IPP IPSU CAN Bus Processor Software Requirements

Fluids and Combustion Facility Common Subsystems

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PREFACE

The National Aeronautics and Space Administration (NASA) is developing a modular, multi-user experimentation facility for conducting fluid physics and combustion science experiments in the microgravity environment of the International Space Station (ISS). This facility, called the Fluids and Combustion Facility (FCF), consists of three test platforms: the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Shared Accommodations Rack (SAR).

The Image Processing Package (IPP) is an Orbital Replacement Unit (ORU) that mounts on the CIR optics bench or in the SAR. An IPP contains two independent Image Processing and Storage Units (IPSU's). Each IPSU controls the operation of an imaging diagnostic package and may also control one or more illumination packages. It acquires digital images and ancillary data from a diagnostic package, temporarily stores that data on local disk drives, and transfers the data to the Input/Output Processor (IOP) for downlinking. An IPSU also provides RS170 analog video output for real-time viewing on orbit and on the ground.

Each IPP IPSU contains an IPP IPSU CAN Bus Processor (CBP). The IPP IPSU CBP will provide health and status monitoring of the IPP IPSU and other command and control functionality for the IPP IPSU.

IPP IPSU CAN BUS PROCESSOR SOFTWARE REQUIREMENTS FOR THE FLUIDS AND COMBUSTION FACILITY COMMON SUBSYSTEMS

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REVISION PAGE
IPP IPSU CAN BUS PROCESSOR SOFTWARE REQUIREMENTS

Revision	Date	Description of Change or ECO's Incorporated	Verification and Date
Draft	10/12/00	Initial Draft for Review	
Draft	10/20/00	Incorporate comments from reviewers.	10/26/00
Rev. 1	12/19/00	Defined system modes, added Requirements Traceability and Qualification Provisions table, removed Qualification Provisions table and section, added acronym list.	01/04/01

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1.0 SCOPE

1.1 IDENTIFICATION

This document establishes the software performance and software qualification requirements for the Image Processing Package (IPP) Image Processing and Storage Units (IPSU) Controller Area Network (CAN) Bus Processor. The IPP IPSU CAN Bus Processor (IPP IPSU CBP) is a component of the IPP IPSU package.

1.2 SYSTEM OVERVIEW

The IPP IPSU is a component of the Fluids and Combustion Facility, which resides in the United States Laboratory Module of the International Space Station.

The IPP IPSU controls the operation and acquisition of images from science diagnostic packages via package-dependent digital communications. Two IPP IPSUs are contained in a single Orbital Replacement Unit called the Image Processing Package.

Each IPP IPSU includes an IPP IPSU CBP. The IPP IPSU CBP provides health and status monitoring within the IPP and other command and control functionality for an IPP IPSU.

1.3 DOCUMENT OVERVIEW

This document describes the Software Requirements for the IPP IPSU CAN Bus Processor.

2.0 REFERENCED DOCUMENTS

This section discusses all documents, including both government and non-government documents referenced in this specification

2.1 Government Documents

None.

2.2 Non-Government Documents

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

FCF-SPC-0001	FCF System Specification
<TBD 02-01>	
FCF-SPC-TBD	Critical Item Product Specification: Image Processing Package
CIR-REQ-0079	ITI IPSU Software Requirements
FCF-ICD-0076	FCF Software Interface Control Document
FCF-REQ-0063	FCF Software Requirements Document

2.3 Order of precedence for documents.

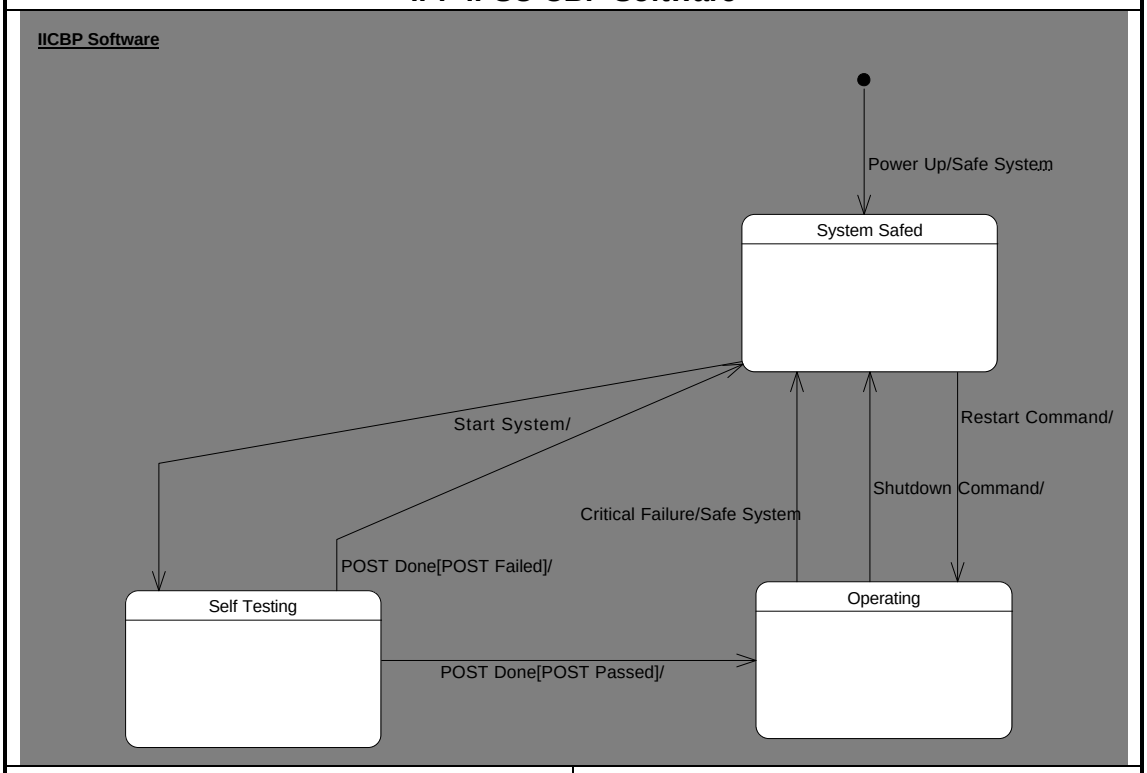
In the event of a conflict between this document and other documents referenced herein, the requirements of this document shall apply. In the event of a conflict between this document and the contract, the contractual requirements shall take precedence over this document. All documents used, applicable or referenced, are to be the issues defined in the Configuration Management (CM) contract baseline. All document changes, issued after baseline establishment, shall be reviewed for impact on scope of work. If a change to an applicable document is determined to be effective, and contractually approved for implementation, the revision status will be updated in the CM contract baseline. The contract revision status of all applicable documents is available by accessing the CM database. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 REQUIREMENTS

The requirements that form this document are found in FCF-SPC-0001 in association with FCF-SPC-TBD. <TBD 03-01>

3.1 REQUIRED STATES AND MODES

IPP IPSU CBP Software



Type: State Diagram	
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Figure 3-1 IPP IPSU CBP System Modes

3.1.1 System Safed

The system safed state will is entered when the system is powered up. The safed conditions will be in effect until the self testing state is complete and the system moves to the operating state. The system will enter the system safe state if the shut down command is received via the CAN Bus. This is done in preparation for a system power down.

Requirement Id	Requirement Description
1.	The “System Safed” mode will be entered immediately after the system is powered up.
2.	The safed conditions will exist until the system completes the “Self Testing” state and moves to the “Operating” state.
3.	The system will enter the “System Safe” state if the shut down command is received via the CAN Bus.
4.	The system will enter the “System Safe” state when system malfunctions are detected by the system self testing procedures.
5.	While in the “System Safed” state the IPP IPSU MP reset line will remain in its inactive state.

3.1.2 Self-Testing

The system self-test will be preformed upon system power up and periodically during normal operations.

3.1.3 Operating

The system will be in the operating state as long as the system self-test has not detected an off-nominal condition or the system has been safed by the “safe system” command. During the operating state all commanding capabilities, health and status broadcast capabilities, and closed loop fan speed control capabilities will be valid.

3.2 CSCI CAPABILITY REQUIREMENTS

3.2.1 Commanding Capabilities

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall receive commands over the CAN bus. [FCF-SPC-0001, 3.8.1.3.4]
2.	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to perform a hardware reset of the associated IPP IPSU single board computer (SBC).
3.	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to move to the Fail-safe state in preparation for power down.
4.	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to move from the Fail-safe state back to the Operating state.

3.2.2 Health and Status Broadcast Capabilities

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall send health and status data to the IOP via CAN bus at a rate of one Hz. [FCF-SPC-0001, 3.8.1.3.4]
2.	The IPP IPSU CBP Health and Status information shall include the temperature of SCSI disk drive 1.
3.	The IPP IPSU CBP Health and Status information shall include the temperature of SCSI disk drive 2.
4.	The IPP IPSU CBP Health and Status information shall include the temperature of the 5 volt, 100 watt power converter.
5.	The IPP IPSU CBP Health and Status information shall include the temperature of <TBD 03-02>.

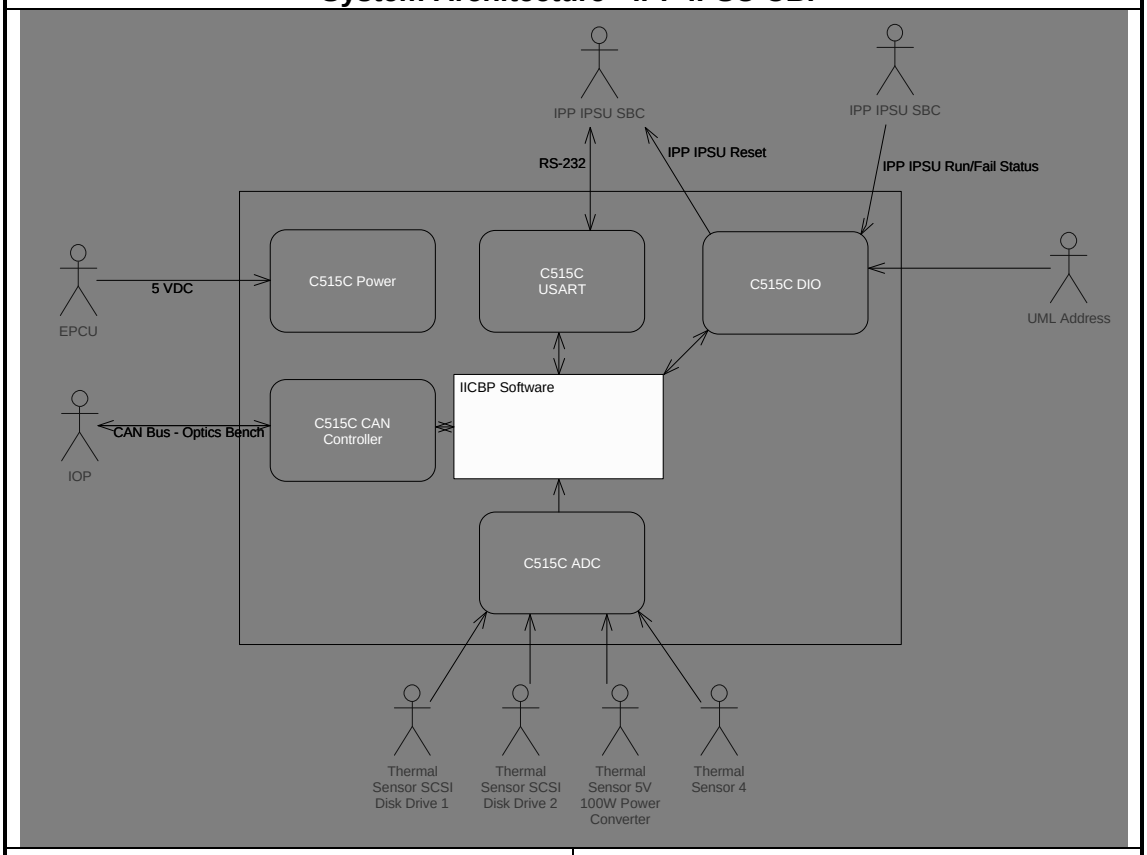
3.2.3 Fail Safe Control Capabilities

Requirement Id	Requirement Description
1.	While the system is safed the IPP IPSU MP reset line will be held in it's inactive state.

3.3 CSCI EXTERNAL INTERFACE REQUIREMENTS

3.3.1 Interface Identification and Diagrams

System Architecture - IPP IPSU CBP



Type: System Architecture Diagram	
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Figure 3-2 IPP IPSU CBP System Architecture

3.3.2 CAN Bus

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall adhere to the CAN communications protocol. 2.0B [FCF-SPC-0001, 3.8.1.3.4]

3.3.3 Input Output Processor (IOP)

Requirement Id	Requirement Description
1.	All communications with the IOP will be over the CAN Bus.

3.3.4 ITI IPSU

Requirement Id	Requirement Description
1.	All data communications with the IPP IPSU SBC shall be through the RS-232 serial port.
2.	Upon request of the IPP IPSU SBC, the IPP IPSU CBP shall report the Universal Mounting Location (UML) address of the IPP, plus an additional bit to identify the IPSU (A or B) within the IPP.
3.	The IPP IPSU CBP shall monitor the IPP IPSU SBC Run/Fail status bit and report that status to the IOP via CAN Bus as part of the Health and Status data.
4.	The IPP IPSU CBP will drive the IPP IPSU SBC reset line low when commanded to by the IOP via CAN bus. This will force a hardware reset of the IPP IPSU SBC.

3.3.5 Thermal Sensors

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall read temperature from four temperature transducers. Those transducers shall be sampled at a rate of 10 Hz.

3.3.6 Universal Mounting Location (UML) Address Bits

Requirement Id	Requirement Description
1.	The IPP IPSU CBP software shall be able to read the UML address of the IPP, plus an additional bit to identify the IPSU (A or B) through its digital I/O lines.

3.4 CSCI INTERNAL INTERFACE REQUIREMENTS

All internal interface requirements are left to the software design. This can be found in CIR-DOC-0086, IPP IPSU Can Bus Processor Software Design Document.

3.5 CSCI INTERNAL DATA REQUIREMENTS

All internal data requirements are left to the software design. This can be found in CIR-DOC-0086, IPP IPSU Can Bus Processor Software Design Document.

3.6 ADAPTATION REQUIREMENTS

There are no adaptation requirements.

3.7 SAFETY REQUIREMENTS

There are no safety requirements.

3.8 SECURITY AND PRIVACY REQUIREMENTS

There are no security and privacy requirements.

3.9 CSCI ENVIRONMENT REQUIREMENTS

There are no environment requirements.

3.10 COMPUTER RESOURCE REQUIREMENTS

3.10.1 Computer Hardware Requirements

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall operate on a Phytec miniMODUL-515C Single Board Computer. The miniMODUL-515C architecture is based on the Infineon SAB-C515C microcontroller.

3.10.2 Computer Hardware Resource Utilization Requirements

Refer to FCF Software Requirements Document, FCF-REQ-0063. Section 3.10.2 Computer Hardware Resource Utilization Requirements.

3.10.3 Computer Software Requirements

Requirement Id	Requirement Description
1.	The IPP IPSU CBP software shall use as its operating system the Real-Time Embedded Multitasking Micro Kernel called CRTX_D, version 1.0.
2.	The IPP IPSU CBP software development shall use the Infineon DaVE Microcontroller Configuration Wizard and Code Generator, Version 2.0 or greater as the basis for the coding project and for all microcontroller register configuration tasks.

3.10.4 Computer Communications Requirements

Requirement Id	Requirement Description
1.	The IPP IPSU CBP shall communicate with other systems via the CAN 2.0B protocol at the 1 Megabit per second baud rate.

3.11 SOFTWARE QUALITY FACTORS

Refer to FCF Software Requirements Document, FCF-REQ-0063. Section 3.11 Software Quality Factors.

3.12 DESIGN AND IMPLEMENTATION CONSTRAINTS

Requirement Id	Requirement Description
1.	The IPP IPSU CBP software analysis and design shall follow the Unified Process (UP) and Unified Modeling Language (UML) to the fullest extent possible.

3.13 PERSONNEL-RELATED REQUIREMENTS

There are no personnel-related requirements.

3.14 TRAINING-RELATED REQUIREMENTS

There are no training-related requirements.

3.15 LOGISTICS-RELATED REQUIREMENTS

There are no logistics-related requirements.

3.16 OTHER REQUIREMENTS

There are no other requirements.

3.17 PACKAGING REQUIREMENTS

There are no packaging requirements.

3.18 PRECEDENCE AND CRITICALITY OF REQUIREMENTS

All requirements for the IPP IPSU CBP have equal weights.

4.0 REQUIREMENTS TRACEABILITY AND QUALIFICATION PROVISIONS

Parent Document Name and Requirement Number	Software Requirement Specification Number	Software Requirement	Use Case	NA	I	A	T	D
N/A	3.1.1 [1]	The “System Safed” mode will be entered immediately after the system is powered up.	Power Up				X	
N/A	3.1.1 [2]	The safed conditions will exist until the system completes the “Self Testing” state and moves to the “Operating” state.	System Self Test		X			
N/A	3.1.1 [3]	The system will enter the “System Safe” state if the shut down command is received via the CAN Bus.	Shut Down				X	
N/A	3.1.1 [4]	The system will enter the “System Safe” state when system malfunctions are detected by the system self testing procedures.	System Self Test				X	
N/A	3.1.1 [5]	While in the “System Safed” state the IPP IPSU MP reset line will remain in its inactive state.	Safe the System, Reset IPP IPSU				X	
N/A	3.1.2 [1]	Self Testing	System Self Test				X	
N/A	3.1.3 [1]	Operating	Broadcast Health and Status, Monitor Temperatures, Monitor IPP IPSU Status, Parse CAN Message				X	
FCF-SPC-0001, 3.8.1.3.4	3.2.1 [1]	The IPP IPSU CBP shall receive commands over the CAN bus.	Parse CAN Message				X	
N/A	3.2.1 [2]	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to perform a hardware reset of the associated IPP IPSU single board computer (SBC).	Parse CAN Message, Reset IPP IPSU					X
N/A	3.2.1 [3]	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to move to the Fail-safe state in preparation for power down.	Parse CAN Message, Shut Down				X	

N/A	3.2.1 [4]	The IPP IPSU CBP shall receive a command via the CAN bus that will cause the IPP IPSU CBP to move from the Fail-safe state back to the Operating state.	Parse CAN Message, Restart System				X	
FCF-SPC-0001, 3.8.1.3.4	3.2.2 [1]	The IPP IPSU CBP shall send health and status data to the IOP via CAN bus at a rate of one Hz.	Broadcast Health and Status				X	
N/A	3.2.2 [2]	The IPP IPSU CBP Health and Status information shall include the temperature of SCSI disk drive 1.	Broadcast Health and Status, Monitor Temperatures				X	
N/A	3.2.2 [3]	The IPP IPSU CBP Health and Status information shall include the temperature of SCSI disk drive 2.	Broadcast Health and Status, Monitor Temperatures				X	
N/A	3.2.2 [4]	The IPP IPSU CBP Health and Status information shall include the temperature of the 5 volt, 100 watt power converter.	Broadcast Health and Status, Monitor Temperatures				X	
N/A	3.2.2 [5]	The IPP IPSU CBP Health and Status information shall include the temperature of <TBD 03.2.2-04>.	Broadcast Health and Status, Monitor Temperatures				X	
N/A	3.2.3 [1]	While the system is safed the IPP IPSU MP reset line will be held in it's inactive state.	Reset IPP IPSU				X	
FCF-SPC-0001, 3.8.1.3.4	3.3.2 [1]	The IPP IPSU CBP shall adhere to the CAN communications protocol. 2.0B	CAN Bus CSC		X			
N/A	3.3.3 [1]	All communications with the IOP will be over the CAN Bus.	CAN Bus CSC		X			
N/A	3.3.4 [1]	All data communications with the IPP IPSU SBC shall be through the RS-232 serial port.	USART CSC		X			
N/A	3.3.4 [2]	Upon request of the IPP IPSU SBC, the IPP IPSU CBP shall report the Universal Mounting Location (UML) address of the IPP, plus an additional bit to identify the IPSU (A or B) within the IPP.	Query UML Location				X	
N/A	3.3.4 [3]	The IPP IPSU CBP shall monitor the IPP IPSU SBC Run/Fail status bit and report that status to the IOP via CAN Bus as part of the Health and Status data.	Monitor IPP IPSU Monitor				X	
N/A	3.3.4 [4]	The IPP IPSU CBP will drive the IPP IPSU SBC reset line low when commanded to by the IOP via CAN bus. This will force a hardware reset of the IPP IPSU SBC.	Reset IPP IPSU					X
N/A	3.3.5 [1]	The IPP IPSU CBP shall read temperature from four temperature transducers. Those transducers shall be sampled at a rate of 10 Hz.	Monitor Temperatures				X	

N/A	3.3.6 [1]	The IPP IPSU CBP software shall be able to read the UML address of the IPP, plus an additional bit to identify the IPSU (A or B) through its digital I/O lines.	Query UML Locations				X	
N/A	3.10.1 [1]	The IPP IPSU CBP shall operate on a Phytec miniMODUL-515C Single Board Computer. The miniMODUL-515C architecture is based on the Infineon SAB-C515C microcontroller.	N/A		X			
N/A	3.10.3 [1]	The IPP IPSU CBP software shall use as its operating system the Real-Time Embedded Multitasking Micro Kernel called CRTX_D, version 1.0.	CRTX CSC		X			
N/A	3.10.3 [2]	The IPP IPSU CBP software development shall use the Infineon DaVE Microcontroller Configuration Wizard and Code Generator, Version 2.0 or greater as the basis for the coding project and for all microcontroller register configuration tasks.	N/A		X			
N/A	3.10.4 [1]	The IPP IPSU CBP shall communicate with other systems via the CAN 2.0B protocol at the 1 Megabit per second baud rate.	CAN Bus CSC		X			
N/A	3.12 [1]	The IPP IPSU CBP software analysis and design shall follow the Unified Process (UP) and Unified Modeling Language (UML) to the fullest extent possible.	N/A		X			

Table 4-1 Requirements Traceability And Qualification Provisions Table

5.0 NOTES

APPENDIX A ACRONYMS AND ABBREVIATIONS

A.1 Scope.

This appendix lists the acronyms and abbreviations used in this document.

A.2 List of acronyms and abbreviations.

ARIS .....Active Rack Isolation System
ATCU.....Air Thermal Control Unit
AWG.....Architecture Working Group
CAN (bus) .....Controller Area Network (bus)
CBP .....CAN Bus Processor
CC .....Configuration Control
CDMS .....Command and Data Management Subsystem
C&DH .....Command and Data Handling
C&W .....Caution and Warning
CI.....Configuration Item
CIR .....Combustion Integrated Rack
CM.....Configuration Management
CMM.....Capability Maturity Model
COM.....Computer Operation Manual
COTS.....Commercial Off The Shelf
CSC .....Computer Software Component
CSCI .....Computer Software Configuration Item
CSU .....Computer Software Unit
DCM .....Diagnostic Control Module
DDR.....Detailed Design Review
DID .....Data Item Description
ECB .....ECS CAN Bus
ECP .....Engineering Change Proposal
EEU .....ECS Electronics Unit
EHS .....Enhanced HOSC System
EMI .....Electro Magnetic Interference
EPCU .....Electrical Power Control Unit
EPS .....Electrical Power System
ESA .....European Space Agency
ESD .....Electrostatic Discharge
EWT.....Embedded Web Technology
FCA .....Functional Configuration Audit
FCF .....Fluids and Combustion Facility
FCU .....FOMA Control Unit
FDC .....Federal Data Corporation
FIR .....Fluids Integrated Rack

FOMA .....Fuel/Oxidizer Management Assembly
FOT .....Functional Operability Testing
FQT .....Formal Qualification Test
FSAP .....Fluids Science Avionics Processor
FSM.....Firmware Support Manual
FTP .....File Transfer Protocol
GC .....Gas Chromatograph
GRC.....Glenn Research Center
GSE.....Ground Support Equipment
HFR .....High Frame Rate
HiBMs.....High Bit Depth/Multi-spectral
HP.....HRDL Processor
HRDL .....High Rate Data Link
HRFM .....High Rate Frame Multiplexer
HWCI.....Hardware Configuration Item
Hz .....Hertz
I/O .....Input/Output
ICD .....Interface Control Document
IDD .....Interface Design Description
IEEE .....Institute of Electronics and Electrical Engineers
ILS .....Integrated Logistics Support
IMT .....Interface Message Tests
IOP .....Input/Output Processor
IPP .....Image Processing Package
IPSU .....Image Processing and Storage Unit
IRS.....Interface Requirements Specification
IRT.....Interface Recovery Tests
IST.....Interface Stress Test
ISPR .....International Standard Payload Rack
ISR .....Interrupt Service Routine
ISS .....International Space Station
IVT.....Interface Validation Tests
IV&V .....Independent Verification and Validation
JSC.....Johnson Space Center
KSC .....Kennedy Space Center
KPA .....Key Process Area
LAN .....Local Area Network
LCM.....Life Cycle Maintenance
LRDL .....Low Rate Data Link
Mbps.....Mega Bits Per Second
MP .....Main Processor
MRDL .....Medium Rate Data Link
NDI .....Non-Developmental Item
NFS .....Network File System
NRZI .....Non Return to Zero Invert on Ones
NVR.....No Verification Required

OCB.....Optics CAN Bus
OCD.....Operational Concept Description
OOD .....Object-Oriented Design
OPEVAL .....Operational Evaluation
P/CR.....Problem/Change Report
PCA .....Physical Configuration Audit
PCS .....Portable Computer System
PI .....Principal Investigator
PP.....Program Package
POST .....Power-On Self-Test
PR.....Problem Report
P/TR .....Program/Trouble Report
QA .....Quality Assurance
R&R.....Review and Response
RT.....Regression Test
RTOS .....Real-Time Operating System
SAMS .....Space Acceleration Measurement System
SAR .....Shared Accommodations Rack
SBC .....Single Board Computer
SCCB.....Software Configuration Control Board
SCM.....Software Configuration Management
SCMP .....Software Configuration Management Plan
SCSI .....Small Computer Systems Interface
SDD.....Software Design Description
SDF .....Software Development File
SDL .....Serial Data Link
SDL.....Software Development Library
SEE .....Software Engineering Environment
SEI.....Software Engineering Institute
SEN .....Software Engineering Notebook
SEPG.....Software Engineering Process Group
SEPO.....Software Engineering Process Office
SMDP .....Software Management and Development Plan
SOW .....Statement of Work
SPA .....Software Product Assurance
SPI.....Software Process Improvement
SPIP .....Software Process Improvement Plan
SPP .....Software Project Planning
SPS .....Software Product Specification
SQT .....System Qualification Test
SRS .....Software Requirements Specification
SSC .....Station Support Computer
SSDD.....System/Subsystem Design Description
SSS .....System/Subsystem Specification
SSP .....Space Station Program
STD .....Software Test Description

STE.....Software Test Environment
STP.....Software Test Plan
STR .....Software Test Report
SVD .....Software Version Description
TBD .....To Be Determined
TR.....Trouble Report
TSC .....Telescience Support Center
UML .....Unified Modeling Language
VSP .....Video Switch Processor
WBS .....Work Breakdown Structure
WTCS.....Water Thermal Control System

APPENDIX B TBD'S

B.1 Scope.

This appendix lists all items in this document that need to be determined (TBD).

B.2 List of TBD's.

Table 5-1TBD's

TBD Number	Description	Document Paragraph
02-01	IPP Critical Item Product Spec. Doc. Number and Name	2.2
03-01	IPP Critical Item Product Spec. Doc. Number	3.0
03-02	Thermal Sensor 4, name and temperature	3.2.2