EVLA Receivers PDR

(4m, P,) L, S, C BAND RECEIVERS

Trx Projections

EVLA RX FREQ RANGES AND OP TEMPS: REQUIRED vs. PROJECTED

BND	FRQ RANGE (GHz)	REQ Tsys[2] (K)	CURNT Tsys[3] (K)	CURNT Trx[4] (K)	CALC Trx[5] (K)	IDR (dB)
L	1 – 2[1]	26	30	14.7	8.8	TBD
S	2 – 4	29	31	10.9	11.0	TBD
C	4 – 8	31	40	15.5	15.6	TBD

(1) 1200-2000 MHz nominal, response fall-off from 1000-1200 MHz.
(2) From VLA Expansion Project, Phase I, The Ultra Sensitive Array, Table 3.1
(3) From VLBA pointing gains table file @ "/home/jansky/POINTING/gains.table"
(4) Average of "SOIDA" test data of a sample of receivers, 3 pts/band, equal weighting.
(5) From R. Hayward noise budget analysis—See this presentation for details.

Estimated Receiver IF Output Power

Rx	BW (GHz)	T(Sky) (°K)	IF Power (dBm)
L	1	25	-43.9
S	2	25	-45.9
C	4	25	-42.5

Gain/Phase Stability Improvement

- Calibration Noise Sources:
  - Constant Current Circuits
  - Temperature Stabilization
- Post Amps:
  - Temperature Stabilization
- IF/LO Cabling:
  - Improved rigidity & support of heliax cables

Feedhorn Overview

Band Designation	Frequency (GHz)	Bandwidth Ratio	Feed Type	Feed Size (L x Dia.) (in.)
L	1.0-2.0 (1)	2.0:1	Profiled, Corrugated Conical	162.0 x 62.5
S	2.0-4.0	2.0:1	Profiled, Corrugated Conical	132.9 x 47.3
C	4.0-8.0	2.0:1	Profiled, Corrugated Conical	66.5 x 24.2

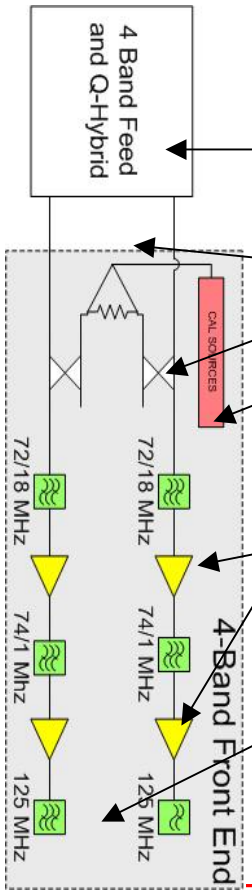
Notes:
(1) Optimized over 1.2 - 2.0 GHz
(2) Designed and used in current VLA configuration

Polarizer Overview

Band Designation	Frequency (GHz)	Bandwidth Ratio	Polarizer Type	Polarizer Length (in.)
L	1.0-2.0 (1)	2.0:1	Quad-ridge OMT w/ 90 deg Hybrid	19.8
S	2.0-4.0	2.0:1	Quad-ridge OMT w/ 90 deg Hybrid	9.9
C	4.0-8.0	2.0:1	Quad-ridge OMT w/ 90 deg Hybrid	5.0

Notes:
(1) Optimized over 1.2 - 2.0 GHz
(2) Designed and used in current VLA configuration
(3) Turnstile Junction OMT (Boifot, Wallack)
(4) Four Component Combination (Circ to Sq. Transition, 90 deg Phase Shifter, 45 Twist, OMT)

4-band



73-75 MHz, 2 channel VLA 4-band Receiver (existing)

Custom cross-dipole, NRL design, near prime focus—At 290 K.

Commercial wide-band hybrid, quadrature phase shifter—At 290 K.

Cal coupler—At 290 K

Cal source, NoiseCom/MC63147– At 290 K.

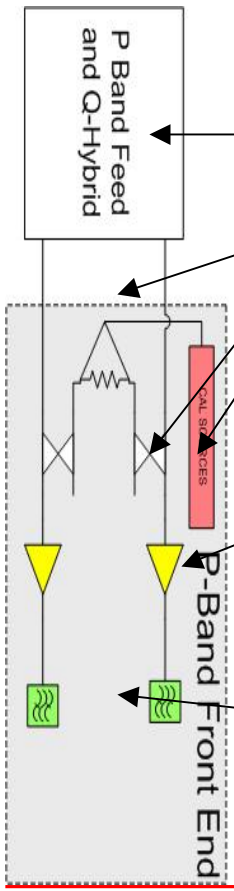
LNA, NRL design—At 290 K, Te=TBD K, G=TBD dB

2 outputs at 73-75 MHz, -TBD dBm

Cryogenics: None.

Receiver FE NF est=TBD K

P-band



308-248 MHz, 2 channel VLA P-band Receiver (existing)

Custom cross-dipole, NRAO design, near prime focus—At 290 K.

Commercial wide-band hybrid, quadrature phase shifter—At 290 K.

Cal coupler—At 290 K

Cal source, NoiseCom/MC63147– At 290 K.

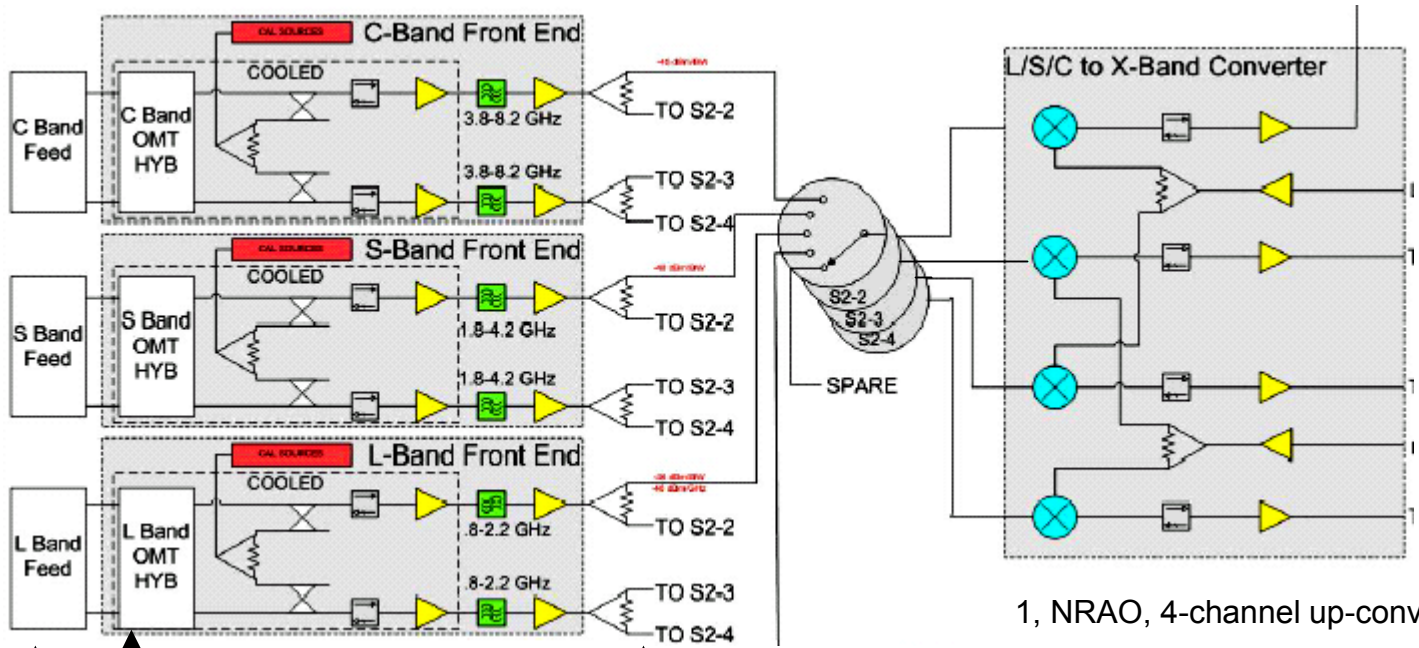
LNA, NRAO design—At 290 K, Te=28 K, G=33 dB

2 outputs at 308 - 348 MHz, -35 dBm

Cryogenics: None.

Receiver FE NF est=55 K

LSC Top Level



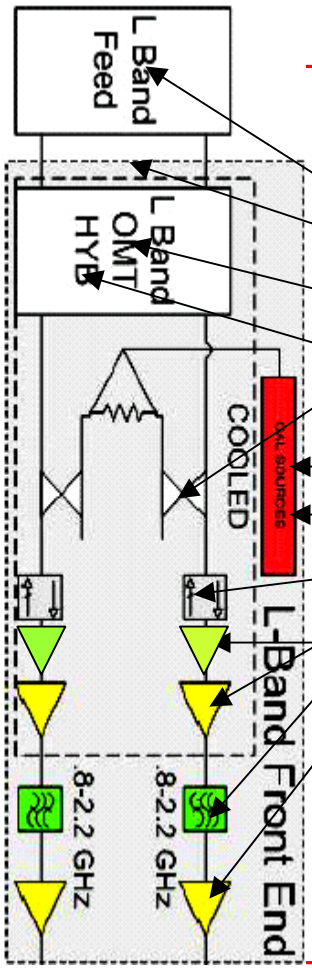
1, NRAO, 4-channel up-converter module.

Each polarization output spilt into 2 independently tunable channels.

NRAO e-formed, quad-ridged, OMT.

NRAO profiled, corrugated feeds.

L-band



1 – 2 GHz, 2 x 1 GHz channel EVLA L-band Receiver Development

Feedhorn, @ 300 K, NRAO,	3.474 K
Vacuum window, @ 300 K, NRAO,	0.069 K
Quadridge OMT, e-formed, @ 300 K, NRAO,	1.165 K
Wide-band hybrid, 90 deg phase shifter, @ 15 K, TRM,	0.848 K
Cal coupler, @ 15 K, Narda,	0.848 K
Cal source, @ 290 K, NoiseCom,	
S-Cal source, @ 290 K, NoiseCom,	
Isolator, @ 15 K, (Opt),	(.500 K)
LNA, @ 15 K, Te=2 K, G=25 * 2 dB, NRAO (planned)	2.300 K
Filter, @ 300 K, K&L,	
Post-amp, various OEMs, @ 300 K, NF<3 dB, G>20 dB	0.007 K
2 outputs at 2–4 GHz, -44 dBm	
Cryogenics: CTI-350 refrigerator.	
Receiver FE NF est=	**8.78/11.27 K**

L-Band Noise Budget

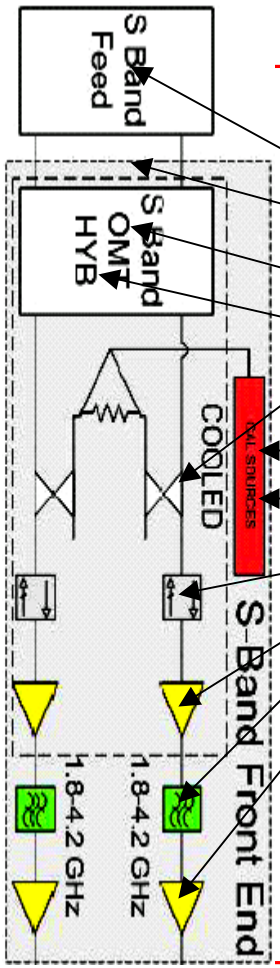
Component	Temp (K)	L/G (dB)	ΔT_{Rx} (K)
Feed	300	0.05	3.474
Vacuum Window	300	0.001	0.069
OMT	50	0.1	1.165
Hybrid	18	0.2	0.848
Cal Coupler	18	0.5	0.848
LNA – 1st G-Block	Tn = 2	25	2.271
Cooled Filter	18	3	0.64
LNA – 2nd G-Block	Tn = 4	25	0.029
Coax	150 & 300	2 & 0.5	0.003
Post Amp	NF=2 dB	25	0.007
Splitter	300	4	0.000
Mixer	300	10	0.001
Total T_{Rx}			8.78

Cooled Isolator (0.5 dB) add 2.49°K

L-band Reuse?

- Retain:
  - Noise diode, CTI 350 frig, Cal coupler & splitter? (New for solar?), Vacuum sensor, Dewar? (with extensions), Misc con & attn.
- Scrap:
  - LNAs, Post-amps, OMT, FH, Filters, M&C.

S-band



2 – 4 GHz, 2 x 2 GHz channel EVLA S-band Receiver Development

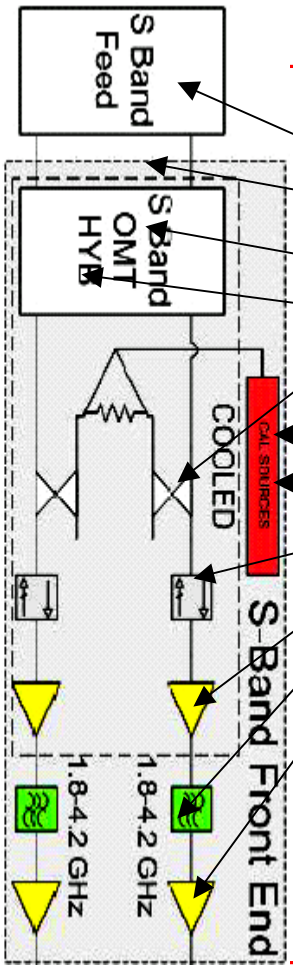
Feedhorn, @ 300 K, NRAO,	3.474 K
Vacuum window, @ 300 K, NRAO,	0.069 K
Quadridge OMT, e-formed, @ 300 K, NRAO,	1.165 K
Wide-band hybrid, 90 deg phase shifter, @ 15 K, TRM,	0.848 K
Cal coupler, @ 15 K, Narda,	0.848 K
Cal source, @ 290 K, NoiseCom,	
S-Cal source, @ 290 K, NoiseCom,	
Isolator, @ 15 K, (Opt),	(.500 K)
LNA, @ 15 K, Te=4 K, G=40 NRAO (planned)	4.541 K
Filter, @ 300 K, K&L,	
Post-amp, @ 300 K, NF<2 dB, G>25 dB, various OEMs,	0.035 K
2 outputs at 2–4 GHz, -44 dBm	
Cryogenics: CTI-350 refrigerator.	
Receiver FE NF est=	**11.01/13.76 K**

S-Band Noise Budget

Component	Temp (K)	L/G (dB)	ΔT_{Rx} (K)
Feed	300	0.05	3.474
Vacuum Window	300	0.001	0.069
OMT	50	0.1	1.165
Hybrid	18	0.2	0.848
Cal Coupler	18	0.2	0.848
LNA	Tn = 4	40	4.541
Cold SS Coax	150	2	0.010
Warm Coax	300	0.5	0.007
Post Amp	NF=2 dB	25	0.035
Splitter	300	4	0.000
Mixer	300	10	0.004
IF Cable	300	3	0.005
Total T_{Rx}			11.01

Cooled Isolator (0.5 dB) add 2.75°K

C-band



4 – 8 GHz, 2 x 4 GHz channel EVLA C-band Receiver Development

Feedhorn, @ 300 K, NRAO,	3.474 K
Vacuum window, @ 300 K, NRAO,	0.069 K
Quadridge OMT, e-formed, @ 300 K, NRAO,	1.165 K
Wide-band hybrid, 90 deg phase shifter, @ 15 K, TRM,	0.848 K
Cal coupler, @ 15 K, Narda,	0.848 K
Cal source, @ 290 K, NoiseCom,	
S-Cal source, @ 290 K, NoiseCom,	
Isolator, @ 15 K, (Opt),	(.500 K)
LNA, @ 15 K, Te=2 K, G=25 * 2 dB, NRAO	9.082 K
Filter, @ 300 K, K&L,	
Post-amp, various OEMs, @ 300 K, NF<3 dB, G>20 dB	0.035 K
2 outputs at 2–4 GHz, -44 dBm	
Cryogenics: CTI-350 refrigerator.	
Receiver FE NF est=	**11.01/14.32 K**

C-Band Noise Budget

Component	Temp (K)	L/G (dB)	ΔT_{Rx} (K)
Feed	300	0.05	3.474
Vacuum Window	300	0.001	0.069
OMT	50	0.1	1.165
Hybrid	18	0.2	0.848
Cal Coupler	18	0.2	0.848
LNA	Tn = 8	40	9.082
Cold SS Coax	150	2	0.010
Warm Coax	300	0.5	0.007
Post Amp	NF=2 dB	25	0.035
Splitter	300	4	0.000
Mixer	300	10	0.004
IF Cable	300	3	0.005
Total T_{Rx}			11.01

Cooled Isolator (0.5 dB) add 3.31°K

C-band Reuse?

- Retain:
  - Noise diode?, Misc con & attn.
- Scrap:
  - LNAs, Post-amps, OMT, FH, Filters, M&C, CTI 1020 frig, Entire dewar box.