Attachment 16

Non-proprietary Westinghouse Electric Company document WNA-SD-00250-WBT-NP, Revision 3, "Software Design Description for the Post Accident Monitoring System AC160 Software (Non-Proprietary)" dated October 2011 (Letter Item 10)

Westinghouse

Westinghouse Non-Proprietary Class 3

Nuclear Automation
Watts Bar Unit 2 NSSS Completion Program
I&C Projects

Software Design Description for the Post Accident Monitoring System AC160 Software

WNA-SD-00250-WBT-NP,
Rev. 3

October 2011

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REVISION HISTORY

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DOCUMENT TRACEABILITY & COMPLIANCE

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Post Accident Monitoring System – System Design Specification	WNA-DS-01667-WBT-P	4
Software Requirements Specification for the Post Accident Monitoring System	WNA-SD-00239-WBT-P	4

OPEN ITEMS

Item	Description	Status
None		

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ACRONYMS AND TRADEMARKS

Acronyms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 2), NABU-DS-00115-GEN, "Safety System Standard Definitions" (Reference 3), or included below to ensure unambiguous understanding of their use within this document.

Acronym	Definition
CET	Core Exit Thermocouple
CETMS	Core Exit Thermocouple Monitoring System
DSP	Data Set Peripheral
dP	Differential Pressure
ERR	Error (Terminal)
EUDH	Expected Uncompensated Dynamic Head
FE	Function Enable
HI	High
ICC	Inadequate Core Cooling
IL	Integer Long (data type)
ILPB	Integer Long Packed Bit
LO	Low
NDH	Normalized Dynamic Head
R	Real (data type)
RVLMS	Reactor Vessel Level Monitoring System
S	Seconds
SRR	Software Release Record
SW	Software
T	Temperature
TD	Time Delay
TR	Common Qualified Platform "Topical Report"
UDH	Uncompensated Dynamic Head

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GLOSSARY OF TERMS

Standard terms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 2), NABU-DS-00115-GEN, "Safety System Standard Definitions" (Reference 3), or included below to ensure unambiguous understanding of their use within this document.

Term	Definition
AC160 Station	Made up of a single base station subrack (CI631, PM646A, and S600 input/output [I/O] modules) and any optional I/O station or extension subrack (S600 I/O modules only). All processor modules (PMs) within the same AC160 station share the same Advant® Fieldbus 100 (AF100) bus address (base station subrack thumbwheel switch).
ACC *Advanced* Tool	The Advant graphical application programming tool for configuring and programming software is used in generating the PMS AC160 software. Consists of the Application Builder (AB) and Function Chart Builder (FCB). The ACC Advanced Tool also requires a library of standard PC and database (DB) elements.
AI687	A high-speed analog input module that processes 0-100 mV resistance temperature detector (RTD) and thermocouple signals.
AI688	A high-speed analog input module that processes 0-1V, 0-10V, and 4-20 mA input signals.
AO650	An analog output module that converts digital signals from the PM into analog signals. This module has eight output channels with 0-20 mA, 4-20 mA, -20-20 mA, -10-10V, 0-5V, 1-5V, and 0-10V ranges.
BAX	Database source code file (DB part of user program).
CI527	AF100 communications interface module that provides the AF100 high-speed bus control for the PC Node Box (FPDS).
CI631	AF100 communications interface module that provides the AF100 high-speed bus control for the AC160 station.
CONTRM	Control module structure PC element used for execution control of modules within a PC program.
DAT	A database element associated with AF100 communications.
Data Set Peripheral (DSP)	Database element representing a block of data (up to eight DATs) to be received or sent over the AF100.

GLOSSARY OF TERMS (cont.)

Term	Definition
DI621	Digital input module that provides an interface for 32 hardwired digital input signals up to 48 VDC.
Division	A grouping of hardware that is electrically isolated from other hardware. AP1000® has four divisions labeled A, B, C, and D.
DO620	Digital output module that converts internal binary signals from the PM to binary signals for use by an external process application. Each module supports up to 32 digital output channels.
DP620	Digital pulse counter module with five channels.
FALSE	Logical "0."
FUNCM	The function control module (FUNCM) is a PC element that has no execution effects and is used to help structure a PC program.
I/O Channel	A single point on an I/O module; for example, the AI687 has sixteen channels (inputs).
IDENT	Numerical representation that identifies the DSP on a given AF100. Range is between 1 and 50. Also used for unique addressing of Advant high-speed datalinks (HSLs) of the same data type.
Instrumentation Channel	An arrangement of electrical and mechanical components or modules – or both – from the measured process variable to the display device as required to sense, process, and display the measured variable.
MDAT	A database element associated with AF100 communications.
PCPGM	PC program structure PC element that defines the program header and defines the frequency at which the AF100 data is transferred between the PM646A and the CI631.
PM646A	A PM for the AC160 system used for safety applications.
Programming	As it relates to the AC160 programmable controller, the creation and modification of PC programs, including connections within the PC program and to DB elements.

GLOSSARY OF TERMS (cont.)

Term	Definition
SYS-CRC	PC element that monitors the CRC checksums taken from the system software and any options (i.e., libraries) and application software.
SYSL	A PC element that measures PM system load.
Supervision	Monitoring input parameters and responding to abnormal conditions appropriately.
TRUE	Logical "1."

REFERENCES

Following is a list of references used throughout this document.

1. NABU-DP-00014-GEN, Rev. 2, "Design Process for Common Q Safety Systems," Westinghouse Electric Company LLC.

2. WNA-PS-00016-GEN, Rev. 5, "Standard Acronyms and Definitions," Westinghouse Electric Company LLC.

3. NABU-DS-00115-GEN, Rev. 0, "Safety System Standard Definitions," Westinghouse Electric Company LLC.

4. 00000-ICE-3889, Rev. 12, "Coding Standards and Guidelines for Common Q Systems," Westinghouse Electric Company LLC.

5. WCAP-16096-NP-A, Rev. 1A, "Software Program Manual for Common Q Systems," Westinghouse Electric Company LLC.

6. WNA-DS-01667-WBT-P, Rev. 4, "Post Accident Monitoring System – System Design Specification," Westinghouse Electric Company LLC.

7. WNA-SD-00239-WBT-P, Rev. 4, "Software Requirements Specification for the Post Accident Monitoring System," Westinghouse Electric Company LLC.

8. WCAP-16097-P-A, Appendix 1, Rev. 0, "Common Qualified Platform Post Accident Monitoring Systems," Westinghouse Electric Company LLC.

9. WNA-DS-00315-GEN, Rev. 2, "Reusable Software Element Document CRC for Calibration Data," Westinghouse Electric Company LLC.

10. 00000-ICE-3238, Rev. 5, "Common Q Software Requirements Specification Post Accident Monitoring System," Westinghouse Electric Company LLC.

11. WNA-DS-01617-WBT-P, Rev. 4, "Post Accident Monitoring System-System Requirements Specification," Westinghouse Electric Company LLC.

12. WNA-DS-01715-GEN, Rev. 4, "Standard Reusable Software Element Document for PM Diagnostics Type Circuit," Westinghouse Electric Company LLC.

13. 00000-ICE-30152, Rev. 5, "Common Q Software Design Description Post Accident Monitoring System AC160 Station," Westinghouse Electric Company LLC.

REFERENCES (cont.)

14. 3BDS 005 665R401, Rev. A, "Data Base Elements, Advant Controller 160, Version 1.3 Reference Manual," Asea Brown Boveri.

15. WNA-DS-01838-GEN, Rev. 3, "Standard Reusable Software Element Document for Fourth-Order Polynomial Fluid Density Curve Fit Custom PC Element," Westinghouse Electric Company LLC.

16. WNA-DS-01839-GEN, Rev. 4, "Standard Reusable Software Element Document for Summation of Reference Leg Density Correction Custom PC Element," Westinghouse Electric Company LLC.

17. WNA-DS-01840-GEN, Rev. 2, "Standard Reusable Software Element Document for 2-Input Maximum Comparison with Status Control Custom PC Element," Westinghouse Electric Company LLC.

18. WNA-DS-01841-GEN, Rev. 2, "Standard Reusable Software Element Document for 2-Input Minimum Comparison with Status Control Custom PC Element," Westinghouse Electric Company LLC.

19. WNA-DS-01842-GEN, Rev. 4, "Standard Reusable Software Element Document for RVLIS Static Level Calculation Custom PC Element," Westinghouse Electric Company LLC.

20. WNA-DS-01845-GEN, Rev. 6, "Standard Reusable Software Element Document for Dynamic Head Compensation Calculation Custom PC Element," Westinghouse Electric Company LLC.

21. WNA-DS-01846-GEN, Rev. 2, "Standard Reusable Software Element Document for Normalized Dynamic Head Compensation Custom PC Element," Westinghouse Electric Company LLC.

22. WNA-DS-01847-GEN, Rev. 2, "Standard Reusable Software Element Document for Void Fraction Custom PC Element," Westinghouse Electric Company LLC.

23. WNA-DS-01848-GEN, Rev. 4, "Standard Reusable Software Element Document for the Reactor Vessel Level Monitoring Custom PC Element," Westinghouse Electric Company LLC.

24. WNA-DS-01849-GEN, Rev. 2, "Standard Reusable Software Element Document for the Reactor Coolant Pump Status Custom PC Element," Westinghouse Electric Company LLC.

25. WNA-DS-01994-GEN, Rev. 0, "Standard Reusable Software Element Document for a First Order Lag Filter Custom PC Element," Westinghouse Electric Company LLC.

26. WNA-DS-01505-GEN, Rev. 0, "Standard Reusable Software Element Document for Reflash Type Circuit," Westinghouse Electric Company LLC.

REFERENCES (cont.)

27. WNA-DS-01564-GEN, Rev. 2, "Standard Reusable Software Element Document for Exclusive Module Error Type Circuit," Westinghouse Electric Company LLC.

28. WNA-DS-02065-GEN, Rev. 2, "Standard Reusable Software Element Document for Reactor Vessel Level Alarm Custom PC Element," Westinghouse Electric Company LLC.

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SECTION 1
INTRODUCTION

1.1 OVERVIEW

This document describes the design of the Watts Bar 2 Post-Accident Monitoring System (PAMS) software in accordance with:

- NABU-DP-00014-GEN, "Design Process for Common Q Safety Systems" (Reference 1)
- 00000-ICE-3889, "Coding Standards and Guidelines for Common Q Systems" (Reference 4)
- WCAP-16096-NP-A, "Software Program Manual for Common Q Systems" (Reference 5)

This document applies only to the Watts Bar 2 PAMS Advant® Controller 160 (AC160) PM646A user application programs.

Within the Asea Brown Boveri (ABB) master programming language (AMPL) configuration control (ACC) *Advanced* Tool, each PM646A processor module (PM) is classified as a node. Each node contains a separate user application program made up of a configuration part (database [DB] elements of the related node) and a program part (process control [PC] elements of the related PC program). Within this document, the term "configuration" refers to the creation and modification of DB elements (i.e., configuration from a software point of view), and the term "programming" refers to the creation and modification of a PC program, including connections within the PC program and to DB elements.

1.2 SCOPE

The software requirements for the user application program in the Watts Bar 2 PAMS defined herein are based on the generic Common Q PAMS, [

]^{a,c}

The Watts Bar 2 PAMS will use the Westinghouse Reactor Vessel Level Instrumentation System (RVLIS) in place of the Heated Junction Thermocouple (HJTC) system.

1.3 OBJECTIVE

This document provides documentation for the design and implementation of the Watts Bar 2 PAMS AC160 PM646A user application programs in accordance with WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and 00000-ICE-3238, "Common Q Software Requirements Specification Post Accident Monitoring System" (Reference 10). A detailed description of the AC160 is defined in WNA-DS-01667-WBT-P, "Watts Bar NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6).

(Last Page of Section 1)

SECTION 2
GENERAL DESCRIPTION

2.1 GENERAL DESCRIPTION

The Watts Bar 2 PAMS consists of two divisions. Each division contains one AC160 station. Each station contains:

1. One CI631 communication module
2. One PM646A processor module
3. One DI620 digital input module
4. Two AI688 analog input modules
5. Two AO650 analog output modules
6. One DO620 digital output module
7. Four AI687 analog input modules

The AC160 processors are located in the Watts Bar 2 PAMS cabinets.

2.2 GENERAL PURPOSE

The Watts Bar 2 PAMS measures process input signals, and calculates the following Inadequate Core Cooling (ICC) functions: Core Exit Temperature, Subcooled Margin, and Reactor Vessel Level. It also provides outputs to the plant computer system, plant annunciators, and analog outputs. The PAMS processor nodes are identified in Section 2 of the Watts Bar 2 PAMS software requirements specification, WNA-SD-00239-WBT-P (Reference 7).

2.3 FUNCTIONAL DESCRIPTION

2.3.1 General Functional Description – PAMS Processor

[

]^{a,c}

2.3.2 Interfaces and Signal Flow Overview – PAMS Processor

2.3.2.1 PAMS Interface

The PAMS processor receives all signal inputs from the AC160 AI687, AI688, and DI620 modules, as defined in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Output signals are sent to the AC160 AO650 and DO620 modules, as defined in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

2.3.2.2 MTP Interface

[

]^{a,c}

2.3.2.3 Operator's Module Interface

[

]^{a,c}

2.3.2.4 AF100 Interface

All data from the MTP and OM (described above) is received via the AF100 bus. Data sent out from the PAMS processor over the AF100 bus includes addressable constants display values, diagnostic messages, and test parameters.

The main signal flow of the PAMS processor is shown in Figure 2-1.

a,c

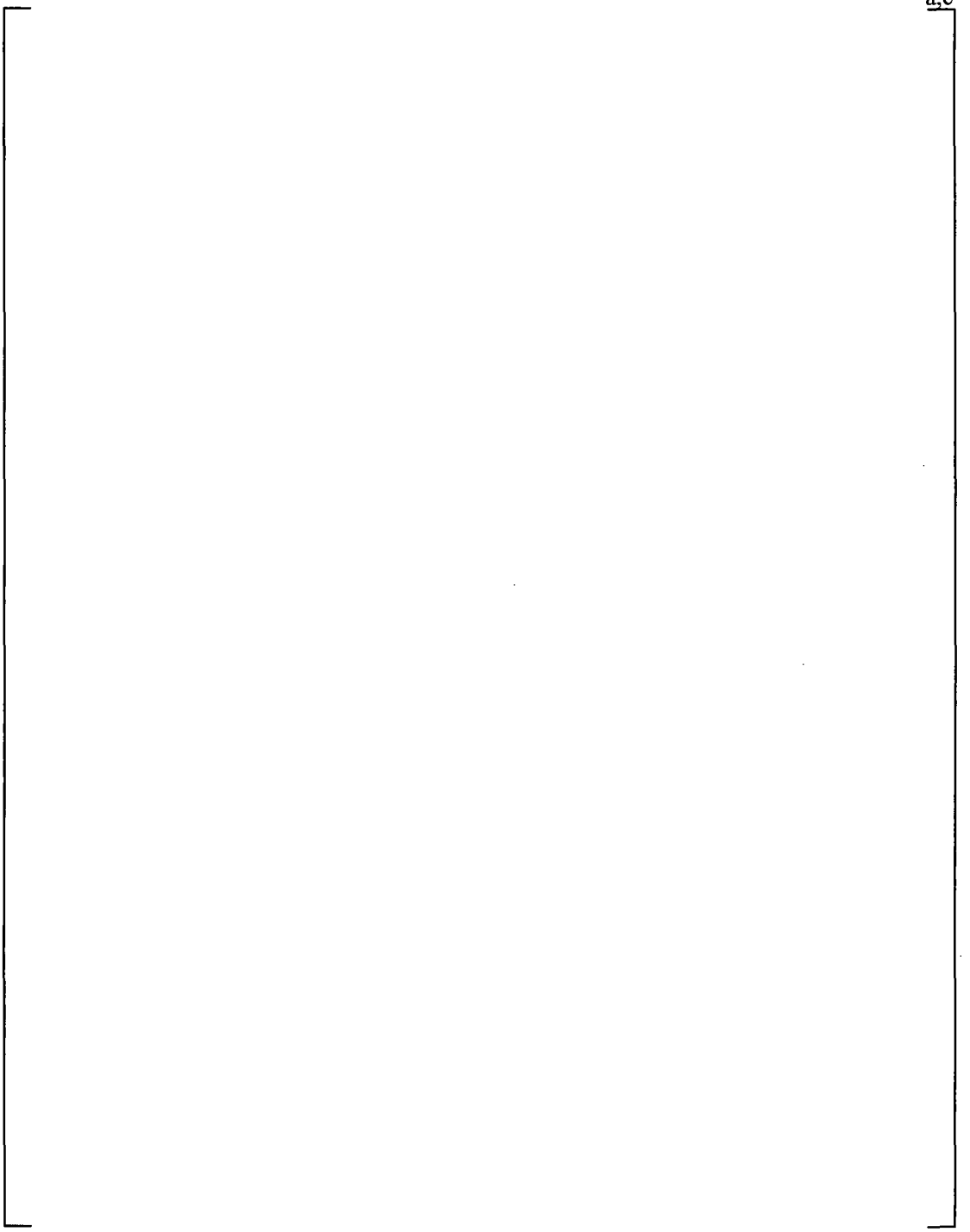

Figure 2-1. PAMS Main Signal Flow

2.3.3 Addressable Constants Data

Addressable constants – including alarm setpoints and test initiation flags – used by the AC160 PM646A are modifiable from the flat panel display system (FPDS). To modify addressable constants, plant personnel must activate the function enable (FE) keyswitch. The addressable constants are

range-limit-checked to ensure that they are within the valid range. [

]^{a,c}

2.3.4 Testing Features

The AC160 PM646A provides diagnostic, automatic, and manual testing of the PM646A[

]^{a,c}.

The PM646A processor performs online diagnostics during allotted idle time. [

]^{a,c} The FE keyswitch permissive will be required in order to perform this surveillance test[

]^{a,c}.

2.3.5 Miscellaneous User Information

Not applicable.

(Last Page of Section 2)

SECTION 3
COMPUTER SYSTEM DESCRIPTION

3.1 AC160 PRODUCT DESCRIPTION

The Watts Bar 2 PAMS is implemented using the ABB AC160 family of products as its software-based platform. The AC160 platform is described in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WCAP-16097-P-A, Appendix 1, "Common Qualified Platform Topical Report" (Reference 8).

3.2 AC160 PRODUCT CONFIGURATION

The AC160 configuration for the Watts Bar 2 PAMS is described in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6).

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SECTION 4
STANDARD SOFTWARE DESCRIPTION

4.1 ACC TOOL

Application user programs are developed on a personal computer using the ACC *Advanced* Tool, as defined in Section 3.2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

4.2 AC160 BASE SOFTWARE AND OPTIONS

The AC160 Base software (SW) – as defined in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) – is loaded onto the PAMS processor(s). [

]^{a,c}

4.3 TYPE CIRCUITS

4.3.1 Standard Type Circuits

The PAMS processor uses the standard type circuits listed in Table 7.1-1 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

4.3.2 Processor-Specific Type Circuits

No processor-specific type circuits are used in the Watts Bar 2 PAMS.

(Last Page of Section 4)

SECTION 5
APPLICATION SOFTWARE DESCRIPTION

5.1 NODE DESCRIPTION

The PAMS node consists of the logic necessary to perform the CET, sub-cooled margin, and the reactor vessel level logic, as documented in WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System-System Requirements Specification" (Reference 11), WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6), and WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The AC160 processor node and the associated file names are given in Tables 2.3-1 and 2.3-2 in Section 2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.1.1 General Constraints

The PAMS processor's application software general constraints are identified in Section 2.3 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

AC160-specific constraints are identified in subsection 7.1.13 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.1.2 Naming Conventions

Standard naming convention requirements and guidelines used in the PAMS processor are defined in 00000-ICE-3889, "Coding Standards and Guidelines for Common Q Systems" (Reference 4) and used in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.1.3 Initialization

Standard initialization requirements and guidelines used in the PAMS processor are identified in subsection 5.1.1 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2 DB SECTION DESCRIPTION

5.2.1 DB Section General Description

The DB section contains the DB elements necessary to connect the PC program section to external interfaces. The DB elements interface connections include connection for AC160 modules, and connections to the AF100 bus and DAT connections. The DB elements used for the PAMS processor are identified in Table 5.2-1.

The station addresses are identified in Tables 2.3-1 and 2.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.2 DB Element Call Names

DB elements are created by selection of their call names. Table 5.2-1 gives the call names for the DB elements.

Table 5.2-1. PAMS Processor DB Elements

DB Element Type	Call Name
Processor Module	PM646
Communication Interface	CI631
Analog Input Module	AI687
Analog Input Module	AI688
Digital Input Module	DI620
Digital Output Module	DO620
Analog Output Module	AO650
Real Data Memory	DAT(R)
Boolean Data Memory	DAT(B)
Integer Data Memory	DAT(I)
Integer Long Data Memory	DAT(IL)
Data Set Peripheral AF100 Message	DSP

5.2.3 DB Element Configuration

DB elements are configured using the Function Chart Builder (FCB) to enter terminal values. Parameters applicable to all PAMS processor(s) are described and listed in the sections below.

5.2.4 DB Element Module Bus and Station Addresses

The bus and station portions of the module DB element address are given in Tables 2.3-1 and 2.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The AC160 basic station thumbwheel switch must be set to the applicable station number shown in Tables 2.3-1 and 2.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The DB section data set peripheral (DSP) station number will use the DSP station numbers as defined in Tables 2.3-1 and 2.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5 DB Element Module Parameter Settings

5.2.5.1 Processor Module PM646A

The position parameters for the PM646A module are given in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). The module names are set to the node numbers given in Tables 2.3-1 and 2.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7). The other parameters for the PM are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.2 CI631 Communication Interface Module [CI1]

The position parameters for the CI631 module are given in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). The module name is CI1. The other parameters for the communication interface module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.3 DI620 Module [DI1]

The position parameters for the DI1 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the DI1 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The following names will be assigned to the digital input channels.

Table 5.2-2. Primary Subrack, RF616, Position 4 for Digital Input Card DI620

a,c

Table 5.2-2. Primary Subrack, RF616, Position 4 for Digital Input Card DI620 (cont.)

a,c

All other parameters for the DI1 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.4 AI688 Module [AI1]

The position parameters for the AI1 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specifications" (Reference 6). [

]^{a,c} The other parameters for the AI1 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The following names will be assigned to the analog input channels for the AI1 module.

Table 5.2-3. Primary Subrack, RF616, Position 5 for Analog Input Card AI688

a,c

Table 5.2-3. Primary Subrack, RF616, Position 5 for Analog Input Card AI688 (cont.)

a,c

All other parameters for the AI1 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.5 AI688 Module [AI2]

The position parameters for the AI2 module are in Section 4 of WNA-DS-01667-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AI2 module are set according to Section 4 of WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-4. Primary Subrack, RF616, Position 6 for Analog Input card AI688

a,c

Table 5.2-4. Primary Subrack, RF616, Position 6 for Analog Input card AI688 (cont.)

a,c

All other parameters for the AI2 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.6 AO650 Module [AO1]

The position parameters for the AO650 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AO1 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-5. Primary Subrack, RF616, Position 8 for Analog Output Card AO650

a,c

Table 5.2-5. Primary Subrack, RF616, Position 8 for Analog Output Card AO650 (cont.)

a,c

All other parameters for the AO1 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.7 AO650 Module [AO2]

The position parameters for theAO2 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AO2 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-6. Primary Subrack, RF616, Position 9 for Analog Output Card AO650

a,c

All other parameters for the AO2 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.8 DO620 Module [DO1]

The position parameters for the DO1 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the DO1 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-7. Primary Subrack, RF616, Position 10 for Digital Output Card DO620

a,c

[ ]a,c

All other parameters for the DO1 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.9 AI687 Module [AI3]

The position parameters for the AI3 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AI3 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-8. Train A Secondary Subrack, RF620, Position 11 for Analog Input Card AI687

a,c

Table 5.2-9. Train B Secondary Subrack, RF620, Position 11 for Analog Input Card AI687

a,c

Table 5.2-9. Train B Secondary Subrack, RF620, Position 11 for Analog Input Card AI687 (cont.)

a,c

All other parameters for the AI3 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.10 AI687 Module [AI4]

The position parameters for the AI4 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AI4 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-10. Train A Secondary Subrack, RF620, Position 12 for Analog Input Card AI687

a,c

Table 5.2-10. Train A Secondary Subrack, RF620, Position 12 for Analog Input Card AI687 (cont.)

a,c

Table 5.2-11. Train B Secondary Subrack, RF620, Position 12 for Analog Input Card AI687

a,c

All other parameters for the AI4 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.11 AI687 Module [AI5]

The position parameters for the AI5 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]^{a,c}
The other parameters for the AI5 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-12. Train A Secondary Subrack, RF620, Position 13 for Analog Input Card AI687

a,c

[

]

Table 5.2-13. Train B Secondary Subrack, RF620, Position 13 for Analog Input Card AI687

a,c

All other parameters for the AI5 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.5.12 AI687 Module [AI6]

The position parameters for the AI6 module are in Section 4 of WNA-DS-01667-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6). [ ]a,c
The other parameters for the AI6 module are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.2-14. Train A Secondary Subrack, RF620, Position 14 for Analog Input Card AI687

a,c

Table 5.2-15. Train B Secondary Subrack, RF620, Position 14 for Analog Input Card AI687

a,c

Table 5.2-15. Train B Secondary Subrack, RF620, Position 14 for Analog Input Card AI687 (cont.)

a,c

All other parameters for the AI6 channels are set according to Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.6 Communication DB Elements

5.2.6.1 AF100 BUS Communication

To send and receive data on the AF100 network, DSPs are used. A DSP can hold one to eight DAT values.

5.2.6.2 DSPs

This section describes how DSPs are used and the naming conventions. Standard signal naming conventions are documented in 00000-ICE-3889, "Coding Standards and Guidelines for Common Q Systems" (Reference 4) and subsection 2.3.1 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.6.2.1 DSP Terminal Settings

Standard DSP configuration requirements and guidelines used in the PAMS station or processor are identified in Section 4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.2.6.2.2 **DATs**

[

]^{a,c} The specific DAT names assigned are provided in the tables that follow, organized by DSP names.

5.2.7 Sending Data DSP Elements

Data will be transmitted from the AC160 to the MTP and OM via DSPs. The AC160 will broadcast information onto the AF100 bus, where it is available to both the MTP and OM. Table 5.2-16 lists the sending DSPs.

Table 5.2-16. WBT PAMS Sending DSPs

a,c

[

]

Table 5.2-16. WBT PAMS Sending DSPs (cont.)

a,c

Table 5.2-16. WBT PAMS Sending DSPs (cont.)

a,c

Table 5.2-16. WBT PAMS Sending DSPs (cont.)

a,c

Note:

1. NO – represents the following depending on the type of DSP:
   - B Number of Boolean RECords (NO_BREC) in the set.
   - I Number of INTeger (NO_INT) records in the set.
   - IL Number of INTeger Long (NO_INTL) records in the set.
   - R Number of Real (NO_REAL) records in the set.

5.2.7.1 DSP Name: PID_STA1

[

]a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

5.2.7.2 DSP Name: PID_STA2

This DSP transmits various status bits to the OM and to the MTP.

a,c

a,c

a,c

5.2.7.3 DSP Name: PID_SYS

This DSP contains information on the AC160 system status. [

]a,c

a,c

5.2.7.4 DSP Name: PID_ ACSYSTEM

This DSP transmits addressable constants back to the OM and to the MTP.

a,c

5.2.7.5 DSP Name: PID_IO

[

]a,c

[

]a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

5.2.7.6 DSP Name: PID_EU

[

]a,c

a,c

5.2.7.7 DSP Names: PID_AI1 _IN, PID_AI2 _IN

[

]a,c

a,c

a,c

a,c

5.2.7.8 DSP Names: PID_CET_IN1, PID_CET_IN2, PID_CET_IN3, PID_CET_IN4, PID_CET_IN5

[

]^{a,c}

a,c

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a,c

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a,c

5.2.7.9 DSP Names: PID_CET_OUT1, PID_CET_OUT2, PID_CET_OUT3, PID_CET_OUT4

[ ]a,c

a,c

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a,c

a,c

5.2.7.10 DSP Name: PID_IO_PROC

[ ]a,c

a,c

5.2.7.11 DSP Name: PID_ACCET

[

]a,c

a,c

5.2.7.12 DSP Names: PID_SMM_OUT1, PID_SMM_OUT2

[ ]a,c

a,c

[ ]a,c

a,c

5.2.7.13 DSP Name: PID_ACSMM

[ ]a,c

a,c

5.2.7.14 DSP Names: PID_RVL_OUT1, PID_RVL_OUT2, PID_RVL_OUT3, PID_RVL_OUT4, PID_RVL_OUT5, PID_RVL_OUT6

[ ]a,c

a,c

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a,c

5.2.7.15 DSP Names: PID_RVLIS_1, PID_RVLIS_2, PID_RVLIS_3, PID_RVLIS_4, PID_RVLIS_5, PID_RVLIS_6, PID_RVLIS_7, PID_RVLIS_8, PID_RVLIS_9, PID_RVLIS_10, PID_RVLIS_11, PID_RVLIS_12, PID_RVLIS_13, PID_RVLIS_14 PID_RVLIS_15, PID_RVLIS_16, PID_RVLIS_17, PID_RVLIS_18, PID_RVLIS_19, PID_RVLIS_20, PID_RVLIS_21, PID_RVLIS_22, PID_RVLIS_23, PID_RVLIS_24, PID_RVLIS_25, PID_RVLIS_26, PID_RVLIS_27, PID_RVLIS_28, PID_RVLIS_29, PID_RVLIS_30, PID_RVLIS_31, PID_RVLIS_32, PID_RVLIS_33

[ ]^{a,c}

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5.2.7.16 DSP Names: PID_ANASEL1, PID_ANASEL2

[

]a,c

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a,c

5.2.7.17 DSP Names: PID_RTD_IN

[ ]a,c

a,c

a,c

5.2.8 Receiving Data DSP Elements

[

]a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Table 5.2-17. WB PAMS Receiving DSPs

a,c

Notes

1. [ ]a,c
2. NO – represents the following depending on the type of DSP:
   - B Number of Boolean RECords (NO_BREC) in the set.
   - I Number of INTeger (NO_INT) records in the set.
   - IL Number of INTeger Long (NO_INTL) records in the set.
   - R Number of Real (NO_REAL) records in the set.

5.2.8.1 DSP Names: MTP_STAT

[

]a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

5.2.8.2 DSP Names: MTP_SYSTEM, MTP_ISYSTEM

[

]a,c

a,c

a,c

a,c

5.2.8.3 DSP Names: MTP_CET, MTP_ICET,

[

]a,c

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a,c

a,c

5.2.8.4 DSP Names: MTP_SMM, MTP_ISMM_

[

]a,c

a,c

a,c

a,c

5.2.8.5 DSP Names: MTP_SMMTST

[

]a,c

a,c

5.2.8.6 DSP Names: MTP_RVLIS_1, MTP_IRVL_1, MTP_RVLIS_2, MTP_IRVL_2, MTP_RVLIS_3, MTP_IRVL_3, MTP_RVLIS_4, MTP_IRVL_4, MTP_RVLIS_5, MTP_IRVL_5, MTP_RVLIS_6, MTP_IRVL_6, MTP_RVLIS_7, MTP_IRVL_7, MTP_RVLIS_8, MTP_IRVL_8, MTP_RVLIS_9, MTP_IRVL_9, MTP_RVLIS_10, MTP_IRVL_10, MTP_RVLIS_11, MTP_IRVL_11, MTP_RVLIS_12, MTP_IRVL_12, MTP_RVLIS_13, MTP_IRVL_13, MTP_RVLIS_14, MTP_IRVL_14, MTP_RVLIS_15, MTP_IRVL_15, MTP_RVLIS_16, MTP_IRVL_16, MTP_RVLIS_17, MTP_IRVL_17, MTP_RVLIS_18, MTP_IRVL_18, MTP_RVLIS_19, MTP_IRVL_19, MTP_RVLIS_20, MTP_IRVL_20, MTP_RVLIS_21, MTP_IRVL_21, MTP_RVLIS_22, MTP_IRVL_22, MTP_RVLIS_23, MTP_IRVL_23, MTP_RVLIS_24, MTP_IRVL_24, MTP_RVLIS_25, MTP_IRVL_25, MTP_RVLIS_26, MTP_IRVL_26, MTP_RVLIS_27, MTP_IRVL_27, MTP_RVLIS_28, MTP_IRVL_28, MTP_RVLIS_29, MTP_IRVL_29, MTP_RVLIS_30, MTP_IRVL_30, MTP_RVLIS_31, MTP_IRVL_31, MTP_RVLIS_32, MTP_IRVL_32

[

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5.2.8.7 DSP Names: MTP_ANASEL1, MTP_IANASEL1, MTP_ANASEL2, MTP_IANASEL2

[

]a,c

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a,c

5.2.8.8 DSP Names: MTP_AO_TEST, OM_ AO_TEST

[

]a,c

a,c

5.2.8.9 DSP Names: MTP_AC1_CRCS, OM_AC1_CRCS, MTP_AC2_CRCS, MTP_AC3_CRCS, MTP_AC4_CRCS

[

]a,c

a,c

[ ]a,c

a,c

[ ]a,c

a,c

[ ]a,c

a,c

5.2.8.10 MDATs

MDATs are not utilized in the Watts Bar 2 PAMS.

5.2.8.11 HSLs

HSLs are not utilized in the Watts Bar 2 PAMS.

5.3 PC SECTION DESCRIPTION

The PAMS processor performs the functions described in Section 2.3 of this document. The main signal flow path for the PAMS processor is shown in Figure 2-1.

5.3.1 General PC Section Program Structure

For structuring and execution control, the program consists of a Program Header (PCPGM), [ ]^{a,c} Control Module Headers (CONTRMs), and Function Modules (FUNCMs). The CONTRM is used for execution control within the program. The FUNCM has no effect on the execution, but is used to improve the structure of the program.

5.3.2 Program Structure PC Elements

5.3.2.1 PCPGM

The PAMS processor application programs starts with the PCPGM PC element. [

]^{a,c}

5.3.2.2 CONTRM

[

]^{a,c}

5.3.2.3 FUNCM

In the PAMS application software, FUNCMs are used to improve the structure of the PC program. The FUNCM elements do not affect the execution.

5.3.3 Program Structure

5.3.3.1 Application Program Structure

The PAMS processor's application program structure requirements are documented in Section 5 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

The tree representation of the overall program structure is presented in Figure 5-1. The FUNCMs depicted are top-level and will be further subdivided into functionally associated parts.

a,c

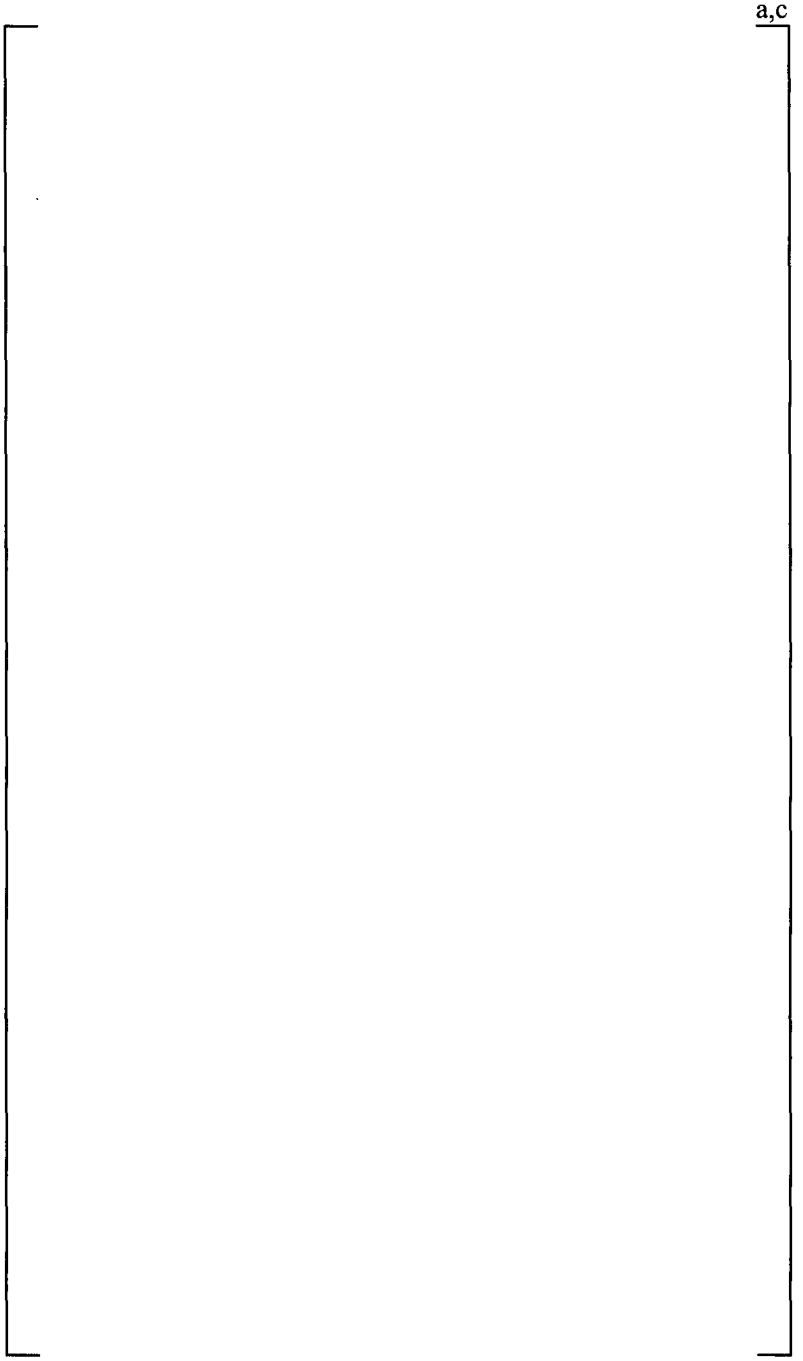


Figure 5-1. PAMS Program Tree Structure

5.3.3.2 Module Timing Constraints

The PAMS processor timing constraints are identified in Section 7.1.6 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4 WATTS BAR 2 PAMS

5.4.1 Online Diagnostics FUNCM

5.4.1.1 Online Diagnostics Implementation

Type

An AC160 function module (FUNCM).

Purpose

This function module performs startup, supervision, and diagnostics for PAMS.

Function

PAMS diagnostics logic monitors the AC160 system to determine failures in accordance with Section 5 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7). PAMS supervisory logic is described on a higher level in Section 5.3 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

This FUNCM will utilize the

- PM_DIAG type circuit (TC) – see WNA-DS-01715-GEN, "Standard Reusable Software Element Document for PM Diagnostics Type Circuit" (Reference 12).
- REFLASH type circuit (TC) – see WNA-DS-01505-GEN, "Standard Reusable Software Element Document for REFLASH Type Circuit" (Reference 26).

This module will perform the following functions:

Supervisory diagnostics – utilizing the PM_DIAG type circuit, see subsection 5.4.1.1.1
[ ]^{a,c}
Trouble Annunciation – alarm generation [ ]^{a,c} see subsection 5.4.1.1.6.

Subordinates

The Online Diagnostics algorithm module consists of [ ]^{a,c} PC elements to perform the aforementioned functions. [ ]^{a,c}

Dependencies

The Online Diagnostics module has no dependencies.

Interface

The interface for this module is to the database input channels (Section 5.2) and to the dataset elements (Section 5.2).

Resources

No other external services are directly called by the source code.

Processing

The diagnostic processing will be done in different sections and the descriptions follow.

5.4.1.1.1 PM Diagnostics

Processor-Specific Supervision Implementation

The PM_DIAG TC is defined in WNA-DS-01715-GEN, "Standard Reusable Software Element Document for PM Diagnostics Type Circuit" (Reference 12).

The following logic diagram is from WNA-DS-01715-GEN, "Standard Reusable Software Element Document for PM Diagnostics Type Circuit" (Reference 12).

a,c

Figure 5-2. PM_DIAG Logic

The input terminal names for the PM_DIAG TC are listed in Table 5.4-1.

Table 5.4-1. PM_DIAG Input Signals

a,c

Table 5.4-1. PM_DIAG Input Signals (cont.)

a,c

The connections to the terminals for the Watts Bar 2 PAMS application are as follows:

[

]a,c

[

]a,c

Table 5.4-2. PM_DIAG AF100 Outputs

a,c

Table 5.4-2. PM_DIAG AF100 Outputs (cont.)

a,c

5.4.1.1.2 **Heartbeats**

The AC160 heartbeat generation will be implemented using the standard element SYSTIME [ ]a,c.

The OM and MTP heartbeat checks will be implemented as depicted in Figure 5-3.

a,c

Figure 5-3. FPD Heartbeat Check

Rationale: R5.3.22-2, R5.3.22-3, R7.1.3.3-3, and R7.2.36 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.1.1.3 **Watchdog Timer**

This logic will be programmed using standard PC elements.

[

]a,c

[a,c]

Figure 5-4. Watchdog Timer Logic

5.4.1.1.4 **Station Status**

[ ]a,c

[a,c]

Figure 5-5. Station Status Example

Rationale: R5.3-5 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.1.1.5 **AF100 Fiber Error Detection**

[ ]a,c

a,c

Figure 5-6. AF100 Error Detection

[

]a,c

5.4.1.1.6 **Digital Alarm Outputs**

Various alarms are generated [ ]a,c. All of these are sent to the OM and MTP for display. A few are sent to digital outputs for annunciation in the control room. Subsection 4.3.2 of WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System-System Requirements Specifications" (Reference 11) defines the following annunciator alarms to be sent to the digital outputs for the single channel:
[

]a,c

5.4.1.1.7 **Low RCS Subcooled Margin Alarm**

[

]a,c

Figure 5-7. RCS SM Alarm

Rationale: R7.1.5.2-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7.)

5.4.1.1.8 **Low Reactor Level Alarm**

[

]a,c The conditions for the alarm are given in R2.5.3.4.17-4 through R2.5.3.4.17-8 of WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System-System Requirements Specifications" (Reference 11). [

]a,c

Rationale: R7.1.4.3-43 and R7.1.4.6-3 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.1.1.9 **Low CET Saturation Margin or High Representative CET Temperature Alarm**

[

]a,c

a,c

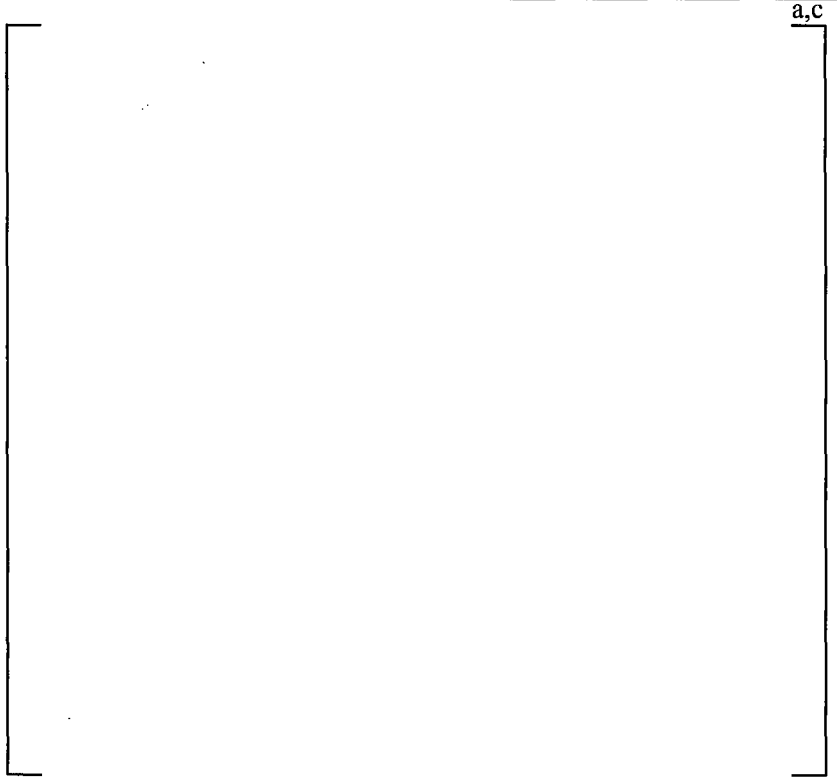


Figure 5-8. Alarm Generation

Rationale: R7.1.4.6-3 of WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7.)

5.4.1.1.10 **ICC Alarm**

[

]a,c

a,c

Figure 5-9. ICC Alarm

Rationale: R7.1.4.6-2 of WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.1.1.11 System Trouble Alarm

The logic for the System Trouble Alarm is shown in Figure 5-10. [

]^{a,c}

The System Trouble conditions are listed in Table 5.4-3.

Table 5.4-3. System Trouble Annunciator Alarm Conditions

a,c

a,c

Figure 5-10. Trouble Alarm Logic

Rationale: Satisfies R7.1.4.6-1, R7.1.4.6-3 and R7.1.5.2-6 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.1.1.12 **Annunciator Re-flash**

An active annunciator will re-flash if a new alarm condition occurs. [

]a,c

a,c

Figure 5-11. Annunciator Re-flash

Rationale: R7.1.4.6-4, R7.1.4.6-5, and R7.1.4.6-6 of WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.2 INPUT PROCESSING FUNCM

5.4.2.1 Input Processing Implementation

Type

An AC160 function module (FUNCM).

Purpose

This function module inputs and processes the analog signals to PAMS.

Function

As described in WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7), this module will perform the following functions:

1. Read input signals from S600 I/O modules [ ]^{a,c}
2. Convert input signals to engineering units
3. Determine signal quality from I/O status [ ]^{a,c}
4. Provide signal values in engineering units to other PAMS functions and to the OM and MTP over the AF100 bus

[

]^{a,c}

Subordinates

[

]^{a,c}

Dependencies

[

]^{a,c}

Interface

The interface for this module is to the database input channels (Section 5.2), to the dataset elements (Section 5.2), and to the PAMS algorithms input terminals.

Resources

No other external services are directly called by the source code.

Data

[

]^{a,c}

Processing

The diagnostic processing will be done in different sections and the descriptions follow.

5.4.2.2 Redundant Analog Inputs

The algorithm for handling failover for the redundant analog inputs is shown in the following figure.
[

]a,c

a,c

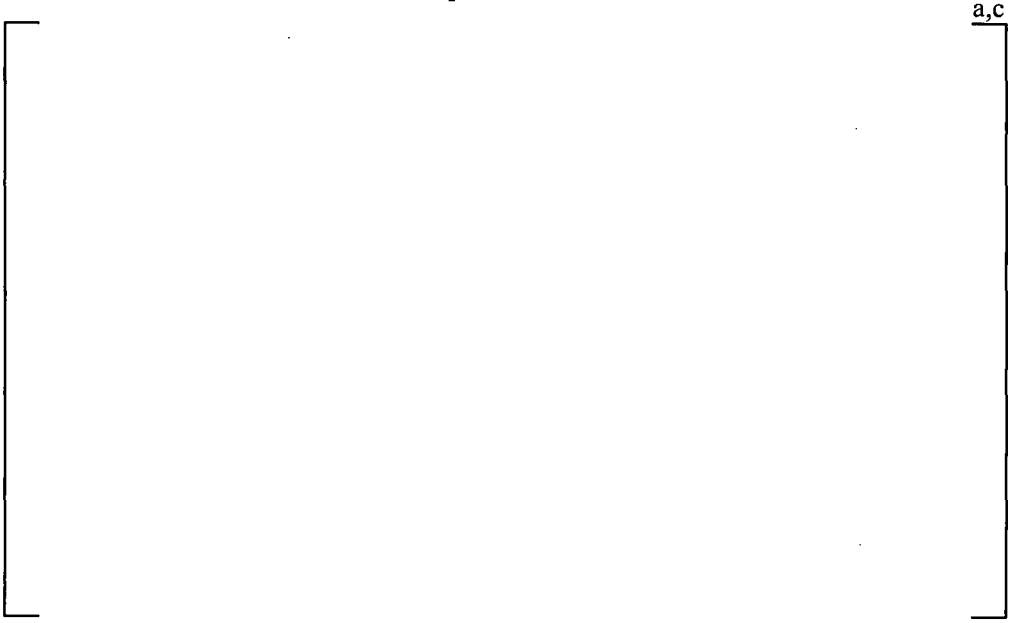


Figure 5-12. Sample of Redundant Input Failover

Rationale: R7.1.4.1-8, R7.1.4.1-9, and R7.1.4.1-10 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.2.3 Engineering Units Conversion

The algorithm used for converting analog inputs to engineering units is shown in Figure 5-13. [

]a,c

[a,c

]

Figure 5-13. Sample of Input Processing Implementation

[

]a,c

[a,c

]

Figure 5-14. RCS Inputs to CET Monitoring and SM Test Switch

5.4.2.4 Differential Pressure Processing

[

]a,c

a,c

Figure 5-15. Differential Pressure Processing

Rationale: Satisfies R7.1.4.3 8 and R7.1.4.3 47 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.2.5 CET and RTD Substitution

[

]a,c

a,c

Figure 5-16. CET and RTD Substitution

Rationale: Satisfies R7.1.4.2-4 and R7.1.4.3-52 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.3 PAMS FUNCM

5.4.3.1 PAMS SMM Algorithm Implementation

Type

An AC160 function module (FUNCM).

Purpose

This function module performs the SMM calculations, which include CET processing and the SM calculations.

Function

As described in 00000-ICE-3238, "Common Q Software Requirements Specification Post Accident Monitoring System" (Reference 10), this FUNCM will perform the following functions:

1. CET Processing
2. SM Calculation

Each of these functions is described in further detail in Section 6 of 00000-ICE-30152, "Common Q Software Design Description Post Accident Monitoring System AC160 Station" (Reference 13).

Also included in this section are any PAMS functions accomplished using standard PC elements, such as alarm processing, analog output processing, and the test-enable function.

Subordinates

[

]^{a,c}

Dependencies

[ ]^{a,c}

Interface

[

]^{a,c}

Resources

No other external services are directly called.

Processing

[

]^{a,c}

a,c

Figure 5-17. PAMS Algorithms Interconnections

5.4.3.2 CET_MON Implementation

[

]a,c

a,c

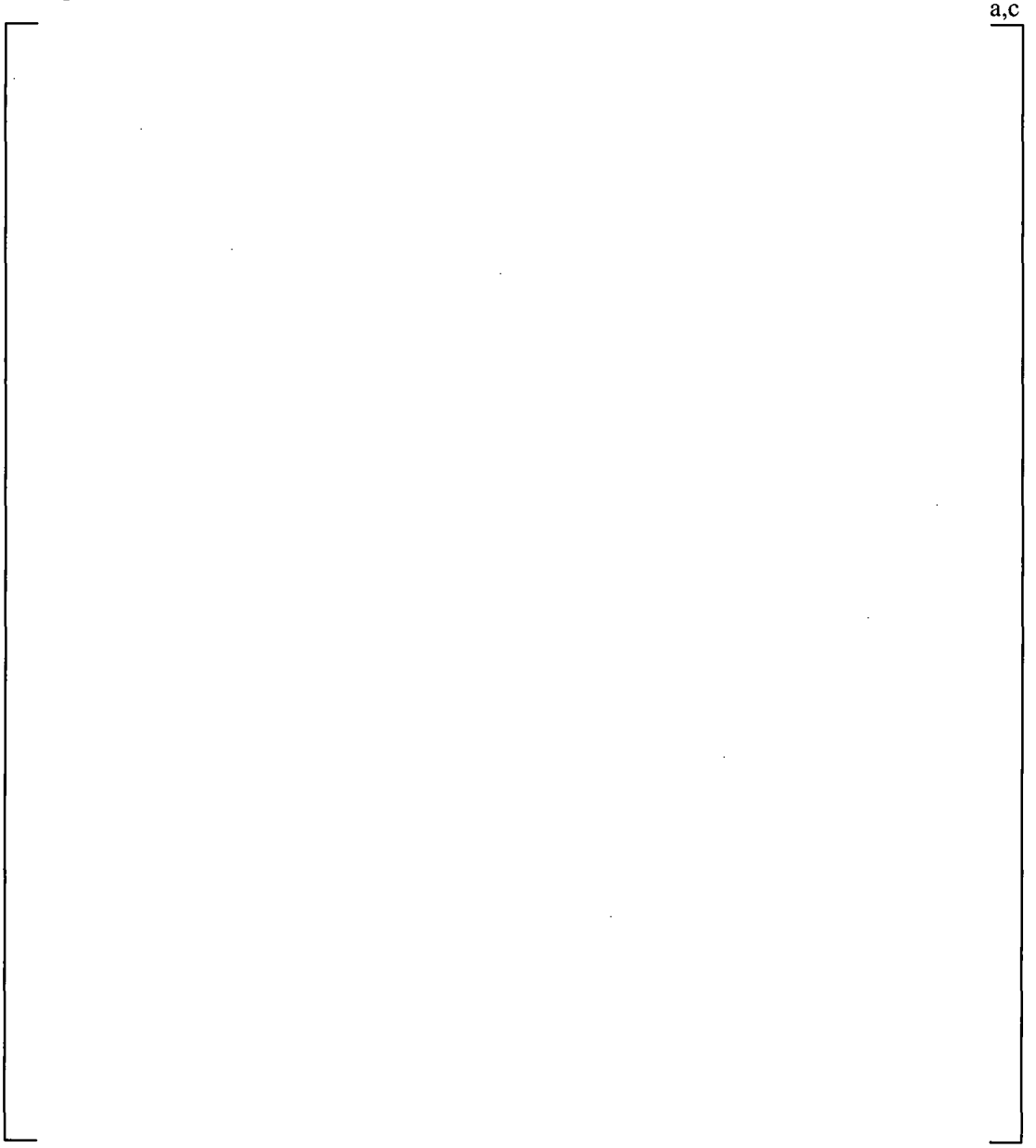


Figure 5-18. CET_MON Element Terminals

Table 5.4-4. CET_MON Input Signal Description

a,c

Table 5.4-4. CET_MON Input Signal Description (cont.)

a,c

Table 5.4-5. CET_MON Input Signal Connections[1]

a,c

Table 5.4-5. CET_MON Input Signal Connections(1) (cont.)

a,c

[

]a,c

[

]a,c

[

]a,c

Table 5.4-6. CET_MON Outputs

a,c

Table 5.4-6. CET_MON Outputs (cont.)

a,c

5.4.3.2.1 CET_MON Initialization

[

]a,c

a,c

Figure 5-19. CET_MON Initialization

5.4.3.3 SM_MON Implementation

The Watts Bar 2 SM_MON software is defined in 00000-ICE-30152, "Common Q Software Design Description Post Accident Monitoring System AC160 Station" (Reference 13). This section identifies the differences between the generic PAMS AC160 SMM software and the Watts Bar 2 PAMS implementation.

a,c

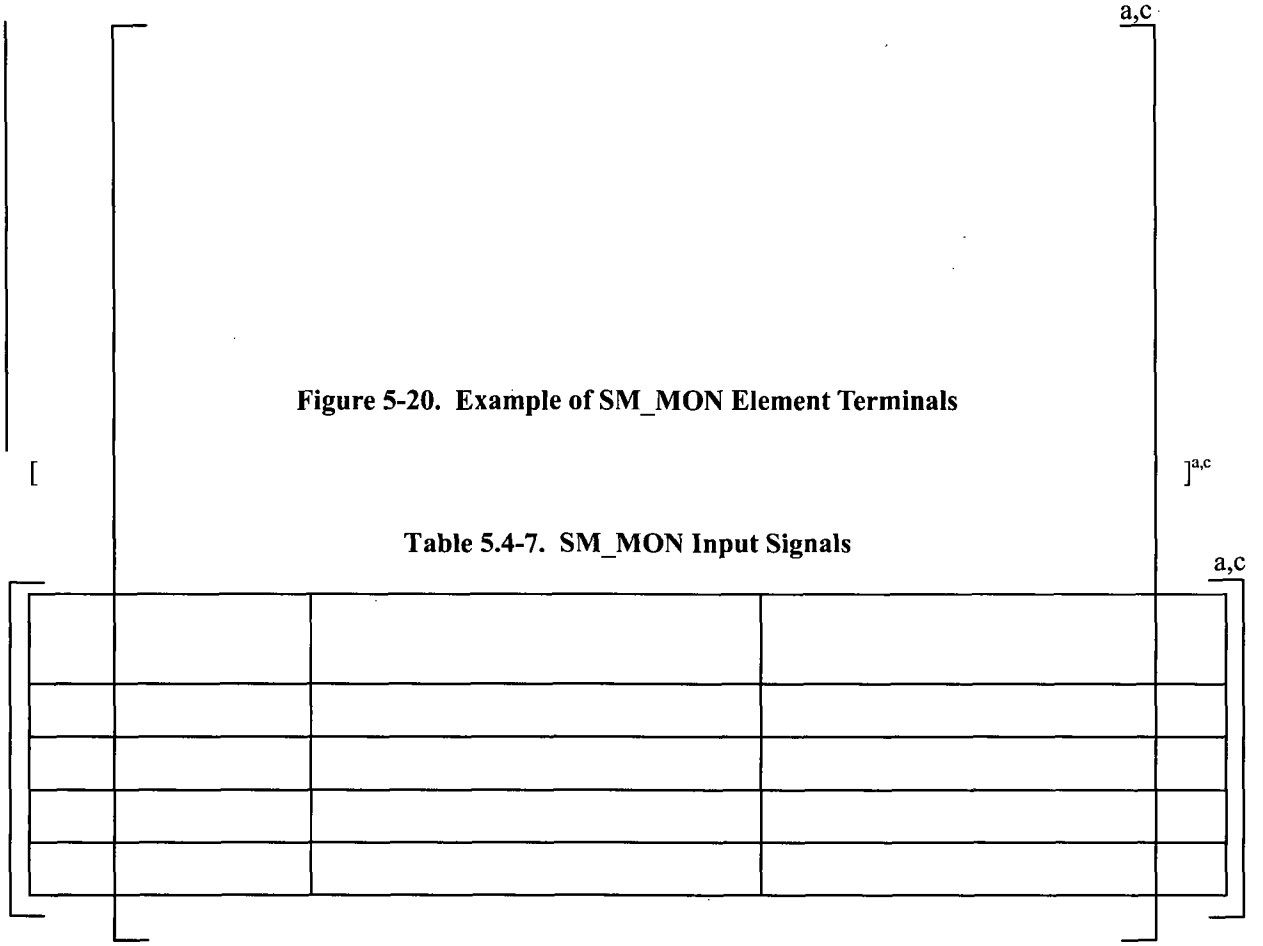


Figure 5-20. Example of SM_MON Element Terminals

[ ]a,c

Table 5.4-7. SM_MON Input Signals

a,c

Table 5.4-7. SM_MON Input Signals (cont.)

a,c

Table 5.4-7. SM_MON Input Signals (cont.)

a,c

[

]a,c

[

]a,c

Table 5.4-8. SM_MON Outputs

a,c

[

]a,c

[

]a,c

[

]a,c

Table 5.4-9. Bit Naming for SM_STAT Bits Assignment

a,c

a,c

[

]a,c

Table 5.4-10. Bit Naming for SWVSMM Bits Assignment

a,c

5.4.3.3.1 **Predefined Analog Outputs**

The predefined analog outputs per WNA-DS-01667-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Design Specification" (Reference 6) are:

[

]a,c

[

]a,c

a,c

Figure 5-21. Saturation Margin Outputs

a,c

Figure 5-22. Reactor Vessel Level Analog Output

Figure 5-23. TCREP Analog Output

5.4.3.3.2 Maximum and Second Maximum CET in a Quadrant

[

]^{a,c}

Figure 5-24. Quadrant Max CET Processing

5.4.4 RVLIS FUNCM

Type

An AC160 function module (FUNCM).

Purpose

[

]a,c

Function

As described in Section 7 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7), the following functions will be performed by this FUNCM:
[

]a,c

Each of these functions is described in further detail in subsections 5.4.4.2 and 5.4.4.3.

Subordinates

[

]a,c

Dependencies

The PAMS algorithm module depends on the input processing function for converted input signals.

Interface

The interface for this module is to various DATs, AOs (subsections 5.4.3.3.1 and 5.4.5.5), and DOs via annunciator testing (subsection 2.3.4).

Resources

No other external services are directly called.

Processing

[

]a,c

5.4.4.1 RVLIS Input/Output Overview

Table 5.4-11. RVLIS Input Signals

a,c

Table 5.4-11. RVLIS Input Signals (cont.)

a,c

Table 5.4-11. RVLIS Input Signals (cont.)

a,c

Table 5.4-11. RVLIS Input Signals (cont.)

a,c

Table 5.4-11. RVLIS Input Signals (cont.)

a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

Table 5.4-12. RVLIS DENSO4 Density Coefficients

a,c

Table 5.4-12. RVLIS DENSO4 Density Coefficients (cont.)

a,c

Table 5.4-13. Miscellaneous RVLIS Hardcoded Constants

a,c

Rationale: Satisfies R7.1.4.3-2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

Table 5.4-14. RVLIS Outputs

a,c

Table 5.4-14. RVLIS Outputs (cont.)

a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

Table 5.4-15. RCP Statuses

a,c

5.4.4.2 PAMS RVLIS Static Algorithm Implementation

a,c

Figure 5-25. RVLIS Static Algorithm

[

]a,c

Rationale: Satisfies R7.1.4.3-1, R7.1.4.3-3, and R7.1.4.3-4 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.4.2.1 RTD Density FUNCM

a,c

Figure 5-26. RTD Density FUNCM

[

]a,c

[

]a,c

Rationale: Satisfies R7.1.4.3-9, R7.1.4.3-10, R7.1.4.3-45, R7.1.4.3-46 and R7.1.4.3-52 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01838-GEN, "Standard Reusable Software Element Document for Fourth-Order Polynomial Fluid Density Curve Fit Custom PC Element" (Reference 15).

5.4.4.2.2 **Hot Leg Density FUNCM**

a,c

Figure 5-27. Hot Leg Density FUNCM

[

]a,c

[

]a,c

Rationale: Satisfies R7.1.4.3-10, R7.1.4.3-13, R7.1.4.3-14 and R7.1.4.3-15 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01840-GEN, "Standard Reusable Software Element Document for 2-Input Maximum Comparison with Status Control Custom PC Element" (Reference 17).

5.4.4.2.3 RLDCORR FUNCM

a,c

Figure 5-28. RLDCORR FUNCM

[

]a,c

[

]a,c

Rationale: R7.1.4.3-11, R7.1.4.3-12 and R7.1.4.3-50 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01839-GEN, "Standard Reusable Software Element Document for Summation of Reference Leg Density Corrections Custom PC Element" (Reference 16).

5.4.4.2.4 MAX/MIN Vessel Density FUNCM

a,c

Figure 5-29. MAX/MIN Vessel Density FUNCM

[

]a,c

Rationale: R7.1.4.3-13 and R7.1.4.3-14 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01841-GEN, "Standard Reusable Software Element Document for 2-Input Minimum Comparison with Status Control Custom PC Element" (Reference 18).

5.4.4.2.5 Static Outrange FUNCM

a,c

Figure 5-30. Static Outrange FUNCM

[

]a,c

Table 5.4-16. Hydraulic Isolation Contacts STATIC Outrange Failure States

a,c

Rationale: R7.1.4.3-20 in WNA-SD-00239-WBT-P, "RRAS Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.4.2.6 Upper Static FUNCM

a,c

Figure 5-31. Upper Static FUNCM

[

]a,c

Rationale: Satisfies R7.1.4.3-16, R7.1.4.3-17, R7.1.4.3-20, R7.1.4.3-35, R7.1.4.3-36, and R7.1.4.3-40 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01842-GEN, "Standard Reusable Software Element Document for RVLIS Static Level Calculation Custom PC Element" (Reference 19).

5.4.4.2.7 Lower Static FUNCM

a,c

Figure 5-32. Lower Static FUNCM

[

]a,c

Rationale: Satisfies R7.1.4.3-16, R7.1.4.3-17, R7.1.4.3-20, R7.1.4.3-35, R7.1.4.3-37, and R7.1.4.3-41 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01842-GEN, "Standard Reusable Software Element Document for RVLIS Static Level Calculation Custom PC Element" (Reference 19).

5.4.4.3 PAMS RVLIS Dynamic Algorithm Implementation

a,c

Figure 5-33. RVLIS Dynamic Algorithm

[

]a,c

Rationale: Satisfies R7.1.4.3-1of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.4.3.1 **Dynamic RLDCORR FUNCM**

a,c

[

]

Figure 5-34. Dynamic RLDCORR FUNCM

[

]a,c

Rationale: R7.1.4.3-11 and R7.1.4.3-12 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01839-GEN, "Standard Reusable Software Element Document for Summation of Reference Leg Density Corrections Custom PC Element" (Reference 16).

5.4.4.3.2 **DHCALC FUNCM**

a,c

Figure 5-35. DHCALC FUNCM

[

]a,c

Rationale: Satisfies R7.1.4.3-28, R7.1.4.3-29, R7.1.4.3-30, R7.1.4.3-31, and R7.1.4.3-32 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-01845-GEN, "Standard Reusable Software Element Document for Dynamic Head Compensation Calculation Custom PC Element" (Reference 20).

5.4.4.3.3 PUMPSTAT FUNCM

a,c

a,c

Figure 5-36. PUMPSTAT FUNCM

[

]a,c

[

]^{a,c}

Rationale: Satisfies R7.1.4.3-6, R7.1.4.3-7, R7.1.4.3-21, R7.1.4.3-22, R7.1.4.3-23, R7.1.4.3-24, R7.1.4.3-25, R7.1.4.3-26, and R7.1.4.3-27 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7) and WNA-DS-1849-GEN, "Standard Reusable Software Element Document for the Reactor Coolant Pump Status Custom PC Element" (Reference 24).

5.4.4.3.4 VOIDFRAC/NDH FUNCM

a,c

]a,c

Figure 5-37. VOIDFRAC/NDH FUNCM

[

]a,c

[

]a,c

Rationale: Satisfies R7.1.4.3-33 and R7.1.4.3-34 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7), WNA-DS-01846-GEN, "Standard Reusable Software Element Document for Normalized Dynamic Head Compensation Custom PC Element" (Reference 21), and WNA-DS-01847-GEN, "Standard Reusable Software Element Document for Void Fraction Custom PC Element" (Reference 22).

5.4.4.3.5 Scaling FUNCM

a,c

Figure 5-38. Scaling FUNCM

[

]a,c

[

]a,c

Rationale: Satisfies R7.1.4.3-38, R7.1.4.3-39, and R7.1.4.3-42 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.4.3.6 Level and Alarm FUNCM

a,c

a,c

Figure 5-39. Level and Alarm FUNCM

[

]a,c

[

]a,c

Rationale: Satisfies R7.1.4.3-5, R7.1.4.3-18, R7.1.4.3-19, R7.1.4.3-21, R7.1.4.3-22, R7.1.4.3-43, and R7.1.4.3-44 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7), WNA-DS-01848-GEN, "Standard Reusable Software Element Document for Reactor Vessel Level Monitoring Custom PC Element" (References 23), and WNA-DS-02065-GEN, "Standard Reusable Software Element Document for Reactor Vessel Level Alarm Custom PC Element" (Reference 28).

5.4.5 MAINTENANCE FUNCM

5.4.5.1 Maintenance Algorithm Implementation

Type

An AC160 function module (FUNCM).

Purpose

This function module performs the surveillance tests and the user selection of the three analog outputs.

Function

As described in WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7), this module will perform the following functions:
[

]^{a,c}

Subordinates

None.

Dependencies

The Maintenance module has no dependencies.

Interface

The interface for this module is to the database input channels (Section 5.2) and to the dataset elements (Section 5.2).

Resources

No other external services are directly called by the source code.

Processing

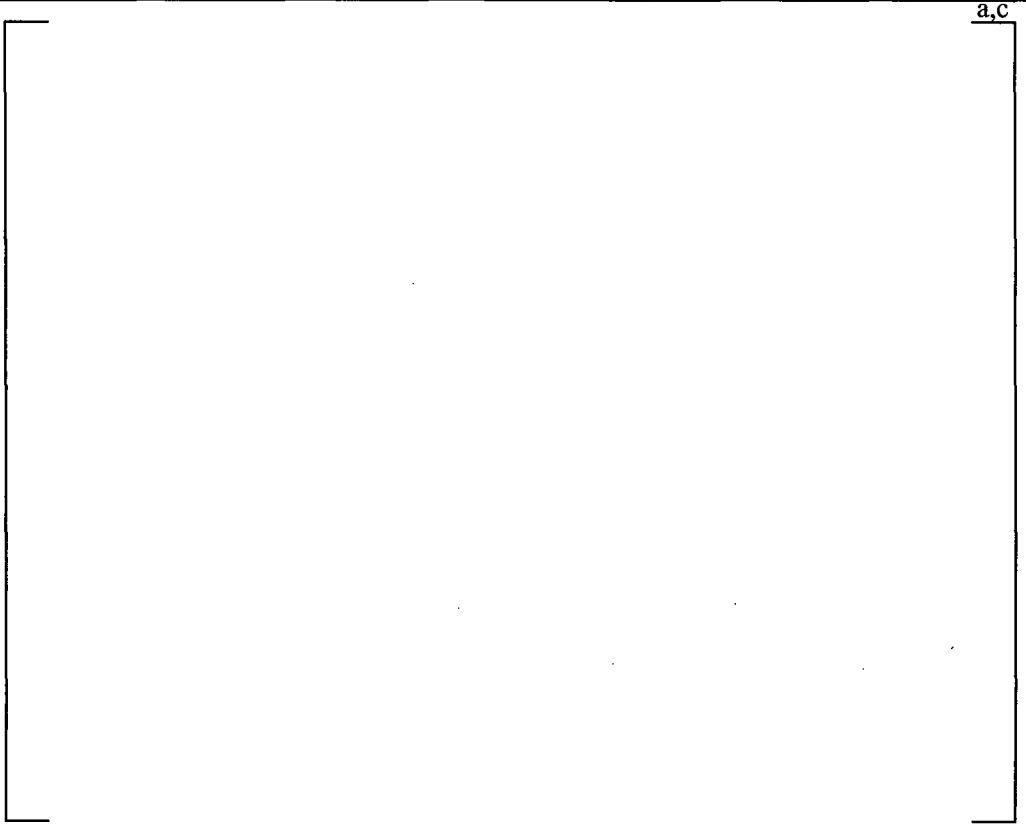
The diagnostic processing will be done in different sections and the descriptions follow.

5.4.5.2 SMM Test

[

]^{a,c}

[a,c



]a,c

Figure 5-40. Test Inputs to SM Monitoring

5.4.5.3 Annunciator Test

[

]a,c

a,c

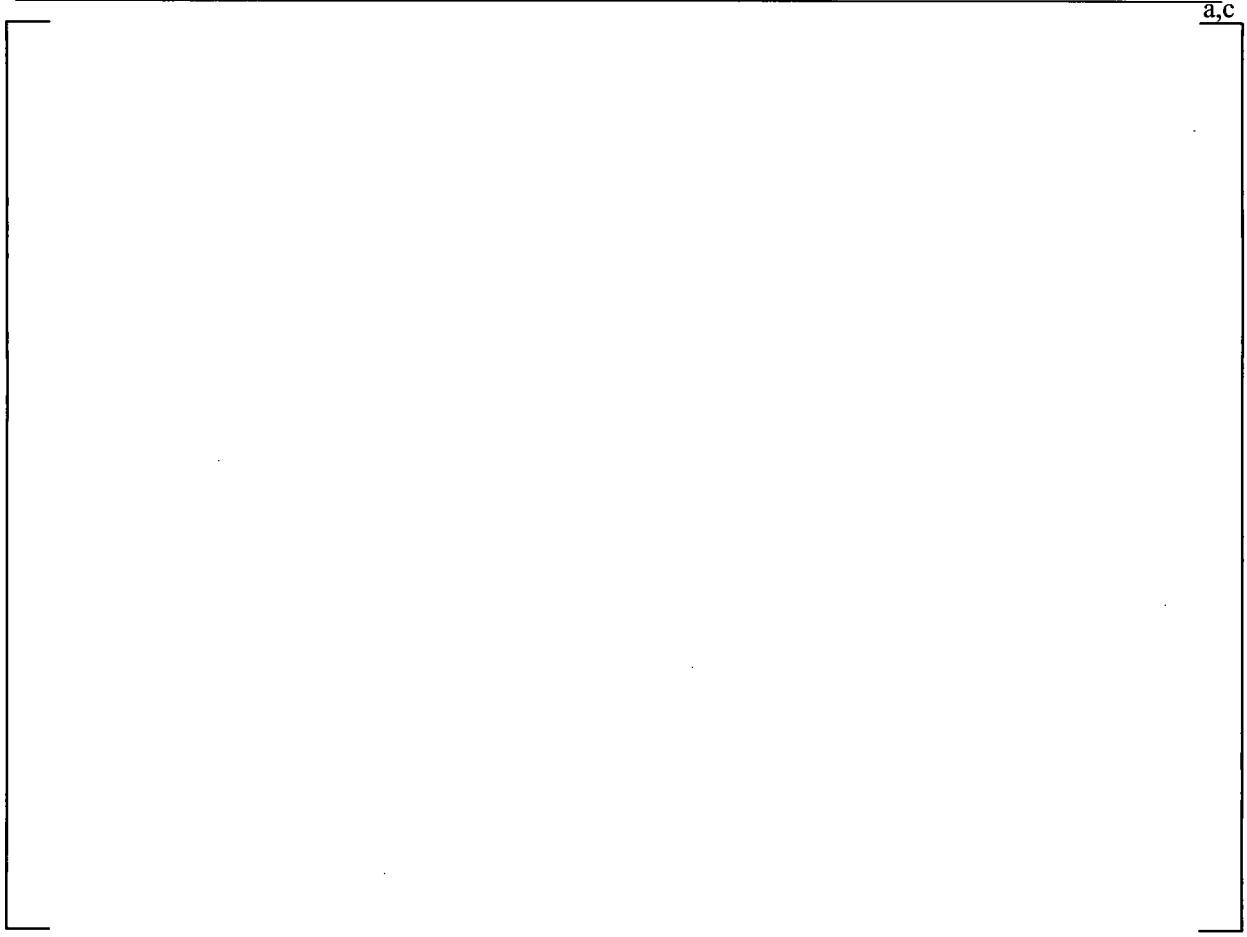


Figure 5-41. Annunciator Test

Rationale: Satisfies R6.2-4 and R7.1.4.6-6 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7); R4.3.2-7 of WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System-System Requirements Specification" (Reference 11).

5.4.5.4 Analog Output Test

[

]a,c

a,c

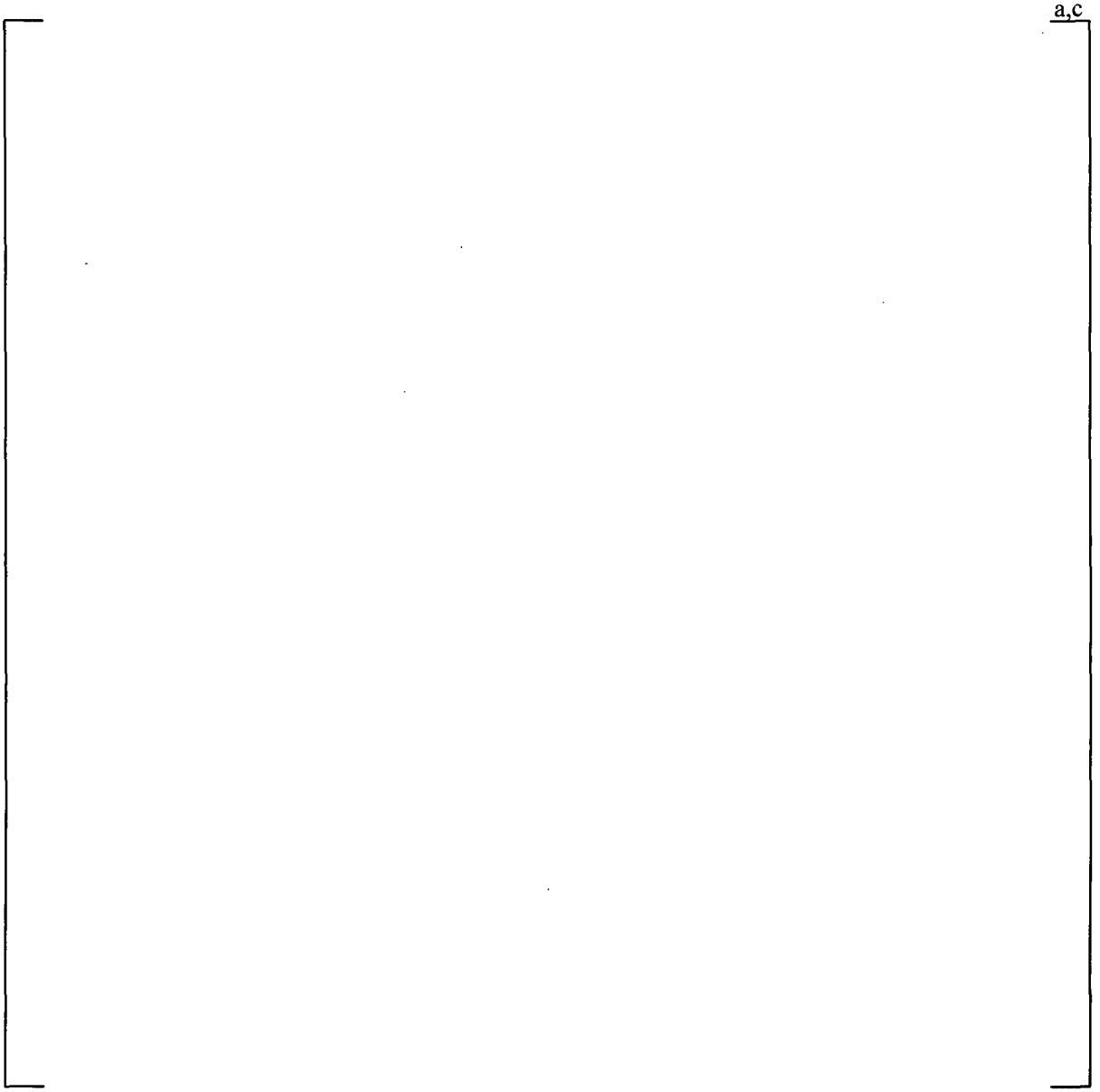


Figure 5-42. Analog Output Test

Rationale: Satisfies R6.2-6, R6.2-7, and R6.2-8 and R7.2.26 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.5.5 User-Selectable Analog Output

[

]a,c

[

]a,c

a,c

Figure 5-43. Analog Output Selection

Rationale: Satisfies R7.15.1-4 and R7.15.1-5 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

5.4.6 Addressable Constants FUNCM

5.4.6.1 Addressable Constants Implementation

Type

An AC160 function module (FUNCM).

Purpose

[

]a,c

Function

[

]a,c

Subordinates

[

]a,c

Dependencies

The Addressable Constants module has no dependencies.

Interface

The interface for this module is to the dataset elements (Section 5.2).

Resources

No other external services are directly called by the source code.

Processing

The processing will be done in different sections and the descriptions follow.

5.4.6.1.1 Addressable Constants Verification

[

]a,c

a,c

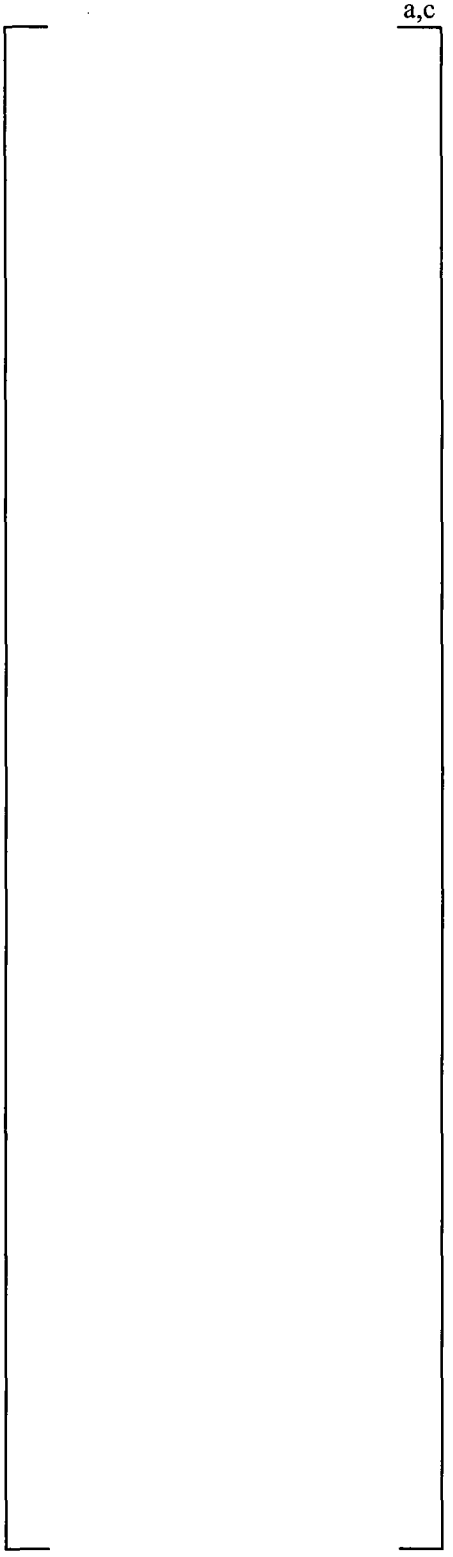


Figure 5-44. CAL_CRC Terminals

[

]a,c

Table 5.4-17. CAL_CRC OM Input DSPs/DATs

a,c

Table 5.4-18. CAL_CRC MTP Input DSPs/DATs

a,c

Table 5.4-18. CAL_CRC MTP Input DSPs/DATs (cont.)

a,c

Table 5.4-18. CAL_CRC MTP Input DSPs/DATs (cont.)

a,c

Table 5.4-18. CAL_CRC MTP Input DSPs/DATs (cont.)

a,c

[

]a,c

Table 5.4-19. CAL_CRC MTP Output DSPs/DATs

a,c

Table 5.4-19. CAL_CRC MTP Output DSPs/DATs (cont.)

a,c

5.4.6.1.2 **Addressable Constants Selection**

Addressable constants are changeable through the OM or MTP. To determine which value should be passed to the algorithms, subsection 5.5.2 of 00000-ICE-30152, "Common Q Software Design Description Post Accident Monitoring System AC160 Station" (Reference 13) will apply.

Addressable constants changes can be made on the OM or MTP. [

]a,c

a,c

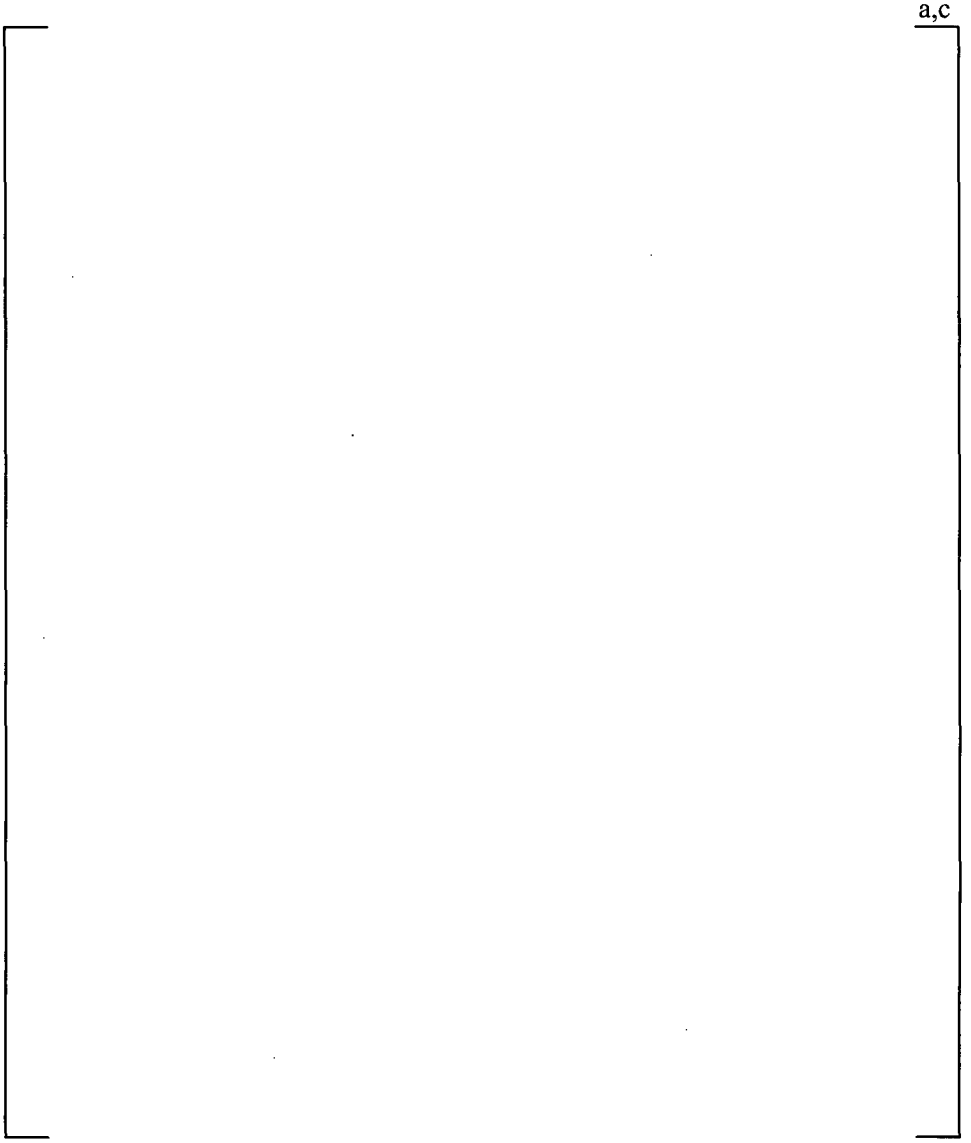


Figure 5-45. OM/MTP/AC160 Addressable Constants Selection

[

]a,c

[

]a,c

a,c

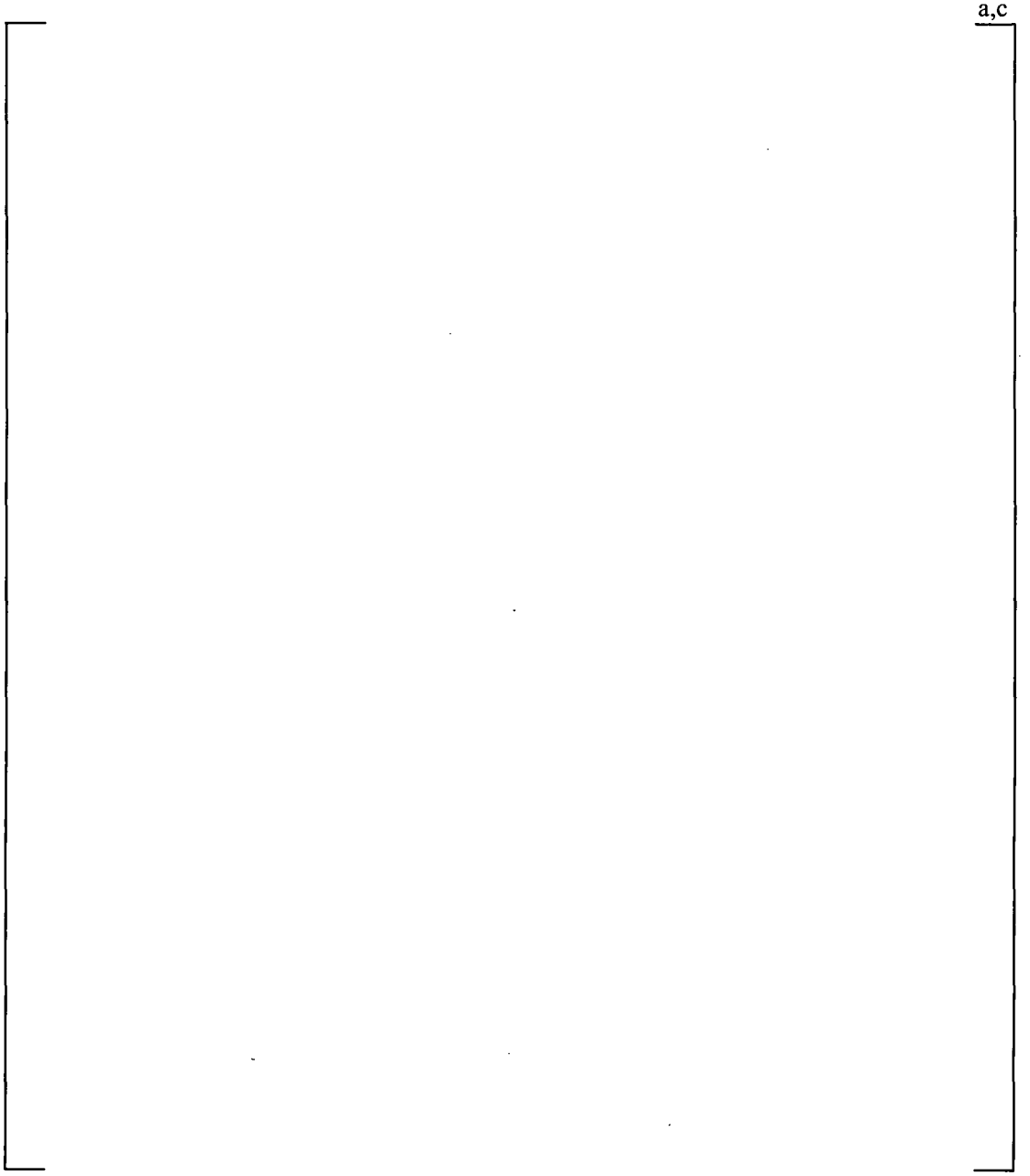


Figure 5-46. Selection of OM/MTP Data

(Last Page of Section 5)

SECTION 6
SAFETY AND SECURITY

6.1 SAFETY

The PAMS AC160 application programs adhere to the safety requirements and guidelines cited in Section 8.1 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

6.2 SECURITY

The PAMS AC160 application programs adhere to the security requirements and guidelines cited in Section 8.2 of WNA-SD-00239-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Software Requirements Specification for the Post Accident Monitoring System" (Reference 7).

(Last Page of Section 6)