

Astro-G and ground network Interface control document

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1. Introduction

This document defines the interface among the following components:

- Satellite
 - Observation interface
- Tracking stations

- VLBI data terminal
 - Hardware interface
 - Software interface
- Orbit/log/delta T files

- Correlator
 - KJJVC (Korea Japan Joint VLBI Correlator)
 - VLBA Socoro correlator
 - JIVE correlator
 - LBA correlator

- Ground radio telescope Network (TBD)
 - EAVN (TDB)
 - VLBA (TDB)
 - EVN (TDB)
 - LBA (TDB)

This document will be distributed to international participants of VSOP-2 project as a reference document in order to control interface between vsop-2 project and other systems and devices.

2.1 Observation interface

Astro-G observation capability is summarized in Table 1.

Table 1 Observation capability of Astro-G satellite

Frequency range	Q-band (L) : 41-43.18 GHz Q-band (H) : 43-45 GHz K-band : 20.6-22.6 GHz X-band : 8.0-8.8 GHz
Polarization	RHCP and LHCP
Band and polarization selection	See Table 2
System noise temperature (typical)	Q-band : 61 K-band : 37 X-band : 88
Side band of mixers and ADC	DC of Q-band (L/H) : USB DC of K-band : LSB DC of X-band (=BBC) : USB BBC (Base Band Converter) : USB ADC : USB
Frequency selection step of BBC	32 MHz
Number of baseband channel	2 channel
Bandwidth and quantization	1) BW 128 MHz-2bit-2ch 2) BW 256 MHz-1bit-2ch
Amplitude flatness in frequency band	2dB pp (Maximum)
Frequency switching capacity	Available (Within 10 seconds, TBD)
Antenna switching capability	Available (Minimum switching period is 1minute for 2.8 deg separation angle; The maximum slewing speed is 2.8deg/15sec)
Amplitude calibration capability	Available by the power meters and the thermometers of the LNA

Table 2 Band combination capability

		RHCP				LHCP			
		Q-H	Q-L	K	X	Q-H	Q-L	K	X
RHCP	Q-H	o				o		o	o
	Q-L		o				o	o	o
	K			o		o	o	o	o
	X				o	o	o	o	o
LHCP	Q-H	o		o	o	o			
	Q-L		o	o	o		o		
	K	o	o	o	o			o	
	X	o	o	o	o				o

(QH: Q-band High, QL: Q-band Low, K: K-band, X: X-band)

2.2 Hardware interface of data terminal

Hardware interface of output data from an Encoder of the tracking station is in accordance with VSI-H. The interface is summarized in Table 3.

The most favorable VLBI terminal for the tracking stations is Mark5B considering technical readiness and compatibility with international VLBI correlators. Though Mark 5Bs have VSI-H input interface, VSI-H output interface is not formally supported. Mark 5B for the tracking stations can be upgraded to support VSI-H output with some additional software.

Table 3 Hardware interface of VLBI Data terminal used in tracking stations

Interface	VSI-H rev 1.0
Mechanical interface	MDR 80 pin connector
Electrical interface	LVDS
Number of channel	1
Clock rate	32MHz
Signals	DATA:32 bit Clock: Defined by VSI-H specification 1PPS: Defined by VSI-H specification VALID: Defined by VSI-H specification QDATA: Time code of 115.2 kbps serial data. ADS-1000 QDATA compatible.
Expected VLBI terminal	Mark 5B (VSI-output supported)

2.3 Control interface of data terminal

Tracking station data terminal (Mark5B expected) is controlled as a standard VSI device. Available command list will be designed as VSI-S with some special command extensions. The control interface is summarized in Table 4.

Table 4 Control interface of VLBI Data terminal

Open Systems Interconnection Reference Model	X <input type="checkbox"/> (OSI)	Application layer: VSI-S Transport layer: TCP Network layer: IP Data link layer: IEEE802.3 Physical layer: IEEE802.3
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2.4 Tracking station special data/log interface

Tracking station special data/log interface are summarized in Table 5.

Table 5 Tracking station special interface

type	items	Format
input	Orbit / antenna and frequency	Same as halca (TBD)
	Schedule	Same as halca (TBD)
output	Log, TLM and Status	Same as halca (TBD)
	Delta T file	Same as halca
	Doppler Data	Same as halca (TBD)

3.1 Interface of KJJVC

KJJVC (Korea Japan Joint VLBI Correlator) is under development. VSOP2 correlation with EAVN (East Asia VLBI Network) will be carried out by KJJVC. The interface and availability related to vsop-2 correlation are summarized in Table 6 and Table7. KJJVC supports three types of VLBI terminals with VSI-H. The physical, electrical and timing interface of data from terminal to KJJVC is based on VSI-H. MDR80pin connector pin allocation and data interface is summarized in Figure 1 and 2. The data array format required for KJJVC is shown Table 8. P-DATA is used for time code written in Ascii code. The Data format of P-DATA is shown in Table 9. Sample code of 2bit data of KJJVC is shown in Table 10.

Table 6 VLBI data input interface of KJJVC

Available terminal	DIR-2000 (IF: VSI-H) Mark5B (IF: VSI-H) K5/VSI (IF: Ethernet, dedicated interface)
Hardware interface from terminal to correlator	VSI-H (DIR-2000 and Mark5B) or LAN (K5) Communication line connection: Ethernet (TBD)
Required control interface of terminal with correlator operation system	VSI-S on TCP/IP Or special data transfer interface (TBD)
Time code	P-DATA

Table 7 Availability of vsop-2 correlation of KJJVC

Maximum number of stations	16
Polarization processing	Available
Maximum baseline	+/- 36,000 km
Maximum delay rate	25 microsec/sec
FFT point number	256/128/64/32/16/8k (k=1024)
Delta T file support	Available
Bandwidth per channel	512/256/128/64/32/16/8 MHz
LSB and USB correlation	Available
1-bit and 2bit correlation	Available
Minimum integration period	25msec

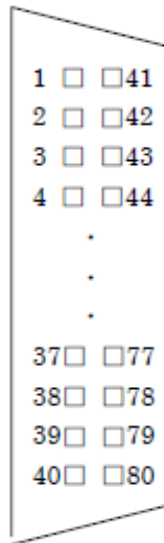


Figure 1 MDR80pin connector pin allocation

PIN	SIGNAL	IN/OUT	PIN	SIGNAL	IN/OUT
1	BSp[0]	IN	41	BSn[16]	IN
2	BSn[0]	IN	42	BSp[16]	IN
3	BSp[1]	IN	43	BSn[17]	IN
4	BSn[1]	IN	44	BSp[17]	IN
5	BSp[2]	IN	45	BSn[18]	IN
6	BSn[2]	IN	46	BSp[18]	IN
7	BSp[3]	IN	47	BSn[19]	IN
8	BSn[3]	IN	48	BSp[19]	IN
9	BSp[4]	IN	49	BSn[20]	IN
10	BSn[4]	IN	50	BSp[20]	IN
11	BSp[5]	IN	51	BSn[21]	IN
12	BSn[5]	IN	52	BSp[21]	IN
13	BSp[6]	IN	53	BSn[22]	IN
14	BSn[6]	IN	54	BSp[22]	IN
15	BSp[7]	IN	55	BSn[23]	IN
16	BSn[7]	IN	56	BSp[23]	IN
17	BSp[8]	IN	57	BSn[24]	IN
18	BSn[8]	IN	58	BSp[24]	IN
19	BSp[9]	IN	59	BSn[25]	IN
20	BSn[9]	IN	60	BSp[25]	IN
21	BSp[10]	IN	61	BSn[26]	IN
22	BSn[10]	IN	62	BSp[26]	IN
23	BSp[11]	IN	63	BSn[27]	IN
24	BSn[11]	IN	64	BSp[27]	IN
25	BSp[12]	IN	65	BSn[28]	IN
26	BSn[12]	IN	66	BSp[28]	IN
27	BSp[13]	IN	67	BSn[29]	IN
28	BSn[13]	IN	68	BSp[29]	IN
29	BSp[14]	IN	69	BSn[30]	IN
30	BSn[14]	IN	70	BSp[30]	IN
31	BSp[15]	IN	71	BSn[31]	IN
32	BSn[15]	IN	72	BSp[31]	IN
33	1PPSp	IN	73	N.C.	—
34	1PPSn	IN	74	N.C.	—
35	N.C.	—	75	PDATA _n	IN
36	N.C.	—	76	PDATA _p	IN
37	PVALID _p	IN	77	N.C.	—
38	PVALID _n	IN	78	N.C.	—
39	CLOCK _p	IN	79	N.C.	—
40	CLOCK _n	IN	80	N.C.	—

Figure 2 MDR80pin connector pin allocation (Data interface, specification of VSI-H)

Table 8 Data array format required for KJJVC. M and L mean MSB and LSB, respectively. Numbers in boxes indicate relative sample #'s in time order.

Data format (1bit-256MHzBW-2ch)

Bit

0

31

CHA														CH B																	
M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L						
0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7

Data format (2bit-128MHzBW-2ch)

Bit

0

31

CHA														CH B																			
0	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	0	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1

Table 9 P-DATA format.

#	VSI ID	,	TIME	,	SP F	,	CLK Freq.	,	SP B	,	Test pattern	,	VP1	,	VP2	;	C R
---	--------	---	------	---	------	---	-----------	---	------	---	--------------	---	-----	---	-----	---	-----

TIME is required for KJJVC. The format of TIME is YYYYDDHMMSS. VSI ID, SPF, CLK SPB, Text pattern, VP1 and Vp2 are optional for KJJVC. The length from the first delimiter “#” to the final “CR” must be shorter than 2028 Byte.

Table 10 Sample code of 2bit data of KJJVC

Signal level	Sample code
>Threshold	11
0 ->Threshold	10
0 -> neg. Threshold	01
<neg. Threshold	00

3.2 Interface of VLBA correlator

The interface and availability of vsop-2 correlation are summarized in Table 11 and Table 12, annotated with respect to the VLBA software correlator as of 2008.5.2 by Jonathan Romney, National Radio Astronomy Observatory.

Table 11 VLBI data input interface of **VLBA Software Correlator**

Available terminal	Mark 5C (20 units) Mark 5B emulation mode supported
Hardware interface from terminal to Correlator	Data: 10Gbit Ethernet, copper Control: 1Gbit Ethernet
Required control interface of terminal with correlator operation system	VSI-S (as extended for Mark 5C) on TCP/IP
Time code	Embedded in Mark 5C packets

Table 12 Availability of vsop-2 correlation

Maximum stations	Unlimited ★★
Polarization processing	Available
Maximum baseline	Unlimited ★
Maximum delay rate	Unlimited ★
FFT point number	Unlimited ★★
Spacecraft orbit & Delta T file support	To be implemented if funding available.
Bandwidth per channel	Unlimited ★★ in correlator. 0.5 – 256 MHz (binary steps) in DBE.
LSB and USB correlation	Available
1-bit and 2bit correlation	Unlimited ★★
Minimum integration period	Unlimited ★★

NOTES

Unlimited ★: The software correlator has no fixed limits on these items, and they do not contribute significantly to processing load. Additional programming effort might be required to support extreme cases.

Unlimited ★★: The software correlator has no fixed limits on any of these items, but they do contribute significantly to processing load. Extreme combinations may exceed the available capacity, requiring procurement of additional processors. We cannot quantify this overall load limit at present, but could do so well before launch.

3.3 Interface of JIVE correlator

The interface and availability of vsop-2 correlation are summarized in Table 13 and Table 14. Interface of connectors, data format, sample code and so on will be confirmed later.

Table 13 VLBI data input interface of correlator

Available terminal	
Hardware interface from terminal to Correlator	
Required control interface of terminal with correlator operation system	
Time code	

Table 14 Availability of vsop-2 correlation

Maximum stations	
Polarization processing	
Maximum baseline	
Maximum delay rate	
FFT point number	
Delta T file support	
Bandwidth per channel	
LSB and USB correlation	
1-bit and 2bit correlation	
Minimum integration period	

3.3 Interface of LBA correlator

The interface and availability of vsop-2 correlation are summarized in Table 15 and Table 16. Interface of connectors, data format, sample code and so on will be confirmed later.

Table 15 VLBI data input interface of correlator

Available terminal	
Hardware interface from terminal to Correlator	
Required control interface of terminal with correlator operation system	
Time code	

Table 16 Availability of vsop-2 correlation

Maximum stations	
Polarization processing	
Maximum baseline	
Maximum delay rate	
FFT point number	
Delta T file support	
Bandwidth per channel	
LSB and USB correlation	
1-bit and 2bit correlation	
Minimum integration period	