FISHER®
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Configuring CL6010, CL6210, and CL7010-Series Interactive and Computing Controllers

Configuration Engineering Manual
CE4.2:CL6211
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Documentation Map

Interactive and Computing Controllers

This map shows documents for interactive and computing controllers. The number, title, and binder location are shown for each document. To help you identify which document contains the information you are looking for, see the descriptions on the back of this map.

YOU ARE HERE

CE4.2:CL6211
Configuring CL6010, CL6210, and CL7010-Series Interactive and Computing Controllers

PN4.1:CD6201
Installing Type CD6201 Controller Operator Station Units
PN4.2:CL6011
Installing CL6010, CL6210, and CL7010-Series Interactive and Computing Controllers
PN4.4:CP6211
Installing Type CP6211 and CP6212 Controller Card File Units
PN4.10:DH6011
Installing Type DH6011 Data Concentrator Unit and Type DH6012 Redundant Data Concentrator Package

MM4.10:DH6003(A)
Maintaining Type DH6003, DH6011, and DH6012 Data Concentrator Units

X00206:CL6211—0

Fisher documentation supports each stage of system development.

System Development Stages	Document Type & Contents
System Design	*Configuration Engineering Manuals* Configuration data-entry help for a product, including theory of operation for improved product use. *User Manual for Configuration Products* Operating methods and procedures for using the configuration software. *Technical Reference Manuals* Advanced user information for expanding the capability of the PROVOX system.
System Planning and Installation	*Installation Planning Manuals* Site preparation, including the environment, power, and grounding. Also, product input/output signal wiring, cable connections, and software installation.
System Startup and Operation	*User Manuals* Operating methods and procedures for a product. *Tutorials* Structured training of operators.
Maintenance	*Maintenance Manuals* Preventative maintenance, calibration, troubleshooting, and repair procedures.

Ordering Information — To order additional manuals, contact your local sales representative, specifying the number, title, and quantity of each document required.

Interactive and Computing Controller Configuration Engineering Manual

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1 Introduction

1.1 Audience Description

This *Configuration Engineering Manual* contains the information needed to configure the Interactive and Computing Controllers, and is written for the configuration engineer who is familiar with these controllers and the ENVOX™ configuration system.

The Fisher Educational Services course in System Configuration provides training to the skill level required to effectively use this manual. *Using ENVOX Configuration Software* (UM4.14:SW3151) and this *Configuration Engineering Manual* supplement the information presented in this course, and may be used as reference documents during configuration.

1.2 Products Discussed in this Document

This document will deals with Type CL6011 / CL6012 Interactive Controllers and Type CL6211 / CL7011 / CL7012 Computing Controllers. These products are compatible with the ENVOX configuration system.

This document does not provide information relating to other PROVOX® devices, except where those devices directly affect, or are affected by, the Interactive and Computing Controllers.

1.3 Document Usage

If you are not familiar with the Interactive and Computing Controllers, read sections 1, 2, and 3. These sections describe how the PROVOX system works, and provide the operating theory for the Interactive and Computing Controllers.

If you understand the theory of operation for the Interactive and Computing Controllers, begin with sections 4 and 5; they provide practical configuration information.

1.4 Related Documents

The Documentation Map at the front of this manual shows the documentation for the Interactive and Computing Controllers. Additional reference documents are:

- *Using ENVOX Configuration Software* (UM4.14:SW3151)
- *Type CD6201 Controller Operator Station Unit* (Bulletin 4.1:CD6201)
- *Type CL6011 and CL6012 Interactive Controllers* (Bulletin 4.2:CL6011 and Bulletin 4.2:CL6011[S1])
- *Type CL6211, CL7011 and CL7012 Computing Controllers* (Bulletin 4.2:CL6211 and Bulletin 4.2:CL6211[S1])
- *Type CP6211 amd CP6212 Controller Card File Units* (Bulletin 4.4:CP6211)
- *Type DH6011 Data Concentrator and DH6012 Redundant Data Concentrator* (Bulletin 4.10:DH6011)

1.5 Document Content

The full contents of this document are described below, with additional detail shown in the table of contents.

Section 1 introduces this manual and includes the purpose of this document, the intended audience, and conventions.

Section 2 provides an overview of PROVOX DCS products, the Interactive and Computing Controllers, and an explanation of how each product is used in a PROVOX system.

Section 3 provides a description of the theory of operation of the Interactive and Computing Controllers.

Section 4 presents the information needed for configuring the Interactive and Computing Controllers.

Section 5 provides Interactive and Computing Controller configuration tips.

Appendix A contains loading and sizing information.

A glossary of process control terminology, an index of the information in this document, and a Reader Evaluation Form are also included.

1.6 Conventions

The following conventions are used in this document:

Abbreviations — The configuration system on-line HELP messages include the definition of abbreviations which are used in this document. The same information is also included in the glossary of this document.

Revision Control — The title page of each document lists the printing date of the document. The product version number covered in the document is listed in section 1.2

Cross Referencing — References to other documents for additional information list the document name. See the Documentation Map for the document number.

1.7 Excellence in Documentation

Our goal is to provide you with documents that excel in meeting your needs. Through surveys and interviews, we continually evaluate our documents as part of the broad Fisher customer-support program. Various documents are produced for different purposes and for readers with varying backgrounds and experience. This manual was written for the reader level described in section 1.1.

To help us evaluate how well this manual fills your needs, please complete the survey form included inside the back cover. If you have suggestions on ways to improve any page of the document, please mark your suggestions on a copy of the page and enclose the copy with the survey. Thank you for providing this information.

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2 Product Overview

2.1 PROVOX System Overview

A PROVOX system consists of a set of individual devices that are linked together by a communications scheme referred to as the PROVOX Data Highway. All communicating PROVOX devices are connected to this highway. Figure NO TAG illustrates the layout of a system and how the primary and secondary communication paths are connected.

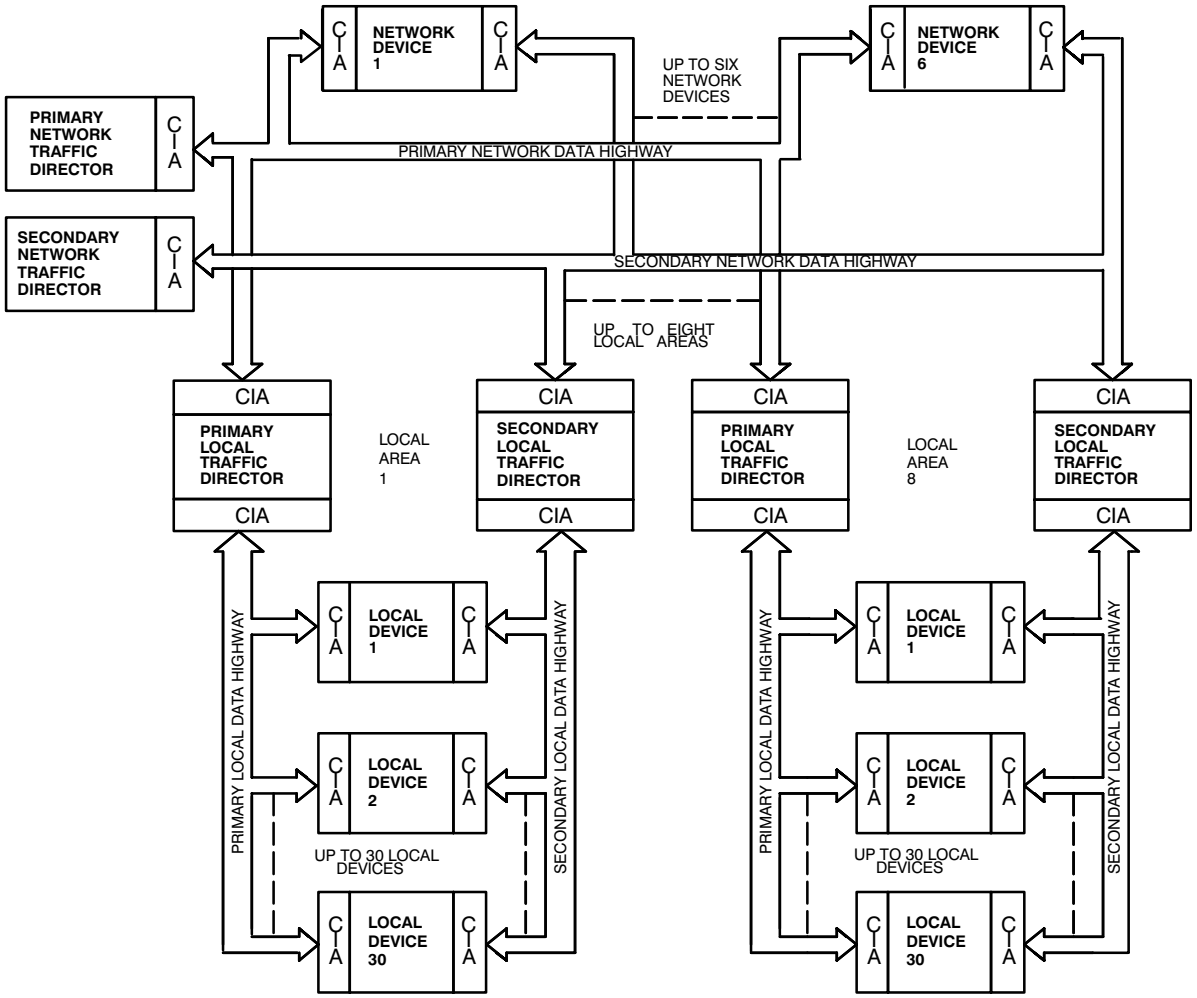

Figure 2-1. Typical Data Highway Installation with a Secondary Highway

The following paragraphs provide a brief description of each PROVOX device that can be connected to the PROVOX Data Highway. These devices can be connected as either network or local devices.

PROVUE® — The PROVUE operations consoles are a family of operator interface devices, each of which consists of an electronics unit and up to four high resolution color video display units. PROVUE consoles are used to operate processes being controlled by PROVOX devices.

ENVOX — An ENVOX workstation consists of an interface card file and a desk top computer with a Fisher configuration software package. It is used for configuring PROVOX devices, and for performing device diagnostics.

20-Series (SR90) Controller Family — The 20-Series (SR90) Controller Family is made up of three devices: the Multiplexer, the Integrated Function Controller, and the Unit Operations Controller. These controllers are referred to as a "family" because they share a common hardware and software platform, and are designed for batch and continuous control applications.

Programmable Controller Interface Unit — The Programmable Controller Interface Unit (PCIU) permits the monitoring of programmable controller (PLC) operation. Communication between the PLC and PCIU is conducted over an RS232C link.

Multiplexer — The Multiplexer is a data acquisition device that accepts input signals from a wide variety of analog, discrete, and pulse count sources.

Trend Unit — The Trend Unit allows the user to store or display selected process data from PROVOX devices. Trend data may be stored in RAM on a temporary basis or to floppy if a permanent record is desired. A display of the trended data may be viewed on a console and a hard copy may be made if necessary.

Local Traffic Director — The Local Traffic Director (LTD) is a highway device that controls communications between the devices on a local data highway. The LTD is also used to manage communications between a device on the local highway and a device on the network highway. Two LTDs may be used in a local area for redundant communication capability.

Network Traffic Director — The Network Traffic Director (NTD) is a PROVOX Data Highway device that controls the communications of network devices and communicates with the local areas through LTDs. Two NTDs may be used to provide redundant communication capability.

Computer / Highway Interface Package — The Computer/Highway Interface Package (CHIP) provides plant computers with access to the entire PROVOX process database. This allows users to do special calculations for optimization, reporting, process analysis, and other plant management tasks.

Application Software — Application software consists of packages such as Data Historian, Console Trend Display, and Batch Data Manager. These software packages perform a variety of data acquisition/management/display functions. Application software packages interface with PROVOX devices through the CHIP.

Data Concentrator Unit / Regulatory Controller — The Data Concentrator Unit (DCU) is a device which serves as a buffer between the PROVOX Data Highway and Configurable, Computing, and Interactive Controllers. These controllers are designed for continuous control applications.

2.2 The Computing Controller Unit

The Computing Controller is a user−configured, digital controller for continuous processes. It combines advanced computing power with linear and nonlinear control for single loop and cascade control applications. The controller can perform control tasks such as blending, temperature and flow linearization, pH control, and mass flow calculations. Operator interface is achieved through a system console or through a panel−mounted operator station.

The Type CL7011 Computing Controller Assembly consists of a printed circuit card that occupies one slot in a rack−mounted controller card file. The computing controller assembly employs a microprocessor for performing signal processing and communications. All calculations use floating−point arithmetic to reduce scaling requirements. Predefined control algorithms and functions are contained in the controller for simplified configuration. Because all configuration data are retained in nonvolatile memory, re−configuration of the controller after a power failure is normally not required. All process input and output (I/O), Data Concentrator, and power connections between the controller and the card file are made through the back edge of the controller card. Operator station communications and power are provided through a connector on the front edge of the controller card. The Type CL6211 Computing Controller Assembly consists of a Type CL7011 Computing Controller Assembly and a Type CD6201 Controller Operator Station Unit. The Type CL7012 Computing Controller Assembly is a redundant version of the Type CL7011 Computing Controller Assembly.

2.3 The Interactive Controller Unit

The Interactive Controller Unit (IAC) is a user−configured, digital controller for continuous processes. It has the control and computing capability to implement complex applications requiring interaction among several loops. The controller can perform complex strategies such as distillation column control, industrial boiler control, and combustion control. Operator interface is achieved through a system console or through panel−mounted operator stations.

The Type CL6011 Interactive Controller Unit consists of various printed circuit card assemblies and interconnect assemblies that are combined to form four models as follows:

- 2−wide unit
- 3−wide (with discrete I/O) unit
- 3−wide (with process I/O) unit
- 4−wide unit

Each of the four models contains a microprocessor unit (MPU) card assembly. The MPU card performs the central processing for the controller and handles all communications between the controller and devices on the data highway, such as a console. All calculations use floating− point arithmetic to reduce scaling requirements. The MPU card also produces and receives discrete signals to and from field devices.

In addition to the MPU card, each model also contains one or two Type CL7015 Process I/O Assemblies. The process I/O card accepts analog input signals from field devices, performs analog−to−digital and digital−to−analog conversions, and generates analog output signals to field devices. Since the process I/O card has its own microprocessor, it maintains all analog outputs independent of the MPU card for added security. Each process I/O card has two ports through which the controller can communicate with two operator stations.

Two of the interactive controller models contain a Type CL7014 Discrete I/O Assembly. The discrete I/O card receives discrete signals from field devices and produces discrete signals to field devices. In addition, the discrete I/O card has two operator station ports.

The 2−wide and 4−wide interconnect assemblies provide all the necessary electrical connections between the card assemblies. The Type CL7016 Interconnect Assembly (2−wide) provides connections between the two cards of the 2−wide model, occupying two slots in a controller card file. The Type CL7006 Interconnect Assembly (4−wide) provides connections between the three or four cards of the 3 or 4−wide models, occupying four slots in a controller card file. Both interconnect assemblies attach to the backplane of the controller card file; in this way, interconnects are made simultaneously with card file connections when the controller cards are installed in the card file.

The Type CL6012 Interactive Controller Assembly is a redundant version of the Type CL6011 Interactive Controller Assembly.

2.4 Controller/Data Concentrator Architecture

The Interactive and Computing Controllers are connected to the Data Concentrator as shown in Figure 2-2.

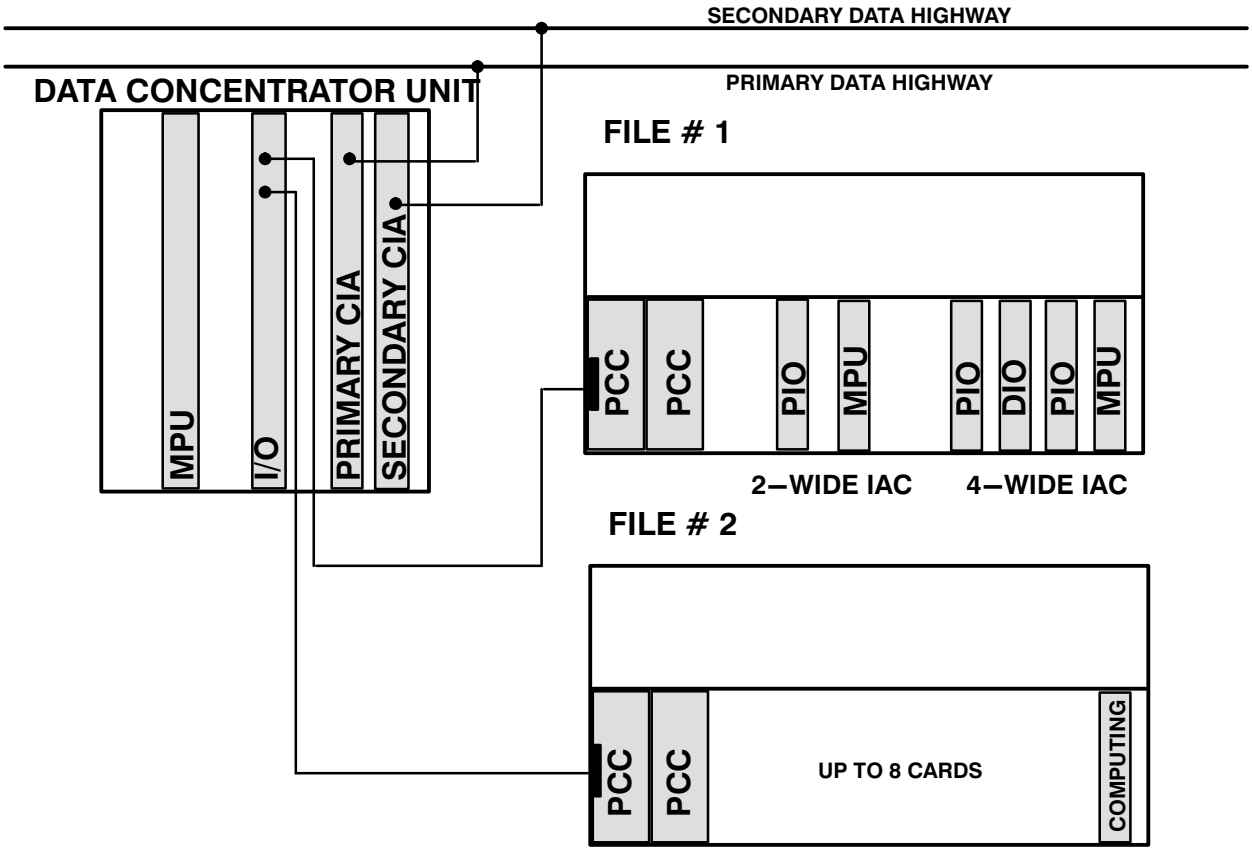

Figure 2-2. Controller/Data Concentrator Architecture

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3 Theory Of Operation

3.1 Operating States

3.1.1 Database Hold

A Regulatory Controller may power up in a state termed “Database Hold” or “No Configuration”, which simply means that the controller has not been loaded with a user configuration. A user configuration is required to allow the device to perform the desired algorithm(s). A Regulatory Controller in Database Hold is indicated by error “−7−” on an Operator Station, or the “Unavailable” integrity error on an operator’s console. To correct this condition, the user must download the desired configuration to the controller (see section NO TAG on page NO TAG for details concerning Upload/Download).

A controller may enter the Database Hold state under the following conditions:

- When first powered up after being received from the factory;

  Recovery − See the Installation/Maintenance manual

- After being un−powered for a time period exceeding 24 hours;
  Recovery − See the Installation/Maintenance Manual

- After rejecting an attempted user download that exceeds the capacity of the device (either a configuration error was detected during download, or the device limits, such as available RAM, have been exceeded).

  Recovery − The user should correct the configuration error, or reduce the size of the configuration, and re−attempt the download.

3.1.2 Normal Processing

After the controller has received a successful download of the user’s configuration, the controller enters the Normal Processing state. In this state, all of the normal controller functions are performed, such as point processing (input and output scanning, and control algorithm processing), communications processing, and self test operations.

3.1.3 Overload

The Computing and Interactive controllers can reach an overload condition, indicated by error "−0−" on the Operator Station, or an "error" integrity condition shown on an operator's console. This overload condition simply means that the controller has so much work to do, that it is not able to complete the control algorithm processing in each scheduled interval.

The overload condition could be caused by one or more of the following:

- Control Algorithm Loading (FST configuration)
- Communications Loading (Operator Stations, DCU Polling, or Redundancy)

Recovery from a sustained controller overload condition requires removal of the cause of the overload. This is most normally accomplished by modifying and downloading the controller configuration (such as either reducing the number of points configured in the controller, or reducing the size/complexity of the FST configuration).

For further details concerning the cause and effect of overload, see section 3.5.4 on page 3¿52 titled Communications Trade−offs (with Control).

3.2 Point Processing

3.2.1 Data Acquisition

A configured controller performs the following operations in sequence:

1. Scan all inputs (discrete and analog) for current data.
2. Process the control algorithm and logic specified by the controller FST.
3. Output all data to the output channels (discrete and analog).
4. Wait for the next time to run the control logic (steps 1 through 3 above).

This method of input/output scanning isolates the FST, and the output channels, from data value changes during the FST execution. That is, if you read the same input channel at two different points within the FST, you are assured to read the same value both times. Also, if you write to the same output channel twice during the execution of an FST, only the last value written will be detected at the output channel.

A similar "isolation" of the communication channels is also performed before and after the FST execution. This isolates the FST from data change requests received from an operator during the execution of an FST, such as Mode and SP changes. If an operating parameter is changed by both the FST and the Operator during the time of a single FST execution, the following forced precedence is enforced at the end of the FST execution:

Operating Parameter	Precedence
PV	Control
SP	Communications
IVP (Valve Output)	Communications
Mode	Control
Bias	Control
Ratio	Control

A side effect of this forced precedence is, if the control algorithm (FST) repeatedly forces an operating parameter change to a point on successive executions, the control algorithm can effectively "lock out" any operator changes to that operating parameter on that point. Details of this situation are included in section 5.6 (page 5-9).

An unconfigured controller (current state is "Database Hold" or "No Configuration") will still scan input channels, and force output channels; however the control algorithm (FST) is not being executed. This allows the Trace Utility to be used to examine controller input channels, and force controller output channel values (output override) if needed. Also note, when the transition from Normal Operating state to Database Hold

first occurs, the output channels are held at their last output value. See the User's Manual for a more complete description of the Trace Utility.

A controller which is in the Overload state is still processing inputs, executing the FST instructions, and writing to the output channels. However, this entire cycle takes longer than the allowed scan time for the FST (normally one−quarter second) − therefore, there is no delay to the start of the next cycle of events (that is scan inputs, FST, write outputs). If this situation is sustained, the controller will report the overload condition to the operator interface device(s).

3.2.2 Fast Scan Controllers

Certain models of the Computing and Interactive controllers are designed to execute the FST and control algorithms at a rate faster than the normal one−quarter second (4 Hz). These models operate at one−tenth second (10 Hz) and one−twentieth second (20 Hz) scan rates.

These models of the regulatory controllers may be needed for applications which require extremely fast response times to changing process conditions, such as pressure override, etc.

The architecture of the fast scan controllers is identical to the standard regulatory controllers. That is, the input/output scanning and FST execution are performed in the same sequence, and many of the trade−offs and constraints apply equally to all models of the regulatory controllers.

Note

Since the FST is executed more frequently on the fast scan controllers, the control algorithm must be simpler when implemented in a fast scan controller in order to avoid an overload condition. THE FAST SCAN CONTROLLERS ARE NORMALLY LIMITED TO SUPPORTING FEWER POINTS AND/OR FEWER FST STEPS THAN THE NORMAL SCAN RATE CONTROLLERS.

The configuration device does not specifically configure a fast scan version of the controllers. Therefore, loading checks and point count limits are not enforced by the configuration device.

For more detail concerning controller loading and estimation, please refer to Appendix A, Loading and Sizing Calculations.

3.3 Direct Control Points

The IAC and Computing controllers provide control of continuous processes through the use of direct control points (DCPs). The primary components of each DCP are a Primary Control Algorithm (PCA), and a station type. The PCA contains all of the intelligence (e.g., PID equations) necessary to transform the DCP's inputs into outputs. The station type is used to define the modes of operation (i.e., Manual, Automatic, etc.) that are valid for the point. The PCA and station also contain several functions, such as anti−reset windup, that can be configured to provide proper control of the process. Some of the functions, such as restart values, are common to both the PCA and station.

3.3.1 Primary Control Algorithms

Direct control points (DCPs) are available in five basic versions:

- Manual Loader
- Bias and Gain
- High/Low Signal Selector
- Proportional−Derivative with Bias
- Proportional−Integral−Derivative

Five advanced DCPs are also available:

- Error−Squared Proportional−Integral−Derivative
- Notch Gain Proportional−Integral−Derivative
- Adaptive Gain Proportional−Integral− Derivative
- Control Sequence
- Control Sequence with Bias

The names of these DCP versions are referred to as the Primary Control Algorithms (PCAs). The details of these PCAs are described in the following sections.

3.3.1.1 Manual Loader

The Manual Loader algorithm is the simplest type of DCP available in the Controller, and allows for manual control of the Implied Valve Position (IVP) of the DCP, i.e., the signal to the final control element will always equal the IVP value that is entered. The manual loader also allows an analog value to be monitored and displayed as the process variable of the DCP, and allows a process set point to be entered. While the process variable and set point of the manual loader DCP do not affect

the IVP, they do provide the ability to establish a reference point for the process (set point) and the ability to determine how the process variable compares to that reference point for alarming purposes.

The modes of operation which are valid for the manual loader PCA, manual (MAN) and Direct Digital Control (DDC), determine who is allowed to change the IVP value. While in manual mode, the point provides an operator with control of the IVP value. A host computer is allowed to change the IVP value when the point is in DDC mode. The operator is allowed to change the set point in either mode unless the set point has been configured to track the process variable while in DDC mode.

3.3.1.2 Bias & Gain

The Bias and Gain algorithm performs a linear transformation on the process variable of the DCP to convert it to IVP. The algorithm adds the bias value of the DCP to the process variable, and then multiplies the result by the configured gain value. Both the bias value and the gain value are tunable. Even though it has no effect on the IVP of the point, an adjustable set point value is available as a reference value to be used for alarms.

The two types of control action that are available for the Bias & Gain PCA are Direct and Reverse. Direct action causes the IVP of the point to increase if the PV increases. Reverse action causes the IVP to decrease if the PV increases. The effects of bias and gain on the PV are shown in Figure NO TAG for both direct and reverse control action.

It should be noted that the bias value and gain value are tuned independently of the valve action. For example, two parallel valves in a split range operation could both be direct acting even though one valve might be a “fail open” type and the other one a “fail closed” type.

The following equations describe the Bias and Gain algorithm:

Direct Action: $IVP = GAIN \cdot (PV + LOOP\ BIAS) + TBIAS$

Reverse Action: $IVP = 100 - GAIN \cdot (PV + LOOP\ BIAS) + TBIAS$

Note that TBIAS is zero if transfer bias ramping is not enabled. Refer to section NO TAG on page NO TAG.

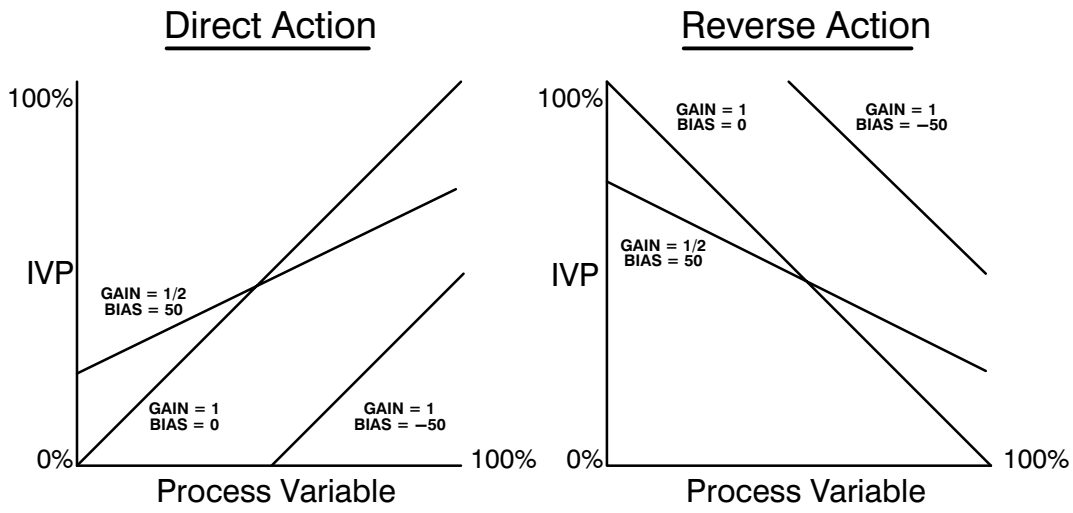


Figure 3-1 . Effects of Bias & Gain

3.3.1.3 High/Low Signal Selector

The High/Low Signal Selector algorithm is used to select an analog value from one of four process variable inputs when in automatic mode, and pass that value through the algorithm so that it becomes the IVP of the point.

The signal selector is typically used in override applications where its process variable inputs are the outputs of other points. For proper operation, the signal selector and its associated points must have the same increase open/close settings (e.g., a point that is configured as increase open must be connected to a signal selector that is increase open).

The signal selector can be configured to select the input that results in the highest IVP for the point, or the input that results in the lowest IVP for the point. A HIGH signal selector selects the input that will cause the highest IVP; LOW selects the lowest IVP. HIGH would be the highest voltage for an increase—open valve and the lowest voltage for an increase—close valve.

The signal selector allows for one to four inputs to be compared. The signal value of the “selected” input channel becomes the point’s process variable, and the process variable input to the alarms. The IVP is written into the set point value of the point, and is also used as the set point input to the alarms.

3.3.1.4 Proportional—Derivative with Bias

The Proportional—Derivative with Bias (P/PD with Bias) PCA provides a standard one or two mode control function. The P/PD with Bias PCA is normally used as a PD controller, but it also allows the derivative term to be tuned to zero to create a proportional—only controller.

The control algorithm can be viewed as a dual input, single output math function whose output is derived from the periodic execution of a set of positional control equations. The DCP's process variable is used as the first input, the DCP's set point is used as the second input, and the result of the control function becomes the IVP of the point.

The P/PD with Bias control algorithm is based on the following transfer function:

$$\frac{IVP(s)}{error(s)} = \frac{K(T_d s + 1)}{\alpha T_d s + 1}$$

where: T_d = rate time constant
α = rate action limiter; 0.125
K = proportional gain

By using the intermediate term DN(s), the transfer function can be rearranged to:

$$\frac{DN(s)}{PV(s)} = \frac{T_d s + 1}{\alpha T_d s + 1}$$

$$\frac{IVP(s)}{SP(s) - DN(s)} = K$$

These equations can be represented in the time domain as:

$$DN(s) = T_d \frac{dPV}{dt} + PV - \alpha T_d \frac{dDN}{dt}$$

$$IVP = K(SP - DN)$$

The equations shown are for reverse acting loops. The signs of the SP and DN terms are inverted for direct acting loops. Note that the SP term has been isolated so that rate action occurs only on changes to the PV, which is necessary to obtain good control action in response to set point changes. Also note that the rate action has been filtered to prevent the algorithm from over reacting to high frequency noise.

The P/PD algorithm will also allow bias and transfer ramping bias to be added. Refer to section NO TAG on page NO TAG. In this case, the final equations become:

$$IVP = K(SP - DN) + LOOP\ BIAS + TBIAS$$

3.3.1.5 Proportional—Integral—Derivative

The Proportional—Integral—Derivative (PID) PCA provides one, two, or three mode control capability based upon a positional control algorithm. The PID PCA allows the proportional and derivative terms to be tuned to zero, allowing the point to function as a PI, a PID, or an I—only controller.

Like the proportional—derivative with bias PCA, the PID control algorithm can be viewed as a dual input, single output math function. The point's process variable value is used as one input, the set point is the second input, with the resulting output of the math function being the IVP of the point.

The PID algorithm is based on the following transfer function:

$$\frac{IVP(s)}{error(s)} = \frac{K(T_i s + 1)(T_d s + 1)}{T_i s(\alpha T_d s + 1)}$$

where: T_i = integral time constant
T_d = rate time constant
α = rate action limiter; 0.125
K = proportional gain

By using an intermediate term, DN(s), the transfer function can be rearranged to:

$$\frac{DN(s)}{PV(s)} = \frac{T_d s + 1}{\alpha T_d s + 1}$$

$$\frac{IVP(s)}{SP(s) - DN(s)} = \frac{K(T_i s + 1)}{T_i s}$$

The equations can then be represented in the time domain as:

$$DN(s) = T_d \frac{dPV}{dt} + PV - \alpha T_d \frac{dDN}{dt}$$

$$IVP = K[(SP - DN) + \frac{1}{T_i}\int_0^{\infty} (SP - DN)dt]$$

Note that like the P/PD with Bias PCA, the set point term of the PID algorithm has been isolated so that rate action occurs only on changes to the PV, and that the rate action has been filtered to prevent the algorithm from over reacting to high frequency noise. Again, the equations shown are for reverse acting loops, and the signs of the SP and DN terms are inverted for direct acting loops.

A feature of the PID PCA that is not shown in the control equations is the concept of "one half proportional bands" that establish when the point's IVP will come off of its limits. As their name implies, the one half proportional band limits are positioned on either side of set point, with each limit one half of a control proportional band away from set point.

Once the IVP of a DCP is output limited, at which point the integral term of the equation stops winding up, it will not come off the limit until the process variable crosses its one half proportional band point. By design, the valve position will be 50% from the limit when the process variable crosses its set point.

Figure NO TAG illustrates the one half proportional band concept. As an example, one may consider the one half proportional bands of a DCP with a gain of 10. The proportional band is 10%, with each one half proportional band at 5% above and below the set point. If the set point is 70%, the one half proportional bands will be at 65% and 75%. Assuming the valve is closed and the IVP is at its low limit, as shown at Point A, the valve will not start to open until the process variable increases to 65% at Point B. When the process variable equals the set point at Point C, the process variable will have moved 5% past the one half proportional band limit at a gain of 10, which will cause the valve to move 50%.

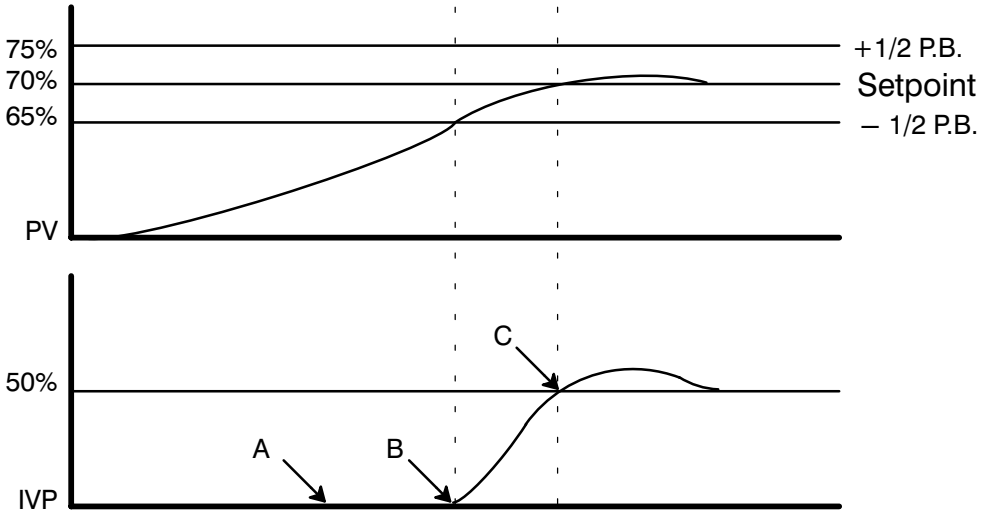


Figure 3-2. One Half Proportional Band Concept

One half proportional bands are built into each of the PID based algorithms, and are valuable on high gain DCPs where the valve output is at its output limit during a portion of the control cycle.

3.3.1.6 Error Squared

The Error Squared PI/PID PCA provides two or three mode control capability. The proportional gain of the algorithm changes as a function of the square of the error term, i.e. the effective proportional gain increases as the deviation between the process variable and set point increases. This action is illustrated in Figure 3-3. The control action is based on the following equations:

$$DN(s) = T_d \frac{dPV}{dt} + PV - \alpha T_d \frac{dDN}{dt}$$

$$IVP = K[\,|SP - DN| \cdot (SP - DN) + \frac{1}{T_i}\int_0^{\infty} (SP - DN)dt]$$

The Error Squared PCA, other than it's proportional gain feature, performs the same as the PID algorithm.

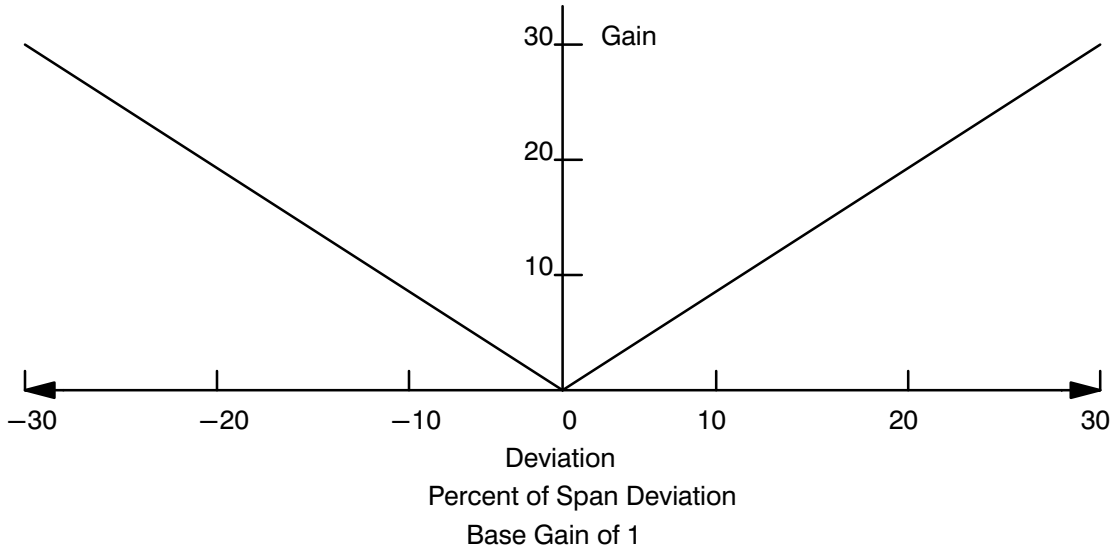


Figure 3-3. Error Squared Algorithm Response

3.3.1.7 Notch Gain

The Notch Gain PI/PID PCA provides two or three mode control capability in which the proportional gain of the algorithm changes based on the value of the process variable relative to it's upper and lower gain break points. The base proportional gain is multiplied by the Notch Ratio whenever the process variable is within the notch region established by the break points. The proportional gain is unchanged whenever the process variable is above the upper break point or below the lower break point. This action is illustrated in Figure 3-4 on page 3-12.

The control action is based on the following equations:

$$DN(s) = T_d \frac{dPV}{dt} + PV - \alpha\, T_d \frac{dDN}{dt}$$

$$IVP = K \left[(SP - DN) + \int_0^{\infty} \left(\frac{1}{T_i} \cdot (SP - DN) - K1 \cdot (1 - R) \frac{d(SP - DN)}{dt} \right) \right.$$

where: UBP= Upper Break Point
LBP= Lower Break Point
K1=ON/OFF Logic Switch
If UBP > PV > LBP Then
K1 = 1
Else
K1 = 0

Note that the integral and rate time constants are not affected by the notch ratio.

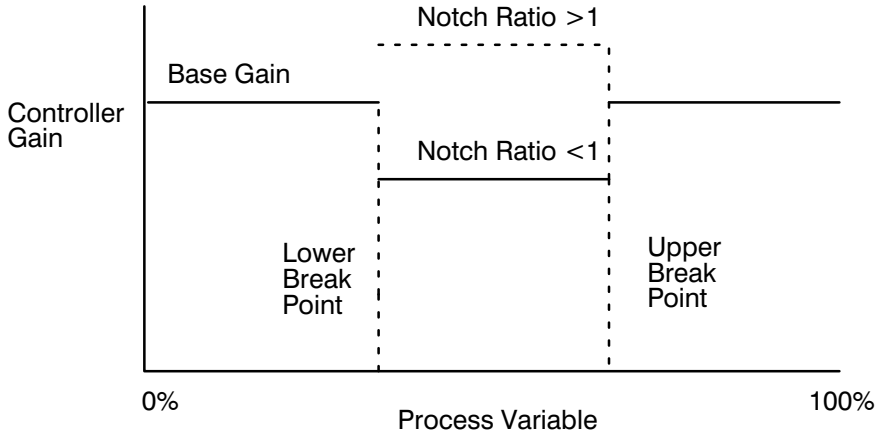


Figure 3-4. Notch Gain Algorithm Response

3.3.1.8 Adaptive Gain

The Adaptive Gain PI/PID PCA provides two or three mode control capability with the ability to modify it's proportional gain as a function of designated parameters. The process variable, the deviation between the process variable and set point, the implied valve position, an external analog value, an external discrete value, or any combination of these parameters may be used to modify the proportional gain of the loop.

There are two proportional gains associated with the adaptive gain PCA. The controller base gain is the gain that is tuned into the controller and modified by the adaptive gain control calculations. The active gain is the actual gain used by the controller. Each adaptive gain variable changes its adaptive gain factor for the loop. The total active gain is the product of all of the adaptive gain factors multiplied by the nominal base gain.

The total active gain is limited by the Gain Limit configuration item. The gain limit is a high limit when it is set above the base gain value and a low limit when it is set below the base gain value. The gain limit provides a “hard” limit that the active gain cannot exceed.

Process Variable Adaptive Gain — When the active gain is being modified by the process variable, it will change based upon the process variable value, the value of the upper and lower break points, and the upper and lower gain factors.

The upper and lower break points are adjustable values that divide the process variable span into three regions as shown in Figure 3-5 on page 3-14. The lower gain factor determines the gain when the process variable is below the lower break point. The farther below the break point the process variable is, the more the process variable adaptive gain factor changes. The upper gain factor determines the gain when the process variable is above the upper break point. The farther above the break point the process variable is, the greater the change in the adaptive gain factor. The process variable active gain factor is 1.0 when the process variable is between the upper and lower break points.

The resulting active gain changes linearly based on the difference between the break point and the adapting variable. The rate of change of the active gain is established by the respective gain factor. The gain factor is defined as the ratio of the base gain to the active gain when the adaptive variable is 10% of span from the break point. The gain factor is used to calculate the adaptive gain factor, which is computed as follows:

$$AGF = 1 - [(1 - GF)(DEV)/10]$$

The adaptive gain factor is then used to calculate the loop’s active gain.

A gain factor greater than one causes the active gain to increase as the adaptive variable moves away from the break point. A gain factor less than one causes the active gain to decrease as the adaptive variable moves away from the break point. The effect of gain factor changes is illustrated in Figure 3-5 on page 3-14.

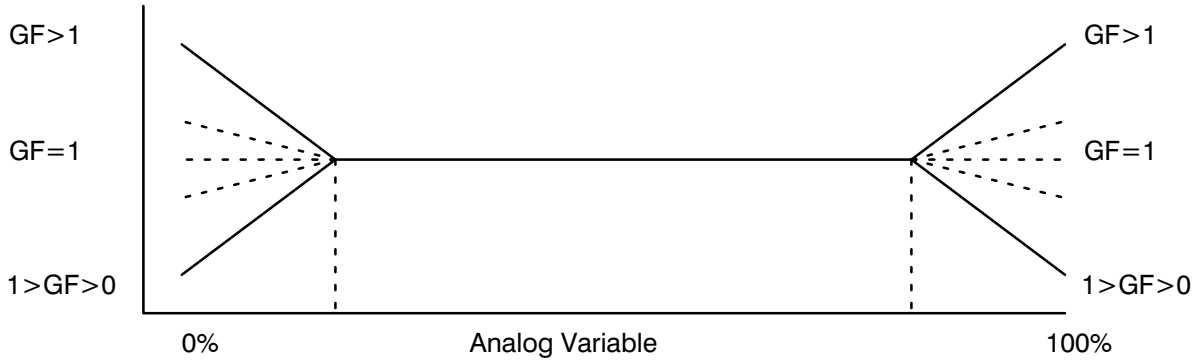


Figure 3-5. Process Variable Adaptive Gain

Deviation Adaptive Gain — The deviation signal (the difference between process variable and set point) may be used to modify the loop's active gain. The operation of deviation adaptive gain is similar to that of process variable adaptive gain except that the upper and lower break points are used to divide the positive to negative deviation span into three sections.

Analog Value Adaptive Gain — The Analog Adaptive Gain Modifier (AAGM) FST instruction allows an analog value to change the active gain of the loop. The analog value is assumed to be in engineering units. The analog value adaptive gain operates in the same manner as the process variable adaptive gain. See page 4¿29 for more information on AAGM instruction.

Implied Valve Position Adaptive Gain — The Implied Valve Position (IVP) adaptive gain function will change the loop's active gain based on the relationship of the IVP to the upper and lower break points and their respective gain factors.

The IVP adaptive gain factor will assume one of three values; the upper gain factor value, the lower gain factor value, or unity. The IVP adaptive gain factor will be set equal to the upper gain factor when IVP exceeds the upper break point. The IVP adaptive gain factor will be set equal to the lower gain factor when IVP falls below the lower break point. The IVP adaptive gain factor will be set equal to the unity gain when IVP is between the upper and lower break points. Figure 3-6 on page 3-15 illustrates the operation of the IVP adaptive gain function.

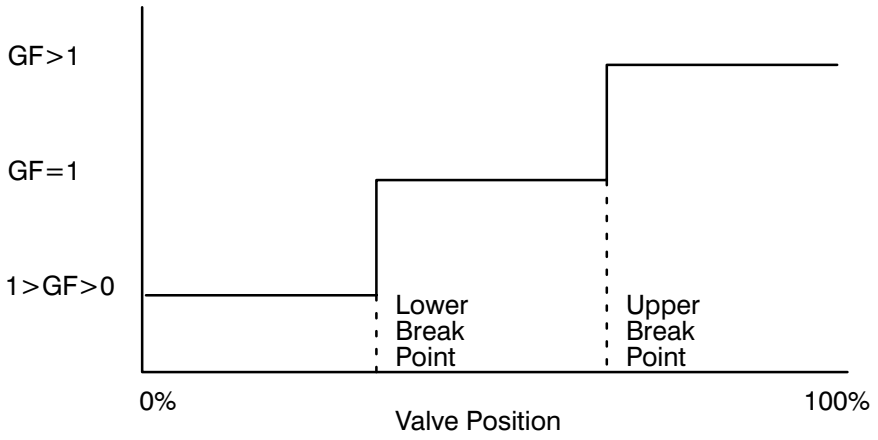


Figure 3-6. Implied Valve Position Adaptive Gain

Discrete Adaptive Gain — The Discrete Adaptive Gain Modifier (DAGM) FST instruction will change the loop's active gain based on the value of a discrete register or loadable function and the value of the discrete gain factor. The discrete adaptive gain factor will be set equal to the discrete gain factor when the discrete value is equal to one. The discrete adaptive gain factor will be set equal to the unity gain when the discrete value is equal to zero. Figure 3-7 illustrates the operation of the discrete adaptive gain function. See the FST Section for more information on the DAGM instruction.

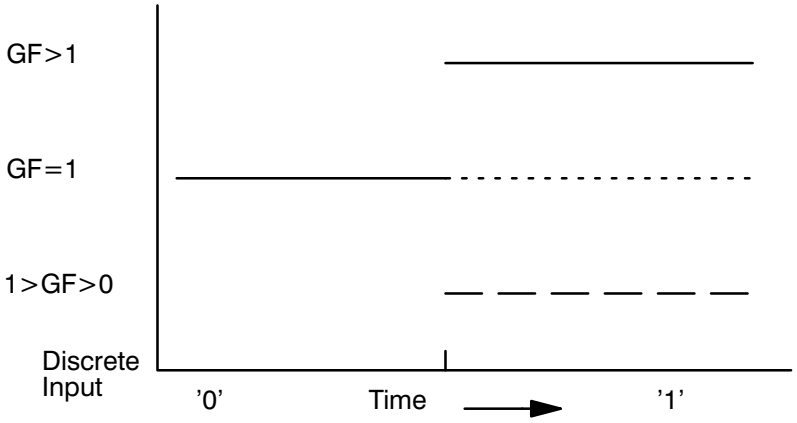


Figure 3-7. Discrete Adaptive Gain

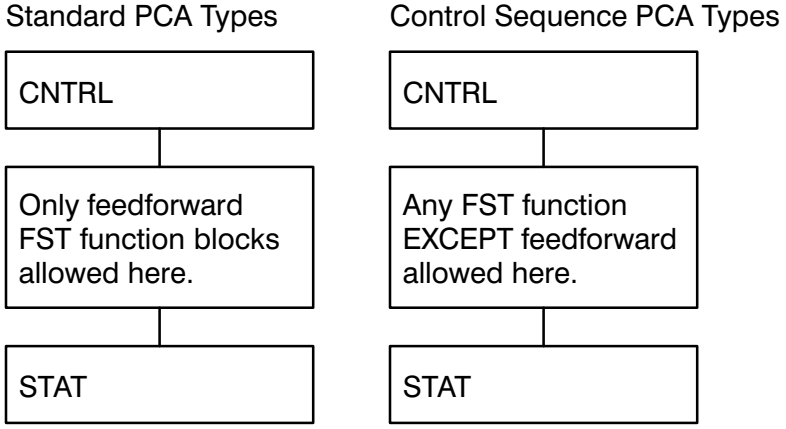
3.3.1.9 Control Sequence with and without Bias

The Control Sequence PCA provides a limited set of functions upon which a user—defined algorithm may be based. The Control Sequence PCA provides display and communications interface for the loop, and also calculates the difference between the loop's process variable and set point. Valve increase open/close adjustment, trip points for alarms A, B, C, and D, and set point high/low limits are also provided.

The Control Sequence PCA allows the user to customize the PCA computation to perform any unique control algorithm. A minimum set of standard features are provided by the CONTROL and STATION FST function blocks when the Control Sequence PCA type has been selected. These standard features include Operating Parameter display and communications support (PV, SP, IVP, Mode, Bias, and Ratio), parameter limiting, alarming, tracking, etc.

3.3.1.9.1 FST Configuration using Control Sequence PCA

The user may program any set of computations between the CONTROL and STATION FST blocks, using the standard FST functions. This is different from the "normal" PCA types, which will NOT allow the user to program any FST functions between the CONTROL and STATION FST blocks. These configuration restrictions are as follows:



Notice that the FST will not allow the user to configure any feedforward FST function block into this loop when the Control Sequence PCA type is selected. The user must accommodate any feed forward action required by including the FST logic necessary to support that feed forward action.

3.3.1.9.2 Equations for CONTROL FST Function Block

The Signal Value Analog (SVA) output of the CONTROL FST function block for a Control Sequence PCA type is equal to the loop deviation error (PV minus SP for direct action, or SP minus PV for reverse action). The SVA output value is always a percent deviation signal, computed after the PV and SP have been converted to percent on the Engineering Units scale. The Signal Value Discrete (SVD) output of the CONTROL FST function block is set to zero when the PCA is being initialized (such as after a power fail restart, or after any mode change is received), and is set to one whenever the PCA is performing all normal forward

calculations. (The configuration engineer can take advantage of this SVD output signal to initialize or balance any FST computations that are being performed in place of the standard PCA computations.)

The standard PCA functions such as SP limiting, SP velocity limiting, SP tracking, etc. are all supported by the Control Sequence PCA types when the CONTROL FST function block is executed.

3.3.1.9.3 Equations for STATION FST Function Block

The Signal Value Analog (SVA) input to the STATION FST function block for a Control Sequence PCA type must be a percent value equal to the valve position (current signal) to be sent to the final control element, exclusive of any Bias that is present on the loop. The equations for the STATION FST function block are:

SVA(out) = SVA(in) + Bias + Transfer Bias
for an increase open valve:
IVP = SVA(out)
for an increase close valve:
IVP = 100% − SVA(out)

The Signal Value Discrete (SVD) output of the CONTROL FST function block is set equal to the state of the deviation alarm (Alarm A).

The standard STATION functions such as IVP limiting, output tracking, Mode limiting, alarming, Transfer Bias ramping, Bias balancing (when Transfer Bias ramping is disabled), and Watch Dog Timer for DDC or Supervisory modes are all supported by the Control Sequence PCA types when the STATION FST function block is executed.

3.3.2 Station Types

The station type of a direct control point is defined by the modes that are valid for it (e.g., an Automatic/Manual station type). Several combinations of station types are valid, and are defined as follows: MAN, AUT/MAN, AUT/MAN/RSP, AUT/MAN/SUP, AUT/MAN/DDC, MAN/DDC, AUT/MAN/DDC/SUP.

The mode of operation for a direct control point primarily determines who can adjust the set point and IVP. The different modes that are available are: Manual (MAN), Automatic (AUT), Remote Set Point (RSP), Supervisory (SUP), and Direct Digital Control (DDC). The mode of a point can be changed by an FST or an operator at a PROVOX console or operator station.

3.3.2.1 Modes

Manual Mode (MAN): In MAN mode, the operation of the Primary Control Algorithm (PCA) is suspended, and the operator is allowed to adjust the IVP. If output tracking is enabled, and output tracking override in manual mode is enabled, the IVP is dictated by the track signal value. If the set point tracking in manual mode option is enabled, then the operator entered SP is overridden by the track signal value. Note that the set point has no effect on the IVP. The bias value can also be changed.

Automatic Mode (AUT): While in AUT mode, the set point and the bias (if applicable) are entered by the operator. All of the functions associated with the PCA are then executed, which determines the final IVP unless output tracking is enabled.

Remote Set Point Mode (RSP): RSP mode is similar to AUT in that the PCA functions, or output tracking if enabled, determine the final IVP. In RSP mode, the set point is received through a configured analog value, The bias value can still be entered by the operator.

Supervisory Mode (SUP): The SUP mode is similar to the RSP mode except that in SUP mode, the set point is received from a host computer. and is not operator adjustable. The bias value can still be entered by the operator.

Direct Digital Control Mode (DDC): In DDC mode, the operation of the PCA is suspended, and a host computer controls the IVP. The operator can still enter the set point unless the set point tracking in DDC mode is enabled, in which case the operator entered set point is overridden by the track signal value.

3.3.2.2 Mode Transfers

When a point is involved in a mode transfer, it is common for some or all of the operating data to change. The mode transfer logic for each direct control point guarantees that mode changes are bumpless and balanceless.

Any Mode to Manual: The present value of the IVP and set point are maintained until the operator initiates a change, unless Set Point Tracks PV in MAN mode is enabled.

Manual or DDC to Automatic: The present value of all operating data, including the set point and IVP, is used to initialize the PCA at the beginning of the transfer. If enabled, transfer bias ramping begins ramping the IVP from the value at the time of transfer to the value calculated by the PCA.

Manual to RSP: The present value of all operating data is used at the beginning of the transfer, with the exception of the set point, which is now input from the RSP input. The PCA initialization and transfer bias ramping (if enabled), are the same as in the manual or DDC to automatic transfer.

Automatic to RSP: During this transfer, the execution of the PCA is re−initialized because the source of the set point has changed. This is done to prevent a bump in the IVP due to a difference between the local set point and the remote set point. Transfer bias ramping, if applicable, will be performed on the output.

RSP or Supervisory to Automatic: For this transfer, the set point remains at its last established value until it is changed by the plant operator. The IVP will not change.

Manual to Supervisory: The present value of all operating data is used at the beginning of the transfer, with the exception of the set point, which is now supplied by a host computer. The IVP will not be changed unless transfer bias ramping is enabled.

Automatic to Supervisory: During this transfer, the PCA is re−initialized because the set point source has changed. This is done to prevent a bump in the IVP due to a difference between the local set point and the set point supplied by the host computer. Transfer bias ramping will be performed on the output if it is enabled; otherwise, the IVP will not change.

Manual or Automatic to DDC: This transfer causes the IVP to hold until changed by a host computer. The set point will not change unless set point tracking in DDC mode is enabled, in which case the set point will track the process variable.

3.3.3 Direct Control Point Details

3.3.3.1 Primary Control Algorithm Function Details

Primary Control Algorithm functions are items available for use with direct control points (DCPs) that are configured to set up proper control of the process. Their use depends on the requirements of the process. The details of these functions are described in the following sections.

3.3.3.1.1 Anti—Reset Windup

In a situation where a point has reached an output limit, and the integral action has been stopped to prevent windup, it may be desirable to have the IVP move very rapidly once it comes off of its limit. The Anti—Reset Windup (ARW) feature provides the option of having the integral term of a DCP unwind at a speed 16 times the normal, tuned reset speed. This feature reduces the effects of reset windup on process variable overshoot.

The PID PCA allows the user to establish limits based on the position of the IVP that define when the ARW action occurs. The ARW High Limit and ARW Low Limit values are used to determine the boundaries. When the calculated IVP exceeds an ARW limit but not an output limit, the integral action provides normal reset speed for “windup” towards the output limit and fast reset speed for “wind down” back to the ARW limit.

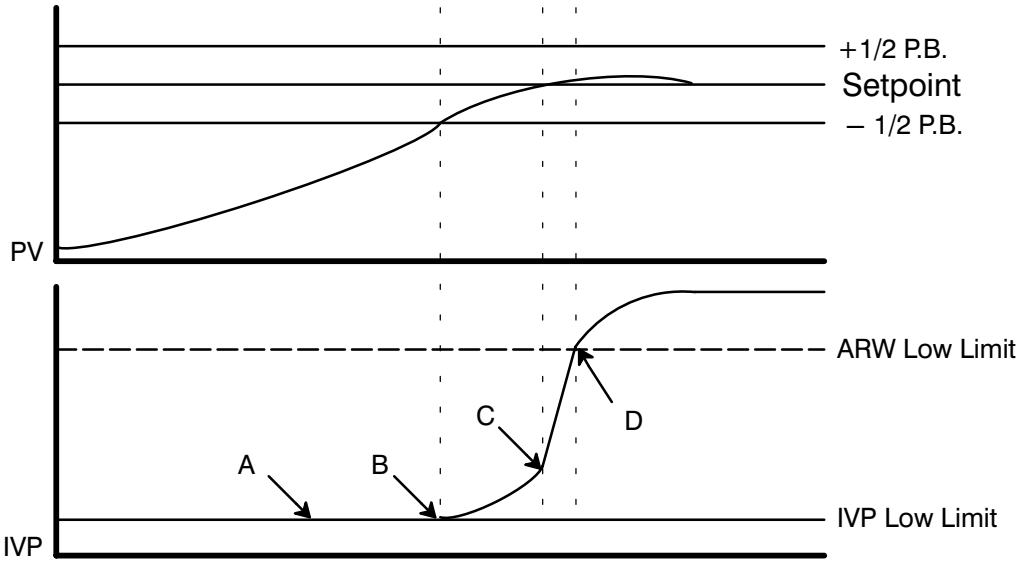


Figure 3-8. Anti—Reset Windup

In the example shown in Figure NO TAG, the IVP of the DCP has reached a lower limit at Point A. When the magnitude of the error term decreases to within 1/2 the proportional band at Point B, the IVP starts to come off of the limit. As the process variable crosses the set point at Point C, the sign of the error becomes negative. At this point, the integral term “winds down” at 16 times the tuned reset speed until the IVP reaches the ARW low limit at Point D. The normal reset action is then resumed. The fast reset speed quickly changes the magnitude of the integral term, resulting in less process variable overshoot.

3.3.3.1.2 Set Point Limiting

The set point limiting function is used to restrict the upper and lower limits of a DCP's set point, and prevent that set point from moving outside of the range established by a configured high and low set point limit. If a new set point is entered for the DCP, and that value exceeds the set point high limit, then the set point is set to that limit, and the SP High (SPHI) alarm bit is set to a value of 1. If the new set point is less than the set point low limit, then the set point is set equal to that limit, and the SP Low (SPLO) alarm bit is set to 1. The SPHI and SPLO alarm bits allow for operator indication at the console that either high or low set point limiting has occurred. Set point limiting is available on all PCAs except the high/low signal selector.

3.3.3.1.3 Set Point Velocity Limiting

All Primary Control Algorithms except Manual Loader, Signal Selector, and Bias and Gain support a feature called "SP Velocity Limiting". This configuration choice enables a tuning parameter which is then used to limit the maximum rate of change of the SP value used by the PCA, internally. Effectively, this limits the allowable change that the operator can make to the operating point of the process when in the Automatic control mode.

Note that the SP Velocity Limiting will limit the internal SP value, which is not displayed to the operator. The user simply selects the desired SP, and the PCA then limits the results of the operator change accordingly.

Since the SP Velocity Limiting only limits the internal SP value used by the PCA, the FST function SPLD (Set Point Load) will load the SP value selected by the operator, and the SVA output of the SPLD FST function will not reflect the velocity limited SP used by the PCA.

3.3.3.1.4 Transfer Bias Ramping

Bumpless transfers from the manual mode to the automatic mode on bias & gain and P/PD PCAs are achieved by either an internal transfer bias or a backward calculated DCP bias. Transfer bias ramping allows the normal DCP bias value to be maintained during a mode transfer. If it is not enabled, the normal DCP bias value is changed during the mode transfer and must be reset after the transfer has been completed.

When transfer bias ramping is enabled, the internal transfer bias value is back calculated to achieve a bumpless mode transfer. For example, if the IVP was 60% while the DCP was in manual mode, and the IVP should be 50% after the switch to automatic mode, the transfer bias value will be set to 10%.

After the DCP is in automatic mode, the transfer bias value ramps linearly to zero, which causes a corresponding change in the IVP. In the previous example, this would cause the IVP to ramp from 60% back down to the desired value of 50%. The time required for the transfer bias value to ramp to zero is tunable. A ramp time of zero will cause a bump in the IVP when the mode is changed from manual to automatic.

When transfer bias ramping is disabled, the normal DCP bias value is back calculated during a transfer from manual to automatic mode, and set to a value that will achieve a bumpless transfer. Once the mode transfer has been completed, the DCP bias value can be changed to any desired value. Figure 3-9 on page 3-22 shows the effects of a manual to automatic mode change on the bias and transfer ramping bias values of a DCP.

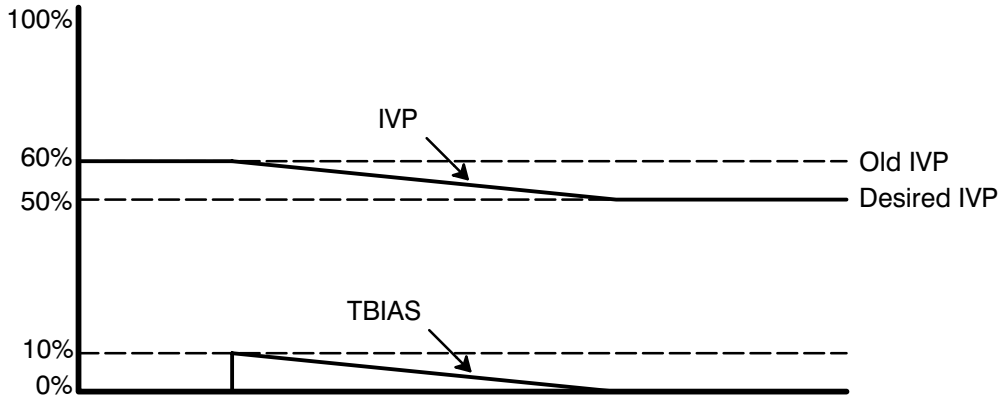


Figure 3-9. Transfer Bias Ramping

3.3.3.2 Primary Control Algorithm Modifiers

There are several function sequence table functions, such as dead−time compensation, that act as primary control algorithm (PCA) modifiers. These functions modify the PCA for specific applications. Descriptions of these functions follow.

3.3.3.2.1 Dead−time Compensation

The Dead−time Compensation function (DTC) extends the continuous control capability of a direct control point to include processes having significant reaction lag time compared to the dominant process time constant. The DTC function performs a Smith Predictor dead−time compensation algorithm, which models the process as a first order process having a gain, a time constant, and a dead−time. A model process variable value is then calculated, which is passed to the primary control algorithm as a pseudo−process variable.

The DTC function compensates the process variable in a series of calculations after alarming has been performed and the actual process

variable has been stored as the point's process variable attribute. The first step is calculating a model process variable using the Model Dead−time value. This model process variable is then used to calculate the model error by taking the difference between the model process variable and the actual process variable. The model error value is then corrected by adjusting either the model gain or the model bias, a choice which is dependent upon whether the primary process load disturbance modifies the process gain or the process bias. A second model process variable, which is the model of the process variable as it would appear without dead−time, is then calculated. This new model process variable also takes into account the Model Error, and is the process variable which is output from the compensation function to the PCA.

If the model process variable accurately reflects the actual process, then the model output cancels the process feedback signal. Under these conditions, the closed loop characteristics are only a function of the controller and the process model without dead−time. An improvement in control is then possible because of the elimination of dead−time from the model equation. This option is available only with the PID PCA.

The DTC function allows for a reset to be used to disable the function. When the reset value is a logic 1, the function is disabled. When the reset value is set back to a logic 0, the function re−initializes and starts performing its compensation routine.

3.3.3.2.2 Override

The override function causes the output of the control algorithm to perform either output or integral tracking. When output tracking is enabled, the control algorithm output tracks the specified track signal value when the point is in auto, RSP, SUP or DDC modes. This function also allows for output tracking to override manual mode. When output tracking is disabled and integral tracking is enabled, an analog value is read in from the specified track signal value and is substituted for the calculated integral term in the control algorithm.

Note

To avoid loop windup in override control applications for which integral tracking (operand 4) is enabled, place a FIL function and a RGST function immediately after the AOUT function of the loop containing the signal selecting operation. The name of the general register used by the RGST function is then specified in operand 2 of the OVRD function. Refer to section NO TAG (page NO ATG) for instructions on determining the correct filter time constant. Refer to the FST configuration section for more details on the individual functions.

3.3.3.2.3 Track

The track function modifies the tracking characteristics of a point. It causes the output of the control algorithm to track the specified track signal value when tracking is enabled. This function also allows for tracking to override manual mode.

3.3.3.2.4 Gas Chromatograph Interface

Gas Chromatograph Interface (GCI) performs a sample and hold operation on the process variable input whenever the GCI data ready input makes a 0 to 1 transition. The GCI function will enable integral control action for the length of time specified (controller on—time) after the GCI data ready input has made a 0 to 1 transition. The controller integral action is then held after the controller on—time has elapsed. There will be no change to the output of the control algorithm when the integral action is held because the GCI function is holding its output which would be the process variable to the control algorithm. When used, the feedforward function is active when the control algorithm is being held by the GCI function. Therefore, the output from the station will change when there is a change in feedforward control action.

If a new GCI data ready input is not received by the time the specified timeout time has elapsed, the GCI function sets the point to the manual mode and sets the discrete signal value output of the GCI function block to a logic 1 to indicate timeout. A new data ready trigger will reset the discrete signal value output to a logic 0, but will not automatically switch the mode.

3.3.3.2.5 Cascade

The cascade function provides cascade control linkage between two direct control points; the second of which must have remote set point mode. The implied valve position (IVP) of the primary loop is automatically placed into the set point of the secondary loop when the secondary loop is in the remote set point mode.

When the secondary loop is in the manual mode, the IVP of the primary loop tracks the process variable of the secondary loop.

When the secondary loop is in the local automatic mode, the IVP of the primary loop tracks the local set point of the secondary loop.

When the secondary loop is in the remote set point mode, the IVP of the primary loop becomes the set point of the secondary loop.

The primary loop will perform normal PID control action when the secondary loop is in the remote set point mode and the IVP of the secondary loop is not output limited. When the IVP of the secondary loop is output limited and a change in the primary loop's IVP will cause the secondary loop to drive harder against its output limit, the integral action will be disabled in the primary loop. This will prevent the primary loop from winding up its output when the secondary loop is already output limited in the direction the primary loop is tending to drive the secondary loop.

3.3.3.3 Station Function Details

Station functions are items available for use with direct control points (DCPs) that are configured to set up proper control of the process. Their use depends on the requirements of the process. The details of these functions are described in the following sections.

3.3.3.3.1 Alarm Processing

Each DCP is automatically configured with three standard alarms. Two of these alarms (Alarm B and C) are absolute high/low alarms, the third one (Alarm A) is a deviation alarm. These alarms are based on the process variable and set point of the DCP. Two function sequence table (FST) function blocks must be used to activate discrete outputs with the alarm states. The desired alarm must first be loaded into the discrete signal value using the Alarm Monitor Load (ALMLD) function (page 4¿42). The discrete signal is then directed to the discrete output using the Discrete Output (DO) function (page 4¿64). When the alarm is set, the configured discrete output will be set to 1. When the alarm is cleared, the configured discrete output will be set to 0. To obtain reverse logic, a logical inverse (NOT) function (page 4¿128) can be placed between the ALMLD and DO functions.

In addition, alarm D is available as a user−defined alarm. It is implemented using the Alarm Store (ALMST) FST function (page 4¿44). When the discrete signal value input to the ALMST function is a logic 1, the alarm is set. When the discrete signal value input to the ALMST function is a logic 0, the alarm is not set.

Absolute Alarms

Absolute alarms monitor the process variable of a point, and may be individually configured as high or low alarms. If an absolute alarm is configured as a high alarm and the value of the process variable goes above the alarm trip point, then the alarm is set. When the process variable falls below the level defined by the trip point minus the deadband, the alarm is cleared.

Similarly, if an absolute alarm is configured as a low alarm and the value of the process variable goes below the trip point, then the alarm is set. When the process variable increases above the level defined by the trip point plus the deadband, the alarm is cleared. Figure 3-10 illustrates the relationship between the process variable, the alarm trip points and the deadband.

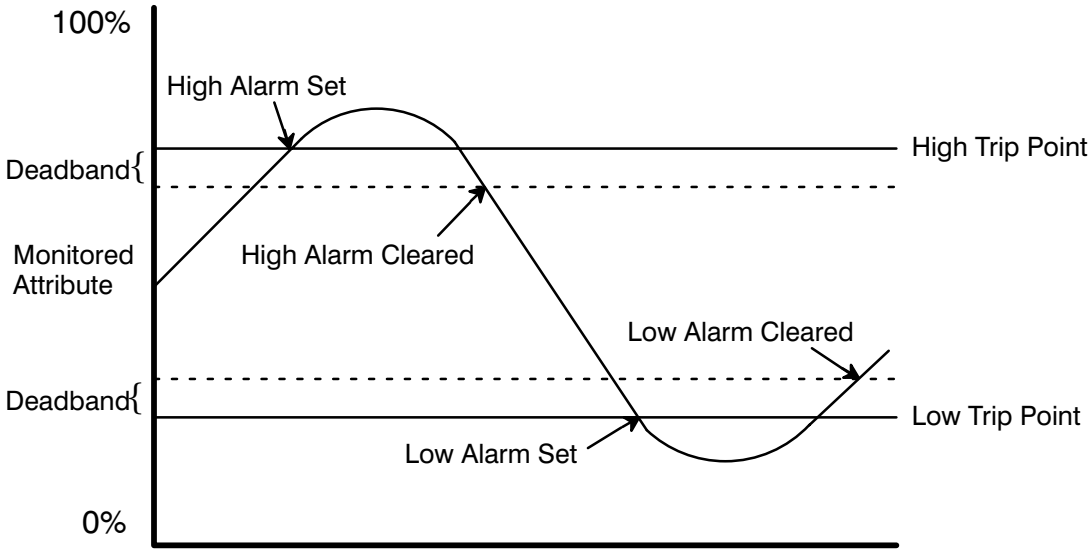


Figure 3-10. Absolute Alarms

The absolute alarm equations are shown below:

The alarm is set if: PV >= HTP or PV <= LTP
The alarm is cleared when: PV < (HTP − DB) or PV > (LTP + DB)

Where:
DB = deadband
HTP = high trip point
LTP = low trip point
PV = process variable

Deviation Alarm

A deviation alarm is triggered when the absolute value of the difference between the process variable and the set point exceeds the value of the deviation alarm trip point. The deviation alarm is cleared when the absolute difference between the process variable and the set point is less than the value of the deviation alarm trip point minus the deadband. Figure 3-11 shows the points at which the deviation alarm is set and cleared.

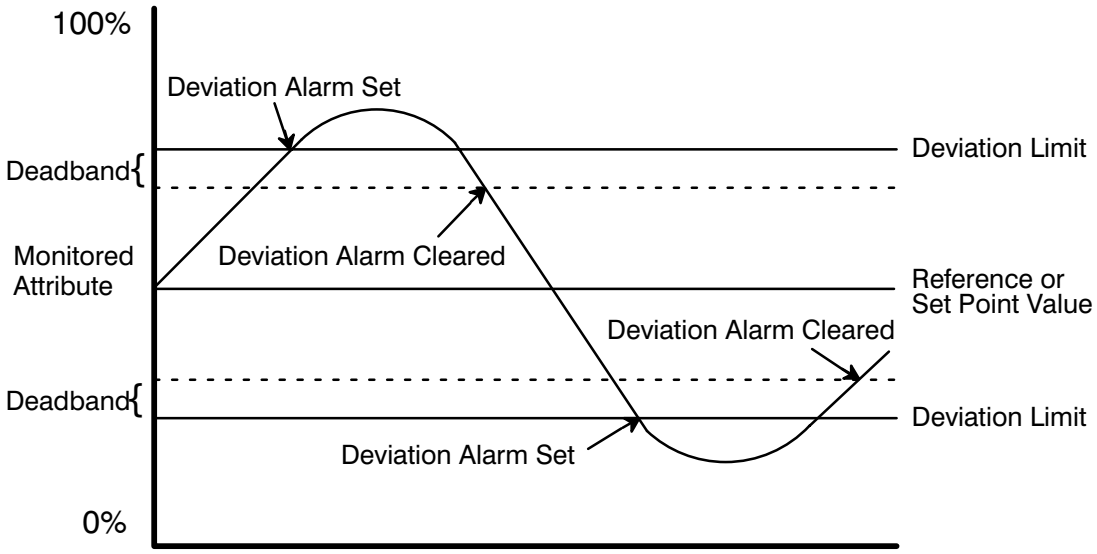


Figure 3-11. Deviation Alarms

The deviation alarm equations are shown below:

The alarm is set if: PV >= (SP + DTP) or PV <= (SP − DTP)
The alarm is cleared when: PV < (SP + DTP − DB) or
PV > (SP − DTP + DB)

Where:
DB = deadband
DTP = deviation trip point
SP = set point
PV = process variable

Alarm D is a user defined alarm. It is implemented using the Function Sequence Table (FST) Alarm Store (ALMST) function . When the Discrete Signal Value input to the ALMST function is a logic 1, the alarm is set. When the Discrete Signal Value input to the ALMST function is a logic 0, the alarm is not set. Refer to the FST section of the Configuration Manual for details on the ALMST function.

3.3.3.3.2 Output Limiting

The output limiting function, which is available on all PCA types, is used to prevent the IVP of a point from exceeding a configured high or low limit. If the IVP value generated by the station function exceeds the configured IVP high limit, then the IVP is set to that limit and the Valve Output High (VOHI) alarm bit is set to a value of 1. If the IVP is less than the configured IVP low limit, then the IVP is set to that limit and the Valve Output Low (VOLO) alarm bit is set to 1. The VOHI and VOLO alarm bits allow for operator indication at the console that either high or low output limiting has occurred.

3.3.3.3.3 Watchdog Timer

Watchdog timer allows the direct control point to be placed in a specified backup mode if an update from a console or computer is not received before the specified time interval and the watchdog timer alarms. It can only be used with a station type that supports SUP or DDC modes.

3.3.3.4 Functions Common to Primary Control Algorithm and Station

Both the primary control algorithm and the station contain some functions that are common in theory. These functions are restart values and set point tracking which are described in the following sections.

3.3.3.4.1 Restart Values

There are several direct control point parameters that have configurable restart values that may be used if the controller is restarting from a power failure or a download. In addition to the restart values, the parameters may also restart from the last value established before a shutdown of the controller. The parameters which have configurable restart values are the Set Point (SP), the Implied Valve Position (IVP), the operating mode (MODE), the bias (BI), and ratio. Indirect Control Point (ICP) reference values will automatically restart at the last value when a power failure occurs.

Restart Value Storage

The restart values are retained in non−volatile memory (NVM). Power fail restart will recall these values from NVM. The restart from last values are updated in NVM once a minute if the values have changed significantly. The required amount of change before the NVM value is updated is 5% of span for set point, bias, IVP and ICP reference values. The required amount of change before the NVM value is updated is an absolute change of 0.12 for the ratio value. Mode is updated upon any change.

Restart After a Power Failure

After a power failure, when restart from last value is specified, the restart parameters are set to the last value established before the power failure. When a specific restart value is defined, that value is used as the restart value after power failure.

Restart After a Download

After a download, when restart from last value is specified, the following restart parameters are set to their failsafe values; set point = 0%, bias = 0%, and ratio = 1. When a specific restart value is defined for these parameters, that value is used. Mode always restarts at manual after a download regardless of the defined restart value. The restart of the IVP is described below.

The restart value of the IVP depends on whether the corresponding point was previously configured. If the point was not previously configured and restart from last value is specified, the IVP is set to 0%, and if a predefined restart IVP value is specified, that value is used.

If the point was previously configured, then the point holds the last value prior to download even if a predefined restart value is specified. When the increase open/close setting of the point is changed, the communicated IVP value is inverted (refer to the following example).

Example — The point was originally increase open, IVP was 75% and the current output was 16 mA. The point was changed to increase close. The new IVP value is 25% and the current output remains at 16 mA.

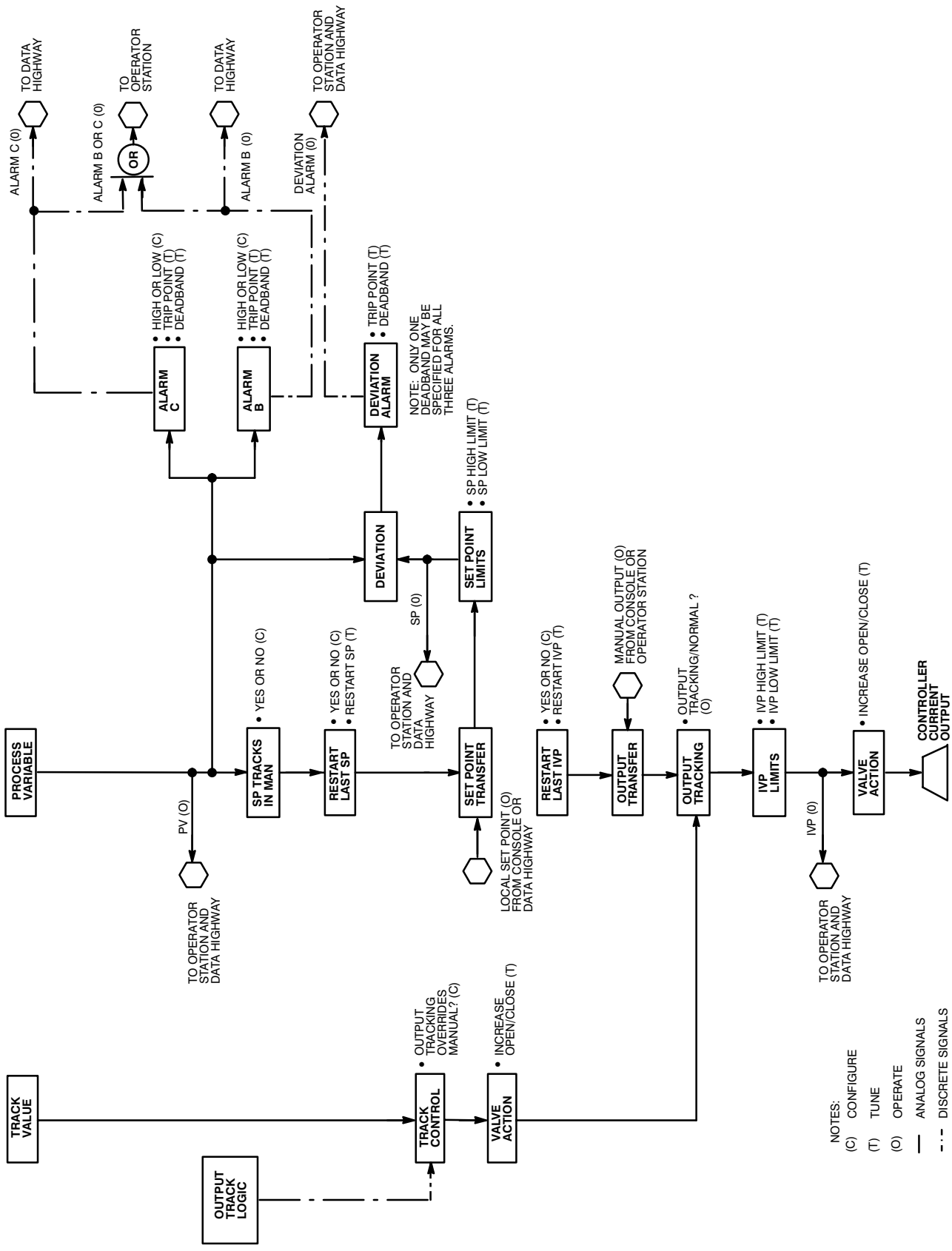
3.3.3.4.2 Set Point Tracking

Set point tracking is an optional way for a PCA to obtain its set point. The set point can be configured to track the process variable when the point is in DDC or manual mode. If set point tracking in DDC mode is enabled and the point is in DDC mode, then the set point is set equal to the process variable value. If set point tracking in manual mode is enabled and the point is in manual mode, then the set point is once again set equal to the process variable value.

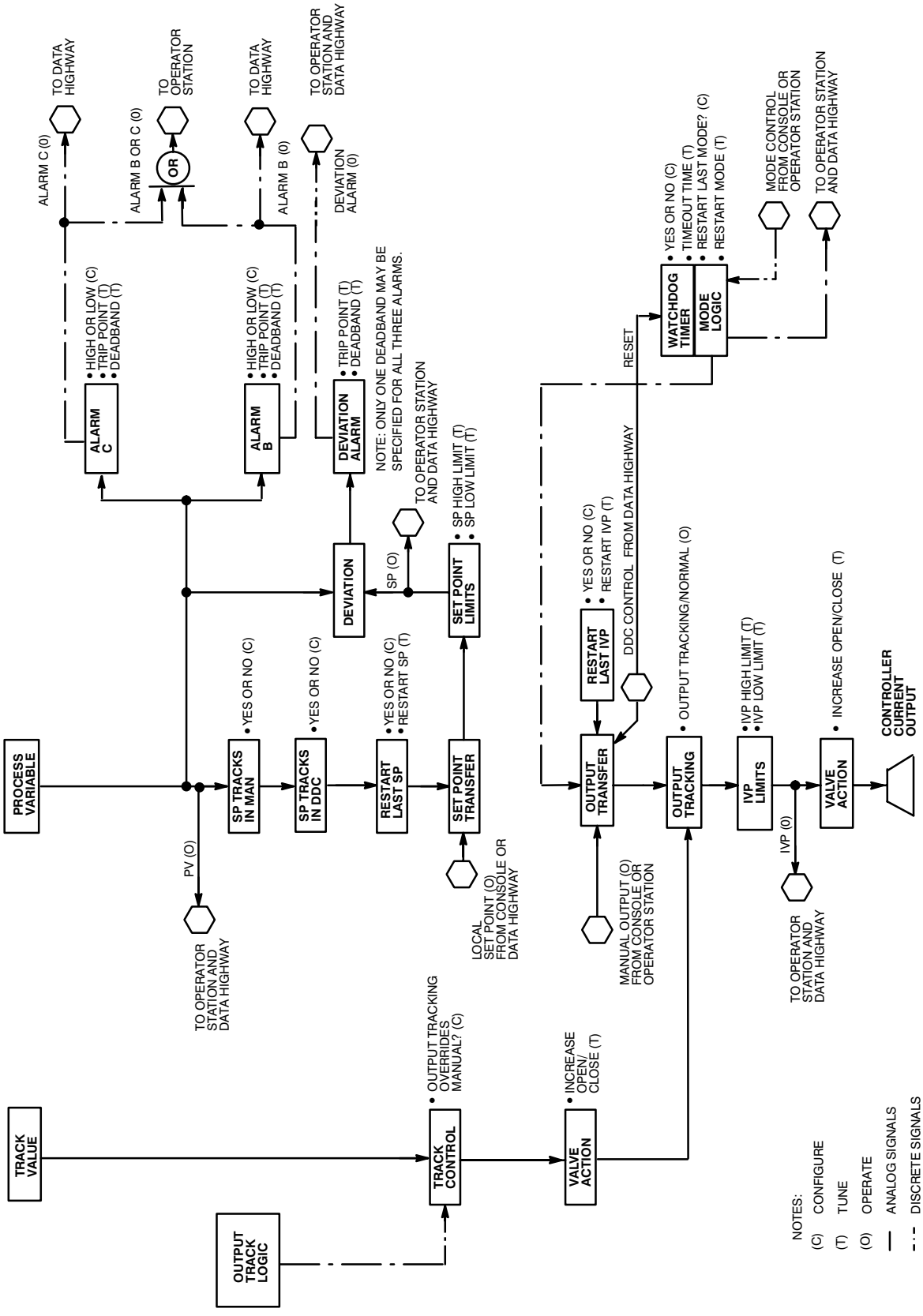
Set point tracking in manual mode is available for all PCAs except the bias and gain and the high/low signal selector, which effectively performs set point tracking all of the time. Likewise, set point tracking in DDC mode is available only if DDC is a valid mode for the point's configured station type.

3.3.4 Direct Control Point Diagrams

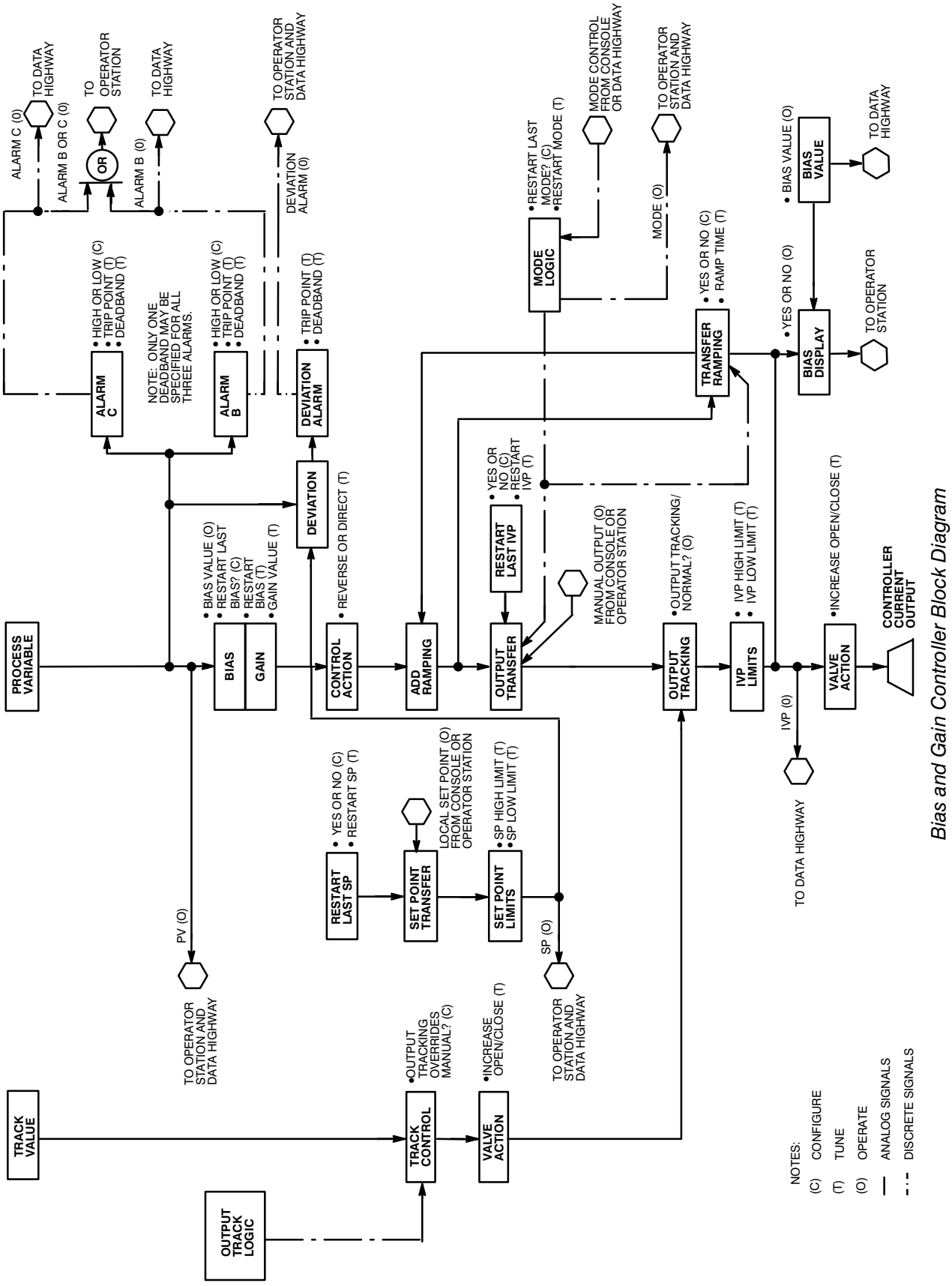
The diagrams on the following pages illustrate the processing of the various combinations of PCAs and station types.



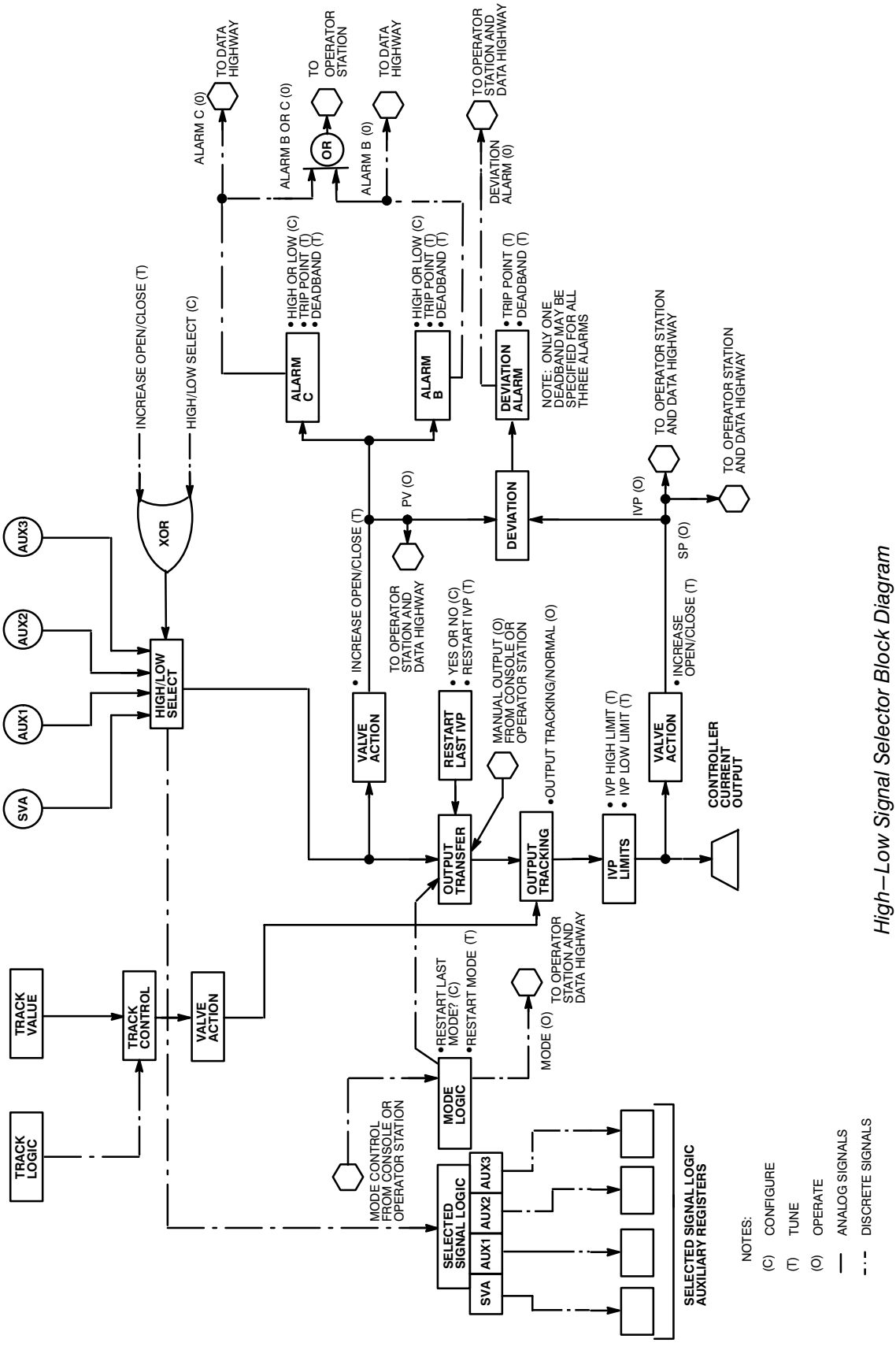
Manual Loader Controller Block Diagram



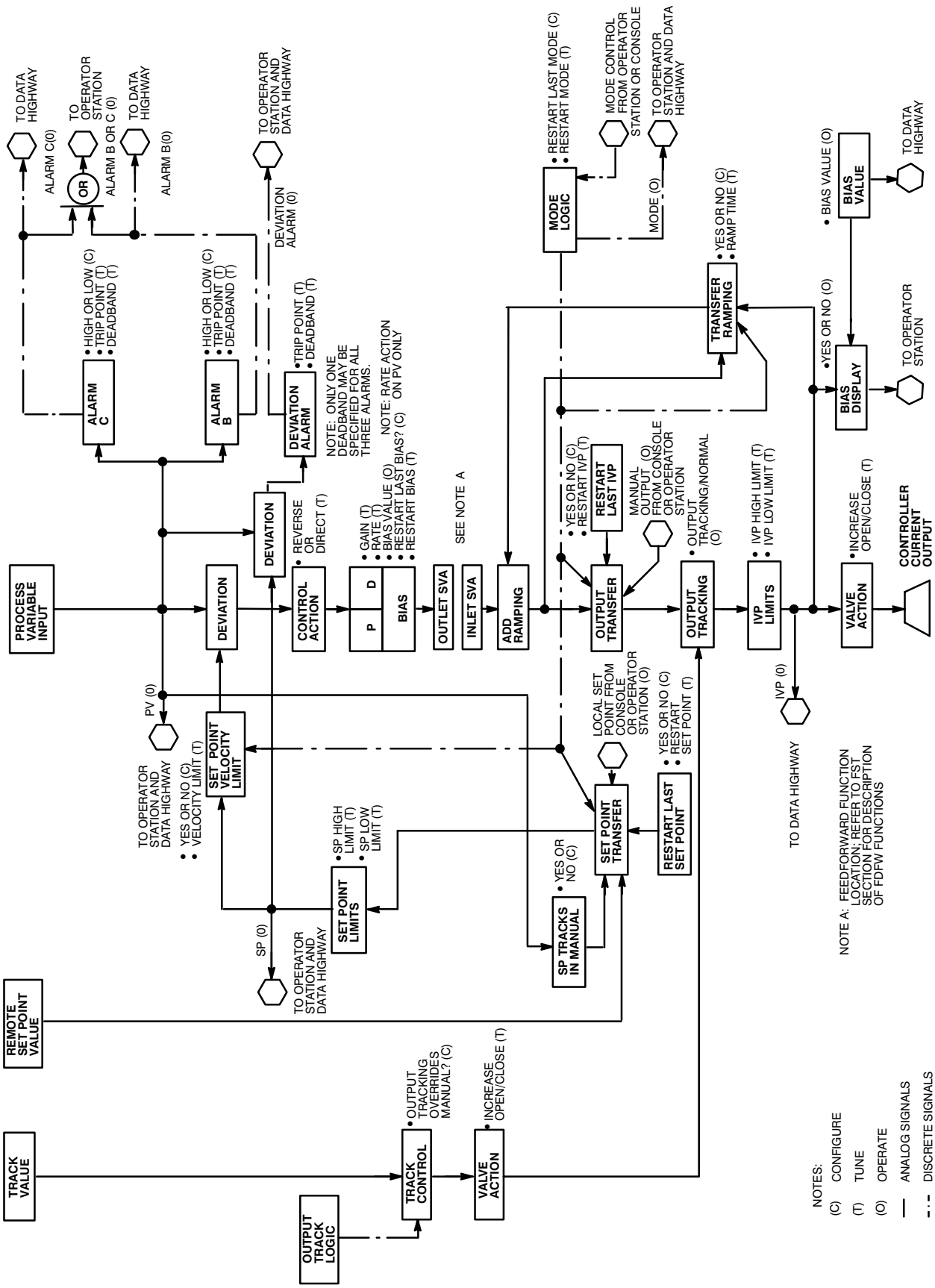
Manual Loader MAN/DDC Controller Block Diagram



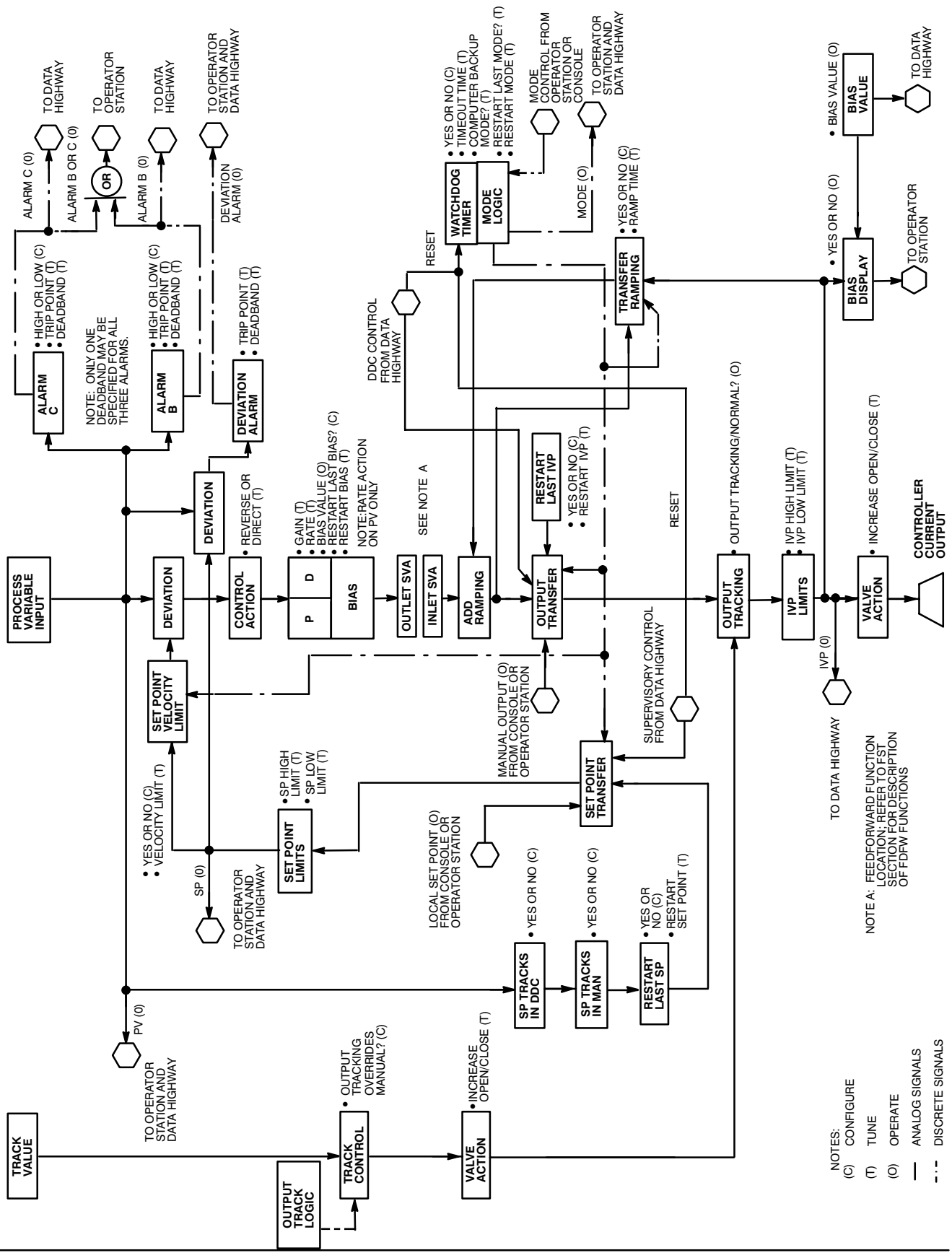
Bias and Gain Controller Block Diagram



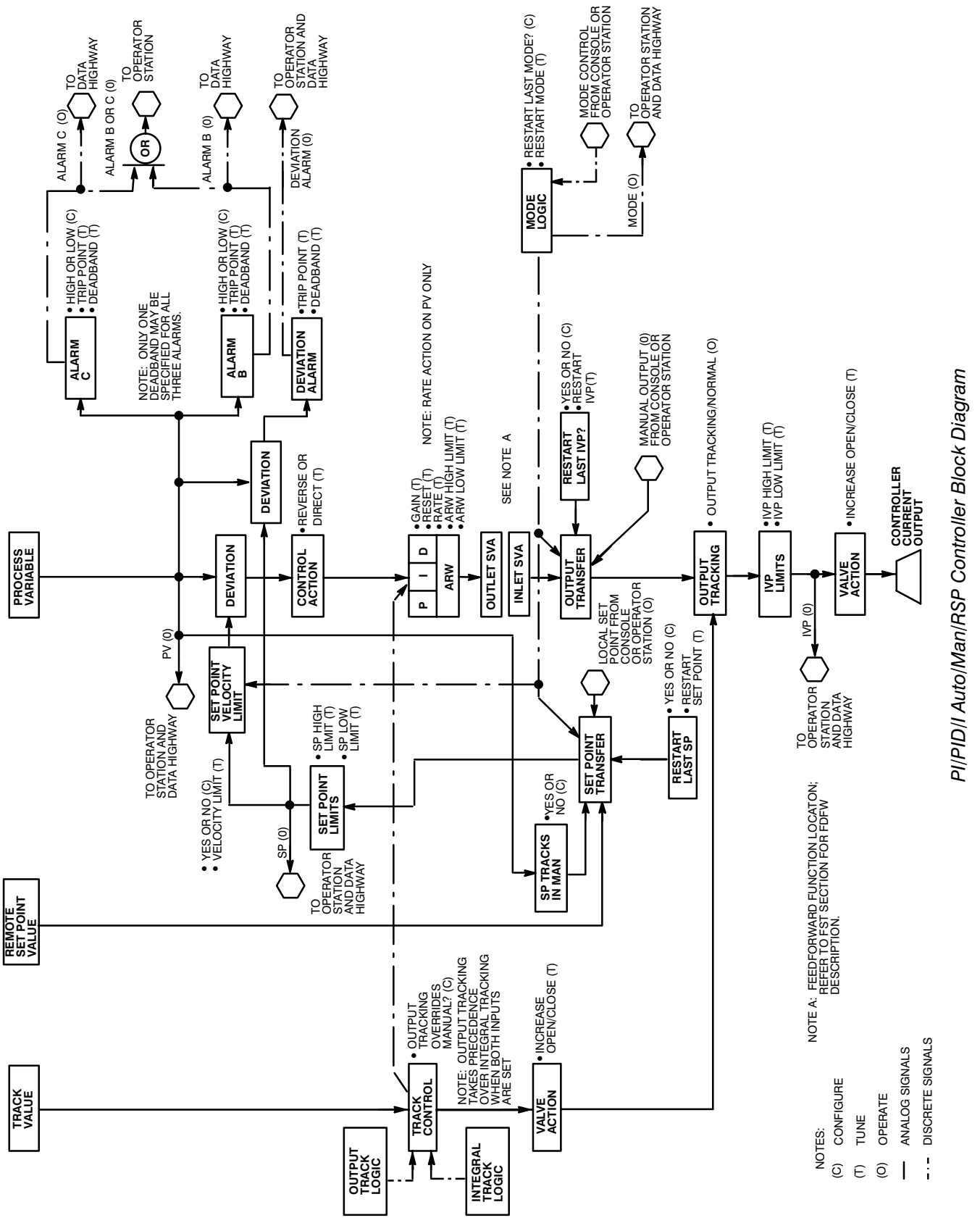
High–Low Signal Selector Block Diagram



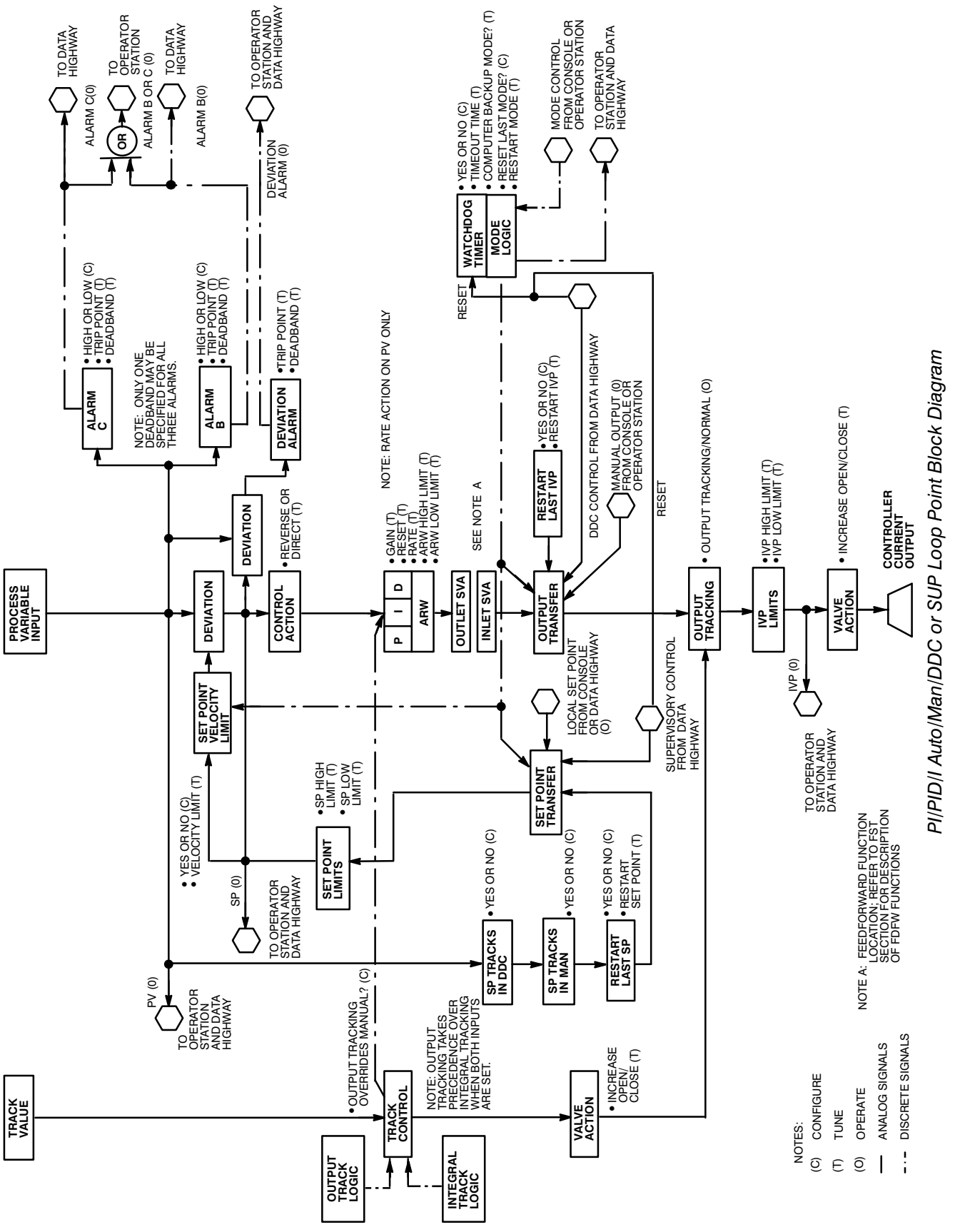
P/PD Auto/Man/RSP Controller Block Diagram

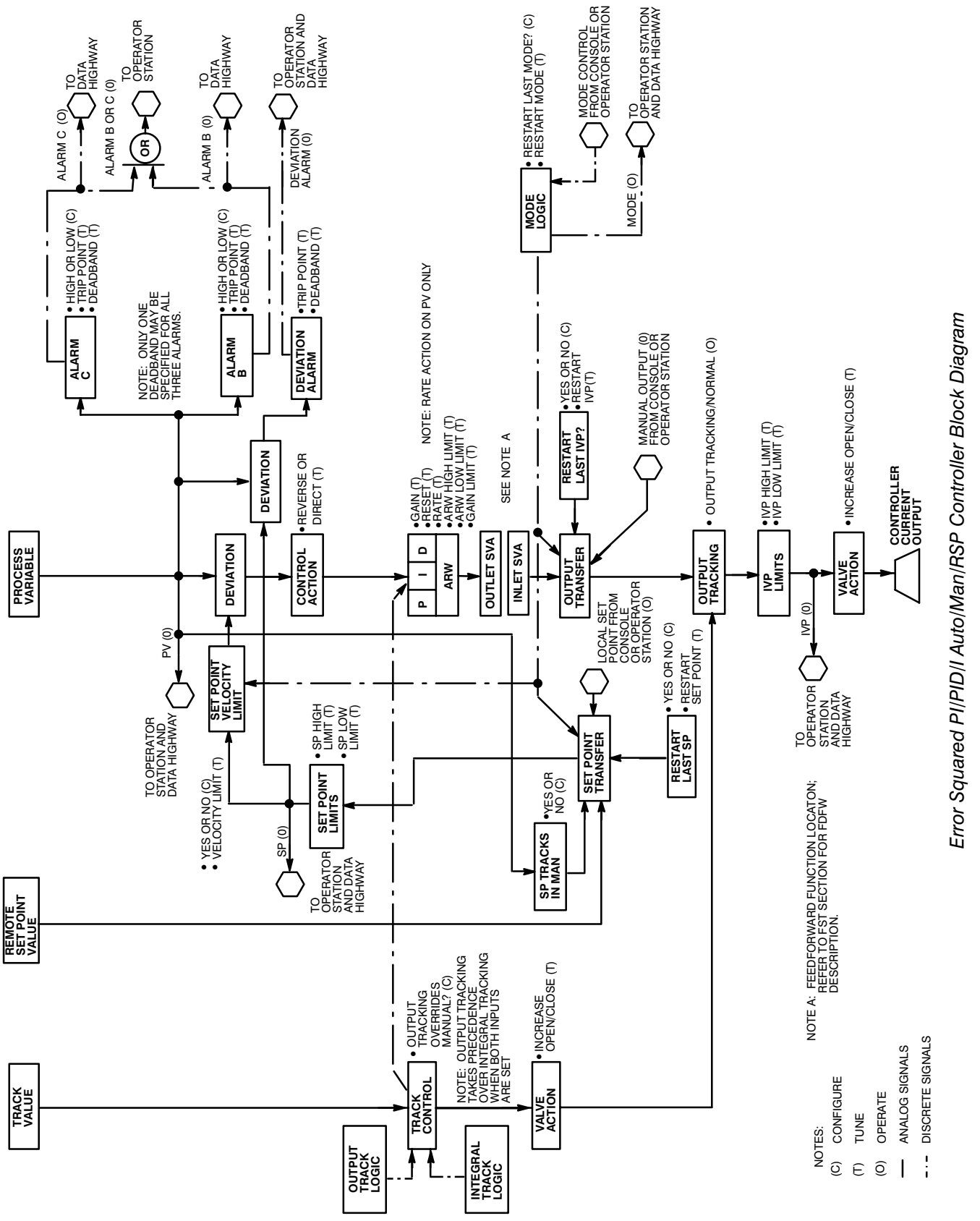


P/PD Auto/Man/DDC or SUP Controller Block Diagram

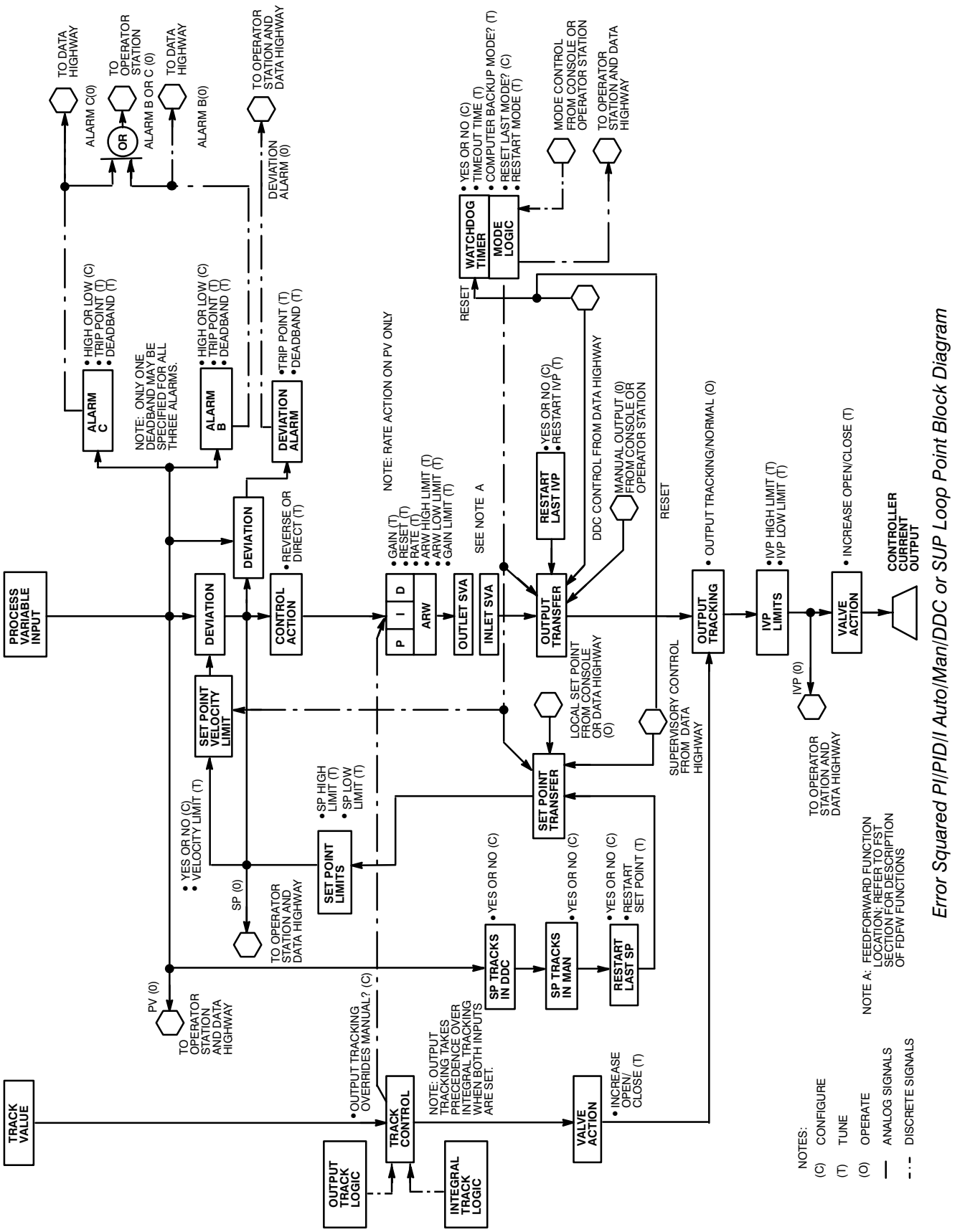


PI/PID/I Auto/Man/RSP Controller Block Diagram

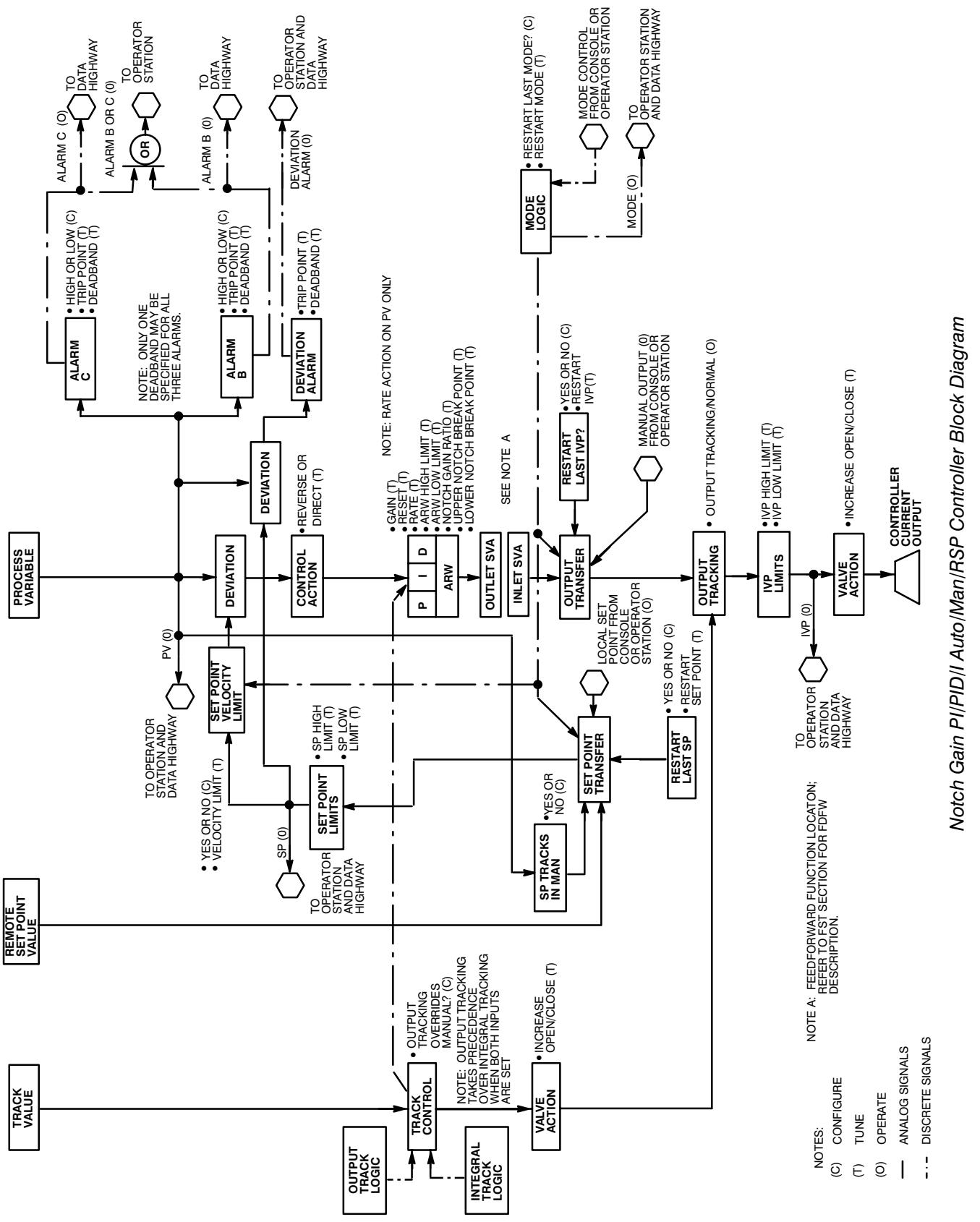

TRACK VALUE
PROCESS VARIABLE INPUT
TRACK CONTROL
OUTPUT TRACK LOGIC
INTEGRAL TRACK LOGIC
VALVE ACTION
DEVIATION
SET POINT VELOCITY LIMIT
CONTROL ACTION
P I D
ARW
OUTLET SVA
INLET SVA
OUTPUT TRANSFER
SET POINT LIMITS
SET POINT TRANSFER
SP TRACKS IN DDC
SP TRACKS IN MAN
RESTART LAST SP
RESTART LAST IVP
WATCHDOG TIMER
MODE LOGIC
OUTPUT TRACKING
IVP LIMITS
VALVE ACTION
ALARM C
ALARM B
DEVIATION ALARM
OR
CONTROLLER CURRENT OUTPUT
PI/PID/I Auto/Man/DDC or SUP Loop Point Block Diagram



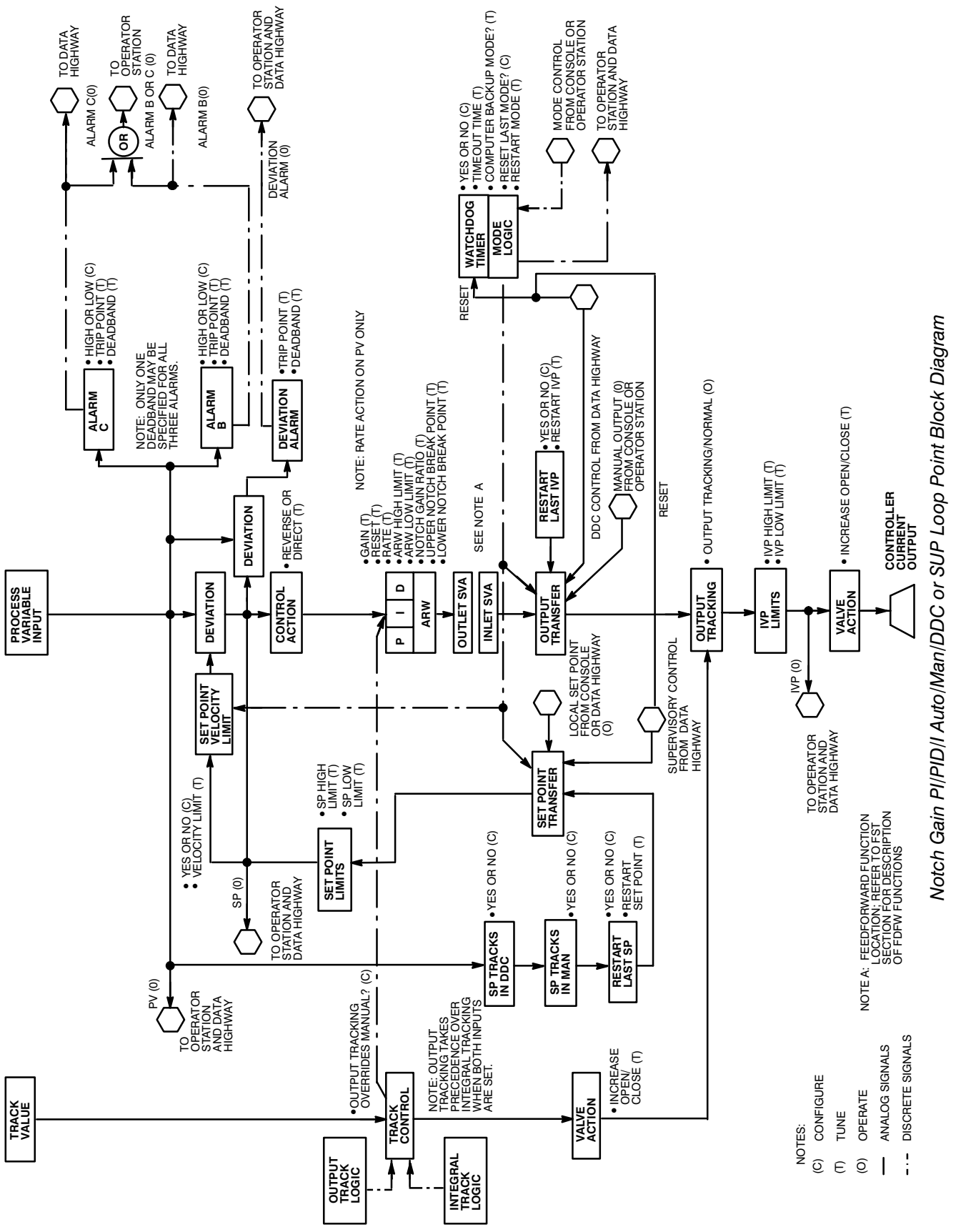
Error Squared PI/PID/I Auto/Man/RSP Controller Block Diagram



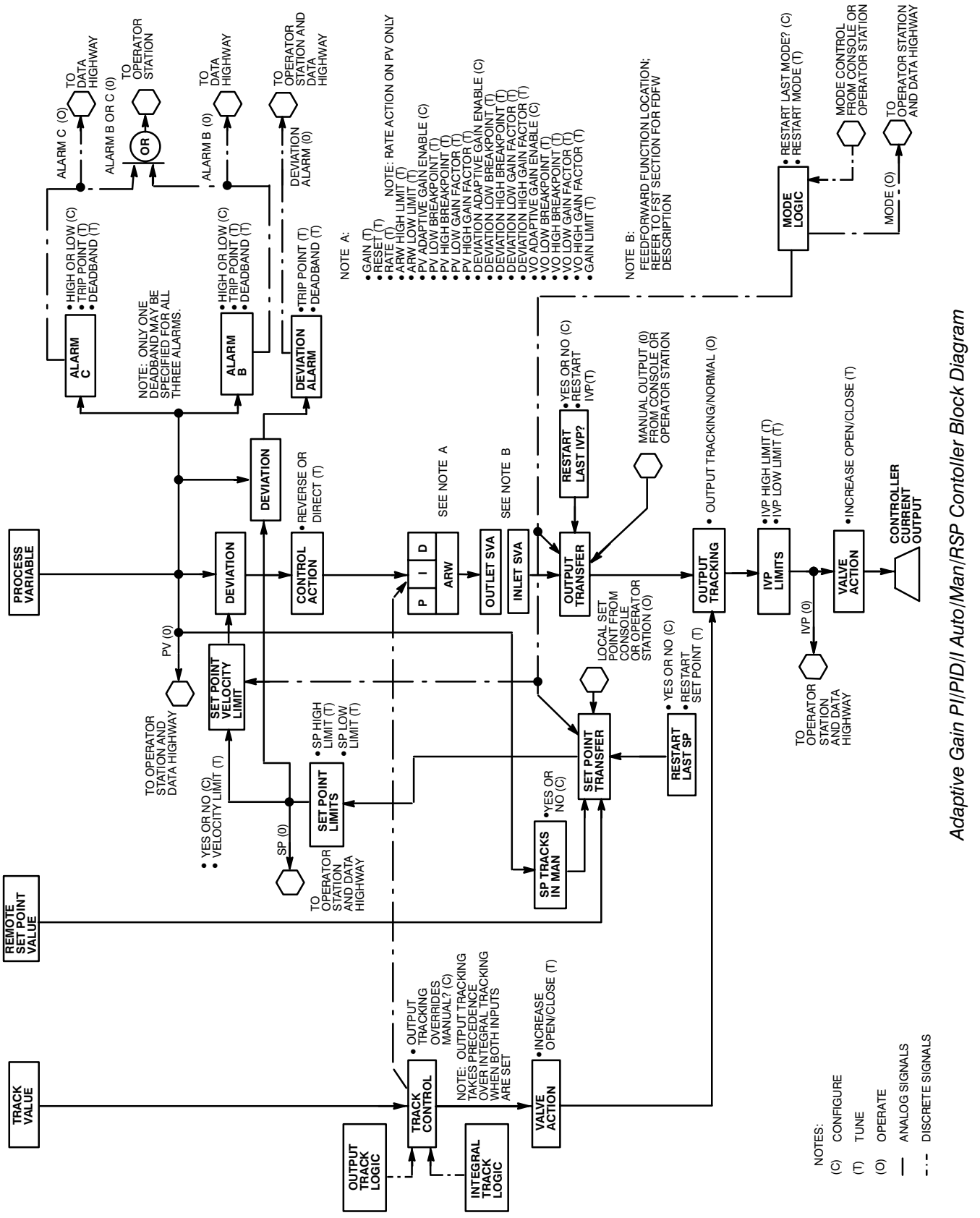
Error Squared PI/PID/I Auto/Man/DDC or SUP Loop Point Block Diagram



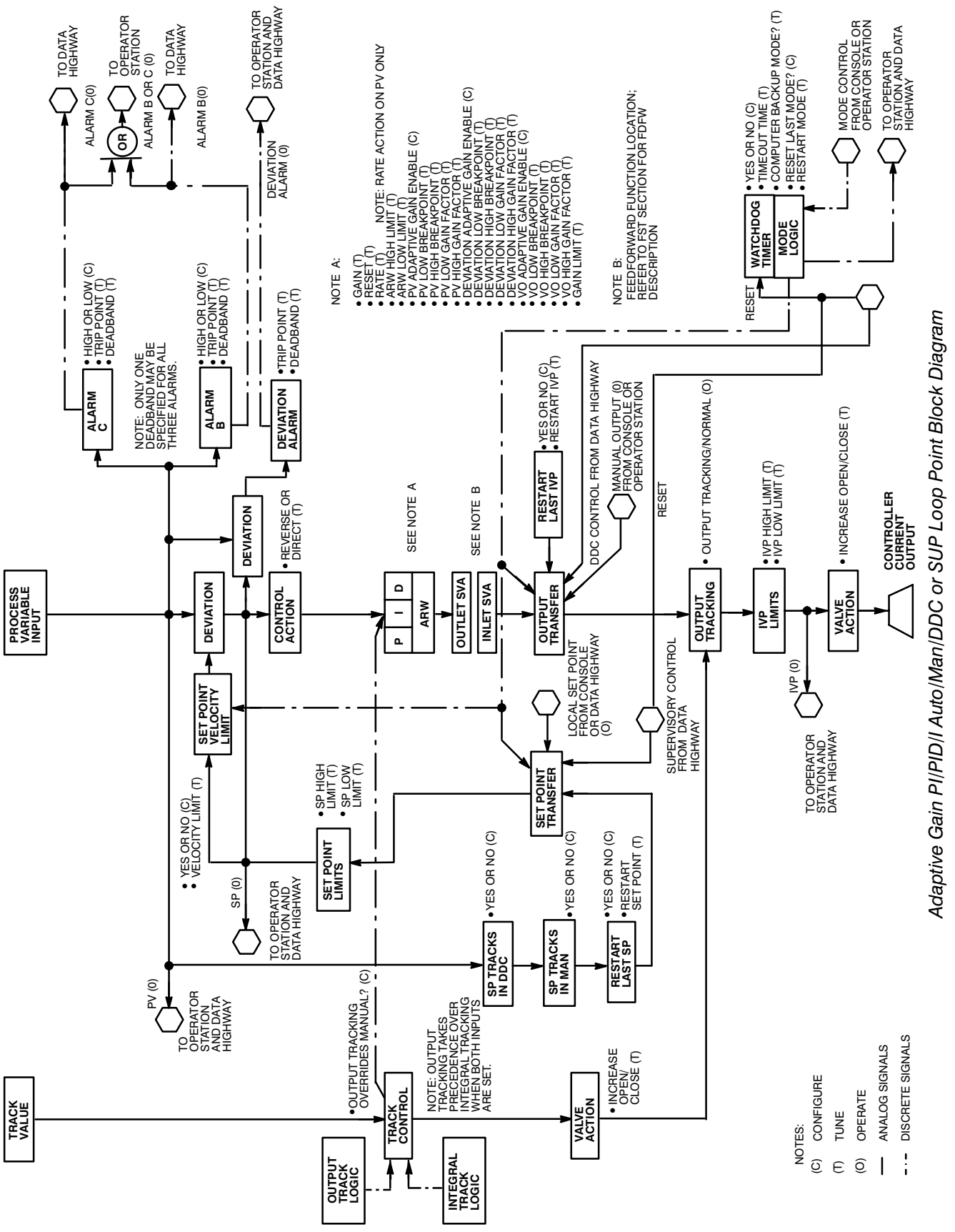
Notch Gain PI/PID/I Auto/Man/RSP Controller Block Diagram



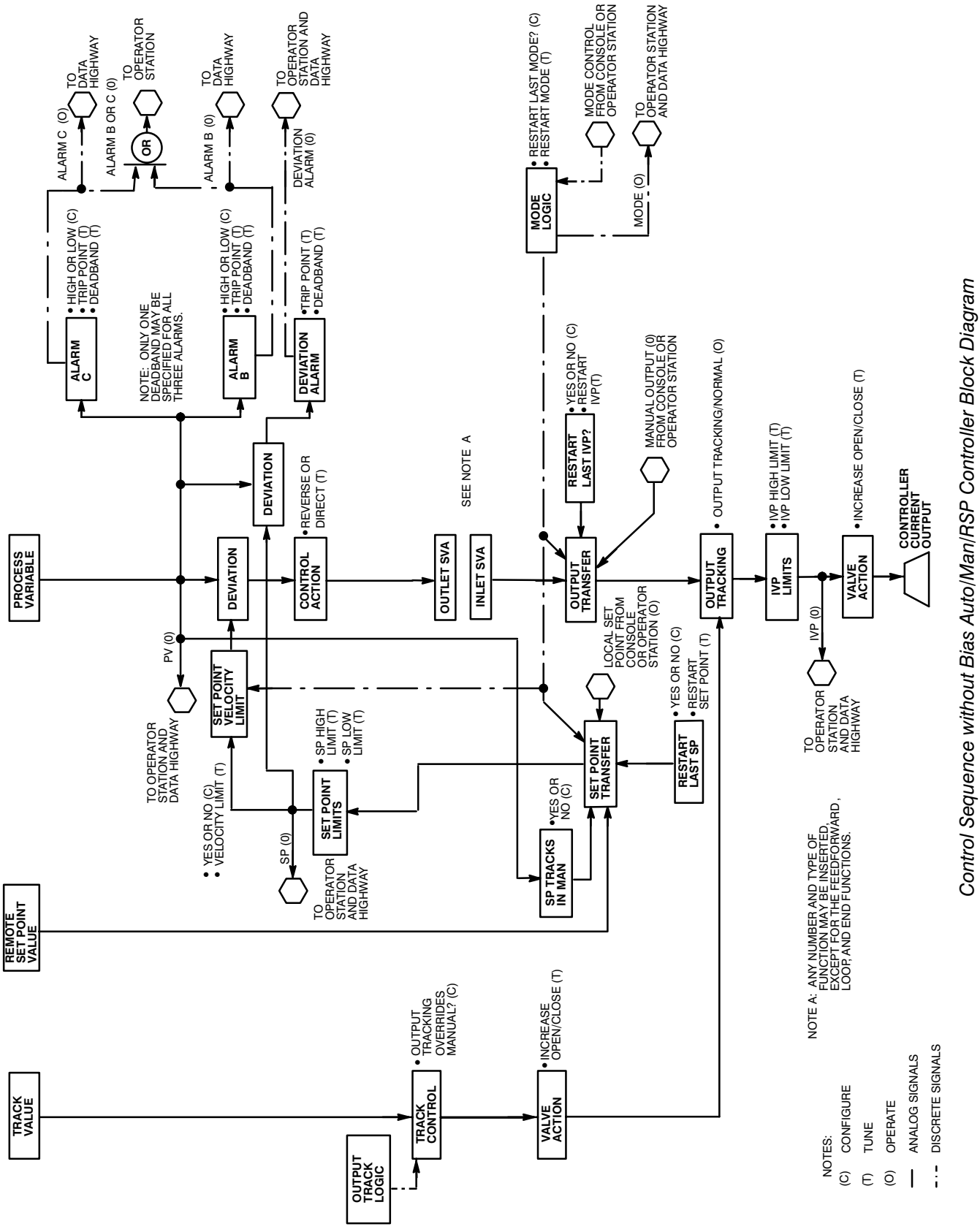
Notch Gain PI/PID/I Auto/Man/DDC or SUP Loop Point Block Diagram



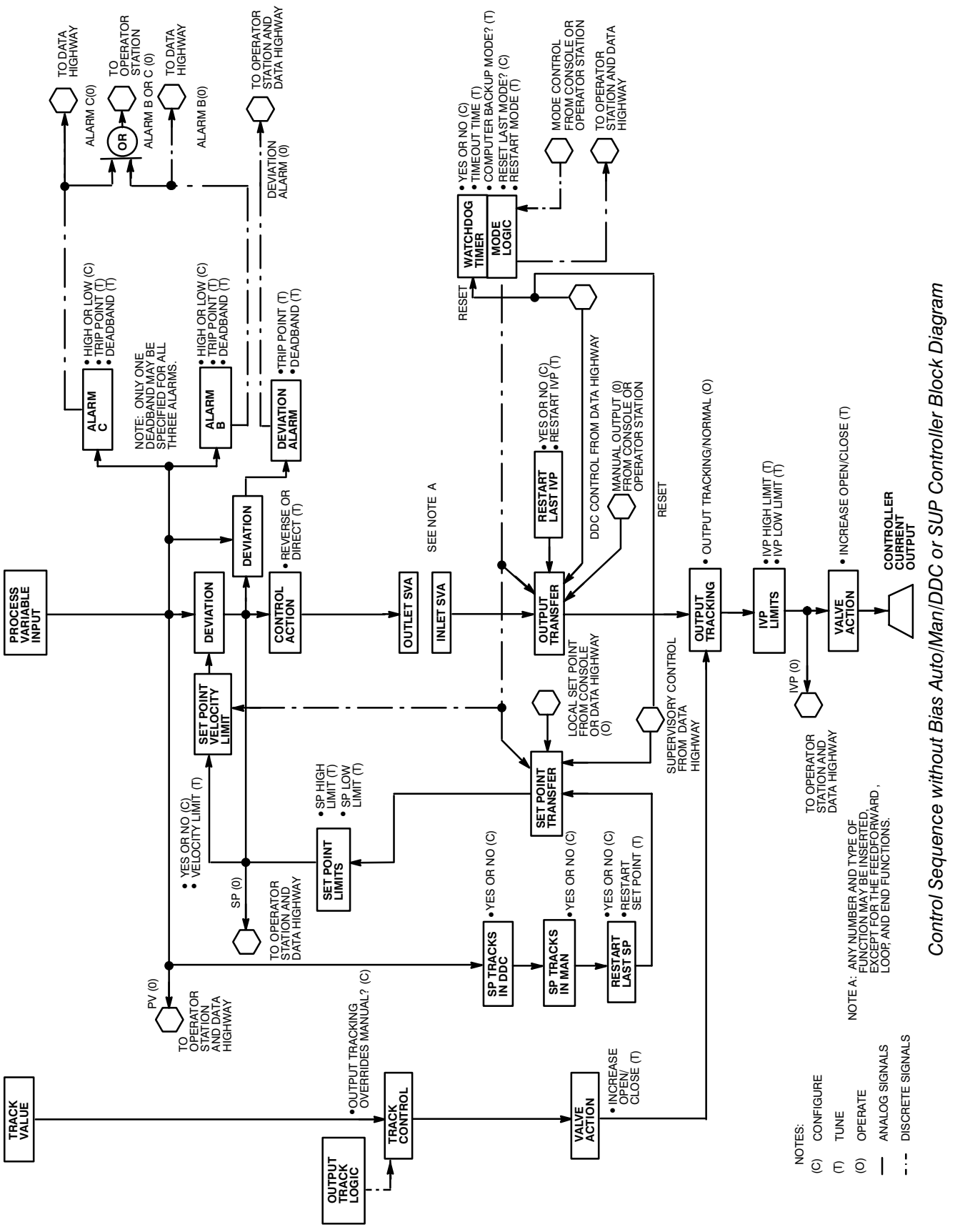
Adaptive Gain PI/PID/I Auto/Man/RSP Contoller Block Diagram



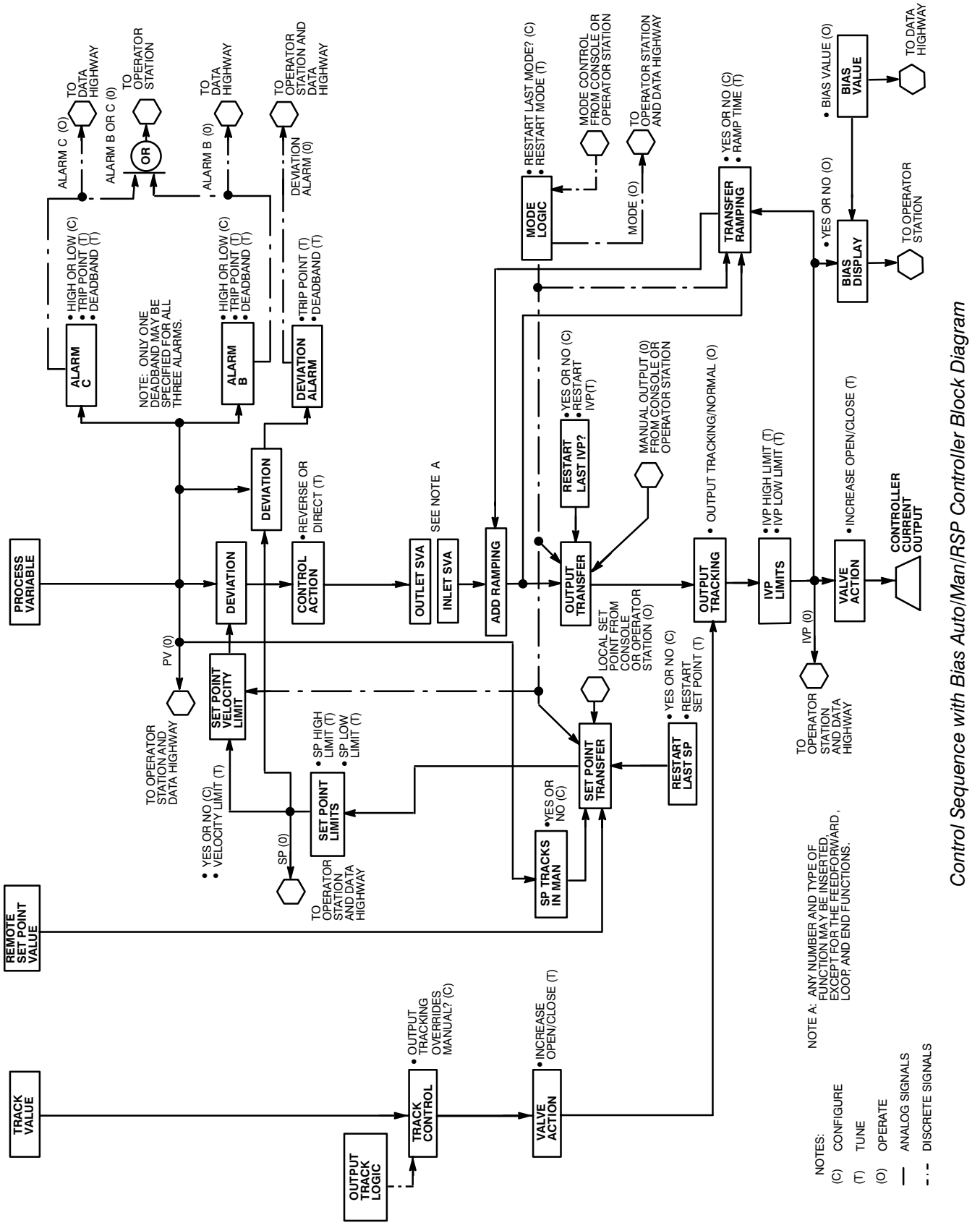
Adaptive Gain PI/PID/I Auto/Man/DDC or SUP Loop Point Block Diagram



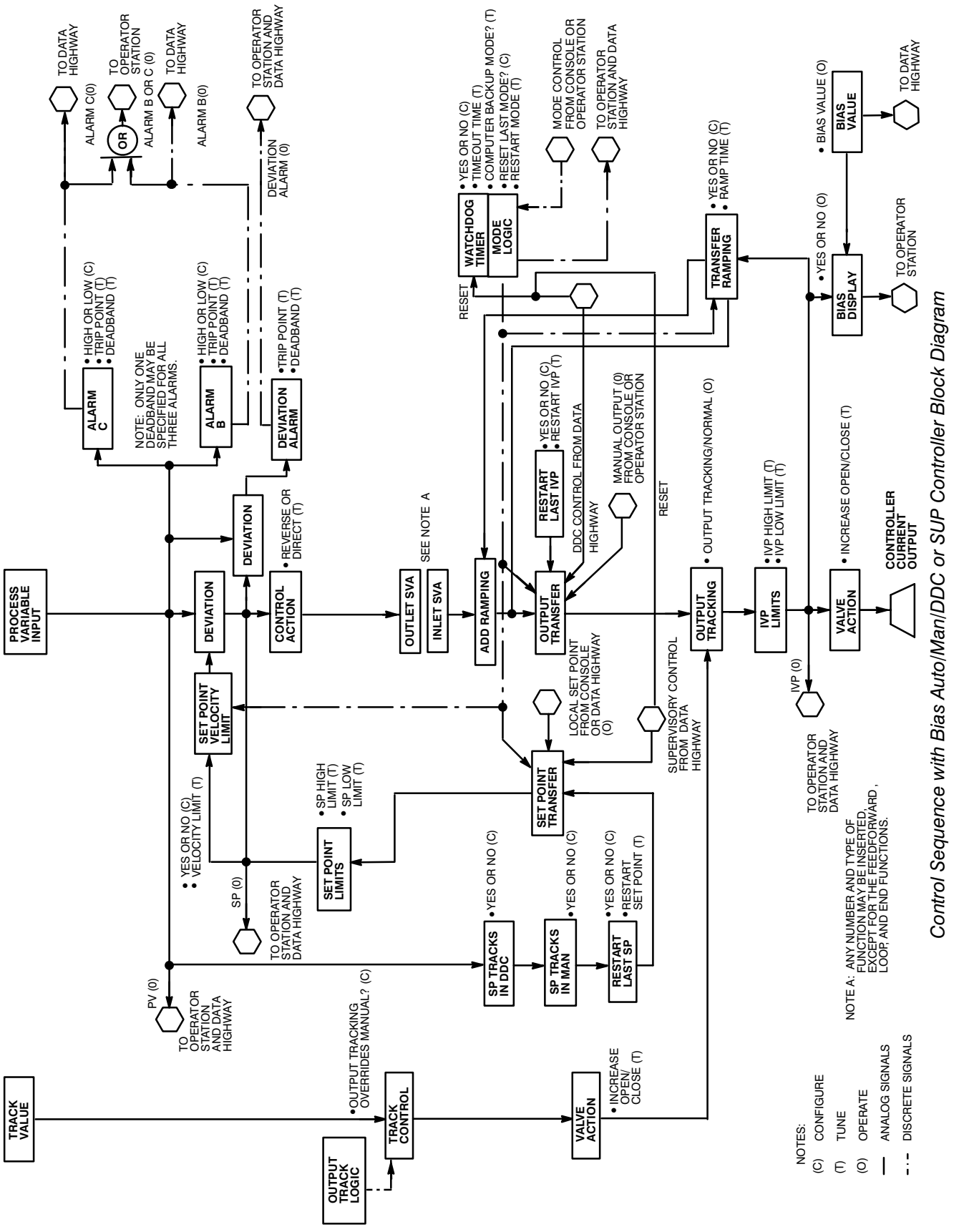
Control Sequence without Bias Auto/Man/RSP Controller Block Diagram



Control Sequence without Bias Auto/Man/DDC or SUP Controller Block Diagram



Control Sequence with Bias Auto/Man/RSP Controller Block Diagram



Control Sequence with Bias Auto/Man/DDC or SUP Controller Block Diagram

3.4 Upload/Download

When the controller is first powered up it does not contain the information it needs to perform control. The user defined control information that must be provided to the controller is referred to as “configuration” data. The transfer of the configuration data from the configuring device to the controller is called “downloading.” The controller only supports total downloads. A total download always clears the old configuration and re−configures the controller.

The process of moving data from the controller back to the configuration device, is called “uploading.” This allows updating of the configuration information after tuning changes have been made at the controller. Note that only tuning parameters are uploaded.

3.4.1 Initiating a Download

If the controller is currently configured and operating when a download is initiated, the Function Sequence Table (FST) is allowed to complete execution before the download starts. The controller holds its analog and discrete outputs at the values they were at prior to the download. It then goes into the database hold state which indicates the database is now invalid.

3.4.2 Completing a Download

During the download control action is suspended and the controller indicates its database hold condition. Once the download is completed, the restart parameters are set to their proper values and the controller comes out of the database hold state. See section NO TAG on page NO TAG for a more detailed explanation of restart parameters after a download. The controller then updates its non−volatile memory (NVM) with the new configuration data.

If an error occurs while downloading a simplex controller and the download is not accepted, the controller will remain in the database hold state. The controller will come out of the database hold state when either a download is successful or the controller is power cycled. Power cycling causes the controller to reload its previous configuration from NVM.

3.4.3 Tuning Parameter Upload

Uploading is the transfer of the controller tuning parameters from the controller to the configuration device. Only tuning parameters can be transmitted back to the configuration device, no other configuration information can be uploaded.

3.4.4 Redundant Controller Downloads

The operator interface for the upload and download of a redundant controller is no different than it is for the simplex controller. The fact that a redundant controller is being downloaded is transparent to the operator. See section 3.6 on page 3-53 for a detailed explanation of redundant controller downloads.

3.5 Communications

The Regulatory Controllers respond to communication request messages by prioritizing certain requests as having more importance than other requests. This allows the controller to respond to requests for process critical information more quickly than other requests which are not nearly as time critical.

The priority of different request messages can be viewed as fitting into these two categories; Process Data requests and Maintenance Data requests.

3.5.1 Process Data Communications

Certain request messages can be categorized as giving information specifically related to the process under control. This data is called Process Data. Some examples include:

- Process Variable
- Set Point
- Implied Valve Position
- Bias
- Ratio
- Mode
- Alarms
- Tracking (Implied Valve Position tracking, etc.)
- Limiting (SP limited, Implied Valve Position limited, etc.)
- Diagnostics (Detailed Device Status)

When the Regulatory Controllers receive a request for Process Data, this message is processed at a higher priority internally than the Control Task. The latest available information is immediately returned to the requestor.

If a Process Data change request is received, such as a Mode change or a SP change request, this request is processed immediately and a response is immediately generated. The action required by this change request is buffered internally to be acted on by the Control Task at then next opportunity (e.g. the next FST scan cycle).

3.5.2 Maintenance Data Communications

Certain request messages can be categorized as related to maintenance of the controller operation. These request messages are called Maintenance Data communications. Some examples include:

- Tuning
- Trace
- Download / Upload

When the Regulatory Controllers receive a request for Maintenance Data, this message is processed at a lower priority internally than the Control Task. This allows the normal control action of the Regulatory Controller to be performed without being interrupted by the overhead necessary to respond to the maintenance request message. (Note that certain maintenance request messages will interact directly with the execution of the Control Task, such as the Trace single−step function and download.)

Any Maintenance Data request that simply accesses information will cause the Regulatory Controller to respond with the latest information recorded within the controller. Any Maintenance Data request that will cause a change to one of the controller's internal parameters (e.g. DDP change request) will cause a response message to be generated to the requestor and, if the change request was successful, this changed parameter will be buffered internally to be acted on by the Control Task at then next opportunity (e.g. the next FST scan cycle).

3.5.3 Task Priorities

The Regulatory Controllers treat each action that is required under the following priority structure. Any higher priority action will "interrupt" a lower priority action in progress.

Priority Rank	Internal Task to Perform
Higher Priority	Process Data Communications Task Control Task Maintenance Data Communications Task
Lower Priority	Self Test Task

Note that certain tasks are periodic (caused by elapsed time intervals), while other tasks are event driven (caused by the occurrence of some external event, such as the receipt of an incoming request message). Therefore, this can easily lead to the need to do more than one thing at (nearly) the same instant in time. In this case, the highest priority item will be completed first, then the next highest priority item will be completed, etc.

Just as any human being can only be expected to do one task at a time, so also the Regulatory Controllers can only perform one task (or operation, if you will) at a time. Therefore, the priority (shown above) of each task is used to determine which task is more important than another task, when there is more than one task to be performed at a given instant in time.

3.5.4 Trade—offs between Communications and Control

There is a limit to how many tasks the controller can perform within a given period of time. The user can only configure a certain number of functions for the controller to perform (see section A.1 in Appendix A concerning controller loading). There is also some trade—off between how much communications load the controller can support for a given Control Task loading. **A close examination of the controller loading calculations will show that a fully configured Interactive or Computing controller can spend more than 50 percent of its time servicing the communications channel(s)!**

For control applications where the controller configuration exceeds the available CPU load, it may be necessary to examine the communications support required in the given application, as well as the control loading given by the configuration. Both should be considered when trying to optimize a configuration application.

3.6 Redundancy

Interactive and Computing controllers can be applied in a redundant physical configuration. The user's application configuration can be directly applied to a redundant controller set, as long as the redundant controller loading is not exceeded. That is, there is nothing specific that the user must configure in order to apply his control strategy to a redundant controller application.

PROVOX Redundancy is designed to maintain system availability (both control and operator interface) under any single point failure condition. Any single failure in the redundant system will cause the PROVOX system to automatically switch in a redundant unit, if necessary, to recover from the fault. System availability under multiple failure conditions is not specifically guaranteed. However, no design constraints have been applied to preclude the system functioning at an optimum level under multiple failure conditions.

3.6.1 Redundancy Architecture and Definition of Terms

The physical connection and installation of the redundant controllers determines the PRIMARY and SECONDARY controller assignments. The PRIMARY controller refers to the controller normally intended to have control of the output channels. The SECONDARY controller is normally intended to be following the action of the PRIMARY controller, awaiting to resume the control functions on demand.

The terms ACTIVE and STANDBY refer to which controller is currently operating the output channels. An ACTIVE controller has control of the output channels, and is performing its normal control algorithm. A STANDBY controller does not have control of the output channels, and is being forced to track the current operating conditions of the ACTIVE controller.

Although it makes no difference to the operation of a PROVOX control system, the PRIMARY controller is normally intended to be the ACTIVE unit (controlling the output channels). The SECONDARY controller is normally intended to be the STANDBY unit (tracking the ACTIVE unit, prepared to resume control operations).

For clarity, SWITCHOVER refers to the transition from the PRIMARY controller in the ACTIVE state, to the SECONDARY controller assuming the ACTIVE state. Similarly, SWITCHBACK refers to the transition from the SECONDARY controller in the ACTIVE state, to the PRIMARY controller assuming the ACTIVE state.

Functionally, this form of redundancy is often referred to as “hot backup” or “hot spares”, because the extra unit is standing in a configured and powered up state, prepared to resume the control actions as quickly as possible whenever a fault should happen to occur.

3.6.2 Redundant Controller Upload and Download

3.6.2.1 Upload and Download Transparency

The user downloads a redundant controller using the same method as downloading any simplex (non−redundant) controller.

3.6.2.2 Initialization of Control Action After Download

Initialization of the control algorithms after a download proceeds as follows:

1. Download data is received at the ACTIVE unit. During the duration of the download, the ACTIVE controller is performing an output hold operation on all analog output channels.
2. At the completion of a download the ACTIVE controller resumes its normal control algorithms. See the section on Upload/Download for a more detailed explanation of initialization of the output channels after a download.
3. Immediately after the completed download, the configuration is passed to the STANDBY controller over the inter−controller communications link. This communications link is established via the interconnects in the controller card file.
4. Once the STANDBY controller has successfully received the complete download data transfer, normal inter−controller tracking operations are performed.

3.6.2.3 Recovery After Configuration Download Error Detection

If a configuration error is detected during the download of a redundant controller, or if a timeout occurs during the download sequence because the download transmission is unsuccessful for some reason, the ACTIVE redundant controller will abort the download in progress, and reload the previous configuration from Non−Volatile Memory (NVM). If at the same time the redundant controller is reporting an NVM error, it will remain in database hold until a download is successful.

3.6.3 Redundant Controller Normal Online Operation

The redundant controllers normal online operation requires the ACTIVE controller to continuously update the STANDBY controller, to keep the STANDBY controller matched to the current operating point of the ACTIVE controller. Effectively, the STANDBY controller is forced to track the operation of the ACTIVE controller.

3.6.3.1 Inter—Controller Tracking

Under normal operation, redundant controllers are continuously passing data back and forth between the ACTIVE and STANDBY controllers. Both status and tracking information is passed between the controllers. A special inter—controller tracking message is passed as often as possible, to continuously keep the STANDBY controller updated to the current operating point of the ACTIVE controller. This is NOT a lock—step redundancy, that is, the controller central processing units are not forced to examine and validate each operation that the other controller performs. The inter—controller tracking message will force the STANDBY controller to match the ACTIVE controller at a specific instant in time. The STANDBY controller will then continue performing its normal forward control algorithms — as if it were in control of the outputs (but it actually is not in control of the outputs).

3.6.3.2 Tuning Parameter Handshake

Any tuning parameter change received at the active controller is immediately saved into Non—Volatile Memory (NVM). This allows the controller to retain this data on a power fail restart condition. The same tuning parameter change request is also queued for transmission to the STANDBY controller. This will guarantee that the STANDBY controller is operating with the same tuning parameter constants as the ACTIVE controller.

3.6.4 Redundant Controller Power Fail Restart

The redundant controllers will restart according to the following sequence after any power failure occurs.

3.6.4.1 Active and Standby Controller Determination

Upon restart after a power failure, the redundant controllers determine their active/standby status from the position of the output relays. Whichever controller currently is connected to the output terminations becomes the active controller.

3.6.4.2 Operating Parameter Restart Values

Both the active and standby controller will execute a restart initialization of the operating parameter values as defined by the user configuration. Once both controllers have completed their restart operation, the active controller initiates the inter—controller tracking communications, which forces the standby controller to track the current operating point of the active controller.

3.6.4.3 Configuration Validation

The active controller will perform the following steps after a power fail restart condition:

1. Self test runs to completion.
2. The user's configuration is recalled from Non—Volatile Memory (NVM).
3. Operating Parameter restart values are applied to each Direct Control Point (DCP) and Indirect Control Point (ICP).
4. The Function Sequence Table (FST) is allowed to run for the first time.
5. Controller status information is exchanged with the standby controller.
6. If both the active and standby controller have loaded a configuration the standby controller configuration is validated to match the active controller configuration.
7. If the configurations do not match, the active controller initiates a download to the standby controller, forcing the standby controller to match the active controller.
8. Once the configuration is validated, the inter—controller tracking operation is performed, and normal online operation of the redundant controllers continues.

3.6.5 Failure Detection

The controller redundancy scheme is implemented to perform as a redundant unit along with the Redundant Data Concentrator Unit (RDCU). Therefore, failure detection, and switchover decisions, are all

implemented at the DCU level. The redundant controllers perform simply as slaves to the RDCU in a redundant switchover decision. The following paragraph(s) briefly explain how this failure detection mechanism is implemented.

The Redundant Data Concentrator Unit (RDCU) is designed to periodically poll the ACTIVE controller for status information and Operating Data, and at the same time periodically interrogate the STANDBY controller for status information. Any failure critical to the control or operator interface, detected at the ACTIVE RDCU, will cause a switchover to occur. These conditions include:

- Primary controller response message timeout
- Arithmetic Processor error (Interactive controller only)
- Input/Output self—test error (includes calibration out of tolerance)
- Communications error rate excessive

Although multiple failures are not meant to be covered in all of their potential combinations, there is a limited set of “optimization switchover” decisions that are incorporated into the RDCU decision mechanism. For instance, if a communications timeout occurs on a primary controller communications channel, the RDCU will switch even if the secondary controller system is currently reporting a calibration error. The premise here is that some control is better than no control at all.

Note however that a switchover would not occur if a communications timeout occurs on the primary controller system, when another communications failure is being reported on the secondary controller system, because the RDCU cannot determine which would be a more “optimum” control system under the failure conditions reported. Also, optimization cannot be performed when multiple communications fails on a controller subsystem (example, two controller timeouts occurring on the primary system, and only one on the secondary system), as there is no voting mechanism to determine the highest availability of the control system.

The RDCU will only make one switchover (or switchback) decision, and then the automatic switch decision algorithm is disabled. Automatic switch enable/disable status is reported on the RDCU diagnostic displays. Disabling automatic switch will prevent any possibility that the RDCU may cycle between redundant units when the system is experiencing intermittent failures, such as power cycling problems, etc. Once automatic switch is disabled, the operator must intervene to correct the error condition, and then enable the automatic switch decision algorithm. Any integrity error, including disabled automatic switch, is reported as an integrity problem with the RDCU, requiring operator attention.

3.6.6 Control Action After Switchover/Switchback

A switchover (or switchback) decision can be made by the RDCU, or can be commanded by the operator via the RDCU diagnostic package. The RDCU commands the controller subsystem to resume control, and the controller subsystem then commands the output relays to switch to the new active controller units. Switchover of the RDCU/controllers system is designed to occur within one second of failure detection of any single point failure.

The controller which resumes control will simply discard any tracking communications in progress, and proceed on the next Function Sequence Table (FST) execution with normal control processing. As soon as the other controller unit (the new standby controller) becomes available, the active controller resumes the inter—controller tracking operation.

3.7 Controller Self Test

The controllers perform checks on internal operation of various subsystems, as outlined below. All of the self test checks are performed periodically in a background state, at a priority lower than any other function that the controller is required to complete.

3.7.1 Ram/Rom Check

Periodically the Random Access Memory (RAM) and Read Only Memory (ROM) are checked for normal function. The RAM check is a read/write check, performed when no other operations are going on. The ROM check performs a cyclic redundancy checksum across various segments of the ROM to insure that no detectable data alteration has occurred.

3.7.2 Non—Volatile Memory Check

The controllers retain their application configuration in a non—volatile memory (NVM) storage device, which requires no power supply to retain the data. Data retention of these un—powered devices can degrade over time, and the controllers are designed to retain the configuration data for a minimum of 24 hours in a non—powered state. Actual data retention can far exceed this minimum requirement.

The NVM check performs a periodic checksum validation of the configuration information, and operating parameter restart values.

3.7.3 Analog Output Self Test

Periodic checks are performed on the analog output subsystem to assure that the intended analog signals are actually being transferred to the terminations. There is special circuitry incorporated on the controller units to allow a detection of the current signal being sent out of the current driver subsystem. This allows an actual current output self test to measure the current value being issued from the controller, and then compare this value to the intended signal. Any sustained deviation greater than 4 percent will cause an analog calibration error to be signalled.

Also, there is an on—board voltage reference source, that allows the controller to determine if the calibration of the input/output subsystem has exceeded 4 percent. If this voltage reference error is detected, an analog calibration error is signalled.

3.7.4 Discrete Input Output Self Test

The discrete input output self test simply performs a check on the input output driver device setup, and is incapable of validating the discrete input output circuitry itself. Any alteration to the setup of the discrete input output driver device is reported as a discrete input output self test error.

3.7.5 Communications Error Rate Excessive Self Test

Incoming communications messages are checked for parity, framing, and overrun errors. Any sustained communications error rate greater than 5 percent will cause an error to be signalled.

3.7.6 Function Sequence Table (FST) Overload Self Test

Checks are performed to determine if the control task (the Function Sequence Table, or FST) has completed in its allotted time, normally one−quarter second. If the control FST does not complete within one−quarter second, and this condition is sustained for more than several executions, an FST overload error condition will be signalled. This indicates that the controller configuration load, and the associated communications load that the controller is required to support, is too great for the controller to complete within the window of time of one−quarter second. The user must take action to correct this situation. See section NO TAG on page NO TAG which describes the trade−offs between communications and control, and how to deal with reducing the controller load imposed by each of these.

3.7.7 Free Time Computation

The controller performs a background computation to determine how much idle time is available. Idle time, or free time, refers to the time where there are no tasks scheduled to be performed by the controller. A controller with no configuration, and a minimum of communications support, will normally report 100 percent free time. The only operations being performed by the controller under these conditions are the overhead scheduling operations, and the controller internal self test tasks. The percent of free time is a value that is reported on the controller diagnostic displays.

3.7.8 Recommended Minimum Free Time Value

The user should take precautions to assure that the controller free time (loading) is never reduced below 20 percent free time. This idle time is required to take care of the processor computations required under burst load conditions. A burst load can be induced by many conditions, such as the following:

- Communications load, such as asynchronous requests on multiple communications channels happening to coincide in time.
- Controller tracking operations, which may require extra computations internally to balance the control algorithms.
- Diagnostic and/or Tuning operations, which cause the controller to perform extra computations concurrent with normal control algorithms.
- FST branching, where the user configuration may under certain circumstances perform extra steps during a brief transition period.

Note that the simple fact that less than 20 percent free time has been computed by the controller will NOT cause an integrity error to be reported, (unless it should happen to have forced the FST execution to exceed the FST scan rate, which would force an FST overload to be signalled). Therefore, as part of the system configuration and commissioning, the configuration engineer should insure that the controller loading requirements have been met.

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4 Configuration

This section covers the detailed configuration of IAC and Computing Controllers. You should have already read the previous section dealing with the controller's Theory of Operation (section 3).

4.1 Configuring IAC and Computing Controllers

Configuration of IAC and Computing Controllers consists of defining and/or configuration of the following:

- Device Definition
- DCPs
- FSTs
- Analog ICPs
- Discrete ICPs
- Target Data

A configuration process flowchart is shown in Figure NO TAG on page NO TAG.

4.1.1 Configuration Tasks

Configuration of the controller consists of creating, generating, and downloading information. The following sections give a brief overview of this process.

4.1.1.1 Creating Configuration Data

The configuration is accomplished through the use of configuration forms. There is a configuration form for each of the items previously listed. The following sections describe each of these forms and define the data that you enter in each field. Figure NO TAG (page NO TAG) is an overview of the ENVOX forms used to create configuration data.

Forms are used to create the device definition and points. They are also used to verify configuration data and generate configuration download

files. Each form includes one or more prompts with blank fields in which the information for each field is entered as necessary. Many fields provide a list of valid selections that may be accessed through a function key.

The ENVOX software checks the validity of things such as range, valid values, relationship to other points, and so on as the information is entered. If an error is detected, ENVOX software highlights the field and tells why the information is incorrect.

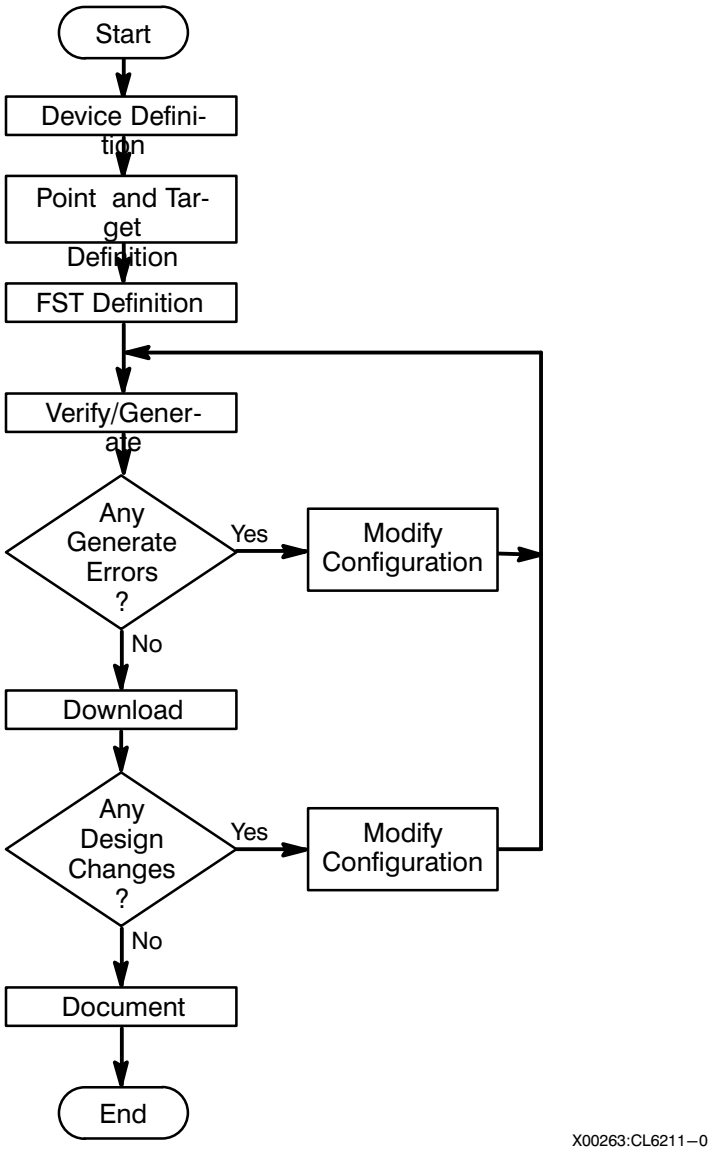


Figure 4-1. Configuration Flowchart

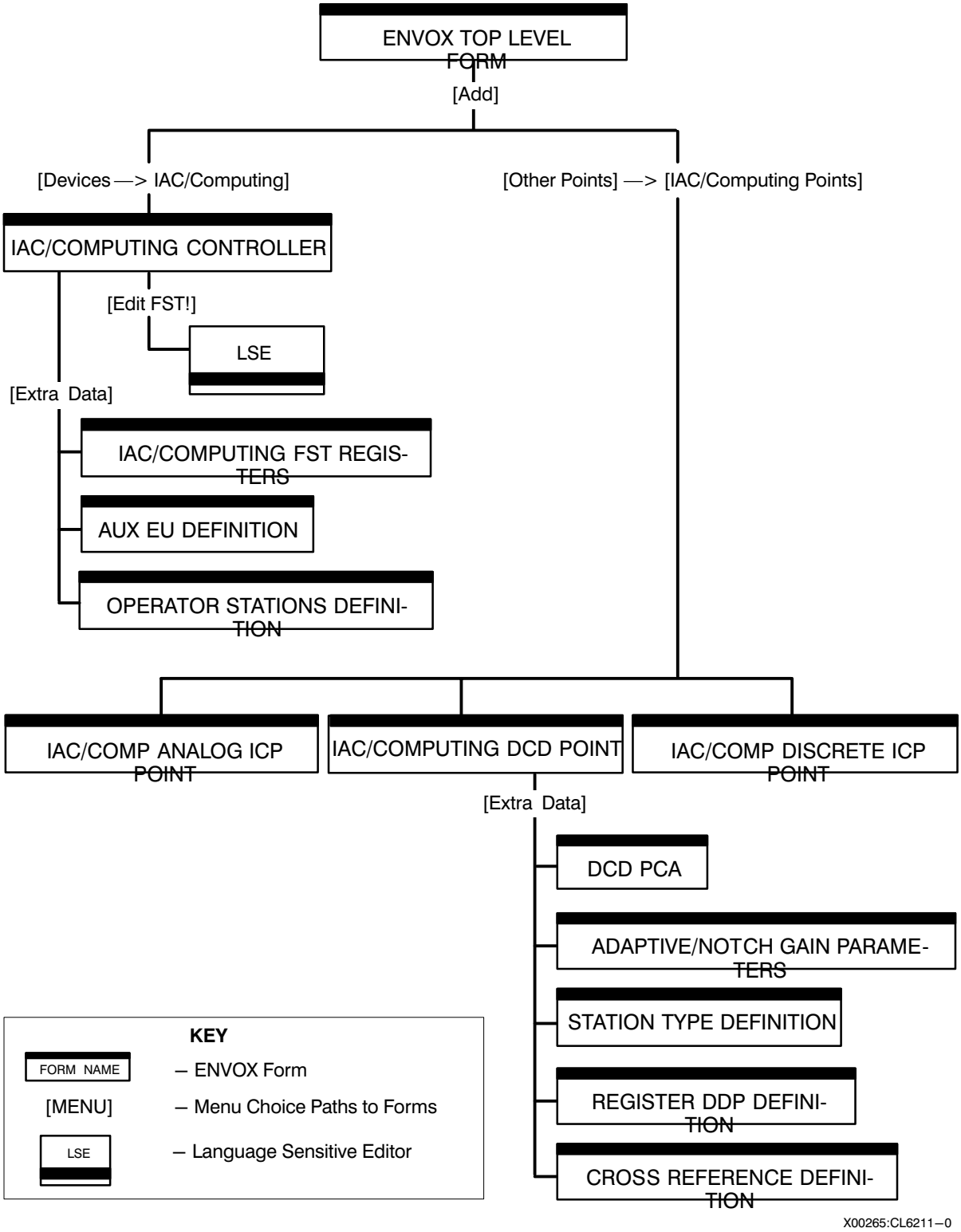


Figure 4-2. Overview of ENVOX Configuration Forms

4.1.1.2 Generating Configuration Data

Configuration generation checks the consistency of the data ENVOX did not already verify during the creation process. The generate option then sorts the configuration data into a download file.

4.1.1.3 Downloading Configuration Data

The download utility sends the download files to the controller. Refer to section NO TAG (page NO TAG) for additional information on downloading.

4.1.2 Configuration-Related Activities

There are activities that, while not directly part of configuration, are related to configuring the controller. These activities generally occur after a configuration has been written and downloaded to a controller. Refer to UM4.14:SW3151 *Using ENVOX Configuration Software* for more information.

4.1.2.1 Upload

Once the controller has been configured and brought on-line, a PROVOX console can be used to change the device tuning parameters. “Uploading” is the process of merging these on-line tuning parameter changes into the ENVOX configuration database.

4.1.2.2 Documentation

The documentation utility is used to create reports to document the controller configuration. This documentation provides a hardcopy of the device definition and point information.

4.1.3 Organization of Configuration Information

The point configuration items are grouped by form. Item descriptions normally include a definition of the field, a list of valid entries for the field, and a list of any related DDPs. Additional information about most items may be found in the Theory of Operation section of this manual.

If the point being configured is to be targeted to another PROVOX device, i.e. its operating data is to be sent to a device such as a PROVOX console or a CHIP device, the configuration items for targeting are found under the “Target!” menu option on the point configuration form. The configuration items that must be defined for targeting are contained in section NO TAG (page NO TAG).

4.2 Device Definition

IAC and Computing Controller device definition consists of completing the main device definition form, and associated forms to define FST Registers, Operator Stations, and Auxiliary Engineering Units.

The main device definition form identifies the physical location of the data concentrator unit, to which the controller is connected, on the PRoVOX data highway and the controller type.

Type — This field defines the controller type. Valid types are: COMPUTING, IAC2, IAC3 ANALOG, IAC3 DISCRETE or IAC4.

Highway No. — The highway number is the number of the data highway that the data concentrator unit (DCU), to which the controller is connected, communicates on. Valid highway numbers are 0 through 8.

Device No. — The device number is the number of the communications interface assembly (CIA) of the data concentrator unit (DCU), to which the controller is connected. If the highway number is 0, valid device numbers are 1 through 6. If the highway number is 1 through 8, valid device numbers are 1 through 30.

Port No. — The port number is the number of the data concentrator port to be assigned to this controller. The port numbers correspond to the card slots of the controller card files. If two simplex (non−redundant) card files are connected to a data concentrator, ports 1 through 8 are assigned to the card slots of one file, and ports 9 through 16 are assigned to the card slots of the other file. If four redundant card files are connected to a data concentrator, ports 1 through 4 are assigned to the like−numbered pairs of primary and secondary card slots of the first file, ports 5 through 8 are assigned to the like−numbered pairs of primary and secondary card slots of the second file, and so on. Valid port numbers are 1 through 16 (see note below).

Note

For an interactive controller, the port number corresponding to the card slot position of the MPU card must be selected. For example, if a four−wide interactive controller is installed in slots 1 through 4 of the first card file (simplex or redundant), port number 4 is selected (the MPU card is always in the right−most slot). Not all ports are valid for interactive controllers (i.e. no variety of interactive controller can reside in port 1).

Strategy — The strategy field is a 12 character text field that can be used to help group points together. For example, if the plant consists of a boiler, a reactor, and a tank, the strategy field of each point could be set to either ”Boiler”, ”Reactor”, or ”Tank”. This data is not checked or processed in any way, but points can be sorted by the strategy field.

4.2.1 FST Registers

This portion of configuration defines the general purpose registers to be used by the function sequence table (FST) of the controller.

Number — This is a read only field that indicates the number of the general register within the controller. For the computing controller this field is 1 through 24. For the interactive controller this field is 1 through 49.

Register name — The name of the register, up to eight characters in length. Since each register is identified by its name, each name must be unique for the controller.

Type v — The register types are MONITOR, REFERENCE, or MONITOR REFERENCE. This determines the kind of access allowed to the register by the function sequence table (FST) of the controller or by the operator interface device (console or hand−held tuner). Table 4-1 lists the three types of registers and shows the access allowed for each. For example, a monitor register can be written into (data store) or read by (data load) the controller, but the operator interface can only read it.

Table 4-1. Access to Register Types

Type of Register	Controller Access		Operator Interface Access	
	Read	Write	Read	Write
Monitor	x	x	x	—
Reference	x	—	x	x
Monitor−Reference	x	x	x	x

Analog — The initial analog value of the register. This value can be any valid floating point number.

Discrete — The initial discrete value of the register. Choose between ON and OFF. ON corresponds to a high value or a 1, and OFF corresponds to a low value or a 0.

4.2.2 Aux EU Definition

This portion of configuration defines engineering unit end points for signal parameters that are used in certain functions in the FST that perform scaling. Auxiliary engineering unit (AUX EU) definition provides extra capacity for signal parameters that are not scaled using indirect control point (ICP) or direct control point (DCP) engineering units. For example, if two analog input signals that are summed together have different units, and only one of the two is scaled in an ICP, then the end points of the other analog input are listed as an auxiliary engineering unit pair.

Type — The type of the controller that is currently being configured. This is a read only field displaying the type that was entered in the previous device definition phase of configuration.

No. — The numbers of the 20 AUX EUs are listed in this read only field. Note that the first 10 are available for both computing and interactive controllers, while the second 10 (11 through 20) are available for the interactive controller only.

Name — The name of the AUX EU. This can be up to 8 characters in length. The name must be unique to the controller.

High Scale Value — The number to be used as the 100% value for the auxiliary engineering unit. This value can be any valid floating point number.

Low Scale Value — The number to be used as the 0% value for the auxiliary engineering unit. This value can be any valid floating point number.

4.2.3 Operator Stations Definition

This portion of configuration defines the operator station ports that are connected to panel−mounted, Controller Operator Station Units. Both the type of operator station and the direct control point (DCP) or points to be displayed on the operator station are identified. If no operator stations are connected to the controller, operator station definition is not required.

Type — The type of the controller that is currently being configured. This is a read only field displaying the type that was entered in the previous device definition phase of configuration.

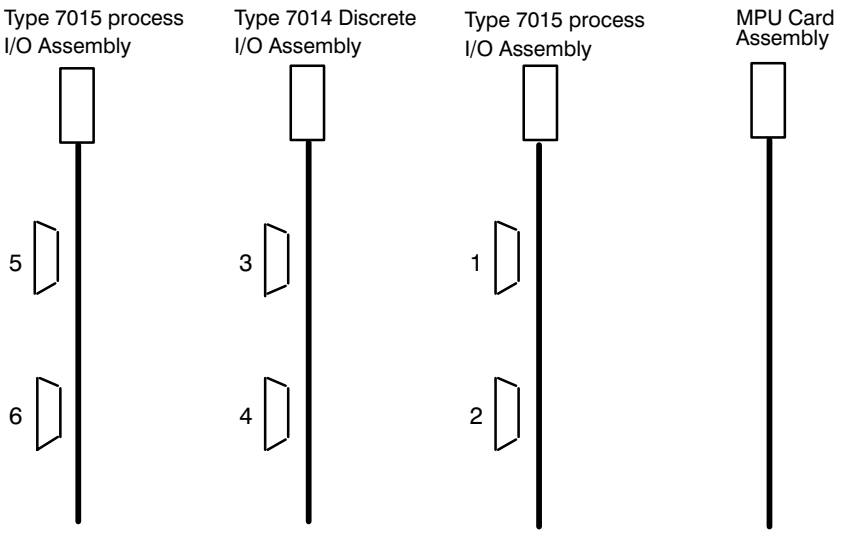
Port No. — The port number of the operator station(s) that the controller currently being configured will utilize. A computing controller has one operator station port. An interactive controller has two, four, or six ports depending on whether the controller is a 2−,3−, or 4−wide model.

Valid port numbers for each controller type are listed in Table 4-2.

Table 4-2. Valid Operator Station Port Numbers

Controller Type	Valid Operator Station Port No(s).
Computing	1
2—wide IAC	1 or 2
3—wide analog IAC	1,2,5 or 6
3—wide discrete IAC	1,2,3 or 4
4—wide IAC	1 thru 6

Interactive operator station ports are identified right to left, top to bottom as shown in Figure 4-3.



Operator Station Ports (Six Shown)

NOTE:
For a 3—Wide Interactive Controller with process I/O (Discrete I/O card not present), the ports are still numbered as shown above (1, 2 ; 5, 6).

Figure 4-3. Operator Station Port Numbering of IAC Cards

Type — This field defines the type of operator station to be connected to the operator station port. Choose from either SINGLE, DOUBLE, or CASCADE. A single operator station displays the data from one DCP or control loop. A double station displays data from two independent DCPs or control loops. A cascade station displays the data from two cascaded DCPs or control loops.

Primary DCP v — This is the tag of the DCP to be communicated to the operator station as the primary, first, or only point, depending on the type of operator station selected. The tag entered must be a DCP within this controller.

Secondary DCP v — This is the tag of the DCP to be communicated to the operator station as the secondary or second point, depending on whether the operator station is a CASCADE or DOUBLE station. This field is disabled if the operator station type is SINGLE. The tag entered must be a DCP within this controller.

4.3 Direct Control Point Configuration

The Interactive and Computing Controllers provide control of continuous processes through the use of Direct Control Points. The major components of each Direct Control Point are:

- Primary Control Algorithm (PCA)
- Station Type
- FST (a series of auxiliary loop functions)

The PCA contains all of the intelligence necessary to transform the loop's inputs into outputs. The station type is used to define the modes of operation that are valid for the point. The FST functions define the control sequence and are used to connect the various input and output channels to the specific control functions that the user has selected.

A total of six forms are used in defining Direct Control Points. The configuration items for these forms are described in the following sections.

4.3.1 Direct Control Point Definition

Description — The description of the point may be up to 16 characters in length. The first 12 characters will appear on the faceplate display of a console on the line immediately below the point tag. All 16 characters may be used on a custom display. Any printable character may be used in the description.

Device — This is the tag of the Interactive or Computing controller device on which this Direct Control Point resides. This is a read−only field.

EU Descriptor — The engineering units descriptor identifies the units of the device or measured variable being controlled. Examples of this are % OPEN or GPM. Units may be up to six characters in length.

High Scale Value — The High Scale Value represents the 100−percent value of the process variable, in engineering units. The valid range for high scale value is any floating point number; however, it may not be the same as the low scale value. Select the level in engineering units corresponding to the maximum expected value of the process variable. This configuration item may be changed using DDP #2, EU 100%.

Index — The point index for this Direct Control Point. Normally, the first point configured on the device is given the index 1, the next point 2, etc. Computing Controllers may have 2 DCPs. 2−Wide IACs and 3−Wide IACs with Discrete I/O may have 4 DCPs. 3−Wide IACs with Process I/O and 4−Wide IACs may have 8 DCPs.

Low Scale Value — The low scale value represents the 0−percent value of the process variable, in engineering units. The valid range for low scale value is any floating point number; however, it may not be the same as the high scale value. For weigh scale interface, 0 must be entered. For other inputs, select the level in engineering units corresponding to the minimum expected value of the process variable. This configuration item may be changed using DDP #1, EU 0%.

PCA Type — The PCA of the Direct Control Point determines the algorithm that will be used to process the PV. The valid types are:

- Manual Loader
- Bias and Gain
- Signal Selector
- P/PD with Bias
- PI/PID/I
- Error-Squared PI/PID
- Notch Gain PI/PID
- Adaptive Gain PI/PID
- Control Sequence
- Control Sequence with Bias

Refer to Table NO TAG (page NO TAG) for a description of the various PCA types.

Table 4-3. List of Valid PCA Types

PCA NUMBER	PCA TYPE	DESCRIPTION
1	Manual loader	Remotely positions a final control element under operator control.
2	Bias and Gain	Provides a proportional bias and gain function on the process variable input. Bumpless transfer is provided by a transfer bias.
3	High/Low Signal Selector	Provides a four−input signal selector with high or low signal selection and logic outputs indicating the selected input.
4	P/PD with Bias	Provides a standard proportional or proportional and rate control action with an adjustable bias for manual reset.
5	PI/PID/I	Provides a standard proportional and reset or proportional, rate, and reset control action or an integral−only function.
6	Error−Squared PI/PID	Provides a proportional and reset or proportional, rate, and reset control action in which the proportional action acts upon the error squared.
7	Notch Gain PI/PID	Provides a proportional and reset or proportional, rate, and reset control action in which the proportional action can be decreased within a given range of the process variable.
8	Adaptive Gain PI/PID	Provides a proportional and reset or proportional, rate, and reset control action in which the proportional action can be changed: (1) Outside a given range of process variable, deviation from set point, valve output, or some analog value; (2) When a discrete value changes state; (3) When a combination of events from 1 and 2 are true.
9	Control Sequence	Computes an error signal which can then be modified by user−selected functions. Set point tracking, limiting, and velocity limiting are available.
10	Control Sequence with Bias	Identical to control sequence PCA except that transfer ramping and an operator adjustable bias are also provided.

Station Type — The station type of a point primarily determines who controls the set point and where the set point originates. Valid station types include:

- Man
- Aut/Man
- Aut/Man/RSP
- Aut/Man/Sup
- Aut/Man/DDC
- Man/DDC
- Aut/Man/DDC/Sup
- Aut/Man/DDC/Sup/RSP

The valid station types for a point also depend upon the selected PCA type. Refer to Table NO TAG (page NO TAG) for a list of valid PCA / Station combinations.

Strategy — The strategy field is a 16−character text field that can be used to help group points together. For example, if the plant consists of a boiler, a reactor, and a tank, the strategy field of each point could be set to either “Boiler”, “Reactor”, or “Tank”. This data is not checked or processed in any way, but points can be sorted by the strategy field.

4.3.2 Primary Control Algorithm (PCA)

Index — The point index uniquely identifies this point, and, when specified, may be used in place of the point tag to access this point. Generally, the first Direct Control point that is configured is assigned point index number 1, and the following points are numbered consecutively.

Action — Defines the relationship between a change in PV and a corresponding change in IVP. When DIRECT is selected, an increase in PV results in an increase in the IVP. When REVERSE is selected, an increase in PV results in a decrease in the IVP. For example, if a valve is controlling the flow of water through a pipe, the valve must close (IVP decrease) as the flow increases beyond set point. Therefore, the appropriate selection would be REVERSE. The loop action may be changed using DDP #9, REV ACT?

ARW High Limit — The Anti−Reset Windup (ARW) high limit sets the upper limit for the anti−reset windup function of the PI/PID/I PCA. In a situation where a Direct Control point has reached an output limit and the integral action has been stopped to prevent windup, it may be desirable to have the IVP move very rapidly once it comes off its limit. The ARW function provides the option of having the integral term of the Direct Control point decrease, or unwind, at a speed 16 times the normal reset speed. This reduces the effects of reset windup on PV overshoot. The valid range is −13.97 to 113.97 percent, and is tunable using DDP #21, ARW HILM.

ARW Low Limit — The Anti−Reset Windup (ARW) low limit sets the low limit for the anti−reset windup function. The valid range is −13.97 to 113.97 percent, and is tunable using DDP #20, ARW LOLM. Refer to ARW HIGH LIMIT for a complete description.

Table 4-4. List of Valid PCA / Station Combinations

Station Number	Station Type	Description
1	Manual Station	For manual (operator) adjustment of the controller output. Used with Manual Loader PCA only.
2	Auto/Manual Station	In Auto, PCA determines the controller final output value. In manual, controller output is manually adjusted. Used with the following PCAs: Bias and Gain Signal Selector P/PD with Bias PI/PID/I Error−Squared PI/PID Notch Gain PI/PID Adaptive Gain PI/PID Control Sequence Control Sequence with Bias
3	Auto/Manual/RSP Station	Auto and manual modes are the same as Auto/Manual Station. Remote Set Point is an automatic mode in which the set point is received from a different source (such as an analog input) and is not operator−adjustable. Used with the following PCAs: P/PD with Bias PI/PID/I Error−Squared PI/PID Notch Gain PI/PID Adaptive Gain PI/PID Control Sequence Control Sequence with Bias
4	Auto/Manual/SUP Station	Auto and manual modes are the same as in Auto/Manual Station. Supervisory is an automatic mode in which the set point is received from a host computer and is not operator−adjustable. Used with the following PCAs: P/PD with Bias PI/PID/I Error−Squared PI/PID Notch Gain PI/PID Adaptive Gain PI/PID Control Sequence Control Sequence with Bias
5	Auto/Manual/DDC Station	Auto and manual modes are the same as in Auto/Manual Station. In Direct Digital Control, a host computer sends a valve output value to the controller. Used with the following PCAs: P/PD with Bias PI/PID/I Error−Squared PI/PID Notch Gain PI/PID Adaptive Gain PI/PID Control Sequence Control Sequence with Bias
6	Manual/DDC Station	Manual mode is the same as Manual Station. In DDC, a host computer sends an output value to the controller. Used with Manual Loader PCA only.
7	Auto/Manual/DDC/SUP Station	Same as Auto/Manual/DDC Station, except that a supervisory mode is also available. Supervisory is an automatic mode in which the set point is received from a host computer and is not operator−adjustable. Used with the following PCAs: P/PD with Bias PI/PID/I Error−Squared PI/PID Notch Gain PI/PID Adaptive Gain PI/PID Control Sequence Control Sequence with Bias

Gain — The proportional gain for BIAS AND GAIN, P_PD WITH BIAS, and PI/PID/I Direct Control points. The valid range for gain is any floating point number from 0.0 to 128.0, and is tunable using DDP #3, GAIN.

Gain Limit — The proportional gain limit for the ERROR_SQUARE PI/PID, and ADAPTIVE_GAIN PI/PID Direct Control points. The valid range for gain limit is any floating point number from 0.0 to 128.0, and can be changed using DDP #4, GAIN LM. For the ADAPTIVE_GAIN PI/PID PCA type, if the gain limit is greater than the gain value, the limit serves as a high gain limit; if the gain limit is less than the gain value, the limit serves as a low gain limit.

PCA Type — The PCA of the Direct Control point determines the algorithm that will be used to process the PV. The PCA is defined on the Direct Control Point form, and is displayed here for reference only.

Rate — Used to define the derivative gain of a P/PD WITH BIAS or PI/PID/I Direct Control point. The valid range for rate is any floating point value from 0.0 to 895.0 minutes. The rate time may be changed using DDP #6, RATE.

Ratio Enable — Determines whether this point supports the Ratio value. The valid range is YES or NO. This configuration item cannot be changed from the DDP list.

Reset — Used to define the integral gain of a PI/PID/I Direct Control point. The valid range for reset is any floating point value from 0.0 to 293.0 repeats per minutes. The reset value may be changed using DDP #5, RESET.

Restart Bias — Defines the initial value of the bias after a power fail restart, if the Restart from Last Bias enable configuration item is answered NO. The valid range is −113.97 to 113.97 percent for the BIAS AND GAIN PCA, and −13.97 to 113.97 percent for the P_PD WITH BIAS PCA. The restart bias value may be changed using DDP #31, RST BIAS.

Restart from Last Bias — This configuration item allows the use of the Restart Bias value after a power fail has occurred. If NO is selected, the restart bias value defined in the Restart Bias configuration item is used. If YES is selected, the last bias value prior to power fail is restored upon restart. This configuration item is valid for Bias and Gain and P/PD WITH BIAS PCAs.

Restart from Last Ratio — This configuration item allows the use of the Restart Ratio value after a power fail has occurred. If NO is selected, the restart Ratio value defined in the Restart Ratio configuration item is used. If YES is selected, the last Ratio value prior to power fail is restored upon restart.

Restart from Last SP — This configuration item allows the use of the Restart SP value after a power fail has occurred. If NO is selected, the restart SP value defined in the Restart SP configuration item is used. If YES is selected, the last SP value prior to power fail is restored upon restart.

Restart Ratio — Defines the initial value of the ratio after a power fail restart, if the Restart from Last Ratio enable configuration item is answered NO. The valid range is 0.02 to 50.0; this parameter is unit−less, and can be changed using DDP #32, RST RAT.

Restart SP — Used to define the initial value of the SP after a power fail, if the Restart from Last SP enable configuration item is answered NO. The valid SP range is −13.97 to 113.97 percent of the engineering unit span. The restart SP value may be changed using DDP #30, RST SP.

Signal Select — This Signal Selector PCA configuration item determines whether the selected signal will correspond to the highest or the lowest implied valve position (IVP). When the signal selector is in the automatic mode, the signal present at the selected input is transferred to the output. A HIGH signal selector selects the input that will cause the highest IVP; LOW selects the lowest IVP. The selection is based on the increase open/close setting for the Direct Control point, i.e., a HIGH selector will select the input that will result in the largest IVP for an increase−open valve, or the input that will result in the lowest IVP for an increase−close valve. In an override scheme, all Direct Control points connected to the signal selector and the signal selector inputs must have increase open valve action.

SP High Limit — The set point high limit is the highest set point that can be selected for the Direct Control point. set point high limit is expressed in engineering units and must be between −13.97 and 113.97 percent of the engineering unit span. The limit may be changed by tuning DDP #17, SP HI LM.

SP Low Limit — The set point low limit is the lowest set point that can be selected for the Direct Control point. set point low limit is expressed in engineering units and must be between −13.97 and 113.97 percent of the engineering unit span. The limit may be changed by tuning DDP #16, SP LO LM.

SP Tracks PV in Manual Enable — Permits the set point to track the process variable when the Direct Control point is in the manual mode. This will cause the set point to identically match the process variable within the limits established by the SP high and low limits.

SP Velocity Limit — Limits the internal SP value used by the Direct Control Point for control and alarming to a maximum rate of change, when the point is in AUTO mode. The valid range is any floating point value in the range 0.0 to 976.369 EUs per minute. The limit may be changed by tuning DDP #15, SP VL LM.

SP Velocity Limit Enable — When this configuration item is answered YES, the internal SP value used by the Direct Control Point is limited by a rate of change value, specified by SP Velocity Limit.

Station Type — The station type of a Direct Control point primarily determines who controls the set point and where the set point originates. The station type is defined on the Direct Control Point form, and is displayed here for reference only.

Transfer Bias Ramp Enable — When this configuration item is answered YES, a Transfer Ramping Bias is enabled for BIAS AND GAIN Direct Control points. When the Direct Control point mode changes from Manual to Automatic, the output will ramp from its manually set value to its new, automatically calculated value over the period of time specified by the Transfer Ramp Time.

Transfer Ramp Time — This configuration item is used only if the transfer ramp enable configuration item was answered YES. It specifies the amount of time, in minutes, for IVP to ramp from its manual mode value to the automatically calculated value. The valid transfer ramp time range is 0.0 to 134.23 minutes, and may be changed using DDP #7, RAMP TIM.

4.3.3 Adaptive/Notch Gain Parameters

The Adaptive/Notch Gain Parameters form is valid for PCA types Adaptive Gain PI/PID and Notch Gain PI/PID only.

DEV Tuning Enable — This configuration item activates the Adaptive Gain action which modifies the proportional gain of the loop based on the current deviation of PV from SP. YES enables DEV adaptive gain action, NO disables this action. The details of deviation adaptive gain are outlined in section 3.3.1.8 beginning on page 3-12.

DEV Lower Break point — The DEV lower break point specifies the point at which the current deviation of the loop will begin to affect the loop proportional gain, to the extent specified by the DEV lower gain factor. DEV lower break point is expressed in engineering units and must be between −136.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #40, DEV LOBP.

DEV Lower Gain Factor — The DEV lower gain factor specifies the gain ratio multiplier which is applied when the current deviation of the loop is ten percent beyond the lower break point. DEV lower gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #42, DEV LOGF.

DEV Upper Break point — The DEV upper break point specifies the point at which the current deviation of the loop will begin to affect the loop proportional gain, to the extent specified by the DEV upper gain factor. DEV upper break point is expressed in engineering units and must be between −136.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #41, DEV HIBP.

DEV Upper Gain Factor — The DEV upper gain factor specifies the gain ratio multiplier which is applied when the current deviation of the loop is ten percent beyond the upper break point. DEV upper gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #43, DEV HIGF.

IVP Tuning Enable — This configuration item activates the Adaptive Gain action which modifies the proportional gain of the loop based on the current valve position. YES enables IVP adaptive gain action, NO disables this action. The details of IVP adaptive gain are outlined in section 3.3.1.8 beginning on page 3-12.

IVP Lower Break point — The IVP lower break point specifies the point at which the current valve position of the loop will begin to affect the loop proportional gain, to the extent specified by the IVP lower gain factor. IVP lower break point is expressed in percent and must be between −36.0 and 136.0 percent. The limit may be changed by tuning DDP #44, VO LOBP.

IVP Lower Gain Factor — The IVP lower gain factor specifies the gain ratio multiplier which is applied when the current valve position of the loop is below the lower break point. IVP lower gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #46, VO LOGF.

IVP Upper Break point — The IVP upper break point specifies the point at which the current valve position of the loop will begin to affect the loop proportional gain, to the extent specified by the IVP upper gain factor. IVP upper break point is expressed in percent and must be between −36.0 and 136.0 percent. The limit may be changed by tuning DDP #45, VO HIBP.

IVP Upper Gain Factor — The IVP upper gain factor specifies the gain ratio multiplier which is applied when the current valve position of the loop is above the upper break point. IVP upper gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #47, VO HIGF.

Lower Notch Break point — This parameter is only valid for the Notch Gain PI/PID PCA type. The lower notch break point specifies the point at which the notch gain becomes effective. When the current Process Variable of the loop is between the lower and upper notch break points, the loop proportional gain is multiplied by the notch ratio value. The lower notch break point is expressed in engineering units and must be

between −36.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #33, NTC LOBP.

Notch Ratio — This parameter is only valid for the Notch Gain PI/PID PCA type. The notch ratio is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #35, NTC RAT.

PCA Type — The PCA of the Direct Control point determines the algorithm that will be used to process the PV. The PCA is defined on the Direct Control Point form, and is displayed here for reference only.

PV Tuning Enable — This configuration item activates the Adaptive Gain action which modifies the proportional gain of the loop based on the current PV. YES enables PV adaptive gain action, NO disables this action. The details of PV adaptive gain are outlined in section 3.3.1.8 beginning on page 3-12.

PV Lower Break point — The PV lower break point specifies the point at which the current Process Variable of the loop will begin to affect the loop proportional gain, to the extent specified by the PV lower gain factor. PV lower break point is expressed in engineering units and must be between −36.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #36, PV LOBP.

PV Lower Gain Factor — The PV lower gain factor specifies the gain ratio multiplier which is applied when the current Process Variable of the loop is ten percent beyond the lower break point. PV lower gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #38, PV LOGF.

PV Upper Break point — The PV upper break point specifies the point at which the current Process Variable of the loop will begin to affect the loop proportional gain, to the extent specified by the PV upper gain factor. PV upper break point is expressed in engineering units and must be between −36.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #37, PV HIBP.

PV Upper Gain Factor — The PV upper gain factor specifies the gain ratio multiplier which is applied when the current Process Variable of the loop is ten percent beyond the upper break point. PV upper gain factor is expressed as a ratio, and must be between 0.02 and 50.0; this parameter is unit−less. The limit may be changed by tuning DDP #39, PV HIGF.

Station Type — The station type of a Direct Control point primarily determines who controls the Direct Control point set point and where the set point originates. The PCA is defined on the Direct Control Point form, and is displayed here for reference only.

Upper Notch Break point — This parameter is only valid for the Notch Gain PI/PID PCA type. The upper notch break point specifies the point

at which the notch gain becomes effective. When the current Process Variable of the loop is between the lower and upper notch break points, the loop proportional gain is multiplied by the notch ratio value. The upper notch break point is expressed in engineering units and must be between −36.0 and 136.0 percent of the engineering unit span. The limit may be changed by tuning DDP #34, NTC HIBP.

4.3.4 Station Parameters

Alarm A — Alarm A is the deviation alarm for the Direct Control point. The deviation limit, which defines how far the process variable must vary from the set point before Alarm A is set, must be configured. The alarm word that will be displayed at the console when the alarm is set must also be defined (may be up to eight characters in length). The value range for the deviation limit is 0 to 136.0 percent of engineering unit span. The deviation limit may be changed using DDP #11, ALM A TR.

Alarm B — Alarm B is one of two absolute alarms for the Direct Control point (see Alarm C). The alarm must be configured as either a high or low alarm. The trip point, which defines when the alarm is set, and the alarm word (up to eight characters in length) that will be displayed at the console must also be defined. The value range for the trip point is −16.0 to 136.0 percent of engineering unit span. The trip point may be changed using DDP #12, ALM B TR.

Alarm C — Alarm C is one of two absolute alarms for the Direct Control point (see Alarm B). The alarm must be configured as either a high or low alarm. The trip point, which defines when the alarm is set, and the alarm word (up to eight characters in length) that will be displayed at the console must also be defined. The value range for the trip point is −16.0 to 136.0 percent of engineering unit span. The trip point may be changed using DDP #13, ALM C TR.

Alarm D — Alarm D is a user defined alarm. This alarm can only be set/reset by the Function Sequence Table (FST). The alarm word (up to eight characters in length) that will be displayed at the console must be defined.

Alarm Deadband — The deadband is the amount by which the PV must move away from a trip point, or by which the deviation limit must move towards a set point, before the alarm is cleared. The valid range is 0 to 136.0 percent of engineering units span. The deadband may be changed using DDP #14, ALM DBND.

Increase to Close — Establishes the relationship between the output current and the implied valve position. When YES is selected, an increase in implied valve position causes a decrease in output current, opening an increase−to−close valve. When NO is selected, an increase in the implied valve position causes an increase in the output current, opening an increase−to−open valve. The YES/NO selection may be changed using DDP #10, INC CLO?

IVP High Limit — Limits the maximum IVP value regardless of the mode of the Direct Control point. When the IVP reaches this limit on a PI_PID_I Direct Control point, the integral action is disabled to prevent windup. Implied valve position is expressed as a percent, and may be tuned using DDP #19, VO HI LM.

IVP Low Limit — This is the same as the IVP high limit configuration item, except it sets the low limit. The IVP low limit may be tuned using DDP #18, VO LO LM.

PCA Type — The PCA of the Direct Control point determines the algorithm that will be used to process the PV. The PCA is defined on the Direct Control Point form, and is displayed here for reference only.

Restart from Last IVP — This configuration item allows the use of the restart IVP value after a power fail has occurred. If NO is selected, the restart IVP value defined in the restart IVP configuration item is used. If YES is selected, the last IVP value prior to power fail is restored upon restart.

Restart from Last Mode — This configuration item allows the use of the restart Mode after a power fail has occurred. If NO is selected, the restart mode defined in the restart Mode configuration item is used. If YES is selected, the last Direct Control point mode prior to power fail is restored upon restart.

Restart IVP — Defines the initial value of the IVP after a power fail, if the restart from last IVP enable configuration item is answered NO. The restart IVP is expressed as a percent, and may be changed using DDP #29, RST VO.

Restart Mode — Defines the initial Direct Control point mode after a power fail, if the restart from last mode enable configuration item is answered NO. The restart Mode may be any mode available with the station type selected. The restart mode for the Direct Control point may be changed using DDP #28, RST MD.

SP Tracks PV in DDC Mode Enable — Causes the set point to track the process variable when the Direct Control point is in the DDC mode. YES enables set point tracking; NO disables it.

Station Type — The station type of a Direct Control point primarily determines who controls the Direct Control point set point and where the set point originates. The PCA is defined on the Direct Control Point form, and is displayed here for reference only.

Watchdog Timer Enable — Determines if the Watchdog Timer function is activated on this Direct Control Point (see the parameter definition for Watchdog Timer Timeout Time). If the user answers YES, the Watchdog Timer function is enabled.

Watchdog Timer Timeout Time — Defines the timeout time applied when the Direct Control Point is in the Direct Digital Control (DDC) or Supervisory SP (SUP) modes. If the time interval between receipt of DDC or Supervisory change requests exceeds the Watchdog Timer Timeout Time, the controller switches to the Watchdog Timer Timeout Backup Mode. The valid range is 0 to 134.23 minutes, and can be changes using DDP #26, WDOG TIM.

Watchdog Timer Timeout Backup Mode — Defines the Direct Control point mode after the Watchdog Timer Timeout Time expires. The Watchdog Timer Timeout Backup Mode may be either Manual (MAN) or Auto (AUT) mode. The Watchdog Timer Timeout Backup Mode for the Direct Control point may be changed using DDP #27, BCKUP MD.

4.3.5 DCP Cross Reference Definition

This section of configuration selects those operating parameters from other configured DCPs that are to appear in the console detail display for the DCP currently being configured.

PCA Type — This is a read−only field displaying the PCA type of the DCP for which DCP cross referencing of operating parameters is being defined.

Station Type — This is a read−only field displaying the Station type of the DCP for which DCP cross referencing of operating parameters is being defined.

No — This column lists the number for the eight possible DCPs. These numbers appear automatically; therefore, no entry is made.

DCP v — The name of the DCP for which cross−referencing of operating parameters to this DCP is desired.

PV — If the PV of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

SP — If the SP of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

VO — If the VO of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

MODE — If the MODE of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

BIAS — If the BIAS of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

RATIO — If the RATIO of the indicated DCP is to appear on the detail display of this DCP, choose YES. Otherwise, choose NO.

4.3.6 DCP Register DDP Definition

This portion of configuration selects the registers to be displayed on the system console (or a hand−held tuner) as a detail display parameter (DDP). A detail display is available for each point configured in the controller. For each detail display containing direct control point (DCP) data, any or all of the registers may be selected to appear in the display.

PCA Type — This is a read−only field displaying the PCA type of the DCP for which the register DDPs are being defined.

Station Type — This is a read−only field displaying the Station type of the DCP for which the register DDPs are being defined.

No. — This is a read−only field displaying the number of the general register. For a computing controller the number is 1 through 24. For an interactive controller the number is 1 through 49.

Register v — The name of the general register as defined previously in the FST registers definition with a maximum length of 8 characters.

Format — This field determines the portion of the register that is to be displayed as a DDP. Choose between ANALOG, DISCRETE or BOTH.

4.4 Function Sequence Table (FST)

An FST is the algorithm that runs under each direct control point and is constructed of individual functions (instructions) that are linked together to create a control strategy. The instructions are selected from a predefined library of instructions stored in the controller. These individual instructions are entered on the DCP FST form using the Instruction Editor (refer to the ENVOX User's Manual for more information on the Instruction Editor).

Each DCP defined for a controller must be placed in a separate loop of the FST. Each loop in the FST must begin with the LOOP instruction and end with the END instruction. Each loop in the FST can contain up to 100 steps. The maximum total steps for all loops is 200 for the Computing controller and 250 for the Interactive controller.

The FST instructions in this section are listed in alphabetical order. To simplify locating an instruction which will perform a particular function, Table 4-5 contains an index of FST instructions listed by function type. There are 12 major function groups: mathematical functions, logic functions, conversion functions, loop mode functions, operating data load/store functions, general register load/store functions, time related functions, PCA modifier functions, input/output functions, operator station functions, loop housekeeping functions, and feedforward functions.

Most FST instructions consist of the function mnemonic and one or more operands. Refer to the following section for a complete list of FST mnemonics, operands, and descriptions of each instruction. Operands can be analog and discrete values, register names, and other alphanumerics that relate the individual functions to other functions or to important controller and loop parameters. Some functions accept analog and discrete loadable functions as an operand. A list of loadable functions is provided in Table 4-6. Loadable functions are used to reduce the number of FST steps required to define an FST for certain control strategies.

Table 4-5. Index of FST Instructions by Function Type

GROUP	FUNCTION	FUNCTION NAME	PAGE
MATHEMATICAL	ABS	Absolute Value	4-32
FUNCTIONS	B	Fixed Bias	4-48
	CHS	Change Sign	4-52
	DIF	Difference	4-62
	DIV	Divide	4-63
	EXP (1)	Exponent	4-72
	HS	High Select	4-91
	K	Fixed Gain	4-110
	LIMIT	Limiter	4-112
	LN (1)	Natural Logarithm	4-116
	LOG (1)	Base 10 Logarithm	4-117
	LS	Low Select	4-119
	MASFLW	Mass Flow (Ideal Gas)	4-121
	MIDSEL	Middle Selector	4-124
	MUL	Multiply	4-126
	POLY	Polynomial Conversion	4-135
	PWR (1)	Power	4-138
	SQRT	Square Root	4-149
	SUM	Summation	4-152
	TFR	Signal Transfer	4-153
LOGIC	AND	Logical AND	4-45
FUNCTIONS	BDET	Bi−directional Edge Trigger	4-49
	FFR	Flip−Flop Reset	4-80
	FFS	Flip−Flop Set	4-82
	HLV	Hold Last Value	4-89
	HSM	High Signal Monitor	4-92
	LSM	Low Signal Monitor	4-120
	NOT	Logical Inverse	4-128
	OR	Logical OR	4-129
	PDET	Positive Directional Edge Trigger	4-132
	PFR	Power Fail Restart	4-134
	XOR	Logical Exclusive OR	4-165
CONVERSION	ADSVT	Analog−to−Discrete Signal	4-33
FUNCTIONS		Value Transfer	
	DASVT	Discrete−to−Analog Signal	4-59
		Value Transfer	
	EUP	Engineering−Units−to−Percent	4-71
		Conversion	
	PEU	Percent−to−Engineering Units	4-133
		Conversion	

GROUP	FUNCTION	FUNCTION NAME	PAGE
LOOP MODE	IFTAUT	If True, Set Automatic Mode	4-101
FUNCTIONS	IFTDDC	If True, Set Direct Digital Control Mode	4-102
	IFTMAN	If True, Set Manual Mode	4-103
	IFTRSP	If True, Set Remote Set Point Mode	4-106
	IFTSUP	If True, Set Supervisory Mode	4-107
	TIFAUT	True if Automatic Mode	4-154
	TIFDDC	True if Direct Digital Control	4-155
	TIFMAN	True if Manual Mode	4-156
	TIFRSP	True if Remote Set Point Mode	4-157
	TIFSUP	True if Supervisory Mode	4-158
OPERATING DATA	ALMLD	Alarm Monitor Load	4-42
REGISTER	ALMST	Alarm Monitor Store	4-44
LOAD/STORE	ICPLDA	Indirect Control Point Load Analog	4-93
FUNCTIONS	ICPLDD	Indirect Control Point Load Discrete	4-95
	ICPSTA	Indirect Control Point Store Analog	4-96
	ICPSTD	Indirect Control Point Store Discrete	4-98
	PVLD	Process Variable Load	4-137
	RSPST	Remote Set Point Store	4-143
	%RSPST	Percent Remote Set Point Store	4-144
	RTOLD	Ratio Load	4-145
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NOTE (1) : Not available for the Computing Controller

Table 4-6. Loadable Functions

Mnemonic	Description	Discrete or Analog
PFR	Power Fail Restart	Discrete
TIFMAN	True if Manual Mode	Discrete
TIFAUT	True if Auto Mode	Discrete
TIFRSP	True if Remote Set Point	Discrete
TIFSUP	True if Supervisory Mode	Discrete
TIFDDC	True if Direct Digital Control Mode	Discrete
SPLD	Set Point Load	Analog
PVLD	Process Variable Load	Analog
VOLD	Valve Output Load	Analog
RTOLD	Ratio Load	Analog
SSLD	Signal Selector Status Load	Discrete
ICPLDA	Indirect Control Point Load Analog	Analog
ICPLDD	Indirect Control Point Load Discrete	Discrete
ALMLD	Alarm Monitor Load	Discrete
RGLD	Register Load	Analog and Discrete
RGLDA	Register Load Analog	Analog
RGLDD	Register Load Discrete	Discrete
AIN	Analog Input	Analog and Discrete
AINEU	Analog Input in Engineering Units	Analog and Discrete
AINSQR	Analog Input Square Root	Analog and Discrete
AINTCJ	Analog Input Type J Thermocouple	Analog and Discrete
AINTCK	Analog Input Type K Thermocouple	Analog and Discrete
AINTCE	Analog Input Type E Thermocouple	Analog and Discrete
AINTCT	Analog Input Type T Thermocouple	Analog and Discrete
DI	Discrete Input	Discrete

AAGM

AAGM

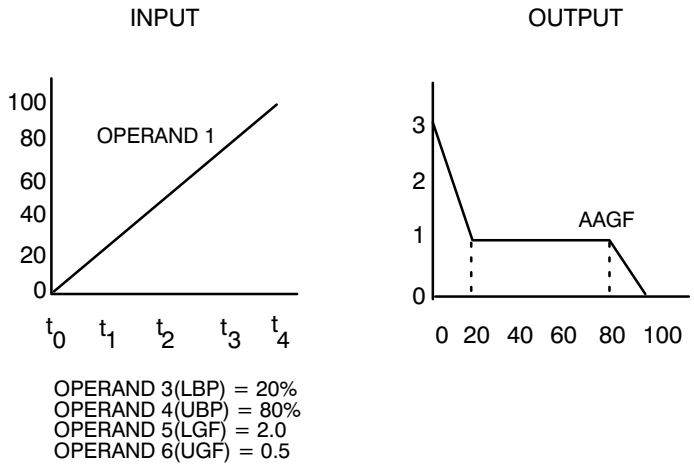
INSTRUCTION NAME: AAGM (analog adaptive gain modifier)

DESCRIPTION: This instruction is used only once per loop and in conjunction with the adaptive gain PCA. Based on an analog value, it modifies the gain of only the proportional action term of the PI/PID algorithm. This modifier creates four registers, which are required to store the upper break point, upper gain factor, lower break point, and lower gain factor. The SVA and SVD inputs remain unchanged.

When the analog value (operand 1) is below the lower break point (operand 3) or above the upper break point (operand 4), the analog adaptive gain factor (AAGF) will change linearly, based on the difference between the analog value and the break point. The lower and upper gain factors (operands 5 and 6) determine the rate of change in AAGF. Gain factors greater than 1 cause AAGF to increase as the analog value moves away from the break point, while gain factors less than 1 cause AAGF to decrease. When the analog value is 10 percent away from a break point, AAGF equals the gain factor.

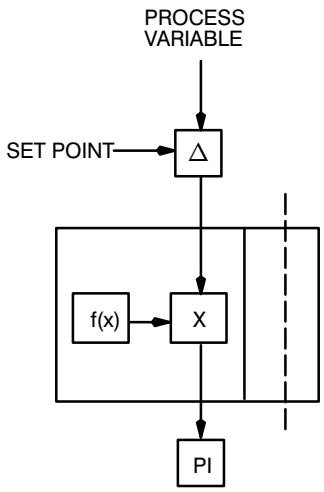
When the analog value is between the upper and lower break points, AAGF equals 1.

GRAPHIC REPRESENTATION:



OPERAND 3(LBP) = 20%
OPERAND 4(UBP) = 80%
OPERAND 5(LGF) = 2.0
OPERAND 6(UGF) = 0.5

SYMBOLIC REPRESENTATION:



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AAGM AAGM

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CONFIGURATION FORMAT: AAGM (

Analog value	>>
Eng conversion factors	>>
Lower break point	>>
Upper break point	>>
Lower gain factor	>>
Upper gain factor	>>
Comment	>>

OPERAND DESCRIPTIONS:

Analog value — The name of the general register or analog loadable function that contains the adaptive gain signal.

Eng conversion factors — The name of the direct control point (DCP), indirect control point (ICP), or auxiliary engineering unit pair that contains the engineering units high and low values.

Lower break point — A tuning parameter that specifies the value of the lower break point. Break point values are —136 to 136 percent of engineering units span (in percent).

Upper break point — A tuning parameter that specifies the value of the upper break point. Break point values are —136 to 136 percent of engineering units span (in percent).

Lower gain factor — A tuning parameter that indirectly determines the analog adaptive gain below the lower break point (see Description section above). Gain factor values are 0.02 to 50.

Upper gain factor — A tuning parameter that indirectly determines the analog adaptive gain above the upper break point (see Description section above). Gain factor values are 0.02 to 50.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If AGS < LBP
  Then AAGF = 1 — [(1—LGF)X((LBP—AGS)/10)]
If LBP <= AGS <= UBP
  Then AAGF = 1
If AGS > UBP
  Then AAGF = 1 — [(1—UGF)X((AGS—UBP)/10)]

(Continued on next page)

AAGM

AAGM

(Continued from previous page)

Where: AGS = adaptive gain signal (operand 1)
LBP = lower break point (operand 3)
UBP = upper break point (operand 4)
AAGF = analog adaptive gain factor
LGF = lower gain factor (operand 5)
UGF = upper gain factor (operand 6)

SVA(out) = SVA(in)
SVD(out) = SVD(in)

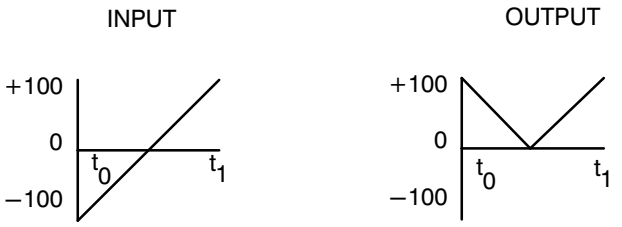
ABS

ABS

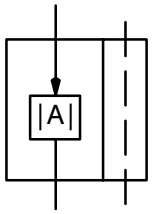
INSTRUCTION NAME: ABS (absolute value)

DESCRIPTION: This instruction takes the absolute value of the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ABS (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

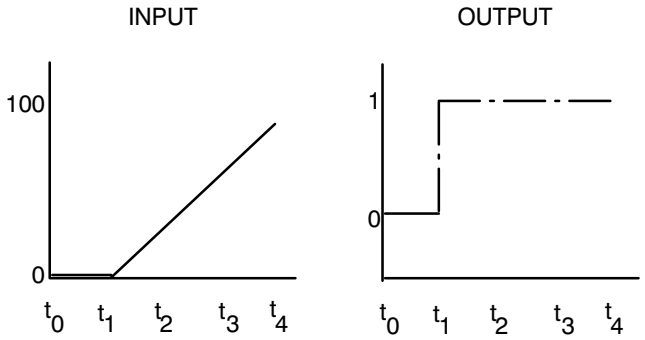
SVA(out) = |SVA(in)|
SVD(out) = SVD(in)

ADSVT ADSVT

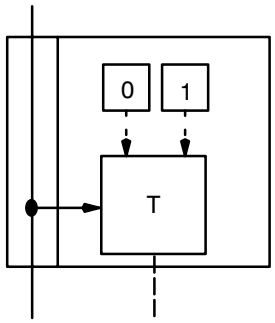
INSTRUCTION NAME: ADSVT (analog to discrete signal value transfer)

DESCRIPTION: This instruction sets the SVD output to 0 when the absolute value of the SVA input is less than 1. When the absolute value of the SVA input is greater than or equal to 1, the SVD output is 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ADSVT (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If |SVA(in)| < 1
Then SVD(out) = 0
If |SVA(in)| >= 1
Then SVD(out) = 1
SVA(out) = SVA(in)

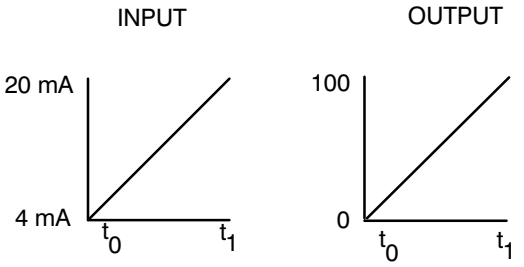
AIN

AIN

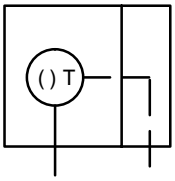
INSTRUCTION NAME: AIN (analog input)

DESCRIPTION : This instruction sets the SVA output equal to the value, in percent, of the analog input at the channel specified by operand 1. The SVD output is 0 if the analog input value is between −2 and 102 percent of span. If the analog input value is outside of this range, the SVD output is 1.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AIN (

AIN channel	>>
Comment	>>

OPERAND DESCRIPTIONS:

AIN channel − The channel number of the desired analog input. The relationship between AIN channel number for each analog input function and the actual field wiring terminal designations is as follows:

Controller type	Field wiring Terminal designation	AIN channel number
Computing	MV1+ to MV5+	1 to 5
2−Wide	MV1+ to MV10+	1 to 10
3−Wide Discrete	MV1+ to MV10+	1 to 10
3−Wide Analog	MV1+ to MV10+	1 to 10
	MV16+ to MV20+	16 to 20
4−Wide	MV1+ to MV20+	1 to 20

Comment − A comment up to 255 characters long.

(Continued on next page)

AIN

AIN

(Continued from previous page)

FUNCTION EQUATIONS:

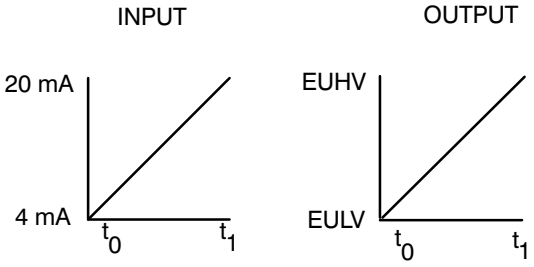
SVA(out) = Analog input value (in percent)
If −2% <= Analog input value <= 102%,
  Then SVD(out) = 0
Else
  SVD(out) = 1

AINEU AINEU

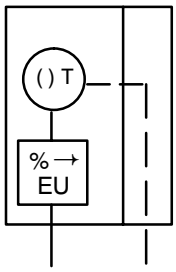
INSTRUCTION NAME: AINEU (analog input in engineering units)

DESCRIPTION: This instruction sets the SVA output equal to the value, in engineering units, of the analog input at the channel specified by operand 1. The engineering units used to convert the input are specified by values in operand 2. The SVD output is 0 if the analog input value is between −2 and 102 percent of span. If the analog input value is outside of this range, the SVD output is 1.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AINEU (

AIN channel	>>
Eng conversion factors	>>
Comment	>>

OPERAND DESCRIPTIONS:

AIN channel − The channel number of the desired analog input. The relationship between AIN channel number for each analog input function and the actual field wiring terminal designations is as follows:

Controller type	Field wiring Terminal designation	AIN channel number
Computing	MV1+ to MV5+	1 to 5
2−Wide	MV1+ to MV10+	1 to 10
3−Wide Discrete	MV1+ to MV10+	1 to 10
3−Wide Analog	MV1+ to MV10+	1 to 10
	MV16+ to MV20+	16 to 20
4−Wide	MV1+ to MV20+	1 to 20

(Continued on next page)

AINEU AINEU

(Continued from previous page)

Eng conversion factors – The name of the ICP, DCP, or auxiliary engineering unit pair that contains the engineering units high and low values.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = [(EUHV – EULV)X(Analog input value/100)+EULV]

Where: EULV = Engineering units low value
EUHV = Engineering units high value

If –2% <= Analog input value <= 102%
Then SVD(out) = 0
Else
SVD(out) = 1

AINSQR

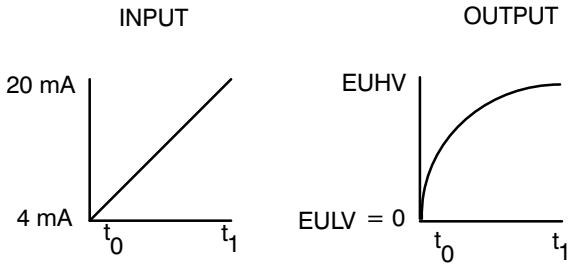
AINSQR

INSTRUCTION NAME: AINSQR (analog input square root)

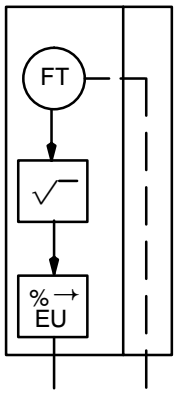
DESCRIPTION: This instruction sets the SVA output equal to the square root of the value, in engineering units, of the analog input at the channel specified by operand 1. The engineering units used to convert the input are specified by values in operand 2. The square root operation retains the sign of the analog input value after taking the square root of the analog input. The low engineering units value can have a suppressed or elevated value. For example, this allow bi−directional flow and elevated flow measurements. In an elevated flow measurement, the range may be from 500 GPM (4 mA) to 1000 GPM (20 mA). In a bi−directional flow measurement, the engineering units range from −200 GPM (4 mA) to 400 GPM (20 mA). Note that the use of this function depends upon the hardware configuration.

The SVD output is 0 if the analog input value is between −2 and 102 percent of span. If the analog input value is outside this range, the SVD output is 1.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AINSQR (

AIN channel	>>
Eng conversion factors	>>
Comment	>>

(Continued on next page)

AINSQR AINSQR

(Continued from previous page)

OPERAND DESCRIPTIONS:

AIN channel — The channel number of the desired analog input. The relationship between AIN channel number for each analog input function and the actual field wiring terminal designations is as follows:

Controller type	Field wiring Terminal designation	AIN channel number
Computing	MV1+ to MV5+	1 to 5
2—Wide	MV1+ to MV10+	1 to 10
3—Wide Discrete	MV1+ to MV10+	1 to 10
3—Wide Analog	MV1+ to MV10+	1 to 10
	MV16+ to MV20+	16 to 20
4—Wide	MV1+ to MV20+	1 to 20

Eng conversion factors — The name of the ICP, DCP, or auxiliary engineering unit pair that contains the engineering units high and low values.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

$SVA(out) = SQRT[((EUHV^2 - EULV^2)/100) \times AIV + EULV2]$

Where: EULV = Engineering units low value
EUHV = Engineering units high value
AIV = Analog input value (in percent)

If −2% <= Analog input value <= 102%
Then SVD(out) = 0
Else
SVD(out) = 1

AINTC

AINTC

INSTRUCTION NAME: AINTCE, AINTCJ, AINTCK, AINTCT

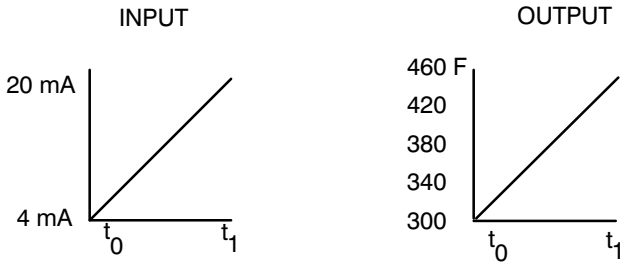
(analog input thermocouple type E, J, K and T)

DESCRIPTION: These instructions perform linearization of high level (4 to 20 milliamps, 1 to 5 volts dc) thermocouple input signals based on the thermocouple conversion factors included in the functions. The maximum ranges for each thermocouple type are as follows:

Type E: 0 to 1600^0F
Type J: 0 to 1400^0F
Type K: 0 to 2400^0F
Type T: −300 to 700^0F

Operand 1 specifies the channel number of the analog input to be converted. The SVD output is 0 if the analog input value is between −2 and 102 percent of span. If the analog input value is outside this range, the SVD output is 1.

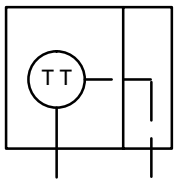
GRAPHIC REPRESENTATION:



4 mA to 20 mA is equal to 300 to 460 Degrees F

THIS EXAMPLE SHOWS THE TYPE J THERMOCOUPLE. THE THERMOCOUPLE CONVERSION IS DONE BY COMPARING INPUT TO TABLE VALUES AND DOING A LINEAR INTERPOLATION BETWEEN POINTS.

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AINTC***** (

AIN channel	>>
Eng conversion factors	>>
Temperature units	>>
Comment	>>

***** – either E, J, K or T

(Continued on next page)

AINTC AINTC

(Continued from previous page)

OPERAND DESCRIPTIONS:

AIN channel — The channel number of the desired analog input. The relationship between AIN channel number for each analog input function and the actual field wiring terminal designations is as follows:

Controller type	Field wiring Terminal designation	AIN channel number
Computing	MV1+ to MV5+	1 to 5
2—Wide	MV1+ to MV10+	1 to 10
3—Wide Discrete	MV1+ to MV10+	1 to 10
3—Wide Analog	MV1+ to MV10+	1 to 10
	MV16+ to MV20+	16 to 20
4—Wide	MV1+ to MV20+	1 to 20

Eng conversion factors — The name of the ICP, DCP, or auxiliary engineering unit pair that contains the engineering units high and low values.

Temperature units — This specifies the temperature scale used in the conversion, either Fahrenheit or Celsius.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = f(Analog input value)
If −2% <= Analog input value <= 102%
  Then SVD(out) = 0
Else
  SVD(out) = 1

ALMLD

ALMLD

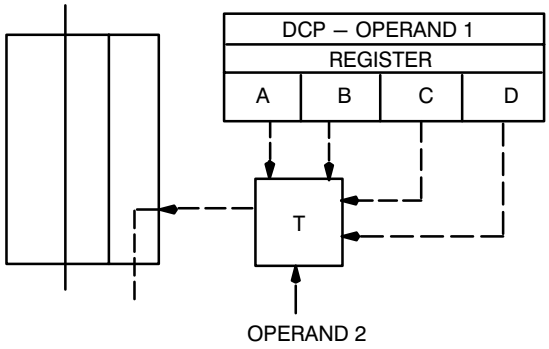
INSTRUCTION NAME: ALMLD (alarm monitor load)

DESCRIPTION: This instruction sets the SVD output to 0 or 1 depending on the state of the alarm monitor contained in operand 2. If the state of the alarm monitor is '0', then the SVD (out) is '0'. If the state of the alarm monitor is '1', then the SVD (out) is '1'. The direct control point (DCP) associated with the alarm monitor is contained in operand 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ALMLD (

Loop tag	>>
Alarm number	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop associated with the alarm monitor.

Alarm number – The number designator that identifies the alarm type, as follows:

1 – Deviation alarm (A)
2 – High or low alarm (B)
3 – High or low alarm (C)
4 – User defined alarm (D)

Comment – A comment up to 255 characters long.

(Continued on next page)

ALMLD

ALMLD

(Continued from previous page)

FUNCTION EQUATIONS:

If Alarm monitor = 0 (no alarm)
  Then SVD(out) = 0
If Alarm monitor = 1 (alarm)
  Then SVD(out) = 1
SVA(out) = SVA(in)

ALMST

ALMST

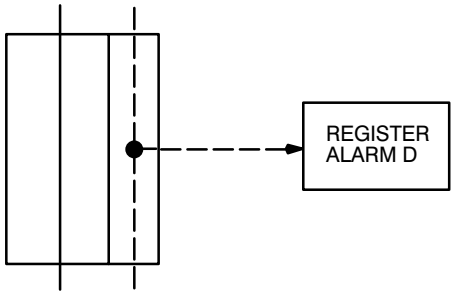
INSTRUCTION NAME: ALMST (alarm monitor store)

DESCRIPTION: This instruction stores the SVD input into the user defined alarm (D) operating data register for the DCP that is located in the same FST loop as the ALMST function. The user alarm is set to alarm if the SVD input is 1 and reset if it is 0. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ALMST (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

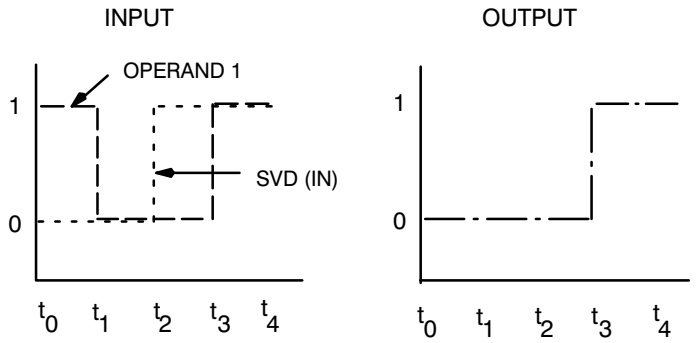
AND

AND

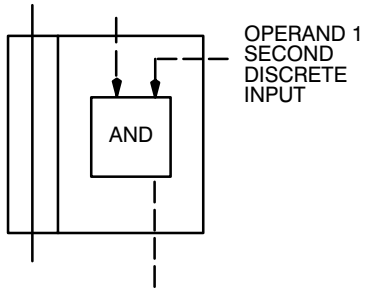
INSTRUCTION NAME: AND (logical AND)

DESCRIPTION: This instruction takes a logical AND of the SVD input and the discrete value contained in operand 1. When both the SVD input and the discrete value are 1, the SVD output is 1. When either the SVD input or the discrete value, or both, are 0, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AND (

Second input	>>
Comment	>>

OPERAND DESCRIPTIONS:

Second Input – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

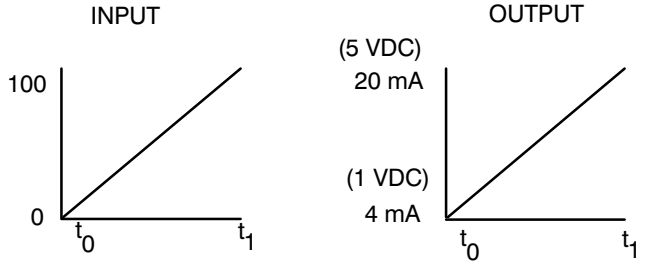
If SVD(in) = 1, and Discrete Value = 1,
  Then SVD(out) = 1
Else SVD(out) = 0
SVA(out) = SVA(in)

AOUT AOUT

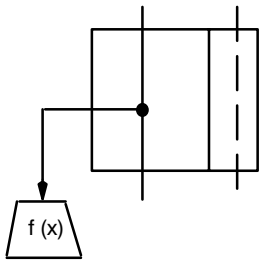
INSTRUCTION NAME: AOUT (analog output)

DESCRIPTION : The analog output will be 4 to 20 milliamps or 1 to 5 volts dc for an SVA input span of 0 to 100 percent, depending upon which output channel number is selected. The SVA and SVD inputs remain unchanged. Therefore, the SVA input is available for use in the next function.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: AOUT (

AOUT channel >>
Comment >>

OPERAND DESCRIPTIONS:

AOUT channel – The channel number of the desired analog output. The type and number of outputs for each controller are as follows:

	AOUT channel number					
Controller type	1	2	3	4	5	6
Computing (1)	CO+(2)	VO+(2)				
2–Wide	CO1+	CO2+	VO1+			
3–Wide Discrete	CO1+	CO2+	VO1+			
3–Wide Analog	CO1+	CO2+	VO1+		CO4+	VO2+
4–Wide	CO1+	CO2+	VO1+	CO3+	CO4+	VO2+

(Continued on next page)

AOUT AOUT

(Continued from previous page)

Notes:

(1) – Later models of Computing controller have a selectable output channel 2 (current OR voltage).

(2) – CO and VO stand for current output (4 to 20 mA) and voltage output (1 to 5 Vdc) respectively; this nomenclature is associated with field wiring connections in the controller.

CONFIGURATION EXAMPLES : AOUT (2)

FUNCTION EQUATIONS:

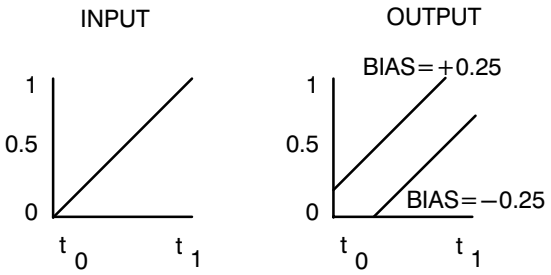
Analog output = SVA(out) = SVA(in)
SVD(out) = SVD(in)

B B

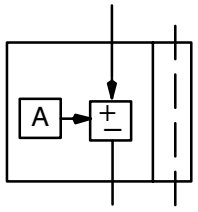
INSTRUCTION NAME: B (fixed bias)

DESCRIPTION: This instruction adds the fixed bias contained in operand 1 to the SVA input. This bias value can only be changed in the configuration mode. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: B (

Bias value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Bias value — This value (any floating point number) is selected during controller configuration and cannot be changed in either operate or tune modes.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

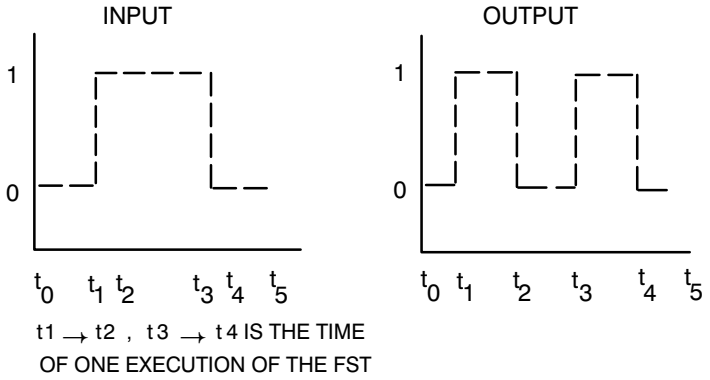
SVA(out) = SVA(in) + bias value
SVD(out) = SVD(in)

BDET BDET

INSTRUCTION NAME: BDET (bi—directional edge trigger)

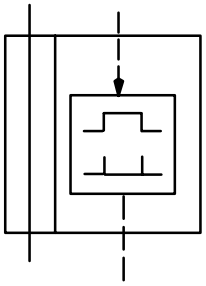
DESCRIPTION: This instruction sets the SVD output to a 1 when the SVD input changes from 0 to 1. The SVD output remains at 1 for one execution (cycle) of the FST and then returns to 0. When the SVD input changes from 1 to 0, the SVD output is again set to 1 and remains at 1 for one execution of the FST. The SVD output then returns to 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



t1 → t2 , t3 → t4 IS THE TIME OF ONE EXECUTION OF THE FST

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: BDET (

Comment >>

OPERAND DESCRIPTIONS:

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) <> SVD(in) last cycle
Then SVD(out) = 1
If SVD(in) = SVD(in) last cycle
Then SVD(out) = 0
SVA(out)=SVA(in)

CASC CASC

INSTRUCTION NAME: CASC (cascade)

DESCRIPTION: This instruction provides cascade control linkage between two direct control points, the second of which must have remote set point mode. The implied value position (IVP) of the primary loop is automatically placed into the set point of the secondary loop when the secondary loop is in the remote set point mode.

When the secondary loop is in the manual mode, the IVP of the primary loop tracks the process variable of the secondary loop, if the primary loop is not in manual mode.

When the secondary loop is in the local automatic mode, the IVP of the primary loop tracks the local set point of the secondary loop, if the primary loop is not in manual mode.

When the secondary loop is in the remote set point mode, the IVP of the primary loop becomes the percent of span remote set point for the secondary control loop.

The primary loop will perform normal PID control action when the secondary loop is in the remote set point mode as long as IVP of the secondary loop is not output limited. When the secondary controller IVP is output limited, and the change in IVP of the primary control loop causes the secondary loop to drive harder against its output limit, the integral action is disabled in the primary loop. This prevents the primary loop from winding up its output when the secondary loop is already output limited in the direction the primary loop is tending to drive it. The following guidelines apply to the use of the cascade function:

- The primary loop must be set up for increase to open valves.
- The secondary loop must have the auto/manual/RSP station type.
- The cascade function cannot be used in the same loop as the TRK or OVRD functions.
- The secondary loop can use any of the PCA modifier functions.
- CASC can be used only once per direct control point.

CONFIGURATION FORMAT: CASC (

Loop tag >>
Track overrides manual enable >>
Comment >>

(Continued on next page)

CASC CASC

(Continued from previous page)

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the secondary loop in the cascade control system. The cascade function will automatically recall the appropriate analog track value based on the mode of the secondary loop.

Track overrides manual enable – When the primary loop is in manual mode, enabling this parameter forces the output of the primary loop to track: 1) the process variable of the secondary loop when the secondary loop is in manual, and 2) the set point of the secondary loop when the secondary loop is in automatic. ENABLED or DISABLED can be specified.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

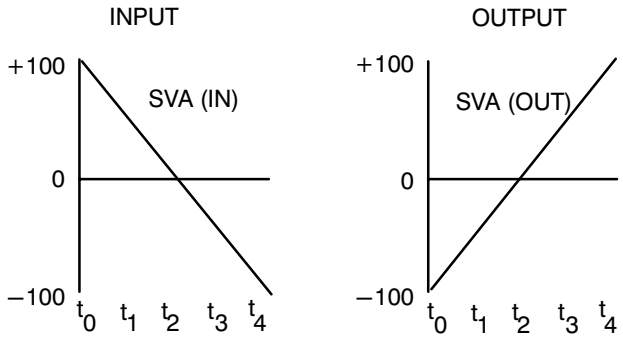
CHS

CHS

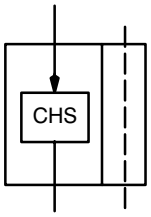
INSTRUCTION NAME: CHS (change sign)

DESCRIPTION: This instruction changes the polarity of the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: CHS (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = −SVA(in)
SVD(out) = SVD(in)

CNTRL CNTRL

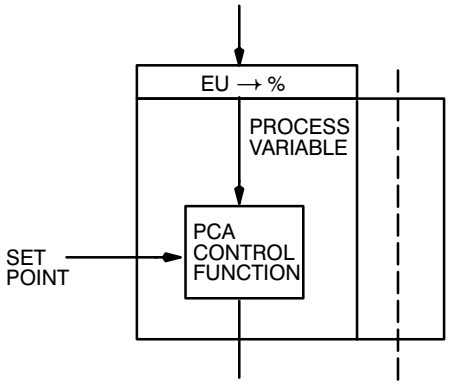
INSTRUCTION NAME: CNTRL (control)

DESCRIPTION: This instruction initiates the primary control algorithm (PCA) within a control loop. When this function is performed, the information defined during the PCA definition phase of configuration is used in the control strategy. The SVA input is always the process variable value in engineering units. The SVD input remains unchanged. Each loop can have either one CNTRL (or %CNTRL) function or none at all.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: CNTRL (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

PV = SVA(in) (in engineering units)
SVA(out) = f(CNTRL)
SVD(out) = SVD(in)

%CNTRL %CNTRL

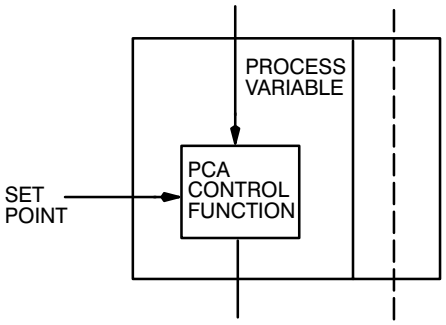
INSTRUCTION NAME: %CNTRL (percent control)

DESCRIPTION: This instruction is similar to the CNTRL function, except that the SVA (process variable) input must be in percent of span. All other information is the same.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: %CNTRL (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

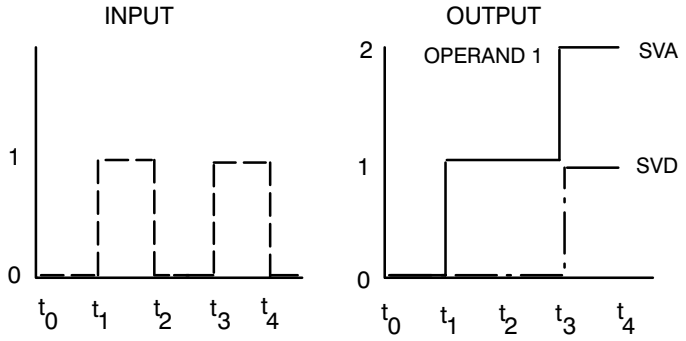
PV = SVA(in) (in percent of span)
SVA(out) = f(%CNTRL)
SVD(out) = SVD(in)

CTR CTR

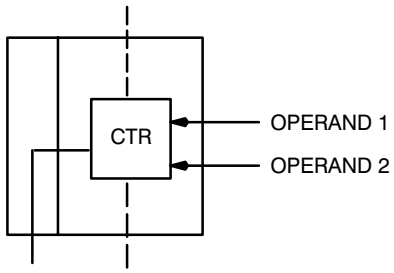
INSTRUCTION NAME: CTR (counter / ramp)

DESCRIPTION: This instruction counts the logic 0 to logic 1 transitions of the SVD input. The SVA and SVD output values depend on the present state of the SVD input, the counter/ramp value in operand 1, and the reset value in operand 2. Each transition of the SVD input increments an internal counter by 1 count. If the reset value in operand 2 is 0, the SVA output is set equal to the internal count. When the internal count equals the value in operand 1, the SVD output is 1. When the reset value in operand 2 is 1, the SVD output and the internal count are reset to 0. Note that the internal count can exceed the value specified in operand 1.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: CTR (

Counter/ramp value	>>
Reset	>>
Comment	>>

OPERAND DESCRIPTIONS:

Counter/ramp value — A tuning parameter that specifies the value to which the internal counter is compared. Counter/ramp values are 0 to 2,147,480,000.

Reset — The name of the general register or discrete loadable function that contains the discrete reset value.

Comment — A comment up to 255 characters long.

(Continued on next page)

CTR

CTR

(Continued from previous page)

FUNCTION EQUATIONS:

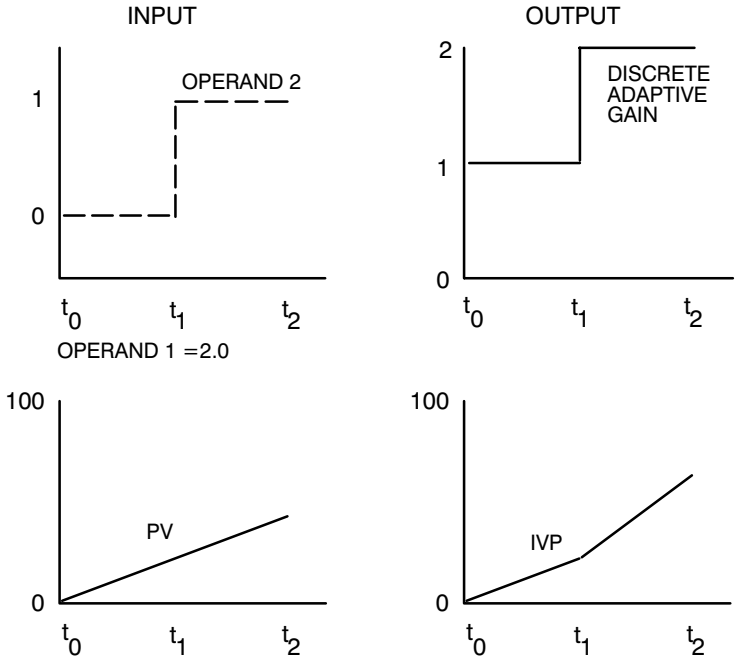
If internal count < counter/ramp value, and reset = 0
  Then SVD(out) = 0
If internal count >= counter/ramp value, and reset = 0
  Then SVD(out) = 1
If reset value = 1
  Then internal count = 0 and SVD(out) = 0
SVA(out) = internal count

DAGM DAGM

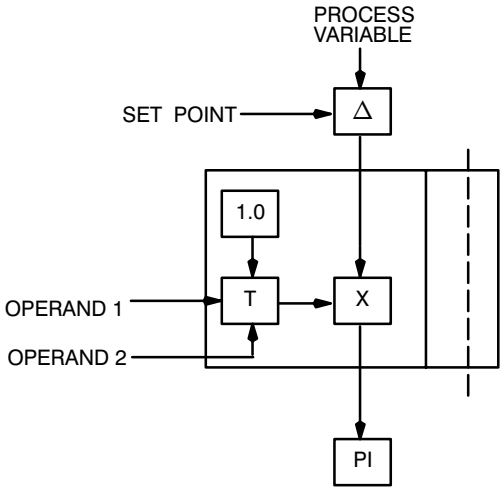
INSTRUCTION NAME: DAGM (discrete adaptive gain modifier)

DESCRIPTION: This instruction is used with the analog adaptive gain PCA only once per control loop. One auxiliary register (operand 1) is created that contains the gain factor. Operand 2 contains a discrete value that sets the gain factor to 1, or to the value in operand 1, depending on the status. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DAGM (

Discrete gain factor	>>
Input value	>>
Comment	>>

(Continued on next page)

DAGM DAGM

(Continued from previous page)

OPERAND DESCRIPTIONS:

Discrete gain factor – A tuning parameter that specifies the value of the discrete adaptive gain factor. The valid range is 0.02 to 50.

Input value – The name of the general register or discrete loadable function that contains the discrete enable/disable value (0 = disable, 1 = enable).

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If input value = 0
 Then Discrete adaptive gain = 1 (unity)
If input value = 1
 Then Discrete adaptive gain = discrete gain factor (operand 1)
SVA(out) = SVA(in)
SVD(out) = SVD(in)

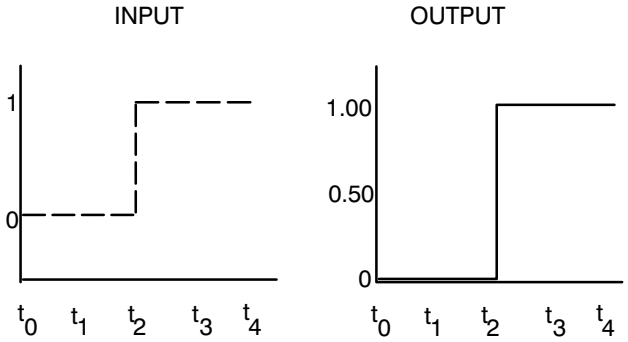
DASVT

DASVT

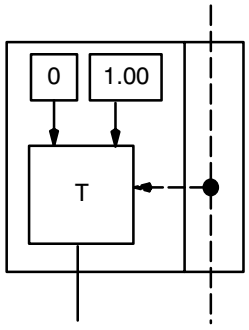
INSTRUCTION NAME: DASVT (discrete to analog signal value transfer)

DESCRIPTION: This instruction changes the SVD input to an SVA output. When the SVD input is 0, the SVA output is 0. When the SVD input is 1, the SVA output is 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DASVT (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) = 0
Then SVA(out) = 0.00
If SVD(in) = 1
Then SVA(out) = 1.00

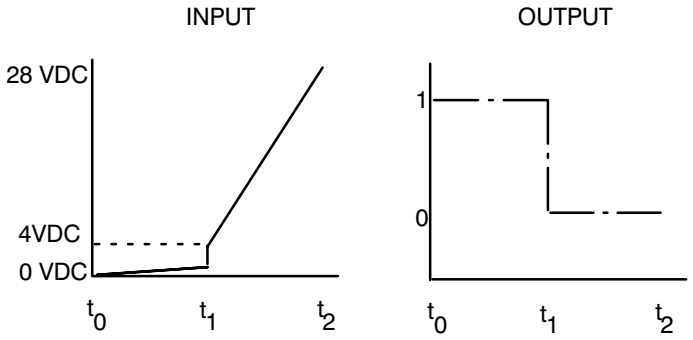
SVD(out) = SVD(in)

DI DI

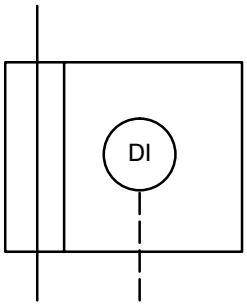
INSTRUCTION NAME: DI (discrete input)

DESCRIPTION : This instruction sets the SVD output equal to logic 1 when the value of the SVD input, at the channel specified by operand 1, is between 0 and 1 volt dc across the discrete input terminals. When the SVD input value is between 4 and 28 volts dc across the terminals, the SVD logic output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DI (

DI channel >>
Comment >>

OPERAND DESCRIPTIONS:

DI channel — The channel number of the desired discrete input. The type and number of inputs for each controller is as follows:

Controller type	Field wiring Terminal designation	DI channel number
Computing	DI1 to DI4	1 to 4
2—Wide	DI1 to DI4	1 to 4
3—Wide Discrete	DI1 to DI4	1 to 4
3—Wide Analog	DI1 to DI4	1 to 4
4—Wide	DI1 to DI8	1 to 8

Comment — A comment up to 255 characters long.

(Continued on next page)

DI

DI

(Continued from previous page)

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
If 0 <= Discrete input <= 1 Vdc,
  Then SVD(out) = logic 1
If 4 <= Discrete input <= 28 Vdc,
  Then SVD(out) = logic 0

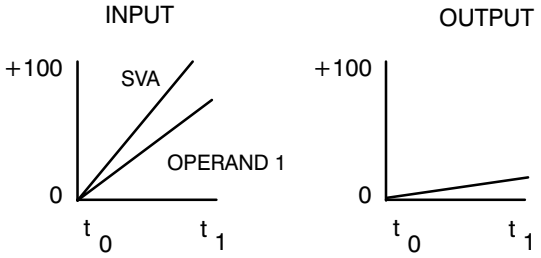
DIF

DIF

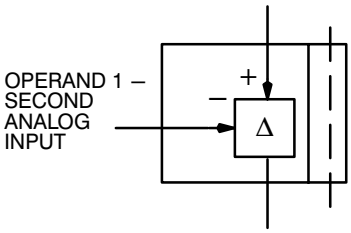
INSTRUCTION NAME: DIF (difference)

DESCRIPTION: This instruction subtracts the analog value contained in operand 1 from the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DIF (

Value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Value – The name of the general register or analog loadable function that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in) – analog value
SVD(out) = SVD(in)

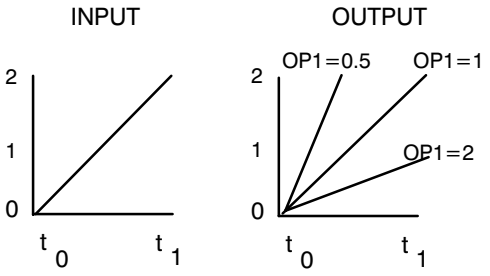
DIV

DIV

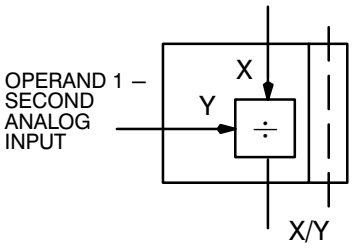
INSTRUCTION NAME: DIV (divide)

DESCRIPTION : This instruction divides the SVA input by the analog value contained in operand 1. The SVD input remains unchanged. An analog value of zero results in an SVA output value magnitude of 9.223372 X 10(to the 18th power) with the sign of the SVA input.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DIV (

Value	>>
Comment	>>

OPERAND FORMAT:

Value – The name of the general register or analog loadable function that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

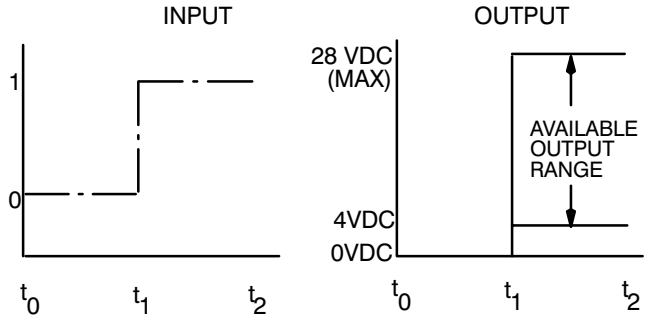
SVA(out) = SVA(in) / Analog Value
SVD(out) = SVD(in)

DO DO

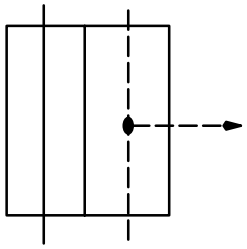
INSTRUCTION NAME: DO (discrete output)

DESCRIPTION : This instruction closes a relay contact at the channel specified by operand 1 when the SVD input is a logic 0. When the SVD input is a logic 1, the relay contact is open, which is also the power fail state of the output. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DO (

DO channel >>
Comment >>

OPERAND DESCRIPTIONS:

DO channel – The channel number of the desired discrete output. The type and number of outputs for each controller are as follows:

Controller type	Field wiring Terminal designation	DO channel number
Computing	DO1 to DO2	1 to 2
2–Wide	DO1 to DO4	1 to 4
3–Wide Discrete	DO1 to DO8	1 to 8
3–Wide Analog	DO1 to DO4	1 to 4
4–Wide	DO1 to DO8	1 to 8

Comment – A comment up to 255 characters long.

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DO

DO

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FUNCTION EQUATIONS:

SVA(out) = SVA(in)
If SVD(in) = logic 0
  Then relay contact is closed
If SVD(in) = logic 1
  Then relay contact is open

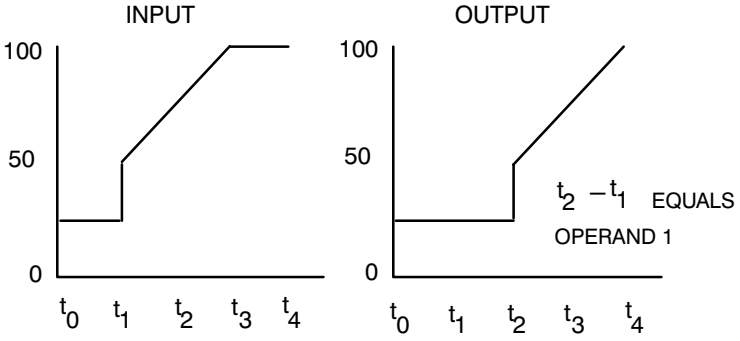
DT

DT

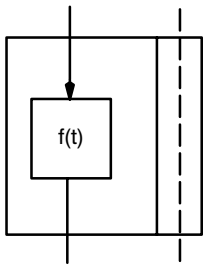
INSTRUCTION NAME: DT (dead time)

DESCRIPTION : This instruction delays the SVA output for a length of time specified by the value in operand 1. Operand 2 contains a reset value that sets the SVA output and register stacks equal to the SVA input. The SVA input is sampled with the period equal to 1/16 of the dead time. The SVA output is the linear time interpolation between the current SVA output and the next output value in the register stack. The register stack can hold up to 16 values. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: DT (

Dead time	>>
Reset	>>
Comment	>>

OPERAND DESCRIPTIONS:

Dead time — A tuning parameter that specifies the time in minutes for the SVA input to progress through the register stack and become the SVA output. Dead time values are: 0, or 0.0644 to 2109.85 minutes for the 4 hertz version controller; 0, or 0.0258 to 843.94 minutes for the 10 hertz version controller; and 0, or 0.0129 to 421.97 minutes for the 20 hertz version controller.

Reset — The name of the general register or discrete loadable function that contains the reset value (1 or 0).

Comment — A comment up to 255 characters long.

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DT

DT

(Continued from previous page)

FUNCTION EQUATIONS:

If reset value = 0,
  Then SVA(out) @ t2 = SVA(in) @ t1
  (Dead time = t2 – t1)
If reset value = 1,
  Then SVA(out) = SVA(in)
SVD(out)=SVD(in)

DTC DTC

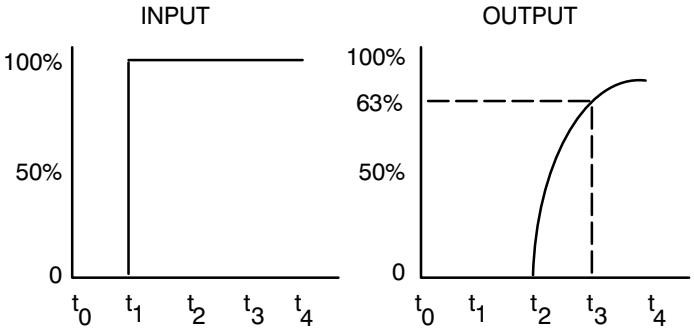
INSTRUCTION NAME: DTC (dead time compensation)

DESCRIPTION: This instruction provides feedback control for a loop with significant transport delay, based on actual process dead time, gain, and lag time. DTC provides a process model that simulates the expected response of the process. By predicting the process response, the loop can be tuned as though the process has no significant transport delay. The dead time compensation is based on a linear process variation to a change in valve output. The SVA and SVD inputs remain unchanged. DTC can be used in conjunction with GCI and CASC.

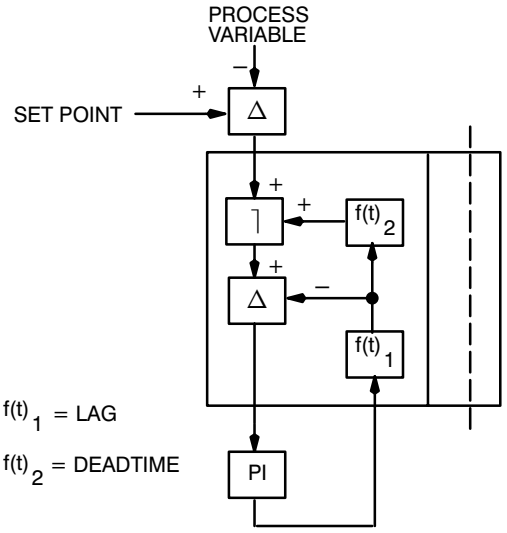
The DTC function can be used in the same FST loop with the following PCA types only:

- PI/PID/I
- Error−squared PI/PID
- Notch Gain PI/PID
- Adaptive Gain PI/PID

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



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DTC DTC

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CONFIGURATION FORMAT: DTC (

Process gain	>>
Process time constant	>>
Process dead time	>>
Reset	>>
Comment	>>

OPERAND DESCRIPTIONS:

Process gain – A tuning parameter that specifies the proportional relationship of the process variable (PV) and the valve output (VO). Gain = (ΔPV) / (Δ VO). Gain values are 0, or 0.003906 to 127.996.

Process time constant – A tuning parameter that specifies the first order filter, where the time for the process variable to change is 63.2 percent of the change in valve output minus the transport delay. Time constant values are: 0, or 0.0042 to 134.23 minutes for the 4 hertz version controller; 0, or 0.0017 to 53.69 minutes for the 10 hertz version controller; and 0, or 0.0009 to 26.84 minutes for the 20 hertz version controller.

Process dead time – A tuning parameter that is equal to the actual ”transport delay” of the process in minutes. Dead time values are: 0, or 0.0644 to 2109.85 minutes for the 4 hertz version controller; 0, or 0.0258 to 843.94 minutes for the 10 hertz version controller; and 0, or 0.0129 to 421.97 minutes for the 20 hertz version controller.

Reset – The name of the general register or discrete loadable function that contains the discrete value used to reset the DTC function (0 = enabled, 1 = reset).

Comment – A comment up to 255 characters long.

CONFIGURATION EXAMPLE:

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

END END

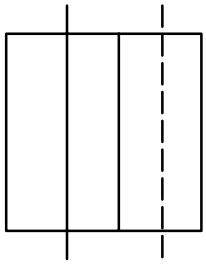
INSTRUCTION NAME: END

DESCRIPTION: This instruction is required as the last function in the function sequence table. The SVD and SVA inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: END (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

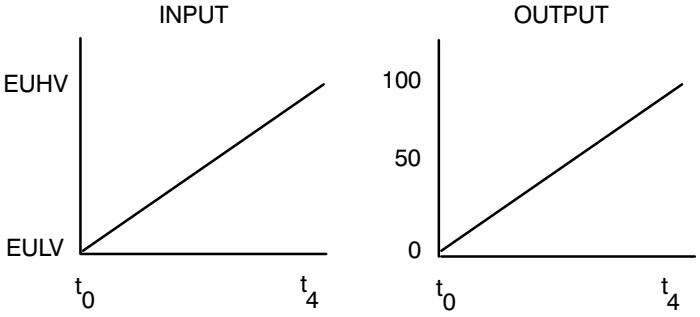
EUP

EUP

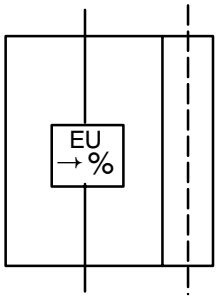
INSTRUCTION NAME: EUP (engineering units to percent conversion)

DESCRIPTION: This instruction converts an engineering−unit SVA input value to percent of span based on the engineering units high value (EUHV) and the engineering units low value (EULV) contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: EUP (

Eng conversion factors >>
Comment >>

OPERAND DESCRIPTIONS:

Eng conversion factors − The name of the direct control point (DCP), indirect control point (ICP), or auxiliary engineering unit pair that contains the engineering units high and low values.

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = [(SVA(in) − EULV)/(EUHV − EULV)] X 100%
SVD(out) = SVD(in)

Where: EULV = Engineering units low value
EUHV = Engineering units high value

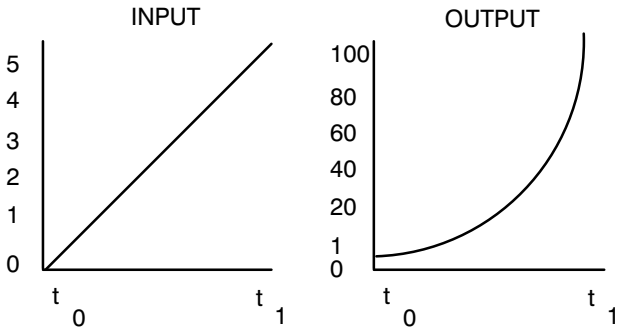
EXP

EXP

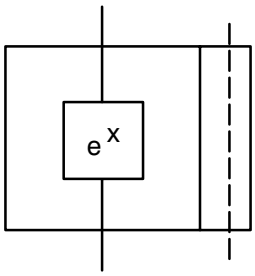
INSTRUCTION NAME: EXP (exponent) (Invalid for Computing Controller)

DESCRIPTION : This instruction uses the SVA input as the exponent to "e" (2.71828). The SVD input remains unchanged. The SVA input is limited to +/− 32, resulting in SVA output limits of 1.266417 X 10^{-14} to 7.896296 X 10^{13}.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: EXP (

Comment >>

Comment − A comment up to 255 characters long.

OPERAND DESCRIPTIONS:

FUNCTION EQUATIONS:

SVA(out) = (e)(raised to the power of SVA(in))
SVD(out) = SVD(in)

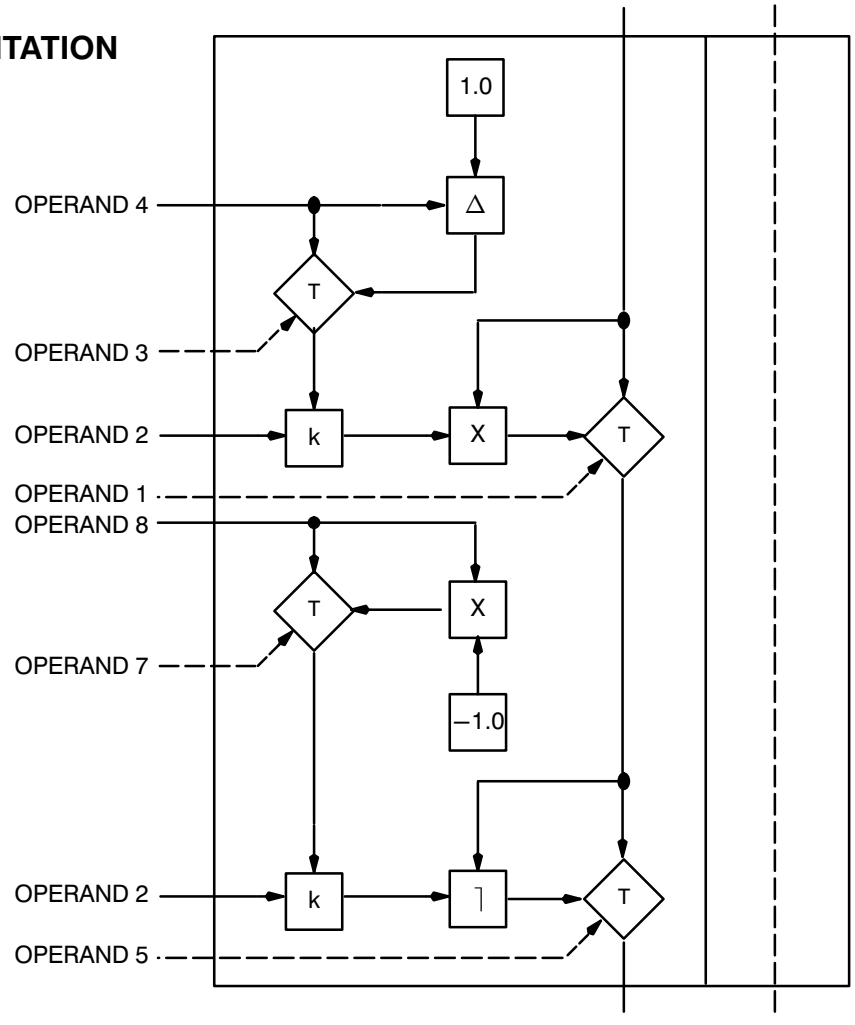
FDFW FDFW

INSTRUCTION NAME: FDFW (feedforward)

DESCRIPTION: This instruction multiplies the SVA input by a feedforward scale factor and adds another positive or negative feedforward scale factor to the result to produce the SVA output. These feedforward scale factors are described in the FDFWM and FDFWS function descriptions. The SVD input remains unchanged.

GRAPHIC REPRESENTATION: **SYMBOLIC REPRESENTATION:**

NO GRAPHIC REPRESENTATION



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FDFW FDFW

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CONFIGURATION FORMAT: FDFW (

Multiplier enable	>>
Multiplier gain	>>
Multiplier REV/DIR	>>
Multiplier value	>>
Summer enable	>>
Summer gain	>>
Summer REV/DIR	>>
Summer value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Multiplier enable — A tuning parameter that enables or disables the multiplier input (operand 4). (YES = enable, NO = disable).

Multiplier gain — A tuning parameter that determines the multiplier gain. Gain values are from 0 to 10.00.

Multiplier REV/DIR — A tuning parameter that affects the polarity of the multiplier value (operand 4). (DIR = no change, REV = 1.0 — operand 4).

Multiplier value — The name of the general register or analog loadable function that contains the analog value for the multiplier input.

Summer enable — A tuning parameter that enables or disables the summing input (operand 8). (YES = enable, NO = disable).

Summer gain — A tuning parameter that determines the summer gain. Gain values are from 0 to 10.00.

Summer REV/DIR — A tuning parameter that affects the polarity of the summer input (operand 8). (DIR = no change, REV = change sign).

Summer value — The name of the general register or analog loadable function that contains the analog value (in percent) for the summer input.

Comment — A comment up to 255 characters long.

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FDFW FDFW

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FUNCTION EQUATIONS:

If operand 1 = operand 5 = YES, and operand 3 = operand 7 = DIR
Then SVA(out) = [(SVA(in) X operand 2 X operand 4) + (operand 6 X operand 8)]

If operand 1 = operand 5 = YES, operand 3 = REV, and operand 7 = DIR
Then SVA(out) = [(SVA(in) X operand 2 X(1 − operand 4) + (operand 6 X operand 8)]

If operand 1 = operand 5 = YES, operand 3 = DIR, operand 7 = REV
Then SVA(out) = [(SVA(in) X operand 2 X operand 4) +100 − (operand 6 X operand 8)]

If operand 1 = operand 5 = YES, and operand 3 = operand 7 = REV
Then SVA(out) = [(SVA(in) X operand 2 X (1 − operand 4) +100 − (operand 6 X operand 8)]

If operand 1 = operand 5 = NO
Then SVA(out) = SVA(in)

SVD(out) = SVD(in)

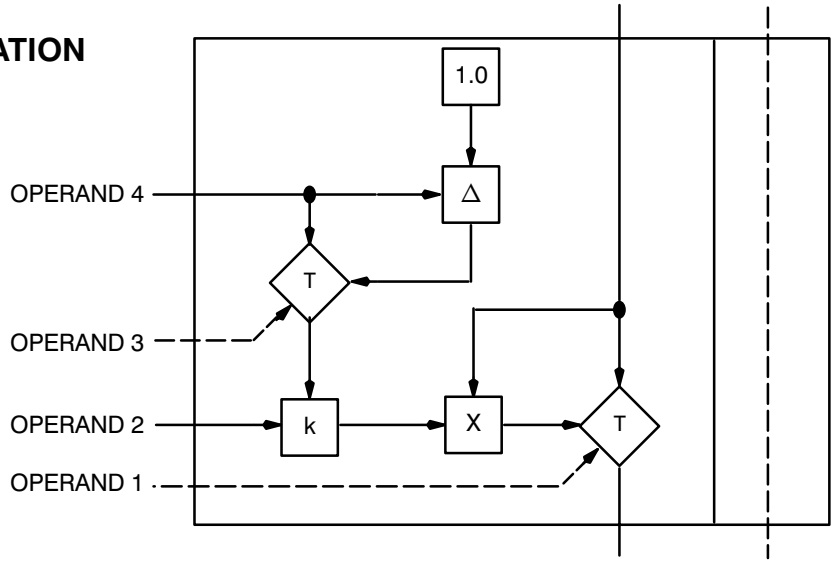
FDFWM FDFWM

INSTRUCTION NAME: FDFWM (feedforward multiply only)

DESCRIPTION: This instruction multiplies the SVA input by a feedforward scale factor. When the multiplier function (operand 1) is enabled, operands 2, 3, and 4 combine to generate the feedforward output. When operand 3 is set to reverse, the multiplier value (operand 4) will be subtracted from 1.0, scaled by the multiplier gain (operand 2), and multiplied by the SVA input to produce the SVA output. When multiplier REV/DIR (operand 3) is set for direct actions, the SVA input, the multiplier value (operand 4) and the multiplier gain (operand 2) are multiplied together to produce the SVA output. The SVD input remains unchanged.

GRAPHIC REPRESENTATION: **SYMBOLIC REPRESENTATION:**

NO GRAPHIC REPRESENTATION



CONFIGURATION FORMAT: FDFW (

Multiplier enable	>>
Multiplier gain	>>
Multiplier REV/DIR	>>
Multiplier value	>>
Comment	>>

(Continued on next page)

FDFWM FDFWM

(Continued from previous page)

OPERAND DESCRIPTIONS:

Multiplier enable — A tuning parameter that enables or disables the multiplier input (operand 4). (YES = enable, NO = disable).

Multiplier gain — A tuning parameter that determines the multiplier gain. Gain values are from 0 to 10.00.

Multiplier REV/DIR — A tuning parameter that affects the polarity of the multiplier value (operand 4). (DIR = no change, REV = 1.0 — operand 4).

Multiplier value — The name of the general register or analog loadable function that contains the analog value for the multiplier input.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If operand 1 = YES, and operand 3 = DIR
Then SVA(out) = SVA(in) X operand 2 X operand 4

If operand 1 = YES, and operand 3 = REV
Then SVA(out) = SVA(in) X operand 2 X (1 — operand 4)

SVD(out) = SVD(in)

FDFWS

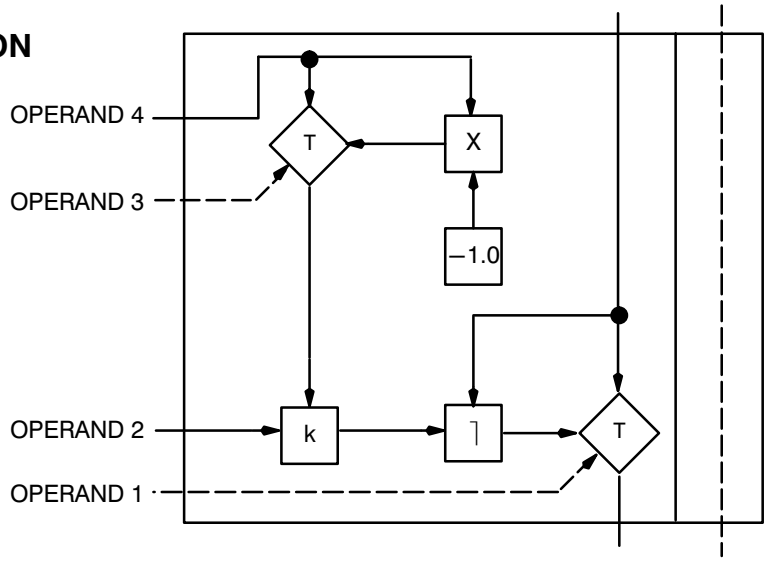
FDFWS

INSTRUCTION NAME: FDFWS (feedforward sum only)

DESCRIPTION: This instruction adds a positive or negative feedforward scale factor to the SVA input. When the summer function (operand 1) is enabled, operands 2, 3, and 4 combine to generate the feedforward output. When operand 3 is set to reverse, the product of the summer gain (operand 2) and the summer value (operand 4) is subtracted from the SVA input to produce the SVA output. When summer DIR/REV (operand 3) is set for direct action, the SVA input is added to the product of the summer gain (operand 2) and the summer value (operand 4) to produce the SVA output. The SVD input remains unchanged.

GRAPHIC REPRESENTATION: **SYMBOLIC REPRESENTATION:**

NO GRAPHIC REPRESENTATION



CONFIGURATION FORMAT: FDFWS (

Summer enable	>>
Summer gain	>>
Summer REV/DIR	>>
Summer value	>>
Comment	>>

(Continued on next page)

FDFWS FDFWS

(Continued from previous page)

OPERAND DESCRIPTIONS:

Summer enable — A tuning parameter that enables or disables the summing input (operand 8). (YES = enable, NO = disable).

Summer gain — A tuning parameter that determines the summer gain. Gain values are from 0 to 10.00.

Summer REV/DIR — A tuning parameter that affects the polarity of the summer input (operand 4). (DIR = no change, REV = change sign).

Summer value — The name of the general register or analog loadable function that contains the analog value (in percent) for the summer input.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If operand 1 = YES, and operand 3 = DIR
Then SVA(out) = SVA(in) + (operand 2 X operand 4)

If operand 1 = YES, and operand 3 = REV
Then SVA(out) = SVA(in) — (operand 2 X operand 4) + 100

SVD(out) = SVD(in)

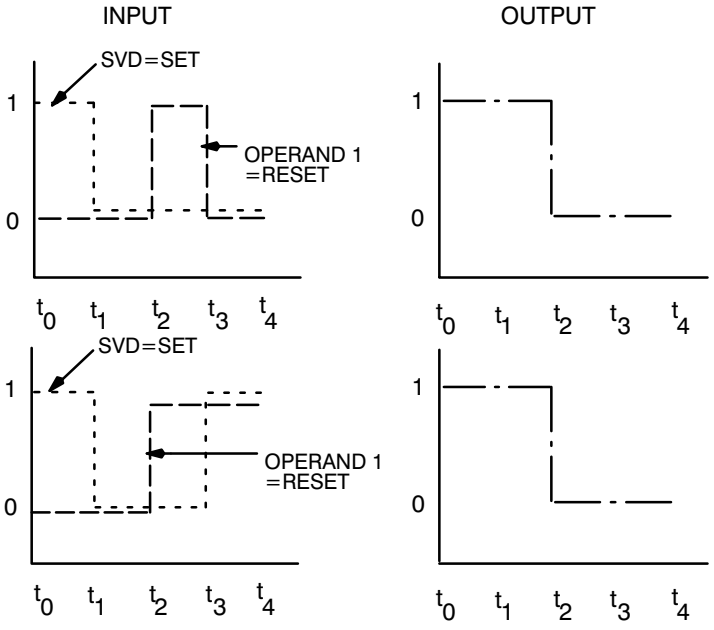
FFR

FFR

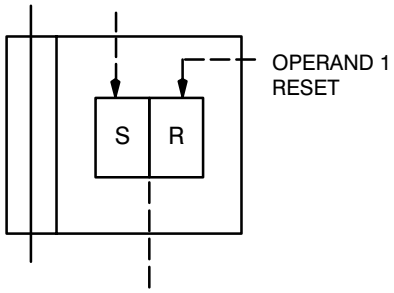
INSTRUCTION NAME: FFR (flip—flop reset)

DESCRIPTION: This instruction sets the SVD output to the last SVD output if both the SVD input and the discrete value contained in operand 1 are 0. The SVD output is 1 if the SVD input (SET) is 1 and the discrete value contained in operand 1 (RESET) is 0. The SVD output is 0 if the SVD input (SET) is 0 and the discrete value contained in operand 1 (RESET) is 1. The SVD output is 0 if the SVD input and the discrete value contained in operand 1 are both 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



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FFR FFR

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TRUTH TABLE:

SVD(in)	Reset	SVD(out)
0	0	Last SVD(out)
1	0	1
0	1	0
1	1	0

CONFIGURATION FORMAT: FFR (

Reset >>
Comment >>

OPERAND DESCRIPTIONS:

Reset – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) = 0 and Discrete Value = 0
  Then SVD(out) = Last SVD(out)
If SVD(in) = 1 and Discrete Value = 0
  Then SVD(out) = 1
If SVD(in) = 0 and Discrete Value = 1
  Then SVD(out) = 0
If SVD(in) = 1 and Discrete Value = 1
  Then SVD(out) = 0

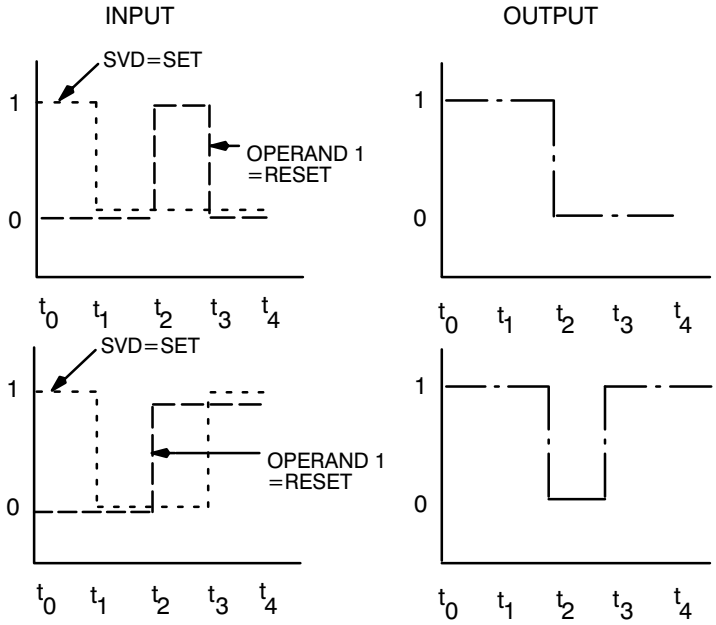
SVA(out) = SVA(in)

FFS FFS

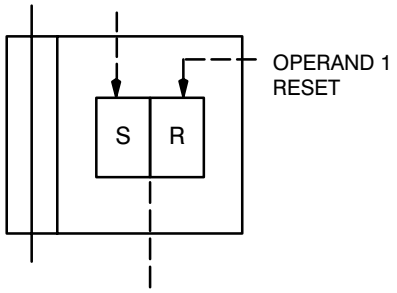
INSTRUCTION NAME: FFS (flip—flop set)

DESCRIPTION: This instruction sets the SVD output to the last SVD output if both the SVD input and the discrete value contained in operand 1 are 0. The SVD output is 1 if the SVD input (SET) is 1 and the discrete value contained in operand 1 (RESET) is 0. The SVD output is 0 if the SVD input (SET) is 0 and the discrete value contained in operand 1 (RESET) is 1. The SVD output is 1 if both the SVD input and the discrete value are 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



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FFS FFS

(Continued from previous page)

TRUTH TABLE:

SVD(in)	Reset	SVD(out)
0	0	Last SVD(out)
1	0	1
0	1	0
1	1	1

CONFIGURATION FORMAT: FFS (

Reset >>
Comment >>

OPERAND DESCRIPTIONS:

Reset – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) = 0 and Discrete Value = 0
  Then SVD(out) = Last SVD(out)
If SVD(in) = 1 and Discrete Value = 0
  Then SVD(out) = 1
If SVD(in) = 0 and Discrete Value = 1
  Then SVD(out) = 0
If SVD(in) = 1 and Discrete Value = 1
  Then SVD(out) = 1

SVA(out)=SVA(in)

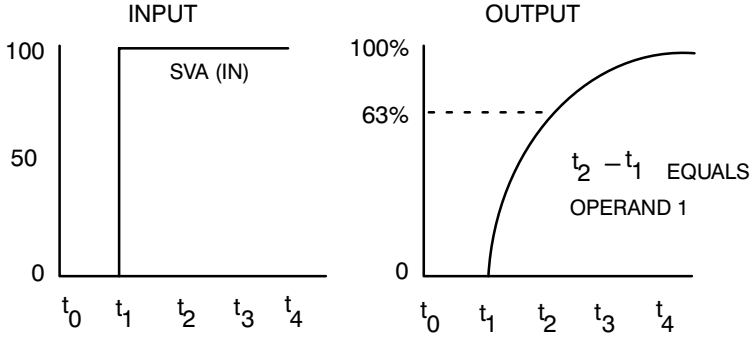
FIL

FIL

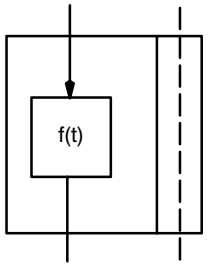
INSTRUCTION NAME: FIL (first order digital filter)

DESCRIPTION : This instruction performs first−order filtering on the SVA input. The time constant of the filter defines the time required for 63.21 percent of a step change at the input of the filter to appear at the output. The time constant is contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: FIL (

First order time constant >>
Comment >>

OPERAND DESCRIPTIONS:

First order time constant − A tuning parameter that specifies the filter time constant in minutes. The time constant is any non−negative floating point number.

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out)@t2 = [(TP/Δt)SVA(out)@t1 + SVA(in)]/(1 + TP/Δt) :
approximately = SVA(in)/(TPs +1)

Where: SVA(out)@t2 = Latest output value
SVA(out)@t1 = Previous output value
TP = Filter time constant in minutes (operand 1)
Δt = t2 − t1 = sample time in minutes
SVD(out) = SVD(in)

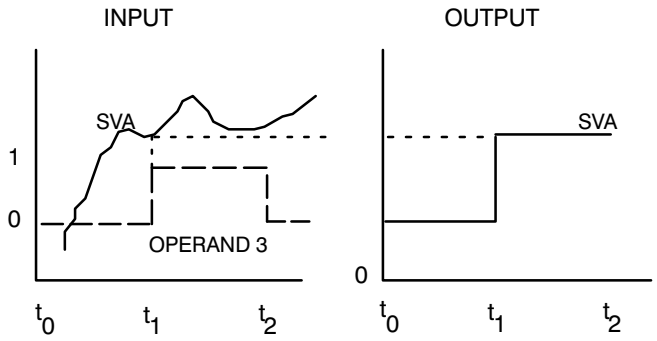
GCI GCI

INSTRUCTION NAME: GCI (gas chromatograph interface)

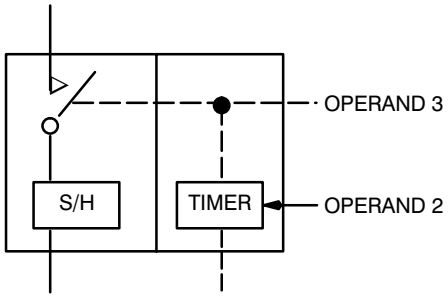
DESCRIPTION: This instruction performs a sample and hold operation on the SVA input whenever the GCI data ready input (operand 3) makes a 0 to 1 transition. The GCI function will enable integral control action for the length of time specified by operand 1 (controller time on) after the GCI data ready input has made a 0 to 1 transition. The controller integral action is then held after the controller time on has elapsed. During this time, there will be no change to the SVA output of the CNTRL (control) function because the SVA output of the GCI function is also the SVA input to the control block. When used, the feed forward function is active when the control algorithm is being held by the GCI function. Therefore, the output from the station will change when there is a change in feed forward control action.

If a new GCI data ready input is not received by the time the GCI function has timed out, the GCI function sets the control loop to the manual mode and sets its SVD output to a logic 1 to indicate timeout. A new data ready trigger will reset the SVD output to a logic 0, but will not automatically switch mode. On power up, the SVA and SVD outputs are set to 0.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: GCI (

Controller time on	>>
GCI timeout time	>>
GCI data ready	>>
Comment	>>

(Continued on next page)

GCI GCI

(Continued from previous page)

OPERAND DESCRIPTIONS:

Controller time on — This tuning parameter is an analog value that sets the length of time in minutes that the control action is enabled. Time on values are: 0, or 0.0042 to 134.23 minutes for the 4 hertz version controller; 0, or 0.0017 to 53.69 minutes for the 10 hertz version controller; 0, or 0.0009 to 26.84 minutes for the 20 hertz version controller.

GCI timeout time — This tuning parameter is an analog value that sets the maximum length of time in minutes between data ready inputs before the controller goes to manual mode. Timeout values are the same as the time on values in operand 1.

GCI data ready — The name of the general register or discrete loadable function that contains the GCI data ready status (1 = data ready, 0 = data not ready).

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

1. If HD = 0 and GCI data ready (operand 3) = 1
   Then HA = SVA(in)
2. SVA(out) = HA (previous sampled input)
3. If timeout time (operand 2) has timed out
   Then SVD(out) = 1
4. If timeout time (operand 2) has not timed out
   Then SVD(out) = 0
5. HD = GCI data ready (operand 3)

On power up:
SVA(out) = 0
HA = 0
SVD(out) = 0
HD = 0

Where: HA = SVA input holding register
HD = SVD input holding register

GOTO GOTO

INSTRUCTION NAME: GOTO (unconditional transfer)

DESCRIPTION: This instruction changes the order in which the FST is performed by transferring the SVA and SVD outputs to the function identified by the label name contained in operand 1. The transfer is unconditional; every time GOTO is executed, the transfer will occur.

The SVA and SVD inputs remain unchanged. Restrictions on the use of GOTO are:

- Transfers can only occur within the control loop where the GOTO is used.
- Transfers can only be to a higher numbered FST step (i.e., GOTO cannot transfer backwards).
- GOTO can only be nested fifteen levels deep (i.e., GOTO loops can proceed within GOTO loops, up to a maximum of fifteen).
- GOTO should not transfer past any of the functions listed below (i.e., the following functions should not be placed between GOTO and the function to be transferred to):

AAGM	FDFW	OVRD
CASC	FDFWS	%CNTRL
CNTRL	FDFWM	SGSL
DAGM	FIL	STAT
DT	GCI	TRK
DTC	LL	VLIM
END		

(Continued on next page)

GOTO GOTO

(Continued from previous page)

If it is necessary to conditionally select the outputs of any of the functions above, store the outputs in general registers and then conditionally select the general registers as shown in the following example:

```
AINSQR (1, DCP1)        { INLET FLOW A }
RGST   (REG1)           { STORE FLOW A IN REGISTER 1 }
AINSQR (2, ICP2)        { OUTLET FLOW B }
RGST   (REG2)           { STORE FLOW B IN REGISTER 2 }
IFF    (REG3, LABEL1)   { IF REGISTER 3 IS LOW, GOTO LABEL1 }
IFT    (REG3, LABEL2)   { IF REGISTER 3 IS HIGH, GOTO LABEL2 }
LABEL1 RGLD (REG1)      { RECALL FLOW A FROM REGISTER 1 }
GOTO   (LABEL3)         { SKIP NEXT STEP IF PREVIOUS STEP WAS DONE }
LABEL2 RGLD (REG2)      { RECALL FLOW B FROM REGISTER 2 }
LABEL3 FIL  (1)         { FILTER RESULTANT FLOW }
```

CONFIGURATION FORMAT: GOTO (

```
Label name      >>
Comment         >>
```

OPERAND DESCRIPTIONS:

Label name – The label that identifies where FST execution is to be transferred to. Label names can be any string up to 12 characters consisting of characters, numbers, hyphens and underscores.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)
Transfer location = function identified by label name in operand 1.

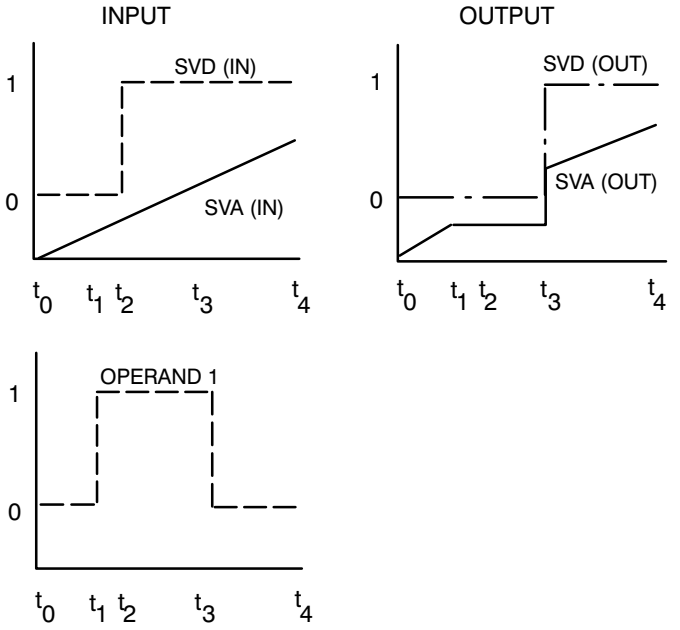
HLV

HLV

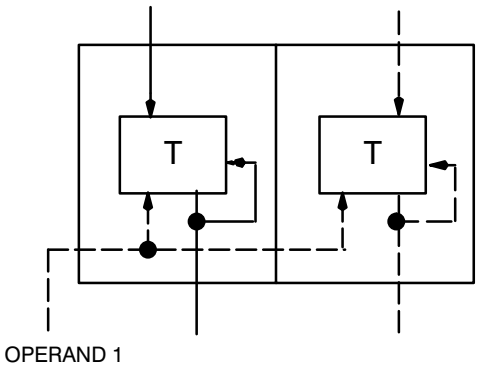
INSTRUCTION NAME: HLV (hold last value)

DESCRIPTION: This instruction holds the previous values of the SVA and SVD outputs when the discrete value contained in operand 1 is 1. When the discrete value is 0, the SVA and SVD inputs are passed unchanged to the next step.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: HLV (

Hold signal	>>
Comment	>>

OPERAND DESCRIPTIONS:

Hold signal – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

(Continued on next page)

HLV

HLV

(Continued from previous page)

FUNCTION EQUATIONS:

If discrete value = 1
Then SVA(out) = last SVA(out)
SVD(out) = last SVD(out)

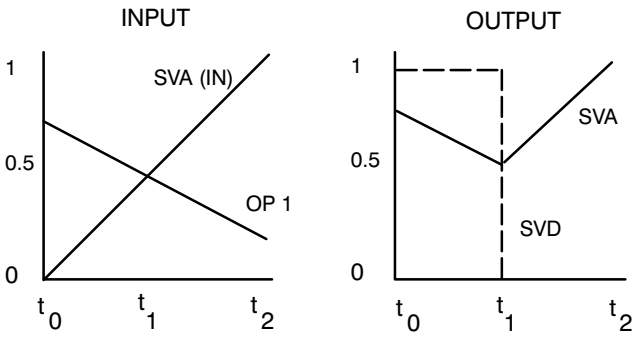
If discrete value = 0
Then SVA(out) = SVA(in)
SVD(out) = SVD(in)

HS HS

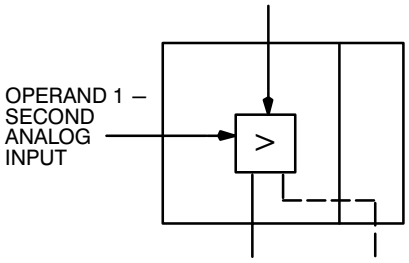
INSTRUCTION NAME: HS (high select)

DESCRIPTION: This instruction compares the SVA input to the analog value contained in operand 1 and outputs the greater of the two values. The SVD output is 0 if the SVA input is greater than or equal to the analog value, or 1 if the SVA input is less than the analog value.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: HS (

Second input	>>
Comment	>>

OPERAND DESCRIPTIONS:

Second input – The name of the general register or analog loadable function that contains the analog value. This value is updated on every execution of this function.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVA(in) >= Analog value
Then SVA(out) = SVA(in)
SVD(out) = 0

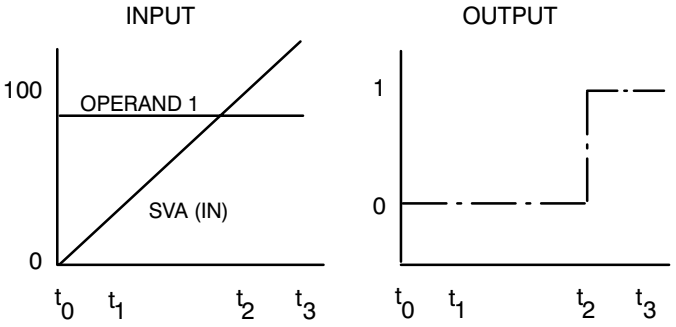
If SVA(in) < Analog value
Then SVA(out) = Analog value
SVD(out) = 1

HSM HSM

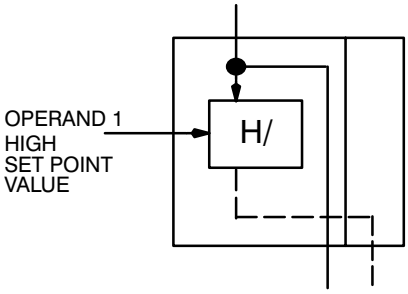
INSTRUCTION NAME: HSM (high signal monitor)

DESCRIPTION: This instruction compares the SVA input to the analog value contained in operand 1. If the SVA input is greater than the analog value, the SVD output is 1. If the SVA input is less than or equal to the analog value, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: HSM (

Reference value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Reference value – The name of the general register or analog loadable function that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVA(in) > Analog value
Then SVD(out) = 1

If SVA(in) <= Analog value
Then SVD(out) = 0

SVA(out) = SVA(in)

ICPLDA ICPLDA

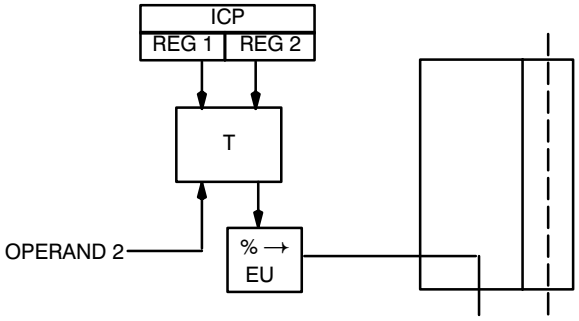
INSTRUCTION NAME: ICPLDA (indirect control point load analog)

DESCRIPTION: This instruction sets the SVA output equal to the analog indirect control point (ICP) value contained in operand 2. Operand 1 contains the ICP name. The ICP value contained in operand 2 is in units of percent. Before becoming the SVA output, the ICP value is converted to engineering units (E.U.'s) using the engineering units high value (EUHV) and the engineering units low value (EULV) of the ICP contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ICPLDA (

ICP tag	>>
ICP reg number	>>
Comment	>>

(Continued on next page)

ICPLDA ICPLDA

(Continued from previous page)

OPERAND DESCRIPTIONS:

ICP tag – The tag of the ICP.

ICP reg number – The number of the ICP operating data register that contains the ICP value. Two registers are available and are specified as follows:

ICP Type	Register Type	Register No.
Monitor	Monitor	1
Reference	Reference	1
Monitor–	Monitor	1
Deviation	Monitor	2
Reference–	Monitor	1
Deviation	Reference	2

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = (ICP value) [(EUHV – EULV)/100] + EULV
SVD(out) = SVD(in)

Where: EULV = Engineering units low value
EUHV = Engineering units high value

ICPLDD ICPLDD

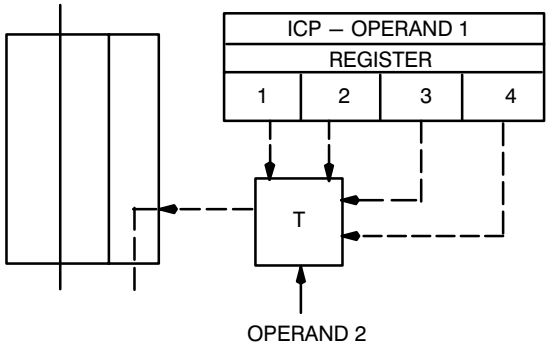
INSTRUCTION NAME: ICPLDD (indirect control point load discrete)

DESCRIPTION: This instruction sets the SVD output equal to the discrete indirect control point (ICP) value contained in operand 2. Operand 1 contains the ICP name. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ICPLDD (

ICP tag >>
ICP reg number >>
Comment >>

OPERAND DESCRIPTIONS:

ICP tag – The tag of the ICP.

ICP reg number – The number of the ICP operating data register that contains the ICP value. There are four discrete registers available, numbered 1 to 4.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = ICP value
SVA(out) = SVA(in)

ICPSTA ICPSTA

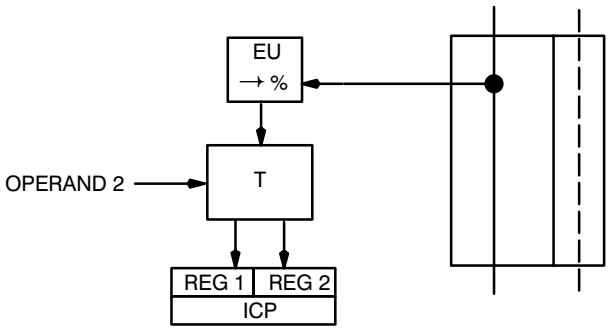
INSTRUCTION NAME: ICPSTA (indirect control point store analog)

DESCRIPTION: This instruction stores the SVA input in the ICP operating data register specified by operand 2. Operand 1 contains the ICP name. The SVA input is converted from engineering units (E.U.'s) to percent of span before being stored. The engineering units low value (EULV) and the engineering units high value (EUHV) of the ICP contained in operand 1 are used in the conversion. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ICPSTA (

ICP tag	>>
ICP reg number	>>
Comment	>>

(Continued on next page)

ICPSTA ICPSTA

(Continued from previous page)

OPERAND DESCRIPTIONS:

ICP tag — The tag of the ICP.

ICP reg number — The number of the ICP operating data register that will store the ICP value is specified as follows:

ICP Type	Register Type	Register No.
Monitor	Monitor	1
Monitor—	Monitor	1
Deviation	Monitor	2
Reference—	Monitor	1
Deviation	Reference	———

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

ICP value = [(SVA(in) — EULV)/(EUHV — EULV)] X 100%
SVA(out) = SVA(in)
SVD(out) = SVD(in)

Where: EULV = Engineering units low value
EUHV = Engineering units high value

ICPSTD ICPSTD

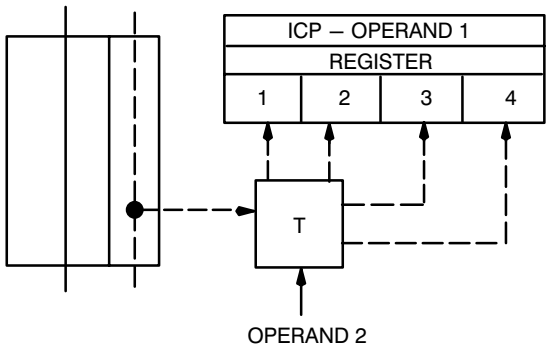
INSTRUCTION NAME: ICPSTD (indirect control point store discrete)

DESCRIPTION: This instruction stores the SVD input in the ICP operating data register specified by operand 2. Operand 1 contains the ICP name. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: ICPSTD (

ICP tag	>>
ICP reg number	>>
Comment	>>

OPERAND DESCRIPTIONS:

ICP tag – The tag of the ICP.

ICP reg number – The number of the ICP operating data register that will store the ICP value. There are four discrete registers available, numbered 1 to 4. The valid register types for this function are monitor or monitor–reference only.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

ICP value = SVD(in)
SVA(out) = SVA(in)
SVD(out) = SVD(in)

IFF IFF

INSTRUCTION NAME: IFF (if false transfer)

DESCRIPTION: This instruction transfers the SVA and SVD outputs to the function identified by the label name contained in operand 2 based on the status of operand 1. If the status of operand 1 is 0, the transfer will take place. If the status of operand 1 is 1, no transfer will take place, and the SVA and SVD outputs go to the next function in the FST. Restrictions on the use of IFF are the same as for the GOTO instruction. The SVA and SVD inputs remain unchanged.

CONFIGURATION FORMAT: IFF (

Trip transfer status	>>
Label name	>>
Comment	>>

OPERAND DESCRIPTIONS:

Trip transfer status — The name of the general register or discrete loadable function that contains the transfer status (1 or 0).

Label name — The label that identifies where FST execution is to be transferred to. Label names can be any string up to 12 characters consisting of characters, numbers, hyphens and underscores.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)
If Trip transfer status = 1
  Then no transfer
If Trip transfer status = 0
  Then transfer execution to label name

IFT

IFT

INSTRUCTION NAME: IFT (if true transfer)

DESCRIPTION: This instruction is similar to IFF, except the transfer status values are reversed. If the status of operand 1 (see IFF) is 0, no transfer will take place. If the status is 1, a transfer will take place, based on the value in operand 2. All other information is identical to that of IFF.

CONFIGURATION FORMAT: IFT (

Trip transfer status	>>
Label name	>>
Comment	>>

OPERAND DESCRIPTIONS:

Trip transfer status – The name of the general register or discrete loadable function that contains the transfer status (1 or 0).

Label name – The label that identifies where FST execution is to be transferred to. Label names can be any string up to 12 characters consisting of characters, numbers, hyphens and underscores.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)
If Trip transfer status = 0
  Then no transfer
If Trip transfer status = 1
  Then transfer execution to label name

IFTAUT IFTAUT

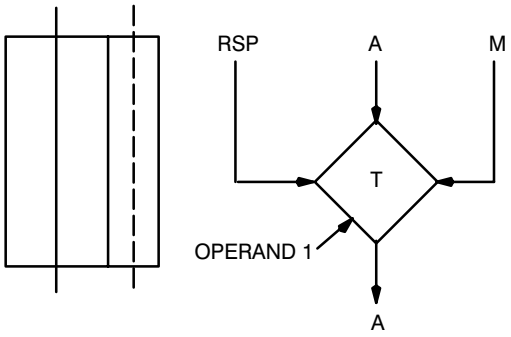
INSTRUCTION NAME: IFTAUT (if true set automatic mode)

DESCRIPTION: This instruction places the loop being executed into the automatic mode if the discrete value in operand 1 is 1. If the discrete value is 0, the mode will not change. The SVA input remains unchanged. Refer to section 5.6 on page 5-9 for more information on using this instruction.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: IFTAUT (

Logic signal >>
Comment >>

OPERAND DESCRIPTIONS:

Logic signal – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = SVD(in)
If discrete value = 1
  Then mode = automatic
If discrete value = 0
  Then mode = no change

SVA(out) = SVA(in)

IFTDDC

IFTDDC

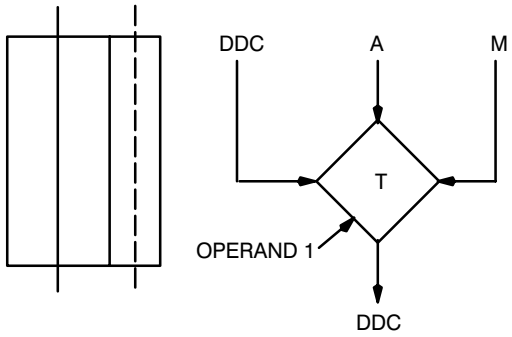
INSTRUCTION NAME: IFTDDC (if true set direct digital control mode)

DESCRIPTION: This instruction places the loop being executed into the direct digital control mode if the discrete value in operand 1 is 1. If the discrete value is 0, the mode will not change. The SVA input remains unchanged. Refer to section 5.6 on page 5-9 for more information on using this instruction.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: IFTDDC (

Logic signal	>>
Comment	>>

OPERAND DESCRIPTIONS:

Logic signal — The name of the general register or discrete loadable function that contains the discrete value.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = SVD(in)
If discrete value = 1
  Then mode = direct digital control
If discrete value = 0
  Then mode = no change

SVA(out) = SVA(in)

IFTMAN IFTMAN

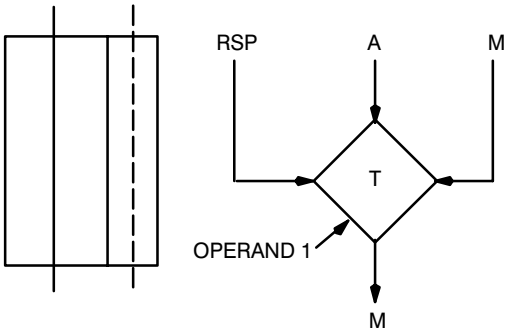
INSTRUCTION NAME: IFTMAN (if true set manual mode)

DESCRIPTION: This instruction places the loop being executed into the manual mode if the discrete value in operand 1 is 1. If the discrete value is 0, the mode will not change. The SVA input remains unchanged. Refer to section 5.6 on page 5-9 for more information on using this instruction.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: IFTMAN (

Logic signal >>
Comment >>

OPERAND DESCRIPTIONS:

Logic signal – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = SVD(in)
If discrete value = 1
  Then mode = manual
If discrete value = 0
  Then mode = no change

SVA(out) = SVA(in)

IFTOSP IFTOSP

INSTRUCTION NAME: IFTOSP (if true, operator station primary point)

DESCRIPTION: This instruction switches the operator station specified by operand 2 to the primary DCP based on the logical state of the logic value specified by operand 1. This function is used with double or cascade operator station types. The SVA and SVD inputs remain unchanged.

CONFIGURATION FORMAT: IFTOSP (

Logic signal	>>
Operator station port #	>>
Comment	>>

OPERAND DESCRIPTIONS:

Logic signal — The name of the general register or discrete loadable function that contains the logic value.

Operator station port # — The number assigned to the operator station. See Operator Station definition section, Table 4-2 on page 4-9 for possible operator station port numbers for each controller type.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If logic value = 0
  Then selected DCP is unchanged
If logic value = 1
  Then Primary DCP is selected
SVA(out) = SVA(in)
SVD(out) = SVD(in)

IFTOSS IFTOSS

INSTRUCTION NAME: IFTOSS (if true, operator station secondary point)

DESCRIPTION: This instruction switches the operator station specified by operand 2 to the secondary DCP based on the logical state of the logic value specified by operand 1. This function is used with double or cascade operator station types. The SVA and SVD inputs remain unchanged.

CONFIGURATION FORMAT: IFTOSS (

Logic signal	>>
Operator station port #	>>
Comment	>>

OPERAND DESCRIPTIONS:

Logic signal — The name of the general register or discrete loadable function that contains the logic value.

Operator station port # — The number assigned to the operator station. See Operator Station definition section, Table 4-2 on page 4-9 for possible operator station port numbers for each controller type.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If logic value = 0
Then selected DCP is unchanged
If logic value = 1
Then Secondary DCP is selected
SVA(out) = SVA(in)
SVD(out) = SVD(in)

IFTRSP

IFTRSP

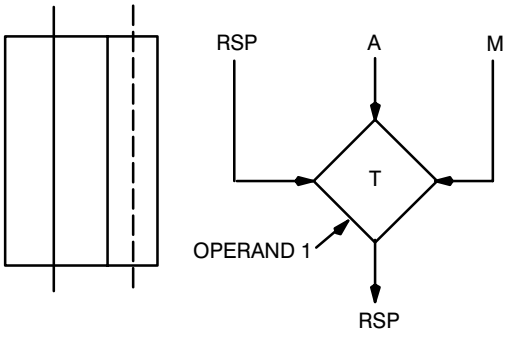
INSTRUCTION NAME: IFTRSP (if true set remote set point mode)

DESCRIPTION: This instruction places the loop being executed into the remote set point mode if the discrete value in operand 1 is 1. If the discrete value is 0, the mode will not change. The SVA input remains unchanged. Refer to section 5.6 on page 5-9 for more information on using this instruction.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: IFTRSP (

Logic signal >>
Comment >>

OPERAND DESCRIPTIONS:

Logic signal – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = SVD(in)
If discrete value = 1
  Then mode = remote set point
If discrete value = 0
  Then mode = no change

SVA(out) = SVA(in)

IFTSUP IFTSUP

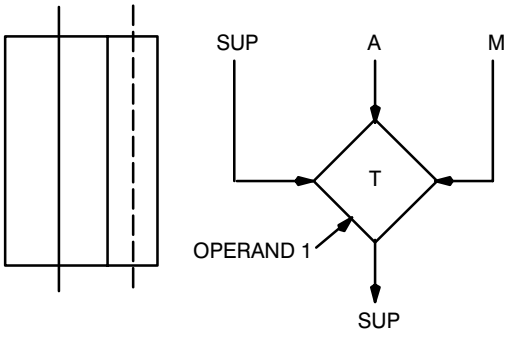
INSTRUCTION NAME: IFTSUP (if true set supervisory mode)

DESCRIPTION: This instruction places the loop being executed into the supervisory mode if the discrete value in operand 1 is 1. If the discrete value is 0, the mode will not change. The SVA input remains unchanged. Refer to section 5.6 on page 5-9 for more information on using this instruction.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: IFTSUP (

Logic signal >>
Comment >>

OPERAND DESCRIPTIONS:

Logic signal – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVD(out) = SVD(in)
If discrete value = 1
Then mode = supervisory
If discrete value = 0
Then mode = no change

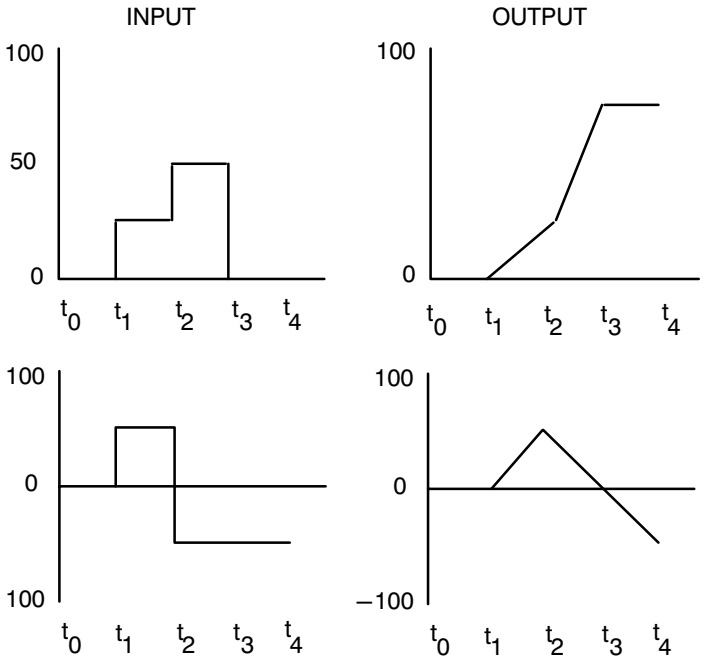
SVA(out) = SVA(in)

INT INT

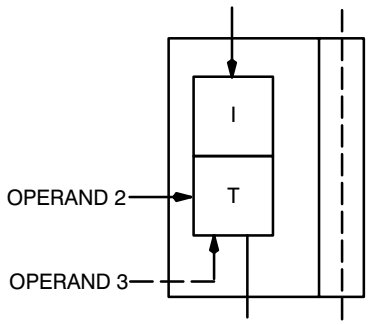
INSTRUCTION NAME: INT (integrator)

DESCRIPTION : This instruction takes the time integral of the SVA input. The analog value contained in operand 1 is the integral gain in units of repeats per minute. Operand 2 is an analog value that is the SVA output when the integrator function is reset (initial condition). Operand 3 is a discrete value that resets the function. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: INT (

Integrator gain	>>
Initial condition	>>
Reset signal	>>
Comment	>>

(Continued on next page)

INT INT

(Continued from previous page)

OPERAND DESCRIPTIONS:

Integrator gain — A tuning parameter value in units of repeats per minute. The gain is any non—negative floating point number. For a constant input, the output will change by the input value multiplied by the integrator gain per minute.

Initial condition — The name of the general register or analog loadable function that contains the analog value used as the SVA output when the value in operand 3 is 1.

Reset signal — The name of the general register or discrete loadable function that contains the reset value. (Logic 0 = normal integration, logic 1 = reset to initial value specified in operand 2)

Comment — A comment up to 255 characters long.

CONFIGURATION EXAMPLE: INT (2.9, AIN (1), DI (1))

FUNCTION EQUATIONS:

If Reset signal = 0,
Then SVA(out) = HA + [(TP X Δt) X SVA(in)]
Where: HA = SVA(out) last cycle
TP = Integrator gain in repeats per minute (operand 1)
Δt = Sample time in minutes
If Reset signal = 1,
Then SVA(out) = Analog value in operand 2

SVD(out) = SVD(in)

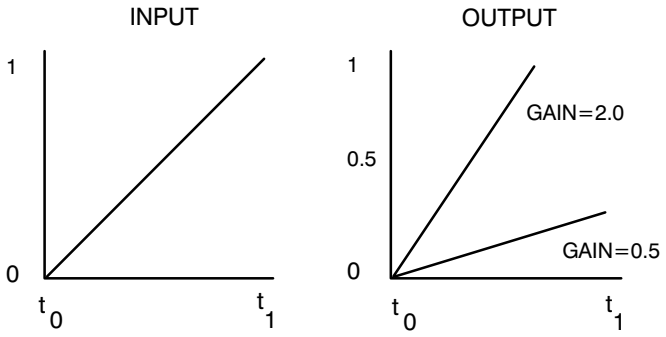
On power up:
SVA(out) = HA = Analog value in operand 2
SVD(out) = SVD(in)

K K

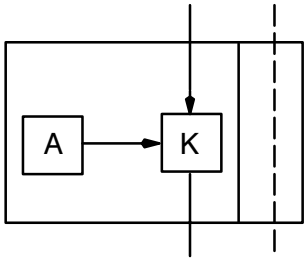
INSTRUCTION NAME: K (fixed gain)

DESCRIPTION: This instruction multiplies the SVA input by the fixed gain value contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: K (

Gain value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Gain Value – This value (any floating point number) is selected during controller configuration and cannot be changed in either the operate or tune modes.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in) X Fixed gain value
SVD(out) = SVD(in)

LABEL LABEL

INSTRUCTION NAME: LABEL

DESCRIPTION : This instruction is used to identify where FST execution is to be transferred to when a branch instruction is encountered. The SVA and SVD inputs remain unchanged.

CONFIGURATION FORMAT: LABEL (

Label string >>
Comment >>

OPERAND DESCRIPTIONS:

Label string – The label that identifies where FST execution is to be transferred to. Label names can be any string up to 12 characters consisting of characters, numbers, hyphens and underscores.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If a branch instruction branches
  Then FST execution continues at the specified label string
Else
  Continue with next instruction

SVD(out) = SVD(in)
SVA(out) = SVA(in)

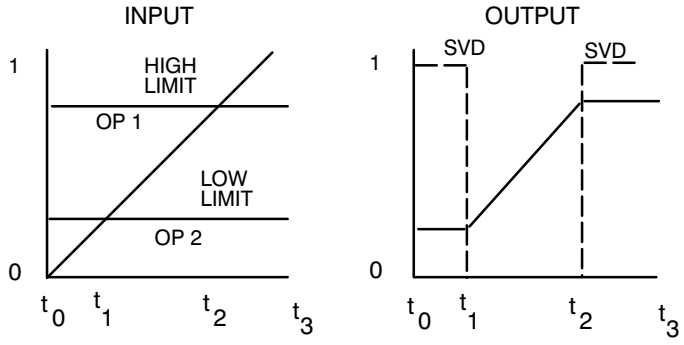
LIMIT LIMIT

INSTRUCTION NAME: LIMIT (limiter)

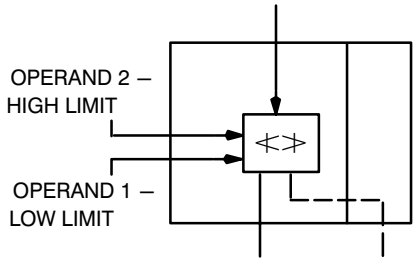
DESCRIPTION : This instruction places upper and lower limits on the SVA input. The SVA input is compared to the high limit contained in operand 1 and the low limit contained in operand 2. When the SVA input is between (or equal to) these limit values, the SVA output equals the SVA input and the SVD output equals 0.

When the SVA input is lower than the low limit value, the SVA output equals the low limit value, and the SVD output equals 1. When the SVA input is higher than the high limit value, the SVA output equals the high limit value and the SVD output equals 1.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LIMIT (

Upper Limit Value	>>
Lower Limit Value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Upper limit value – The name of the general register or analog loadable function that contains the high limit.

Lower limit value – The name of the general register or analog loadable function that contains the low limit.

Comment – A comment up to 255 characters long.

(Continued on next page)

LIMIT

LIMIT

(Continued from previous page)

FUNCTION EQUATIONS:

If Low limit value <= SVA(in) <= High limit value, Then
  SVA(out) = SVA(in)
  SVD(out) = 0
If SVA(in) < Low limit value, then
  SVA(out) = Low limit value
  SVD(out) = 1
If SVA(in) > High limit value, then
  SVA(out) = High limit value
  SVD(out) = 1

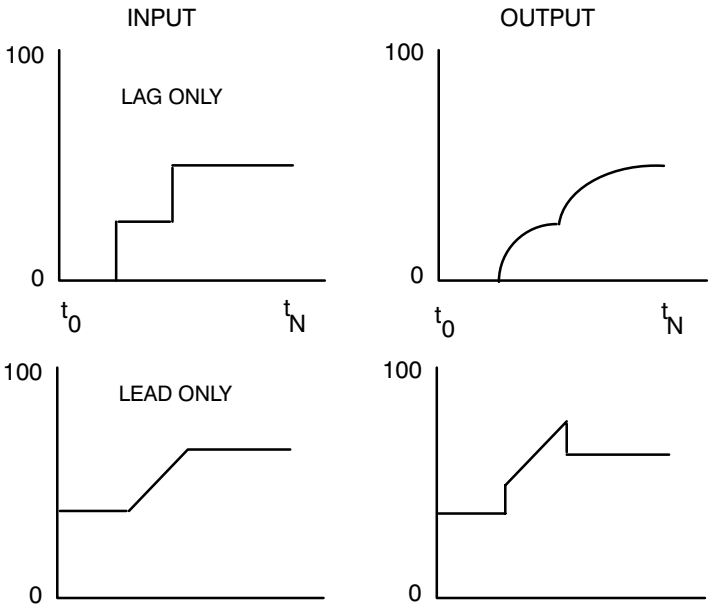
LL

LL

INSTRUCTION NAME: LL (lead/lag compensation)

DESCRIPTION : This instruction provides lead and/or lag compensation for the SVA input. Operand 1 is the output gain of the function, operand 2 is the lead time in minutes, and operand 3 is the lag time in minutes. Operand 4 contains a discrete reset value for the function. Gain, lead time, and lag time are all enabled when the reset value is 0. When the reset value is 1, only gain is enabled. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:

NO SYMBOLIC REPRESENTATION

CONFIGURATION FORMAT: LL (

Lead/lag gain	>>
Lead time	>>
Lag time	>>
Reset signal	>>
Comment	>>

(Continued on next page)

LL LL

(Continued from previous page)

OPERAND DESCRIPTIONS:

Lead/lag gain – A tuning parameter that specifies the gain of the function. Lead/lag values are any non–negative floating point number.

Lead time – A tuning parameter that specifies the lead time for the function in minutes. Lead time values are any non–negative floating point number.

Lag time – A tuning parameter that specifies the lag time for the function in minutes. Lag time values are any non–negative floating point number.

Reset signal – The name of the general register or discrete loadable function that contains the reset value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If Reset value = 0,
Then SVA(out) = $[K(T_1s + 1)/(T_2s + 1)]$SVA(in)
If Reset value = 1,
Then SVA(out) = K(SVA(IN))
SVD(out) = SVD(in)

Where: K = gain value
T_1 = time constant for lead time
T_2 = time constant for lag time
s = Laplace operator

On power up:
SVA(out) = SVA(in) X K
SVD(out) = SVD(in)

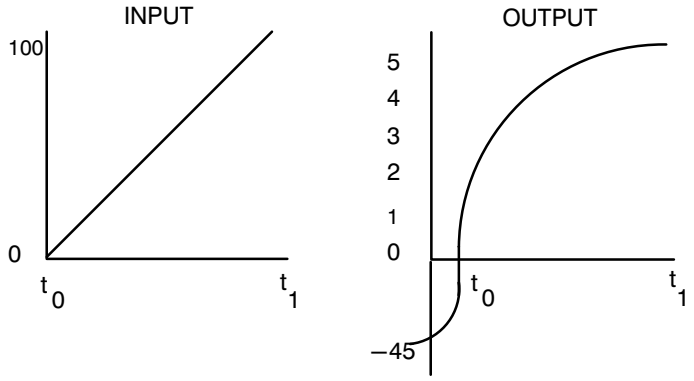
LN

LN

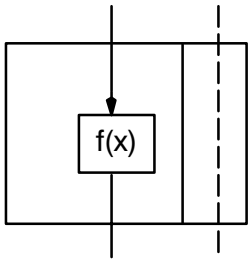
INSTRUCTION NAME: LN (natural logarithm) (Invalid for Computing Controller)

DESCRIPTION : This instruction takes the natural logarithm (base e) of the SVA input. The SVD input remains unchanged. When the SVA input is zero or a negative number, the SVA output is always −45.05457.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LN (

Comment >>

OPERAND DESCRIPTIONS:

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = ln[SVA(in)]
SVD(out) = SVD(in)

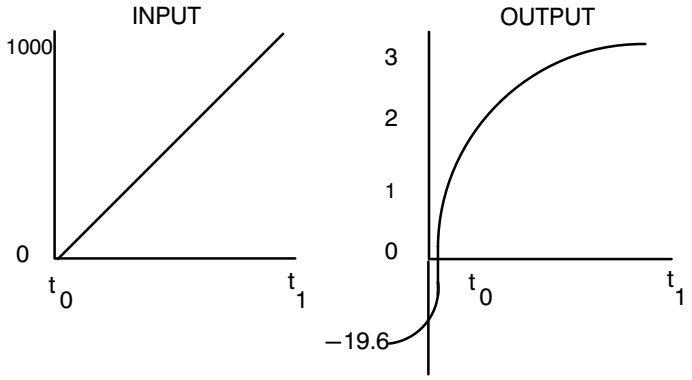
LOG

LOG

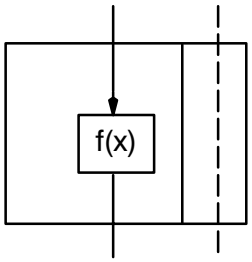
INSTRUCTION NAME: LOG (base 10 logarithm) (Invalid for Computing Controller)

DESCRIPTION: This instruction takes the base 10 logarithm of the SVA input. The SVD input remains unchanged. When the SVA input is zero or a negative number, the SVA output is always −19.56695.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LOG (

Comment >>

OPERAND DESCRIPTIONS:

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = Log_{10}[SVA(in)]
SVD(out) = SVD(in)

LOOP LOOP

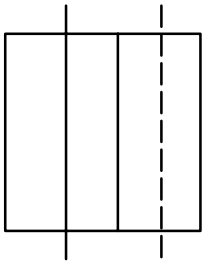
INSTRUCTION NAME: LOOP (beginning of LOOP)

DESCRIPTION: This instruction marks the beginning of a DCP in the FST. Each loop must have only one PCA associated with it. LOOP must be the first function in each loop in the FST. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LOOP (

Loop (DCP) tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop (DCP) tag – The tag name of the DCP (point tag) associated with the loop function.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

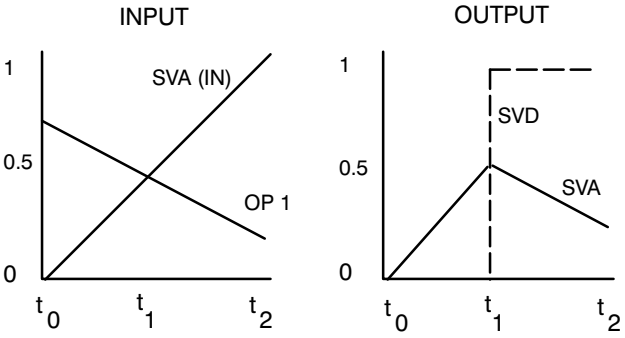
LS

LS

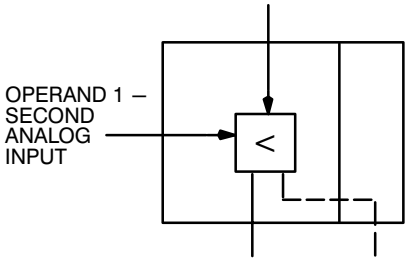
INSTRUCTION NAME: LS (low select)

DESCRIPTION: This instruction compares the SVA input to the analog value contained in operand 1 and outputs the lesser of the two values. The SVD output is 0 if the SVA input is less than or equal to the analog value, or 1 if the analog value is less than the SVA input.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LS (

Second input	>>
Comment	>>

OPERAND DESCRIPTIONS:

Second input – The name of the general register or analog loadable function that contains the analog value. This value is updated on every execution of this function.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVA(in) <= analog value
Then SVA(out) = SVA(in)
SVD(out) = 0

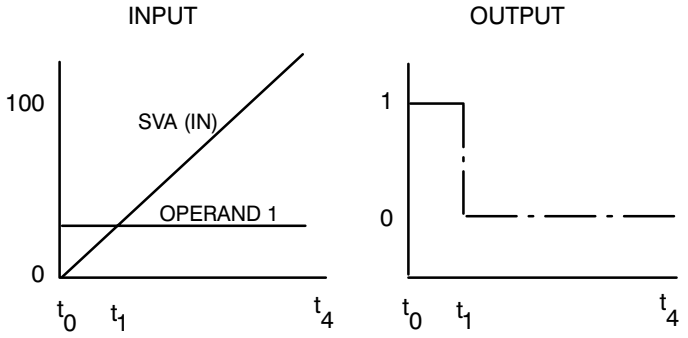
If SVA(in) > analog value
Then SVA(out) = analog value
SVD(out) = 1

LSM LSM

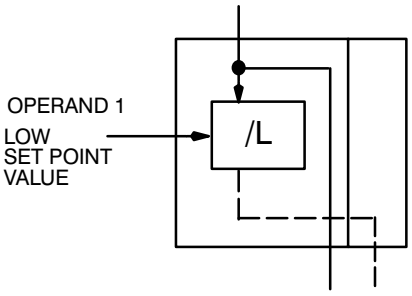
INSTRUCTION NAME: LSM (low signal monitor)

DESCRIPTION: This instruction compares the SVA input to the analog value contained in operand 1. If the SVA input is less than the analog value, the SVD output is 1. If the SVA input is greater than or equal to the analog value, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: LSM (

Reference value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Reference value — The name of the general register or analog loadable function that contains the analog value.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVA(in) < analog value
  Then SVD(out) = 1
If SVA(in) >= analog value
  Then SVD(out) = 0

SVA(out) = SVA(in)

MASFLW MASFLW

INSTRUCTION NAME: MASFLW (mass flow — ideal gas)

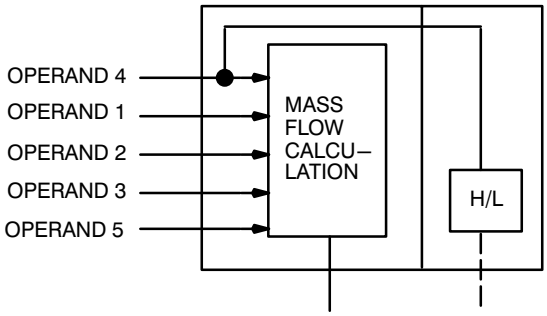
DESCRIPTION: This instruction incorporates the temperature and pressure of a gas, at flowing conditions, into the linearization of an analog flow input. The input is a signal from a non—linearized flow transmitter, and the SVA output is in engineering units. The MASFLW function differs from the AINSQR function in that the AINSQR function assumes constant pressure and temperature, whereas the MASFLW function handles pressure and temperature as variables.

The SVD output serves as an out of range indication. When the input is between —2 and 102 percent of span, the SVD output is 0. If the input is outside of this range, the SVD output is 1.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: MASFLW (

Pressure	>>
Temperature	>>
Scalar (k)	>>
AIN channel	>>
Eng conversion factors	>>
Comment	>>

OPERAND DESCRIPTIONS:

Pressure — The name of the general register or analog loadable function where the pressure (P) in psig of the flow system is stored.

Temperature — The name of the general register or analog loadable function where the temperature (T) in ^{0}F of the flow system is stored.

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MASFLW

MASFLW

(Continued from previous page)

Scalar (k) — This value (k) is calculated from the equation given below.

AIN channel — The channel number of the nonlinear flow transmitter signal input (E). The relationship of channel numbers to actual field wiring terminal designations is as follows:

Controller type	Field wiring Terminal designation	AIN channel number
Computing	MV1+ to MV5+	1 to 5
2—Wide	MV1+ to MV10+	1 to 10
3—Wide Discrete	MV1+ to MV10+	1 to 10
3—Wide Analog	MV1+ to MV10+	1 to 10
	MV16+ to MV20+	16 to 20
4—Wide	MV1+ to MV20+	1 to 20

Eng conversion factors — The name of the DCP, ICP, or auxiliary engineering unit pair where the engineering units (E.U.'s) high and low limits are defined (L and H).

Comment — A comment up to 255 characters long.

(Continued on next page)

MASFLW MASFLW

(Continued from previous page)

FUNCTION EQUATIONS:

$SVA(out) = K[SQRT[(((H^2 - L^2)E/100) + L^2)X((P + 14.7)/(T + 460))]]$

Where: E = Transmitter input, 0 to 100 percent
L = Low engineering units conversion factor
H = High engineering units conversion factor
P = Gauge pressure of gas in psig
T = Temperature of gas in ^0F
K = SQRT[(Tc + 460)/(Pc + 14.7)]

Where: Tc = Temperature in ^0F of gas at standard operating conditions.
Pc = Gauge pressure in psig of the gas at standard operating conditions.

Note that Tc and Pc are the values used in the original orifice calculations.

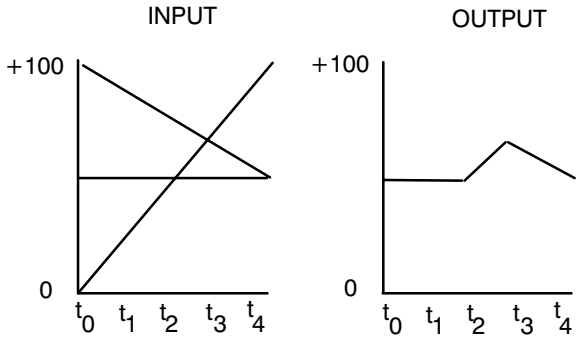
If −2 percent <= transmitter input <= 102 percent
Then SVD(out) = 0
Else
Then SVD(out) = 1

MIDSEL MIDSEL

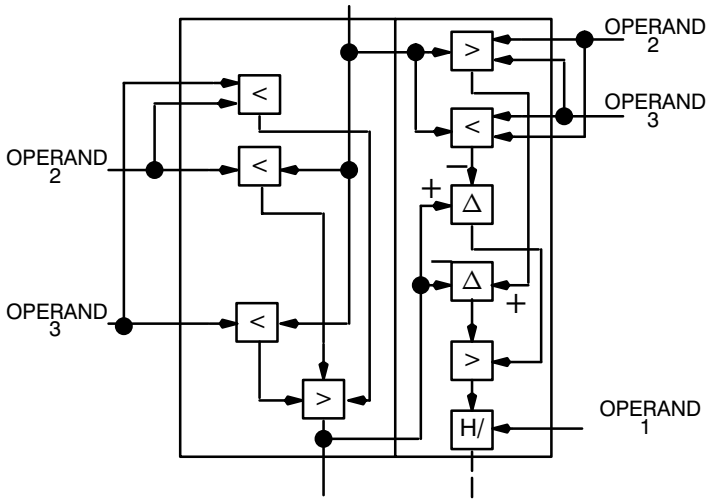
INSTRUCTION NAME: MIDSEL (middle selector)

DESCRIPTION: This instruction selects the middle value of three inputs. This middle value then becomes the SVA output. One input is the SVA input, and the other two inputs are analog values stored in general registers or loadable functions. An additional analog value is stored as a dead band value, which is used to determine the status of the SVD output. If the difference between the highest value and the middle value is greater than the dead band value, or if the difference between the middle value and the lowest value is greater than the dead band value, the SVD output is 1. Otherwise the SVD output is 0.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: MIDSEL (

Mid−selector range	>>
Second input	>>
Third input	>>
Comment	>>

(Continued on next page)

MIDSEL MIDSEL

(Continued from previous page)

OPERAND DESCRIPTIONS:

Mid—selector range — This tuning parameter specifies the acceptable range (dead band) between values. Dead band values are any non—negative floating point number.

Second input — The name of the general register or analog loadable function that contains the second input.

Third input — The name of the general register or analog loadable function that contains the third input.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = middle value [SVA(in), second input, third input]
If ((highest value — middle value) > dead band) OR
((middle value — lowest value) > dead band)
Then SVD(out) = 1
Else
SVD(out) = 0

Where: dead band = operand 1
second input = operand 2
third input = operand 3

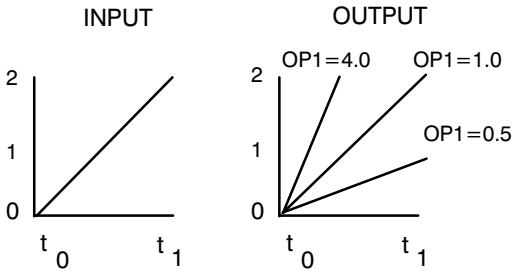
MUL

MUL

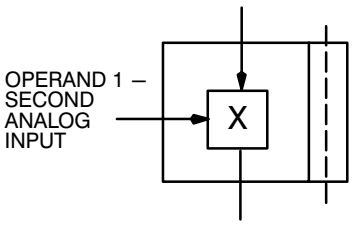
INSTRUCTION NAME: MUL (multiply)

DESCRIPTION : This instruction multiplies the SVA input by the analog value contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: MUL (

Value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Value – The name of the general register or analog loadable function that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in) X Analog Value
SVD(out) = SVD(in)

NOP NOP

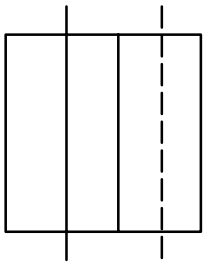
INSTRUCTION NAME: NOP (no operation)

DESCRIPTION : This instruction is used as a place holder in the FST. For example, if an operation function is removed from the FST, replacing it with NOP allows the line numbers of the FST to remain unchanged, thus eliminating re−numbering functions. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: NOP

Comment >>

OPERAND DESCRIPTIONS:

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

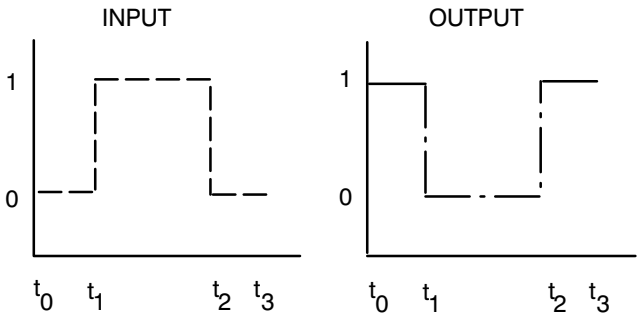
NOT

NOT

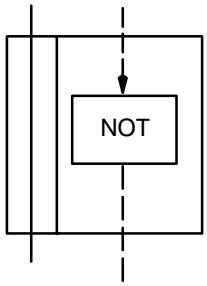
INSTRUCTION NAME: NOT (logical inverse)

DESCRIPTION : This instruction takes the logical inverse of the SVD input. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: NOT (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) = 1
  Then SVD(out) = 0
If SVD(in) = 0
  Then SVD(out) = 1

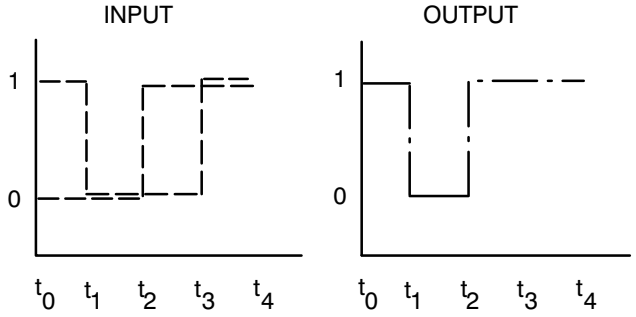
SVA(out) = SVA(in)

OR OR

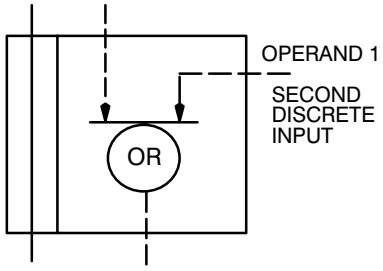
INSTRUCTION NAME: OR (logical OR)

DESCRIPTION: This instruction performs a logical OR of the SVD input and the discrete value contained in operand 1. If both the SVD input and the discrete value are 0, then the SVD output is 0. When either the SVD input or the discrete value, or both, are 1, then the SVD output is 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: OR (

Second Input >>
Comment >>

OPERAND DESCRIPTIONS:

Second Input – The name of the general register or discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) = Discrete Value = 0
Then SVD(out) = 0
Else SVD(out) = 1

SVA(out)=SVA(in)

OVRD OVRD

INSTRUCTION NAME: OVRD (override)

DESCRIPTION: This instruction causes the output of the station function (STAT) to perform either output or integral tracking. When the value in operand 3 is 1, the STAT function output tracks the value in operand 2. When the value in operand 3 is 0 and the value in operand 4 is 1, the STAT function output performs integral tracking.

A controller in the AUTO, RSP, SUP, or DDC mode will perform output tracking if the value in operand 3 is 1. A controller in manual mode will perform output tracking when operand 1 is enabled and operand 3 is 1. (Normal manual mode operation will occur if operand 1 is disabled.) Output tracking sets the output of the STAT function equal to the track value in operand 2.

A controller in the AUTO, RSP, or SUP mode will perform integral tracking when the value in operand 3 is 0 and integral tracking is enabled (operand 4 = 1).

Note

To avoid loop windup in override control applications for which integral tracking (operand 4) is enabled, place a FIL function and a RGST function immediately after the AOUT function of the loop containing the signal selecting operation. The name of the general register used by the RGST function is then specified in operand 2 of the OVRD function.

Refer to section NO ATG (page NO ATG) for instructions on determining the correct filter time constant.

The OVRD function must precede the CNTRL function in the FST and cannot be used in the same loop in conjunction with a cascade, track, or another override function. The SVA and SVD inputs remain unchanged.

(Continued on next page)

OVRD OVRD

(Continued from previous page)

GRAPHIC REPRESENTATION:

LOGIC STATE		OPERAND 3	
		0	1
OPERAND 4	0	CONTROL ACTION	OUTPUT TRACKING OPERAND 2
	1	INTEGRAL TRACKING OPERAND 2	OUTPUT TRACKING OPERAND 2

SYMBOLIC REPRESENTATION:

NO SYMBOLIC REPRESENTATION

CONFIGURATION FORMAT: OVRD (

Track overrides manual enable >>
Track value >>
Output track enable >>
Integral track enable >>
Comment >>

OPERAND DESCRIPTIONS:

Track overrides manual enable – Allows the controller to track the external signal in manual mode. ENABLE or DISABLE can be specified.

Track value – The name of the general register or analog loadable function that contains the external track signal value (in percent).

Output track enable – The name of the general register or discrete loadable function that contains the output track enable value (1 = enable, 0 = disable).

Integral track enable – The name of the general register or discrete loadable function that contains the integral track enable value (1 = enable, 0 = disable).

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

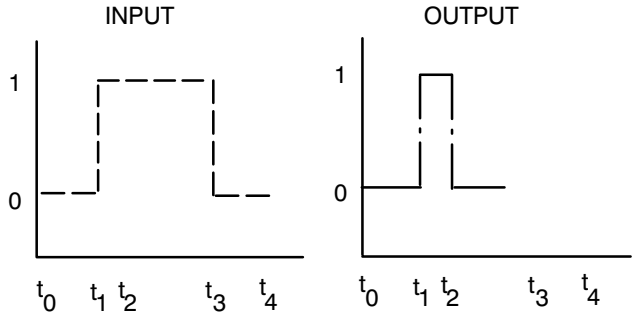
PDET

PDET

INSTRUCTION NAME: PDET (positive—directional edge trigger)

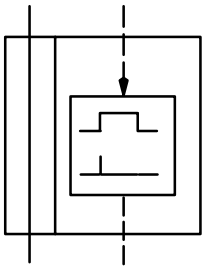
DESCRIPTION: This instruction sets the SVD output to 1 when the SVD input changes from 0 to 1. The SVD output remains at 1 for one execution (cycle) of the FST and then returns to 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



t1 → t2 IS THE TIME
OF ONE EXECUTION OF THE FST

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: PDET (

Comment >>

OPERAND DESCRIPTIONS:

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) > SVD(in) Last Cycle
Then SVD(out) = 1
Else SVD(out) = 0

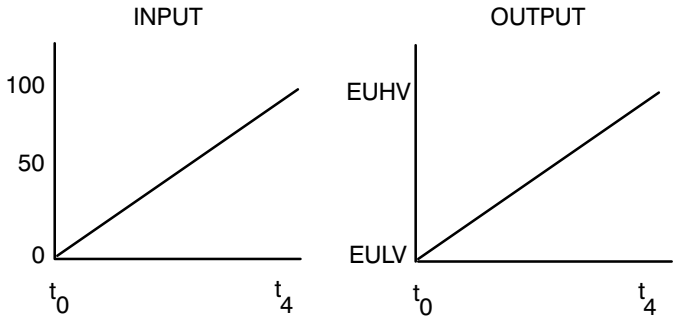
SVA(out)=SVA(in)

PEU PEU

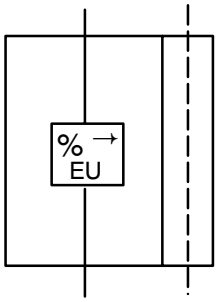
INSTRUCTION NAME: PEU (percent to engineering units conversion)

DESCRIPTION : This instruction converts the SVA input (in percent of span) to engineering units based on the engineering units high value (EUHV) and the engineering units low value (EULV) contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: PEU (

Eng conversion factors >>
Comment >>

OPERAND DESCRIPTIONS:

Eng conversion factors – The name of the direct control point (DCP), indirect control point (ICP), or auxiliary engineering unit pair that contains the engineering units high and low values.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)[(EUHV – EULV)/100] + EULV
SVD(out) = SVD(in)

Where: EULV = Engineering units low value
EUHV = Engineering units high value

PFR

PFR

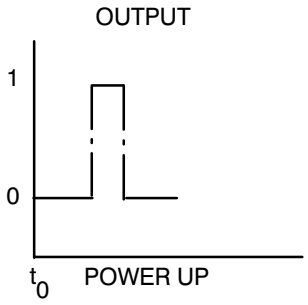
INSTRUCTION NAME: PFR (power fail restart)

DESCRIPTION : This instruction sets the SVD output to 1 during the first FST execution (cycle) following a power restart. For the second and all other executions, the SVD output is 0. The SVA input remains unchanged.

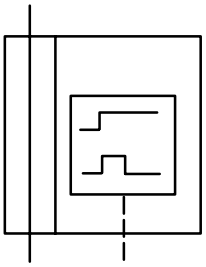
GRAPHIC REPRESENTATION:

INPUT

NOT APPLICABLE



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: PFR

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If first FST execution after power restart,
  Then SVD(out) = 1
If second or more executions,
  Then SVD(out) = 0

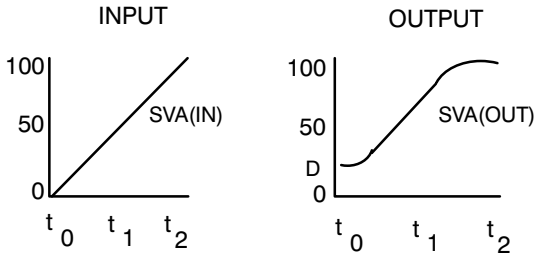
SVA(out) = SVA(in)

POLY POLY

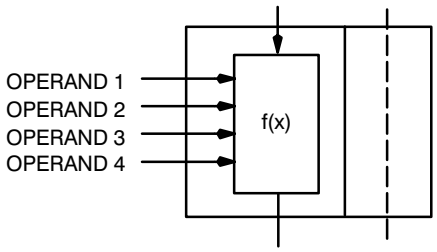
INSTRUCTION NAME: POLY (polynomial conversions)

DESCRIPTION: This instruction performs a third−order polynomial conversion of the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: POLY (

A coefficient	>>
B coefficient	>>
C coefficient	>>
D coefficient	>>
Comment	>>

OPERAND DESCRIPTIONS:

A coefficient − This tuning parameter specifies the value of coefficient A.

B coefficient − This tuning parameter specifies the value of coefficient B.

C coefficient − This tuning parameter specifies the value of coefficient C.

D coefficient − This tuning parameter specifies the value of constant D.

Comment − A comment up to 255 characters long.

(Continued on next page)

POLY

POLY

(Continued from previous page)

FUNCTION EQUATIONS:

$SVA(out) = AX^3 + BX^2 + CX + D$

Where: X = SVA(in)
A = coefficient of X^3 term
B = coefficient of X^2 term
C = coefficient of X term
D = constant

The coefficients and constants can be any floating point number.

SVD(out) = SVD(in)

PVLD PVLD

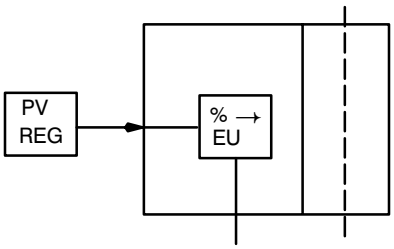
INSTRUCTION NAME: PVLD (process variable load)

DESCRIPTION: This instruction sets the SVA output equal to the value of the process variable (PV) of the loop specified by operand 1. The process variable is the SVA input being used by the PCA. The process variable value is converted from percent of span being used by the PCA to engineering units (E.U.'s) using the engineering units low value (EULV) and the engineering units high value (EUHV) of the loop specified by operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: PVLD (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag of the loop that contains the process variable value. The process variable value is recalled from the process variable operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = (PV value)[(EUHV–EULV)/100] + EULV
SVD(out) = SVD(in)

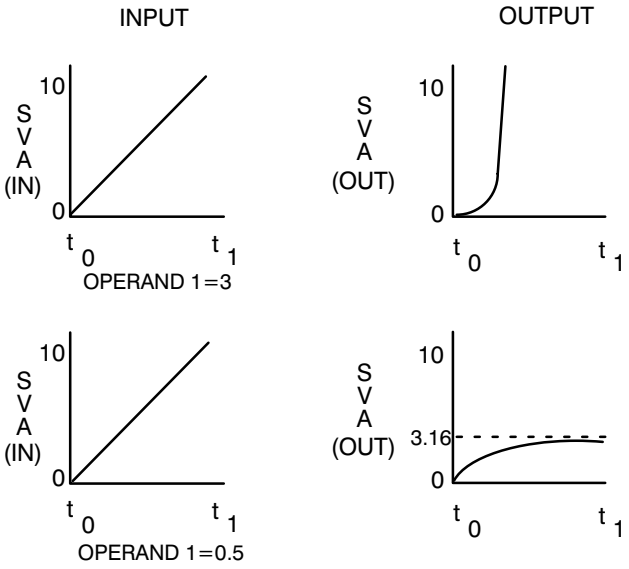
Where: EULV = Engineering units low value
EUHV = Engineering units high value

PWR PWR

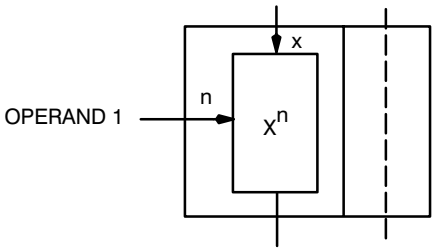
INSTRUCTION NAME: PWR (power) (Invalid on Computing Controller)

DESCRIPTION: This instruction raises the absolute value of the SVA input to the power specified by the analog value contained in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: PWR (

Exponent >>
Comment >>

OPERAND DESCRIPTIONS:

Exponent — The name of the general register or analog loadable function that contains the analog value.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

$SVA(out) = |SVA(in)|^{Analog\ Value}$

Where: $-32 <= \text{analog value} \times \ln[SVA(in)] <= 32$

$SVD(out) = SVD(in)$

RGLD RGLD

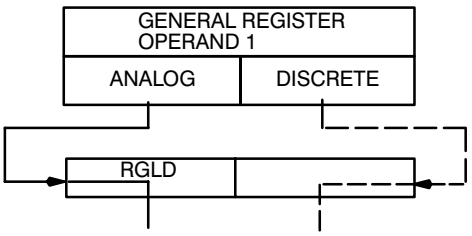
INSTRUCTION NAME: RGLD (register load analog and discrete)

DESCRIPTION: This instruction sets both the SVA and SVD outputs equal to their respective analog and discrete values contained in the general register specified by operand 1.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RGLD (

Register name >>
Comment >>

OPERAND DESCRIPTIONS:

Register name – The name of the general register that contains the analog and discrete values.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = analog value
SVD(out) = discrete value

RGLDA RGLDA

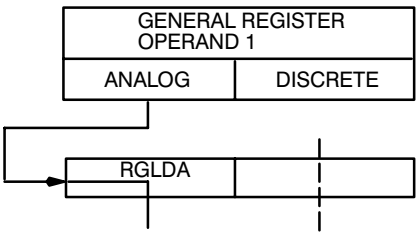
INSTRUCTION NAME: RGLDA (register load analog)

DESCRIPTION: This instruction sets the SVA output equal to the analog value contained in the general register specified by operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RGLDA (

Register name >>
Comment >>

OPERAND DESCRIPTIONS:

Register name – The name of the general register that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = analog value
SVD(out) = SVD(in)

RGLDD RGLDD

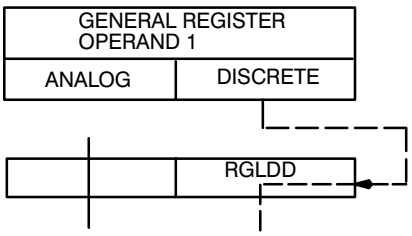
INSTRUCTION NAME: RGLDD (register load discrete)

DESCRIPTION: This instruction sets the SVD output equal to the discrete value contained in the general register specified by operand 1. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RGLDD (

Register name >>
Comment >>

OPERAND DESCRIPTIONS:

Register name – The name of the general register that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = discrete value

RGST

RGST

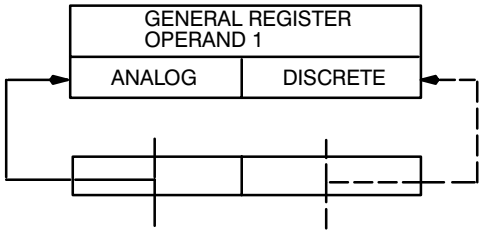
INSTRUCTION NAME: RGST (register store analog and discrete)

DESCRIPTION: This instruction stores both the SVA and SVD input values into the monitor or monitor−reference general register specified by operand 1. The SVA and SVD inputs remain unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RGST (

Register name	>>
Comment	>>

OPERAND DESCRIPTIONS:

Register name − The name of the monitor or monitor−reference general register that will store the SVA and SVD input values.

Comment − A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(in) = SVA(out) = analog value
SVD(in) = SVD(out) = discrete value

RSPST RSPST

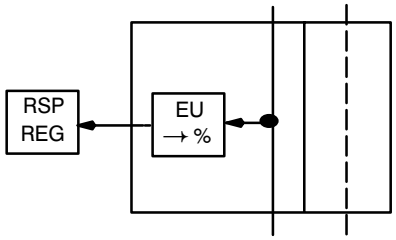
INSTRUCTION NAME: RSPST (remote set point store)

DESCRIPTION: This instruction stores the SVA input into the remote set point operating data register of the loop being performed. The SVA input is converted from engineering units (E.U.'s) to percent of span before being stored. The engineering units low value (EULV) and the engineering units high value (EUHV) of the loop being performed are used in the conversion. The SVA and SVD inputs remain unchanged. The remote set point is only stored when the loop is in the remote set point mode.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RSPST (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

RSP value = [(SVA(in) – EULV)/(EUHV – EULV)] X 100%
SVA(out) = SVA(in)
SVD(out) = SVD(in)

Where: EULV = Engineering units low value
EUHV = Engineering units high value

%RSPST %RSPST

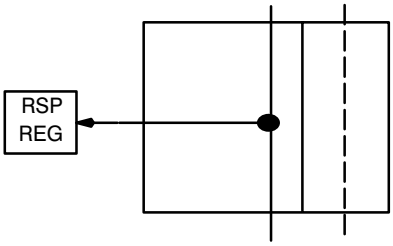
INSTRUCTION NAME: %RSPST (percent remote set point store)

DESCRIPTION: This instruction stores the SVA input in the remote set point operating data register of the loop being executed. The SVA and SVD inputs remain unchanged. The remote set point SVA(in) must be in terms of percent of span for the loop. The remote set point value is stored only when the loop is in the remote set point mode.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: %RSPST (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

RSP value = SVA(in)
SVA(out) = SVA(in)
SVD(out) = SVD(in)

RTOLD RTOLD

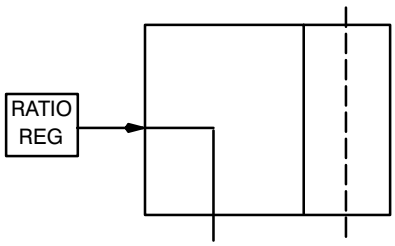
INSTRUCTION NAME: RTOLD (ratio load)

DESCRIPTION: This instruction sets the SVA output equal to the ratio value of the loop specified in operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RTOLD (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop that contains the ratio value. The ratio value is recalled from the ratio operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = ratio value
SVD(out) = SVD(in)

RTOST RTOST

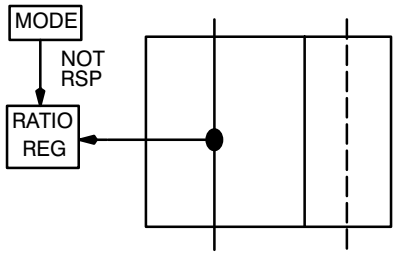
INSTRUCTION NAME: RTOST (ratio store)

DESCRIPTION: This instruction stores the SVA input into the ratio operating data register of the loop being executed. The SVA and SVD inputs remain unchanged. The ratio values are limited to between 0.01 and 10.00. The SVA input is stored only when the loop is NOT in the RSP mode.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: RTOST (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

ratio value = SVA(in)
SVA(out) = SVA(in)
SVD(out) = SVD(in)

SGSL SGSL

INSTRUCTION NAME: SGSL (signal selector)

DESCRIPTION: This instruction creates three auxiliary analog registers for use with the signal selector PCA. Operands 1, 2, and 3 specify the source of the second, third and fourth analog inputs, respectively. The SVA and SVD inputs remain unchanged.

Note

To disable a particular input, place the mnemonic ACCUM in the appropriate operand.

CONFIGURATION FORMAT: SGSL (

Second value	>>
Third value	>>
Fourth value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Second value — The name of the general register or analog loadable function that contains the second analog input value.

Third value — The name of the general register or analog loadable function that contains the third analog input value.

Fourth value — The name of the general register or analog loadable function that contains the fourth analog input value.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

SPLD SPLD

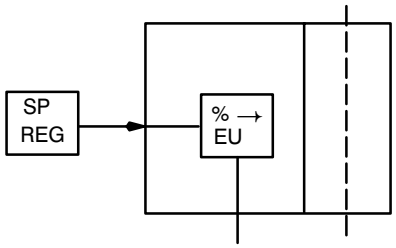
INSTRUCTION NAME: SPLD (set point load)

DESCRIPTION: This instruction sets the SVA output equal to the value of the set point of the loop specified by operand 1 for the present loop mode. The set point value is converted from percent of span to engineering units (E.U.'s) using the engineering units low value (EULV) and the engineering units high value (EUHV) of the loop specified by operand 1. This function can be used for automatic, remote set point, or supervisory set point values. The set point is limited by its high and low limits, but is not velocity limited. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: SPLD (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop that contains the set point value. The set point value is recalled from the set point operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = (set point value)[(EUHV – EULV)/100] + EULV
SVD(out) = SVD(in)

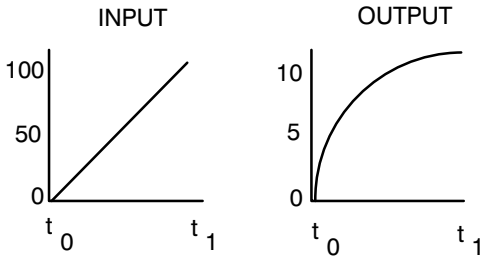
Where: EULV = Engineering units low value
EUHV = Engineering units high value

SQRT SQRT

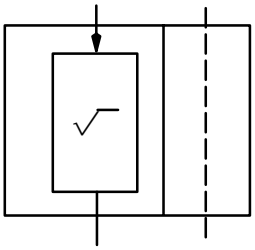
INSTRUCTION NAME: SQRT (square root)

DESCRIPTION : This instruction takes the square root of the SVA input. The SVD input remains unchanged. Input values less than zero are changed to zero.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: SQRT (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SQRT(SVA(in)) {for SVA(in) >= 0}
SVA(out) = 0 {for SVA(in) < 0}
SVD(out) = SVD(in)

SSLD SSLD

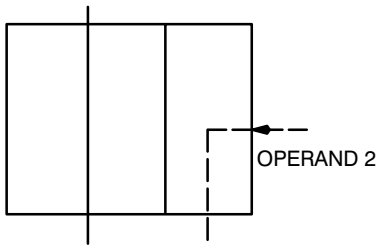
INSTRUCTION NAME: SSLD (signal selector status load)

DESCRIPTION: This instruction is used only with the signal selector PCA. It sets the SVD output to 0 if the input signal specified by operand 2 is selected by the PCA. If any other input signal is selected by the PCA, the SVD output is 1. Operand 1 contains the name of the signal selector loop. This function can be used as the third operand of the OVRD (override) function. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: SSLD (

Loop tag	>>
Signal selector input #	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag — The tag name of the loop that contains the signal selector PCA.

Signal selector input # — The number of the signal selector input that contains the input signal. There are four possible signal selector inputs; therefore, this number is from 1 to 4. Number 1 corresponds to the SVA input, and numbers 2 through 4 correspond to operands 1 through 3 of the Signal Selector function.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

If signal selected = input signal number in operand 2
  Then SVD(out) = 0
If signal selected <> input signal number in operand 2
  Then SVD(out) = 1

SVA(out) = SVA(in)

STAT STAT

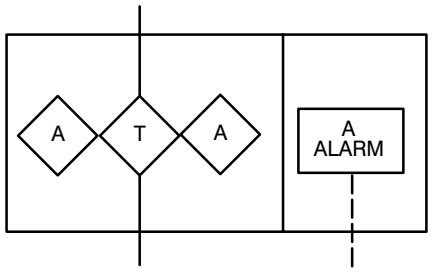
INSTRUCTION NAME: STAT (station)

DESCRIPTION: This instruction designates the location in the FST where the station type is executed. When this function is performed, the parameters defined during the station definition phase of configuration are used to produce the SVA output. STAT is always used with CNTRL or %CNTRL functions, and it is used only once per loop or not at all. The SVD output is set to 1 if alarm A is in alarm. Otherwise, it is set to 0.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: STAT (

Comment >>

OPERAND DESCRIPTIONS:

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

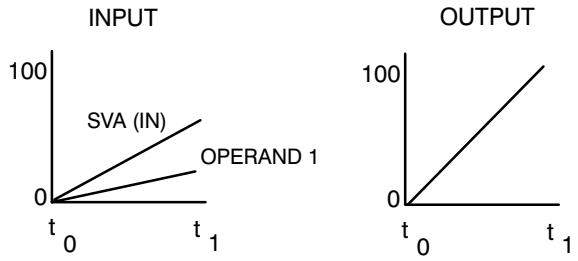
SVA(out) = f(STAT)
If alarm A is in alarm
  Then SVD(out) = 1
If alarm A is not in alarm
  Then SVD(out) = 0

SUM SUM

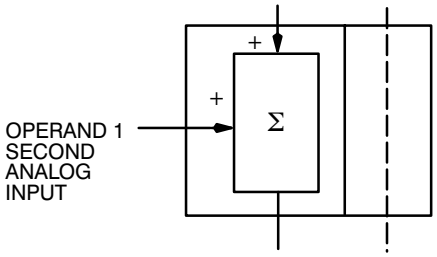
INSTRUCTION NAME: SUM (summation)

DESCRIPTION: This instruction adds an analog value to the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: SUM (

Value	>>
Comment	>>

OPERAND DESCRIPTIONS:

Value – The name of the general register or analog loadable function that contains the analog value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

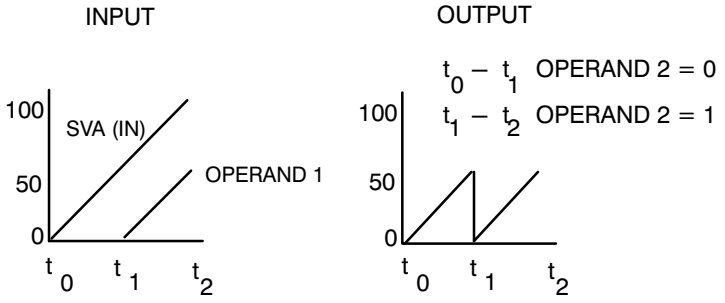
SVA(out) = SVA(in) + analog value
SVD(out) = SVD(in)

TFR TFR

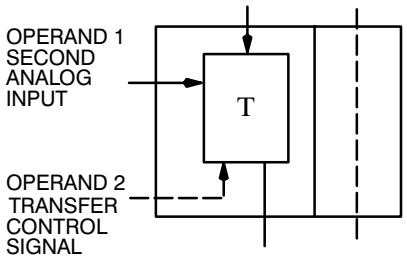
INSTRUCTION NAME: TFR (signal transfer)

DESCRIPTION: This instruction selects either the SVA input or the analog value contained in operand 1, depending on the transfer control status contained in operand 2. When the transfer control status is 1, the SVA output is the analog value. When the transfer control status is 0, the SVA output is the SVA input. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TFR (

Second input	>>
Signal select	>>
Comment	>>

OPERAND DESCRIPTIONS:

Second input – The name of the general register or analog loadable function that contains the analog value.

Signal select – The name of the general register or discrete loadable function that contains the discrete transfer control status (1 or 0).

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If transfer control status = 1
  Then SVA(out) = analog value
If transfer control status = 0
  Then SVA(out) = SVA(in)

SVD(out) = SVD(in)

TIFAUT

TIFAUT

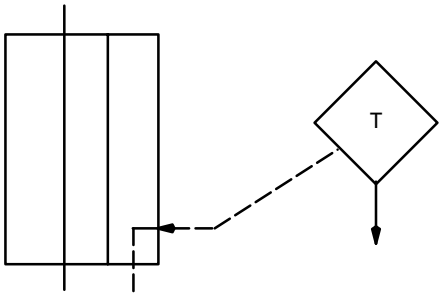
INSTRUCTION NAME: TIFAUT (true if automatic mode)

DESCRIPTION: This instruction sets the SVD output to 1 if the mode of the direct control point (DCP) contained in operand 1 is automatic. If the mode is not automatic, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TIFAUT (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop containing the DCP mode. The mode is recalled from the mode status operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If DCP mode = automatic
Then SVD(out) = 1
If DCP mode <> automatic
Then SVD(out) = 0

SVA(out) = SVA(in)

TIFDDC TIFDDC

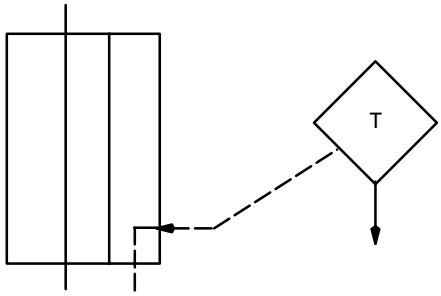
INSTRUCTION NAME: TIFDDC (true if direct digital control mode)

DESCRIPTION: This instruction sets the SVD output to 1 if the mode of the direct control point (DCP) contained in operand 1 is direct digital control (DDC). If the mode is not direct digital control, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TIFDDC (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop containing the DCP mode. The mode is recalled from the mode status operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If DCP mode = direct digital control
Then SVD(out) = 1
If DCP mode <> direct digital control
Then SVD(out) = 0

SVA(out) = SVA(in)

TIFMAN TIFMAN

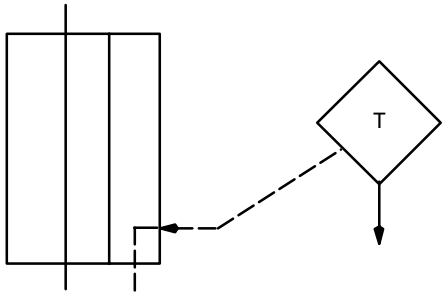
INSTRUCTION NAME: TIFMAN (true if manual mode)

DESCRIPTION: This instruction sets the SVD output to 1 if the mode of the direct control point (DCP) contained in operand 1 is manual. If the mode is not manual, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TIFMAN (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop containing the DCP mode. The mode is recalled from the mode status operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If DCP mode = manual
Then SVD(out) = 1
If DCP mode <> manual
Then SVD(out) = 0

SVA(out) = SVA(in)

TIFRSP TIFRSP

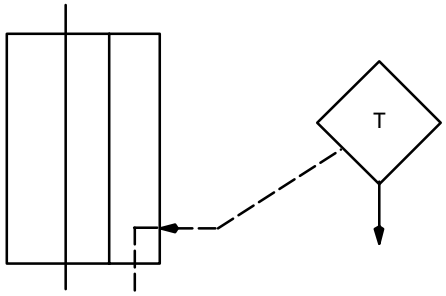
INSTRUCTION NAME: TIFRSP (true if remote set point mode)

DESCRIPTION: This instruction sets the SVD output to 1 if the mode of the direct control point (DCP) contained in operand 1 is remote set point. If the mode is not remote set point, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TIFRSP (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop containing the DCP mode. The mode is recalled from the mode status operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If DCP mode = remote set point
Then SVD(out) = 1
If DCP mode <> remote set point
Then SVD(out) = 0

SVA(out) = SVA(in)

TIFSUP TIFSUP

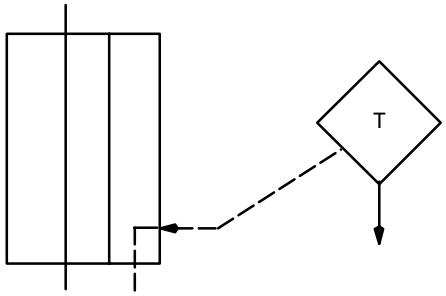
INSTRUCTION NAME: TIFSUP (true if supervisory mode)

DESCRIPTION: This instruction sets the SVD output to 1 if the mode of the direct control point (DCP) contained in operand 1 is supervisory. If the mode is not supervisory, the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: TIFSUP (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag – The tag name of the loop containing the DCP mode. The mode is recalled from the mode status operating data register for the specified loop.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If DCP mode = supervisory
Then SVD(out) = 1
If DCP mode <> supervisory
Then SVD(out) = 0

SVA(out) = SVA(in)

TM

TM

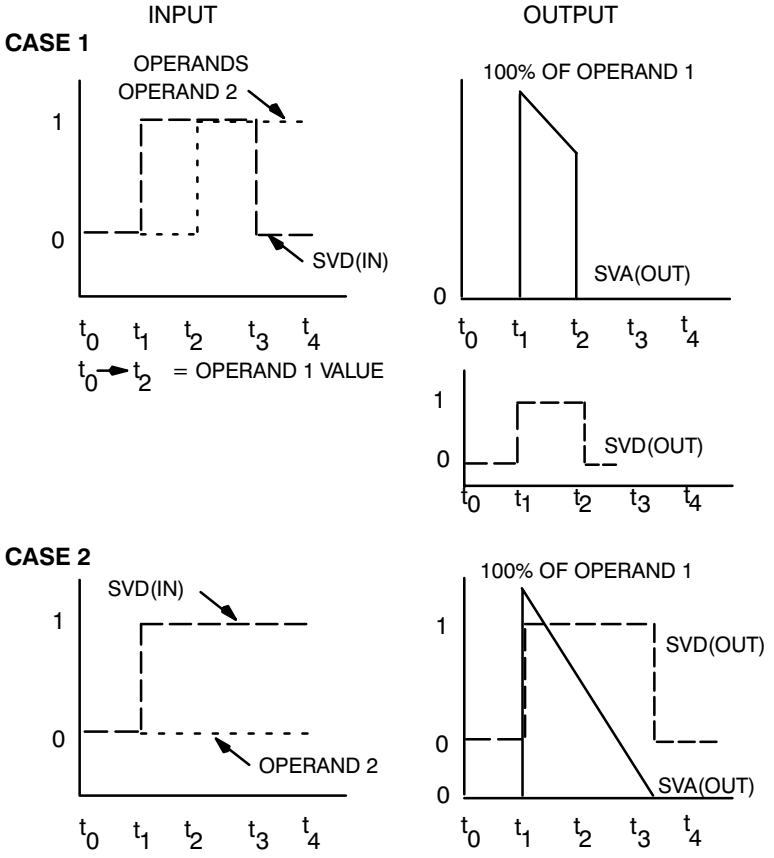
INSTRUCTION NAME: TM (timer)

DESCRIPTION : This instruction provides a time−out interval for the SVD input. A transition of the SVD input from the logic 0 to the logic 1 state causes the SVD output to go to the logic 1 state for the time specified by the time−out value in operand 1, if the reset value in operand 2 is 0. The time−out value is loaded into an internal register (HA) with each transition of the SVD input from 0 to 1. Register HA is then decreased with each execution of the function until one of the following occurs:

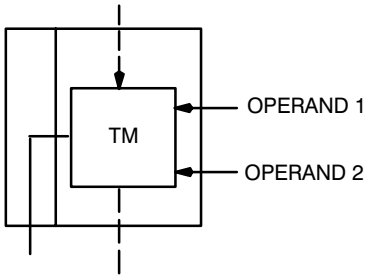
- The SVD input goes from 0 to 1
- The reset value goes to 1
- Register HA reaches a count of 0

When register HA reaches 0, the SVD output is set to 0. If the reset value is 1, the SVA and SVD output will be 0.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



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TM

TM

(Continued from previous page)

CONFIGURATION FORMAT: TM (

Timer time	>>
Reset signal	>>
Comment	>>

OPERAND DESCRIPTIONS:

Timer time – This tuning parameter specifies the time–out interval in minutes. Timer time values are: 0, or 0.0042 to 8,921,000 for the 4 hertz version controller; 0, or 0.0016 to 3,568,400 for the 10 hertz version controller; and 0, or 0.0009 to 1,784,200 for the 20 hertz version controller.

Reset signal – The name of the general register or discrete loadable function that contains the reset value (1 = reset, 0 = normal).

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) > HD, and Reset value = 0 {a 0 to 1 transition of SVD(in)}

1. HA = Timer time
   If SVD(in) <= HD, and reset value = 0 {no 0 to 1 transition of SVD(in)}
2. HA = HA – Δt, HA limited to >= 0
   If SVD(in) <= HD, and Reset value = 0 {no 0 to 1 transition of SVD(in)}
3. HD = SVD(in) last cycle
4. SVA(out) = HA
5. SVD(out) = 1, If Reset value = 0 and HA > 0
6. SVD(out) = 0, If Reset value = 1 or HA = 0
7. On power up or if reset value = 1:
   SVA(out) = HA = 0
   SVD(out) = 0
   HD = SVD(in)

Where: HD = discrete hold value (SVD(in) from last cycle)
Δt = sample time in minutes
Timer time = value specified in operand 1
Reset value = value specified in operand 2

TRK TRK

INSTRUCTION NAME: TRK (track)

DESCRIPTION: This instruction modifies the tracking characteristics of a control loop based on control conditions specified by the track value in operand 2. When the track enable value in operand 3 is 1, the output of the STAT function is set equal to the value in operand 2. Operand 2 contains the track signal. If the track enable value in operand 3 is 0, output tracking is disabled.

The SVA and SVD inputs remain unchanged. TRK can be used only once per direct control point.

CONFIGURATION FORMAT: TRK (

Track overrides manual enable >>
Track value >>
Track enable >>
Comment >>

OPERAND DESCRIPTIONS:

Track overrides manual enable — A discrete value that allows the controller to track the external signal in manual mode. ENABLED or DISABLED can be specified.

Track value — The name of the general register or analog loadable function that contains the track signal (in percent).

Track enable — The name of the general register or discrete loadable function that contains the track enable value (1 = enable, 0 = disable).

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

SVA(out) = SVA(in)
SVD(out) = SVD(in)

VLIM

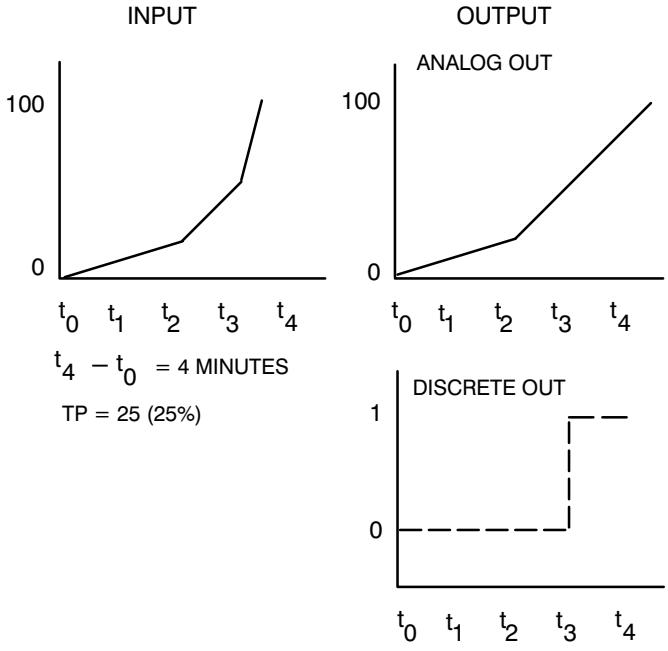
VLIM

INSTRUCTION NAME: VLIM (velocity limiter)

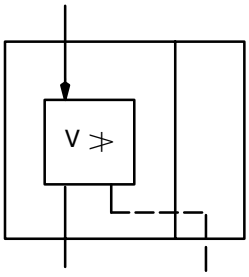
DESCRIPTION: This instruction limits the rate of change of the SVA input to a predetermined value. The SVA output is the same as the SVA input unless the rate of change of the input exceeds the velocity limit specified by the analog value in operand 1. If the velocity limit is exceeded, the output will change at a rate equal to the velocity limit.

The SVD output equals 0 when the SVA output is not limited. The SVD output equals 1 when the SVA output is limited.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: VLIM (

Velocity limit >>
Comment >>

(Continued on next page)

VLIM VLIM

(Continued from previous page)

OPERAND DESCRIPTIONS:

Velocity limit – This tuning parameter specifies the value of the velocity limit. It must have the same units as the SVA input expressed as a rate of change (E.U.'s / minute). The velocity limit can be any non–negative floating point number.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If $|SVA(in) - HA| <= \text{Velocity limit} \times \Delta t$
Then $SVA(out) = SVA(in)$, $SVD(out) = 0$

If $SVA(in) - HA > \text{Velocity limit} \times \Delta t$
Then $SVA(out) = HA + (\text{Velocity limit} \times \Delta t)$, $SVD(out) = 1$

If $HA - SVA(in) > \text{Velocity limit} \times \Delta t$
Then $SVA(out) = HA - (\text{Velocity limit} \times \Delta t)$, $SVD(out) = 1$

Where: $HA = SVA(out)$ last cycle
Δt = sample time in minutes

VOLD VOLD

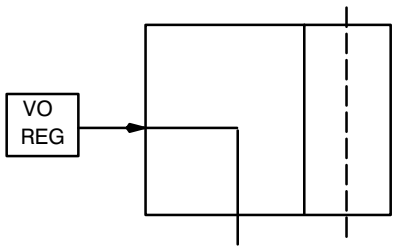
INSTRUCTION NAME: VOLD (valve output load)

DESCRIPTION: This instruction sets the SVA output equal to the implied valve position of the loop specified by operand 1. The SVD input remains unchanged.

GRAPHIC REPRESENTATION:

NO GRAPHIC REPRESENTATION

SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: VOLD (

Loop tag	>>
Comment	>>

OPERAND DESCRIPTIONS:

Loop tag — The tag name of the loop that contains the implied valve position. The implied valve position value is recalled from the implied valve position operating data register for the specified loop.

Comment — A comment up to 255 characters long.

FUNCTION EQUATIONS:

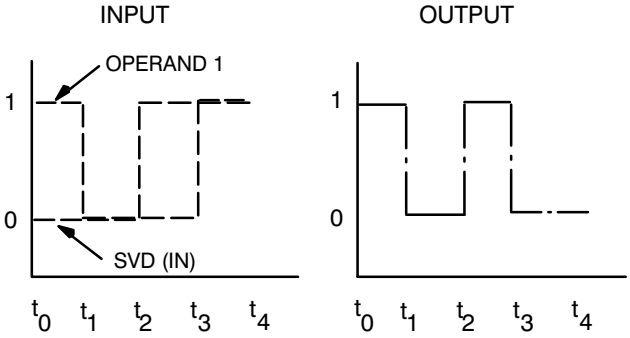
SVA(out) = implied valve position
SVD(out) = SVD(in)

XOR XOR

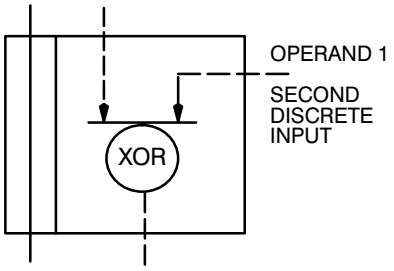
INSTRUCTION NAME: XOR

DESCRIPTION: This instruction performs a logical exclusive OR of the SVD input and the discrete value contained in operand 1. If either (but not both) the SVD input or the discrete value is 1, then the SVD output is 1. If both the SVD input and the discrete value are either 0 or 1, then the SVD output is 0. The SVA input remains unchanged.

GRAPHIC REPRESENTATION:



SYMBOLIC REPRESENTATION:



CONFIGURATION FORMAT: XOR (

Second Input >>
Comment >>

OPERAND DESCRIPTIONS:

Second Input – The name of the general register or the discrete loadable function that contains the discrete value.

Comment – A comment up to 255 characters long.

FUNCTION EQUATIONS:

If SVD(in) or Discrete Value = 1
  Then SVD(out) = 1
If SVD(in) = Discrete Value = 0
  Then SVD(out) = 0
If SVD(in) = Discrete Value = 1
  Then SVD(out) = 0

SVA(out) = SVA(in)

4.5 IAC/Computing Analog ICP Point

This section of configuration defines an analog Indirect Control Point (ICP). An analog ICP is an analog value used in operator interface displays or by certain functions in the FST of the controller.

Device v — The device tag name of the controller that is currently being configured up to 12 characters in length.

Index — The number of this ICP within the controller. The number of available ICPs for each controller are listed in Table 4-7.

Table 4-7. Valid Index Numbers for Analog ICPs.

Controller	Quantity of ICPs	Valid ICP Index
Computing	4	9 to 12
2−Wide IAC	6	9 to 14
3−Wide Discrete IAC	6	9 to 14
3−Wide Analog IAC	12	9 to 20
4−Wide IAC	12	9 to 20

Description — The description of the point may be up to 16 characters in length. The first 12 characters will appear on the faceplate display of a console on the line immediately below the point tag. All 16 characters may be used on a custom display. Any printable character may be used in the description.

Strategy — The strategy field is a 12 character text field that can be used to help group points together. For example, if the plant consists of a boiler, a reactor, and a tank, the strategy field of each point could be set to either “Boiler”, “Reactor”, or “Tank”. This data is not checked or processed in any way, but points can be sorted by the strategy field.

EU Descriptor — The units (such as gpm) of the analog value being defined in the ICP, up to six characters in length.

High Scale Value — The value that defines the upper engineering unit end point for the analog value being defined in the ICP. Any valid floating point number is allowed, however, it may not be the same as the Low Scale Value. This tuning parameter may be changed using DDP #2, EU 100%.

Low Scale Value — The value that defines the lower engineering unit end point for the analog value being defined in the ICP. Any valid floating point number is allowed, however, it may not be the same as the High Scale Value. This tuning parameter may be changed using DDP #1, EU 0%.

Type v — The type of the analog ICP may be one of the following: MONITOR, REFERENCE, MONITOR DEVIATION, or REFERENCE DEVIATION. This selection determines the kind of access allowed to the analog ICP register(s). Table 4-8 describes the access allowed by the controller itself or by an operator interface device. Note that a MONITOR DEVIATION type is two MONITOR values that are displayed side by side in a group or detail display, and a REFERENCE DEVIATION type is one MONITOR value and one REFERENCE value that are displayed side by side.

Table 4-8. Access to Analog ICP Types

Type of Analog ICP	Controller Access Read	Controller Access Write	Operator Interface Access Read	Operator Interface Access Write
Monitor	x	x	x	—
Reference	x	—	x	x
Monitor Deviation (both monitor values)	x	x	x	—
Reference Deviation Reference Value	x	—	x	x
Monitor Value	x	x	x	—

4.6 IAC/Computing Discrete ICP Point

This section of configuration defines a discrete ICP. A discrete ICP is a set of discrete values used in operator interface displays or by certain functions in the FST of the controller.

Device v — The device tag name of the controller that is currently being configured up to 12 characters in length.

Index — The number of this ICP within the controller. The number of available ICPs for each controller are listed in Table 4-9.

Table 4-9. Valid Index Numbers for Discrete ICPs.

Controller	Quantity of ICPs	Valid ICP Index
Computing	4	9 to 12
2−Wide IAC	6	9 to 14
3−Wide Discrete IAC	6	9 to 14
3−Wide Analog IAC	12	9 to 20
4−Wide IAC	12	9 to 20

Description — The description of the point may be up to 16 characters in length. The first 12 characters will appear on the faceplate display of a console on the line immediately below the point tag. All 16 characters may be used on a custom display. Any printable character may be used in the description.

Strategy — The strategy field is a 12 character text field that can be used to help group points together. For example, if the plant consists of a boiler, a reactor, and a tank, the strategy field of each point could be set to either “Boiler”, “Reactor”, or “Tank”. This data is not checked or processed in any way, but points can be sorted by the strategy field.

EU Descriptor — Units used for reference if the following engineering unit conversion values are used for scaling by functions in the FST.

High Scale Value — The value that defines the upper engineering unit end point to be used for scaling in the FST. Any valid floating point number is allowed, however, it may not be the same as the Low Scale Value. This tuning parameter can be changed using DDP #2, EU 100%.

Low Scale Value — The value that defines the lower engineering unit end point to be used for scaling in the FST. Any valid floating point number is allowed, however, it may not be the same as the High Scale Value. This tuning parameter can be changed using DDP #1, EU 0%.

No. — A read−only field displaying the number of the discrete register within the ICP. There are four sets of discrete values associated with each discrete ICP.

Type v — This field defines the type of each discrete register. Valid types are MONITOR, REFERENCE, or MONITOR REFERENCE. The type selected determines the kind of access allowed to the discrete ICP register. Table 4-10 describes the access allowed by the controller itself or by an operator interface device.

Table 4-10. Access to Discrete ICP Types

Type of Analog ICP	Controller Access Read	Controller Access Write	Operator Interface Access Read	Operator Interface Access Write
Monitor	x	x	x	—
Reference	x	—	x	x
Monitor Reference	x	x	x	x

Description — The user description of the discrete register used in the ICP up to 12 characters long.

On Alarm Word — The on alarm word associated with each discrete register in the ICP to be displayed at the console. This field may be up to 8 characters long.

Off Alarm Word — The off alarm word associated with each discrete register in the ICP to be displayed at the console. This field may be up to 8 characters long.

4.7 Target Data Configuration

4.7.1 Target Data Configuration Items

The TARGET DATA form is used to define items related to targeting a point to other PROVOX devices. Refer to section NO TAG (page NO TAG) for additional information relating to targeting points. Refer to *Using ENVOX Configuration Software* UM4.14:SW3151 for instructions on creating target groups.

There are additional parameters that must be specified when targeting this point to UOC, TREND, and PROVUE devices. These additional forms are accessed from the EXTRA DATA menu option.

Alarm Display — Indicates if an alarm display is to be configured for this point. YES indicates an alarm display will be configured, NO indicates an alarm display will not be configured. If no alarm display is configured, the system will use the configured detail display.

Alarm Display v— Identifies the specific display that is to appear when an operator selects this point. The display must be in the display list of all the PROVUE consoles that the point is being targeted to.

Alarm Group A — Identifies the number of the alarm group to which the A alarm for this point is assigned. This will determine how this particular alarm is handled and its priority level. Valid range for this value is 1 to 7 for P4.1 and earlier PROVUE consoles, or 0 to 7 for P5.0 and later versions.

Alarm Group B — Identifies the number of the alarm group to which the B alarm for this point is assigned. This will determine how this particular alarm is handled and its priority level. Valid range for this value is 1 to 7 for P4.1 and earlier PROVUE consoles, or 0 to 7 for P5.0 and later versions.

Alarm Group C — Identifies the number of the alarm group to which the C alarm for this point is assigned. This will determine how this particular alarm is handled and its priority level. Valid range for this value is 1 to 7 for P4.1 and earlier PROVUE consoles, or 0 to 7 for P5.0 and later versions.

Alarm Group D — Identifies the number of the alarm group to which the D alarm for this point is assigned. This will determine how this particular alarm is handled and its priority level. Valid range for this value is 1 to 7 for P4.1 and earlier PROVUE consoles, or 0 to 7 for P5.0 and later versions.

Current? — This field is set to YES if the device specified by the configuration Device on the same row is in the current target device group. A target device group is composed of all of the PROVUEs, controllers, and CHIPs that have the same Reporting Mode, Sample Interval and Dead zone, and within the device type have the same field values (other than DBI or index values). A target device group may consist of up to 32 devices.

Generally, if YES appears next to a device in the Device field on any set of the targeting forms, then the data currently displayed applies to that device. Any change to a target value affects all devices in the Device field marked as YES. This is a read-only field, which was defined on the TARGET DATA form.

Device — This refers to the name of the device to which the point is to be targeted. This is a scrolled list of all the devices to which the point is being targeted.

Deadzone — Identifies the amount, in percent of span, by which an analog value must change since it was last reported before the value will be transmitted over the highway if the Reporting Mode is set to Exception. Valid entries for this field are 0.03124, 0.0625, 0.125, 0.25, 0,5, 1, 2, and 4.

Index — This is the numeric value given to this point in the target device. This is called DBI for PROVUE, Relative DBI in the UOC/IFC, and DBI in CHIP.

PPA — Identifies the Plant Process Area (PPA) that this point is to be a member of. This point should be placed into a PPA with other points that are to use the same alarm strategy. All points in the PPA will be grouped into the same Plant Management Areas (PMAs).

Reporting Mode — Determines, along with the DEADZONE and SAMPLE INTERVAL, how often (frequently) a particular point will send data over the highway to the devices in the current target group. Valid choices for this field are:

- CHANGE OF STATE — Change-of-State reporting communicates the point's operating data immediately if an alarm state has changed, without waiting for the end of a point's Sample Interval.
- PERIODIC — Periodic reporting communicates the point's operating data at the end of its Sample Interval regardless of whether any of the point's operating parameters has changed by more than the Dead zone value.
- EXCEPTION — Exception reporting communicates the point's operating data at the end of its Sample Interval if one of the point's operating parameters has changed by more than the Dead zone value, or if the point's refresh period has transpired.

BACKGROUND and EXCEPTION, NO REFRESH are not valid.

Sample Interval — The sample interval is the rate at which this point will send its operating data to the target devices if the reporting mode is Periodic. Valid entries for this field are 0, 0.5, 1, 3, 5, 10, 15 and 60 seconds.

Type — This read−only field displays the device type of the target device. This field aids in identifying specific revision levels or names of devices the point is being targeted to.

4.7.1.1 UOC Target Data Configuration Items

The UOC TARGET DATA form is used to define items related to targeting a point to a UOC, IFC, or MUX device. If extended alarms or pressure/temperature compensation are enabled for the target point, the associated form under the “Extra Data” menu option must be completed. These functions may be enabled for the target point even though they are not valid for the IAC and Computing Controllers.

Only the fields on the UOC TARGET DATA form that are valid for the IAC and Computing Controllers are described below.

Current? — This field is set to YES if the device specified by the configuration Device on the same row is in the current target device group. A target device group is composed of all of the PROVUEs, controllers, and CHIPs that have the same Reporting Mode, Sample Interval and Dead zone, and within the device type have the same field values (other than DBI or index values). A target device group may consist of up to 32 devices.

Generally, if YES appears next to a device in the Device field on any set of the targeting forms, then the data currently displayed applies to that device. Any change to a target value affects all devices in the Device field marked as YES. This is a read-only field which is defined on the TARGET DATA form.

Deadzone — The deadzone value indicates the amount by which the PV must change before the point will be updated at the console if the Reporting Mode is set to Exception. This is a read-only field which is defined on the TARGET DATA form.

Device — This refers to the name of the device to which the point is to be targeted. This is a scrolled list of all the devices to which the point is being targeted. This is a read-only field which is defined on the TARGET DATA form.

Rate Filter Enable — When the rate filter is enabled, momentary variations in RAV will be smoothed out using a first-order filter. Enabling the rate filter function also allows the filter time constant to be entered. The Rate Function Enable configuration item must be set to YES before

the rate filter can be enabled. YES enables the rate filter function; NO disables it. The rate filter may be enabled for the target point even if it is not enabled for the source point.

Rate Filter Time — The rate filter time constant is a number from 0 to 600 representing the filter time constant in minutes, and is valid only if the rate filter function is enabled. This defines the time required for 63.21 percent of a step change at the input of the filter to appear at the output. If desired, the filter time constant may be set to zero, effectively disabling the filter. However, it should be noted that a filter time of zero still causes increased loading.

Rate Function Enable — When the rate function is enabled, the rate of change of the PV in engineering units per minutes will be calculated, and the result will be placed in RAV attribute. If the rate function is enabled, the rate filter may also be enabled. YES enables the rate function; NO disables the function. The rate function may be enabled for the target point even though it is not valid for the IAC and Computing Controllers.

Reporting Mode — There are three reporting methods: Exception, Periodic, and Change-of-State. This is a read-only field which is defined on the TARGET DATA form.

Sample Interval — The sample interval is the rate at which this point will send its operating data to the target devices. This is a read-only field which is defined on the TARGET DATA form.

Scan Rate — The scan rate may be set to 0.2, 0.5, 1, 2, 5, 15, 30, or 60 (seconds). The scan rate is not tunable and therefore can only be entered during the initial configuration or subsequent configuration updates.

Extended Alarms Configuration Items

The UOC EXTENDED ALARMS form is used to define up to four alarms for a point.

Alarm No. — This read−only field specifies the number of the alarm being configured.

Alarm Type — Specifies whether the alarm is a high alarm, low alarm, or deviation alarm.

Attr — This configuration item specifies the attribute that will be monitored. All attributes listed in Table NO TAG (page NO TAG) are valid for Loop points. Valid attributes for AI points are PV, %PV, and RAV.

Deadband — Alarm deadband may be used to prevent unnecessary alarm re−activation when the measured variable is close to the alarm trip point. The value of the monitored attribute must move away from the trip point towards the set point by more than the deadband before the alarm will be

cleared. The valid deadband range for each available point attribute is listed in Table NO TAG (page NO TAG).

Dev Limit — The deviation limit is the amount by which a value must vary from the reference value to trigger a deviation alarm. The valid deviation limit for each available loop point attribute is listed in Table NO TAG (page NO TAG).

Initially Enabled — A YES response enables the alarms.

HI-LO Trip / **Dev Ref —** If the alarm type is a high or low alarm, the value at which a high or low alarm is triggered. If the alarm type is a deviation alarm, the base value from which a deviation alarm is measured. The valid trip point or deviation limit for each available attribute is listed in Table NO TAG (page NO TAG).

Table 4-11. Extended Alarm Attributes for UOC AI and Loop Points

ATTR	TRIP VALUE and REFERENCE VALUE	DEV LIMIT and DEADBAND	Necessary Conditions
CO1	−13.97−113.97%	0−127.94%	Control Output 1 must be HELD IN LOOP.
SP	See Note	0−127.94% of EU span	
%SP	−13.97−113.97%	0−127.94%	
PV	See Note	0−127.94% of EU span	
%PV	−13.97−113.97%	0−127.94%	
IVP	See Note	0−127.94% of EU span	
%IVP	−13.97−113.97%	0−127.94%	
BIAS	See Note	0−227.94% of EU span	Loop type must be Bias & Gain
BIAS	See Note	0−127.94% of EU span	Loop type must be P_PD with Bias
%BIAS	−113.97−113.97%	0−227.94%	Loop type must be Bias & Gain
%BIAS	−13.97−113.97%	0−127.94%	Loop type must be P_PD with Bias
RAV	Any floating point number	Any positive F.P. number	Rate function must be enabled

Note: The valid range is 13.97% of engineering unit span below the Low Scale Value (113.97% for BIAS on Bias and Gain PCAs) to 13.97% of engineering unit span above the High Scale Value. (For example, if Low Scale Value is set to −50.0 and High Scale Value is set to +50.0, the valid range is −63.97 to +63.97.)

UOC PT Compensation Configuration Items

The PT COMPENSATION form is used to define the information relating to pressure / temperature (PT) compensation for points being targeted to a UOC.

Absolute Pressure Conversion — The value required to convert the gauge pressure to absolute pressure, in engineering units. The controller uses this value to calculate K for the Ideal Gas equation. The valid range is any floating point value.

Absolute Pressure Conversion — The value required to convert the gauge pressure to absolute pressure, in engineering units. The controller uses this value to calculate K for the Ideal Gas equation. The valid range is any floating point value.

Absolute Temperature Conversion — The value required to convert the temperature to degrees Rankine or Kelvin. The controller uses this value to calculate K for the Ideal Gas equation. The valid range is any floating point value.

Gas Compensation Type — This configuration item is used to select the type of compensation; PRESSURE, TEMPERATURE or PRESSURE/TEMPERATURE. This configuration item is only valid if SQRT GAS FLOW, LINEAR GAS ORIFICE, or LINEAR GAS TURBINE has been selected as the PT Compensation Type.

Intercept for Density Equation — Represents the intercept of the density curve. This configuration item is only valid if SQRT LIQ FLOW, LINEAR LIQ ORIFICE, or LINEAR LIQ TURBINE have been selected as the PT Compensation Type. The intercept may be any floating point value.

Meter Calibration Density — The value entered here should be taken from the flow device specification sheet. The specification sheet should have an operating condition for design density (density at flowing conditions). This configuration item is only valid if SQRT LIQ FLOW, LINEAR LIQ ORIFICE, or LINEAR LIQ TURBINE have been selected as the PT Compensation Type. The valid range is any floating point value.

Meter Calibration Pressure — The value entered here should be taken from the flow device specification sheet. The specification sheet should have an operating condition for design pressure (flowing pressure). The controller expects this value to be relative, for example, PSIG as opposed to PSIA. The units used also need to be consistent with the units entered for absolute conversion. The valid range is any floating point value.

Meter Calibration Temperature — The value entered here should be taken from the flow device specification sheet. The specification sheet should have an operating condition for design temperature (flowing temperature). The controller expects this value to be relative, for example, DEG C as opposed to DEG K. The units used also need to be consistent with the units entered for absolute conversion. The valid range is any floating point value.

PT Compensation Type — This configuration item is used to select the type of compensation. The choices are SQRT GAS FLOW, LINEAR GAS ORIFICE, LINEAR GAS TURBINE, SQRT LIQ FLOW, LINEAR LIQ ORIFICE, and LINEAR TURBINE.

Pressure Source — The pressure source is the tag of the point which provides the pressure value to the pressure/temperature compensation function. This tag may be up to twelve characters in length.

Slope for Density Equation — Represents the slope of the density curve. This configuration item is only valid if SQRT LIQ FLOW, LINEAR LIQ ORIFICE, or LINEAR LIQ TURBINE has been selected as the PT Compensation Type. Slope may be any floating point value.

Temperature Source — The tag of the point which provides the temperature value to the pressure/temperature compensation function. The tag may be up to twelve characters in length.

4.7.1.2 PROVUE Target Data Configuration Items

The PROVUE TARGET DATA form is used to define items related to targeting a point to a PROVUE console. This information applies to all PROVUE consoles which are in the current target group.

Current? — This field is set to YES if the device specified by the configuration Device on the same row is in the current target device group. A target device group is composed of all of the PROVUEs, controllers, and CHIPs that have the same Reporting Mode, Sample Interval and Dead zone, and within the device type have the same field values (other than DBI or index values). A target device group may consist of up to 32 devices.

Generally, if YES appears next to a device in the Device field on any set of the targeting forms, then the data currently displayed applies to that device. Any change to a target value affects all devices in the Device field marked as YES. This is a read-only field which is defined on the TARGET DATA form.

Deadzone — The dead zone value indicates the amount by which the PV must change before the point will be updated at the console if the Reporting Mode is set to Exception. This is a read-only field which is defined on the TARGET DATA form.

Decimal Places — Specifies the number of decimal places, 0 through 7, that will be displayed throughout the console(s). The number of decimal places specified applies to all faceplate and value fields for this point.

Device — This refers to the name of the device to which the point is to be targeted. This is a scrolled list of all the devices to which the point is being targeted. This is a read-only field which is defined on the TARGET DATA form.

Expected Value — This field represents a reference value which may be compared to the process variable. The valid range is any floating point value. This field is only valid for Analog ICPs targeted to UOC AI points.

Reporting Mode — There are three reporting methods: Exception, Periodic, and Change-of-State. This is a read-only field which is defined on the TARGET DATA form.

Sample Interval — The sample interval is the rate at which this point will send its operating data to the target devices. This is a read-only field which is defined on the TARGET DATA form.

Scale — Identifies the percent of span representing full scale on the deviation bar in the overview display. The valid range is any number between 1 and 100.

Suppress Local Alarm — This field determines if this point will have alarms suppressed. YES prevents alarm messages from being displayed at the console for this point. Selecting YES will also cause "ALMSUP" to be displayed in the status block of the faceplate for this point. NO causes the console to process alarms normally using alarm priority, PPA State and PMA mode information. This field may be tuned via local PROVUE DDPs.

Suppress Operator Change — This field determines whether the operator will be able to change the operating parameter of this point from the console. YES disables operating parameter changes, NO enables them. Selecting YES also causes "OPCSUP" to be displayed in the status block of the faceplate for this point. This field may be tuned via local PROVUE DDPs.

Suppress Message — This field determines whether this point will have alarm messages printed on the printer. Selecting YES will disable alarm message printing and cause "MSGS" to be displayed in the status block of the faceplate for this point. NO enables alarm message printing based on alarm priorities, PPA state and PMA mode information. This field may be tuned via local PROVUE DDPs.

Suppress Operator Change Message — This field determines whether this point will have operator change messages printed on the printer. Selecting YES will disable operator change message printing and cause "OPMSGS" to be displayed in the status block of the faceplate for this point. NO enables operator change message printing. This field may be tuned via local PROVUE DDPs.

Unit Point — Identifies whether this point should be attached to a unit point for the purpose of monitoring alarms for a batch end log. Only points which are unique to a particular unit point should use this field. Selecting YES allows entering the tag of a unit point. The local PROVUE database for the specified unit point is where this point's alarm data will be stored. Selecting NO disables the ability to store alarm data for batch end logs.

Unit Point v — Identifies the tag of the unit point where this point's alarm data will be stored. The alarm data may be used for printing out batch end logs whenever the specified unit is in use.

PROVUE Extended Alarms Configuration Items

The PROVUE EXTENDED ALARMS form is used to define up to four alarms for a point. These alarms are local to the PROVUE console, and are not related to the internal extended alarms for a UOC, IFC, or MUX.

Alarm No. — This read−only field specifies the number of the alarm being configured.

Alarm Type — Specifies whether the alarm is a high alarm, low alarm, or deviation alarm.

Alarm Word — Identify what you want displayed on the console when the extended alarm is active. Enter as many as 8 characters in this field.

Attr — This configuration item specifies the attribute that will be monitored. The valid attributes are:

- PV − Process Variable
- RA − Ratio Value
- SP − Set Point
- %BI− Percent Bias Value
- %OUTPUT − Percent output Value.

For deviation alarms either SP and PV may be entered, however, the deviation is always calculated as the difference between those two attributes. They may only be compared to each other, not to any other attributes. Not all attributes are valid for all console point types.

Deadband — Alarm deadband may be used to prevent unnecessary alarm re−activation when the measured variable is close to the alarm trip point. The value of the monitored attribute must move away from the trip point towards the set point by more than the deadband before the alarm will be cleared. The valid range is any positive floating point number.

Group No. — Identifies the number of the alarm group that this alarm group will be assigned. Valid range is 1 to 7 for P4.1 and earlier PROVUE consoles, or 0 to 7 for P5.0 and later versions.

Trip / **Dev Limit —** The deviation limit is the amount by which a value must vary from the reference value to trigger a deviation alarm. The valid range is any positive floating point number.

4.7.1.3 Trend Target Data Configuration Items

The TREND TARGET DATA form is used to define items related to targeting a point to a DC6971 Trend Unit. For additional Trend Unit configuration information, refer to *Configuring Type DC6971 Trend Units.*

Current? — This field is set to YES if the device specified by the configuration Device on the same row is in the current target device group. A target device group is made up of all the PROVUEs, controllers, and CHIPs that have the same Reporting Mode, Sample Interval and Dead zone, and within the device type have the same field values (other than DBI or index values). A target device group may consist of up to 32 devices.

Device — The name of the device to which the point is to be targeted. This is a scrolled list of all the devices that the point is being targeted to. This is a read-only field, which was defined on the TARGET DATA form.

Historic Enabled — If the selected point variable is to be historically trended (its values are to be stored on the Trend Unit's diskette), select YES. Otherwise, select NO.

Historic Rate — This field specifies the sample rate at which the reported point variable is accessed by the Trend Unit. The sample rate may be 5, 15, or 30 seconds, or 1, 4, 8, 24, or 72 minutes.

Variable — This field is used to select the point variable that will be trended. Valid entries are PV, SP, VO, BIAS, and RATIO, depending upon the source point type.

Volatile Blocks — If volatile trending has been enabled for the selected point variable, the number of Trend Unit memory blocks to be allocated for that variable must be entered. The valid range is any number between 1 and 255, where 1 block equals 60 sample values.

Volatile Enabled — If the selected point variable is to be trended (its values are to be stored in the Trend Unit's RAM), select YES. Otherwise, select NO.

Volatile Rate — This field specifies the sample rate at which the reported point variable is accessed by the Trend Unit. The sample rate may be 5, 15, or 30 seconds, or 1, 4, 8, 24, or 72 minutes.

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5 Configuration Tips

5.1 Targeting Points

The ENVOX workstation makes target information part of the source point. This allows a point to be targeted to multiple devices without entering the target data multiple times, but will still allow different target parameters for different devices if desired.

This is accomplished through the use of Target Groups. A target group is a list of target devices for a point, PROVUEs, UOCs, CHIPs and Trend Units, which share the same target definition (reporting parameters, etc.). This prevents the need for multiple entry of the same data if the target parameters are the same for more than one device.

For example, consider a point that is targeted to 2 PROVUEs and a CHIP, all with change−of−state reporting, 0.5% dead zone, and 3 a second sample interval. These would all be targeted by creating one target group with those parameters, plus all the other PROVUE-specific parameters such as extended alarms, message suppress, etc. The appropriate information for those three devices (the target group), which are going to share target parameters, is entered on the Target Data device list.

Now assume the same point is to be targeted to three other PROVUEs with exception reporting, 0.125% dead zone, and a 1 second sample interval. The targeting would be accomplished by creating another target group with these parameters, and entering the list of device names.

The target parameters may be different for each device if desired. In a worst-case scenario, where all devices that are to be targeted have different target parameters, a different target group would be created for each target device.

To target a point, select the “Target!” menu option to access the Target Data form. This form has fields for entering most of the target parameters, plus a group field where a list of target devices can be entered. The list of devices actually shows all the devices the point is targeted to, with the devices in the current group being identified by the word YES in the “Current?” field.

To look at a different target group select the “Next!” menu option. This will display a different set of parameters, and a different list of devices will be marked “Current”. To create a new target group, select “New!” and enter the new data.

Notice that not all of the PROVUE target parameters are on the Target Data form(e.g. message suppress, unit point, etc). They are accessed

on a secondary form by a “PROVUE” selection under the “Extra Data” menu option. There are also secondary forms for UOC and Trend Unit specific data that is required. These “Extra Data” menu selections are only available if a device of the relevant type appears in the current group.

Although the group field only displays six devices at a time, the VT220 “Prev Screen” and “Next Screen” keys allow scrolling through the complete target device list. Notice that “Index” (relative DBI) is specified individually for each target device.

5.2 Ratio Control

Ratio control is used in continuous applications for blending two or more ingredients in given proportions. Controller loop points using a station type which includes RSP (remote set point) as a valid mode may use ratio control.

When ratio is enabled on a loop point, it provides a method for an operator to enter a number between 0.1 and 10. To incorporate the operator entered number into the control strategy it is necessary to use FST instructions. Refer to Figure 5-1 for an example of a ratio application.

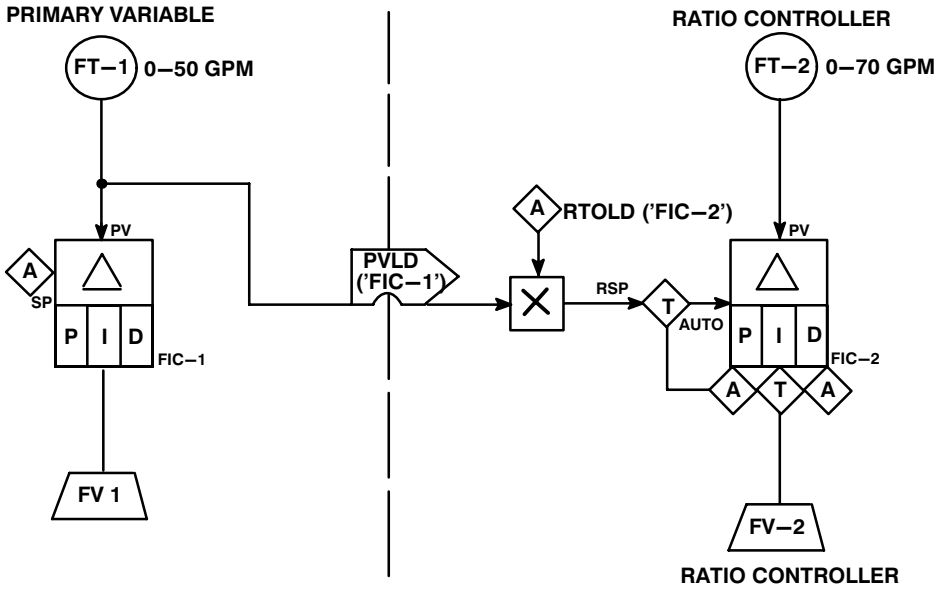

Figure 5-1. Ratio Control

The following FST steps in the ratio controller will read the primary variable, apply the ratio, and store the remote set point in the ratio controller:

```
RTOLD( FIC–2 ),
MUL(PVLD( FIC–1 )),
RSPST,
```

Should it be necessary to limit the range of ratio adjustment of the operator, the LIMIT instruction could be inserted between the RTOLD and MUL steps as follows:

```
RTOLD( FIC–2 ),
LIMIT( HI_R_LMT ,LO_R_LMT ),
MUL(PVLD( FIC–1 )),
RSPST,
```

Finally, should it be necessary for the ratio value to track the actual ratio between the two flows for bumpless transfer to RSP mode, the following instructions could be used:

Without Limits

```
SPLD( FIC–2 ),                [1]
DIV(PVLD( FIC–1 )),
RTOST,                        [2]
RTOLD( FIC–2 ),
MUL(PVLD( FIC–1 )),
RSPST,
```

With Limits

```
SPLD( FIC–2 ),                [1]
DIV(PVLD( FIC–1 )),
LIMIT( HI_R_LMT ,LO_R_LMT ),
RTOST,                        [2]
RTOLD( FIC–2 ),
LIMIT( HI_R_LMT ,LO_R_LMT ),
MUL(PVLD( FIC–1 )),
RSPST,
```

NOTES:

[1] SP TRACKS PV IN MANUAL should be ENABLED to provide proper tracking function.

[2] The RTOST function only writes to the ratio value when the loop is not in RSP mode.

5.3 Register Conservation Techniques

When implementing complex control strategies, occasionally the number of registers available in the controller may be a limiting factor. This section will discuss FST coding techniques to reduce the number of registers required to implement control strategies. The techniques discussed will be the following:

- Loadable Functions
- Scratch Registers

- Split Registers

5.3.1 Loadable Functions

Loadable functions may be used to conserve both FST steps and general registers. Generally, loadable functions may be used as an operand for any instruction which requires the use of a general register. Refer to Table 4-6 on page 4-28 for a list of loadable functions, and section 4.4, beginning on page 4-24, for definition of operands for FST instructions.

Consider an application where it is desired to regulate flow from a pump, as shown in Figure 5-2.

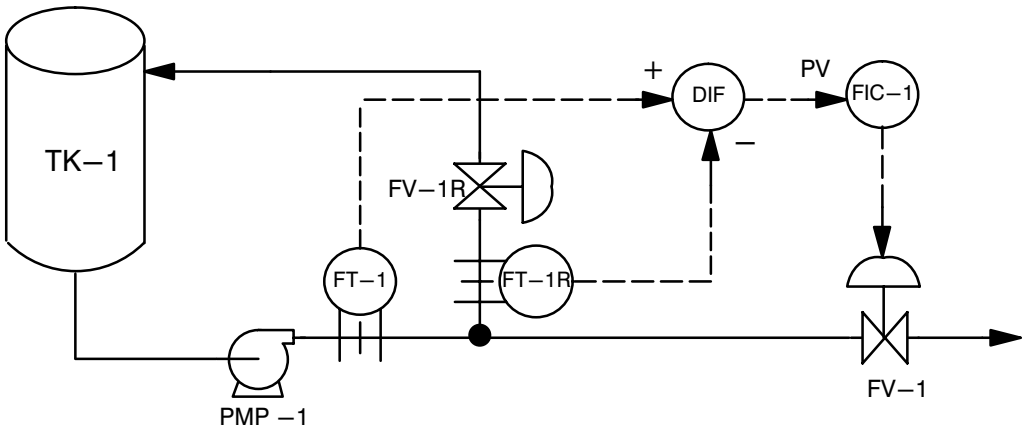

Figure 5-2. Analog Loadable Function

The measured inputs are pump flow FT–1 and recirc flow FT–1R. The process variable for a loop needs to be the difference between two analog inputs. Following are two possible FST code segments which accomplish the flow measurement:

Register Method:

```
AINSQR(2, FT–1R ),          {Load recirc flow in SVA}
RGSTA( FT–1RFLW ),          {Store in register FI–1RFLW}
AINSQR(1, FT–1 ),           {Load pump flow in SVA}
DIF( FT–1RFLW ),            {Determine out flow}
CNTRL,
STAT,
AOUT(1),
```

Loadable Function Method:

```
AINSQR(1, FT–1 ),           {Load pump flow in SVA}
DIF(AINSQR(2, FT–1R )),     {Subtract recirc flow to determine
                             out flow}
```

CNTRL,
STAT,
AOUT(1),

Note:

The loadable function method does not require the general register used with the register method, and also uses two less FST instructions.

Example 2: Discrete Loadable Function
Given the above example, it is desired to close FV−1 when PMP−1 is not running. Discrete input 1 will be set to a logic 1 when the pump is stopped. Following are two possible ways to implement that strategy:

Register Method:

```
DI(1),                                  {Read pump status}
RGST( PMP1STS ),                        {Store in register PMP1STS}
AINSQR(2, FT–1R ),                      {Load recirc flow in SVA}
RGSTA( FT–1RFLW ),                      {Store in register FI–1RFLW}
AINSQR(1, FT–1 ),                       {Load pump flow in SVA}
DIF( FT–1RFLW ),                        {Determine out flow}
TRK(ENABLED, ZERO, PMP1STS),            {Close valve if pump stopped}
CNTRL,
STAT,
AOUT(1),
```

Loadable Function Method:

```
AINSQR( 1, FI–1R ),                     {Load pump flow in SVA}
DIF(AINSQR( 2, FI–1R )),                {Subtract recirc flow to
                                         determine out flow}
TRK(ENABLED, ZERO ,DI(1)),              {Close valve if pump stopped}
CNTRL,
STAT,
AOUT(1),
```

Note:

The general register ZERO is a reference register with 0.00 stored as an initial value in the SVA.

As you can see, the use of loadable functions may greatly reduce requirements for both general registers and FST instructions.

5.3.2 Scratch Registers

Setting aside two to three general registers as “scratch” registers is another method which may be used to conserve the number of registers required to implement a control strategy. A scratch register is a register which may be used multiple times for different purposes during an FSTs execution. Generally the scratch register holds intermediate results for use by subsequent FST instructions. Consider the following examples where it is necessary to implement the boolean logic of DI 1 OR DI 2, and have the inputs tunable for normally open/normally closed contacts:

Example 1:

```
DI ( 1 ),
XOR ( DI1_NOT ),
RGST ( DI1 ),
DI ( 2 ),
XOR ( DI2_NOT ),
OR ( DI1 ),
```

Using this technique it is necessary to use one register to store the status of DI 1.

Example 2:

```
DI ( 1 ),
XOR ( DI1_NOT ),
RGST ( SCRATCH ),
DI ( 2 ),
XOR ( DI2_NOT ),
OR ( SCRATCH ),
```

The second method uses a scratch register. After the OR instruction, the register SCRATCH is available to be re—used for other intermediate results later in the FST.

5.3.3 Split Registers

Every general register in a continuous controller is made up of an analog portion and a discrete portion. Registers are normally named and used for one specific function, many times using only the analog portion or the discrete portion, but not both. It is possible to take advantage of this situation by doubling up on the usage of registers.

Example:

The analog portion of a reference register contains a fuel BTU value for use in calculations within the FST. It is also desired to tune the discrete logic of a discrete input. The analog portion of the register could be used for the BTU value, and the discrete portion of the register could be used for the discrete input logic tuning.

Note

Whenever performing this type of split function operation with registers it is especially important to document the use of each register DDP for operations and maintenance personnel.

5.4 Tunable Discrete I/O Logic

Often, during implementation of control strategies which use discrete I/O, it is necessary to invert the logic the discrete input or output is using to match field equipment. Although it is possible to modify the configuration, changing FST instructions to invert the logic, the inversion may be accomplished via a tuning parameter. Consider the following FST code segments:

```
DI(1),                  {Read Discrete Input}
XOR( DI1_NOT ),         {Tune Discrete Logic}
```

or

```
XOR( DO1_NOT ),         {Tune Discrete Logic}
DO(1),                  {Output logic}
```

As demonstrated in the truth table below, when the register is set to a logic 0, the SVD passes unchanged. If the register is set to a logic 1, the discrete logic is inverted. The register used should be a reference register with initial value enabled, and the discrete portion set to the desired value. The discrete portion of the register should be included in a register DDP list to make the discrete logic tunable.

Register Value	XOR SVD Input	XOR SVD Output	
0	0	0	Logic Normal
0	1	1	
1	0	1	Logic Inverted
1	1	0	

5.5 Zero Dropout on Analog Inputs

Due to the accuracy limitations of certain field devices it is often desirable to force an analog input value to zero when it drops below a certain point. In the case of flow transmitter inputs where square root is used, a small offset in the calibration of the field device may cause a significant flow indication when there is actually zero flow. These offset indications may cause inaccuracies in accumulations, and distraction for the system operators.

In the computing and interactive controllers, this situation is may be remedied by using the following FST code segment:

```
AINSQR(1, FI–1 ),          {Read Input; use proper tag name
                            for E.U. conversion}
LSM( DROPOUT ),            {Detect lower value than trip point}
TFR( ZERO ,ACCUM),         {Switch in Zero if flow below
                            trip point}
```

After these instructions, the SVA will either contain 0.0 if the input is below the trip point, or the actual flow. The register DROPOUT should be configured as a reference register with initial value enabled. The initial analog value of DROPOUT should be set to the desired trip point. The analog portion of register DROPOUT may be included in a register DDP list if it desired to make the trip point tunable. Note that any input failure monitoring FST instructions should be placed between the AINSQR and LSM instructions.

5.6 Loop Mode FST Functions

The loop mode functions perform the operating mode changes and mode status checking for the controller.

There is an interaction between the IF TRUE SET functions and commands from an operator station or the data highway. Commands for mode changes from an operator station or data highway are entered into the proper direct control unit at the end of the FST execution. This ensures that all loops will have the same data base during the FST execution. The IF TRUE SET functions will set the mode of the loop at the time of execution of that function block. For example, if the IFTMAN function has a logic high SVD input, it will immediately change the mode of the currently executing loop. If this function has a logic high input and is placed before the CNTRL function, then that loop is put in the manual mode even if commands sent by the operator station or data highway are to the contrary. This type of setup can lock out changes in the control mode by an operator station or data highway.

An IF TRUE SET function can be used just after a positive edge trigger (PDET) function so that the control mode will not be locked. A rising edge on the logic input to the PDET function will send a pulse to an IF TRUE SET function which sets the mode of the loop. An operator station or data highway command could then change the mode of the loop because the IF TRUE SET function was not locked in the true state, only pulsed to the true state.

5.7 Use Of Filtering In Override Control Applications

Override control is a useful strategy for dealing with a variety of system constraints so as to maximize operating unit efficiency or production, or to ensure the safety of plant equipment and personnel.

Correct application of override control requires filtering of the track value which is used as the integral term for the PID aglorithm in the overridden upstream controller. This is accomplished by configuring the controller to pass the track value through a first order filter. The filter time constant is tuned to a value equal to the reciprocal of the reset action used in the upstream controller, i.e. the filter action is adjusted according to the dynamic characteristics of the controlled loops. The filter prevents the possibility of substantial overshoot or undershoot in the control system's response to a process disturbance.

The exact filtering technique used is dependant upon the dominant time constant of each control loop, and the relative relationship between the two loop time constants. The following sections provide guidelines for implementing the various filtering techniques.

5.7.1 Use Of Filtering In Override Control On Loops With Similar Dynamic Characteristics

Loops which have similar dynamic characteristics should make use of track value filtering as previously described. The filter time constant is tuned to a value equal to the reciprocal of the reset action used in the upstream controller.

For example, consider two loops acting in an override control system, where the loops are tuned as follows:

Gain = 0.3
Reset = 20.0 repeats / minute
Rate = 0.0

The user must filter the tracking value with a first order filter having a time constant of 1/20.0, or 0.05 minutes. The DCPs FST must be configured to provide the filtering action.

5.7.2 Use Of Filtering In Override Control On Loops With Significantly Different Dynamic Characteristics

For loops with significantly different dynamic characteristics, the loop with the “fastest” reset (largest number of repeats per minute) should be used to determine the filter time constant. Aside from this, these loops should make use of track value filtering as previously described. The filter time constant is tuned to a value equal to the reciprocal of the reset action used in the “fastest” upstream controller.

For example, consider two loops acting in an override control system, where the loops are tuned as follows:

Loop 1

Gain = 0.4
Reset = 30.0 repeats / minute
Rate = 0.0

Loop 2

Gain = 0.5
Reset = 4.0 repeats / minute
Rate = 0.0

The user must filter the tracking value with a first order filter having a time constant of 1/30.0, or 0.033 minutes. The DCPs FST must be configured to provide the filtering action.

5.7.3 Use Of Filtering For Override Control On Slow Loops

If override control is used on a process which exhibits very slow dynamic response, the filtering action can affect the controller output tracking when the loops are in Manual mode. The affect can be prevented by disabling the track value filter.

Typically, the filter should be reset to the output of the signal selector loop whenever the signal selector is in the Manual mode. This will force the output values of the upstream controllers to track the value of the signal selector loop whenever the operator is manually adjusting the valve position.

For slow loops with significantly different dynamic characteristics, the loop with the “fastest” reset (largest number of repeats per minute) should still be used to determine the filter time constant. Aside from this, these loops should make use of track value filtering as previously described. The filter time constant is tuned to a value equal to the reciprocal of the reset action used in the “fastest” upstream controller.

The DCPs FST must be configured to provide the filtering action. The following FST instructions illustrate the proper technique for implementing the filtering action.

```
LOOP    ('POINT–1')

 AIN   (1)
 OVRD  (ENABLED, 'TRACK–REG', TIFMAN ('SS–LOOP'),
             SSLD ('SS–LOOP', 2))
 CNTRL
 STAT

END


LOOP    ('POINT–2')

 AIN   (2)
 OVRD  (ENABLED, 'TRACK–REG', TIFMAN ('SS–LOOP'),
             SSLD ('SS–LOOP', 1))
 CNTRL
 STAT

END

LOOP    ('SS–LOOP')

 SGSL  (VOLD ('POINT–1'), ACCUM, ACCUM)
 CNTRL
 STAT
 AOUT  (2)
 LL    (1.0, 0.0, time_constant, TIFMAN ( 'SS–LOOP' ))
 RGST  ('TRACK–REG')

END
```

Where:

time_constant = 1 / reset of the “fast” loop

TRACK−REG = is an intermediate storage register, whose value is fed into the OVRD function block of the upstream controllers

SS−LOOP = the tag of the signal selector point

5.7.4 Operating Characteristics Of Override Control Loops

The override control system may exhibit some or all of the following characteristics:

- If the upstream controllers are in Auto mode, and the signal selector loop is changed from Man to Auto mode, the output may change by a value equal to the largest deviation times gain value of the upstream controllers. Since a signal selector, by definition, routes the selected input value directly to the output while in Auto mode, the output will change as a step function when the mode change occurs.

  For instance, consider two loops which are tuned with a gain of 0.3 and reset of 20.0 repeats/minute. If both loops showed a deviation of −20 percent with a low signal selector, then the mode change could cause a change to the valve output value of −6.0 percent. (An error of −20 multiplied by a gain of 0.3 = −6.0 percent.)

  In addition, the valve output may be observed to change in steps under these conditions, rather than moving smoothly through the corrective range of action required by this process condition. This stepping action in the valve output could continue until the PV for one of the loops approaches SP.

  This characteristic is only observed if both upstream controllers have a deviation in the direction that would normally force the valve action in the signal select direction (e.g., a negative deviation with a low selector, or a positive deviation with a high selector).

- By design, proportional action will not have any affect on the output of the overridden controller; thus, the overridden control loop will not take over control until its PV crosses SP.

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A Loading and Sizing Calculations

To determine whether or not a controller is adequate for a given application (before actually downloading the configuration to it), loading and sizing calculations must be performed.

Processor loading is presented first, with one procedure for a simplex (non−redundant) controller and one for a redundant controller. RAM sizing is discussed next, and is likewise divided into two procedures. Keep in mind that these loading and sizing calculations are only approximations; in a “close fit” situation, contact your Fisher sales office or sales representative for recommendations.

Note:

For controllers in systems with a personal computer or a console serving as the operator interface, the equivalent of sizing calculations is available through on−line diagnostic programs. After the configuration has been downloaded to the controller, the diagnostic program can be used to determine the actual loading of the controller. Refer to the maintenance manual for further information.

A.1 Loading Calculations

The following sections provide instructions for calculating controller loading. Refer to Table A-1 to determine the maximum number of unit loads for each controller type.

Table A-1. Maximum Controller Loading Values

Controller	Units
Simplex Computing:	
4 hertz version	4500
10 hertz version	1500
20 hertz version	600
Redundant Computing	4100
Simplex Interactive (All Models):	
4 hertz version	4150
10 hertz version	1200
20 hertz version	400
Redundant Interactive (All Models)	3900

A.1.1 Simplex Controller Loading

To determine the processor loading for a simplex computing or interactive controller, perform the following steps:

1. Multiply the number of operator stations (refer to the number of operator station ports defined in the Operator Station Definition portion of the device definition) to be connected to the controller by 163 for a computing controller, or by 201 for an interactive controller. Record this figure.

2. Count the number of indirect control points (ICPs) defined in the Analog and Discrete ICP Point sections of configuration. For a computing controller, multiply this number by 101 and record the result. For an interactive controller, multiply this number by 130 and record the result.

3. Count the number of direct control points (DCPs) defined in the DCP Point Definition sections of configuration. For a computing controller, multiply this number by 113 and record the result. For an interactive controller, multiply this number by 188 and record the result.

4. Total the loading values of each FST function defined in the FST section of configuration (refer to Table A-2, beginning on page A-7, for FST function loading values). Record the result.

5. Count the number of functions used in the FST, and record this number.

6. (This step is for communicating systems only. If the controller is not connected to a data concentrator, proceed to step 7.) For a computing controller, write down 234. For an interactive controller, write down 272. This figure represents the base data concentrator communications load.

7. Add the figures recorded in steps 1 through 6. This sum is the total loading value (approximate) for the controller in this application. Compare this figure with the maximum loading value listed in Table A-1 for the controller. If the total loading value exceeds the maximum loading value allowed for the controller, check your calculations for correctness. If the calculations are correct, take one of the following actions:

- If the total loading value is only slightly higher than the maximum (5 to 10 percent), the configuration may still be acceptable. If possible, try it out by performing configuration entry (see the system user manual) and then loading it into a controller of the same type for which the configuration is intended.
- Change the controller configuration to reduce the loading.
- Use a model of controller that has a greater maximum loading value.
- Place part of the configuration for the control strategy into another controller.

A.1.2 Redundant Controller Loading

To determine the processor loading for a redundant computing or interactive controller, perform the following steps:

1. Count the number of general registers defined in the FST Registers form. For a redundant computing controller, multiply this number by 9 and record the result. For a redundant interactive controller, multiply this number by 10 and record the result.

2. Count the number of indirect control points (ICPs) defined in the Analog and Discrete ICP Point sections of configuration. For a redundant computing controller, multiply this number by 101 and record the result. For a redundant interactive controller, multiply this number by 130 and record the result.

3. Count the number of direct control points (DCPs) defined in the DCP Point Definition sections of configuration. For a redundant computing controller, multiply this number by 139 and record the result. For a redundant interactive controller, multiply this number by 199 and record the result.

4. Count the number of occurrences of the following FST functions defined in the FST section of configuration: BDET, CTR, DT, FFR, FFS, FIL, GCI, HLV, INT, LL, PDET, TM, and VLIM. Multiply the total number of occurrences by 12 and record the result.

5. Total the loading values of each FST function defined in the FST section of configuration (refer to Table A-2, beginning on page A-7, for FST function loading values). Record the result.

6. Count the number of functions used in the FST, and record this number.

7. For a redundant computing controller, write down 246. For a redundant interactive controller, write down 314. This figure represents the base data concentrator communications load.

8. Total the figures recorded in Steps 1 through 7. This sum is the total loading value (approximate) for the controller in this application. Compare this figure with the maximum loading value listed in Table A-1 for the controller. If the total loading value exceeds the maximum loading value allowed for the controller, check your calculations for correctness. If the calculations are correct, take one of the following actions:

- If the total loading value is only a little higher than the maximum (5 to 10 percent), the configuration may still be acceptable. If possible, try it out by performing configuration entry (see the system user manual) and then downloading it into a controller of the same type for which the configuration is intended.
- Change the controller configuration to reduce the loading, such as by deleting any general registers or ICPs that are not needed.
- Use a model of controller that has a greater maximum loading value.
- Place part of the configuration for the control strategy into another controller.

A.2 Sizing Calculations

A.2.1 Simplex Controller Sizing

To determine the RAM sizing for a simplex computing or interactive controller, perform the following steps:

1. Write down 150. This figure represents the typical overhead value required for each controller.

2. Count the number of general registers defined in the FST Registers form. Multiply this number by 13 and record the result.

3. Count the number of auxiliary engineering unit pairs (AEUPs) defined in the AUX EU Definition form. Multiply this number by 15 and record the result.

4. Count the number of ICPs defined in the Analog and Discrete ICP Point sections of configuration. Multiply this number by 24 and record the result.

5. Count the number of DCPs defined in the DCP Point Definition sections of configuration. Multiply this number by 237 and record the result.

6. Multiply the number of FST steps defined in the FST section of configuration by 4.4. Record the result.

7. Add the figures recorded in Steps 1 through 6 to obtain the approximate RAM usage. If the total does not exceed 1328 for a computing controller, or 6848 for an interactive controller, the controller is adequately sized. If the total exceeds these values, check your calculations for correctness. If the calculations are correct, take one or more of the following actions:

- If the total is only a little higher than the maximum (about 5 percent), the configuration may still be acceptable. If possible, try it out by performing configuration entry (see the system user manual) and then downloading it into a controller of the same type for which the configuration is intended.
- Delete any general register cross references and operating data cross references that are not needed (subtract 2 from the total for each cross reference that you delete).
- Delete any general registers (subtract 5 for each one deleted), general register initial values (subtract 6 each), AEUPs, or ICPs that are not used or required.
- Reduce the number of steps in the FST or the number of any other configuration items.
- If a computing controller is being sized, use a 2—wide interactive controller instead.
- If an interactive controller is being sized, place part of the control strategy into a computing controller, or into another interactive controller.

A.2.2 Redundant Controller Sizing

To determine the RAM sizing for a redundant computing or interactive controller package, perform the following steps:

1. Write down 170. This figure represents the typical overhead value required for each controller.

2. Count the number of general registers defined in the FST Registers form. Multiply this number by 18 and record the result.

3. Count the number of auxiliary engineering unit pairs (AEUPs) defined in the AUX EU Definition form. Multiply this number by 15 and record the result.

4. Count the number of ICPs defined in the Analog and Discrete ICP Point sections of configuration. Multiply this number by 28 and record the result.

5. Count the number of DCPs defined in the DCP Point Definition sections of configuration. Multiply this number by 255 and record the result.

6. Multiply the number of FST steps defined in the FST section of configuration by 6.6. Record the result.

7. Add the figures recorded in steps 1 through 6 to obtain the approximate RAM usage. If the total does not exceed 1328 for a computing controller, or 6848 for an interactive controller, the controller is adequately sized. If the total exceeds these values, check your calculations for correctness. If the calculations are correct, take one or more of the following actions:

- If the total is only a little higher than the maximum (about 5 percent), the configuration may still be acceptable. If possible, try it out by performing configuration entry (see the system user manual) and then downloading it into a controller of the same type for which the configuration is intended.
- Delete any general register cross references and operating data cross references that are not needed (subtract 2 from the total for each cross reference that you delete).
- Delete any general registers (subtract 5 for each one deleted), general register initial values (subtract 6 each), AEUPs, or ICPs that are not used or required.
- Reduce the number of steps in the FST or the number of any other configuration items.
- If a computing controller is being sized, use a 2—wide interactive controller instead.
- If an interactive controller is being sized, place part of the control strategy into a computing controller, or into another interactive controller.

Table A-2. Loading Values for FST Instructions

Function Mnemonic	Interactive Controller Loading Values (units)	Computing Controller Loading Values (units)
AAGM	27	153
ABS	2	2
ADSVT	4	5
AIN	15	25
AINEU	24	55
AINSQR	39	128
AINTCE	53	113
AINTCJ	51	114
AINTCK	52	115
AINTCT	53	112
ALMLD	4	5
ALMST	3	4
AND	3	4
AOUT	19	25
B	4	20
BDET	2	3
CASC	6	9
CHS	2	6
CNTRL(1)		
P/PD	51	149
PID/PI/I	61	199
Notch Gain PID/PI	61	199
Control Sequence	31	112
Control Sequence with Bias	31	112
Adaptive Gain PID/PI	74	411
Error−Squared PID/PI	77	231
Manual Loader	29	110
Bias and Gain	45	144
Signal Selector	28	113
CTR	32	51
DAGM	7	7
DASVT	5	8
DI	5	6
DIF	8	21
DIV	8	57
DO	6	7
DT	30	107
DTC	48	179
END	5	5
EUP	13	74
EXP	58	N.A.
FDFW	59	169
FDFWM	31	101
FDFWS	30	65
FFR	4	19
FFS	4	19
FIL	24	99
GCI	13	46

Function Mnemonic	Interactive Controller Loading Values (units)	Computing Controller Loading Values (units)
GOTO	3	3
HLV	8	11
HS	23	37
HSM	19	34
ICPLDA	16	55
ICPLDD	4	5
ICPSTA	21	91
ICPSTD	4	6
IFF	6	6
IFT	6	6
IFTAUT	5	5
IFTDDC	5	5
IFTMAN	5	5
IFTOSP	6	5
IFTOSS	6	6
IFTRSP	5	5
IFTSUP	5	5
INT	38	53
K	4	19
LIMIT	38	55
LL	53	172
LN	58	N.A.
LOG	59	N.A.
LOOP	4	4
LS	19	37
LSM	19	36
MASFLW	70	249
MDSEL	71	106
MUL	7	20
NOP	1	1
NOT	1	1
OR	3	4
OVRD	15	29
%CNTRL(1)		
P/PD	43	75
PID/PI/I	53	124
Notch Gain PID/PI	54	136
Control Sequence	24	47
Control Sequence with Bias	24	47
Adaptive Gain PID/PI	66	344
Error−Squared PID/PI	70	166
Manual Loader	22	40
Bias and Gain	37	74
Signal Selector	19	45
PDET	2	3
PEU	12	37
PFR	1	1
POLY	33	98
%RSPST	12	23

Function Mnemonic	Interactive Controller Loading Values (units)	Computing Controller Loading Values (units)
PVLD	18	55
PWR	213	N.A.
RGLD	7	10
RGLDA	7	9
RGLDD	3	4
RGST	5	6
RSPST	19	91
RTOLD	14	24
RTOST	14	23
SGSL		
Four Inputs Enabled	61	321
Three Inputs Enabled	44	236
Two Inputs Enabled	27	154
One Input Enabled	10	69
SPLD	18	55
SQRT	11	66
SSLD	4	4
STAT	18	35
SUM	7	21
TFR	12	16
TIFAUT	4	4
TIFDCC	4	4
TIFMAN	4	4
TIFRSP	4	4
TIFSUP	4	4
TM	19	40
TRK	12	105
VLIM	33	58
VOLD	9	26
XOR	3	4

(1) Loading value depends on the Primary Control Algorithm (PCA) defined on the DCP Point form.

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Glossary

A

Absolute Alarm An alarm which is triggered when the signal that is being monitored reaches an absolute level, as opposed to a level which is relative to another value. High Alarms and Low Alarms are types of absolute alarms. [See Deviation Alarm.]

Accumulator A register or other memory location that temporarily holds the result of a calculation or logic operation.

ACIA Acronym: Asynchronous Communications Interface Adapter

A/D Acronym: Analog-to-Digital, or Analog to Digital Converter

Adaptive Control
A control technique that involves automatic change of control parameter values to improve the performance of the control system.

Adaptive Gain A type of primary control algorithm which allows the proportional gain to change based on the value of an analog signal, a discrete signal, the process variable, the implied value position, or the process error.

Address One or more integers arranged to identify the location of a device or logical unit of an instrumentation system. In PROVOX systems, address values identify such things as data highway, device, file, card, and channel.

AEUP Acronym: Auxiliary Engineering Unit Pair

AFP Acronym: Auxiliary Function Parameter

AI Acronym: Analog Input

Alarm Deadband
The amount by which the PV must return within normal limits for the system to clear an alarm. (For example, if the system activates an alarm as soon as the PV exceeds 100 percent, and the deadband is 5 percent, the system will not clear the alarm until the PV drops to 95 percent.)

Alarm Trip Point
The user-defined value, near either end of a measured variable range, at which the system activates an alarm. Such activation occurs as the measured variable moves out of range (for example, going below the trip point for a low alarm).

Algorithm A set of logical steps to solve a problem or accomplish a task. A computer program contains one or more algorithms. Many configurations of PROVOX systems also contain algorithms, particularly in operations, procedures, and function sequence tables.

Alphanumeric Consisting of letters or numbers.

Analog Infinitely variable over a given range. A process control system senses a physical variable such as voltage, current, or resistance as an analog value.

Analog Input (AI)
A PROVOX point type. An analog input point receives a single analog value, the process variable.

Analog Output (AO)
A PROVOX point type. An analog output point generates a single analog value, the set point.

Analog to Digital Converter (A/D or ADC)
An integrated circuit device that converts analog signals into a digital form. This enables a digital computer to operate on such signals.

Anti-Reset Windup
An additional gain factor, equal to 16 times the integral (reset), applied to controllers to help them recover faster from output saturation, or windup.

AO Acronym: Analog Output

Architecture The arrangement and interconnection of the various parts of a microprocessor or computer system.

Array A computer or microprocessor variable for the storage of many values of the same type, with indices that permit access to values individually or in certain groups. Common arrays are one-dimensional (a simple row), two-dimensional (an arrangement of rows and columns), and three-dimensional (an arrangement of rows or columns along the x, y, and z axes). Some computer languages allow arrays that have more than three dimensions.

ARW Acronym: Anti-Reset Windup

ASCII A standard digital encoding scheme for data: a 7-bit binary code represents numbers, letters, symbols, and control codes. (The designation is an acronym for American Standard Code for Information Interchange.) Also, a PROVOX point type. An ASCII point contains a single real value, referenced by the set point attribute, and an 80-character ASCII string.

Asynchronous Communications Interface Adaptor (ACIA)
A circuit component that interfaces between the MPU data bus and external devices that have a serial data format. The MPU or another microprocessor controls the ACIA.

Attribute An individual parameter of a process control point. Also the name of a PROVOX data type.

AUTO Abbreviation: Automatic Mode

Automatic Mode (AUTO)
A loop control mode: the control algorithm changes the control output to minimize the difference between the values of the set point and the process variable.

AUX EU Acronym: Auxiliary Engineering Units

Auxiliary Engineering Unit Pair (AEUP)
Two values used to define the upper and lower limits of an auxiliary engineering unit range.

Auxiliary Engineering Units (AUX EU)
The name (tag) of a set of engineering units which may be used by FST functions. Auxiliary engineering units are used when none of the standard DCP engineering units apply to the value being manipulated.

Auxiliary Function Parameter (AFP)
A special tuning parameter for certain FST functions. An AFP appears on the detail display as a detail display parameter (DDP) for a direct control point (DCP).

B

B&G Acronym: Bias and Gain

Baby N Connector (BNC)
A type of connector for coaxial cable; used for data highways of PROVOX systems.

Basic Data Acquisition System (BDAS)
The portion of a PROVOX console that requests and collects data from the various other devices in the system. (See also EDAS.)

Batch A specific quantity of a given product, produced in a single complete processing procedure.

Baud The unit of measurement of serial transmission speed for digital data. Baud usually means bits per second, but may have a different meaning if the encoding method used is frequency multiplexing.

BCD Acronym: Binary-Coded Decimal

BDAS Acronym: Basic Data Acquisition System

Bias A value added to a controller input or output, as part of a control strategy. For example, bias can determine the nominal setting of a control valve for a steady-state process.

Bias and Gain A primary control algorithm which calculates its output by adding a bias value to the process variable and then multiplying the result by a gain value.

Binary Involving two characteristics, conditions, or possibilities. For example, base-two numbers (numbers that use only the digits 0 and 1) are binary numbers.

Binary Coded Decimal (BCD)
A digital encoding system for decimal numbers: a set of four binary digits represents each decimal digit, 0 through 9.

Bit (Binary Digit) A single place in a binary number. The only possible values for a bit are 0 and 1.

BNC Acronym: Baby N Connector

Boot or Boot Up
To start the operating-system software of a computer, so that the computer is ready for application software.

Breakpoint A trace utility mode, in which accumulator values appear on the VDU as the trace point FST steps execute. In breakpoint mode, FST execution stops at each trace point.

Buffer A storage device that compensates for different rates of data flow, or time occurrences of events, when transmitting data from one device to another. Alternatively, an isolating circuit that prevents a driven circuit from influencing the driving circuit.

Bus A general term for a group of signal lines to be considered together, as in a data bus or address bus. The data highway of a PROVOX system is such a bus.

Byte A unit of binary digits (bits). Usually a byte consists of eight bits.

C

CASC Abbreviation: Cascade Control

Cascade Control
A control technique that uses the output of one control loop (in AUTO or MAN mode) as the set point for another control loop (in RSP mode).

Central Processing Unit (CPU)
The portion of a computer that manipulates and modifies data, carrying out the instructions of the computer program.

CHIP Acronym: Computer/Highway Interface Package

CIA Acronym: Communications Interface Assembly

CMOS Acronym: Complimentary Metal Oxide Semiconductor

CO Acronym: Current Output

Communications Interface Assembly (CIA)
A printed circuit card that links files of PROVOX devices and the data highway. The CIA provides the timing and data conversion necessary for communications.

Complimentary Metal Oxide Semiconductor (CMOS)
A family of digital integrated circuits that use transistors operating in a push-pull mode to carry out logic functions. A CMOS usually is capable of low-powered operation.

Computer/Highway Interface Package (CHIP)
A PROVOX software product that allows user-written programs to interact with the PROVOX database. There are different CHIP versions, so that any of several types of computers can be the host computer.

CONFIG Abbreviation: Configuration

Configuration (CONFIG)
Giving instructions and supplying reference information to the controllers and other devices that make up a process control instrumentation system. For some PROVOX systems, configuration consists of responding to prompts in a series of screen displays. For other PROVOX systems, configuration consists of creating and manipulating special ASCII text files.

Configuration Source File
A special ASCII text file that certain PROVOX systems use for configuration. Such a source file contains instructions and reference information for the controllers and other devices of the system.

Controller A device that operates automatically to regulate a controlled variable.

Control Loop An arrangement of mechanical and electronic components for process control. A product flows through one or more mechanical components of the loop. The electronic components of the loop continuously measure one or more aspects of the product flow, then alter those aspects as necessary to achieve a desired process condition. A simple control loop measures only one variable. More sophisticated control loops measure many variables and maintain specified relationships between those variables.

Control Algorithm
A mathematical representation of a control action to be performed.

Control Sequence
A type of primary control algorithm which provides basic functions such as alarming, data communication, tracking, and error signal calculation, but does not provide any form of PID control action. This allows the user to create a customized control algorithm transfer function using FST instructions.

CPU Acronym: Central Processing Unit.

CRC Acronym: Cyclic Redundancy Check

CRT Acronym: Cathode Ray Tube.

Current to Pressure Transducer (I/P)
An electronic component or device that converts a milliamp DC signal to a proportional pneumatic pressure output signal.

Cyclic Redundancy Check (CRC)
A method of error detection in data transmission and data storage. The check evaluates both the number of ones and zeroes in a block (parity) and the position of the values in the block.

D

D Abbreviation: Derivative Control Action (Rate)

D/A Acronym: Digital to Analog, or Digital to Analog Converter

DAC Acronym: Digital to Analog Converter

Damping How an output settles to a steady state after a change in the measured signal. When the response to an output change is as fast as possible without overshoot, the response is critically damped. If the response is slower than critical it is overdamped, and if an overshoot occurs the response is underdamped.

Data A general term that denotes any information an MPU can process.

Database A collection of data stored in a systematic way so that searches and sorts are rapid and retrieval of items is simple.

Database Index (DBI)
A sequential integer by which a computer or other electronic device finds or keeps track of storage locations in a database. In PROVOX controllers, a unique database index is assigned to each point for identification.

Data Concentrator
A highway device that collects and consolidates information for configurable, computing, and interactive controllers, interfacing the controllers to the data highway; also known as data concentrator unit (DCU).

DBI Acronym: Database Index

DBND Abbreviation: Deadband

DC Acronym: Direct Current, also Data Concentrator

DCD Acronym: Discrete Control Device

DCP Acronym: Direct Control Point

DCU Acronym: Data Concentrator Unit (same as Data Concentrator)

DDC Acronym: Direct Digital Control

DDP Acronym: Detail Display Parameter

Deadband [See Alarm Deadband]

Derivative Control Action (D)
Control action in which the change in the output value is proportional to the rate of change of the input. Rate action is another name for derivative control action.

Detail Display A type of pre-formatted console display that shows the values of operating data and certain other parameters of a specified point.

Detail Display Parameter (DDP)
An item of information usually considered changeable or tunable for a point. Common examples are gain, rate, reset, and alarm trip points.

Deviation Usually, the difference between set point and process variable. More generally, any departure from a desired or expected value or pattern.

Deviation Alarm
An alarm that signals a specified amount of difference exists between two monitored values; usually the process variable and the set point.

DI Acronym: Discrete Input

Diagnostics One or more programs in a computer or microprocessor that can detect and pinpoint a configuration error or a hardware fault. Also, the utility or functionality such programs add to a product.

Digital to Analog Converter (DAC or D/A)
A component or device that converts digital data or a digital signal into an analog voltage of corresponding value.

DIO Acronym: Discrete Input/Output

Direct Acting Control action in which the absolute value of the output signal increases as the absolute value of the input signal (process variable) increases.

Direct Control Point (DCP)
The collection of set point, process variable, and valve position values along with tuning parameters for a control loop.

Direct Digital Control Mode (DDC)
A loop control mode: a process-control computer or a computer program, a unit point, or a logic control point directly sets the output of a point.

Discrete Having either of two states, for example, on or off, or 1 or 0.

Discrete Control Device (DCD)
A PROVOX point type. A DCD point combines as many as 8 discrete output and 16 discrete input channels into a single point.

Discrete Input (DI)
A PROVOX point type. A DI point monitors a single discrete value, which is referred to as the process variable.

Discrete Input/Output (DIO)
The reception and transmission of discrete signals. In PROVOX systems, DIO usually refers to a discrete input/output card.

Discrete Monitor (DM)
A PROVOX point type. A DM point reads 16 discrete input channel values, then consolidates these values into either a 16-bit binary value or a 4-bit binary-coded decimal value.

Discrete Output (DO)
A PROVOX point type. A DO point generates a single discrete value, referred to as the set point.

DO Acronym: Discrete Output

Download To transfer configuration information from a configuration device to other devices of a process control system.

E

EAROM Acronym: Electrically Alterable Read-Only Memory

EDAS Acronym: Extended Data Acquisition System

Electrically Alterable Read-Only Memory (EAROM)
A type of semiconductor memory device, electrically erasable and reprogrammable, that is used primarily for read-only information.

Electromagnetic Interference (EMI)
The general category of electrical noise induced by radio frequency and magnetic, electrostatic, or capacitive coupling.

Electrostatic Damage (ESD)
Deterioration of integrated circuits due to high levels of static electricity. Symptoms of ESD include degradation of performance, device malfunction, and complete failure.

EMI Acronym: Electromagnetic Interference

Engineering Units (EU)
The units of measurement for an analog process variable. Possible examples are gallons per hour, degrees Celsius, and pounds per square inch. The low (0 percent) and high (100 percent) engineering unit limits define the anticipated range of the variable. For example, low and high engineering-unit values of 50 and 1550 might define a range for degrees Fahrenheit. In this example, the span would be 1500 degrees; each percent would equal 15 degrees.

Engineering Units Descriptor
The name of the units an engineering units value represents. Possible examples include MTRS for *meters*, LB/SQIN for *pounds per square inch*, and DEGSCEL for *degrees Celsius*.

Engineering Units High Value (EUHV)
A floating-point number that represents the upper limit of the input range of an analog input value.

Engineering Units Low Value (EULV)
A floating-point number that represents the lowest limit of the input range of an analog input signal.

Enhanced Pulse Count Input (EPCI)
A PROVOX point type. An EPCI point reads a series of electronic pulses or switch closures as an unsigned, 16-bit integer value, then calculates accumulation and rate values.

EPCI Acronym: Enhanced Pulse Count Input

EPROM Acronym: Erasable Programmable Read-Only Memory

Erasable Programmable Read-Only Memory (EPROM)
A semiconductor memory device that is programmable electrically, but erasable only by exposure to high-intensity ultraviolet light. Another name for ultraviolet read-only memory.

ERR Abbreviation: Error

Error Signal In a closed loop, the difference between the actual value of a particular signal and its desired value.

Error-Squared PI_PID
A type of primary control algorithm which is similar to a normal PI_PID algorithm, but acts on the square of the error signal instead of the normal error signal value.

ESD Acronym: Electrostatic Damage

EU Acronym: Engineering Units

EUHV Acronym: Engineering Units High Value

EULV Acronym: Engineering Units Low Value

Exception A type of unsolicited reporting: the reporting device sends a new value only if the sample period has expired and the value has changed by more than a specified amount since the last transmission.

EXT Abbreviation: External. In PROVOX systems, EXT usually refers to an External Interface card.

Extended Data Acquisition System (EDAS)
Additions to the basic console and unit controller functions that permit pressure/temperature compensation, alarm generation, accumulations, and rate-of-change calculations.

Extended Functions
Optional capability that can be enabled for certain point types, increasing the number of functions the point can perform. Common extended functions are pressure/temperature compensation, signal characterization, and extended alarms.

F

Faceplate An established display figure that shows the most important information about a process control point. Faceplates are vertical rectangles, several of which fit on a console screen at once.

FDFWD Acronym: Feedforward

Feedforward (FF or FDFWD)
A type of control action that takes into account signal other than the process variable, in order to anticipate and minimize deviations of the process variable.

FF Acronym: Feedforward

FIL Abbreviation: Filter

Filter Time Constant (FTIM)
The length of time required for 63.21 percent of a step change at the input of a filter to appear at the output.

Firmware Computer or microprocessor programming stored on a chip, in such a way that users cannot change the programming.

Floating Point Pertaining to decimal value presentation in which the position of the decimal point does not remain fixed with respect to one end of the digits.

FST Acronym: Function Sequence Table

FTIM Acronym: Filter Time Constant

Function Sequence Table (FST)
A list of controller instructions arranged to perform logical and mathematical operations in a specific order. An FST resembles a sequence of programming subroutines, but defining an FST does not involve actual computer programming.

G

Gain The change in the output of a controller divided by the change in the input to the controller. The amount of gain determines how much the controller output changes in response to process deviations.

Group A PROVOX point type. A group point controls as many as 8 DCD points allowing them to work in unison.

Group Display A set of 12 point faceplates that appear together on a PROVOX console screen, so that an operator can see at a glance the most important information about 12 different points. During system configuration the user establishes the number of group displays, as well as which point faceplates make up each group display.

Group Template

A matrix of set point values defined for a group point. For each group set point, the group template specifies a unique combination of set points for the individual DCDs which are subordinate to the group point.

H

Hard Manual Mode (HMAN)

A special control mode associated with controller backup. In Fisher systems with Redundant Manual Units, if a controller fails, the operator can retain manual mode control of the loop output.

High-Low Signal Selector

A type of primary control algorithm (PCA) which monitors up to four input signals, and is configured to select either the highest or lowest value. The selected input signal is then routed directly to the PCA's output.

I

I Abbreviation: Integral (Reset)

IAC Acronym: 1. (adjective): interactive. 2. (noun) Interactive Controller

ICP Acronym: Indirect Control Point

IFC Acronym: Integrated Function Controller

Implied Valve Position (IVP)

The output of a primary control algorithm (PCA). Usually, the IVP determines how much to open a valve actuator, which moves to the appropriate position.

Indirect Control Point (ICP)

A point which is made up of a set of analog or discrete values that may be displayed at a console, but is not used to directly control a process.

Input/Output (IO or I/O)

Signal reception and transmission, or signal interfacing. Input, for a process control device, involves accepting and processing signals from field devices. Output, for a process control device, involves converting commands into electrical signals to field devices.

Integer Any positive or negative natural number, or zero. Also, a PROVOX point type. An integer point reads a series of electronic pulses or switch closures, receives a 16-bit unsigned integer input value, or generates a 16-bit integer output value. The preferred name for integer point is pulse count input (PCI) point.

Integral (Reset) Control Action
Control action in which the output value is proportional to the time integral of the input, i.e., the rate of change of the output is proportional to the input signal. Reset action is another name for integral control action.

Integrated Function Controller (IFC)
An advanced function controller of the UOC family, that provides multiloop continuous control capability with interlocking and sequencing through the use of FSTs and LCPs.

Interactive Controller (IAC)
A regulatory controller that handles from one to eight control loops.

IO or I/O Acronym: Input/Output

I/P Symbol: Current to Pressure Transducer

IVP Acronym: Implied Valve Position

K

K Symbol: Gain

Keyword A word used in a unit operation expression in place of a numeric value. Also, in ASCII configuration source files, a word or expression that begins a phrase. A few particular keywords constitute their own phrases, that is, have no operands. Most keywords, however, need operands to complete their phrases.

L

LCP Acronym: Logic Control Point

Local Traffic Director (LTD)
A communications device that controls the data flow on a local data highway. As many as 30 devices can be on the local highway. An LTD also stores and forwards messages to other local areas.

Log A summary of process operation data, especially a list of significant events and the times at which they occurred.

Logic Control Point (LCP)
A PROVOX point type. An LCP executes a programmed subroutine referred to as a Function Sequence Table FST.

Loop Control loop. Also, a PROVOX point type. A loop point provides control for a continuous process.

LTD Acronym: Local Traffic Director

M

Machine Code Instructions that consists exclusively of binary digits, which a microprocessor or computer can understand directly.

MAN Abbreviation: Manual Mode

Manual Loader A type of primary control algorithm which does not perform any changes to its output signal unless called upon to do so by an operator.

Manual Mode (MAN)
A loop control mode: the operator directly sets the output of a control loop.

Measured Variable (MV)
A physical quality or quantity which is monitored as part of a control strategy. Common measured variables are temperature, level, and rate of flow. The term *process variable* is a synonym.

Microprocessor A complex integrated circuit that can be programmed to perform different tasks.

Microprocessor Unit (MPU)
A general-purpose integrated circuit that performs the functions of the central processing unit (CPU) of a computer.

Monitor Register
A type of register used in an FST or a calculation. A monitor register can be written into or read by the device containing the register, but other PROVOX system devices can only read its value.

Monitor-Reference Register
A type of register used in an FST or a calculation. A monitor-reference register can be written into or read by both the device containing the register and other PROVOX system devices.

MPU Acronym: Microprocessor Unit

Multifunction Key

A keyboard key whose function changes according to the portion of software executing at the moment. Commonly, the screen display indicates the current functions of multifunction keys. Other terms for multifunction key are *softkey* and *function key*.

Multiplexer (MUX)

A PROVOX highway device that transfers information between the data highway and field devices (both analog and discrete).

MUX Abbreviation: Multiplexer

MV Acronym: Measured Variable

N

ND Acronym: Network Device

Network Device (ND)

A PROVOX device that communicates directly with a network traffic director. An ND can be any device, but usually is one that collects information from several local highways. Local traffic directors, consoles, and trend units are common network devices.

Network Traffic Director (NTD)

A PROVOX device that controls the data flow for the network data highway. The NTD links network devices and local data highways via the local traffic directors.

Non-Volatile Memory (NVM)

A type of semiconductor memory that retains its contents even though power is disconnected.

Notch Gain PI_PID

A type of primary control algorithm (PCA) which is similar to a normal PI_PID algorithm, but allows the proportional gain to be changed while the process variable is in a certain region of its span (the notch).

NTD Acronym: Network Traffic Director

NVM Acronym: Non-Volatile Memory

O

OAR Acronym: Operator Action Request

Octal Involving eight characteristics, conditions, or possibilities. For example, octal numbers have the base (radix) 8.

Operand A value that modifies or qualifies a function.

Operating Parameter
A parameter that appears in a point faceplate. Examples include process variable, set point, valve output (percent IVP), mode, and alarms.

Operating System
The software that controls and supervises all the internal operations of a computer.

Operation [See Unit Operation.]

Operator Action Request (OAR)
A notice of operator action required before a unit operation can continue.

Operator Station
A local control station that can be connected to controllers. An operator station displays some of the same information that appears in a detail display, and gives basic control over a DCP.

Overwrite To write data to a memory location that already contains information, replacing the existing information with new information.

P

P Abbreviation: Proportional Control Action (Gain)

Packet A block of data, or message, handled by a communications network in a well-defined format.

Parallel Simultaneous: said of data transmission on two or more channels at the same time.

Parallel Discrete Output (PDO)
A PROVOX point type. A PDO point generates values for 16 discrete output channels, in the form of a binary value (0-65535) or binary-coded decimal value (0-9999).

PB Acronym: Proportional Band

PCA Acronym: Primary Control Algorithm

PCI Acronym: Pulse Count Input

PCIU Acronym: Programmable Controller Interface Unit

PD Acronym: Proportional Derivative

PDO Acronym: Parallel Discrete Output

Periodic A type of unsolicited data reporting: the sending device transmits data at a fixed rate, whether or not that data has changed since the last transmission.

Peripheral Interface Adapter (PIA)
An integrated circuit device that provides a number of parallel discrete input and output signals that can be controlled by the address and data signals of an MPU.

PFR Acronym: Power Fail Restart

Phase In batch control, several related elemental control steps grouped together for the purpose of batch tracking or operator intervention at the unit operations control level. A set of phases makes up a unit operation.

PI Acronym: Proportional/Integral Control Action or Process Instrumentation

PIA Acronym: Peripheral Interface Adapter

PID Acronym: Proportional/Integral/Derivative Control Action

PI_PID_I Acronym: Proportional/Integral—Proportional/Integral/Derivative—Integral-only Control Action

PIO Acronym: Process Input/Output

PLC Acronym: Programmable Logic Controller

Point A set of process-control data and services. The makeup and structure of each point depends on its role in collecting and reporting data and the type of device in which the point resides. Points are the most important logical units of a process control system; the number of points is one measure of a system's size and sophistication.

Port A communications terminal of a controller card file. Each port is dedicated to the reporting of one controller. Consequently, port numbers identify particular controllers.

P_PD Acronym: Proportional—Proportional/Derivative Control Action

Primary Control Algorithm (PCA)
The principal control equation of a continuous control loop in a PROVOX controller. The PCA type and station (STA) type, defined during configuration, determine the main functionality of a control loop point.

Process Input/Output (PIO)
The name of an interactive controller card that accepts analog input signals, performs A/D and D/A conversions, and generates analog output signals.

Process Variable (PV)
A physical quality or quantity which is monitored as part of a control strategy. Common measured variables are temperature, level, and rate of flow. The term *measured variable* is a synonym.

Programmable Controller Interface Unit (PCIU)
A PROVOX highway device that permits programmable controllers to receive and respond to commands from other PROVOX devices such as consoles, trend units, and UOCs, via the data highway.

Programmable Read-Only Memory (PROM)
A chip which is programmable only by means of a special device; once programmed in this way, it effectively becomes a ROM.

PROM Acronym: Programmable Read-Only Memory

Proportional Band
The change in a controller input required to produce a full-range change in output, due to proportional control action. The proportional band is reciprocally related to the proportional gain, and may be expressed as a percent of input span or in input units.

Proportional Control Action (P)
A control method in which there is a continuous linear relationship between output and input. The proportional amount is known as gain.

Proportional/Derivative Control Action (PD)
Control action in which the output is proportional to a combination of the linear relationship between output and input and the time rate of change of the input.

Proportional/Integral Control Action (PI)
Control action in which the output is proportional to a combination of the linear relationship between output and input and the time integral of the input.

Proportional/Integral/Derivative Control Action (PID)
Control action in which the output is proportional to a combination of the linear relationship between output and input, the time integral of the input, and the time rate of change of the input.

PROVOX Trademark for Fisher Controls' product line of advanced process control equipment: distributed microprocessor-based control and data acquisition devices that communicate with operator consoles over a data highway.

PROVUE Trademark for Fisher Controls' line of console products that use a global database configuration and have high-resolution graphics, ergonomically designed keyboards, and color printers.

Pseudo Function Sequence Table (PFST)
The established set of function blocks within a configurable controller or a UOC/IFC Loop point. Each of these function blocks, within the fixed sequence, can be enabled or disabled to yield a variety of control effects.

Pulse Count Input (PCI)
A PROVOX point type. A PCI point either reads a series of electronic pulses or switch closures or receives a 16-bit unsigned integer in the range 0-65535. An alternate name for PCI point is integer point.

PV Acronym: Process Variable

R

RAM Acronym: Random-Access Memory

Random-Access Memory (RAM)
A type of semiconductor memory. A user can read from and write to a RAM as often as desired.

Rate Another name for derivative control action.

Ratio An operator-changeable proportion that a controller maintains between the values of two variables, as part of a control strategy.

Read-Only Memory (ROM)
A semiconductor memory device in which information is stored permanently. A user can examine ROM contents as often as desired but cannot change the contents.

Reference Register
A type of register used in an FST or a calculation. A reference register can be written into or read by other PROVOX system devices, but the device containing the register can only read its value.

Register A memory location used for storage of a value.

Remote Set Point Mode (RSP)
A loop control mode: the controller algorithm changes the control output to minimize the difference between values of the set point and the process variable. The set point value comes from outside of the control loop; typically the output of another control loop becomes the set point.

REQ/RESP Acronym: Request/Response

Request/Response (REQ/RESP)
A one-time data reporting method: the receiving device requests data, and the responding device sends it. Request/response reporting contrasts with unsolicited reporting, which happens without a request, according to a schedule.

Reset Another name for integral control action. Also, to return an MPU and any associated circuits, or a computer program, to an initial state.

Resistance Temperature Detector (RTD)
A device or element that measures process temperature very accurately. RTDs sense temperature changes by measuring the resistance of a coiled metal wire, typically platinum.

Reverse Acting Control action in which the absolute value of the output signal decreases as the absolute value of the input signal (process variable) increases.

ROM Acronym: Read-Only Memory

RSP Acronym: Remote Set Point Mode

RTD Acronym: Resistance Temperature Detector

S

Scan Sequential interrogation of devices or points.

Serial Sequential: said of data transmitted one bit after another.

set point (SP) An input variable that contains the desired value for a process variable. Control loop algorithms compare the process variable with the set point, to determine an appropriate output.

Signal Value Analog (SVA)
The analog or floating point portion of the accumulator register in the FST of a controller.

Signal Value Discrete (SVD)
The discrete portion of the accumulator register in the FST of a controller.

Softkey Another name for multifunction key.

Software Microprocessor or computer programs and routines that a user can change.

SP Acronym: set point

SSDA Acronym: Synchronous Serial Data Adapter

STA Abbreviation: Station

Stand-Alone Said of a self-contained system that exists and performs as an autonomous unit.

STAT Abbreviation: Station

Station (ST, STA, or STAT)
Definition of the valid control modes for a control loop. Possible modes include manual (MAN), automatic (AUTO), remote set point (RSP), supervisory (SUP), direct digital control (DDC), and computer (COM).

SUP Abbreviation: Supervisory Mode

Supervisory (SUP)
A loop control mode: the control algorithm changes the control output to minimize the difference between the values of the set point and the process variable. A process computer, a computer program, a unit point, or a logic control point supplies the set point value.

SVA Acronym: Signal Value Analog

SVD Acronym: Signal Value Discrete

Synchronous Serial Data Adapter (SSDA)
An integrated circuit device that provides a bidirectional serial interface for synchronous data exchange. It contains interface logic for simultaneously transmitting and receiving standard synchronous communications characters.

Systems Engineering
The implementation of a hardware-and-software system resulting from analysis of a control problem.

T

Tag A unique identifying mnemonic or label for a controller, instrument signal, or point of a process control system.

Target Device Any system device that receives point information, commonly a display device that shows the information to an operator.

TC Abbreviation: Thermocouple

Template A matrix of values used to define set points for DCD or Group points, or to define alias names for unit operations.

Trace To view register or accumulator contents throughout the execution of a control algorithm, as part of verifying configurations. Trace programs also commonly let the user insert specific values into registers or accumulators and check their influence on algorithm results, without affecting actual output signals to field devices.

Trace Point An FST step at which the operator, using the trace utility, can see the contents of a register or accumulator. Typically, the operator can set as many as 10 trace points in an FST (that is, designate as many as 10 of the FST steps to be trace points).

Transducer A device that converts one physical signal to another type, for example, an electrical signal into a mechanical signal.

Transistor-Transistor Logic (TTL)
The basis of a popular family of integrated circuit devices for logic functions. These devices have arrays of bipolar transistors in which 0 volts represents a logical 0, and 5 volts represents a logical 1.

Trip Point [See Alarm Trip Point]

TTL Acronym: Transistor-Transistor Logic

Tuning The adjustment of control terms or parameter values to produce a desired control effect.

Tuning Parameter
A parameter which is adjustable without reconfiguring a device; an operator adjusts such a parameter to alter control effects. Common examples are gain, rate, reset, and alarm trip points. Such parameters appear in detail displays.

U

Ultraviolet Read-Only Memory (UVROM)
A semiconductor memory device that is programmable electrically, but erasable only by exposure to high-intensity ultraviolet light. Another name for Erasable Programmable Read-Only Memory.

Uninterruptible Power Supply (UPS)
A backup device for an AC power source. A UPS connects between the AC power source and computer equipment. Should there be a failure of or interruption in the AC power source, the UPS supplies continuous power to the computer.

Unit A specific group of plant equipment that processes a particular batch. For control purposes, such a unit is one entity. Also, a PROVOX point type. A unit point has the ability to control a plant process unit.

Unit Operation A batch control program; a list of controller instructions to perform specific mathematical and logical functions, as part of a time-and-event sequence for a defined set of plant equipment (the unit). A unit operation consists of phases, each of which is a set of related steps. Each step is an elemental control action.

Unit Operations Controller (UOC)
A PROVOX controller designed for batch, sequencing, discontinuous, and unit-oriented continuous-control applications.

Unsolicited An automatic, repetitive reporting method for routine operating data.

UOC Acronym: Unit Operations Controller

Upload The movement of configuration instructions from system devices to a configuration device or interface. An upload lets the current values of tuning parameters be incorporated into the configuration source files, eliminating specific user entry. Uploads also may be used to verify that configuration instructions are correct.

UPS Acronym: Uninterruptible Power Supply

Utility Programs Standard useful programs, such as those for sorting files, copying disks, downloading, and performing diagnostics.

UVROM Acronym: Ultraviolet Read-Only Memory

V

Valve Output (VO)
A controller voltage or current output that can be used by an actuator to open or close a valve.

VDU Acronym: Video Display Unit

Velocity Limit A restriction on the rate of change of a particular variable.

Video Display Unit (VDU)
An electronic assembly that displays alphanumeric data and graphic images on a screen, for viewing by a user.

VO Acronym: Valve Output or Voltage Output

Voltage Output (VO)
A terminal, available on a PROVOX controller or multiplexer, that produces a 1- to 5-volt analog output signal.

W

Watchdog Timer (WDT)
An electronic interval timer that generates a priority interrupt unless periodically recycled by a computer or microprocessor. Should the computer or microprocessor fail, it does not recycle the timer, which sends out the interrupt signal.

WDT Acronym: Watchdog Timer

Window A trace utility mode, in which accumulator values appear on the VDU as the trace point FST steps execute. In window mode, FST execution does not stop at trace points.

Word The fundamental unit of data storage used by a computer, usually 16 bits long. The number of bits can be different in some computers or microprocessors, however, varying from 4 to 64 bits.

XYZ

XFR Symbol: Transfer

XMIT Symbol: Transmit

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