TESS Command and Telemetry Simulator (CTSIM)

Performance Specification

37-14020 Rev A

(formerly Orbital 6150-PF7201)

Prepared by
Orbital Sciences Corporation

and adopted by

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REVISION HISTORY			
REV	DATE	REASON FOR CHANGE/CHANGE	SECTION(s) AFFECTED
-		Initial Release: Submittal to MIT for completion and release	All
A		MKI Document Release; ECO 37-157, 6 Nov 2014	All

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1 INTRODUCTION

1.1 SCOPE

This CTSIM performance specification establishes the baseline set of requirements needed to verify the ICD for the TESS Spacecraft-to-Instrument EICD and ground interfaces. The focus of the CTSIM implementation is to verify timing, command, and telemetry interfaces and protocols. In addition, the CTSIM provides the user with an incremental set of flight-like (to the extent possible) flight software (FSW) functions and tasks.

The CTSIM implementation will provide the necessary interface and safe-to-mate procedures that will allow interface with flight hardware.

The CTSIM is not intended to function as an electrical simulator. No effort has been made to provide or simulate power switch characteristics or thermal sensing.

This document may in some cases duplicate specific software or interface requirements, but effort has been made to avoid where possible. Requirements that are duplicated in this document are in place to assure that specific software and hardware capabilities are available to support the simulation.

1.2 ACRONYMS AND ABBREVIATIONS

AC	Alternating Current or Attitude Control (depending on context)
APID	Application Identification
CCSDS	The Consultative Committee for Space Data Systems
CTSIM	Command and Telemetry Simulator
DHU	Data Handling Unit
ECI	Earth Centered Inertial frame
ECEF	Earth Centered Earth Fixed frame
EDU	Engineering Development Unit
EGSE	Electrical/Electronic Ground Support Equipment
ESD	Electro Static Discharge
EICD	Electrical Interface Control Document
FSW	Flight Software
HDS	Hybrid Dynamic Simulator
ICD	Interface Control Document
ITAR	International Traffic in Arms Regulations
ITF	Instrument Transfer Frame
KVM	Keyboard, Video, Mouse
LVLH	Local Vertical / Local Horizontal frame
MAESTRO	Mission Adaptable Environment for Spacecraft Test and Real-time Operations
MAU	Master Avionics Unit
MIT	Massachusetts Institute of Technology
PPM	Pulses Per Million
PPS	Pulse Per Second
SDP	Software Development Plan
SIMICS	PC-Based emulation of the Rad750 Single Board Computer. Includes ability to embed other models and simulations
TESS	Transiting Exoplanet Survey Satellite
TCP/IP	Transmission Control Protocol/Internet Protocol
TVAC	Thermal Vacuum testing
UART	Universal Asynchronous Receiver Transmitter
UDP/IP	User Datagram Protocol/Internet Protocol
UPS	Uninterruptible Power Supply
VAC	Volts AC

2 APPLICABLE DOCUMENTS

2.1 ORBITAL SCIENCES CORPORATION AND MIT DOCUMENTS

DN-TESS-SYS-003	TESS Observatory States and Subsystem Modes
6150232000R0	TESS Spacecraft to Instrument Electrical Interface Control Document (EICD)
TBD	DHU FSW Users Manual
6150-GD4900	TESS FSW User's Manual
6150-SRS4910	TESS Flight Software (FSW) Subsystem Specification

2.2 OTHER DOCUMENTS

CCSDS - 203.0-B-1	Telecommand Part 3 Data Management Service
CCSDS - 102.0-B-4	Packet Telemetry

3 REQUIREMENTS

3.1 SIMULATION SYSTEM

The CTSIM **shall** simulate a flight-like command and telemetry interface to the MAESTRO EGSE via serial interface or Ethernet.

The CTSIM **shall** provide flight-like electrical interfaces to the DHU that comply with the spacecraft to instrument EICD (6150232000R0). Only digital communication, timing and command/telemetry signals will be supported. Power and analog interfaces will not be supported.

The CTSIM **shall** provide the capability to generate errors in timing, commanding and communication to the DHU including:

a. Bad APIDs
b. Length/Checksum errors
c. Framing errors
d. Dropped packets
e. Bad Secondary Header Function Code
f. Bad CCSDS Secondary Header Checksum
g. Turn on/off 1PPS signal
h. Arbitrarily adjust the phase of the 1PPS with respect to “time-at-the-tone” message

The CTSIM **shall** include flight software that provides flight-like (to the extent possible) command, telemetry, and data flow for the required software tasks.

The CTSIM will be a rack mounted workstation PC running Windows 7. 64-bit. Orbital Sciences **shall** provide an interface cable between the CTSIM rack and the DHU such that it provides flight-like connectors for mating with the DHU.

The TESS Command and Telemetry database **shall** be maintained in the Orbital Sciences Corporation Composer system and released under Orbital's ISO Configuration Management process.

MAESTRO and the Command & Telemetry database will be resident on a Linux Workstation (mini or micro tower) running Red Hat Enterprise Linux. This workstation will be mounted inside the CTSIM rack.

A rack-mounted keyboard-video-monitor (KVM) switch will be installed in the CTSIM rack for control of the CTSIM and MAESTRO EGSE.

3.2 System Interfaces and Functions

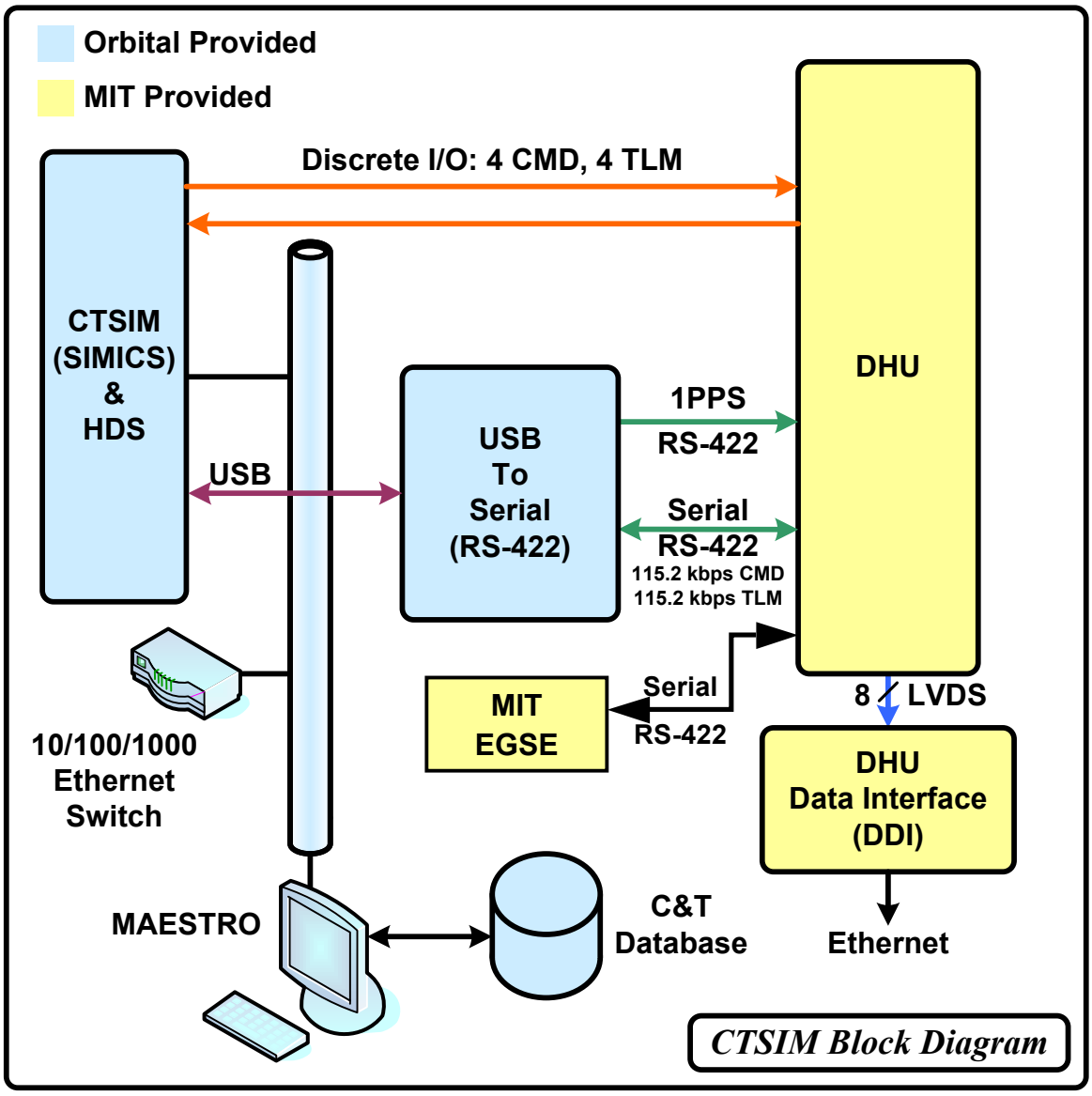

Figure 3-1 - CTSIM Block Diagram

3.2.1 Spacecraft Simulator Interfaces

The CTSIM **shall** include the following interfaces:

1. TCP/IP or UDP/IP socket for command and telemetry
2. TCP/IP or UDP/IP socket for Hybrid Dynamic Simulator (HDS)

3. 1 Pulse Per Second over RS-422
4. One full-duplex 115.2 kilobaud RS-422 level serial interface
5. Four digital command output signals
6. Four digital telemetry input signals
7. AC Power

3.2.1.1 CTSIM Interface Connector Specifications

3.2.1.1.1 RS-422 1PPS/Serial Interface Connector

The RS-422 1PPS/Serial Interface Connector **shall** be a DB9 Male connector as shown in Figure 3-2.

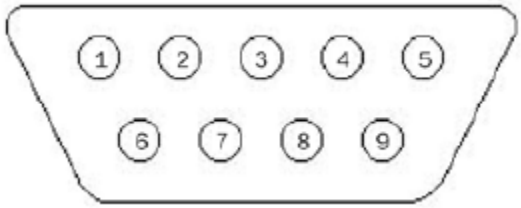

Figure 3-2 - Male DB9 Connector Pinout - Connector Face View

3.2.1.1.2 Command/Telemetry Interface Connector & MIT EGSE Connector

The Command/Telemetry Interface Connector **shall** be a DB9 Male connector as shown in Figure 3-2.

3.2.1.2 Interface Electrical Specifications

3.2.1.2.1 Time Synchronization Pulse

The CTSIM **shall** provide a 1PPS signal to the Instrument that is compliant with the EICD, Section 4.6-A and 4.6-B.

3.2.1.2.2 Discrete Digital Command/Telemetry

The CTSIM **shall** provide four discrete +5V CMOS, single-ended output signals for commanding to the DHU.

The CTSIM **shall** provide four discrete +5V CMOS, single-ended input signals with pull-up resistors to +5V for DHU telemetry.

3.2.1.2.3 Power Requirements

The CTSIM **shall** be powered by AC in the range of 100-240 VAC at 50 Hz or 60 Hz

The CTSIM **shall** draw no more than 1900W worst-case in any configuration.

AC Input	
Description	**Range**
Voltage & Frequency	100 - 240 VAC; 50/60 Hz
Power	1900 W

Table 3-1 - AC Input Specifications

The CTSIM **shall** include an uninterruptable power supply (UPS) capable of providing maximum power for a minimum of 6 minutes.

3.2.1.3 CTSIM Command and Data Handling Interface Specifications

3.2.1.3.1 Physical Layer

The CTSIM physical interface **shall** be compliant to the EICD, Sections 4.3 (Protocol and Framing) and 4.4.1 (Physical Layer).

3.2.1.3.2 Simulator to Instrument Telecommand Packets

The CTSIM Instrument Telecommand packets **shall** be compliant to the EICD, Section 4.4.2.

3.2.1.3.3 Simulator to Instrument Telemetry Packets

The CTSIM Spacecraft Telemetry packets **shall** be compliant to the EICD, Section 4.4.3.

3.2.1.3.4 Instrument to Simulator Telemetry Packets

The CTSIM **shall** be able to receive and process Instrument Telemetry packets in compliance with the EICD, Section 4.5.

3.2.1.4 DHU Interface Connector Specifications

The CTSIM to DHU Interface Harness will be provided along with the CTSIM rack. The harness **shall** mate with the DHU using the same interface connector types and pinouts as defined in the EICD.

3.2.2 SPACECRAFT SIMULATOR SOFTWARE

3.2.2.1 Supported Tasks

The CTSIM **shall** provide flight-like command and data handling capability to the Instrument.

3.2.2.2 Special Software Functions

The CTSIM may be able to provide capabilities to inject faults into the Instrument interface. This capability will be defined after some further discussion.

3.2.2.3 Supported Modes

The CTSIM **shall** support the TESS operating states and modes as defined in DN-TESS-SYS-003 as they pertain to commanding the DHU and receiving/processing telemetry.

Only limited support for ACS operating modes will be provided initially. The CTSIM should support the ability to tell the DHU that the ACS subsystem is operating in the various modes that are defined to facilitate DHU testing.

3.2.2.4 Command List

TBD – MAESTRO Commands sufficient to command the delivered tasks will be provided

3.2.2.5 Telemetry List

TBD – MAESTRO Telemetry sufficient to view the status of delivered tasks will be provided

3.2.3 SPACECRAFT SIMULATOR ENCLOSURE

The CTSIM will be configured in a single ruggedized 19 inch rack system. The rack configuration will be approximately as shown in Figure 3-3.

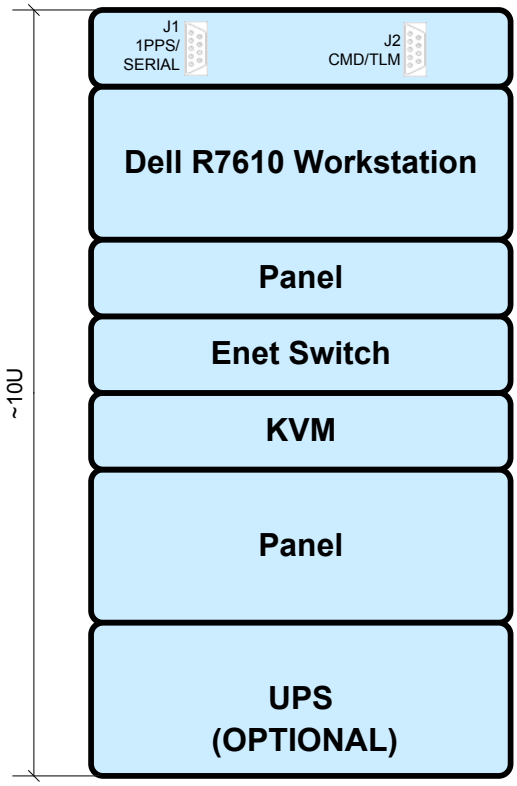

Figure 3-3 - CTSIM Rack Configuration

3.2.4 SPACECRAFT SIMULATOR ENVIRONMENTS

The CTSIM will be designed to survive the thermal environments specified in Table 3-2.

Temperature	
Description	**Range**
Operating	10° to 32° C (50° to 90° F)
Non-operating	-20° to 55° C (-29° to 131° F)
Relative Humidity	30% to 80% (non-condensing)

Table 3-2 - CTSIM Thermal Environment Specifications

4 QUALITY & SECURITY

4.1 NAMEPLATE AND MARKING

TBD

4.2 ESD

The front and back of the rack inside and outside **shall** be marked with ESD stickers indicating that the rack contains ESD sensitive electronics.

4.3 SAFE-TO-MATE INFORMATION

CTSIM safe-to-mate procedures **shall** be included in the setup and configuration documentation delivered with the CTSIM hardware.

4.4 ITAR AND ORBITAL PROPRIETARY

The information contained on the hard drive of the CTSIM **shall** be considered ITAR Tech Data.

The information on the hard drive of the CTSIM **shall** be considered Orbital Proprietary.

The hard drive of the CTSIM **shall** be encrypted.

The encryption password for the hard drive should be a combination of the program name, the date of the program's phase-B start (YYYYMMDD), and one of the following characters #, $, ^, !. e.g. TESS20130801$

4.5 TRANSPORT

The top of the rack **shall** have a sticker or placard with the ESD and environmental requirements clearly marked

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5 USER'S MANUAL AND TRAINING

A CTSIM User's Manual **shall** be developed and delivered with the CTSIM hardware.

CTSIM training **shall** be developed.

CTSIM training **shall** include the following topics:

1. System overview
2. Theory of operation
3. EGSE interfaces
   a. MAESTRO interfaces
   b. Differences to flight MAESTRO configuration
4. Hardware
   a. Description of components
   b. Software task implementation and interfaces
5. Software
   a. Description of simulations
   b. Software task implementation and interfaces
6. Hardware setup
   a. Unpacking
   b. Setup and configuration
   c. Maintenance
7. Problem Reporting
   a. Software
   b. Hardware

6 SOFTWARE AND C&T DATABASE DELIVERIES

Orbital CTSIM Software will be configuration managed and formally released using processes compliant to the TESS SDP. Orbital will deliver executable binary images with the CTSIM hardware and electronically if future releases are required.

The TESS Command and Telemetry MAESTRO Database for the CTSIM Software will be configuration managed and formally released by Orbital.

7 NOTES

7.1 TBD / TBR LIST

Section	Text
3.2.2.4	TBD – MAESTRO Commands sufficient to command the delivered tasks will be provided
3.2.2.5	TBD – MAESTRO Telemetry sufficient to view the status of delivered tasks will be provided
4.1	Nameplate and Marking

Table 7-1 - TBD/TBR List

8 APPENDIX – A

8.1 COMMAND AND TELEMETRY SIMULATOR SETUP, CONFIGURATION, AND MAINTENANCE

This section to be developed in a subsequent release.

9 APPENDIX – B

9.1 PARTS LIST

Item #	Item	Description
1	Dell Precision R7610	Dell Precision R7610 2U Rack Workstation. Xeon® E5-2600. Windows 7 64-bit Pro. 64GB RAM RAID 1+0
2	Dell OptiPlex 9020	Dell OptiPlex 9020 Mini-Tower Workstation, RedHat Linux
3	SIMICS License	Orbital Capital
4	BC635PCI-V2-OCXO	Microsemi Time & Freq Processor, Non-GPS with OCXO
5	Switch	8-Port 10/100/1000 Ethernet Switch - DGS-1016D
6	PEX4S232485	4 Port PCIe Serial Combo Card
7	PCIe-DIO24	24-channel, PCI Express (PCIe) bus compatible digital I/O board
8	Hard Case	1SKB-R912U20 - SKB Roto Shock Rack Cases 12U 20"
9	SMT3000RM2U	APC Smart-UPS RM SMT3000RM2U 2700W/3000VA 2U 120V LCD UPS System
10	Power Strip	Cyberpower CPS-1215RMS Rackmount PDU Power/Surge Strip - 12-Outlet 15A 1800VA 1800 Joules
11	2U 16x DB9 Panel	~~16 Port DB25 2U Rack Mount Panel - WRP-25-16~~ 16 Port DB9 2U Rack Mount Panel - WRP-09-16 ??
12	1U Blank Panel	2x 1U Rack Blank Panel for 19-Inch Server Racks and Cabinets BLANKB1 (Black)
13	DB9 Connectors	DB9 Connectors for 2U Panel x 2
14	RJ-45 to DB9 Cables	RJ-45 to DB9 x 2
15	Female DB9 Gender	Male DB9 Gender changer x2
16	DB37 Interface Cable	DB37 to DB9 Interface Cable
17	Connector Covers	Fillers for unused connectors
18	SMK980-17	17" Keyboard, Video, Monitor Switch