

**WATLOW ANAFAZE 8 PID CONTROLLER
Installation And Operation Manual**

Revision 5

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ANAFAZE 8 PID Serial Numbers P2000 and higher

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PLEASE NOTE EXTERNAL SAFETY DEVICES MUST BE USED WITH THIS EQUIPMENT SEE WARNING ON NEXT PAGE.

WARNING

ANAFAZE HAS MADE EFFORTS TO ENSURE THE RELIABILITY AND SAFETY OF THE ANAFAZE 8 PID CONTROLLER AND PROVIDE RECOMMENDATIONS FOR ITS SAFE USE IN SYSTEMS APPLICATIONS. PLEASE NOTE THAT IN ANY APPLICATION, FAILURES CAN OCCUR THAT WILL RESULT IN FULL CONTROL OUTPUTS OR OTHER OUTPUTS THAT MAY CAUSE DAMAGE OR UNSAFE CONDITIONS IN THE EQUIPMENT OR PROCESS CONNECTED TO THE ANAFAZE 8 PID.

GOOD ENGINEERING PRACTICES, ELECTRICAL CODES, AND INSURANCE REGULATIONS REQUIRE INDEPENDENT, EXTERNAL, SAFETY DEVICES BE USED TO PREVENT POTENTIALLY DANGEROUS OR UNSAFE CONDITIONS ASSUMING THAT THE ANAFAZE 8 PID CAN FAIL WITH OUTPUTS FULL ON, OR OUTPUTS FULL OFF, OR OTHER CONDITIONS THAT WOULD BE UNEXPECTED.

THE ANAFAZE 8 PID INCLUDES A RESET CIRCUIT THAT WILL SET THE CONTROL OUTPUTS TO ZERO IF THE MICROPROCESSOR RESETS -- NORMALLY THE RESULT OF A POWER FAILURE AND POWER RETURN. THE COMPUTER OR OTHER HOST DEVICE SHOULD BE PROGRAMMED TO AUTOMATICALLY RELOAD THE CURRENT ANAFAZE 8 PID OPERATING CONSTANTS, OR SAFE VALUES FOR THE PROCESS, UPON RETURN OF SYSTEM POWER. THE COMPUTER CAN ALSO BE PROGRAMMED TO CHECK PROCESS DATA AND CAUSE ALARMS INCLUDING CONTACT OUTPUTS FOR AUTOMATIC SHUT DOWN TO ASSIST IN PREVENTING DANGEROUS OR UNSAFE CONDITIONS. ANAFAZE WILL BE PLEASED TO PROVIDE APPLICATION ASSISTANCE AND PROGRAMMING IF DESIRED. IN ANY EVENT, THESE SAFETY FEATURES DO NOT ELIMINATE THE NEED TO PROVIDE EXTERNAL, INDEPENDENT SAFETY DEVICES IN POTENTIALLY DANGEROUS OR UNSAFE CONDITIONS.

ANAFAZE ALSO OFFERS AN OPTIONAL EEROM MEMORY THAT WILL STORE COMPUTER ENTERED OPERATING CONDITIONS THAT WILL BE USED BY THE ANAFAZE 8 PID AS INITIAL CONDITIONS AT START-UP. THIS FEATURE STILL DOES NOT ELIMINATE THE NEED FOR APPROPRIATE EXTERNAL, INDEPENDENT SAFETY DEVICES.

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1.0 INTRODUCTION

The ANAFAZE 8 PID is a full-featured, industrial-quality, eight-loop, three-mode controller offering unique shared processing technology in local or distributed systems. Through shared processing, the operational functions are divided: the ANAFAZE 8 PID microprocessor intelligence controls the eight loops while a computer or programmable controller enters control settings and performs other operations as needed.

Up to eight loops can be controlled by each ANAFAZE 8 PID, with separate selection of setpoints, alarm points and control constants. A group of optically isolated measurement circuits accept direct connection of sensors -- including thermocouples, RTD's, infrared non-contact, milliamp, and voltage -- reducing the need for costly isolators or transmitters. Sensor and control cable costs are reduced by installing the controller near the process and using serial communication to the host computer. Plug-in RS-232, RS-422, or 20ma current loop interfaces are available at selectable baud rates. Control output for each loop is a separate plug-in board with a choice of time proportioning voltage, on/off output, or analog voltage or current. With the alarm expander option two alarms can be set for each loop with digital outputs on alarm for annunciation or emergency shutdown. Indicator LEDs show the status of each loop, the communication interface, and the AC power.

For simple applications any computer with a serial interface may be used to set the input types, control constants, control setpoints, and alarm levels for each loop. Once set, the ANAFAZE 8 PID functions as a stand-alone controller, with alarm checking on each loop, and the computer need only periodically poll the controller to generate operator displays and to verify correct operation.

ANAFAZE offers ANASOFT which is a menu driven software applications package for IBM PC and compatible computers. Please contact ANAFAZE for additional information.

Up to 32 local or remote ANAFAZE 8 PID controllers can be connected on a single communication line, totaling 256 loops, and multiple lines can be used for very large systems. Since the ANAFAZE 8 PID fully controls each loop, supervision requirements are simplified, thus allowing the use of inexpensive programmable controllers or personal computers.

2.0 SPECIFICATIONS

2.1 ANALOG INPUTS

| | |
|-----------------------|--|
| Number of channels: | eight |
| Multiplexing: | three wire reed relay, guarded inputs |
| A/D converter: | integrating voltage to frequency |
| Loop update: | each loop 2 times per second |
| Input isolation: | optical coupling |
| Input resolution: | 0.02% full scale |
| Temp. coefficient: | .025% per degree |
| Measurement accuracy: | +0.2% full scale |
| Thermocouple break: | up scale standard |
| Standard input types: | All are present in every system: select by command from host, any order, any mix: (a) Thermocouple ranges: * J T/C: -50F to 1400F K T/C: -110F to 2500F T T/C: -120F to 750F (b) Voltage and current scaling: 0 to 100% (0 to 50ma, 0 to 10v etc.) (c) Voltage input ranges, set for each channel: 0 to 60mv min, 0 to 100v max: normal (d) Current input ranges: select resistor to match above voltage ranges |
| Optional input types: | E, S, R, or B T/C RTD Non-contact infrared Temperature Ranges below 0 degrees * Assumes PID temp is 0 to 50 degrees C If otherwise, contact factory. |

2.2 OPERATING PARAMETERS

Independently set for each loop from computer or programmable controller.

| | |
|----------------------|---|
| Input type | any standard type (see above), any mix |
| Gain (proportional) | 0 to 499 |
| Reset (integral) | 0 (off) to 1020 seconds |
| Rate (derivative) | 0 (off) to 255 seconds |
| Digital Filter | 0 to 15 levels [0-7.5 sec.time const.] |
| Setpoint | 0 to span |
| High alarm | 0 to span [requires alarm expander] |
| Low alarm | 0 to span [requires alarm expander] |
| Control output level | automatic, 0-100% or when using manual control 0 to 100% (0.1% resolution). As set from keyboard. |

2.3 REPORTING PARAMETERS

The computer can request any of the following for any loop:

Operating parameters: all of the above
Analog inputs: sensor input

2.4 COMMUNICATIONS

Types RS-232, RS-422, or 20ma current loop
Baud rate jumper selectable, 300 to 9600
Error check full echo of all settings
Isolation optical for 20ma, optional for RS-232
Data format standard ASCII
Display LED indicates communication active

2.5 CONTROL AND ALARM OUTPUTS

Select up to eight:

Time proportioning: voltage output: pulsed 6VDC at 6ma (or On/Off)maximum -- for solid state or other relays
Analog: voltage or current: selectable (4 to 20ma, 2 to 10v etc.)
Display: LED indicates control output is active

2.6 DIGITAL INPUT OR OUTPUT

2 DigitalOutputs: opencollector;
true= < 0.5v @ 4ma
false = 5v @ 400ohms
1 Digital Input: true = < 0.5v; false = > 3.5v

2.7 GENERAL

Power input: 120VAC, 60Hz
Operating ambient: 0 to 50 C
Humidity: 10% to 90%, non-condensing
Enclosures: NEMA 4, 12, 13 and others optional
Physical: 11.2" wide, 13.25" high, 4" deep
Mounting: 4 bolts; 10.25" wide, 12.25" high
Weight: approximately 5 pounds

2.8 SUBASSEMBLY IDENTIFICATION

The ANAFAZE 8 PID controller consists of a measurement/processing unit with integral mounting frame, plug-in terminals for field wiring, LED indicators, power supply, and 9 card slots.

ANAFAZE 8 PID MEASUREMENT PROCESSOR UNIT

| | |
|---------------|--------------------------------------|
| A8PID-MPU | Standard measurement/processing unit |
| A8PID-MPU-IR4 | Standard MPU wired for 4 IR inputs |
| A8PID-MPU-IR8 | Standard MPU wired for 8 IR inputs |
| A8PID-SIXXX | Custom input scaling per input |

COMMUNICATION INTERFACES (must select one per MPU)

| | |
|---------------|-----------------------------------|
| A8PID-232-N | Standard non-isolated RS-232 card |
| A8PID-232-ISO | Isolated RS-232 interface card |
| A8PID-422 | RS-422 interface card |
| A8PID-20MA | 20MA current loop interface card |

OUTPUT CARDS (select up to 8 per MPU)

| | |
|--------------------|------------------------|
| A8PID-TPV | Time proportioning DCV |
| A8PID-O/F | On-Off DCV |
| A8PID-A/ISO/4-20MA | Analog isolated 4-20MA |
| A8PID-A/4-20MA | Analog 4-20MA |
| A8PID-A/0-5V | Analog 0-5V |
| A8PID-A/0-10V | Analog 0-10V |

ALARM OUTPUT AND MEMORY CARD (optional one per MPU)

| | |
|-----------|----------------------|
| A8PID-AEX | Alarm expansion card |
|-----------|----------------------|

CABLES

| | |
|---------|--|
| CA-232M | 25' RS-232 cable male computer connector |
| CA-232F | 25' RS-232 cable female computer connector |
| CA-AEX | 2' 50 pin ribbon cable: AEX to PCB-24 |

INPUT/OUTPUT ACCESSORIES -- USE WITH AEX

| | |
|-----------|---------------------------------------|
| PCB-24 | 24-position input/output module board |
| PCB-IAC15 | 120VAC input module |
| PCB-IAC5A | 240VAC input module |
| PCB-IDC5N | 3.3-60VDC input module |
| PCB-OAC5 | 120VAC output module 5A SSR |
| PCB-OAC5A | 240VAC output module 5A SSR |
| G280D10 | 280VAC 10A solid state relay SSR |
| G280D45 | 280VAC 45A solid state relay SSR |

SOFTWARE

| | |
|-------------|--|
| ANASOFT-PID | Software operating program for ANAFAZE 8 PID |
|-------------|--|

3.0 INSTALLATION

There are some precautions that must be observed when installing the ANAFAZE 8 PID:

WARNING-ELECTRICAL SHOCK DANGER

It is very important that all signal lines including the power input be disconnected before servicing the ANAFAZE 8 PID. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN POWER IS TURNED OFF.

Since the ANAFAZE 8 PID can make measurements of input signals that are not referenced to ground, the ANAFAZE 8 PID ground and other signal lines can have power line or other high voltage present even if the input power is turned off. This could happen, for example, if a thermocouple was inadvertently shorted to the AC power line.

WARNING - USE CORRECT INSULATION TRIM LENGTH AND WIRE GAGE

The correct insulation trim length is 1/4" or 5mm. Care must be taken to prevent contact between any wires and the case which is grounded. The terminal manufacturer has UL approval for #14 to #30 AWG (American Wire Gage). ANAFAZE recommends using #18 or #20 AWG.

To effectively use the plug-in terminals, the wire insulation should be trimmed so that the wire fits inside the terminal with no bare wire exposed. Stranded wire should be tinned.

WARNING - SUPPORT CABLES

Power, input, and output cables should be supported to reduce strain on the connectors and to prevent them from being pulled out of the terminal strips.

3.1 PHYSICAL CONSIDERATIONS

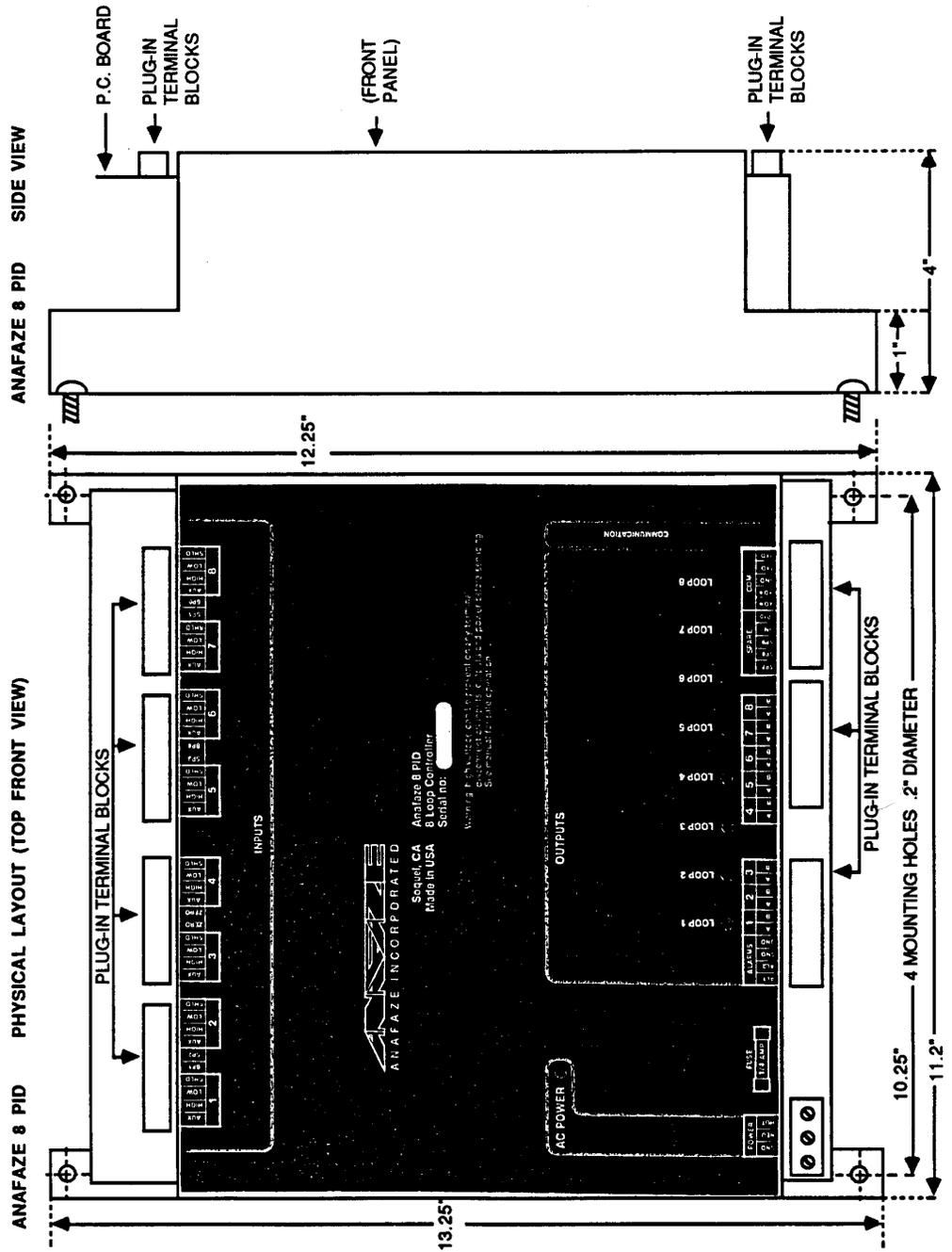
The ANAFAZE 8 PID consists of a single PC board with an aluminum housing. Nine rear slots are provided for plug-in option boards, one for communication and eight for control outputs.

3.1.1 MOUNTING [SEE PHYSICAL LAYOUT ON NEXT PAGE]

WARNING ELECTRICAL SHOCK DANGER

Always mount the ANAFAZE 8 PID so that access is controlled to prevent any contact with the terminals. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN POWER IS TURNED OFF.

ANAFAZE 8 PID PHYSICAL LAYOUT DIAGRAM



For optimum performance when directly connecting thermocouple inputs, the terminal strips should be kept horizontal. In addition the unit should be protected from thermal shocks whenever possible. This will minimize any temperature gradients across the terminal strips and result in the highest accuracy.

3.1.2 ENCLOSURES

Different enclosures can be used depending on the environmental protection required.

3.1.3 DETACHABLE TERMINAL BLOCKS

WARNING - ALWAYS CHECK TERMINAL LOCATION AND ORIENTATION

All connections except, for the AC power supply, are made on removable terminal strips. Terminal strip removal is achieved by pulling them directly away from the circuit board. The terminal strips must be carefully installed in the correct position on the circuit with all 10 pins correctly aligned.

3.2 COMMUNICATIONS SET-UP AND CONNECTIONS

The ANAFAZE 8 PID is designed for three types of serial communications: RS-232, RS-422, and 20ma current loop. Up to 32 units can be connected on one communication line.

3.2.1 COMMUNICATIONS PROTOCOL

The unit uses standard ASCII codes for characters. Parity is not used since the ANAFAZE 8 PID responds to every command verifying to the host computer that the command has been correctly received. The ASCII format is the most commonly used. It contains one start bit, 8 data bits and one stop bit. The computer manual contains information on how to set-up the parameters for communication. For example using an IBM PC in BASIC the command is:

```
OPEN "COM1:2400,N,8,1,RS,CS,DS as #1
```

This statement does the following:

- opens communication port 1
- at 2400 baud
- with no parity
- 1 start bit, 8 data bits, 1 stop bit
- suppresses RTS (Ready To Send)
- ignores CTS (Clear To Send)
- ignores DSR (Data Set Ready)
- as file #1.

Please see your computer manual for additional details.

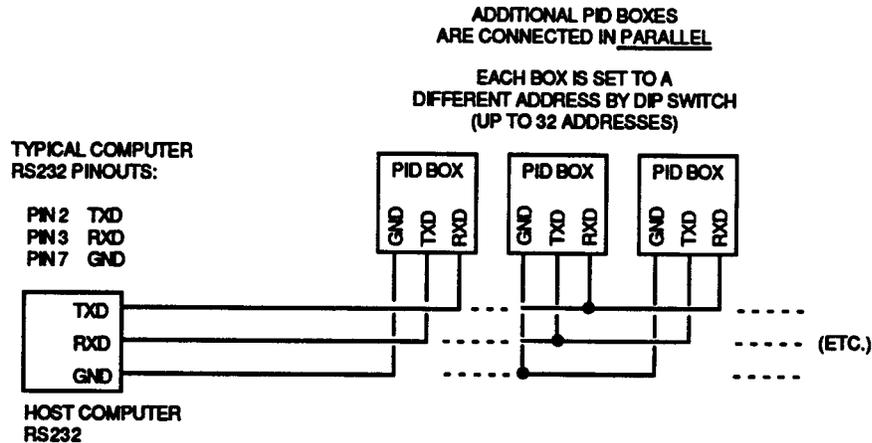
Please note that the ANAFAZE 8 PID does not require an automatic LF line feed at the end of each communication. Do not use this feature available in the IBM PC BASIC or any other software package.

3.2.2 COMMUNICATIONS PLUG IN OPTIONS

Communication interfaces plug into slot 1 at the back of the ANAFAZE 8 PID frame. The standard selection includes: RS- 232, RS-422, and 20ma current loop. An optically isolated RS-232 interface is available.

3.2.3 RS-232 Option [Non-Isolated]

The ANAFAZE 8 PID is designed to communicate with the host computer using three wires, thus minimizing the interconnection cost. SEE DIAGRAM:



The ANAFAZE 8 PID transmits data on TXD and receives data on RXD. The host computer TXD output should be connected to the ANAFAZE 8 PID RXD input. The ANAFAZE 8 PID TXD output should be connected to the host computer RXD input. Host computer communication ground should be connected to the ANAFAZE 8 PID communication ground.

Multiple ANAFAZE 8 PID units are connected on the RS-232 line in parallel. The ANAFAZE 8 PID nearest to the computer is connected as described above. Then each Anafaze 8 PID controller is daisy chained wire for wire to the next unit. The next units' TXD is connected to the first units' TXD, RXD to RXD, and ground to ground etc.

Some host computers or other RS-232 devices use additional communication lines that are not required by ANAFAZE 8 PID. These include:

- | | |
|---------------------|---------------------------|
| RTS - Ready To Send | DSR - Data Set Ready |
| CTS - Clear To Send | DTR - Data Terminal Ready |

If the host computer uses RTS and CTS or DSR and DTR, these lines should be connected together in pairs [or as shown in the computer manual]. Normally this is done in the RS-232 connector hood at the host computer. Alternately the effect of these lines can be eliminated in software. The ANAFAZE 8 PID is ready to receive data; therefore these lines are not required.

3.2.4 RS-232 NOISE PICK-UP

The RS-232 interface is designed so that all ANAFAZE 8 PID controllers on the same RS-232 interface will be listening on initial power up. None of the units will have control of the TXD line. A command sent through the host computer initializing the desired unit starts proper communication between that ANAFAZE 8 PID and the host computer.

Since the TXD line is not controlled, a high impedance may result, causing some 60Hz or 50Hz noise to be picked-up on the line. The noise may be interpreted as characters by the host computer. This may continue until the first unit is selected. After unit selection, the host computer should clear its input buffer. To prevent this, lower the impedance of the TXD line by connecting a 15K ohm resistor between the host computer RXD line and the -5 or -15 volt communication supply at the host. The reduction in the impedance should be enough to prevent this character pick-up.

3.2.5 RS-422 OPTION

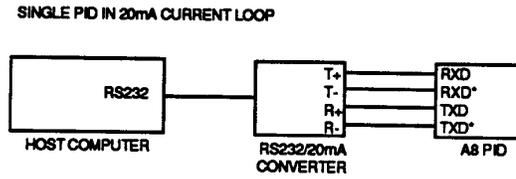
The RS-422 is similar to RS-232 with the exception that the RS-422 requires two balanced lines for transmit and two lines for receive. The lines operate exactly out of phase referenced to +5 and 0 volts, permitting longer interconnect lengths. ANAFAZE 8 PID connections are as follows:

| PID | COMPUTER |
|------|----------------------------------|
| TXD | +422 Output (Start bit +5 volts) |
| TXD* | -422 Output (Start bit 0 volts) |
| RXD | +422 Input |
| RXD* | -422 Input |
| GND | GND Ground |

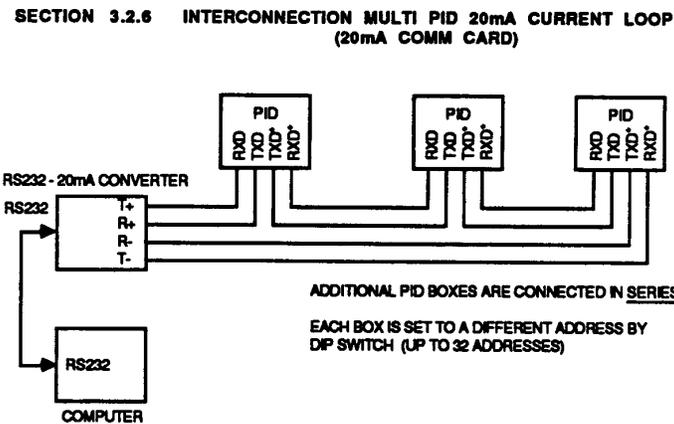
3.2.6 20ma CURRENT LOOP OPTION

Current loop is recommended for longer cable runs and noisy environments. The ANAFAZE 8 PID current loop is optically isolated. It uses an external power supply for the current loop which is normally included in the device communicating with the controller. Consult ANAFAZE for recommendations.

The connections are shown for a single controller:

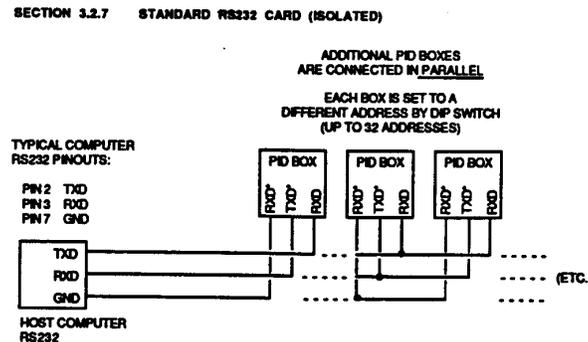


Multiple ANAFAZE 8 PIDs are connected in series. R+ is connected to the first unit TXD and TXD* from the first unit is connected to TXD of the next unit. These serial connections are continued until the last unit is reached. The last unit TXD* is connected to the computer R-. T+ is connected to the first unit RXD and the RXD* is connected to the next unit. The last unit RXD* is connected to the computer T- as shown:



3.2.7 OPTICALLY ISOLATED RS-232 INTERFACE

The optically isolated interface allows connection to computers using RS-232 with additional noise protection. Many computer RS-232 interfaces connect the RS-232 signal ground directly to the computer third wire ground. Thus any power line noise is directly connected to the ANAFAZE 8 PID through the serial interface. In addition if there is common mode voltage between the ANAFAZE 8 PID and the computer this noise will also be coupled into the communication lines. To prevent this problem for RS-232 users, the optically isolated RS-232 interface is recommended. The connections are different from the normal serial interface since the ground is isolated. The connections are as diagrammed:



Multiple ANAFAZE 8 PID's are connected in parallel. The RXD of the first unit is connected to the RXD of the next unit, the RXD* to the RXD*, and the TXD* to the TXD*.

3.3 CONFIGURATION

3.3.1 CONFIGURATION SWITCH

WARNING - TURN OFF POWER BEFORE CHANGING SWITCH

The unit configuration switch is located near the center of the main circuit board. It is a six position DIP switch which is used to set the unit number. The switch functions are:

Position one: Unit group select 1 or 2

Position two: Spare

Position three through six: Selects the unit number using the standard binary code. The units are selected by commands in the format Bab, where "B" is the unit command code,"a" is the unit group select either 1 or 2, and "b" is 0 through F. Unit group 1 or 2 are selected by SW1. Selection of 0 through F is made on the configuration switch according to the following table:

| Unit number | sw3 | sw4 | sw5 | sw6 |
|-------------|-----|-----|-----|-----|
| 0 | F | F | F | F |
| 1 | F | F | F | O |
| 2 | F | F | O | F |
| 3 | F | F | O | O |
| 4 | F | O | F | F |
| 5 | F | O | F | O |
| 6 | F | O | O | F |
| 7 | F | O | O | O |
| 8 | O | F | F | F |
| 9 | O | F | F | O |
| A | O | F | O | F |
| B | O | F | O | O |
| C | O | O | F | F |
| D | O | O | F | O |
| E | O | O | O | F |
| F | O | O | O | O |

Where O = on and F = off

3.3.2 BAUD RATE SELECTION

WARNING - TURN OFF POWER BEFORE CHANGING BAUD RATE

Baud rate is selected by positioning a selector jumper on J1 on the main circuit board. The position farthest from the card cage is 600 baud and the positions are then as follows:

600
300
2400
4800
1200
9600

Units are normally shipped from the factory with the baud rate set at 2400 baud. This rate is recommended for most applications.

3.4 AC POWER INPUT

WARNING - POWER MUST BE 110VAC, 60HZ

The ANAFAZE 8 PID requires 110VAC at 60Hz for power input. A power on LED will indicate when power is applied.

WARNING - HIGH VOLTAGE MAY BE PRESENT WHEN POWER IS DISCONNECTED

3.4.2 POWER CONNECTIONS

The power must be connected according to the terminal labels. The abbreviations are:

| | |
|-----|--|
| GND | Third wire ground -- normally Green wire |
| NEU | 110VAC Neutral -- normally white wire |
| HOT | 110VAC Hot -- normally black wire |

3.4.3 POWER FUSE

A 1/4 amp fuse is located beneath the circuit board near the power terminals. Power to the ANAFAZE 8 PID must be removed before changing the fuse.

4.0 ANALOG INPUTS

Connecting analog signals to the ANAFAZE 8 PID is normally straightforward. Most signals, including thermocouples can be directly connected and mixed in any order. However, some problems may occur that could reduce accuracy and possibly damage the unit. Sections 4.1 through 4.4 indicate some of the potential areas for concern. [See typical input DIAGRAM in section 4.13]

4.1 COMMON MODE VOLTAGE

Common mode voltage is the voltage between the ground at the sensor and the ground at the ANAFAZE 8 PID. It can be an AC or DC voltage and appears equally at the high and low input terminals. Frequently it is caused by large currents flowing in the ground path between the ANAFAZE 8 PID and the sensors. The effects are minimized by locating the ANAFAZE 8 PID as close as possible to the sensors. Do not exceed the maximum common mode voltage of 125 volts AC.

4.2 NORMAL MODE VOLTAGE

Normal mode voltage appears across the terminals of the input and is the signal from the sensor plus any undesirable noise. The major cause of this noise is AC power line pick-up. The effects are reduced by the ANAFAZE 8 PID's capacity to integrate the signal over a multiple of the power line frequency. Further reduction can be achieved by locating the ANAFAZE 8 PID near the sensors and by using twisted and shielded sensor wires. Do not exceed the maximum normal mode voltage of 2 millivolts.

4.3 GROUNDING

For best accuracy, observe the grounding recommendations for connecting each input and output signal. The analog signal grounds should be connected to the ground terminals on the analog input terminals. The communication and control outputs should also be connected with their respective grounds. Do not mix the grounds or connect them together. The analog input section is optically isolated from the processing and control section. Connecting the grounds together will negate this feature and could damage the unit. If possible, route the analog signal cables separately from the communication, control and power cables.

4.4 SOURCE IMPEDANCE

Each sensor has a certain output impedance which is effectively connected across the ANAFAZE 8 PID input amplifier when a measurement is made. To reach the rated accuracy, the maximum source impedance should be 20 ohms. Consult ANAFAZE for operation with higher source impedance.

4.5 USE OF THE SHIELD CONNECTION

The shield connection provides a third input which is switched as each channel is measured. It is the ground reference for the measurement section. By switching this reference with every channel, the effective measurement ground can float to match the ground at the sensor, thus greatly reducing the error caused by different ground potentials (common mode).

The system is factory set for use with non-shielded cables. Jumper JU1 connects all low inputs to shield. Normally when non-shielded cables are used, this will result in the lowest noise pick-up.

If shielded cables are used, the shield should be connected to ground or the low signal output at the sensor if possible. If this is done, jumper JU1 must be removed and all non-shielded inputs must have a jumper connected between the low input and the shield input at the ANAFAZE 8 PID.

WARNING - USE SHIELD CORRECTLY

If the shield is used for any input always remove the factory installed jumper JU1. If the jumper is removed the shield must be individually connected for each input.

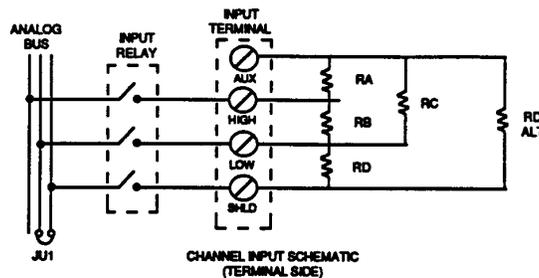
4.6 INPUT CIRCUITS

WARNING - PRODUCT CHANGE NOTICE

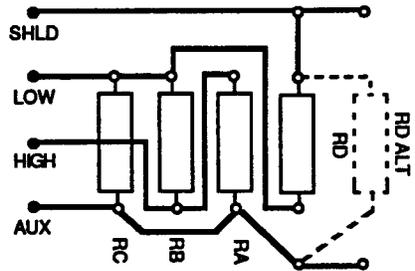
This section applies to serial numbers greater than 1333. After serial number 1333 the input circuit has been changed to add a position for a fourth input resistor.

The ANAFAZE 8 PID contains an isolated area that can be used to install resistors to scale input voltages and connect inputs to match the 0 to 60mv (0 to 100%) input range.

Inputs are scaled by installing resistors for each channel. The input circuit is designed to enable connection of current inputs (such as 4 to 20ma), for voltage inputs, and for connection of transducers (RTD) in bridge configurations. Please consult ANAFAZE for additional information. ANAFAZE will supply fully configured units for different applications—please consult the factory for a quotation. The input circuit is shown below:



RA, RB, RC, and RD are selected separately for each input and are labeled on the PC board for each loop. CH 1 (channel 1) is loop 1 etc. Resistors should be 1% metal film, 1/4 watt or better for higher accuracy. Other components such as capacitors can also be installed when required for signal conditioning. Please consult ANAFAZE. The resistors are normally soldered on the component side of the main PC board before installation. The silk screen shows the location of each input. The locations and interconnections are shown below for a typical input:



PC BOARD RESISTOR LAYOUT (COMPONENT SIDE)

4.7 VOLTAGE INPUTS

Voltage inputs should be connected with the positive side to the HIGH terminal and the negative side to the LOW terminal. The input range is 0 to 60 mv. Signals greater than 60 mv must be scaled with resistors to match the input full scale to 60 mv. For scaling the positive input should be connected to the AUX terminal and the negative input to the LOW terminal. Typical scaling resistors are as follows:

| | |
|---------------|---------------|
| 0 to 5v | 0 to 10v |
| RA = 4.75k | RA = 4.75k |
| RB = 649 ohms | RB = 301 ohms |

Please note section 4.5 regarding the shield connection.

Please note section 4.11 regarding scaling and calibration.

Using the suggested input, scaling resistors may cause additional error due to the value of R[b]. This possible error can be corrected by using MX+b. Call ANAFAZE for assistance.

4.8 THERMOCOUPLE INPUTS

All thermocouple types may be directly connected to the ANAFAZE 8 PID. Types J,K, and T linearization and cold junction compensation are provided standard in the ANAFAZE 8 PID. For other thermocouple types, optional input ranges are required. Thermocouples should be connected with the positive lead to the HIGH terminal and the negative lead to the LOW terminal. Note section 4.5 on shielding.

4.9 CURRENT TRANSMITTER INPUTS

Current inputs are accommodated by placing resistors in the input section to convert the current input into a voltage. Different current input ranges are accommodated by selecting the proper resistor values. In general RC is selected to maintain a low source resistance. RA and RC produce the input full scale of 60mv. The positive input should be connected to the AUX terminal, and the negative input to the LOW terminal.

The following input values are suggested:

| | |
|----------------|----------------|
| 4 to 20 ma | 0 to 10 ma |
| RA = 93.3 ohms | RA = 26.7 ohms |
| RB = 20.0 ohms | RB = 20.0 ohms |
| RC = 20.0 ohms | RC = 20.0 ohms |

Please note section 4.5 regarding the shield connection.

Please note section 4.11 regarding scaling and calibration.

4.10 INFRARED NON-CONTACT TEMPERATURE SENSORS

The ANAFAZE 8 IRSM infrared sensing module is ideally suited for many infrared non-contact temperature applications. It can be supplied by ANAFAZE as a fully integrated system with the controller configured to provide sensor power and for direct connection of the sensor input. The following connections are required if the IRSM internal ambient sensor is not used:

| ANAFAZE 8 PID | IRSM WIRES | | |
|-------------------|---------------------|--------|----------------|
| | Pin | Color | Function |
| AUX | A | Orange | Signal out |
| HIGH | -- no connection -- | | |
| LOW | B | White | Signal ground |
| SHLD | K | Shield | Shield |
| SPARE 1 (+5vdc) | E | Red | +5vdc supply |
| SPARE 2 (pwr gnd) | C | Black | power ground |
| SPARE 2 (pwr gnd) | J | Brown | no peak hold |
| No connections | D | Green | +15vdc supply |
| | F | Blue | Ambient sensor |
| | H | Yellow | Track and hold |

Resistor Values -- input is 0 to 10ma for 0 to 1000 deg F

| | |
|----|----------------|
| RA | RA = 26.7 ohms |
| RB | RB = 20.0 ohms |
| RC | RC = 20.0 ohms |
| RD | RD = not used |

If desired a second input can be used to monitor the IRSM internal ambient temperature. Please consult ANAFAZE for additional information.

4.11 SCALING AND CALIBRATION

Since a computer is used to display the reading and load the setpoints, a mathematical step can be used to convert measurements and setpoints to engineering units and correct for known sensor calibration errors.

For example, the ANAFAZE 8 PID does all thermocouple calculations in degrees F since this provides almost twice the resolution of degrees C. If degrees C display and setpoints are desired the computer makes the F to C conversion as data is received from the ANAFAZE 8 PID and converts the setpoints from C to F as they are sent to the controller.

In a similar manner, linear sensors can be converted to engineering units and adjusted for known calibration errors with a conversion step. For a linear sensor two outputs can be measured (x_1 and x_2) and converted into engineering units (y_1 and y_2) using the standard formula:

$$y = mx + b$$

where $m = (y_2 - y_1)/(x_2 - x_1)$
and $b = y_2 - mx_2$ or $b = y_1 - mx_1$

The same conversion formula can be used to convert the desired setpoint into a percentage of full scale which allows the ANAFAZE 8 PID to control to the actual measured signals while the computer displays the measurements and setpoints in engineering units. This approach eliminates the need for potentiometers and other analog adjustments on each input channel.

The ANASOFT PID software for the IBM PC and compatible computers includes these scaling functions as part of the menu driven program. Please consult ANAFAZE for additional information.

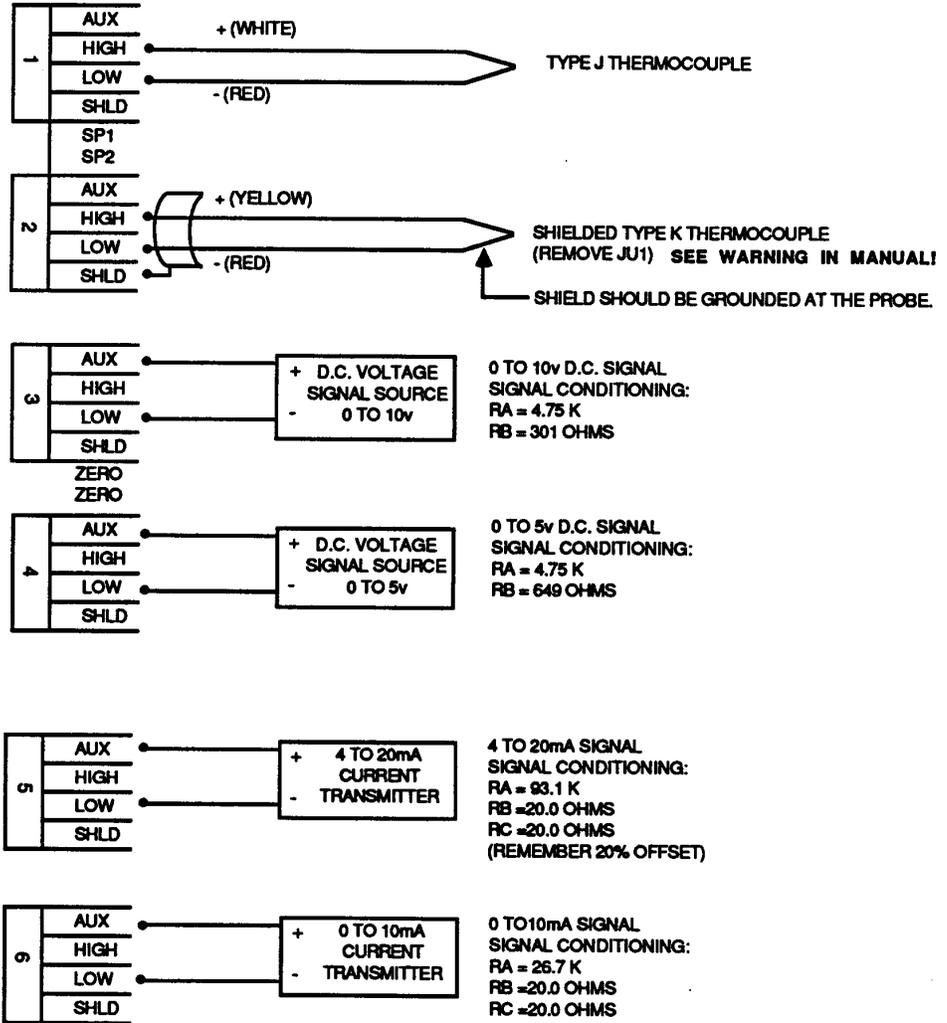
4.12 RTD INPUTS

RTD's can be connected in different configurations including bridge circuits, three wire and four wire -- please request a copy of the ANAFAZE RTD application bulletin.

4.13 DIAGRAM OF TYPICAL INPUTS

4.13 DIAGRAM OF TYPICAL INPUTS

SECTION 4.13 TYPICAL INPUTS TO ANAFAZE 8 PID



USE ONLY $\pm 1\%$ METAL FILM RESISTORS OR BETTER

THE RESISTOR VALUES ARE ONLY EXAMPLES AND MAY BE CHANGED AS NEEDED

5.0 CONTROL OUTPUTS

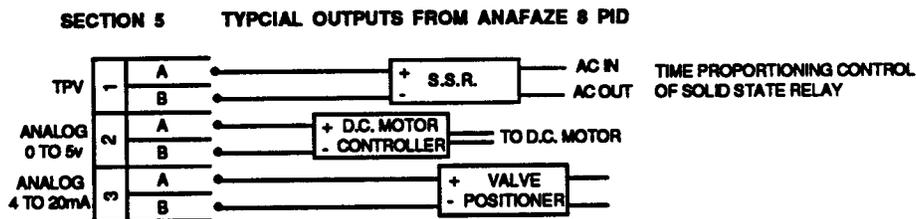
Control output boards are plugged into rear slots on the main circuit board as follows:

ANAFAZE 8 PID serial numbers above 2000 only.

| Loop | Slot |
|------|-------|
| 1 | OUT 1 |
| 2 | OUT 2 |
| 3 | OUT 3 |
| 4 | OUT 4 |
| 5 | OUT 5 |
| 6 | OUT 6 |
| 7 | OUT 7 |
| 8 | OUT 8 |

Comm COMM (communications interface)

Note: Use caution when inserting or removing boards. Power must be off and care must be taken to align the pins and insert the boards without bending the pins. Different plug-in boards allow a variety of outputs as shown in this DIAGRAM:



WARNING -- GROUND LOOP POTENTIAL

The ground of every control output card is connected to the ANAFAZE 8 PID logic ground. Use caution when connecting external devices that may have their low side at a voltage other than controller ground, since potential ground loops can be created. Use isolated relays or the isolated analog output card if possible grounding problems are expected.

5.1 TIME PROPORTIONING VOLTAGE

Time proportioning boards are available with voltage output primarily intended to drive optically-isolated solid-state relays. For relay outputs, or contactors the output should be connected through optically-isolated solid-state relays. The output is 6vDC at approximately 6ma. Terminal A for each loop is connected to the plus input on the relay, terminal B to the minus input.

The time proportioning output is turned on for a percentage of the ANAFAZE 8 PID cycle time according to the calculated control output. Thus if the calculation calls for 20% output and the cycle time is 5 seconds the output will be on for 1 second and then off for 4 seconds.

5.2 ON/OFF VOLTAGE

The on/off voltage board provides the same voltage output as the time proportioning voltage board except the cycle time is not used. If any level of control output is called for by the PID calculation, the output will be turned on and remain on until the calculated control output is zero.

5.3 ANALOG OUTPUT -- VOLTAGE OR CURRENT

Analog output boards can be configured for current (ma) or voltage (up to 10v) outputs. The plus side of the output is terminal "A" and the negative side is terminal "B" for each loop. Maximum loop impedance is 500 ohms. Units are shipped configured as ordered. To change the configuration of an analog output card, carefully remove the card from the card cage and change as follows:

For 4 to 20ma: J1 in, J2 in, remove R15
For 0 to 16ma: J1 in, J2 out, remove R15
For 0 to 10ma: J1 out, J2 out, remove R15
For 0 to 10v : No jumpers, R15 = 1k
For 0 to 5v : No jumpers, R15 = 499ohms
[use 1% metal film resistors]

5.4 ISOLATED ANALOG OUTPUT -- VOLTAGE OR CURRENT

The isolated analog output can be configured as above for voltage or current. To maintain isolation an external loop supply is required. The supply should be between 15VDC and 20VDC and is connected to screw terminals J2. The middle terminal is connected to the plus on the power supply, and the terminal adjacent to the J2 label is connected to the power supply minus.

5.5 DIGITAL INPUT

One digital input is provided for logic inputs that can be read from the computer. Connect signal to "IN" pin and signal return to "GND"

ON < 0.5V
OFF > 3.5V
2MA sink current

5.6 DIGITAL OUTPUTS

Two digital outputs are provided which can be set from the computer. Each output is an open collector transistor which is turned on when the output is set to "ON". The status of the outputs can be checked by the computer.

- Output 1 pin is labeled "AL 1".
- Output 2 pin is labeled "AL 2".

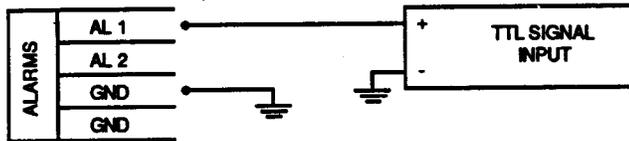
Each of the outputs can be configured as diagrammed:

SECTION 5.6

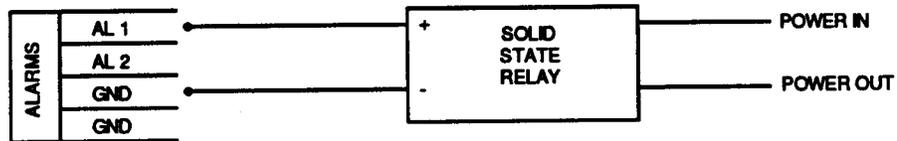
DIGITAL OUTPUTS ON ANAFAZE 8 PID

THREE MODES OF OPERATION:

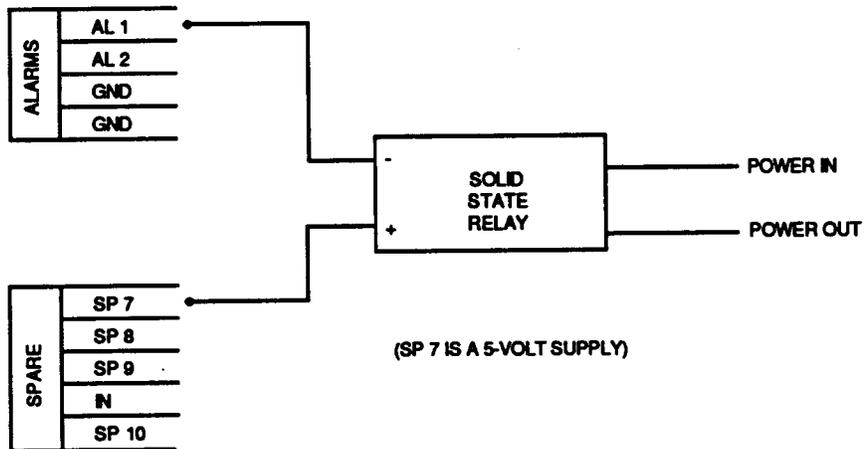
1. TTL Signal — Normally True (no alarm)



2. Driving Solid-State Relay — Normally On (no alarm)



3. Driving Solid-State Relay — Normally Off (no alarm)



1. As a TTL signal by connecting to "AL" pin and "GND".
ON < 0.5V at 4ma sink
OFF = 5V at 400ohm source resistance

2. To drive A 3-32V type solid state relay. **TRUE LOGIC**
Connect "AL" pin to - side of control input.
Connect +5V (pin "SP7" for S.N.P2000 and above) to + side of control input.

When output is on, relay turns on.
When output is off, relay turns off.

3. To drive a 3-32V type solid sate relay. **INVERTED LOGIC**
Connect "AL" pin to + side of relay.
Connect "GND" pin to - side of relay.
When output is on, relay turns off.
When output is off, relay turns on.

5.7 ALARM EXPANDER AND DIGITAL I/O

The optional alarm expander provides EEROM [memory] storage of control parameters and is highly recommended in critical situations. The Alarm expander also provides for 22 digital input and output lines. Please see the separate manual for this device.

6.0 OPERATION

The ANAFAZE 8 PID is operated using the communications interface according to the commands sent from the host computer. ANAFAZE provides a standard software package for IBM and compatible computers -- ANASOFT-PID. Alternatively a custom program can be written according to the guidelines in 6.2

6.1 ANASOFT-PID

ANASOFT-PID is a menu driven program that operates up to 16 ANAFAZE 8 PID controllers using an IBM PC or compatible computer. It provides a summary screen with color graphic displays of system operating conditions. A detailed, password protected, tuning screen allows entering of all control parameters, names for control loops, engineering unit and calibration factors, and other loop data. The program provides automatic data storage on diskette in LOTUS compatible files and automatic printout at user selected intervals. It is written in BASIC and is supplied complete with source listings and operating manual so it can be modified by users.

6.2 CUSTOM APPLICATION PROGRAMS

To begin operation, the following sequence is recommended:

1. Program the host computer to emulate a terminal.
2. Connect the host computer to the ANAFAZE 8 PID and operate the system manually from the computer keyboard.
3. Write applications software for the host computer and automatically operate the system.

6.3 TERMINAL EMULATION WITH THE HOST COMPUTER

A software program should be written that directs the host computer to operate through the communication interface as if it was a terminal. In writing the program the following commands and characteristics are to be taken into consideration.

A. Configuration Command- The communication interface is to be set for the proper baud rate, parity, and ASCII character format. The ANAFAZE 8 PID can be set for baud rates of 300, 600, 1200, 2400, 4800 or 9600. The ANAFAZE 8 PID does not use parity and requires one start bit, eight data bits, and one stop bit. See section 4.2 for a more detailed hardware description.

B. Character Output - Characters that are typed on the keyboard are transferred to the communications interface for output by the software. The ANAFAZE 8 PID requires commands that are ASCII capital letters and numbers which are terminated by a carriage return. Section 7 describes the commands.

C. Character Display- Characters that are received by the communications interface from the ANAFAZE 8 PID need to be transferred to the host computer display. All data sent from the ANAFAZE 8 PID is terminated by a carriage return and a line feed which formats the display.

The host computer manual provides the information needed to write this type of program. An example in BASIC is provided in Appendix 1 for the IBM PC. An alternative method for system checkout is to use a terminal to verify correct operation of the ANAFAZE 8 PID and the interface cable.

6.4 MANUAL OPERATION WITH HOST COMPUTER

After the software, as described in section 6.3, is written the host computer is connected to the ANAFAZE 8 PID as described in section 3. The system is tested manually by typing commands on the host computer keyboard and checking the response from the ANAFAZE 8 PID. All commands can be checked, channels programmed for input types, and data measured and displayed at the host computer. Check that baud rates and unit numbers are correctly set. **Please note that all letters must be CAPITALS.**

6.5 APPLICATION SOFTWARE

Application software can now be written using the terminal emulation software as a driver for the ANAFAZE 8 PID. The list below suggests some possible measurement and control routines for inclusion in application software.

- Ramp and Soak
- Profiles and automatic multi-job set-up
- Adaptive Control
- Auto-tune
- Cascade Control
- Graphics Displays

ANAFAZE maintains a staff of engineers that can provide assistance in generating software for custom applications. In addition ANAFAZE will design and implement your entire turn key hardware and software system. Please contact your local representative or ANAFAZE directly for a quotation.

Standard Input Types:

| Code | Input |
|-------------|-------------------------------|
| J | J thermocouple -50 to 1400 F |
| K | K thermocouple -110 to 2500 F |
| T | T thermocouple -120 to 750 F |
| U | 0 to 100%, 0 to 60mv |

See hardware sections for scaling milliamp and voltage inputs when using the U range.

Setpoints for millivolt inputs are in percent of full scale to the nearest 0.1% i.e., values from 0000 to 1000.

Setpoints for thermocouple inputs are in degrees F to the nearest degree.

Example: [NOTE: CR is carriage return, LF is line feed]

Command: C3J1200CR sets loop 3 as J thermocouple with 1200F setpoint

Response: C3J1200CRLF

To Query for the input type and setpoint:

Command: C(n)QCR

Example:

Command: C3QCR

Response: C3J1200CRLF

7.3 CONTROL CONSTANTS

To set the proportional (gain) value:

K(n)P(abc)CR K is the constant indicator
 n is the loop number 1 to 8
 P indicates the proportional constant
 abc is the value from 0 to 499

Example:

Command: K5P200CR sets the proportional gain loop 5 to 200

Response: K5P200CRLF

To query the proportional value:

K(n)PQCR

Example:

Command: K5PQRC

Response: K5P200CRLF loop 5 proportional gain is 200

To set the integral multiplier:

T(1)M(a)CR

T is the time indicator

1 affects all loops

M indicates the multiplier

a is the value from 1 to 3

Command affects all loops.

The integral multiplier sets the range and resolution of the integration time. Values can be input according to the following table with corresponding resolution:

| Multiplier | Range | Resolution |
|-------------------|---------------|-------------------|
| 1 | 0 to 255 sec | 1 sec |
| 2 | 0 to 510 sec | 2 sec |
| 3 | 0 to 765 sec | 3 sec |
| 4 | 0 to 1020 sec | 4 sec |

Example:

Command: T1M3CR sets integral multiplier to 3 for all loops

Response: T1M3CRLF

Note: Changing the integral multiplier after setting the integration time will cause the integration time to change.

To query the integral multiplier:

T(1)MQCR

To set the integration (reset) time:

T(n)I(abcd)CR

T is the time indicator

n is the loop number

I is the integral indicator

abcd is the value from 0000 to 1020 sec

The integration range depends on the integral multiplier, see above. [abcd must be divisible by the integral multiplier]

To query the integration time:

T(n)IQCR

To pre-set the integral sum value:

I(n)S(abcde)CR

I is the Integral indicator
n is the loop number 1 to 8
S is integral sum indicator
abcde is the value from 0 to 65536

Normally this is set to 0 when control is first started. Although the integral sum can be negative in the calculation it can only be preset positive.

Example:

Command: I2S00000CR sets integral sum to 0

Response: I2+00000CRLF

To query the integral sum value:

I(n)QCR

To set the derivative (rate) value:

T(n)D(abcd)CR

T is the time indicator
n is the loop number 1 to 8
D is the derivative indicator
abcd is the value from 0000 to 0255 sec.

Example:

Command: T4D0020CR sets rate to 20

Response: T4D0020CRLF

To query the derivative value:

T(n)DQCR

To set the digital filter on the control output

D(n)F(a)CR

D is the digital filter command
n is the channel number 1 to 8
F is the filter indicator
a is the filter value 0 to 15

Increasing the number provides additional filtering of the control output (slows the control response). The calculated control output for the last update is averaged with up to 15 times the previous output depending on the value entered for the digital filter. Digital filter values greater than 9 are entered by higher single character ASCII values as follows:

| Digital Filter | ASCII character |
|----------------|-----------------|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |
| 10 | : |
| 11 | ; |
| 12 | < |
| 13 | = |
| 14 | > |
| 15 | ? |

Example:

Command: D3F4CR sets digital filter level 4 for loop 3

Response: D3F4CRLF

To query for the digital filter value:
D(n)QCR

7.4 ANALOG (CONTROL) OUTPUT

To set the analog output and suspend PID control:

O(n)V(abcd)CRO is the output indicator

n is the loop number

V is suspend control indicator

abcd is the value 0 to 1023.

The output level can be set independently for each loop and used for open loop control. With control suspended the output does not have to be related to input in any manner.

The output level can only be set when control is suspended, sending this command with the "V" will suspend control and set the value. The controller is always computing the proper control output and therefore control can be switched on at any time with the following command.

The full scale output is 1023, or slightly better resolution than 0.1%.

The command can be repeated as needed to change the output level to any value desired.

Example:

Command: O7V0512CR suspends control and sets output to 50%

Response: O7V0512CRLF control is suspended, output fixed at 50%

To initiate PID control:

O(n)P0000CR O is the output indicator
n is the loop number
P is the start control indicator
0000 is a filler in the command

Example:

Command: O5P0000CR turn on PID control for loop 5

Response: O5P0213CRLF control is on for loop 5 output value is 213 out
of 1024 or 20.8% full scale.

The output value with control on is always changing as calculated by the control algorithm.

To query the value of the analog output (control on or off):

O(n)QCR

Example:

Command: O7QCR query analog output/status loop 7

Response: O7V0512CRLF control is suspended value is set at 50%

Example:

Command: O5QCR query analog output/status loop 5

Response: O7P0786CRLF control is on, output currently is 786 (78.6% full
scale)

To set the time proportioning cycle time:

T(1)R(abcd)CR T is a time indicator
1 indicates general command, all loops
R indicates cycle time
abcde is a multiplier of the 55ms base

The range is from 0 to 29,999. The cycle time is calculated as 55ms plus 55ms times the number entered. Thus the range is 0 to 29999 corresponds to 55ms to about 1650 seconds.

Example:

Command: T1R00090CR sets cycle time to about 5 seconds

Response: TR00090CRLF cycle time is about 5 seconds

To query the cycle time:

T1RQCR

7.5 DIGITAL INPUT AND OUTPUTS

To set the digital outputs and query the digital outputs and digital input:

M(a)(b)

M is the digital input output command

a is the I/O number as follows:

1 is output 1

2 is output 2

3 is input only, b must = Q

b is the command as follows:

O is output on (1&2 only)

F is output off (1&2 only)

Q is status query

Example:

Command: M1OCR turn on output 1

Response: M1OCRLF output 1 is on

Example:

Command: M1QCR check status of output 1

Response: M1OCRLF output 1 is on

Example:

Command: M3OCR **incorrect command** digital input cannot be set

Response: .CRLF response to incorrect command

7.6 ANALOG INPUTS

To read the analog input one input at a time

S(n)CR

S is the scan command

n is the loop number

The response is in degrees F for thermocouple inputs with resolution to 0.1 F. For all other inputs on the millivolt scale the response is in percent of full scale with resolution of 0.01%. A plus or minus sign follows the loop number.

Example:

Command: S3CR read analog input loop 3 (J/TC)

Response: S3+11867CRLF temperature loop 3 is 1186.7 F

Example:

Command: S6CR read analog input loop 6 (millivolt)

Response: S6+08765CRLF input is 87.65% full scale

To read analog inputs from all loops

SFCR SF is the Scan Fast command

The response is:

+abcd+efgh+ijkl+mnop+qrst+uvwx+yzab+cdefCRLF

+abcd is the sign and value for loop 1
+efgh is the sign and value for loop 2
+ijkl is the sign and value for loop 3
+mnop is the sign and value for loop 4
+qrst is the sign and value for loop 5
+uvwx is the sign and value for loop 6
+yzab is the sign and value for loop 7
+cdef is the sign and value for loop 8

The Scan Fast Command is a single command that returns the analog input value for each of the eight analog channels of the selected ANAFAZE 8 PID. The analog data is returned in a hexadecimal format to reduce the number of characters transmitted.

To calculate the value for each loop input, the digits are determined by taking the ASCII value of each digit (i.e., in BASIC a command like ASC(a)) and subtracting 48. This will result in values from 0 to 15. These values are then multiplied by powers of 16 for each digit. The least significant digit is the right most of the four. For example, the data for loop 1:

$$\text{value} = (\text{ASC}(\text{a})-48)*4096 + (\text{ASC}(\text{b})-48)*256 + (\text{ASC}(\text{c})-48)*16 + \text{ASC}(\text{d})-48$$

$$16 \text{ cubed} = 4096, 16 \text{ squared} = 256$$

This command can be used to reduce the communication time between the computer and the ANAFAZE 8 PID. Note that in multiple controller systems the desired controller must be selected prior to the SF (or any other) command.

Example:

Command: SFCR

Response: +032;+001;+0334+0333+033=+034>+61:8+31:~CRLF

the value for loop 8 is calculated from 31:~

$$3*4096 + 1*256 + 10*16 + 15 = 12719$$

As loop 8 is a J/TC this is 1271.9 F

The value is given in hexadecimal format where each character has the value between 0 and 15 per the following table:

| Value | ASCII Character | ASCII Code | |
|-------|-----------------|------------|-----------|
| | | (HEX) | (decimal) |
| 0 | 0 | 30 | 48 |
| 1 | 1 | 31 | 49 |
| 2 | 2 | 32 | 50 |
| 3 | 3 | 33 | 51 |
| 4 | 4 | 34 | 52 |
| 5 | 5 | 35 | 53 |
| 6 | 6 | 36 | 54 |
| 7 | 7 | 37 | 55 |
| 8 | 8 | 38 | 56 |
| 9 | 9 | 39 | 57 |
| 10 | : | 3A | 58 |
| 11 | ; | 3B | 59 |
| 12 | < | 3C | 60 |
| 13 | = | 3D | 61 |
| 14 | > | 3E | 62 |
| 15 | ? | 3F | 63 |

APPENDIX 1 - SAMPLE BASIC TERMINAL PROGRAM FOR IBM PC

This program will transmit characters entered on the keyboard to the ANAFAZE 8 PID and display them on the screen. Characters sent from the ANAFAZE 8 PID will also be displayed. The program is set for 2400 baud -- which is how the ANAFAZE 8 PID's are configured when they are shipped from the factory.

```
10
'*****
*
20 'TERMIN2 -- Terminal Emulation Program
30
'*****
*
100 CLOSE :OPEN "COM1:2400,N,8,1,RS,CS,DS," AS #1 'OPEN
COM
    1 2400 BAUD,NO PARITY
110 CLS:PRINT "TO OPERATE: ANY KEY PRESSED WILL BE SENT
TO
    THE ANAFAZE 8, ANY ANSWER WILL BE DISPLAYED"
120 IF EOF(1) THEN 130 ELSE N$=INPUT(1,#1):GOTO 120
'CLEARS BUFFER
130 A$=INKEY$
140 IF A$="" THEN 150 ELSE PRINT A$;:PRINT #1,A$;:GOTO
130
150 IF EOF(1) THEN 130 ELSE N$=INPUT$(1,#1):PRINT
N$;:GOTO 150
```

**ANAFAZE 8 PID
AEX (ALARM EXPANDER BOARD) OPTION
MANUAL SUPPLEMENT**

Revision 2
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ANAFAZE 8 PID AEX (ALARM EXPANDER BOARD) OPTION

ANAFAZE 8 PID MANUAL SUPPLEMENT

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WARNING

This unit operates with the ANAFAZE 8 PID controller. The controller manual including the warranty and WARNING for safe use are an integral part of this manual and must be read for safe use. ALWAYS USE EXTERNAL SAFETY DEVICES IF POTENTIAL UNSAFE PROCESS CONDITIONS CAN EXIST. THIS UNIT CAN FAIL IN UNEXPECTED WAYS -- POTENTIALLY UNSAFE CONDITIONS MUST BE EXTERNALLY GAURDED AGAINST.

1. THEORY OF OPERATION

The Alarm Expander Module (AEX) is an optional plug-in card for the ANAFAZE 8 PID that provides 22 discrete input/output lines and EEROM [memory] storage capability for PID loop constants and output states.

Of the 22 I/O lines, six are dedicated as inputs while the remaining 16 are user-selectable as inputs or outputs in groups of four. A combination of hardware jumpers and software direction commands is used to dictate data direction.

Loop constants and output levels are read from the EEROM on power up. This removes the need to download these values each time the process is started. At any time while running the user may command the PID to save all current operating parameters to EEROM storage for use as default values upon the next start-up.

The user may select one of two operational modes available: Automatic Alarm Mode and I/O Control Mode.

1.1 AUTOMATIC ALARM MODE

In the automatic alarm mode lines 0 to 15 are defined as outputs providing a high and low alarm signal for each of the eight loops on the ANAFAZE 8 PID. The user may set the upper and lower alarm setpoints for each channel through software. Lines 16 to 21 are still available as inputs.

1.1.1 ALARM MODE I/O LINE CONFIGURATION

The alarm mode input and output designations are as follows:

| I/O Line Nr. | Input/Output | Designation |
|---------------------|---------------------|--------------------|
| 00 | Output | Loop 1 High Alarm |
| 01 | Output | Loop 2 High Alarm |
| 02 | Output | Loop 3 High Alarm |
| 03 | Output | Loop 4 High Alarm |
| 04 | Output | Loop 5 High Alarm |
| 05 | Output | Loop 6 High Alarm |
| 06 | Output | Loop 7 High Alarm |
| 07 | Output | Loop 8 High Alarm |
| 08 | Output | Loop 1 Low Alarm |
| 09 | Output | Loop 2 Low Alarm |
| 10 | Output | Loop 3 Low Alarm |
| 11 | Output | Loop 4 Low Alarm |
| 12 | Output | Loop 5 Low Alarm |
| 13 | Output | Loop 6 Low Alarm |
| 14 | Output | Loop 7 Low Alarm |
| 15 | Output | Loop 8 Low Alarm |
| 16 | Input | User Designated |
| 17 | Input | User Designated |
| 18 | Input | User Designated |
| 19 | Input | User Designated |
| 20 | Input | User Designated |
| 21 | Input | User Designated |

1.1.2 ALARM DEADBAND

To prevent oscillating of the alarm output when the measured temperature hovers around the alarm setpoint, a deadband may be specified. The deadband is defined as a percentage of the setpoint for all 16 alarm settings.

For high alarms, the alarm output will be set when the measured temperature reaches the high alarm setpoint but will not be cleared until the temperature drops below its lower deadband limit.

For low alarms, the alarm output will be set when the measured temperature drops below the low alarm setpoint and will not be cleared until the temperature rises above its upper deadband limit.

The user may select an alarm deadband of 0 to 9 % of the setpoint. Refer to the command summary at the end of this section for further information.

Entering a deviation percentage of 0% (which is the default value) will result in no deadband and alarms will be set and cleared as measured temperatures cross the alarm setpoints.

NOTE: Entering a new deviation percentage will result in the 8 upper and 8 lower deadband limits being recalculated instantly. Entering a new alarm setpoint (high or low) for any loop will result in the deadband limit for that alarm setting being recalculated at that time.

1.1.3 GLOBAL ALARMS

Two global alarms are provided in Automatic Alarm Mode: one for high alarms and one for low alarms.

The alarm output AL1 on the PID is set if any one of the 8 Expander Card High Alarm Outputs is on. It is cleared when no High Alarm Outputs are Set on the Expander Card.

The alarm output AL2 on the PID is set if any one of the 8 Expander Card Low Alarm Outputs is on. It is cleared when no Low Alarm Outputs are Set on the Expander Card.

1.2 I/O CONTROL MODE

In I/O control mode lines 0 to 15 are under user control and may be defined as inputs or outputs and written or read accordingly.

Refer to the command summary at the end of this section for further information regarding commands to set, clear and interrogate the status of I/O lines.

2. HARDWARE DESCRIPTION

2.1 ANAFAZE 8-PID CONNECTION

The Alarm Expander Board plugs into the A8PID at connector J3 and connects to J2 by a short ribbon cable.

The alarm expander can be used with ANAFAZE 8 PID units with a serial number of 2000 and higher. Please consult the factory for information regarding earlier units.

2.2 EXTERNAL INTERFACE

The I/O interface is accomplished by a 50-pin flat cable connecting J1 on the AEX Board to an external I/O Module Board such as the GORDOS PB-24 or OPTO PB-24. The I/O Board accepts plug-in AC/DC INPUT/OUTPUT modules selected to match the users needs.

AEX Board J1 Connection Diagram

| J1 Pin Nr | I/O Line Nr. | J1 Pin Nr | Signal |
|-----------|--------------|-----------|--------|
| 01 | NU | 02 | Ground |
| 03 | NU | 04 | Ground |
| 05 | 21 | 06 | Ground |
| 07 | 20 | 08 | Ground |
| 09 | 19 | 10 | Ground |
| 11 | 18 | 12 | Ground |
| 13 | 17 | 14 | Ground |
| 15 | 16 | 16 | Ground |
| 17 | 15 | 18 | Ground |
| 19 | 14 | 20 | Ground |
| 21 | 13 | 22 | Ground |
| 23 | 12 | 24 | Ground |
| 25 | 11 | 26 | Ground |
| 27 | 10 | 28 | Ground |
| 29 | 09 | 30 | Ground |
| 31 | 08 | 32 | Ground |
| 33 | 07 | 34 | Ground |
| 35 | 06 | 36 | Ground |
| 37 | 05 | 38 | Ground |
| 39 | 04 | 40 | Ground |
| 41 | 03 | 42 | Ground |
| 43 | 02 | 44 | Ground |
| 45 | 01 | 46 | Ground |
| 47 | 00 | 48 | Ground |
| 49 | +5VDC | 50 | Ground |

2.2.1 CONNECTOR TYPES REQUIRED

The Alarm Expander Board is designed to interface directly to the PB24 Board with a 50 pin ribbon cable (optional...ANAFAZE P/N P2000). If the user wishes to provide his own cable, use a 50 pin socket connector, Spectra-Strip 802-050-002 or equivalent.

2.2.2 INTERFACE CHARACTERISTICS

The Alarm Expander interface circuitry is designed to interface to optical isolators to avoid problems caused by noise in an industrial environment. The user should use extreme care to avoid noise and ground loops if optical isolation is not used.

When I/O lines 00-15 are used as outputs (or in Alarm mode) they are active low and have the capability of sinking up to 24 mA. This load should be connected to a voltage not exceeding 5 VDC.

All inputs (lines 00-21) are also active low and source less than 1 mA when the input is low. The input voltage must be greater than 0 VDC and less than 5 VDC. A true input must be less than 0.8 VDC.

2.2.3 POWER REQUIREMENTS

The ANAFAZE 8-PID internal power supply can support the Alarm Expander and up to 160 mA total current to support solid state relays. If the PB-24 Board is used, the internal power supply will support all 16 outputs simultaneously. If any other output interface is used, the user should be careful not to draw more than 160 mA from the internal supply.

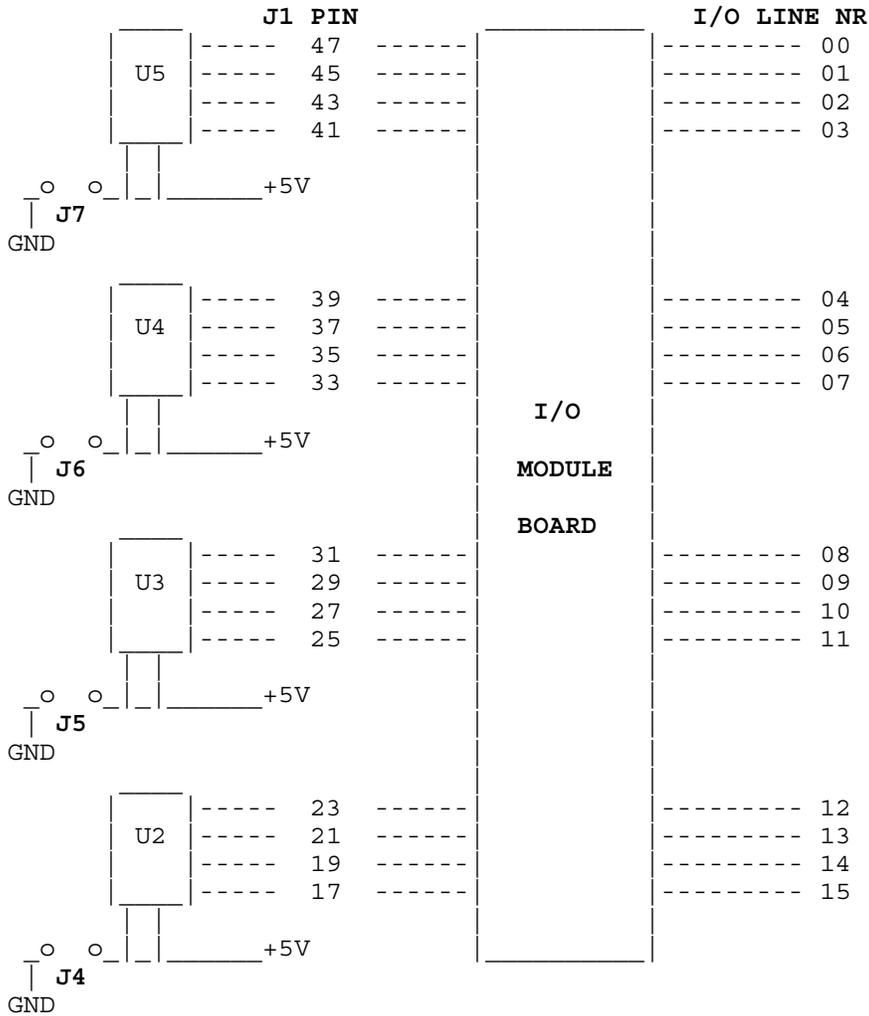
2.3 DATA DIRECTION JUMPERS

The AEX Board has four jumpers, one for each group of four lines that may be selected as inputs or outputs. These must be configured to match the desired I/O configuration. All four are factory installed in the default alarm mode in which all 4 groups (16 lines) are outputs. To use a four-line group as inputs the associated jumper must be removed (cut).

NOTE: Physical jumpers on the board **MUST** be properly configured to match software data direction initialization to prevent errors.

Refer to the diagram below for interconnection and jumper information:

EXPANDER BOARD



The four jumpers (J4, J5, J6 and J7) are located at the left side of the drawing and determine the data direction by tying the driver enable pins high or low.

With a jumper installed the associated four lines are defined as outputs. Without the jumper the four lines are defined as inputs.

3. COMMAND SUMMARY

All AEX commands are prefaced by the character 'X' to identify it as an "eXpander" card command.

I/O lines are addressed from 00 to 21 to correspond with I/O Module Board designations.

When writing to all outputs with a single command (See Section 3.8) a bit position is reserved for all 22 lines regardless of whether they are inputs or outputs. The unnecessary bits will not affect the status of input lines.

3.1 MODE SELECTION

XM(m) <CR> m is either A to select Alarm Mode
or C to select Control Mode

Example:

Command: **XMA <CR>**

Response: **XMA <CR><LF>**

To query the current AEX mode setting:

Command: **XMQ <CR>**

Example:

Command: **XMQ <CR>**

Response: **XMC <CR><LF>**

The controller will read the default mode from EEROM memory on power-up and is originally set to Alarm Mode. A mode selection command during operation will affect both the run-time and stored Mode setting.

If Automatic Alarm Mode is selected, Lines 0 - 15 are considered outputs and cannot be redefined.

3.2 ENTERING ALARM SETPOINTS

The user may enter a high and low alarm setpoint for each of the eight loops individually. When entered, alarm setpoints are interpreted within the context of the input type selected for that channel.

3.4 DEFINING I/O LINES AS INPUTS OR OUTPUTS (CONTROL MODE ONLY)

If Control Mode is selected the user may define the four groups of I/O lines as input or output for each group.

XD (abcd) <CR>

D is the Direction indicator a, b, c and d are either 0 or 1 indicating whether group 1, 2, 3 and 4, respectively, are inputs (0) or outputs (1).

Example:

Command: **XD0011 <CR>**

Sets group 1 and 2 (lines 0-7) as input and group 3 and 4 (lines 8-15) as outputs.

Response: **XD0011 <CR><LF>**

To query the data direction setting for the AEX:

XDQ <CR>

Example:

Command: **XDQ <CR>**

Response: **XD0011 <CR><LF>**

I/O line group data direction settings are read from EEROM upon power-up and microprocessor reset.

NOTE: Hardwire jumpers on the Expander Card itself **MUST** be configured to match the software setting of inputs and outputs or false data may be read. Jumpers J4, J5, J6 and J7 are factory-installed to configure the four banks as outputs. The user must remove (cut) jumpers for any banks he wishes to use as inputs.

3.5 READING INDIVIDUAL I/O LINE STATUS

All I/O lines, whether designated as inputs or outputs, may be queried see their HIGH or LOW status. All lines must be addressed by their two-digit I/O Line Nr (00-21). If the line specified is an input, the current input level will be reported. If the line specified is an output, then the output status will be reported.

XS (n) <CR>

S is the status indicator
n is the line nr. 00 to 21

Example:

Command: **XS03 <CR>**

Read I/O line nr 3

Response: **XS03F <CR><LF>**

Input 3 is OFF (LOW level TTL signal)

Or: **XS030 <CR><LF>** Input 3 is ON (HIGH level TTL signal)

3.6 SETTING INDIVIDUAL OUTPUT LINE LEVELS

I/O lines defined as Outputs may be set or cleared individually. Lines must be addressed by their two digit I/O Line Nr (00-15). It is the users responsibility to properly address lines designated as outputs although attempting to set or clear an input line will have no affect on that line.

XO (n)(a) <CR> O is the Output indicator
 n is the output line nr. 0 to 15
 a is either an "O" (output ON)
 or "F" (output OFF)

Example:

Command: **XO15O <CR>** Set output nr 15 ON (HIGH TTLsignal)

Response: **XO15O <CR><LF>** Output nr 15 is ON

3.7 READING ALL LINES

The status of all 22 I/O lines (inputs and outputs alike) may be retrieved with a single command to save time. The line status is returned in compact hexadecimal format with each bit representing one line. Refer to Section 3.10 for further explanation of this data format.

XSf <CR> S is the status indicator
 F is the fast scan indicator

Example:

Command: **XFS <CR>**

Response: **XS(abcdef) <CR><LF>**
 a is the value for lines 21 to 20
 b is the value for lines 19 to 16
 c is the value for lines 15 to 12
 d is the value for lines 11 to 08
 e is the value for lines 07 to 04
 f is the value for lines 03 to 00

Example Response Deciphering: Response: **XS3;2>:7 <CR> <LF>**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------|--|----|----|----|----|----|----|----|--|----|----|----|----|--|----|----|----|----|--|----|----|----|----|--|----|----|----|----|
| ASCII Char | | 3 | | ; | | 2 | | > | | : | | 7 | | | | | | | | | | | | | | | | |
| Dec Value | | 3 | | 11 | | 2 | | 14 | | 10 | | 7 | | | | | | | | | | | | | | | | |
| Hex Value | | 3 | | B | | 2 | | E | | A | | 7 | | | | | | | | | | | | | | | | |
| Binary Value | | 1 | 1 | | 1 | 0 | 1 | 1 | | 0 | 0 | 1 | 0 | | 1 | 0 | 1 | 0 | | 0 | 1 | 1 | 1 | | | | | |
| I/O Line Nr | | 21 | 20 | | 19 | 18 | 17 | 16 | | 15 | 14 | 13 | 12 | | 11 | 10 | 09 | 08 | | 07 | 06 | 05 | 04 | | 03 | 02 | 01 | 00 |

Once broken down to its binary format the response indicates that Lines 21, 20, 19, 17, 16, 13, 11, 10, 09, 07, 05, 02, 01 and 00 are all High (ON) and the rest are Low (OFF).

3.8 WRITING ALL OUTPUT LINES

All 16 possible output Lines may be set or cleared simultaneously with one command. The desired level of each line [1=High(ON) 0=Low(OFF)] is represented by one bit in a hexadecimal byte representing each four-line group. Refer to Section 3.10 for further explanation of this compressed data format.

To set the level of all output lines with one command:

XOF (abcd) <CR>

O is the Output indicator
 F is the Fast write indicator
 a is the value for output lines 15-12
 b is the value for output lines 11-08
 c is the value for output lines 07-04
 d is the value for output lines 03-00

Example:

Command : **XOF0000 <CR>** Set all outputs low (off).

Response: **XOF0000 <CR><LF>**

Command : **XOF1111 <CR>** Set lines 12, 08, 04, and 00 high (on).

Response: **XOF1111 <CR> <LF>**

Example Command Construction:

- Turn ON Lines 15, 14, 13, 12, 09, 04, 02
- Turn OFF Remaining Lines

| | | | | | | | | | | | | | | | | |
|---------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| I/O Line Nr | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
| Binary Value | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Hex Value | F | | | | 2 | | | | 1 | | | | 4 | | | |
| Dec Value | 15 | | | | 2 | | | | 1 | | | | 4 | | | |
| ASCII Char | ? | | | | 2 | | | | 1 | | | | 4 | | | |

Resulting Command: **XOF?214 <CR>**

3.9 SETTING THE ALARM DEADBAND

XAD(a) <CR> where a is the percentage (0-9)

Example:

Command : **XAD1 <CR>** Select a 1% deadband

Response: **XAD1 <CR> <LF>**

Example: Loop 3 High Alarm Set - 1000 F
 (J T/C) Low Alarm Set - 900 F
 Deadband Percent - 1 %

High Alarm will clear at 990 F
Low Alarm will clear at 909 F

Example: Loop 8 High Alarm Set - 0900 (90% FS)
 (Millivolt) Low Alarm Set - 0100 (10% FS)
 Deadband Percent- 1 %
 High Alarm will clear at 89.1% FS
 Low Alarm will clear at 10.1% FS

3.10 HEXADECIMAL DATA FORMAT

For the fast read and write commands (Sections 3.7 and 3.8) a compressed hexadecimal data format is used in which each ASCII character represents a value between 0 and 15 (0 thru F in hexadecimal).

Since it takes four binary bits to represent each of these hexadecimal characters (0-F), each character can hold the status of a four line group of I/O Lines. If the bit is a "1" the line is high (on). If the bit is a "0" the line is low (off). For the fast status read this requires six characters to cover 22 lines and for the Fast Output Write command four characters are required to handle 16 lines.

The ASCII characters are derived as per the following table:

| Value | Hex Value | Binary Value | ASCII Character | ASCII (Hex) | Code (Decimal) |
|-------|-----------|--------------|-----------------|-------------|----------------|
| 00 | 0 | 0000 | 0 | 30 | 48 |
| 01 | 1 | 0001 | 1 | 31 | 49 |
| 02 | 2 | 0010 | 2 | 32 | 50 |
| 03 | 3 | 0011 | 3 | 33 | 51 |
| 04 | 4 | 0100 | 4 | 34 | 52 |
| 05 | 5 | 0101 | 5 | 35 | 53 |
| 06 | 6 | 0110 | 6 | 36 | 54 |
| 07 | 7 | 0111 | 7 | 37 | 55 |
| 08 | 8 | 1000 | 8 | 38 | 56 |
| 09 | 9 | 1001 | 9 | 39 | 57 |
| 10 | A | 1010 | : | 3A | 58 |
| 11 | B | 1011 | ; | 3B | 59 |
| 12 | C | 1100 | < | 3C | 60 |
| 13 | D | 1101 | = | 3D | 61 |
| 14 | E | 1110 | > | 3E | 62 |
| 15 | F | 1111 | ? | 3F | 63 |

Examples:

I/O Line Nrs - Groups

| GROUP | 6 | | | | 5 | | | | 4 | | | | 3 | | | | 2 | | | | 1 | | | |
|--------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|--|
| LINE # | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 | | |
| Write Output | -- | -- | -- | -- | -- | -- | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | | |

Command: **XOF<3?1 <CR> <LF>**

- Turns on Outputs 15, 14, 09, 08, 07, 06, 05, 04, 00
- Turns off Outputs 13, 12, 11, 10, 03, 02, 01

| GROUP | 6 | | | | 5 | | | | 4 | | | | 3 | | | | 2 | | | | 1 | | | |
|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|--|
| LINE # | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 | | |
| Read Status | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | | |

Command: **XSf <CR>** Read all lines

Response: **XS301?91 <CR><LF>**

Indicates line status as in example above:

- Lines 21, 20, 12, 11, 10, 09, 08, 07, 04, 00 are High (ON)
- Lines 19, 18, 17, 16, 15, 14, 13, 06, 05, 03, 02, 01 are Low (OFF)