Interface Control Document

For: Analog Signal Processing Subsystem (ASP)

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Change Record

Version	Date	Affected Section(s)	Reason/Initiation/Remarks
A	2008-11-12	All	Initial Template Draft
B	2009-2-23	All	Updated per MCS Common ICD
C	2009-3-6	All	Common ICD refinement
D	2009-4-10	3.2, 4.1, 4.6.2, 4.6.3	MCS Common ICD v 1.0 formatting
E	2009-11-09	2.1.2, 2.1.4, 2.2.2, 2.2.4, 3.1/260, 4.1.1/260, 4.2.1/260, 4.3.1/260, 5.1/260.1/2, 6.2	Format fields. MIB Labels.
F	2011-12-14	4.1, 4.2, 4.3	Updates to reflect the new ASP MCS software. Added information about how SPI bus commands are processed. Added timing constraints on commands and command rates. Added information about periods of unresponsiveness.
G	2012-9-20	4.1, 4.2, 4.3	Updated to reflect the new Python-based ASP MCS system. Removed the information about periods of unresponsiveness. Added a list of command exit codes and subsystem status codes. Updated the command times for INI and SHT. Removed the command times for FIL, AT1, AT2, ATS, and FPW. Added new MIB entries for the ARX and FEE voltages.

Table of Contents

List of Tables

List of Figures

No table of figures entries found.

1 DESCRIPTION

1.1 Purpose

The purpose of this document is to define the Station Monitor and Control, Level-1 interface between the Analog Signal Processing Monitor and Control (ASP-MCS). The ASP described here is used to adjust the gains of each antenna signal, send power to the Front-End Electronics (FEE), and provide adequate filtering of the RF signal prior to digitization.

1.2 Scope

The document contains lists of monitor and control points available in the ASP and their suggested access rates.

1.3 Related Documents and Drawings

- MCS Common ICD [1]
- PCD Common ICD [2]
- ASP Preliminary Design [3]

All EMs, LWA Memos, schematics, module drawings, wiring diagrams, other ICDs, etc.

1.4 Applicable Documents and Drawings

- LWA Station Architecture [4]
- LWA Analog Signal Path Planning [5]
- LWA Technical Requirements [6]

ICD definition document, station architecture, technical requirements, etc.

1.5 Order of precedence

In the event of conflict between the text of this document and applicable documents, the applicable documents shall take precedence unless explicitly mentioned in this document.

2 ABBREVIATIONS AND ACRONYMS

See [4]

2.1 Glossary

See [4]

3 PHYSICAL SYSTEM INTERFACES

3.1 Mechanical Interface

See [3]

3.2 Electrical Power Interface

The ASP is powered from the Shelter-PCD via two controlled power ports.

Port 1: 240 VAC, ~ 15 A - FEE & ARX Power
Port 2: 110 VAC, ~ 1 A - MCS Power

3.3 Electronic Interface

3.3.1 List of Connectors

Table 1: List of Connectors

Subsystem	Signals	No. of connectors	Type of connector
SEP	260 dual polarization signals from antennas.	520	SMA
MCS	Monitor/Control	1	RJ-45
DP	260 dual polarization differential signals from ARX. Each Cat-7 cable has 4 pairs which carry signals from 2 polarizations of 2 stands.	130	RJ-45

4 MONITOR/CONTROL INTERFACE

4.1 Overview

The ASP-MCS module consists of a single software controllable component. Message formats and responses will conform to the MCS Common ICD [1].

4.1.1 MCS Interface

The ASP Monitor/Control interface accepts a CAT-6 cable from the station MCS and is fully controllable through the MCS Common ICD defined in [1].

4.1.2 Filter Configuration

Each pair of 260 receiver channels can select between one of four filter configurations:

1. Full Bandwidth, 10 MHz to 80 MHz;
2. Reduced Bandwidth, 28 MHz to 54 MHz;
3. Split Bandwidth, 10 MHz to 80 MHz, with additional attenuation control over the low frequency portion of the passband (diplexed at 41 MHz); and
4. Signal path off.

In the above, the listed bandwidths are to the 3 dB level.

4.1.3 Gain Control

60 dB of gain control (via digital step attenuators) is available in 2 dB steps for each pair of 260 receiver channels. In addition to the 60 dB of gain control, the Split Bandwidth filter configuration provides another 30 dB of gain control (2 dB steps) for the 10 MHz to 30 MHz portion of the passband.

4.1.4 FEE Power

On/off control for the FEE is provided for all 520 receiver channels (each channel, and each polarization).

4.2 Monitor (RPT) Responses

4.2.1 Summary of Monitor Points

Table 2: Summary of Monitor Points

MIB Label	MIB Index	Section
MCS-RESERVED	1	4.2.2.1
ASP-POWER	2	4.2.2.2
ARX-FILTERS	3	4.2.2.3
ARX-ATTEN	4	4.2.2.4
FEE-PWR	5	4.2.2.5
ASP-TEMP	6	4.2.2.6

4.2.2 Monitor Points in Detail

Monitor data shall be polled by the MCS system according to the protocol specified in the MCS Common ICD, using the MIB structure described in MCS Common ICD, section 3 [1]. It should be noted that branching on MIB indices is not currently supported by ASP-MCS.

4.2.2.1 MCS-RESERVED

ASP MIB index 1 provides the MCS-required MIB entries as specified in [1].

Table 3: MCS Reserved MIB Entries

Index	Label	Data	Format
1	MCS-RESERVED		
1.1	SUMMARY	Defined in [1]	[7 bytes, ASCII]
1.2	INFO	Defined in [1]	[256 bytes, ASCII]
1.3	LASTLOG	Log items specified in [7]	[256 bytes, ASCII]
1.4	SUBSYSTEM	Value always “ASP”	[3 bytes, ASCII]
1.4	SERIALNO	Serial number of ASP-MCS module only	[5 bytes, ASCII]
1.5	VERSION	Firmware version of ASP-MCS module	[256 bytes, ASCII]
1.X ($X \geq 6$)	reserved	TBD	TBD

4.2.2.2 ASP-POWER

ASP MIB index 2 provides information about the ASP Power. There are two subsystems for power in the ASP; ARX power, and FEE power. For each of these power subsystems, there are multiple power supplies connected in parallel to source the total current required. An overall power status is indicated in 2.1.1 and 2.2.1 (ON or OFF). The number of supplies that are connected in parallel is indicated in 2.1.2 and 2.2.2 (ARX and FEE supplies respectively). Individual power module information for each of these units is indicated in 2.1.3 and 2.2.3 (ARX and FEE units respectively). The total current output of the paralleled supplies is indicated in 2.1.4 and 2.2.4 (ARX and FEE power respectively).

Table 4: ASP Power MIB Entries

Index	Label	Data	Format
2	ASP-POWER		
2.1	ARXSUPPLY-INFO		
2.1.1	ARXSUPPLY	Overall ARX power status. Values are “ON ” or “OFF” (note the space character used for ON).	[3 bytes, ASCII]
2.1.2	ARXSUPPLY-NO	Number of power supplies for ARX power. Values are 1 to N, where N is the number of power supplies.	[2 bytes, ASCII]
2.1.3	ARXSUPPLY-STATUS		
2.1.3.X	ARXPWRUNIT_X	Reserved for individual supply status. Values are a text string describing the power supply status of unit X. If 2.1.2 is N power supply units, there are MIB entries up to 2.1.3.N	[256 bytes, ASCII]
2.1.4	ARXCURR	Value units are in mA	[7 bytes, ASCII]
2.1.5	ARXVOLT	Value units are in volts DC	[7 bytes, ASCII, decimal point allowed]
2.2	FEESUPPLY-INFO		
2.2.1	FEESUPPLY	Values are “ON ” or “OFF” (note the space character used for ON).	[3 bytes, ASCII]
2.2.2	FEESUPPLY_NO	Number of power supplies for FEE power. Values are 1 to N, where N is the number of power supplies.	[2 bytes, ASCII]
2.2.3	FEESUPPLY-STATUS		
2.2.3.X	FEEPWRUNIT_X	Reserved for individual supply status. Values are a text string describing the power supply status of unit X. If 2.2.2 is N power supply units, there are MIB entries up to 2.2.3.N	[256 bytes, ASCII]
2.2.4	FEECURR	Value units are in mA	[7 bytes, ASCII]

Index	Label	Data	Format
2.2.5	FEEVOLT	Value units are in volts DC	[7 bytes, ASCII, decimal point allowed]

4.2.2.3 ARX-FILTERS

ASP MIB index 3 provides information about the ARX filter configurations. Each antenna stand has a corresponding filter configuration. The same filter configuration is used for both polarizations.

Table 5: ARX Filter MIB Entries

Index	Label	Data	Format
3	ARX-FILTERS		
3.1	FILTER_1	Current value set for the filter of stand 1. Values are: *0 = Split Bandwidth Filter Configuration* *1 = Full Bandwidth Filter Configuration* *2 = Reduced Bandwidth Filter Configuration* *3 = Signal Chain OFF*	[1 byte, ASCII]
...	...	...	...
3.260	FILTER_260	Current value set for the filter of stand 260. Values are: *0 = Split Bandwidth Filter Configuration* *1 = Full Bandwidth Filter Configuration* *2 = Reduced Bandwidth Filter Configuration* *3 = Signal Chain OFF*	[1 byte, ASCII]

4.2.2.4 ARX-ATTEN

ASP MIB index 4 provides information about the ARX attenuator settings. Each antenna stand has a corresponding attenuator setting for each of it's three attenuators. The same attenuation setting is used for both polarizations.

Table 6: ARX Attenuator MIB Entries

Index	Label	Data	Format
4	ARX-ATTEN		
4.1	ATTEN-1		
4.1.1	AT1_1	Current value set for the attenuator 1 of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]
...	...	...	...
4.1.260	AT1_260	Current value set for the attenuator 1 of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]
4.2	ATTEN-2		
4.2.1	AT2_1	Current value set for the attenuator 2 of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]
...	...	...	...
4.2.260	AT2_260	Current value set for the attenuator 2 of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]
4.3	ATTEN-SPLIT		
4.3.1	ATSPLIT_1	Current value set for the split bandwidth attenuator of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]
...	...	...	...
4.3.260	ATSPLIT_260	Current value set for the split bandwidth attenuator of stand 1. Values range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).	[2 bytes, ASCII]

4.2.2.5 FEE-PWR

ASP MIB index 5 provides information about the individual FEE settings. FEE power is controlled through the ARX per polarization and the status is indicated as sub-branches of the stand's index.

Table 7: FEE Power MIB Entries

Index	Label	Data	Format
5	FEE-PWR		
5.1	FEEPWR_1		
5.1.1	FEEPOL1PWR_1	Current value set for polarization 1 of stand 1 FEE power. Values are "ON " or "OFF" (note the space character used for ON).	[3 bytes, ASCII]
5.1.2	FEEPOL2PWR_1	Current value set for polarization 2 of stand 1 FEE power. Values are "ON " or "OFF" (note the space character used for ON).	[3 bytes, ASCII]
...	...	...	...
5.260	FEEPWR_260		
5.260.1	FEEPOL1PWR_260	Current value set for polarization 1 of stand 260 FEE power. Values are "ON " or "OFF" (note the space character used for ON).	[3 bytes, ASCII]
5.260.2	FEEPOL2PWR_260	Current value set for polarization 2 of stand 260 FEE power. Values are "ON " or "OFF" (note the space character used for ON).	[3 bytes, ASCII]

4.2.2.6 ASP-TEMP

ASP MIB index 6 provides information from the ASP temperature sensors. Index 6.1 provides a quick-look at the status of the ASP temperature. Index 6.2 is the number of temperature sensors in the ASP. Index 6.3 sub-branches describe where the temperature sensors are located in ASP. Index 6.4 sub-branches contain the temperature data for each sensor.

Table 8: ASP Temperature MIB Entries

Index	Label	Data	Format
6	ASP-TEMP		
6.1	TEMP-STATUS	Current summary status of the ASP temperature. Values are: “IN_RANGE”, all temperatures are within the defined range. “OVER_TEMP”, one or more sensors is over the defined temperature range. “UNDER_TEMP”, one or more sensors is under the nominal temperature range.	[256 bytes, ASCII]
6.2	TEMP-SENSE-NO	Number of temperature sensors implemented in ASP.	[3 bytes, ASCII]
6.3	SENSOR-NAME		
6.3.X	SENSOR-NAME-X	Text string containing a description of the physical placement of the temperature sensor. If 6.2 is N sensors, there are MIB entries up to 6.3.N	[256 bytes, ASCII]
6.4	SENSOR-DATA		
6.4.X	SENSOR-DATA-X	Temperature of sensor X. If 6.2 is N sensors, there are MIB entries up to 6.4.N Value in degrees Celsius.	[10 bytes, ASCII, base-10, decimal point allowed]

4.3 Control Commands

4.3.1 General Consideration

Upon receipt of a control command, ASP will send a response within 3 seconds. In its response, ASP indicates whether the command was accepted or rejected by sending A (accepted command) or R (rejected command), followed by MIB index 1.1 (SUMMARY). In the event that a command is rejected, the comment field of the response will include an error code, as specified in Appendix A, Table 9, terminated by an exclamation point and a human-readable error message that elaborates on the reason the command was rejected. This error message is also copied to the MIB index 1.3 (LASTLOG).

ASP also has a variety of WARNING and ERROR conditions that are actively monitored. In the event that one of the conditions enumerated in Appendix A, Table 10 is detected, the MIB index 1.2 (INFO) is set with elaboration on the reason for the condition. The structure of the INFO index will be a list of space-separated MIB labels related to the condition terminated by an exclamation mark, a subsystem status code, as specified

in Appendix A, Table 10, terminated by an exclamation mark, and a human-readable error message. It should be noted that a WARNING condition will be automatically cleared when the condition leading to the warning no longer exists. An ERROR condition can only be cleared through external actions, i.e., issuing a SHT command followed by an INI and/or power cycling the ASP rack.

4.3.2 Summary of Control Commands

Table 3: Summary of Commands

Message Type	Description	Section
INI	ASP Initialization	4.3.3.1
FIL	ARX Filter Setting	4.3.3.2
AT1	ARX Attenuator 1 Setting	4.3.3.3
AT2	ARX Attenuator 2 Setting	4.3.3.4
ATS	ARX Split Bandwidth Setting	4.3.3.5
FPW	FEE Power Setting	4.3.3.6
RXP	ARX Power Supply Setting	4.3.3.7
FEP	FEE Power Supply Setting	4.3.3.8
SHT	ASP shutdown	4.3.3.9

4.3.3 Commands in Detail

Control of the ASP is accomplished using the Message Type format described in the MCS Common ICD, section 5 [1].

All data fields for these ASP message types are numeric.

4.3.3.1 INI – ASP Initialization

"INI" = ASP Initialization. Upon ASP-MCS boot-up, the station MCS must send the INI command before any other control command can be sent. The purpose of this message TYPE is to inform the ASP-MCS of the number of ARX boards currently installed. The data field for this message TYPE is "ARX boards installed". Example: Data field = 16 corresponds to 16 ARX boards installed in the ASP (256 ARX channels or 128 stands). Valid ARX boards installed numbers range from 01 to 33.

The "INI" command takes approximately 20 seconds to complete for the maximum number of ARX boards (33).

4.3.3.2 FIL – ARX Filter Setting

"FIL" = ARX Filter Setting. The purpose of this message TYPE is to provide the ability to change filter settings in the ARX. The data field for this message type is "stand number"

and “filter setting”. Example: Data field = 02702 corresponds to stand number 27, filter setting 2 (see Section 4.1.3 for a description of the filters). Valid stand numbers range from 000 to 260 (where 000 applies the setting to ALL stands) and valid filter settings range from 00 to 03 (summarized below).

00 = Split Bandwidth Filter Configuration
01 = Full Bandwidth Filter Configuration
02 = Reduced Bandwidth Filter Configuration
03 = Signal Chain OFF

4.3.3.3 AT1 – ARX Attenuator 1 Setting

“AT1” = ARX Attenuator 1 Setting. The purpose of this message TYPE is to provide the ability to change the Attenuator 1 settings in the ARX. The data field for this message type is “stand number” and “attenuation setting”. Example: Data field = 02708 corresponds to stand number 27, attenuator 1 setting of 16 dB. Valid stand numbers range from 000 to 260 (where 000 applies the setting to all ALL stands) and valid attenuator 1 settings range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).

4.3.3.4 AT2 – ARX Attenuator 2 Setting

“AT2” = ARX Attenuator 2 Setting. The purpose of this message TYPE is to provide the ability to change the Attenuator 2 settings in the ARX. The data field for this message type is “stand number” and “attenuation setting”. Example: Data field = 02708 corresponds to stand number 27, attenuator 2 setting of 16 dB. Valid stand numbers range from 000 to 260 (where 000 applies the setting to all ALL stands) and valid attenuator 2 settings range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).

4.3.3.5 ATS – ARX Split Bandwidth Attenuation Setting

“ATS” = ARX Split Bandwidth Attenuation Setting. The purpose of this message TYPE is to provide the ability to change the Split Bandwidth Attenuator settings in the ARX. The data field for this message type is “stand number” and “attenuation setting”. Example: Data field = 02708 corresponds to stand number 27, split bandwidth attenuator setting of 16 dB. Valid stand numbers range from 000 to 260 (where 000 applies the setting to all ALL stands) and valid attenuator settings range from 00 to 15 (00 corresponds to 0 dB and 15 corresponds to 30 dB, each increment represents a 2 dB step).

4.3.3.6 FPW – FEE Power Setting

“FPW” = FEE Power Setting. The purpose of this message TYPE is to provide the ability to turn on and off the FEE power for each polarization of each stand. The data field for this message type is “stand number”, “polarization”, and “power setting”. Example: Data field = 027211 corresponds to stand number 27, polarization 2, FEE power ON. Valid stand numbers range from 000 to 260 (where 000 applies the setting to all ALL

stands), valid polarization numbers are 1 and 2, and valid power settings are 00 and 11 (00 corresponds to FEE power OFF and 11 corresponds to FEE power ON).

4.3.3.7 RXP – ARX Power Supply Setting

"RXP" = ARX Power Supply Setting. The purpose of this message TYPE is to provide the ability to turn on and off the ARX power supplies. The data field for this message type is "power setting". Example: Data field = 00 corresponds to ARX power supplies OFF. Valid power settings are 00 and 11 (00 corresponds to ARX power OFF and 11 corresponds to ARX power ON).

4.3.3.8 FEP – FEE Power Supply Setting

"FEP" = FEE Power Supply Setting. The purpose of this message TYPE is to provide the ability to turn on and off the ARX power supplies. The data field for this message type is "power setting". Example: Data field = 00 corresponds to ARX power supplies OFF. Valid power settings are 00 and 11 (00 corresponds to ARX power OFF and 11 corresponds to ARX power ON).

4.3.3.9 SHT – ASP Shutdown

"SHT" = ASP shutdown. This command puts ASP into a low power state. The purpose of this message TYPE is to whether the "SHT" command needs to executed in the next available SPI bus command slot (TYPE of SCRAM) or not (empty TYPE).

The "SHT" command takes approximately 10 s to complete.

4.3.4 Command/Response Examples

Example 1 (see [1] for format description)

MCS sends the AT2 command to ASP:
ASPMCSAT2’’’’’1391’’’5’54828’12345678’00008

- DESTINATION is the ASP subsystem
- SENDER is MCS
- TYPE = "AT2"
- REFERENCE = 1391
- DATALEN = 5 bytes
- MJD = 54828, so Dec 28, 2008 UT
- MPM = 12345678, about 3.4 hours past UT midnight
- Mandatory space following the MPM field
- The data field is:
    - 000 = apply setting to all stands
    - 08 = 16 dB set on attenuator 2

ASP responds with:
MCSASPAT2”””1391’”0’54828’12345698’A’NORMAL

• DESTINATION is the MCS subsystem
• SENDER is ASP
• TYPE = “AT2”
• REFERENCE = 1391
• DATALEN = 0 bytes
• MJD = 54828, so Dec 28, 2008 UT
• MPM = 12345698, so ASP sent the response 20 ms after MCS sent the command
• Mandatory space following the MPM field
• R-Response & R-SUMMARY are ‘Accepted’ & ‘Normal Operation’
• The data field is empty

Example 2 (see [1] for format description)

MCS sends the FPW command to ASP:
ASPMCSFPW”””1391’”6’54828’12345678’261211

The data field is:
261 = stand number 261 (note, this is out of range)
2 = Polarization 2
11 = Power ON

ASP responds with:
MCSASPFPW”””1391’”0’54828’12345698’R’NORMAL’DATA_OUT_OF_RANGE

The data field is:
R = Command was rejected
NORMAL = ASP MIB index 1.1 entry indicating SUMMARY = NORMAL
DATA_OUT_OF_RANGE = elaboration on why the command was rejected

5 SAFETY INTERFACE

The ASP has no safety issues requiring monitoring. No action of the monitor and control system can cause incorrect or dangerous conditions in the ASP.

6 REFERENCES

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[3] J. Craig, "Preliminary Design of the LWA Analog Signal Processor," LWA Engineering Memo ASP0003, February 4, 2009. http://panda.unm.edu/lwa/engineering/

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Appendix A

A.1 Command Exit Codes

Table 9: Command Exit Codes

Exit Code	Meaning
0x00	Command accepted/processed without error
0x01	Invalid number of ARX boards
0x02	Invalid stand
0x03	Invalid polarization
0x04	Invalid filter code
0x05	Invalid attenuator setting
0x06	Invalid power setting
0x07	Invalid command arguments
0x08	Blocking operation in progress
0x09	Subsystem already initalized
0x0A	Subsystem needs to be initialized
0x0B	Command not implemented

A.2 Subsystem Status Codes

Table 10: Subsystem Status Codes

Status Code	Meaning
0x00	Subsystem is operating normally
0x01	Power supply over temperature
0x02	Power supply under temperature
0x03	Power supply over voltage
0x04	Power supply under voltage
0x05	Power supply over current
0x06	Power supply module fault error
0x07	Failed to process SPI commands
0x08	Failed to process I2C commands
0x09	Board count mis-match
0x0A	Temperature over TempMax value
0x0B	Temperature under TempMin value
0x0C	Power supplies off
0x0D	Temperature warning[1]

[1] This is a WARNING rather than an ERROR condition.