Neil A. Armstrong Test Facility
SEC Facility Data System (FDAS)
System Functional Requirements

revision 46010 (*2024-08-02*)

Comments and Suggestions - Click HERE

Introduction and Scope

The NASA Glenn Research Center's Armstrong Test Facility (GRC-ATF) seeks procurement of a new Facility Data Acquisition System (FDAS) to collect, store, process, and monitor over 1,000 channels of data generated during vibration, acoustic, shock, separation, and various other types of testing at GRC-ATF's Space Environments Test Complex (SEC).

This document contains requirements relating specifically to the functional performance of the SEC-FDAS at NASA's Neil A. Armstrong Test Facility in Sandusky, Ohio. These requirements must be met "in addition to" any other requirements listed in an overall procurement statement of work for the SEC-FDAS at GRC-ATF.

Note: ! indicates a new or updated requirement that is not part of the current SEC FDAS procurement.

F.1 System Facility Interface Requirements

The NASA GRC-ATF SEC FDAS shall be designed to conform to the following overall system design requirements:

	ID	Requirement	Value
	F.1.1	Electrical Power	Single Phase 120 VAC
	F.1.2	Operating Temperature	0° C to 40° C
	F.1.3	Operating Humidity	Less than 90% non-condensing
!	**F.1.4**	External UTC Time Sources	IRIG-B and GPS
!	**F.1.5**	Timing System 1 PPS Accuracy	< 10 ns RMS to UTC(USNO) when GPS locked* * This assumes a stationary platform with a minimum of a 4 satellites locked
!	**F.1.6**	Timing System 1 PPS Stability	TDEV < 10 ns @ τ <105 secs, σy(τ) <6x10-14 @ τ=105 secs * * The time deviation (TDEV) of the offset measurements in seconds. The tau (τ) associated with this measurement is one second, which is the update interval of the position fixes received from the GPS Receiver. σy is the Allan deviation. https://en.wikipedia.org/wiki/Allan_variance
!	**F.1.7**	Timing System 1 PPS Output	TTL pulse into 50Ω
!	**F.1.8**	Timing System 1 PPS Output Minimum Width	*<tbd>*
!	**F.1.9**	Form factor	Standard 19" wide rack mount
!	**F.1.10**	Max width	≤ 3 standard racks (total)

!	**F.1.11**	Max Height	≤ 44U rack height (each)
!	**F.1.12**	Analog Input Connector	All Analog Input Connection shall conform to the following: • 37 DB (MIL STD *tbd*) • 16 Differential Voltage Input Channels per 37 DB Conn. • Pin-out per NASA SPEC (*tbd*)
!	**F.1.13**	System Component Distributability	All data processing components shall be able to be distributed via standard Ethernet (IEEE-802.x)

F.2 Digitizing Electronics

The NASA GRC-ATF SEC FDAS Digitizing Electronics shall be designed to digitize analog signals in accordance with the following Digitizing Electronics requirements:

	ID	Requirement	Value
	F.2.1	Number of Channels	≥ 1,024 Channels
!	**F.2.2**	Data Sample Rates	Include, but not limited to: 1. 250 kSPS 2. 50 kSPS 3. 25 kSPS 4. 5 kSPS 5. 1 kSPS
	F.2.3	Data Sample Rate Selectability	User selectable from the DAS software application
	F.2.4	Input Type	Direct Voltage Input, Pre-conditioned signals
	F.2.5	Channel Input Range	± 10 V
	F.2.6	ADC Resolution	≥ 24-bit
	F.2.7	Channel-to-Channel Synchronization	± 0.1 µs
	F.2.8	Crosstalk Rejection	≥ 80 dB DC to 2 kHz
	F.2.9	AC/DC input coupling	Per-channel selectable
	F.2.10	AC/DC input coupling state selectability	User selectable from the DAS software application
	F.2.11	Input Impedance	≥ 100 kΩ
	F.2.12	Gain Accuracy	≥ ± 0.5% DC
!	**F.2.13**	Measurement Bandwidth	Alias free measurements from DC to: 1. 100 kHz @ 250 kSPS 2. 20 kHz @ 50 kSPS 3. 10 kHz @ 25 kSPS 4. 2 kHz @ 5 kSPS 5. 400 Hz @ 1 kSPS
	F.2.14	Passband Ripple	≤ 0.1 dB
	F.2.15	Digitizer On-board FMC	Yes, User Programmable
	F.2.16	Digitizer On-board FMC Firmware Source Code Availability	Provided
	F.2.17	Digitizer On-board FMC Firmware Source Code Licensing	Open-Sourcable, BSD or similar
	F.2.18	Digitizer Timing System Interface	Event-based, 100% mRF* protocol compatible * The mRF timing spec is published at: http://mrf.fi/fw/DCManual-191127.pdf
	F.2.19	Digitizer DAS Application Interface	100% Open-Standards-based

	F.2.20	Digitizer DAS Application Interface Driver Licensing	Open-Sourcable, BSD or similar
!	**F.2.21**	Anti-Electrostatic Discharge Handling Requirement	An antistatic mat and antistatic strap is required when handling the unit.
!	**F.2.22**	Maximum Mechanical Vibration Limits during Operations	0.2 G rms at 5 Hz to 500 Hz (all operation orientations)
!	**F.2.23**	Maximum Mechanical Shock Limits during Operations	6 consecutively executed shock pulses in the positive and negative x, y, and z axis of 5 G for up to 10 ms.
!	**F.2.24**	Maximum Mechanical Vibration Limits during Handling and Transportation	1.5 G rms at 10 Hz to 500 Hz for 15 minutes (all six sides tested)
!	**F.2.25**	Maximum Mechanical Shock Limits during Handling and Transportation	6 consecutively executed shock pulses in the positive and negative x, y, and z axis (one pulse on each side of the system) of 50 G for up to 2 ms.

F.3 Digitizing Electronics - Per Channel Warning and Alarm Threshold Detection

The NASA GRC-ATF SEC FDAS Digitizing Electronics shall provide be designed to provide a permissive interlock output analog signals in accordance with the following Digitizing Electronics requirements:

	ID	Requirement	Value
!	**F.3.1**	Alarm Detection Upper Threshold	Each channel of the digitizing electronics shall have a dedicated programmable upper threshold value which is used to assert an alarm condition when the channel measurement is greater than this upper alarm threshold value.
!	**F.3.2**	Alarm Detection Lower Threshold	Each channel of the digitizing electronics shall have a dedicated programmable lower threshold value which is used to assert an alarm condition when the channel measurement is less than this lower alarm threshold value.
!	**F.3.3**	Warning Detection Upper Threshold	Each channel of the digitizing electronics shall have a dedicated programmable upper threshold value which is used to assert a warning condition when the channel measurement is greater than this upper warning threshold value.
!	**F.3.4**	Warning Detection Lower Threshold	Each channel of the digitizing electronics shall have a dedicated programmable lower threshold value which is used to assert a warning condition when the channel measurement is less than this lower warning threshold value.
!	**F.3.5**	Warning and Alarm Threshold Programming	All 4 measurement threshold settings for each channel shall be: • stored in the digitizing electronics • remotely set outside the digitizing electronics • continuously readable from outside the digitizing electronics
!	**F.3.6**	Threshold Calculations	All 4 measurement threshold calculations shall be: • made by hardware and/or firmware within the • made on every sample (no sampling)

F.4 Digitizing Electronics - Fast Shutdown Output Interlock

Each Digitizing Electronic Unit of the NASA GRC-ATF SEC FDAS shall have an output connector that allows each digitizer unit to be serially connected to form a system-level crash chain permissive circuit used for Machine Protection and Fast Abort Applications. This Digitizing Electronics - Fast Shutdown Output Interlock capability shall meet the following requirements:

	ID	Requirement	Value
!	**F.4.1**	Permissive Condition	The Safety System Permissive Output shall be designed to remove the permissive state if any channel of the digitizing electronic unit is in an alarm state.

!	**F.4.2**	Overall Response Time	≤ 30 ms *from the time the abort condition occurs on the digitizing device's input to the time the permissive condition is revoked on the digitizing device permissive output)*
!	**F.4.3**	Fail Safeness	The Safety System Permissive Output shall be designed to fail safely.
!	**F.4.4**	Electrical Isolation	The Safety System Permissive Output shall be designed to ensure full electrical isolation of the digitizing electronics from other components connected to it.
!	**F.4.5**	Event Latching	The Safety System Permissive Output shall be designed to latch any event that triggers the removal of the safety permissive
!	**F.4.6**	Remote Reset	The Safety System Permissive Output shall be designed to reset a latched permissive event from a remote application
!	**F.4.7**	Remote Monitoring	The Safety System Permissive Output shall be designed to allow remote monitoring of the permissive state from a supervisory application
!	**F.4.8**	Output Connector	single connector providing the permissive output interlock condition able to be added serially to an overall system-level crash chain permissive circuit.
!	**F.4.9**	Panel Indicator	single LED indicating the state of the permissive output

F.5 Data Recording

The NASA GRC-ATF SEC FDAS shall be designed to record data in accordance with the following data recording requirements:

ID	Requirement	Value
F.5.1	Storage Reliability	≥ RAID 5
F.5.2	1,024 Channel Individual Recording Duration	≥ 15 minutes for full 1,024 channels all acquiring at 50 kHz Sample Rate
F.5.3	256 Channel Individual Recording Duration	≥ 15 minutes for partial 256 channels acquiring at 250 kHz Sample Rate
F.5.4	Number of consecutive recordings prior to system offload	≥ 15 recordings each case
F.5.5	Recording timestamping vs UTC	± 0.1 µs
F.5.6	Per Recording Meta-Data Capture	The following (at a min): 1. Customer Name 2. Project ID 3. Test Facility 4. Recording ID 5. Recording Start Time 6. Operator Name
F.5.7	Per channel Calibration Data Capture	The following (at a min): 1. Channel ID 2. Digitizer ID 3. Cal. Slope 4. Cal. Offset 5. EU Slope 6. EU Offset 7. EU Unit 8. Calibration Date
F.5.8	Calibration Settings	The following (at a min): 1. Calibration Slope 2. Calibration Offset
F.5.9	EU Conversion Configuration	The following (at a min): 1. EU conversion slope 2. EU conversion offset

	F.5.10	Post-record process protection (Ref: pbtracker:Topic:Y7k104fdvtydd6wm)	All Post-record background processes are protected from interruption by the operator

F.6 Real-Time Monitoring (RTM)

The SEC-FDAS shall be capable of monitoring channel data in real-time in a manner that fulfills the following minimum real-time monitoring requirements

ID	Requirement	Value
F.6.1	Channel Availability for RTM	All
F.6.2	Number of RTM PCs	≥ 2
F.6.3	Simultaneous RTM channels	≥ 16 per RTM PC
F.6.4	RTM FFT Analysis Option	All channels fully selectable
F.6.5	RTM Power Spectral Density (PSD) Analysis Option	All channels as selected
F.6.6	RTM Time Domain Analysis Option	All channels as selected
F.6.7	RTM Peak Detection Feature	All channels as selected
F.6.8	RTM Display Measurement to Display Latency	≤ 0.5 seconds

F.7 Software Application

The NASA GRC-ATF SEC FDAS Software Application shall be designed to meet or exceed the following minimum system software application requirements:

ID	Requirement
F.7.1	Software Architecture conforms to the Neil A. Armstrong Test Facility Common DAC System System Architecture Specification revision 37113 dated November 3, 2023
F.7.2	GUI interface for all specified functions
F.7.3	Alarm and Limit Summary Display and Monitoring capability
F.7.4	Whole system configuration Save and Restore capability
F.7.5	The DAS system will be able to define all User-defined Per-Test channel configuration using a CSV Import capability where the CSV has the following columns:

Column Name		Description	Column Name		Description
SIGNAL	=	Overall System CH #	CUSTMEASLOC	=	Custom Measurement Location
CHASSIS	=	Digitizer #	ESLO	=	Volts to EU Slope
CHANNEL	=	Digitizer Channel #	EOFF	=	Volts to EU Offset
CONNECTOR	=	Digitizer Connector #	MAXEULVL	=	Max EU level (before clip)
USE	=	Channel Use (Yes/No)	SAMPLPERSEC	=	Sample Rate
CUSTNAM	=	Channel User Label	HIlim	=	High Warning Level (in EU)
DESC	=	Channel Description	LOlim	=	Low Warning Level (in EU)
IDLINE5	=	tbd	HIHIlim	=	High Alarm Limit (in EU)
RESPNODE	=	tbd	LOLOlim	=	Low Alarm Limit (in EU)
RESPDIR	=	Response Direction	COUPLING	=	Coupling (AC or DC)
SPECDATATYP	=	Specific Data Type field	CONFIGTIMEID	=	Configuration Timestamp
EGU	=	engineering unit	DBREL	=	EU value for dB relative calculations

	F.7.6	Current User-defined Per-Test channel configuration CSV export capability • CSV export (fields same as import)
	F.7.7	Electronic Logbook capability

F.7.8	General/Universal Screenshot capability • automatic filenaming with timestamps • automatic filename included in the screenshot	

F.8 Configuration by CSV

F.8.1	The DAC system shall be able to support per-test user-defined channel channel labels of the following length:	≥ 40 characters
F.8.2	The DAC system shall be able to utilize the following characters as valid characters in the per-test user-defined channel channel labels:	• Uppercase letters (A-Z) • Lowercase letters (a-z) • Numbers (0-9) • Parentheses " (" and ") " • Minus sign (-) • Plus Sign (+) • Asterisk (*) • Periods (.) • Underscores (_)

F.9 Data Export

The NASA GRC-ATF SEC FDAS shall be designed to export recorded data in accordance with the following data export requirements:

ID	Requirement	
F.9.1	from user selectable recordings	
F.9.2	from user selectable channels	
F.9.3	from user selectable time ranges	
F.9.4	in user selectable formats	
F.9.5	in the CSV format	
F.9.6	in the UFF58 format • UFF58b	

F.10 UFF58 Export Header Requirements

The NASA GRC-ATF SEC FDAS shall be designed to export UFF58 recorded data in accordance with the following UFF58 data export format requirements:

F.10.1 Exported UFF58b files shall contains the following numeric values in the Response Direction field (Field 7) based on the Response Direction column data in the input configuration CSV as follows:

CSV String	Field 7 Value	CSV String	Field 7 Value
blank	= 0	scalar	= 0
X+	= 1	X-	= -1
Y+	= 2	Y-	= -2
Z+	= 3	Z-	= -3
XR+	= 4	XR-	= -4
YR+	= 5	YR-	= -5
ZR+	= 6	ZR-	= -6

F.10.2 Exported UFF58b files shall contains the following numeric values in the Specific Data Type field (Field 1) based on the Specific Data Type column data in the input configuration CSV as follows:

CSV String	Field 7 Value	CSV String	Field 7 Value	CSV String	Field 7 Value
blank	= 0	*7 is skipped*		pressure	= 15
unknown	= 0	displacement	= 8	sound pressure	= 15
general	= 1	reaction force	= 9	mass	= 16
stress	= 2	*10 is skipped*		time	= 17
strain	= 3	velocity	= 11	frequency	= 18
4 is skipped		acceleration	= 12	rpm	= 19
temperature	= 5	excitation force	= 13	order	= 20
heat flux	= 6	*14 is skipped*			

F.11 Secure Web-Based Data Export

F.11.1 The DAC system shall include a local open-source web-server that facilitates secure data export by making a specific folder (and any subfolders) accessible to remote network clients from a standard web-browser.

Rationale - The DAC operator needs to be able to provide the data to the Facility's Data Export System without the need for removable media

F.11.2 The DAC system export web server will not expose any files or folders on the system that contain any OS system or DAC application processes or configuration data.

Rationale - Remote clients should only be able to access data the the DAC operator has staged in a special location for export as required by NASA's' Zero-Trust Architecture rules for Data at Rest (DAR)

F.11.3 The DAC system's web server shall run using a self-signed certificate that enables the remote browser-based client to obtain data from the system using the https protocol on port 443.

Rationale - The DAC systems web-server must be capable of conforming to NASA's Zero-Trust Architecture rules for Data In Transit (DIT). The use of a self-signed cert forces the provider to configure the webserver for cert use. NASA will provide the final trusted cert separately.

F.11.4 The DAC system's data export webserver shall be capable of switching from a self-signed certificate to a NASA provided certificate without changing the webserver configuration. The DAC operator will be able to simply replace the self-signed cert with the NASA cert and restart the webserver service.