CONTROL DATA® 1700 Computer System

1700 PROCESS INPUT ACQUISITION SYSTEM
VERSION 1.0
SOFTWARE USER'S MANUAL

APPLICATION SOFTWARE PRODUCT

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NOTE

This manual assumes that the reader is familiar with the CONTROL DATA®* 1700 Computer, E006 Operating System, and the 1700 Macro Assembler.

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INTRODUCTION

The Process Input Acquisition (PIA) System obtains plant variables at various frequencies and checks for out-of-range variables. PIA uses methods such as deadband and/or significant change alarming, outputs a message if the value is outside of range, and stores the value of the variable in core for use by other programs. The PIA system requires the E006 Operating System Monitor; certain drivers and a message handling routine must be included with the Monitor. PIA is a medium-speed system (maximum read rate is approximately 200 points per second), which used the scan cycle philosophy to determine the frequency at which a point is to be scanned. The system is based on a memory configuration of core and drum. Each individual system requires a new set of parameters be assigned to the various programs and tables. Preparameterized versions which may meet individual needs are available.

Section One
PIA SYSTEM DESCRIPTION

SYSTEM FUNCTION

The PIA system provides a means of reading industrial process variables into the computer and storing these values in a table in core for use by other process programs. In this capacity, PIA functions as a scan. The frequency at which a variable is read may differ for each variable. Predefined frequencies are set up, and each variable is assigned a frequency. These frequency groups are called scan cycles. If PIA cannot meet the frequency requirements during normal operation because of system overloading, a message is printed on the alarm comment medium. In addition, error checking is done on the input variable to determine if the value is within the acceptable range of the measuring equipment and if the measuring equipment is functioning correctly. Failure of the error check results in the appropriate message on the alarm comment medium. In this case, the value of the variable in the current value table remains unchanged.

An additional function of PIA is to determine if the process variable is within a predefined operating range. In this capacity, PIA functions as an alarm scan. High and low alarm limits define the acceptable range of the process variable. Additional features add a deadband to the limits to prevent continuous alarming when the variable fluctuates near the limit. PIA also can alarm periodically once the variable has exceeded its limits (when a significant change in the variable occurs). Alarm conditions produce the appropriate message on the alarm comment medium.

Locations where such features as direct digital control, integrating and overaging, and trouble location annunciations may be included are indicated within PIA. In addition, PIA includes the conversion routines necessary to convert the digital counts as received from the analog-to-digital converter to engineering units for use by the alarm checking routine and other process programs. The conversion routines interface indirectly with PIA via the appropriate analog-to-digital converter driver within the Operation System Monitor. Associated with PIA and for use by the process operator or engineer are various demand functions or operator requests for changing and obtaining status of process variables.

SYSTEM CONFIGURATION

The Process Input Acquisition System contains the following basic parts.

a. Basic PIA Routines.

b. Descriptive Word-Handling Routines.

c. Conversion Routines.

d. Tables of Descriptive Words, Values, and Point Descriptions.

e. PIA-Associated Demand Functions.

The PIA system requires the E006 Operating System Monitor. The Monitor must include the following modules:

a. CONTROL DATA® 1530 or 1534 Analog-to-Digital Converter Driver.

b. CONTROL DATA® 1751 Drum Driver.

c. 1700 Message Interpreter and Message Write System.

d. CONTROL DATA® 1587 Operator Console Interpreter.

e. CONTROL DATA® Input/Output or 1582 Logging Typewriters with color-shift control.

Figure 1.1 shows the interrelation of these parts.

SYSTEM CHARACTERISTICS

SCAN CYCLES

Initially defined is a set of frequency scan cycles at which process variables are to be read. The set may contain any reasonable number of scan cycles greater than one; however, four to seven scan cycles is normal. Two scan cycles, resulting in sequential scanning of all points, are possible but include the burden required to process many scan cycles, if the system is not altered. Each process variable to be scanned by PIA is assigned a scan cycle. The number of inputs that the hardware can scan each second limits the number of process variables which can be assigned to the scan cycles.

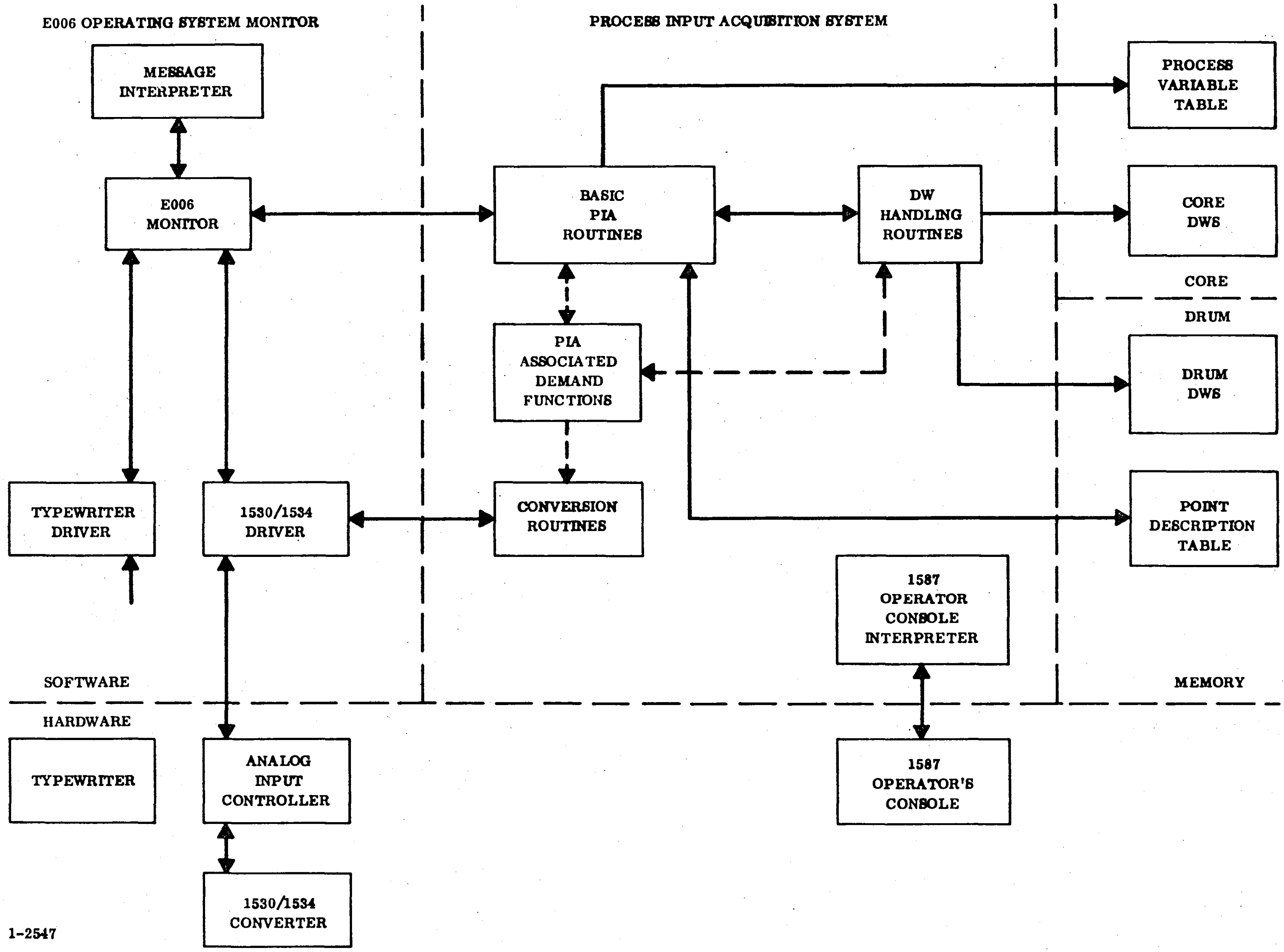


FIGURE 1.1. BASIC COMPONENTS OF PIA SYSTEM

Scan cycles are assigned numbers 0 through N. Scan cycle zero is defined as a dummy scan cycle. Therefore, at least two scan cycles are required. Process variables in the dummy scan cycle are not scanned. A process variable is suspended from the scan by placing the variable into scan cycle zero.

PROCESS VARIABLE NUMBER ASSIGNMENTS

All process variables to be scanned by the PIA system, whether they are inputs to the system or values calculated from inputs, must be assigned an ordinal number called an internal point number. In general, process variables not scanned by PIA are also assigned a point number for consistency. The internal point number is used by PIA and its associated routines for computer internal processing. An external point number, defined by the system designer, for use by the process operator may also be available. In this case, a translation program is required by the routines which interface with the operator using the external point number. When an external number is not required, the internal number is used.

The external point number is defined as an alphabetic character followed by five digits. If a different format is required, the translation routine requires alteration.

DESCRIPTIVE WORDS

Associated with each point number is the information necessary to process the point by the PIA system. The information is packed in a set of computer words with one or more pieces of information per word. This set is called point descriptive words and is abbreviated DW or DWS. DWS consist of fields containing the infomation. Each field can be 1 ot 16 bits in length. Fields cannot be split between computer words. The information contained in a field is called field data. Descriptive words are divided into two groups: core resident and drum resident. Part of the descriptive word fields is required to be core resident descriptive words. The remaining part may be core or drum resident descriptive words, but the system requires that drum resident descriptive words exist. Therefore, some fields must be on drum.

ORDERING OF DESCRIPTIVE WORDS

Descriptive words are grouped first according to scan cycle and then by point number. Grouping by scan cycle decreases the amount of drum traffic in handling drum resident descriptive words. Consequently, it is possible to transfer contiguous sets of descriptive words from the same scan cycle from drum to core. Internal point numbers are assigned according to the ordering of descriptive words (from 1 to N). Ordering of core and drum descriptive words must be the same (see Figure 1.2). Even though a process variable is assigned to a specific scan cycle for optimizing the number of drum

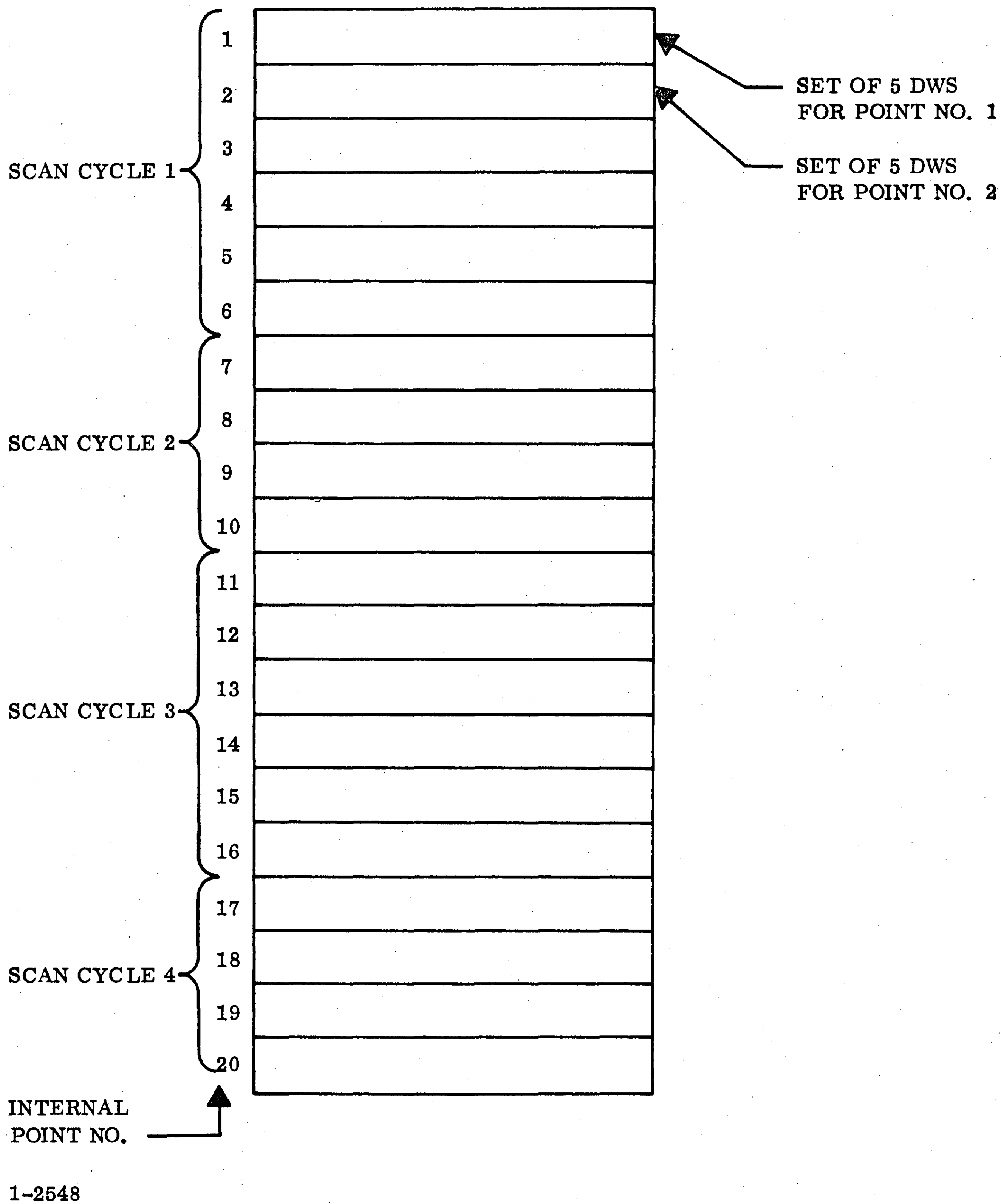


FIGURE 1.2. DESCRIPTIVE WORD ORDERING EXAMPLE

transfers, it may be changed to another scan cycle by the operator or by the program. The DWS is not relocated because a field in the DWS defines in which scan cycle the variable is, not the DWS ordering. The grouping by scan frequency is done by its normal operating scan cycle. Changing scan cycles increases the drum traffic required by PIA. Consequently, a limitation exists on the number of points which can have their scan cycle changed.

DESCRIPTIVE WORD FIELDS

The following descriptive word fields are assigned in the PIA system. Included in parentheses are the standard mnemonics used by PIA.

a. High Alarm State Indicator (ASIHI), 1 bit.

   Set when point is in high alarm. Reset when point is normal. Required for deadband.

b. Low Alarm State Indicator (ASILØ), 1 bit.

   Set when point is in low alarm. Reset when point is normal. Required for deadband.

c. High/Low Alarm State Indicator (ASIHL), 1 or 2 bits.

   For 1 bit, set when point is in alarm; reset when point is normal. For 2 bits, the left bit must be high alarm state indicator and the right bit low alarm state indicator.

d. Bad Input/Invalid Input (BADINP), 1 bit.

   Set when point is found to have a bad input (e. g. open, overrange of converter, etc.) and when point is suspended from scan (scan cycle zero).

e. Scan Cycle Designator (SCYDEG).

   Scan cycle number 0 - N. Zero is dummy scan cycle. Any number of scan cycles is permitted.

f. Point Type (PTTYPE).

   Indicates type of point (e. g. , analog input, composed point, calculated point). Used to indicate which converter to use in a multiconverter system. Type 0 is defined as analog input for systems with only one converter.

g. Multiplexer (Channel) Address (MPXADD).

Address used by hardware to determine the multiplexer input point.

h. Gain (GAIN), 2 bits.

For 1534 converter, defines the gain at which point is to be read. Gain = 0 - 3 corresponds to lowest to highest gain.

i. Speed of Reading Indicator (SPEED).

For 1530 converter, defines the rate at which a point is to be converted. Speed = 0 - 3 corresponds to slowest to fastest rate.

j. Conversion Routine Index (CØNRØU).

For indexing to proper conversion routine.

k. Conversion Constant Index (CØNCØN).

For indexing to proper conversion constants to be used by conversion routine.

l. Scaling Factor (EXPØNX), 3 bits.

Power of 10 by which the result of the conversion calculation must be multiplied to obtain the result for units specified. Example: Output of conversion routine is 1000; scaling factor is -1; corrected result is 100. 0.

m. Engineering Units (ENGUNT), 4 bits.

Engineering units index used for setting the units window in the digital display.

n. Alarm Point Indicator (ALMPTI), 1 bit.

Indicates the point is an alarm point.

o. Alarm Cutout (ACMCUT), 1 bit.

Suspends alarm checking if set. May be same as alarm point indicator if no record of alarm points is required.

p. Low Alarm Limit (LIMTLØ), 1 word.

Minimum value of acceptable operating range of point. Value at which PIA first indicates point is in alarm.

q. High Alarm Limit (LIMTHI), 1 word.

Maximum value of acceptable operating range of point. Value at which PIA first indicates point is in alarm.

r. Deadband Range (DEADBD).

The value of the deadband established at both limits. The deadband is the same for both limits. It is expressed in engineering units as calculated by the conversion routines.

s. Significant Change Limit (SIGLIM).

The value of the increment added to or subtracted from the value of the point for calculating the high and low significant change limits.

t. Last Value (LASTVL), 1 word.

The value of the process variable used to calculate significant change limits.

u. Alarm Message Cutout Bits.

At present, preparameterized versions assign only one bit for all types of cutouts. The following types of message cutouts are conducted properly by the PIA programs:

1. High and Low Alarm Message Cutout (MSGØUT).

2. Significant Change Alarm Message Cutout (MSGCSC).

v. Composed Point Index (CØMPTN).

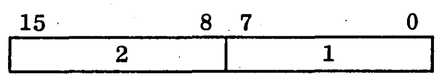
An index available for use by composed point calculation.

CORE DESCRIPTIVE WORD FORMATS

Certain dynamic descriptive word fields are assigned to core, thus eliminating a large amount of drum traffic that would be necessary if these fields were drum resident.

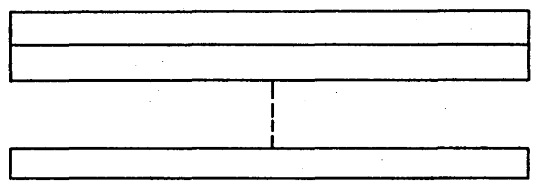
The size of core descriptive words may vary depending on how many DW fields are to be core resident. For standardization, core DWS must have one of the following types of formats to utilize the standard Descriptive Word Handler and Changer routines.

a. Eight bits per point:



Point NOs. 1 and 2

b. An integer number of words per point.



Point NO. 1
Point NO. 2

Point NO. n

The following fields are required to be assigned to core descriptive words:

a. Scan cycle designator.

b. High alarm state indicator.

c. Low alarm state indicator.

d. Input error indicator.

e. Scaling factor.

If no deadband alarming is included in the system, the high and low alarm state indicators may be combined into one bit.

DRUM DESCRIPTIVE WORD FORMAT

The drum descriptive word format must be type b as defined for core descriptive words. To identify a set of DWS, the internal point number is permanently assigned to bits 0 through 11 of the first word of drum DWS.

The following fields are required to be assigned by the PIA system and are normally assigned to drum DWS.

a. Multiplexer (or channel) address.

b. Amplifier gain or speed of converting.

c. Conversion routine index.

d. Conversion constant index.

e. Point type designator.

f. Alarm point indicator.

g. Alarm message cutout bit.

h. High alarm limit.

i. Low alarm limit.

j. Point number.

k. Last alarmed value.

l. Significant change limit.

m. Deadband range.

n. Alarm cutout.

DESCRIPTIVE WORD HANDLING ROUTINES

PIA routines require information contained in the various fields of a point's descriptive words. Since the fields are not fixed but may be unique for each system, a centralized routine (Descriptive Word Handler) is used to define these fields and mask them from the descriptive words. The Descriptive Word Handler requires that the DWS be in core. Therefore, for drum descriptive words, the caller must transfer the DWS to core before calling the Descriptive Word Handler to remove the field. To assist the caller in executing this transfer, a routine called the Descriptive Word Finder exists. The Descriptive Word Changer routine is used to change DWS. A description of each routine follows.

DESCRIPTIVE WORD HANDLER

The Descriptive Word Handler (DWH) is used to obtain a field from the descriptive words. Each field is assigned a field number. DWH contains a table, indexable by the field number, which contains a word of information defining the location of the field within the descriptive word set (see Section Three).

Fields located in core DWS, may be handled by DWH at any time. Fields located in drum DWS, must have the DWS transferred to core before DWH can obtain the field. The caller must specify the field index number of the desired field and the location of the drum DWS for core and drum fields or the point number for core fields only.

DESCRIPTIVE WORD FINDER

The Descriptive Word Finder (DWF) facilitates transferring of drum DWS to core. DWF locates the set of descriptive words to be transferred and inserts this information into a drum transfer call. DWF requires the caller to specify the point number of the first set, the number of sets to be transferred, and the core location of the drum read request parameters to be filled. The caller can then make a drum Read request immediately following the call to DWF. Use of DWF centralizes the location where the drum address of the drum descriptive words must be stored.

DESCRIPTIVE WORD CHANGER

The Descriptive Word Changer (DWC) centralizes the changing of DW fields. This is a requirement for drum DWS, if more than one routine is permitted to change the same field, because changes can be lost. DWC stacks requests in a buffer if necessary. For drum resident fields, the DWS are read into core, the new field is inserted into the DWS, and the DWS are written onto drum. Core resident field changes are executed immediately. DWC requires the caller to define the field index number, the core location of the transferred drum DWS (or point number for core resident fields), and the new value of the field.

CURRENT VALUE TABLE

Located in core is a table of the last good value of each point as read or calculated by PIA. The value is a signed integer in the range ±32,767. Each point is updated as a function of the scan cycle. If the value is not being updated by the scan, the bad input field in the DWS is set. Multiplying the integer value by the power of 10 (found in the exponent field of the DWS) locates the decimal place correctly.

The value table is ordered identically to the DWS and is therefore indexable by the internal point number. Indexing may be done indirectly via a cell in the cummunication area.

CONVERSION ROUTINES

When PIA requests the value of a process variable via the analog-to-digital converter driver, the result must be in engineering units. To obtain this value the driver must convert from counts to engineering units. Conversion is begun by a call to the conversion routine which is not part of the driver. The conversion routine has various conversion routines for thermocouples and various transducer outputs (ax + b, liner conversion). The correct routine is entered via a jump table indexed by the conversion routine index field.

Each conversion routine may have sets of constants to vary the range of the conversion. These constants are stored in tables that are indexed by the conversion constant index field. Both conversion routine index and conversion constant index are obtained from the descriptive words for the point via the Descriptive Word Handler. The converter driver, conversion routines, and conversion constants are all core-resident programs in the standard PIA system.

A special pseudo-driver (Special Conversion Routine, SCR) is available to handle calculated or composed points. A calculated point is one which requires a number of process variables to obtain their value. The value of the process variables is obtained from the process variable value table. By the use of the SCR, information for the calculated point may be drum resident and read into core at the time the point is to be calculated.

The calling sequence for the SCR must be identical to that of the analog-to-digital converter driver so that the PIA system can call either driver. The point identify field in the DWS defines the type of point (analog or calculated) and also indicates to the PIA which driver to call.

SYSTEM OPERATION

The PIA system consists of the following basic routines:

a. Input Scan Sequencer.

b. Alarm Limit Comparator.

c. Alarm Message Initiator.

The Input Scan Sequencer is the heart of the PIA system. It initiates the calls to the A/D driver or pseudo-driver via the Monitor to read the inputs into the system or calculate the value. Upon completion of the driver request, the Alarm Limit Comparator is called for processing of the point for input error and outside alarm limits. Any message required, either by the Sequencer or the Comparator, is initiated by a call to the Alarm Message

Initiator. The Input Scan Frequency Changer is a required auxiliary routine. It is used when changing a process variable's scan cycle (see Figure 1.3).

INPUT SCAN SEQUENCER

The primary function of the Input Scan Sequencer is to initiate the action necessary to obtain the value of a point. The value is then processed by the Alarm Limit Comparator for alarm checking. First, the Sequencer must determine the sequence in which the points are to be scanned. This is accomplished by the Load Buffer Routine which fills a core buffer with drum descriptive words in the sequence in which they are to be scanned. The sequence is determined by the number of points from each scan cycle which must be scanned each scan period. Therefore, the total number of points in a scan cycle are all scanned within the desired period.

When the Sequencer has control, a call is made to the Load Buffer Routine to fill the core buffer. In this way the drum descriptive words are available to the Sequencer before they are needed to make an A/D driver call. When the Sequencer makes an A/D call, it uses the next set of drum descriptive words in the core buffer. As many A/D driver calls are made by the Sequencer as are initially provided by the system user. When no more calls can be made, control is returned to the Monitor.

If the number of points required to be scanned in a scan period are not scanned within that period for a specified number of times, the Sequencer initiates an alarm message indicating that the PIA system is overloaded. This may occur if there are other users of the A/D driver.

If a calculated point pseudo-driver is used, the point type field in the DWS is used as an index to a logical unit table. The Sequencer then requests the point from the pseudo-driver and not the A/D driver. If more than one A/D converter is present in a system, the point type also specifies the logical unit for the other A/D converter.

ALARM LIMIT COMPARATOR

The Alarm Limit Comparator has available to it the result of the driver that obtained the value of the point to be processed. This routine is divided into two parts: error and alarm checking.

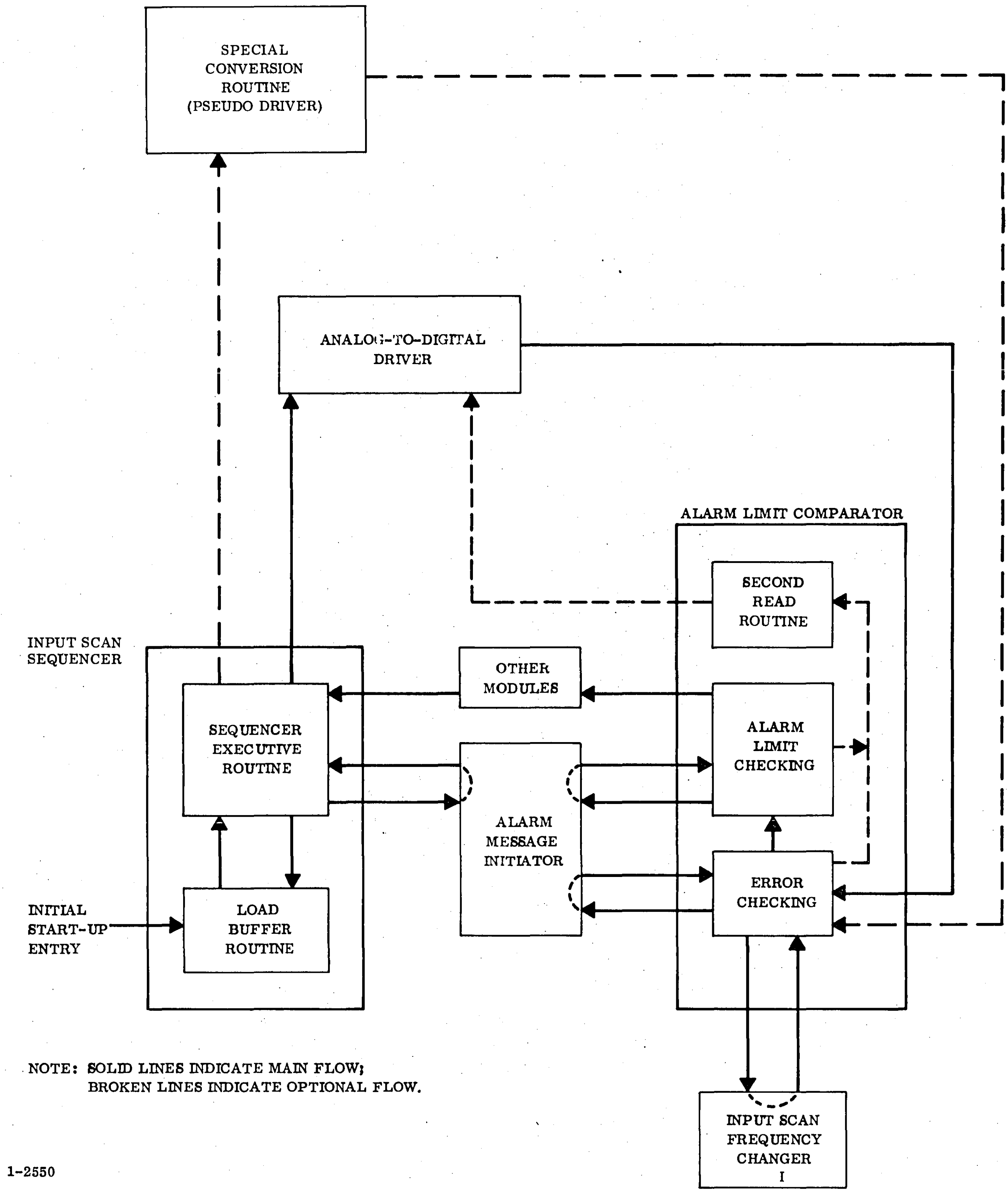


FIGURE 1. 3. PROCESS INPUT ACQUISITION STRUCTURE

ERROR CHECKING

The following error checks are made if the result the Comparator receives has the error flag set.

a. Internal or external reject.

b. Open input.

c. Input is over the range of the converter.

d. Input is under the range of the converter.

e. Input is over a specified allowable range.

f. Input is under a specified allowable range.

g. An input to a calculated point is in error.

An alarm message is initiated and an input error bit in the DW is set. Subsequent readings of the point produce no message as long as the point is in error. When the error condition is corrected, a return-to-normal message is initiated and the error bit is reset. If the error flag is not set, alarm checking is performed. For c and d above (out of converter range), the point is deleted from the scan by placing the point in the dummy scan cycle. This is done by calling the Input Scan Frequency Changer.

ALARM CHECKING

The value of the point is checked for being above a high limit or below a low limit. If the point is outside of the limits, a high or low alarm message is initiated and the high or low alarm state indicator is set in the DW. No more messages are produced while the point remains out of limits. When the point returns within limits, a return-to-normal message is initiated and the corresponding alarm state indicator is reset. Two other optional alarm features are included in the standard PIA system:

a. Deadband alarming.

b. Significant change alarming.

Deadband alarming permits a deadband zone to exist between the actual alarm limit as stored and used for alarming when the point is within limits and the limit that is used when the point is already in alarm. Deadband alarming decreases the number of alarms produced for a point that varies around the value of the stored limit. A field in the DW contains the deadband value. The same value is used for both high and low limits.

Significant change alarming permits alarming of a point already in alarm when it varies some specified amount. Thus, a point that is in alarm is bracketed with high and low significant change limits. When either of these limits are exceeded, a message is initiated, and the present value of the point becomes the newly bracketed point. A significant change of zero means that a point alarms each time the point is scanned. A field in the DW contains the significant change value. A second reading of points in error or alarm is provided to validate the error or alarm.

Each of the following features is also included and has associated with it a field in the DW:

a. An alarm point indicator tells the Comparator whether the point is an alarm point or a point being scanned only to update its value in the value table.

b. An alarm cutout indicator tells the Comparator if this alarm point is to be processed for alarming.

c. A message cutout indicator for each of the different kinds of alarming (high, low, and significant change) tells the comparator whether a message should be initiated.

The Alarm Limit Comparator is a subroutine that may be used by other system programs for error and alarm checking, if the priority level is the same as the Sequencer (ALC is not re-entrant).

ALARM MESSAGE INITIATOR

The Alarm Message Initiator has three types of message formats:

a. Alarm message.

b. Error message.

c. Scan overload/miscellaneous.

Each type is a single line of type on an alphanumeric printout device (e.g., typewriter).

The format for each type follows and is printed in the order specified. Alarm conditions are printed in red; return-to-normal conditions are printed in black.

ALARM MESSAGES

a. Alarm or return-to-normal indicator.

b. Time in hours, minutes, and seconds.

c. An alpha description of the process variable preceded by its external point number.

d. Type of alarm (e.g., low operating or high significant change).

e. Value of variable at time of alarm.

f. Value of limit that caused alarm (varies for significant change limits).

ERROR MESSAGES

a. Alarm or return-to-normal indicator.

b. Time in hours, minutes, and seconds.

c. An alpha description of the process variable preceded by its external point number.

d. Type of alarm (e.g., over-range of converter, under-range of transmitter).

MISCELLANEOUS

a. Alarm or return-to-normal indicator.

b. Time in hours, minutes, and seconds.

c. Type of alarm (e.g., scan overload).

The external point number and alpha description of the process variable are drum resident; they are located in the point description table. Entries in the point description table are of equal length, and the table is indexable by a multiple of the internal point number. The multiple depends upon the size of the entries. The first three words of each entry should be the external point number to utilize the existing software.

INPUT SCAN FREQUENCY CHANGER

This routine changes the scan cycle to which a process variable is assigned if overloading the system does not result from the change. Various tables accessed by the Sequencer and defining scan cycle information are contained in this routine:

a. Table of number of scan periods in each scan cycle period.

b. Table of number of points per scan cycle.

c. Table of number of points to be scanned per scan period (scaled 2^8).

The scan period is the basic timing increment for the scan. Scan cycles must be multiples of the scan periods. Normally, the fastest scan cycle is the scan period, but it is not a requirement.

This routine is used by the Alarm Limit Comparator and the various demand functions that change scan cycles.

Section Two
PIA-ASSOCIATED OPERATOR DEMAND FUNCTIONS

GENERAL DEMAND FUNCTION OPERATION

A simplified explanation of the operation to initiate a demand function follows as an introduction to the PIA-associated demand functions.

The 1587 Operator's Console switches are setup as instructed by a specific demand function. Upon pressing the ENTER button, an interrupt occurs which initiates the Operator Console Interpreter Routine. This routine reads all console switch settings and stores the reading in a data table. The Interpreter then schedules the desired demand functions. All demand functions interface only with the data table (see Figure 2.1).

AVAILABLE DEMAND FUNCTIONS

CHANGE, RESTORE, DELETE SCAN CYCLE
This routine changes the scan cycle to which a process variable is assigned. It can also restore the normal scan cycle to a process variable or assign it to the dummy scan cycle (suspend from scan).

PRINT ALARM, DELETE, INPUT ERROR POINT REVIEW
This routine prints the process variables with the desired status. All points that are in an alarm condition, all points which have been deleted (suspended), or all points with input errors are printed.

CHANGE ALARM LIMITS
This routine changes the high and low alarm limits for a process variable.

CHANGE DESCRIPTIVE WORD FIELD
This routine changes the contents of the specified field in a process variable's set of descriptive words.

PRINT DESCRIPTIVE WORD FIELD
This routine prints one field or all fields from a process variable's set of descriptive words.

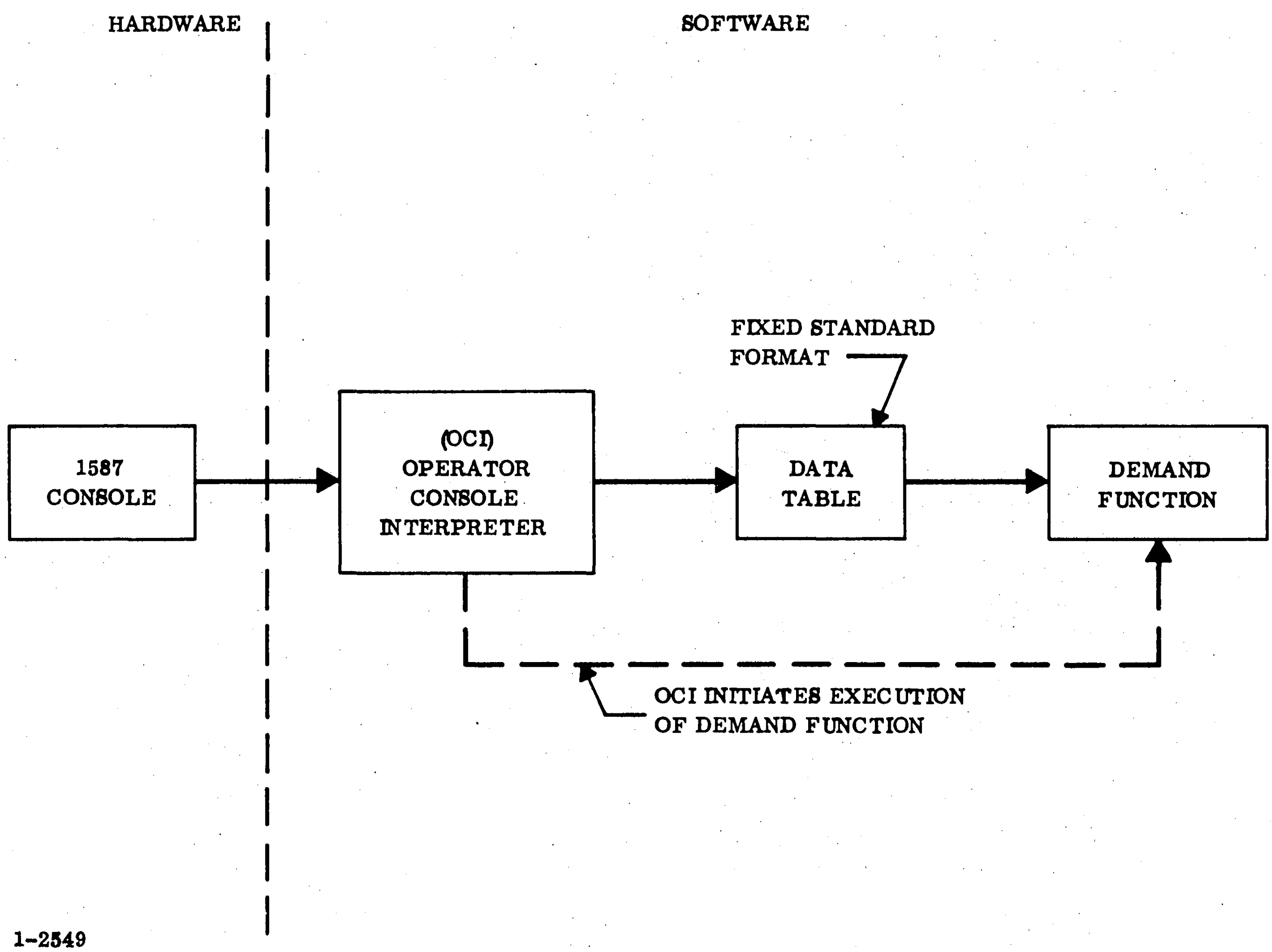


FIGURE 2.1. DEMAND FUNCTION OPERATION

CHANGE CONVERSION CONSTANTS

This is a general routine for changing words in a predetermined set of tables. The conversion constant tables need only be included in the set for changing ability.

Section Three
PIA SYSTEM CONSTRUCTION

SYSTEM DEFINITION

PROCESS VARIABLE CHARACTERISTICS

A process system contains several different types of methods for obtaining process variables. Process variables may be analog inputs, digital inputs, event counters, calculated points, composed points, etc. Analog inputs may be further classified into types of source such as, individual variables, pneumatic multiplexer, chromatograph, etc. Each process variable, regardless of source, is assigned a system point number. Points for various types of inputs and sources are grouped with consecutive point numbers. Various programs have the responsibility of processing a group of points. Thus, a system with the three types of sources mentioned above might have an internal number assignment as follows:

1 - n	PIA points
n + 1 - m	Pneumatic multiplexer points
m + 1 - P	Chromatograph points

Therefore, all points in a system are assigned point numbers, but only a portion of these points need to be processed by PIA. For system construction, including PIA, cards punched by the system designers contain all pertinent data about a process variable. These cards are then processed to build DWS and point descriptions and are used for obtaining information for system parameterizations. Figure 3. 1 defines the card format to be used.

DEFINING SCAN CYCLES

A set of scan cycles is defined and each is given a number. Number one is assigned to the fastest, two to the next fastest, etc. Scan cycle zero is reserved for the dummy scan cycle. Each process variable is assigned to a scan cycle. The arrangement of the process variable within a scan cycle group and the arrangement of the scan cycles within the PIA group define the internal point number assignment given to each process variable (see Figure 1. 2).

DEFINING DW FORMATS

Each process variable processed by PIA requires that a set of DWS be defined for it. The set is divided into two parts; one part is core resident, the other part is drum resident. Section One defines the required fields

	CONTINUATOR	COMMON REFERENCE NUMBER	EXTERNAL POINT IDENTIFICATION	ALPHANUMERIC DESCRIPTION	ENGINEERING UNITS (ALPHANUMERIC)	SCALE FACTOR	INSTRUMENT LIMITS				
							HI LIMIT ENG UNITS	LO LIMIT ENG UNITS	HI LIMIT INST. UNITS	LO LIMIT INST. UNITS	INST. UNITS
1											
2											
3											
4											
5											
6											
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ANALOG INPUT SIGNAL LIST PART I	CONTROL DATA	TITLE **FIELD ASSIGNMENT LISTING**		(MANILA)
		DRAWN BY	DATE	DRG. NO.
		PROJECT	REVISION	SHEET OF
	ANALOG-DIGITAL SYSTEMS DIVISION			LA JOLLA, CALIFORNIA

FIGURE 3.1. ANALOG INPUT SIGNAL LIST (SHEET 1)

	CONTINUATOR	COMMON REFERENCE	INPUT SOURCE	SUB-MULTIPLEXER POSITION NUMBER	TRANSDUCER TYPE	TRANSDUCER TOLERANCE (%)	SCAN CYCLE	ALARM ACTION		HIGH ALARM LIMIT (ENG UNITS)	LO ALARM LIMIT (ENG UNITS)	SIGNIF. CHANGE (%)	DEADBAND (%)	RELATED FUNCTIONS							CONV. ROUTINE			CONVERSION CONSTANT A	CONVERSION CONSTANT B	CONVERSION CONSTANT C
								INDEX	SUB-INDEX					COMP PT.	CUT-OUT	DDC	LOGS	CALC.	RATE PT.	I & A	INDEX	SUB-INDEX				
1																										
2																										
3																										
4																										
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										
13																										
14																										
15																										
16																										
17																										
18																										
19																										
20																										

ANALOG INPUT SIGNAL LIST PART II	CONTROL DATA	TITLE (ORANGE)	
	DRAWN BY	DATE	DRG. NO.
	PROJECT	REVISION	SHEET OF
	ANALOG-DIGITAL SYSTEMS DIVISION		**LA JOLLA, CALIFORNIA**

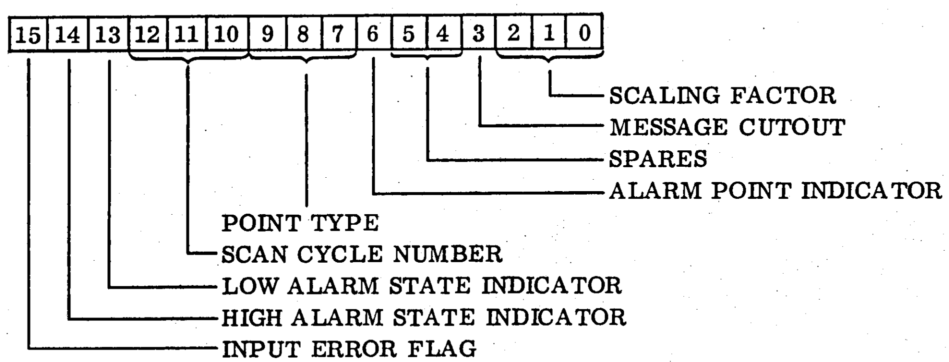
FIGURE 3.1. ANALOG INPUT SIGNAL LIST (SHEET 2)

	CONTINUATOR	COMMON REFERENCE	MULTIPLEXER POINT NO.	INTERNAL POINT I.D.	AMP GAIN/DAD SPD.		FIELD OVERFLOW COLUMN		FIELD OVERFLOW COLUMN			COMMENTS	REVISION LEVEL
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

ANALOG INPUT SIGNAL LIST PART III	CONTROL DATA	TITLE (BLUE)		
		DRAWN BY	DATE	DRG. NO.
		PROJECT	REVISION	SHEET OF
	ANALOG-DIGITAL SYSTEMS DIVISION			LA JOLLA, CALIFORNIA

FIGURE 3.1. ANALOG INPUT SIGNAL LIST (SHEET 3)

for core resident DWS and the required fields for drum resident DWS. Other fields may be added as required for the individual system. An example of each DW is shown below.



SAMPLE CORE DW FORMAT
(1 word per process variable)

<table>
<tr><th>WORD NO.</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="2"></td><td colspan="2">GAIN</td><td colspan="12">PØINTN</td></tr>
<tr><td>1</td><td colspan="7">DDCLØP</td><td colspan="9">MPXADD</td></tr>
<tr><td>2</td><td colspan="16">LIMTHI</td></tr>
<tr><td>3</td><td colspan="16">LIMTLØ</td></tr>
<tr><td>4</td><td></td><td colspan="5">ENGUNT</td><td colspan="7">CONCØN</td><td colspan="3">CØNRØU</td></tr>
<tr><td>5</td><td colspan="16">LASTVL</td></tr>
<tr><td>6</td><td colspan="4"></td><td colspan="12">CØMPTN</td></tr>
<tr><td>7</td><td colspan="8">DEADBD</td><td colspan="8">SIGLIM</td></tr>
</table>

SAMPLE DRUM DW FORMAT
(See Section One for definitions of abbreviations.)

NOTE

The first location of the core DWS must be labeled CDWRD and defined as an entry point within the core DW deck.

DEFINING POINT DESCRIPTIONS

A table of point descriptions, which contain the alpha description and external point number of each process variable, must be constructed and loaded onto drum. The table normally contains an entry for each point in the system, including those not processed by PIA and is ordered by internal point number. All entries must be the same length, thus enabling the routines to calculate the drum address as a multiple of the internal point number. There is no limitation in the size of the entry, although the field width of the print-out device should be considered. This table is generated using the ALF pseudo-operation in the Assembler. A sample entry is:

```
ALF   19,  P12005      WATER SYSTEM   1      PH
```

- P12005 — External Point Number
- WATER SYSTEM 1 — Process Variable Description
- PH — Units

DEFINING CURRENT VALUE TABLE

The value table is an area in core reserved for the value of each system variable.

NOTE

The first location of the value table must be labeled VALU and defined as an entry point within the value table deck.

DEFINING CONVERSION ROUTINES

Engineering units are used for all limit checking and storing of the process variable value. The conversion is done in the analog-to-digital converter driver. The driver uses a return jump to an externally defined conversion routine which requires that a conversion routine be supplied. The driver converts digital counts as obtained from the converter to millivolts with the appropriate scaling. The conversion routines convert millivolts to engineering units using the scaling supplied by the driver. The scaling is defined in the driver and is a function of the gain of the input amplifier for the 1534 converter.

Each conversion routine is assigned a conversion routine index. A jump table uses this index to transfer control to the proper conversion routine for each process variable. The conversion routines usually have a set of constants. Associated with them to vary the range of their output. Each entry in the constant table is assigned a conversion constant index. Refer to Analog-Digital

Systems Division Programming Specification NO. 38919000 (see Appendix A) to determine the conversion routines available and how to calculate conversion constants.

DEFINING PRIORITY LEVELS

The various modules in PIA and associated software must be assigned priority levels in which to operate. The following programs must be assigned an operating priority level.

a. A/D Converter Driver.

b. Input Scan Frequency Changer.

c. Input Scan Sequencer.

d. Demand Functions.

The following rules apply in assigning priority levels for the routines.

a. The A/D driver should be at a fairly high priority level to insure that the ready interrupt from the converter is recognized as soon as possible. It must also be one level higher than the highest user.

b. Input Scan Frequency Changer Routine must be one level higher than the highest user. The two users in the PIA system are the Alarm Limit Comparator and the Change Scan Cycle demand functions.

c. The Sequencer must have as priority level at least one less than the Input Scan Frequency Changer. Its level should be one higher than direct digital control if DDC is triggered by PIA.

d. All demand functions should be at the same low level, but they are higher than Job Processor programs.

The four programs are released with the following priority level assignments:

Priority Level	Program
10	A/D Converter Driver
8	Input Scan Frequency Changer
7	Input Scan Sequencer
4	Demand Function

The remaining programs in the PIA system are assigned to the Sequencer level.

NEW SYSTEM PROGRAMS

One area in the PIA system which may require new programs is conversion routines and calculated points. The conversion routines must be written in Assembler languages and added to the conversion routine. The calculations for calculated points may be written in either Assembler or FORTRAN language and added to the calculated point pseudo-driver. The pseudo-driver contains no calculations, but is a skeleton to which programs can be added.

SYSTEM STARTUP

PIA system startup is performed by scheduling the initializer entry in the Sequencer. This entry is LDBUF1 and is defined as an entry point. Startup is normally accomplished by inserting the required Scheduler call into the System Startup Routine which starts other system functions, i.e., Clock, Time of Day, Update, etc. This routine is initiated by the System Initializer.

SYSTEM DECK REQUIREMENTS

The PIA system requires that the E006 Monitor and certain drivers be core resident; message handling routines must be mass memory resident. These decks in binary form are supplied by the Systems Maintenance and Integration Department, Analog-Digital Systems Division. They are ready to load into the computer without change.

PIA program decks are supplied in source language format. This enables the system designer to parameterize each deck as required. The decks are then assembled and loaded under one *L statement during initialization. The various tables for core and drum are loaded under their own *L or *M statement.

E006 MONITOR DECKS

Many combinations of the Monitor modules provide a system which fulfills the requirements of PIA. The following set of modules and drivers are considered to be standard for the Monitor configuration.

Number	Description
To Be Defined	E006 Monitor with buffering, message interpreter capabilities, and communication area loaded for PIA vectors.
38863400	1751 Drum Driver with Disk Sector Address Simulator
34593300	1534 A/D Converter Driver, or

Number	Description
84801600	1530 A/D Converter Driver
39008600	Input/Output Typewriter Driver, or
84642800	1582 Logging Typewriter Driver
39036700	Software Buffer Driver and Buffer Handling Routines
38858800	Message Interpreter and Message Write Request
84584400	Operator Console Interpreter
84761500	1587 Interrupt Response Routine

PIA DECKS The following PIA source decks should be obtained to build the PIA system:

Number	Description
38899900	Descriptive Word Finder
38875200	Descriptive Word Handler* (1/2 word per core DW)
84765200	Descriptive Word Handler (N words per core DW)
38932200	Descriptive Word Changer
38918900	Input Scan Frequency Changer
38875300	Alarm Limit Comparator
38890100	Alarm Message Initiator
38919000	Conversion Routines
38923700	Input Scan Sequencer

ASSOCIATED DEMAND FUNCTION DECKS

The following PIA-associated demand function source decks are also available:

Number	Description
38942400	Change Scan Cycle
38979600	Point Review
38991100	Change Alarm Limits
34740100	Change Descriptive Words
34740200	Print Descriptive Word Fields
84740300	Change Conversion Constants

SYSTEM PARAMETERIZING AND TABLE BUILDING

Each routine in the PIA system must be parameterized by changing equivalence cards and/or correcting or adding entries to tables. The required parameterization for each routine follows: For more details, refer to the Programming Specifications indicated in Appendix A.

DESCRIPTIVE WORD FINDER

The following equivalence cards must be corrected:

a. Most significant part and least significant part of drum address of drum DWS.

b. Number of drum DWS per points.

DESCRIPTIVE WORD HANDLER

A table (DWFT) defines to the Handler the location of the field in the DWS. The table is preset for a DW format as shown in Figure 2.1 and Defining DW Formats, above. Any additions or changes must be made by changing the entry in the table for the desired field. Entries have the following format:

15 — 11	10 — 7	6 — 3	2 — 0
WD	LG	LB	F

where WD = Word number in DW set

LG = Length of field minus one

LB = Least significant bit number of field

F = Type of field (0 = drum, 1 = core, etc.)

DESCRIPTIVE WORD CHANGER

The following equivalence cards must be corrected:

a. Number of Descriptive Word Fields (entries in DWFT table in DWH).

b. Number of core descriptive words per point number*.

c. Number of point numbers per core descriptive word*.

d. Number of drum descriptive words per point number.

e. Number of pending drum DW changes allowed (used to build a table for stacking requests).

INPUT SCAN FREQUENCY CHANGER

The following equivalence cards must be corrected:

a. Number of the last (maximum) scan cycle.

b. Maximum number of points per scan period. This is a function of the hardware. For example, if the scan period is 1 second and the hardware is capable of 200 points per second, the maximum number of points PIA can process in a scan period is 200.

Three tables must also include changes or additions. There is an entry in each table for each scan cycle, including the dummy.

a. PPSTBL Table.

This table contains the number of points to be scanned per scan period for each scan cycle. Entries in this table are calculated as follows:

$$\frac{\text{NO. of points in scan cycle}}{\text{Scan Cycle Period / Scan Period}} \times 2^{8}$$

*Not less than one.

The integer result is the table entry. If there is no integer result, it is set to one.

b. NCPSC Table.

This table contains the number of points in each scan cycle.

c. PCPSC Table.

This table contains the number of scan periods in each scan cycle period.

INPUT SCAN SEQUENCER The following equivalence cards must be corrected:

a. Input Scan Sequencer priority level.

b. A/D converter logical unit number.

c. Calculated point pseudo-driver logical unit number.

d. Number of clock counts per second.

e. Descriptive word field index for scan cycle.

f. Descriptive word field index for point type.

g. Mass memory logical unit number.

h. Number of scan cycles (including dummy)

i. First PIA point number.

j. Last PIA point number.

k. Number of drum DWS per point.

l. Number of A/D parameter lists.

m. Number of times scan allowed to exceed its scan period before scan overload alarm given.

n. Minimum time to start of next scan period (clock counts).

o. Number of entries in DW buffer table.

p. Maximum allowable number of consecutive points assigned to DW buffer before transfer of DWS is initiated.

q. A/D converter call request priority level.

r. Drum driver request priority level.

ALARM LIMIT COMPARATOR

The Input Scan Frequency Changer Priority level equivalent card must be corrected.

The following DW field indices must be provided in the descriptive words:

a. Alarm state indicator high and low.

b. Bad input or invalid data.

c. Scan cycle designator.

d. Alarm point indicator.

e. Alarm message cutout.

f. Significant change usage cutout.

g. High limit.

h. Low limit.

i. Last good value.

j. Significant change limit.

k. Deadband.

l. Alarm checking cutout.

NOTE

The two submodules, deadband and significant change alarm checking, can be eliminated by removing the appropriate cards and providing a substitute link. The sections are clearly marked on the program listing.

The Second Read Routine must be loaded with the ALC routine. See Programming Specification NO. 38875300 for deletion instructons.

ALARM MESSAGE INITIATOR

The following equivalence cards must be corrected:

a. Number of words in each point description entry.

b. Alarm comment medium logical unit.

c. Alarm comment medium request priority.

d. Most and least significant part of drum address for point description.

e. Most and least significant part of drum address for miscellaneous messages.

The length and relative drum location of miscellaneous message blocks must be inserted in a table labeled T4MAT3.

SYSTEM ASSEMBLING AND LOADING

Once the PIA source decks are parameterized, they can be assembled with either the A006 Utility Assembler or A007 Macro Assembler. At system initialization, the binary tapes or cards of the following PIA programs are required:

a. Core Resident Programs.

    1. Descriptive Word Finder.
    2. Descriptive Word Handler.
    3. Descriptive Word Changer.
    4. Input Scan Frequency Changer.
    5. Input Scan Sequencer.
    6. Alarm Limit Comparator.
    7. Alarm Message Initiator.
    8. Conversion Routine.
    9. Current Value Table.
    10. Core Descriptive Words.

b. Drum Resident Programs.

1. Drum Descriptive Words.
2. Point Descriptions.
3. PIA-Associated Demand Functions.

The core programs are loaded under one *L statement without directory entry. PIA-Associated Demand Functions in conjunction with the Operator Console Interpreter routine are loaded under one *M statement to permit linking between demand functions and Operator Console Interpreter. The drum DWS and point descriptions are loaded under separate *M statements which specify their location on drum.

Appendix A
SUPPLEMENTARY DOCUMENTATION

The following Analog-Digital Systems Division Programming Specifications are required for a detailed description of each program and instructions for parameterizing.

SPECIFICATION NUMBER	SPECIFICATION TITLE
38841800	1700 Process Input Acquisition System
38858800	1700 Message Interpreter and Message Write Request
38875200	1700 Descriptive Word Handler
38875300	1700 Alarm Limit Comparator
38870100	1700 Alarm Message Initiator
38899900	1700 Descriptive Word Finder
38918900	1700 Input Scan Frequency Changer
38919000	1700 Conversion Routines
38923700	1700 Input Scan Sequencer
38932200	1700 Descriptive Word Changer
38933100	1700 Special Conversion Routine Structure
38942400	1700 Change Scan Cycle Demand Function
38979600	1700 Point Review Demand Functions
33991100	1700 Change Alarm Limits Demand Function
84584400	1587 Operator Console Interpreter
84593300	1533/1534 Analog-to-Digital Converter Driver
84740100	Change Descriptive Words Demand Function
84740200	Print Descriptive Word Fields Demand Function
84740300	Change Conversion Constants Demand Function