EVLA Project Book, Chapter 5.

5 RECEIVERS

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Revision History
2001-July-01: Initial release.
2001-Oct-01: Sys-def & detail added.
2002-May-17: Consolidated

5.0 Receiver Parameters (Summary)

TABLE 5-1: EVLA RECEIVER PARAMETERS

Frequency (GHz)	1.2 - 2[1]	2 – 4	4 – 8	8 – 12	12 – 18	18 – 26	26 – 40	40 - 50
Band[2]	"L"	"S"	"C"	"X"	"Ku"	"K"	"Ka"	"Q"
Tsys (Kelvins)	21	27	28	31	37	55	58	78-106
Trcvr (Kelvins)	10	13	13	18	24	31	40	47
Feed type[3]	compact	compact	compact	conical	conical	conical	conical	conical
Efficiency[4]	.50	.62	.60	.56	.54	.51	.39	.34
Location[5]	-84.1°	101.6°	165.2°	-156.3°	47.6°	25.9°	-16.9°	4.5°
Polarizer[6]	QR, hyb.	QR, hyb.	QR, hyb.	note[7]	PS,W-B	PS,W-B	PS,W-B	SS
L.O. Frequency	NA	NA	NA	NA	11 – 14	14 – 18	12 – 16.7	16.7 - 20
L.O. multiplier[8]	NA	NA	NA	NA	X 2	X 2	X 3	X 3
Frequency output	1 – 2	2 – 4	4 – 8	8 – 12	8 – 18	8 – 18	8 – 18	8 - 18
Power output[9] (dBm)	-32	-32	-32	-30	-36	-36	-36	-36
Output to module	T302	T302	T302	T304	T303	T303	T303	T303
Refrigerator model[10]	1020	350	350	22	350	350	350	22

[1] 1 GHz is the nominal low end of this band, but full performance is specified only above 1.2
[2] These 60-year-old radar band designations are very obsolete, but handy.
[3] All feeds are corrugated horns.
[4] Total system efficiency.
[5] As seen from apex. Counterclockwise around the feed circle. 0° at right side of elevation axis.
[6] All dual circular polarization. "QR, hyb" means a Quad-Ridge OMT followed by a 90° hybrid. "PS, W-B" means a waveguide Phase Shifter followed by Wollack's implementation of a Bøifot class IIb OMT. "SS" means a Sloping Septum polarizer.
[7] Decision between QR, hyb or PS, W-B will be made after comparison of the detailed, scaled designs.
[8] The frequencies in the row above will be multiplied by this factor in the receiver.
[9] Total power contained in the output band specified, observing "cold sky".
[10] CTI Incorporated model numbers.

5.1 General: This section will cover those items common to all the receivers. Individual receivers will be discussed in the sections indicated in the "Details" row of table 5-1.

5.1.1 Cryogenics: Receivers are built as vacuum-insulated metal cylinders, or dewars. Components inside the dewar are cooled to 15 Kelvins (nominal) for low-noise performance. The refrigerator also provides a stage at 50K (nominal) to which thermal radiation shields are attached.

Helium gas is supplied to the refrigerator at 300 psi and returned to the compressor at 75 psi in a closed loop system. Dynisco Transducer Model G850-100-5C Pressure sensors (28 V, 0-500 psig) will report helium pressures through the Monitor and Control system.

Since the existing two helium motor-compressors on each antenna are not adequate to provide the increased Helium flow required by the EVLA, they must be upgraded. We will use a higher-displacement motor-compressor. The new motor-compressor is the same external size as the existing unit, which avoids modification to the compressor cabinets.

Specifications: Copeland Corporation Model 3RAA-031-TAC
CFH 520.5 Med. Temp Refrigerant
22300 BTUH
3 Horsepower 208 volts, 3 Phase

One compressor will supply L-, K-, S-, and X-band refrigerators and the other C, Ku, Ka, and Q.

5.1.1.1 Vacuum: Vacuum pumps are required to evacuate the dewars to 0.5 Torr for the cooling cycle to work. Receiver pump-down time is of the order of 10 minutes in most cases. Two Alcatel Model 2008A (1/2 hp, 9 CFM) vacuum pumps will be used in each EVLA antenna.

Each pump will connect to a vacuum manifold, which serves 4 receivers. 3/4" vacuum hose will be used to connect to the manifold. Each receiver controls a solenoid that can open the line between the vacuum manifold and the dewar. Each receiver can issue a "pump request" signal to the vacuum pump on its manifold. When no receivers are being pumped, a solenoid on the manifold is opened to atmosphere. The resulting pressure on the receiver's solenoid causes it to seat more firmly and reduces any tendency to leak. Control logic in the receiver controls the sequencing of pumps, solenoids, heaters, and refrigerators.

A Hastings DV-6m Tube monitors the vacuum of each receiver and manifold.

5.1.2 Noise calibration: Each receiver is provided with an injected noise signal equivalent to approximately 5% of the nominal system temperature for that band. This noise can be commanded on or off by the Monitor and Control system. During normal observing it is controlled by a 9.6 Hz square wave with 50% duty cycle. The noise for both LCP and RCP on any receiver is generated by a single source on that receiver.

5.1.3 Monitor and Control: Each receiver will have a set of ancillary electronics, traditionally called the "card cage", attached. This circuitry will control the state of the receiver, provide bias to the Low Noise Amplifiers, and provide preliminary signal conditioning for the monitor outputs. It will accept commands from, and output data to, the Monitor and Control system via the Monitor Interface Board (MIB).

The Monitor and Control system will report the following parameters:

- Dewar Temperature: 15K, 50K stations and case (ambient) temperature.
- Vacuum: Dewar, Manifold.
- LNA FET biases: voltages and currents for each stage of each low noise amplifier.
- Noise source parameters: voltage, current, and attenuator setting (if required).
- Switch positions and gains for normal or solar observing.
- RCP output total power.
- LCP output total power.
- Receiver ID: Band, Serial No., and Revision Level.

The Monitor and Control system can command the following actions

:

Cool down, Warm up, Pump dewar, etc.
Set configuration for normal or solar observing.

5.1.4 Solar Observing: Although a preliminary scheme for solar observing has been devised, its cost has not been evaluated in detail. Initial implementation may be only partial, depending on the amount of money available from contingency funds. We will in any case make those small changes to the receivers which will allow the specifically solar equipment to be added later.

5.1.5 Polarizers: Below 8 GHz: These 3 bands will use a quad-ridge OMT and 90° hybrid. Design of the quad-ridge OMT to cover the full bandwidth with good performance involves some risk, but is required to obtain the bandwidth. OMTs for each band will be scaled from the basic design.

12 to 40 GHz: These 3 bands will use a corrugated waveguide phase shifter designed by Srikanth, followed by a Wollack's design of a Bøifot type IIb OMT. This has been done successfully at K-band on the VLA and designs for other bands will be scaled from this.

40 - 50 GHz: This band will continue to use the Atlantic Microwave sloping septum polarizer currently used on the VLA.

5.1.5 Requirements and specifications: These are listed in section 2.2 of this book.

5.1.6 Testing: The following parameters shall be recorded in easily-retrievable digital form before the receiver is installed:

Across the band:
- receiver temperature
- noise calibration values
- gain
- output power
- 1% compression (or 1 dB compression, if 1% is difficult to measure).

Frequency-independent:
- Cool-down from ambient, plot vs. time.
- Normal cold-stage temperatures and other cryogenic data as required.
- Current for each supply voltage.
- Complete set of monitor data.

Also record: Serial numbers and locations (e.g., RCP or LCP) of important components

All records to be dated and record the name of the person testing the receiver and the equipment used.