COS DCE BOOT FSW v1.13 Component Test Results
Requirement 5.2.3.1Housekeeping Response Within One Second

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THE UNIVERSITY OF COLORADO
At Boulder
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1. INTRODUCTION

1.1 PURPOSE

This document presents the Cosmic Origins Spectrograph (COS) Device Control Electronics (DCE) Flight Software (FSW) certification procedure. The purpose of this procedure is to verify that the FSW satisfies Software Requirements according to the method specified in the DCE FSW Test Plan (STP).

1.2 SCOPE

This test procedure comprises the steps necessary to verify that the FSW satisfies Software Requirements Document (SRD) paragraph 5.2.3.1 — Housekeeping Response within One Second.

1.3 LIMITATIONS AND CONSTRAINTS

This test cannot be run in parallel with any other commanding activity directed at the DCE FSW (such as, for example, the periodic transmission of NOOP commands). Test hardware shall be visually inspected, and its configuration noted, prior to conducting this test.

1.4 PROCEDURE OVERVIEW

The procedure requires the **hks** tools running on the Sun SparcStation Electronic Ground Support Equipment (EGSE) whose network IP address is one of

shorty.ssl.berkeley.edu
taiyo.ssl.berkeley.edu
ginger.ssl.berkeley.edu.

Test time shall be scheduled in advance. The Test Conductor must be logged into the Unix system as user **eagcos**, and be commanding from the appropriate directory. This directory contains both the test script file and the shell script file; these two files control test execution. The test is conducted by invoking the shell script. This shell script in turn invokes the Perl 5 program **UniScript.pl**, which resides in its own distinct directory. The test procedure steps have been pre-recorded in the test script file, and are executed interpretively by the **UniScript** program. The shell script and test script are attached to this document as appendices. As **UniScript** executes the test script it sends results to the operator console and to two report files, which are also placed in the current directory. After completion of the test script, the Test Conductor can certify successful test

execution by examining the contents of the report files and determining that required outputs are present in them. Printed copies of the report files are attached to the manually completed checklist (Paragraph 4 below) as documentation of the test.

1.5 THEORY OF TEST

The essence of the test is to keep track of the ongoing "time-line" as commands are sent to, and housekeeping data returned from, the DCE. Since the Unix operating system does not provide timer services with less than 1-second resolution, the script makes use of the elapsed time values maintained by the FSW: specifically, in addition to the **LFCTIME** variable provided in the HK data, another variable, used internally by FSW, namely **mTICKS**, provides .02-second granularity. Hence, the epoch since the last timer reset (power-on or watchdog), can be determined to within a fiftieth of a second as **LFCTIME** + **mTICKS**/50. It is verified that the HK data following a command does not lag the previous data by more than .9 seconds by remembering the "preceding" time, comparing it with the "current time", and, if the difference is less than .9 seconds, making the "current time" the new value of "preceding time", sending the next command, and so on. An initial **LFDNOOP** command is sent to provide an "origin" for the time values.

1.6 TEST SCRIPT IMPLEMENTATION

1.6.1 Explanation of the CHECK Directive

For the purposes of this section, the term "system time" is defined to mean the sum of the HK variable **LFCTIME** and 1/50th of the value of the FSW variable **mTICKS** (at 0x2460 in the Patchable Constants). The latter variable counts 20-ms "ticks" since the last incrementation of **LFCTIME**, but is not automatically made available in the HK data. The script acquires its value by setting memory monitor 7 to 0x2460, then using the (8-bit) value **LFDMONS**[7] in the HK data. The script also uses two Perl scalar variables, **$xt** and **$yt**,[1] representing, respectively, system time computed from the previous HK packet, and system time computed from the current packet. **$xt** is initialized by means of a **CHECK** directive that always succeeds, namely

```
CHECK  1,(($xt=$LFCTIME+$LFDMONS[7]/50.0)==$xt)
```

[1] These variables are "automatically re-vivified" (see Perl documentation) for this script by virtue of their occurrence in the Perl-expression argument of a **UniSCript CHECK** directive; they are not "standard" Perl variables like **$B1**, **$CRC1**, etc.

Verifying the requirement that each HK pack arrive no later than .9 seconds after the preceding one (assuming commanding at .9-second intervals) is equivalent to executing the following simple segment of Perl code after reception of each HK packet:

```
$yt = $LFCTIME+$LFDMONS[7]/50.0; # seconds + (fiftieths of a second)/50
if ($yt <= $xt + .9)      # should not be later than previous system time + .9sec
  {$xt = $yt}             # if OK, update $xt to current system time
else
  {$xt = 0}               # if not, set $xt=0; CHECK will discover this
if ($xt == 0)
  {terminate the script}
```

It is possible, owing to the ingenious quiddities of Perl assignment (**=**) and conditional-value (**?:**) operators, to compress this segment into a single Perl expression, and hence to incorporate it into a single **UniScript CHECK** directive. This is done as follows. The Perl expression

($yt=$LFCTIME+$LFDMONS[7]/50.0) <= $xt+.9

compares the current system time with that of the previous HK packet; but it also has the "side-effect" of assigning the current system time to **$yt** (as a floating-point number). Furthermore, the value of the expression is either **true** or **false**, and so may be used as the 1st operand of a Perl "conditional operator" **?:**[2]. Hence the expression

(($yt=$LFCTIME+$LFDMONS[7]/50.0) <= $xt+.9) ? $yt : 0

evaluates to **$yt** (if **$yt** is no later than **$xt** + .9 seconds in the system time epoch) — or to 0 (if the current HK packet arrived too late to satisfy the software requirement 5.2.3.1). The expression

$xt=(($yt=$LFCTIME+LFDMONS[7]/50.0) <= $xt+.9) ? $yt : 0

therefore assigns to **$xt** either the current system time, **$yt**, or 0, depending, in effect, on whether the test requirement was verified or not. However, this expression, in addition to assigning a value to **$xt**, also *itself takes on the assigned value*; hence its value (namely **$xt**) may be compared with 0, the "error value". The result of this greater-than (**>**) comparison, either **true** (i.e., test succeeded) or **false** (test failed), is the condition checked by the script statement

```
CHECK  1,(($xt=(($yt=$LFCTIME+LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
```

[2] *x1* **?** *x2* **:** *x3* takes the value *x2* if *x1* is **true**, otherwise the value *x3*.

1.6.2 Test Script Arguments

The script is parameterized as shown in the following Table:

Table 1-1: Parameters/Arguments for stp5_2_3_1.tst

Parameter	Meaning	Correct Argument for Version 1.13
#0	Absolute hex storage address of intermediate "scratch" buffer for ROM data	C000
#1	Absolute hex storage address, + 256, of intermediate "scratch" buffer for ROM data	C100
#2	Absolute hex storage address of FSW **NO_OPER** subroutine	0340
#3	Absolute hex storage address of FSW **mTICKS** byte (Patchable Constants)	2460

These parameters must be encoded into the shell script **u** (see Appendix A).

2. SPECIAL INSTRUCTIONS

2.1 QUALITY ASSURANCE

QA support is required to verify the configuration and setup environment as well as monitoring test steps and verifying results.

2.2 SAFETY

2.2.1 Personal Safety

To ensure the safety of the test personnel during test execution the guidelines contained in Paragraph 3.4, Reference [1] will be adhered to.

2.2.2 Test Article and Equipment Safety

To ensure the safety and well-being of the COS operations bench, SITS, and related test equipment, the following primary safety requirements will be in effect during the execution of this test procedure:

- If access within one (1) meter of COS bench electronics is necessary, wrist straps attached to technical ground shall be used by all personnel involved in handling of

any COS test article. Overcurrent and overvoltage shall be set to remove power if nominal limits are exceeded.

- Emergency Power Shutdown — If, during the COS DCE FSW test, power is ON and a severe test equipment failure results in the power system exceeding specified limits, the Test Conductor shall direct or perform shutdown of power.

2.3 CONTAMINATION

All flight hardware shall be handled with clean latex gloves; it shall be covered with clean ESD material and/or stored in a clean flow-bench.

3. SUPPORT REQUIREMENTS

3.1 PERSONNEL

Execution of the COS DCE FSW certification procedure requires the following personnel (to be completed at the Test Readiness Review (TRR):

Test Director: _____

Test Conductor: _____

Test Technician: _____

QA: _____

3.2 TOOLS, EQUIPMENT, AND MATERIALS

The following is a list of tools, equipment, or materials required in this test. Record manufacturer and model, metrology, or property numbers of equipment used, where appropriate. Record calibration due dates where appropriate.

Boot Mode ROM: schematic **27C256**

Engineering Ground Support Equipment (see paragraph 1.4). Indicate specific configuration:

EGSE			DCE		
taiyo	**shorty**	**ginger**	**ETU**	**DCE #1**	**DCE #2**
	X			X	

3.3 DATA/SOFTWARE

The following files must be present:

Table 3-1: Required Program and Data Files

EGSE (shorty) Directory	File	Description
\disks\galex\users\galex\tcs\uniscript	**UniScript.pl**	**UniScript** interpreter
\disks\galex\users\galex\tcs\uniscript\stp5_2_3_1	**u**	Shell script for this procedure
Ditto	**stp5_2_3_1.tst**	Test script for this procedure (Appendix B)

In addition, the **hks** tools must be active. Directions for activating **hks** are given in UCB-COS-DOC-1118 (Paragraph 3.4, Reference [4]).

3.4 REQUIRED DOCUMENTATION

Reference	Document Number	Title
1	NHB 1700.1(V1-A)	*NASA Basic Safety Manual*
2	COS-03-0057	*DCE FSW Test Procedure 5.2.3.1* (this document)
3	UCB-COS-008	*COS FUV Detector Software Test Plan*
4	UCB-COS-DOC-1118	*COS EGSE Startup Procedure*

4. PROCEDURE/TASK STEPS

4.1 PRE-OPERATION ACTIVITIES

4.1.1 Make Sure that **hks** Tools Are Active

Follow the procedure given in Paragraph 3.4, Reference [4].

4.1.2 Make Sure that the Proper ROM Is Installed

Visually verify that the ROM under test is installed: if EEPROM, in U18: if PROM, in U2 and U7.

4.1.3 Log In to the EGSE

In the following steps, the EGSE system ("taiyo") may be any of the systems listed in Paragraph 1.4. *Output*, from either the Unix system or from **UniScript**, to the Telnet terminal is represented in the Courier typeface. *Input* from the Test Conductor is represented in the **Courier-Bold** typeface.

Step	Operator Entry/System Response	Description
1	C:\tcs\us> **telnet taiyo.ssl.berkely.edu**	Establish connection to **taiyo** via Telnet client program
2	Login: **xxx** Password: **--------**	Using telnet window, login as user **tcs**

4.1.4 Set Current Directory

Step	Operator Entry/System Response	Description
3	tcs@taiyo% **cd ~galex/tcs** tcs@taiyo% **pwd** /disks/galex/users/galex/tcs	Change current directory as shown

4.1.5 **slogin** as eagcos

Step	Operator Entry/System Response	Description
4	tcs@taiyo% **slogin –l eagcos taiyo.ssl.berkeley.edu** eagcos@taiyo.ssl.berkeley.edu's password: ***(get from SSL personnel)*** Last login: Sat Oct 7 10:41:05 2000 from auntem.ssl.berke Sun Microsystems Inc. SunOS 5.8 Generic February 2000 You have mail. COS EGSE software version: devel	**slogin** as **eagcos**; get password from SSL personnel

4.1.6 Set Current Directory

Step	Operator Entry/System Response	Description
5	eagcos:taiyo% **cd /disks/galex/users/galex/tcs/uniscript/stp5_2_3_1** eagcos:taiyo% **pwd** /disks/galex/users/galex/tcs/uniscript/stp5_2_3_1	Change current directory as shown

4.1.7 Ensure that Proper Files are Present

Step	Operator Entry/System Response	Description
6	eagcos@taiyo% **ls –l** Total 12 -rw-r--r-- 1 tcs eag 1398 Oct 8 18:03 stp5_2_3_1a.tst -rw-r--r-- 1 tcs eag 62 Oct 9 17:44 u	List files; the **.tst** file and the shell script **u** should be present

4.2 OPERATION EXECUTION

4.2.1 Establish Initial Test Conditions

Step	Operator Entry/System Response	Description
7	eagcos:taiyo% **set path=($path ~dbb/scripts/bin)**	Set path as shown to enable access to **hks** tools

4.2.2 Execute the Script

Step	Operator Entry/System Response	Description
8	**sh u** $pstring=C000,C100,0340,2460,0,0,0,0 Parameters are: Script File: stp5_2_3_1 #0: C000 #1: C100 #2: 0340 #3: 2460 #4: 0 #5: 0 #6: 0 #7: 0 Report file >/disks/galex/users/galex/tcs/ver_1_13/stp5_2_3_1/stp5_2_3_1.rp1 successfully opened. Report file >/disks/galex/users/galex/tcs/ver_1_13/stp5_2_3_1/stp5_	Shell to **u**. You should see the accompanying output as **UniScript** executes

Step	Operator Entry/System Response	Description
	2_3_1.rp2 successfully opened. Script file /disks/galex/users/galex/tcs/ver_1_13/stp5_2_3_1/stp5_2_3_1.tst successfully opened at level 0. "Press Y when ready to conduct test 5.2.3.1" y Continuing. "Sending POR, collecting initial HK" LFDMADDR 7,mTICKS,EXTERN WAIT 0: HKV0=1; HKV1=25; wc=5 "Sending LFDNOOP to get command stream started" LFDNOOP WAIT 0: HKV0=2; HKV1=1; wc=0 "Sending LFDCOPY" LFDCOPY SOURCE,SOURCE,NBYTES,BANK WAIT 0: HKV0=3; HKV1=2; wc=0 "Sending LFMCRC" LFDCRC SOURCE,NBYTES,CODE WAIT 0: HKV0=4; HKV1=3; wc=0 "Sending LFDDIAGC" LFDDIAGC WAIT 0: HKV0=5; HKV1=4; wc=0 "Sending LFDDNLOD" LFDDNLOD SOURCE,NBYTES	

Step	Operator Entry/System Response	Description
	WAIT 0: HKV0=6; HKV1=4; wc=0 "Sending LFDGOTO" LFDGOTO NOOP WAIT 0: HKV0=7; HKV1=6; wc=0 "Sending LFDHKREQ" LFDHKREQ WAIT 0: HKV0=8; HKV1=7; wc=0 "Sending LFDMADDR" LFDMADDR 0,SOURCE,DATA WAIT 0: HKV0=9; HKV1=8; wc=0 "Sending LFDUPLOD" LFDUPLOD DEST,NBYTES,0 WAIT 0: HKV0=10; HKV1=9; wc=0 "Sending LFDWDOG" LFDWDOG 1 WAIT 0: HKV0=11; HKV1=10; wc=0 "Sending LFDNOOP" LFDNOOP WAIT 0: HKV0=12; HKV1=11; wc=0 "Test stp5.2.3.1 completed successfully" eagcos:shorty%	

4.3 POST-OPERATION ACTIVITIES

4.3.1 Copy Reports to PC Files and Print Them

Using an FTP client, copy the **u**, **stp5_2_3_1.tst**, **stp5_2_3_1.rp1**, and **stp5_2_3_1.rp2** files to appropriate PC files. Include these files as Appendices A, B, C, and D with this completed form.

4.3.2 Complete The Test Procedure Form

Ensure that all blank fields in this report are completed correctly and submit the completed report to QA.

SUMMARY SHEET

OPERATION TITLE: _____ WOA# _____

TEST ARTICLES IDENTIFICATION (including serial and/or part numbers):

_____

TASKS/STEPS COMPLETED: _____

_____

LOCATION: _____

TEST STARTED: TEST TERMINATED

TIME: _____ Hr/Min TIME: _____ Hr/Min

DATE: _____ DATE: _____

LOGS USED: _____

ANOMALY REPORTS GENERATED: _____

_____

COMMENTS: _____

_____

_____

_____

_____

TEST CONDUCTOR: _____

Signature/Date

QA REPRESENTATIVE: _____

Signature/Date

Appendix A. Shell Script u

```
#!/bin/sh
pkill cosnoopy
perl ../UniScript.pl stp5_2_3_1 "C000,C100,0340,2460,0,0,0,0"
cosnoopy&
```

Appendix B. Test Script stp5_2_3_1.tst

```
; ********************************************************************
; ********************************************************************
; **                                                                **
; **  BBBB    OOO    OOO   TTTTT          OOO   N   N  L      Y   Y  **
; **  B   B  O   O  O   O    T           O   O  N   N  L      Y   Y  **
; **  B   B  O   O  O   O    T           O   O  NN  N  L       Y Y   **
; **  BBBB   O   O  O   O    T           O   O  N N N  L        Y    **
; **  B   B  O   O  O   O    T           O   O  N  NN  L        Y    **
; **  B   B  O   O  O   O    T           O   O  N   N  L        Y    **
; **  BBBB    OOO    OOO     T            OOO   N   N  LLLLL    Y    **
; **                                                                **
; ********************************************************************
; ********************************************************************
; ***************************************************************************************
; * STP 5.2.3.1                                                                         *
; * ----------------------------------------------------------------------------------- *
; * Verify that the HK packets produced in the test of 5.2.2.1 above have less          *
; * than 1 second intervals between each packet.                                        *
; * ----------------------------------------------------------------------------------- *
; * The script makes rather opaque use of two Perl variables, $xt and $yt.              *
; * $xt is initalized by means of a CHECK directive that always succeeds, namely        *
; *                                                                                     *
; *                  CHECK 1,(($xt=$LFCTIME+$LFDMONS[7]/50.0)==$xt)                     *
; *                                                                                     *
; * After each HK packet is received, the following operations are performed            *
; *                                                                                     *
; *     $yt = $LFCTIME+$LFDMONS[7]/50.0; # seconds + (fiftieths of a second)/50         *
; *                                                                                     *
; *     if ($yt < $xt + .9)              # this should not be later than the last     *
; *                                      #   t-value + .9sec                           *
; *        {$xt = $yt}                   # if t-value OK, update $xt                  *
; *                                                                                     *
; *     else                                                                            *
; *                                                                                     *
; *        {$xt = 0}                     # if not, set $xt=0; CHECK will discover     *
; *                                      #   this                                      *
; *     if ($xt == 0)                                                                   *
; *                                                                                     *
; *        {terminate the script}                                                       *
; *                                                                                     *
; * These operations are, somewhat opaquely, compressed into a single CHECK             *
; * directive as follows:                                                               *
; *                                                                                     *
; * CHECK 1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0) <= $xt+.9) ? $yt : 0) > 0)           *
; *          ••    ••                                •         •          •    •       *
; *          ••    ••••••••••••••••••••••••••••••••••          •          •    •       *
; *          ••    ••••••••••••••••••••••••••••••••••••••••••••          •    •       *
; *          ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••    •       *
; *          ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••      *
; * ----------------------------------------------------------------------------------- *
; * Parameters:                                                                         *
; * #0 SOURCE ("scratch area")                                                          *
; * #1 DEST   ("scratch area + 256")                                                    *
; * #2 NOOP   (address of LFDNOOP command routine)                                      *
; * #3 mTICKS (address of mTICKS in Patchable Constants)                                *
; ***************************************************************************************
;
ECHO     2
;
SYM      SOURCE  =0x#0
SYM      DEST    =0x#1
SYM      NOOP    =0x#2
;
;SYM      NBYTES  =16
SYM      NBYTES  =1024
SYM      CODE    =0
SYM      ID      =0
```

```
SYM       SETTING =0
SYM       BANK    =0
SYM       RATE    =0
SYM       SEGMENT =0
SYM       DIR     =0
SYM       POWER   =0
SYM       STATE   =0
SYM       HIVOLT  =0
SYM       LIMIT   =0
SYM       VOLTAGE =0
SYM       ACTUATOR=0
SYM       ABORT   =0
SYM       OVERRIDE=0
SYM       DOOR    =0
SYM       MOVE    =0
SYM       BANK    =0
SYM       DATA    =0
SYM       DELTA1  =5
SYM       DELTA2  =25
SYM       NSEC    =5
SYM       EXTERN  =0
SYM       mTICKS  =0x#3
;
; ****************************************
; * Wait until setup (if any) is complete *
; ****************************************
;
WTOR          "Press Y when ready to conduct test 5.2.3.1"
;
; ***********************************************
; * Force Boot State, set up monitor for mTICKS *
; ***********************************************
;
DTG           3,"(0) Sending POR, collecting initial HK"
WTO           "Sending POR, collecting initial HK"
POR
;DELAY         DELTA1
WAIT          2
LFDMADDR      7,mTICKS,EXTERN
WAIT          NSEC,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
;
; *******************************************
; * Sync up with HK, get initial value of $xt *
; *******************************************
;
;LFDNOOP
;
DTG           3,"(1) Sending LFDNOOP to get command stream started"
WTO           "Sending LFDNOOP to get command stream started"
CHECK         1,(($xt=$LFCTIME+$LFDMONS[7]/50.0)==$xt)
LFDNOOP
;
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(2) Sending LFDCOPY"
WTO           "Sending LFDCOPY"
;LFDCOPY       SOURCE,DEST,NBYTES,BANK
LFDCOPY       SOURCE,SOURCE,NBYTES,BANK
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(3) Sending LFMCRC"
WTO           "Sending LFMCRC"
LFDCRC        SOURCE,NBYTES,CODE
```

```
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(4) Sending LFDDIAGC"
WTO           "Sending LFDDIAGC"
LFDDIAGC
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(5) Sending LFDDNLOD"
WTO           "Sending LFDDNLOD"
LFDDNLOD      SOURCE,NBYTES
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(6) Sending LFDGOTO"
WTO           "Sending LFDGOTO"
LFDGOTO       NOOP
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(7) Sending LFDHKREQ"
WTO           "Sending LFDHKREQ"
LFDHKREQ
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(8) Sending LFDMADDR"
WTO           "Sending LFDMADDR"
LFDMADDR      0,SOURCE,DATA
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(9) Sending LFDUPLOD"
WTO           "Sending LFDUPLOD"
LFDUPLOD      DEST,NBYTES,0
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(10) Sending LFDWDOG"
WTO           "Sending LFDWDOG"
LFDWDOG       1
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;
DTG           3,"(11) Sending LFDNOOP"
WTO           "Sending LFDNOOP"
LFDNOOP
DELAY         DELTA1
WAIT          0,HK
LOG           1,LFDCMDX,LFDCMDR,LFCPKT,LFDCBUF,LFCTIME,LFDMONS
CHECK         1,(($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
;DELAY          DELTA1
;DTG            3,"(10) Sending LFDJMPCS"
```

```
;WTO           "Sending LFDJMPCS"
;LFDJMPCS      0
; ------------------------------------------------------------------------
;LFGBWK        SETTING,SEGMENT,0
;LFGEWK        SETTING,SEGMENT,0
;LFGLQT        SETTING,SEGMENT
;LFGSHFT       SETTING,SEGMENT,0
;LFGSTIM       RATE,SEGMENT
;LFGSTR        SETTING,SEGMENT,0
;LFGTT         SETTING,SEGMENT,DIR
;LFGUQT        SETTING,SEGMENT
;LFHQPWR       0
;LFHRAMPT      RATE
;LFHSTATE      STATE
;LFHVENA       HIVOLT
;LFHVILIM      LIMIT
;LFHVLOW       VOLTAGE,SEGMENT
;LFHVMAX       VOLTAGE,SEGMENT
;LFHVNOM       VOLTAGE,SEGMENT
;LFHVPWR       POWER
;LFHVSET       VOLTAGE,0
;LFPCRP        INTERVAL,SEGMENT,COUNT
;LFRACT1       POWER
;LFRACT2       POWER
;LFRACTEN      ACTUATOR
;LFRACTRS      0
;LFRAXPWR      POWER
;LFRILIM       LIMIT
;LFRSOVD       OVERRIDE
;LFRMDIR       DIR
;LFRMENA       DOOR
;LFRMPWR       MOVE
;
;WAIT          NSEC,HK
;LOG           1,LFDCBUF,LFCTIME,LFDCMDX,LFDCMDR,LFCPKT
;CHECK         1,($LFDCMDR,LFCPKT==$LFDCMDX && LFDCMDX==9)
;
DTG           1, "(12) Test stp5.2.3.1 completed successfully"
WTO           "Test stp5.2.3.1 completed successfully"
```

Appendix C. Test Report stp5_2_3_1.rp1

```
                                        55555          222           333
1
                                        5             2   2         3   3
11
                         ssss  ttttt  pppp   555               2             3
1
                        s        t    p   p     5             2             3
1
                        sssss    t    pppp       5           2              3
1
                            s    t    p      5   5          2            3   3
1
                        ssss     t    p       555   _____  22222  _____   333   _____
111

Ver 01.13  Wed Jan 17 16:26:37 2001    "(0) Sending POR, collecting initial HK"

LFDMADDR     7,mTICKS,EXTERN

Addr Addr HK-Name         Value
---- ---- -------------- -----
170C-170D LFDCMDX         0001
1718-1719 LFDCMDR         0001
1700-1703 LFCPKT          0000002E

1664-167F LFDCBUF         8080  7F7F  0019  FFE6  0000  FFFF  0000  FFFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME         00000037

1738-173F LFDMONS         FF FF FF FF FF FF FF 1D

Ver 01.13  Wed Jan 17 16:26:39 2001    "(1) Sending LFDNOOP to get command stream
started"

CHECK:   (($xt=$LFCTIME+$LFDMONS[7]/50.0)==$xt)
eval:    ((0000=0037+0000[7]/50.0)==0000)

S U C C E S S

LFDNOOP

Addr Addr HK-Name         Value
---- ---- -------------- -----
170C-170D LFDCMDX         0001
1718-1719 LFDCMDR         0001
1700-1703 LFCPKT          00000001

1664-167F LFDCBUF         8181  7E7E  0001  FFFE  0007  FFF8  2460  DB9F  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME         00000001

1738-173F LFDMONS         FF FF FF FF FF FF FF 2D

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0037=((0000=0001+0000[7]/50.0)<=0037+.9)?0000:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:40 2001    "(2) Sending LFDCOPY"

LFDCOPY      SOURCE,SOURCE,NBYTES,BANK

Addr Addr HK-Name         Value
---- ---- -------------- -----
170C-170D LFDCMDX         0001
```

```
1718-1719 LFDCMDR        0001
1700-1703 LFCPKT         00000002

1664-167F LFDCBUF        8080  7F7F  0002  FFFD  0000  FFFF  0000  FFFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000002

1738-173F LFDMONS        FF FF FF FF FF FF FF 09

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0001=((0001=0002+0000[7]/50.0)<=0001+.9)?0001:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:40 2001    "(3) Sending LFMCRC"

LFDCRC       SOURCE,NBYTES,CODE

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0002
1718-1719 LFDCMDR        0002
1700-1703 LFCPKT         00000003

1664-167F LFDCBUF        8383  7C7C  0003  FFFC  C000  3FFF  C000  3FFF  0400  FBFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000002

1738-173F LFDMONS        FF FF FF FF FF FF FF 1B

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0002=((0002=0002+0000[7]/50.0)<=0002+.9)?0002:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:40 2001    "(4) Sending LFDDIAGC"

LFDDIAGC

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0003
1718-1719 LFDCMDR        0003
1700-1703 LFCPKT         00000004

1664-167F LFDCBUF        8282  7D7D  0004  FFFB  C000  3FFF  0400  FBFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000002

1738-173F LFDMONS        FF FF FF FF FF FF FF 28

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0002=((0002=0002+0000[7]/50.0)<=0002+.9)?0002:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:40 2001    "(5) Sending LFDDNLOD"

LFDDNLOD     SOURCE,NBYTES

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0003
1718-1719 LFDCMDR        0003
1700-1703 LFCPKT         00000004
```

```
1664-167F LFDCBUF        8282  7D7D  0004  FFFB  C000  3FFF  0400  FBFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000002

1738-173F LFDMONS        FF FF FF FF FF FF FF 28

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0002=((0002=0002+0000[7]/50.0)<=0002+.9)?0002:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:41 2001    "(6) Sending LFDGOTO"

LFDGOTO      NOOP

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0005
1718-1719 LFDCMDR        0005
1700-1703 LFCPKT         00000006

1664-167F LFDCBUF        AEAE  5151  0006  FFF9  C000  3FFF  0400  FBFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000003

1738-173F LFDMONS        FF FF FF FF FF FF FF 1A

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0002=((0002=0003+0000[7]/50.0)<=0002+.9)?0002:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:41 2001    "(7) Sending LFDHKREQ"

LFDHKREQ

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0005
1718-1719 LFDCMDR        0005
1700-1703 LFCPKT         00000007

1664-167F LFDCBUF        EAEA  1515  0007  FFF8  0340  FCBF  0000  FFFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000003

1738-173F LFDMONS        FF FF FF FF FF FF FF 24

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0003=((0003=0003+0000[7]/50.0)<=0003+.9)?0003:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:41 2001    "(8) Sending LFDMADDR"

LFDMADDR     0,SOURCE,DATA

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0006
1718-1719 LFDCMDR        0006
1700-1703 LFCPKT         00000008

1664-167F LFDCBUF        FFFF  0000  0008  FFF7  0000  FFFF  0000  FFFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000004
```

```
1738-173F LFDMONS        FF FF FF FF FF FF FF 01

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0003=((0003=0004+0000[7]/50.0)<=0003+.9)?0003:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:42 2001    "(9) Sending LFDUPLOD"

LFDUPLOD     DEST,NBYTES,0

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0007
1718-1719 LFDCMDR        0007
1700-1703 LFCPKT         00000009

1664-167F LFDCBUF        8181  7E7E  0009  FFF6  0000  FFFF  C000  3FFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000004

1738-173F LFDMONS        7D FF FF FF FF FF FF 10

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0004=((0004=0004+0000[7]/50.0)<=0004+.9)?0004:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:42 2001    "(10) Sending LFDWDOG"

LFDWDOG      1

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0008
1718-1719 LFDCMDR        0008
1700-1703 LFCPKT         0000000A

1664-167F LFDCBUF        ADAD  5252  000A  FFF5  C100  3EFF  0400  FBFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000004

1738-173F LFDMONS        7D FF FF FF FF FF FF 22

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
eval:    ((0004=((0004=0004+0000[7]/50.0)<=0004+.9)?0004:0)>0)

S U C C E S S

Ver 01.13  Wed Jan 17 16:26:42 2001    "(11) Sending LFDNOOP"

LFDNOOP

Addr Addr HK-Name        Value
---- ---- -------------- -----
170C-170D LFDCMDX        0009
1718-1719 LFDCMDR        0009
1700-1703 LFCPKT         0000000B

1664-167F LFDCBUF        F1F1  0E0E  000B  FFF4  0001  FFFE  0000  FFFF  0000  FFFF  0000
FFFF  0000  FFFF

1680-1683 LFCTIME        00000004

1738-173F LFDMONS        7D FF FF FF FF FF FF 2E

CHECK:   (($xt=(($yt=$LFCTIME+$LFDMONS[7]/50.0)<=$xt+.9)?$yt:0)>0)
```

```
eval:    ((0004=((0004=0004+0000[7]/50.0)<=0004+.9)?0004:0)>0)
S U C C E S S
Ver 01.13  Wed Jan 17 16:26:43 2001    "(12) Test stp5.2.3.1 completed successfully"
```

Appendix D. Test Report stp5_2_3_1.rp2

```
                                        55555          222           333
1
                                        5             2   2         3   3
11
                         ssss  ttttt  pppp   555               2             3
1
                        s        t    p   p     5             2             3
1
                        sssss    t    pppp       5           2              3
1
                            s    t    p      5   5          2            3   3
1
                        ssss     t    p       555   _____  22222  _____   333   _____
111

Ver 01.13  Wed Jan 17 16:26:37 2001    "(0) Sending POR, collecting initial HK"

-------------------------------------------------------------------------
                          P O R   P A C K E T
-------------------------------------------------------------------------
80000000
-------------------------------------------------------------------------

-------------------------------------------------------------------------------------------
                               C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EDB9F 044C2460 044AFFF8 04480007
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFFE 04440001 04427E7E 04408181
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:39 2001    "(1) Sending LFDNOOP to get command stream
started"

-------------------------------------------------------------------------------------------
                               C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFFFF 04480000
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFFD 04440002 04427F7F 04408080
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:40 2001    "(2) Sending LFDCOPY"

-------------------------------------------------------------------------------------------
                               C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FBFF 04500400 044E3FFF 044CC000 044A3FFF 0448C000
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFFC 04440003 04427C7C 04408383
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:40 2001    "(3) Sending LFMCRC"

-------------------------------------------------------------------------------------------
```

```
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFBFF 044C0400 044A3FFF 0448C000
--------------------------------------------------------------------------------
               SN            OPCODE
0446FFFB 04440004 04427D7D 04408282
--------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:40 2001    "(4) Sending LFDDIAGC"

--------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFFFF 04480000
--------------------------------------------------------------------------------
               SN            OPCODE
0446FFFA 04440005 04420B0B 0440F4F4
--------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:40 2001    "(5) Sending LFDDNLOD"

--------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFBFF 044C0400 044A3FFF 0448C000
--------------------------------------------------------------------------------
               SN            OPCODE
0446FFF9 04440006 04425151 0440AEAE
--------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:41 2001    "(6) Sending LFDGOTO"

--------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFCBF 04480340
--------------------------------------------------------------------------------
               SN            OPCODE
0446FFF8 04440007 04421515 0440EAEA
--------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:41 2001    "(7) Sending LFDHKREQ"

--------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFFFF 04480000
--------------------------------------------------------------------------------
               SN            OPCODE
0446FFF7 04440008 04420000 0440FFFF
--------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:41 2001    "(8) Sending LFDMADDR"

--------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
--------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044E3FFF 044CC000 044AFFFF 04480000
--------------------------------------------------------------------------------
```

```
               SN            OPCODE
0446FFF6 04440009 04427E7E 04408181
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:42 2001    "(9) Sending LFDUPLOD"

-------------------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFBFF 044C0400 044A3EFF 0448C100
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFF5 0444000A 04425252 0440ADAD
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:42 2001    "(10) Sending LFDWDOG"

-------------------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFFFE 04480001
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFF4 0444000B 04420E0E 0440F1F1
-------------------------------------------------------------------------------------------


Ver 01.13  Wed Jan 17 16:26:42 2001    "(11) Sending LFDNOOP"

-------------------------------------------------------------------------------------------
                              C O M M A N D   P A C K E T
-------------------------------------------------------------------------------------------
            PARM4             PARM3             PARM2             PARM1             PARM0
045AFFFF 04580000 0456FFFF 04540000 0452FFFF 04500000 044EFFFF 044C0000 044AFFFF 04480000
-------------------------------------------------------------------------------------------
               SN            OPCODE
0446FFF3 0444000C 04427F7F 04408080
-------------------------------------------------------------------------------------------
```