

EVLA Front-End CDR

The New EVLA Receiver Card Cage



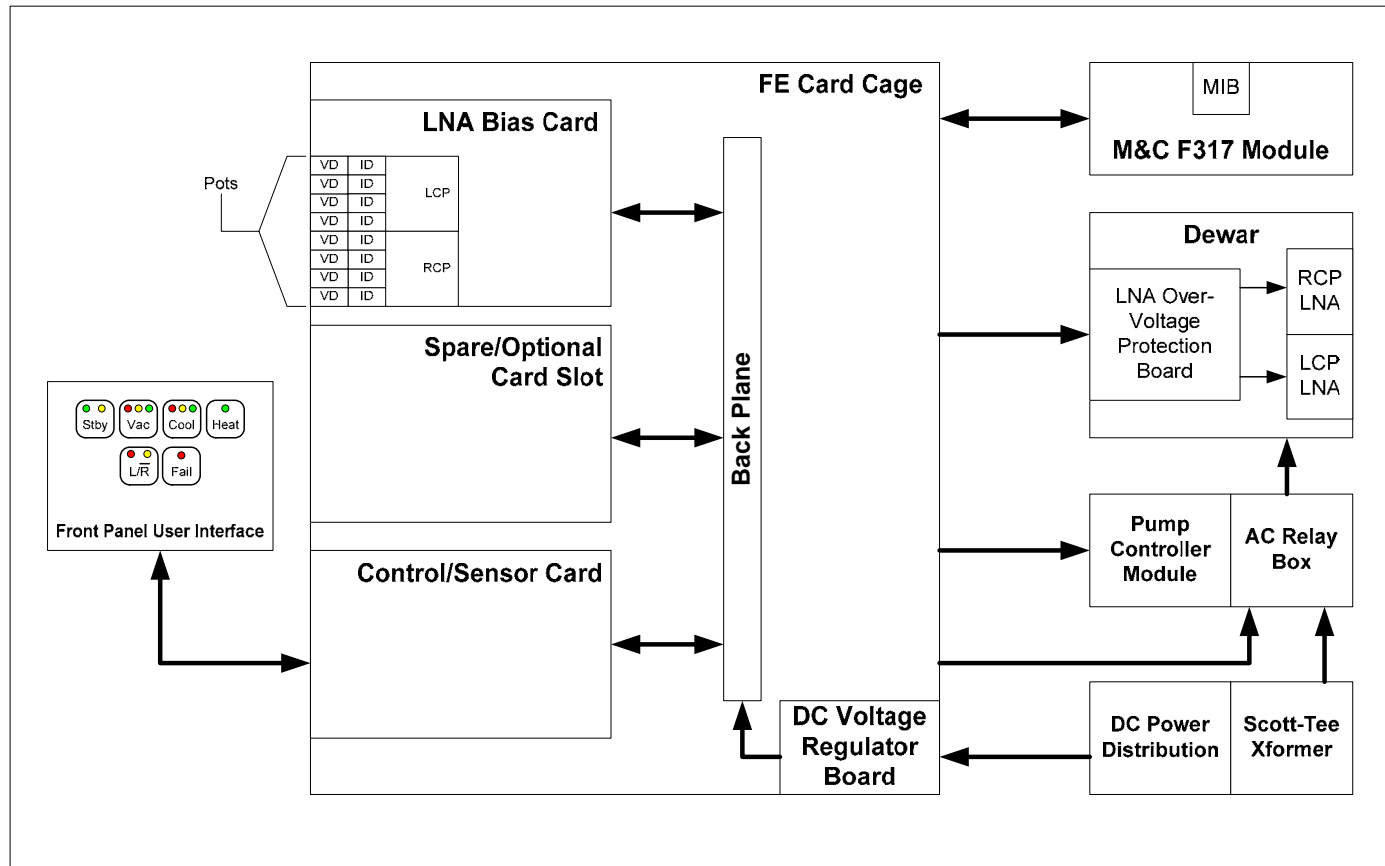
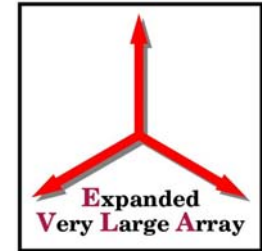
Overview



- The EVLA Card Cage shall:
 - Provide 8 stages of conditioned LNA bias
 - Control and monitor cryogenic sensors
 - Interface to Monitor/Control system
 - (But allow stand-alone bench testing)
 - Mount to EVLA receivers
 - Minimize EMI
 - Minimize assembly time and cost



Block Diagram





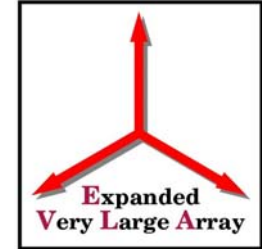
Pseudo-passive Scheme



- 96 available analog monitor points, selectable in banks of 3
- Default critical diagnostic parameters
 - Gate voltage sums (RCP, LCP)
 - 15K stage temperature
- MIB mounted remotely
- No digital signal traffic during observation



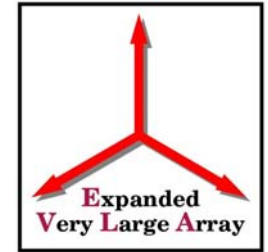
Card Cage: EVLA vs. VLA/VLBA



VLA/VLBA	EVLA
4 stages of bias/card	8 stages of bias per card
Hard-wired logic	Programmable logic
Hand-wired interconnects	Backplane/ribbon cable
Clock-driven display	Pseudo-passive monitoring
Unique to each Rx band	Universal design
AC/digital EMI	No AC or fast clocks
Open, custom chassis	Modified COTS enclosure

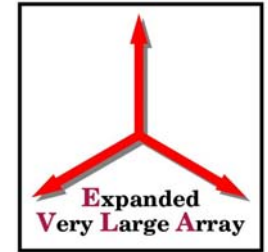


Chassis: VLA

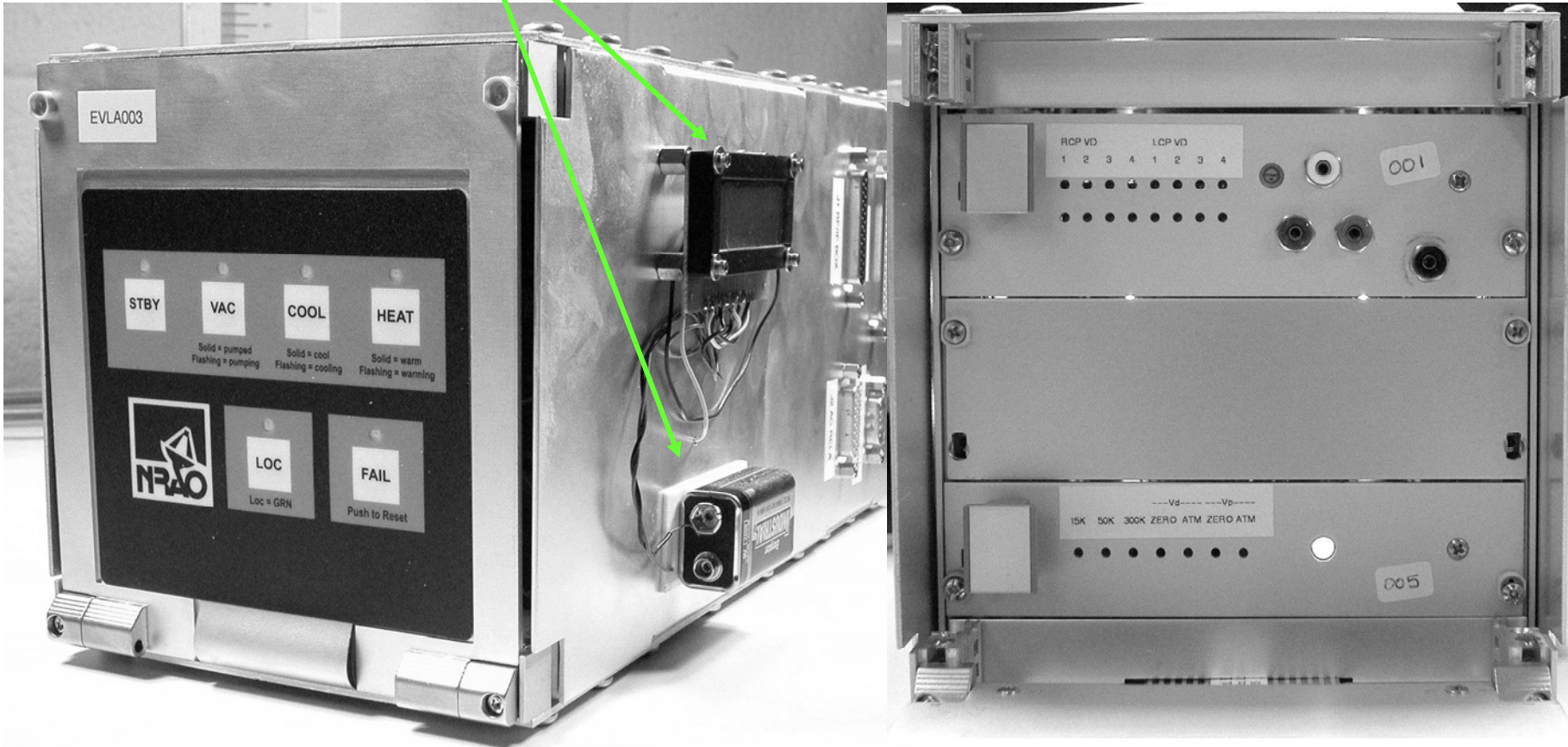




Chassis: EVLA

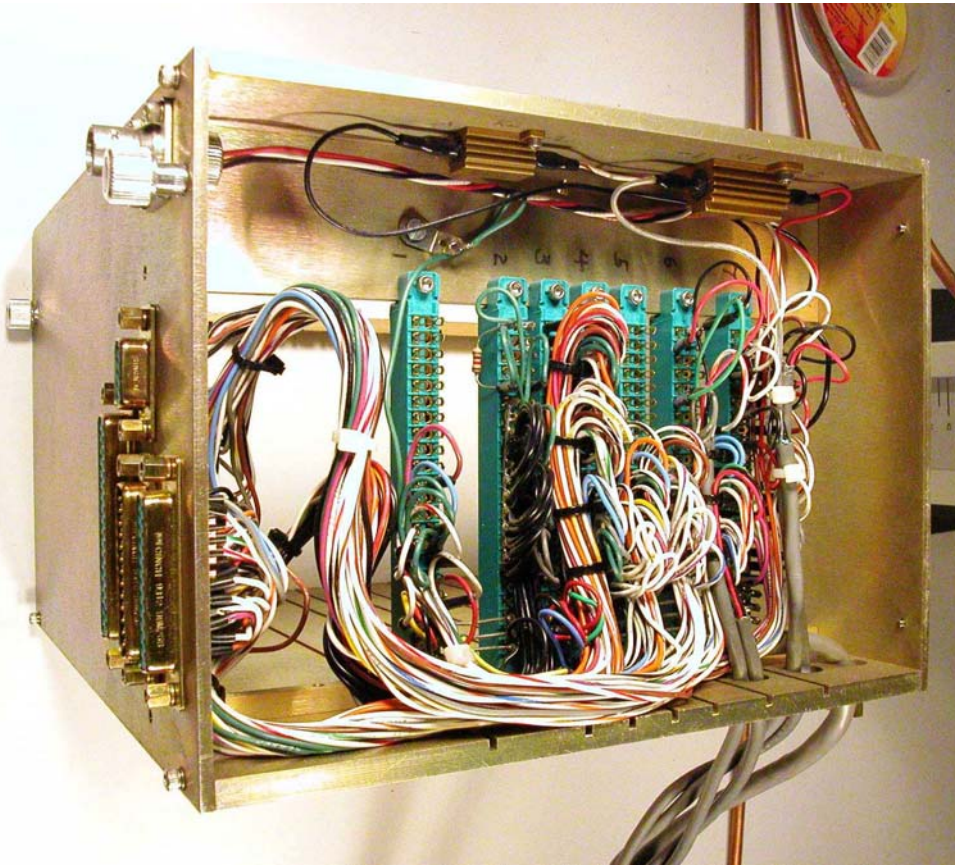
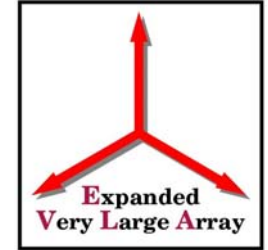


Interim only





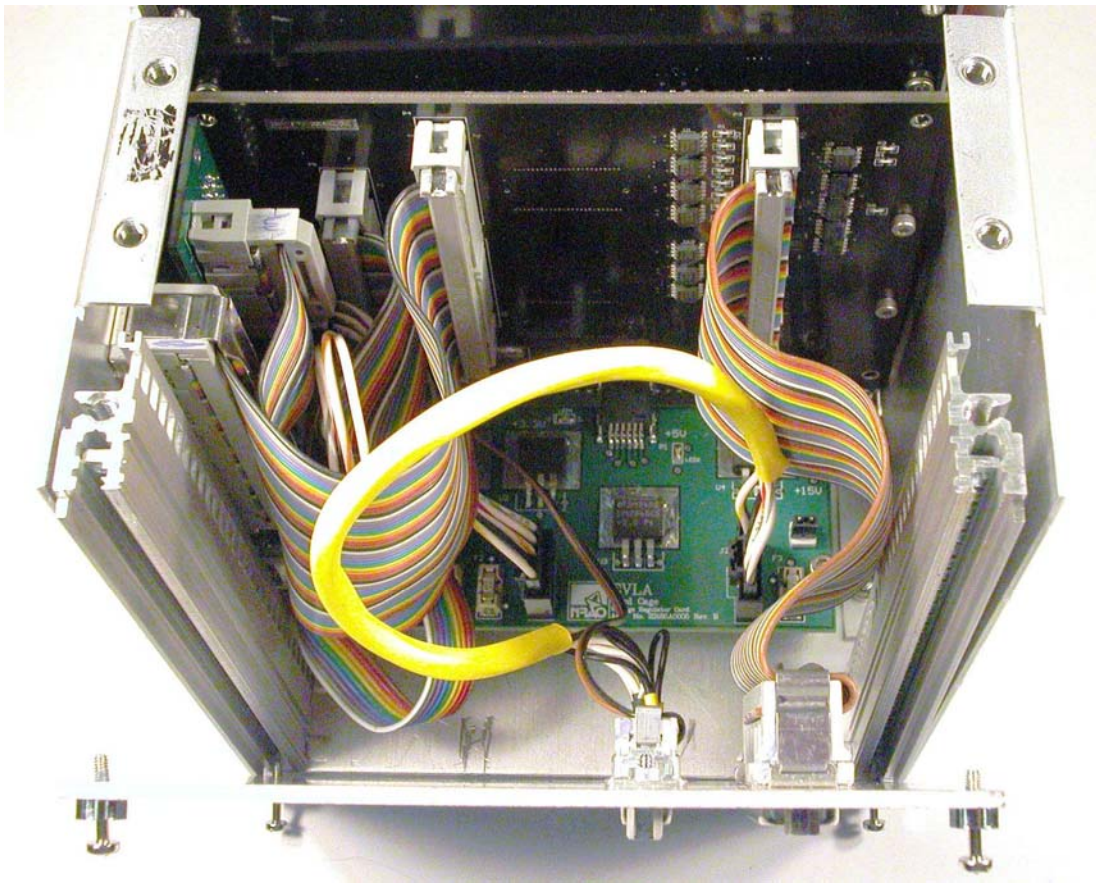
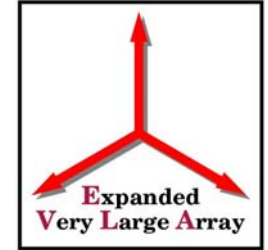
Wiring: VLA



- 250-300 individual solder points
- Wire directions hand-randomized to prevent EMI due to AC



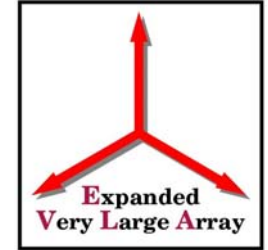
Wiring: EVLA



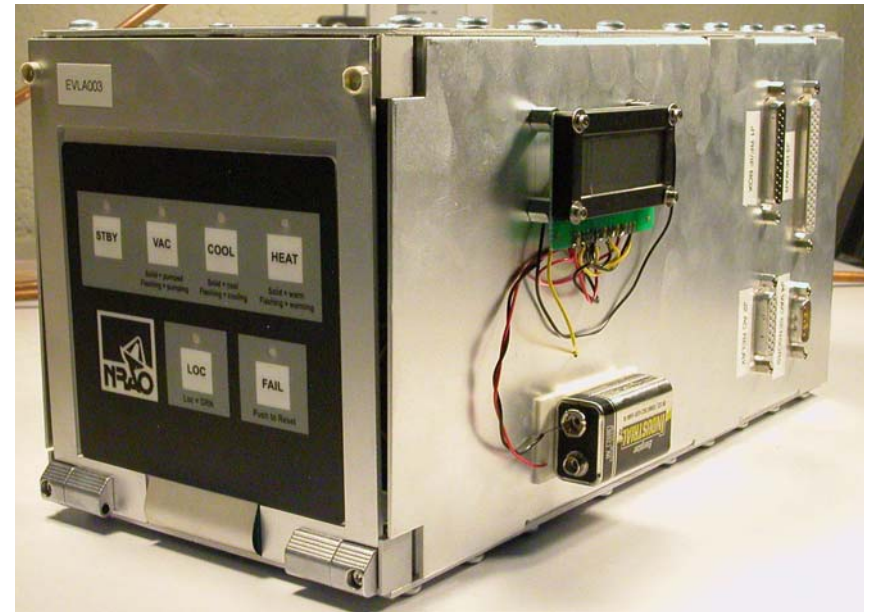
- 6 IDC connections
- 8 solder points
- 16 crimps
- No AC, clocks



Enclosure



- COTS Stamped Al VME Chassis
- Pre-assembled with hardware
- 1/3 the weight of extruded aluminum
- 1/4 the cost!





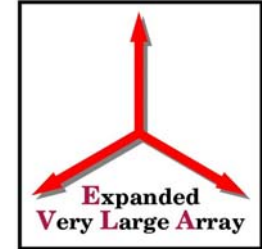
Minimizing Assembly



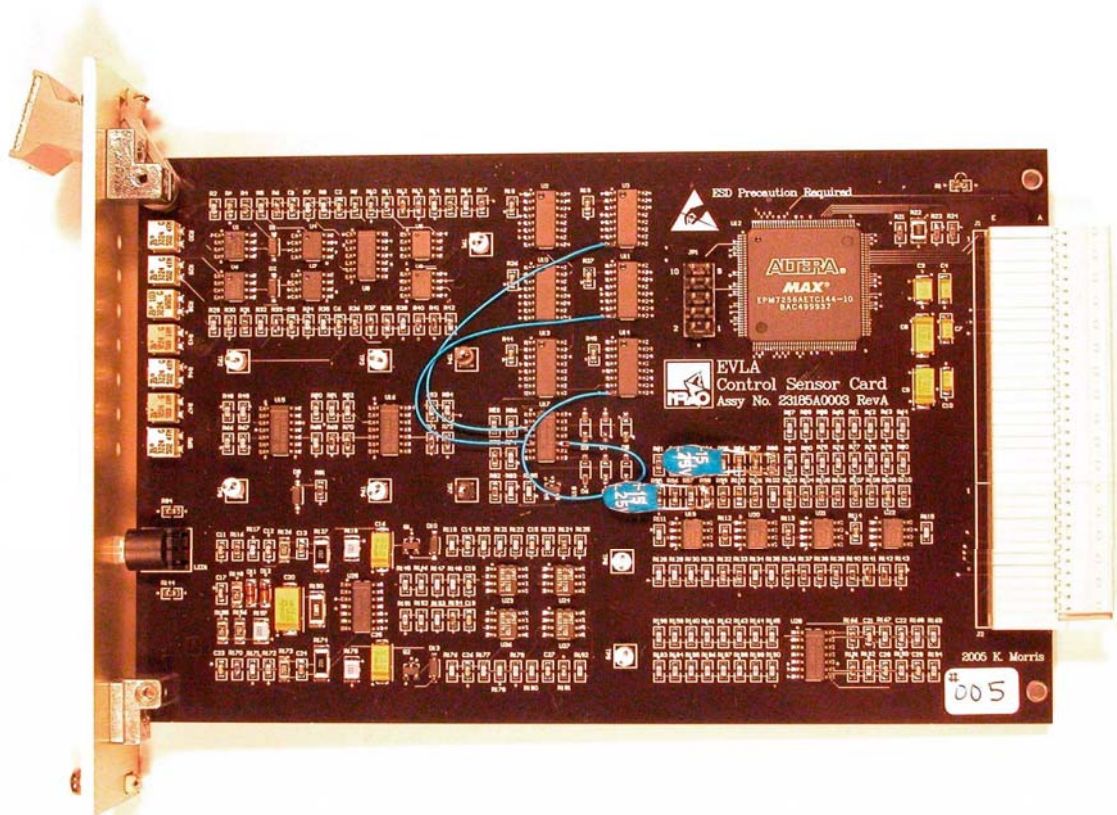
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- IDC/Crimp vs. hand-soldering
 - Pre-assembled chassis
 - Modular, universal design



Control/Sensor Card

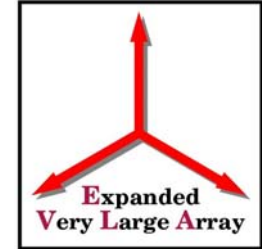


- Replaces VLA:
 - Control,
 - Sensor and
 - Monitor cards
- Altera CPLD
- No fast clock!
- 4" x 6" Eurocard

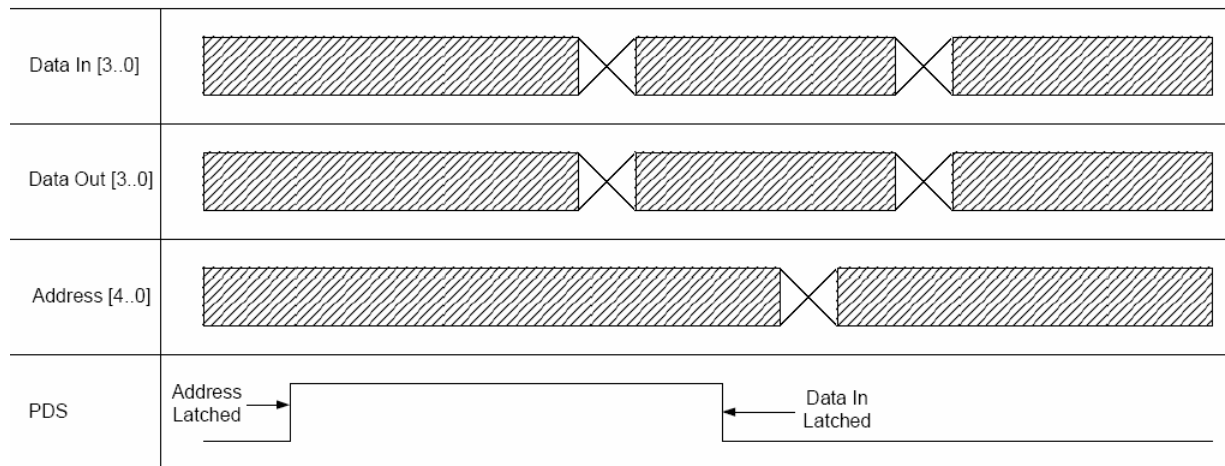




Control PLD

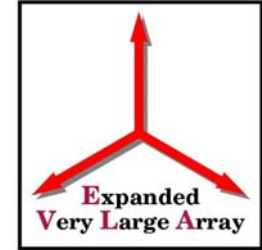


- Communication registers for Digital IO
 - 32 x 4 latching input registers
 - 32 x 4 output registers
 - SPI-compatible

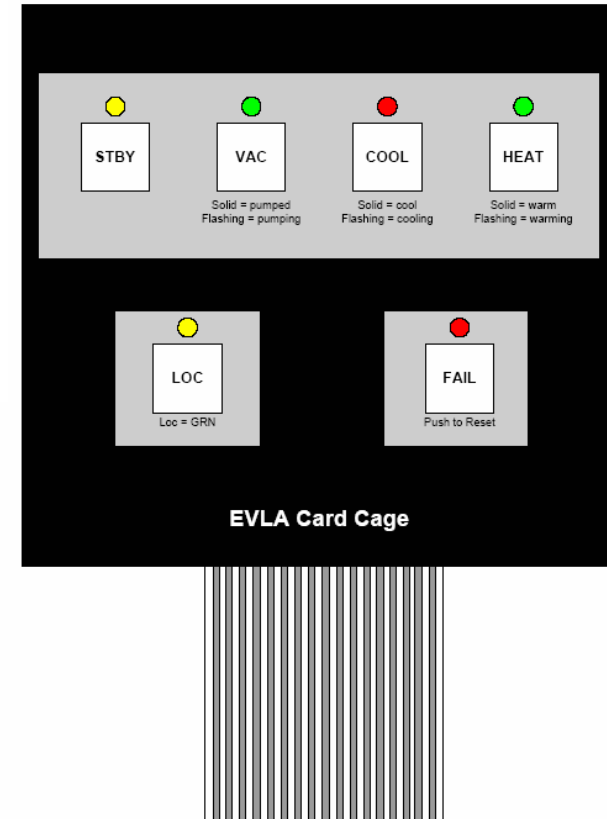




Cryogenic State Machine



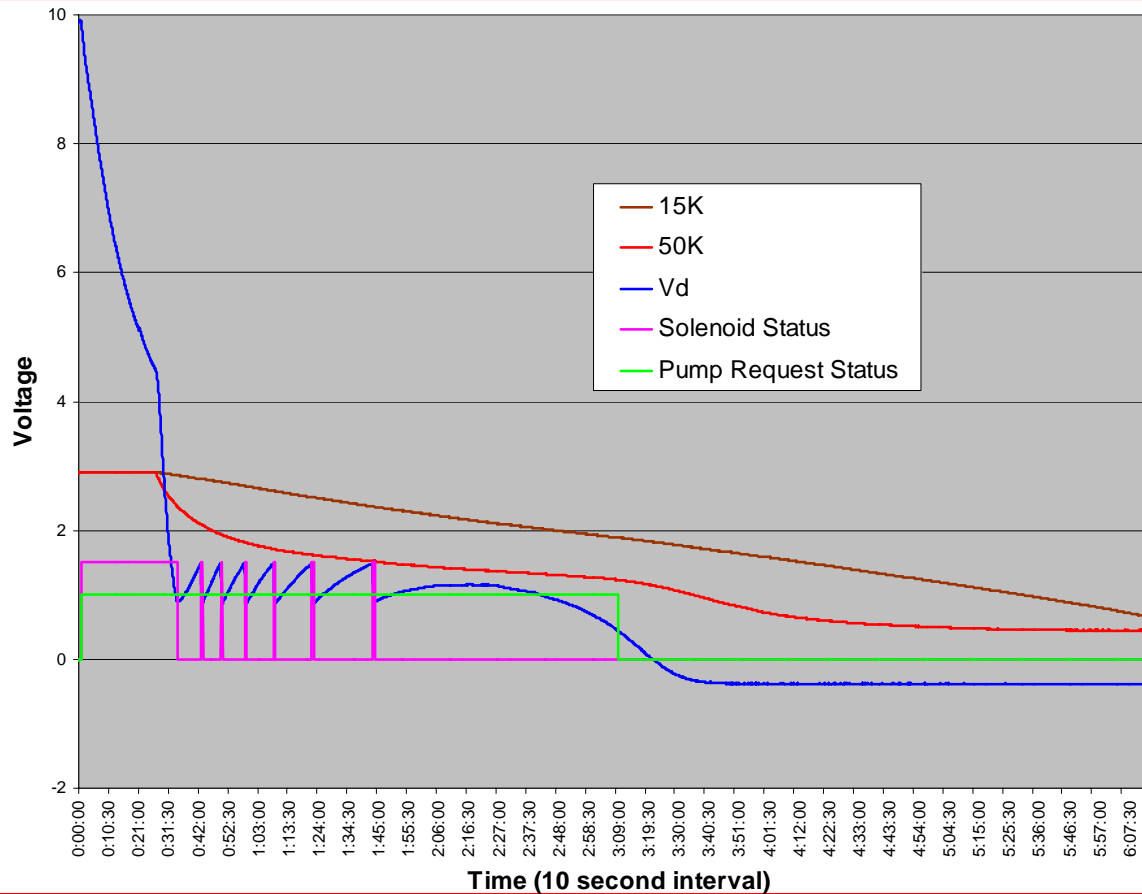
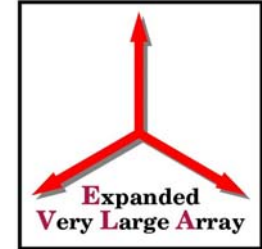
- 9 sensor comparators
- 4 user-set state commands
- 14-way LED state indicator
- Local/remote control



		LEDs					Requests				
		L/R	STBY	COOL	VAC	HEAT	FAIL	Pump	Fridge	Solenoid	Heater
State	L/R	Red = Remote Yellow = Local	--	--	--	--	--	--	--	--	--
	STBY	--	Yellow	Off	Off	Off	Off	Off	Off	Closed	Off
	VACUUMING	--	Green	Red	Yellow	Off	Off	On	Off	Open	Off
	VACUUMED	--	Green	red	Green	Off	Off	On	Off	Open	Off
	COOLING	--	Green	Yellow	Green	Off	Off	On	On	Open	Off
	COOL	--	Green	Green	Green	Off	Off	Off	On	Closed	Off
	HEATING	--	Green	Off	Green	Green	Off	On	Off	Open	On
	FAIL	--	--	--	--	--	Red	--	--	--	--

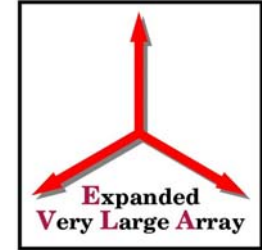


Cryogenic Control

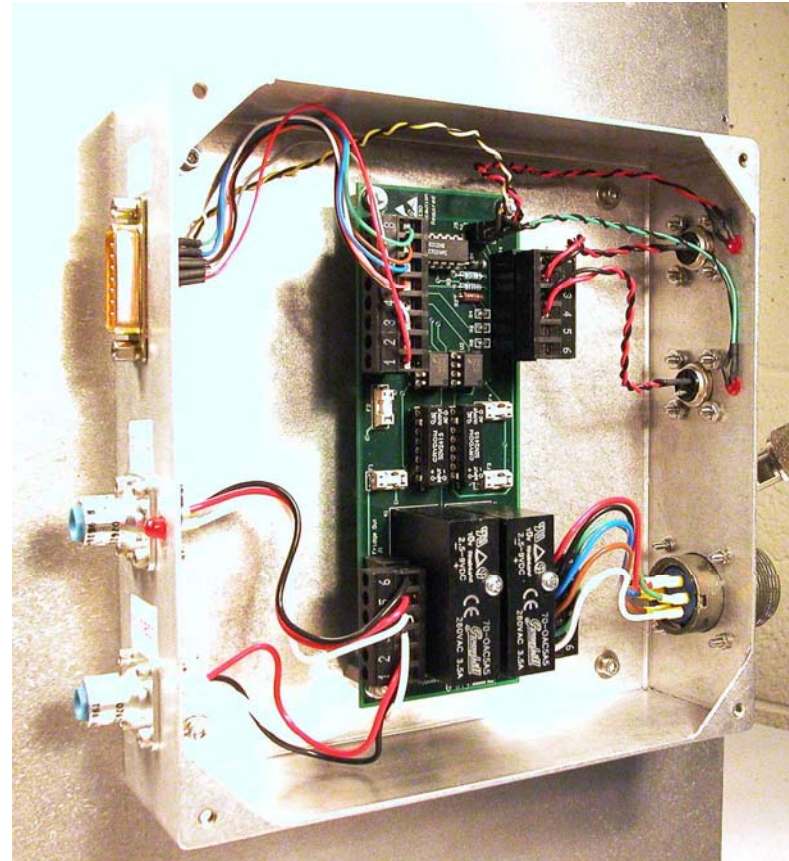




AC Relay Box

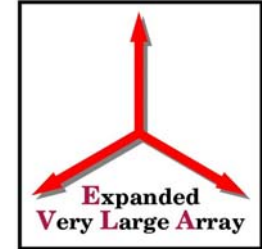


- Removes AC & its EMI from Card Cage
- Allows logic bypass for Fridge
- Separate LED for each request

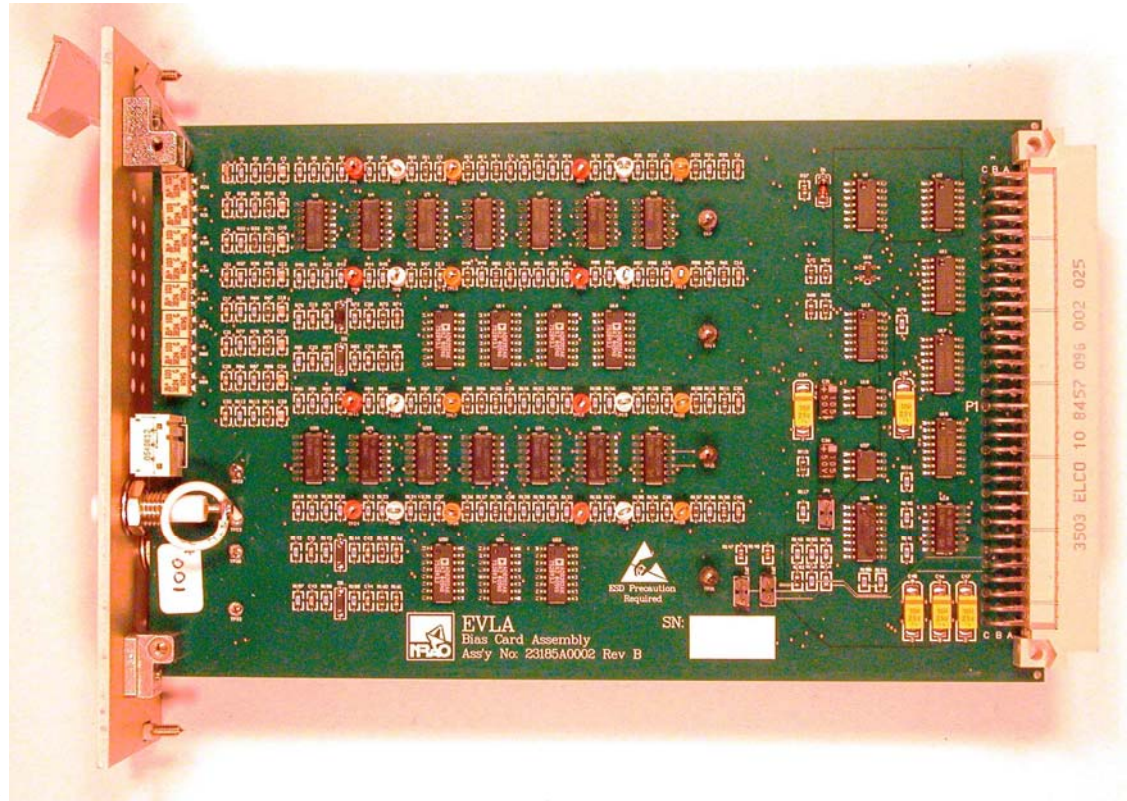




8-Stage Bias Card

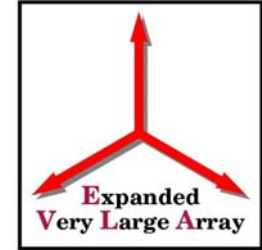


- Based on GBT 6-stage design
- Allows disabling of stages in banks of 2
- V_D , I_D , and V_G are monitored
- 4" x 6" Eurocard

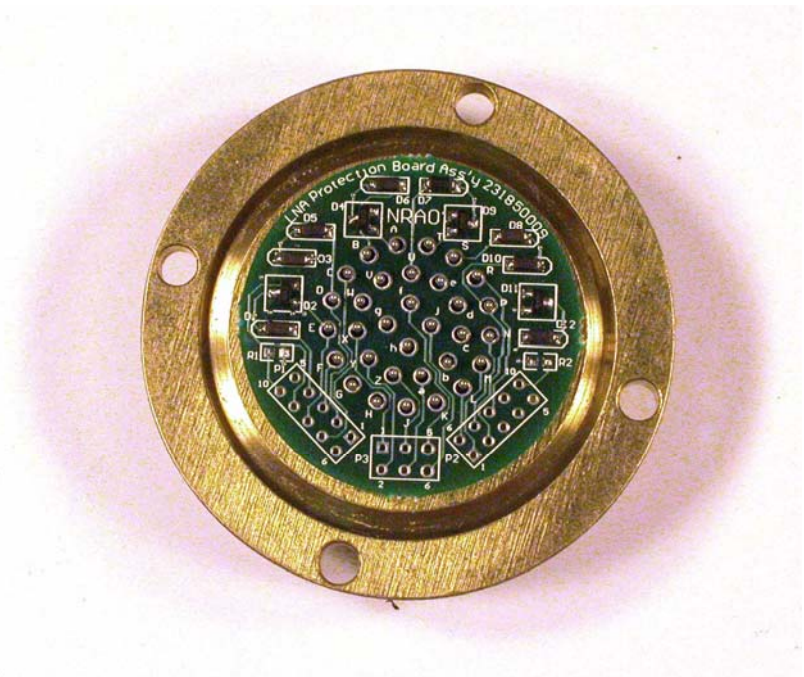




LNA Diode Protection Board



- Accommodates 8 bias stages
- Drain voltage clamped to $+6\text{V}/-1\text{V}$
- Gate voltage clamped to $+1\text{V}/-2\text{V}$
- Soldered to hermetic feedthrough

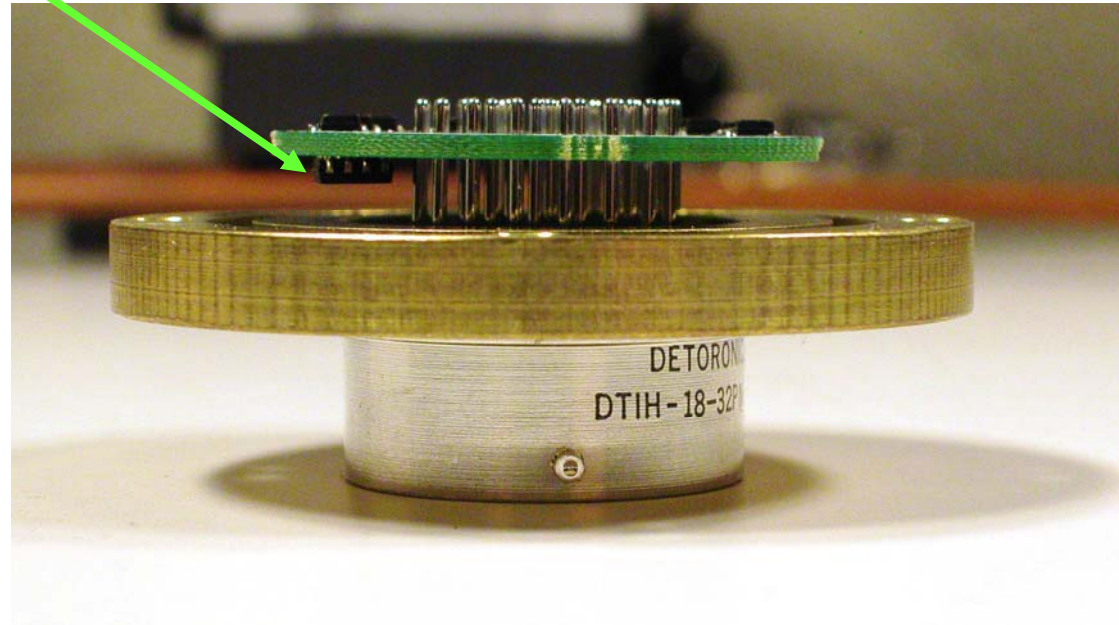




Receiver ID

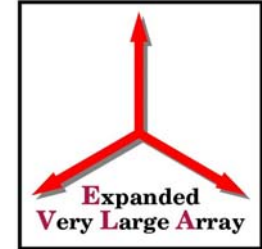


- Band code, Receiver S/N, and revision stored in 64kB EEPROM
- Spare capacity for text—
CAL files,
bias settings, etc.
- Follows receiver,
not Card Cage

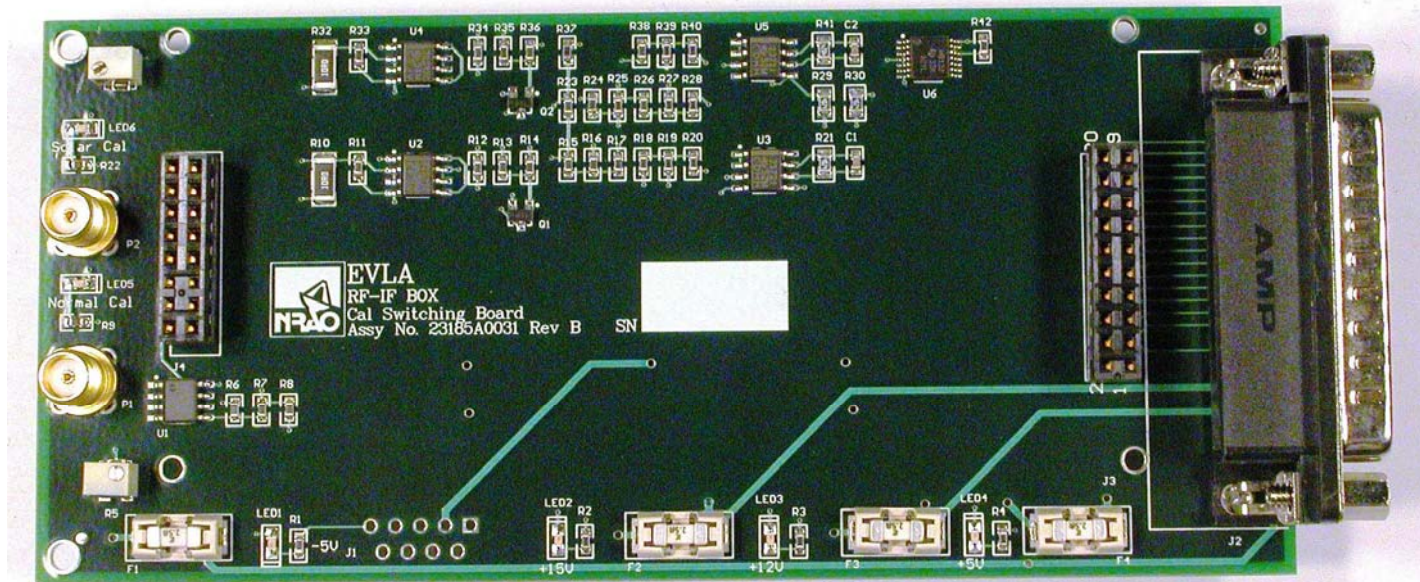




RF/IF Box Interface

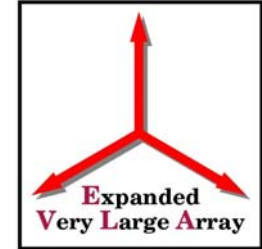


- Accommodates VLA and EVLA solar calibration
- 28V noise cal is not switched in Card Cage

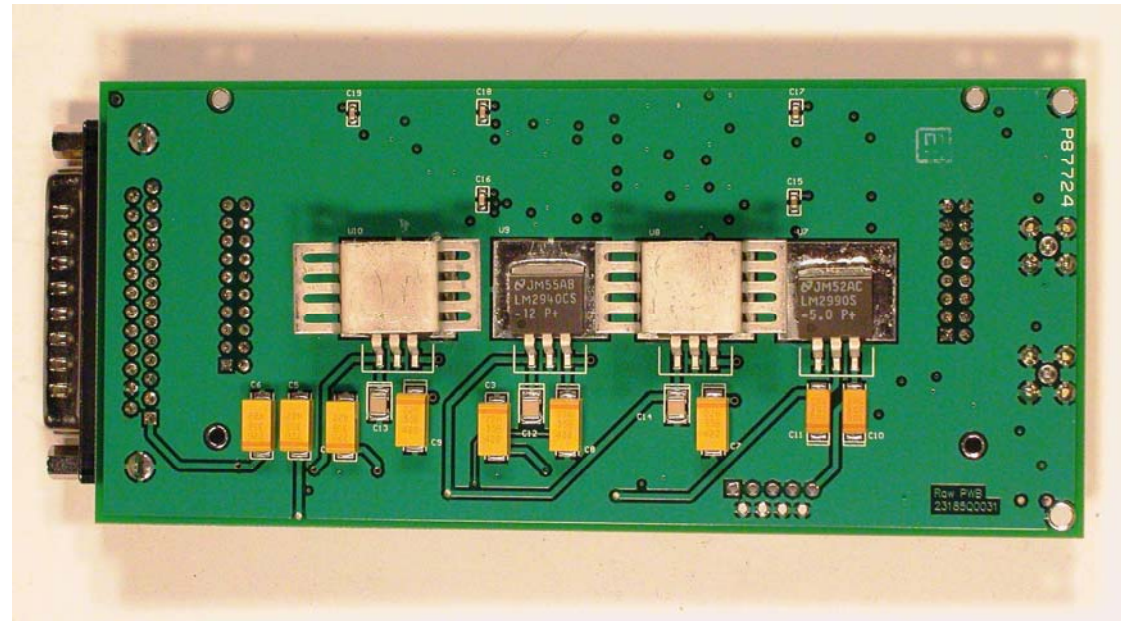




RF/IF Box Interface

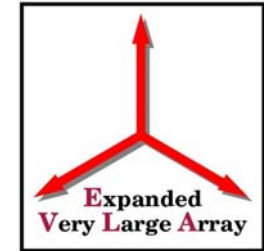


- SPI for logic, step attenuators
- LVTTTL from Card Cage to external switching circuit
- Separate voltage regulation for Room-Temp RF components



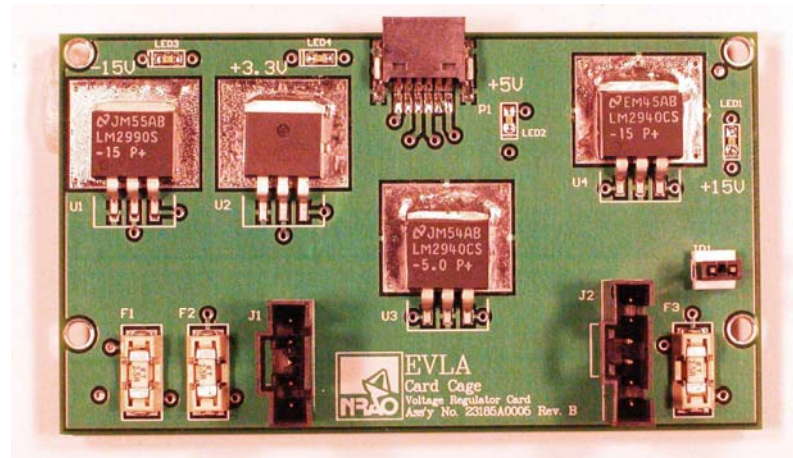


DC Power



- +17, -17, +7, +32V from DC distribution
 - Through to RF/IF interface
- +15, -15, +5, +3.3V for Card Cage, AC Relay Box

Voltage from DC Distribution	Card Cage Current (A)	RF/IF Box Current (A)	AC Relay Box Current (A)	Total at DC Distribution Current (A)
+17 VDC	0.60	1.40	0.00	2.00
-17 VDC	0.26	0.10	0.00	0.36
+7 VDC	0.64	0.90	0.05	1.59
+32.0 VDC	0.00	0.08	0.00	0.08





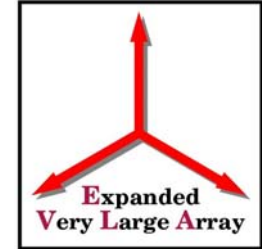
Monitor & Control



- Up to 35' cable run → Differential (25 STPs)
 - +/-5V analog range
 - LVDS for digital
- Monitor 3 of 96 possible analog points
 - Select with 5-bit address from F317
 - Change only when data will not be corrupted



Production Costs



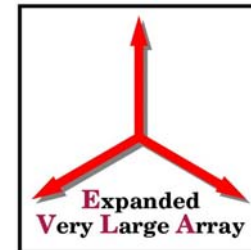
Unit	cost for 30 (5 antenna/yr.)	cost for 165 (entire array)
Backplane	\$5,263	\$13,657
Daughtercard	\$7,042	\$22,169
Bias Card	\$6,913	\$32,386
Control/Sensor Card	\$9,630	\$34,485
Voltage Regulator Card	\$2,243	\$9,613
RF/IF Box Cal Switching	\$3,516	\$13,536
Ribbon Cable Assemblies	\$1,897	\$8,286
Chassis	\$8,163	\$39,271
Total	\$44,667	\$173,403
Each	\$1490	\$1050



Summary



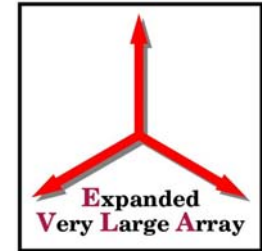
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- Eliminates EMI from fast clocks/AC
 - Universal to all receivers
 - Minimizes assembly time & cost
 - Leverages existing NRAO designs (where possible)



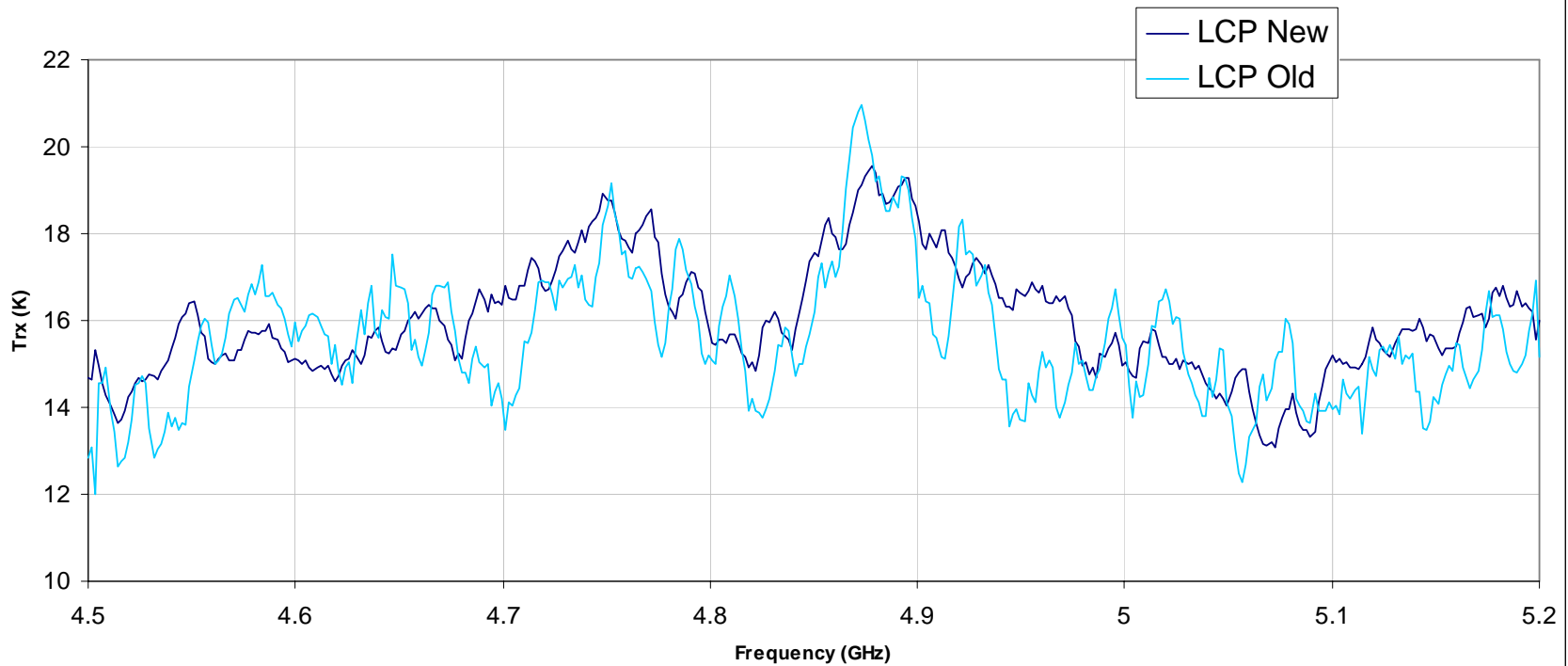
Questions?



Effect of Bias Card on Receiver Performance

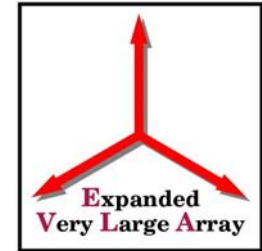


**C Band #05 LCP Trx Including warm test polarizer
Old vs New card cage**

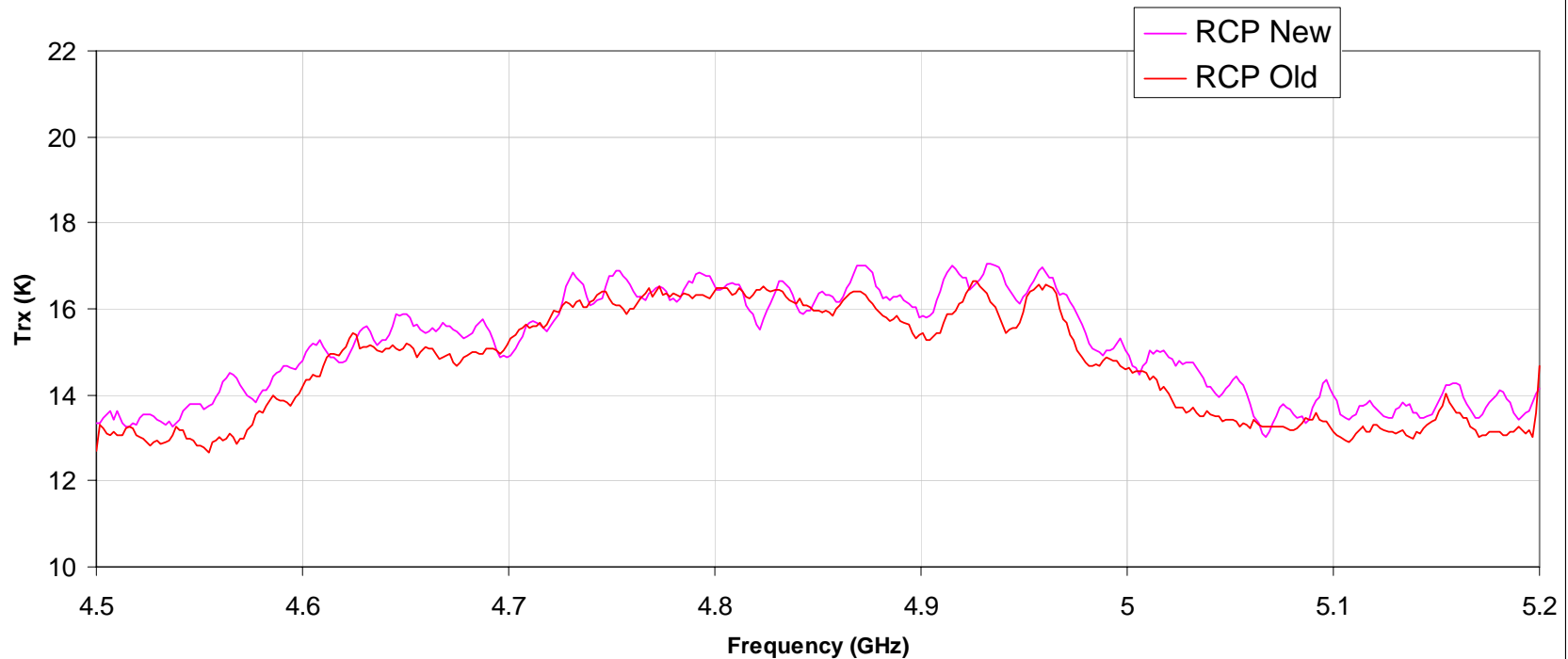




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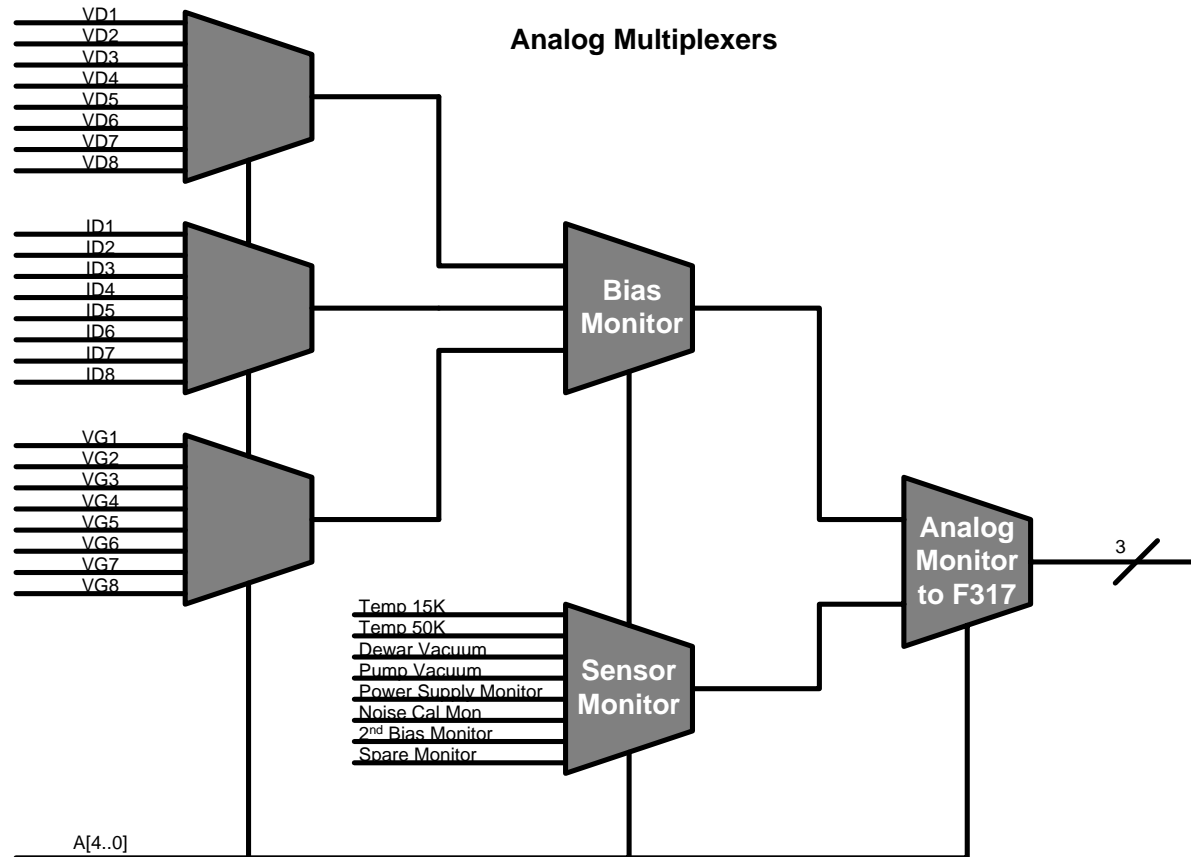
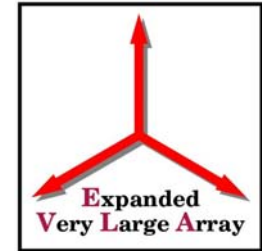


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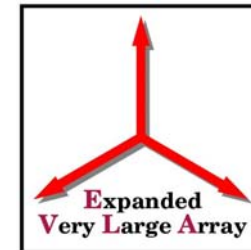


Monitor and Control





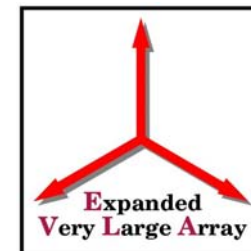
Monitor & Control: Digital Monitors



Address	Digital I/O Bit 3		Digital I/O Bit 2		Digital I/O Bit 1		Digital I/O Bit 0	
	DO-3	DI-3	DO-2	DI-2	DO-1	DI-1	DO-0	DI-0
0	Data Echo Out 3	Data Echo In 3	Data Echo Out 2	Data Echo In 2	Data Echo Out 1	Data Echo In 1	Data Echo Out 0	Data Echo In 0
1	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused
2		Pump Request Status P		Heater Request Status Q		Fridge Request Status R		Solenoid Req Status S
3..5	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused
6	L_Stage 1/2 Enable	L_Stage 1/2 Status	L_Stage 3/4 Enable	L_Stage 3/4 Status	R_Stage 1/2 Enable	R_Stage 1/2 Status	R_Stage 3/4 Enable	R_Stage 3/4 Status
7	Command Local/Remote*	Monitor Local/Remote*			Command Cryo C1	Monitor Cryo C1	Command Cryo C0	Monitor Cryo C0
8	Set Noise Diode step Att NA3	Noise Diode Step Att Status NA3	Set Noise Diode Step Att NA2	Noise Diode Step Att Status NA2	Set Noise Diode Step Att NA1	Noise Diode Step Att Status NA1	Set Noise Diode Step Att NA0	Noise Diode Step Att Status NA0
9					Set Noise Diode Step Att NA5	Noise Diode Step Att Status NA5	Set Noise Diode Step Att NA4	Noise Diode Step Att Status NA4
10	Set RCP Solar Step Att RA3	RCP Solar Step Att Status RA3	Set RCP Solar Step Att RA2	RCP Solar Step Att Status RA2	Set RCP Solar Step Att RA1	RCP Solar Step Att Status RA1	Set RCP Solar Step Att RA0	RCP Solar Step Att Status RA0
11	Set RCP Solar Switch RS	RCP Solar Switch Status RS			Set RCP Solar Step Att RA5	RCP Solar Step Att Status RA5	Set RCP Solar Step Att RA4	RCP Solar Step Att Status RA4
12	Set LCP Solar Step Att LA3	LCP Solar Step Att Status LA3	Set LCP Solar Step Att LA2	LCP Solar Step Att Status LA2	Set LCP Solar Step Att LA1	LCP Solar Step Att Status LA1	Set LCP Solar Step Att LA0	LCP Solar Step Att Status LA0
13	Set LCP Solar Switch LS	LCP Solar Switch Status LS			Set LCP Solar Step Att LA5	LCP Solar Step Att Status LA5	Set LCP Solar Step Att LA4	LCP Solar Step Att Status LA4
14	Filter Command Active/Bypass FL3	Filter Status Active/Bypass FL3	Filter Command Active/Bypass FL2	Filter Status Active/Bypass FL2	Filter Command Active/Bypass FL1	Filter Status Active/Bypass FL1	Filter Command Active/Bypass FL0	Filter Status Active/Bypass FL0
15..30	Unused	Unused	Unused	Unused	Unused	Unused	Unused	Unused
31		Monitor Local/Remote*				Monitor Cryo C1		Monitor Cryo C0



Monitor & Control: Analog Monitors



Address	Analog Monitor Signal	Analog-1	Analog-2	Analog-3		Address	Analog Monitor Signal	Analog-1	Analog-2	Analog-3
0	RCP1 LNA Stage 1	VD1	ID1	VG1		18	RCP2 LNA Stage 3	VD11	ID11	VG11
1	RCP1 LNA Stage 2	VD2	ID2	VG2		19	RCP2 LNA Stage 4	VD12	ID12	VG12
2	RCP1 LNA Stage 3	VD3	ID3	VG3		20	LCP2 LNA Stage 1	VD13	ID13	VG13
3	RCP1 LNA Stage 4	VD4	ID4	VG4		21	LCP2 LNA Stage 2	VD14	ID14	VG14
4	LCP1 LNA Stage 1	VD5	ID5	VG5		22	LCP2 LNA Stage 3	VD15	ID15	VG15
5	LCP1 LNA Stage 2	VD6	ID6	VG6		23	LCP2 LNA Stage 4	VD16	ID16	VG16
6	LCP1 LNA Stage 3	VD7	ID7	VG7		24	Temperatures	Dewar 15K	Dewar 50K	CC Temp
7	LCP1 LNA Stage 4	VD8	ID8	VG8		25	Vacuum Pressures	Dewar	Pump	
8	RF/IF Box Monitors	Normal Cal V	Normal Cal I	RF/IF Box Temp		26	Power Supply Voltages	+15V	-15V	+5V
9..15	Unused					27	Spare Analog Monitors	Spare-1	Spare-2	Spare-3
16	RCP2 LNA Stage 1	VD9	ID9	VG9		28..30	Unused			
17	RCP2 LNA Stage 2	VD10	ID10	VG10		31	Default (Passive) Monitor Points	RCP Gate Avg	LCP Gate Avg	Dewar 15K Temp