs or box knockouts before pulling cable.

5.4. FITTINGS & BOXES

- 5.4.1. Box hubs with gaskets are recommended when entering the BTA Instrument, Motion Module, and all Auxiliary Boxes.
- 5.4.2. Boxes and fittings for splices, taps, or terminations must be of the threaded type with close-fitting covers. See Figure 6.
- 5.4.3. In dust environments, fittings and boxes are recommended to be dusttight with threaded bosses for connection to conduit or cable or cable terminations.

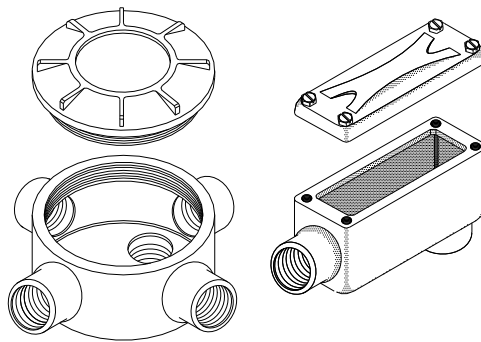


Figure 6. Dusttight Boxes & Fittings

6. TEMPERATURE SYSTEMS

The following components and connections are what you will need to know to make the temperature part of the system run. See Figure 1.

6.1. AUXILIARY SWITCH These are used to minimize the amount of wire and cable necessary by eliminating redundant runs. A full temperature system can keep track of 256 separate thermocouple sensors. Only one Group (or section) of eight is connected to the Instrument at any one time. The switch is an enclosure that holds one or more of the Auxiliary Bearing Boards. See Figure 7

6.1.1. WHERE TO INSTALL THE AUXILIARY SWITCHES. These boxes are mounted in a remote location in close proximity to the grouping of sensors that they read. It may be advantageous to mount many of the Auxiliaries in the same enclosure. These may be installed near the sensor or near the instrument.

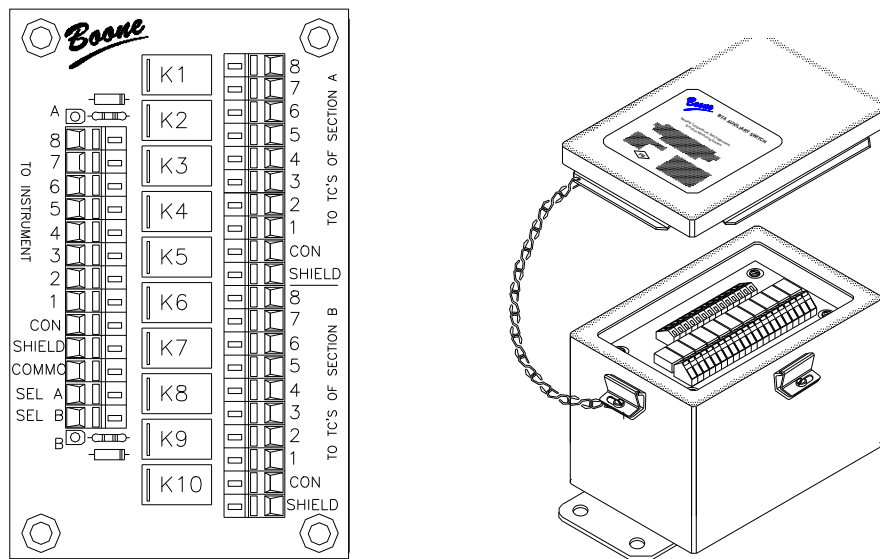


Figure 7. Auxiliary Switch with Auxiliary Bearing Board

6.1.2. Auxiliary Bearing Board (200052), These boards (Figure 7.) contain the switching for two *Auxiliary Sections*, labeled: *SECTION A*, *SECTION B* on the board. Each group can switch 8 Thermocouple sensors. (See Figures. 7 & 12). Each BTA Auxiliary Bearing Board has two Sections marked "Group A" & "Group B". Each of these two Sections can service 8 Thermocouples. Therefore we dedicate one 8-TC Shielded Leadwire Cable for each Section A & B. Each Cable consists of a white constantan wire and 8 individually colored copper wires. Each 8-TC Cable can bring the thermocouple signals from as many as 8 sensors back to either the "A" or "B" side of the board. Never split the sensors from one 8-TC Cable between both groups on the board. This would require that both groups share the constantan and will result in temperature reliability problems. It is much easier to do this correctly at first than to try to troubleshoot the problem later.

6.2. CONNECTING AUXILIARIES TO INSTRUMENT

Control Wire runs from the BTA Instrument to the Remote Auxiliary Boxes and between each subsequent Remote Aux. See Figures 7 & 8.

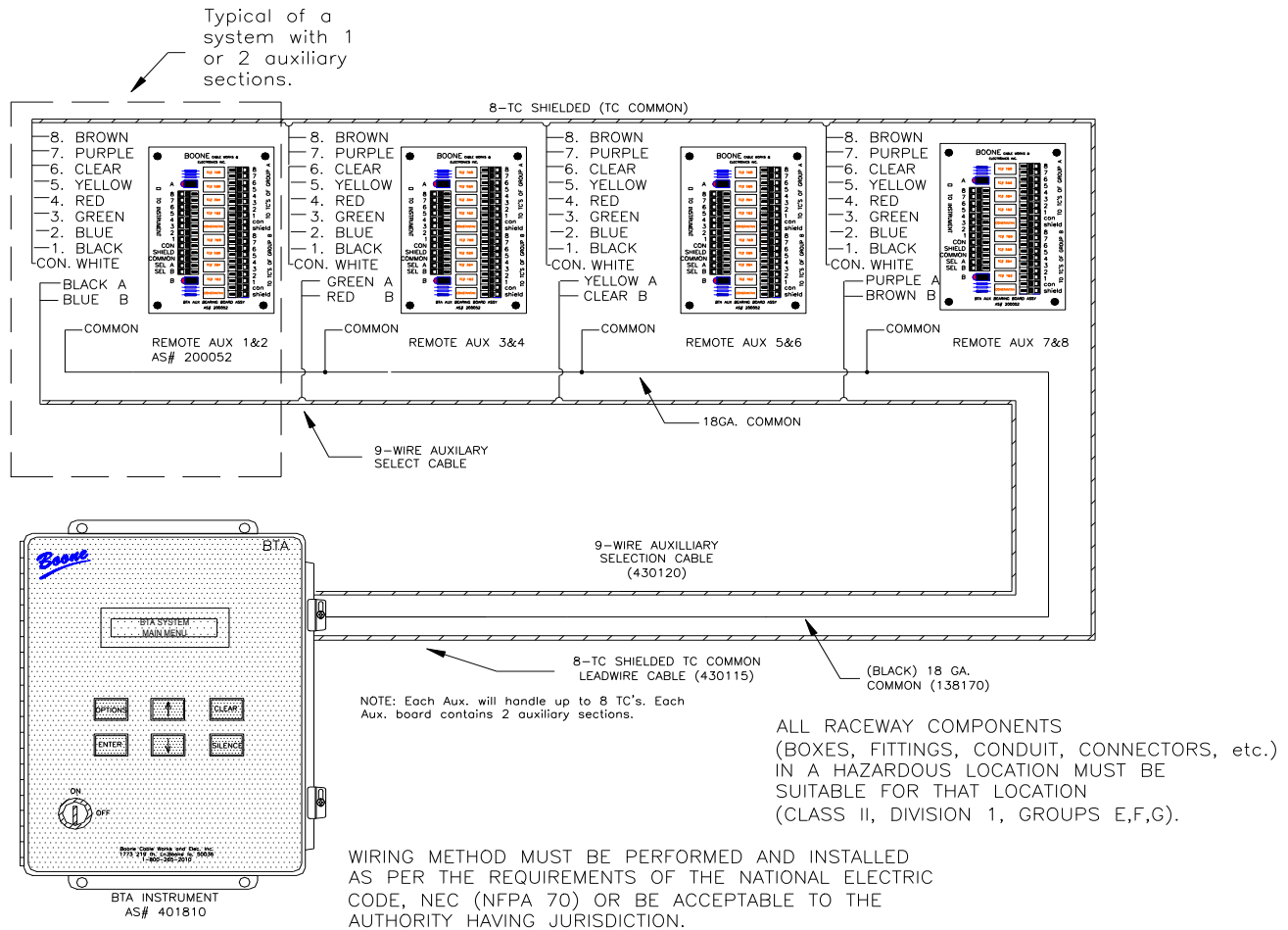


Figure 8. INSTRUMENT - AUXILIARY CONNECTIONS

6.2.1. 9-Wire Auxiliary Selection Cable (430120) A cable made up of 9 copper, 26 AWG wires for *Auxiliary Selection*, used to select an individual Auxiliary Section (SELECT GROUP A or B) This cable is unshielded and carries the +15VDC control signal. Its purpose is to connect the *BTA Instrument* to all *Remote Auxiliary Boards* (SEL A or SEL B). If more than 9 *Auxiliary Sections* are used, then an additional 9-Wire Auxiliary Select Cables must be used. Be sure that if more than one are used that you mark them with Brady Tags or some similar type product to distinguish one from the other.

6.2.2. 18 AWG Common Wire (138170), stranded copper with black TTFN insulation. Serves as a common return path from all the Auxiliary Switches Selections thus completing the selection circuit. Every Auxiliary Bearing Board is connected in parallel to the instrument with this wire.

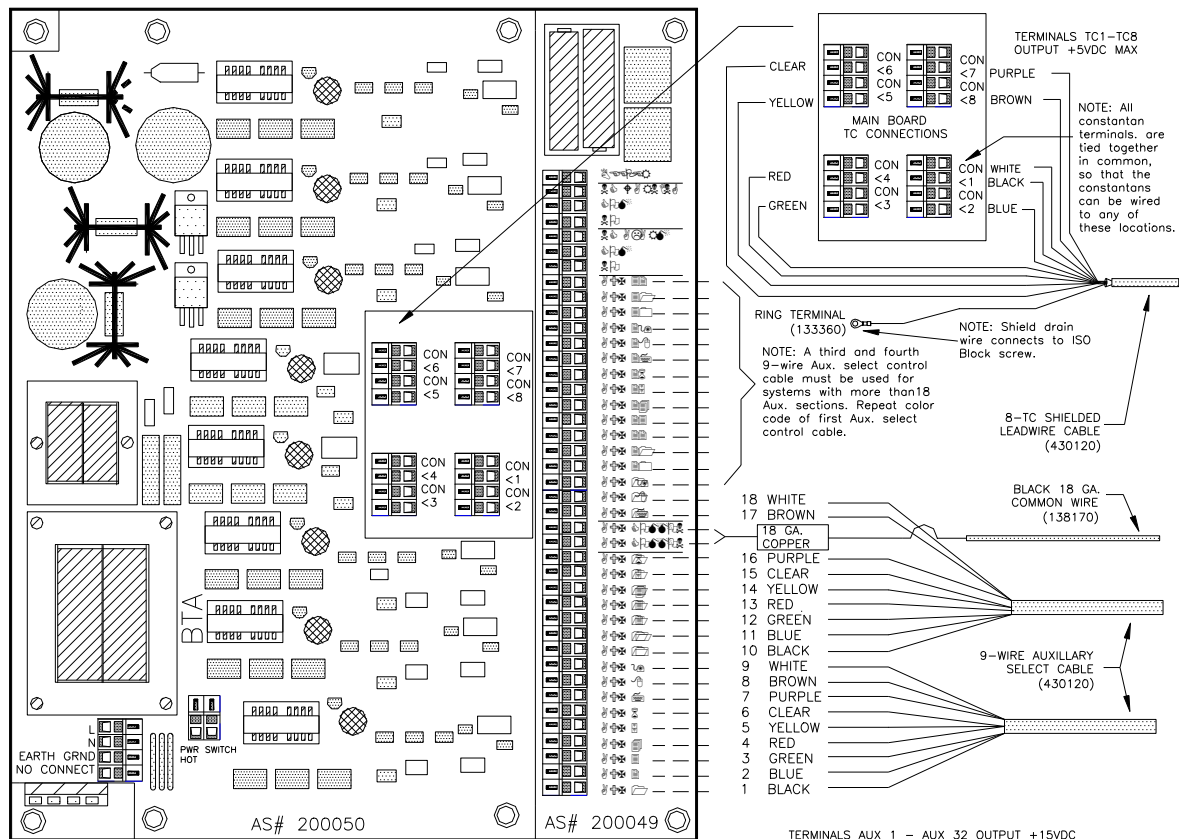


Figure 9. INSTRUMENT CABLE CONNECTIONS

6.2.3.8-TC Shielded Leadwire Cable (430120) Its purpose is to bring Temperature data in the form of thermocouple signals back to the *Instrument* from each *Auxiliary Board*.

6.2.3.1. Shield Drain Wire - Its purpose is to eliminate Electro-Magnetic Interference (EMI) on lead wire, and serve as a path for lightning strikes and transients to earth. It must connect to Earth Ground (PE2). Connect the *Drain* wire to the screws of the aluminum *Isothermal Block* with the crimp-on ring terminal and screws. Do not allow the exposed bare drain wire to touch inside of conduit or enclosure. Insulate any exposed part with tape or spaghetti tube. See figures 4,10.

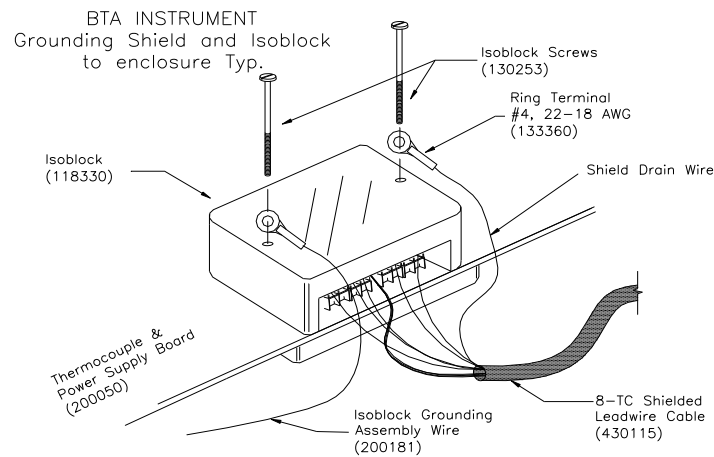


Figure 10. INSTRUMENT CABLE CONNECTIONS

6.3. CONNECTING TEMPERATURE WARNING & ALARM RELAYS

These relays are provided to switch externally-supplied power to alert devices (visual, audible), control circuits or PLC inputs. These outputs activate and change states (closed-to-open or open-to-closed) when a *Warning* or *Alarm* Condition is recognized.

6.3.1. WIRING 1 Warning, 1 Alarm, have FORM "2C" (SPDT) dry contacts. For applications involving AC line voltage, leave connections to the contacts and external devices to a qualified electrician. See figure 11.

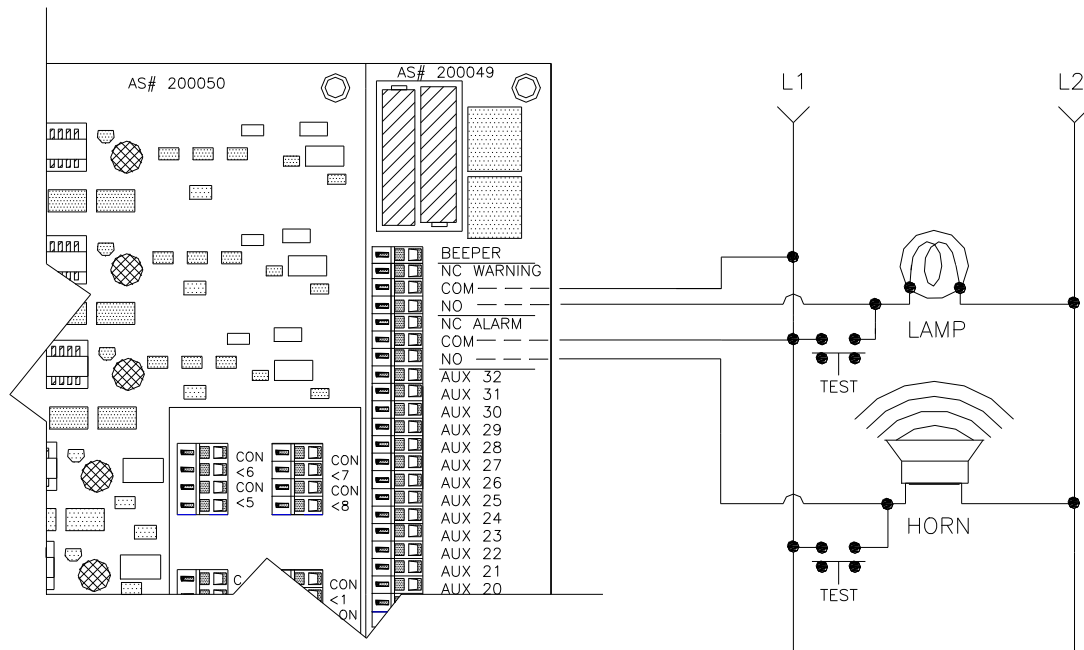


Figure 11. Connections to Temperature Warning & Alarm Relays

6.4. CONNECTING AUXILIARIES TO SENSORS

6.4.1. Auxiliary Extension Leadwire Cable (same as 8-TC Shielded Leadwire Cable) it runs from a grouping of Temperature Sensors to the input side of an Auxiliary Section. Be sure to connect shield drain wire to the “shield” terminal end only. See figure 12.

BTA – AUXILIARY WIRING TYPICAL

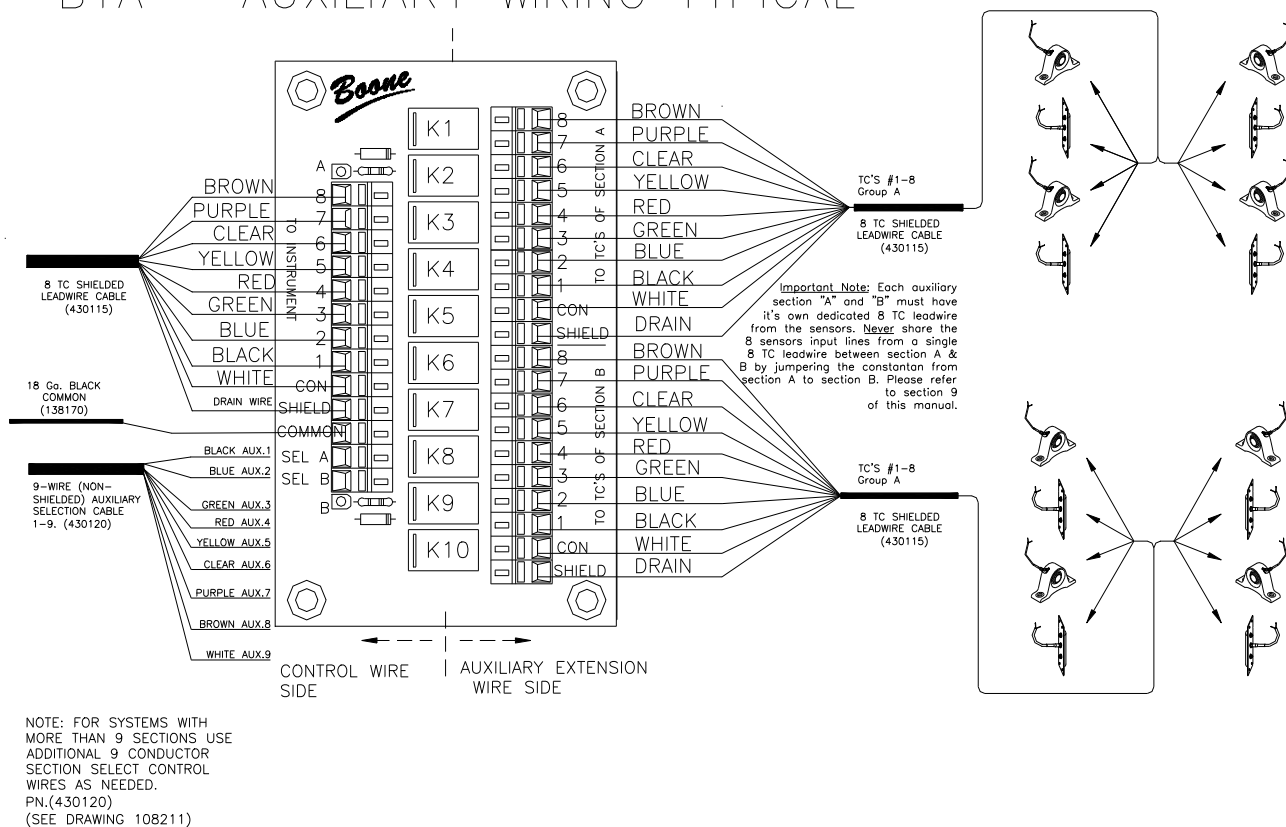


Figure 12. AUXILIARY CONNECTIONS

6.4.2. Terminations are done where the cables are connected to the circuit boards. BTA boards use a Cage-Clamp type terminal blocks. See Figure 13. For the gauges of wire used in our cables, we have found that this spring-pressure provides a more reliable connection regardless of temperature variations, vibration, and corrosive environments. They also reduce overall wiring and maintenance time. See Figures 9, 11 & 12.

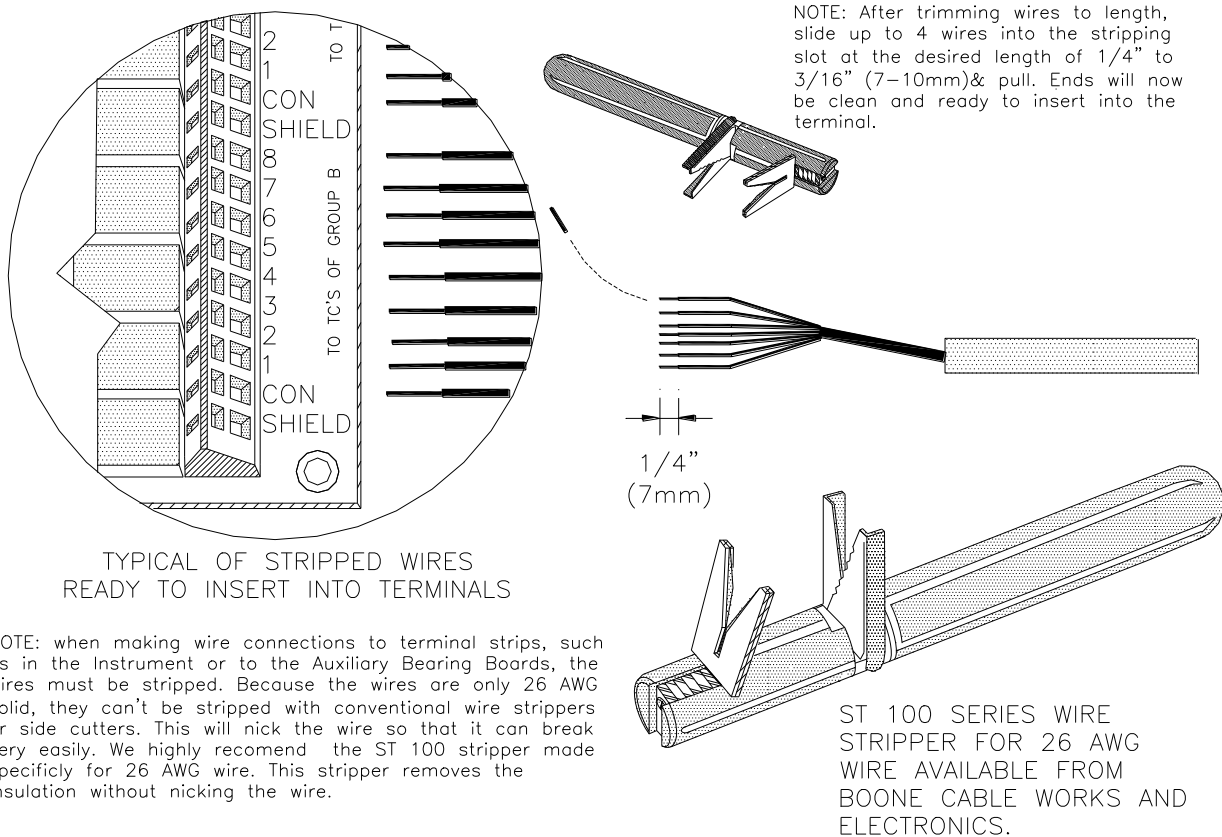


Figure 13. Termination of Wires

6.5. SPLICING Good connections are critical to the integrity of the system. Attention to detail here will yield a trouble free system and greatly reduce start up problems. Wire-to-wire splicing, is done for example where the sensor pigtail is connected to the *8-TC Shielded Leadwire Cable* (430115) so it can be extended to the *Auxiliary Bearing Board* (See figure12). It is also done where a section of *9-Wire Auxiliary Select Cable* (430120) needs to be extended or branched off in another direction. Splices should never be made and pulled into the conduit run.

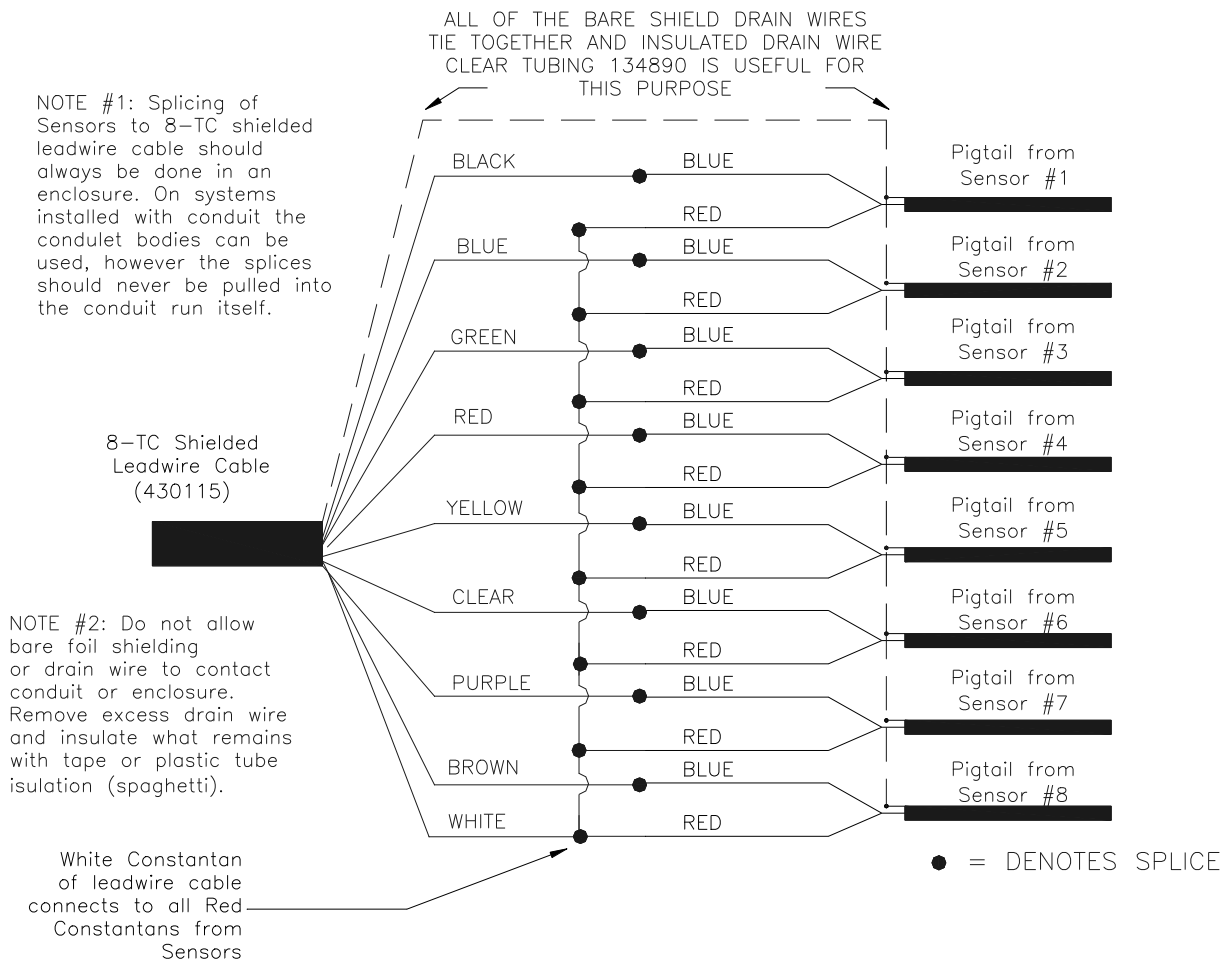


Figure 14. SPLICING

6.5.1. Wire-To-Wire Splicing Wire-to-wire splicing should be done inside a splice box or in a conduit fitting. A splicing enclosure will provide mechanical protection from collateral damage related to moving machinery, or vigorous housekeeping. The splice is more vulnerable to environmental effects and physical damage than the remainder of the wire run, which is still in its jacket. A splice enclosure also keeps them free of dirt and moisture. Splicing enclosures should be placed in an easily accessible location and has a proper dusttight cover. See Figure 14 & 15.

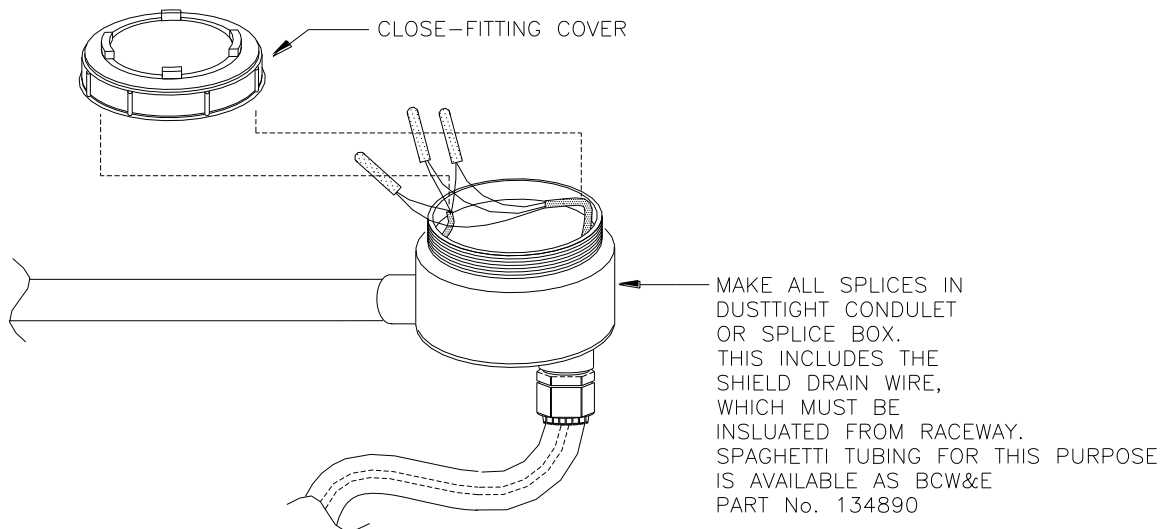


Figure 15. SPLICING IN A FITTING

6.5.2. Crimps All wire-to-wire splices should be made with Line B grease filled wire connectors. These connectors and the proper crimping tool for installation are available from BOONE CABLE WORKS AND ELECTRONICS and can be ordered with the system. These crimps offer the highest degree of reliability, insulation, and moisture protection of any we have found. They also have the added benefit of not requiring the stripping of the insulation from the individual conductors when connecting two 26 AWG wires. The crimps are insulated outside and are grease filled inside. The grease retards corrosion and resists water, thus making a good conductive splice that is well insulated. After the splice bundle is completed, several wraps of good quality electrical tape will provide abrasion resistance, and make for a neat looking splice. Please refer to the detailed splicing section, and Figure 16 for specific steps related to making wire connections.

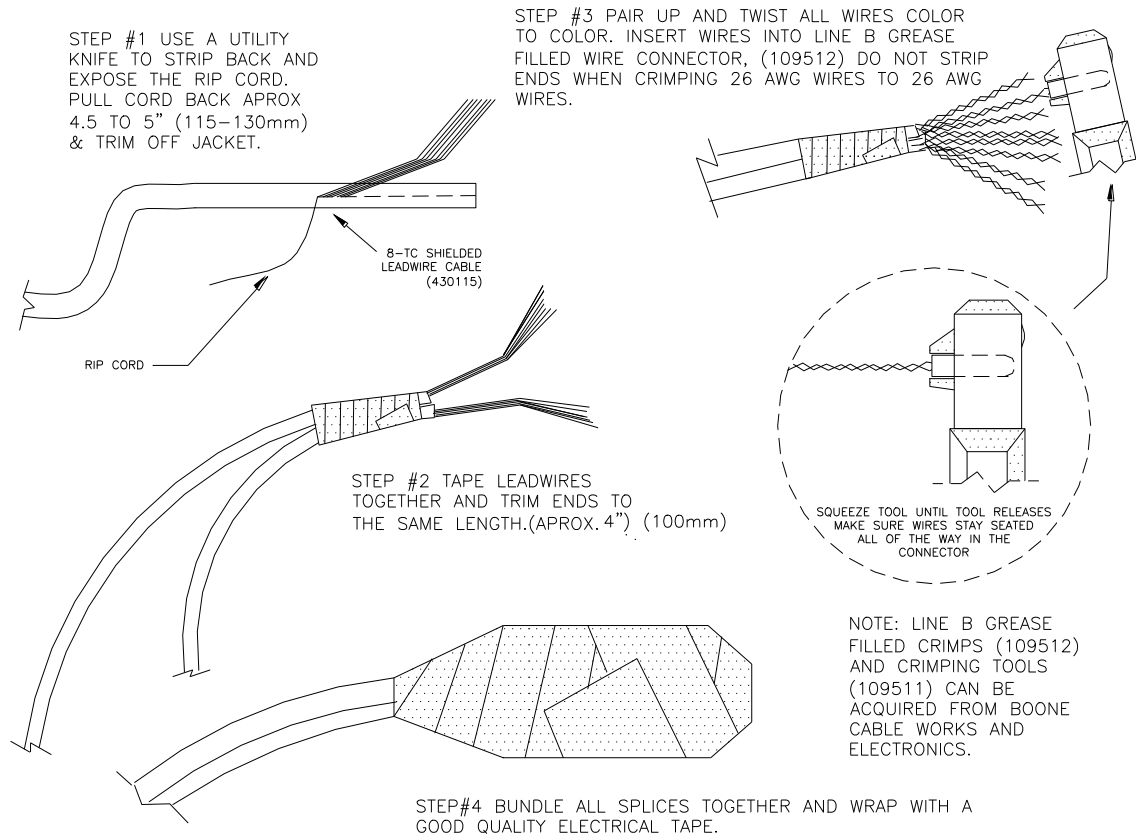


Figure 16. Cable Splicing with Crimps

6.5.3. Detailed Splicing Instructions

6.5.3.1. When making same size wire to wire connections, first pair up the two or more cables and tape them together about 5" to 6" (13-15cm) from the end.

6.5.3.2. Locate the parallel ridge that runs the length of the cable. You will have to look closely to see it. This ridge identifies the location of the nylon ripcord under the jacket of the cable.

6.5.3.3. After you have exposed about an inch (25mm) of the ripcord you can now grab it with a pair of needle nose pliers and pull it back to the tape, splitting the jacket as you go.

6.5.3.4. After you have done this to all cables to be spliced, you can trim off the jacket at the tape, exposing the individual wires inside.

6.5.3.5. Gather the wires in bundles of the same color. Nine colors are repeated in all the cables and are always Black, Blue, Green, Red, Yellow, Clear (copper), Purple, Brown and White. 8-TC Shielded Leadwire Cable (430115) has the constantan wire insulated white. 9-Wire Auxiliary Select Cable (430120) has no shield or constantan; all are copper.

6.5.3.6. Trim all wire bundles to the same length of about 4.5" to 5" (115-130mm) long and separate bundles.

6.5.3.7. Pair up the wires color to color and twist them together as in Figure 14. If more than 3 wires are to be spliced under the same crimp, you must strip off the insulation before twisting.

6.5.3.8. After all of the pairs have been twisted, slide a line B Grease filled crimp over each pair, being certain that they are fully seated.

6.5.3.9. Use only the appropriate crimping tool designed for proper seating of the crimps to ensure that a good connection is made on each twisted pair.

6.5.3.10. As long as there are no more than three wires under a crimp splicing can be accomplished without stripping the individual conductors. If stripping is needed it should be done using the appropriate tool referred to in Figure 13.

6.5.3.11. Differing Wire Gauges - In some situations, wires of different gauge sizes must be spliced. One such connection of this type is where the sensor pigtail connects to the remote extension wires. In these situations, it is necessary to strip both ends before pairing up and twisting them together. Be sure that the crimp is fully seated over the bare ends and that no bare wire is sticking out from under the crimp. Use the crimping tool and finish the connection as usual.

6.5.3.12. Drain Wire - Be sure to maintain electrical continuity between all shield drain wires at each splice location, and at termination points. This shield drain wire must terminate at earth ground in the Instrument only. It should not be grounded to the conduit or other structures at splice locations.

6.6. TEMPERATURE SENSORS Bearing Temperature and Rub Sensors are classified as simple apparatus and record the temperature increases of monitored equipment through the use of Thermocouple technology. These devices are passive transducers and do not generate any significant voltage (<20mV DC). As the temperature increases these thermocouples indicate the proportional increase in temperature of the effected equipment. These devices are connected back to the BTA Auxiliary switch Box through the use of 1/2" conduit.

6.6.1. BELT ALIGNMENT RUB BLOCK (401541) A "RUB" includes a conduit-ready (1/2-inch size) coupling welded to a mounting plate. A half-round block of brass stock is bolted to the plate. It is prepared to accept the Drill & Tap Type Temperature Sensor. See Figure 17.

6.6.1.1. Drill & Tap 1/8-Inch NPT Probe (401608) is intended for Rub Blocks associated with belt alignment. The thermocouple is embedded in a brass fitting that has 1/8-Inch NPT threads.

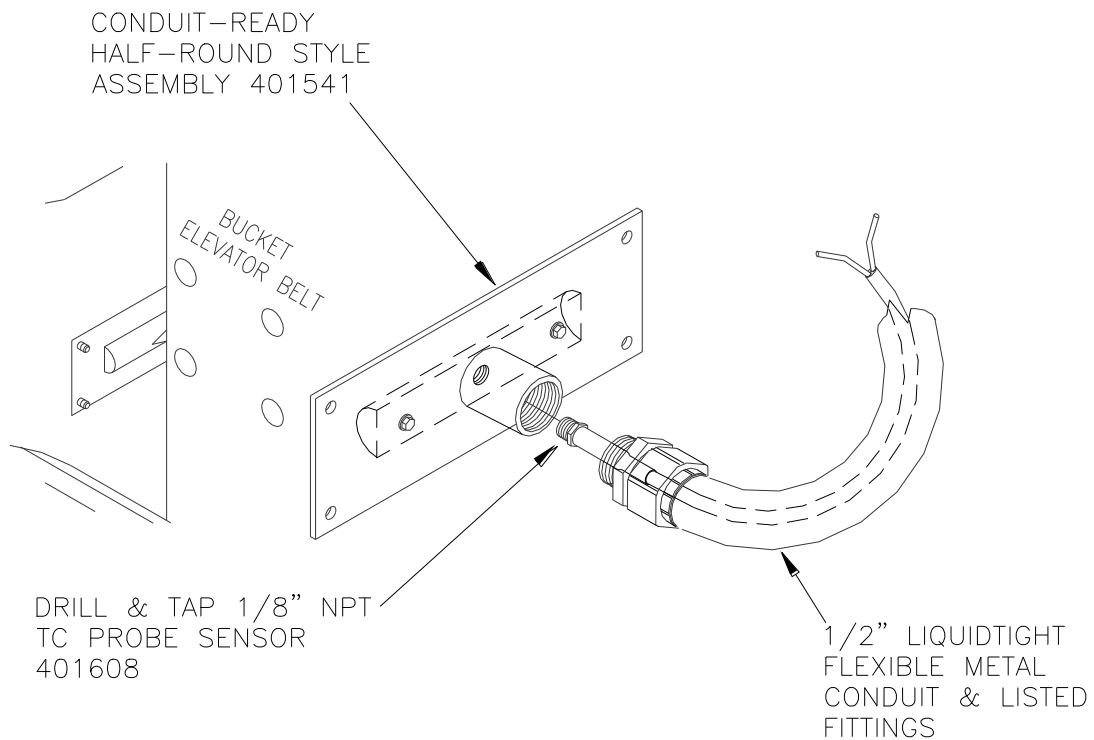


Figure 17. Rub Block & Drill & Tap 1/8-Inch NPT Probe Sensor

6.6.1.2. INSTALLING ALIGNMENT RUBS ON A BUCKET ELEVATOR BELT

- 6.6.1.2.1. Measure the diameter of the tail pulley to establish the track of the belt within the leg casing relevant to the desired location of the rub block. This can usually be accomplished through the removal of the inspection plate or inspection door.
- 6.6.1.2.2. If you still cannot locate the exact track of the belt by the previous method, then the following alternative may help. Measure out one inch from the inside of the trunk casing of the leg. (See Figure 18)

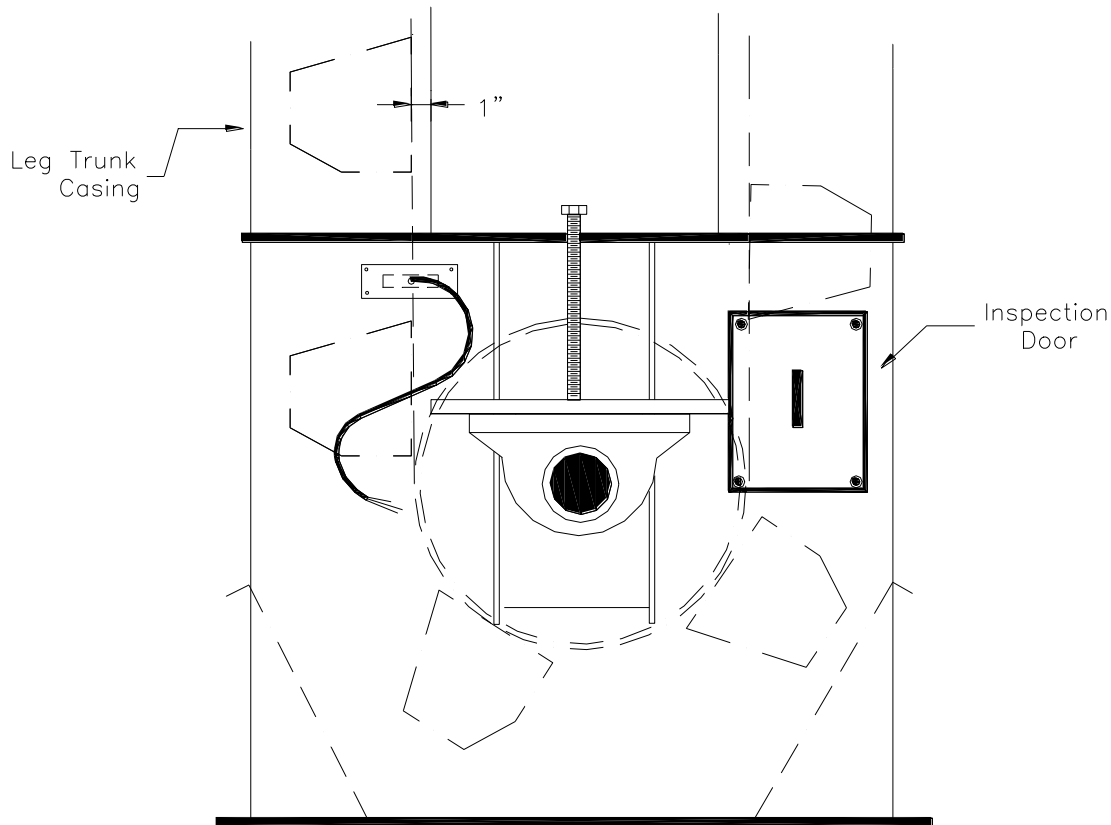


Figure 18. Rub Location on Elevator Tail

- 6.6.1.2.3. Extend this down in a vertical line to the desired height from the floor for the rub; at this point make your vertical and horizontal alignment marks. With a $\frac{1}{4}$ " drill bit, make a hole at the intersection of these two marks. Probe through the hole with a small, stiff piece of wire to locate the belt track exactly. Now you can locate the vertical alignment mark that will serve to center the rub on the belt. This method will usually allow you to get close enough that the $\frac{1}{4}$ " hole will be covered by the rub mounting plate when finished.

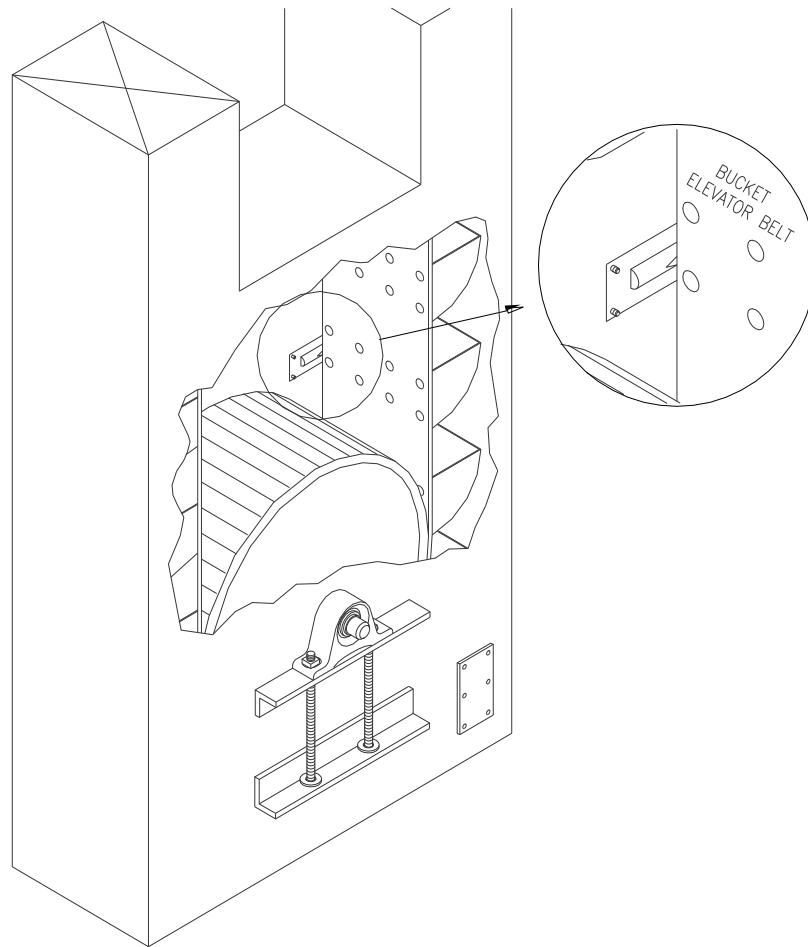


Figure 19. Rub Sensor

6.6.1.2.4. After you have located and marked the vertical belt alignment mark with a pencil or marker, then you can mark the horizontal height, being mindful of obstructions that might interfere with flush mounting of the rub. NOTE: the height selected should ideally be the same for all the rubs on the leg, and should take into account that the tail, pulley is adjustable up and down to account for belt stretch and load. Remember to place the rub so that it will engage the belt regardless of the location of the pulley.

6.6.1.2.5. Next take the appropriate template provided, see Figure 20. and place it against the leg casing in alignment with the vertical and horizontal alignment marks that you have made previously in steps one and two. Dashed lines have been provided on the template for this purpose. The template is the exact size of the rub mounting plate to aid you in locating the rub away from obstructions. Minor adjustments can be made so long as the belt will still contact the brass portion of the rub fully should it track out of alignment. The location of the brass rub is indicated by the 5-1/8" x 1-1/4" cutout on the 3" x 8" template. You can use these as guides if minor adjustments are necessary. In some cases you may have to relocate the rub altogether in order to find a flush mounting location that still lines up with the belt. See Figure 18. The template is punched so that you can use it to mark out the mounting holes for the rub as well.

- 6.6.1.2.6. Once you have found a suitable mounting location, use the center cutout of the 3 x 8" template to mark the minimum area of the leg casing that must be removed to allow for the rub. Use a hole-saw to make an opening for the reciprocating saw (Saws-All). The hole can be cut using a reciprocating saw.

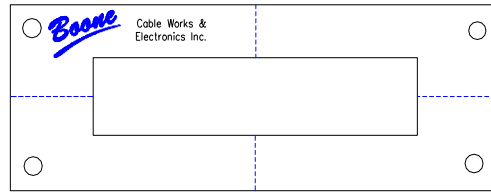


Figure 20. Rub Installation Template

- 6.6.1.2.7. Be careful not to cut the belt when you make your cutout.
- 6.6.1.2.8. After you have made the appropriate size hole in the leg casing to accommodate the rub block, you can install the Drill & Tap Sensor into the pre drilled and tapped 1/8" NPT hole provided in the rub block. See Figures 17 & 21.
- 6.6.1.2.9. Now you can mount the rub and sensor assembly in the opening using the four self-drilling "TEKS" (extra-wide washer head, serrated to prevent stripping) screws provided with each rub assembly.

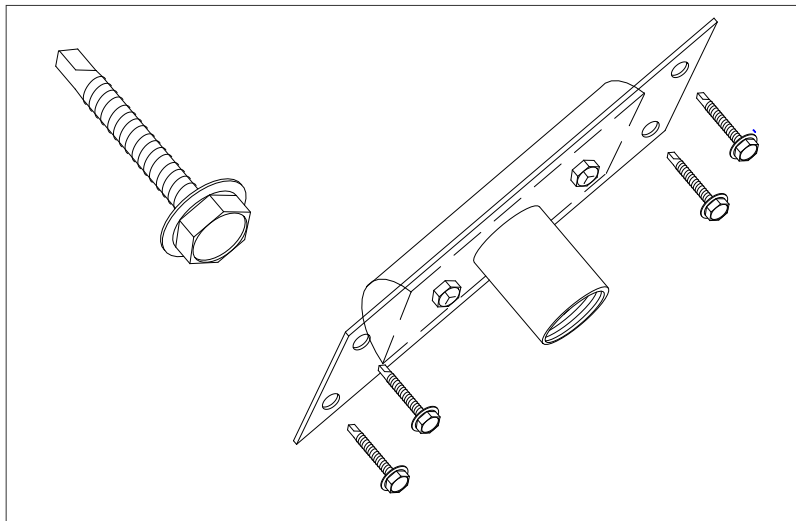


Figure 21. Mounting Half-Round Rub with Tek Screws

- 6.6.1.2.10. Once the rub assembly has been installed, be sure to use a product such as RTV silicone or Liquid Metal seam sealer to form a dust tight seal around the outside of the rub mounting plate.

- 6.6.1.2.11. Conduit is recommended to protect the probe pigtail cable. This can be achieved with Liquidtight Flexible Metal Conduit (LFMC) and fittings. LFMC is particularly useful if the bearing must be able to move. Leave enough slack in the pigtail and LFMC to accommodate this movement. The conduit ready adapter is meant to facilitate connection to the LFMC.

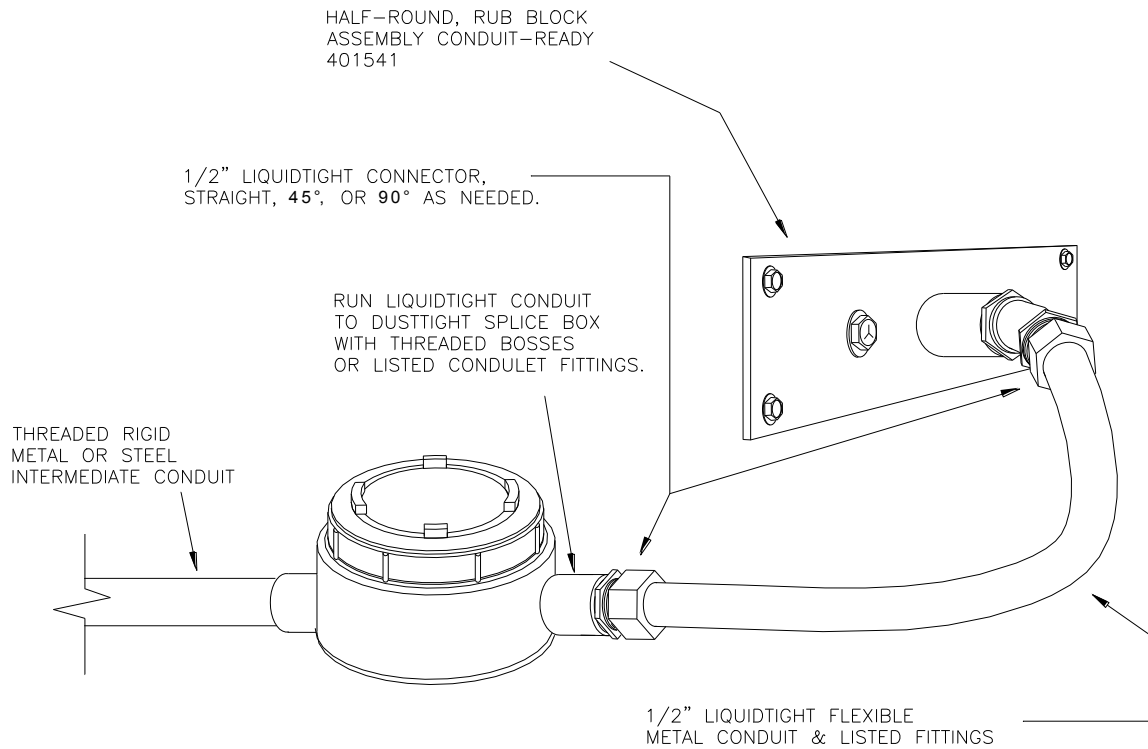


Figure 22. Conduit-Ready Rub

- 6.6.1.2.12. Locate and install all subsequent rubs and sensors in the same manner as described above.

6.6.1.3. INSTALLING ALIGNMENT RUBS ON A HORIZONTAL CONVEYOR BELT

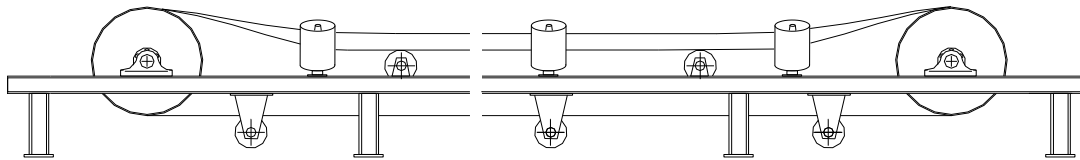


Figure 23. Open Frame Belt Conveyor

6.6.1.3.1. In some cases it is desirable to mount rub blocks on open frame conveyors. Some suggestions on possible mounting configurations can be found in Figure 24.

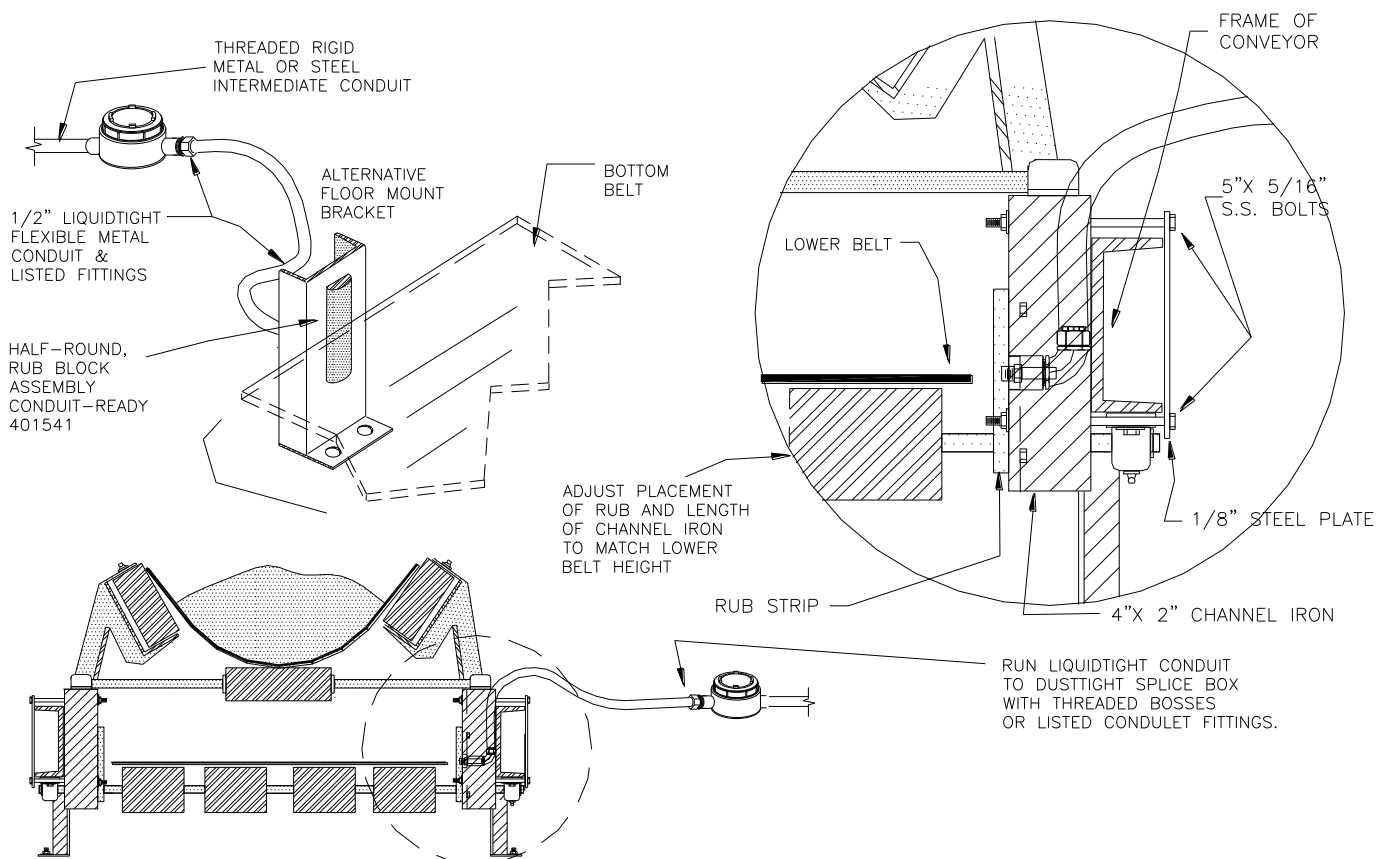


Figure 24. Rub Mounted on an Open Frame Conveyor

6.6.2. Bearing Probe (401605) is inserted into the grease fitting of the bearing housing. The thermocouple is embedded in the tip of the probe tube.

6.6.2.1. Bearing Probe Installation

6.6.2.1.1. Remove grease fitting (Zerk) from bearing housing. Most bearing housings are drilled and tapped for 1/8" NPT grease fittings (Zerks). If it is tapped for 1/8" NPT, proceed by inserting male threaded end of 1/8" NPT Steel Street Tee (200010) into the hole that has been vacated by the grease Zerk. Be careful not to over tighten. Screw existing Zerk into the side opening of the Tee and aim it so that it can be greased easily. See Figure 25.

6.6.2.1.2. Some bearings are tapped for Zerks using 1/4" x 28 SAE threads. "Boone Cable Works" can provide you with special probes, compression fittings, and an adapter that will fit these locations.

6.6.2.1.3. Much larger bearings occasionally use a housing tapped for 1/4" NPT zerks. "Boone Cable Works" can also provide adapters for these locations. The standard Tee, compression fitting, and probe are used with this adapter. However, a new 1/8" NPT Zerk must be used, and occasionally an extension will be in order. Zerks, Extension Nipples, and Adaptors can usually be found locally at an auto parts outlet if needed, or can be purchased from B.C.W. & E.

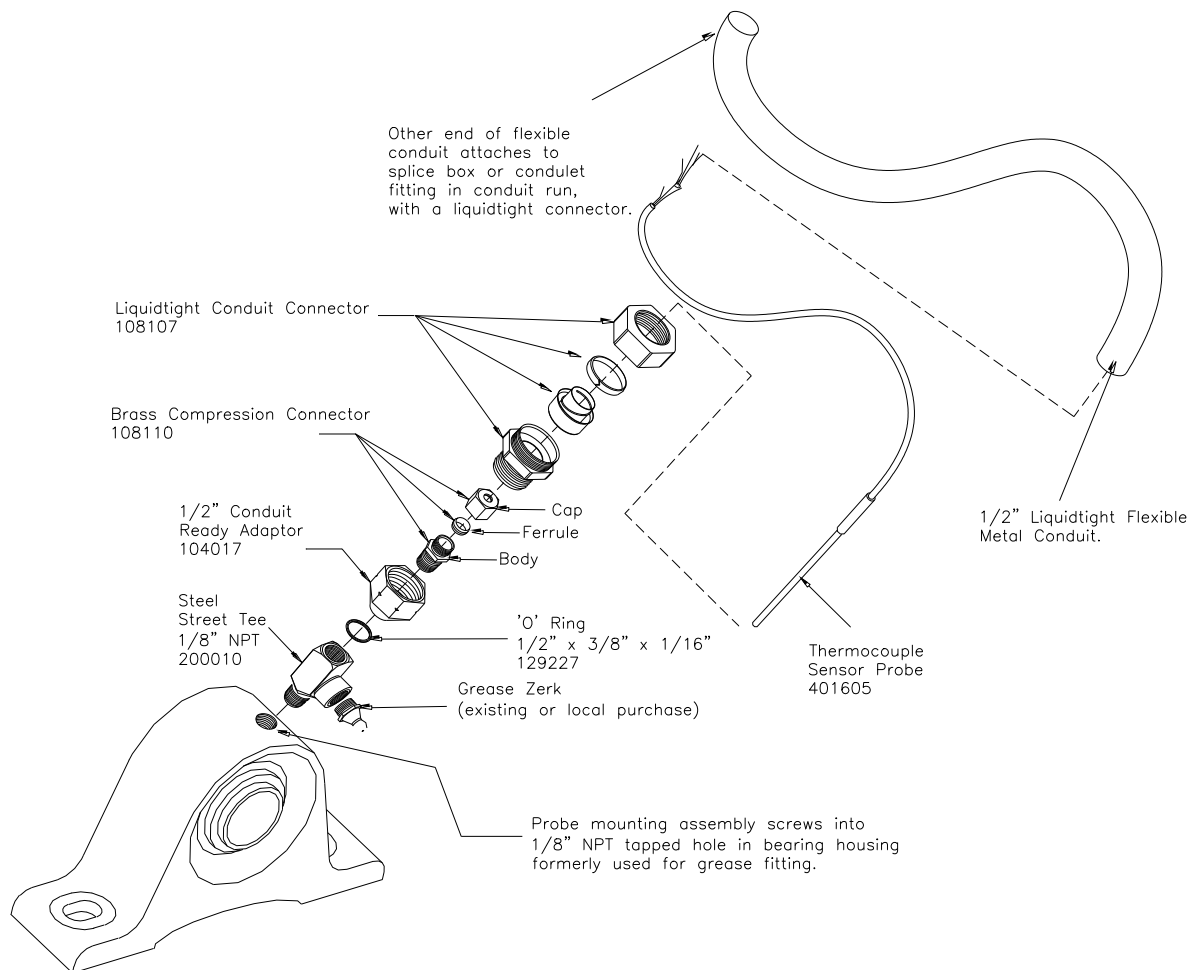


Figure 25. Bearing Probe Sensor and Fittings

- 6.6.2.1.4. After the Tee and Zerk have been installed, screw the compression fitting into the top of the Tee.
- 6.6.2.1.5. Thread the compression nut and the compression ferrule onto the stainless steel bearing probe. Insert the assembly through the top of the compression body and down through the Tee until it bottoms out on the bearing race. Now withdraw it about 1/16" to 1/8" and tighten compression nut until snug + ¼ turn. The compression nut must be tight enough to resist hydraulic pressure applied to it by greasing, but not so tight as to excessively distort the probe.
- 6.6.2.1.6. Conduit is recommended to protect the probe pigtail cable. This can be achieved with Liquidtight Flexible Metal Conduit (LFMC) and fittings. LFMC is particularly useful if the bearing must be able to move. Leave enough slack in the pigtail and LFMC to accommodate this movement. The conduit ready adapter is meant to facilitate connection to the LFMC.

7. MOTION SYSTEMS

The following components and connections are what you will need to know to make the motion part of the system run.

7.1. FEATURES

7.1.1. FAIL – SAFE SHUTDOWN OPERATION The BTA has been designed such that only when it is scanning for hazards will it allow the interlocked equipment to be started and kept running. When legitimate slowdowns occur, a shutdown alarm will be generated by the BTA. Motion Monitors for Elevators must wind up in a state that guarantees a Fail-Safe shut down condition. Not having Fail-Safe shut down capability can be disastrous. Hazard Monitors should be part of the interlocking circuitry that automatically trips the motor controls and falls into a safe condition in the event of a failure or breakage in any part of the circuit. If any part of the system fails, an alarm signal is immediately generated. This can come in the event of a true alarm condition or failure in the monitoring system (power loss, accidental breakage, shorting). When the ENABLE is high indicating the conveyor is powered, at that time the output Relays are energized to latch the interlocking circuitry to keep the system running. In the event of a system failure, output relay switches to open or alarm condition. Any disruption causes an unlatching of normal state and thus a fail-safe condition. This action complies with NFPA 61, §7.4.1.5 with relays to shut-down power to drive motor, feed conveyor, and actuate an alarm. OSHA Standard 29 CFR – 1910.272 is also covered.

7.1.2. START-UP PERIOD MONITORING Two features help monitor the period before the conveyor reaches full speed.

7.1.2.1. START-TO-MOVE (STM): From the time that the start button is pushed (speed channel enabled) and the motor is powered, the monitored equipment has “n” seconds to begin moving. It does not have to reach normal speed during this time, just begin moving. If no movement is sensed, alarm state is entered and a shutdown is triggered. Thus preventing catastrophic damage from a “choked” leg.

7.1.2.2. ACCELERATION TO NORMAL SPEED: After the equipment starts moving, instantaneous (differential) acceleration is checked so that slippage will not generate heat at the contact surface of the drive pulley lagging and belt. Minimum acceleration must be maintained throughout this period. If proper operational speed is not accomplished in X seconds, an alarm state is entered and a shutdown is triggered. Acceleration must be positive or zero (non-negative). Deceleration (negative) at any time during the acceleration period will result in an alarm and thus a shutdown. The speed above the Warning level does not have to be reached until the 1-30 second acceleration time-out period expires. Once the speed is brought above warning level, the BTA system is set for regular Belt-Slip Monitoring. The Fail-Safe operation also applies during this period

7.2. MOTION MODULE (401812) This module is an add-on enclosure separate from the main BTA Instrument. Signals from 8 or fewer Speed Sensors are input to the Signals are conditioned before being passed to the BTA Instrument. Speed is then determined and any slow-down from normal speed is monitored. Unlike the BTA Instrument, the Motion Module continuously monitors the speed signals. Slow-downs will be detected instantly. A *WARNING* is displayed if a slowdown occurs below 90% of normal speed (or traditionally -10%). An *ALARM* is displayed if a slowdown occurs below 80% of normal speed (or traditionally -20%). These settings are adjustable. External signal devices can be activated for each piece of conveying equipment that is monitored. See figures 26 & 27.

7.2.1. MOUNTING It is attached to the Instrument by the use of two ½ inch conduits. One for the pair of Ribbon Cables. A second one for cable and wires. It should be mounted within 2 feet (60cm).

7.2.2. RPM-SPEED BOARD (200051). This electronic circuit board is the primary component in the Enclosure. It connects to all other components including the Instrument. See Figures 1 26 & 28.

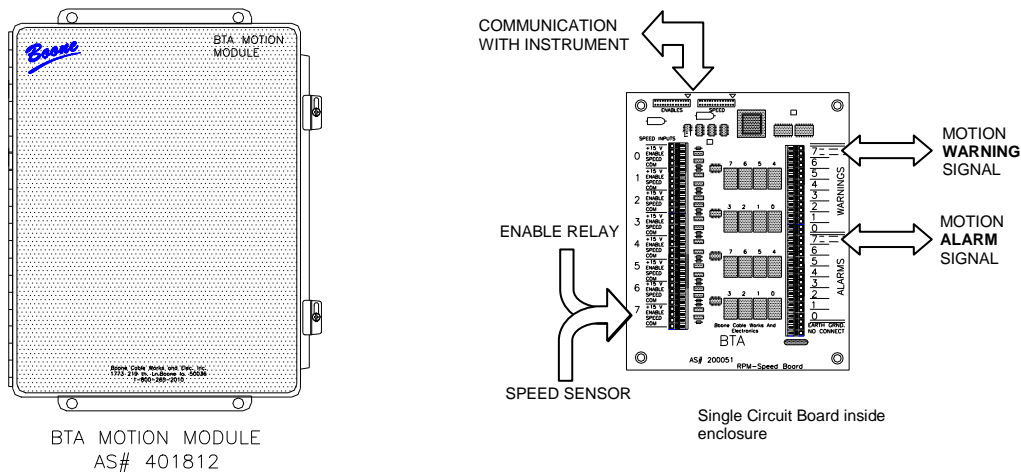


Figure 26. Motion Module & Rpm-Speed Board

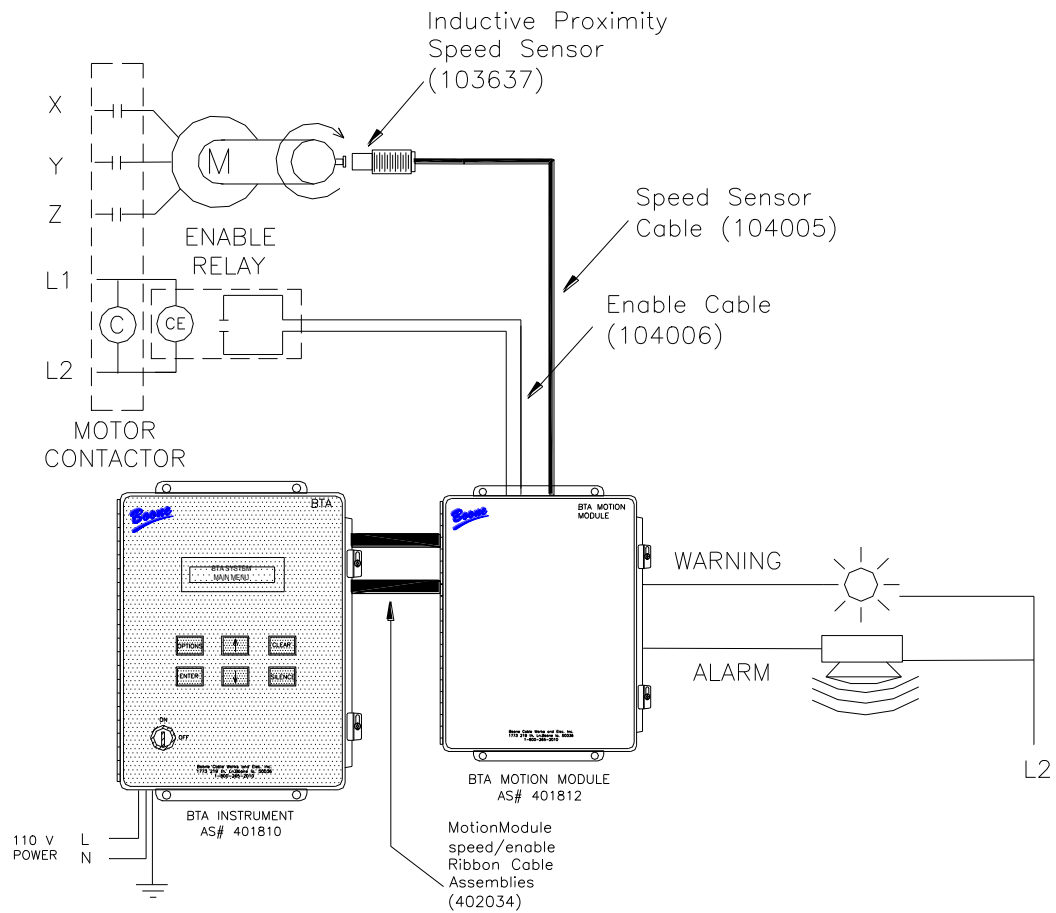


Figure 27 Basic Motion Module Connections

7.3.RPM-SPEED BOARD CONNECTIONS

All connections to and from the Motion Module come together on this board. Figure 28 shows typical connections necessary for one Speed Sensor. Following sections will describe each of the connections in more detail.

If a channel is used, it needs connection to both a Speed Sensor and an Enable Relay. Terminals are located on the left side of the board for connection of the 8 channels (labeled 0-7).

- Speed Sensor Cable - connect power and signal.
- Enable Relay Cable - connect signal.

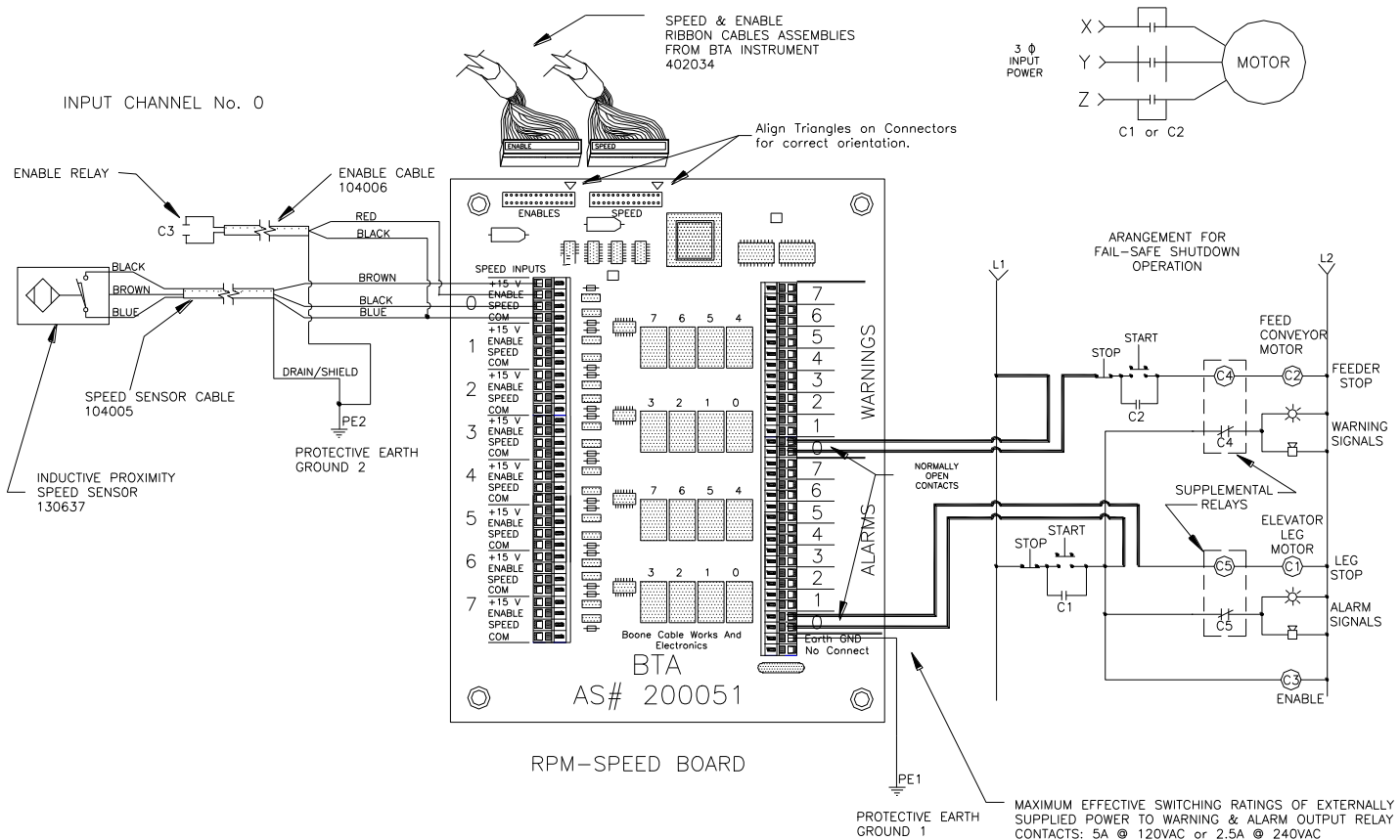


Figure 28. Motion Module Connections

7.3.1. SPEED / ENABLE RIBBON CABLES (402034) This pair of cables provide power and communications connections between *The Motion Module* and the *BTA Instrument*. +5VDC and +15VDC power is passed by the cables through ½" diameter conduits. Signals from the sensors are passed back to the Instrument as well. Keep the length under 2' (60cm) between the two enclosures. The cables are rolled up in a round tough shielded outer jacket. A shield grounding wire is attached to one side of each cable and must be terminated to the EMI Ground (PE2).

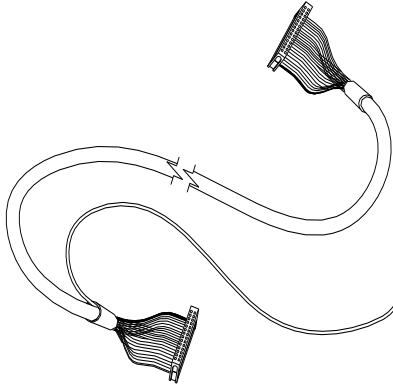


Figure 29. Speed / Enable Ribbon Cable

7.3.2. SPEED SENSOR (103637) is an *Inductive Proximity Switch* identical to the Turck P/N Ni10-G18-AN6X. Each time the sensor detects the target, it switches from OFF to ON state. The sensor provides a pulse to the Motion Module. It is a three-wire, current-sinking (npn type). It gets its power from the RPM-Speed Board and provides signal input for a single channel. This sensor is presently FM Approved for use in Class II, Division 2, Groups E F and G. Further testing was required to qualify this apparatus for Division 1. This sensor is connected to the BTA Motion Module which will be mounted in an ordinary location. See Figure 30.

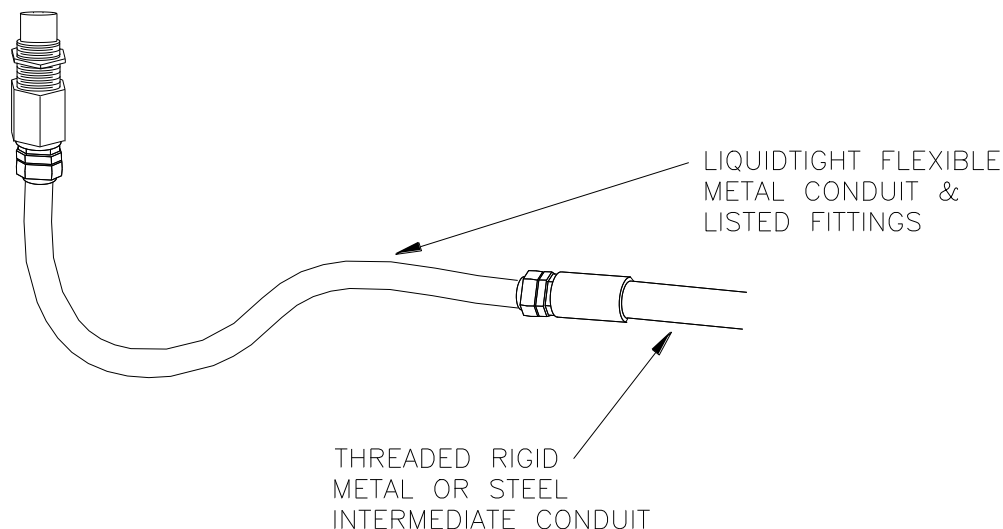


Figure 30. Speed Sensor with Mounting Hardware

7.3.2.1. MOUNTING SPEED SENSORS

7.3.2.1.1. BRACKET MOUNTING A universal mounting bracket and lock rings can be provided. This bracket allows for some adjustment so that head to target spacing can be modified. However, an additional bracket may need to be fabricated onto the monitored piece of equipment to get the sensor into its approximate final position. This bracket if necessary should be designed sturdy enough as to provide a solid mounting surface free of the effects of machinery vibration that could have an effect on head spacing. The speed sensor can be mounted in either a radial or an axial configuration to accommodate any potential clearance problems. When using bracket with Liquidtight Flexible Metal Conduit (LFMC), keep in mind the weight of the LFMC that contributes to the strain on the mounting bracket.

AXIAL MOUNTING See Figure 31 for a typical drawing showing one possible radial mounting scenario. The target will need to be drilled and tapped into the flat face of the shaft close to the outside edge. This will provide a circular path of travel (lateral approach) that only brings the target into alignment with the sensor once per revolution.

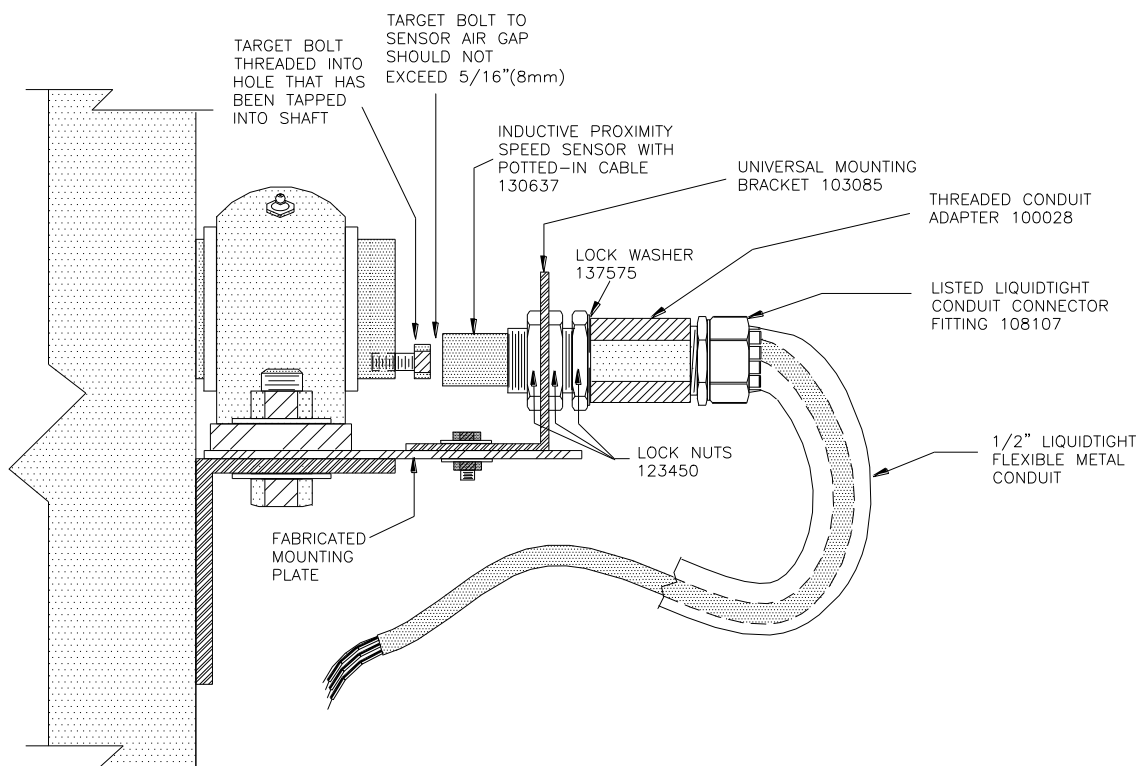
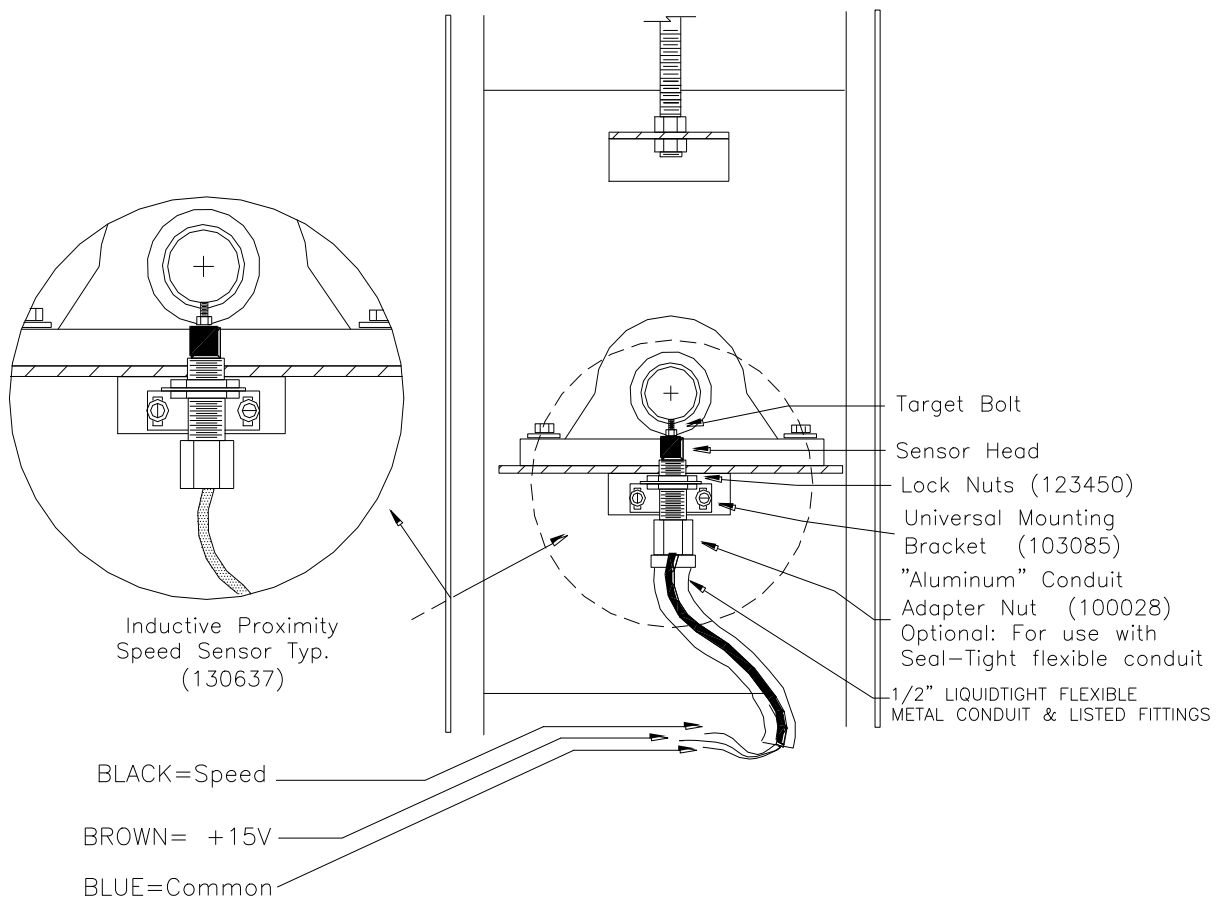


Figure 31. Axial Mount, Lateral Approach of Target to Sensor Face

RADIAL MOUNTING When the sensor is mounted radially (See Figure 32) the target must be drilled and tapped into the curved side of the shaft



7.3.2.1.2. **SHAFT MOUNTING:** (optional) in cases where the sensor-to-target distance may change over time (such as the Tail end of a Leg where the shaft is adjustable to change belt tension), it may be necessary to use a *Whirligig™ Universal Shaft Sensor Mount* (137690). It provides a more reliable installation of the sensor by ensuring that the distance from the sensor face to the target is fixed regardless of how the shaft position. It provides a bracket to hold the sensor, a target fixed to the shaft, and a guard to cover rotating parts. See Figures 33 & 34.

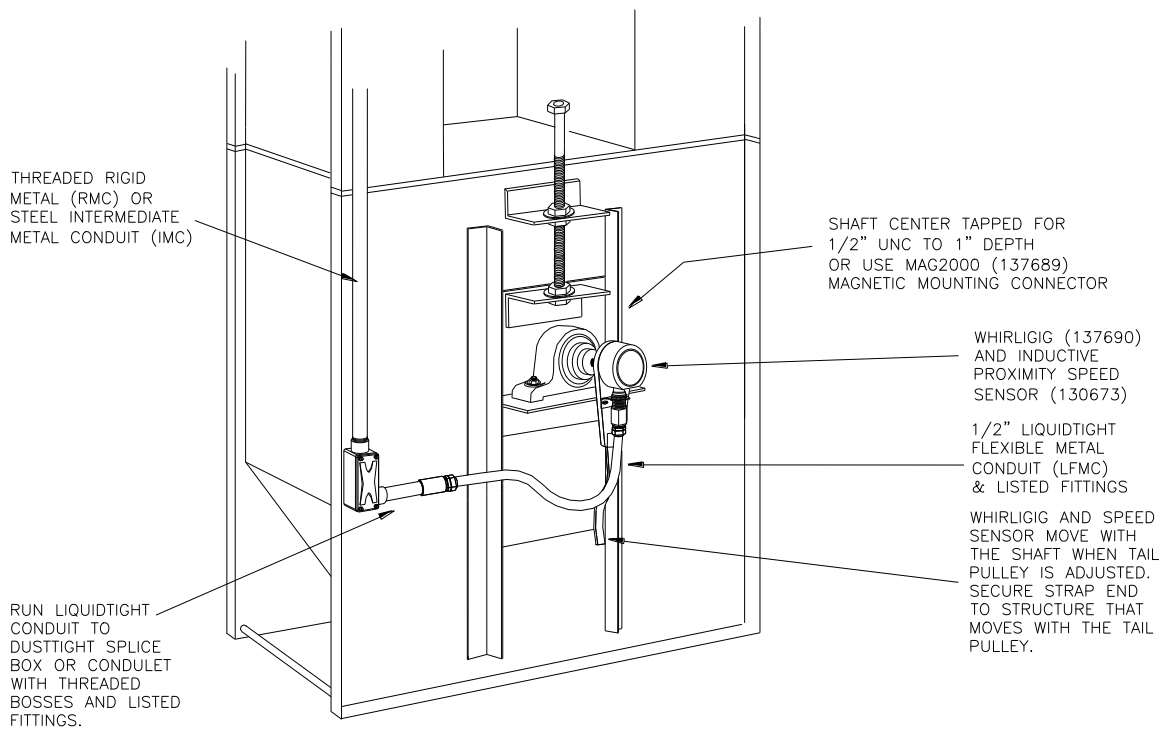


Figure 33. Sensor Mounting on Tail of Elevator Leg

MOUNTING HOLE The *Whirligig* mounts in a hole, centered on the axis of the shaft. A square with a centering head works well to find the center. Thread the hole with a 1/2" UNC Bottom Tap, to a depth of 1". In a field installation, this may be difficult. Fortunately, the *Whirligig* will still function in a hole that is slightly off axis. A small degree of wobble is acceptable. Thread the *Whirligig* into the machine shaft with a 5/8" open ended wrench and suitable thread locking adhesive (Loctite™).

MAGNETIC MOUNTING In situations where drilling and tapping a center hole is not practical, Boone Cable Works offers the *MAG-CON™* magnetic mounting fixture (137689). It uses a powerful magnet to attach the *Whirligig* to the end of the shaft without a center hole. The *MAG-CON* will not work on stainless steel shafts.

SENSOR BRACKET When installing the sensor to the *Whirligig* base plate, use the universal bracket supplied with the *Whirligig*. Leave a small gap 1/16" (2 mm) between the sensor face and the guard cover. Do not exceed a 1/4" (6 mm) gap to assure proper operation. The operation of the proximity switch can be tested with the equipment shaft stationary, by placing a thin metal blade in this gap. See Figure 34.

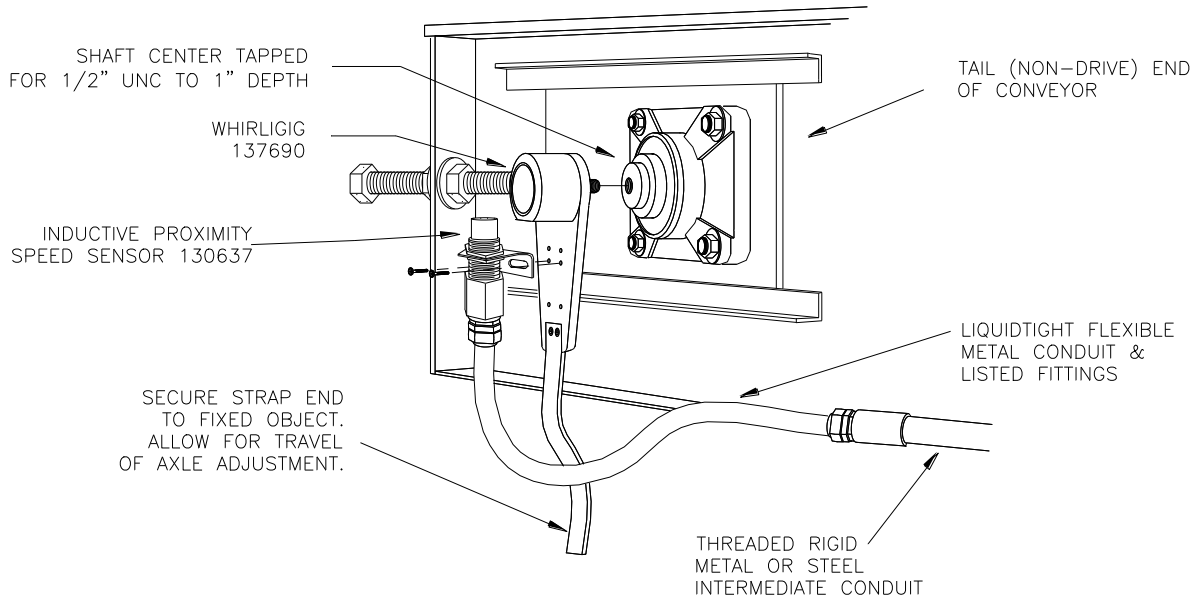


Figure 34. Shaft Mounting of Speed Sensor

7.3.2.2. SPEED SENSOR CABLE (104005) The speed sensor is connected to the speed board by shielded 3-conductor, 20 AWG, cable. This wire has the same color code as the wire from the sensor: Brown = +15V; Black = SPEED; Blue = COM. Shield drain wire must be tied to earth ground at the instrument end only *Sensors* procedure.

7.3.2.3. WIRING SPEED SENSORS - The *RPM-Speed Board* is mounted in the *Motion Module* enclosure. Figure 28 gives an example of a system with one Speed Sensor.

Cable	Wire color	Board Terminal
Speed Sensor	Brown	+15 V
	Black	Speed
	Blue	COM
	Shield/Drain	EMI Ground

Table 4. Speed Sensor Connections

Table 4. Speed

7.3.3. ENABLE RELAY The Enable Relay is put in place so that false alarms will not be read from equipment that is shut down (i.e. RPM=0 or decelerating) and let the BTA Instrument know when the equipment is powered and to consider speed readings valid. See figures 27 & 28. This relay energizes when the contactor for the motor driving the rotating equipment receives electrical power. The contacts on this relay are connected between the “Enable” and “COM” terminals of the *RPM-Speed Board*. This could be installed by a licensed electrician from locally purchased parts.

7.3.3.1. RELAY MODULE Where multiple pieces of equipment are monitored, A *Relay Module* may be purchased through Boone Cable Works. The *Relay Module* is a third box and provides a convenient way to group Enable Relays but it is not approved for Hazardous locations and is recommended for ordinary locations such as control rooms and is usually mounted in their own enclosure near the source.

7.3.3.2. WIRING ENABLE RELAYS The relay contacts are connected to the *ENABLE* and *COM* terminals of the *RPM-Speed Board*. The Enable Relay must connect to the same Speed Input Channel (0-7) as its Speed Sensor. Connections to the relay coil from the motor contactor control (usually ~115 VAC) should be left to a qualified electrician.

7.3.3.3. ENABLE CABLE (104008) is a shielded two conductor cable plus a drain wire. It provides an excellent way to connect the *RPM-Speed Board* to the Enable Relay. See figures 27 & 28.

Cable	Wire color	Board Terminal
Enable	Red	+15 V
	Black	Speed
	Shield/Drain	EMI Ground

Table 5. Enable

Relay Connections

7.3.4. WARNING & ALARM RELAY CONTACTS Terminals for access to these contacts are located on the right side of the board. See figure 28. Only the normally-open set are available for switching externally applied power. Normally-Open Output Relays energize for normal use providing fail-safe operation. They are designed to cause shutdown if interlocked both from slowdown or damage to wiring. Refer to section 7.1 Features. A qualified electrician should do electrical hook ups on the Warnings and Alarms side of the board, where AC line voltage may be used.

7.4. CONNECTING CABLE SHIELDS TO EMI GROUND

7.4.1. CONNECTIONS For a general description of Motion Module connections see figure 27.

7.4.1.1. GROUNDING Figure 28 shows that in addition to the standard circuit safety ground (PE1), an additional EMI ground (PE2) has been provided for. This is allowed for under the NEC for electronic equipment.

7.4.1.2. SHIELD TERMINATION The terminal block on the Motion Module Panel (PE2) is a convenient point to ground all cable shield drain wires at one central known ground.

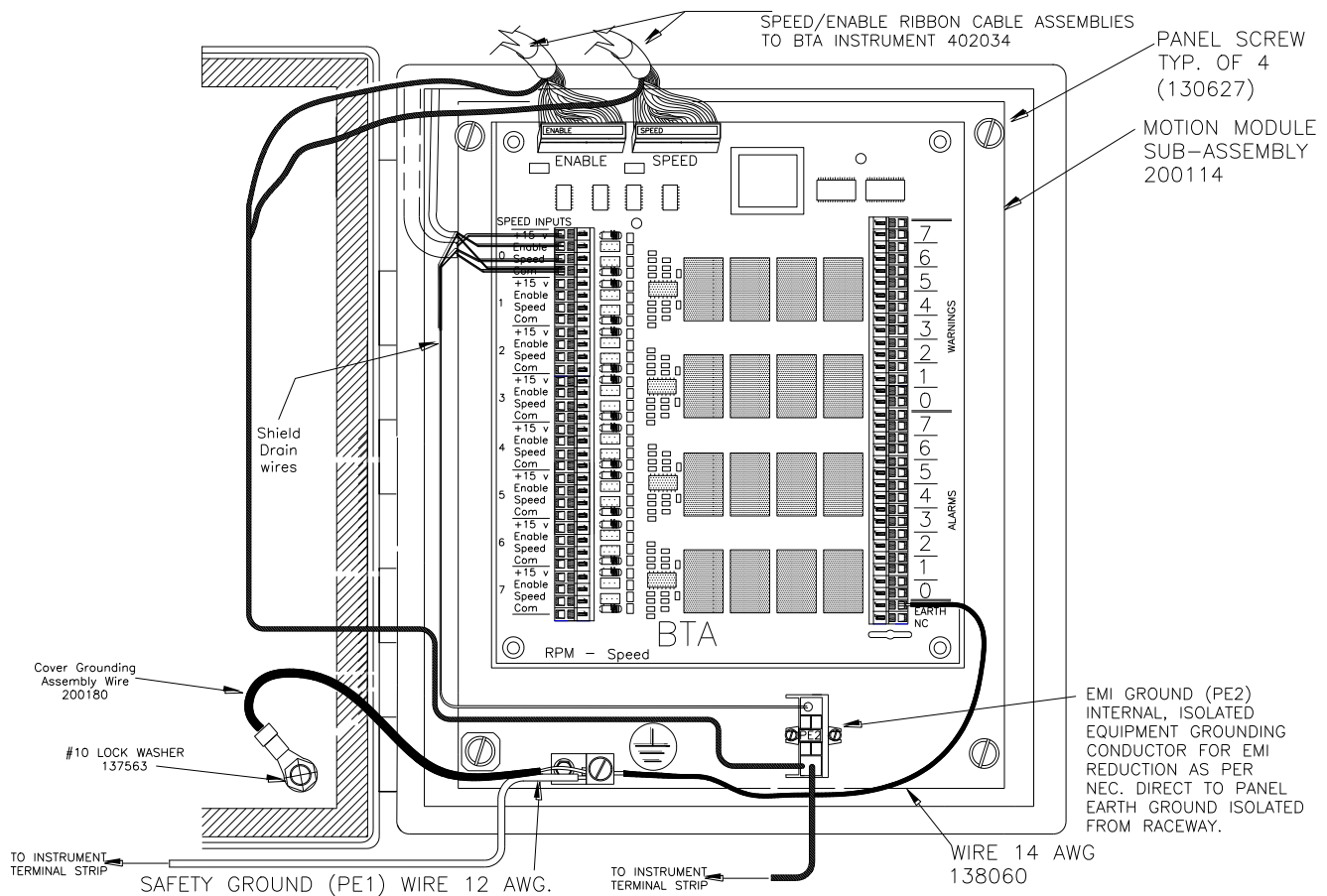


Figure 28. Motion Module Grounding Connections

8. START-UP PROCEDURE

Before the BTA System is ready to begin the SCAN SENSORS function, several procedures must be performed:

- 8.1. ENTER FACILITY CONFIGURATION: In most cases, the *Facility Configuration* will be programmed in the BTA at the factory. When this is not the case, manually enter the Zones and Sensors by following the *EDIT SENSOR CONFIGURATION* Function as outlined in the *SETUP MENU* of the *BTA OPERATION MANUAL*.
- 8.2. MANUAL SENSOR SELECT: It is recommended that each TC circuit be checked for continuity and temperature with this function. It allows the operator to manually read any *TEMPERATURE SENSOR* by dialing up its *AUX* and *TC Number*. It also is a very helpful way to troubleshoot Open Thermocouples and incorrectly wired *Remote Auxiliary Boxes*. See the *MANUAL SENSOR SELECT* Function outlined in the *SETUP MENU* of the *BTA OPERATION MANUAL*. Freeze Mist Test- verify the sensor name and address. 2-way radios, keep them away from operating speed sensors.
- 8.3. CALIBRATE SPEED SENSORS: Applicable only with the *Motion MODULE*, this function establishes a *REFERENCE RPM* value for each speed sensor channel that is used. With the equipment rotating at normal speed, follow the *CALIBRATE SPEED SENSORS* function outlined in the *SETUP MENU* of the *BTA OPERATION MANUAL*.
- 8.4. CHECK OPERATION OF *WARNING* and *ALARMS*: It is recommended that warning and alarm conditions be set up to check the operation of the relay contacts that control External Alert Devices (lights, horns, buzzers, sirens) if applicable. The BTA can be caused to go into a warning or alarm state by temporarily changing the values in *SET ALARMS* Function or disconnecting a TC Common Input line. Return values and connections to normal when complete.

9. BTA SPECIFICATIONS

9.1. INSTRUMENT

- 9.1.1. OPERATIONAL TEMPERATURE -30°C to 50°C (-30°F to 122°F)
- 9.1.2. DIMENSIONS 14" Height, 12" Width, 6" Depth
- 9.1.3. ENCLOSURE RATING NEMA 12, 13
- 9.1.4. INPUTS
 - 9.1.4.1. POWER 40 W
 - 9.1.4.2. Voltage 120 VAC (240 available)
 - 9.1.4.3. Frequency 50-60 Hz
 - 9.1.4.4. Sensors
 - Type: "T" Thermocouples (Copper, Constantan)
 - Range: -90°C to 200°C (-130°F to 392°F)
 - Max Quantity 256 (8 TC channels X 32 AUXILIARIES)
 - 9.1.4.5. Keypad 6 switch, Membrane type, Polyester cover.

DISPLAY: Vacuum Fluorescent, 2 Line X 16 Characters
 AUDIBLE ALERT: Pies-Ceramic Transducer
 Sound Pressure: 85 dBa
 Tone (Frequency): ~2900 Hz
 RELAY DRY CONTACTS
 Switching Ratings for
 Externally supplied power: 5 A @ 120 VAC
 Temperature: SPDT 1 for Warning, 1 for Alarm
 Speed: SPST 8 for Warning, 8 for Alarm

AUXILIARY SWITCH CONTROL 32 lines + Common
 Voltage: +15VDC

PORTS

Serial: RS-232 Interface, 9-PIN SUB-D connector.
 RS-485 Interface, 4 Conductor terminal block
 Capability to Report out to BCS 1000 Windows
 Application or PLC
 Parallel: To Unidirectional Printer, 25 PIN, D-SUB connector.

9.2. MOTION MODULE

9.2.1.	OPERATIONAL TEMPERATURE	-30°C to 50°C (-30°F to 122°F)
9.2.2.	DIMENSIONS	12" Height, 10" Width, 5" Depth
9.2.3.	ENCLOSURE RATING	NEMA 12, 13
9.2.4.	INPUTS	
9.2.4.1.	Power	9 W
9.2.4.2.	Voltage	15 VDC (from Instrument)
9.2.4.3.	Sensors	
	Type	Inductive Proximity, NPN Current Sinking
	Model:	TURCK Ni10-G18-AN6X (Recommended)
	Voltage	+15VDC
	Rated Operating	
	Distance	10 mm (0.4")
	Range:	10 to 1500 Rev. per minute
	Max Quantity	8
9.2.4.4.	MOTION ENABLE	Relay contacts signal unit when motor energized.

9.3. AUXILIARY SWITCH

9.3.1.	OPERATIONAL TEMPERATURE	-30°C to 50°C (-30°F to 122°F)
9.3.2.	DIMENSIONS	8" Height, 6" Width, 5" Depth
9.3.3.	ENCLOSURE RATING	NEMA 12, 13
9.3.4.	INPUTS	
9.3.4.1.	Power	1.5W
9.3.4.2.	Voltage	15 VDC
9.3.4.3.	Sensors	
	Type:	"T" Thermocouples (Copper, Constantan)
	Range:	-90°C to 200°C (-130°F to 392°F)
	Max Quantity	256 (8 TC channels X 32 AUXILIARIES)

10. GLOSSARY

CONSTANTAN: A copper-nickel alloy (shiny silver) used as the negative lead in Type T thermocouples.

CRIMPER: A pliers like tool used to compress the crimps to the proper pressure and configuration.

CRIMPS: A splicing device primarily used on the light gauge lead wires. It consists of an outer plastic jacket, an inner perforated metal which bites through the insulation and into the conductors, and an inner watertight sealant (silicone grease).

DRAIN WIRE: A non-insulated wire in contact with parts of a cable, usually the shield, and used in the termination to that shield and as a ground connection.

ELECTROMAGNETIC INTERFERENCE, EMI The result of stray voltages and/or currents coupling between electronic systems adversely affecting electronic equipment and cause intermittent data problems.

JACKET: The outer protective covering of a cable.

LEADWIRE: A multi-conductor extension cable used to extend from the thermocouple to a remote switching unit (AUX).

SECTION: A group of thermocouples assigned to a particular switch.

SENSOR: A device that responds to a physical stimulus (heat, light, sound, pressure, motion, flow, etc.) and produces a corresponding electrical signal.

SHIELD: A tape (foil), serve, or braid placed around cables, to prevent signal leakage or interference.

THERMOCOUPLE, TC: A temperature sensor created by joining two dissimilar metals. The junction produces a small voltage as a function of the temperature.

CONFIGURATION: A text file, which designates all the sensors and settings to which fit the BTA to a particular facility or application.

EMBEDDED SYSTEM: A specific-purpose computer that is physically embedded within a larger system (grain elevator). Its primary purpose is to maintain some property or relationship (no hot spots or slow motion) between the other components of the system in order to achieve the overall system objective (a safe grain elevator).



BTA ETHERNET - SYSWATCH INTERFACE CONNECTIONS

1. INTRODUCTION

The *BTA-ETHERNET SysWatch INTERFACE* is a device that allows up-to-date sensor information from the BTA to be displayed graphically on the SYSWATCH Windows Application installed on a PC. Without this Interface, serial data from the BTA cannot directly be put on the Local Area Network since it is not in an acceptable form. This feature streams a serial report giving basic information such as the sensor's number location, temperature or speed, time, date, and enable/disable status.

The system design enables sensor inputs to be connected to an existing facility computer network so any user on the network can view the monitored inputs.

SysWatch software, which provides report generation. A graphical representation of the facility and its equipment allows for easy identification of equipment conditions and alarm sources

Installation Procedure for BTA SysWatch Network

Install Hardware

Mount cabinet to wall

Connect Ethernet switch to card using LAN cable.

Figure 1 details connections of the system.

DC POWER TAP CABLE

BTA MPU COMMUNICATION CABLE

Wire *ETHERNET INTERFACE* card to BTA (each connection uses 1 pair)

Power from the BTA +15 VDC On-Board Supply.

Serial Communication using the BTA RS-485 port.

Remote Silence Relay that accomplishes the same action as pressing the < SILENCE> key on the front of the BTA Instrument Unit.

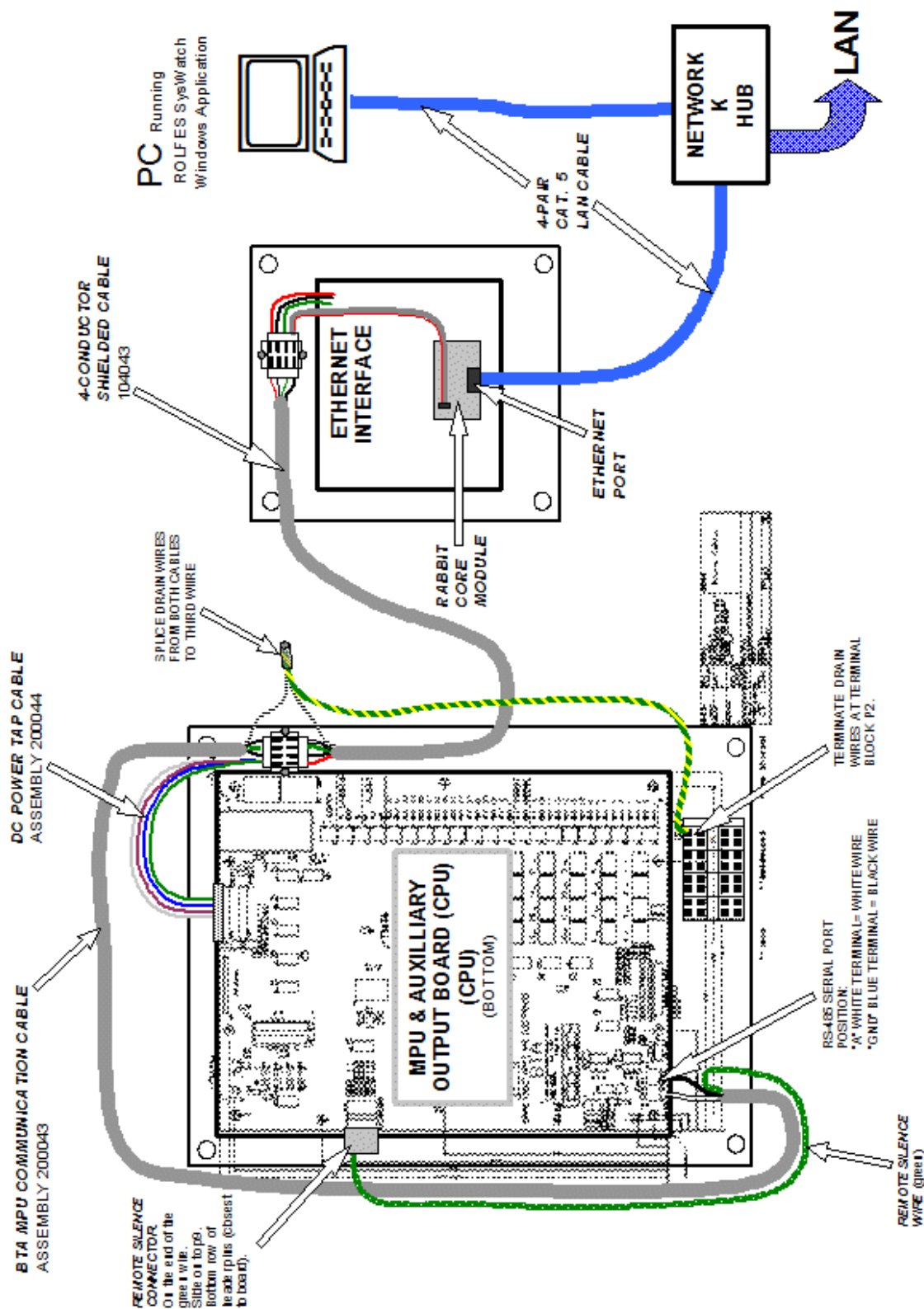


Figure 1. BTA-ETHERNET-SysWatch INTERFACE CONNECTIONS.

2. CONNECTIONS TO THE BTA INSTRUMENT

2.2. DC POWER

The *ETHERNET INTERFACE* derives its power from a +15 VDC Supply located on the *MPU & AUX OUT BOARD*.

2.2.1. TEMPERATURE SYSTEMS ONLY (NO MOTION)

The DC Power Supply is accessed by using the *POWER TAP CABLE* connected to the *HEADER* (dual row male connector with exposed pins) named "SPEED". It is identified on the circuit board by the designator "P1" as shown below on Figure 3. Though P1 has 13 pins in a row, the receptacle has socket openings for 14 pins. One of the openings in the *POWER TAP CABLE* receptacle will be occupied with a keying pin to assure the proper alignment. Slide receptacle down over the outer-most row of pins.

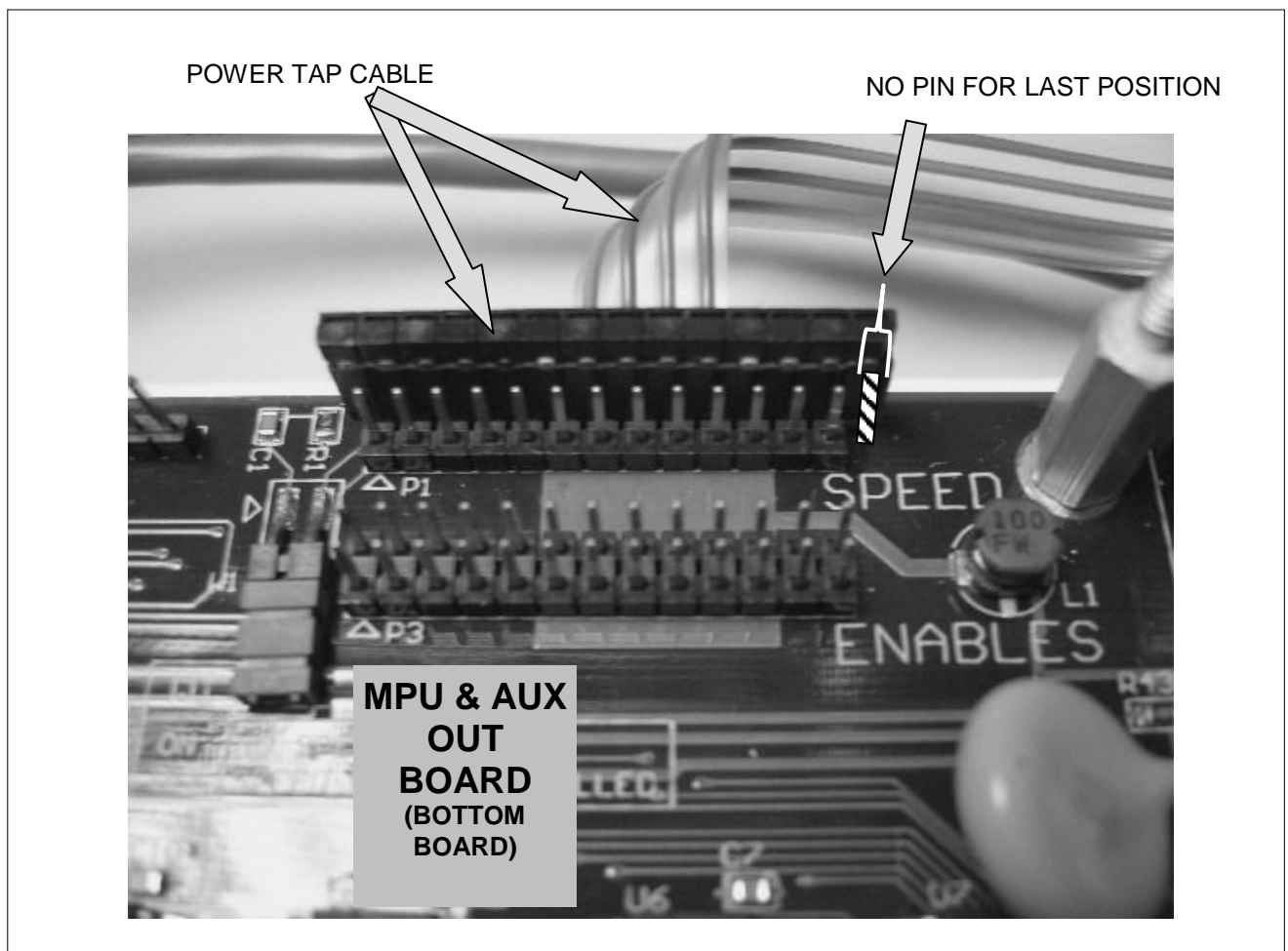


Figure 3. Close up of DC Power Tap on the *MPU & AUX OUTBOARD*

2.2.2. SYSTEMS WITH MOTION MODULE

This module is an add-on enclosure separate from the main *INSTRUMENT*. The primary component in the module enclosure is an electronic circuit board assembly called the *RPM-SPEED BOARD*. Power and communications between the *MOTION MODULE* and the *INSTRUMENT* are passed by a pair of round cables called *SPEED / ENABLE RIBBON CABLES*.

Using the *POWER TAP CABLE* is not possible in this case because the header connector named "SPEED" (identified by the designator P1 printed on the circuit board) is occupied by *SPEED / ENABLE ROUND RIBBON CABLES* connected to the *RPM-SPEED BOARD*. This pair of cables provides power and communications connections between The Motion Module and the BTA Instrument.

The ETHERNET INTERFACE derives its power from a +15 VDC Supply located on the MPU & AUX OUT BOARD. It is accessed by connected to as shown below on Figure X. The end of the *POWER TAP CABLE* with the socket connector slides down over the outer row of the pins of P1.

RS-485 Another definition of serial communications interfaces which is a more industrial standard which can go longer distances and is more immune to interference. This is an optional port to be used instead of RS-232 when distances are from 50 to 3600 feet. As used in this application, an Output Port only. It is a balanced differential two-line (A= -Signal, B= +Signal) system. A 4-conductor terminal block is provided for this. Connect wires directly to block. Although RS-485 able to handle multiple drops on the line, when used with a BTA system, a single BTA can be the only drop on the line. There is no master/slave relationship from BTA to Host PC.

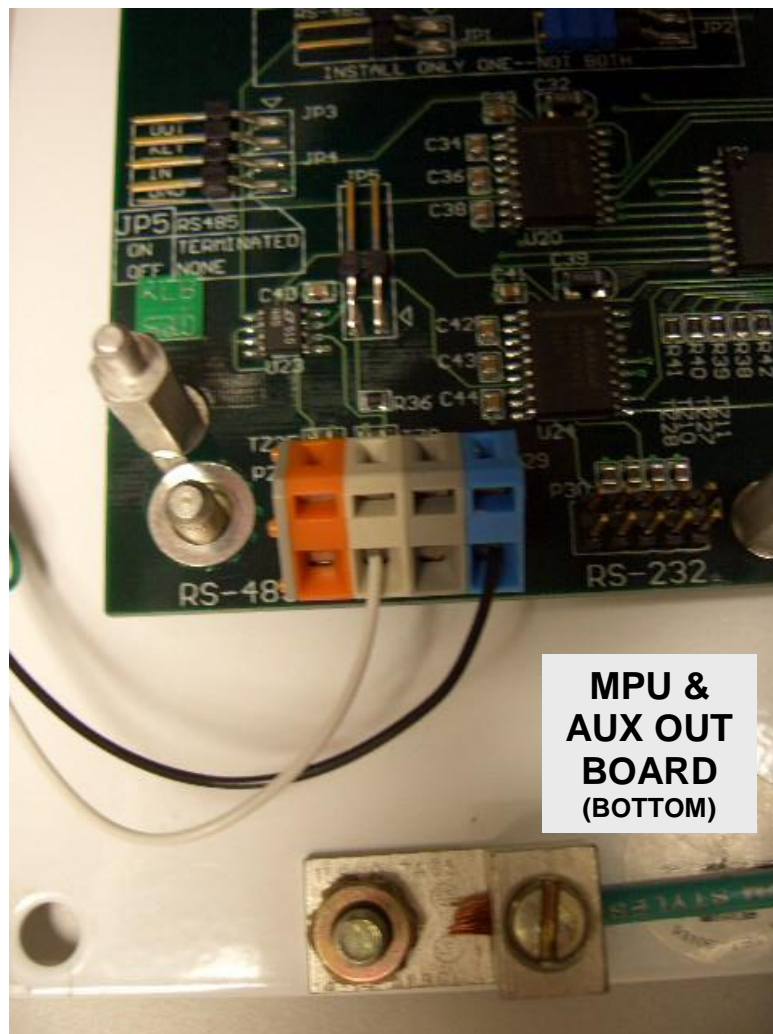


Figure 2. RS-485 PORT SERIAL COMMUNICATION OUTPUT TO ETHERNET INTERFACE

CONNECTIONS TO THE ETHERNET INTERFACE

This provides:

- Power from the BTA

- Output cord length: 6'
- Output connector: 2.1mm x 5.5mm F2 (center positive)

- Connection to the BTA to act as a remote Silence.

- Platform for the Rabbit Core Module, RCM2200 integrated Ethernet Port

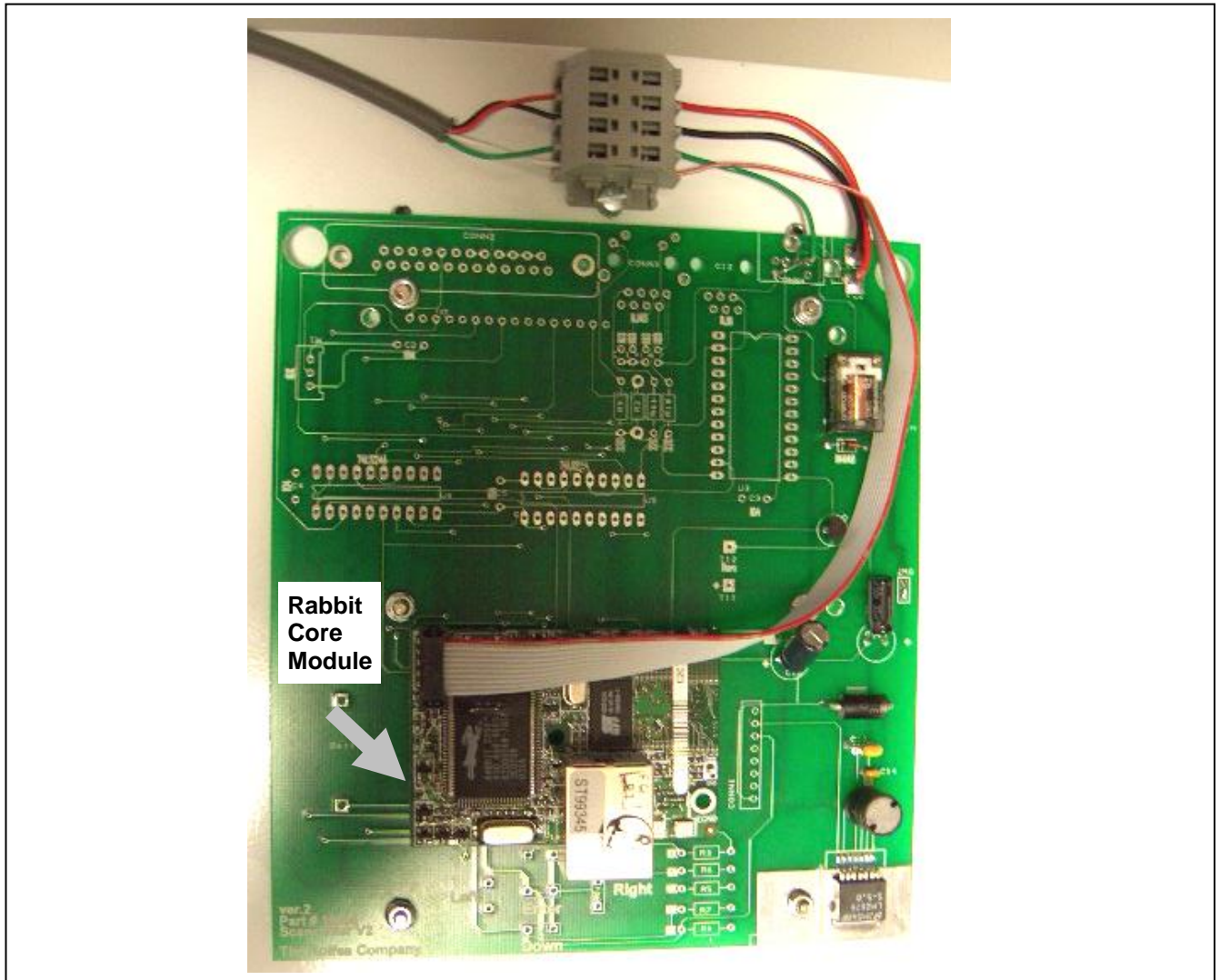


Figure 4. ETHERNET INTERFACE in enclosure

10-pin connector header J1 orient the marked (usually red) edge of the cable towards pin 1 of the connector. the programming port, is a 2 x 5 header with a 2 mm pin spacing. Serial Communication Green light will be constant on when there is power to the rabbit unit. Amber light will only flicker when BTA is scanning.



Figure 5. Detail of Rabbit Core Module (RCM2200) mounted in ETHERNET INTERFACE

Verify Network Connections

Connect computer to Ethernet switch.
Start Ser2UDPtest program.
Start scan (Press Enter of BTA twice to start scan).
Verify packets received on screen.

Install SysWatch software

Install syswatch software on customer's computer (supplied on CD).

- Insert CD into computer. If setup fails to start click on My Computer, then click on CD drive, click on arlite.exe.

Click on Install SysWatch. Wait for install to complete.

Click on Install Configuration. Wait for install to complete.

Change the IP address for the BTA using Ser2UDPtest.

Change the IP address in the SysWatch program

- Click Options in menu, click Configuration, click System Configuration.
- Type in password when prompted.
- Change IP address in Sysdef string to match BTA IP address.

SYsdef = 1, 7, 192.168.0.201,BTA 1,F

Installation Notes

Before Installation reserve one static IP address for each BTA. This needs to be coordinated with the customers IT group.

Verify BTA screen update is set to 1 sec.

If any point in BTA is disabled, then the corresponding Alarm and Warning Setpoints must be changed.

- Right click on temperature on SysWatch screen.
- Select Change Set points.
- Change Alarm to 255, Warning to 245.
- SysWatch will update value to L/O after 2 full scan intervals.
- Note: Set points can also be changed from point configuration menu.

INSTRUMENT SETTINGS:

SERIAL MODE = WINDOWS COMM

SERIAL CONFIGURATION = 19200 N-8-1

DISPLAY RATE = 1 SECOND

(save settings to memory, power cycle BTA off and on, to have the new baud rate take effect)

SERIAL REPORT MODE

The BTA monitor has 2 serial ports, RS-232 and RS-485, which can be used to transmit a continuous stream of sensor information to another data-terminal device. Normal output consists of an abbreviated report giving basic information such as the sensor's identity (known by its hardware address), current reading of temperature or speed, time, date, and enable/disable status, alert state (alarm or warning condition). ASCII text sent and multiple baud rates are supported. The report update runs at the rate which is tied to the display rate on the BTA (adjustable from 1-30s). If any setting or configuration changes on the BTA unit are reported out the serial port. The BTA has to have its Serial Mode enabled to use this feature. Two types of serial data will come across the ports: ACTUAL SERIAL REPORT OF SENSOR DATA and the CONFIGURATION FILE.

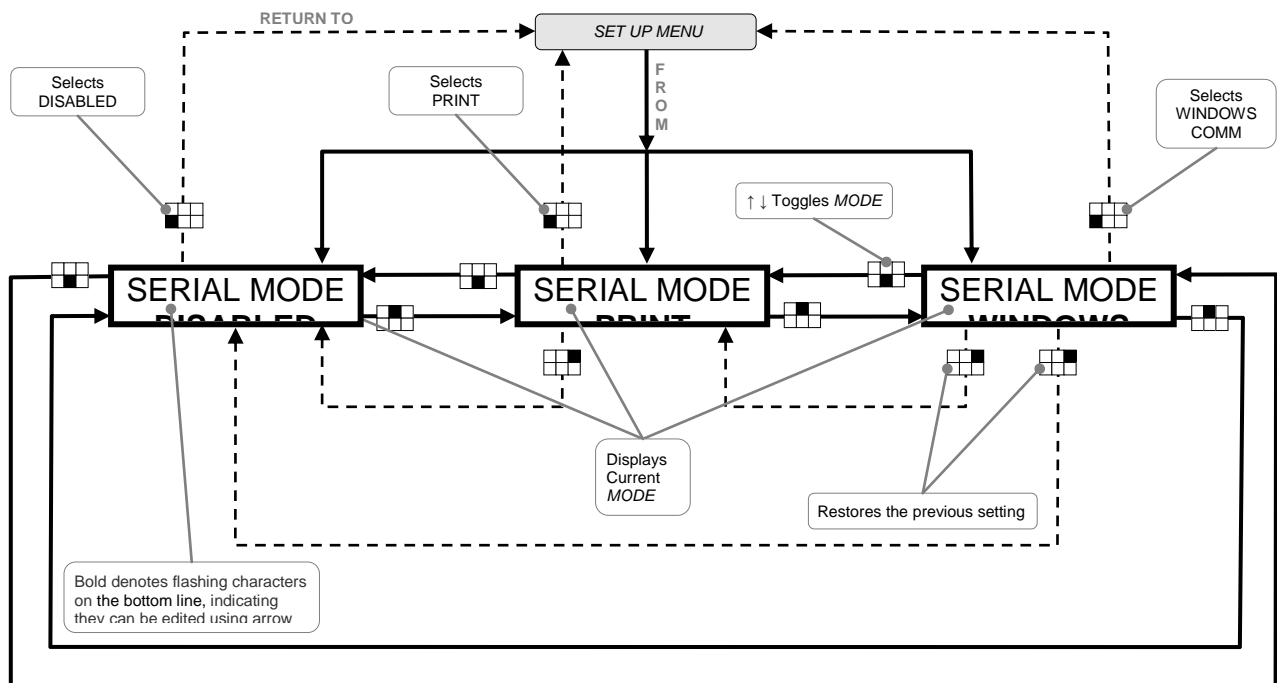
WINDOWS COMM

The serial report is sent out one of the serial ports to a PC or PLC. The port hardware settings used are described in SERIAL CONFIGURATION.

RS-485 SERIAL PORT

It is a source for serial report data sent to a PC located a long distance from the BTA (up to 3600 feet).

The simplex method data transmission is used. The BTA is always the sender, no control or handshaking.



SERIAL MODE MENU ITEM



BTA USER GUIDE

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1. INTRODUCTION

The **B**earing **T**emperature and **A**lignment, **BTA**, system is a specialized computer designed to monitor overheating or belt-slipping hazards and control conveying equipment (belts, bucket elevator legs, drags, augers) in grain elevators and mills. Its purpose is the prevention of ignition to grain dust explosions and fires. The operator is alerted to potentially dangerous conditions when points of friction (motors, bearings, or alignment rubs) become hotter than predetermined limits. The same is true for Belt-Slippage showing up as speed slowdowns or stoppages. Sophisticated features watch a total of 256 different temperature sensors and 8 motion sensors. Information that is collected from the sensors can be logged automatically, and reports can be generated from the data. Though it operates as a "Stand-Alone" system, provisions have been made to send out data and reports from the BTA to peripherals such as PC or PLC.

Though the software and menus were written for agricultural applications, the BTA is useful anywhere bulk material handling equipment is used. Problems can be watched and caught in the early stages before total equipment failure. The life of bearings can be greatly extended by using the BTA as a tool for preventive maintenance. In addition to controlling relays that operate a light, buzzer or bell, temperature and speed information is collected for further use.

This GUIDE will assist you in customizing the settings for your unique facility. The features of menu functions are also outlined.

1.1. TEMPERATURE SYSTEMS

Every temperature system consists of the *INSTRUMENT*, *AUXILIARY SWITCHES*, *THERMOCOUPLE SENSORS*, and *LEAD WIRE CABLE*. A full temperature system can keep track of 256 separate remotely located sensors, though is not connected to all the sensors at once. A technique called Multiplexing is used whereby temperature data is continually pulled from several sources over the same data lines

1.1.1. INSTRUMENT

Is an *EMBEDDED SYSTEM*, so called here because it is physically embedded within a grain facility. A microcontroller (similar to a microprocessor, but designed specifically for use in embedded systems) is the heart of the system and runs the monitoring program.

1.1.2. AUXILIARY SWITCHES

Are used to connect the *INSTRUMENT* to groups of eight sensors at a time. This group of 8 is otherwise known as a *SECTION*. The *INSTRUMENT* selects each Auxiliary in the system in a round robin manner called *SCANNING SENSORS*. The thermocouples on that Auxiliary are polled and their temperature values are read. The maximum number of Auxiliary Switches is 32.

1.1.3. THERMOCOUPLE SENSORS, TC

Are rugged, versatile, temperature transducers, formed by a junction of dissimilar metals. Type "T" thermocouples consist of copper & constantan (copper & nickel alloy) that generates a small voltage proportional to temperature. They are encapsulated in a package or tube readily adapted to fit on a bearing or rub. The common abbreviation for this junction is TC.

1.2. MOTION SYSTEMS

Every motion system consists of the *INSTRUMENT*, *MOTION MODULE*, *SPEED SENSORS*, and *LEAD WIRE CABLE*. It can run in addition to a temperature system.

1.2.1. MOTION MODULE

Is an add-on enclosure whose purpose is to input the signals from the speed sensors (8 maximum) into *CHANNELS* numbered 0-7, and electronically condition them before passing them on to the *INSTRUMENT*. Speed is then continuously determined and any slow-down from normal speed is detected instantly. Separate adjustable settings are available to trigger an *ALERT STATUS* (*WARNING* or *ALARM* traditionally -10% and -20% respectively). 16 General-purpose output relays are also on board (2 per channel: warning and alarm) to control shut-down circuitry or supplemental audible or visual devices. External signal devices can be activated for each piece of conveying equipment that is monitored.

1.2.2. SPEED SENSORS

Speed sensors are Inductive Proximity Switches that send a pulse to the *MOTION MODULE* each time a target on a rotating shaft passes in front. A pulse for each revolution of the shaft is then electronically prepared before being sent off to the *INSTRUMENT* so it can determine speed.

1.2.3. FAIL-SAFE

The motion part of the program has been designed for Fail-Safe operation. Fail-Safe is a very important concept that compensates automatically and safely for a failure in any mechanisms or power sources. Motor controls that are interlocked with the BTA will not be allowed to start and run unless the system is *SCANNING SENSORS*. Any disruption such as a component failure or breakage in the circuit causes the motor controls to switch automatically to a safe condition. The results without Fail-Safe capability can be disastrous.

1.2.4. START-UP PERIOD MONITORING

Two features help monitor the period before the conveyor reaches full speed.

1.2.4.1. START-TO-MOVE

From the time that the start button is pushed and the motor is powered, the monitored equipment has 1-30 seconds (adjustable) to begin moving. If no movement is sensed, alert status is entered and a shutdown is triggered, preventing catastrophic damage from a "choked" leg.

1.2.4.2. ACCELERATION TIME-OUT

After the equipment starts moving, instantaneous (differential) acceleration is checked so that slippage will not generate heat at the contact surface of the drive pulley lagging and belt. Minimum acceleration must be maintained throughout this period.

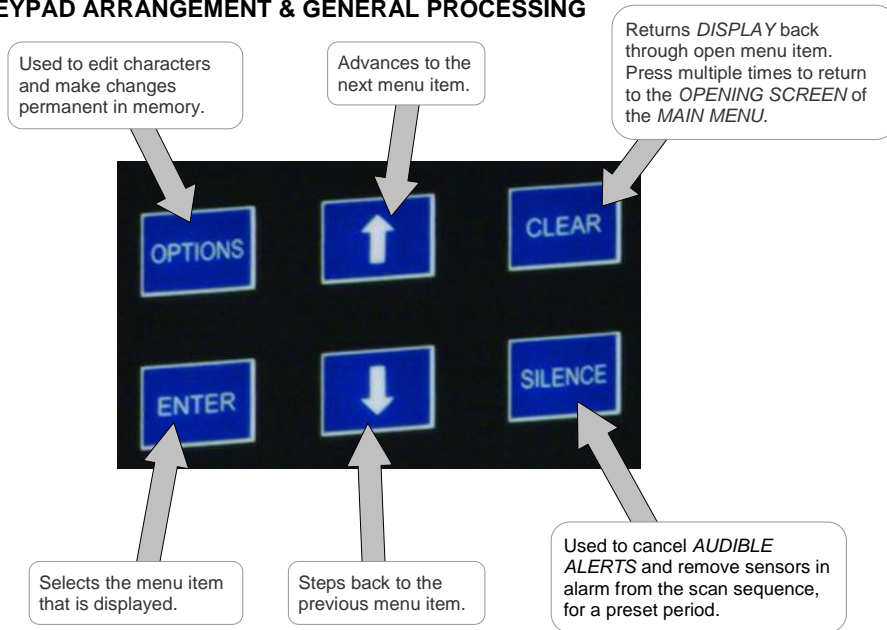
2. USER INTERFACE

The user interacts with an internal software program via a menu-driven interface. Navigation through the menus is accomplished by reading the Display and pressing Keypad buttons in response to what is being shown.

2.1. KEYPAD

The membrane keypad is very reliable and completely sealed from moisture and dust. It contains two rows each of three domed touch-pad buttons that provide users with tactile feedback. The convention used for key stroke and their associated actions is as follows:

KEYPAD ARRANGEMENT & GENERAL PROCESSING



2.1.1. FRONT KEYPAD LOCK-OUT

This software feature is to prevent unauthorized tampering with the operation of the monitor. The unit can be set to deny access to the use of certain essential keys. Functions such as halting normal scanning and set-up parameters can be kept secure. It can be disabled if desired.

2.2. DISPLAY

The display used in the BTA Instrument is a Vacuum Fluorescent (VF) type, chosen for its vivid high brightness, wide viewing angle, wide temperature range, wide humidity range, fast visual response, reliability, and readability even in sunlight. This display shows up to two lines containing as many as 16 characters in each line. It is able to display all standard alphanumeric characters. Unlike LCDs, most VFDs continue to function normally in subzero temperatures making them ideal for outdoor devices in cold climates.



2.3. AUDIBLE ALERT DEVICE

Sound on the front cover of the instrument is generated via this device. Its distinctive WARBLE tone cuts through ambient noise, making it sufficient to alert an operator in the immediate proximity of the instrument. The sound level volume is adjustable through the damper on the front. This type of device is superior to electromagnetic buzzers, because of its reliable solid state construction. It produces no arcing (low voltage operation) and is very durable, resulting in more consistent sound quality during its life. It is also weather-proof and suitable for use in corrosive environments both outdoor and indoor.

3. POWER UP

This section details the action taken by the *INSTRUMENT* unit when it first powers up. Electrical power is controlled from the optional *KEY-LOCK POWER SWITCH* on the front of the unit. This prevents any unauthorized personnel from letting your facility go without hazard monitoring. System can be wired such that it will not allow conveying equipment to run without the BTA Monitoring operation.

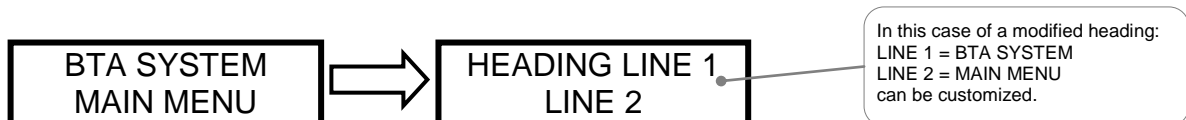
3.1. POWERING UP THE UNIT

The user powers up the *INSTRUMENT* by turning the power switch to the "ON" position. This will start an initialization period of about 10 seconds. During this time, you may hear the audible alert, and a character may be generated to the printer. The unit will then show the *HEADING* on the *OPENING SCREEN*.

3.2. OPENING SCREEN

After the initialization is done, the *INSTRUMENT* will display the *HEADING*. Keypad activity will then be monitored. The heading can be changed by using the *SETUP MENU* item *MODIFY HEADING*. The image below shows a modified *HEADING*.

The default *OPENING SCREEN* of BTAs directly from the factory has the following as their heading:



4. ORGANIZING YOUR FACILITY

It is helpful to structure and order your configuration ahead of time. The following concepts have been created to make this easier.

4.1. ZONES

A *ZONE* is an arbitrary grouping of sensors that exists in software. Each zone name must be unique. They are most often chosen based on some piece of conveying equipment, a building or location (i.e. Leg, House, Conveyor, Drag, Belt), but they do not have to be. At least one is required, but a total of 99 separate zones are possible in the configuration.

4.2. SENSORS

A *SENSOR* describes a point in the facility that is a source of temperature or motion information. They are most often chosen based on some potential place of friction (i.e. Bearing, Motor, Rub, or Idler), but this is not required (i.e. ambient). Sensor names within a zone must be unique, however from zone to zone; the same sensor name can be reused. At least one is required, but a total of 256 separate temperature sensors or 8 motion sensors are possible. Whenever possible choose names by using the *preferred words*: BEARING, BRG, MOTOR, MTR, RUB, or IDLER, so you can take advantage of the "SET ALL BEARINGS, RUBS, etc," feature in the "SET ALARMS" item of the main menu. This will allow the user to make semi-global changes to settings of sensors with these preferred words in their names, a powerful and time-saving feature.

5. THE COMMAND AND MENU STRUCTURE

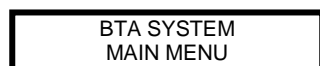
Instructions to operate and setup the BTA internal program are chosen from a series of Menus; the MAIN MENU and the secondary SETUP MENU. Both Menus lead to further options. Their structure is represented by a series of diagrammatical drawings. To get a clearer idea of how to move around throughout the menu structures, they are mapped out in easily learned, easy-to-use diagrams that appear on the following pages.

The MAIN MENU holds the most commonly used list of options. The SETUP MENU holds the items that configure the BTA to the requirements and desires of the operator and the facility it monitors. To prevent unauthorized changes, the SETUP MENU is normally hidden from the user until the proper combination of keys is pressed which advances display and allows access.

5.1. LEGEND

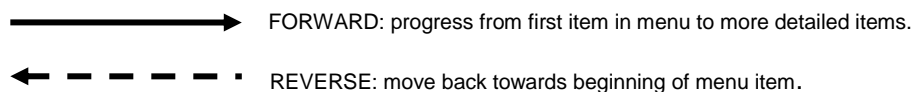
In the menu mapping diagrams that you will see in the rest of this user's guide, the *KEYPAD* commands that navigate you through the menus are represented as simplified small image (icon) of the key being pressed. The conventions of how screens, indicators and key strokes interact are illustrated below.

5.5.1. DISPLAY SCREENS

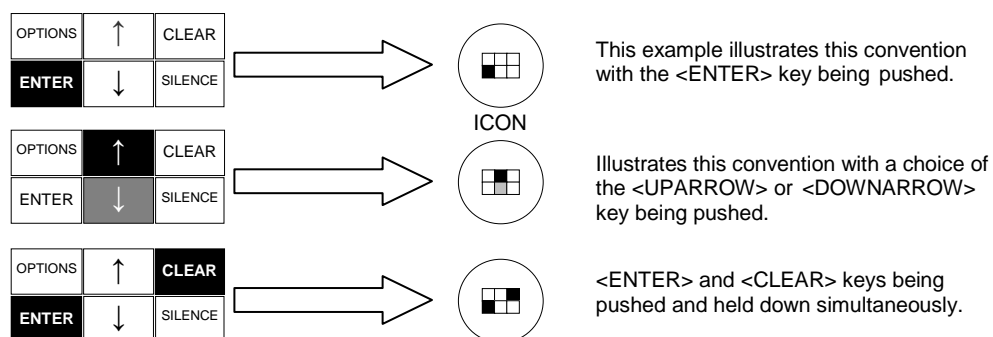


This example illustrates information conveyed at the *OPENING SCREEN*.

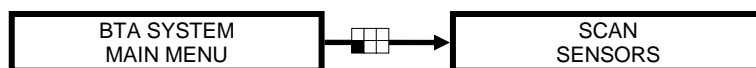
5.5.2. GENERAL DIRECTION INDICATORS



5.5.3. ALTERNATIVE KEY COMMANDS

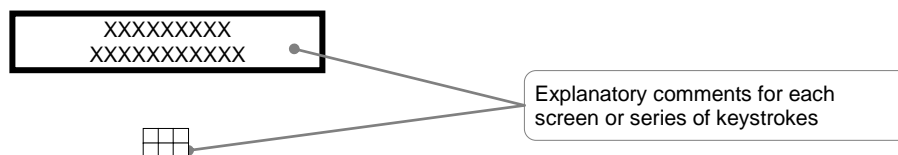


5.5.4. NAVIGATION THROUGH MENUS USING KEY COMMANDS



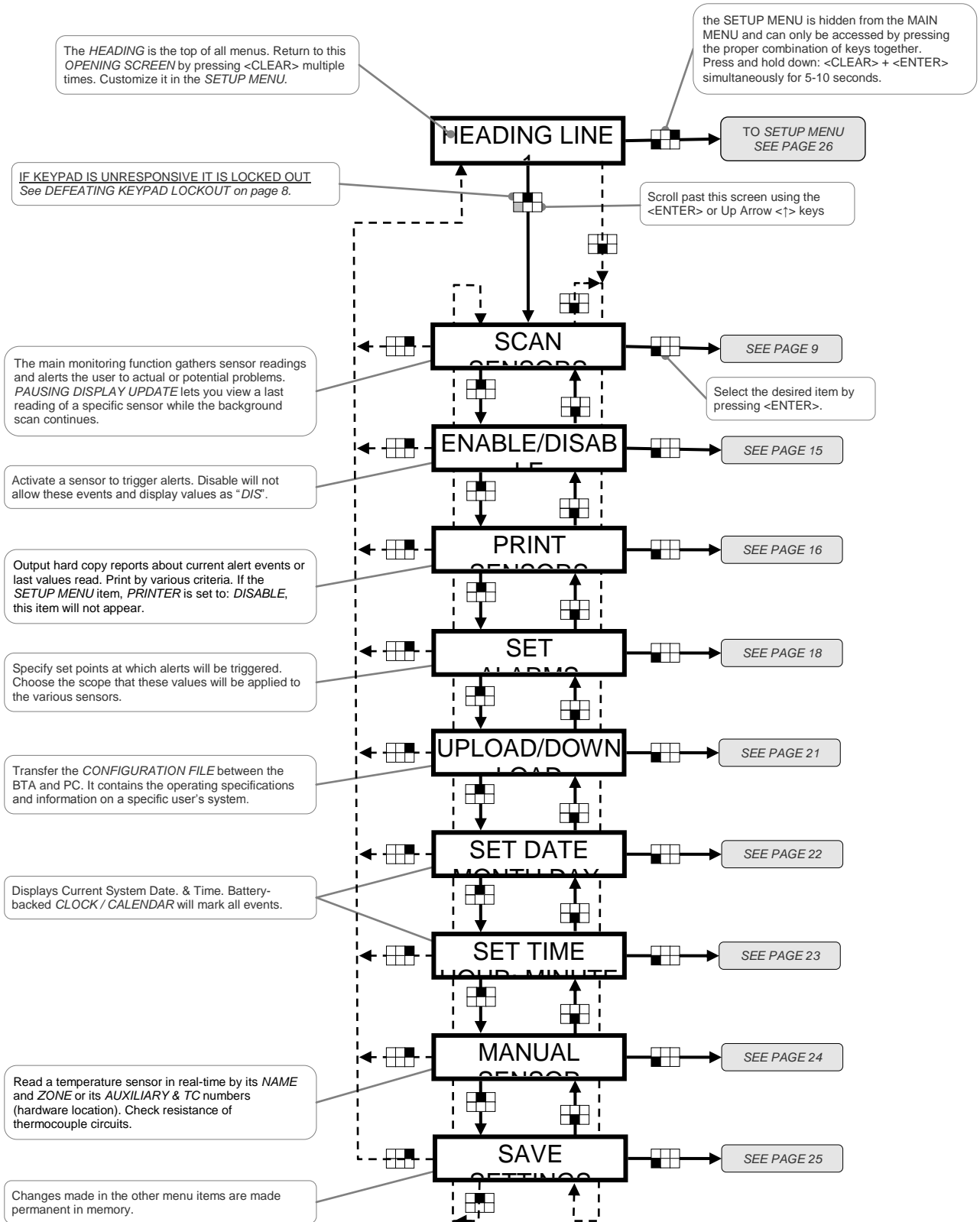
This example illustrates advancing to another screen by a key stroke.

5.5.5. COMMENTS



6. MAIN MENU OVERVIEW

The Main Menu holds a list of the most important options & commonly used items appearing on the front Vacuum Fluorescent Display. Menus provide the user with an easily learned, easy-to-use way of operating the program through commands and selections.

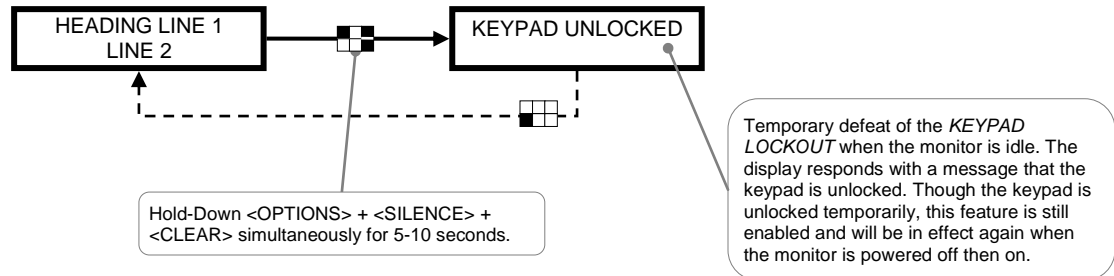


6.1 DEFEATING KEYPAD LOCKOUT

One of the first things you may need to do to use the system is to regain control from the *KEYPAD LOCKOUT* feature. It prevents unauthorized personnel from tampering with the settings or operation of the monitor. All keys except for <ENTER> and <SILENCE>, will be unresponsive when this feature is in effect. *SCAN SENSORS* and *SILENCING* an *ALERT* are then the only operations allowed. *HALTING SCAN* and changing set-up parameters will be impossible until the *LOCKOUT* is temporarily defeated and control over *KEYPAD* is regained. Defeat is temporary here because it is intended to last only for a short time while the authorized person takes control. Permanent control of the *KEYPAD LOCKOUT* status is only done in the *SETUP MENU* (page 49). Unless it is deliberately disabled in *SETUP*, *LOCKOUT* is still enabled and will come back in effect the next time the power is turned off and on again.

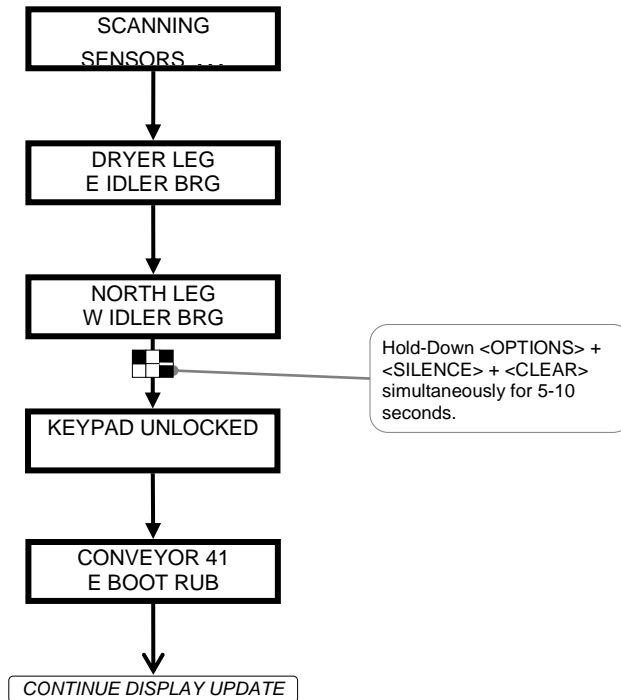
6.1.1. WHEN MONITOR IDLE AT OPENING SCREEN

Defeating the lockout first at the *OPENING SCREEN* is done because navigation to any other menu items is impossible. If you do not see the *OPENING SCREEN* on the display, return to it from anywhere in the menu structure by pressing <CLEAR> multiple times until it appears. The diagram below outlines the display screens and key strokes necessary to restore full-function of all the keys.



6.1.2.**WHEN MONITOR SCANNING SENSORS**

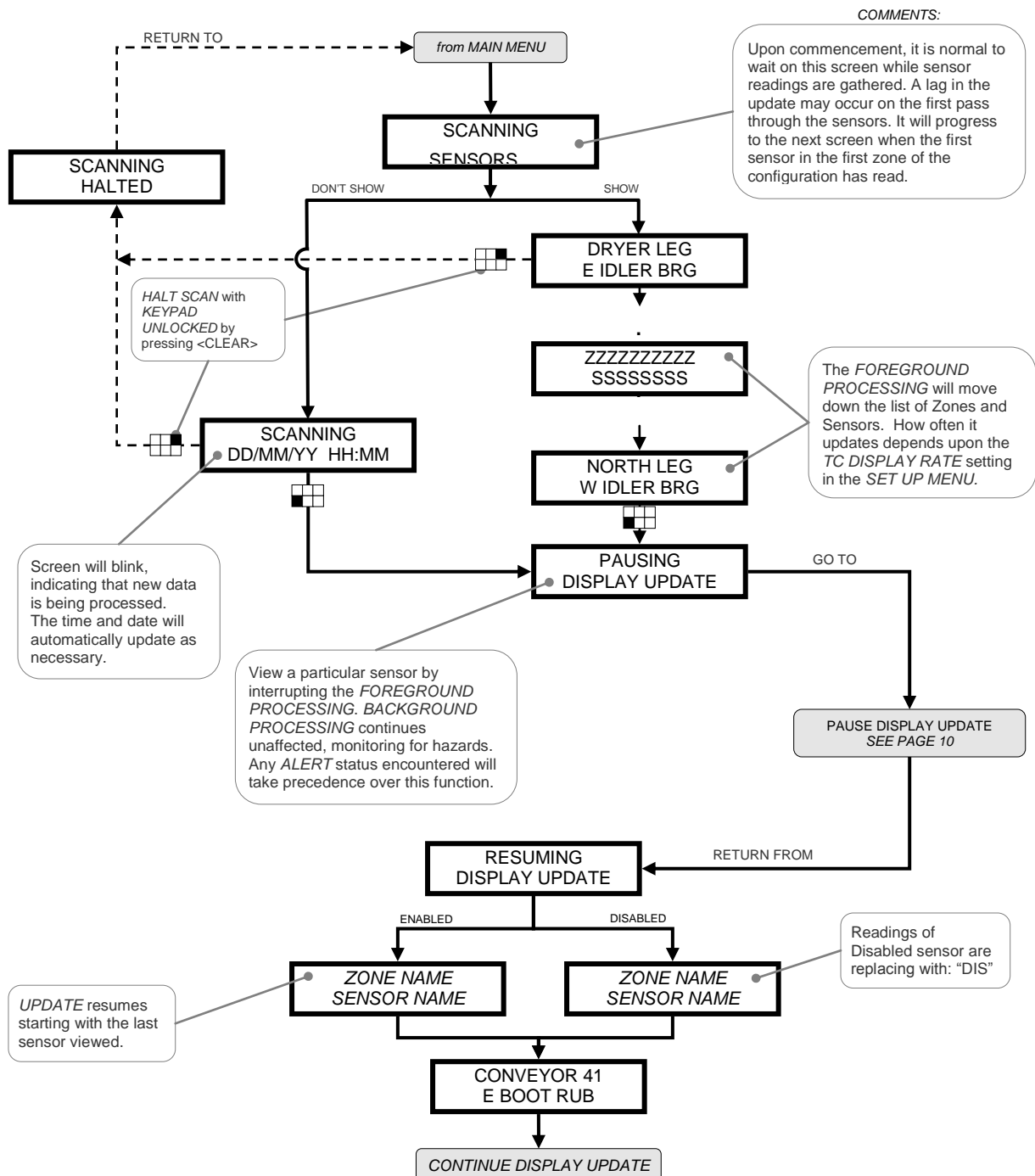
There may be the case, such as *PAUSING THE DISPLAY UPDATE* to view a particular sensor, where you want to regain control of the keypad without halting the scan. Provision has been made so that all keys will have their functionality restored, but *SCAN SENSORS* will continue unaffected. The key stroke combination necessary to defeat the *KEYPAD LOCKOUT* is the same as in the case above, but the display will continue through the process of updating normally through the list zones and sensors.



6.2. SCAN SENSORS / DISPLAY UPDATE

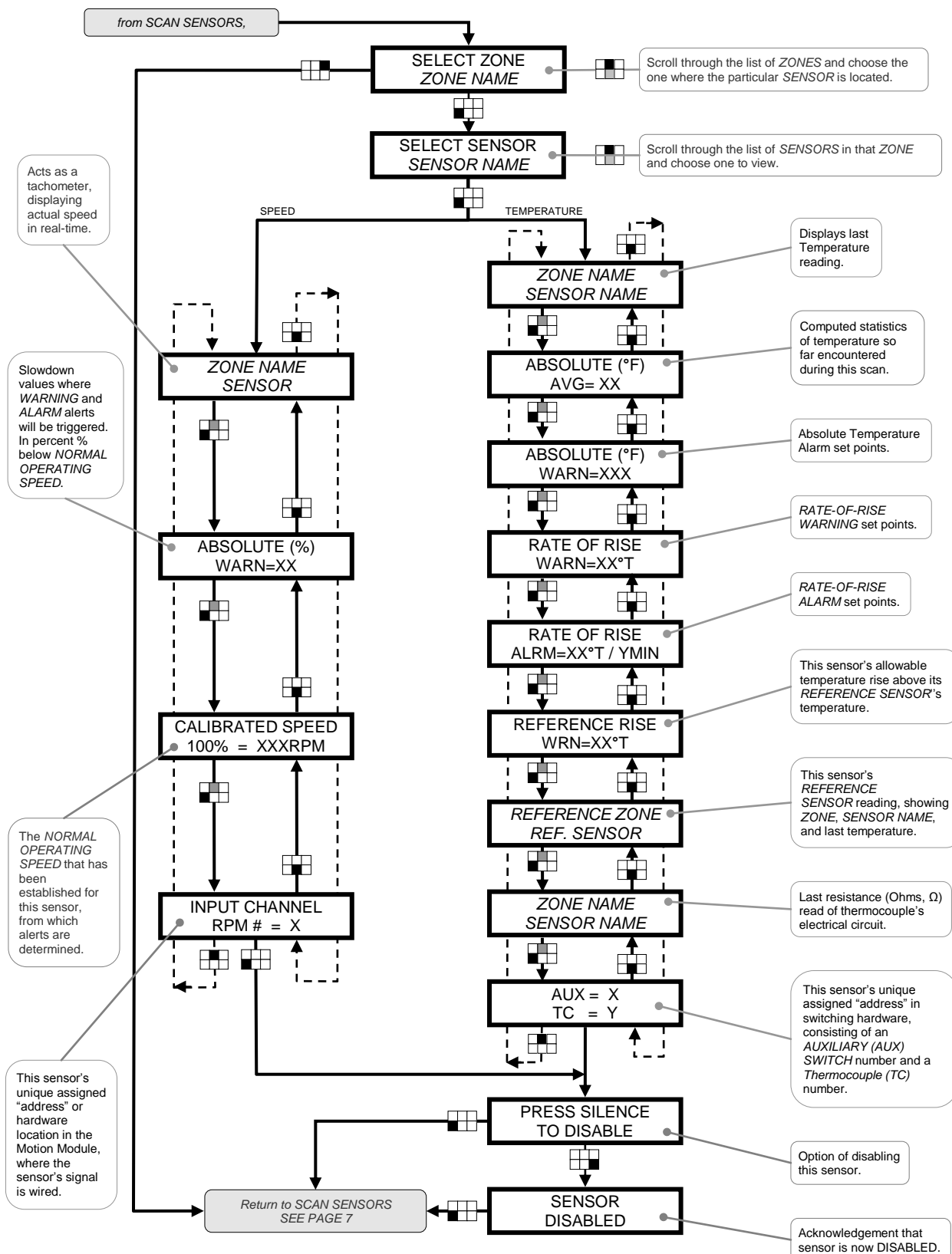
This starts the principle monitoring function of the system. It consists of two related but separate processes going on in the BTA. They are the *BACKGROUND PROCESSING* (unseen and operates independently) and *FOREGROUND PROCESSING* (The part currently having control and responding to commands from the user). The *SCAN SENSORS* function can either be accessed from the *MAIN MENU* by pressing <ENTER>, or if the *SETUP MENU* item *AUTOMATIC START* is set to "ON" the system will start the scan if no keys are pressed in any 5 minute period. Please refer to *SENSOR BACKGROUND PROCESSING* and Section *SENSOR FOREGROUND PROCESSING* (appendices A & B) for an overview of the *SCAN SENSORS* operation.

This item will not appear in the *MAIN MENU* if there are no sensors defined. In this case, refer to the *SETUP MENU*, item *EDIT SENSOR CONFIGURATION* to define zones and sensors.



6.2.1. PAUSE DISPLAY UPDATE / VIEW SENSORS

It is possible to view a particular sensor by interrupting the *FOREGROUND PROCESSING* as the *SCAN SENSORS* function proceeds through the list of sensors. Pausing display is can also be done when an *ALERT* status is acknowledged with <SILENCE>.



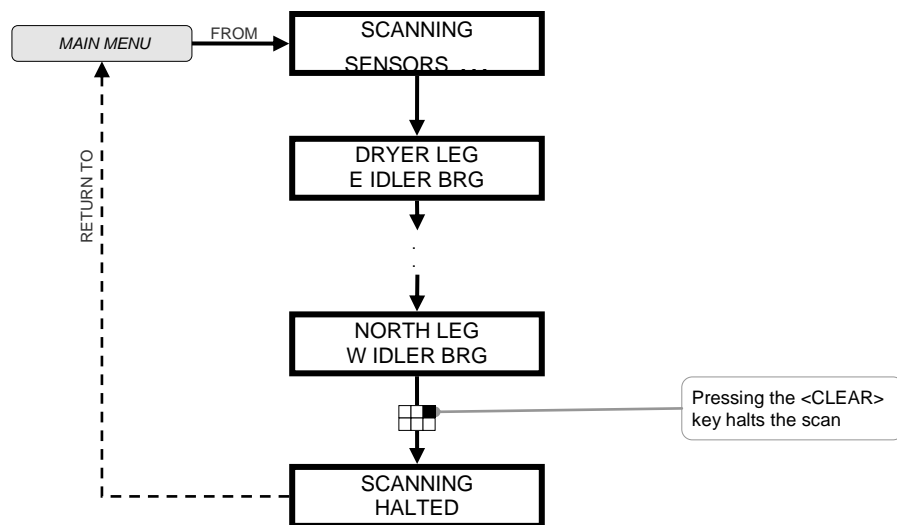
6.2.2. HALTING THE SCAN

Halting the scan may have more effects than just the stoppage of monitoring. If the elevator motor control circuits are interlocked with the BTA in such a way that they shut down when the scanning halts, this may lead to an undesired or disastrous situation. To prevent this different features concerning how to halt the scan have been incorporated.

The diagrams below outlines the display screens and key strokes necessary to halt the scan under the possible conditions of *KEYPAD LOCKOUT*.

6.2.2.1. HALTING WITH KEYPAD UNLOCKED

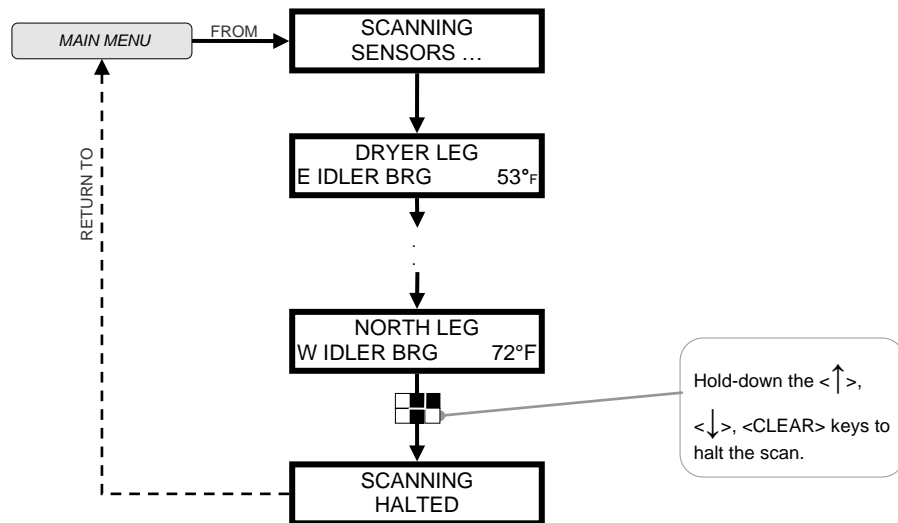
Normally When the KEYPAD is unlocked all the keys are fully-functional. Pressing the <CLEAR> key halts the scan. This can be done any time after scan sensors is started. Depending on the circumstances, any running motors monitored by the BTA could be shut down without intending to.



6.2.2.2. HALTING WITH KEYPAD LOCKED OUT

In this case you want to just halt the scan, but keep the KEYPAD LOCKOUT in effect.

If the unit is performing the normal scanning of sensors with Keypad Locked-Out, then there is a special combination of key strokes to halt the scan. Hold-down the following combination of keys for 5-10 seconds. Depending on the circumstances, any running motors monitored and interlocked with the BTA will probably be shutdown with or without intention.



6.2.3. WHAT YOU MAY SEE WHILE SCANNING SENSORS

6.2.3.1. NOTABLE SCREENS

Screens that are worthy of comment are explained below. They do not necessarily mean that there is a problem, but are just out of the ordinary display of temperature or speed information.

ZONE NAME
SENSOR NAME

ZONE NAME
SNSR NAME DIS

Solid "DIS" characters take the place of values and indicate that the SENSOR NAME is *DISABLED* in software. All monitoring of this sensor will be suppressed and alerts for it will be disallowed.

ZONE NAME
SENSOR NAME ----

FOR TEMPERATURE SENSORS: 4 Solid ---- hyphen characters take the place of values. They indicate that the sensor's location (AUX & TC) has not yet been scanned by the BACKGROUND PROCESS, so there is yet no temperature value to be displayed. This will be seen on the first pass of the scan through the list of sensors when the organization of the zones and sensors do not match the progression through the AUXs and TCs.

ZONE NAME
SENSOR NAME ----RPM

FOR SPEED SENSORS: 4 Solid ---- hyphen characters take the place of values and indicate that the Speed Input Channel is hardware *ENABLED*, but there is yet no signal from the Speed Sensor, so there is yet no value to be displayed.

ZONE NAME
SENSOR NAMERPM

FOR SPEED SENSORS: 4 Solid period characters (dots) indicate that the Speed Input Channel is hardware *DISABLED* or waiting for the *START-UP DELAY* to expire.

6.2.3.2. ALERT DESCRIPTIONS

The possible alert descriptions that can be generated in the course of scan sensors are explained below. They are grouped according to what the type of test or parameter has been violated. Meaningful information as to the nature of the hazard event can be displayed in separate messages to the display, printer or serial port. This detailed feedback is very helpful in troubleshooting why the sensor warning or alarm occurred. When an event occurs indicating a problem, the sensor of interest appears on the Display screen, an audible alert sounds, and a print report is generated.

6.2.3.2.1. TEMPERATURE ALERTS

...ZONE NAME, SENSOR NAME...WARN ABS XXX°T...	ABSOLUTE TEMPERATURE WARNING: an independent advance notice that a potentially dangerous situation is developing. An alert will be triggered when the sensor's value surpasses this first-level threshold and is unrelated to time or other sensors.
...ZONE NAME, SENSOR NAME...ALRM ABS XXX°T...	ABSOLUTE TEMPERATURE ALARM: an independent immediate notice that a dangerous situation now exists and corrective action should be taken. An alert will be triggered when the sensor's value surpasses this highest-level threshold and is unrelated to time or other sensors.
...ZONE NAME, SENSOR NAME...WARN TEMP RISE...	TEMPERATURE RATE OF RISE WARNING: an advance notice that a potentially dangerous situation is developing with the sensor's temperature increase. An alert will be triggered when the sensor's increase during a time period, exceeds the limit of the pre-determined WARNING ratio.
...ZONE NAME, SENSOR NAME...ALARM TEMP RISE...	TEMPERATURE RATE OF RISE ALARM: an immediate notice that a dangerous situation now exists with the sensor's temperature increase and corrective action should be taken. An alert will be triggered when the sensor's increase during a time period, exceeds the limit of the pre-determined ALARM ratio.
...ZONE NAME, SENSOR NAME...ALARM MIN TEMP OT°T...	MINIMUM TEMPERATURE ALARM: All temperatures should fall within a reasonable range of possible values. Reading less than the minimum indicates a problem with the TC circuit or the <i>INSTRUMENT</i> . Without refrigeration temperatures colder than the atmospheric ambient are impossible. An <i>ALARM ALERT</i> is issued.
...ZONE NAME, SENSOR NAME...ALARM MAX TEMP OT°T...	MAXIMUM TEMPERATURE ALARM: All temperatures should fall within a reasonable range of possible values. Reading more than the maximum indicates a true high temperature or a problem with the TC circuit or the <i>INSTRUMENT</i> . An <i>ALARM ALERT</i> is issued.
...ZONE NAME, SENSOR NAME...WARN REF RISE...	TEMPERATURE REFERENCE RISE WARNING: An advanced notice that a potentially dangerous situation is developing with the sensor's temperature above another sensor's, which is designated as its reference. If it is higher than the reference plus the WARNING amount, a <i>WARNING ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM REF RISE...	TEMPERATURE REFERENCE RISE ALARM: an immediate notice that a dangerous situation now exists with the sensor's temperature above another sensor's, which is designated as its reference. If it is higher than the reference plus the ALARM amount, an <i>ALARM ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM UNSTABLE TEMP ...	TEMPERATURE UNSTABLE: an immediate notice that the system was unable to determine a single value for this sensor because it changed too much while being read. The multiple samples that were taken varied outside the acceptable limits. An <i>ALARM ALERT</i> is entered.

6.2.3.2.2. RESISTANCE ALERTS

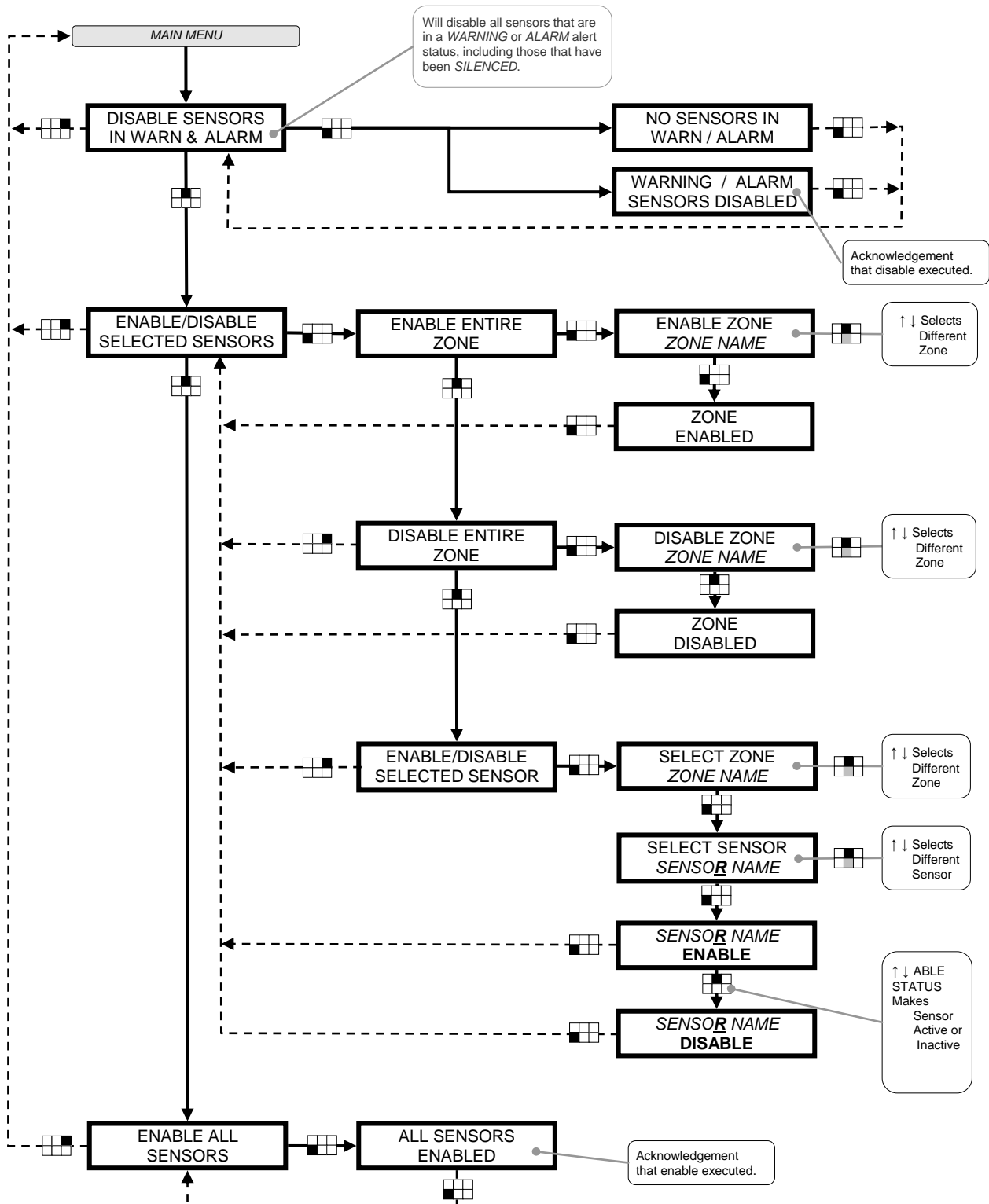
...ZONE NAME, SENSOR NAME...ALARM LOW RES OTΩ ...	MINIMUM RESISTANCE: All resistances should fall within a reasonable range. Outside these limits, the sensor reading will display OT for Open Thermocouple. A value less than the <i>MINIMUM RESISTANCE</i> may indicate that a thermocouple circuit is damaged or the <i>INSTRUMENT'S</i> TC Channel is malfunctioning.
...ZONE NAME, SENSOR NAME...ALARM HIGH RES OTΩ ...	MAXIMUM RESISTANCE: A value exceeding than the <i>MAXIMUM RESISTANCE</i> may indicate that a thermocouple circuit is damaged or a TC Channel in the <i>INSTRUMENT</i> is malfunctioning.
...ZONE NAME, SENSOR NAME...ALARM UNSTABLE RES ...	UNSTABLE RESISTANCE: an immediate notice that the system was unable to determine a single value for this sensor because it changed too much while being read. The multiple samples that were taken varied outside the acceptable limits. An <i>ALARM ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM RES CHANGE XXXΩ...	MAXIMUM RESISTANCE CHANGE: an immediate notice that the resistance value of the TC circuit for this sensor has changed too much from its initial value. The difference between the two is greater than the maximum resistance change. An <i>ALARM ALERT</i> is entered.

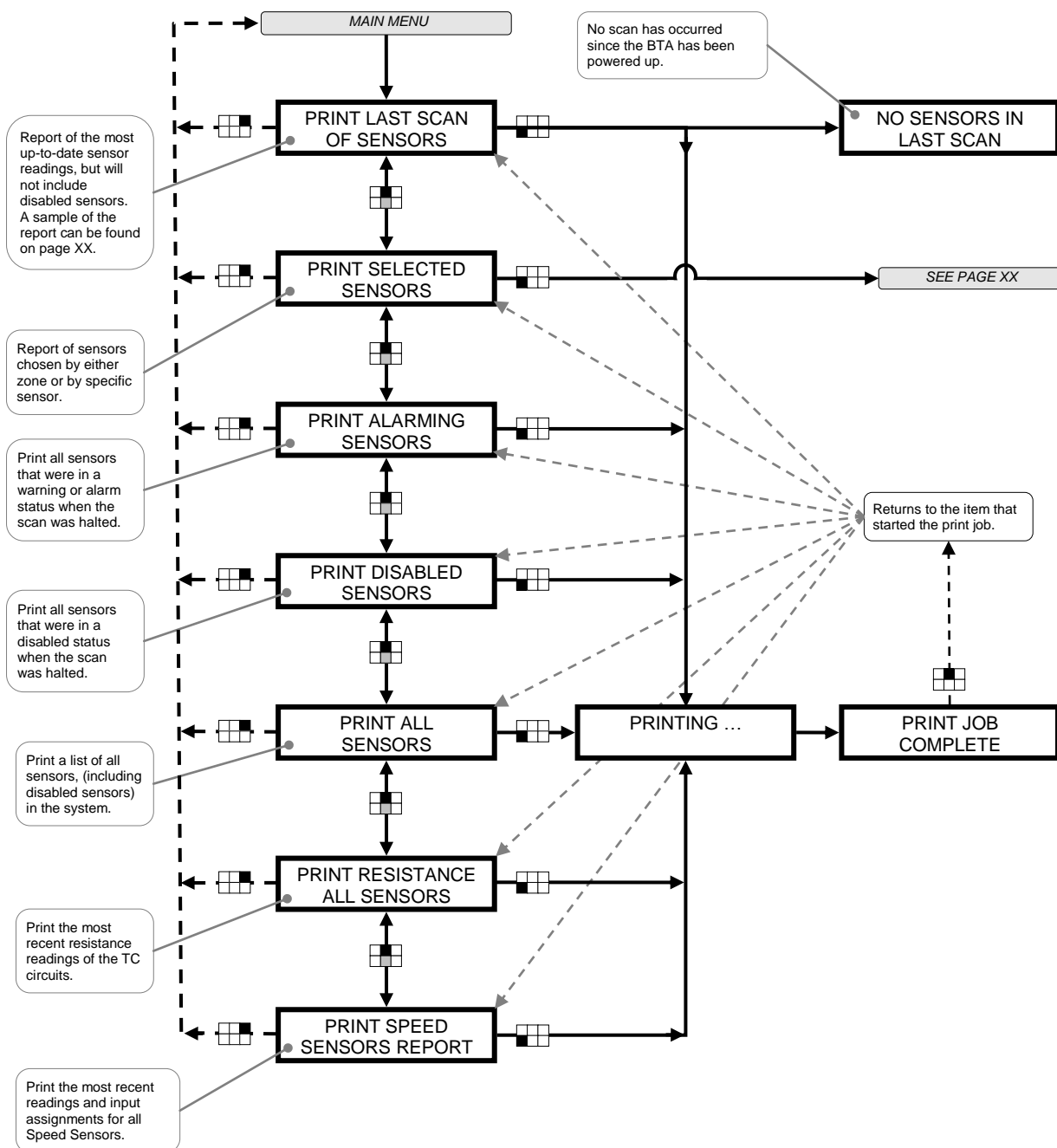
6.2.3.2.3. SPEED ALERTS

...ZONE NAME, SENSOR NAME...WARN SLOWDOWN	WARNING SLOWDOWN: An advanced notice that a potentially dangerous situation is developing with the sensor's decrease from its normal operating speed. These values are percentages with normal = 100%. If it is lower than the <i>NORMAL OPERATING SPEED</i> minus the WARNING amount, a <i>WARNING ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM SLOWDOWN 80%...	ALARM SLOWDOWN: an immediate notice that a dangerous situation now exists with the sensor's decrease from its <i>NORMAL OPERATING SPEED</i> . Corrective action should be taken. These values are in percentages, with normal = 100%. If it is lower than the normal operating speed minus the ALARM amount, an <i>ALARM ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM TIMEOUT ...	ACCELERATION TIMEOUT ALARM: an immediate notice that a dangerous situation now exists with the sensor's acceleration from stop to normal operating speed. Corrective action should be taken. The allocated time for acceleration has expired, without the speed being brought above <i>WARNING LEVEL</i> of the <i>NORMAL OPERATING SPEED</i> . An <i>ALARM ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...CHOKED, NO MOTION...	START-TO-MOVE ALARM: an immediate notice that a dangerous situation now exists because no movement is detected from this sensor, even though the equipment has been turned on. The allocated time has expired for achieving any speed above zero. Corrective action should be taken to prevent catastrophic damage from a "choked" leg. An <i>ALARM ALERT</i> is entered.
...ZONE NAME, SENSOR NAME...ALARM LOW ACCEL ...	LOW INSTANTANEOUS ACCELERATION: an immediate notice that a dangerous situation now exists due to belt slip. Minimum instantaneous acceleration throughout the start up period is not being maintained. An <i>ALARM ALERT</i> is entered. Corrective action should be taken to prevent catastrophic damage from heat generation at the contact surface of the drive pulley lagging and belt.
ZONE NAME SENSOR NAME 9999RPM	DEFECTIVE SIGNAL : 4 Solid "9999" characters indicate the high limit of the Speed Input Channel's ability to determine a RPM from the Speed Sensor. This usually is from a bad Speed Sensor or connection.
ZONE NAME SENSOR NAME ****RPM	CALIBRATE SENSOR: 4 Solid Flashing * * * * asterisk characters indicate there is no <i>NORMAL OPERATING SPEED</i> from which to calculate slow downs. Set this in CALIBRATE SPEED SENSORS item of the SETUP MENU.

6.3. ENABLE / DISABLE SENSORS

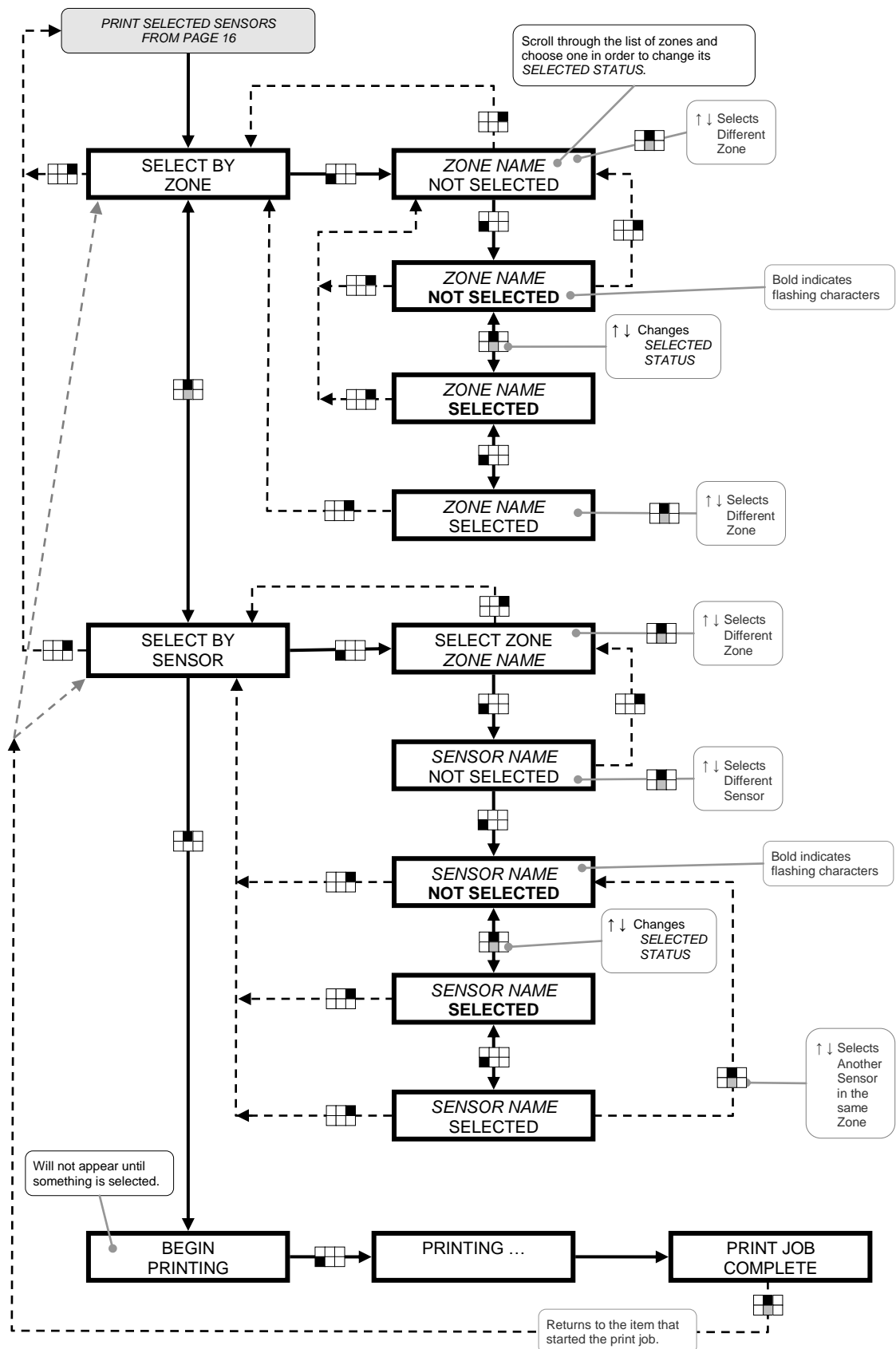
Makes Sensor Active or Inactive in software as far as monitoring is concerned. Enabling makes a sensor able in software to determine alerts. When a sensor is *DISABLED*, all monitoring of this sensor will be suppressed in software and will disallow these alert events. The value “*DIS*” will be displayed instead of the last value read.





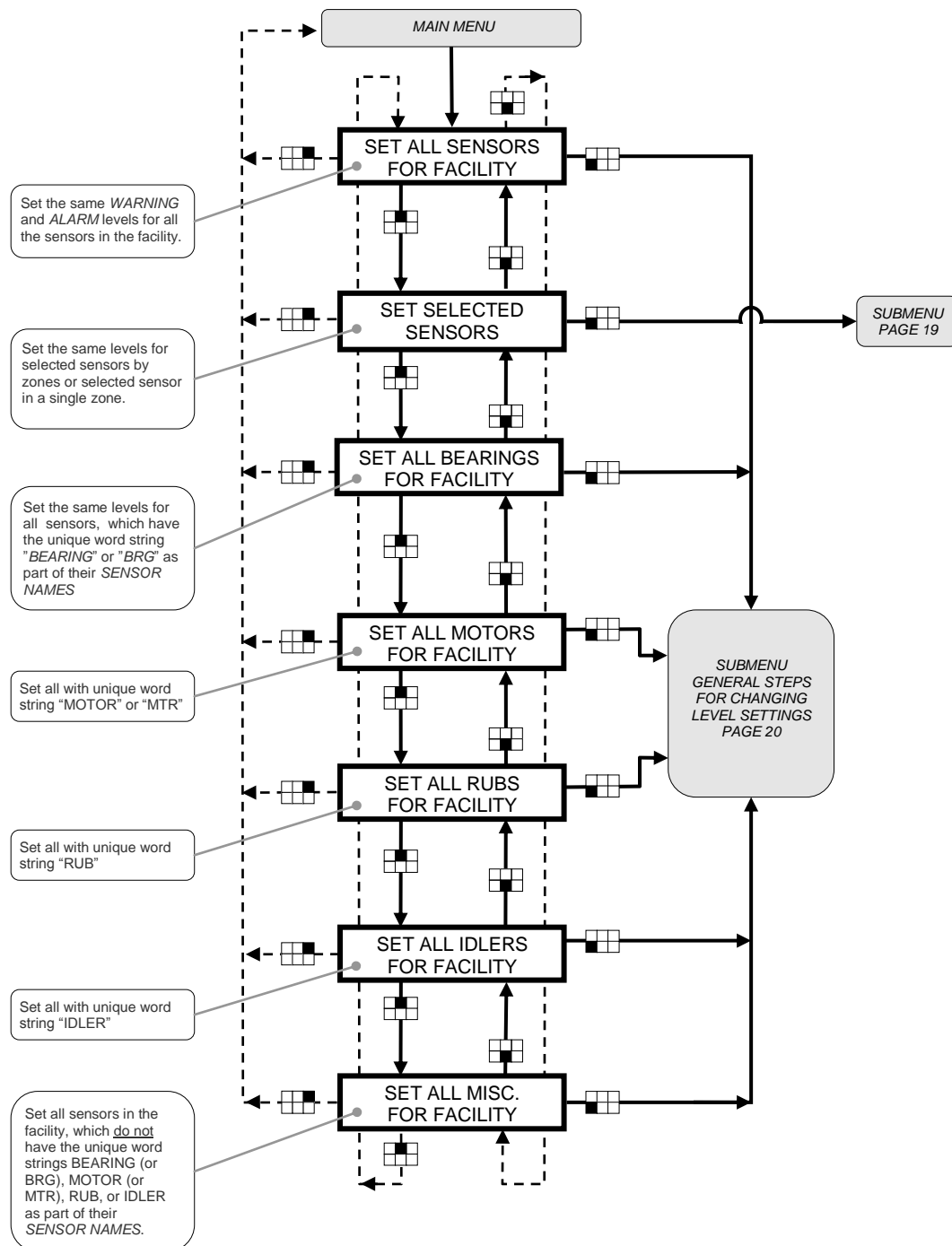
6.4.1. PRINT SELECTED SENSORS Sub-Menu

Create a custom print report of sensors chosen either by zone or by specific sensor.
Multiple zones and or sensors may be selected to be printed together.
All zones start out as **NOT SELECTED**.



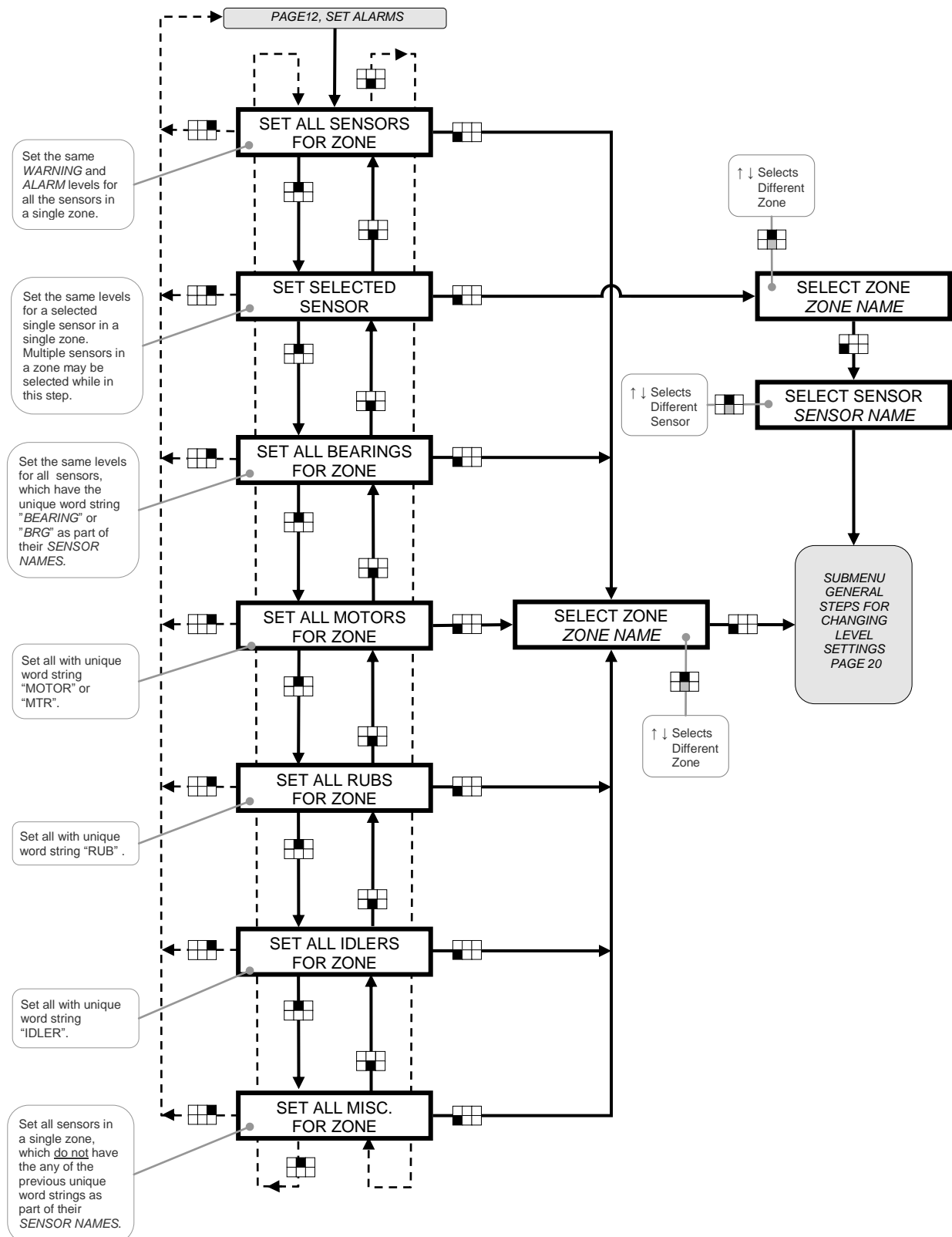
6.5. SET ALARMS

Specify set points at which alerts will be triggered. Most of the menus you see help you choose the scope that these values will be applied to the various sensors. The actual set points at which alerts will be triggered are specified in the section: *GENERAL STEPS FOR CHANGING ALARM & WARNING LEVEL SETTINGS* (page 20). The operator cycles through the *SET ALARMS* menu with the arrow keys and then selects an item with the [ENTER] key. Using any item with "SET ALL..." allows system wide changes in all sensors with the common word in its name. This will require the use of unique words such as *BEARING* (or *BRG*), *MOTOR* (or *MTR*), *RUB*, *IDLER*, in the sensor names. The last item, *SET ALL MISC*, will change sensors with miscellaneous other than *BEARING* (or *BRG*), *MOTOR* (or *MTR*), *RUB*, or *IDLER* in their *SENSOR NAMES*.



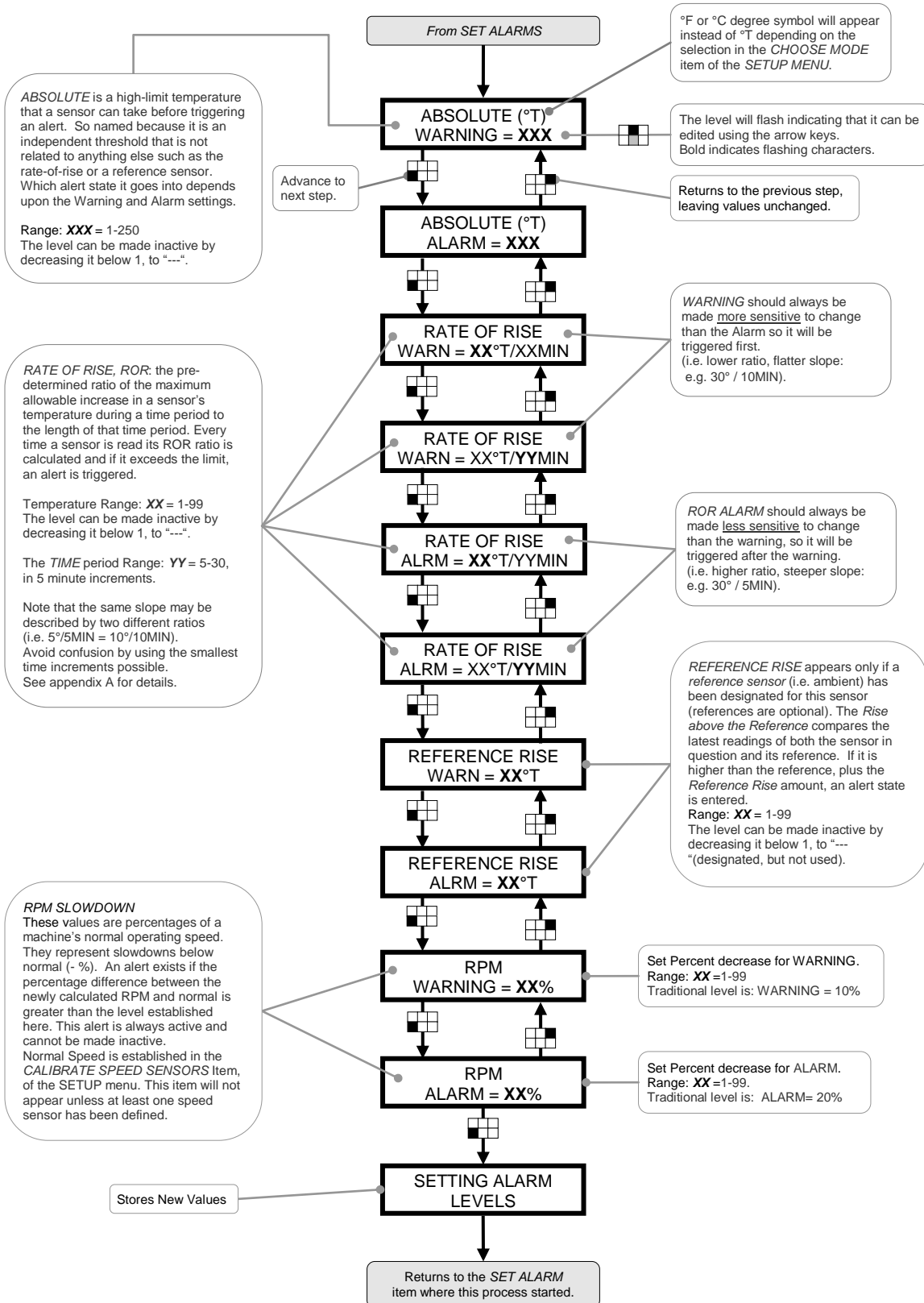
6.5.1. SET SELECTED SENSORS ALARMS Sub-Menu

When selected, the user can set the same *WARNING* and *ALARM* levels for selected sensors by zones or a selected sensor in a single zone. See *GENERAL STEPS FOR CHANGING ALARM & WARNING LEVEL SETTINGS* (page 20) to process changes.



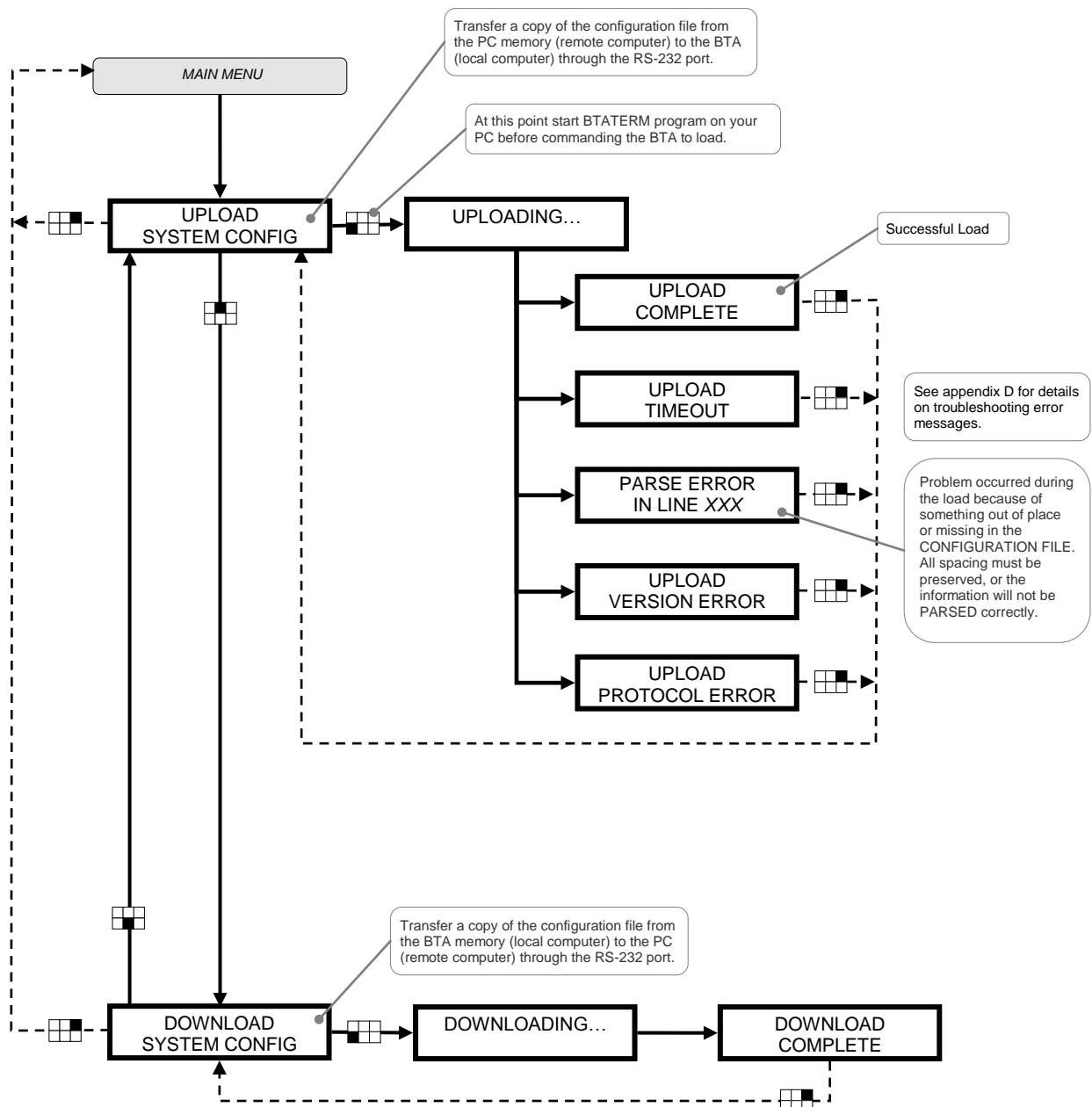
6.5.2. GENERAL STEPS FOR CHANGING LEVEL SETTINGS

Each item in the set alarms menu will end up on this submenu, which is changed with a similar series of steps. They are outlined here as a reference to change any of the items of this menu. Warning is an advance notice, first-level threshold, which makes the operator aware of potential or probable dangerous or harmful situations. Alarm is an immediate notice, highest-level threshold, which makes the operator aware that the dangerous situation previously warned about now exists. It is given so that action will be taken. The alert state that results depends upon the Warning and Alarm settings chosen here.



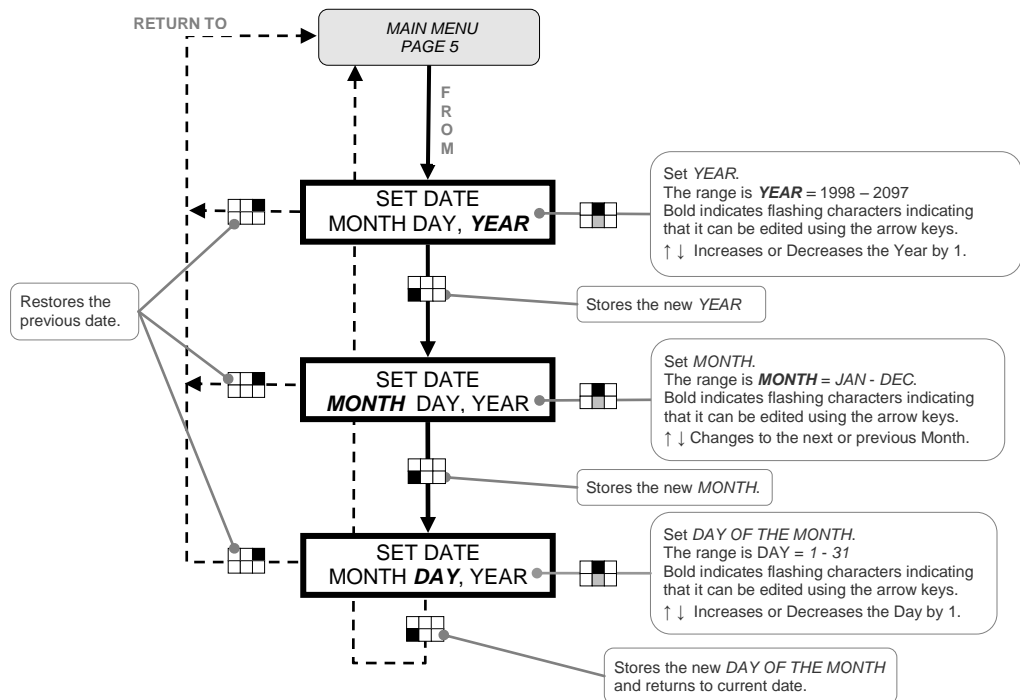
6.6. UPLOAD / DOWNLOAD SYSTEM CONFIGURATION

In order for the BTA to work correctly it must be custom configured. The *CONFIGURATION FILE* can be exchanged between the BTA to the Personal Computer (PC) through the RS-232 serial port. Compared to creating a configuration using the keypad and menus, editing the file on a computer is much easier and quicker. Use the custom utility program "Btaterm" (BTA Terminal) to upload a pre-defined configuration from a host PC to the BTA. Btaterm must be installed on the host PC to make this operation work. The text *CONFIGURATION FILE* has all the information the BTA needs to be set up according to the needs of the user and the facility it monitors. This file tells the BTA exactly where all the sensors are located, what to name them, and what all the values of the warning and alarms are. Usually the BTA will come from the factory pre-programmed for the user's facility. All parameters in the *CONFIGURATION FILE* can also be set and edited from the front keypad and the menus. This item is intended for use by personnel of Rolfes@Boone. See appendix D for details.



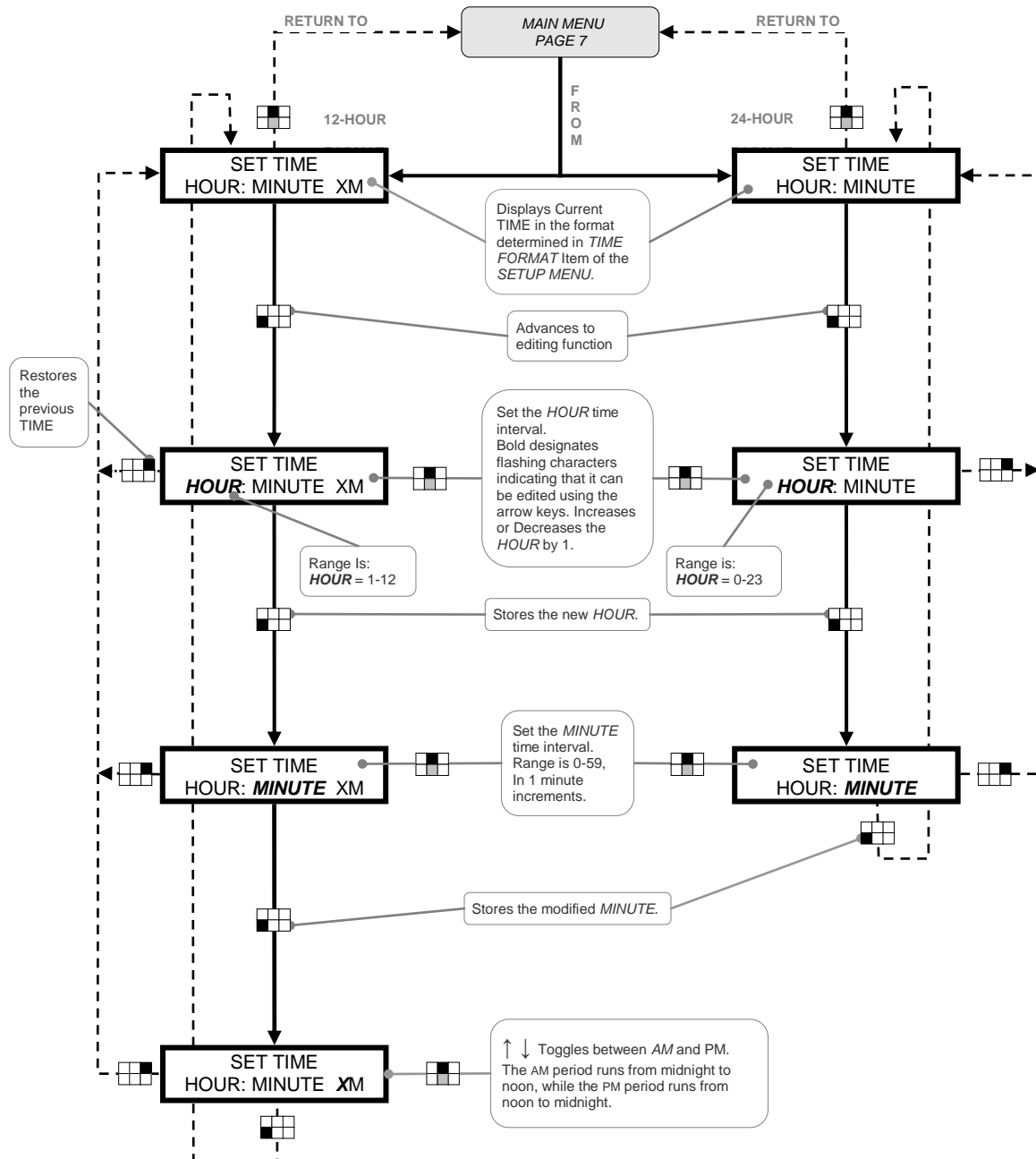
6.7. SET DATE

Alter the date stored in the system. Once set, an internal calendar will keep track of the date. A backup battery insures that this will happen even when the line power has been removed. The number of days in each month and leap year calculations are automatically accounted for.



6.8. SET TIME

Alter the time stored in the system. The Set Time function allows the user to enter the current time. Once set, the internal clock will keep track of the time. A backup battery insures that timekeeping continues even when the line power has been removed. Saving these settings to memory is not necessary. For more information about time settings see in *TIME FORMAT* Item of the *SETUP MENU*.



6.9. MANUAL SENSOR SELECT

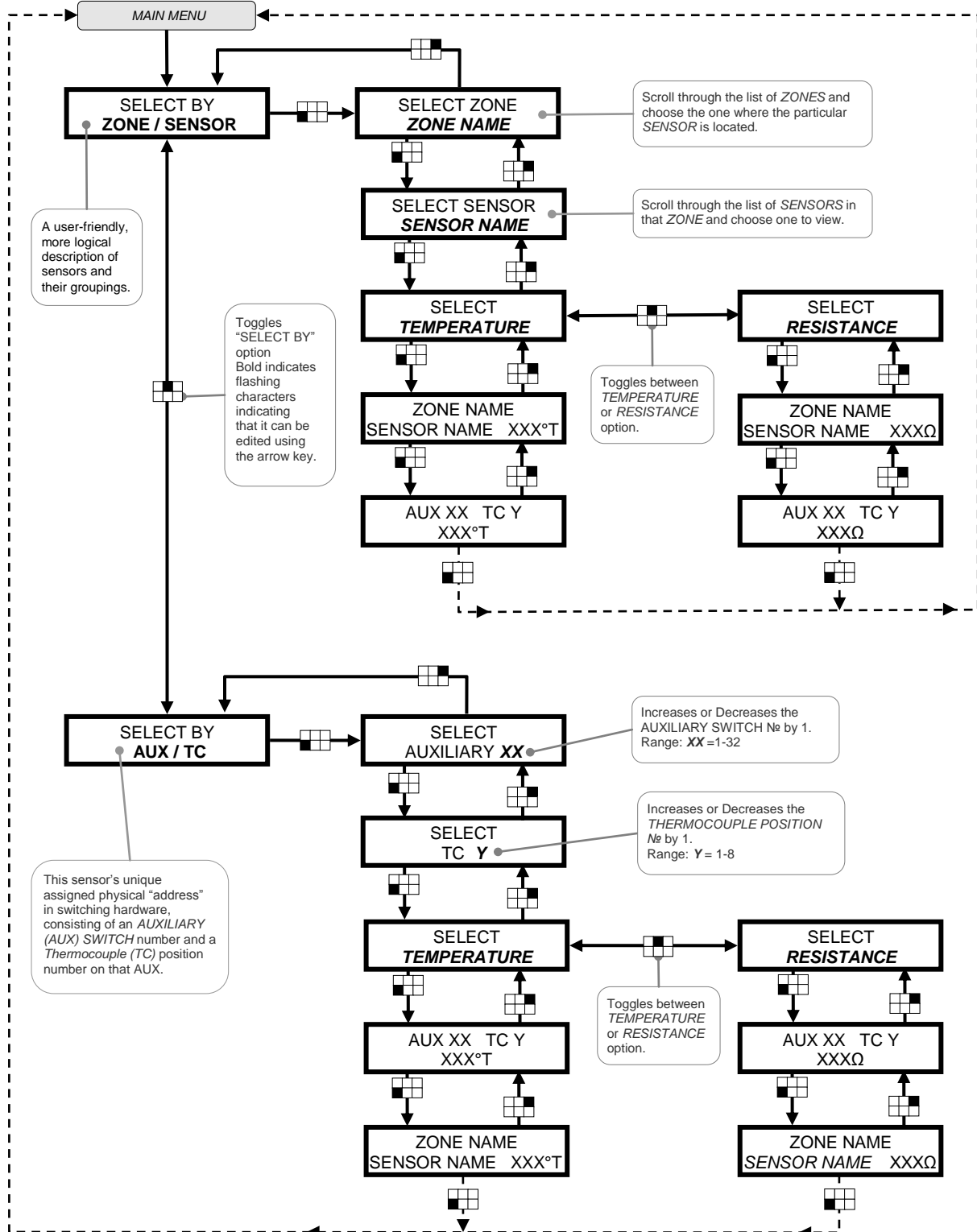
This function allows the operator to manually read any TEMPERATURE SENSOR while the scan is halted. Speed sensors cannot be selected here but can only be done in calibrate speed sensors. This ability can be very helpful in troubleshooting problems with the thermocouple circuit. Finding the sensor of interest can be done in two ways. Every sensor is uniquely identified in the system by two sets of parameters:

6.9.1. ZONE NAME and SENSOR NAME

Exist in software. It is a user-friendly combination that describes a logical grouping of sensors with something in common (i.e. location or machinery) and then a point of friction in that zone (i.e. bearing or rub).

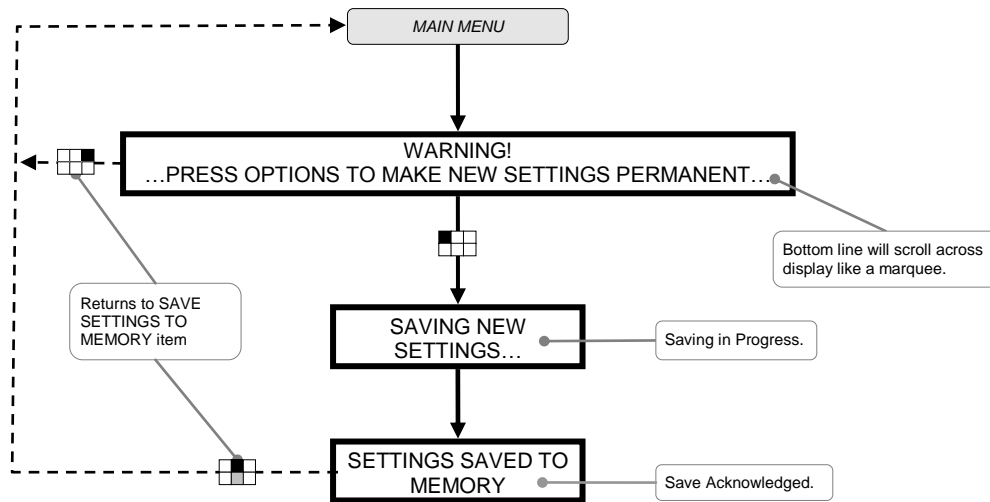
6.9.2. AUXILIARY SWITCH and THERMOCOUPLE NUMBERS

Exist in hardware. It is a combination that describes the unique physical address in remote multiplexing switches, which gathers 8 Thermocouple signals and sends the whole group to the Instrument.



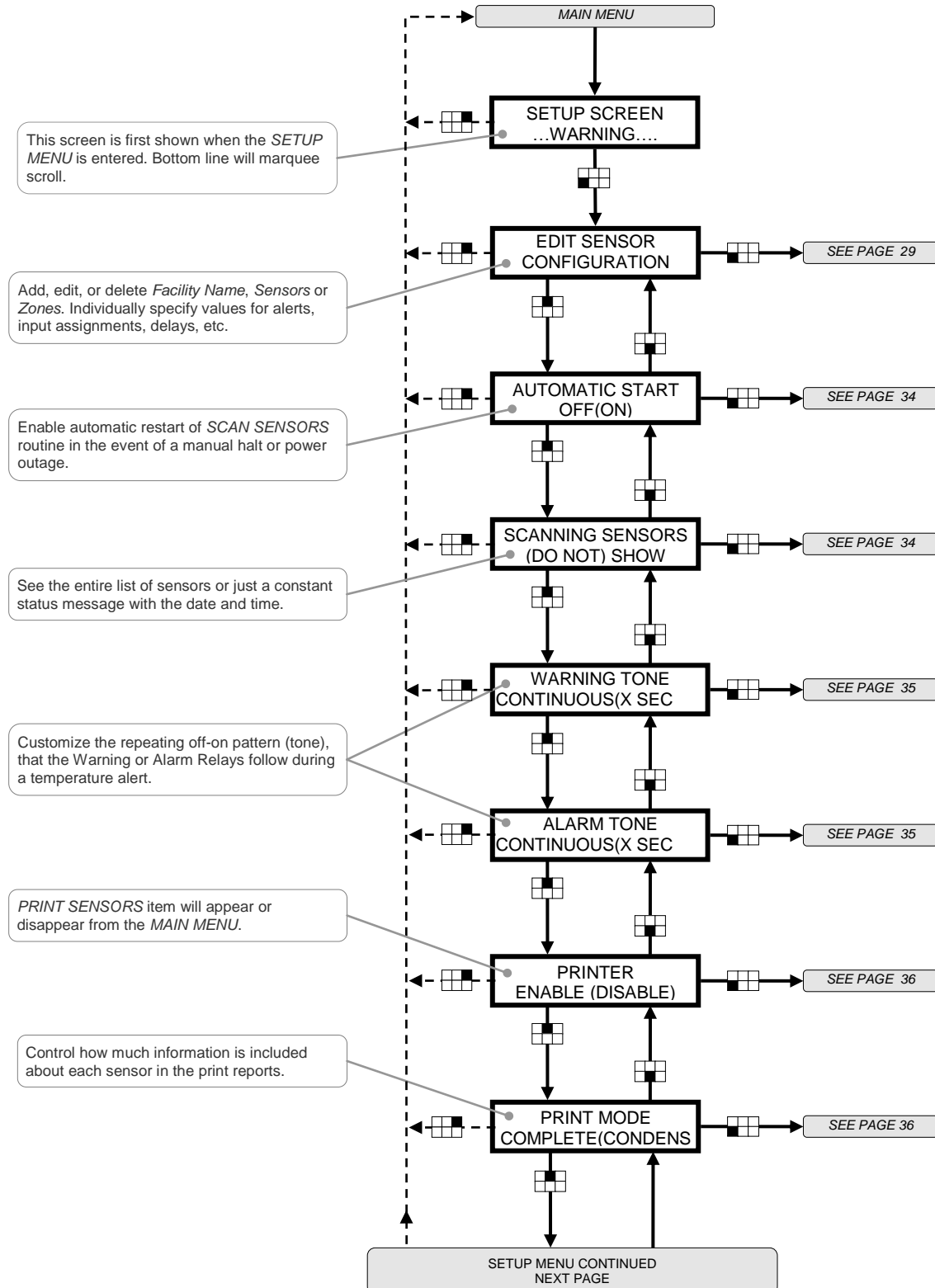
6.10. SAVE SETTINGS TO MEMORY

This function takes the setting changes made in the other menu items and makes them permanent in memory. If they are not set permanently to memory then they will be lost when line power is removed (or power switch turned off). Any changes will not take permanent effect until the SAVE SETTINGS TO MEMORY item has been run. If the SAVE SETTINGS TO MEMORY item has not been run, it is possible to return to any previously permanent settings by simply turning the power off and on.

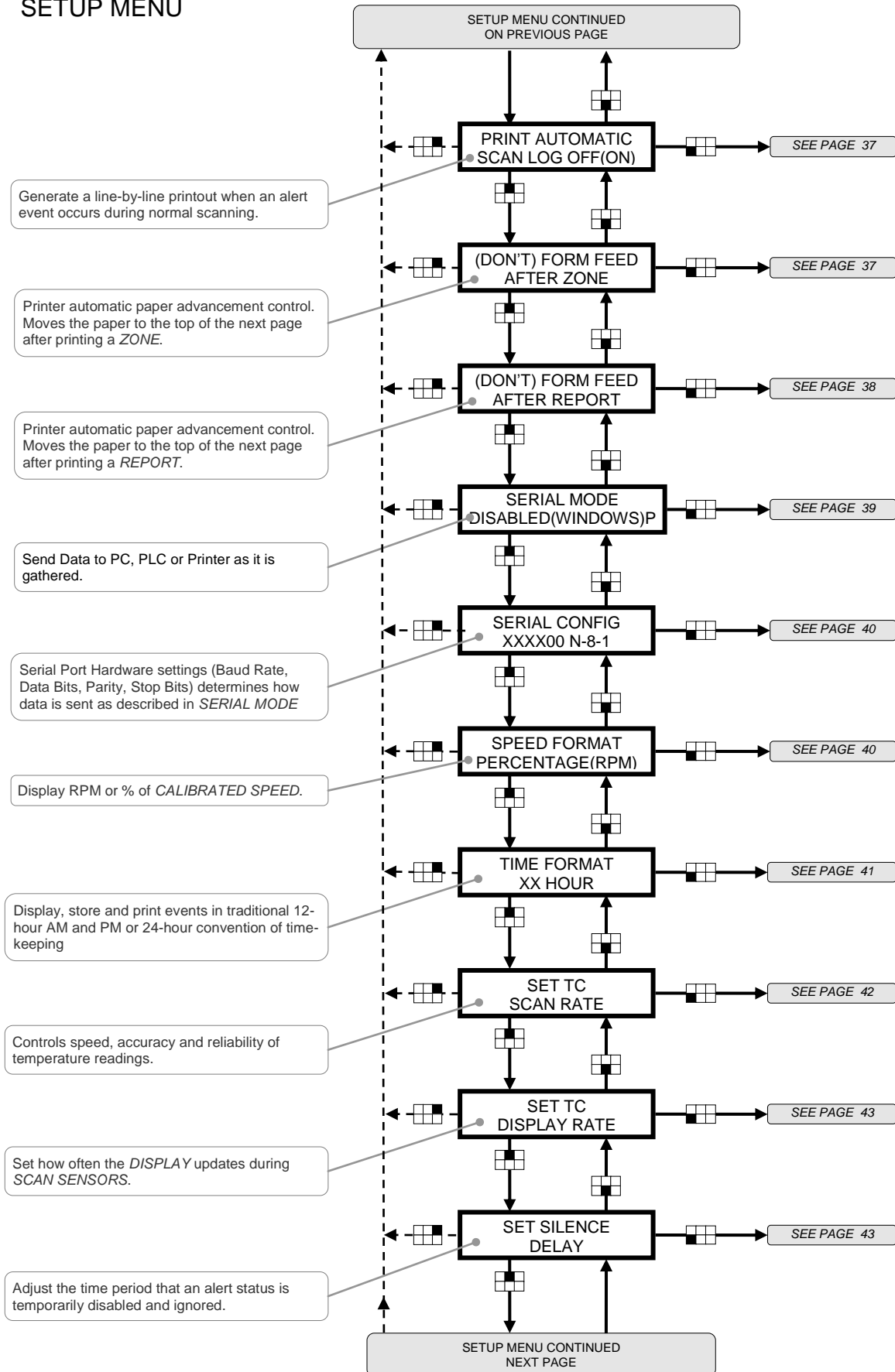


7. SETUP MENU

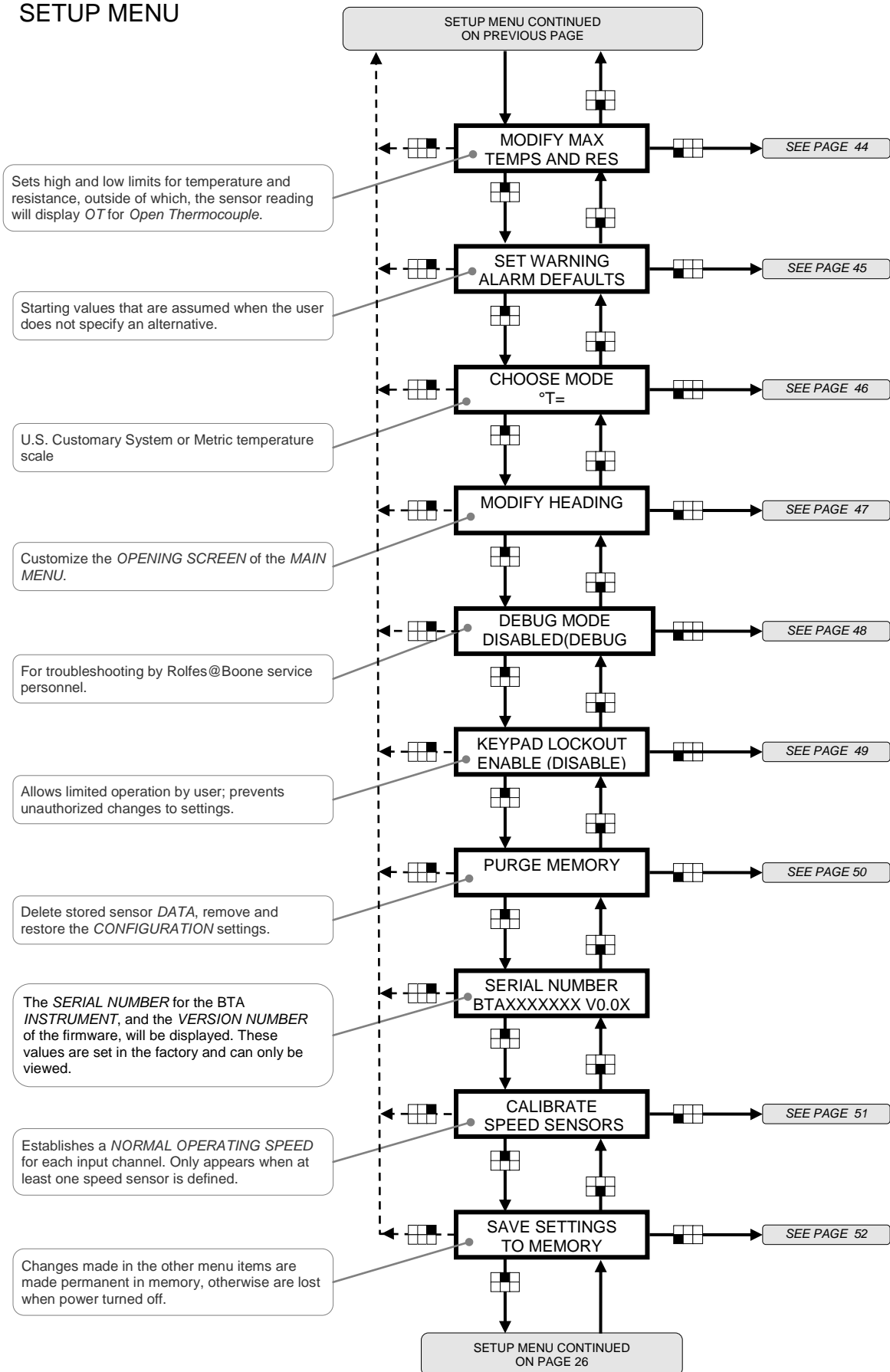
This menu is hidden from the MAIN MENU and holds 27 of the less-commonly used menu items. It is the starting point to prepare the BTA's internal software program for the requirements of the facility and its operator. The user enters or alters the complete configuration by interacting with menu choices and responding with the keypad. To access the SETUP MENU the operator must hold down the <CLEAR> key first and then the <ENTER> key for several seconds until the SETUP SCREEN appears. Navigation through the menus is accomplished by reading the Display and pressing Keypad buttons in response to what is being shown.



SETUP MENU

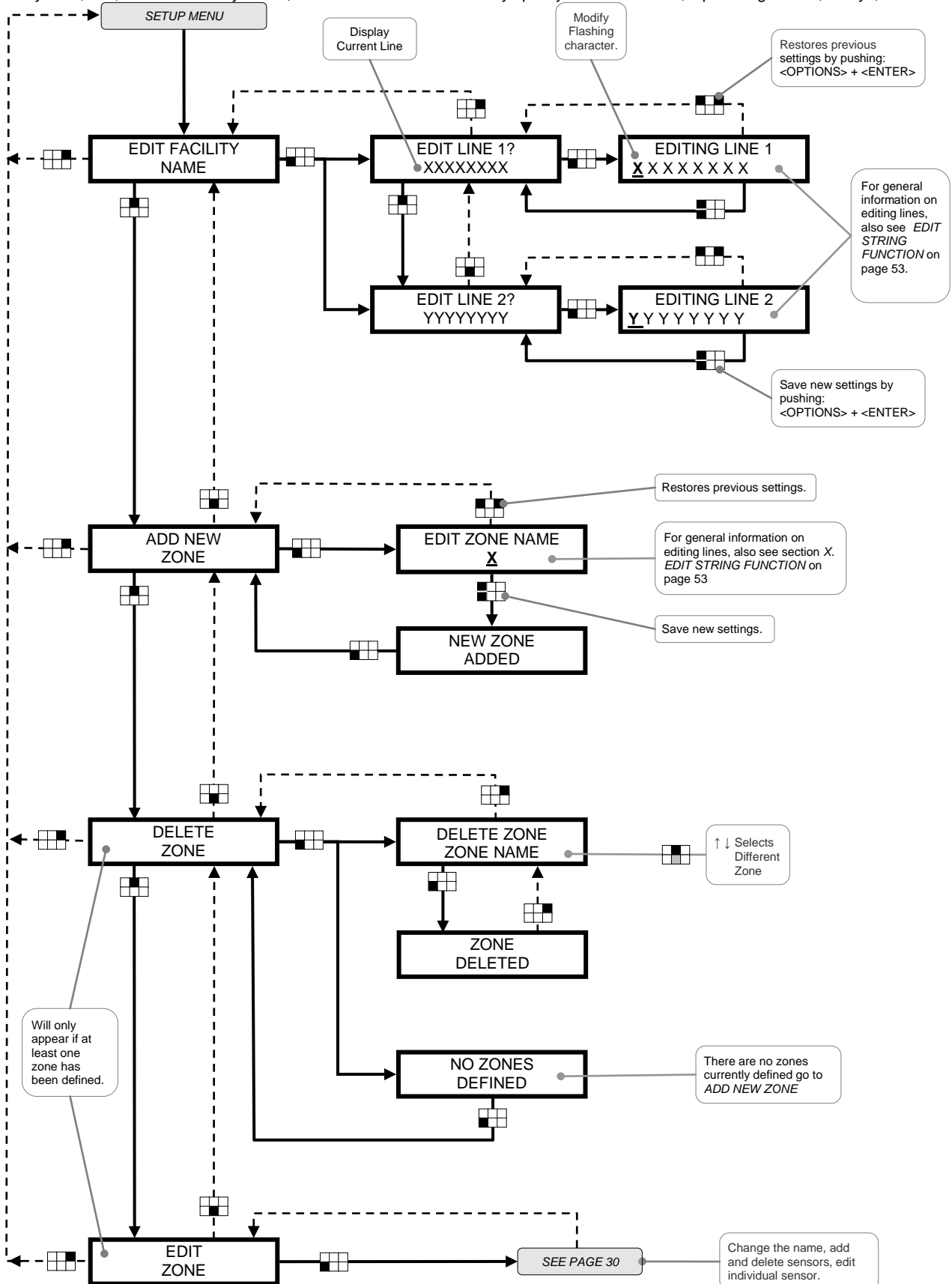


SETUP MENU



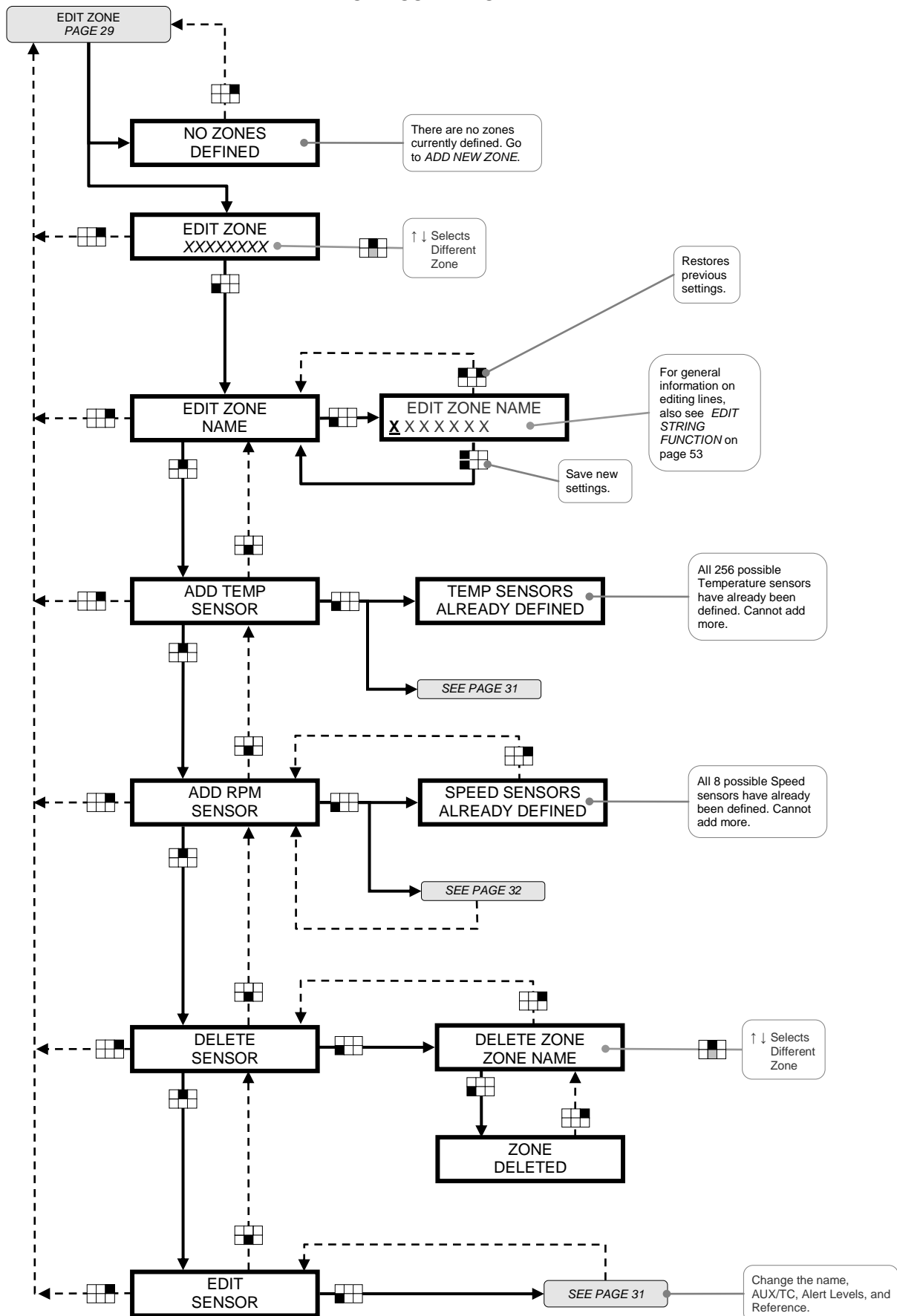
7.1. EDIT SENSOR CONFIGURATION

Allows the operator to configure the system by adding, editing, or deleting various aspects of the sensor specifications used in the facility. Options include the editing of the facility name as well as the addition, deletion, or editing of zones and sensors within that facility. Add, edit, or delete Facility Name, Sensors or Zones. Individually specify values for alerts, input assignments, delays, etc.



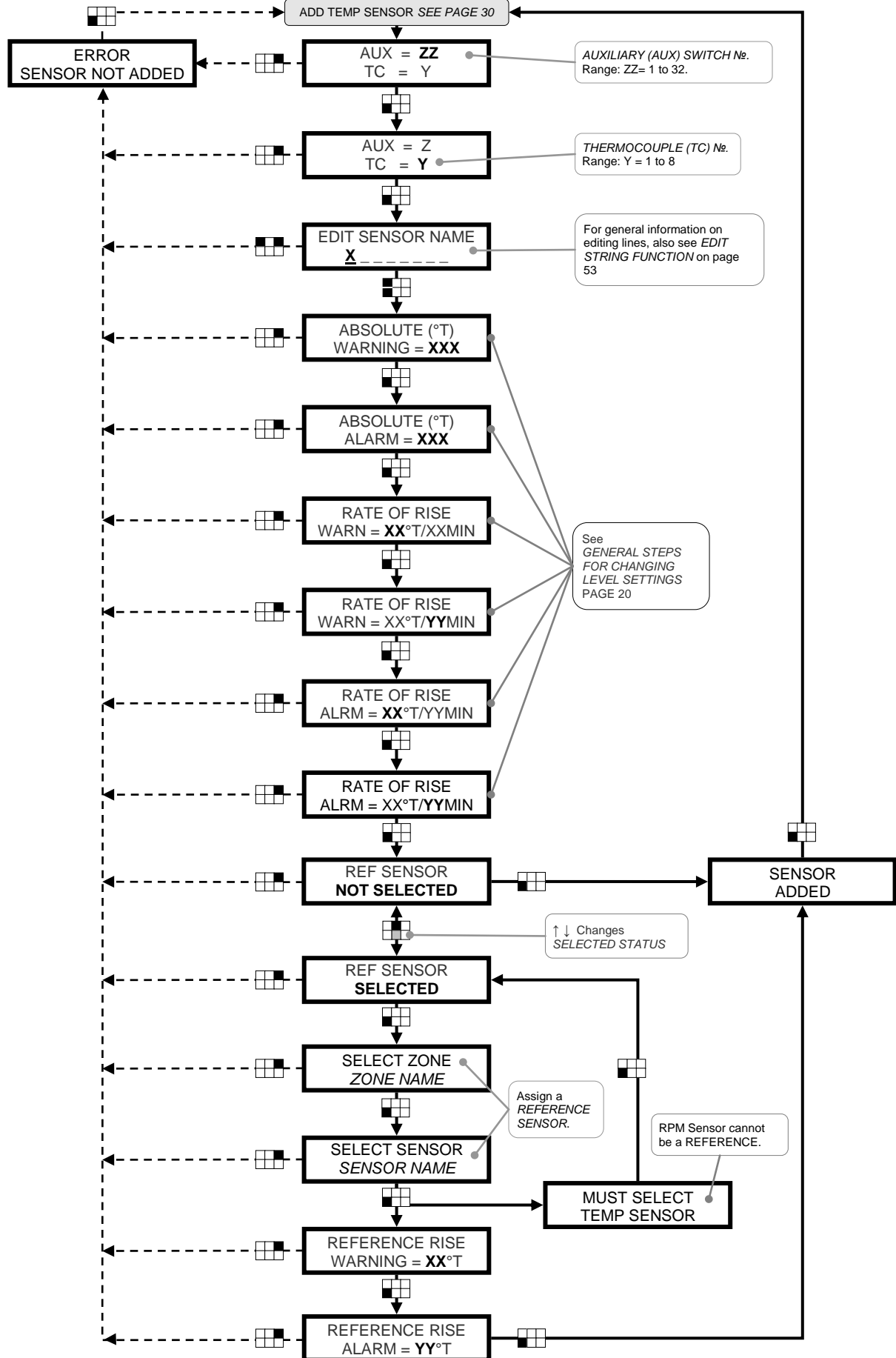
7.1.1.

EDIT ZONE SUBMENU

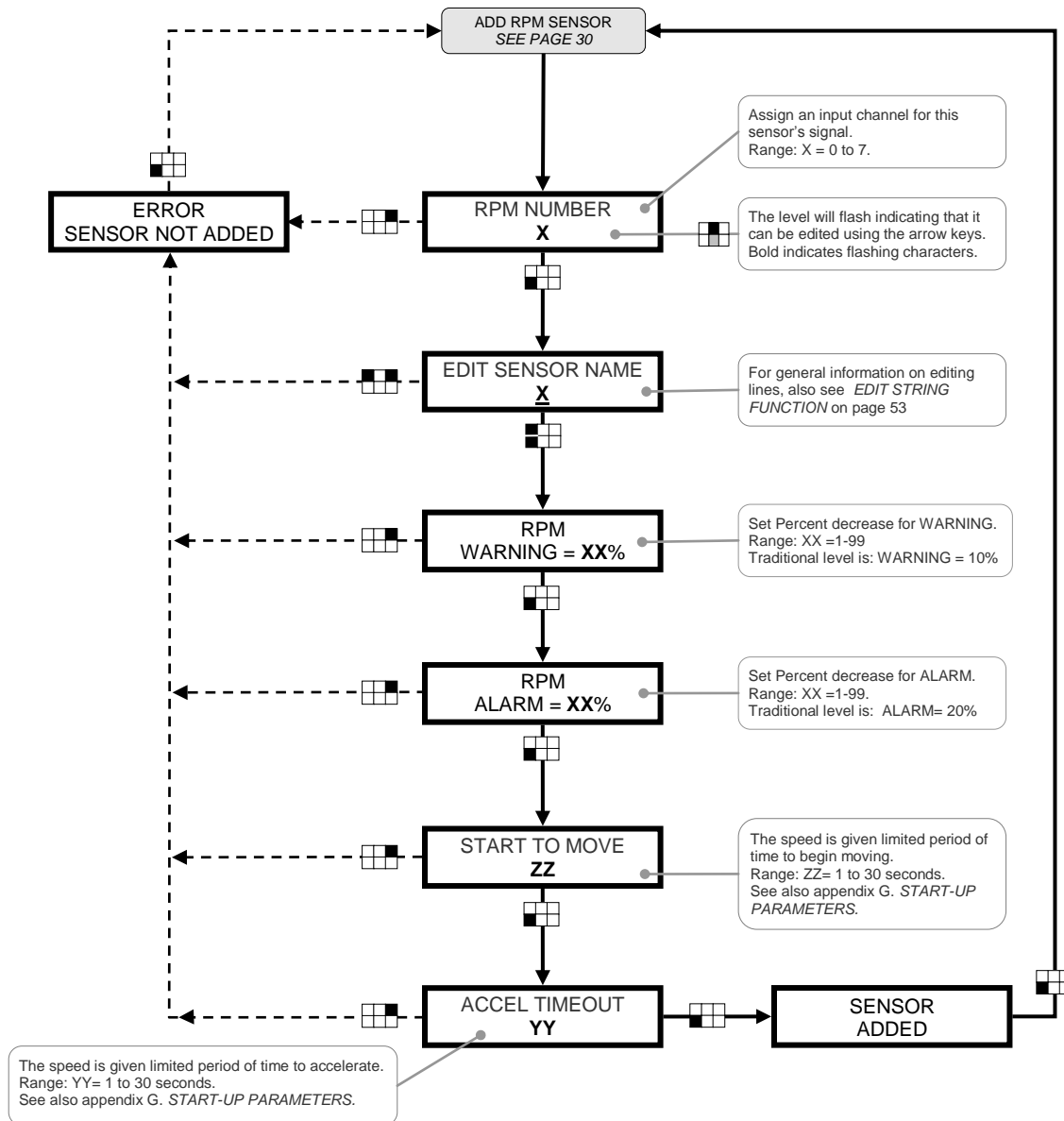


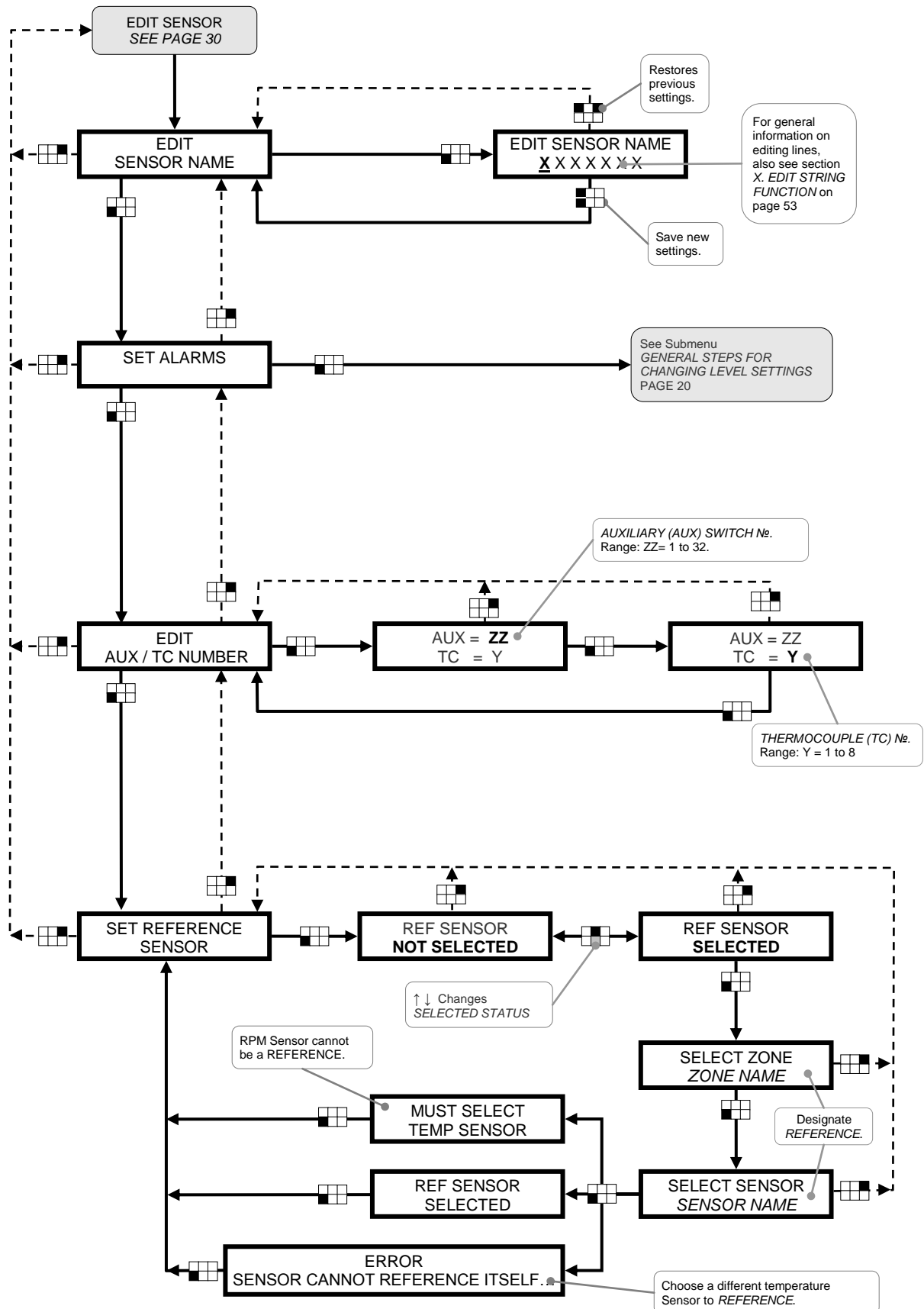
7.1.2.

ADD TEMP SENSOR SUBMENU



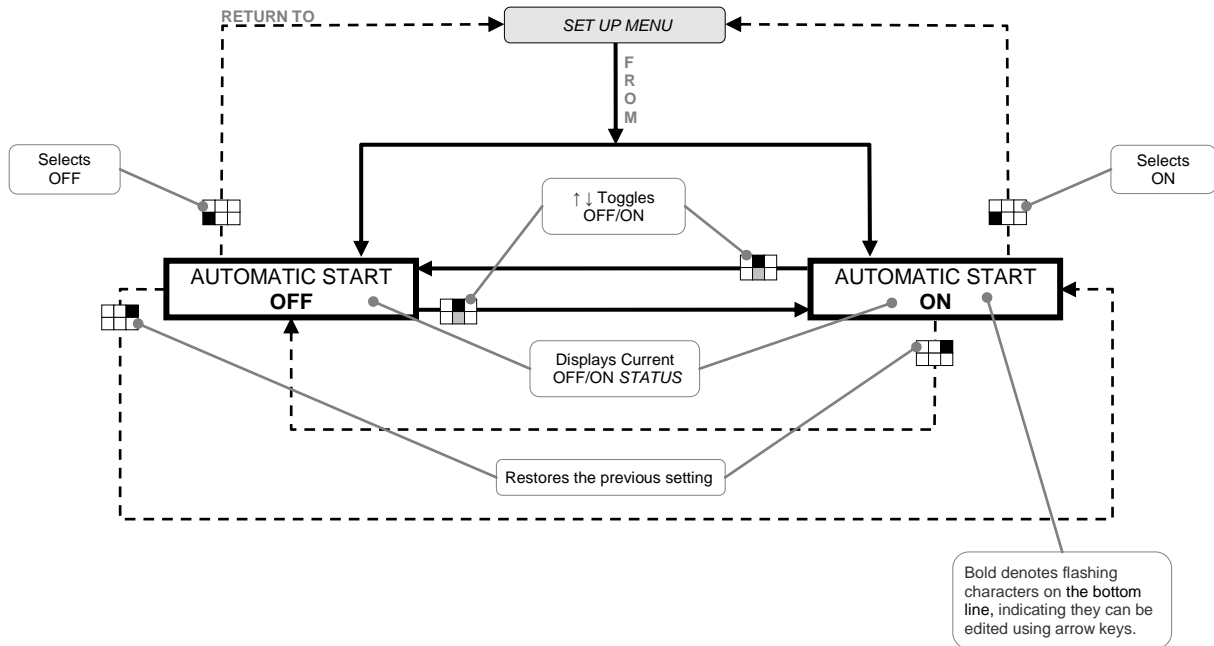
7.1.3. ADD RPM SENSOR SUBMENU





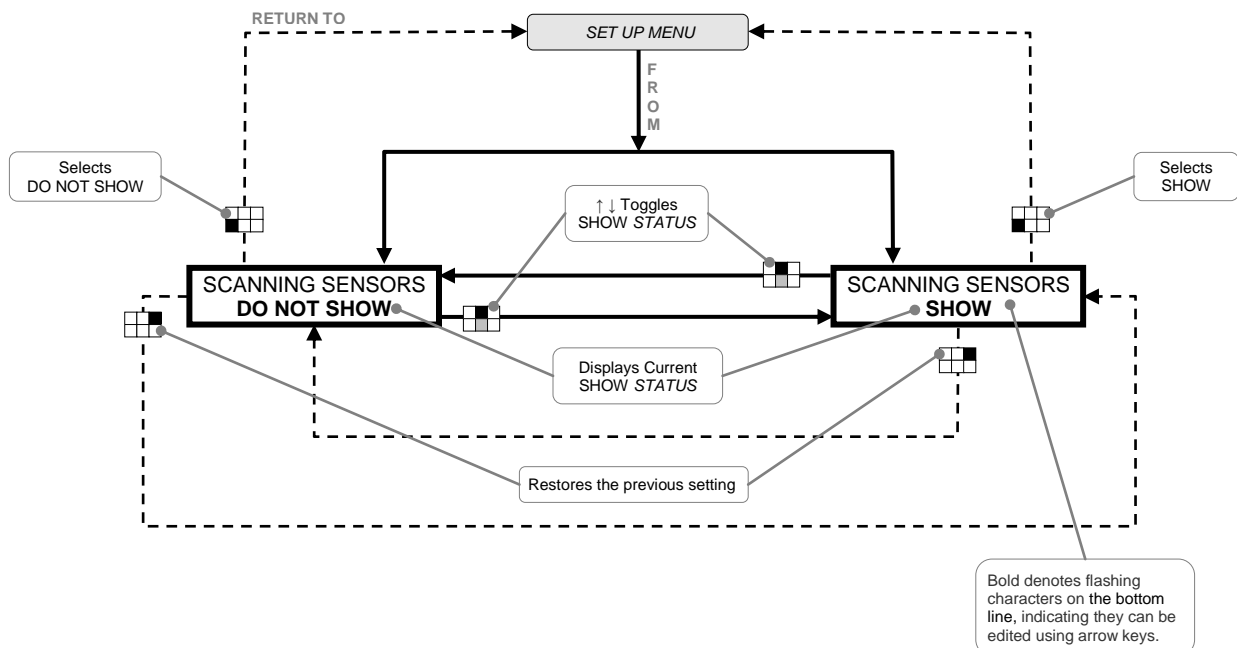
7.2. SET AUTOMATIC START

Enable automatic restart of SCAN SENSORS routine in the event of a manual halt or power outage. The unit can automatically enter scanning mode after five minutes of inactivity (no keys have been pressed). This ensures that hazard protection will automatically resume if the operator does not restart SCAN SENSORS after halting a previous scan. When this item is selected, the user can specify whether or not to allow an AUTOMATIC START.



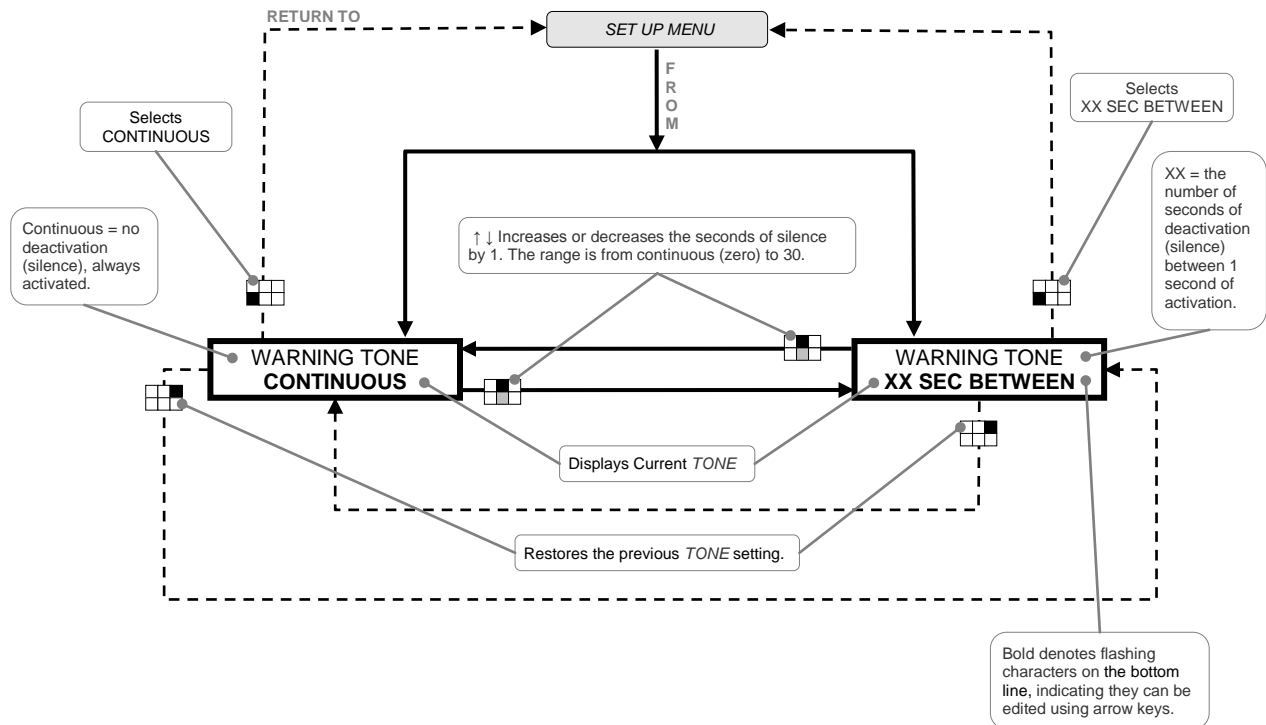
7.3. DISPLAY SCANNING SENSORS

See the entire list of sensors or just a constant status message with the date and time. Allows the choice of whether or not the display will update with new sensor readings or remain static. For more information, see details in the SCAN SENSORS / DISPLAY UPDATE item of the MAIN MENU.



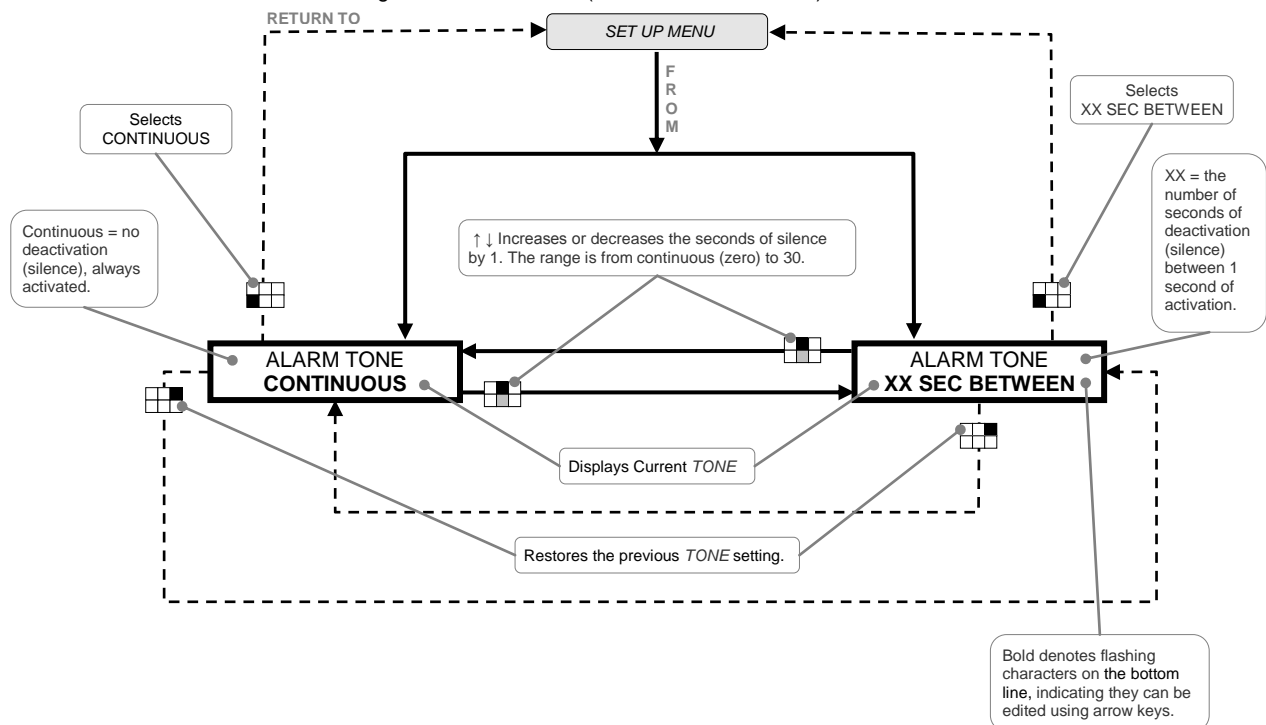
7.4. SET WARNING TONE

This feature allows the user to customize a repeating pattern that the Warning Relay follows during a temperature alert. Once a temperature sensor enters a WARNING ALERT state, the warning relay is activated. It determines the duration that External Alert Devices are working (horn, buzzer, light, etc.). This pattern or TONE, consists of 1 second of activation followed by a number (set here) of seconds of silence (deactivation). This may be set differently so that the operator can hear or see the difference between it and the ALARM ALERT. The range is from continuous (zero seconds of silence) to 30.



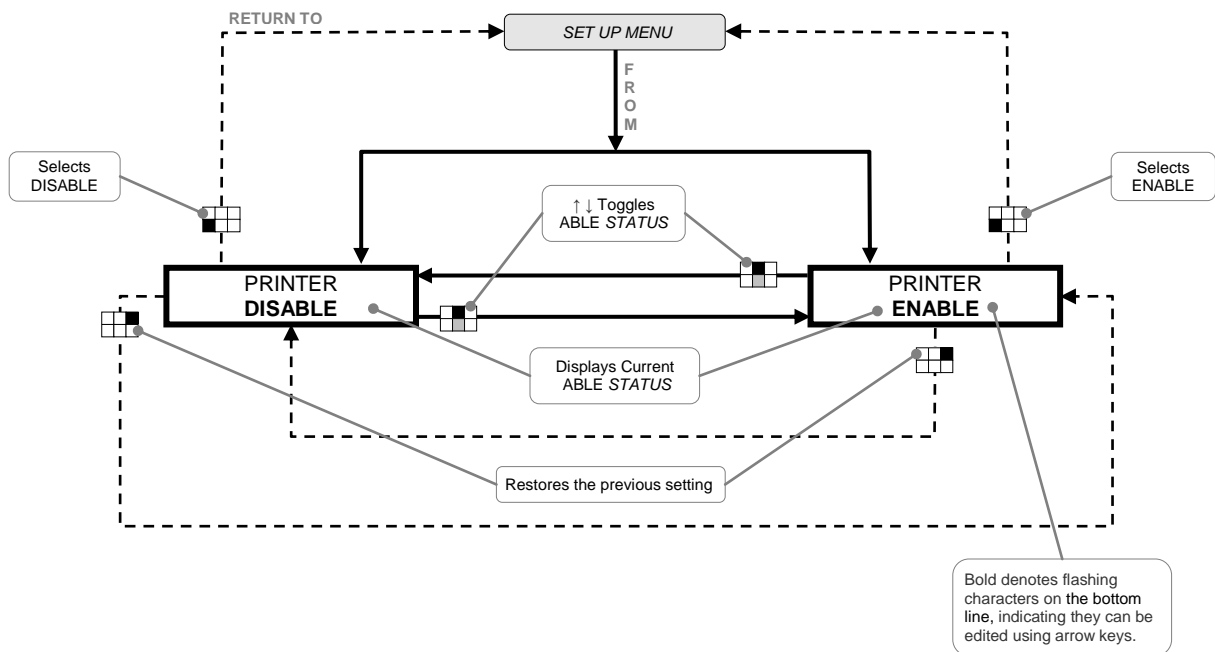
7.5. SET ALARM TONE

This feature allows the user to customize a repeating pattern that the Alarm Relay follows during a temperature alert. Once a temperature sensor enters an ALARM ALERT state, the alarm relay is activated. It determines the duration that External Alert Devices are working (horn, buzzer, light, etc.). This pattern or TONE, consists of 1 second of activation followed by a number (set here) of seconds of silence (deactivation). This may be set differently so that the operator can hear or see the difference between it and the WARNING ALERT. The range is from continuous (zero seconds of silence) to 30.



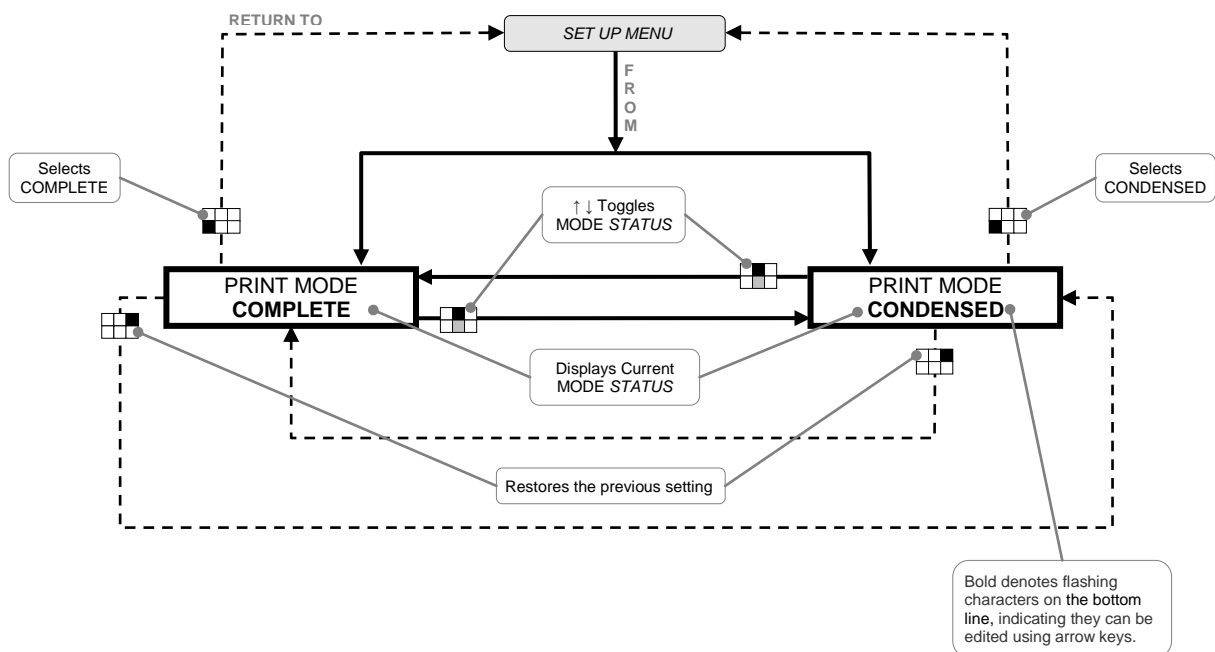
7.6. PRINTER ENABLE

The BTA INSTRUMENT can be connected via the parallel port to a printer. This feature allows the user to remove the PRINT SENSORS item from the MAIN MENU and deactivate any other features or hardware associated with the printer.



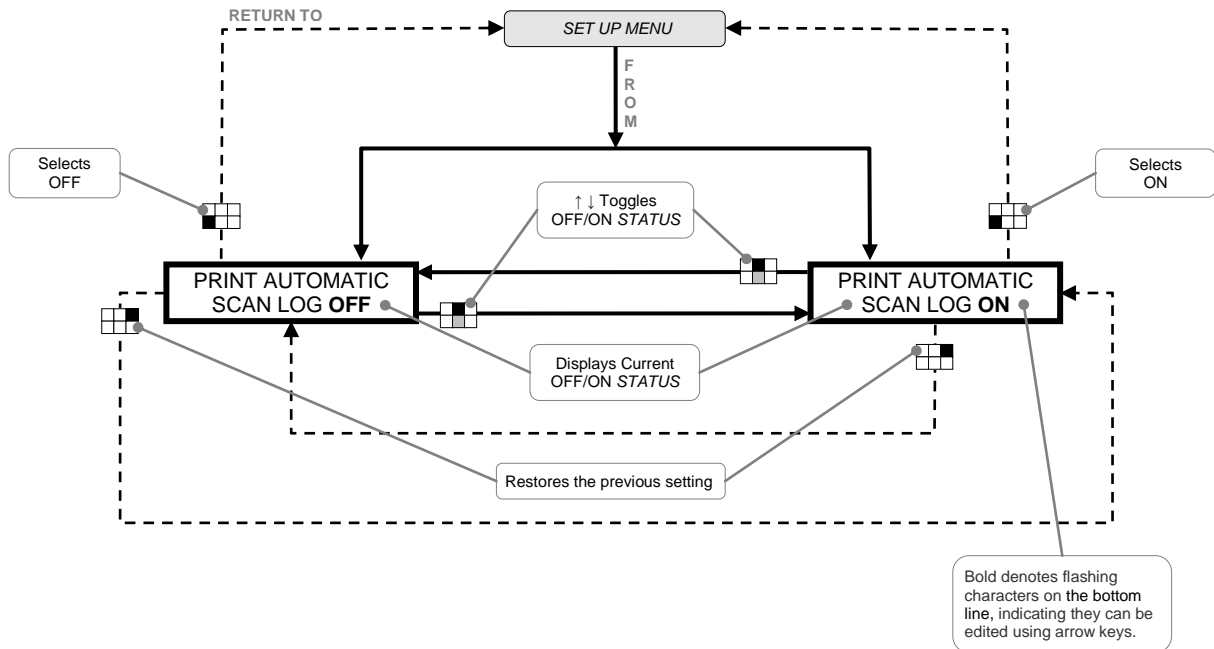
7.7. PRINT MODE

This feature allows the user to specify the print mode, thus controlling how much information is included in the print reports. Print reports can be **CONDENSED** or **COMPLETE**. The **CONDENSED** report will work better for printers (unidirectional only), which do not support more than 80 characters per line (10 characters per inch; 8.5 inch wide paper). This manual is an example of up to 80 characters per line. The **COMPLETE** report works with printers, which support up to 132 characters per line. See appendix C for details and examples.



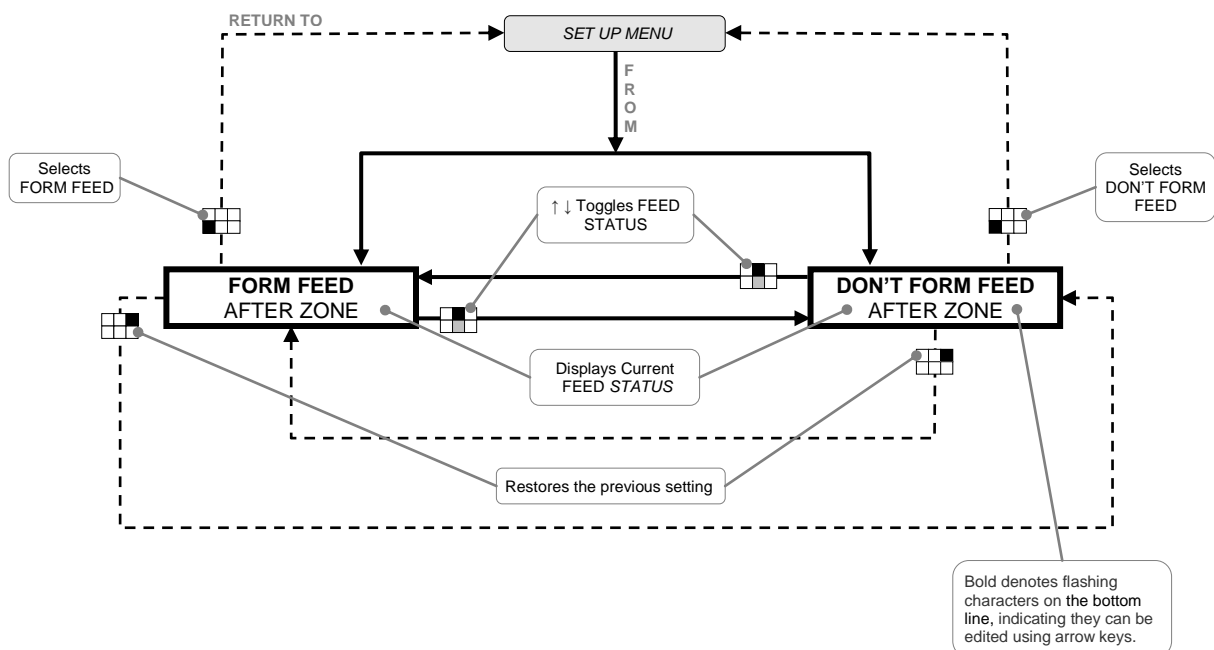
7.8. PRINT AUTOMATIC SCAN LOG

Generate a line-by-line printout when an alert event occurs during normal scanning. If SETUP MENU item, PRINTER is set to ENABLE, then turning this function ON will print a report when a sensor is in a WARNING or ALARM ALERT state. A printout of the violating sensor will be generated upon silencing it; an acknowledgement of that action will also print on the same report.



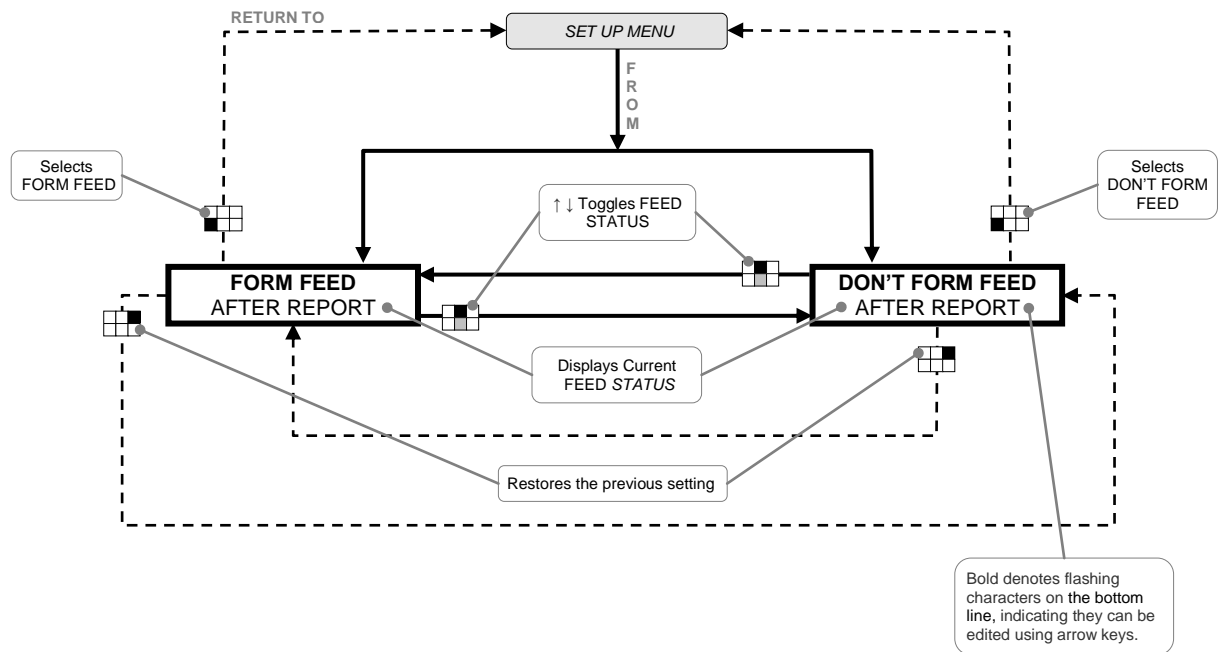
7.9. SET FORM-FEED AFTER ZONES

When selected, the user can specify whether to form-feed (advance the paper to the first line of a new sheet) the printout after each ZONE has been printed. This feature is used to when the operator wishes to separate each ZONE on individual sheet(s) of paper. This function is generally used with tractor feed (continuous form) type printers to automatically advance the paper past the perforation.



7.10. SET FORM-FEED AFTER REPORT

When selected, the user can specify whether to form-feed (advance the paper to the first line of a new sheet) the printout after each REPORT has been printed. This feature is used to when the operator wishes to separate each REPORT on individual sheet(s) of paper. This function is generally used with tractor feed (continuous form) type printers to automatically advance the paper past the perforation.



7.11. SERIAL REPORT MODE

The BTA monitor has 2 serial ports, RS-232 and RS-485, which can be used to transmit a continuous stream of sensor information to another data-terminal device. Normal output consists of an abbreviated report giving basic information such as the sensor's identity (known by its hardware address), current reading of temperature or speed, time, date, and enable/disable status, alert state (alarm or warning condition). ASCII text sent and multiple baud rates are supported. The report update runs at the rate which is tied to the display rate on the BTA (adjustable from 1-30s). If any setting or configuration changes on the BTA unit are reported out the serial port. The BTA has to have its Serial Mode enabled to use this feature. Two types of serial data will come across the ports: ACTUAL SERIAL REPORT OF SENSOR DATA and the CONFIGURATION FILE.

7.11.1. DISABLED

This feature is made inactive. Do this when UP/DOWN LOADING CONFIGURATION in MAIN MENU.

7.11.2. PRINT

The serial report is sent out the printer port.

7.11.3. WINDOWS COMM

The serial report is sent out one of the serial ports to a PC or PLC. The port hardware settings used are described in SERIAL CONFIGURATION.

7.11.3.1. RS-232 SERIAL PORT

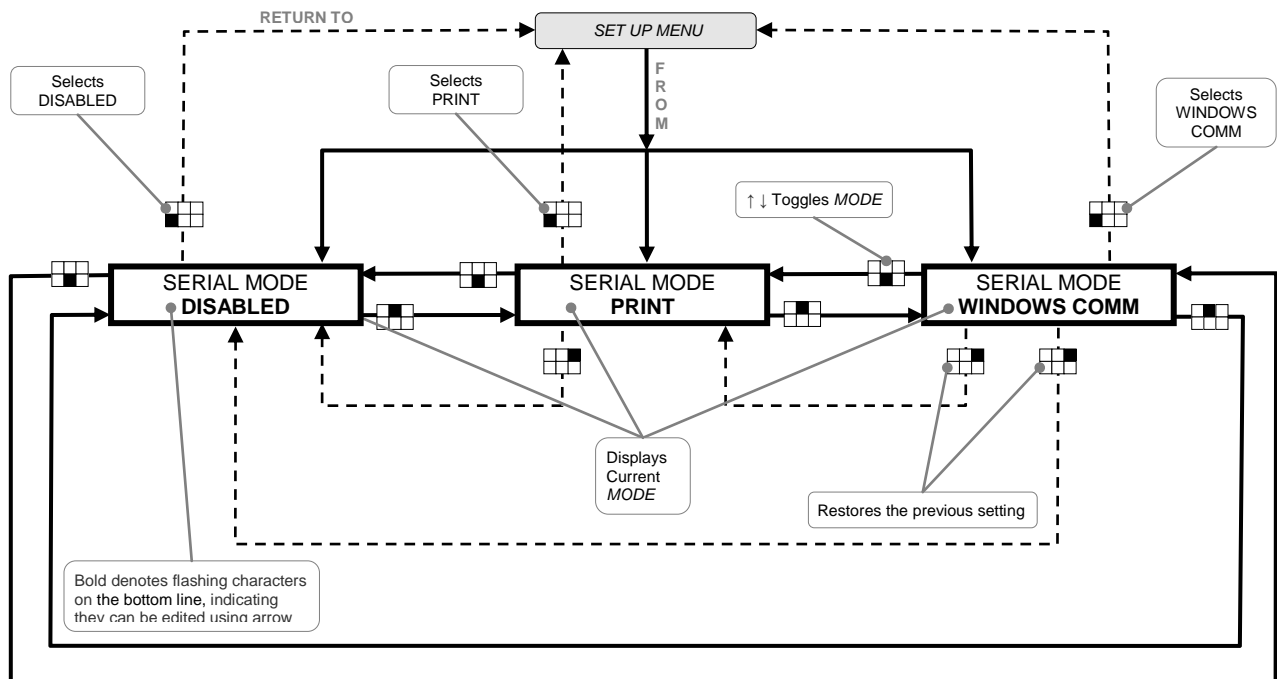
This port is output only when the BTA is scanning for short distances (less than 50 feet). When scanning is halted, this port is used to upload and download configuration files. The Port uses duplex method data transmission.

7.11.3.2. RS-485 SERIAL PORT

It is a source for serial report data sent to a PC located a long distance from the BTA (up to 3600 feet).

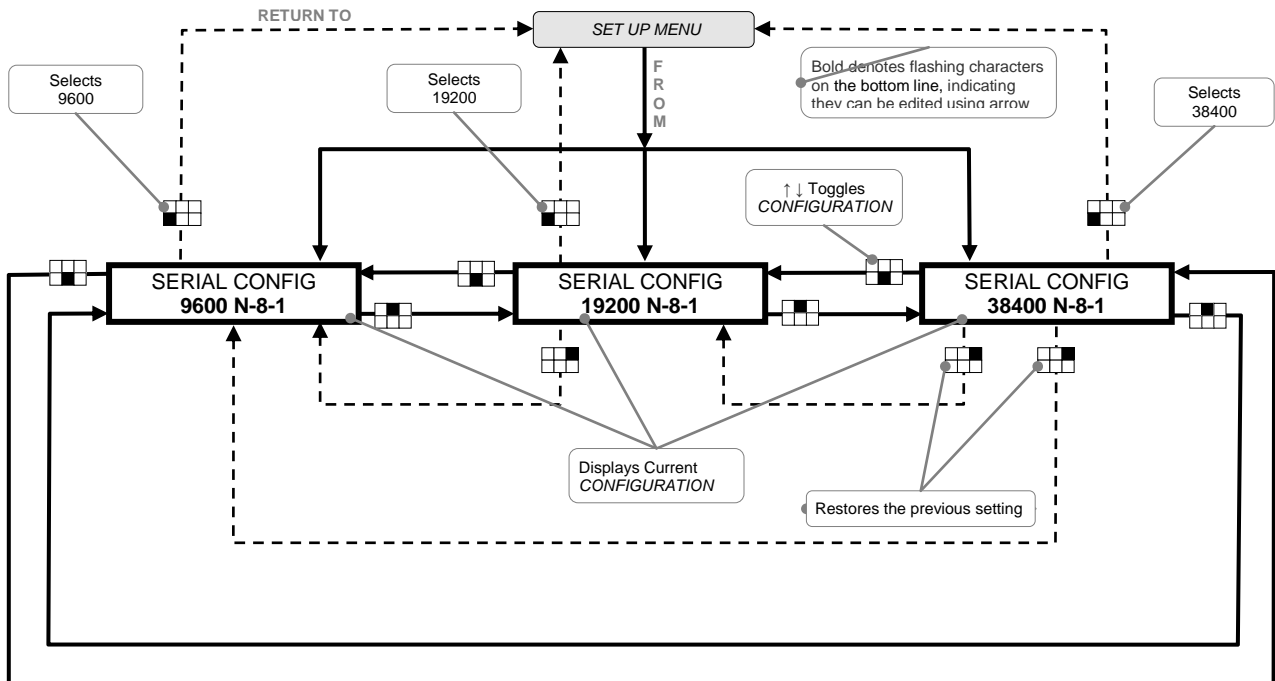
The simplex method data transmission is used through a 1½ pair cable (a single differential pair, ground and shield drain). The BTA is always the sender, no control or handshaking.

In the case of one or more BTAs inputting to one PC it requires some kind of converter at the PC. We use a 2-channel PCI RS-485 Asynchronous Communications Adapter Card from Quatech (one card per two BTAs).



7.12. SERIAL CONFIGURATION

This feature is used to specify how data is sent through the serial ports when SERIAL REPORT MODE is set to WINDOWS COMM or when using UP/DOWN LOADING CONFIGURATION in MAIN MENU. When selected, the user can choose port hardware settings (Baud Rate, Data Bits, Parity, Stop Bits) that must match those found on the PC or PLC. See appendix D for details.



7.13. SPEED FORMAT

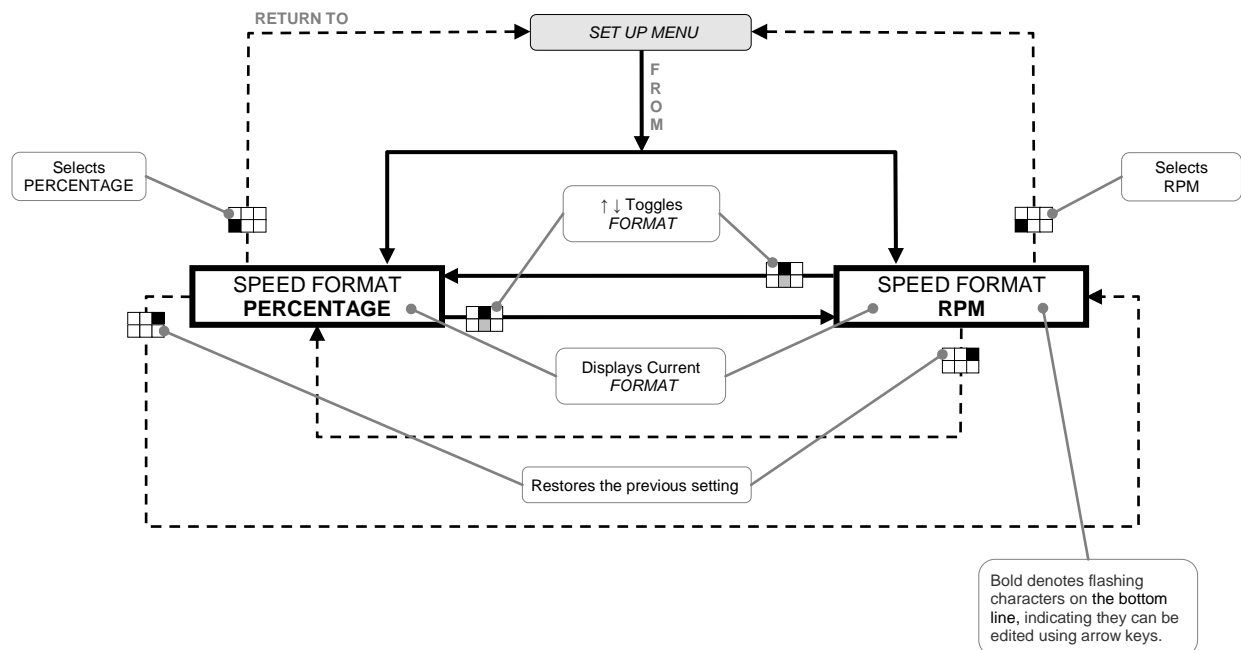
When a speed sensor is encountered during the DISPLAY UPDATE or CALIBRATE SPEED SENSORS item, the display will act as a tachometer showing rotational motion information.

7.13.1. REVOLUTIONS PER MINUTE, RPM

(abbreviated rpm, RPM, r/min, is a unit of frequency, commonly used to measure rotational speed, in particular in the case of rotation around a fixed axis. It represents the number of full rotations something makes in one minute.

7.13.2. PERCENTAGE OF NORMAL OPERATING SPEED, %

Rotational speed (sometimes called speed of revolution) indicates how fast a pulley shaft is spinning rotation around a fixed axis. Rotational speed is typically measured in revolutions per minute (RPM or 1/min).



7.14. TIME FORMAT

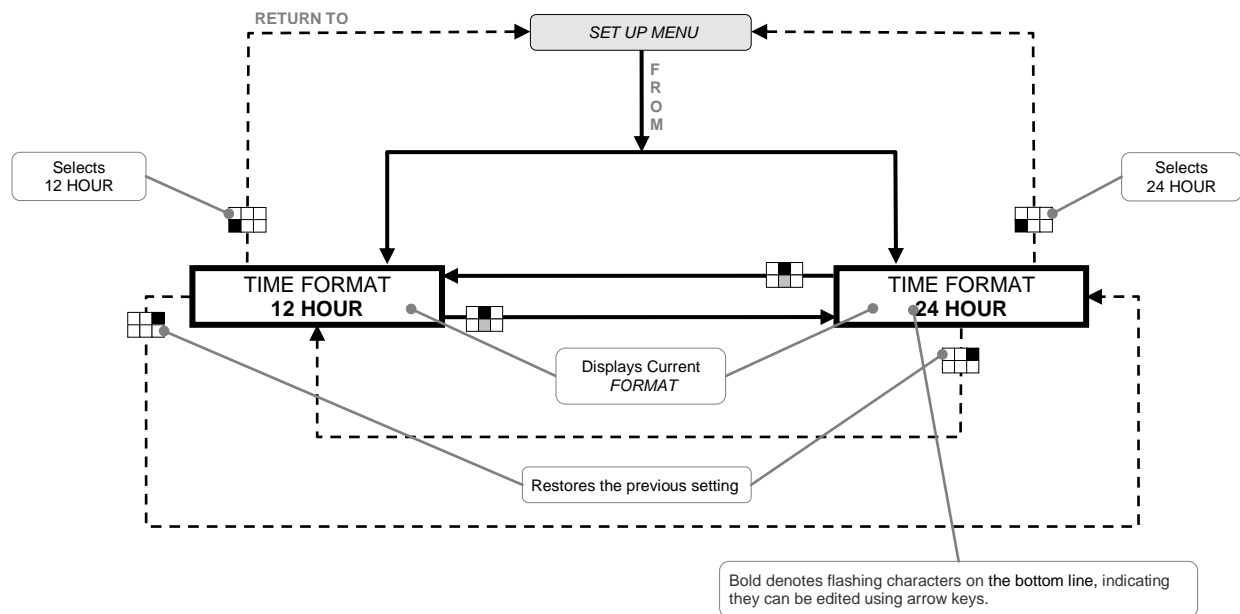
Two clock formats determine how time units will be displayed and printed. They are both offered to suit different elevator requirements: more oriented towards computers and automation, or staffed with personnel.

7.14.1. 24-HOUR

This clock (A.K.A. military time) is a convention of time-keeping that expresses time within a 24-hour range, from 0000 (midnight) to 2359 (one minute before the following midnight). This format eliminates ambiguity between two time periods and is preferred for round-the-clock, international operations and with computers.

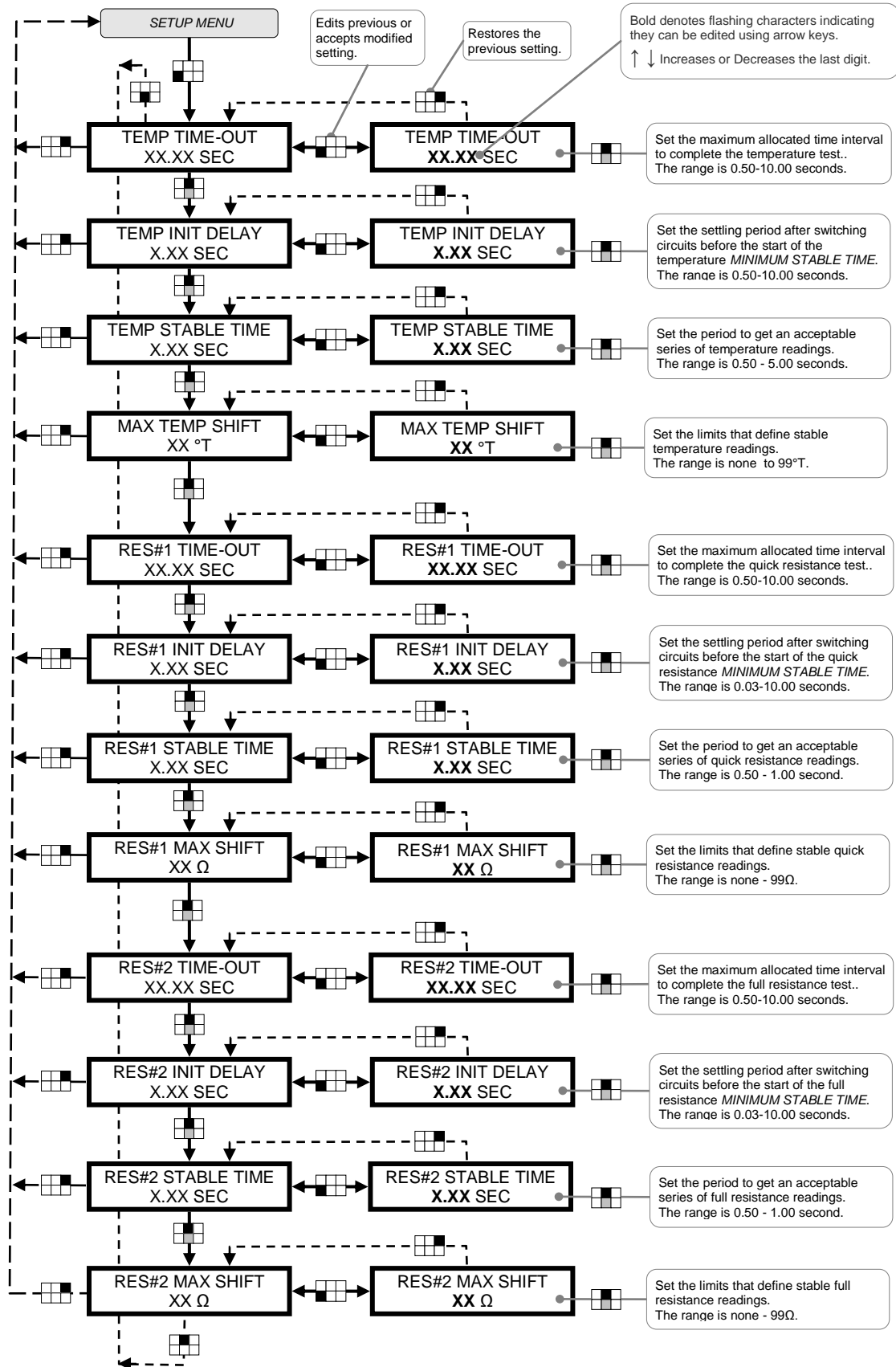
7.14.2. 12-HOUR

This timekeeping convention divides the 24 hours of the day into two periods. The am period runs from midnight to noon, while the pm period runs from noon to midnight. Time is expressed within a 12-hour range, returning to 1:00 after 12:59 AM or PM. This informal format is more conventional in US, Canada & Australia for analog clocks.



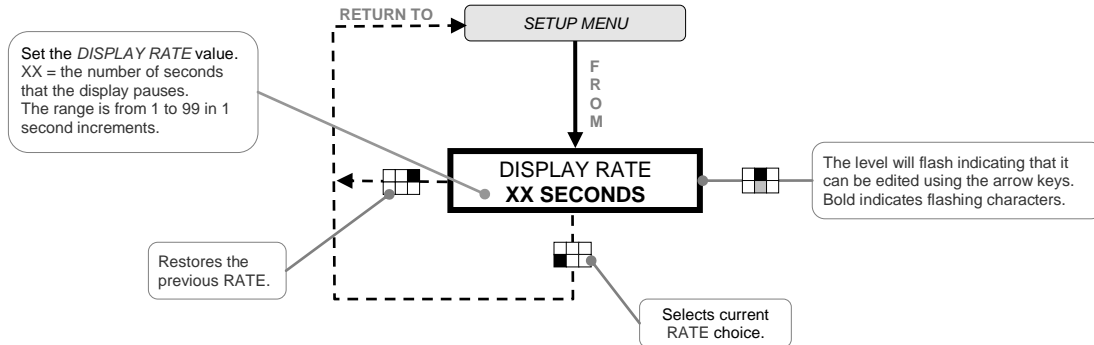
7.15. SET TC SCAN RATE

This function allows the operator to set software parameters that help the BTA conduct more reliable tests of the Thermocouple circuit. During measurement of a sensor's signal for temperature or resistance many readings per second are taken. They may not have identical values. From these just one value is determined as the result. They are set from the factory from values proven to work with most installations. See appendix F for details and examples.



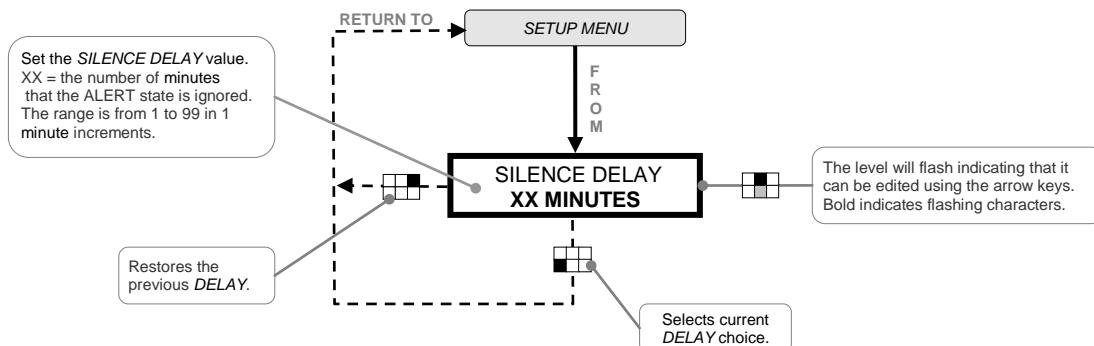
7.16. SET TC DISPLAY RATE

The TC DISPLAY RATE function allows the user to adjust the rate at which the instrument advances the DISPLAY UPDATE during SCAN SENSORS. This value determines how long the sensor and its reading will stay on the screen before moving on to the next. This only applicable if the item DISPLAY SCANNING SENSORS is set to SCANNING SENSORS SHOW.



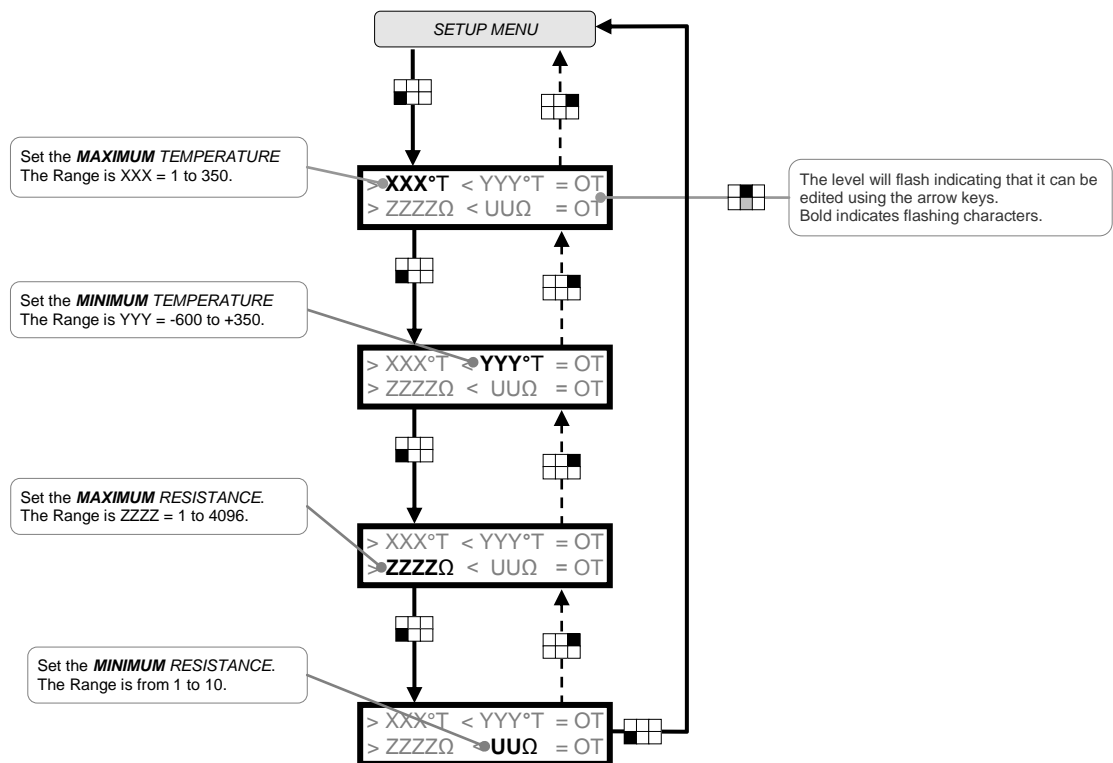
7.17. SET SILENCE DELAY

The SET SILENCE DELAY function allows the user to adjust the time a WARNING or ALARM ALERT state is ignored after pressing <SILENCE>. These ALERTS will return after the expiration of this delay.



7.18. MODIFY MAXIMUM TEMPERATURE AND RESISTANCE

The MAXIMUM TEMPERATURE AND RESISTANCE Menu allows the user to set limits for temperature and resistance values. Outside these limits, the sensor reading will display OT for Open Thermocouple. An OT reading may indicate a problem with the Thermocouple Circuit. The user sets the high and low threshold limits for temperature and resistance readings. If any of these limits are exceeded the ALERT is sounded. The user may be notified by a message on the screen, an audible alert, or by printed report. Exceeding a temperature maximum may indicate that there is a hot Bearing or Rub Block, indicating a belt out of alignment. Exceeding a resistance maximum may indicate that a thermocouple is damaged or misconnected.



7.19. SET WARNING ALARM DEFAULTS

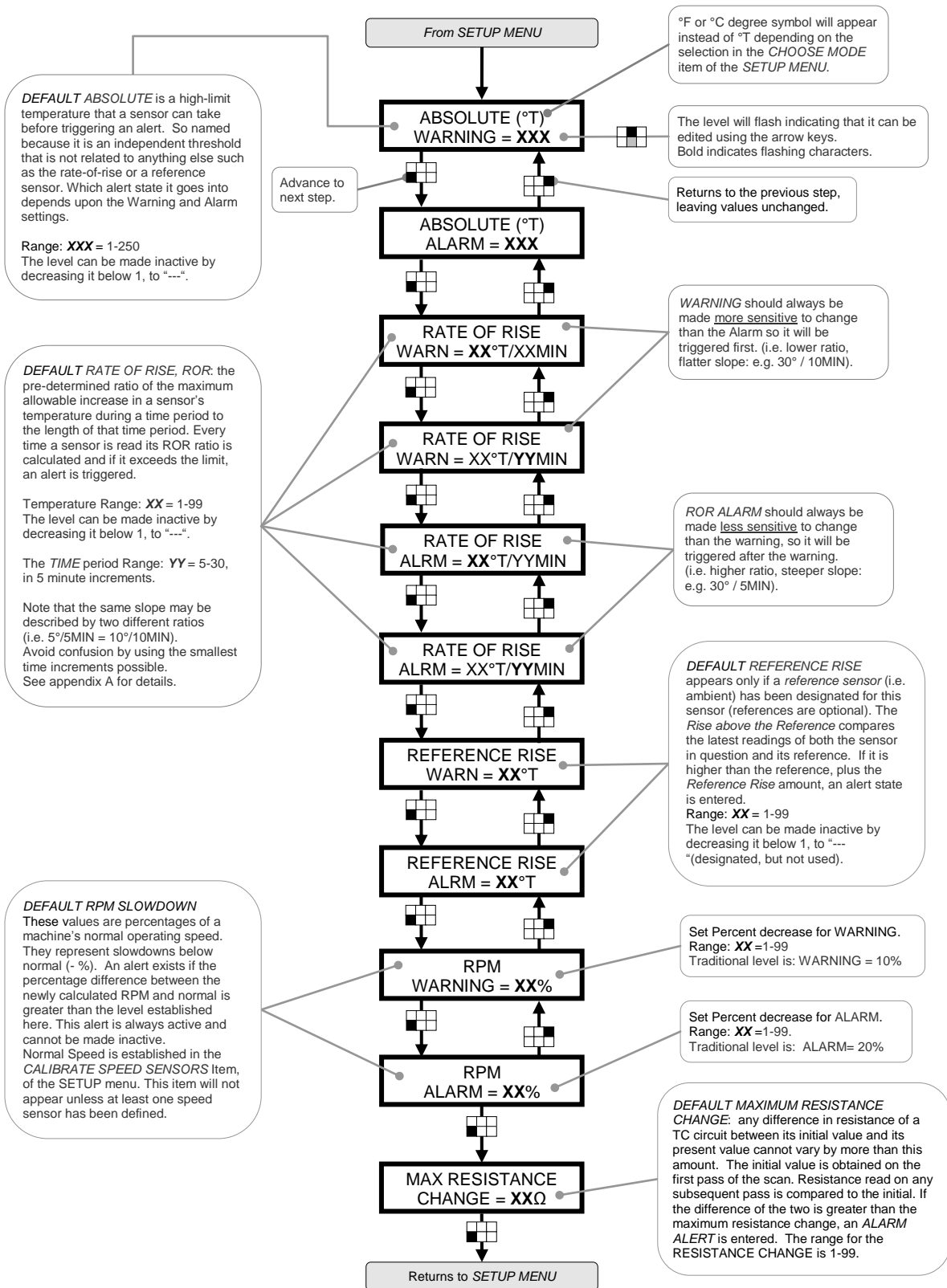
The user can set the starting values of warning and alarm alert levels for new sensors. Defaults are assumed when the user does not specify an alternative. These levels for temperature, time and percent change are traditionally safe starting positions.

7.19.1. WARNING

Is an advance notice, first-level threshold, which makes the operator aware of potential or probable dangerous or harmful situations.

7.19.2. ALARM

Is an immediate notice, highest-level threshold, which makes the operator aware that the dangerous situation previously warned about now exists. It is given so that action will be taken.



7.20. CHOOSE TEMPERATURE MODE (°F, °C)

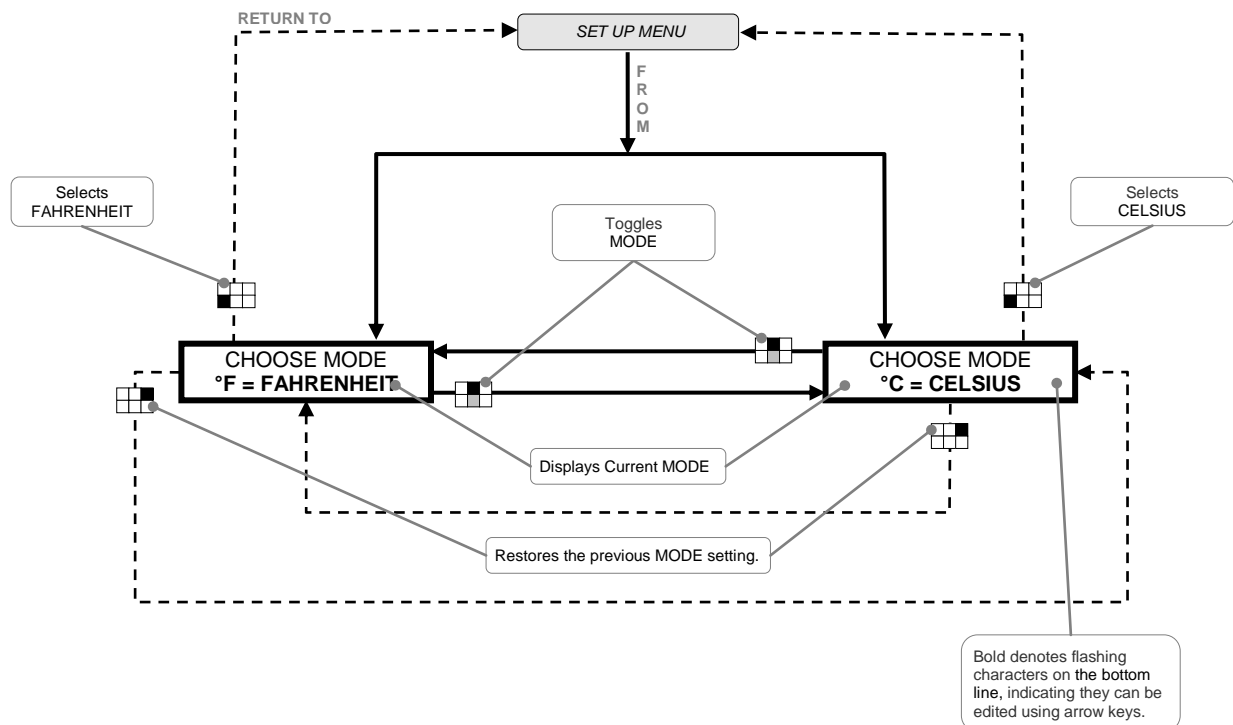
The Celsius and Fahrenheit scales are the only two temperature scales in everyday use. When selected, the user can specify which temperature scale is displayed, stored and printed. All other menu items affected by the temperature scale units will be automatically updated. If the temperature scale is changed after the facility configuration is defined, all affected values will be automatically changed with the equivalent value in the new scale. They are both offered to suit different elevator requirements.

7.20.1. CELSIUS scale, °C

This is the world's most commonly used temperature scale (Metric System) in which water freezes at 0°C and boils at 100°C under normal atmospheric conditions. This scale was phased-in by governments as part of the standardizing process of metrication. The term "Celsius" is usually preferred to "centigrade," especially in technical contexts.

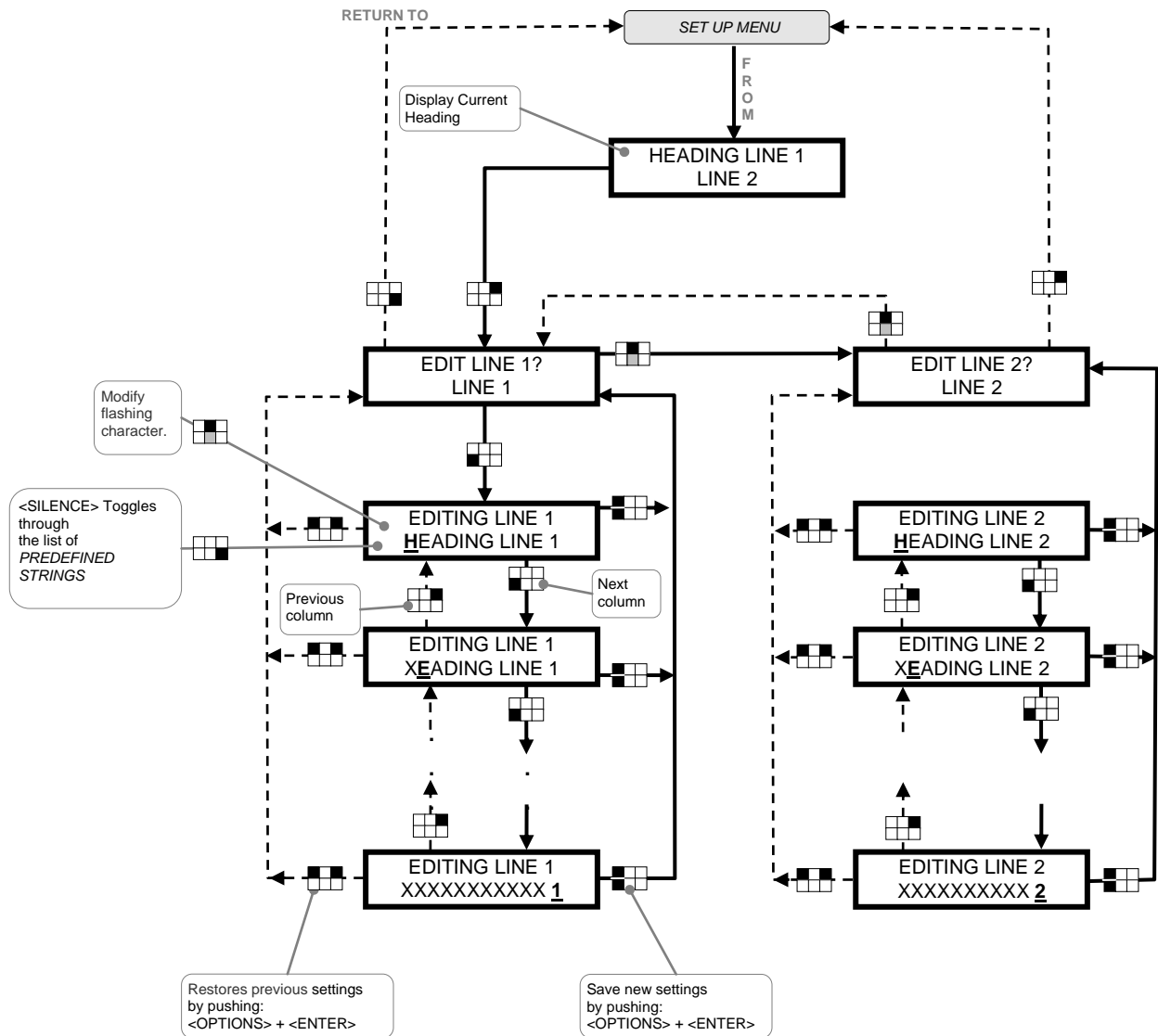
7.20.2. FAHRENHEIT scale, °F

Still widely used in the United States (U.S. Customary or Imperial Units) and a few other English-speaking countries, in this scale water freezes at 32°F and boils at 212°F under normal atmospheric conditions. It's popular because ambient air temperature tends not to go far beyond the range of 0 °F to 100 °F and can be expressed without resorting to fractional degrees.



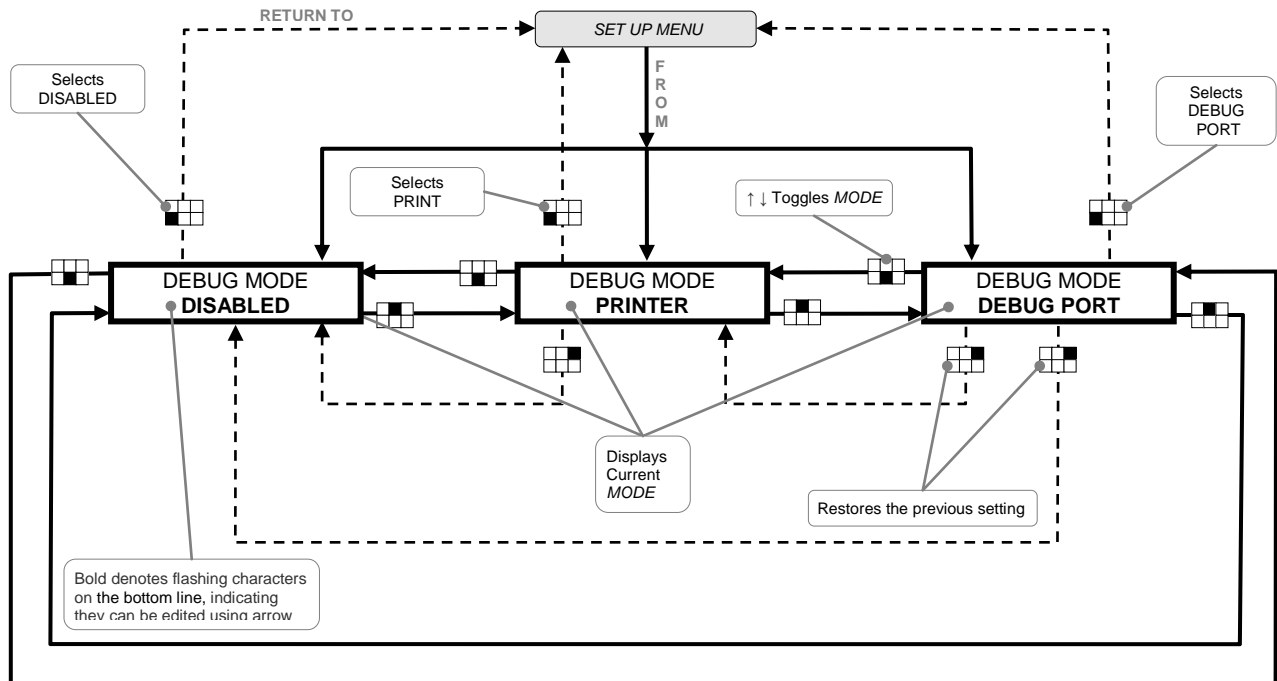
7.21. MODIFY HEADING

This function allows the operator to customize the OPENING SCREEN of the MAIN MENU. This is otherwise known as the HEADING, which has 2 lines each 16 characters in length. For general information on editing lines, also see section: EDIT STRING FUNCTION page 53.



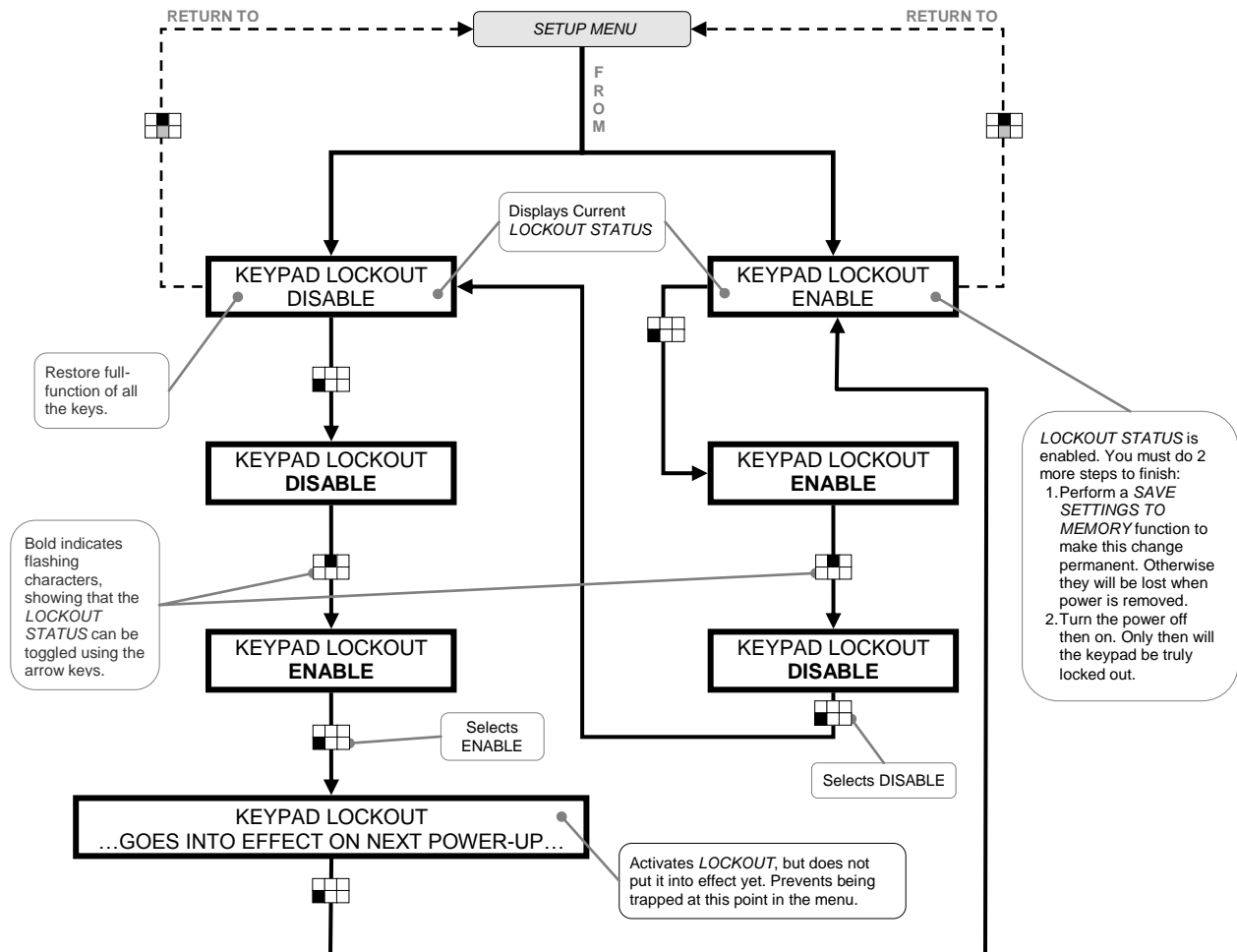
7.22. DEBUG MODE

Used for communicating with other peripheral devices when debugging software and troubleshooting hardware. Normally, this item should be set to "DISABLED". Additionally, PRINT and UPLOAD/DOWNLOAD functions will have difficulty if DEBUG MODE is set to PRINTER or DEBUG PORT. Normally this function is reserved for qualified service persons or as directed by Rolfes@Boone.



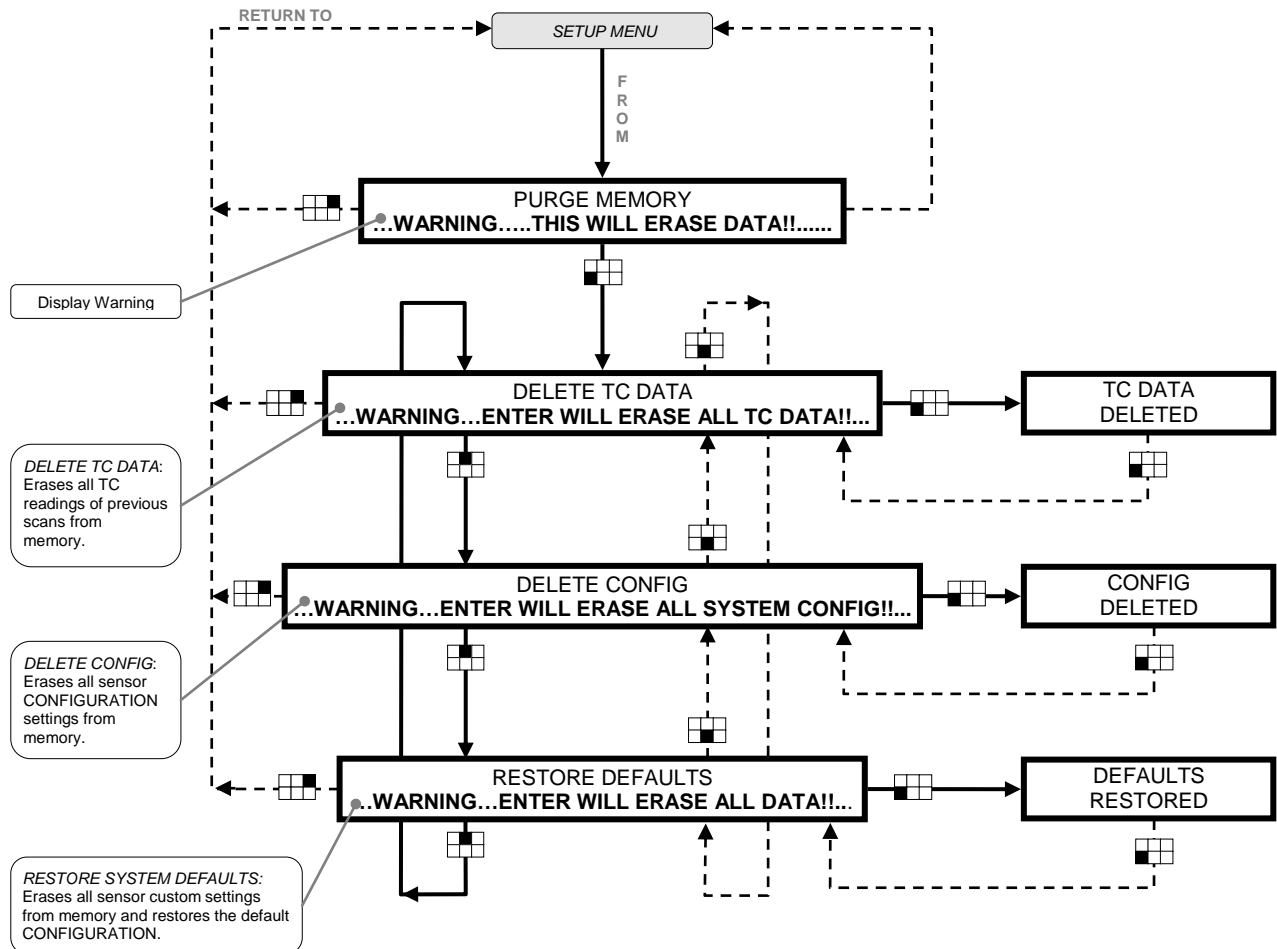
7.23. KEYPAD LOCKOUT

This feature is designed to prevent unauthorized personnel from tampering with the settings and operation of the monitor. Functions such as halting normal scanning and set-up parameters can be kept secure. Once this feature is enabled, all the keys, except for <ENTER> and <SILENCE> will be unresponsive, allowing limited operation by user. Changes to the settings will be impossible. Starting the scan and silencing an alert are then the only operations allowed. Permanent control of the KEYPAD LOCKOUT STATUS is only done in this menu item. The diagram below outlines the display screens and key strokes necessary to perform this. You will first see the status enabled or disabled in the SETUP MENU depending on the condition that it was last left in.



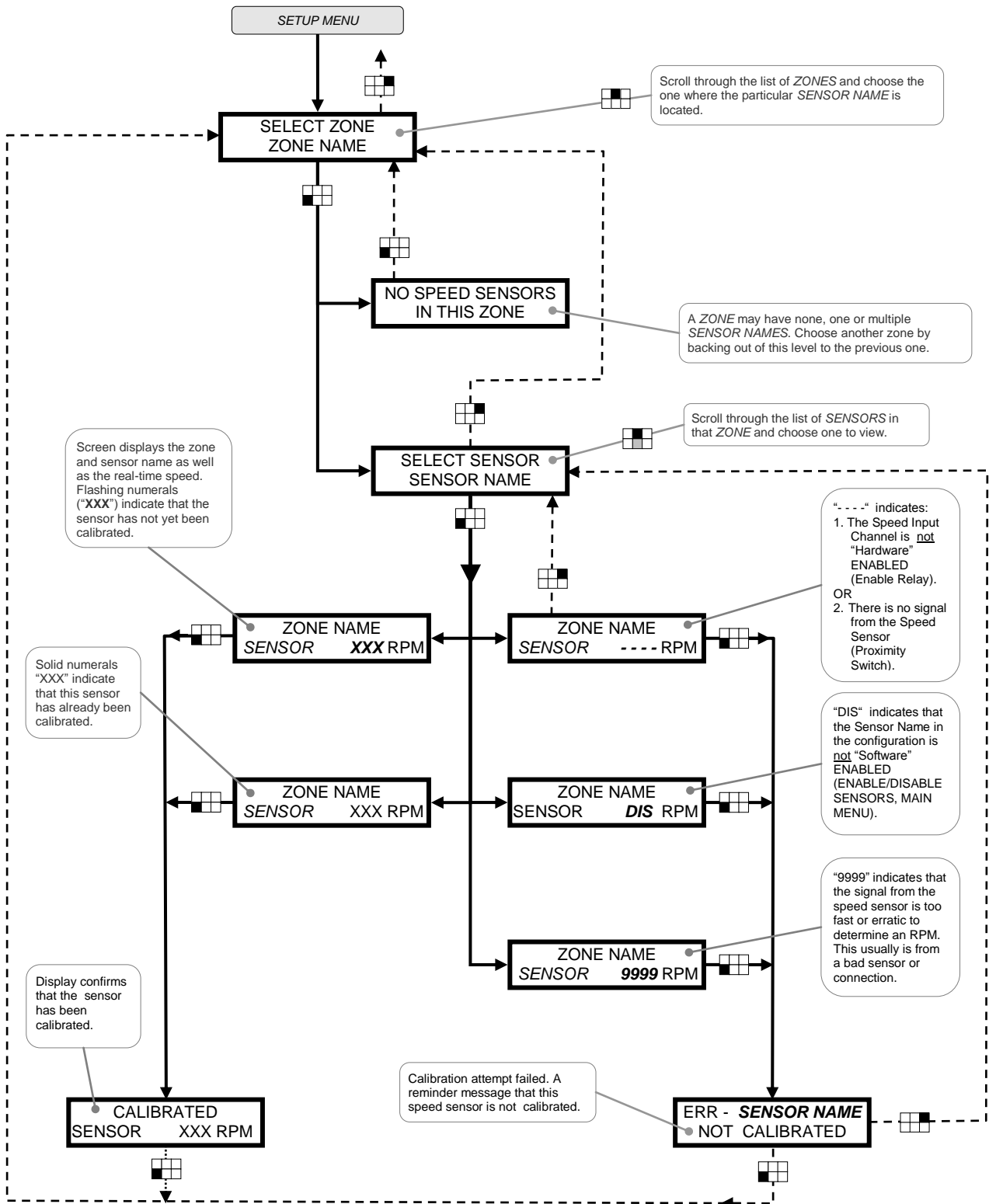
7.24. PURGE MEMORY

From this item you can Delete stored TC DATA from previous scans, remove the sensor CONFIGURATION settings, and restore the CONFIGURATION to default settings. Purge Memory functions will not take permanent effect until the SAVE SETTINGS TO MEMORY item has been run. If the SAVE has not been done, it is possible to get back anything purged in this operation by simply turning off and on power.



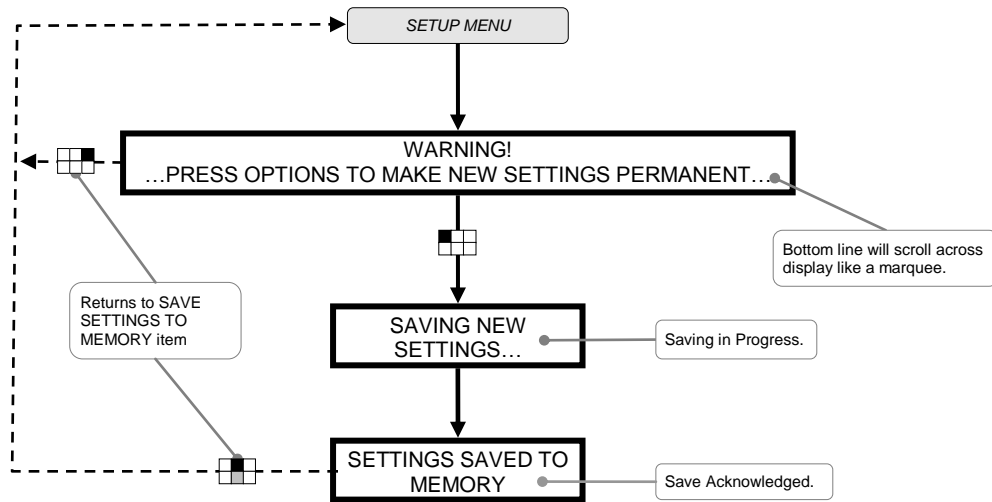
7.25. CALIBRATE SPEED SENSORS

This menu item establishes a NORMAL OPERATING SPEED for each SPEED SENSOR NAME. It only appears in the setup menu when at least one speed sensor is added as part of the facility configuration. This operation must be completed before including speed sensors as part of the SCAN SENSORS function. From this value, the WARNING and ALARM slow down values are calculated as percent decrease below the NORMAL OPERATING SPEED. See also Appendix A, SENSORS BACKGROUND PROCESSING.



7.26. SAVE SETTINGS TO MEMORY

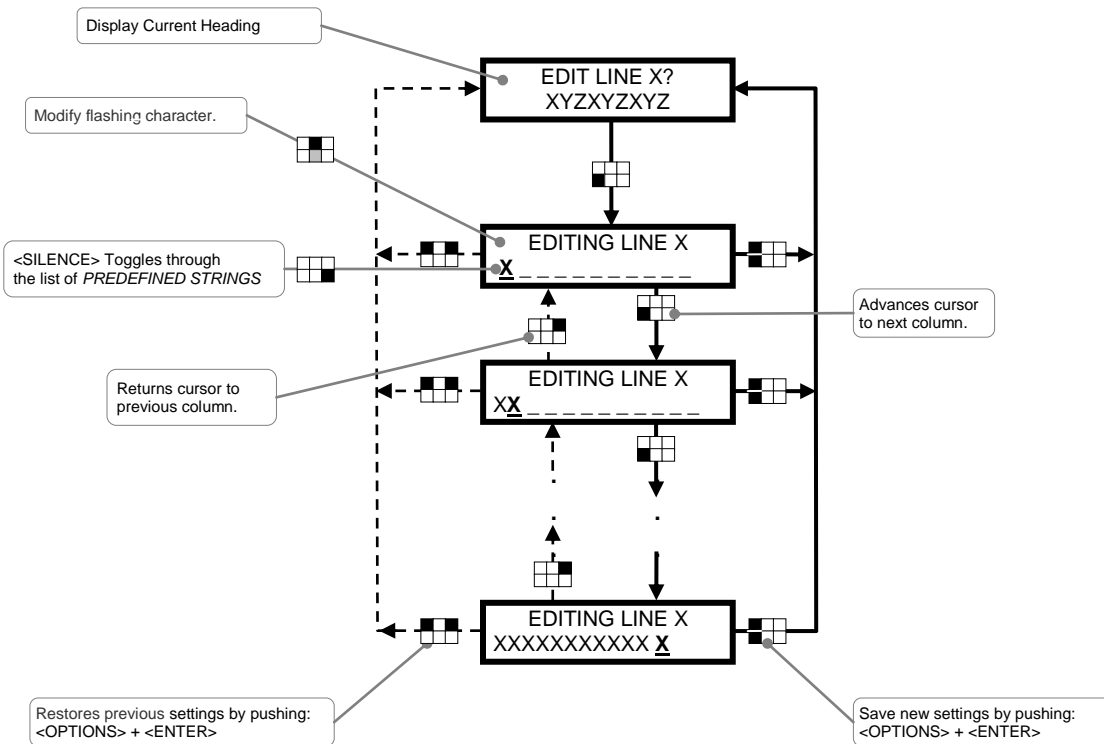
This function takes the setting changes made in the other menu items and makes them permanent in memory. If they are not set permanently to memory then they will be lost when line power is removed (or power switch turned off). Any changes will not take permanent effect until the SAVE SETTINGS TO MEMORY item has been run. If the SAVE SETTINGS TO MEMORY item has not been run, it is possible to return to any previously permanent settings by simply turning the power off and on.



7.27. EDIT STRING FUNCTION

A “string” is a variable made up of characters. An example of a string would be the Facility Name. The strings in a BTA are limited to the size of the DISPLAY, for a maximum length of 32 characters.

The function to edit a string is the same throughout the system, whether the string in question is a HEADING LINE, or a FACILITY NAME, or a SENSOR NAME. The same key combination holds throughout.



PREDEFINED STRINGS are time saving aides in the process of adding or editing a name. They are words and abbreviations that are common an often repeated are stored in memory for easy entry by pressing the **<SILENCE>** key.

The List of includes the following:

AMBIENT	AMB	ANNEX
AUGER	BEARING	BRG
BELT	BOOT	CONCRETE
CONC	CONVEYOR	CONV
DRAG	EAST	ELEVATOR
ELEV	GALLERY	GAL
HEAD	IDLER	LEG
MOTOR	MTR	NORTH
PIT	RUB	SOUTH
SPEED	STEEL	STL
TAIL	TANK	WEST

APPENDIX A. SENSOR BACKGROUND PROCESSING

The system will initiate a BACKGROUND PROCESS, which gathers information and makes decisions to determine if a sensor is out of Specification. It is unseen except when a WARNING or ALARM alert status is encountered. It proceeds at a rate unrelated (usually faster) to the FOREGROUND PROCESSING seen on the display.

The BACKGROUND PROCESS is different for Temperature and Speed sensors .

FOR TEMPERATURE SENSORS

It will continuously cycle through the list of TEMPERATURE SENSORS gathering information in the quickest manner. Temperature information is continually scanned, meaning that the BTA is not connected to all the sensors at once. This is done by reading 8 thermocouples at a time from the same Auxiliary Switch and proceeding to the next Switch. There can be a maximum of 32 Switches. The process for each scan is as follows:

STEP #1. CHECK THE CONTINUITY OF THE THERMOCOUPLE CIRCUIT

This step evaluates the integrity of the system before temperature readings are taken. If this is the initial scan for the facility, the initial resistance of the thermocouple circuit will be read with a more comprehensive resistance check called RES #2. Otherwise, do a quick resistance check called RES #1. A check for Open Thermocouple, OT will be done by comparing it against the MAXIMUM RESISTANCE. If this check is passed, then it will compare the resistance of the thermocouple circuit during this scan to the initial resistance and the difference is compared to the MAXIMUM ALLOWABLE RESISTANCE CHANGE.

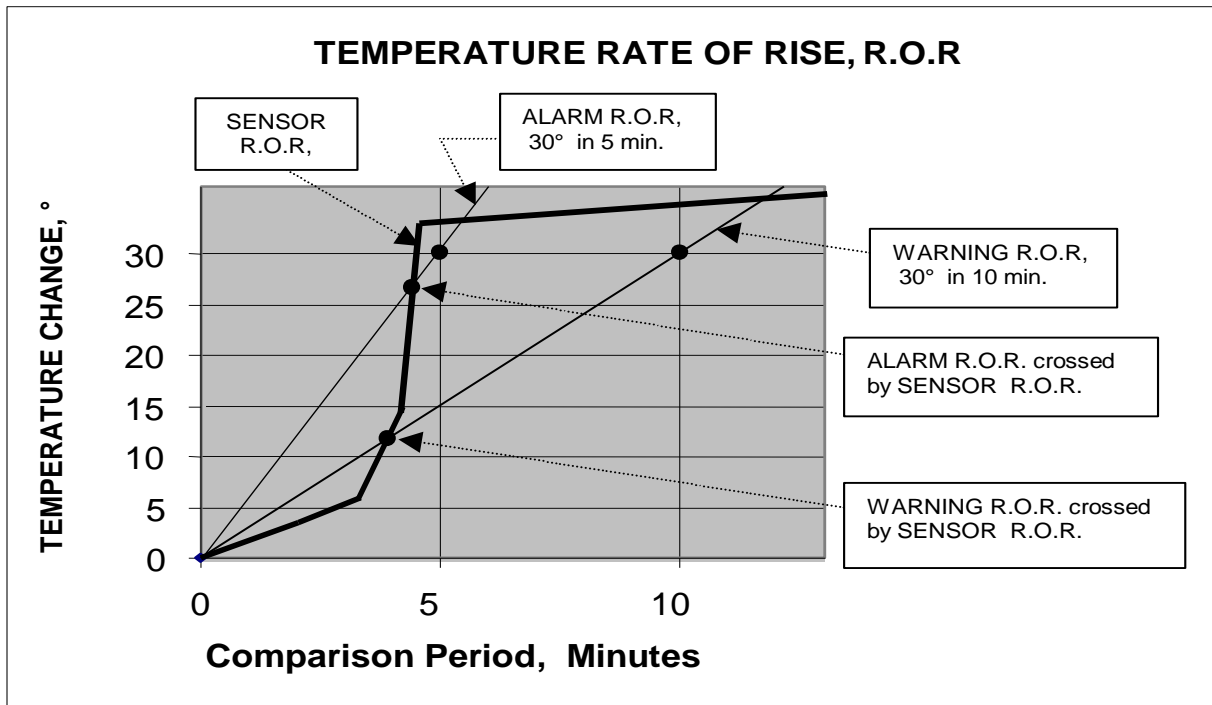
STEP #2. READ THE TEMPERATURE SENSOR

The current temperature sensor is read. The Thermocouple voltage is amplified and its value is converted to a digital form before being sent to the Microprocessor.

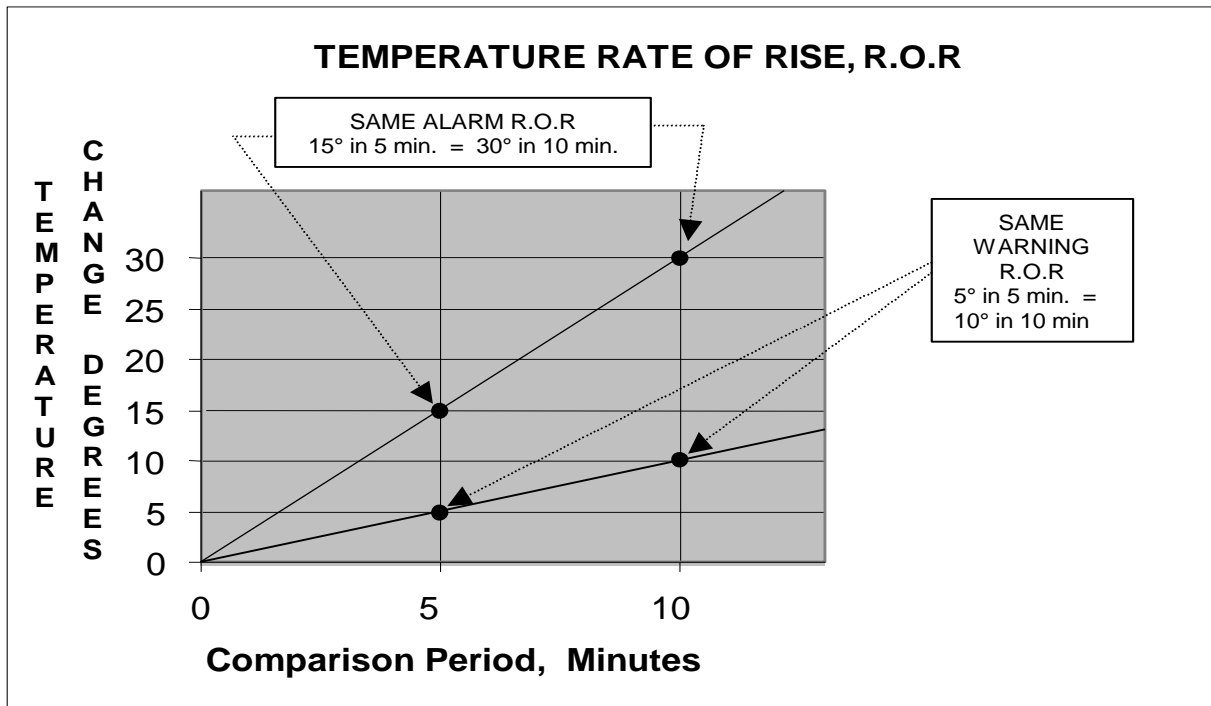
STEP #3. COMPUTE STATISTICS

The following information will be calculated for the sensors using the most recent readings.

- ◆ Average temperature for the scan.
- ◆ High temperature for the scan.
- ◆ Temperature Rate of Rise
(temperature change in a comparison period, see below)
- ◆ Reference Rise (high above the compared sensor).



The figure above describes the Temperature Rate of Rise of an example sensor and how the Warning & Alarm for Rate of Rise can be exceeded. If the plot of the sensor temperature crosses the lines of the Warning or Alarm slopes, the Background Processing will acknowledge that an Alert status now exists. This is because the Rate of Rise was exceeded in a given period of comparison. The period of comparison is always repeating. Note that the Alarm Rate of Rise is always steeper than the Warning.



The figure above describes the Slope of the Rate of Rise settings. Note that the same slope may be described by two different Rate of Rise settings. To keep things clear, use the smallest increment of time whenever possible in the setting. Note also that the Alarm Rate of Rise is always steeper than the Warning.

STEP #4. CHECK FOR ALARM STATUS

The system will use the calculations from Step #3 to determine if the sensor is in an alarm status. An alarm status exists if the newly calculated values exceed the preset alarm levels for any of the following:

- ◆ Absolute Temperature.
 - ◆ Rate of Rise (degrees / minutes).
 - ◆ The Rise above Reference Sensor. The REFERENCE is a source of temperature, which the program looks to for comparison. Latest readings of both are checked.
- A separate detached sensor devoted to measure air temperature can be designated as ambient. Rise above ambient is another check on conditions and can minimize premature alarms.

A violation of any one of these will cause the interruption of FOREGROUND PROCESSING.

STEP #5. CHECK FOR A WARNING STATUS

The system will determine if the sensor is in a warning status. A warning status is present if the newly calculated values exceed the warning levels for absolute temperature, rate of rise and or reference rise. A violation of any one of these will cause the interruption of FOREGROUND PROCESSING.

STEP #6. STORE READINGS FOR INCLUSION IN FOREGROUND PROCESSING

The Temperature and Resistance Readings are then stored to memory for inclusion in the DISPLAY UPDATE as part of the FOREGROUND PROCESSING. Most recent values of readings are always displayed.

FOR SPEED SENSORS

Speed sensors are continuously monitored and not scanned, unlike Temperature Sensors. They are always connected and checked so that a slow down below Warning or Alarm levels will be caught the moment it happens.

STEP #1. CHECK ENABLE STATUS

Each Speed Sensor is given an Enable Status so that false alarms will not be read from equipment that is temporarily shut down (RPM=0). When electrical power is supplied to the motor driving that equipment, a relay is energized, thus changing the status from DISABLE to ENABLE.

STEP #2. CHECK THAT THE ACCELERATION TIMEOUT PERIOD HAS EXPIRED

During the startup of rotating equipment, the BTA will allow a RE-ENABLE DELAY, during which it will disregard information that it receives from the sensor. This gives the equipment time to reach normal operating speed before being monitored and thus preventing false alarms. This RE-ENABLE DELAY can be adjusted from 5 to 30 seconds. This is done in the EDIT SENSOR CONFIGURATION ITEM of the SETUP MENU.

STEP #3. READ THE SPEED SENSOR

The current speed sensor is read. The BTA will store the value in Rotations Per Minute (RPM).

STEP #4. CALCULATE DIFFERENCE BETWEEN CURRENT RPM READING AND THE REFERENCE RPM

A REFERENCE RPM value must first be established for each speed sensor (See the CALIBRATE SPEED SENSORS item of the SET UP MENU). From this REFERENCE RPM, the WARNING and ALARM slow down levels are calculated as the percent decrease below the REFERENCE RPM.

STEP #5. CHECK FOR AN ALARM STATUS

The system will use the calculations from Step #4 to determine if the sensor is in an ALARM status. An ALARM status exists if the percentage difference between the newly calculated RPM and the REFERENCE RPM value is greater than the ALARM level (traditionally 20%). ALARM levels are fully programmable from the keypad. (See MAIN MENU item SET ALARMS)

EXAMPLE: If a monitored shaft has a normal REFERENCE speed of 100 RPM and then is slowed down to 79 RPM then an ALARM status exists because the shaft speed has fallen below the 20% ALARM level.

STEP #6. CHECK FOR A WARNING STATUS

The system will determine if the sensor is in a WARNING status. A WARNING status exists if the percentage difference between the newly calculated RPM and the REFERENCE RPM value is greater than the WARNING level. (traditionally 10%) WARNING levels are programmable from the keypad. (See MAIN MENU item SET ALARMS).

EXAMPLE: If a monitored shaft has a Normal Reference Set speed of 100 RPM and then is slowed down to 89 RPM then a warning status exists because the shaft speed has fallen below the 10% warning level.

STEP #7. INCLUDE READINGS IN FOREGROUND PROCESSING

The Speed Readings are then included in the DISPLAY UPDATE as part of the FOREGROUND PROCESSING. Real-time values of readings are always displayed

APPENDIX B. SENSOR FOREGROUND PROCESSING

Information is displayed by zones, progressing through the list of sensors in that zone. This is often the most logical manner for the user to organize the facility even though data is gathered differently in the Background Processing. The system will perform the following steps:

STEP 1. DISPLAY SENSORS IN WARNING AND ALARM STATUS

If there are no sensors in WARNING or ALARM, the system will advance to Step #3. Otherwise, the system will begin displaying each sensor currently in a warning or alarm status. The temperature or speed will flash on the display. The system will also activate the corresponding relay contacts to start external alert devices.

NORTH LEG
E TAIL BRG **165F**

NORTH LEG
BELT SPD **54RPM**

Display Examples

SILENCE



Acknowledges the current *WARNING* or *ALARM* status and advances to Step #2.

The user must press the SILENCE button to acknowledge each of the sensors in WARNING or ALARM. After a sensor is acknowledged it will no longer be displayed as in WARNING or ALARM. That sensor will be included in the background scan, but its WARNING and ALARM status will be ignored until the SILENCE DELAY has passed. (This delay is in minutes and can be changed through the SET SILENCE DELAY item of the SETUP MENU)

To prevent the sensor from reentering the warning or alarm status, the operator has several options.

- (a.) Disable the sensor from the MAIN MENU item: ENABLE/DISABLE SENSORS.
- (b.) Reset the sensors warning value from the MAIN MENU item: SET ALARMS.
- (c.) Cancel the SCAN SENSORS function, this is not advised because it leaves the facility without hazard monitoring protection.
- (d.) Correct the problem.

Each of these options, (a.), (b.), (c.), are temporary measures only, and should never be used without first checking to be sure that no actual, potentially dangerous conditions exist. If a dangerous status does exit, then immediate steps should be taken to correct the problem before returning the offending equipment to service.

It is possible that a sensor will drop out of a warning or alarm status on it's own on the next scan through. In that event, an acknowledgement by the user is not required.

STEP #2. ACKNOWLEDGEMENT

After the user has pressed [SILENCE] for the currently displayed sensor, he has the opportunity to PAUSE DISPLAY UPDATE and view the sensor's settings by pressing [ENTER]. If the user does not press a key within the time defined by the setting from the Setup Menu item SET TC DISPLAY RATE, the system will return to Step #1.

E TAIL BRG
SILENCED

Display Example

CLEAR



Halts the scanning operation, and exits the *Sensor Algorithm*.

ENTER



PAUSES DISPLAY UPDATE to VIEW SENSOR readings and settings.

STEP #3. UPDATE DISPLAY

If none of the sensors are in a WARNING or ALARM status, or if those statuses have been acknowledged, the system will cycle through each of the ZONES in the facility, sensors by sensor, displaying their most recent values. The rate at which these sensors and their values are displayed is based on the TC DISPLAY RATE setting in the SETUP MENU.

NORTH LEG
E TAIL BRG 104F

Display Example

If the user presses [ENTER], the system pauses the DISPLAY UPDATE (see Main Menu SCAN SENSORS, page 10).

<u>ENTER</u>

Advances to the *VIEW SELECTED SENSORS* function.

<u>CLEAR</u>

Halts the scanning function and *BACKGROUND PROCESSING*.**STEP #4. PRINT SCAN LOG**

If the Setup Menu item SYSTEM TYPE is set to BTA W/PRINTER, and the item PRINT AUTOMATIC SCAN LOG is set to ON, when the background SCAN SENSORS process has encountered a sensor in a warning or alarm status, a print-out of the offending sensor will be generated in the scan log. Upon SILENCING that alarming sensor, an acknowledgement of that action will also print on the same log.

APPENDIX C. PRINT REPORT EXAMPLES

CONDENSED SENSOR REPORT EXAMPLE 80 Characters per Line. (not full scale)

Boone Cable Works & Electronics, Inc.
Hazard Warning System YOUR FACILITY YOUR LOCATION

Scan Started 3/5/00 – 8:05 AM

Zone	Sensor	Date	RPM/ Last Tmp	Avg Tmp	Hi Tmp	Abs Wrn	Abs Alm	ROR Wrn	ROR Alm	Rf Wn	Rf Al	En Ds
EAST LEG E BELT	S DRIVE BRG	03/05/00	101	102	123	160	180	30/10	30/ 5	12	12	EN
RAIL UNLOAD CONV	BOTTM ALIGN	03/05/00	100	101	130	160	180	-----	-----	--	--	EN
EAST LEG N TRUNK	N TAIL BRG	03/05/00	100	101	132	160	180	30/10	30/ 5	17	17	EN

COMPLETE SENSOR REPORT EXAMPLE 132 Characters per Line. (not full scale)

(Adds Auxiliary & Thermocouple Numbers, Time, Reference Sensor, Reference Sensor Zone, Resistance, and Initial Resistance data to the *CONDENSED REPORT*)

Boone Cable Works & Electronics, Inc.
Hazard Warning System

YOUR FACILITY YOUR LOCATION

Scan Started 3/5/00 – 8:05 AM

Zone	Sensor	Aux TC	Date	Time	RPM/ Last Tmp	Avg Tmp	Hi Tmp	Abs Wrn	Abs Alm	ROR Wrn	ROR Alm	Reference Sensor	Ref Sensor Zone	Rf Wn	Rf Al	Res Res	En Init	Ds
EAST LEG E BELT	S DRIVE BRG	1-1	03/05/00	8:24A	101	102	123	160	180	30/10	30/ 5	AMBIENT	OUTSIDE	12	12	158	158	EN
RAIL UNLOAD CONV	BOTTM ALIGN	2-6	03/05/00	8:24A	100	101	130	160	180	-----	-----	AMBIENT	OUTSIDE	--	--	78	78	EN
EAST LEG N TRUNK	N TAIL BRG	5-2	03/05/00	8:24A	100	101	132	160	180	30/10	30/ 5	AMBIENT	OUTSIDE	17	17	298	298	EN

APPENDIX D. DETAILS ON LOADING SYSTEM CONFIGURATION

All the user's choices are handled by the System Configuration, which holds settings on how the BTA operates.

These settings are stored in the system memory.

The most important settings are:

- How many sensors there are.
- What to name them.
- How to organize them into Zones.
- How to call up a sensor to read it.
- When to consider a reading good.
- When to trigger an alert situation indicating a problem.

There are two ways to get this information into the BTA:

- **MENUS AND KEYPAD** Use the menus and the front keypad to manually enter in this information.
- **UPLOAD FROM PC** Use the custom utility program "Btaterm" (BTA Terminal) to upload a pre-defined configuration from a host PC to the BTA. Compared to creating a configuration using the keypad and menus, editing the file on a computer is much easier and quicker. Units from the factory are usually done this way.

THE CONFIGURATION FILE

The Configuration file is a text file which is exchanged between the BTA and the PC. It defines zones, sensor types and names, addresses, alarm settings, all other set up parameters affecting the operation of the BTA. See section 3 for details.

While Btaterm is intended for use by personnel of Boone Cable Works & Electronics, it can also be used by someone who understands how to use it. Improper use though can result in failure to load the configuration or causing the BTA to operate poorly.

SETUP

You will need to prepare the PC & BTA with the appropriate software, cabling, and port settings.

PC Certain files must be copied to your PC to make the upload/download operation work.

"term folder" you must create a new folder on your hard drive called "term" as seen in Figure 1. A typical path would be: "C:\term". Copy the 5 following files from the install disk to the term folder:

- **Btaterm.exe:** a custom utility program performs the exchange and shows you the status as you load.
- **COMMLOG.txt:** text file that logs the communication and progress of the load.
- **RCVCFG.txt:** Btaterm places the configuration here when it is received (downloaded) from the BTA. It will be overwritten whenever Btaterm runs.
- **sendcfg.txt:** Btaterm looks here for the configuration file that is ready to be sent to the BTA (uploaded).
- **FACILITY TEMPLATE** Has been included as a convenient aid to quickly customize a configuration. It is a full configuration having every type and number of sensor identified by generic zone and sensor names. It is easier to delete or overwrite the generic names with the ones you want. Use the cut and paste features if there is a lot of duplication. A Word document of this template is also included because of the greater word processing capabilities of MS Word over Notepad or Wordpad. keep in mind that you must save it as a text document in sendcfg.txt when you are ready to upload it.

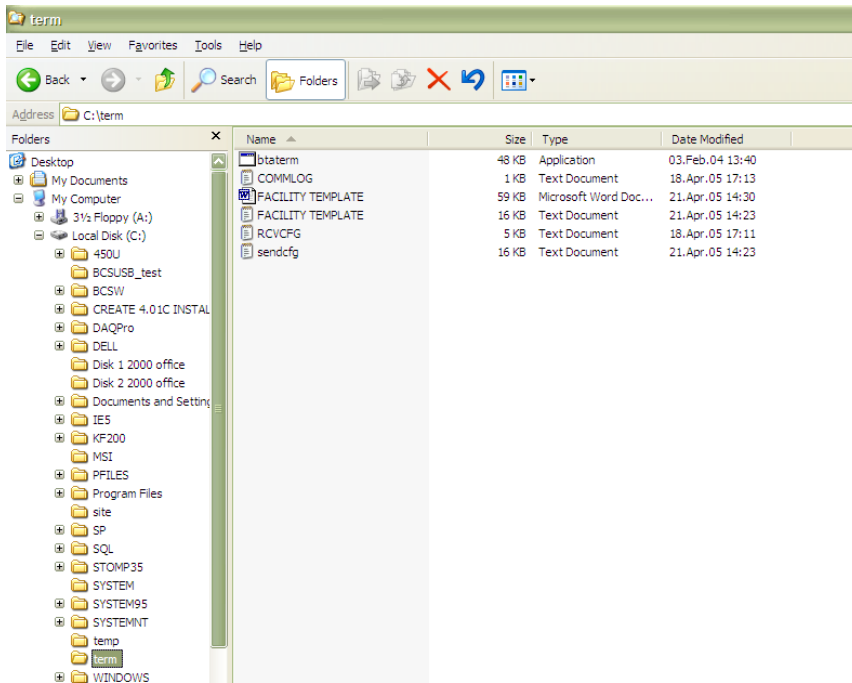


Figure 3. Set Up Of Term Folder

SERIAL PORT SETTINGS Com Port 1 must have these hardware settings.

check or change settings by using the following sequence of commands:

Start → Control Panel → System → System Properties → Hardware → Device Manager → Ports → Communications Port (COM 1) → Properties → Port Settings

Baud Rate bits per second= 38400 (as seen in Figure 2.) Serial communications data transmission rate

Data Bits = 8

(The number of bits in a word.)

Parity= None

(None means that this will disable error checking.)

Stop Bits = 1

(Changes the time between each character being

transmitted.)

Flow control = None

(Changes how the flow of data is controlled.)

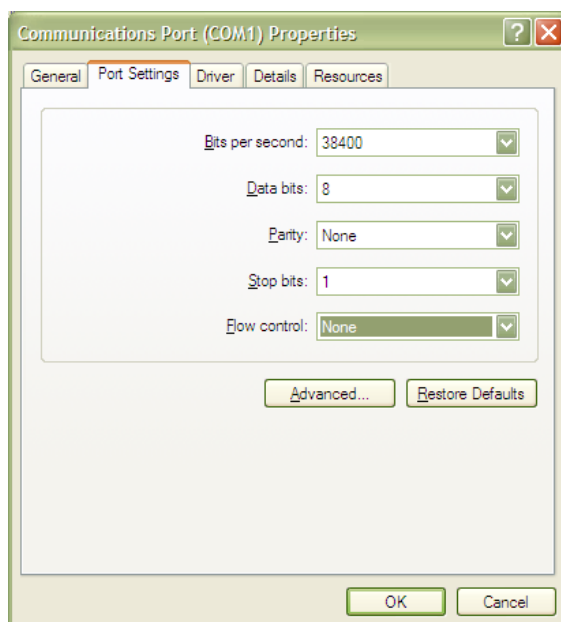


Figure 4. PC Communications Port Settings

INPUT / OUTPUT PORT CONNECTIONS

Make connections of the cables and ports. See Figure 3.

RS-232 PORT; RS-232 is the most common serial communications interface standard for short distances (up to 50 feet). This port is located on the CPU Board (bottom board as seen in Figure 5.) of the BTA instrument identified by the markings "P30" as a 10-pin dual-row male header connector. If the BTA is not already equipped with a 9-pin D-Subminiature Ribbon Cable (as described in 2.2.1.2.) you will have to turn power off to the BTA unit and separate the top board and bottom boards (see Figure 4.) and attach the cable.

TRANSITION RIBBON CABLE; Used as a transition between the null modem cable and the RS-232 port on the board. It has 9-pin D-Subminiature appropriate connectors on each end. Slide the female rectangular socket connector over "P30" with the ribbon cable coming out away from the bottom of the CPU board.

SHUNT CONNECTOR; Usually installed at the factory this blue or black Shunt Connector must be installed on the 2 Pin Male Header Connector identified by the markings "JP2", also located on the CPU Board just above the RS-232 port.

NULL MODEM CROSS-OVER CABLE; This 6 foot molded cable has a 9-pin D-Subminiature Female connector on each end. It must be used instead of a standard serial cable because both the BTA and PC are of the classification Data Terminal Equipment (DTE). The null modem cable connects the transmitter output of one DTE to the receiver input of the other and vice versa.

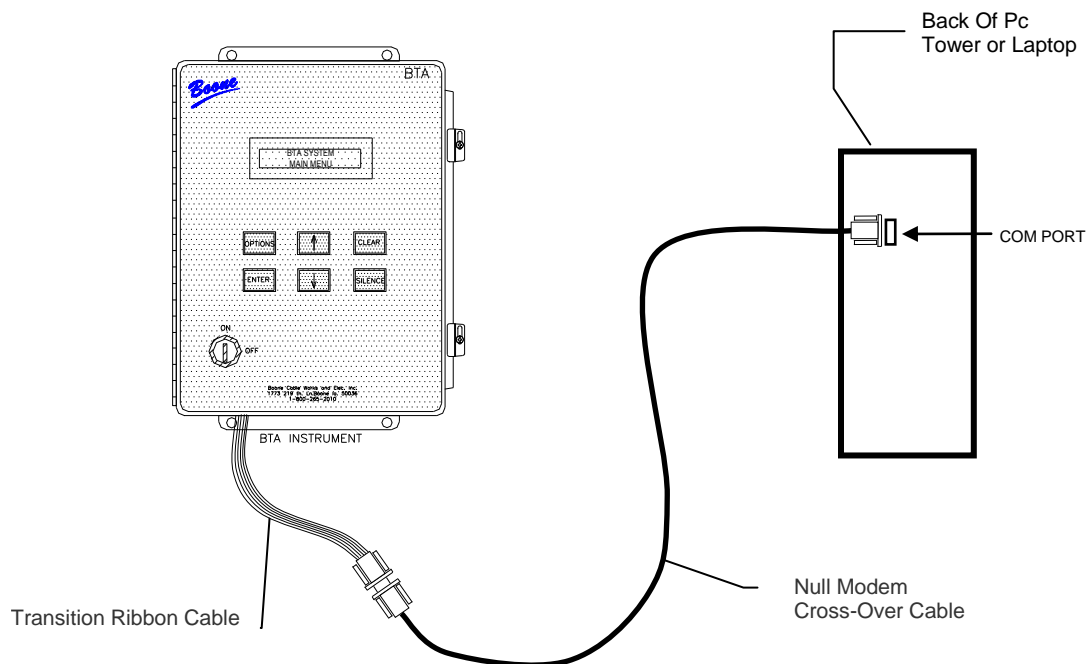


Figure 3. Cable Connections

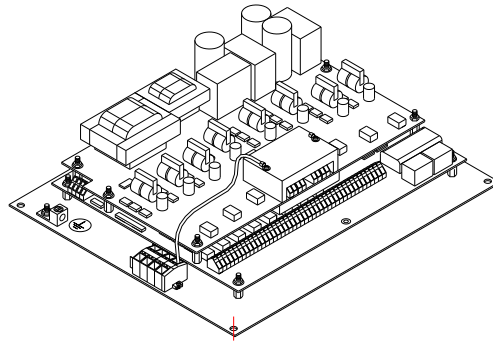


Figure 4. Circuit Boards inside the Instrument.

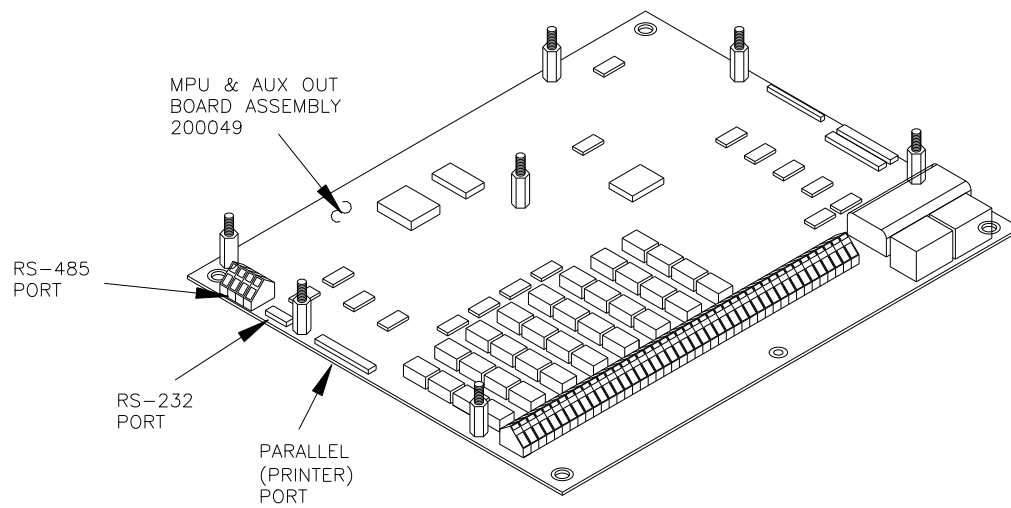


Figure 5. Serial & Parallel Ports on the CPU Board

PREPARING THE CONFIGURATION FILE

The Configuration file is a text file which is exchanged between the BTA and the PC. It defines zones, sensor types and names, addresses, alarm settings, all other set up parameters affecting the operation of the BTA.

Example Configuration File

The following configuration, as seen in Figure 6, contains 16 temperature sensors, and one motion sensor. The temperature sensors come into the BTA instrument on 2 Auxiliary Switches using all 8 TC positions. They are organized into 2 zones. The only motion sensor (257) input is part of zone 1.

```
SERIAL NUM=BTA0004211
FACILITY=ROLFES@BOONE,BOONE IOWA
ZONE=1,GALLERY BELT
ZONE=2,RECLAIM BELT
TEMP=1,1,W HEAD BRG,EN,-1, 85F,10F,10,10F, 90F,10F,5,20F
TEMP=2,1,W HEAD RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=3,1,E HEAD BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=4,1,E HEAD RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=5,1,W TAIL BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=6,1,W TAIL RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=7,1,E TAIL BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=8,1,E TAIL RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=9,2,W HEAD BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=10,2,W HEAD RUB,EN,-1,90F,30F,10,10F,110F,30F,5,20F
TEMP=11,2,E HEAD BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=12,2,E HEAD RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=13,2,W TAIL BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=14,2,W TAIL RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=15,2,E TAIL BRG,EN,-1,160F,30F,10,10F,180F,30F,5,20F
TEMP=16,2,E TAIL RUB,EN,-1,160F,30F,10,10F,180F,30F,5,20F
SPEED=257,1,SPEED,EN,10%,20%,TO,1,5
PRINTER=ENABLE
PRINT MODE=COMPLETE
FF AFTER ZONES=DON'T FORM FEED
FF AFTER REPORT=DON'T FORM FEED
SERIAL MODE=DISABLED
SERIAL CONFIG=38400 N-8-1
SPEED FORMAT=RPM
TIME FORMAT=12 HOUR
AUTOMATIC START=ON
PRINT AUTO SCAN=OFF
SCANNING SENSORS=SHOW
WARNING TONE=CONTINUOUS
ALARM TONE=CONTINUOUS
TEMP MODE=FAHRENHEIT
DEBUG MODE=DISABLED
KEYPAD LOCKOUT=DISABLE
VERSION=3
SILENCE DELAY=1
DISPLAY RATE=1
MAX RESISTANCE=2500
MIN RESISTANCE=5
MAX RES CHANGE=10
MAX TEMP=250F
MIN TEMP=-30F
DEFAULT ALARMS=160F,10F,10,10F,180F,10F,5,20F,10%,20%
SCANNING PARAMS=3,500,50,10,3,500,50,10,100,500,75,11
HEADING=BTA SYSTEM,MAIN MENU
```

Figure 6. Example of a Small Configuration

LEGEND FOR CONFIGURATION FILES

The file has been broken up line by line to better show how to set up the parameters and what they mean. General comments are to the right of each line in brackets {}. Refer to the descriptive explanations below each line.

SERIAL NUM=BTA0504211 {10 total characters maximum}

XXXXAAZZQKK

XXX = model, BTA

AA = year of manufacture: {05=2005}

ZZ = month: {04=April}

QQ = day of month 21=21st

K = number of unit built that day

OR

SERIAL NUM=BTA FM 0103 {also 10 total characters maximum}

XXX VV NNNN {a new serial number sequence was started}

XXX = model, BTA {with the introduction of an FM Approved model}

VV = FM Approved unit

NNNN = Serial Number

FACILITY=ROLFES BOONE,BOONE IOWA {Often used for owner name and location}

-----B-----, -----C-----

B = top line of display {16 characters maximum}

C = bottom line {16 characters maximum}

ZONE=1, GALLERY BELT {Each zone name must be unique}

\$, -----£-----

\$ = zone № {1-99; A total of 99 zones is possible}

£ = zone name {16 characters maximum}

TEMP=1,1, W HEAD BRG ,EN,137, 85F,10F,10,10F,90F,10F,5,20F {temperature sensor format}

L,M,-----N-----,P , Q , R , S , T , U , V , W ,X, Y

L = sensor № {1-256, each № must be unique }

M = zone № {1-99}

N = temperature sensor name {11 characters maximum}

P = sensor disable/enable status {EN=enabled or DIS=disabled}

Q = this sensor's reference sensor {1-256, cannot be its own sensor №; "-1"=none selected}

R = absolute warning temperature {1-250°F; set to "---" to make the warning inactive}

S = rate of rise warning temperature {1-99°F; set to "--" to make the warning inactive}

T = rate of rise warning time {5-30 minutes in 5 minute increments}

U = reference rise warning temperature {1-99°F; set to "--" to make the warning inactive}

V = absolute alarm temperature {1-250°F; set to "---" to make the alarm inactive}

W = rate of rise alarm temperature {1-99°F; set to "--" to make the alarm inactive}

X = rate of rise alarm time {5-30 minutes in 5 minute increments}

Y = reference rise alarm temperature {1-99°F; set to "--" to make the alarm inactive}

SPEED=257,1,SPEED,EN,10%,20%, TO,1,5{speed sensor format}

G ,H,----J----, K , L , M , N ,P,Q

G = speed sensor № {257-264, each № must be unique }

H = zone № {1-99}

J = speed sensor name {8 characters maximum}

K = sensor disable/enable status {EN=enabled or DIS=disabled}

L = rpm warning, % {1-99; traditionally 10; must be lower than alarm}

M = rpm alarm, % {1-99; traditionally 20; must be higher than warning}

N = Time Out Designator {always "TO"}

P = Start-to-Move Time, seconds {1-30; must be lower than Acceleration Time Out}

Q = Acceleration Time Out, seconds {1-30; must be higher than Start-to-Move}

PRINTER=ENABLE {enable or disable}
 PRINT MODE=CONDENSED {condensed or complete}
 FF AFTER ZONES=DON'T FORM FEED {don't form feed or form feed}
 FF AFTER REPORT=FORM FEED {don't form feed or form feed}
 SERIAL MODE=DISABLED {enabled or disabled}
 SERIAL CONFIG=38400 N-8-1 {do not change}
 SPEED FORMAT=RPM {RPM or PERCENTAGE}
 TIME FORMAT=12 HOUR {12 or 24}
 AUTOMATIC START=OFF {on or off}
 PRINT AUTO SCAN=OFF {on or off}
 SCANNING SENSORS=SHOW {show, don't show}
 WARNING TONE=CONTINUOUS {continuous or 1- 30 sec. between}
 ALARM TONE=CONTINUOUS {continuous or 1- 30 sec. between}
 TEMP MODE=FAHRENHEIT {Fahrenheit, Celsius}
 DEBUG MODE=DISABLED {disabled, printer, debug port}
 KEYPAD LOCKOUT=DISABLE {enabled or disabled}
 VERSION=3 {must be 3, do not change}
 SILENCE DELAY=5 {minutes, variable 1- 99}
 DISPLAY RATE=1 {seconds, variable 1- 30}
 MAX RESISTANCE=2500 {Ohms, Ω , 1 to 4096}
 MIN RESISTANCE=5 {Ohms, Ω , 1 to 10}
 MAX RES CHANGE=10 {Ohms, Ω , 1 to 99}
 MAX TEMP=250F {degrees, variable 1 to +350}
 MIN TEMP=-60F {degrees, variable -600 to +350}

DEFAULT ALARMS=160F,10F,10,10F,180F,10F,5,20F,10%,20%

A , B , C , D , E , F , G , H , I , J

A = absolute Warning {surpassing this level will trigger warning alert}
 B = Warning rate of rise {degree increments used with time to set rate}
 C = rate of rise warning time {5 minute increments from 5 to 30}
 D = reference rise warning temperature {this much above reference will trigger warning alert}
 E = absolute alarm temperature {surpassing this level will trigger alarm alert}
 F = rate of rise alarm temperature {degree increments used with time value to set rate}
 G = rate of rise alarm time {5 minute increments from 5 to 30}
 H = reference rise alarm temperature {this much above reference will trigger alarm alert}
 I = rpm warning, % {percent below calibrated reference speed will trigger warning alert}
 J = rpm alarm, % {percent below calibrated reference speed will trigger alarm alert}

SCANNING PARAMS=200,1000,100,5,100,500,75,10,100,1000,75,22

Z , Y , X , W , V , U , T , S , R , Q , P , N

Z = Initial delay, Resistance test #2 {FULL}, {centi-seconds, 1/100, cs; 200cs=2.00s}
 Y = Time-Out, Resistance test #2 {FULL}, {1000cs=10.00s}
 X = Minimum Stable Time, Resistance test #2 {FULL}, {100cs=1.00s}
 W = Maximum Shift, Resistance test #2 {FULL}, {Ohms, Ω }
 V = Initial Delay, Resistance test #1 {QUICK}, {100cs=1.00s}
 U = Time-Out, Resistance test #1 {QUICK}, {500cs=5.00s}
 T = Minimum Stable Time, Resistance test #1 {QUICK}, {75cs=0.75s}
 S = Maximum Shift, Resistance test #1 {QUICK}, {Ohms, Ω }
 R = Initial Delay, Temperature test, centi-seconds {200cs=2.00s}
 Q = Time-Out, Temperature test, {500cs=5.00s}
 P = Minimum Stable Time, Temperature test, {75cs= 0.75s}
 N = Maximum Shift, Temperature test, A/D Clock Ticks, 11 ticks=2°F{1°C}

HEADING=BTA SYSTEM, MAIN MENU<ENTER>

B , D E

B = top line of display {16 characters maximum}
 D = bottom line of display {16 characters maximum}
 E = a hidden ENTER (<Carriage Return>) must finish the file so that the cursor moves to the next line.

SENSOR NUMBER CODE

Each sensor is identified in the configuration by a number from 1 to 264.

This number uniquely associates to a hardware "address" that the sensor is connected to.

For temperature sensors the hardware "address" is known as the Auxiliary (AUX) № and Thermocouple (TC) №. They must lie between 1 and 256.

Temperature Sensor Number = AUX : TC = $[8 \times (\text{AUX №} - 1)] + \text{TC №}$
 Example: 150 = 19 : 6 = $[8 \times (19 - 1)] + 6 = (8 \times 18) + 6 = 144 + 6$

1=1:1	41=6:1	81=11:1	121=16:1	161=21:1	201=26:1	241=31:1
2=1:2	42=6:2	82=11:2	122=16:2	162=21:2	202=26:2	242=31:2
3=1:3	43=6:3	83=11:3	123=16:3	163=21:3	203=26:3	243=31:3
4=1:4	44=6:4	84=11:4	124=16:4	164=21:4	204=26:4	244=31:4
5=1:5	45=6:5	85=11:5	125=16:5	165=21:5	205=26:5	245=31:5
6=1:6	46=6:6	86=11:6	126=16:6	166=21:6	206=26:6	246=31:6
7=1:7	47=6:7	87=11:7	127=16:7	167=21:7	207=26:7	247=31:7
8=1:8	48=6:8	88=11:8	128=16:8	168=21:8	208=26:8	248=31:8
9=2:1	49=7:1	89=12:1	129=17:1	169=22:1	209=27:1	249=32:1
10=2:2	50=7:2	90=12:2	130=17:2	170=22:2	210=27:2	250=32:2
11=2:3	51=7:3	91=12:3	131=17:3	171=22:3	211=27:3	251=32:3
12=2:4	52=7:4	92=12:4	132=17:4	172=22:4	212=27:4	252=32:4
13=2:5	53=7:5	93=12:5	133=17:5	173=22:5	213=27:5	253=32:5
14=2:6	54=7:6	94=12:6	134=17:6	174=22:6	214=27:6	254=32:6
15=2:7	55=7:7	95=12:7	135=17:7	175=22:7	215=27:7	255=32:7
16=2:8	56=7:8	96=12:8	136=17:8	176=22:8	216=27:8	256=32:8
17=3:1	57=8:1	97=13:1	137=18:1	177=23:1	217=28:1	
18=3:2	58=8:2	98=13:2	138=18:2	178=23:2	218=28:2	
19=3:3	59=8:3	99=13:3	139=18:3	179=23:3	219=28:3	
20=3:4	60=8:4	100=13:4	140=18:4	180=23:4	220=28:4	
21=3:5	61=8:5	101=13:5	141=18:5	181=23:5	221=28:5	
22=3:6	62=8:6	102=13:6	142=18:6	182=23:6	222=28:6	
23=3:7	63=8:7	103=13:7	143=18:7	183=23:7	223=28:7	
24=3:8	64=8:8	104=13:8	144=18:8	184=23:8	224=28:8	
25=4:1	65=9:1	105=14:1	145=19:1	185=24:1	225=29:1	
26=4:2	66=9:2	106=14:2	146=19:2	186=24:2	226=29:2	
27=4:3	67=9:3	107=14:3	147=19:3	187=24:3	227=29:3	
28=4:4	68=9:4	108=14:4	148=19:4	188=24:4	228=29:4	
29=4:5	69=9:5	109=14:5	149=19:5	189=24:5	229=29:5	
30=4:6	70=9:6	110=14:6	150=19:6	190=24:6	230=29:6	
31=4:7	71=9:7	111=14:7	151=19:7	191=24:7	231=29:7	
32=4:8	72=9:8	112=14:8	152=19:8	192=24:8	232=29:8	
33=5:1	73=10:1	113=15:1	153=20:1	193=25:1	233=30:1	
34=5:2	74=10:2	114=15:2	154=20:2	194=25:2	234=30:2	
35=5:3	75=10:3	115=15:3	155=20:3	195=25:3	235=30:3	
36=5:4	76=10:4	116=15:4	156=20:4	196=25:4	236=30:4	
37=5:5	77=10:5	117=15:5	157=20:5	197=25:5	237=30:5	
38=5:6	78=10:6	118=15:6	158=20:6	198=25:6	238=30:6	
39=5:7	79=10:7	119=15:7	159=20:7	199=25:7	239=30:7	
40=5:8	80=10:8	120=15:8	160=20:8	200=25:8	240=30:8	

Speed Sensor Number = 256 + RPM# + 1 (RPM # = Speed Input Channel, 0:7)

257=0
 258=1
 259=2
 260=3
 261=4
 262=5
 263=6
 264=7

ZONE PROGRAMMING SHEETS

To aid you in organizing your facility, this form has been created so you can fill in the blanks. Of course you will have to rewrite this in the format of the actual configuration file, but these can record vital information to get you started. See Figure 7 for an example of a programming sheet. Note that sensors in a zone do not have to be arranged according to increasing, consecutive sensor numbers (i.e. 23, 24, 25....30). They can come from random arrangement of auxiliary switches and TC numbers (for example: 30, 25, 23, 28). The monitoring program does not care.

NOTES ON EDITING CHARACTERS

- **Editing with the Keypad and Menus**

There is only a simple set of characters available when entering or editing the configuration using front keypad and BTA menus. Only uppercase letters of the usual list of 36 alpha-numeric characters and special characters / # & . - are available.

- **Editing Text on a PC**

Compared to creating a configuration using the keypad and menus, editing the file on a computer is much easier and quicker. Avoid the use of lower case letters and special characters (\$, @, !, ...etc.), even though you may use these characters and upload them, and they will appear just fine. If any changes are needed later to the configuration, you will need the PC again for editing if you want to keep things consistent.

BTA ZONE PROGRAMMING SHEET

JOB # 134322

FACILITY NAME: LINE 1: ROLFES@BOONE COOP (16 characters maximum)

LINE 2: BOONE IOWA (16 characters maximum)

ZONE NAME: LEG 1 (16 characters maximum) ZONE NO.: 1 (32 maximum)

TEMPERATURE SENSORS							
BTA INSTRUMENT ←					→ FIELD CONNECTIONS		
Item	Sensor #	Sensor Name	Reference Sensor	Aux Switch #	TC #	Section #	Section Group
	(1:256) Factory Use Only	11 Characters Maximum, Including Spaces	“:1” = NONE	2 Switches Per Section (1:32 Max)	(1:8)	Each Section Has 2 Aux Switches	(A or B)
1	1	NW RUB BOOT	10	1	1	1	A
2	2	W BRG BOOT	10	1	2	1	A
3	3	SW RUB BOOT	10	1	3	1	A
4	9	NE RUB BOOT	10	2	1	1	B
5	10	BOOT AMB	:1	2	2	1	B
6	121	SE RUB BOOT	10	16	1	8	A
7	122	W RUB BRG	1	16	2	8	A
8	123	E RUB BRG	1	16	3	8	A
9	124	NW HEAD RUB	97	16	4	8	A
10	212	W HEAD RUB	97	27	4	14	B
11	213	SW HEAD	97	27	5	14	B
12	97	HEAD AMB	1	13	1	7	B
13	99	E HEAD RUB	97	13	3	7	B
14	23	SE HEAD RUB	97	3	7	2	A
15	24	SW HEAD	97	3	8	2	A
16	25	NW HEAD RUB	97	4	1	3	B

MOTION SENSORS			
BTA INSTRUMENT ←			→ RPM – SPEED BOARD
Item	Sensor #	Sensor Name	Input Channel #
	(257:264)	8 Characters Maximum, Including Spaces	(0 – 7)
1	260	BELT SPD	3
2	259	DRAG SPD	2
3	262	AUGR SPD	5

PREFERRED ABBREVIATIONS:

 AMB = AMBIENT
 BRG = BEARING
 CONC = CONCRETE
 CONV = CONVEYOR

 E = EAST
 GAL = GALLERY
 ELEV = ELEVATOR
 MTR = MOTOR

 N = NORTH
 S = SOUTH
 STL = STEEL
 W = WEST

USING THE TEMPLATE The file "FACILITY TEMPLATE" has been included as an aid to customizing a configuration. We have found it is easier to overwrite the generic zone and sensor names and then just cut and paste because there is a lot of duplication in names with slight differences. A Word document of this template is also included because of the greater word processing capabilities of MS Word application over Notepad or Wordpad. Just keep in mind that you must save it as a text document when you are ready to upload it.

copy configuration file in sendcfg.txt

Once your configuration file is completed, place a copy of it in sendcfg.txt file. Storing the master configuration with some identifying file name, such as by facility location or customer name, is recommended.

Examples may include: NC FAYETTEVILLE-STORAGE.txt
MILL.txt

PERFORMING THE LOAD

Refer to Menu Item *UPLOAD / DOWNLOAD SYSTEM CONFIGURATION*: page 21.

Operate the BTA main menu until you reach "UPLOAD CONFIGURATION" or "DOWNLOAD CONFIGURATION".

Start the BTATERM.exe dos program (double click the icon in the term directory). Or in dos mode type: "c:\windows>cd\term, term>btaterm (runs program), dos screen comes up showing that program is waiting for transmission from BTA.

Push <ENTER> on BTA to start UPLOAD or DOWNLOAD.

The COMMLOG on the PC Monitor will show something like the following:

For an UPLOAD

```
BTA TERM
VER 0.06
WAITING FOR TRANSMISSION ...
BTA SENDING CONFIGURATION ...
GET CRC ...
CRC = E23A
INIT BUFFER ...
RECEIVING BYTES ...
BUFFER CRC=E23A (4390 53..0A) ...
WRITING BUFFER ...
MESSAGE COMPLETE
```

For an DOWNLOAD

```
WAITING FOR TRANSMISSION ...
BTA IS REQUESTING CONFIGURATION ...
TERM IS SENDING CONFIGURATION ...
BUFFER CRC =FE3B (1689) ...
CONFIGURATION SENT
WAITING FOR TRANSMISSION ...
BTA REPORTS SUCCESS
WAITING FOR TRANSMISSION ...
```

Push <Escape> on your PC keyboard to quit the BTATERM dos program.

If you downloaded the configuration, look in the "Rcvcfg.txt" file in the term directory.

TROUBLESHOOTING LOADING PROBLEMS

If you saw an UPLOAD TIMEOUT message, probably the BTA and the PC are not connected or not synchronized. Check:

Cables and connections. Must use a Null-Modem cable into COM 1.

Reboot the BTA (turn off and on).

Try performing a Download first to establish communication.

Reboot the PC.

If you saw an PARSE ERROR message it means that the sendcfg.txt was rejected from upload after a certain line in the file. Parsing is an operation the BTA performs on the Configuration File that checks it as it is uploaded for correct parts and their proper order. The line "XXX" refers to the line in file from the very first line (i.e. SERIAL NUM=BTAXXXXXXX). The most common problems are:

The file must have the identical format as the Example in Figure 6. Any extra, missing or incorrect characters, spaces and returns, will result in a Parse Error.

"VERSION=3" This line must be set to three, otherwise the BTA will revert to the default configuration file in memory.

Zone № can be no higher than "99". Example: "ZONE=99,GALLERY BELT". This applies to lines for sensors also that denote the zone №. Examples:

TEMP=1,99, W HEAD BRG..... SPEED=257,99,SPEED.....

No two sensors in the same zone can have the same identical name.

SAVE THE NEWLY LOADED CONFIGURATION.

Be sure to perform a "SAVE SETTINGS TO MEMORY" operation on the BTA to make this new configuration permanent in memory. Otherwise it will be lost the next time the BTA powers down and it will revert to the old configuration.

Recalibrate Speed Sensors if there are any. All Reference speeds will not carry over and must be recalibrated and saved.

APPENDIX E. GLOSSARY

ABSOLUTE: A value that is not related to anything else such as the rate-of-rise or a reference sensor value. Usually the high limit a value can take.

ALARM: a notice that the dangerous situation that was warned about is now existing, given so that action will be taken. The highest level of alert.

ALERT: A signal that warns of attack or danger. A condition or period of heightened watchfulness or preparation for action.

ALGORITHM: A set of rules or procedural steps that are intended to be followed in sequence to solve a particular problem or produce a particular result.

AUXILIARY SWITCH: A remote multiplexing relay switch. Gathers up to 8 Thermocouple signals and sends the whole group to the Instrument.

CONFIGURATION FILE: A text file, which designates the arrangement of zones, sensors and settings, which fit the BTA to a particular facility or application. The form of the facility in which the BTA instrument works.

DEFAULT: A value that the BTA refers to in operation when no alternative has been specified. Any new sensor assumes this value until the warning or alarm level has been changed in the main menu.

ENABLE: To take some action that permits another action to take place. To make a facility or functional unit operational.

EXTERNAL ALERT DEVICES: Horns, Buzzers, Lights, Sirens, etc. that can be controlled by the Instrument in the event of a Warning or Alarm condition.

INPUTS: Inputs are defined as either signals originating from thermocouple sensors, or from speed sensors and are sent back to the BTA for processing. Additional inputs are commands entered through the keypad by the user, and or commands entered through the serial port from software or through computer keyboard interface.

LEVEL: The warning or alarm values assigned to any given sensor.

MICROPROCESSOR, μ P: is the nerve center of the BTA. It is programmed to perform the necessary operations required to process the temperature and speed data and make decisions based on what the user has defined about the facility being monitored. The CPU is a variant of the Intel 80188.

NORMAL OPERATING SPEED: A value of each speed sensor that represents the normal operating condition. This value is used to calculate Speed Warning and Alarms.

PARSE: An operation the BTA performs on a Configuration File that checks it as it is uploaded for correct parts and their proper order.

PROXIMITY SWITCH: A position switch that senses the target without mechanical contact.

RE-ENABLE DELAY: During the initial startup of a speed monitored equipment, the BTA will allow a RE-ENABLE DELAY during which it will disregard information that it receives from the sensor. This gives the equipment time to reach normal operating speed before being monitored and thus preventing false alarms.

REFERENCE: to direct to a source of information or comparison, such as ambient.

RPM NUMBER: The Input Channel of the RPM-SPEED Circuit Board of the BTA INSTRUMENT SPEED MONITOR MODULE.

SCANNING ALGORITHM: The main function of the BTA. A set of procedural steps intended to be followed in sequence to detect a Temperature or Speed Sensor out of specification and set off a Warning or Alarm.

SENSOR: A device that detects and/or measures some physical condition and outputs an analog representation of that value.

SET: To put in a specified state, stable position, adjust for proper functioning.

STRING: A variable made of characters.

TIME-OUT: To cause a timer to run out to signal the end of a period (maximum time) in which an event can occur. An interrupt condition that occurs at the expiration of an allocated time for an event occurrence, without the event having occurred.

WARNING: An advanced notice given to make aware of potential or probable dangerous or harmful situation. The first level of alert.

ZONE: A zone is a user-specified grouping of sensors for a given facility. The length of the identification name of a zone is 1-16 characters.

APPENDIX F. TC SCAN RATE PARAMETERS

PARAMETER		TEMPERATURE TEST			RESISTANCE TESTS					
					#1 QUICK DONE ON ALL PASSES AFTER 1 st			#1 FULL DONE ON 1 st PASS OF SCAN		
		LIMITS		RECOM- MENDED	LIMITS		RECOM- MENDED	LIMITS		RECOM- MENDED
		LOW	HIGH		LOW	HIGH		LOW	HIGH	
TIME- OUT Maximum Allocated Period	Seconds	0.50	10.00	10.00	0.50	10.00	5.00	0.50	10.00	10.00
	PASSING DIFFICULTY	HARDEST	EASIEST	EASIEST	HARDEST	EASIEST	MODERATE	HARDEST	EASIEST	EASIEST
	EFFECT	FAILED READING LIKELY	WILL READ SUCCESSFULLY	WILL READ SUCCESSFULLY	FAILED READING LIKELY	SUCCESSFUL READING LIKELY	SUCCESSFUL READING LIKELY	FAILED READING LIKELY	SUCCESSFUL READING LIKELY	WILL READ SUCCESSF ULLY
INITIAL DELAY Settling Period After Switching	Seconds	0.50	10.00	1.00	0.03	10.00	1.00	0.03	10.00	2.00
	PASSING DIFFICULTY	HARDEST	HARDEST	MODERATE	HARD	HARDEST	EASY	HARD	HARDEST	MODERATE
	EFFECT	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	QUICK, RELIABLE	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	QUICK, RELIABLE	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	SLOWER, MORE RELIABLE
MINIMU M STABLE TIME Period to get an acceptable series of readings	Seconds	0.50	5.00	0.75	0.50	1.00	0.75	0.50	1.00	1.00
	PASSING DIFFICULTY	EASIEST	HARDEST	EASY	EASIEST	HARDEST	MODERATE	EASIEST	HARDEST	HARDEST
	EFFECT	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	QUICK, RELIABLE	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	QUICK, RELIABLE	QUICKEST, LEAST RELIABLE	SLOWEST, MOST RELIABLE	SLOWEST, MOST RELIABLE
MAXIMU M SHIFT Limits that define stable readings		"--" = NONE	99°F (99°C)	4°F (2°C)	1Ω	99Ω	15Ω	1Ω	99Ω	10Ω
	PASSING DIFFICULTY	EXTREME	EASIEST	MODERATE	HARDEST	EASIEST	EASY	HARDEST	EASIEST	MODERATE
	EFFECT	SLOWEST, SEVERE STANDARD	NO RELIABILITY	REASONABLY RELIABLE	SLOWEST, MOST RELIABLE	QUICKEST, NO RELIABILITY	QUICK, ACCEPTABLE RELIABILITY	SLOWEST, MOST RELIABLE	QUICKEST, NO RELIABILITY	SLOWER, MORE RELIABILITY

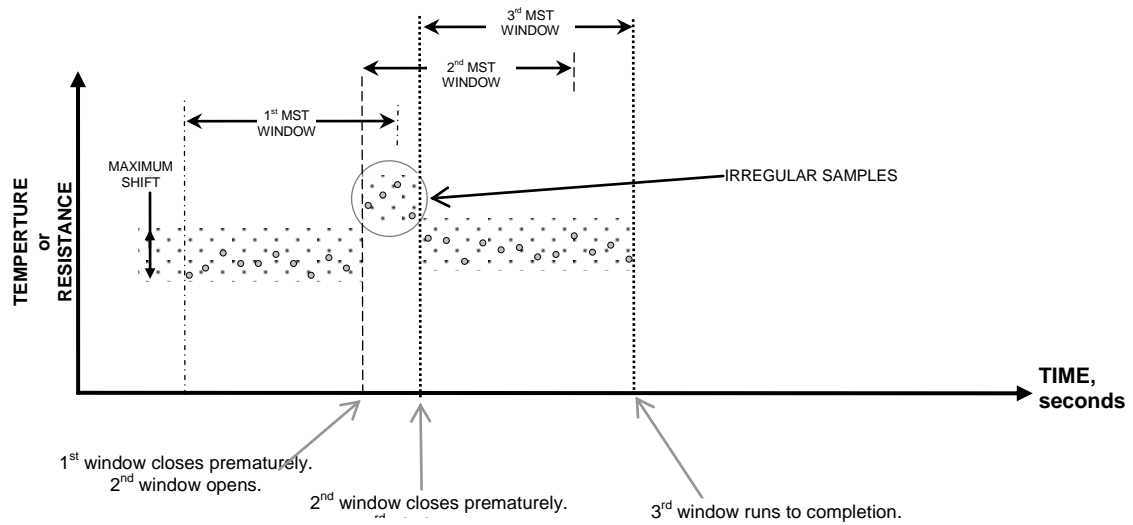
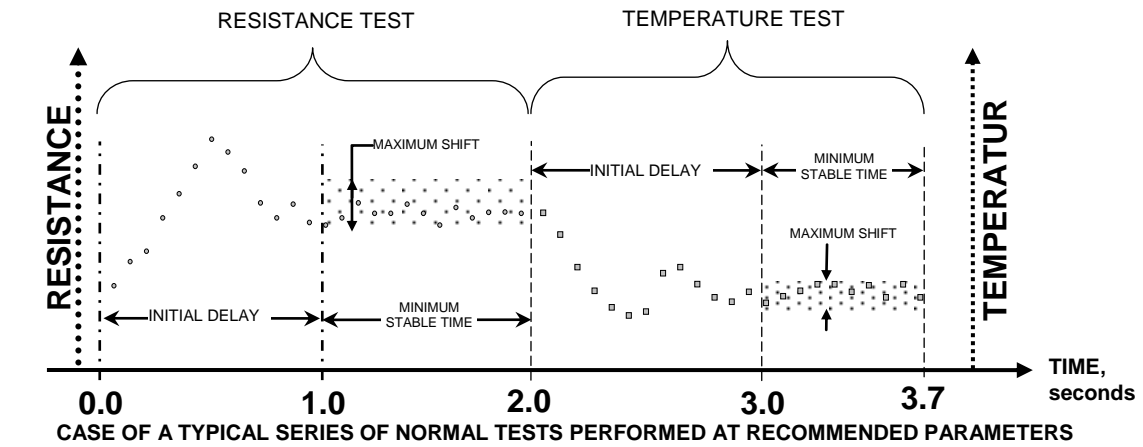
INITIAL DELAY, ID: An interval of time between switching from one multiplexed thermocouple circuit to another and the start of the actual measurement period. A settling time when the program waits for the signal voltages to dampen their fluctuations. If read too soon, the measurement may result in an unreliable value. Generally the longer the length of the total circuit, the more initial delay is needed for good results are to be obtained.

MAXIMUM SHIFT: a band of temperature or resistance values that extends through time, in which readings must fall to be considered stable and reliable. While the *MINIMUM STABLE TIME* window slides through time and collects samples, they must not breach the high and low limits or the values are not considered steady enough to be acceptable.

MINIMUM STABLE TIME, MST: A window of time, in which a minimum amount of samples are measured multiple readings of the same sample, so that there are enough readings to consider a sample stable. The number of readings that take place within that given time must all fall within some given range. Should any readings not satisfy the requirement of *MAXIMUM SHIFT* during this time, a new window of *MINIMUM STABLE TIME* opens; the old window closes because it did not meet the requirement of *MAXIMUM SHIFT*. Readings will continue until an acceptable series of readings fills the *MINIMUM STABLE TIME* window until the *TIME-OUT* period expires.

TIME-OUT: Getting a reliable reading of a thermocouple is supposed to occur within a specified time. However, if the reading is not stable this timer prevents waiting indefinitely. Should the end of this allocated time period (maximum time) expire without a good measurement, the process is interrupted and an alert condition is signaled.

EXAMPLES OF HOW SCAN RATE PARAMETERS ARE USED:



APPENDIX G. START UP MONITORING PARAMETERS

Two features help monitor the period before the conveyor reaches full speed. Once the speed is brought to normal level within the limits of the *START-TO-MOVE* and the *ACCELERATION TIME-OUT* parameters, the system is armed and set for regular Belt-Slip Monitoring. The Fail-Safe operation also applies during this period. See Figure 4 below.

If the existing start/stop control circuits have *DELAY TIMERS* already built in to their operation before installing the BTA, the start-up sequence can be affected with the BTA in the system especially if the parameters of the start-up are not considered. Each situation can be unique so you will have to compensate on-site if there are problems.

START-TO-MOVE (STM)

From the time that the start button is pushed (speed channel enabled) and the motor is powered, the monitored equipment has “n” (adjustable from 1-30 seconds) seconds to begin moving. It does not have to reach normal speed during this time, just begin moving. If no movement is sensed, alert status is entered and a shutdown is triggered, thus preventing catastrophic damage from a “choked” leg. See Figure below. Choice of the maximum value will decrease the usefulness of this feature. The range of values is 1-30 in 1 second increments.

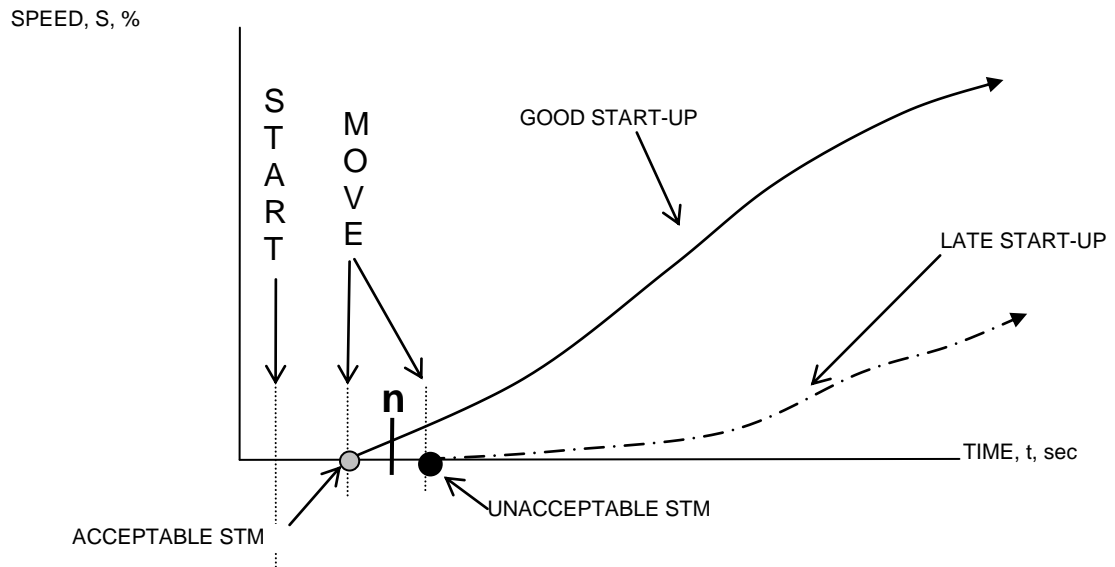
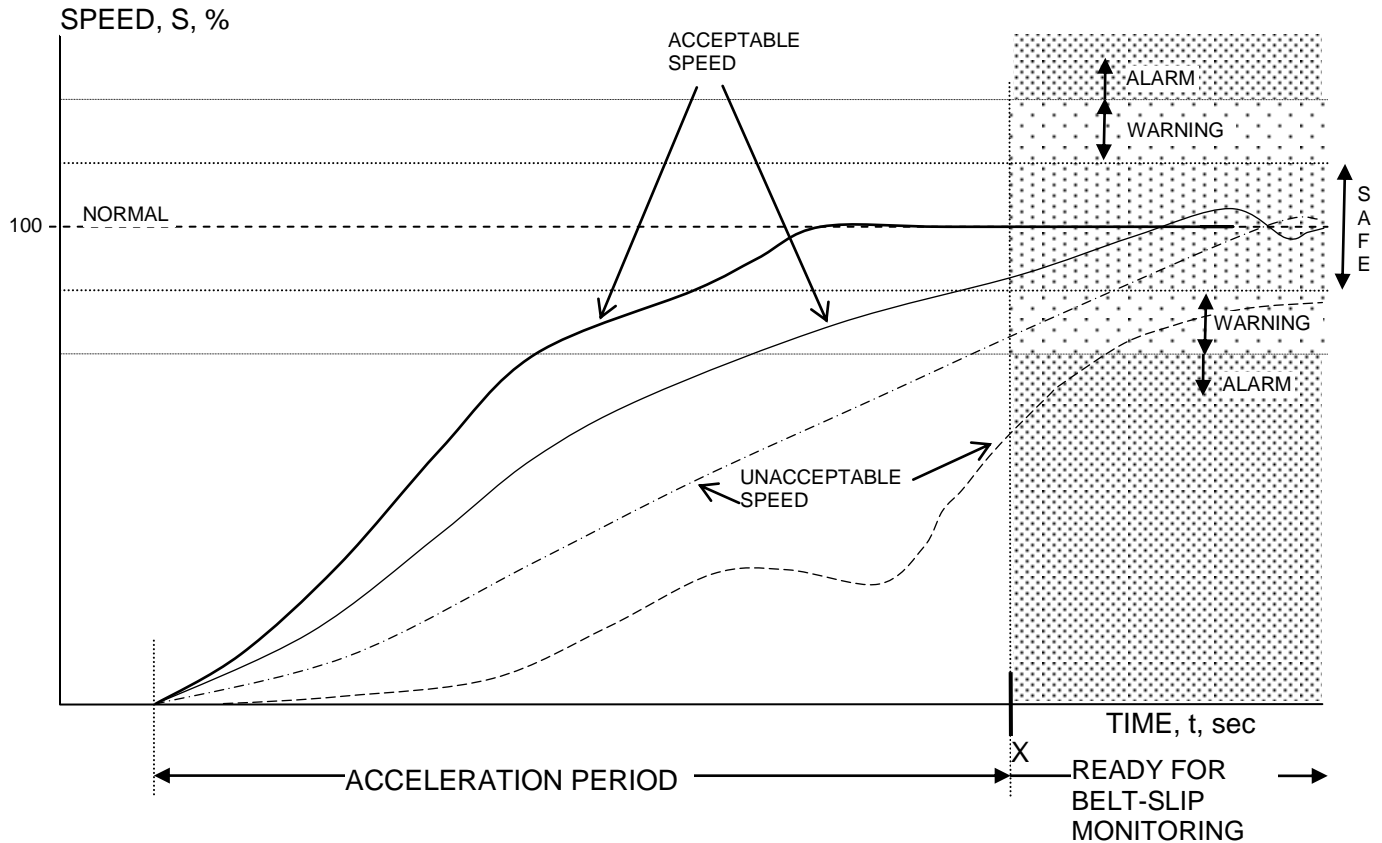


Illustration of ACCEPTABLE and UNACCEPTABLE Start-To-Move Parameters

ACCELERATION TIME-OUT

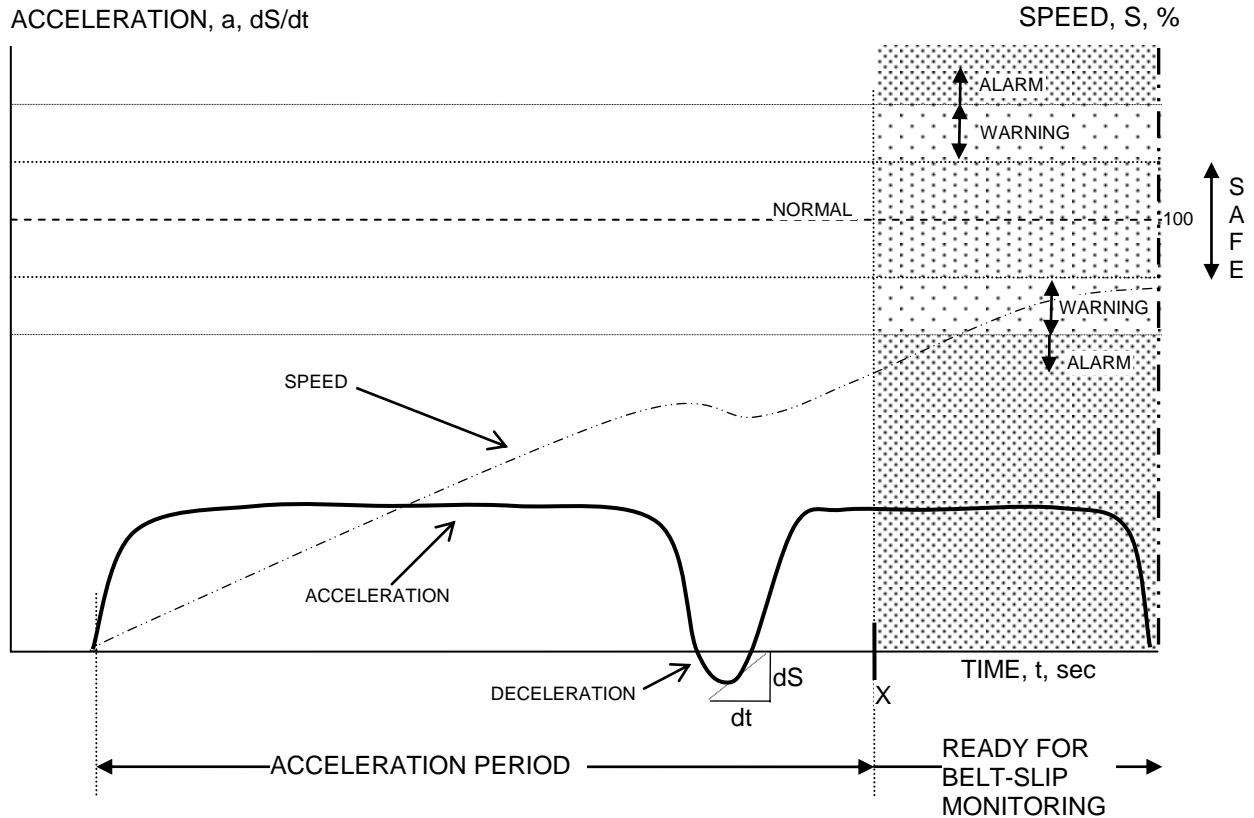
The speed is given **X** seconds (adjustable from 1-30) to reach a proper operational level. If this is not accomplished an alert status is entered and a shutdown is triggered. The speed above the Warning level does not have to be reached until the acceleration time-out period expires. Once the speed is brought above warning level, the BTA system is set for regular Belt-Slip Monitoring. The Fail-Safe operation also applies during this period. Choice of the maximum value will decrease the usefulness of this feature. The range of values is 1-30 in 1 second increments. See Figure below.



START-UP PERIOD MONITORING

INSTANTANEOUS ACCELERATION

After the equipment starts moving, instantaneous (differential) acceleration is checked so that slippage will not generate heat at the contact surface of the drive pulley lagging and belt. Minimum acceleration must be maintained throughout this period. Acceleration must be positive or zero (non-negative). Deceleration (negative) at any time during the acceleration period will result in an alert and thus a shutdown. See Figure below.



Instantaneous Acceleration Monitoring

APPENDIX H. ACTUAL SERIAL REPORT OF SENSOR DATA

Sensors are indicated by their generic hardware address, not by their zone and name as would appear on the BTA display and printouts.

Example of a REPORT with normal and alert messages as viewed through HyperTerminal:

```
S-BEGIN= 2/07/05 23:13
S-T= 2/07/05 23:13
S-R=T 1-2,EN, 76F, 72F,OK, 196
S-R=T 1-3,EN, 76F, 72F,OK, 295
S-R=T 1-4,EN, 76F, 73F,OK, 395
S-R=T 1-5,EN, 76F, 72F,OK, 493
S-R=T 1-6,EN, 76F, 72F,OK, 589
S-R=T 1-7,EN, 76F, 72F,OK, 678
S-R=T 1-8,EN, 76F, 73F,OK, 783
S-T= 2/07/05 23:14
S-R=S0,EN, 135,OK
S-A/W=S0,CHOKED, NO MOTION, 2/07/05 23:14
S-A/W=S0,ALARM STARTUP ENDED, 2/07/05 23:14
S-A/W=S0,WARN SLOWDOWN 89%, 2/07/05 23:14
S-A/W=S0,ALARM SLOWDOWN 78%, 2/07/05 23:14
S-A/W=S0,ALARM SLOWDOWN 144%, 2/07/05 23:14
S-T= 2/07/05 23:14
S-R=T 2-1,EN, 75F, 72F,OK, 102
S-R=T 2-2,EN, 76F, 72F,OK, 196
S-R=T 2-3,EN, 76F, 72F,OK, 295
S-A/W=T 2-4,WARN ABS 107F, 2/07/05 23:14
S-A/W=T 2-4,ALARM ABS 121F, 2/07/05 23:14
S-A/W=T 2-4, WARN TEMP RISE 85F, 2/07/05 23:14
S-A/W=T 2-4,ALARM TEMP RISE 101F, 2/07/05 23:14
S-R=T 2-5,EN, 76F, 72F,OK, 493
S-R=T 2-6,EN, 75F, 72F,OK, 589
S-R=T 2-7,EN, 76F, 72F,OK, 678
S-R=T 2-8,EN, 76F, 73F,OK, 783
S-T= 2/07/05 23:14
S-END= 2/07/05 23:15,1,4,0
```

LEGEND:

S-BEGIN= 2/07/05 23:14 start-date and time are generated at the beginning of each scan session.
M/dd/yy H:mm or when changing over to a new day at midnight.
S-BEGIN= 2/07/05 11:14P
h:mmt

The BTA can be set for dual time formats.

M= Month, no leading zero.
dd= day, with leading zero.
yy= year, last two digits.
H= Hour, 24 hour format, no leading zero.
h= hour, 12 hour format, no leading zero.
mm= minute, with leading zero.
t= AM/PM hour designator, simply "A" or "P", no "M"

S-T= 2/07/05 11:14 is generated when each section (an AUX consisting of 8 TCs) is read.

B C
B= date that the section was read.
C= time that the section was read.

S-R=T 1-2, EN, 76F, 72F,OK, 196 is generated for each sensor reading, date/time implied in the S-T.

Z W-U, X, \$, R, M, L
Z= sensor type: T=temperature.
W= Auxiliary number.
U= Thermocouple number
X= software Enable/Disable status
\$= the current reading
R= the average temperature so far for the day (12:01 to 23:59).
M= alert state the sensor is in: "OK" or "A / W"
L= resistance reading in Ohms.

S-R=S 0,EN,135,OK

Z W, X, \$, M,

Z= sensor type: S=speed.

W= sensor address, speed input channel 0-7

X= software Enable/Disable status

"EN" = enabled status in software, consider valid.

"DIS" = disabled status in software, ignore.

\$= the current reading, always in RPM, never in Percent of normal speed.

"*****" = a time out

"----" = an undefined value, waiting for pulses to count.

"... " = speed sensor is hardware disabled.

M= alert state the sensor is in: "OK" or "A / W "

S-A/W=T 2-4,WARN ABS 107F, 2/07/05 11:01 generated from an alert state (alarm or warning).

Z W-U, G H, J K

Z= sensor type: T=temperature.

W= Auxiliary number.

U= Thermocouple number

G= type of alert state:

"WARN ABS" = absolute temperature warning

"ALARM ABS" = absolute temperature alarm

"WARN TEMP RISE" = temperature rate of rise warning

"ALARM TEMP RISE" = temperature rate of rise alarm

"ALARM HIGH RES" = TC circuit resistance exceeded high limit

"ALARM LOW RES" = TC circuit resistance below low limit

"ALARM RES CHANGE" = TC circuit resistance exceeded maximum change limit.

H= the current reading or "OT"

J= date of the alert

K= time of the alert

S-A/W=S 0,ALARM SLOWDOWN 78%, 2/07/05 9:52 generated from an alert state (alarm or warning).

Z W, G H, J K

Z= sensor type: T=temperature.

W= sensor address, speed input channel 0-7

G= type of alert state:

"CHOKED, NO MOTION" = the start-to-move period has expired with no motion at all.

"ALARM STARTUP ENDED" = have motion, but it is still below warning level when acceleration period ended. Also, belt speed is not smoothly increasing: slippage during acceleration (zero or negative differential acceleration).

"WARN SLOWDOWN" = speed falls below warning level after being above warning level.

"ALARM SLOWDOWN" = speed falls below alarm level after being above warning level.

H= the current reading in % of normal speed, never in RPM.

J= date of the alert

K= time of the alert

S-USER is generated when the user enables or disables a sensor while the scan is going on.

S-USER=T 1-2,DIS, 2/07/05 14:12

S-R=T 1-2,DIS

S-ACK is generated when the user presses the <SILENCE> key on BTA unit.

S-ACK=T 2-2, 2/07/05 14:03

S-END= 2/07/05 23:15, 1,4,0 end-date and time are generated at the end of each scan session or when changing over to a new day at midnight.

♠= the number of sensors in alert state that are unacknowledged.

♥= the number of sensors in alert state that are acknowledged.

♦= the number of sensors that are disabled.