Functional Unit Specification,

Touch Screen Equipment

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NOTE: The official version of this document is maintained electronically in DOORS. Please see the DOORS module BRS Project/Functional Unit Specifications/L3 FUS TSE for the latest official requirements.

ROCKWELL COLLINS, INC.

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FUS-TSE-59

1 Introduction

FUS-TSE-60

1.1 Purpose

FUS-TSE-61 The purpose of this document (1308520-551) is to provide the technical requirements for the Touch Screen Equipment (TSE). Rockwell Collins, Inc. and their subcontractors use this document to design, develop, and test the Touch Screen Equipment as a Line Replaceable Unit (LRU).

FUS-TSE-62

1.2 Scope

FUS-TSE-63 This Functional Unit Specification (FUS) specifies the design and performance requirements of the 10.4 inch integrated Display Unit, Part No. 1308520-100 hereinafter referred to as the "TSE." This FUS also provides design and performance requirements for the 8.4 inch and 6.4 inch versions of the TSE. The TSE is an integral part of the Cabin Electronic System In-Flight Entertainment system as defined in Rockwell Collins *System Specification For The CES-5000 Cabin Electronic System.*

FUS-TSE-64

1.3 Applicability

FUS-TSE-65 This specification is applicable to the 6.4 inch, 8.4inch, and 10.4 inch LCD touch screen personal display monitors for the Cabin Electronic System.

FUS-TSE-66

1.4 Terminology

FUS-TSE-67 Throughout this specification, "**shall**" is used to express a requirement that is binding, "should" and "may" are used to express recommended or allowed actions, and "will" is used to express a declaration of intent.

FUS-TSE-68 To facilitate traceability to higher-level documentation, requirements traceability identification tags from the *System Specification For The CES-5000 Cabin Electronic System* are referenced in brackets at the end of applicable specification requirements in this FUS. The traceability tag format is:

FUS-TSE-69 [NNNN-CCC]

FUS-TSE-70 Where, NNNN is a unique requirement number and CCC is a source identification character code. CCC will either be BA1, denoting a Bombardier source requirement, or RC1, denoting a Rockwell Collins Business and Regional Systems (BRS) derived requirement.

FUS-TSE-71

1.5 Functional Overview

FUS-TSE-72 This section presents a functional overview of the TSE and its relationship to its parent system, the Network and Entertainment Subsystem (NES) system.

FUS-TSE-73

1.5.1 NES System Overview

FUS-TSE-74 The NES is a subsystem of the Cabin Electronic System (CES) for business class aircraft. It provides both aircraft passenger entertainment and office in the sky capability for the business traveler. The NES subsystem provides distributed (multicast) audio and video from standard DVD, CD, or VCR players, Audio and Video On-Demand from a dedicated server, and full browser capabilities in the displays. The modularity of the system components with connectivity to a common Fast Ethernet backbone permits numerous configuration alternatives for independent physical areas or zones in the aircraft. Figure 1-1 provides a representation of the mix of possible system configurations and functional capabilities that can be provided for a multiple zone installation. Functions provided include:

FUS-TSE-75 Touch screen displays for viewing distributed video entertainment from on board video sources

FUS-TSE-76 Stereo audio headphone connections for listening to distributed audio entertainment from onboard audio sources.

FUS-TSE-77 LAN Connectivity for laptop computers

FUS-TSE-78 Connectivity to CD and DVD players

FUS-TSE-79 LAN Connectivity from the CES File Server Equipment (FSE) to the bulkhead monitors

FUS-TSE-80 External portable game device and laptop computer connections to TSEs or overhead monitors

FUS-TSE-81 The Zone Distribution Equipment (ZDE) LRU provides the interface connectivity to support these functions in each seating zone. An aircraft installation can have from one to 6 seating zones supporting up to 24 seats.

FUS-TSE-82 The system is supports up to 24 concurrent streams of the following functions:

FUS-TSE-83 Streaming video

FUS-TSE-84 Streaming audio

FUS-TSE-85 Performance of display control operations

FUS-TSE-86 Surfing the web

FUS-TSE-87 Accessing e-mail

FUS-TSE-88 Provision is also provided to allow carry-on games boxes to be connected to the system and played on CES bulkhead monitors or TSEs.

FUS-TSE-89 Direct viewing of selected video sources at the passenger seats, galley areas and cockpit is provided by the TSE. A touch screen on each TSE allows Interactive communications with the NES and CES.

FUS-TSE-90 Passenger service control functions such as seat adjustment control, reading light, call light selection, and flight attendant Passanger Address (PA) functions are CES functions not provided directly by the NES, however; the CES may use some of the NES LAN and audio amplifier components to support these functions. The CES provides a Personal Control Unit (PCU) for in seat control of In-Flight Entertainment (IFE) and passenger service control functions.

FUS-TSE-91…

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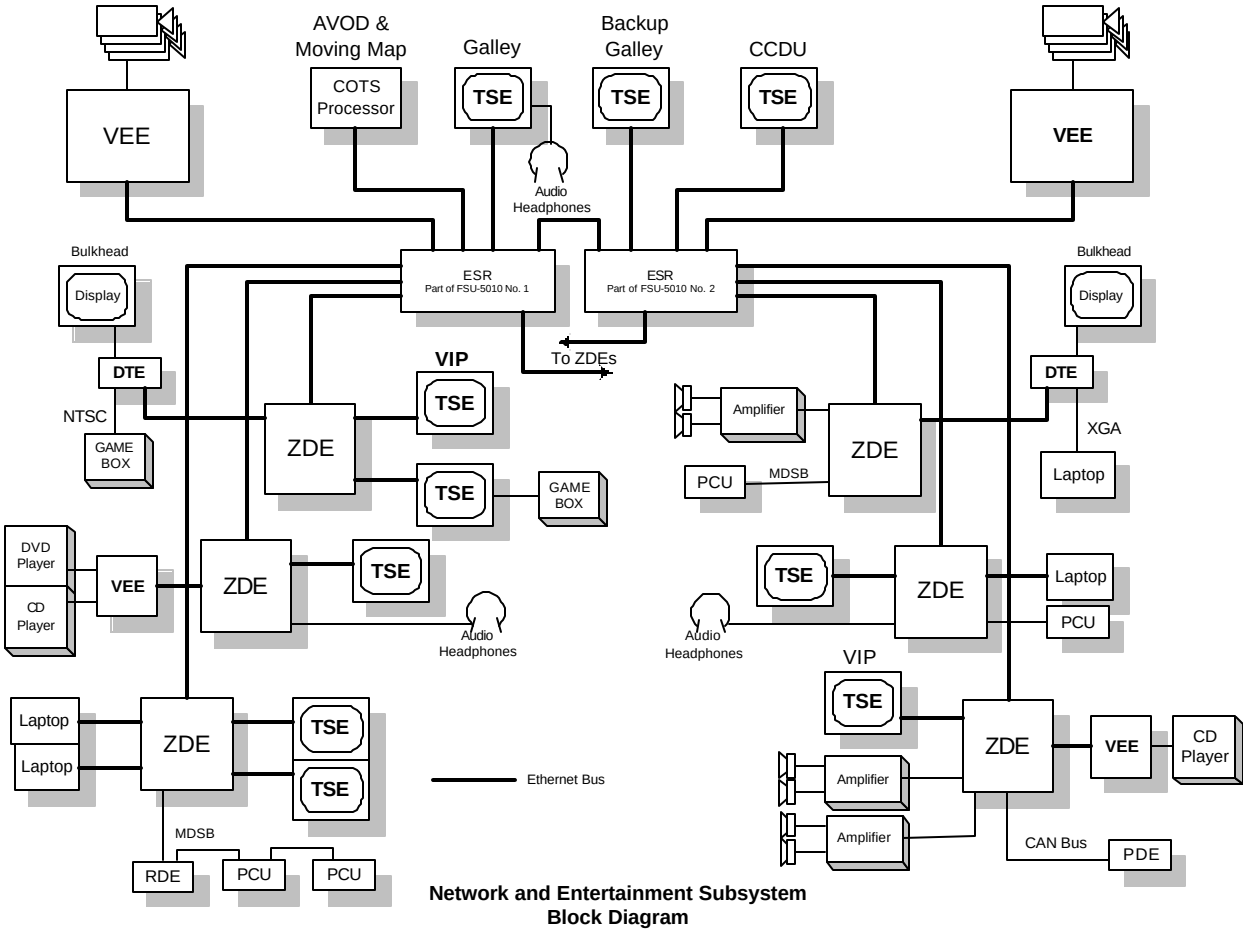


Network and Entertainment Subsystem Block Diagram

Figure 1-1 NES Functional Block Diagram -Installation Configuration Options

FUS-TSE-92

FUS-TSE-93

1.5.2 TSE System Overview

FUS-TSE-94 The TSE is a multiuse LCD touch screen display monitor for the NES. It can be used for the following IFE system functions:

FUS-TSE-95 Passenger viewing of digital video entertainment sources

FUS-TSE-96 Galley and VIP passenger cabin displays for monitor and control of IFE functions

FUS-TSE-97 Pilots Cockpit Control Display Unit (CCDU)

FUS-TSE-98 The TSE connects directly to the NES Ethernet communications backbone through a ZDE to receive and decode MPEG-1 or MPEG-2 audio and video media streams generated by the IFE source. The unit provides display of video entertainment selections, web pages, and display adjustment control menus.

FUS-TSE-99 User control input is via a touch screen for internet/intranet browsing, IFE functional control, and individual display adjustments. For Galley/VIP and CCDU installations, additional CES system level touch screen control functions, not generally available to passengers, can be performed.

FUS-TSE-100 A provision is included to permit the connection of a portable external device through composite video and analog stereo audio inputs.

FUS-TSE-101 The TSE (see Figure 1-2) consists of a Video Controller electronics assembly, a touch screen LCD display assembly, a DC/DC converter, and a backlight power inverter, which are described below.

FUS-TSE-102 **Video Controller:** The Video Controller decodes the MPEG (1 or 2) digital video input stream that is provided to the TSE by the Ethernet Network input. The controller sends the decoded video to the LCD and re-encodes the audio, which is then routed back onto the Ethernet LAN for retransmission as digital audio. A stereo headset output is provided for use at Galley display installations. Analog stereo audio and composite NTSC video inputs from externally sources, when connected, are processed alternatively to the Ethernet provided digital media inputs and provided to the headset output and LCD display. The analog audio is also re-encoded for retransmission on the Ethernet LAN. JTAG and RS-232 ports support maintenance functions, and a RS-232 TSE control port is provided. The Video Controller also processes communications inputs from the LCD display's touch screen panel.

FUS-TSE-103 **Touch Screen LCD Display:** The integral touch screen and LCD display assembly connects to the Video Controller.

FUS-TSE-104 **DC/DC Converter:** The TSE is powered from the aircraft 28 Volt DC power bus. A DC/DC converter converts this power at the correct voltage levels for the Video Controller, LCD and LCD backlight power inverter electronics.

FUS-TSE-105 **LCD Backlight Power Inverter**

FUS-TSE-106 A power inverter provided for the LCD backlight.

FUS-TSE-107

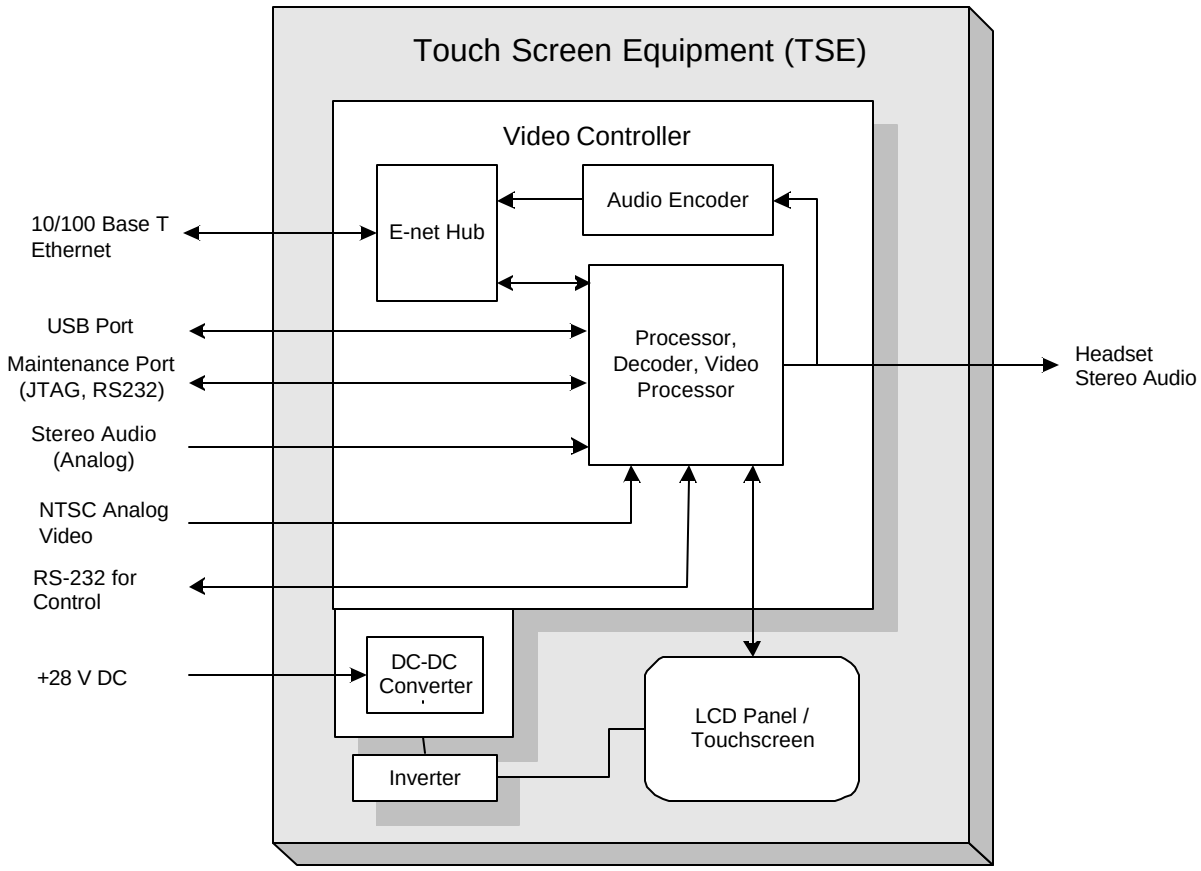


Figure 1-2 TSE Block Diagram

FUS-TSE-108

FUS-TSE-109

1.5.2.1 Video Controller Functional Overview.

FUS-TSE-110 The Video Controller Circuit implementation concepts (see Figure 1-3) are defined in this FUS because it is a common design baseline for both the TSE and DTE (1308524-100) LRUs. It is intended that a common module will be used for both the TSE and DTE applications. For the TSE the Video Controller provides the following functions:

FUS-TSE-111 Connectivity to the Ethernet network

FUS-TSE-112 Decoding of MPEG -1, and -2 video and audio streams from the Ethernet network

FUS-TSE-113 A goal of decoding MPEG -4 video and audio streams from the Ethernet network

FUS-TSE-114 Encoding of MPEG decoded audio for retransmission to the Ethernet network

FUS-TSE-115 Support of IP protocol stack and IP/RTP transport

FUS-TSE-116 Processing of the decoded video for presentation on the LCD display

FUS-TSE-117 Processing of touch screen control commands

FUS-TSE-118 Processing of control command from the Modular Cabinet Equipment (MCE) received via the Ethernet network

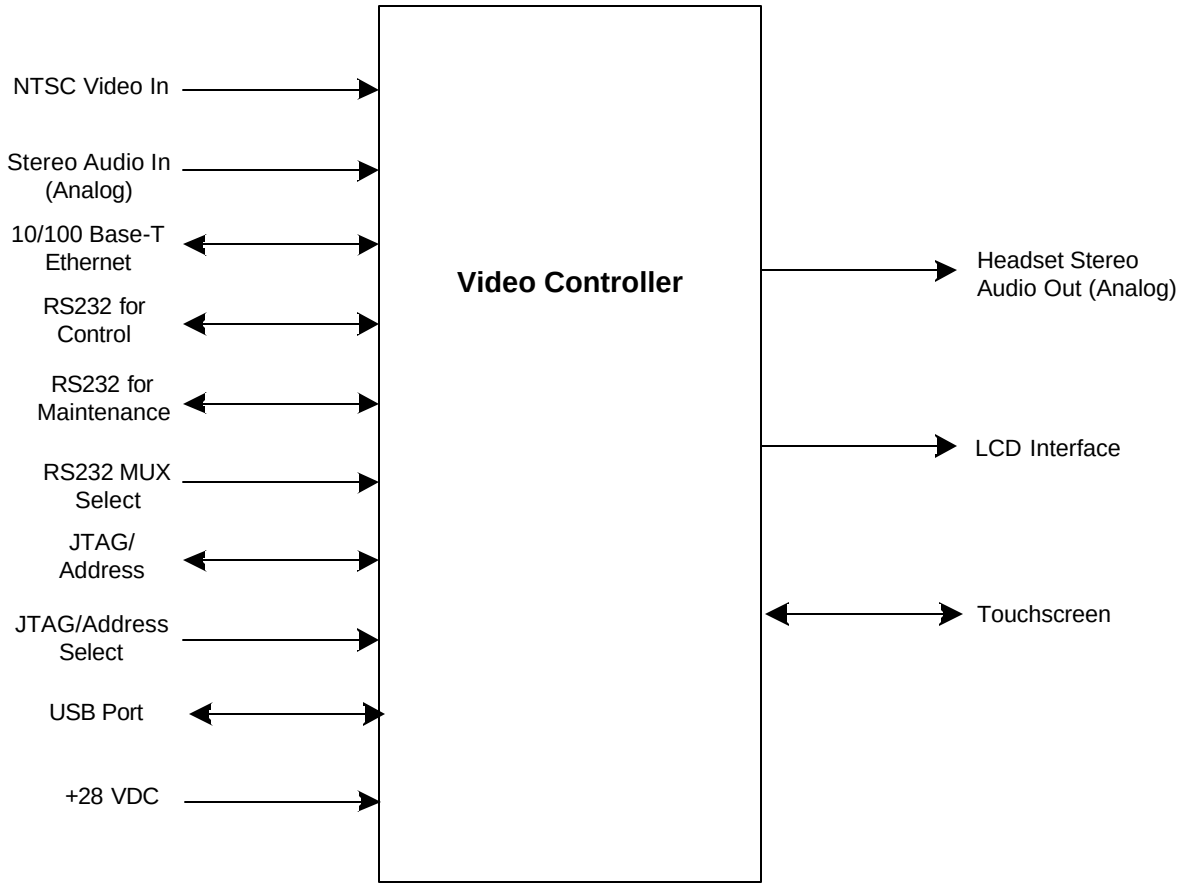
FUS-TSE-119 Processing of maintenance port communications including diagnostics, test, and IP address setting commands

FUS-TSE-120 Providing communications with the RS-232 and USB control ports.

FUS-TSE-121 Performance of BIT/BITE processing tasks to include JTAG functionality (off-line only)

FUS-TSE-122…

…FUS-TSE-122



FUS-TSE-123 Figure 1-3 Video Controller - TSE Implementation

FUS-TSE-124 ## 1.6 Document Overview

FUS-TSE-125 Section 1 contains introductory material including an overview of this unit in terms of its functionality and role in the overall system.

FUS-TSE-126 Section 2 lists the referenced documents.

FUS-TSE-127 Section 3 defines the functional requirements.

FUS-TSE-128 Section 4 provides the verification methods for Section 3 requirements.

FUS-TSE-129 Section 5 lists the acronyms and abbreviations.

FUS-TSE-130 Appendix A is the Verification Cross Reference Matrix (VCRI).

FUS-TSE-131

2 Referenced Documents

FUS-TSE-132 The following documents, in the exact revision shown, form a part of this document to the extent specified herein. For the following documents where no revision or revision date is specified, the most current revision of the cited document as of the revision date of this document, apply.

FUS-TSE-133

2.1 Aircraft Manufacturer [or Customer] Documents

Document Number	Title
TRD-I700-506	Technical Requirements Document for the Cabin Management System for the Bombardier Global-5000

FUS-TSE-141

2.2 Rockwell Collins, Inc. Documents

Document Number	Title
1304548-843	Electrical/EMC Qualification Test Procedure, Non-Seller Furnished Equipment (NON-SFE)
1304551-846	Environmental Qualification Test Procedure, Non-Seller Furnished Equipment (NON-SFE)
1308524-100	Digital Tapping Equipment
16-7-1 FUS	Functional Unit Specification, Audio Encoder-Decoder
523-0778764	Rockwell Collins Workmanship Standards
815-4841-001	Bombardier Global 5000 CES-5000 Cabin Electronic System Specification
829-8407-110	Business and Regional Systems Pro Line 21 Internal/External Packaging Design Guideline
ECM #G5000-RC-BA-5007	Interface Data Guidelines for the CES-5000 Cabin Electronic System

FUS-TSE-170

2.3 Other Documents

Document Number	Title
AC 25-16	FAA Advisory Circular: Electrical Fault and Fire Prevention and Protection
ANSI/ASHRAE Standard 52.1	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ARINC 600	Air Transport Avionics Equipment Interfaces
ASTM F814-84B	Test Method for Specific Optical Density of Smoke Generated by Solid Materials for Aerospace Applications (Discontinued 1995)
EIA/TIA-232-F	Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment employing serial binary data interchange (September 1997).
FAR 25.853	Federal Aviation Regulations, Part 25 Airworthiness Standards: Transport Category Airplanes - Subpart D--Design and Construction, Fire Protection, Compartment Interiors.

FAR 25.853	Federal Aviation Regulations, Part 25 Airworthiness Standards: Transport Category Airplanes - Subpart D--Design and Construction, Fire Protection, Compartment Interiors
FAR 25.869	Federal Aviation Regulations, Part 25 Airworthiness Standards: Transport Category Airplanes - Subpart D--Design and Construction, Fire Protection, Fire protection: systems
IEEE Std 802.3, 2000 Edition	Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications
MIL-STD-1472D	Design Criteria Standard Human Engineering
RTCA/DO-160 Rev D	Environmental Conditions and Test Procedures for Airborne Equipment, Radio Technical Commission for aeronautics
RTCA/DO-178BRevision B	Software Considerations in Airborne Systems and Equipment CertificationRadio Technical Commission for Aeronautics
USB1.1	Open Universal Serial Bus Driver Interface (Open USBDI) Specification

2.4 Order of Precedence

FUS-TSE-214

FUS-TSE-215 In the case of conflict between this documents and the referenced documents, unless otherwise noted, the precedence is as listed below in descending order of precedence.

FUS-TSE-216 Regulatory Standards (e.g., Federal Aviation Administration (FAA), CAA, etc.)

FUS-TSE-217 System Specification (System Specification For The CES-5000 Cabin Electronic System)

FUS-TSE-218 FUS (Functional Unit Specification, Touch Screen Equipment)

FUS-TSE-219 HRS/SRS

FUS-TSE-220 # 3 UNIT Requirements

FUS-TSE-221 This section contains the requirements for the development of the TSE. The traceability of the specified requirements to the verification of those requirements is provided in Appendix A as the Verification Cross Reference Index.

FUS-TSE-222 ## 3.1 Functional Requirements

FUS-TSE-223 The following paragraphs provide the TSE functional requirements allocated and derived from the *System Specification For The CES-5000 Cabin Electronic System* and the *Technical Requirements Document for the Cabin Management System for the Bombardier Global-5000*.

FUS-TSE-224 ### 3.1.1 Modes and States

FUS-TSE-225 The TSE states are:

FUS-TSE-226 Startup - Covers the time from power-on when the processor is doing things like CPU and device initialization, software initialization, etc.

FUS-TSE-227 IP Wait - In this state TSE processors, if in a non pin strapped configuration, are waiting to be given an IP address. During this time the TSE does not talk on Ethernet.

FUS-TSE-228 IP Startup - Covers the time from getting the IP address to having the IP stack up and running. Processors may have to restart after this state.

FUS-TSE-229 Deleted

FUS-TSE-230 Configuring - Processor is in the process of reading it's configuration file and setting up it's configuration - this includes loading new software if necessary to comply with the configuration. Applies to all processors in the TSE.

FUS-TSE-231 Operational - Normal operation, performing functions as defined in this specification.

FUS-TSE-232 Failed - The processor has internal failures and is unable to perform it's operational functions, but may be able to report a failed status (depending on the nature of the failure).

FUS-TSE-233 Decompression - The high voltage converter for the LCD backlight is shut down.

FUS-TSE-234 ### 3.1.2 LCD Display Monitor

FUS-TSE-235 The TSE LCD **shall** be have a 10.4 inch diagonal viewing area with a 4:3 aspect ratio. [0290-RC1].

FUS-TSE-236 The TSE LCD **shall** support an SVGA resolution of 800 x 600 pixels in the x and y axis respectively.

FUS-TSE-237 The TSE LCD **shall** support 6 bit/color - RGB.

FUS-TSE-238 The TSE LCD minimum contrast ratio **shall** be 150:1.

FUS-TSE-239 The TSE LCD **shall** have 120 degree horizontal viewing angle. [0149-BA1]

FUS-TSE-240 The TSE LCD **shall** have 90 degree vertical viewing angle. [0150-BA1]

FUS-TSE-241 The TSE LCD **shall** have a minimum brightness of 200 cd/m^2.

FUS-TSE-242 The TSE **shall** provide control for LCD backlight On/Off and variable brightness.

FUS-TSE-243 The LCD visual characteristics are summarized in Table 3-1. For reference, information is provided for 8.4 inch and 6.4 inch versions of the LCD.

FUS-TSE-244 Table 3-1: TSE LCD Display Characteristics

Parameter	Specification	Units
View Size (diagonal)	10.4, 8.4, or 6.4	Inches
View Size - 10.4	SVGA (800 x 600)	Pixels (x and y axis)
View Size - 8.4	SVGA (800 x 600)	Pixels (x and y axis)
View Size - 6.4	VGA (640 x 480)	Pixels (x and y axis)
Colors - 10.4, 8.4, 6.4	6 bit/color - RGB	-
Contrast Ratio - 10.4	150:1 minimum	-
Contrast Ratio - 8.4	100:1 minimum	-
Contrast Ratio - 6.4	100:1 minimum	-
View Angle (Without Privacy Filter)	Horizontal: ± 60 Vertical: 90	Degree Degree
Brightness (Displayed)	> 200	cd/m^2
Aspect Ratio	4:3	-

FUS-TSE-294 ***Note:*** The requirements of this section apply to the TSE as viewed by the observer. There is no intent to specify characteristics of individual components or subsystems.

FUS-TSE-295 ### 3.1.3 Touch Screen

FUS-TSE-296 *Commentary: The TSE display assembly is comprised of a LCD display, as specified in 3.1.2, plus a continuous touch screen overlay. The touch screen will be used for interaction with the NES system as well as Internet and Intranet browsing.*

FUS-TSE-297 The TSE **shall** provide a continuous touch screen input capability. [0289-RC1]

FUS-TSE-298 The touch screen **shall** not require periodic calibration.

FUS-TSE-299 #### 3.1.3.1 Privacy Filter

FUS-TSE-300 A privacy filter will not be required for the TSE.

FUS-TSE-301 ### 3.1.4 Video and Audio Processing

FUS-TSE-302 *Commentary: The Video Controller provides the processing interface between the TSE external electrical interfaces and the internal LCD Monitor and associated touch screen. The NES Digital Tapping Equipment (DTE) requires an equivalent video controller functionality to provide the NES interface to a bulkhead monitor. For this reason a common Video Controller design is recommended for both the TSE and DTE.*

FUS-TSE-303 To the extent possible a common Video Controller design baseline will be implemented for both the CES TSE and DTE LRUs.

FUS-TSE-304 #### 3.1.4.1 Video Processing

FUS-TSE-305 The Video Controller **shall** decode all MPEG (1 or 2) encoded streams provided by the TSE Ethernet network connection for display on the TSE LCD display. [0133-BA1] [0135-BA1] [0138-BA1] [0294RC1] [0293-RC1]

FUS-TSE-306 The Video Controller **shall** be capable of supporting an MPEG (1 or 2) bit rate of 1 Mbps to at least 6 Mbps, with a goal of achieving 12 Mbps. [0398-RC1]

FUS-TSE-307 The Video Controller **shall** provide the TSE with a stand-alone processing and control capability. [0292-RC1]

FUS-TSE-308 Each Video Controller **shall** provide bi directional control and status communications with the MCE by means of the Ethernet connection. [0293-RC1]

FUS-TSE-309 The Video Controller **shall** alternatively (to the Ethernet streaming media video input) be capable of supporting a composite NTSC input to the TSE and drive its LCD display. [0400-RC1]

FUS-TSE-310 The TSE should be capable of supporting both PAL and composite NTSC video formats from the analog video input.

FUS-TSE-311 The Video Controller should be capable of decoding an MPEG 4 encoded video stream to drive the TSE LCD display.

FUS-TSE-312 Variable control of video display brightness **shall** be provided for the displayed video.

FUS-TSE-313 #### 3.1.4.2 Audio Processing

FUS-TSE-314 *This section defines the Video Processor's requirements for Audio processing for retransmission to be consistent with the audio processing performed by the NES's VEE LRU.*

FUS-TSE-315 The Video Controller **shall** be capable of encoding the audio sound track, associated with the MPEG stream and re-transmitting it to the Ethernet Network as audio packets, as specified in Rockwell Collins Passenger Systems document *Audio Encoder-Decoder Functional Unit Specification*. [0295-RC1]

FUS-TSE-316 The Video Controller **shall** be capable of encoding the analog stereo audio from externally connected sources and re-transmitting it to the Ethernet Network as audio packets, as specified in Rockwell Collins Passenger Systems document *Audio Encoder-Decoder Functional Unit Specification*. [0401-RC1]

FUS-TSE-317 ### 3.1.5 User Controls

FUS-TSE-318 *Commentary: The TSE touch screen operating with an Internet Explorer browser for user control interface will provide controls for adjusting the viewing brightness as well as audio volume and tone. Touch screen control requirements will be different for the different display locations (Passenger Seat, Galley, Cockpit). The customer may define control placement and layout.*

FUS-TSE-319 The TSE **shall** provide an Internet Explorer™ browser as the user control interface.

FUS-TSE-320 The TSE display **shall** have a mechanism for controlling display brightness.

FUS-TSE-321 The TSE control settings **shall** be retained until the LRU is powered off.

FUS-TSE-322 The TSE **shall** provide USB port signals on the TSE I/O connector for mouse or keyboard connection to the TSE.

FUS-TSE-1169 The TSE display shall have a mechanism for audio volume.

FUS-TSE-323 ### 3.1.6 ON/OFF Control

FUS-TSE-324 The TSE **shall** be powered on by the application of +28 VDC input power to the TSE interface connector power connection as specified in Table 3-2.

FUS-TSE-325 The TSE **shall** be powered off by the removal of +28 VDC input power from the TSE interface connector power connection as specified in Table 3-2.

FUS-TSE-326 #### 3.1.6.1 Stowage Sensing

FUS-TSE-327 A powered on TSE **shall** sense if it is in a stowed position and turn off the LCD backlight power source.

FUS-TSE-328 *Commentary: A stowed but powered on TSE may become placed in a location that does not permit good heat transfer from the TSE. To compensate for this, it would be desirable to reduce internal power dissipation by shutting down selected TSE circuits, other than those required to process the stowage sensor state.*

FUS-TSE-329 To the extent possible the TSE **shall** shut down power to non-critical circuit functions to minimize power dissipation and unit heating in the stowed physical environment.

FUS-TSE-330 When removed from a stowed position, the LCD backlight power **shall** be turned on.

FUS-TSE-331 The TSE **shall** report stowed status to the MCE.

FUS-TSE-332 *Commentary: Configurable time delays may be applied to the responses to stowage state changes defined in this paragraph.*

FUS-TSE-333 ### 3.1.7 Oxygen System Activation

FUS-TSE-334 *Commentary: High voltage has a propensity to arc in the high altitude environments. To prevent the possibility of an electric arc occurring near a pure oxygen source deployed for passenger use during cabin decompression, all high voltage sources in the TSE and bulkhead monitors will be shut down in response to notification that the Oxygen System is activated. Also, the NES will send commands to mute cabin and seat audio. Upon receipt of an end of an Oxygen Deployment Event message the NES resumes normal operation.*

FUS-TSE-335 On receipt of an Oxygen Activation message the TSE **shall** turn off the LCD backlight power source.

FUS-TSE-336 The TSE **shall** remain active during the oxygen activation event, and continue to process commands received from the MCE.

FUS-TSE-337 On receipt of a Termination of Oxygen Activation message or control parameter the TSE **shall** turn the LCD backlight power source back on.

FUS-TSE-338 The TSE **shall** not turn on the LCD backlight power source unless the Termination of Oxygen Activation message is received - - No recovery after a timeout period is permissible.

FUS-TSE-339 ### 3.1.8 Configuration

FUS-TSE-340 *Commentary: The TSE operating as a passenger display will obtain information to generate its IP address from the ZDE. For installations with direct connection to the NES, such as for a galley display or a CCDU, the IP address for the TSE will be created using its LRU address.*

FUS-TSE-341 The TSE **shall** provide four pulled up connector pins for setting the LRUaddress by applying a low level or ground to selected pins.

FUS-TSE-1232 The TSE LRU address **shall** consist of three address lines and an odd parity bit.

FUS-TSE-342 If the TSE LRU address pin inputs are floating, the TSE **shall** wait for the receipt of IP base address information over the RS-232 control interface port.

FUS-TSE-343 The TSE **shall** be capable of receiving and transmitting System Network Management Protocol (SNMP) packets for configuration, status reporting, and network.

FUS-TSE-344 Methods for configuration and control of TSE programmable functional parameters **shall** include:

FUS-TSE-345 The utilization of SNMP and Management Information Base (MIB) variables.

FUS-TSE-346 Ethernet message packets from the head end processors in the MCE.

FUS-TSE-347

3.2 Performance Requirements

FUS-TSE-348

There are currently no specific TSE performance requirements for inclusion into this section.

FUS-TSE-349

3.3 External Interfaces

FUS-TSE-350

The following sections describe the external electrical interfaces to the TSE.

FUS-TSE-351

3.3.1 Connectors

FUS-TSE-352

J1 Connector type: 31 pin socket double density D subminiature P/N 2DA31S-FO (ITT Cannon) plus contacts 030-9542-012 (ITT CANNON). Suggested Mating connector: P/N 2DA31P-FO (ITT Cannon) plus contacts 031-9540-000 (ITT CANNON), and Backshell P/N K3047 (KERN ENGINEERING).

FUS-TSE-353

Table 3-2 TSE I/O Connector

FUS-TSE-1228

Function	Cnctr	Pin #	TSE Signal Name	Usage:					
				A	B	C	F	G	M
DC Power (PIN)	J1	13	+28VDC	X	X	X	X	X	X
	J1	14	28V_RTN	X	X	X	X	X	X
Debug Mode Discrete	J1	21	DEBUG						X
Aux Composite Video In	J1	10	NTSC_COMP_IN		X	X			X
	J1	31	NTSC_COMP_RTN		X	X			X
Aux Audio In	J1	7	AUDIO_IN_L		X	X			X
	J1	18	AUDIO_IN_R		X	X			X
	J1	28	AUDIO_IN_RTN		X	X			X
Headphone Audio Out	J1	8	AUDIO_OUT_L					X	X
	J1	19	AUDIO_OUT_R					X	X
	J1	29	AUDIO_OUT_RTN					X	X
RS232	J1	5	RS232_TX	X	X	X			X
	J1	20	RS232_MUX_SEL_0	X	X	X			X
	J1	26	RS232_RX	X	X	X			X
	J1	16	RS232_RTN	X	X	X			X
10/100Base-T Ethernet	J1	1	ETHERNET_TX_H	X	X	X	X	X	X
	J1	22	ETHERNET_TX_L	X	X	X	X	X	X
	J1	11	ETHERNET_RX_H	X	X	X	X	X	X
	J1	12	ETHERNET_RX_L	X	X	X	X	X	X
Guard Ground (no connect)	J1	2	GUARD						
GND REFERENCE	J1	23	GND	X	X	X	X	X	X
JTAG / IP Address Pins	J1	9	ADDRESS/JTAG_SELECT				X	X	X
	J1	30	TDI_/_LRU_ADDRESS_0_LSB				X	X	X
	J1	15	TDO_/_LRU_ADDRESS_1				X	X	X
	J1	17	TCK_/_LRU_ADDRESS_2				X	X	X
	J1	27	TMS_/_LRU_ADDRESS_3_MSB				X	X	X
AUX Reset	J1	6	RESET/TRST						X
USB Port	J1	3	D+			X			X
	J1	24	D-			X			X
	J1	4	+5Vdc			X			X
	J1	25	GND			X			X

FUS-TSE-515 Note: Ground Reference pins are provided for grounding input select, mode and address pins. They may also be used to provide ground reference connections to external devices, but may not be used to sink/source more than 10 milliamps.

FUS-TSE-516 * When TSE is connected to a ZDE, all address lines must be open.

FUS-TSE-517 ## 3.3.2 Inputs

FUS-TSE-518 ### 3.3.2.1 IP Address Discretes

FUS-TSE-1233 A TSE LRU Address input line **shall** be interpreted as a '0' when the pin is open, and a '1' when strapped to ground.

FUS-TSE-1179 The TSE **shall** assign an IP Address to its Audio Encoder processor by adding 1 to the fourth byte of the Control processor's IP Address.

FUS-TSE-520 ### 3.3.2.2 NTSC Composite Video input

FUS-TSE-521 The TSE **shall** provide an external input for a nominal 1Vp-p analog NTSC composite video signal and a 75Ohm characteristic impedance. [0400-RC1]

FUS-TSE-522 The TSE should provide the capability to process PAL and SECAM analog video on the same input designated for NTSC Composite video.

FUS-TSE-523 ### 3.3.2.3 Analog Stereo Input

FUS-TSE-524 The TSE **shall** accept a line-level unbalanced analog stereo input through the TSE interface connector. [0401-RC1]

FUS-TSE-525 When an analog stereo input is present it **shall** be digitally encoded and routed to the Ethernet port for retransmission on the Ethernet network and also presented to the Analog Stereo Output port.

FUS-TSE-526 ### 3.3.2.4 Input Primary Power

FUS-TSE-527 The TSE **shall** provide connection to +28 V DC for primary power as defined in 3.7.1.

FUS-TSE-528 ## 3.3.3 Outputs

FUS-TSE-529 ### 3.3.3.1 Analog Stereo Output

FUS-TSE-530 The TSE **shall** provide an analog stereo output suitable for driving one 32 Ohm to 300 Ohm stereo headphone.

FUS-TSE-531 External connection **shall** be through the TSE interface connector.

FUS-TSE-532 The analog stereo output **shall** consist of the audio content for the displayed video stream from the CES video sources (DVD, or AVOD), stereo audio input from an external carry-on device, or processor audio sources.

FUS-TSE-533 *Commentary: The purpose of this analog stereo audio output is to provide headphone audio for Galley Display installations.*

FUS-TSE-534 ## 3.3.4 Inputs/Outputs

FUS-TSE-535 ### 3.3.4.1 /100 Base-T Ethernet

FUS-TSE-536 All external TSE Ethernet ports should support 10/100 Base-TX shielded twisted pair Ethernet cable connections. [0333-RC1]

FUS-TSE-537 #### 3.3.4.1.1 Ethernet interface

FUS-TSE-538 The TSE **shall** use a 100 Base-T Ethernet port for primary data communications.

FUS-TSE-539 #### 3.3.4.1.2 Ethernet Port Compatibility

FUS-TSE-540 The Ethernet port **shall** be compatible with the IEEE Standard 802.3 specification.

FUS-TSE-541 ### 3.3.4.2 RS-232 Control Interface

FUS-TSE-542 An asynchronous RS-232 interface **shall** be provided to the TSE that conforms to the EIA/TIA-232 specification for the purpose of providing a control communications link with the ZDE. [0403-RC1]

FUS-TSE-543 The TSE RS-232 Control Interface port parameters **shall** default to 9600 bps (bits per second) with 1 start bit, 8 data bits, 1 (odd) parity bit and 1 stop bit.

FUS-TSE-544 The TSE RS-232 Control Interface port parameters **shall** be configurable.

FUS-TSE-545 The TSE RS-232 Control Interface port **shall** be used for providing an update of the TSE IP address.

FUS-TSE-546 ### 3.3.4.3 USB Port

FUS-TSE-547 The TSE **shall** provide standard USB 1.1 interface signal lines on the TSE interface connector for external mouse or keyboard connection to the TSE.

FUS-TSE-548 *Commentary: It is not intended to install an USB 1.1 standard connector on the TSE case but to provide the signal lines for an externally located connector.*

FUS-TSE-549 ## 3.3.5 Maintenance Interfaces

FUS-TSE-550 *Commentary: LRU Maintenance functionality will be provided by electrical connection interfaces and by Light Emitting Diode (LED) indications defined in the following paragraphs:*

FUS-TSE-1182…

..FUS-TSE-1182

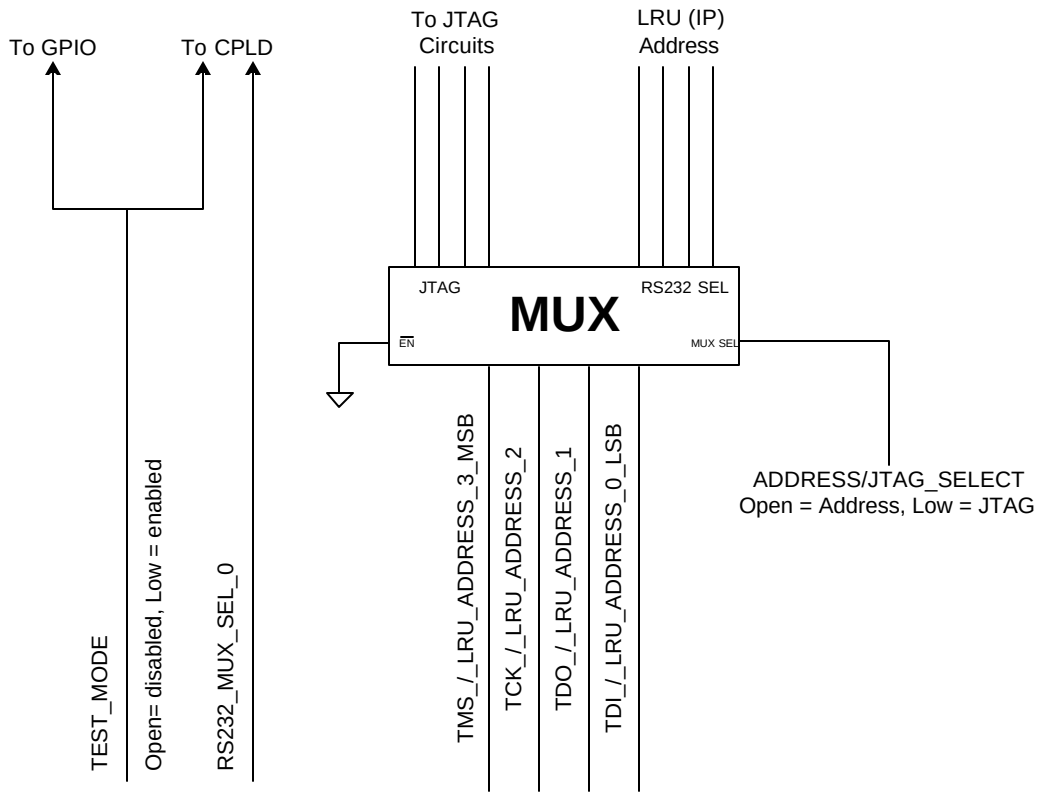


Figure 2-1 Generalized LRU ID/JTAG Controls

FUS-TSE-1181

FUS-TSE-551 **3.3.5.1 Maintenance Connection Interfaces**

FUS-TSE-552 The TSE **shall** provide maintenance connection interfaces on the I/O connector: [0406-RC1]

FUS-TSE-553 ARINC 720 **shall** not apply to TSE maintenance port discrete lines.

FUS-TSE-554 **3.3.5.1.1 Test (Debug) Mode Discrete**

FUS-TSE-555 A discrete input **shall** be provided on the maintenance connector to set the TSE into Test Mode by the application of a low signal level to the input.

FUS-TSE-556 **3.3.5.1.2 RS-232 Maintenance Interface**

FUS-TSE-557 *Commentary: Due to expected Pin limitations on the TSE I/O connector the RS-232 maintenance interface may only be provided internal to the TSE and become accessible after some disassembly of the LRU.*

FUS-TSE-558 An asynchronous RS-232 interface that conforms to the EIA/TIA-232 specification **shall** be provided on the TSE internal video controller circuit board. [0387-RC1]

FUS-TSE-559 The TSE RS-232 Maintenance port parameters **shall** default to 9600 bps (bits per second) with 1 start bit, 8 data bits, 1 (odd) parity bit and 1 stop bit.

FUS-TSE-560 The TSE RS-232 Maintenance port parameters **shall** be configurable.

FUS-TSE-561 #### 3.3.5.1.3 RS-232 MUX Select

FUS-TSE-562 The TSE **shall** provide a discrete for selecting RS-232 maintenance port connections to internal processors.

FUS-TSE-563 #### 3.3.5.1.4 JTAG Interface

FUS-TSE-564 The TSE **shall** provide a standard Joint Test Action Group (JTAG) interface on the maintenance port in accordance with IEEE 1149.1-2001. [0387-RC1]

FUS-TSE-565 The JTAG interface **shall** provide the capability to:

FUS-TSE-566 Perform boundary scan testing of TSE circuit boards,

FUS-TSE-567 Allow in-system programming or reprogramming of hardware devices.

FUS-TSE-568 #### 3.3.5.1.5 JTAG/Address Select Discrete

FUS-TSE-569 A discrete input **shall** be provided on the maintenance connector for assigning dual functionality to four discrete signal lines on the I/O connector.

FUS-TSE-570 JTAG functionality **shall** be assigned to the four discrete lines when the ADDRESS/ JTAG_SELECT line is in the low or ground state.

FUS-TSE-571 TSE base IP addressing functionality **shall** be assigned to the four discrete lines when the ADDRESS/JTAG_SELECT line is in the high or open state.

FUS-TSE-572 Table 3-3 summarizes the control action of the ADDRESS/JTAG_SELECT Discrete for selecting JTAG or LRU Address functionality for the four shared discrete lines.

FUS-TSE-573 Table 3-3 RS232_MUX/JTAG_SELECT

State	TMS_/ _LRU_ADDRESS _3_MSB	TCK_/ _LRU_ADDRESS _2	TDO_/ _LRU_ADDRESS _1	TDI_/ _LRU_ADDRESS _0_LSB
Ground	TMS	TCK	TDO	TDI
Open	LRU Address 3	LRU Address 2	LRU Address 1	LRU Address 0

FUS-TSE-593 #### 3.3.5.1.6 Reset

FUS-TSE-594 A discrete input **shall** be provided on the maintenance connector to reset internal circuit functions by the application of a low signal to the input.

FUS-TSE-595 ### 3.3.5.2 LED Usage Functional Requirements

FUS-TSE-596 #### 3.3.5.2.1 External vs Internal LED Definition

FUS-TSE-597 *Definition: An external LED is visible from outside the LRU without opening the LRU cover.*

Definition: An external LED usually applies to the entire LRU.

FUS-TSE-598

FUS-TSE-599

3.3.5.2.2 External LED Usage

FUS-TSE-600 The requirements involving external LEDs have been deleted

FUS-TSE-601 Deleted

FUS-TSE-602 Deleted

FUS-TSE-603 Deleted

FUS-TSE-604 Deleted

FUS-TSE-605 Deleted

FUS-TSE-606 Deleted

FUS-TSE-607 Deleted

FUS-TSE-608 Deleted

FUS-TSE-609 Deleted

FUS-TSE-610 Deleted

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FUS-TSE-615 Deleted

FUS-TSE-616 Deleted

FUS-TSE-617 Deleted

FUS-TSE-618 Deleted

FUS-TSE-619 Deleted

FUS-TSE-620 Table 3-4 Deleted

Meaning	Green	Yellow	Red	Priority (1 =highest)
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				
Deleted				

Deleted				

FUS-TSE-694 ## 3.4 Internal Interfaces

FUS-TSE-695 The following paragraphs describe the internal electrical interfaces to the TSE.

FUS-TSE-696 ### 3.4.1 Video Controller to LCD Electrical Interface

FUS-TSE-697 The Video Controller **shall** provide the electrical interface to the LCD display panel.

FUS-TSE-698 ### 3.4.2 Touch Screen Interface

FUS-TSE-699 The Video Controller **shall** provide the electrical interface to the LCD display touch screen panel.

FUS-TSE-700 ### 3.4.3 Internal Power Distribution

FUS-TSE-701 The input +28 V DC input power will be converted to circuit level voltages by an internal DC to DC converter.

FUS-TSE-702 ### 3.4.4 IR Sensor

FUS-TSE-703 The TSE **shall** provide an infrared (IR) sensor to determine the stowed position of the TSE.

FUS-TSE-704 The TSE **shall** respond to the sensor activation as defined in 3.1.6.1.

FUS-TSE-1170 ### 3.4.5 Audio IP Address

FUS-TSE-1172 The TSE shall provide an RS-232 interface to the ARM/DSP audio processor.

FUS-TSE-1173 The TSE chall determine an IP address for the connected audio processor.

FUS-TSE-1174 The TSE shall communicate the IP address for audio processor via RS-232.

FUS-TSE-705 ## 3.5 Physical Characteristics

FUS-TSE-706 ### 3.5.1 Dimensions

FUS-TSE-707 The maximum envelope dimensions of the TSE **shall** be in accordance with drawing 1308520 and as specified in Table 3-5 .

FUS-TSE-708 Table 3-5 TSE Maximum Dimensions

Orientation	10.4 Inch TSE (inches)	8.4 Inch TSE (inches)	6.4 Inch TSE (inches)
Width	10.75	9.5	7.61
Height	8.50	7.47	6.10
Depth	1.57	1.57	1.57

FUS-TSE-730 #### 3.5.1.1 Mounting Configurations

FUS-TSE-731 The TSE **shall** be capable of installation at seat locations by plug-in or installed in seat armrests. [0147-RC1]

FUS-TSE-732 The Galley touch screen **shall** be able to be mounted on a bulkhead in the galley area. [0191-BA1]

FUS-TSE-733 Brackets designed for TSE mounting **shall** not be considered part of the maximum dimensions for the LRU. [0146-BA1]

FUS-TSE-734 ### 3.5.2 Weight

FUS-TSE-735 The 10.4 inch TSE weight **shall** not exceed 5.0 pounds [SS Para 4.10].

FUS-TSE-736 The design weight goal for the 10.4 inch TSE **shall** be 3.85 pounds.

FUS-TSE-737 ### 3.5.3 Finish

FUS-TSE-738 The TSE exterior finish color(s) and front panel artwork requirements **shall** be as specified in the outline drawing.

FUS-TSE-739 If an aluminum housing case is provided instead of the standard plastic case, all Interior and Exterior surfaces of the TSE **shall** be prepared in accordance with the requirements of *Business and Regional Systems Pro Line 21 Internal/External Packaging Design Guideline*.

FUS-TSE-740 ## 3.6 Software

FUS-TSE-741 ### 3.6.1 Maintenance

FUS-TSE-742 Software and firmware contained within Programmable Electronic Devices (PEDs) located within this LRU **shall** meet the planning, design, development, test, and certification requirements of RTCA/DO-178B, Level E.

FUS-TSE-743 Firmware may be included within this LRU to provide functions as required by this specification or to meet the derived requirements as specified below.

FUS-TSE-744 Programmable logic contained within PEDs located within this LRU **shall** be managed and controlled via best drawing practices.

FUS-TSE-745 Control/Display software **shall** take into account all standard configurations. [0189-BA1]

FUS-TSE-746 *Rationale: no application software changes will be required when changing from one standard configuration to another. Configuration files may change.*

FUS-TSE-747 ### 3.6.2 Software Download

FUS-TSE-748 Means **shall** be provided in the TSE to allow for the download of software via an external interface to the LRU.

FUS-TSE-749 Bootstrap software/firmware **shall** be downloadable via the JTAG maintenance interface.

FUS-TSE-750 Application software/firmware **shall** be downloadable via the Ethernet interface.

FUS-TSE-751 ### 3.6.3 Firmware Interfaces

FUS-TSE-752 *Commentary: This paragraph normally describes the interfaces for any firmware that will be contained in this LRU to meet either flowed down or derived requirements. Required Interfaces may be to other firmware or to software. Firmware Interface requirements will be defined during the design and development process and are not specified by this document.*

FUS-TSE-753 ### 3.6.4 Firmware Requirements

FUS-TSE-754 *Commentary: Firmware included on a processor board for an LRU may contain modules such as drivers, test primitives, boot loaders, operating systems, etc. This paragraph normally describes the requirements (functions to be performed) for any firmware that will be contained in this LRU to meet either flowed down or derived requirements. Firmware requirements will be defined during the design and development process and are not specified by this document.*

FUS-TSE-755 ### 3.6.5 Operating System

FUS-TSE-756 *Commentary: This paragraph normally describes constraints or specifies the required operating system for each microprocessor or microcontroller in the LRU. The determination of processor and operating systems for implementing the TSE functional requirements will be defined during the design and development process and are not specified by this document.*

FUS-TSE-757 ### 3.6.6 Diagnostics

FUS-TSE-758 *Commentary: This paragraph normally describes constraints or specifies all diagnostic software required for operational LRU testing. The determination of constraints or specification of diagnostic software requirements will be defined during the design and development process and are not specified by this document.*

FUS-TSE-759 ### 3.6.7 Drivers

FUS-TSE-760 *Commentary: This paragraph normally describes constraints or specifies all driver software required for operation of all interface hardware. The determination of driver software requirements will be defined during the design and development process and are not specified by this document.*

FUS-TSE-761 ## 3.7 Power Requirements

FUS-TSE-762 ### 3.7.1 Input Power

FUS-TSE-763 The TSE input power **shall** be 40 Watts maximum. [0386-RC1]

FUS-TSE-764 Input voltages **shall** comply with the requirements of DO-160D Section 16 for Category A equipment. [0386-RC1]

FUS-TSE-765 During steady state operation the cyclic peak-to-peak dc ripple voltage **shall** be less than 4 volts if the input voltage at the TSE connector pins is above or equal to 22 Volts; if not, ripple voltage will be less than 2 Volts.

FUS-TSE-766 The frequency components of the input power ripple voltage **shall** be as specified in paragraph 18.3.1 of DO-160 D change notice 2 for Category A( ) and Z equipment.

FUS-TSE-767 Table 3-6 summarizes the allowable TSE input voltage variation and ripple voltage requirements specified by DO-160D.

FUS-TSE-768 Table 3-6 TSE Input Voltage Requirements

Voltage (Vdc)	Condition	Ripple (Vp-p max)
27.5	Nominal	4
30.3	Maximum	4
22.0	Minimum	4
18.0	Emergency	2

FUS-TSE-790 ### 3.7.2 Power Hold-up Time

FUS-TSE-791 Loss of power to the TSE for less than 200 ms **shall** have no affect on the CES. [0004-BA1]

FUS-TSE-792 ### 3.7.3 Power Cutoff Temperature

FUS-TSE-793 The TSE **shall** contain a temperature sensor as part of the BITE, which does not automatically cause a power shut down in the event of an overtemperature condition.

FUS-TSE-794 The TSE **shall** shut down if an over temperature of 70 (+10, -0) degrees C or under temperature of -15 (-10, + 0) C is detected.

FUS-TSE-795 The TSE **shall** have its power restored and reconnect once the over or under temperature condition goes away.

FUS-TSE-796 ## 3.8 Acoustics

FUS-TSE-797 The TSE should comply with the Acoustical Noise requirement in ARINC 722, paragraph 2.7.

FUS-TSE-798 ## 3.9 Cooling

FUS-TSE-799 The TSE may be actively cooled when operating within the environment specified in paragraph 3.14.

FUS-TSE-800 The TSE **shall not** require conditioned cooling air. [0314-RC1]

FUS-TSE-801 *Comment: Cooling fans may be used for the TSE.*

FUS-TSE-802 ## 3.10 Design and Construction

FUS-TSE-803 ### 3.10.1 Workmanship

FUS-TSE-804 Workmanship **shall** be in accordance with Rockwell Collins Workmanship Standards Manual 523-0778764.

FUS-TSE-805 ### 3.10.2 Interchangeability

FUS-TSE-806 Items identified by the same part number **shall** be functionally, physically, and structurally interchangeable, without the need for any adjustment or alterations with respect to the item's performance or the installation of the item on the aircraft.

FUS-TSE-807 Changes in an item that affect interchangeability **shall** always be attended by a change in part number.

FUS-TSE-808 TSE equipment that is not functionally interchangeable **shall not** be physically interchangeable.

FUS-TSE-809 In the case of multiple connectors on the TSE, unique connectors **shall** be provided to assure only one possible physical mating of cables for each connector.

FUS-TSE-810 ### 3.10.3 Calibration

FUS-TSE-811 The TSE **shall** be designed such that no external calibration or adjustment is required in the field.

FUS-TSE-812 ### 3.10.4 Human Factors

FUS-TSE-813 The TSE should utilize the human engineering principles described in the Department of Defense Criteria Standard, MIL-STD-1472 as a guide.

FUS-TSE-814 The TSE design should minimize factors that degrade the ability to use the system, make the system unduly sensitive to operator misuse, induce misuse of the system, increase risk of personal injury to the user, and be such that the skills and effort required to use the system do not exceed the abilities/capabilities of operational and maintenance personnel.

FUS-TSE-815 Operator misuse (e.g, rapid pushing of function buttons, kicks on seat back, punches or slaps on seat armrest, etc.) should not cause malfunctions.

FUS-TSE-816 The TSE display **shall** be free of rolling noise bars.

FUS-TSE-817 ### 3.10.5 Health and Safety

FUS-TSE-818 All equipment **shall** be designed to adequately protect flight crew, cabin attendants, maintenance crew and passengers from injury due to moving parts, electrical shock, burns, high energy levels, toxicity and radiation as specified in the requirements below.

FUS-TSE-819 #### 3.10.5.1 Personnel Safety

FUS-TSE-820 Exposed corners and projections **shall** be rounded or finished with a minimum radius of 3.2 millimeters to minimize the risk of personal injury.

FUS-TSE-821 Disconnected electrical connectors **shall not** expose hot (power) pins or leads.

FUS-TSE-822 All hot contacts **shall** be covered and recessed.

FUS-TSE-823 The TSE **shall not** contain exposed terminals or circuitry that could cause personal injury.

FUS-TSE-824 Whenever possible, hazards should be eliminated by basic design.

FUS-TSE-825 Identification labels **shall** be concise and specify the same information as published in the TSE maintenance manual.

FUS-TSE-826 The TSE **shall** be marked with hazard warning labels as appropriate specifying the hazard in clear and direct language, and with type larger than other LRU labels, where necessary.

FUS-TSE-827 #### 3.10.5.2 Decompression

FUS-TSE-828 For the CES system a Decompression event is denoted as an Oxygen System Activation event. TSE operational response is defined in 3.1.7.

FUS-TSE-829 #### 3.10.5.3 Electrical Shock

FUS-TSE-830 The TSE **shall** be designed so as to minimize the risk of electrical shock to crew, passengers, and servicing personnel, and also to maintenance personnel using normal precautions.

FUS-TSE-831 The TSE **shall** be designed to provide personnel protection from electrical shock as follows:

FUS-TSE-832 The voltage from equipment to basic structure under normal or fault conditions **shall** not exceed 1.25 volts AC or 5 volts DC in hazardous areas (where there is a likelihood of personnel contact and injury from such contact) where there is potential exposure to large quantities of water.

FUS-TSE-833 The voltage from equipment to basic structure under normal or fault conditions **shall** not exceed 10 volts AC or 30 volts DC in non-hazardous wet areas.

FUS-TSE-834 Electrical equipment operating with voltages higher than defined above requires a single case ground unless completely contained in non-conductive housings.

FUS-TSE-835 The TSE should be completely contained in a non-conductive case.

FUS-TSE-836 ***Note:*** *The TSE will operate from supply voltages of less than 30VDC. However, the backlight inverter may generate high voltages.*

FUS-TSE-837 #### 3.10.5.4 Touch Temperatures

FUS-TSE-838 The external surface temperature of any part of the TSE **shall** not exceed the maximum temperature of 69 ^{o}C (156 ^{o}F) specified in MIL-STD-1472D for prolonged contact or handling for plastic surfaces.

FUS-TSE-839 #### 3.10.5.5 Flammability/Toxicity/Smoke/Gas Emission

FUS-TSE-840 The TSE **shall** comply with the requirements FAR 25.853 (a)(d) and FAR 25.869(a).

FUS-TSE-841 The guidelines defined in FAA Advisory Circular 25-16 **shall** apply as applicable to the TSE design.

FUS-TSE-842 ### 3.10.6 Circuit Protection

FUS-TSE-843 The TSE **shall** be designed to protect against input power over-current or over-voltage conditions.

FUS-TSE-844 The TSE **shall** provide over current or short circuit protection for its exposed outputs; Ethernet, discrete outputs, audio outputs, DC power outputs, and data level outputs.

FUS-TSE-845 To the extent possible the TSE **shall** provide over voltage and or surge current limitation for all exposed inputs; Ethernet, discrete inputs, and data level inputs.

FUS-TSE-846 ### 3.10.7 Electrostatic Discharge

FUS-TSE-847 The Electrostatic Discharge (ESD) requirements **shall** be as specified in the following paragraphs.

FUS-TSE-848 #### 3.10.7.1 Identification of ESD Sensitive Devices

FUS-TSE-849 As a minimum, metal oxide semiconductors/micro-semiconductors and 0.1 percent precision metal film resistors **shall** be identified as electrostatic discharge sensitive devices (EDSDs).

FUS-TSE-850 *Definition: EDSDs are electrical and electronic devices (e.g. transistor, diode, microcircuit) and components (e.g., resistors), which may undergo an alteration of electrical or physical characteristics as a result of up to 10 discharges from a 100-picofarad capacitor charged to 15,000 volts or less, and discharged through a 1500 ohm resistor into any two terminals or any surface and any terminal.*

FUS-TSE-851 Assemblies containing electrostatic discharge sensitive devices **shall**, as a minimum, be identified as follows:

FUS-TSE-852 All EDSD parts **shall** be identified by the Component Maintenance Manual or Overhaul Manual.

FUS-TSE-853 Each assembly, as well as all equipment containing EDSD parts, **shall** be identified with a “Caution” or “Attention” label.

FUS-TSE-854 The label **shall** provide a highly visible indication of the message intended to be conveyed.

FUS-TSE-855 #### 3.10.7.2 Protection of ESD Sensitive Devices

FUS-TSE-856 The potential of damaging any electrical/electronic part contained within the equipment by virtue of discharging an electrostatic pulse into a connector pin, accessible externally to the LRU, **shall** be assessed.

FUS-TSE-857 For each susceptible pin, transient protection circuitry **shall** be provided to preclude any requirements for special handling of completed systems.

FUS-TSE-858 A conductive connector dust cover **shall** be used to protect sensitive electronic circuitry from introduction of an electrostatic pulse through the connector pins.

FUS-TSE-859 A “Caution” label **shall** be affixed near the assembly external connection.

FUS-TSE-860 The label **shall** dictate the need for the conductive dust cover during transportation and storage.

FUS-TSE-861 ### 3.10.8 Nameplates and Product Markings

FUS-TSE-862 The TSE **shall** include a nameplate to identify the model number of the unit and the revision level to which the unit conforms.

FUS-TSE-863 All labels **shall** be engraved directly on the equipment or on a label attached to the equipment.

FUS-TSE-864 The label, which will be in English, **shall** conform to the following:

FUS-TSE-865 Vendor's name and (optionally) CAGE code,

FUS-TSE-866 Description of the equipment item (abbreviated if necessary),

FUS-TSE-867 Equipment code number,

FUS-TSE-868 Equipment part number (P/N),

FUS-TSE-869 Equipment serial number (S/N), and

FUS-TSE-870 Indication of possible alterations (separate from equipment P/N).

FUS-TSE-871 When a modification plate is provided, the modification standard **shall** be recorded by inscribing the numbers of all modifications incorporated, quoting either the modification number or an approved abbreviated identity representing the modification number.

FUS-TSE-872 ## 3.11 Reliability

FUS-TSE-873 ### 3.11.1 Mean Time Between Failure

FUS-TSE-874 The Mean Time Between Failure (MTBF) of the TSE **shall** be at least 10000 flight hours. [0336-BA1]

FUS-TSE-875 ### 3.11.2 Mean Time Between Unscheduled Replacement

FUS-TSE-876 Not Applicable

FUS-TSE-877 ### 3.11.3 Useful Life

FUS-TSE-878 *Commentary: The useful life of the TSE is not specified but the useful system life of the complete CES system is specified to be 30000 flight hours. [0335-BA1]*

FUS-TSE-879 ### 3.11.4 Mean Time To Replace

FUS-TSE-880 Not Applicable

FUS-TSE-881 ## 3.12 Maintainability

FUS-TSE-882 Not Applicable

FUS-TSE-883 ### 3.12.1 Scheduled Maintenance

FUS-TSE-884 Not Applicable

FUS-TSE-885 ### 3.12.2 BIT/BITE

FUS-TSE-886 The TSE **shall** include Built In Test (BIT) and Built In Test Equipment (BITE) to the extent specified herein. [0299-RC1]

FUS-TSE-887 The TSE **shall** perform Power-On BIT and provide a health status report over the Ethernet Network.

FUS-TSE-888 During operation the TSE **shall** perform continuous BIT that is non-intrusive to the TSE operation giving no indication, visual, or other effect that is noticeable to the passenger and report all maintenance diagnostic data to the MCE.

FUS-TSE-889 The TSE **shall** use a periodic health status message to report continuous BIT status over the Ethernet network at a configurable rate. [0270-RC1] [0328-RC1]

FUS-TSE-1175 The TSE **shall** provide BIT status via SNMP.

FUS-TSE-890 During maintenance the TSE **shall** support initiated BIT that may affect functionality of the TSE and NES network.

FUS-TSE-891 #### 3.12.2.1 BIT Non-Intrusive Testing

FUS-TSE-892 The TSE **shall** as a minimum monitor and report the status of the following TSE functions:

FUS-TSE-893 External Ethernet Communications

FUS-TSE-894 Health of the audio processor

FUS-TSE-895 Analog audio output ports

FUS-TSE-896 Power supply monitoring

FUS-TSE-897 Over or under temperature and verification that the power supply is in the OFF state

FUS-TSE-898 NTSC sync status

FUS-TSE-899 Backlight condition

FUS-TSE-900 Entertainment video source status

FUS-TSE-901 Internal communications ports and intra-processor communications

FUS-TSE-902 The TSE **shall** support the reporting of a 32 bit maintenance diagnostic or health message once every second over the Ethernet network [*Interface Data Guidelines for the CES-5000 Cabin Electronic System*]

FUS-TSE-903 ### 3.12.3 Internal Fault Isolation and Detection

FUS-TSE-904 Upon detection of a “fatal” fault, the TSE **shall** terminate all message handling and, where feasible, physically disconnect itself from the Ethernet LAN.

FUS-TSE-905 #### 3.12.3.1 CPU Faults and Failures

FUS-TSE-906 The TSE CPU design should be capable of recovering from at least the following faults and failures:

FUS-TSE-907 Illegal address faults

FUS-TSE-908 Peripheral device failures (e.g. from DMA controllers and graphic controllers)

FUS-TSE-909 Memory test failures (e.g. checksum failures

FUS-TSE-910 Watchdog timeout faults

FUS-TSE-911 Software process monitor faults

FUS-TSE-912 ##### 3.12.3.1.1 CPU Watchdog Timer Fault

FUS-TSE-913 The TSE CPU **shall** include a watchdog timer.

FUS-TSE-914 The watchdog timeout fault **shall** recover the CPU if no activity is detected from the CPU in a given time interval.

FUS-TSE-915 Once a watchdog fault has been detected, the CPU **shall** reset.

FUS-TSE-922 ### 3.12.4 Special Test Equipment

FUS-TSE-923 The following special test equipment will be required to support production, EMI and environmental testing.

FUS-TSE-924 NTSC Signal Generator

FUS-TSE-925 Audio Analyzer

FUS-TSE-926 Personal Computer with one each COM and 10/100 Mbs Ethernet interface ports

FUS-TSE-927 USB keyboard & mouse

FUS-TSE-928 External Power Supply

FUS-TSE-929 Custom test interface box to breakout TSE I/O connections for monitoring and control.

FUS-TSE-930 The TSE should include strategic placement of test points, loop-back features in testing circuit paths, and packaging for easy access to test points.

FUS-TSE-931 ## 3.13 Memory and Processor Growth

FUS-TSE-932 ### 3.13.1 Memory Usage

FUS-TSE-933 The TSE should provide the spare capacity requirements for memory and disk storage as detailed below.

FUS-TSE-934 These requirements should apply to each memory type (for example RAM, ROM, FLASH EEPROM, EEPROM, disk) within the TSE.

FUS-TSE-935 Memory margin should be calculated as 100*(M-U)/M in %, where M is the total amount of memory available without a hardware modification, and U is the worst-case amount used.

FUS-TSE-936 The TSE should achieve memory margins for each type and device of memory of a minimum of 50% at Critical Design Review (CDR), 30% at Test Readiness Review (TRR), and 30% at Consent to Ship (CTS).

FUS-TSE-937 Memory margin should be calculated/measured under the worst case loading conditions.

FUS-TSE-938 The LRU should include the capability to double the installed memory to 2*M.

FUS-TSE-939 ### 3.13.2 CPU Usage

FUS-TSE-940 The TSE should provide the spare capacity requirements for CPU processing as detailed below.

FUS-TSE-941 These requirements should apply to each CPU/processor within the TSE on an individual basis.

FUS-TSE-942 Timing margin should be calculated as 100*(T-t)/T in %, where T is the basic cycle time, and t is the worst-case amount of the cycle used.

FUS-TSE-943 The TSE should achieve timing margin estimates for each CPU/processor of a minimum of 50% at CDR, 30% at TRR, and 30% at CTS.

FUS-TSE-944 CPU usage should be calculated/measured under the worst case loading conditions.

FUS-TSE-945 Timing margins under any load conditions should be such that no Passenger or Crew initiated transactions are lost, with the exception of Emergency PA operation.

FUS-TSE-946 ### 3.13.3 LRU Response Timing

FUS-TSE-947 Not Applicable.

FUS-TSE-948 ## 3.14 Environmental Conditions

FUS-TSE-949

3.14.1 Natural Environments

FUS-TSE-950 The TSE **shall** meet the requirements specified herein when subjected to the environments specified in Table 3-7.

FUS-TSE-951 Table 3-7 Environment

Environmental Conditions	Applicable Specification	Specification Requirement
Temperature	RTCA/DO-160D, Sect 4, Cat A2	
Ground Survival Low Temperature		-55°C
Power On Low Temperature		-55°C
Normal Operational Temp Range		-15°C to +55°C
Short Time (30 min) Operating High Temperature		+70°C
Ground Survival High Temperature		+85°C
Loss of Cooling		+40°C for 30 min
Waterproofness		N/A
Sand and Dust	RTCA/DO-160D, Section 12	ANSI/ASHRAE 52.1-1992, Sect 6.1 test agent
Altitude	RTCA/DO-160D, Section 4, Cat A2	+15,000 ft.
Decompression	RTCA/DO-160D, Section 4, Cat A2	+45,000 ft.
Overpressure	RTCA/DO-160D, Section 4, Cat A2	-15,000 ft.
Temperature Variation	RTCA/DO-160D, Section 5, Cat B	+5°C/min
Humidity	RTCA/DO-160D, Section 6, Cat A	95%RH @ +50°C, 48 hrs.
Vibration	RTCA/DO-160D, Section 8	Cat S, Curve B
Shock	RTCA/DO-160D, Section 7, Cat B	6g (Oper) 11ms
Crash Safety (Impulse)	RTCA/DO-160D, Section 7, Cat B	20g (Non-operating) 11ms
Crash Safety (Sustained)	RTCA/DO-160D, Section 7, Cat 2F, 2R	12g (Non-operating)

FUS-TSE-1029

3.14.2 Electrical / EMI

FUS-TSE-1030 The TSE **shall** be designed to meet the Electrical and EMI environments specified in Table 3-8.

FUS-TSE-1031 The TSE **shall** be tested in accordance with Rockwell Collins 1304548-843.

FUS-TSE-1032 Table 3-8 Electrical and EMI Conditions

Electrical/EMI Conditions	RTCA/DO-160D
Power Input	Sec. 16, Cat A
Magnetic Effect	Sec 15 Cat C
Voltage Spike	Sec. 17, Cat. A
Audio Frequency Conducted Susceptibly	Sec. 18, Cat. Z
Induced Signal Susceptibly	Sec. 19, Cat. Z
RF Conducted Susceptibly	Sec. 20, Notice 3 or later, Cat. T
RF Radiated Susceptibly	Sec. 20, Notice 3 or later, Cat. T
Emission of Radio Frequency Energy	Sec 21, Cat M (see Note 1)
Electrostatic Discharge (ESD)	(3 KV intervals to 15 KV) Cat A
Grounding and Bonding	(ARINC 600, P 3.2.4) < 10 milli ohm
Current Harmonics	(not applicable)
Power Factor	(not applicable)

FUS-TSE-1073 *Deleted*

FUS-TSE-1074 *Note 1 -- The unit **shall** perform to Cat M. However, it should perform to Cat H.*

FUS-TSE-1075 ## 3.15 Other Requirements

FUS-TSE-1076 ### 3.15.1 Tamper Protection

FUS-TSE-1077 The TSE **shall** be designed to discourage tampering by passengers.

FUS-TSE-1078 ### 3.15.2 Packaging

FUS-TSE-1079 #### 3.15.2.1 Mechanical

FUS-TSE-1080 The mechanical packaging for the TSE **shall** be modular.

FUS-TSE-1081 #### 3.15.2.2 Packaging for Shipment

FUS-TSE-1082 ##### 3.15.2.2.1 Article Packaging

FUS-TSE-1083 Individual containers **shall** be so constructed as to allow removal of parts for inspection purposes without damage to the container or labels.

FUS-TSE-1084 Materials and methods used in packaging the article **shall** be suitable to ensure protection of the article from handling damage or deterioration during storage.

FUS-TSE-1085 ##### 3.15.2.2.2 Intermediate Packaging

FUS-TSE-1086 Where size or other considerations result in more than one article being packaged within a shipping carton, the individual articles **shall** be individually packaged within the shipping carton so that suitable protection and identification is provided during storage and handling after removal of the individual articles from the major shipping carton.

3.15.3 Transportability

FUS-TSE-1087

FUS-TSE-1088 The TSE **shall** be designed so as to be capable of being handled and transported to required sites without damage or degradation, utilizing available methods of transport.

3.15.3.1 Compatibility

FUS-TSE-1089

FUS-TSE-1090 The TSE **shall** be compatible with the planned packaging and transportation system to the extent that loads induced in the equipment during transportation will not produce stresses, internal loads or deflections resulting in damage to the equipment.

3.15.3.2 Transportation Methods

FUS-TSE-1091

FUS-TSE-1092 The TSE **shall** be capable of transport via common carrier to required sites.

3.15.3.3 Transport Loads

FUS-TSE-1093

FUS-TSE-1094 The TSE **shall** be transported and packaged such that the transport does not impose more stringent requirements on it than the flight environment.

3.15.3.4 Ground Handling

FUS-TSE-1095

FUS-TSE-1096 The TSE **shall** be capable of withstanding a 1.5-g loading during ground handling.

3.15.3.5 Tiedown Capability

FUS-TSE-1097

FUS-TSE-1098 Tiedown capability is not applicable to the TSE.

3.15.3.6 Tiedown Protective Capability

FUS-TSE-1099

FUS-TSE-1100 The TSE **shall**, for the items that are highly vulnerable to damage during transport, incorporate:

FUS-TSE-1101 Attach points for installation of temporary protective reinforcement structure.

FUS-TSE-1102 Removals of sensitive items for separate shipment.

FUS-TSE-1103 Built-in protective devices.

3.15.3.7 Reliability Impact

FUS-TSE-1104

FUS-TSE-1105 Methods of preservation, packaging and packing utilized for shipment impacted by natural or induced environments during transportation and subsequent storage, **shall** adequately protect the TSE from damage or degradation in reliability or performance.

3.15.4 Direct Contact Packaging

FUS-TSE-1106

FUS-TSE-1107 Packaging materials in direct contact with TSE items **shall** be clean, dust-free.

FUS-TSE-1108 Packaging materials in direct contact with TSE items **shall not** contaminate to the extent of failing any requirements.

3.15.4.1 Packaging Material Selection

FUS-TSE-1109

FUS-TSE-1110 Electrostatic and barrier properties **shall** be considered in the selection of proper packaging material.

3.15.4.2 Bagged Item Protection

FUS-TSE-1111

FUS-TSE-1112 Each bagged item **shall** be further protected by a visibly clean anti-static polyethylene overwrap-bag, and heat-sealed closed.

FUS-TSE-1113 ### 3.15.5 Threaded Parts

FUS-TSE-1114 All threaded parts **shall** be protected with plugs, caps, or fittings.

FUS-TSE-1115 ### 3.15.6 Package Labeling

FUS-TSE-1116 All packages and storage locations containing parts and materials susceptible to dynamic or static electrical, magnetic, or electromagnetic fields **shall** be identified according to field exposure limitations and labeled with warning labels.

FUS-TSE-1117 When the article will require special attention during receiving inspection, installation, or operation, a removable instruction tag will be affixed to each article.

FUS-TSE-1118 #### 3.15.6.1 Ground Warnings

FUS-TSE-1119 The warning labels **shall** specify package and personnel grounding requirements.

FUS-TSE-1120 #### 3.15.6.2 Shipping ESD Devices

FUS-TSE-1121 For shipments requiring customs inspection, additional precautionary notes **shall** be added to the shipping package.

FUS-TSE-1122 Precautionary notes **shall** be written in English and in the language of the country to which the part is destined, with a warning that the equipment may be damaged if the container is opened without observing proper procedures for the protection of electrostatic-sensitive equipment.

FUS-TSE-1123 #### 3.15.6.3 Item Orientation Label

FUS-TSE-1124 Parts that require storage in a particular orientation to preclude performance degradation **shall** be labeled accordingly.

FUS-TSE-1125 # 4 Verification

FUS-TSE-1126 ## 4.1 Verification Methods

FUS-TSE-1127 The requirements specified herein **shall** be verified by one of the methods as described below and as defined in Appendix A.

FUS-TSE-1128 ### 4.1.1 Analysis

FUS-TSE-1129 An element of verification that utilizes established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedure to provide evidence that stated requirements were met.

FUS-TSE-1130 ### 4.1.2 Demonstration

FUS-TSE-1131 An element of verification that generally denotes the actual operation, adjustment, or re-configuration of items to provide evidence that the designed functions were accomplished under specific scenarios. The items may be instrumented and quantitative limits of performance monitored.

FUS-TSE-1132 ### 4.1.3 Inspection

FUS-TSE-1133 An element of verification consisting of investigation, without the use of special laboratory appliances or procedures. Inspection is nondestructive and includes the use of sight, hearing, smell, and touch; simple physical manipulation; mechanical and electrical gauging and measurement; and other forms of investigation.

FUS-TSE-1134 ### 4.1.4 Test

FUS-TSE-1135 An element of verification, that denotes the determination, by technical means, of the properties or elements of items, including functional operation, and involves the application of established scientific principles and procedures.

FUS-TSE-1136 #### 4.1.4.1 Design Verification Test

FUS-TSE-1137 Design Verification Test (DVT) **shall** be performed at the LRU level to verify each of the requirements of this document unless a requirement is verified during qualification testing or can only be verified at the system level.

FUS-TSE-1138 #### 4.1.4.2 Qualification Test

FUS-TSE-1139 The TSE **shall** be subjected to qualification test on at least two initial production units as enumerated in Appendix C.

FUS-TSE-1140 The qualification test **shall** formally demonstrate the performance of the unit(s) designs to functionally perform in its intended installation configuration under degraded or even abnormal conditions such as temperature, vibration, humidity and low, high, or even interrupted power conditions.

FUS-TSE-1141 ##### 4.1.4.2.1 Environmental Tests

FUS-TSE-1142 The TSE environmental tests **shall** be performed in accordance with Rockwell Collins, Inc. document No. 1304551-846 tailored as applicable to comply with DO-160D only requirements.

FUS-TSE-1143 Environmental qualification **shall** be performed to verify conformance to all environmental requirements specified in Table 3-7.

FUS-TSE-1144 The TSE qualification units **shall** be delivered with a formal qualification report detailing the test results.

4.1.4.2.2 Performance Verification Test

FUS-TSE-1145

FUS-TSE-1146 Performance Verification Test (PVT) **shall** exercise critical LRU functionality during qualification testing at the LRU level.

FUS-TSE-1147 Performance requirements to be tested **shall** be selected to verify confidence that the TSE will meet the performance requirements specified herein while being subjected to the qualification environments.

4.1.4.2.3 Electrical/EMI Test

FUS-TSE-1148

FUS-TSE-1149 The TSE Electrical/EMI tests **shall** be performed in accordance with Rockwell Collins, Inc. document No. 1304548-843 tailored as applicable to comply with DO-160D only requirements.

FUS-TSE-1150 Electrical/EMI qualification **shall** be performed to verify conformance to all Electrical/EMI requirements specified in Table 3-8.

FUS-TSE-1151 The TSE qualification units **shall** be delivered with a formal qualification report detailing the test results.

4.1.4.3 Manufacturing Acceptance Test

FUS-TSE-1152

FUS-TSE-1153 Acceptance test **shall** be performed at the LRU level on every unit to validate the manufacturing process before shipment.

FUS-TSE-1154 Each TSE delivered **shall** be subject to an acceptance test that ensures that the requirements set forth herein are satisfied in accordance with the TSE Verification Cross Reference Index (VCRI).

Approvals

	Signatures	Date YYYYMMMDD
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System Architect John Michaylo		
Checked by Engineering Librarian		
Engineering Lead James Whitehouse		
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