

# MMA CDL RECEIVER DEVELOPMENT TASKS

ARK DRAFT 4 22 May 97

MMA9705A.WB2

FTE-Months to Produce Prototypes for 3 Bands				
PhD/MS	Eng	Tech	Shop & Plating	Draftsman

## RF SIGNAL PATH ~ 10 bands

Base	Fabrication	Details	PhD/MS	Eng	Tech	Shop & Plating	Draftsman
Vacuum Windows	CDL	CV Shop	Broadband	1	1	1	0.5
			Tuned	2	3	3	1
IR Filters	CDL	CV Shop	Broadband	2	2	2	1
			Tuned	2	2	2	1
Lenses	CV ?	UAZ Shop	Quasi-optical	3	4	2	—
Pol'n Diplexers	Tuc	CV Shop	Waveguide				2
	Tuc	CV Shop					3
Feed Horns	CV ?	CV Shop & Electroforming		3	2	2	2

## SIS MIXER RECEIVERS ~ 7 bands

LO couplers (for simple mixers)	CDL	CV Shop	Probably not needed				
Mixers	CDL	CV Shop	Single-ended	9	9	12	6
			Balanced	9	9	12	6
			Sideband separating	9	9	12	6
			Balanced sideband separating	9	9	12	6
Wafer fabrication contract	CDL	JPL/UVA	Incl. 1 engr full time on SIS fab'n.		36		
Wafer evaluation circuits	CDL			6	3	6	—
IF quadrature hybrid	CDL	CV Shop		3	6	3	1
Internal IF stage	CDL	CV Lab			— see below —		
Internal bias circuit	CDL	CV Lab		1	1	2	1

## AMPLIFIER RECEIVERS ~ 3 bands

Amplifier	CDL	CV Shop		4	4	4	2
FET Mixer	CDL	CV Shop		6	4	5	2

## FIRST IF (4-12 GHz)

1st IF stage	CDL	CV Shop	4 K in mixer block	24	12	12	2
2nd IF stage	CDL	CDL/Commercial	12 K — possibly a MMIC				
Active Circular Polarizer	CDL	CV Lab		6	6	1	1

## LO PATH ~ 10 bands

Vacuum window or feedthrough	CDL/Tuc	CV Shop		—	1	1	0.5
Photomixer	CDL/Tuc	CV Shop		6	6	6	3
Photomixer development contract	CDL	UCLA					
YTO/Amplifier/Multiplier	CDL/Comm	CV Shop & Comm		6	6	6	2
Gunn/Multiplier	CDL/Comm	CV Shop & Comm		3	3	3	1
In-house multiplier development	CDL	CV Shop & Electroforming		12	12	12	3
Outside multiplier development	CDL	Millitech ??					
Wafer fabrication contract	CDL	UVA ?					
Harmonic Mixer	CDL	CV Shop		3	3	3	2
Levelling	CDL	?	May not be needed	1	2	2	0.5
Filtering	CDL	?	May need for AM s/b noise	2	1	1	0.5

## ANCILLARY CIRCUITS

SIS Bias	CDL	CV Lab		2	3	4	0.1
IF Bias	CDL	CV Lab		—	1	2	0.1
Magnet Bias	CDL	CV Lab		0.2	1	1	0.2
LO Bias	CDL	CV Lab		1	2	4	0.1
LO Phase-Lock	Tuc						
IF Switching	CDL	CV Lab		1	2	2	0.5
Heaters	Tuc						
Temperature Monitors	Tuc						

## REFRIGERATORS

In-house development	CV	CV Shop		12	36	18	9
Evaluation of Commercial systems	CV	CV Shop					

## TEST SETUPS

Computerized Mixer Test Set	CDL	CV Lab	Two needed for prototype work	3	12	12	1
Mixer dip-test evaluation Test Set	CDL	CV Lab		3	3	3	1
Sideband measurement Plates	CDL	CV Lab	Harmonic generator	2	2	2	0.5
			Martin-Puplett	0.5	2	2	1
170-260 GHz VNA extension	CDL	CV Lab		1	4	3	0.3
IF Plates	CDL	CV Lab	1-12 GHz (two needed)	0.5	1	2	0.3
LO Pwr/Noise Test Set	CDL	CV Lab	AM noise & phase stability	1	1	2	0.3
Photomixer Test Set	CDL & Tuc	CV Lab		1	1	2	0.3
Feed/Lens Test Set	CDL	GB ?		1	2	2	1

## LAB SPACE

Two JT SIS test sets		Rm 207 (Kirk's lab)
Two LHe Dewar test sets		Rm 208
In-block IF development		Amplifier lab.
LO development (incl. photomixer)		Rm 122 (Richard's lab)
Instrument building		Rm 210 (Dan's Lab) & 207 (Kirk's lab)
Test set construction		Rm 210 (Dan's Lab) & 207 (Kirk's lab)
Microfabrication (SIS mixers)		Rm 204 (Neil/Francoise)
Additional 1020 compressor		Compressor shed

## TOTALS

FTE-Months	161.2	229	188	71.7	41
FTE-Years	13.4	19.1	15.7	6.0	3.4
FTE's for 3-years	4.5	6.4	5.2	2.0	1.1

# MMA CDL RECEIVER DEVELOPMENT EQUIPMENT -- Year 1

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			Qty	Cost for Qty	Basis	-----Sub-Totals-----
<b>Sideband source plates</b>						<b>\$20,225</b>
YIG Oscillator	Omniiyg			\$2,500	est	
Tripler	Pacific Millimeter			\$800	est	
Harmonic Genreator	Pacific Millimeter			\$1,500	est	
Amplifiers	Lockheed-Martin	26-40 GHz, 20 dB, 20 dBm, low noise.	2	\$4,000	est	
Level-set attenuator	Aerowave			\$575	cat	
Horn	Aerowave			\$850	cat	
Microwave counter	EIP	Source-locking counter		\$10,000	est	
<b>IF plate</b>						<b>\$14,208</b>
LP Filter			2	\$600	guess	
LN Amplifiers	Miteq	1-12 GHz, 23 dB, F = 2.5 dB	2	\$3,000	est	
Step Attenuator	HP	Programable	2	\$2,872	cat	
Transfer switch	HP			\$664	cat	
Power Divider				\$300	guess	
SPDT Switch	HP			\$602	cat	
Amplifiers	Miteq	1-12 GHz, 20 dB, F = 5.3 dB	2	\$1,800	est	
Pad				\$170	est	
YIG Filter	Omniiyg	1-12 GHz, B = 60 MHz		\$2,500	est	
Tunnel Diode Detector				\$300	est	
Noise source				\$1,000	est	
Power Supplies				\$400	est	
<b>Dewar instrumentation</b>						<b>\$17,334</b>
Temperature Gauge	Lakeshore		6	\$1,380	cat	
Temp Sensors	Lakeshore		12	\$480	guess	
LP feedthrough filters	Spectrum Control	SIS bias	80	\$960	guess	
LP feedthrough filters	Spectrum Control	All other lines	24	\$840	est	
Connectors	Deutsch	Hermetic and cable connectors		\$1,000	guess	
Superconducting Magnet		Superconducting wire in Cu sheath		\$400	est	
Vacuum Valve		Solenoid controlled		\$8,000	est	
Turbo pump						\$4,274
4K IF Plate 4-12 GHz						
SP4T Coax Switch	Novak Corp.	Anti-static design.		\$2,000	est	
Loads	EMC	Hot & Cold. Nichrome for 4K operation.		\$230	est	
Pad	HP	Nichrome. Modify for 4K operation		\$303	cat	
Directional Coupler				\$500	est	
Amplifier	NRAO	4-12 GHz		--		
Quad Hybrid	HP or Merrimac	HP nominally 1-18 GHz.		\$1,241	cat	
<b>LO plates</b>						<b>\$95,325</b>
<b>60-90 GHz</b>						<b>\$26,515</b>
Gunn Oscillator	Carlstrom	60-90 GHz		\$8,000	est	
Isolator	Millitech			\$2,000	est	
Level-set attenuator	Aerowave			\$650	cat	
W/G switch	Aerowave			\$2,300	cat	
Wavemeter	Millitech			\$3,000	est	
Power Meter	Anritsu ML83A & MP 717A	Meter & 60-90 GHz Head		\$9,000	est	
E-plane bends	Aerowave		2	\$270	cat	
GDO power supply	Lambda LQ521			\$800	est	
H-plane bends	Aerowave		2	\$270	cat	
Lab-Jack	Cole-Parmer			\$225	cat	
<b>90-120 GHz</b>						<b>\$30,725</b>
Gunn Oscillator	Carlstrom			\$8,000	est	
Isolator	Millitech			\$2,000	est	
Level-set attenuator	Aerowave			\$900	cat	
W/G switch	Aerowave			\$3,000	cat	
Wavemeter	Millitech			\$4,000	est	
Power Meter	Anritsu ML83A & MP 82B	Meter & 90-140 GHz Head		\$11,000	est	
E-plane bends	Aerowave		2	\$400	cat	
H-plane bends	Aerowave		2	\$400	cat	
GDO power supply	Lambda LQ521			\$800	est	
Lab-Jack	Cole-Parmer			\$225	cat	
<b>170-260 GHz</b>						<b>\$38,085</b>
Gunn Oscillator	Carlstrom	60-90 GHz		\$8,000	est	
Isolator	Millitech			\$2,000	est	
Level-set attenuator	Aerowave			\$650	cat	
W/G switch	Aerowave			\$2,300	cat	
Wavemeter	Millitech			\$3,000	est	
Power Meter	Anritsu ML83A & MP 717A	Meter & 60-90 GHz Head		\$9,000	est	
H-plane bends	Aerowave	WR-12	2	\$270	cat	
Tripler	Millitech			\$10,000	est	
E-plane bends	Aerowave	WR-4	2	\$720	cat	
H-plane bends	Aerowave	WR-4	2	\$720	cat	
GDO power supply	Lambda LQ521			\$800	est	
Tripler bias supply	NRAO			\$400	est	
Lab-Jack	Cole-Parmer			\$225	cat	

SIS equipment rack					\$43,300
SIS bias supplies (need 2)				\$300	guess
IF Bias supply				\$300	guess
Magnet Bias supply				\$300	guess
LO Bias supply				\$300	guess
LO Phase-Lock				\$300	guess
IF Switching				\$300	guess
Heater controller				\$300	guess
Temperature Monitors				\$300	guess
XY recorder	HP7090A	(used)		\$3,000	est
IF Spectrum Analyze	Tektronix R3272	For MMA 4-12 GHz IF		\$29,000	quote
Storage scope	Tektronix 7633	SIS junction monitoring. With plug-ins. (used)		\$4,000	est
Power supplies	Acopian VA20MT400	For SIS mixer test set. Overvoltage protected.	2	\$600	est
Line filter				\$300	est
Distribution strips			3	\$100	guess
Rack		With equipment shelves.		\$300	est
Control PC	Pentium	Controls mixer test set		\$3,000	est
PC interface cards				\$600	guess
Wafer Evaluation Teast Set					\$33,750
Capacitance bridge	HP4278A			\$11,550	cat
Network Analyzer	HP8714C 0.3 MHz - 3 GHz	Contains integral source and S-parameter test set		\$18,000	cat
SIS bias supply					
Control PC	Pentium	Controls wafer evaluation test set		\$3,000	est
PC interface cards				\$600	guess
Power supplies	Acopian VA20MT400	For Wafer evaluation test set. Overvoltage protected.	2	\$600	est
Photomixer test set					\$800
Harmonic mixer	Pacific Millimeter	For testing 100 GHz prototype photomixer.		\$400	guess
Power Meter		* In first year, borrow existing lab equipment.		*	
mm Spectrum Analyzer		* In first year, borrow existing lab equipment.		*	
Bias supply				\$400	guess
Lasers		JMP			
Fiberoptic components		JMP			
AM noise measurements		RFB			
PM noise measurements		RFB			
170-260 GHz extension to HP8510					\$46,704
Harmonic generator				\$10,000	guess
Harmonic mixer			3	\$24,000	est
Directional couplers	Aerowave		3	\$10,500	cat
Step Attenuator	HP DC-18 GHz		2	\$2,204	cat
In-block IF development		* In first year, borrow existing lab equipment.		*	\$0
Microfabrication (SIS mixers)					\$50,000
Dicing saw		Present 18-year-old saw is overloaded and ailing.		\$50,000	guess
Vacuum window development					\$6,000
Xtal-Quartz Plates	Boston Piezo Optics			\$6,000	est
Antenna Range instrumentation					\$230,000
Transmitter/Receiver	AB Millimeter			\$150,000	est
Harmonic generators	AB Millimeter	60-90 GHz, 90-140 GHz, 170-260 GHz	3	\$30,000	est
Harmonic mixers	AB Millimeter	60-90 GHz, 90-140 GHz, 170-260 GHz	3	\$30,000	est
Positioners & servos				\$20,000	guess
Miscellaneous					\$42,700
Oven	ATL	Curing epoxy (to replace worn out oven in Dan's lab)		\$4,000	guess
Measuring Microscope	Olympus or Nikon			\$26,000	quote
Lab scope	Tektronix TDS 460A	4 channel, 400 MHz		\$7,700	cat
Additional 1020 compressor				\$5,000	guess
Contracts					\$630,000
Photomixer Development	UCLA			\$130,000.00	
Superconducting Circuit s	JPL			\$250,000.00	
Superconducting Circuit s	UVA			\$250,000.00	

<b>GRAND TOTAL</b>	<b>\$1,230,346</b>
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