

RCA

J. T. Raleigh

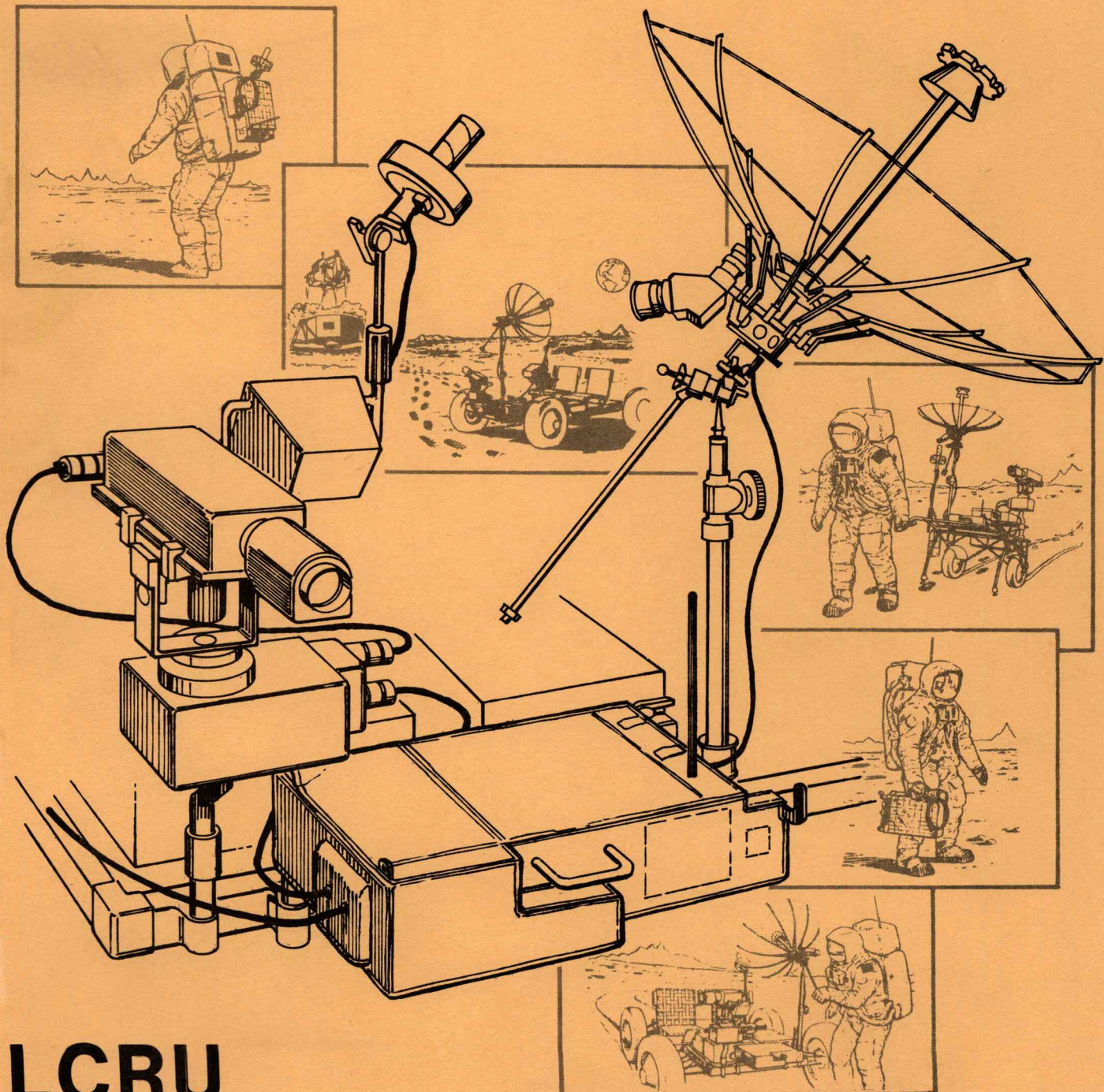
Lunar Communications Relay Unit (LCRU)

Critical Design Review Report

NASA/MSC, Houston, Texas

Sept. 15, 16, 17, 18, 1970

Volume 2



LCRU

LUNAR COMMUNICATIONS RELAY UNIT (LCRU)

CRITICAL DESIGN REVIEW

NASA/MSC HOUSTON, TEXAS

15, 16, 17 and 18 SEPTEMBER 1970

21 SEPTEMBER 1970 - DELTA CDR

VOLUME II

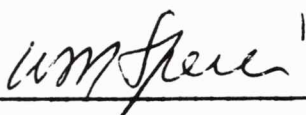
LUNAR COMMUNICATIONS RELAY UNIT • PROGRAM MANAGEMENT OFFICE
RCA • DEFENSE COMMUNICATIONS SYSTEMS, CAMDEN, N.J.

LUNAR COMMUNICATIONS RELAY UNIT (LCRU)

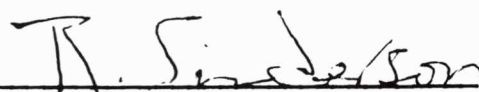
CRITICAL DESIGN REVIEW

NASA/MSC - HOUSTON, TEXAS

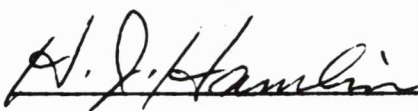
SEPTEMBER 15, 16, 17, 18, 1970



NASA W. SPEIER



NASA R. SINDERSON



RCA H.J. HAMLIN

These Minutes do not constitute contract change authorization. Changes to contract or schedule must be negotiated.

TABLE OF CONTENTS

VOLUME - I

<u>Agenda Item</u>	<u>Page</u>
Agenda	vi
Summary of Review Item Disposition (RID)	1
Attendees, Minutes, RID's from Agenda Items 1 through 6	18
Attendees, Minutes, RID's from EE Meeting Agenda Item 7	26
Attendees, Minutes, RID's from Mechanical Meeting Agenda Item 8	105
Attendees, Minutes, RID's from Thermal Meeting Agenda Item 9	173
Attendees, Minutes, RID's from Test Meeting Agenda Item 10	187
Attendees, Minutes, RID's from Program Support Meeting - Agenda Item 11	231
Minutes, RID Summary, General Session Agenda Item 12	264
Minutes, Demonstration of LCRU Performance Agenda Item 13	267
Minutes, General Session Agenda Item 14	272
RID Summary	274
Attendees, Minutes, Delta CDR Agenda Item 16	284

VOLUME - II

1.0	Introduction	1-1
2.0	Management Overview	2-1
3.0	Subcontracts Summary	3-1
4.0	Circuit Margin Summary	4-1
5.0	Configuration Overview	5-1
6.0	Performance Summary	6-1
7.0	LCRU Electrical Design	7-1

TABLE OF CONTENTS

VOLUME - III

Agenda Item		Page
8.0	LCRU Mechanical	8-1

VOLUME - IV

9.0	Thermal Design	9-1
10.0	Test Program	10-1
11.0	Program Support	11-1



AGENDA
LUNAR COMMUNICATIONS RELAY UNIT
CRITICAL DESIGN REVIEW
SEPTEMBER 15, 16, 17, 18, 1970

9/15/70

9:00 AM

General Session - Chairman: W. Speier - Minutes: A.M. Burke
Co-Chairman: H.J. Hamlin

- 1.0 GROUND RULES/INTRODUCTION W.M. Speier/
H.J. Hamlin
 - 1.1 Purpose
 - 1.2 What we were to do
 - 1.3 What you will see
- 2.0 MANAGEMENT OVERVIEW H.J. Hamlin
 - 2.1 Organization
 - 2.2 Schedule
 - Design Status
 - Manufacturing Status
 - Material Status
 - 2.3 Problems
- 3.0 SUBCONTRACT SUMMARY D.A. Orendac
- 4.0 CIRCUIT MARGIN SUMMARY B.M. Trachtenberg
- 5.0 CONFIGURATION OVERVIEW A.M. Burke
 - 5.1 LCRU Configuration - LRV
 - 5.2 LCRU Assembly Operations
 - 5.3 LCRU Configuration - Walk Mode
 - 5.4 Alternate Mode Capability
 - 5.5 Thermal Considerations
- 6.0 PERFORMANCE SUMMARY J.J. Connelly
 - 6.1 Design
 - 6.2 Weight Budget
 - 6.3 Power Budget



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/15/70 Splinter Meeting

1:00 PM

to

9/16/70

5:00 PM

Room ()

7.0 ELECTRICAL DESIGN - Chairman: R. Sinderson - Minutes: V. Carita
Co-Chairman: J. Connelly

- 7.1 System Design B.M. Trachtenberg
 - 7.1.1 Circuit Margins B.M. Trachtenberg
 - 7.1.2 Signal Design B.M. Trachtenberg
 - 7.1.3 Link Analyses B.M. Trachtenberg
 - 7.1.4 Sub-System Configuration B.M. Trachtenberg
- 7.2 Electrical Interface Design
 - 7.2.1 LCRU Design J.J. Connelly
 - 7.2.2 EM Test Status J.J. Connelly
 - 7.2.3 EMI & Grounding G. Houck
- 7.3 LCRU Internal Electrical Design
 - 7.3.1 VHF Antenna Triplexer E. DeBaecke
 - 7.3.2 S-Band Diplexers E. DeBaecke
 - 7.3.3 VHF Receiver I. Grasheim
 - 7.3.4 VHF Transmitter C. Montini
 - 7.3.5 Down-Link Signal Processor
 - Including VCO's C. Montini
 - 7.3.6 Voltage Regulator C. Montini
 - 7.3.7 S-Band Transmitters V.J. Carita
 - 7.3.8 S-Band Receivers H.E. Hawk
 - 7.3.9 Up-Link Signal Processor O. Ramanis
 - 7.3.10 DC-DC Converter R. Erdman
 - 7.3.11 Battery D.V. Howard
 - 7.3.12 Low Gain Antenna D.V. Howard
 - 7.3.13 High Gain Antenna F.J. Nangle
- 7.4 Integration Design
 - 7.4.1 Case Electrical Integration
 - Signal Flow and Grounding H. Comfort
 - 7.4.2 Control Panel H. Comfort
 - 7.4.3 Cabling H. Comfort
 - 7.4.4 LCRU Power Utilization H. Comfort
- 7.5 External Electrical Design H. Comfort
 - 7.5.1 LCRU LRV TV Cables
 - 7.5.2 HGA LGA Cables



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/15/70 Splinter Meeting - Chairman: H. Schultz - Minutes: J. Liggett
1:00 PM Co-Chairman: J. Liggett

to

9/16/70 8.0 MECHANICAL DESIGN

5:00 PM 8.1 Mechanical Interface Design R. Holston
Room ()

- 8.1.1 LCRU/LRV
- 8.1.2 HGA/LRV
- 8.1.3 LCRU-LM-MESA
- 8.1.4 Battery - LM-MESA

8.2 LCRU Mechanical Design R. Holston

- 8.2.1 Subassembly Arrangement R. Holston
- 8.2.2 LCRU Weight Analysis R. Holston
- 8.2.3 Subassemblies L. Krawitz

8.2.3.1 VHF Receiver L. Krawitz

8.2.3.2 VHF Transmitter

8.2.3.3 VHF Triplexer

8.2.3.4 Down Link Signal Processor

8.2.3.5 Up Link Processor

8.2.3.6 Voltage Regulator

8.2.3.7 Battery

8.2.3.8 S-Band Receiver

8.2.3.9 S-Band Transmitters

8.2.3.10 Diplexer

8.2.3.11 VHF Antenna

8.2.3.12 DC-DC Converter L. Krawitz

8.2.3.13 Antenna Connector W. Babcock

8.2.3.14 High Gain Antenna W. Babcock

8.2.3.15 Low Gain Antenna W. Babcock

8.2.4 Case Design R. Holston

8.2.5 Cover Design

8.2.6 Wax Package Assembly

8.2.7 Control Panel Design

8.2.8 LCRU/LRV Mounting Design

8.2.9 HGA Mast and Interface Design

8.2.10 Stowage Container Design

8.2.11 Vibration and Stress Analysis



AGENDA
LUNAR COMMUNICATIONS RELAY UNIT
CRITICAL DESIGN REVIEW
SEPTEMBER 15, 16, 17, 18, 1970

9/16/70 Splinter Meeting - Chairman: E. Chimenti - Minutes: H. Rosenthal
9:00 AM Co-Chairman: G. Grube

to

9/16/70

5:00 PM

9.0 THERMAL DESIGN

9.1 Design Analyses

B. Shelpuk

- 9.1.1 Multinode Thermal Analysis
- 9.1.2 Component Hot-Spot Analysis
- 9.1.3 Parking Orientation Analysis
- 9.1.4 Walk Back Analysis
- 9.1.5 Phase Change Freezing Analysis
- 9.1.6 Phase Change Material Package Design

9.2 Thermal Design

G. Grube

- 9.2.1 Radiator
- 9.2.2 Thermal Blanket
- 9.2.3 Thermal Finishes
- 9.2.4 Component Temperatures

9.3 Thermal Testing

- 9.3.1 Test Approach
- 9.3.2 Test Results

9/16/70 Splinter Meeting - Chairman: J. Miller - Minutes: R. Virostek
9:00 AM Co-Chairman: R. Virostek

to

9/16/70

5:00 PM

10.0 TEST PROGRAM

- 10.1 Thermal
- 10.2 Engineering Model
- 10.3 DVT
- 10.4 QTP
- 10.5 ATP
- 10.6 Test Equipment Design
- 10.7 MSC/KSC Test Program
- 10.8 MSC Special Test Program



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/16/70	Splinter Meeting - Chairman: D. Becker - Minutes: W. Carlino	
9:00 AM	Co-Chairman: W. Carlino	
to		
9/16/70	11.0 PROGRAM SUPPORT	
5:00 PM	11.1 Reliability	W. Carlino
Room ()		
	11.1.1 RCA Status	
	11.1.2 Subcontractor Status	
	11.1.3 Reliability Design Status	
	11.1.4 Parts Qual.	H. Farcus
	11.1.5 Parts Usage: APL, Derating	H. Farcus
	11.1.6 FMEA	H. Farcus
	11.2 Configuration Control	H. Yarbrough
	11.2.1 Program Control and Status	
	11.2.2 Response to MSC Con Con Comments	
	11.3 Quality Assurance	G. Floyd
	11.3.1 RCA Quality Program Status	
	11.3.2 Subcontractor Controls and Status	
	11.3.3 Equipment Flow Charts	

9/17/70	12.0 GENERAL SPLINTER & RID REVIEWS	
9:00 -	Chairman: W. Speier - Minutes: A.M. Burke	
10:00	Co-Chairman: H.J. Hamlin	
to		
1:00 -	12.1 Electrical Design Splinter Review	J.J. Connelly
5:00	12.2 Mechanical Design Splinter Review	J. Liggett
	12.3 Thermal Design Splinter Review	G. Grube
	12.4 Test Program Splinter Review	R. Virostek
	12.5 Program Support Splinter Review	W. Carlino

9/17/70	13.0 DEMONSTRATION	B.M. Trachtenberg/
10:00 AM		J.J. Connelly
to		
12:00 AM		

9/18/70	14.0 CDR REVIEW BOARD	R. Johnston
9:00 AM		
to		
12:00		

9/18/70	15.0 MINUTES REVIEW AND SIGNOFF	W. Speier
1:00 -		R. Sinderson
ON		H.J. Hamlin
		A.M. Burke
		J.J. Connelly
		D. Orendac
		W. Carlino
		R. Virostek
		J. Liggett

AGENDA

LCRU CREW STATION REVIEW

MSC/BLDG. 5, SEPTEMBER 21, 1970

DELTA CDR

9/21/70

16.0

LCRU Crew Station Review

H. J. Hamlin

LCRU Lunar
Communications
Relay
Unit

CRITICAL DESIGN REVIEW

RCA

9-15-70 thru 9-18-70

1.0 INTRODUCTION/GROUND RULES



AGENDA
LUNAR COMMUNICATIONS RELAY UNIT
CRITICAL DESIGN REVIEW
SEPTEMBER 15, 16, 17, 18, 1970

9/15/70

9:00 AM

General Session - Chairman: W. Speier - Minutes: A.M. Burke
Co-Chairman: H.J. Hamlin

1.0 GROUND RULES/INTRODUCTION

W.M. Speier/
H.J. Hamlin

- 1.1 Purpose
- 1.2 What we were to do
- 1.3 What you will see

2.0 MANAGEMENT OVERVIEW

H.J. Hamlin

- 2.1 Organization
- 2.2 Schedule
 - Design Status
 - Manufacturing Status
 - Material Status

2.3 Problems

3.0 SUBCONTRACT SUMMARY

D.A. Orendac

4.0 CIRCUIT MARGIN SUMMARY

B.M. Trachtenberg

5.0 CONFIGURATION OVERVIEW

A.M. Burke

- 5.1 LCRU Configuration - LRV
- 5.2 LCRU Assembly Operations
- 5.3 LCRU Configuration - Walk Mode
- 5.4 Alternate Mode Capability
- 5.5 Thermal Considerations

6.0 PERFORMANCE SUMMARY

J.J. Connelly

- 6.1 Design
- 6.2 Weight Budget
- 6.3 Power Budget



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/15/70 Splinter Meeting
1:00 PM
to
9/16/70
5:00 PM
Room ()

7.0 ELECTRICAL DESIGN - Chairman: R. Sinderson - Minutes: V. Carita
Co-Chairman: J. Connelly

7.1 System Design B.M. Trachtenberg

7.1.1 Circuit Margins B.M. Trachtenberg
7.1.2 Signal Design B.M. Trachtenberg
7.1.3 Link Analyses B.M. Trachtenberg
7.1.4 Sub-System Configuration B.M. Trachtenberg

7.2 Electrical Interface Design

7.2.1 LCRU Design J.J. Connelly
7.2.2 EM Test Status J.J. Connelly
7.2.3 EMI & Grounding G. Houck

7.3 LCRU Internal Electrical Design

7.3.1 VHF Antenna/Triplexer E. DeBaecke
7.3.2 S-Band Diplexers E. DeBaecke
7.3.3 VHF Receiver I. Grasheim
7.3.4 VHF Transmitter C. Montini
7.3.5 Down-Link Signal Processor
Including VCO's C. Montini
7.3.6 Voltage Regulator C. Montini
7.3.7 S-Band Transmitters V.J. Carita
7.3.8 S-Band Receivers H.E. Hawlk
7.3.9 Up-Link Signal Processor O. Ramanis
7.3.10 DC-DC Converter R. Erdman
7.3.11 Battery D.V. Howard
7.3.12 Low Gain Antenna D.V. Howard
7.3.13 High Gain Antenna F.J. Nangle

7.4 Integration Design

7.4.1 Case Electrical Integration
Signal Flow and Grounding H. Comfort
7.4.2 Control Panel H. Comfort
7.4.3 Cabling H. Comfort
7.4.4 LCRU Power Utilization H. Comfort

7.5 External Electrical Design H. Comfort

7.5.1 LCRU/LRV/TV Cables
7.5.2 HGA/LGA Cables



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/15/70 Splinter Meeting - Chairman: H. Schultz - Minutes: J. Liggett
1:00 PM Co-Chairman: J. Liggett

to

9/16/70

5:00 PM

Room ()

8.0 MECHANICAL DESIGN

8.1 Mechanical Interface Design R. Holston

- 8.1.1 LCRU/LRV
- 8.1.2 HGA/LRV
- 8.1.3 LCRU-LM-MESA
- 8.1.4 Battery - LM-MESA

8.2 LCRU Mechanical Design R. Holston

- 8.2.1 Subassembly Arrangement R. Holston
- 8.2.2 LCRU Weight Analysis R. Holston
- 8.2.3 Subassemblies L. Krawitz

8.2.3.1 VHF Receiver L. Krawitz

8.2.3.2 VHF Transmitter

8.2.3.3 VHF Triplexer

8.2.3.4 Down Link Signal Processor

8.2.3.5 Up Link Processor

8.2.3.6 Voltage Regulator

8.2.3.7 Battery

8.2.3.8 S-Band Receiver

8.2.3.9 S-Band Transmitters

8.2.3.10 Diplexer

8.2.3.11 VHF Antenna

8.2.3.12 DC-DC Converter L. Krawitz

8.2.3.13 Antenna Connector W. Babcock

8.2.3.14 High Gain Antenna W. Babcock

8.2.3.15 Low Gain Antenna W. Babcock

8.2.4 Case Design R. Holston

8.2.5 Cover Design

8.2.6 Wax Package Assembly

8.2.7 Control Panel Design

8.2.8 LCRU/LRV Mounting Design

8.2.9 HGA Mast and Interface Design

8.2.10 Stowage Container Design

8.2.11 Vibration and Stress Analysis



AGENDA
LUNAR COMMUNICATIONS RELAY UNIT
CRITICAL DESIGN REVIEW
SEPTEMBER 15, 16, 17, 18, 1970

9/16/70 Splinter Meeting - Chairman: E. Chimenti
9:00 AM Co-Chairman: G. Grube - Minutes: H. Rosenthal

to
9/16/70
5:00 PM

9.0 THERMAL DESIGN

9.1 Design Analyses

B. Shelpuk

- 9.1.1 Multinode Thermal Analysis
- 9.1.2 Component Hot-Spot Analysis
- 9.1.3 Parking Orientation Analysis
- 9.1.4 Walk Back Analysis
- 9.1.5 Phase Change Freezing Analysis
- 9.1.6 Phase Change Material Package Design

9.2 Thermal Design

G. Grube

- 9.2.1 Radiator
- 9.2.2 Thermal Blanket
- 9.2.3 Thermal Finishes
- 9.2.4 Component Temperatures

9.3 Thermal Testing

- 9.3.1 Test Approach
- 9.3.2 Test Results

9/16/70 Splinter Meeting - Chairman: J. Miller
9:00 AM Co-Chairman: R. Virostek - Minutes: R. Virostek

to
9/16/70
5:00 PM

10.0 TEST PROGRAM

- 10.1 Thermal
- 10.2 Engineering Model
- 10.3 DVT
- 10.4 QTP
- 10.5 ATP
- 10.6 Test Equipment Design
- 10.7 MSC/KSC Test Program
- 10.8 MSC Special Test Program



AGENDA

LUNAR COMMUNICATIONS RELAY UNIT

CRITICAL DESIGN REVIEW

SEPTEMBER 15, 16, 17, 18, 1970

9/16/70	Splinter Meeting - Chairman: D. Becker - Minutes: W. Carlino	
9:00 AM	Co-Chairman: W. Carlino	
to		
9/16/70	11.0 PROGRAM SUPPORT	
5:00 PM	11.1 Reliability	W. Carlino
Room ()		
	11.1.1 RCA Status	
	11.1.2 Subcontractor Status	
	11.1.3 Reliability Design Status	
	11.1.4 Parts Qual.	H. Farcus
	11.1.5 Parts Usage: APL, Derating	H. Farcus
	11.1.6 FMEA	H. Farcus
	11.2 Configuration Control	H. Yarbrough
	11.2.1 Program Control and Status	
	11.2.2 Response to MSC Con Con Comments	
	11.3 Quality Assurance	G. Floyd
	11.3.1 RCA Quality Program Status	
	11.3.2 Subcontractor Controls and Status	
	11.3.3 Equipment Flow Charts	

9/17/70	12.0 GENERAL SPLINTER & RID REVIEWS	
9:00 -	Chairman: W. Speier - Minutes: A.M. Burke	
10:00	Co-Chairman: H.J. Hamlin	
to		
1:00 -	12.1 Electrical Design Splinter Review	J.J. Connelly
5:00	12.2 Mechanical Design Splinter Review	J. Liggett
	12.3 Thermal Design Splinter Review	G. Grube
	12.4 Test Program Splinter Review	R. Virostek
	12.5 Program Support Splinter Review	W. Carlino

9/17/70	13.0 DEMONSTRATION	B.M. Trachtenberg/ J.J. Connelly
10:00 AM		
to		
12:00 AM		

9/18/70	14.0 CDR REVIEW BOARD	R. Johnston
9:00 AM		
to		
12:00		

9/18/70	15.0 MINUTES REVIEW AND SIGNOFF	W. Speier
1:00 -		R. Sinderson
ON		H.J. Hamlin
		A.M. Burke
		J.J. Connelly
		D. Orendac
		W. Carlino
		R. Virostek
		J. Liggett
		G. Grube

AGENDA

LCRU CREW STATION REVIEW
MSC/BLDG. 5, SEPTEMBER 21, 1970

DELTA CDR

9/21/70

16.0

LCRU Crew Station Review

H.J. Hamlin



LCRU CRITICAL DESIGN REVIEW

PURPOSE -

- To review Program Status
- To demonstrate the EM functional modes
- To review test data and the general design
- To review action item and RID status
- To review the quality and reliability programs
- To highlight problem areas and agree in a course of action and response time
- And to conclude that the design as presented is suitable for flight unit assembly and Lunar operation



LCRU CRITICAL DESIGN REVIEW

WHAT WE WERE TO DO -

- Build the Engineering Model
- Conduct Subcontractor CDR's
- Complete drawing package
- Continue LM/LCRU/LRV Interface support
- Release DVT (DVT #2 being held as long as possible)
- Update Subcontractor SCD's
- Commence reliability and parts qual program
- Participate in CSR's
- Proceed with rear mounted sight and new stowage container design
- Complete thermal testing
- Incorporate various CCA and Post PDR changes
- Complete STE design
- Answer Action Items as required



LCRU CRITICAL DESIGN REVIEW

WHAT YOU WILL SEE -

- Engineering Model Demonstration (with TV & EVCS)
- EM Subassembly test data
- Drawing package (less stowage container)
- Program Status
- Thermal Design Report
- Review of Interface Design
- Review of EMI Design
- Implementation of CSR items
- Updated Subcontractor SCD's



CRITICAL DESIGN REVIEW - GENERAL PLAN

MSC - 9/15 - 16 - 17 - 18/1970

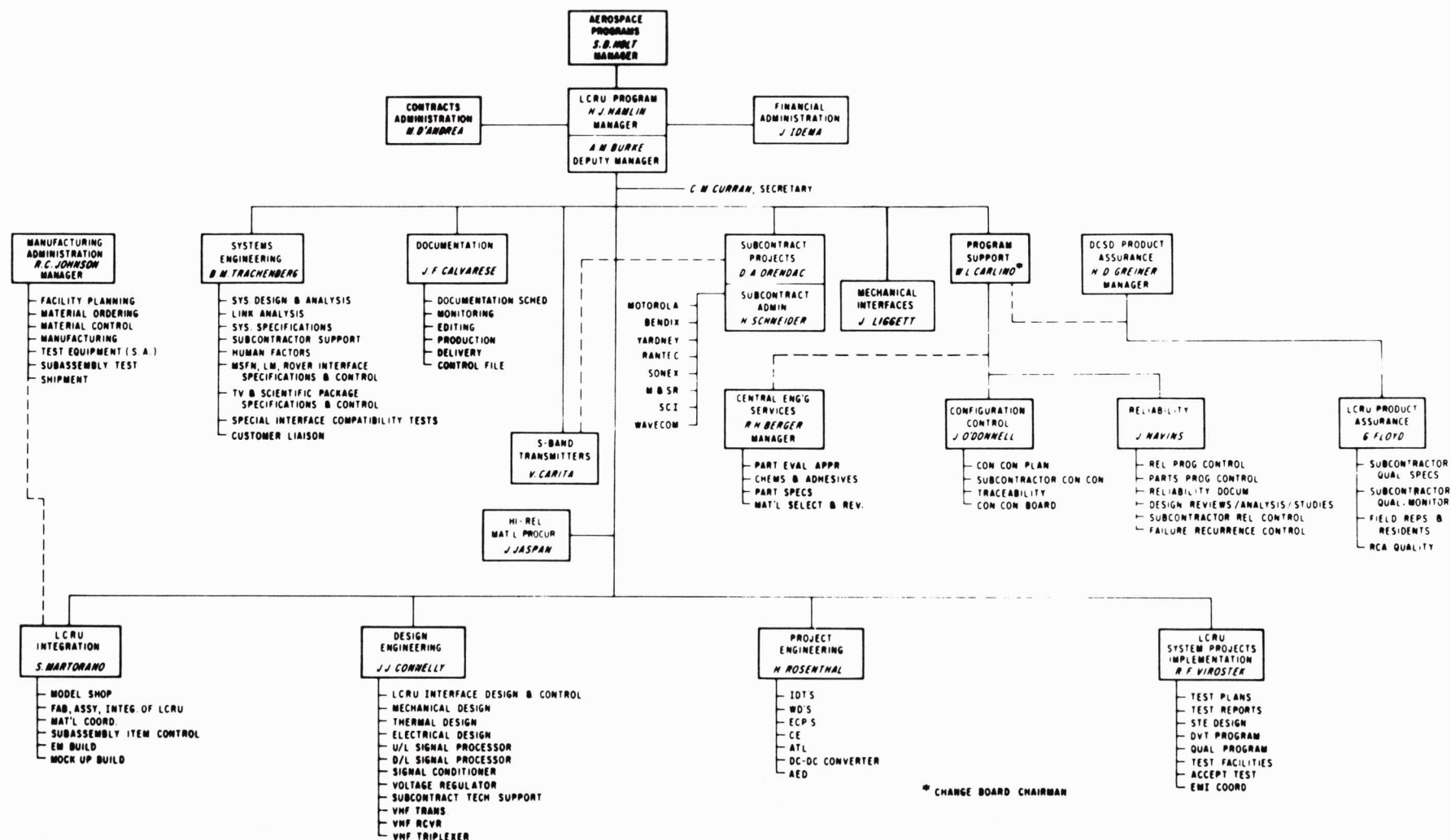
9/13	9/14	9/15	9/16	9/17	9/18
BUILDING 440 ROOM 212	Demonstration Set Up	Demonstration Debug & Checkout		Demo. Teardown and Pack.	
		Gen. Session	1:00 Electrical Review Room ()		
			Mechanical Review Room ()		
			Test Program Review Room ()		
			Thermal Design Review Room ()		
			Program Support Review Room ()		
				10:00 Demo.	12:00 CDR Board
					Minutes Review & Signoff 1:00

RID & Splinter
Meeting Review

2.0 MANAGEMENT OVERVIEW

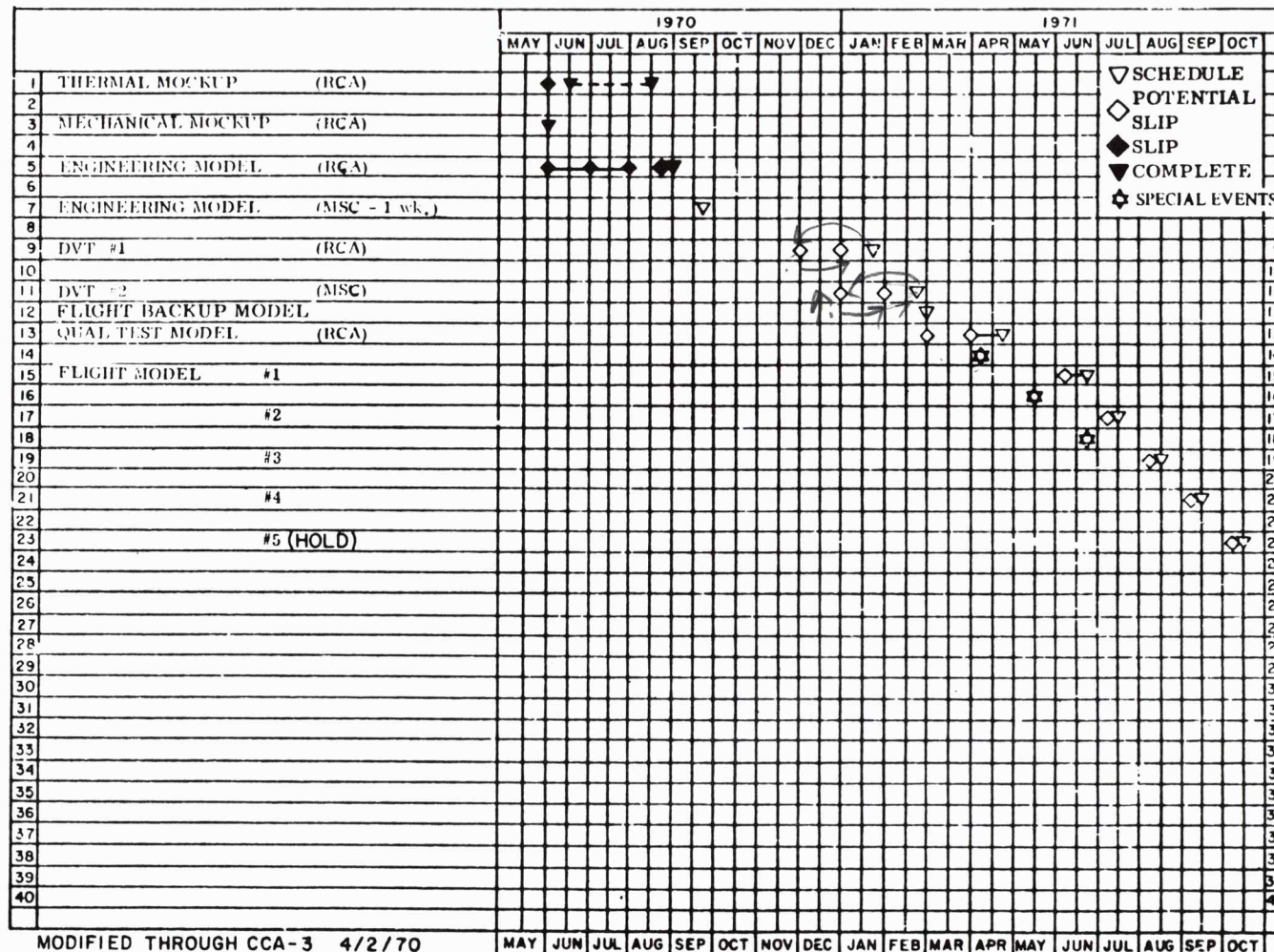


LCRU PROGRAM ORGANIZATION





LCRU - EQUIPMENT MILESTONES AND DELIVERIES



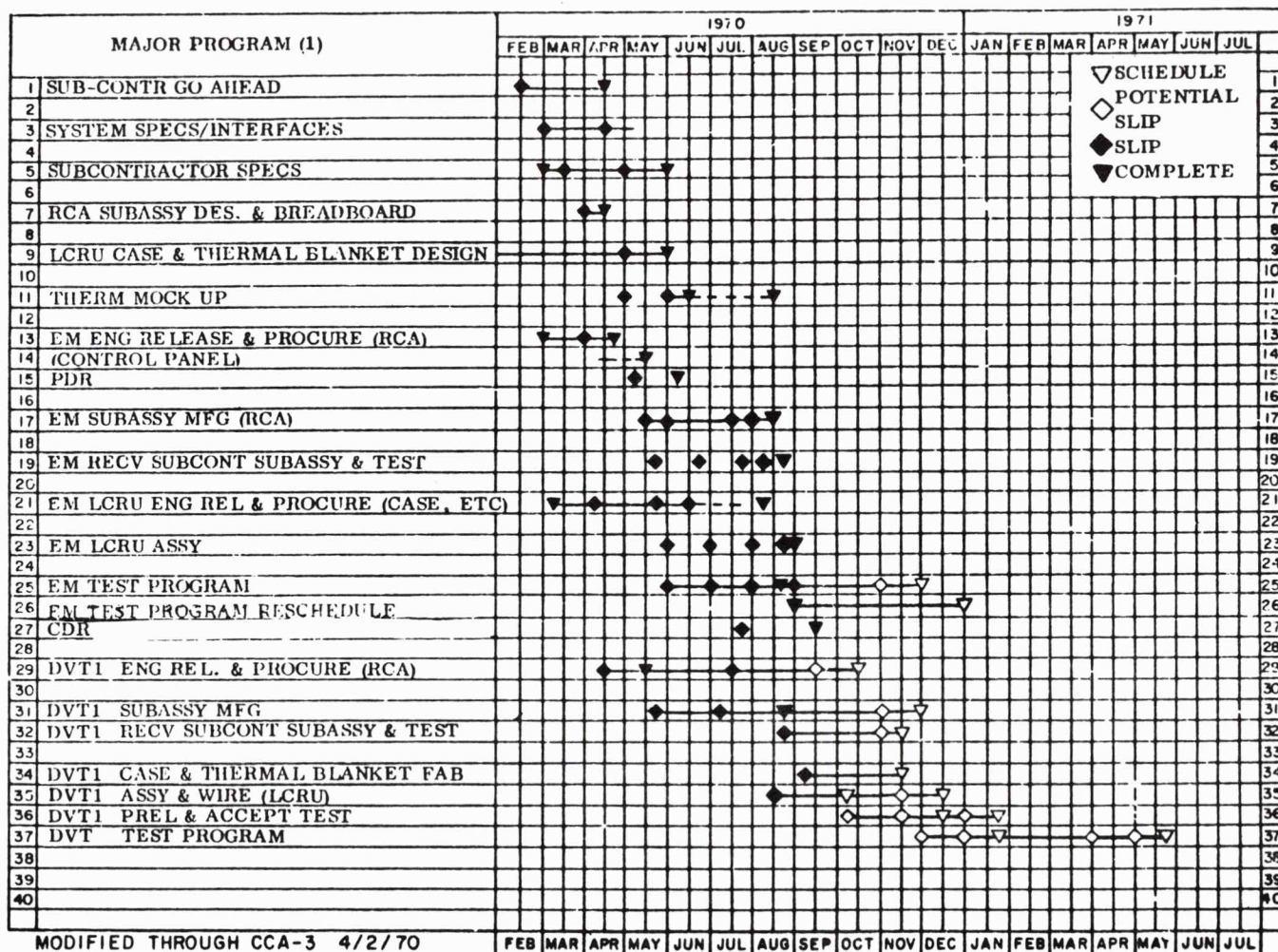
MODIFIED THROUGH CCA-3 4/2/70
MODIFIED THROUGH CCA-5 5/4/70

UPDATED THRU TI-3 7-8-70

UPDATED THRU 7-22-70
UPDATED THRU 7/29/70
UPDATED THRU 9/10/70

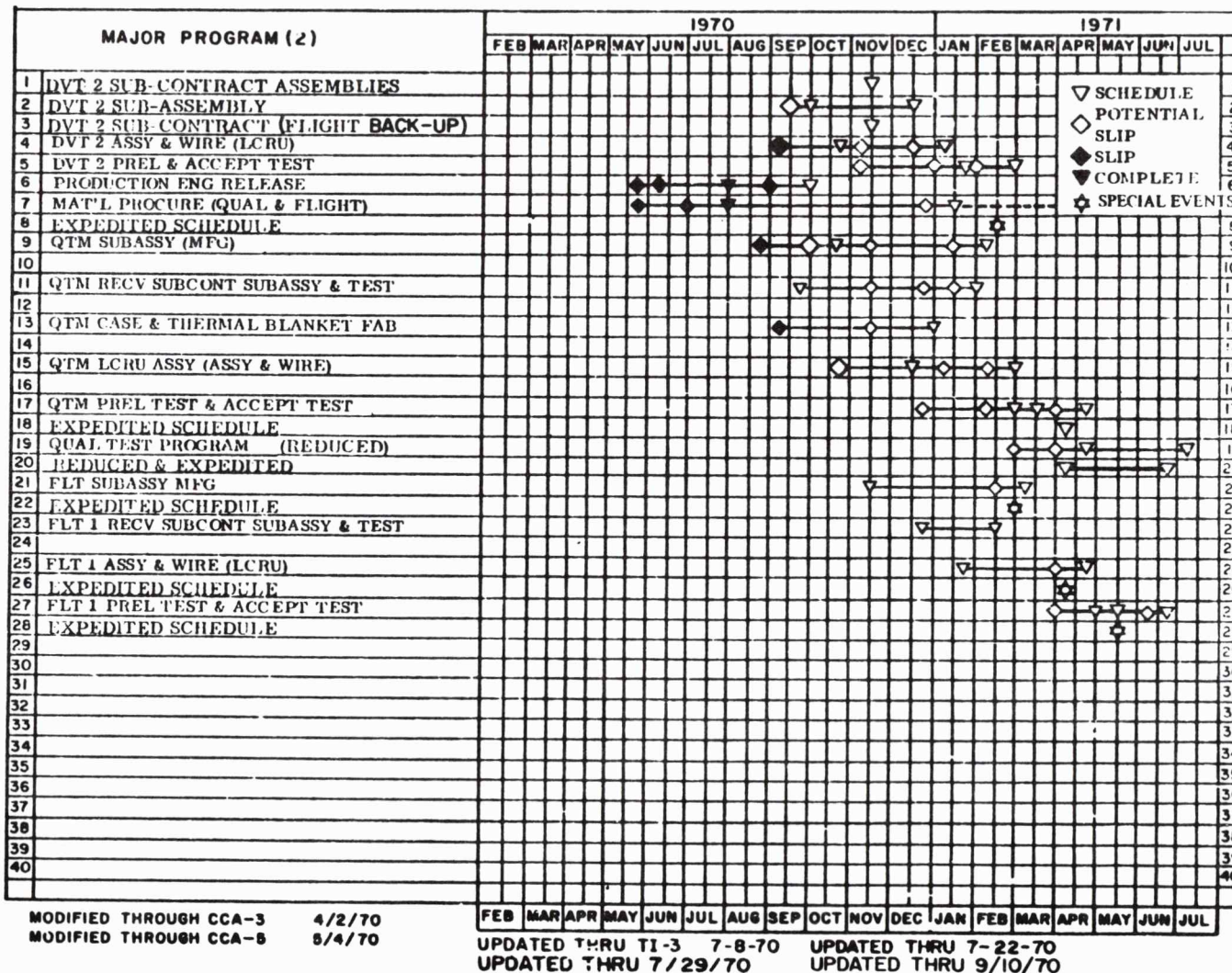


LCRU MAJOR PROGRAM MILESTONES



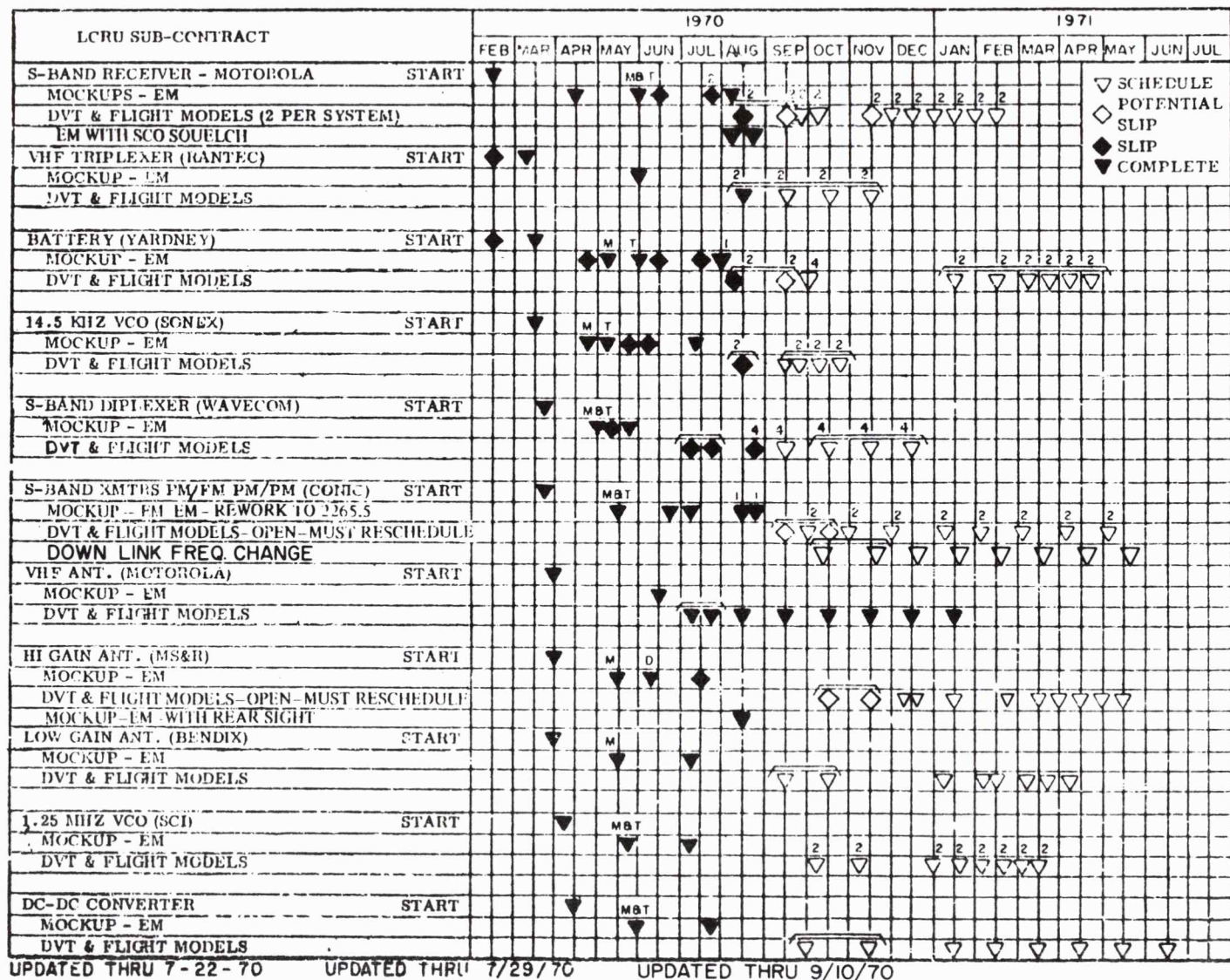


LCRU MAJOR PROGRAM MILESTONES





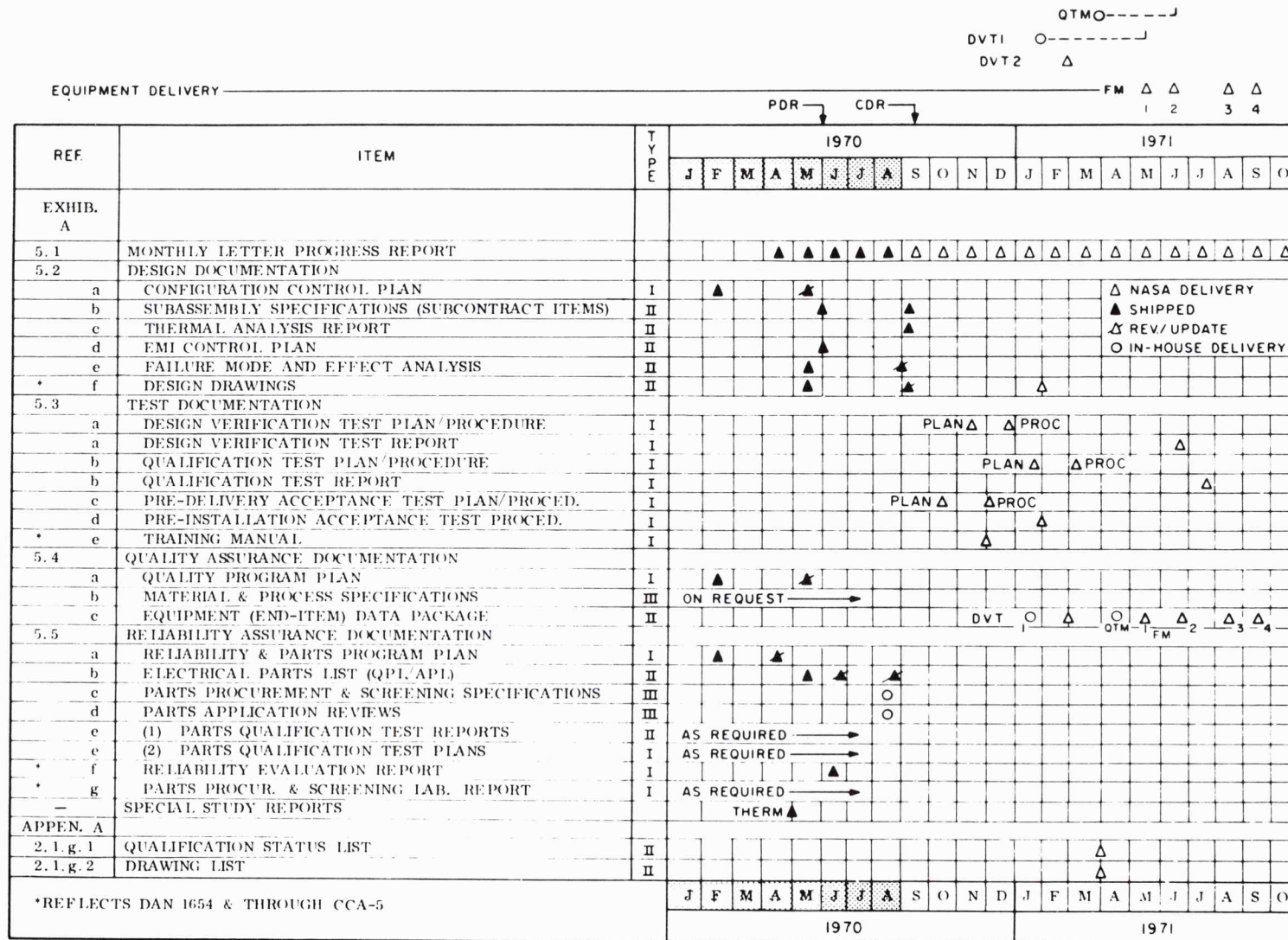
LCRU SUB-CONTRACT 1





LCRU DOCUMENTATION SCHEDULE

2-6





DESIGN STATUS

1. ENGINEERING MODEL

Operation capability is established for all five modes for both uplink and downlink operation. Performance evaluation over temperature range will start after CDR.

2. MECHANICAL MOCK-UP LCRU AND ANCILLARY ITEMS

Complete LRV vibration test support at Kent, Washington. Data will be used to support in-house vibration testing. Mock-up will be converted to crew training model.

3. THERMAL MOCK-UP LCRU

Supporting solar Radiation Tests at MSC. Data to date confirms thermal analysis projections, and confirms acceptability of battery heat sink design.



DESIGN STATUS

4. LCRU DRAWINGS

- a. LCRU case and subsystem drawings complete. To be signed-off and released after CDR approval.
- b. LCRU subassembly drawings signed-off final.
- c. Stowage Container drawings are preliminary. To be finalized after CDR.

5. DVT #1 STATUS

- a. LCRU subassemblies near completion of fabrication. Test will start this week on cordwood assemblies.
- b. Case fab will start after CDR when drawings are signed-off.

6. FLIGHT STATUS

- a. Electrical components are released for all LCRU subassemblies.
- b. Fab will be released after CDR.

7. LCRU SYSTEM TEST

First system test position in operation. It is supporting EM test program.



LCRU CRITICAL DESIGN REVIEW

MANUFACTURING PROGRESS -

- DVT Chassis fabrication in process
- DVT Subassembly has started
- Test Equipment build underway



LCRU HI-REL ELECTRICAL COMPLEMENT

	<u>QTY</u>	<u>BUY</u>	<u>DIVERT</u>	<u>REL</u>	<u>ORD</u>
<u>Bead</u>					
Ferroxcube	1	1	0	X	X
<u>Capacitors</u>					
Aerevox	21	9	12	X	X
Corning Glass	28	0	28	-	-
Electro-Motive	5	5	0	X	X
Erie	2	0	2	-	-
Gen'l Elect.	3	3	0	X	X
Johanson	3	0	3	X	X
Kemet	10	6	4	X	X
Sprague	25	13	12	X	X
Vitramon	1	0	1	-	-
	98	36	62		
<u>Circuit Breaker</u>					
Mech. Prod.	1	1	0	X	
<u>Chokes/Coils</u>					
Delevan	6	0	6	-	-
RCA 1-4	18	4	14	X	X
	24	4	20		
<u>Connectors/Plugs</u>					
American	2	2	0	X	
Bendix	4	4	0	X	
Deutsch	3	3	0	X	
Sealectro	7	6	1	X	
Teledyne	2	2	0		



LCRU HI-REL ELECTRICAL COMPLEMENT (CONT.)

	<u>QTY</u>	<u>BUY</u>	<u>DIVERT</u>	<u>REL</u>	<u>ORD</u>
<u>Crystals/Filters</u>					
McCoy	3	2	1	X	X
Erie	2	1	1	X	
	5	3	2		
<u>Diodes</u>					
Dickson	6	2	4	X	X
Gen'l Elect.	2	2	0	X	X
H/P	1	0	1	-	-
Motorola	5	2	3	X	X
T.I.	1	1	0	X	X
T.R.W.	4	2	2	X	X
Unitrode	1	0	1	-	-
	20	9	11		
<u>Fuse</u>					
Littlefuse	1	1	0	X	
<u>Integrated Circuits</u>					
Motorola	2	1	1	X	X
N.S.C.	2	2	0	X	X
	4	3	1		
<u>Meter</u>					
Weston	1	1	0	X	
<u>Cable</u>					
Rockbestes	1	0	1	(GFE supplied non-payback)	



LCRU HI-REL ELECTRICAL COMPLEMENT (CONT.)

	<u>QTY</u>	<u>BUY</u>	<u>DIVERT</u>	<u>REL</u>	<u>ORD</u>
<u>Resistors</u>					
Allen Bradley	92	9	83	X	X
Dale	1	1	0	X	X
I.R.C.	3	3	0	X	
Mepco	196	102	94	X	X
	292	115	177		
<u>Switches</u>					
Daven	1	1	0	X	X
T.I.	2	2	0	X	
	3	3	0		
<u>Transistors</u>					
Amelco	1	1	0	X	X
Motorola	5	3	2	X	X
N.S.C.	2	2	0	X	X
RCA	5	2	3	X	X
T.I.	2	2	0	X	X
Westinghouse	1	1	0	X	X
	16	11	5		
<u>Thermistors</u>					
Keystone Carbon	4	1	3	X	X
<u>Transformers</u>					
U.T.C.	2	0	2	-	-
TOTALS	490	206	284		



LCRU HI-REL ELECTRICAL COMPLEMENT

ORDER PLACEMENT SCHEDULE

BALANCE DUE AS OF 9/10/70

<u>VENDOR</u>	<u>DESCRIPTION</u>	<u>PART SPEC. #</u>	<u>PLACE SCHEDULE</u>
Mech. Prod.	Circuit Breaker	8555264-1001	9/18
Americon	Connector	8555286-1002,2	9/10
Bendix	Connector	8555282-1001,2,3,4	9/10
Deutsch	Connector	8555283-1001	
		8555291-1001	
		8555292-1001	9/18
Sealectro	Connector	8551446-1002,5,6,7	
		8555280-1001	
		8555287-1001	9/25
Teledyne	Connector	8555284-1001,2	9/25
Erie	Filter	8555281-1001	9/9
Littlefuse	Fuse	8555285-1005	9/18
Weston	Meter	8151104-1001	9/18
IRC	Resistor	8555288-1001,2,3	9/24
T.I.	Switch	8555254-1001,2	9/25



HARDWARE ORIENTED SPECIAL TEST SCHEDULES

TRAINING SUBSYSTEM

LCRU/LRV Crew Review	MSC	Sept. 21, 1970
LM 10 Descent Stage C ² F ²	GAC	Sept. 25 - Oct. 6, 1970
LM/LRV CCSR	MSC	Oct. 15, 1970
Crew Training		Dec. 15

Engineering Model

LCRU/GCTA Interface Test	MSC	Sept. 14 - 19
LCRU/LRV EMI Test	MSC	Dec. 16 - Jan. 8
LCRU/MSFN Performance Analysis	MSC	Jan. 8 - Feb. 1
*LRV/LCRU Thermal Vacuum Test	TBC	Dec. 1 - Dec. 15

Thermal Battery Mock-ups (2) (MSC Fabricated)

LM 10 MESA Thermal-Vacuum Test	GAC	Oct. 9 - Jan. 15
--------------------------------	-----	------------------

Thermal Model

*LRV/LCRU Thermal Vacuum Test	TBC	Dec. 1 - Dec. 15
-------------------------------	-----	------------------

DVT No. 2 Unit

LCRU/MSFN Performance Analysis	MSC	Mar. 1 - Apr. 1
LM 10 C ² F ²	MSC	Apr. 9

*Engineering Model Antennas and Thermal Model LCRU will comprise the LCRU thermal subsystem for the LRV/LCRU TV test.



LCRU CRITICAL DESIGN REVIEW

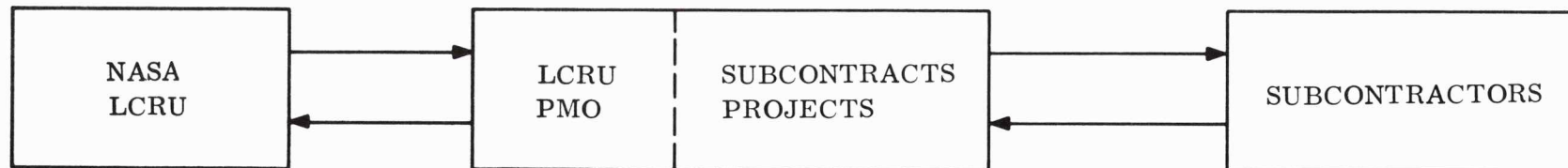
PROBLEMS -

- LM and LRV Vibration Test results
- Vibration inputs to LGA Mast
- Handling of procedures for subcontractor qual/DVT approval
- Shortage of test hardware
- S-Band Transmitter humidity
- SR/TV test chamber down time
- P & I Specification
- LRV/LCRU/TV Interferences (*MECHANICAL*)
- Stowage Container design
- Subcontractor procedure approval
- CDR drawing sign off

3.0 SUBCONTRACT SUMMARY



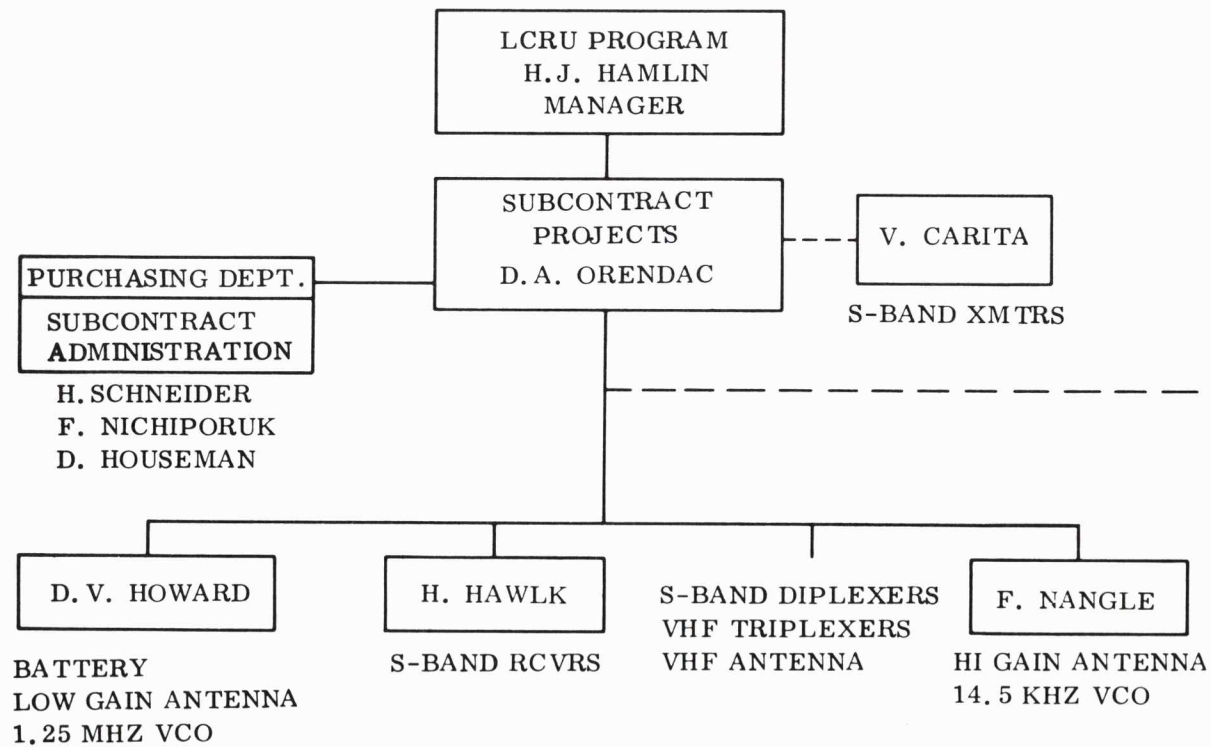
SUBCONTRACT PROJECTS



PROVIDES MANAGEMENT AND TECHNICAL DIRECTION OF
SUBCONTRACTOR CONSISTENT WITH LCRU PMO AND OVERALL NASA REQUIREMENTS
AND FUNCTIONS AS AN INTEGRAL PART OF THE LCRU PMO.



LCRU SUBCONTRACT PROJECT ORGANIZATION



SUPPORTING ACTIVITIES

- SYSTEMS ENG.
- DESIGN ENG.
- RELIABILITY
- QUALITY
- CONFIGURATION CONTROL
- DOCUMENTATION
- FINANCIAL
- MFG.
- DIVISIONAL & CORPORATE OPERATIONS
- SYSTEM PROJECTS IMPLEMENTATION
- EMI/EMC COORDINATOR
- CENTRAL ENGINEERING



LCRU SUBCONTRACT CONTROL DOCUMENTATION

- | | | | |
|----|--|-------------------|--------------|
| 1. | PURCHASE ORDER | RCA PO G9-829 | -0001-80-D71 |
| 2. | EXHIBIT "A" (TO THE P.O.) | LRPO - _ _ -1 | |
| 3. | EQUIPMENT SPECIFICATION (SOURCE CONTROL DRAWING) | | |
| 4. | SUBCONTRACTOR RELIABILITY CONTROL SPECIFICATION | LRSP - SB/RL-1 | |
| | 4a. SUBCONTRACTOR RELIABILITY CONTROL REQUIREMENTS
SUPPLEMENT | LRSS - _ _ /RL-1 | |
| 5. | SUBCONTRACTOR QUALITY CONTROL SPECIFICATION | LRSP-SB/QA-1 | |
| | 5a. SUBCONTRACTOR QUALITY CONTROL REQUIREMENTS
SUPPLEMENT | LRSS - _ _ /QA-1 | |
| 6. | SUBCONTRACTOR CONFIGURATION CONTROL SPECIFICATION | LRSP-SB/CC-1 | |
| | 6a. SUBCONTRACTOR CONFIGURATION CONTROL SUPPLEMENT | LRSS - _ _ -/CC-1 | |

RCA LCRU SUBCONTRACT OVERALL STATUS SUMMARY

ACCOMPLISHED

- VENDOR ENG. MODEL PHASE COMPLETE INCLUDING DELIVERY TO RCA OF S-BAND RCVRS WITH SQUELCH AND S-BAND XMTRS WITH FREQUENCY CHANGE.
- VENDOR PDRS AND CDRS COMPLETE
 - ACTION ITEM CLOSE OUT CONTINUES
 - SPECIFICATION ECN'S PROCESSED INCLUDES KNOWN FEEDBACK FROM LCRU ENGR MODEL, VENDOR ENG MODEL AND LCRU PROGRAM INTERCHANGES (DR'S TI, ETC.)
 - VENDOR REL UPGRADE PROGRAMS IMPLEMENTED (CONIC, MOTOROLA, SCI AND SONEX).

IN PROCESS

- VENDOR DVT PROGRAM IMPLEMENTATION
 - MODELS BEING MANUFACTURED
 - TEST PLANS AND PROCEDURES IN REVIEW
 - TEST MONITORING BEING IMPLEMENTED
 - FEEDBACK FROM LCRU ENGR MODEL COORDINATION
- VENDOR FLIGHT MODEL PROGRAM IMPLEMENTATION
 - PROCUREMENT IN PROCESS
 - MANUFACTURING BEING ESTABLISHED
 - FEEDBACK FROM LCRU TESTING AND VENDOR DVT IMPLEMENTATION
 - TEST MONITORING IMPLEMENTATION



LCRU SUBCONTRACT STATUS

ITEM	VENDOR	GO AHEAD	PDR COMPLETION	CDR DATES
S-BAND RCVR	MOTOROLA	2/17/70	5/18, 19	8/27-28 (Completed)
VHF TRIPLEXER	RANTEC	3/13/70	NA	NA
BATTERY	YARDNEY	3/19/70	5/8	7/28 (Completed)
14.5 KHZ VCO	SONEX	3/19/70	4/22	7/16 (Completed)
HIGH GAIN ANTENNA	RCA MS&R	4/1/70	5/8	8/24 (Completed)
S-BAND XMTRS	CONIC	3/30/70	4/30, 5/1	8/24-25 (Completed)
VHF ANTENNA	MOTOROLA	3/24/70	NA	NA
S-BAND DIPLEXERS	WAVECOM	3/23/70	5/4	6/29 (Completed)
LOW GAIN ANTENNA	BENDIX	4/6/70	5/27, 28	7/15 (Completed)
1.25 MHZ VCO	SCI	4/3/70	5/13, 14	8/25 (Completed)



LCRU SUBCONTRACT DELIVERY SCHEDULE

SUBASSEMBLY	QTY/ LCRU	MECH. MOCKUP	THERMAL MOCKUP	ENGR. MODEL	DVT MODEL	FM 1 QUAL	FM 2	FM 3
S-BAND RECEIVER	2	RCVD	RCVD	RCVD 8-14/8-21*	9-18	11-30	12-15	12-30
VHF TRIPLEXER	1	-	-	RCVD	RCVD 8-17	RCVD 9-17	9-17	10-16
BATTERY	1	RCVD	RCVD	RCVD	10-2	1-4	2-15	3-15
14.5 KHZ VCO	1	RCVD	RCVD	RCVD	9-15	9-21	9-21	9-28
S-BAND DIPLEXER	2	RCVD	RCVD	RCVD	9-25	10-19	10-19	11-18
S-BAND XMTR (FM/PM)	1	RCVD	RCVD	RCVD** NLT-8-26	10-12	12-18	1-20	2-20
S-BAND XMTR (PM/FM)	1	RCVD	RCVD	RCVD** NLT-8-26	10-12	12-18	1-20	2-20
VHF ANTENNA	1	-	-	RCVD	RCVD	8-15 RCVD	9-15 RCVD	9-15 RCVD
HI GAIN ANTENNA	1	RCVD	RCVD	RCVD	12-11	2-15	3-15	4-1
LOW GAIN ANTENNA	1	RCVD	RCVD	RCVD	9-15	1-4	2-1	2-1
1.25 MHZ VCO	2	RCVD	RCVD	RCVD	10-5	12-24	1-7	1-21

*SUBCARRIER SQUELCH ADDED

**XMTR FREQUENCY CHANGE INCORPORATED



LCRU SUBCONTRACTOR SPECIFICATION ECN'S

<u>UNIT</u>	<u>SCD</u>	<u>REV.</u>	<u>ECN STATUS</u>				<u>COMMENTS</u>
			<u>In Process</u>	<u>Change Board</u>	<u>ECN Release</u>	<u>Spec. Release</u>	
S-Band Receiver	8151100	-	Completed	9-10-70			Rev. A
VHF Triplexer	8547878	-	-	-	-	-	
Battery	8151103	-	Completed	9-10-70	9-11-70		Rev. A
VCO 14.5 KHz	8555256	-	Completed	7-30-70	7-31-70	9-11-70	Rev. A
		A	Completed	9-9-70	9-9-70		Rev. B
S-Band Diplexer	8151102	-	Completed	9-10-70	9-11-70		Rev. A
S-Band Xmitr. (FM/PM)	8151101	-	Completed	9-10-70	9-11-70		Rev. A
S-Band Xmitr. (PM/PM)	8151116	-	Completed	9-10-70	9-11-70		Rev. A
S-Band High Gain Antenna	8555262	-	Completed	8-14-70	8-19-70		Rev. A
		A	Completed	9-10-70	9-11-70		Rev. B
SCO 1.25 MHz	8555255	-	Completed	8-14-70	8-19-70		Rev. A
S-Band Low Gain Antenna	8555260		Completed	9-04-70	9-08-70		Rev. A



SUBCONTRACT TECHNICAL STATUS SUMMARY

WAVECOM

S-Band Diplexers

No Major Problems

MOTOROLA

VHF Antenna

All Antennas delivered to RCA

SCI

1.25 MHz SCO

No Major Problems

CDR Completed

DVT - All Parts Rcvd.

FM - All Parts ordered

MOTOROLA

S-Band Rcvr

CDR Completed

Engr. Models with Squelch Ckt rcvd by RCA

AGC Problem Resolved

DVT - All Parts Rcvd.

FM - All Parts ordered

SONEX

14.5 KHz VCO

No Major Problems

CDR Completed

DVT - All Parts Rcvd.

FM - All Parts Rcvd.



SUBCONTRACT TECHNICAL STATUS SUMMARY

RANTEC

VHF Triplexer

No Major Problems
DVT Models Rcvd. by RCA

BENDIX

Lo Gain Antenna

- No Major Problems
- CDR Completed
- Minor Delay in Receipt Ground Planes from Manufacturer
Does not affect RCA/NASA Schedule
- All other materials Rcvd.
- Xmtr Frequency Change to be verified on 1st DVT Model

YARDNEY

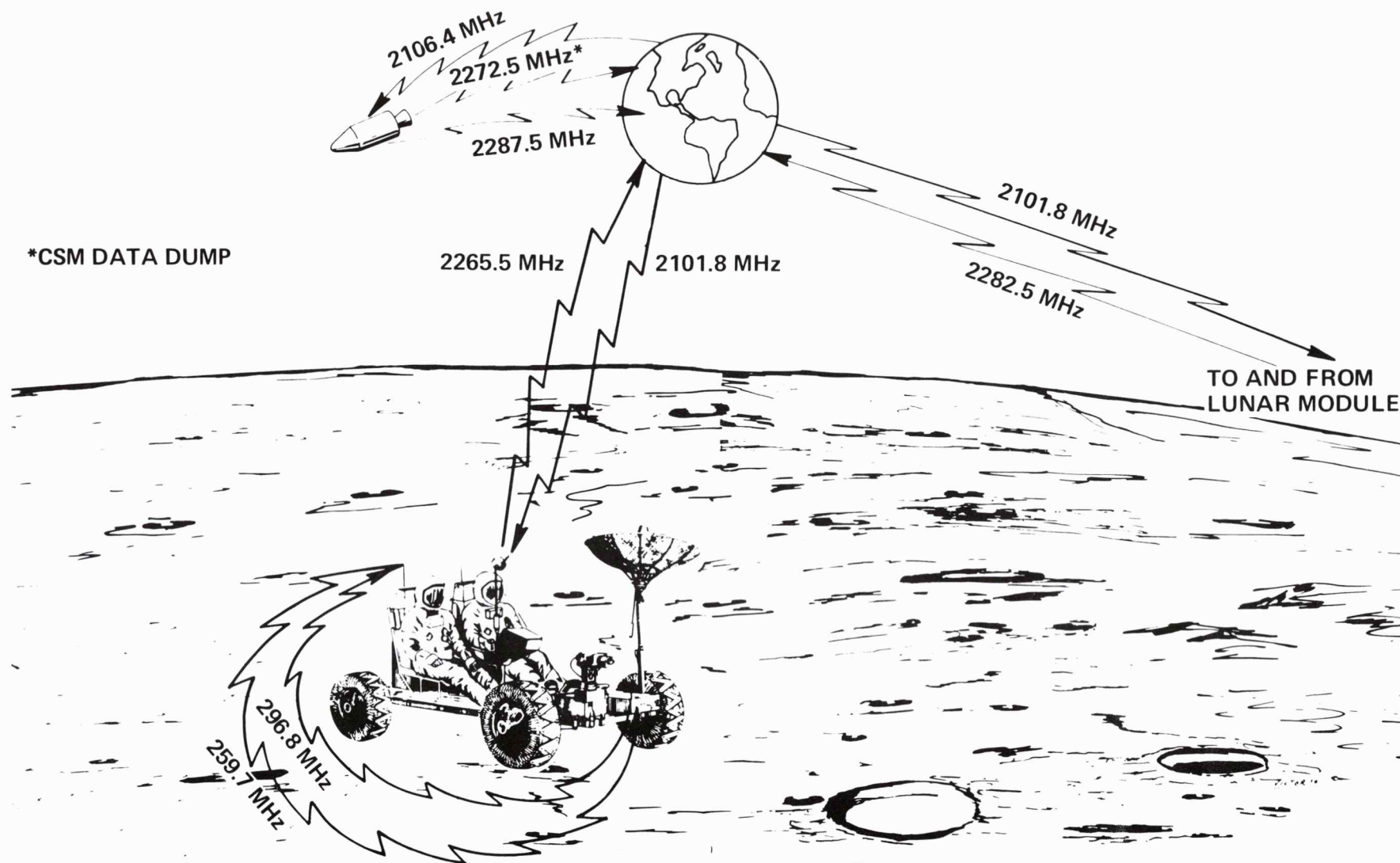
Battery

- No Major Problems
- CDR Completed
- Vibration and Temp. Changes Incorporated into DVT
Test Program
- Velcro strap across handle being incorporated. Yardney
to RCA Schedule affected 2 wks on DVT models. No impact
on NASA Schedule.
- Impedance measurement test in process at Yardney
- Low Temp. Cell Test Evaluation in process at Yardney
- Extended wet life (21 days) Evaluation Test started at
Yardney.

4.0 CIRCUIT MARGIN SUMMARY

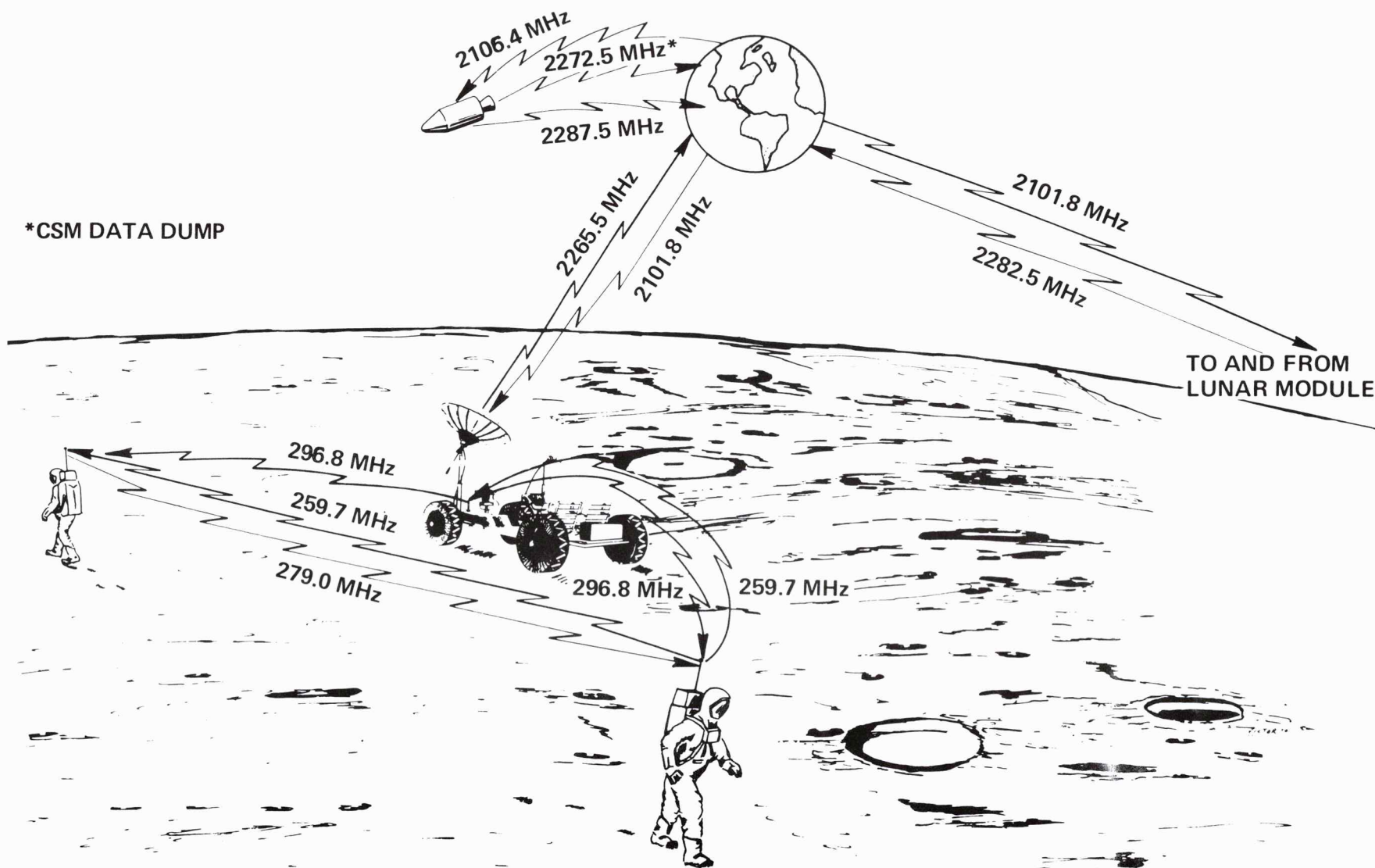
RCA

LCRU IN MOBILE OPERATION ON LRV



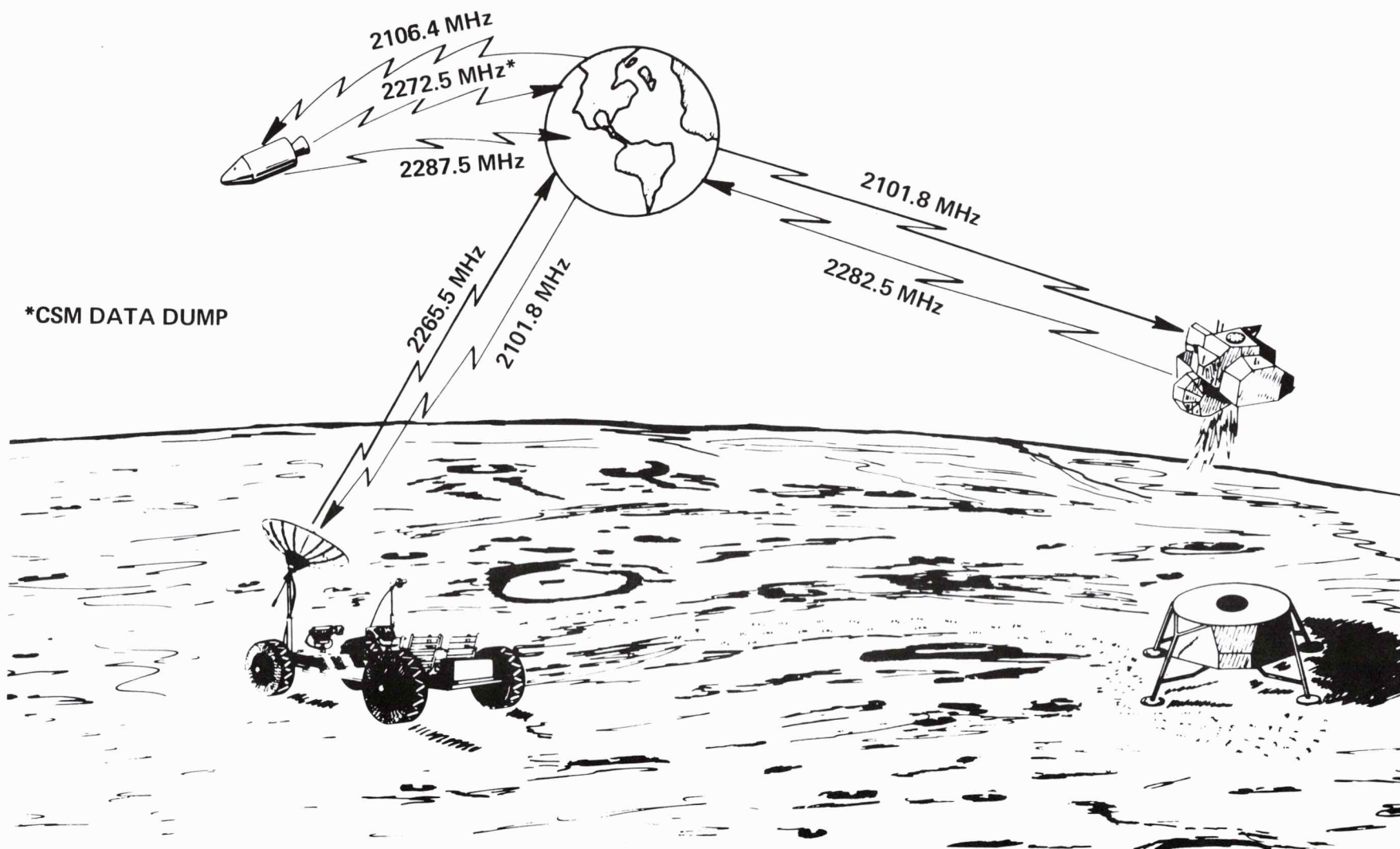


LCRU IN FIXED BASE OPERATION ON LRV



RCA

LCRU IN OPERATION DURING LM ASCENT





NOMINAL CASE LINK MARGIN SUMMARY

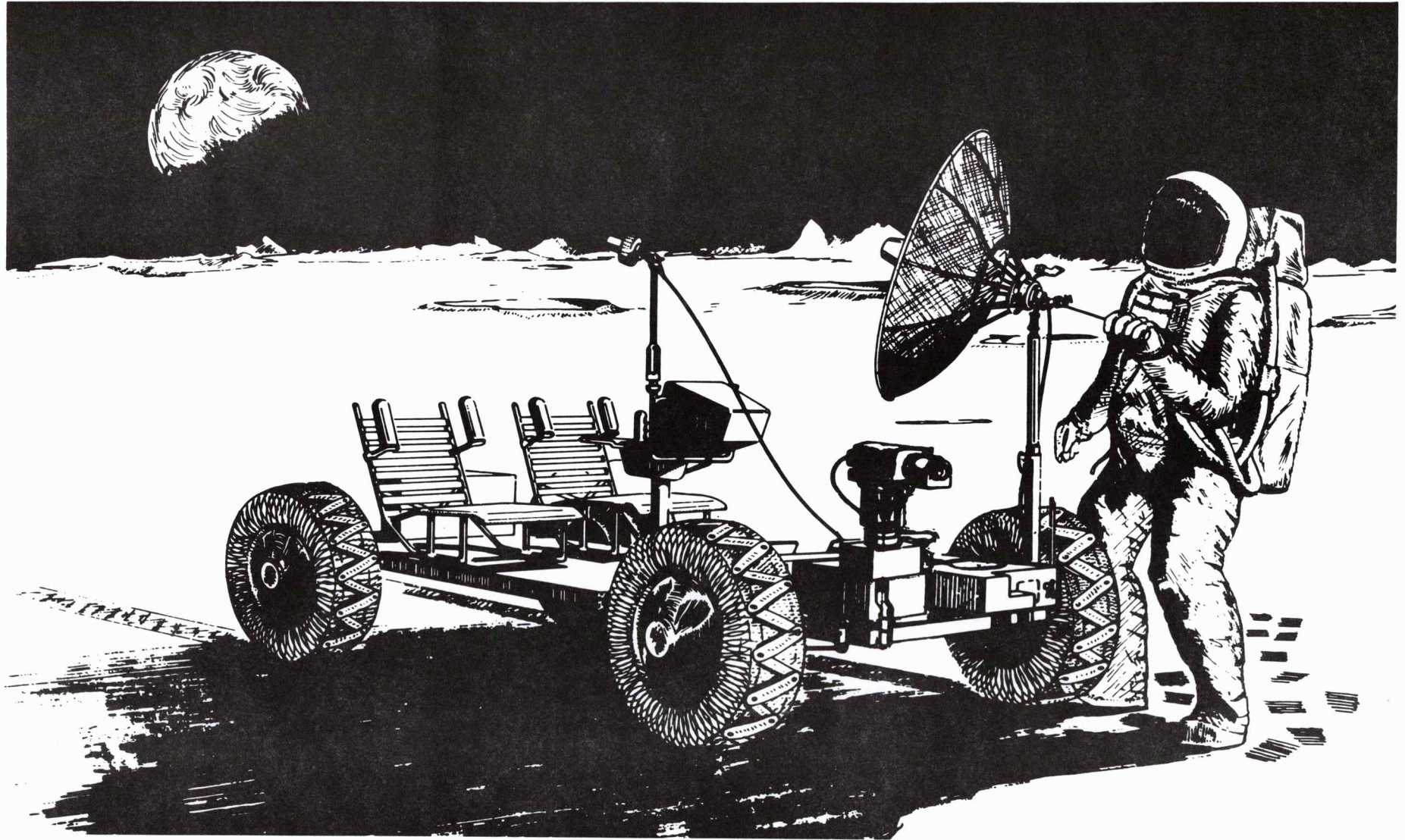
<u>LINK PARAMETER</u>	<u>PMI/WB</u>	<u>PMI/NB*</u>	<u>FM/TV</u>	<u>UPLINK</u>
TRANSMITTER POWER:	7.4w	7.4w	9.1w	10kw
EFFECTIVE ANT. GAIN:	9.5db	9.5db	23.5db	50.5db
EFFECTIVE RADIATED POWER (EIRP INCL ALL CKT LOSSES)	14.9dbw	14.9dbw	31.4dbw	90.5dbw
TOTAL RECEIVED POWER: (INCL ALL CKT. LOSSES)				
85 FT. DISH (52.5 db)	-142.9w	-142.9w	-127.7w	-
210 FT. DISH (60.0db)	-	-	-120.2w	-
LCRU L.G. (6.5 db FOR $\pm 30^\circ$)				-118.5dbw
LCRU H.G. (18.5db FOR $\pm 5^\circ$)				-101.5dbw
MARGINS (db):				
CARRIER	+19.5	+29.4	+10.0/+2.5	+28.0/+11.2
1.25 MHZ SUBCARRIER	+3.9	-	+3.5	-
124 KHZ SUBCARRIER	-	-	-	+40.0/+23.3
70 KHZ SUBCARRIER	-	-	-	+34.4
VOICE CHANNEL	+12.2	+3.3	+11.8	+54.4/+34.8
3.9 KHZ SUBCARRIER	+14.9	+4.4	+14.5	-
5.4 KHZ SUBCARRIER	+11.6	+3.9	+11.2	-
7.35 KHZ SUBCARRIER	+9.9	+4.7	+9.5	-
10.5 KHZ SUBCARRIER	+6.6	+4.6	+6.2	-
14.5 KHZ SUBCARRIER	+6.5	+3.6	+6.1	-
VIDEO CHANNEL			+11.0/+3.5	

* PM2/NB ALL MARGINS 1.0db GREATER THAN PMI/NB

5.0 CONFIGURATION OVERVIEW

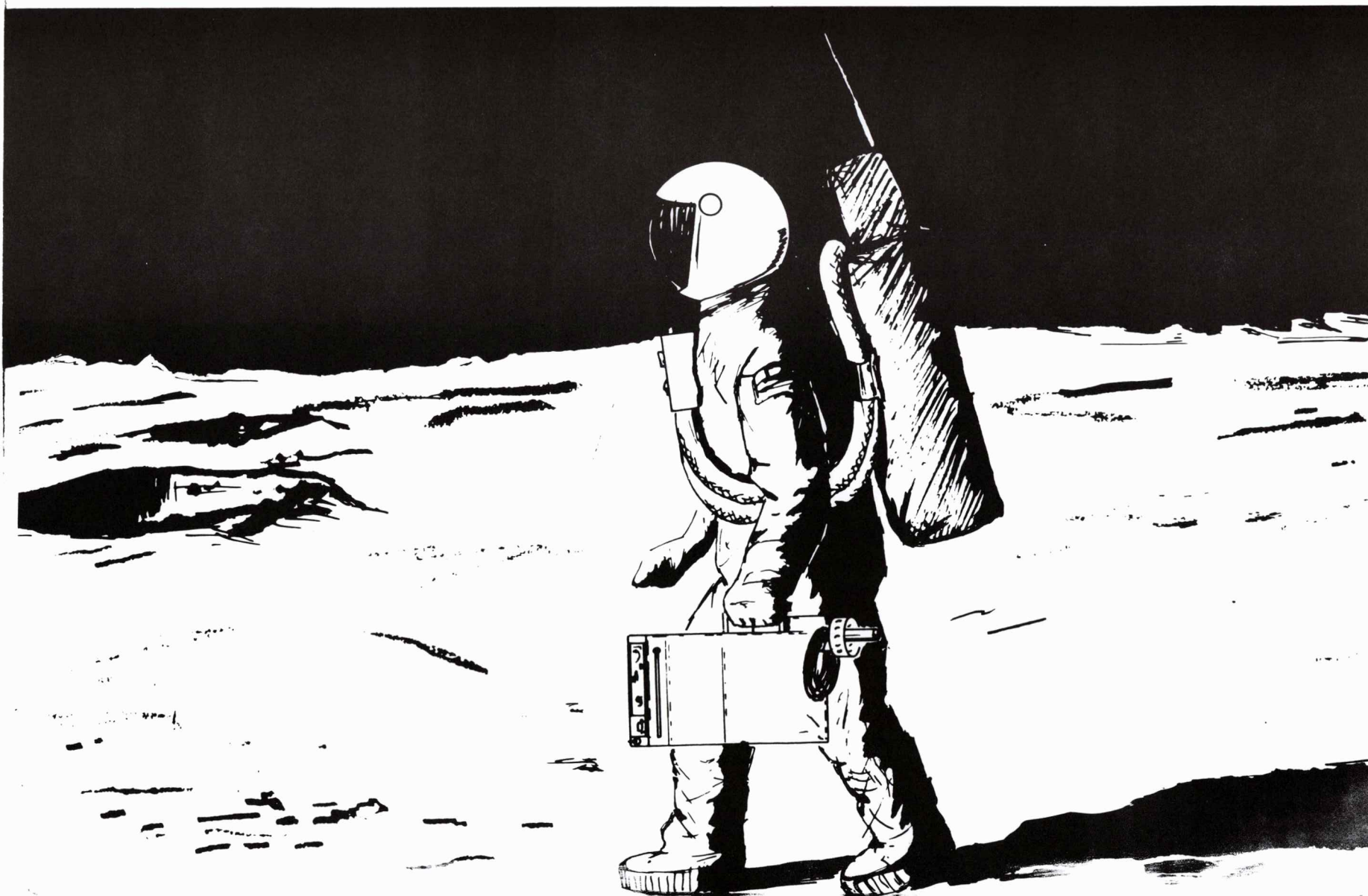
RCA

LRV INTERFACE



RCA

LCRU HAND CARRY MODE



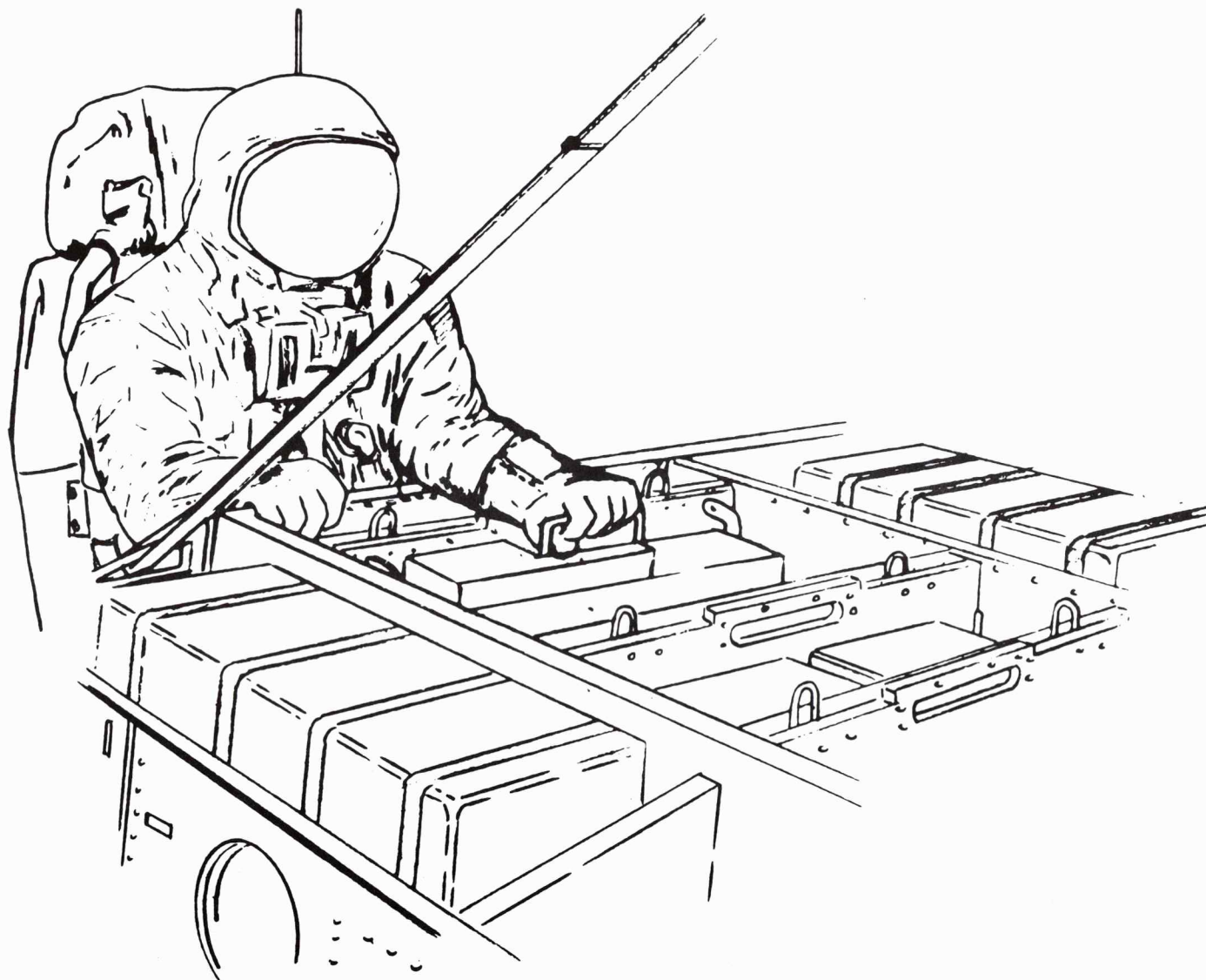


LRV INTERFACE DEPLOYMENT PROCEDURE

- MESA DEPLOYED
- LRV DEPLOYED
- DEPLOY LCRU ON LRV
- DEPLOY HGA ASSEMBLY ON LRV
- DEPLOY LGA ASSEMBLY ON LRV
- MATE ANTENNA AND TV/POWER CONNECTORS



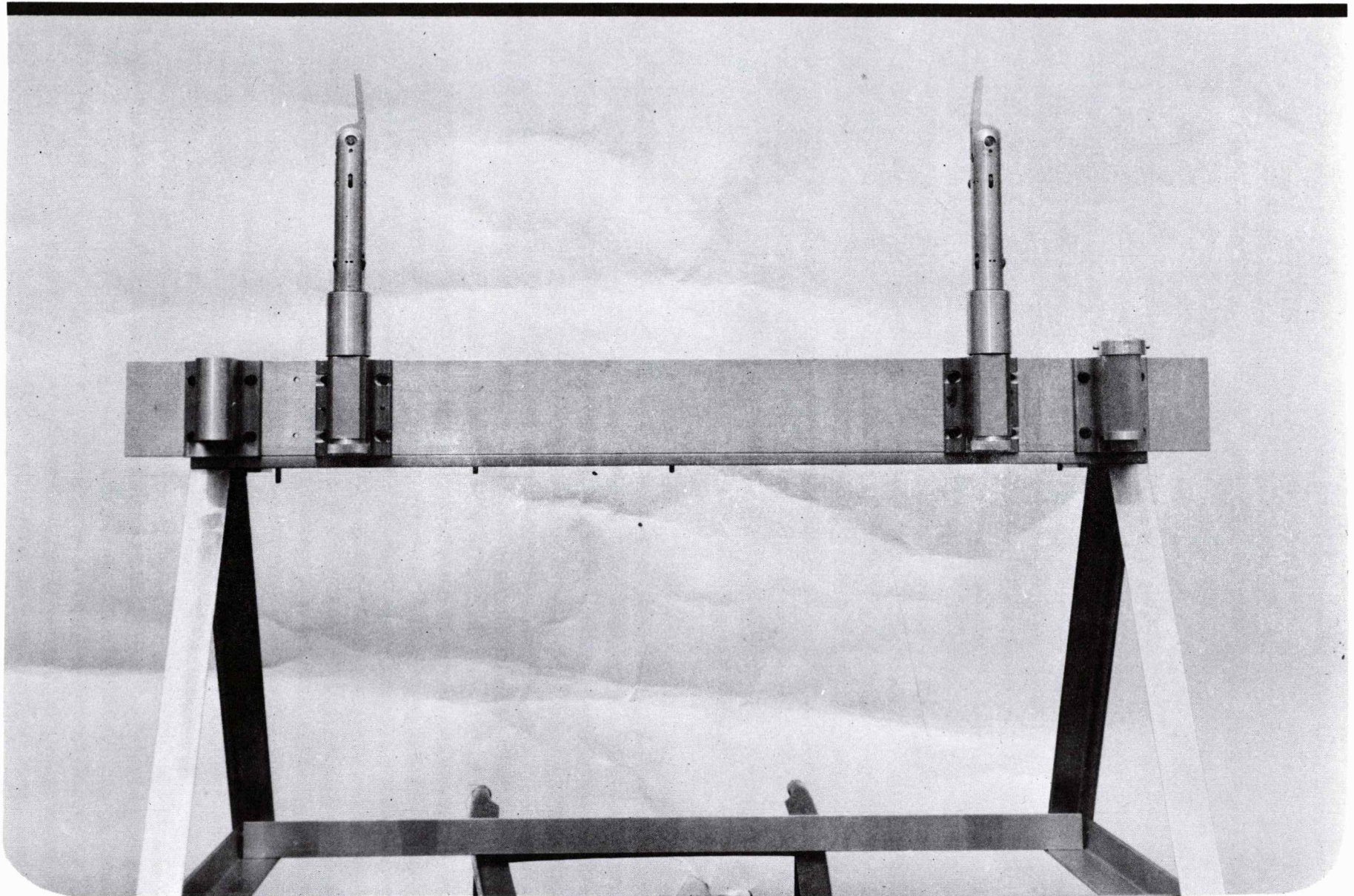
LCRU CASE REMOVAL PRIME MODE WITHOUT PALLET



RCA

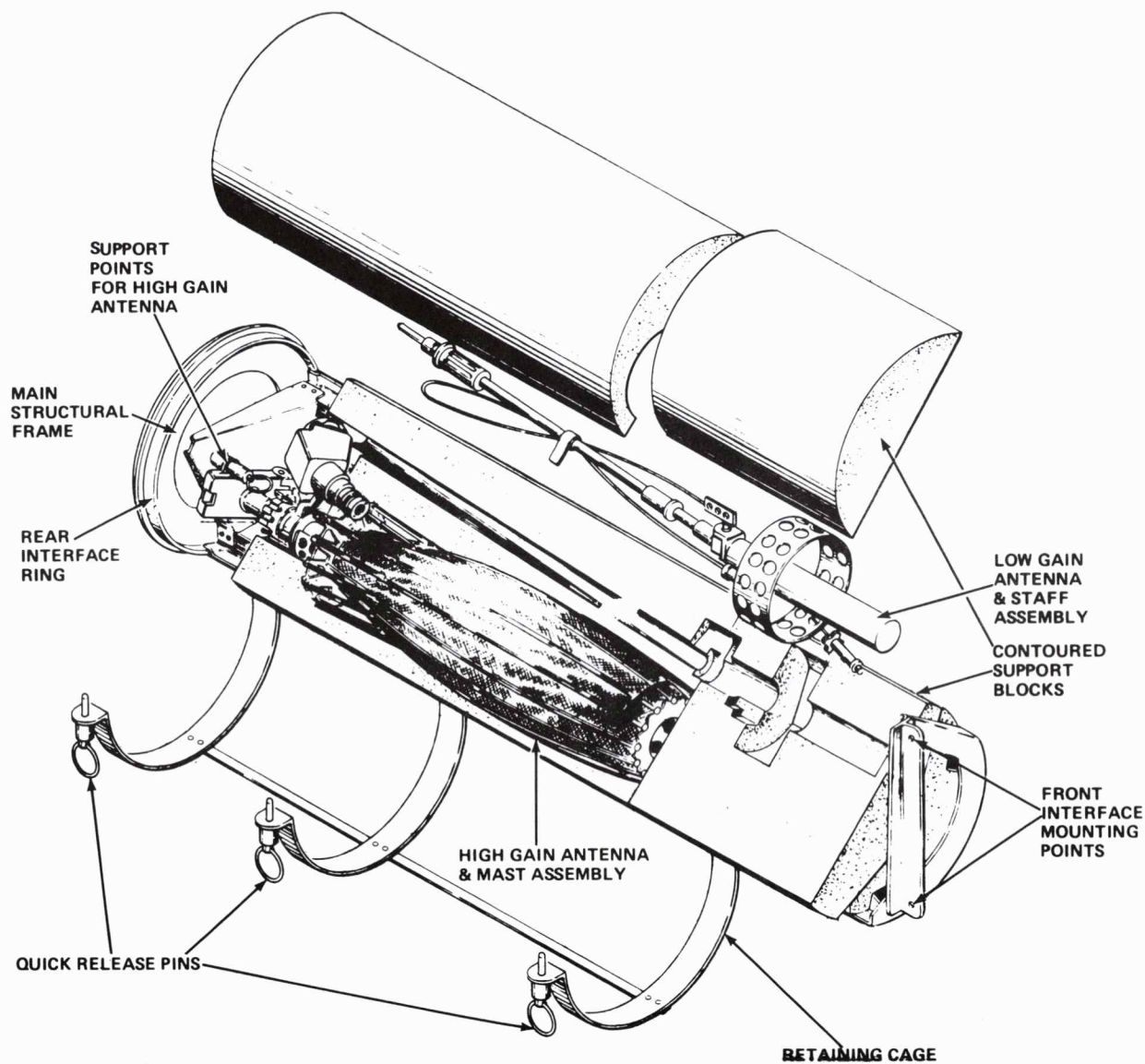
LCRU MOUNTING LEGS

5-5



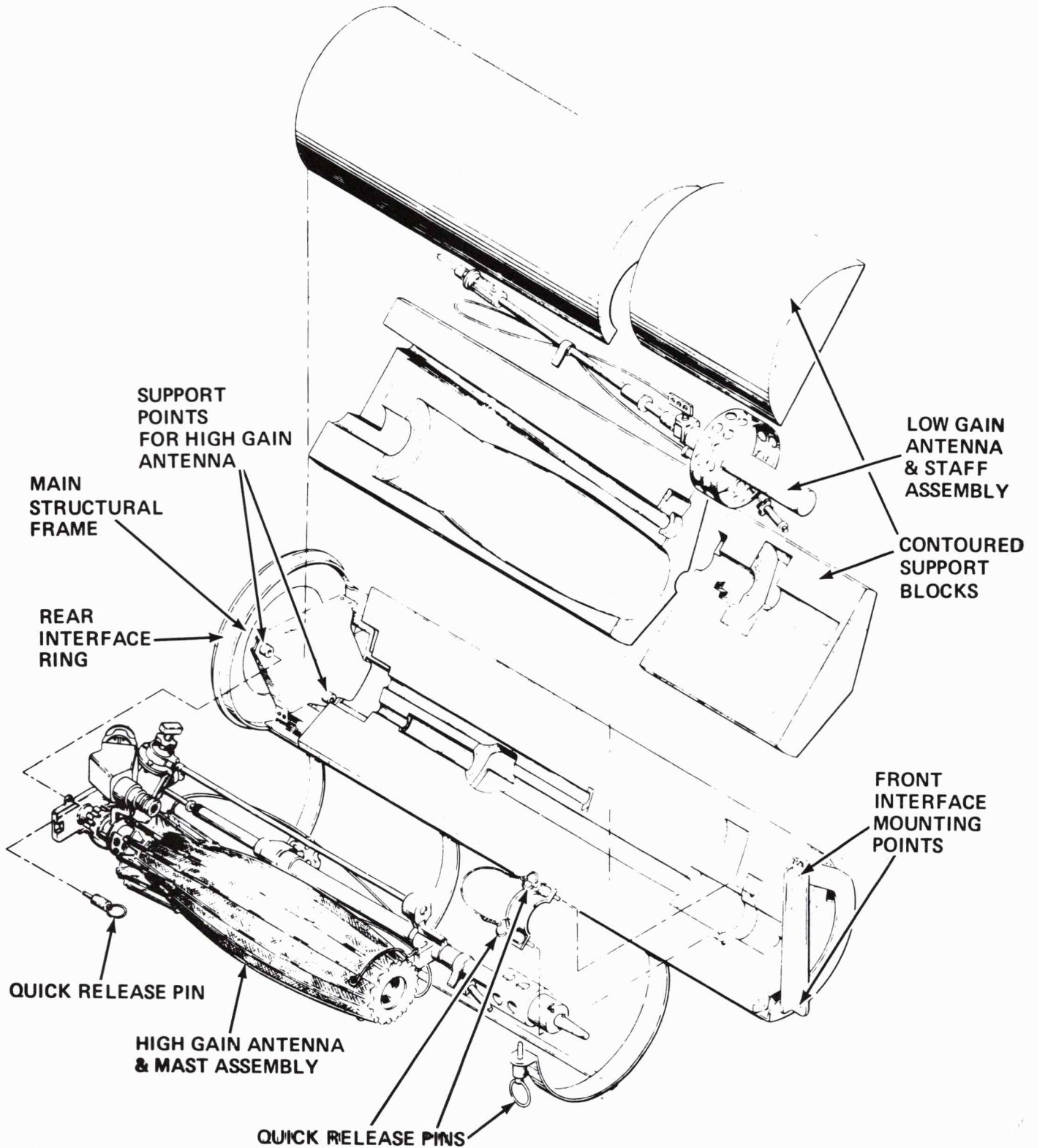


ANCILLARY ITEM STOWAGE CONTAINER HGA IN STOWED POSITION



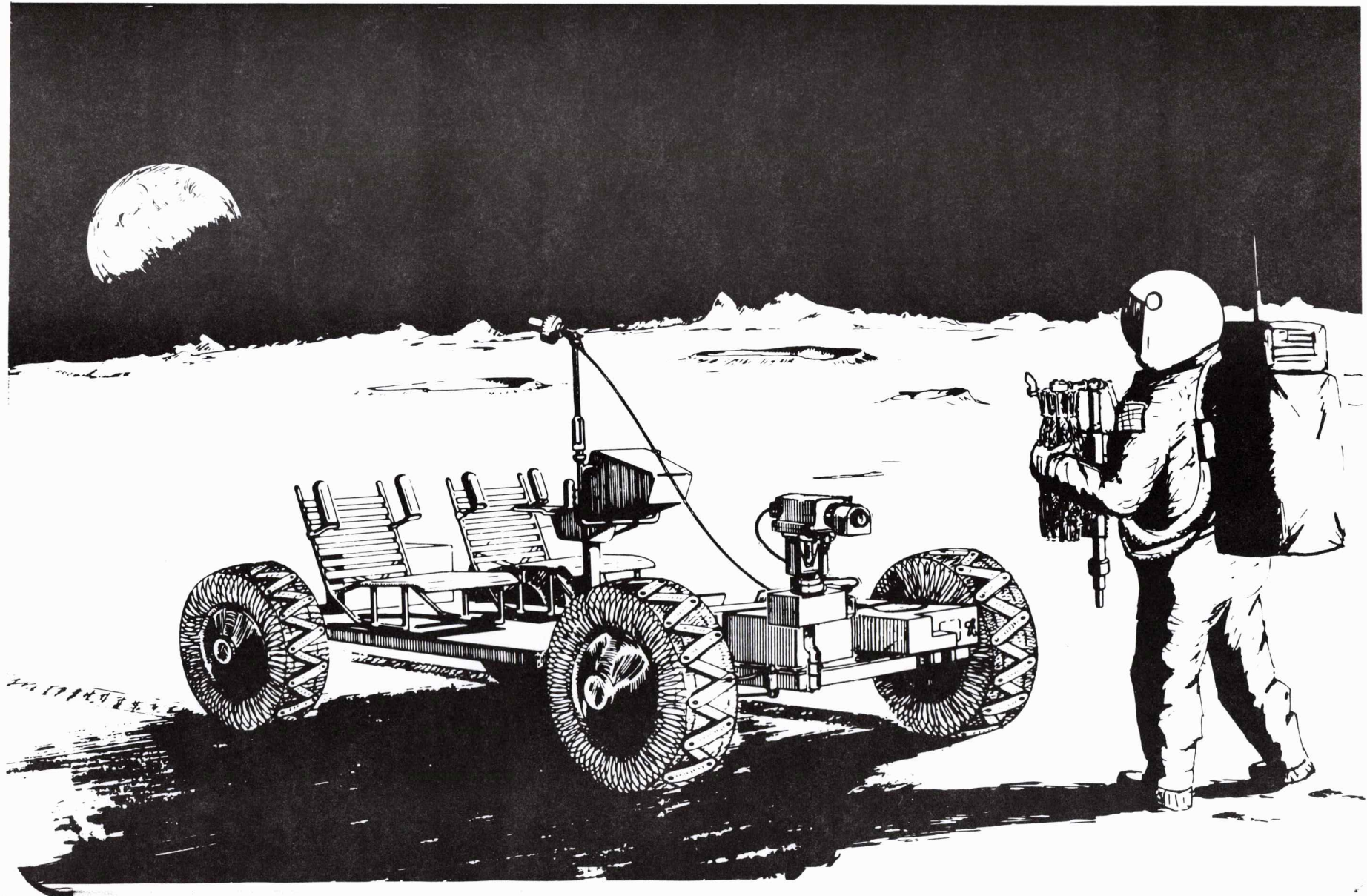


STOWAGE CONTAINER/ANCILLARY ITEMS CONFIGURATION



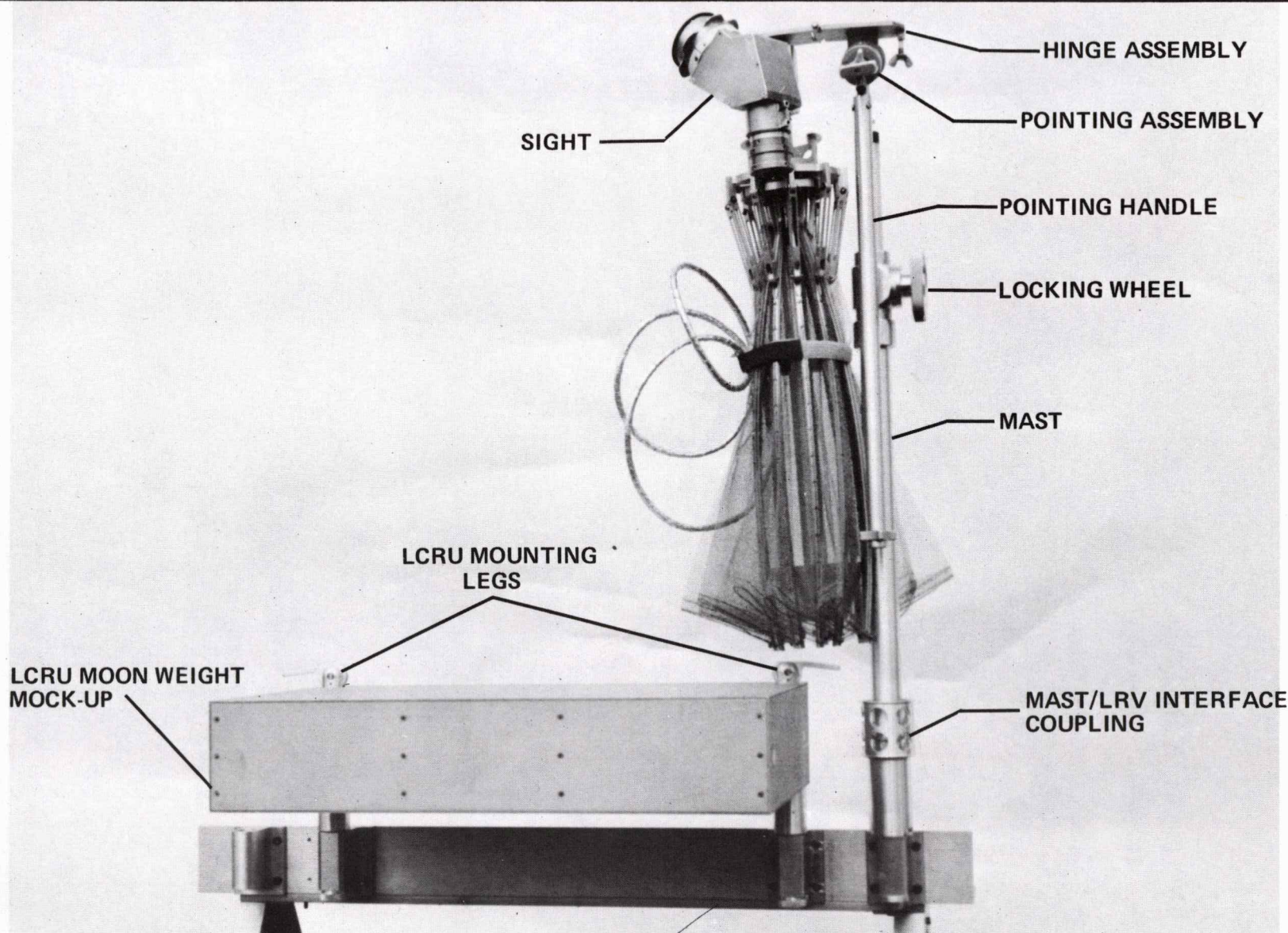
RCA

LRV INTERFACE HGA DEPLOYMENT



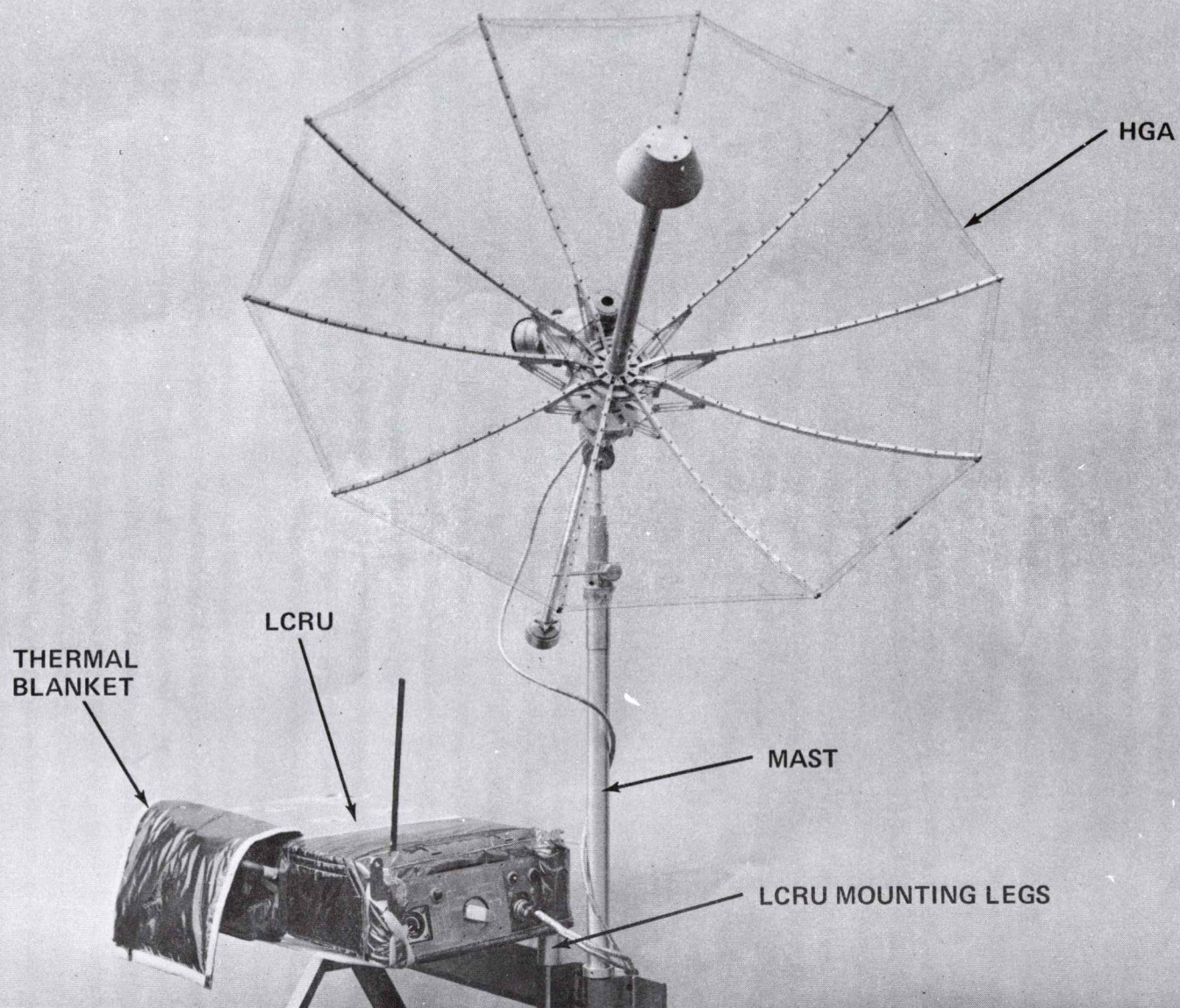


HGA AND MAST ASSEMBLY MECHANICAL MOCK UP



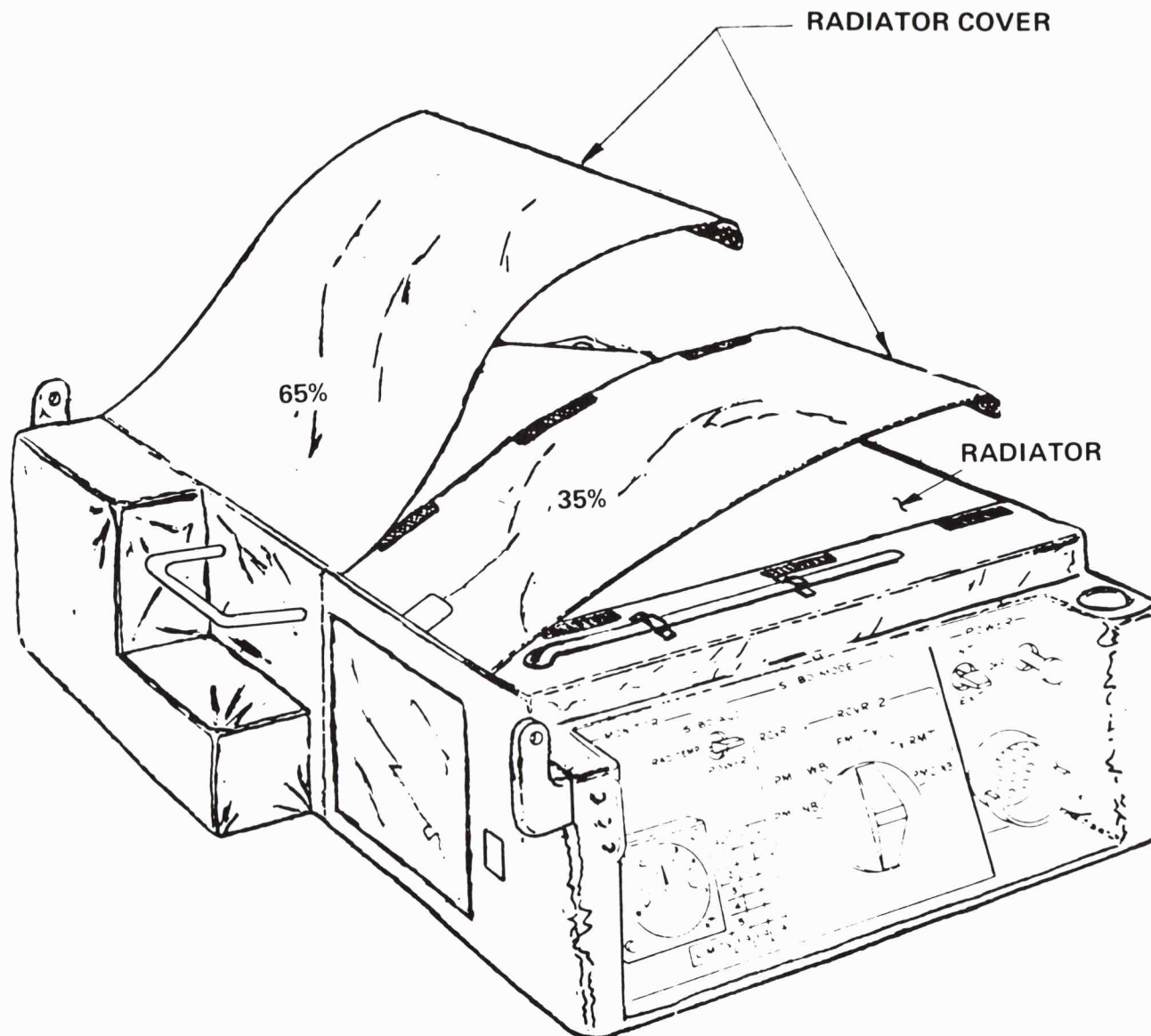
RCA

LCRU SUBSYSTEM MECHANICAL MOCK-UP



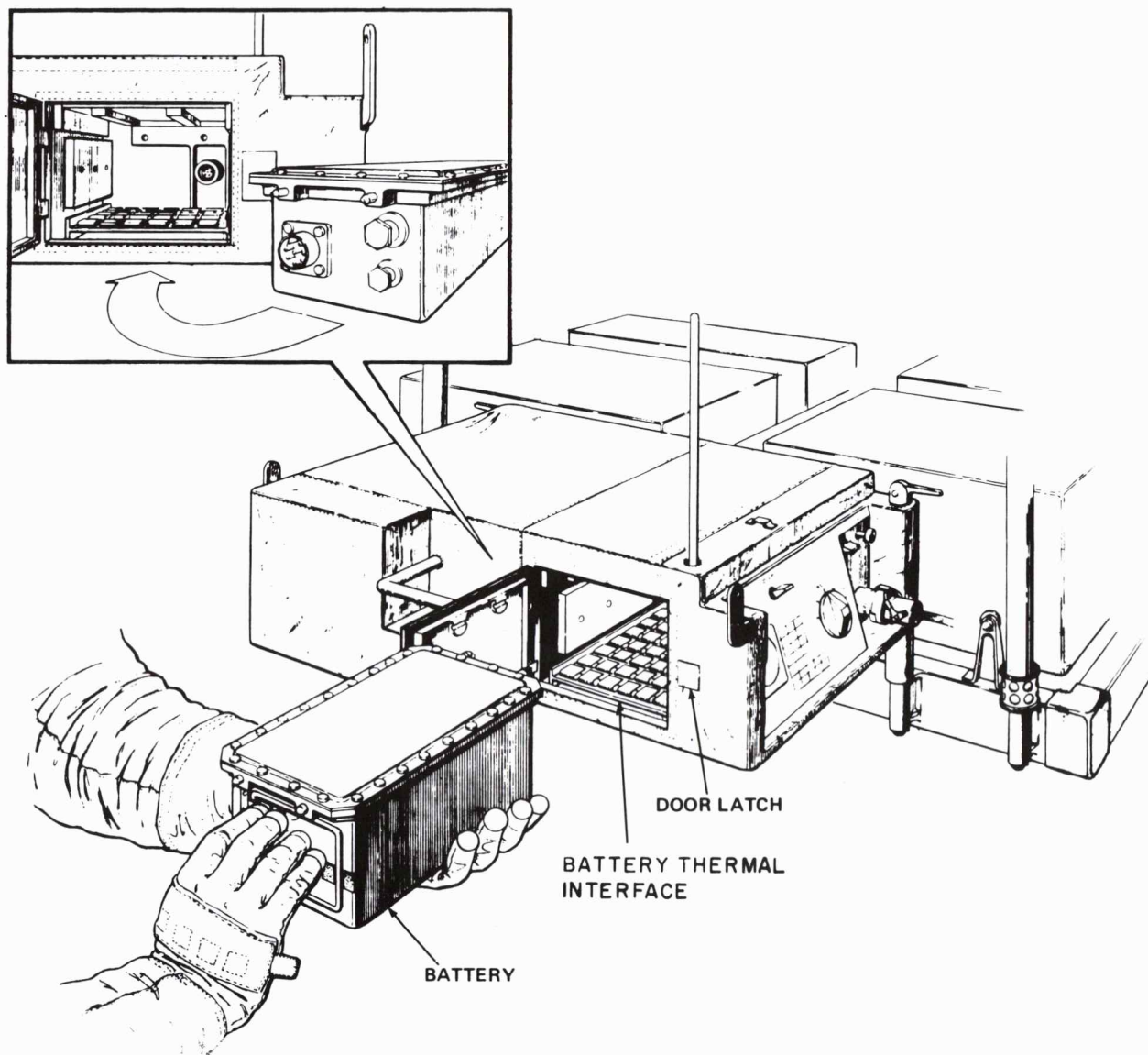


LCRU THERMAL BLANKET



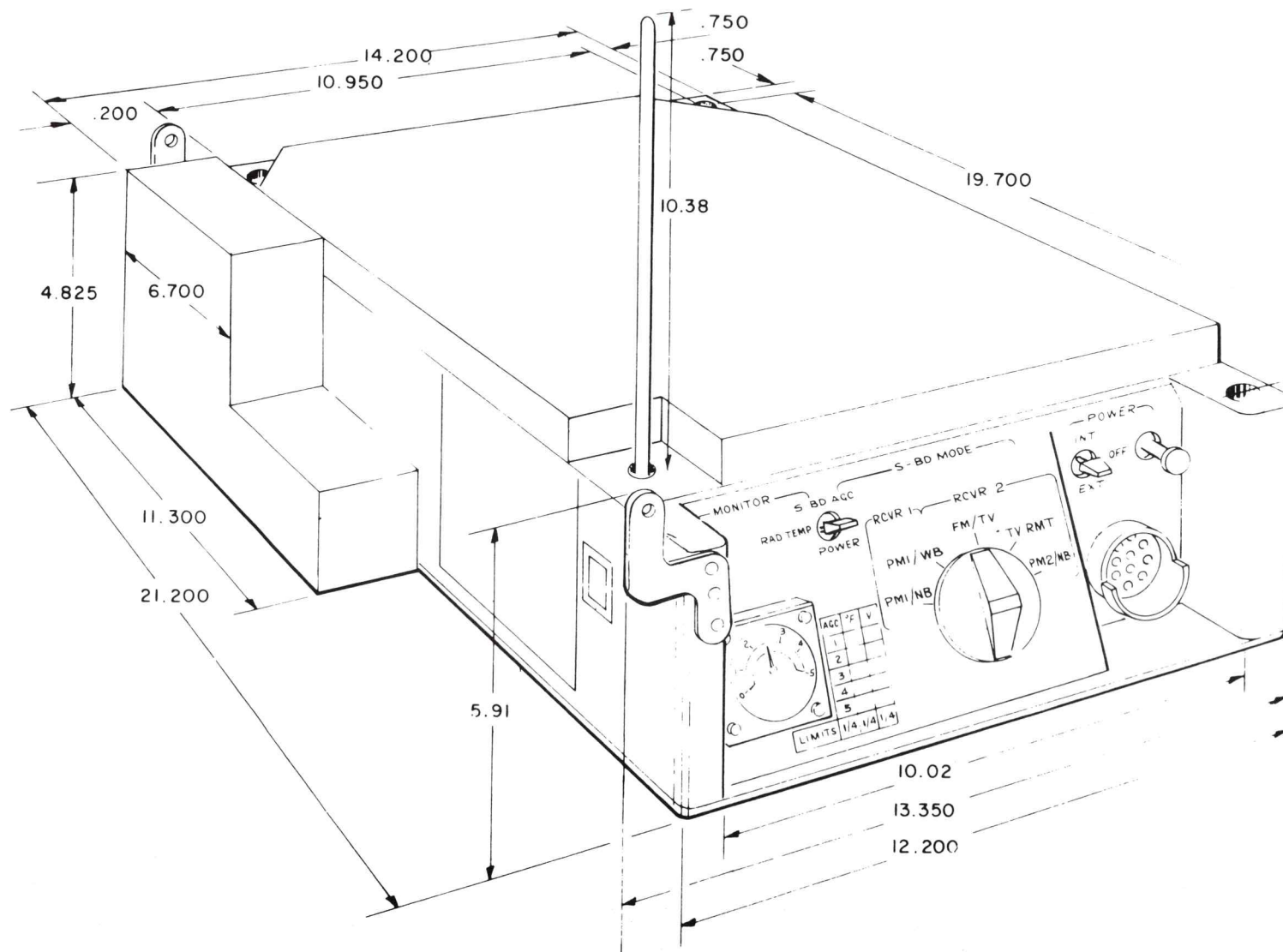


LCRU BATTERY REPLACEMENT



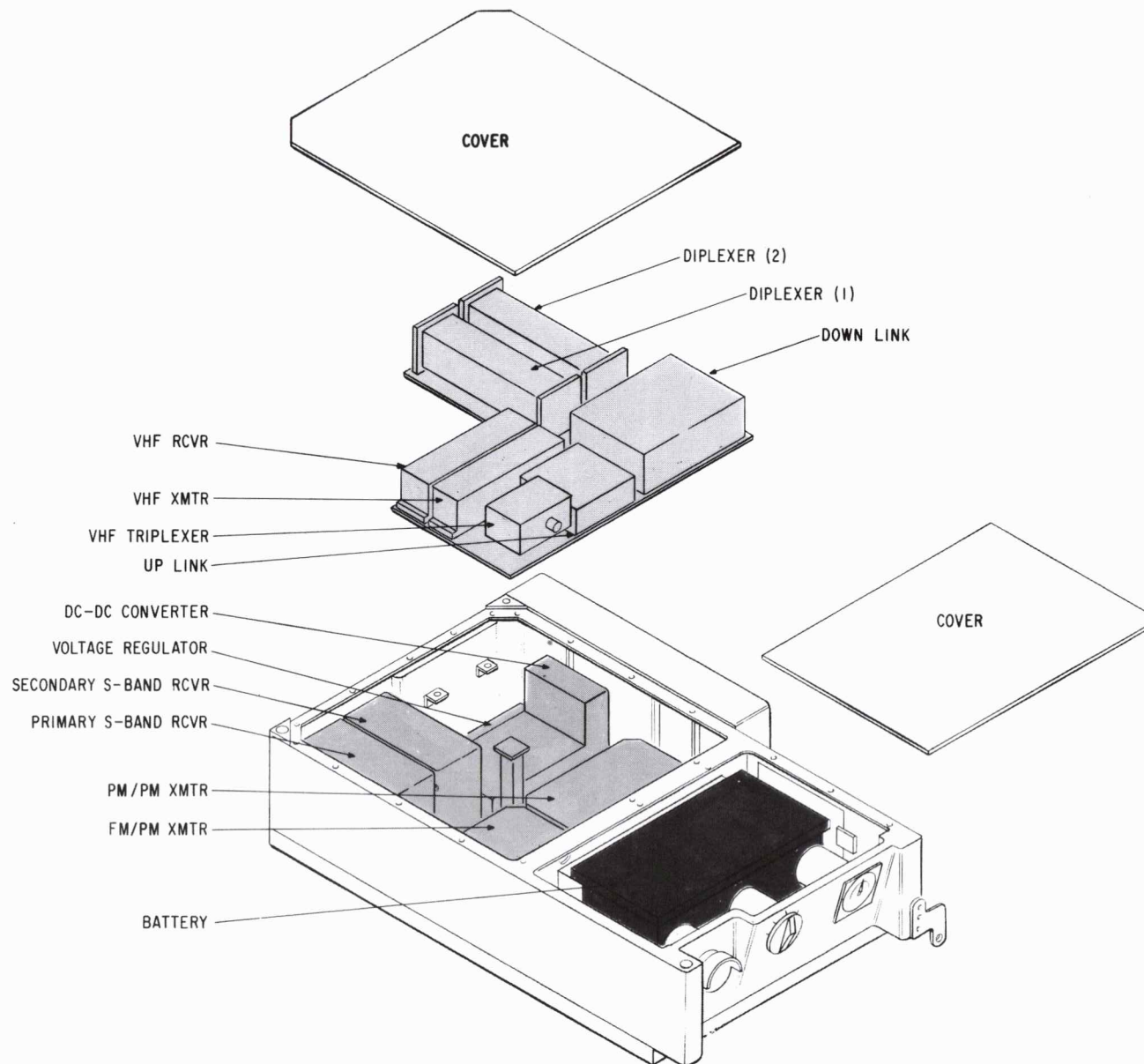
RCA

LCRU UNIT



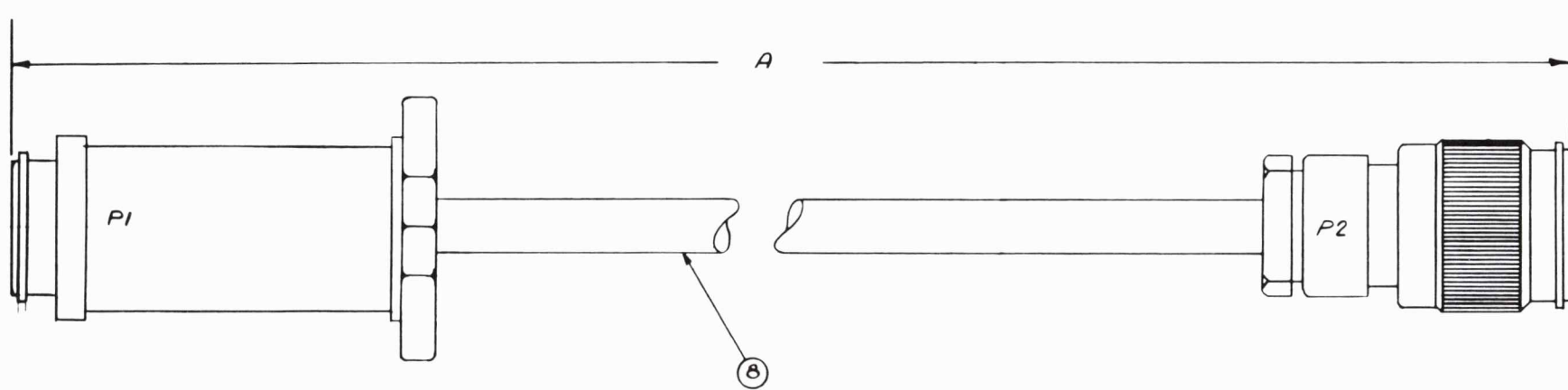


LCRU SUBASSEMBLY ARRANGEMENT



RCA

CABLE ASSY ANTENNA S-BAND HI & LOW GAIN 8670967



ELECTRICAL REQUIREMENTS		
GROUPS	501/503	502/504
ATTENUATION(db)	1.10 MAX	1.40 MAX
VSWR	1.10 MAX	1.16 MAX
FREQ (MHZ)	2100.8-2266.5	2100.8-2266.5

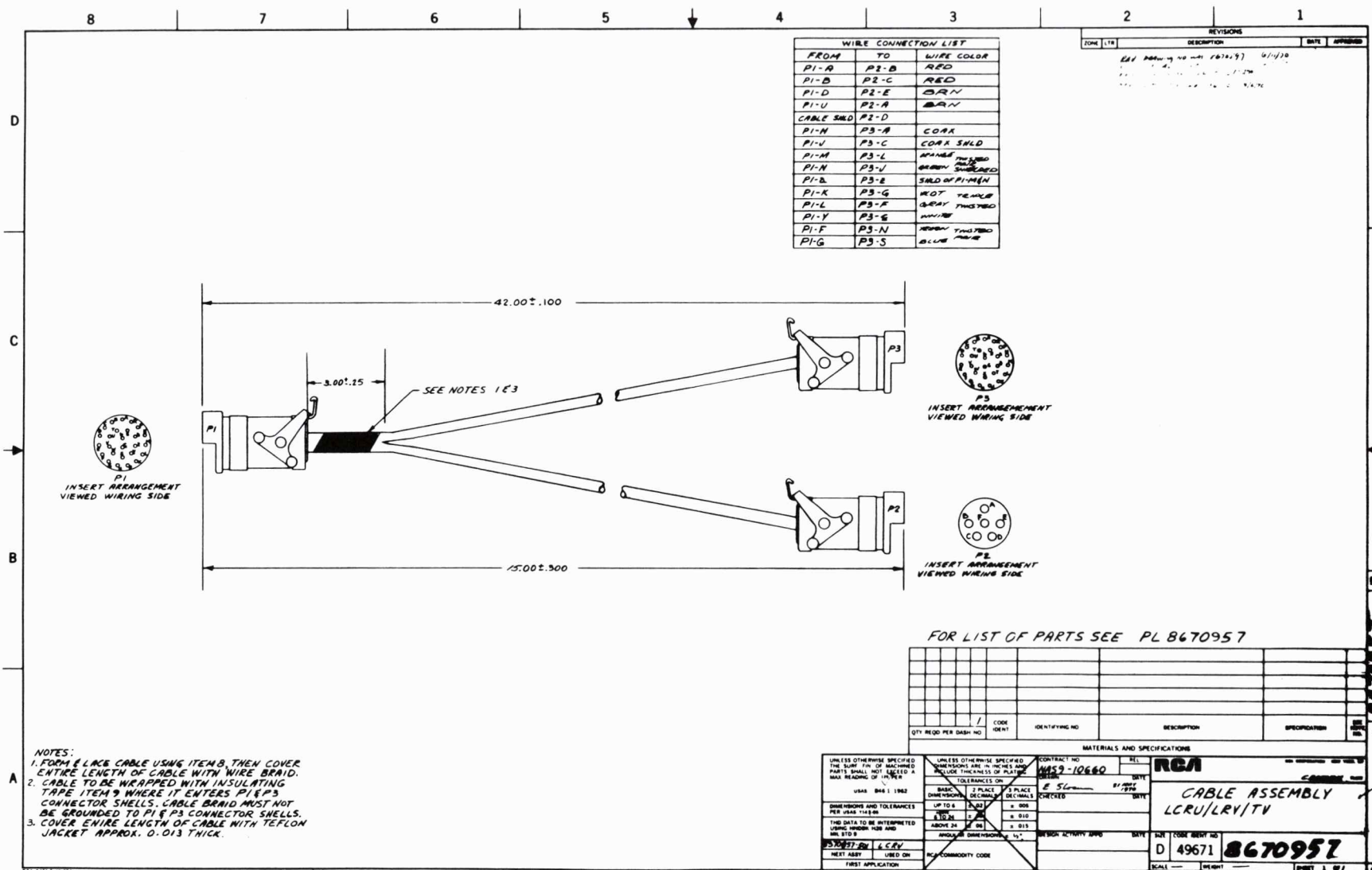
DIM "A"	
GROUP	GROUP
501/503	502/504
84.00 $\pm$ 1.00	96.00 $\pm$ 1.00

RCA

CABLE ASSEMBLY LCRU/LRV/TV

8670957

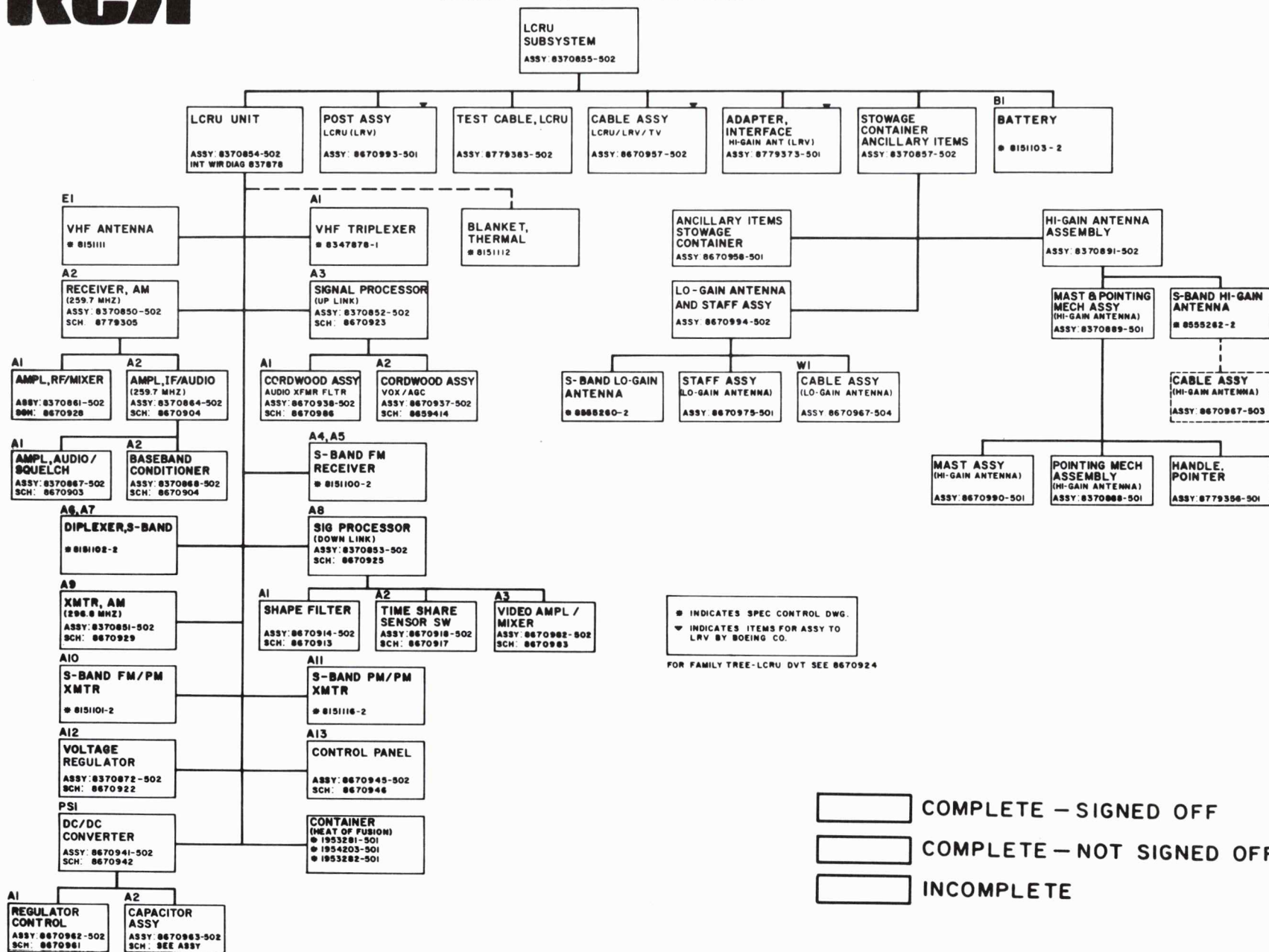
5-16





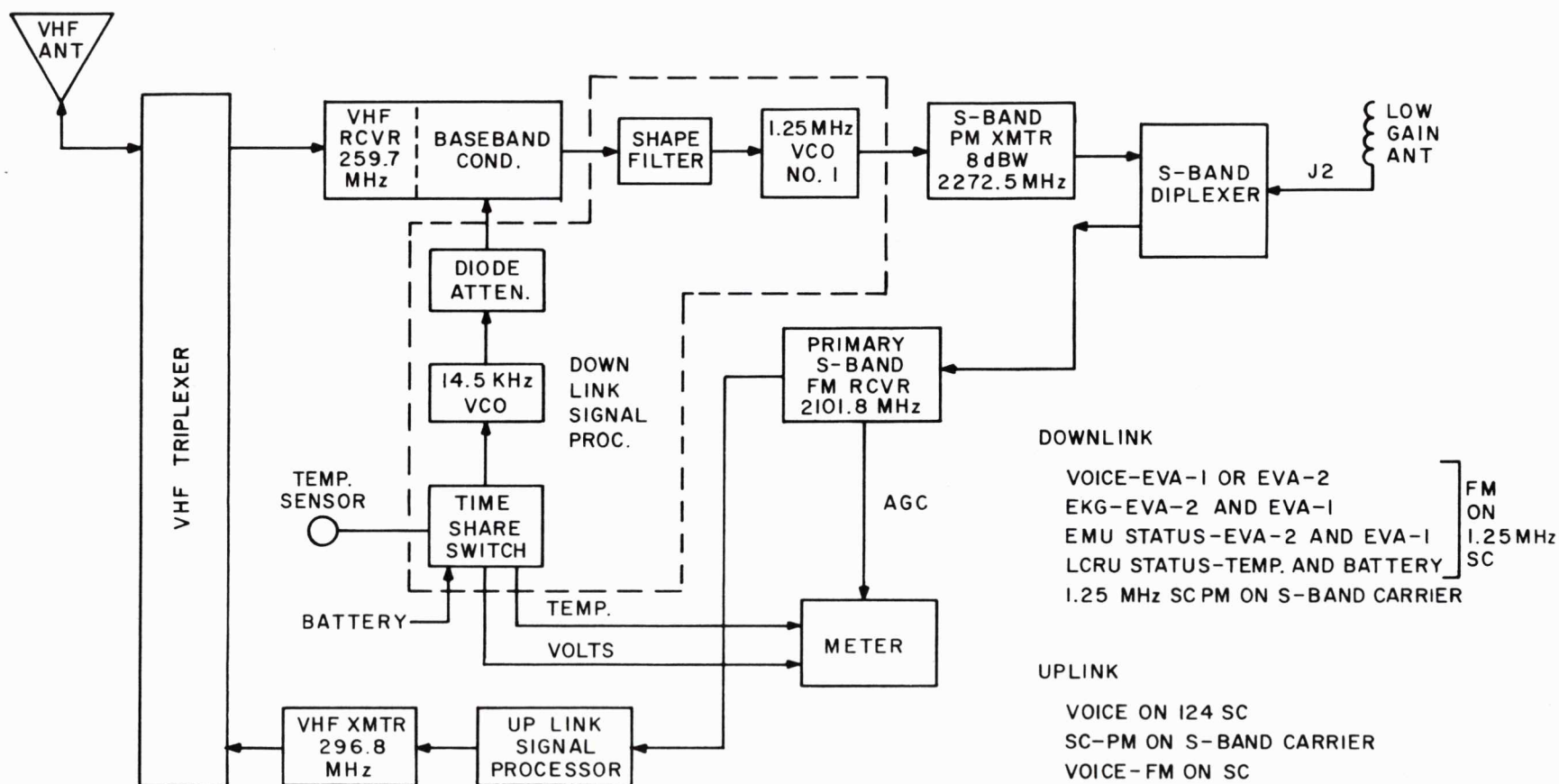
LCRU DRAWING STATUS

FAMILY TREE- LCRU FLIGHT



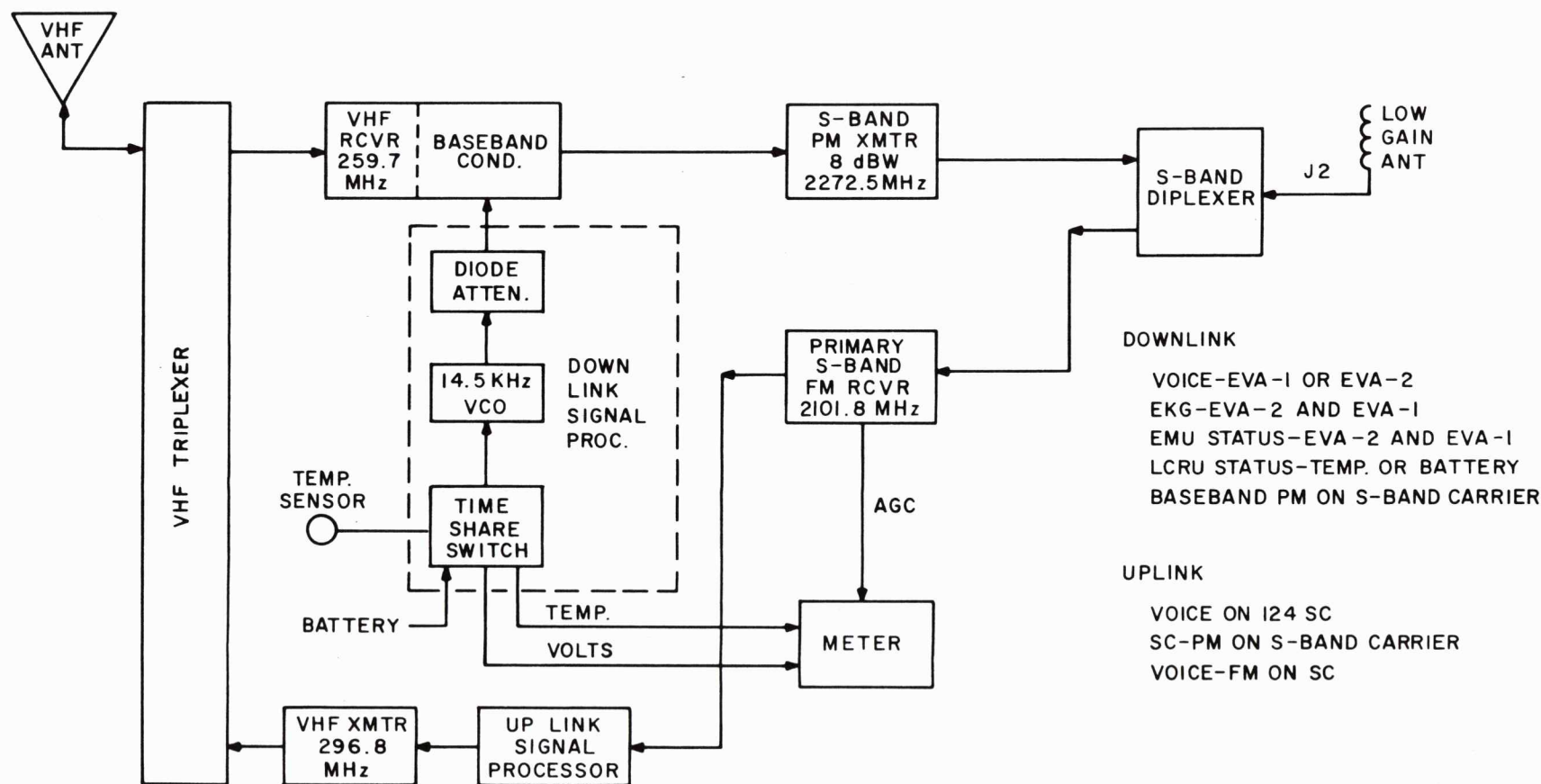


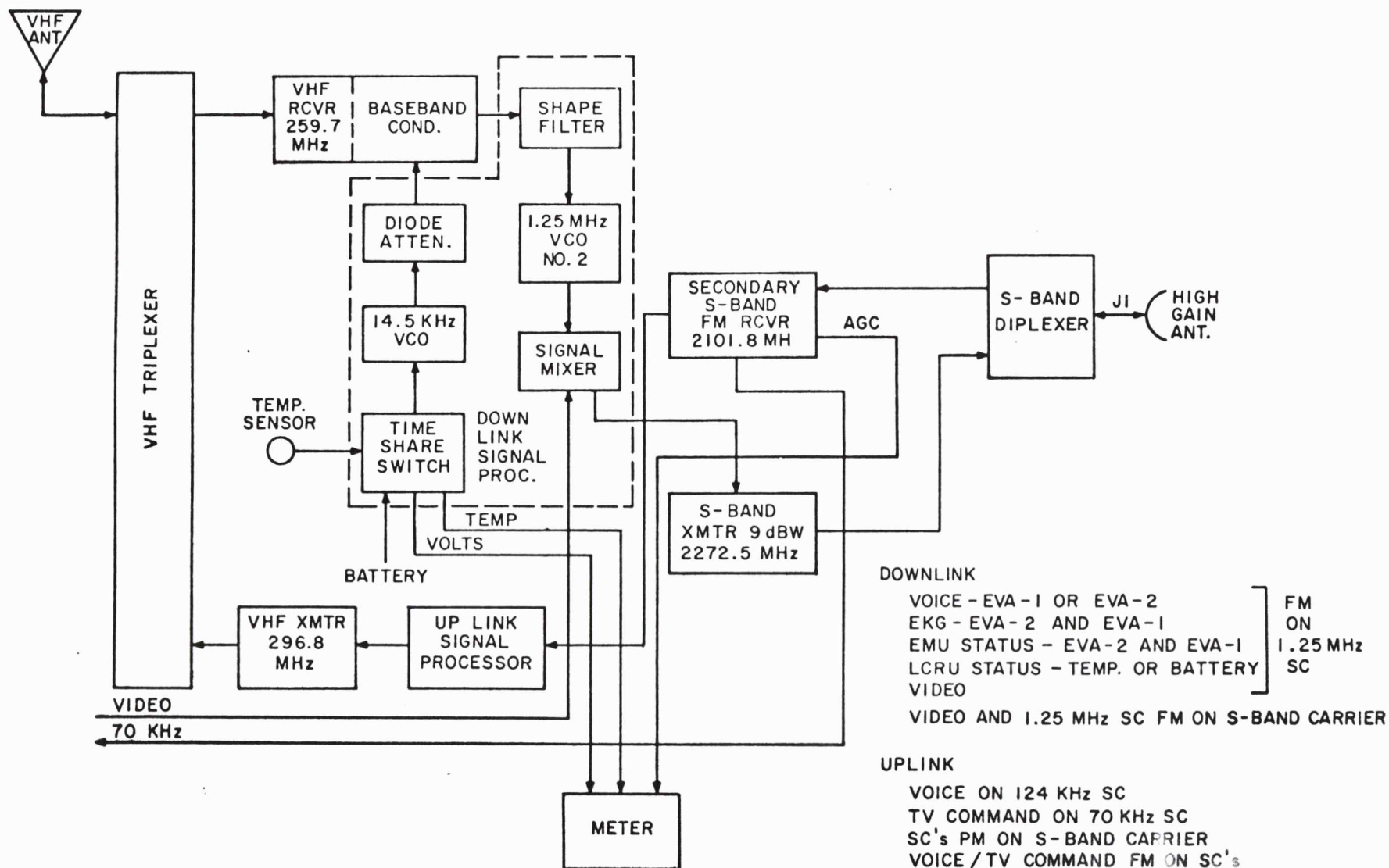
LCRU BLOCK DIAGRAM PM1/WB





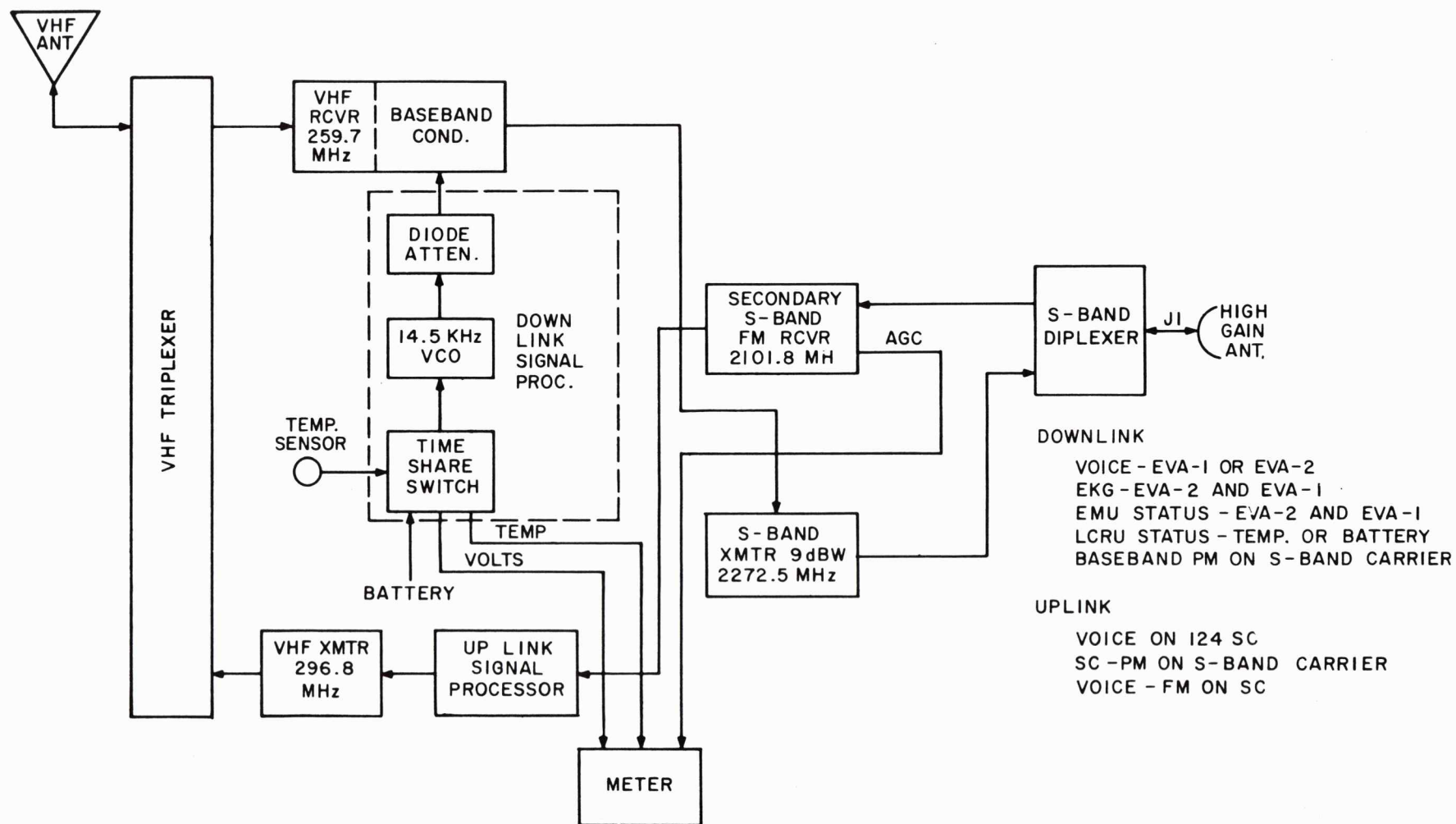
LCRU BLOCK DIAGRAM PM1/NB





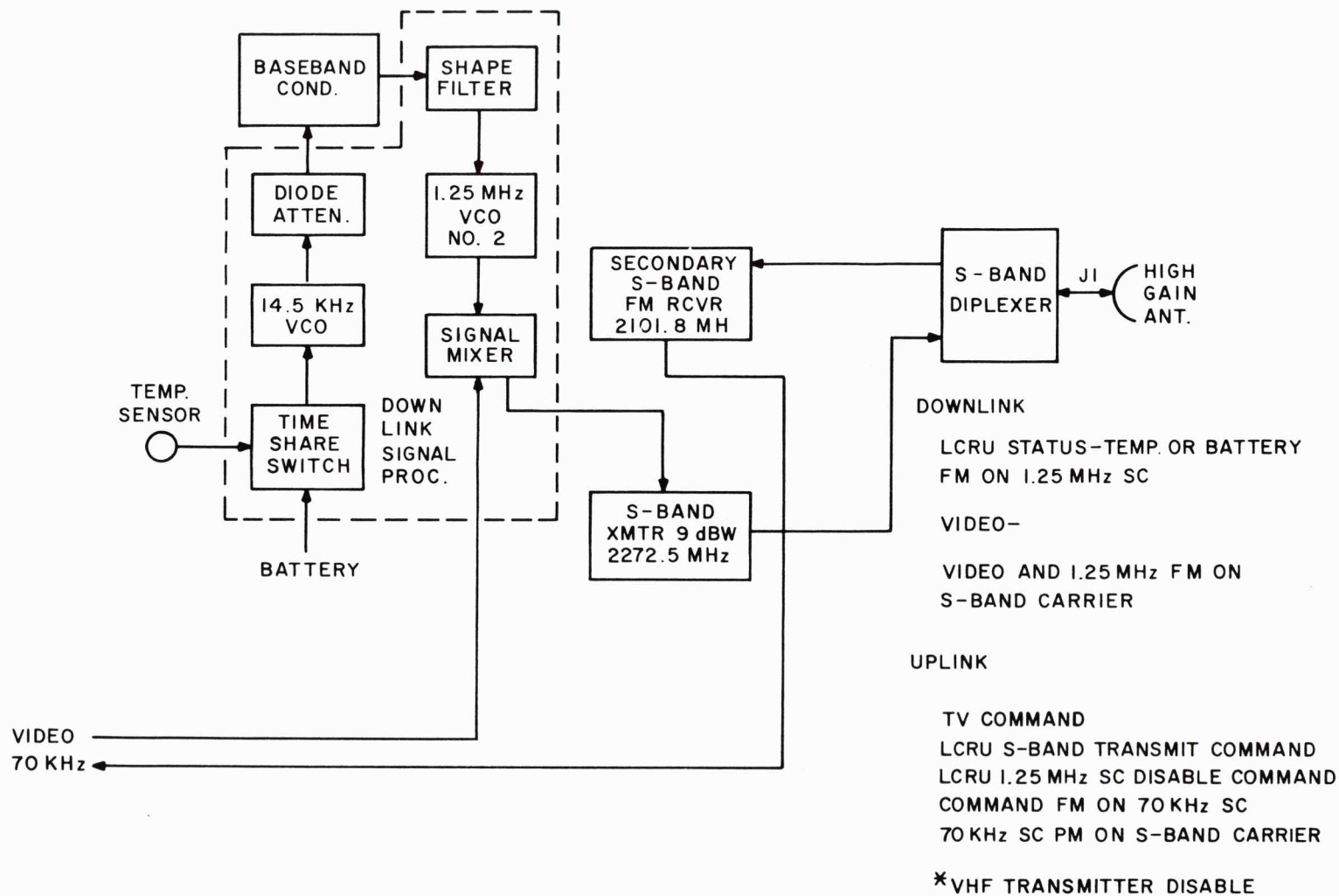


LCRU BLOCK DIAGRAM PM2 / NB





LCRU BLOCK DIAGRAM TV RMT (STANDBY)





LCRU THERMAL CONSIDERATIONS

Thermal Design Includes:

- Radiation cooling - Secondary surface mirrors.
- Thermal adsorption capability - Thermal Phase change material.
- Thermal Blanket - 0, 35, 65, 100% opening.
- Temperature monitoring and telemetry.



LCRU THERMAL CONSIDERATIONS (CONTINUED)

Analyses shows that:

- LCRU on LRV maintained within design temperature range for:
 - A. Worst-case hot and cold mission traverse
 - B. Worst expected mission time lines
- LCRU in handcarry mode within design temperature range for minimum 3.5 hour walk at high sun. Extendable with pre-walk cooldown.
- LCRU has minimum one hour walk capability in event of LRV failure.
- LCRU on Lunar surface within design temperature range for at least 15 minutes at worst-case hot conditions.
- Solar Radiation Thermal Vacuum tests preliminary evaluation supports computer thermal analysis.
- Nominal use of TV Standby can be had between sorties but not over worst ranges. Must have clean radiator.



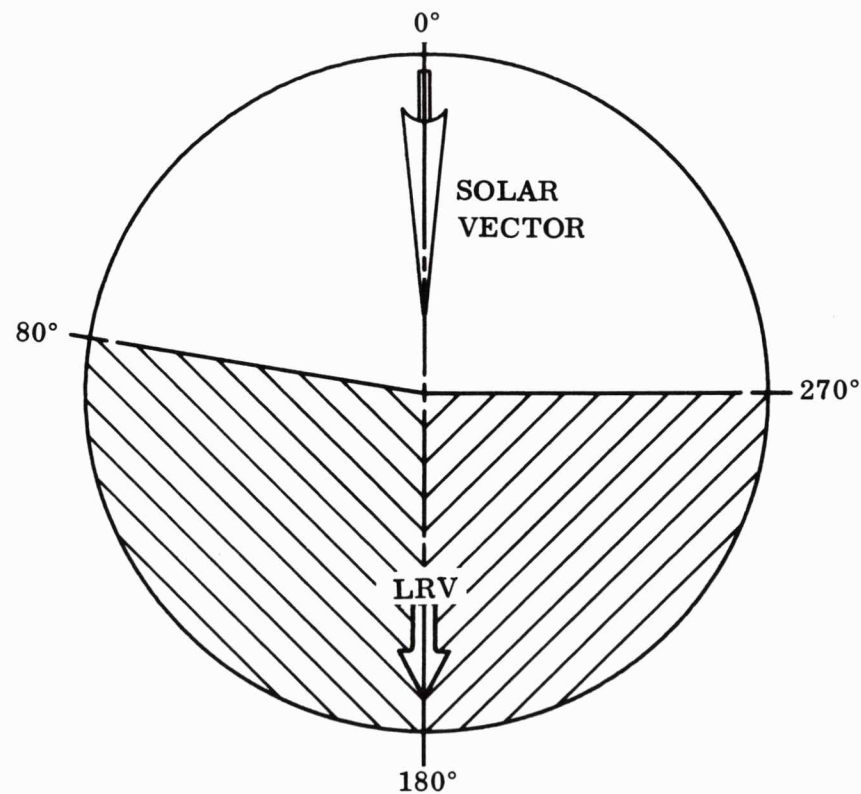
LCRU THERMAL CONSIDERATIONS (CONTINUED)

Operational Requirements are:

- Astronaut interaction required to adjust blankets only before and after sortie
- For walk mode, Astronaut removes thermal radiator cover and keeps radiator surface away from sun wherever possible.
- LCRU prefers LRV part between sorties with sun in rear hemisphere of LRV. (LRV has parking constraints resulting in net acceptable parking attitude at right side of the LRV.
- LCRU has no parking constraints during sortie.



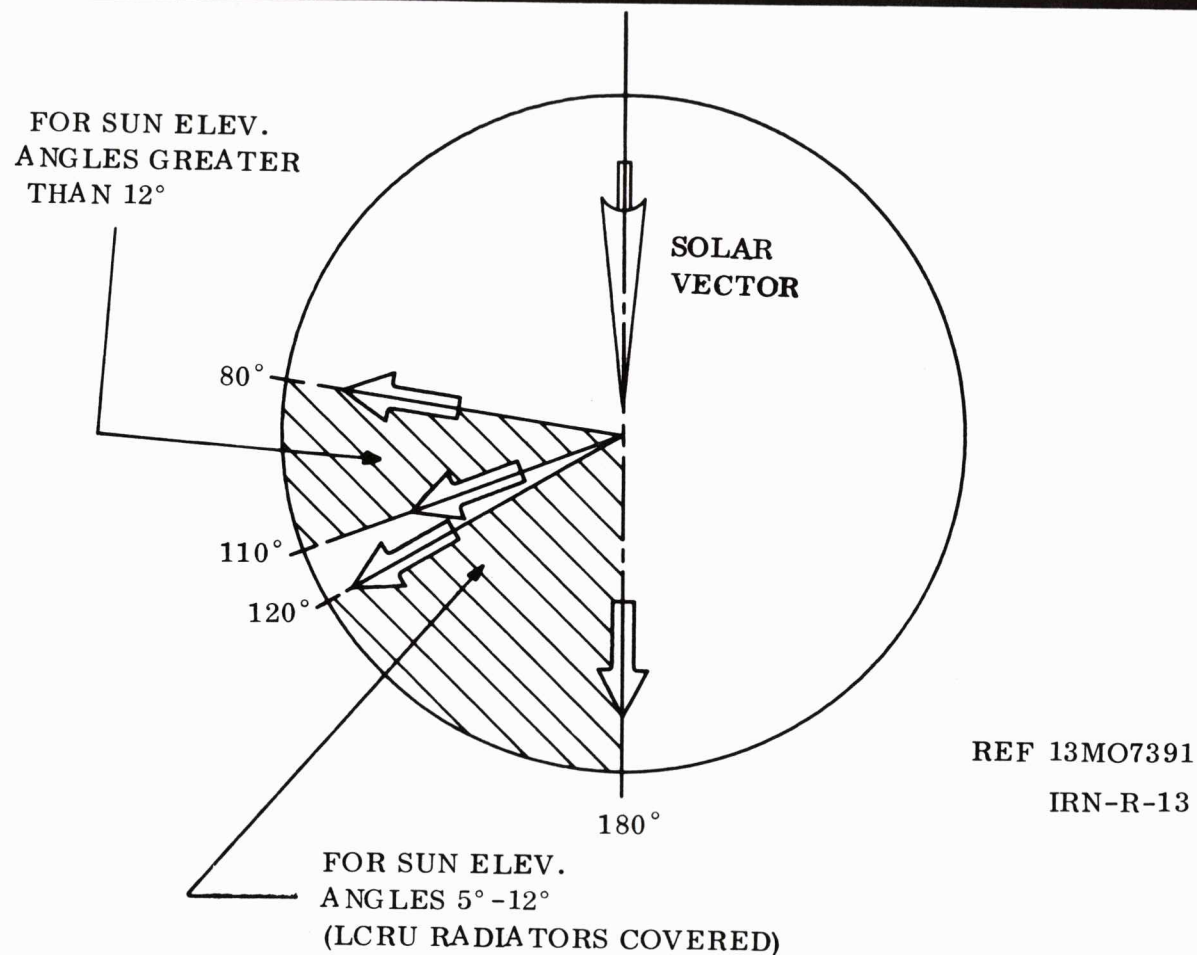
LCRU PARKING ORIENTATION CONSTRAINTS



SHADED AREAS INDICATE THE LRV PARKING ATTITUDES
ACCEPTABLE FOR THE LCRU.



LCRU/LRV PARKING ORIENTATION CONSTRAINTS



SHADED AREAS INDICATE THE PARKING ATTITUDES ACCEPTABLE TO THE LRV AND THE LCRU.

6.0 PERFORMANCE SUMMARY



LCRU SUBSYSTEM DESCRIPTION

GENERAL

Pressurized Case	7.5 PSIA/100% Nitrogen
Redundancy	Duplication of Critical Subassemblies (Except VHF)
Power	Internal or External Option
Operational Modes	Five Modes
Deployment	Quick Simple Deployment of Preassembled Units
Human Factors	Clearly Marked Functions, Positive Lock/Unlock, Positive Action Detents.
Crew Action Requirements	Minimized due to Pre-Assembly - Limited to Antenna Pointing, Mode Switching, Occasional Blanket Adjustment.
Thermal Design	Enables Operation in Lunar Environment Over 5° to 60° Sun Angles.

MECHANICAL

Weight (including antennas and cables)	70 lbs. maximum
Size (LCRU Unit)	22 x 13 x 5.625
Mechanical Compatibility	LM/LRV/TV



LCRU SUBSYSTEM DESCRIPTION (CONT.)

ELECTRICAL

DOWNLINK

VHF Input Frequency	259.7 MHz
VHF Input Power	0 dbm to -90 dbm
S -Band Transmit Frequency	2265.5 MHz
S-Band Transmit Power	8 W or 6 W to Antenna
Antenna Gain (high gain)	23 db (5° beamwidth)
Antenna Gain (low gain)	6.5 db (60° beamwidth)
Data	TV, EVCS Voice, EVCS Subcarriers, and LCRU Telemetry.

UPLINK

S-Band Receive Frequency	2101.8 MHz
S-Band Receive Sensitivity	-98 dbm
VHF Transmit Frequency	296.8 MHz
VHF Transmit Power	0.5 W to Antenna
VHF Antenna Gain	-3 db
Data	Voice & TV Commands



LCRU SUBSYSTEM DESCRIPTION (CONT.)

ENVIRONMENTAL

Temperature	35°F to 120°F (Modules Tested 0°F to 160°F)
Vibration (operational)	.25g sine 2-20 Hz
Vibration (stowed)	22.8g RMS
Shock (stowed)	30g Sawtooth

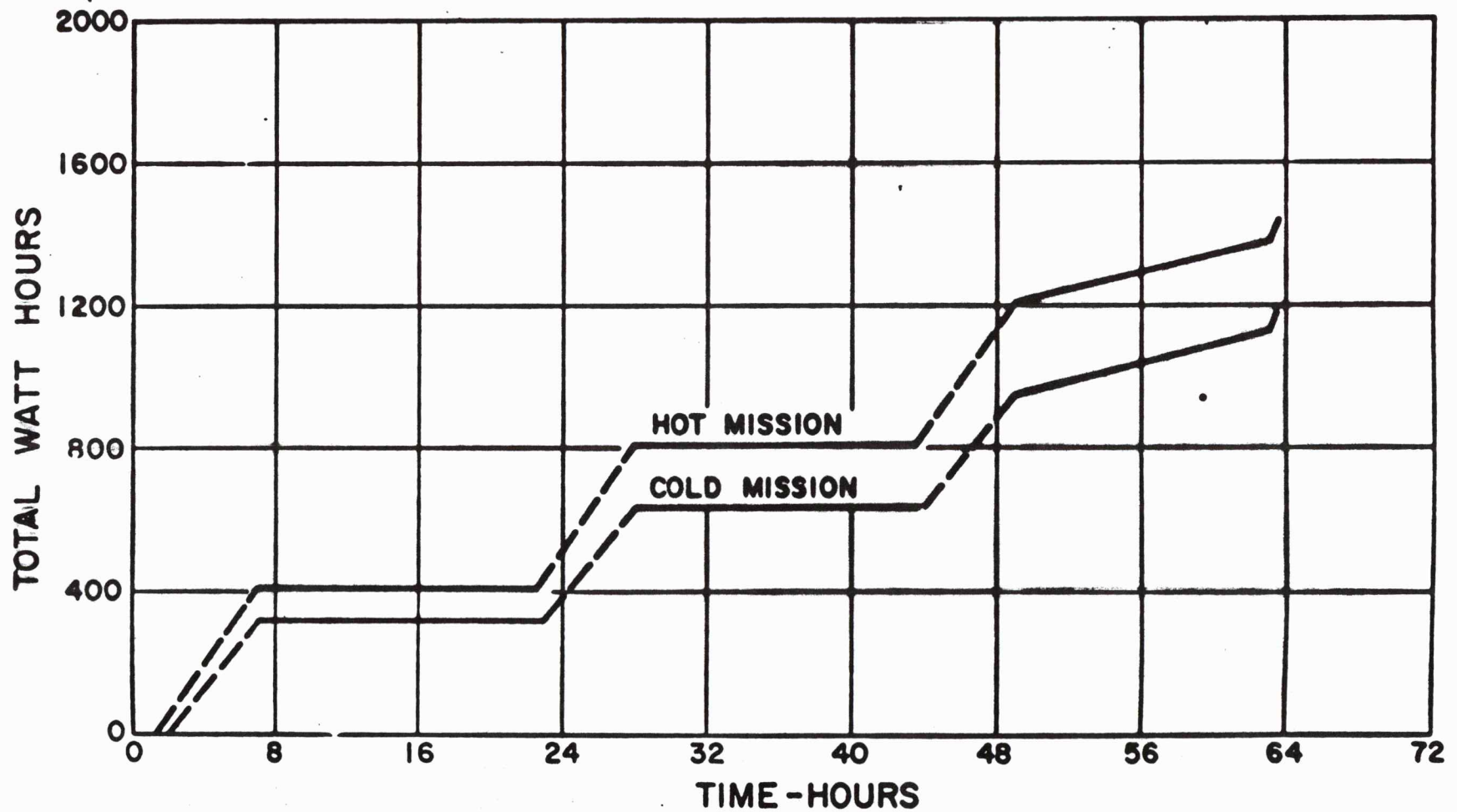


LCRU POWER REQUIREMENTS – WATTS

SUBASSEMBLY	PM1/NB	PM1/WB	FM/TV	TV RMT (STANDBY)	PM2/NB
VHF RECEIVER	1.17	1.17	1.17	1.17	1.17
VHF TRANSMITTER	4.10	4.10	4.10	.35	4.10
S-BAND RECEIVER	1.00	1.00	1.00	1.00	1.00
PM/PM TRANSMITTER	47.8	47.8	0.22	0.22	0.22
FM/PM TRANSMITTER	0.22	0.22	53.7	0.22	53.7
UP LINK SIGNAL PROCESSOR	0.15	0.15	0.15	0.15	0.15
DOWN LINK " "	1.70	2.40	2.40	2.40	1.70
VOLTAGE REGULATOR	2.29	2.42	2.42	1.07	2.29
CAMERA ASSEMBLY (STILL)	--	--	(21.0)	0.00	--
CAMERA ASSEMBLY (IN MOTION)	--	--	21.0-2.0		
TOTAL WATTS AT NOMINAL BATTERY VOLTAGE	58.0	59.4	88.3	13.35	64.5
POWER REQUIREMENTS USING EXTERNAL POWER					
LCRU	58.0	59.4	88.3	13.35	64.5
DC DC CONVERTER	14.7	14.9	22.1	3.35	10.1
TOTAL WATTS	73.3	74.3	110.4	16.73	80.0

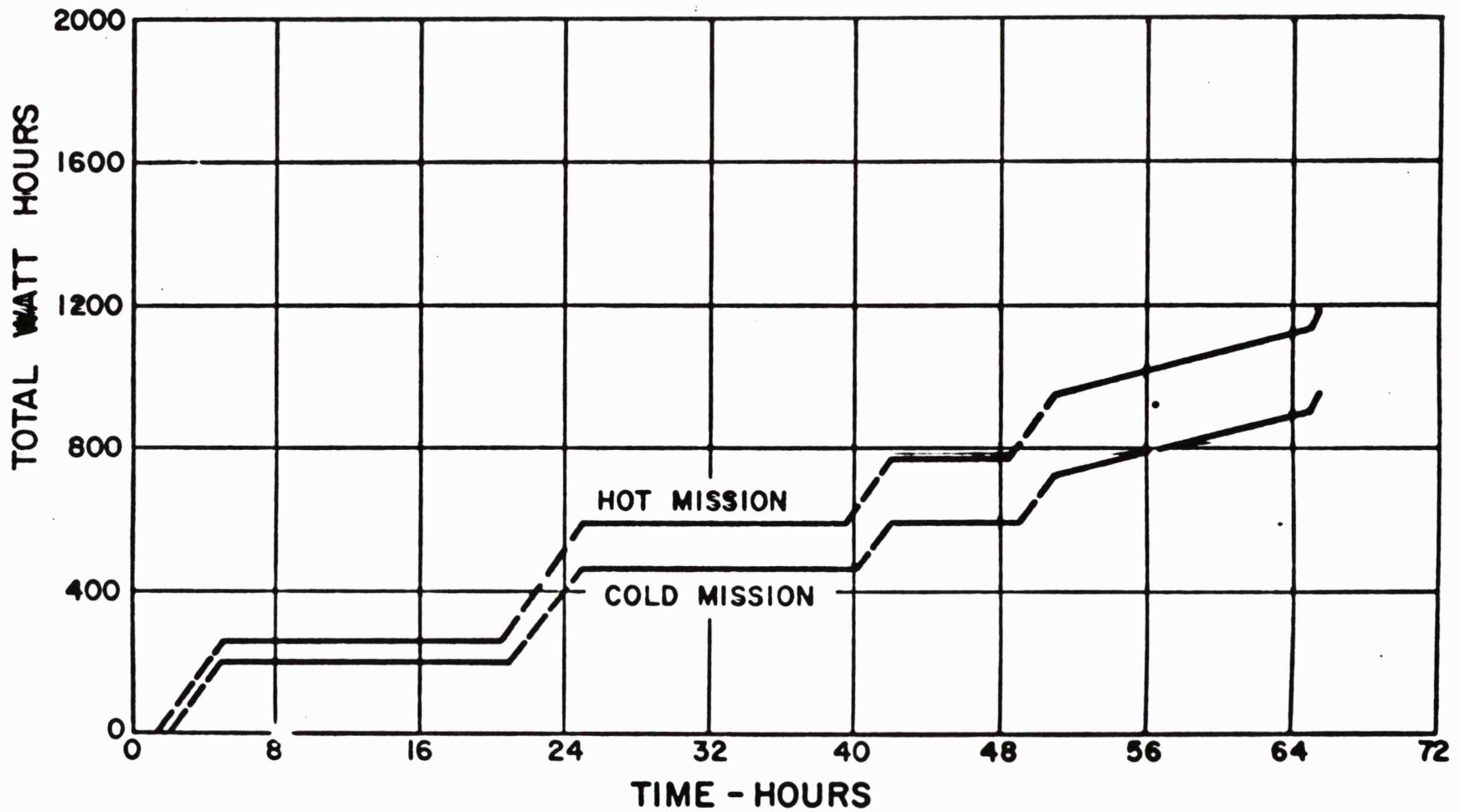


WATT HOURS VS TIME TIMELINE I



RCA

WATT HOURS VS TIME TIMELINE 2





LCRU UNIT WEIGHT ANALYSIS ENGINEERING MODEL

<u>ITEM</u>	<u>WEIGHT, LB.</u>
LCRU UNIT ENGINEERING MODEL	43.000
LESS: WAX PACKAGES THERMAL BLANKET BATTERY HEAT SINK VHF ANTENNA	
WAX PACKAGES	9.270
THERMAL BLANKET	8.875
BATTERY HEAT SINK	.750
VHF ANTENNA	.250
TOTAL LCRU UNIT	<u>54.145</u>



LM INTERFACE

STOWED WEIGHT

WEIGHT, LB

	<u>PDR</u>	<u>TI-3</u>	<u>TI-4</u>	<u>ICD</u>	<u>CDR</u>
● LCRU UNIT	54.790	54.143	52.54	55.0	54.145
● STOWAGE CONTAINER W/CONTENTS	<u>17.106</u>	<u>17.965</u>	<u>17.62</u>	<u>18.0</u>	<u>18.995</u>
TOTAL	71.896	72.108	70.16	73.0	73.140

NOTE: 1. REPLACEABLE BATTERIES NOT INCLUDED
2. LCRU MOUNTING LEGS, POWER
CABLE AND MAST INSERT NOT INCLUDED
IN TI-3, 4 AND CDR TOTAL



LCRU HAND CARRY MODE

HAND CARRY WEIGHT

WEIGHT LB

	<u>PDR</u>	<u>TI-3</u>	<u>TI-4</u>	<u>CDR*</u>
LCRU	54.790	54.143	52.540	54.145
LOW GAIN ANTENNA	.820	.820	.820	.720
LOW GAIN ANTENNA POSITIONING MECHANISM AND ARM	.440	.440	.440	.250
CABLE	<u>.756</u>	<u>.865</u>	<u>.865</u>	<u>.680</u>
TOTAL	56.806	56.268	54.665	55.795
MOONWEIGHT	9.5	9.4	9.1	9.3

*WEIGHTS ARE ACTUALS FOR ENGINEERING MODEL ITEMS



LCRU PERFORMANCE CAPABILITY

SUBASSEMBLY COMPATIBILITY DESIGN

LCRU is constructed and tested to optimize "end to end" relay subsystem performance over operational temperature range.

TV INTERFACE COMPATIBILITY

- A. LCRU design is capable of meeting TV ICD performance requirements.
- B. Close coordination with RCA AED offers maximum TV compatibility.



LCRU PERFORMANCE CAPABILITY, CONT.

LM INTERFACE COMPATIBILITY

- a. LCRU design meets LM ICD requirements. (Except vibration maybe a problem)
- b. LCRU, spare batteries, and stowage container mounting provisions on LM MESA have been coordinated with GAC and are satisfactory.



LCRU PERFORMANCE CAPABILITY (CONT.)

LRV INTERFACE COMPATABILITY

- A. Mechanical, thermal, and electrical design conforms with known LRV ICD requirements.
- B. EMI/grounding scheme eliminates ground currents.
- C. Operation from LRV power is an optional capability.
- D. Pre-assembly of High Gain Antenna assembly and Low Gain Antenna assembly minimizes crew operations.
- E. TV mounting on LRV is identical with HGA mounting for maximum design similarity.
- F. Quick release of LCRU from mounting legs and provision of handle permits minimum deployment time for hand carry mode.
- G. Quick disconnect mechanism on LGA permits rapid deployment on LCRU for hand carry mode.



LCRU PERFORMANCE CAPABILITY, CONT.
LCRU EM PERFORMANCE COMPATIBILITY
WITH LCRU SUBASSEMBLY SPECIFICATION

<u>REQUIREMENT</u>	<u>ACHIEVED</u>
PM/PM Transmitter Performance (6 Watts, min. power output)	X
FM/PM Transmitter Performance (8 Watts, min. power output)	X
VHF Transmitter Performance (.5 Watts, min. power output)	X
VHF Receiver Performance (-106 dbm sensitivity)	X
VHF Triplexer Performance (Tx/Rx isolation)	X
S-Band Diplexer Performance (Tx/Rx isolation)	X
Downlink Signal Processor Performance	X
Telemetry Requirements (temperature and voltage)	X
Uplink Signal Processor Requirements (VHF transmitter control)	X
VHF Antenna Performance	X
Low Gain Antenna Performance	X
HGA Performance (23 db gain)	X



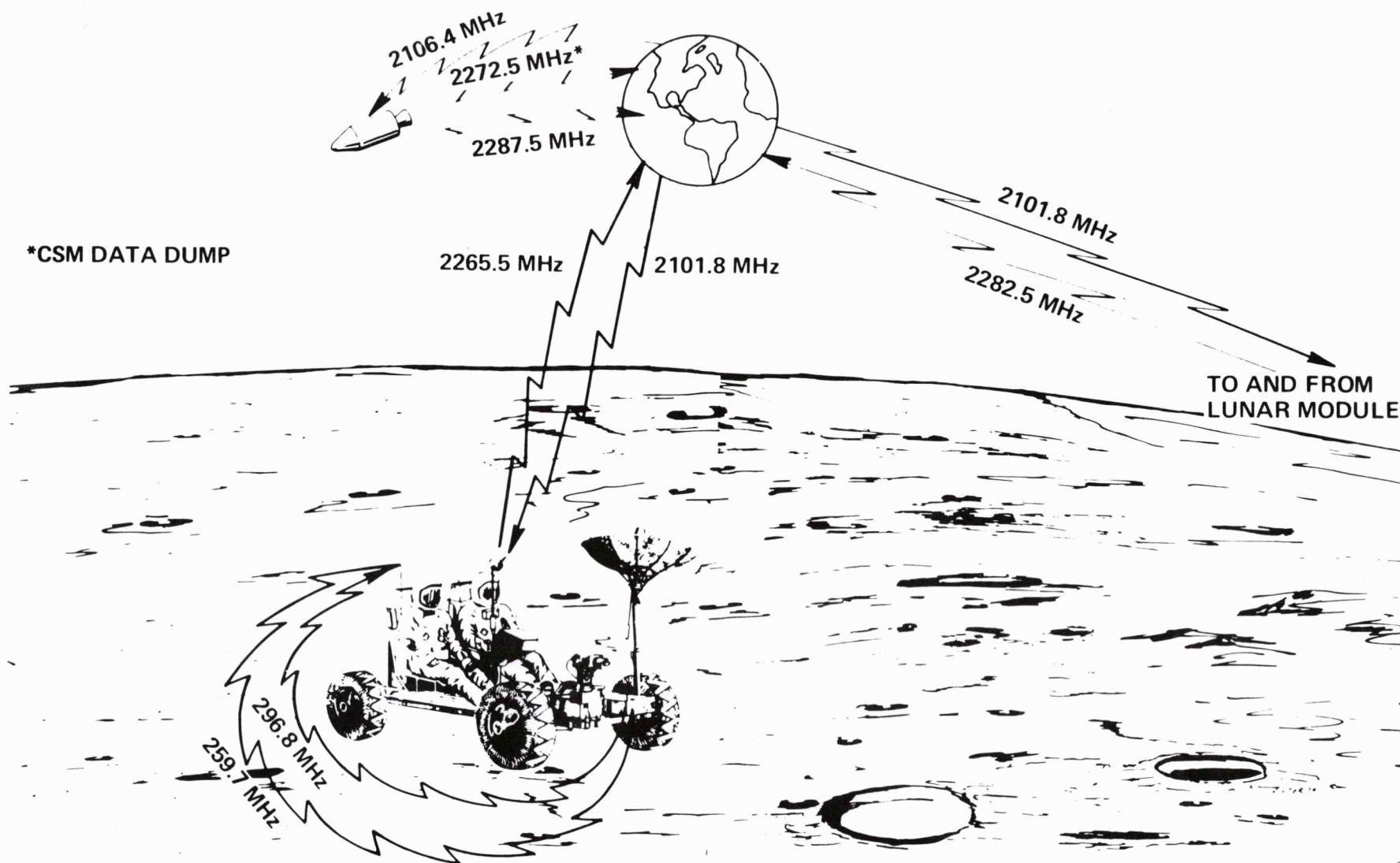
LCRU PERFORMANCE CAPABILITY, CONT.

Although the LCRU packaging is tight and consistent with space packaging techniques, manufacturability of the LCRU and its subassemblies has been implemented to the maximum extent and maintainability provisions (test point accessibility, DTV accessibility, etc.) has been optimized. LCRU failure modes have been analyzed and eliminated to the maximum extent possible consistent with program requirements.

7.0 ELECTRICAL DESIGN

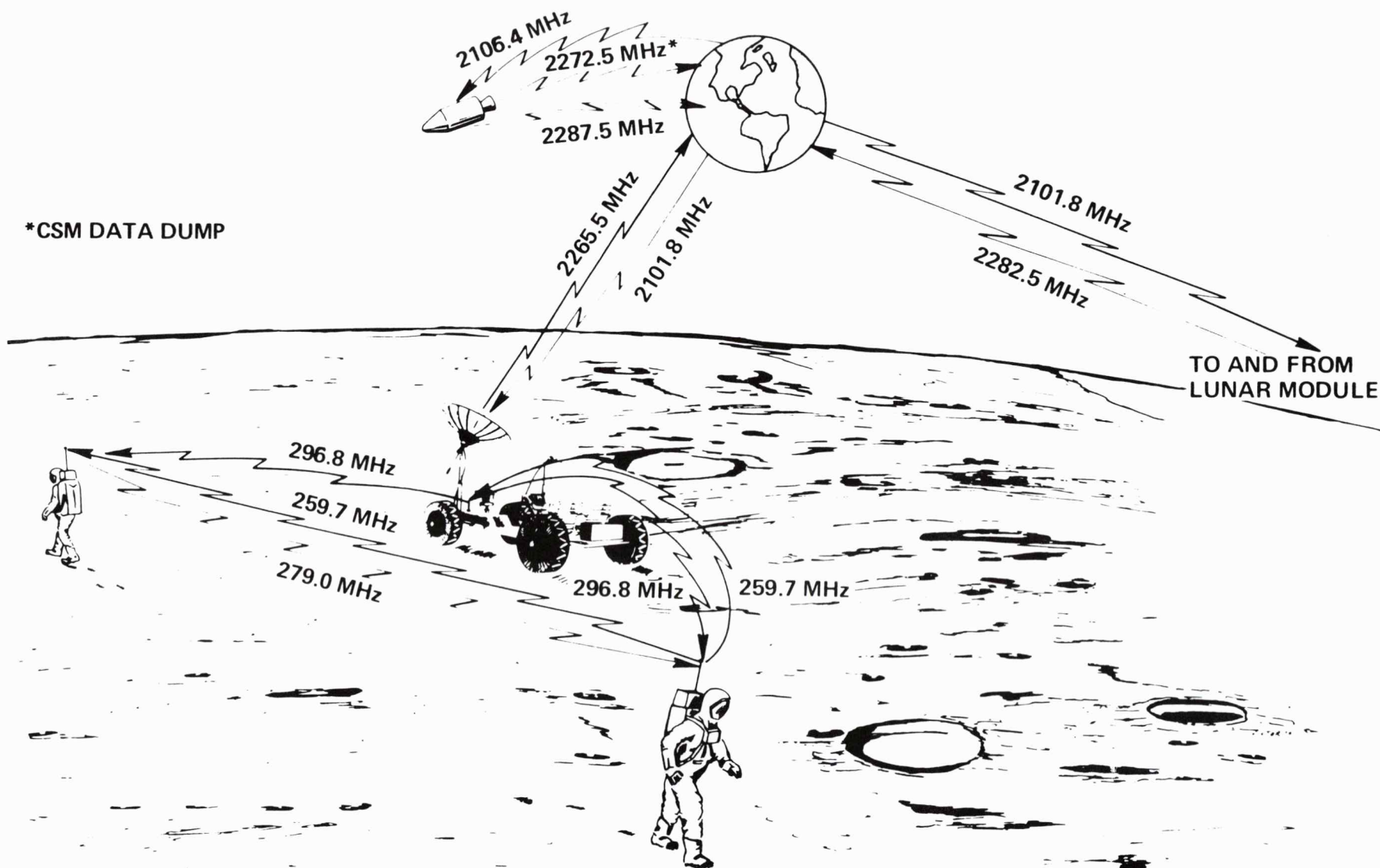


LCRU IN MOBILE OPERATION ON LRV



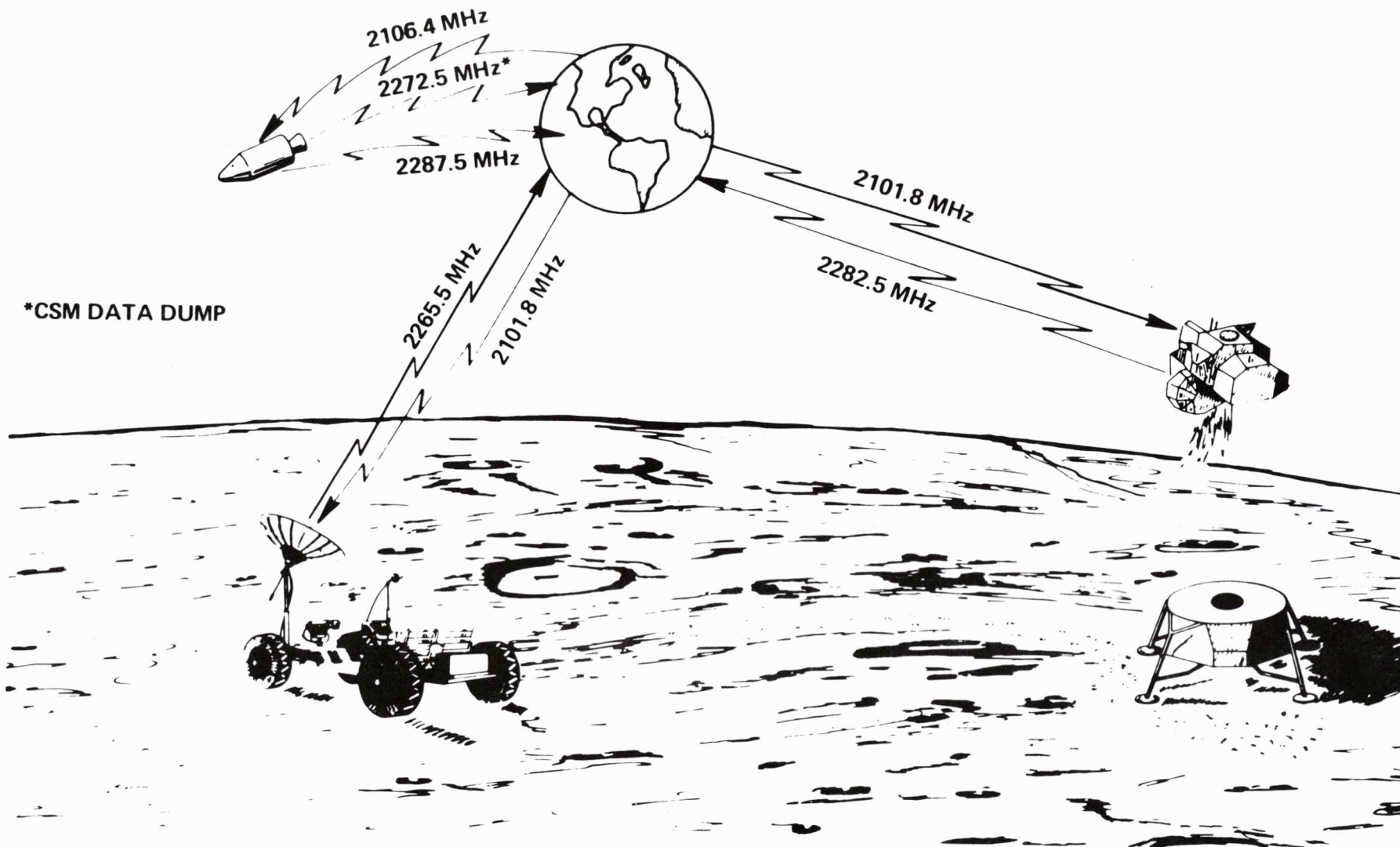


LCRU IN FIXED BASE OPERATION ON LRV



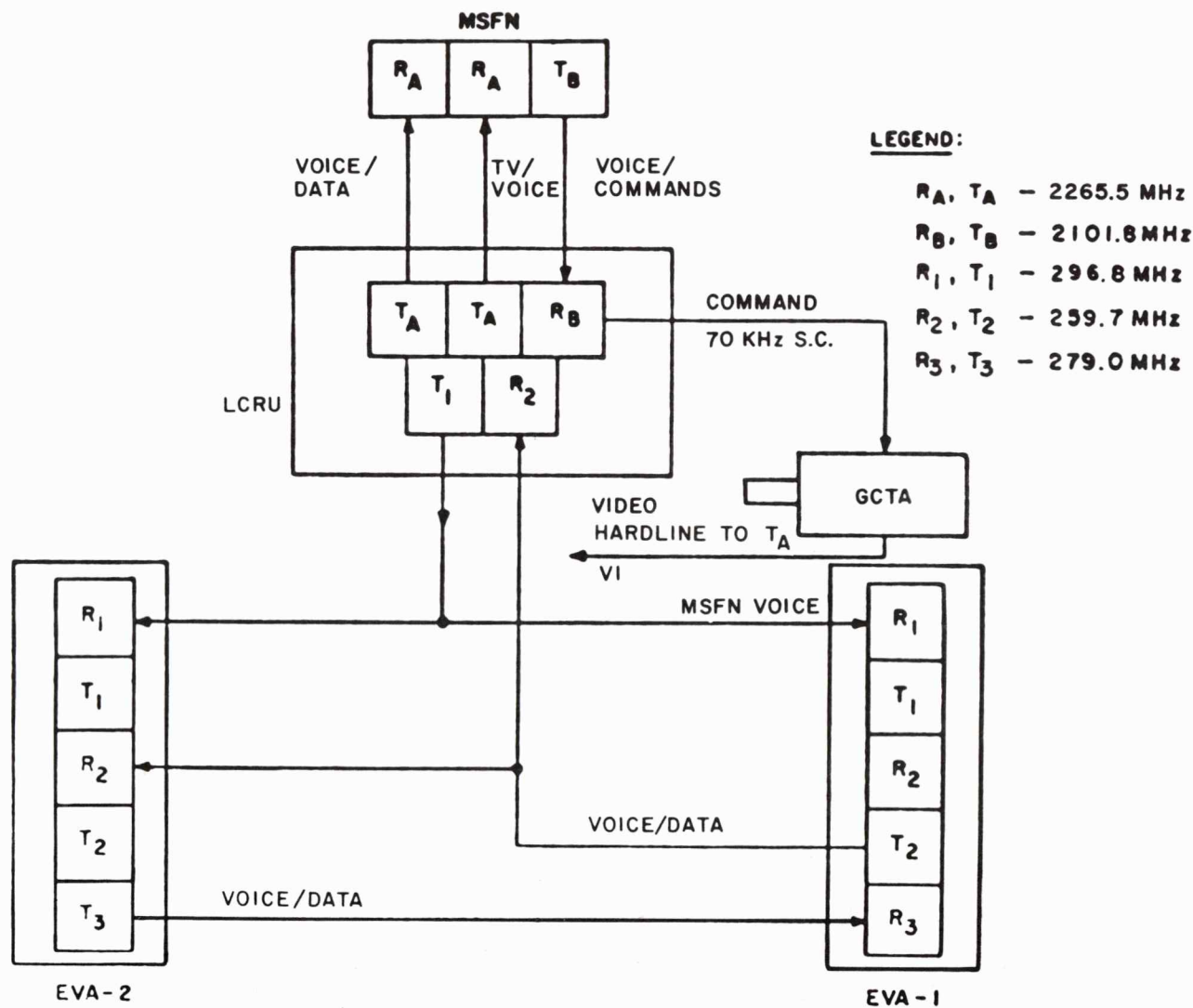


LCRU IN OPERATION DURING LM ASCENT





SYSTEM COMMUNICATIONS LINKS





SIGNAL DESIGN MODULATION PARAMETERS, DOWN LINK

A. 1.25-MHz SUBCARRIER DEVIATIONS

VOICE	(4.35)	6.6 kHz	} ±15% EACH CHANNEL FOR LCRU, ±25% EACH CHANNEL FOR EVCS/LCRU OVERALL TOLERANCE*
3.9-kHz SUBCARRIER	(1.0)	2.7 kHz	
5.4-kHz SUBCARRIER	(1.1)	3.0 kHz	
7.35-kHz SUBCARRIER	(1.93)	5.2 kHz	
10.5-kHz SUBCARRIER	(2.26)	6.1 kHz	
14.5-kHz SUBCARRIER		7.6 kHz	

B. CARRIER DEVIATIONS - PRIMARY PM MODE

1.25-MHz SUBCARRIER	1.85 RAD	±10%
---------------------	----------	------

C. CARRIER DEVIATIONS - SECONDARY PM VOICE MODE

VOICE	(4.35)	0.98 RAD	} ±15% EACH CHANNEL FOR LCRU, ±25% EACH CHANNEL FOR EVCS/LCRU OVERALL TOLERANCE*
3.9-kHz SUBCARRIER	(1.0)	0.23 RAD	
5.4-kHz SUBCARRIER	(1.1)	0.25 RAD	
7.35-kHz SUBCARRIER	(1.93)	0.43 RAD	
10.5-kHz SUBCARRIER	(2.26)	0.51 RAD	
14.5-kHz SUBCARRIER		0.40 RAD	

D. CARRIER DEVIATIONS - TV MODE (COLOR)

TELEVISION		1.7 MHz	±4% (±9% TV/LCRU)
1.25-MHz SUBCARRIER	400	275 kHz	±10%

*Based on nominal ratio signal set received from EVA-1 shown in parentheses.



SIGNAL DESIGN MODULATION PARAMETERS UP LINK

A. CARRIER DEVIATIONS

(1) 124 KHz - VOICE SUBCARRIER	1.1 RAD	$\pm 10\%$
(2) 70-kHz COMMAND SUBCARRIER	.8 RAD	$\pm 10\%$
(2) 124-kHz VOICE SUBCARRIER	.8 RAD	$\pm 10\%$
(3) 30 kHz VOICE SUBCARRIER	1.1 RAD	$\pm 10\%$
(3) 70 KHz COMMAND SUBCARRIER	1.1 RAD	$\pm 10\%$

B. 124-kHz SUBCARRIER DEVIATION ± 7.5 kHz $\pm 10\%$

C. 70-kHz SUBCARRIER DEVIATION ± 5.0 kHz $\pm 10\%$

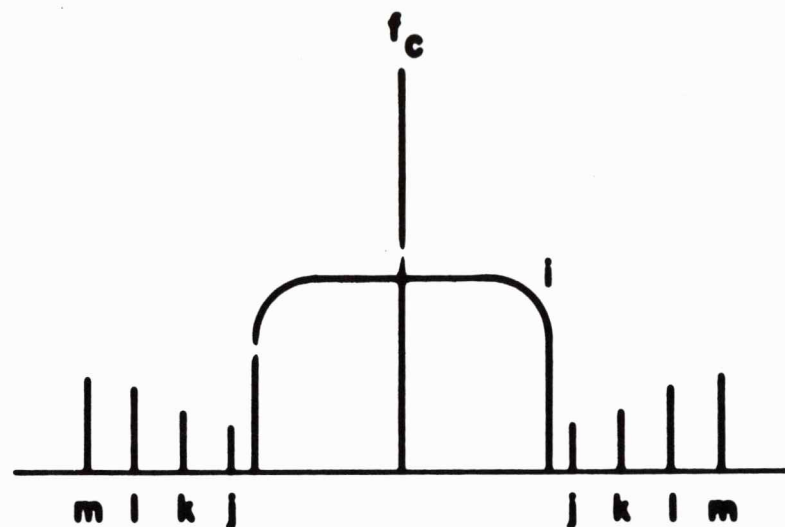
D. CARRIER MODULATION (VHF) 70% $\pm 10\%$

NOTE:

- (1) UP LINK VOICE MSFN TO LCRU
- (2) UP LINK VOICE MSFN TO LCRU
AND UP LINK COMMANDS MSFN TO LCRU/LM
- (3) UP LINK VOICE MSFN TO LM
AND UP LINK COMMANDS MSFN TO LCRU/LM



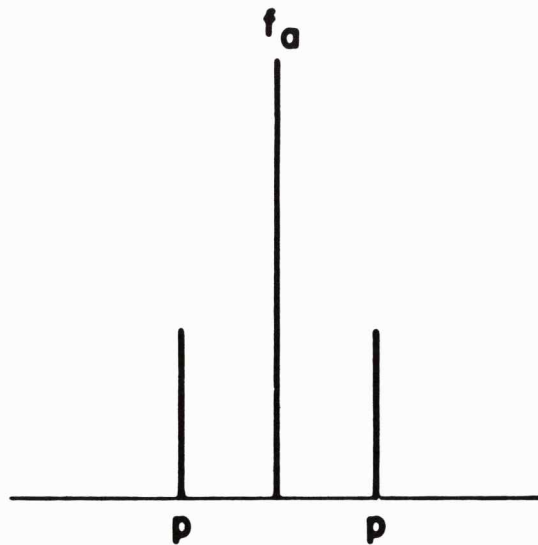
DOWN LINK VHF SPECTRUM



- f_c - 259.7 MHz CARRIER EVC-1 TO LCRU
- i - BASEBAND VOICE, EVA-1 OR EVA-2
- j - 3.9 KHz SUBCARRIER, EVA-2 EKG DATA
- k - 5.4 KHz SUBCARRIER, EVA-1 EKG DATA
- l - 7.35 KHz SUBCARRIER, EVA-2 PLSS STATUS DATA (PAM)
- m - 10.5 KHz SUBCARRIER, EVA-1 PLSS STATUS DATA (PAM)



DOWNLINK S-BAND SPECTRUM PRIMARY MODE (FM/PM)

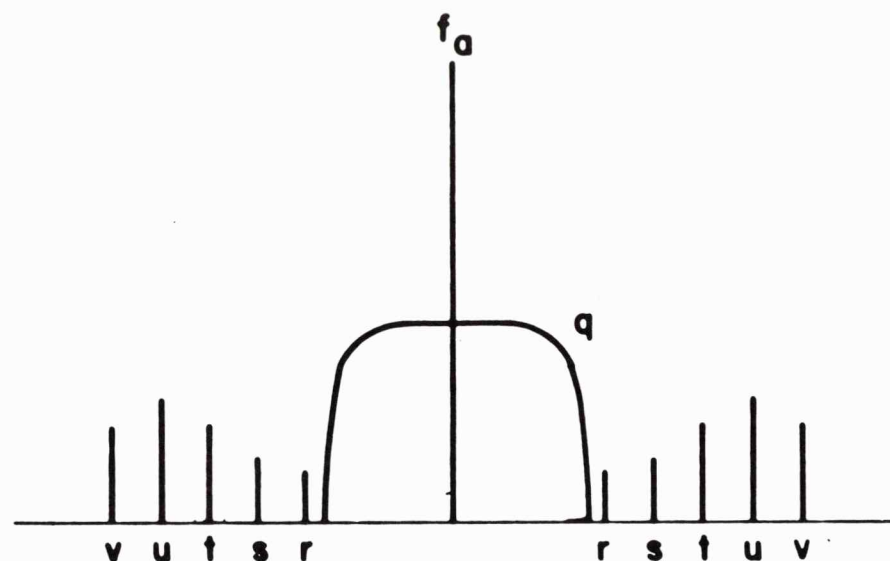


f_a ▪ 2265.5 MHz CARRIER LCRU TO MSFN)

p ▪ 1.25 MHz SUBCARRIER
EVA-1 OR EVA-2 VOICE, AND EMU/LCRU DATA BASEBAND,
FREQUENCY MODULATED ONTO SUBCARRIER



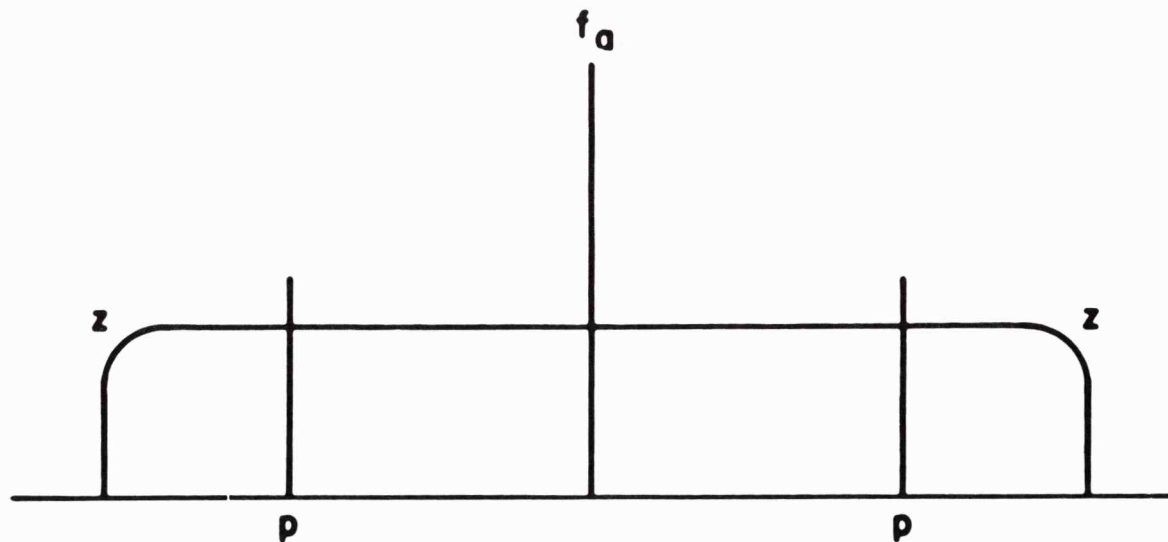
DOWNLINK S-BAND SPECTRUM SECONDARY MODE (PM)



- f_a - 2265.5 MHz CARRIER (LCRU TO MSFN)
- q - BASEBAND VOICE, EVA-1 OR EVA-2
- r - 3.9 KHz SUBCARRIER, EVA-2 EKG DATA
- s - 5.4 KHz SUBCARRIER, EVA-1 DKG DATA
- t - 7.35 KHz SUBCARRIER, EVA-2 PLSS STATUS DATA (PAM)
- u - 10.5 KHz SUBCARRIER, EVA-1 PLSS STATUS DATA (PAM)
- v - 14.5 KHz SUBCARRIER, LCRU STATUS DATA (TIME SHARED)



DOWNLINK S-BAND SPECTRUM TV/VOICE MODE (FM/FM)



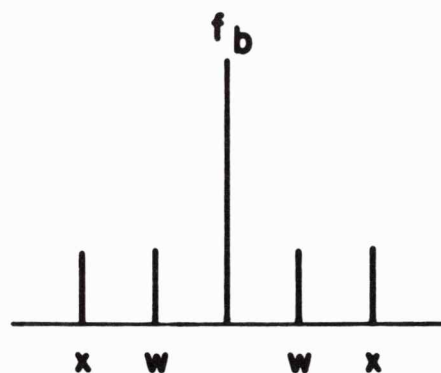
- f_a = 2265.5 MHz CARRIER (LCRU TO MSFN)
- p = 1.25 MHz SUBCARRIER
EVA-1 OR EVA-2 VOICE, AND EMU/LCRU DATA BASEBAND,
FREQUENCY MODULATED ONTO SUBCARRIER
- z = COLOR TELEVISION VIDEO BASEBAND



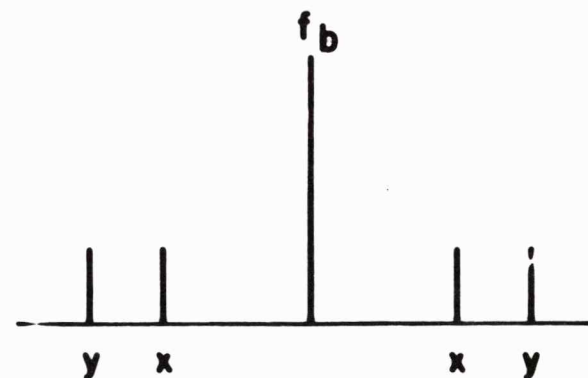
UPLINK S-BAND SPECTRUM

(FM/PM)

LM



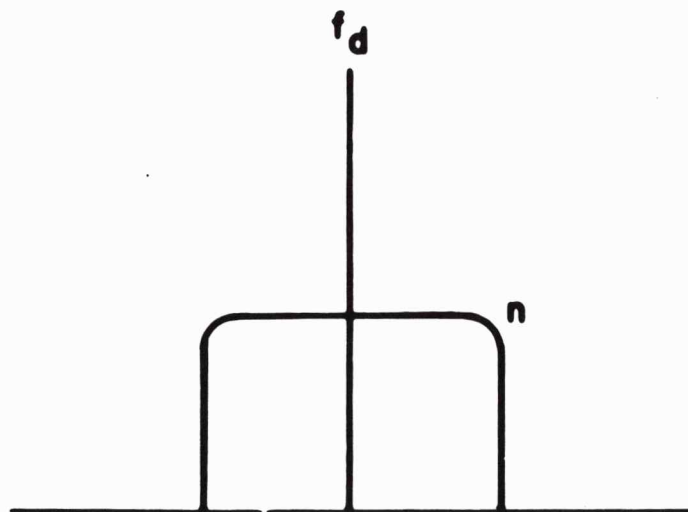
LCRU



- f_b = 2101.8 MHz CARRIER, MSFN TO LCRU OR MSFN TO LM AND LCRU
- w = 30 KHz SUBCARRIER, UPLINK VOICE TO LM
- x = 70 KHz SUBCARRIER, UPLINK COMMAND DATA TO LCRU AND/OR LM
- y = 124 KHz SUBCARRIER, UPLINK VOICE TO LCRU



UPLINK VHF SPECTRUM

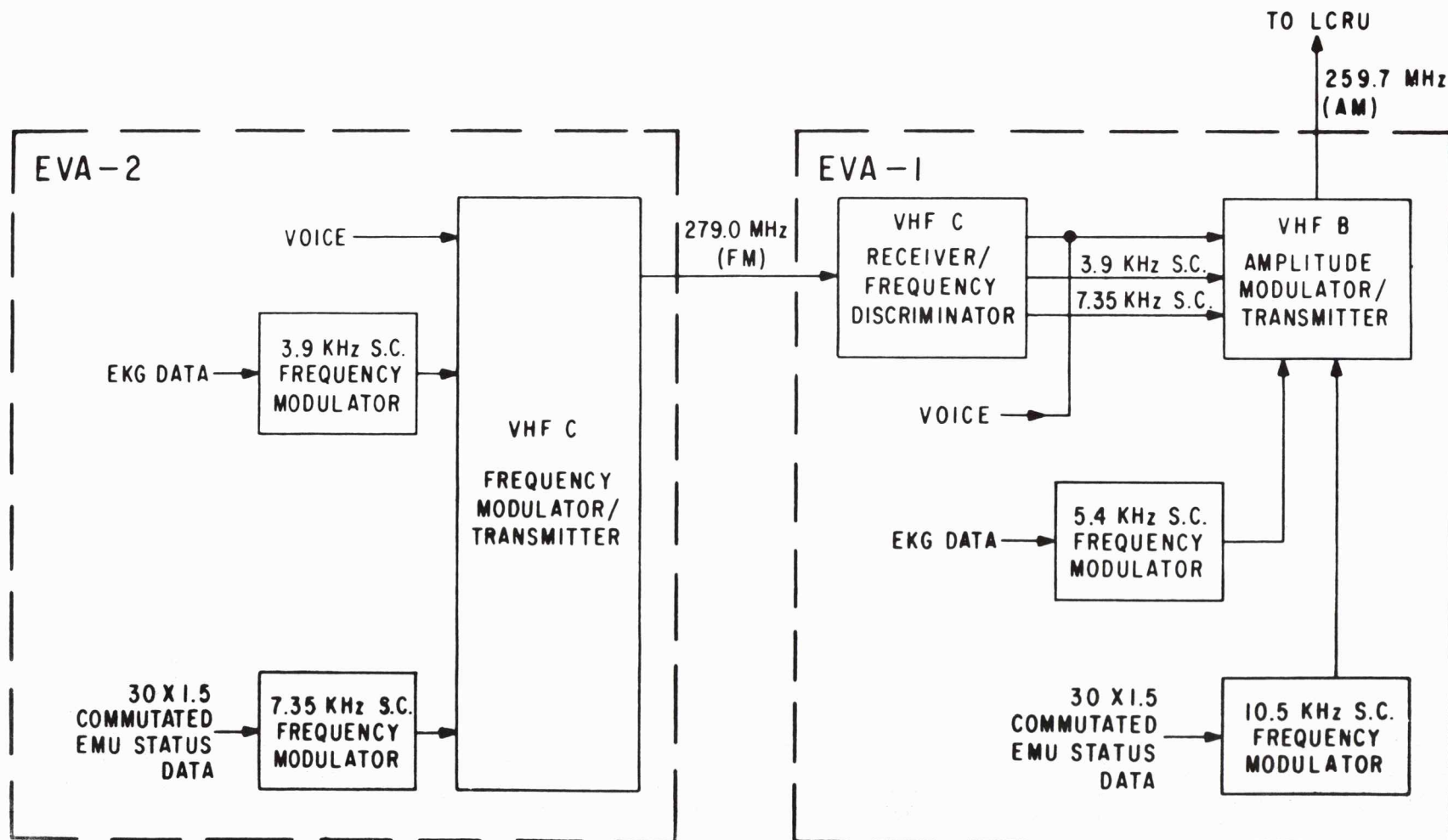


f_d - 296.8 MHz CARRIER, LCRU TO EVC-1 AND EVC-2

n - BASEBAND VOICE, FROM MSFN



EVA PORTION OF DOWN-LINK EVA-2/EVA-1/LCRU/MSFN COMMUNICATIONS SYSTEMS





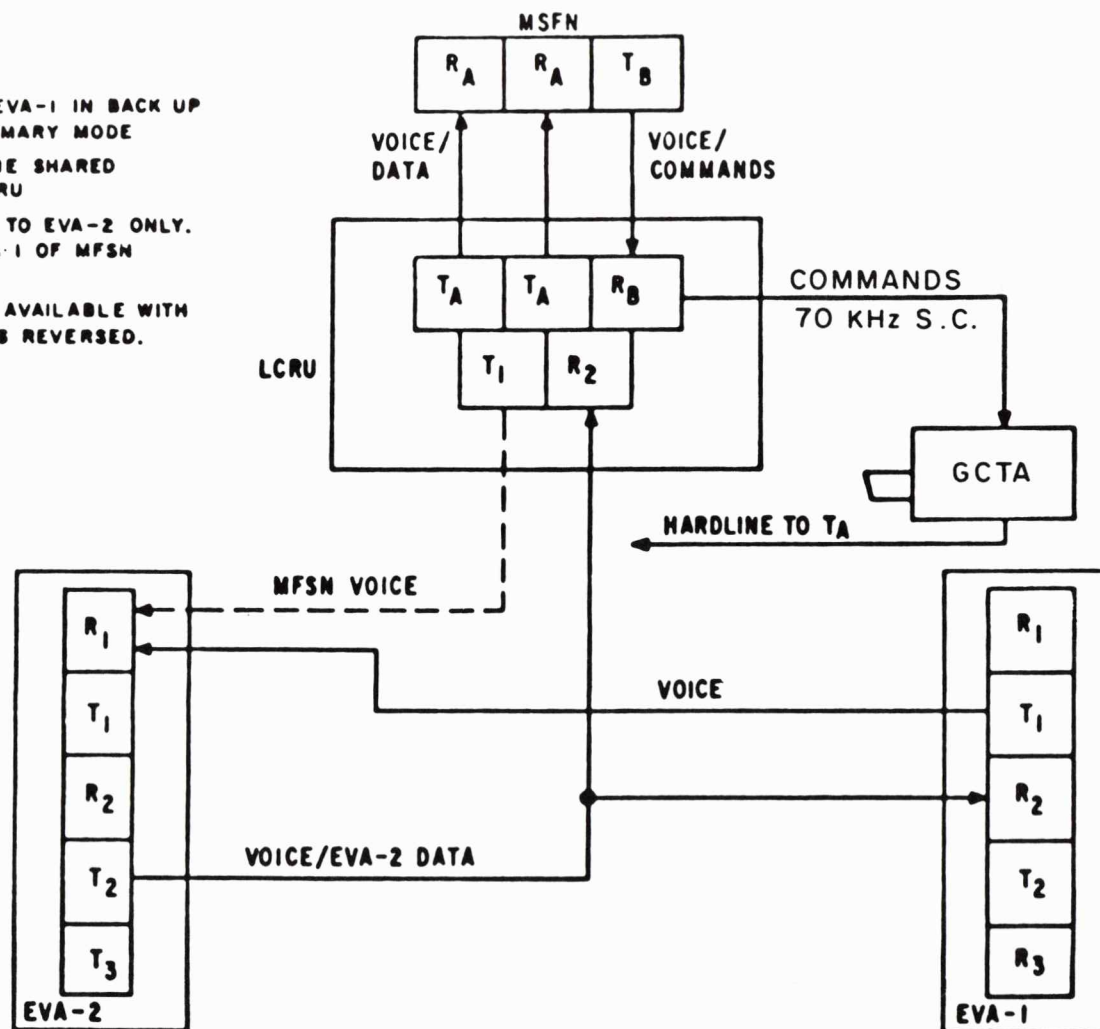
SYSTEM COMMUNICATIONS LINKS (EVCS BACK UP)

OPERATIONAL NOTE:

- .1 CONFIGURATION SHOWS EVA-1 IN BACK UP MODE AND EVA-2 IN PRIMARY MODE
- .2 296.8 MHz CHANNEL TIME SHARED BETWEEN EVA-1 AND LCRU
- .3 MSFN VOICE AVAILABLE TO EVA-2 ONLY. EVA-2 MUST INFORM EVA-1 OF MSFN MESSAGES.
- .4 BACK UP CONFIGURATION AVAILABLE WITH EVA-2 AND EVA-1 STATUS REVERSED.

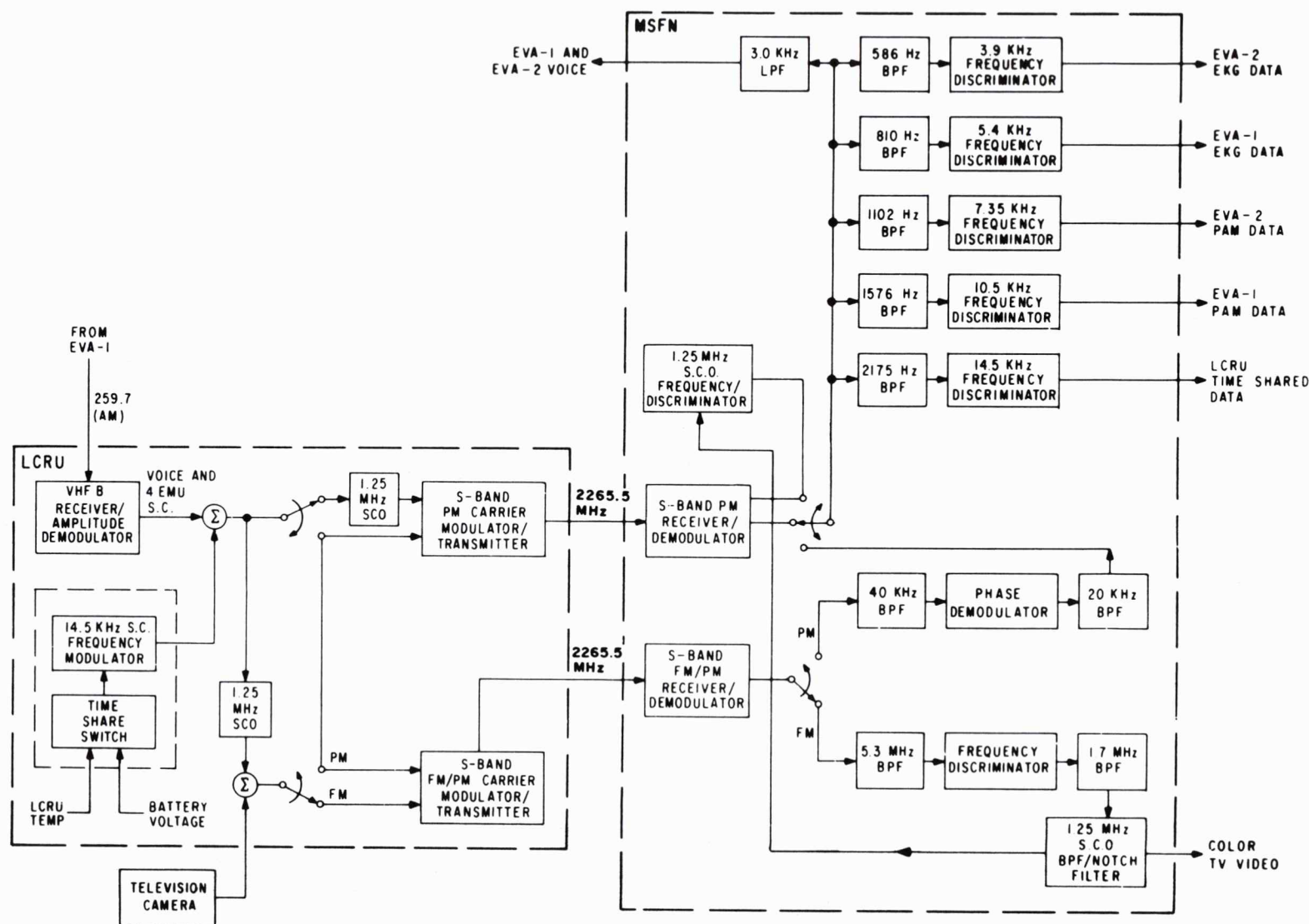
FREQUENCY ASSIGNMENT:

R_A, T_A - 2265.5 MHz
 R_B, T_B - 2101.8 MHz
 R_1, T_1 - 296.8 MHz
 R_2, T_2 - 259.7 MHz
 R_3, T_3 - 279.0 MHz





LCRU/MSFN PORTION OF DOWNLINK EVA-2/EVA-1 LCRU/MSFN COMMUNICATION SYSTEM





SYSTEM CONFIGURATION DOWN LINK

EVCS/LCRU/MSFN

EVCS/LCRU VHF LINK

- LCRU VHF TERMINAL DESIGN BASED ON COMPATIBILITY WITH EVCS DUAL MODE DUPLEX: EVA-2 AT 279 MHz TO EVA-1; 259.7 MHz TO LCRU; AND 296.8 MHz LCRU TO EVA-1 AND EVA-2.
- LCRU VHF TERMINAL DESIGN COMPATIBLE WITH (EVCS BACKUP SIMPLEX MODE: EVC-1 TO EVC-2) TRANSMIT 296.8 MHz AND RECEIVE 259.7 MHz (OR EVC-2 TO EVC-1 SAME FREQUENCIES); IN EITHER CASE, LCRU TRANSMIT CHANNEL 296.8 MHz IS DISABLED, VOXED OFF IN ABSENCE OF MSFN VOICE.
- LINK DESIGN BASED ON EVCS/LM VHF AM LINK, BUT MODIFIED FOR PATH LOSS TO 105 - EVCS/LM 119 db; THIS PROVIDES COMPATIBILITY WITH RF AND SNR INTERFACES EVA INPUTS TO LCRU 30 DB MINIMUM SNR.
- BASEBAND BANDWIDTH - LCRU EMPLOYS EVCS 259.7 MHz RECEIVER (FROM EVC-2) MODIFIED FROM 3 KHz BANDWIDTH TO 20 KHz BANDWIDTH TO ACCEPT BOTH VOICE AND EMU DATA SUBCARRIERS.



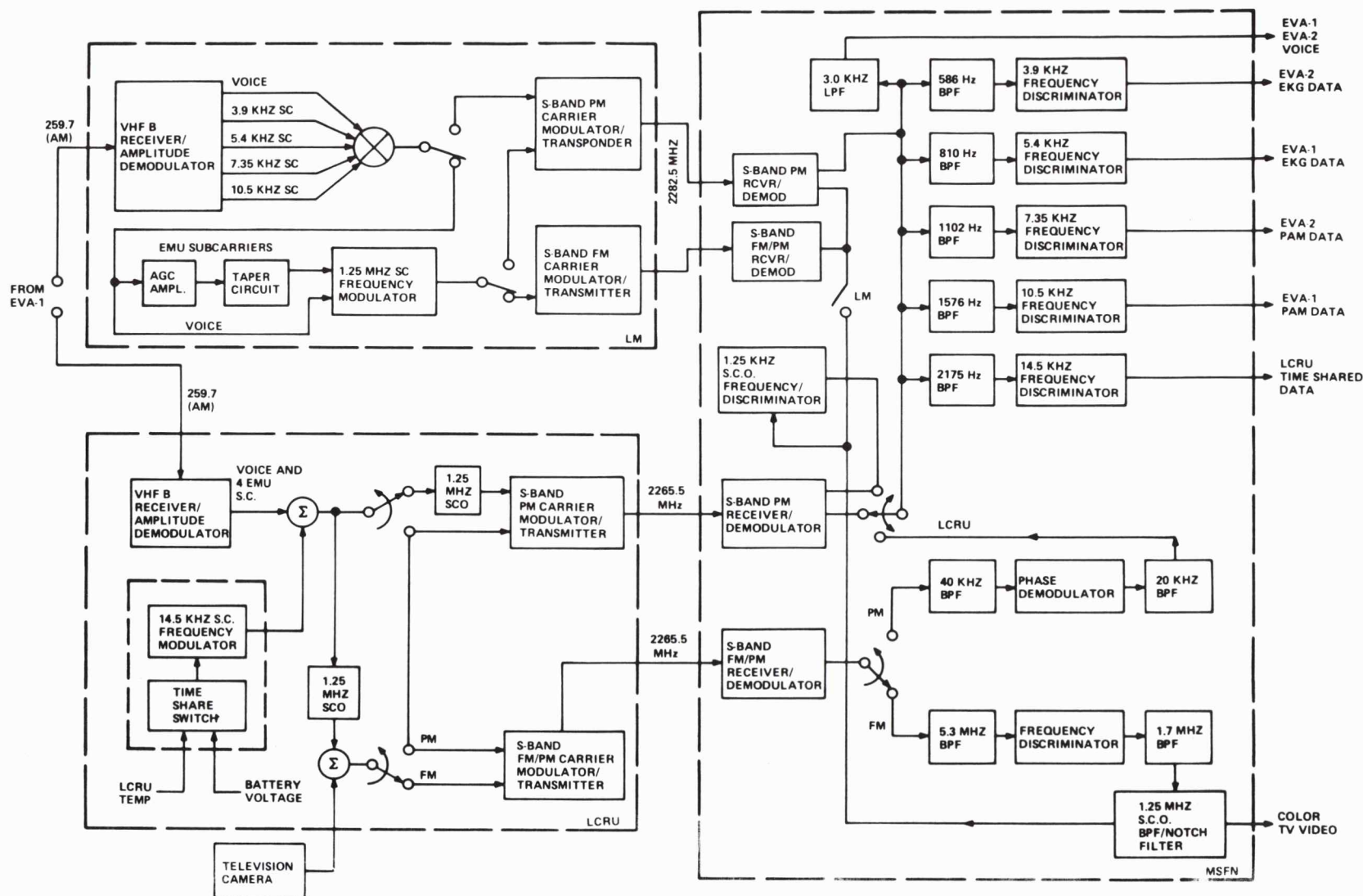
SYSTEM CONFIGURATION DOWNLINK EVCS/LCRU/MSFN

LCRU/MSFN S-BAND LINK

- SIGNAL DESIGN BASED ON COMPATIBILITY WITH MSFN BASEBAND COMPLEX FOR VOICE, THE FIVE DATA SUBCARRIERS AND COLOR TELEVISION.
- LINK DESIGN BASED ON COMPATIBILITY WITH MSFN GROUND STATIONS $f_c = 2265.5$ MHz AND IF NOISE BANDWIDTHS OF 40 KHz AND 5.3 MHz.
- VOICE/DATA LINK EMPLOYS A HELICAL ANTENNA ADJUSTABLE FOR AZIMUTH AND ELEVATION OVER A NOMINAL 60° CONE. ANTENNA GAIN 6.5 DB MINIMUM OVER PATTERN $\pm 30^\circ$ OFF BORESIGHT ALL VOICE/DATA LINKS VIA LCRU HELICAL ANTENNA AND MSFN 85 FOOT DISH.
- TV - VOICE/DATA LINK EMPLOYS 23 DB DEPLOYABLE DISH ANTENNA.
- THE TV LINK CAPABILITY IS PROVIDED FROM A STATIONARY PLATFORM, BETWEEN THE LCRU DISH AND THE MSFN 210 FOOT DISH.
- FM/PM - VOICE/DATA VIA 1.25 MHz SUBCARRIER
- PM - VOICE/DATA VIA BASEBAND
- FM/FM - TV AND VOICE/DATA FREQUENCY MULTIPLEXED (V/D ON 1.25 MHz S.C.)
- REMOTE TV ALLOWS FOR SELECTION OF INDIVIDUAL DOWN LINK CHANNELS, TV OR V/D ON 1.25 MHz S.C.

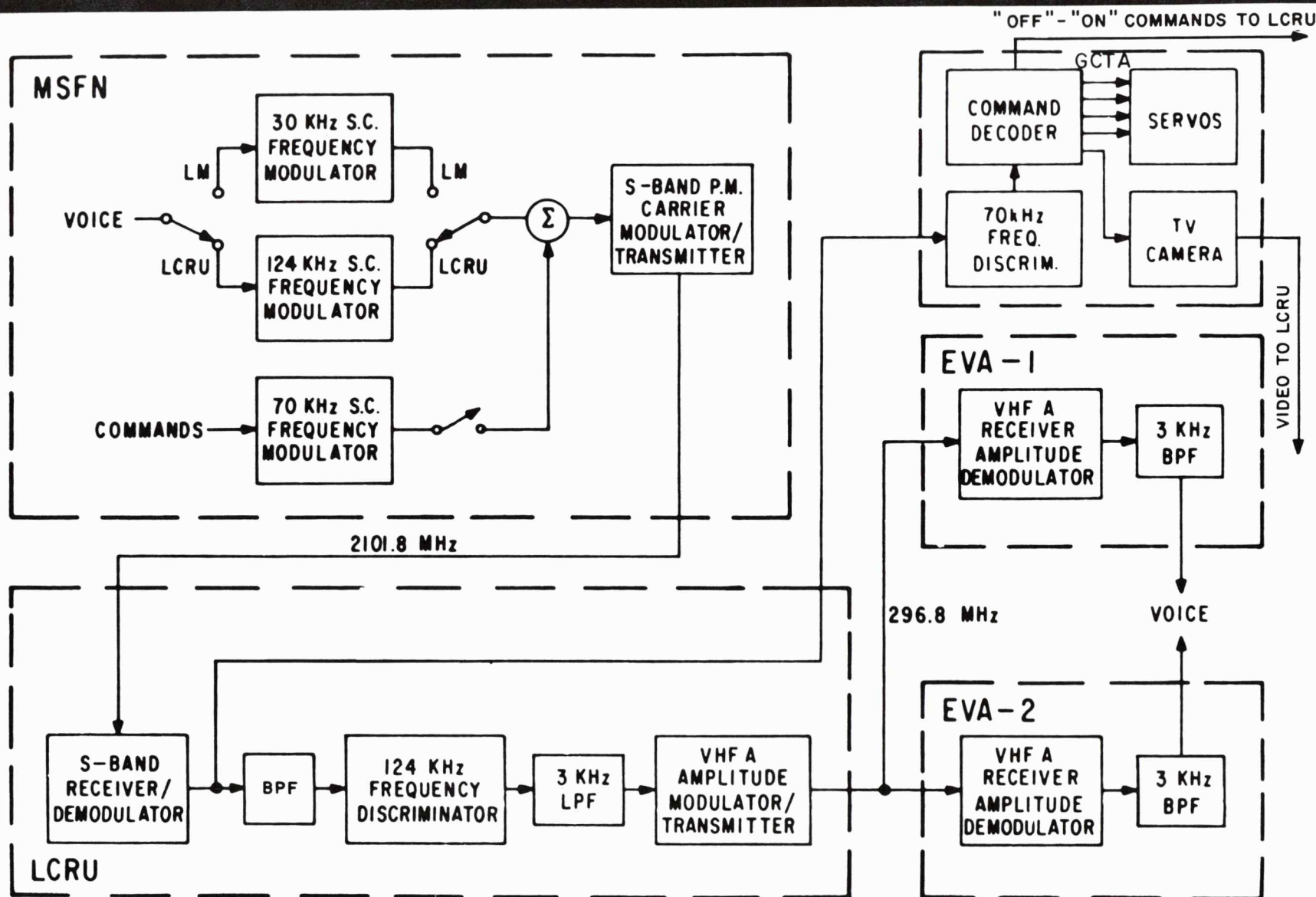


DOWN-LINK COMMUNICATION SYSTEM EVCS/LCRU/MSFN AND LM/LCRU/MSFN





UP-LINK MSFN/LCRU/EVA-1/EVA-2 COMMUNICATIONS SYSTEM





SYSTEM CONFIGURATION UPLINK

MSFN/LCRU/EVA-1, EVA-2

- SIGNAL DESIGN BASED ON COMPATIBILITY WITH MSFN BASEBAND COMPLEX AND FULL TIME SHARING OF LM UPLINK CARRIER OF 2101.8 MHZ.
- LCRU VOICE/DATA LINK EMPLOYS HELICAL ANTENNA TO ACCEPT SIGNALS FROM MSFN 85 FT. DISH. LCRU HELICAL ANTENNA PROVIDES MINIMUM GAIN OF -5 db OVER 115° CONE AND AT LEAST -7 db OVER 120° CONE.
- FM/PM - LCRU UPLINK VOICE ON 124 KHz SUBCARRIER AND COMMAND DATA ON 70 KHz SUBCARRIER. 70 KHz SUBCARRIER TIME SHARED BETWEEN LM AND LCRU.
- UPLINK VOICE FROM LCRU TO EVA-1 AND EVA-2 PROVIDED VIA VOX. TRANSMISSION OVER VHF LINK LIMITED TO MSFN VOICE "ON" AND "OFF" DUTY CYCLE.
- VHF TRANSMISSION DISABLED DURING STANDBY OPERATION.
- AUTOMATIC SQUELCH PROVISION EMPLOYED ON S-BAND LINK, TO PROVIDE RECEIVER QUIETING DURING ABSENCE OF S-BAND CARRIER OR SUBCARRIER
- STANDBY OPERATION - PROVISION FOR REMOTE LCRU TV OPERATION VIA UPLINK COMMAND ON 70 KHz SUBCARRIER.
- SYSTEM HANDOVER FROM LM TO LCRU OR LCRU TO LM PROVIDED SWITCHING OF 30 KHz AND 124 KHz SUBCARRIER AT MSFN.



LINK ANALYSIS PRIMARY VOICE MODE (FM/PM)

	VALUE	SOURCE
A. RF POWER		
TRANSMITTER POWER OUTPUT	8.4 db W	RCA SPEC
TRANSMIT CIRCUIT LOSSES (CABLE LOSS, VSWR, DIPLEXER, CONNECTORS)	2.2 db	CALCULATED
TRANSMIT ANTENNA GAIN (BORESIGHT)	9.5 db	VENDOR DATA
ANTENNA POINTING LOSS (± 30 OFF AXIS)	3.0 db	VENDOR DATA
EFFECTIVE ANTENNA GAIN	6.5 db	RCA SPEC
EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) (REQUIRED MINIMUM = 12.0 db W)	12.7 db W	CALCULATED
SPACE LOSS (215,000 N. MI. AND $f = 2265.5$ MHz)	211.6 db	CALCULATED
MSFN 85-FT ANTENNA GAIN (INCLUDES CIRCUIT AND POLARIZATION LOSSES)	52.5 db	P&I SPEC
TOTAL RECEIVED POWER	-146.4 db W	CALCULATED
B. CARRIER PERFORMANCE:		
MODULATION LOSS (2.04 RADIANS PEAK)	14.0 db	CALCULATED
CARRIER POWER	-160.4 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (50 Hz)	+ 17.0 db Hz	P&I SPEC
NOISE POWER	-188.4 db W	CALCULATED
ACTUAL CNR	+ 28.0 db	CALCULATED
REQUIRED CNR	12.0 db	P&I SPEC
CARRIER MARGIN	+ 16.0 db	CALCULATED



LINK ANALYSIS

PRIMARY VOICE MODE (FM/PM) (CONT.D.)

	VALUE	SOURCE
C. 1.25 MHz SUBCARRIER PERFORMANCE:		
MODULATION LOSS (1.67 RAD)	1.8 db	CALCULATED
SUBCARRIER POWER	-148.2 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (48 kHz)	46.8 db Hz	P&I SPEC
NOISE POWER	-158.6 db W	CALCULATED
ACTUAL SNR	+ 10.4 db	CALCULATED
REQUIRED SNR	+ 10.0 db	P&I SPEC
SUBCARRIER MARGIN	+ 0.4 db	CALCULATED
D. VOICE CHANNEL PERFORMANCE (DEVIATION 4.95 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT ($3\beta^2$)	9.1 db	CALCULATED
PEAK/RMS CORRECTION ($1/2 \rho^2$)	- 8.8 db	CALCULATED
VOICE POWER	-147.9 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (3 kHz)	34.8 db Hz	P&I SPEC
NOISE POWER	-170.6 db W	CALCULATED
ACTUAL VOICE SNR	22.7 db	CALCULATED
REQUIRED SNR	14.0 db	P&I SPEC
VOICE MARGIN	+ 8.7 db	CALCULATED



LINK ANALYSIS

PRIMARY VOICE MODE (FM/PM (CONT'D.))

	VALUE	SOURCE
E. 3.9 kHz SUBCARRIER CHANNEL PERFORMANCE (DEVIATION 2.02 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT (β^2)	- 5.7 db	CALCULATED
PEAK/RMS CORRECTION (1/2)	- 3.0 db	CALCULATED
3.9 kHz SUBCARRIER POWER	-156.9 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (720 Hz)	28.6 db Hz	P&I SPEC
NOISE POWER	-176.8 db W	CALCULATED
ACTUAL SNR	19.9 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
3.9 kHz SUBCARRIER MARGIN	+ 11.4 db	CALCULATED
F. 5.4 kHz SUBCARRIER CHANNEL PERFORMANCE (DEVIATION 2.25 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT (β^2)	- 7.6 db	CALCULATED
PEAK/RMS CORRECTION (1/2)	- 3.0 db	CALCULATED
5.4 kHz SUBCARRIER POWER	-158.8 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (995 Hz)	30. db Hz	P&I SPEC
NOISE POWER	-175.4 db W	CALCULATED
ACTUAL SNR	16.6 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
5.4 kHz SUBCARRIER MARGIN	+ 8.1 db	CALCULATED



LINK ANALYSIS

PRIMARY VOICE MODE (FM/PM) (CONT'D.)

	VALUE	SOURCE
G. 7.35 kHz SUBCARRIER CHANNEL PERFORMANCE		
(DEVIATION = 3.9 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT (β^2)	- 5.5 db	CALCULATED
PEAK/RMS CORRECTION (1/2)	- 3.0 db	CALCULATED
7.35 kHz SUBCARRIER POWER	-156.7 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (1355 Hz)	31.3 db Hz	P&I SPEC
NOISE POWER	174.1 db W	CALCULATED
ACTUAL SNR	17.4 db	CALCULATED
REQUIRED SNR	11.0 db	P&I SPEC
7.35 kHz SUBCARRIER MARGIN	+ 6.4 db	CALCULATED
H. 10.5 kHz SUBCARRIER CHANNEL PERFORMANCE		
(DEVIATION = 4.57 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT (β^2)	- 7.2 db	CALCULATED
PEAK/RMS CORRECTION (1/2)	- 3.0 db	CALCULATED
10.5 kHz SUBCARRIER POWER	-158.4 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (1939 Hz)	32.9 db Hz	P&I SPEC
NOISE POWER	-172.5 db W	CALCULATED
ACTUAL SNR	14.1 db	CALCULATED
REQUIRED SNR	11.0 db	P&I SPEC
10.5 kHz SUBCARRIER MARGIN	+ 3.1 db	CALCULATED



LINK ANALYSIS
PRIMARY VOICE MODE (FM/PM) (CONT'D.)

	VALUE	SOURCE
I.14.5 SUBCARRIER CHANNEL PERFORMANCE (DEVIATION = 5.7 kHz)		
1.25 MHz SUBCARRIER POWER	-148.2 db W	CALCULATED
FM IMPROVEMENT (β^2)	- 8.4 db	CALCULATED
PEAK/RMS CORRECTION (1/2)	- 3.0 db	CALCULATED
14.5 SUBCARRIER POWER	-159.6 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (2680 Hz)	34.3 db Hz	P&I SPEC
NOISE POWER	-171.1 db W	CALCULATED
ACTUAL SNR	11.5 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
14.5 SUBCARRIER MARGIN	+ 3.0 db	CALCULATED



LINK ANALYSIS

SECONDARY VOICE MODE (BASEBAND PM)

	VALUE	SOURCE
A. R.F. POWER		
TRANSMITTER POWER OUTPUT	8.4 db W	RCA SPEC.
TRANSMIT CIRCUIT LOSSES (CABLE LOSS, VSWR, DIPLEXER, CONNECTORS)	2.2 db	CALCULATED
TRANSMIT ANTENNA GAIN (BORESIGHT)	9.5 db	VENDOR DATA
ANTENNA POINTING LOSS (± 30 OFF AXIS)	3.0 db	VENDOR DATA
EFFECTIVE ANTENNA GAIN	6.5 db	RCA SPEC
EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) (REQUIRED MINIMUM 12.0 db W)	12.7 db W	CALCULATED
SPACE LOSS (215,000 N. MI AND $f = 2265.5$ MHz)	211.6 db	CALCULATED
MSFN 85 FT. ANTENNA GAIN (INCLUDES CIRCUIT AND POLARIZATION LOSSES)	52.5 db	P&I SPEC
TOTAL RECEIVED POWER	-146.4 db W	CALCULATED
B. CARRIER PERFORMANCE		
MODULATION LOSS (WORST CASE)	- 4.1 db	CALCULATED
CARRIER POWER	-150.5 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (50 Hz)	17.0 db Hz	P&I SPEC
NOISE POWER	-188.4 db W	CALCULATED
ACTUAL CNR	37.9 db	CALCULATED
REQUIRED CNR	12.0 db	P&I SPEC
CARRIER MARGIN	25.9 db	CALCULATED



LINK ANALYSIS

SECONDARY VOICE MODE (BASEBAND PM) (CONT'D.)

	VALUE	SOURCE
C. VOICE PERFORMANCE		
MODULATION LOSS $\rho = 1.95$ AND $\beta = .73$ RAD)	- 10.4 db	CALCULATED
VOICE POWER	-156.8 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (3 kHz)	34.8 db Hz	P&I SPEC
NOISE POWER	-170.6 db W	CALCULATED
ACTUAL SNR	13.8 db	CALCULATED
REQUIRED SNR	14.0 db	P&I SPEC
VOICE MARGIN	- 0.2 db	CALCULATED
D. 3.9-kHz SUBCARRIER PERFORMANCE		
MODULATION LOSS (0.17 RAD)	- 21.0 db	CALCULATED
3.9-kHz SUBCARRIER POWER	-167.4 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db/Hz	P&I SPEC
NOISE BANDWIDTH (720 Hz)	28.6 db Hz	P&I SPEC
NOISE POWER	-176.8 db W	CALCULATED
ACTUAL SNR	9.4 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
3.9-kHz SUBCARRIER MARGIN	+ 0.9 db	CALCULATED



LINK ANALYSIS

SECONDARY VOICE MODE (BASEBAND PM) (CONT'D.)

	VALUE	SOURCE
E. 5.4-kHz SUBCARRIER PERFORMANCE		
MODULATION LOSS (0.19 RAD)	- 20.1 db	CALCULATED
5.4-kHz SUBCARRIER POWER	-166.5 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (995 Hz)	30.0 db Hz	P&I SPEC
NOISE POWER	-175.4 db W	CALCULATED
ACTUAL SNR	8.9 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
5.4-kHz SUBCARRIER MARGIN	+ 0.4 db	CALCULATED
F. 7.35-kHz SUBCARRIER PERFORMANCE		
MODULATION LOSS (0.32 RAD)	- 15.5 db	CALCULATED
7.35-kHz SUBCARRIER POWER	-161.9 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (1355 Hz)	31.3 db Hz	P&I SPEC
NOISE POWER	-174.1 db W	CALCULATED
ACTUAL SNR	12.2 db	CALCULATED
REQUIRED SNR	11.0 db	P&I SPEC
7.35-kHz SUBCARRIER MARGIN	+ 1.2 db	CALCULATED



LINK ANALYSIS

SECONDARY VOICE MODE (BASEBAND PM) (CONT'D.)

	VALUE	SOURCE
G. 10.5-kHz SUBCARRIER PERFORMANCE		
MODULATION LOSS (0.38 RAD)	- 14.0 db	CALCULATED
10.5-kHz SUBCARRIER POWER	-160.4 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (1939 Hz)	32.9 db Hz	P&I SPEC
NOISE POWER	-172.5 db W	CALCULATED
ACTUAL SNR	12.1 db	CALCULATED
REQUIRED SNR	11.0 db	P&I SPEC
10.5-kHz SUBCARRIER MARGIN	+ 1.1 db	CALCULATED
H. 14.5-kHz SUBCARRIER PERFORMANCE		
MODULATION LOSS (0.30 RAD)	- 16.1 db	CALCULATED
14.5-kHz SUBCARRIER POWER	-162.5 db W	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 db W/Hz	P&I SPEC
NOISE BANDWIDTH (2680 Hz)	34.3 db Hz	P&I SPEC
NOISE POWER	-171.1 db W	CALCULATED
ACTUAL SNR	8.6 db	CALCULATED
REQUIRED SNR	8.5 db	P&I SPEC
14.5-kHz SUBCARRIER MARGIN	+ 0.1 db	CALCULATED



LINK ANALYSIS TV/VOICE MODE (TV FM; VOICE FM/FM)

	<u>VALUE</u>	<u>SOURCE</u>
A. <u>RF POWER</u>		
TRANSMITTER POWER OUTPUT	9.4 dBw	RCA SPEC
TRANSMIT CIRCUIT LOSSES (CABLE LOSS, VSWR, DIPLIXER, CONNECTORS)	2.0 dB	CALCULATED
TRANSMIT ANTENNA GAIN (BORESIGHT)	23.5 dB	VENDOR DATA
ANTENNA POINTING LOSS (± 2.50 OFF AXIS)	0.5 dB	VENDOR DATA
EFFECTIVE ANTENNA GAIN	23.0 dB	RCA SPEC
EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) (REQUIRED MINIMUM = 30.0 dBw)	30.4 dBw	CALCULATED
SPACE LOSS (215,000 N.MI. AND $f = 2265.5$ MHz)	211.6 dB	CALCULATED
MSFN ANTENNA GAIN (INCLUDES CIRCUIT AND POLARIZATION LOSSES):		
85-FT	52.5 dB	P&I SPEC.
210-FT	60.0 dB	EB69-2004(U)
TOTAL RECEIVED POWER:		
85-FT	-128.7 dBw	CALCULATED
210-FT	-121.2 dBw	CALCULATED
NOISE SPECTRAL DENSITY	-205.4 dBw/Hz	P&I SPEC.
PREDETECTION NOISE BANDWIDTH (5.3 MHz)	67.2 dB Hz	P&I SPEC.
NOISE POWER	-138.2 dBw	CALCULATED
RECEIVED PREDETECTION CNR:		
85-FT (REQUIRED 8.0 dB)	9.5 dB	CALCULATED
210-FT (REQUIRED 8.0 dB)	17.0 dB	CALCULATED



LINK ANALYSIS

TV/VOICE MODE (TV FM; VOICE FM/FM (Continued))

	<u>VALUE</u>	<u>SOURCE</u>
B. <u>COLOR TV PERFORMANCE (210-FT):</u>		
RECEIVED PREDETECTION S/N	17.0 dB	CALCULATED
REQUIRED PREDETECTION (THRESHOLD) S/N	8.0 dB	LCRU SPEC.
PREDETECTION CIRCUIT MARGIN	9.0 dB	CALCULATED
FM IMPROVEMENT ($\Delta f = 1.6$ MHz)	6.0 dB	CALCULATED
RECEIVED POSTDETECTION S/N (1.7 MHz NBW)	32.0 dB	CALCULATED
REQUIRED POSTDETECTION S/N (PEAK-PEAK/RMS)	22.0 dB	LCRU SPEC.
POSTDETECTION CIRCUIT MARGIN	+ 10.0 dB	CALCULATED
C. <u>COLOR TV PERFORMANCE (85-FT):</u>		
RECEIVED PREDETECTION S/N	9.5 dB	CALCULATED
REQUIRED PREDETECTION (THRESHOLD) S/N	8.0 dB	LCRU SPEC.
PREDETECTION CIRCUIT MARGIN	1.5 dB	CALCULATED
FM IMPROVEMENT ($\Delta f = 1.6$ MHz)	6.0 dB	CALCULATED
RECEIVED POSTDETECTION SNR (1.7 MHz NBW)	24.5 dB	CALCULATED
REQUIRED POSTDETECTION SNR (PEAK-PEAK/RMS)	22.0 dB	NASA DESIRED
POSTDETECTION CIRCUIT MARGIN	+ 2.5 dB	CALCULATED



LINK ANALYSIS TV/VOICE MODE (TV FM; VOICE FM/FM) (Continued)

	VALUE	SOURCE
D. <u>1.25 MHz SUBCARRIER PERFORMANCE (85 FT.)</u>		
RECEIVED PREDETECTION CNR	9.5 dB	CALCULATED
REQUIRED PREDETECTION (THRESHOLD) CNR	8.0 dB	LCRU SPEC.
PREDETECTION CIRCUIT MARGIN	+ 1.5 dB	CALCULATED
FM IMPRIVEMENT	3.0 dB	CALCULATED
RECEIVED POSTDETECTION SNR (48 kHz)	12.5 dB	CALCULATED
REQUIRED POSTDETECTION SNR	10.0 dB	P&I SPEC.
POSTDETECTION CIRCUIT MARGIN	+ 2.5 dB	CALCULATED
E. <u>BASEBAND PERFORMANCE*</u>		
VOICE CHANNEL MARGIN	+ 10.8 dB	CALCULATED
3.9 kHz SUBCARRIER MARGIN	+ 13.5 dB	CALCULATED
5.4 kHz SUBCARRIER MARGIN	+ 10.2 dB	CALCULATED
7.35 kHz SUBCARRIER MARGIN	+ 8.5 dB	CALCULATED
10.5 kHz SUBCARRIER MARGIN	+ 5.2 dB	CALCULATED
14.5 kHz SUBCARRIER MARGIN	+ 5.1 dB	CALCULATED

*NOTE: SINCE THE 1.25 MHz SUBCARRIER POSTDETECTION CIRCUIT MARGIN IN THIS MODE IS 2.1 dB BETTER THAN FOR THE PRIMARY VOICE MODE, THE BASEBAND MARGINS RESULT AS SHOWN.



LINK ANALYSIS

UPLINK VOICE MODE (FM/PM)

	<u>VALUE</u>	<u>SOURCE</u>	
A. <u>RF POWER</u>			
TRANSMITTER POWER (10 KW)	40 dBw	P&I SPEC.	
TRANSMIT ANTENNA GAIN (INCLUDES CIRCUIT LOSSES)	50.5 dB	P&I SPEC.	
EFFECTIVE RADIATED POWER	+ 90.5 dBw	CALCULATED	
SPACE LOSS (215,000 N. MI. AND f = 2101.8 MHz)	211.0 dB	CALCULATED	
	<u>HIGH-GAIN</u>	<u>LOW-GAIN</u>	
RECEIVED ANTENNA GAIN (BORESIGHT)	21.5 dB	9.5 dB	RCA
ANTENNA POINTING LOSS	3.0 dB	14.5 dB	RCA
RESULTANT ANTENNA GAIN	22.0 18.5 dB	- 7.0 dB ($\pm 60^\circ$)	RCA SPEC.
RECEIVE CIRCUIT LOSS	- 2.3	- 2.5 dB	CALCULATED
TOTAL RECEIVED POWER	-101.5	-130.0 dBw	CALCULATED
RECEIVER NOISE TEMP. (INCL. ANT NOISE)	1602 °K	1537 °K	RCA
NOISE SPECTRAL DENSITY	-196.4 dBw/Hz	-196.4 dBw/Hz	RCA
CARRIER PREDETECTION SIGNAL-TO-NOISE:			
PREDETECTION NOSIE BANDWIDTH (404 kHz)	56.9	56.9 dB Hz	RCA SPEC.
NOISE POWER	-139.5	-139.7 dBw	CALCULATED
PREDETECTION SNR	38.0	9.7 dB	CALCULATED
REQUIRED PREDETECTION SNR	10.0	10.0 dB	RCA
CIRCUIT MARGIN	28.0	- 0.3 dB	CALCULATED



LINK ANALYSIS

UPLINK VOICE MODE (FM/PM) (Continued)

	VALUE		
	<u>HIGH-GAIN</u>	<u>LOW-GAIN</u>	<u>SOURCE</u>
<u>B. 124 kHz SUBCARRIER PERFORMANCE</u>			
124-kHz SUBCARRIER PREDETECTION SIGNAL-TO-NOISE			
FM IMPROVEMENT ($\Delta f = 87$ kHz)	5.7	5.7	CALCULATED
PREDETECTION SNR	43.7	15.4 dB	CALCULATED
REQUIRED PREDETECTION SNR (29 kHz)	10.0	10.0 dB	RCA
PREDETECTION CIRCUIT MARGIN	+33.7	+ 5.4 dB	CALCULATED
124-kHz SUBCARRIER POSTDETECTION SNR			
FM IMPROVEMENT ($\Delta f = 7.5$ kHz)	10.4 dB	10.4 dB	CALCULATED
POSTDETECTION SNR (3 kHz)	54.0	25.8 dB	CALCULATED
REQUIRED POSTDETECTION SNR (3 kHz)	14.0	14.0 dB	P&I SPEC.
POSTDETECTION CIRCUIT MARGIN	40.0	11.8 dB	CALCULATED
<u>C. 70 kHz SUBCARRIER PERFORMANCE</u>			
70-kHz SUBCARRIER PREDETECTION SNR			
FM IMPROVEMENT ($\Delta f = 50$ kHz)	6.4 dB		CALCULATED
PREDETECTION SNR (24 kHz)	44.4 dB		CALCULATED
REQUIRED PREDETECTION SNR	10.0 dB		LCRU SPEC.
PREDETECTION CIRCUIT MARGIN	+34.4 dB		CALCULATED



WORST CASE LINK MARGIN SUMMARY

<u>LINK PARAMETER</u>	<u>PMI/WB</u>	<u>PMI/NB*</u>	<u>FM/TV</u>	<u>UPLINK</u>
TRANSMITTER POWER	7.1 w	7.1 w	8.7 w	10 kw
EFFECTIVE ANT. GAIN:	6.5 db	6.5 db	23.0 db	50.5 db
EFFECTIVE RADIATED POWER (EIRP INCL. ALL CKT LOSSES)	13.0 dbw	13.0 dbw	30.7 dbw	90.5 dbw
TOTAL RECEIVED POWER: (INCL ALL CKT. LOSSES)				
85 FT. DISH (52.5 db)	-146.4 dbw	-146.6 dbw	-128.7 dbw	-
210 FT. DISH (60.0 db)	-	-	-121.2 dbw	-
LCRU L.G. (-7 db FOR $\pm 60^\circ$)	-	-	-	-130.0 dbw
LCRU H.G. (18.5 db FOR $\pm 5^\circ$)	-	-	-	-104.3 dbw
MARGINS (db):				
CARRIER	+ 16.0	+ 25.3	+9.0/+1.5	+ 25.2/-0.5
1.25 MHZ SUBCARRIER	+ 0.4	-	+ 2.5	-
124 KHZ SUBCARRIER	-	-	-	+37.3/+11.8
70 CHZ SUBCARRIER	-	-	-	+ 31.6
VOICE CHANNEL	+ 8.7	- 0.2	+ 10.8	+51.3/+25.8
3.9 KHZ SUBCARRIER	+ 11.4	+ 0.9	+ 13.5	-
5.4 KHZ SUBCARRIER	+ 8.1	+ 0.4	+ 10.2	-
7.35 KHZ SUBCARRIER	+ 6.4	+ 1.2	+ 8.5	-
10.5 KHZ SUBCARRIER	+ 3.1	+ 1.1	+ 5.2	-
14.5 KHZ SUBCARRIER	+ 3.0	+ 0.1	+ 5.1	-
VIDEO CHANNEL	-	-	+10.0/+2.5	-
* PM2/NB ALL MARGINS 1.0 db GREATER THAN PMI/NB				



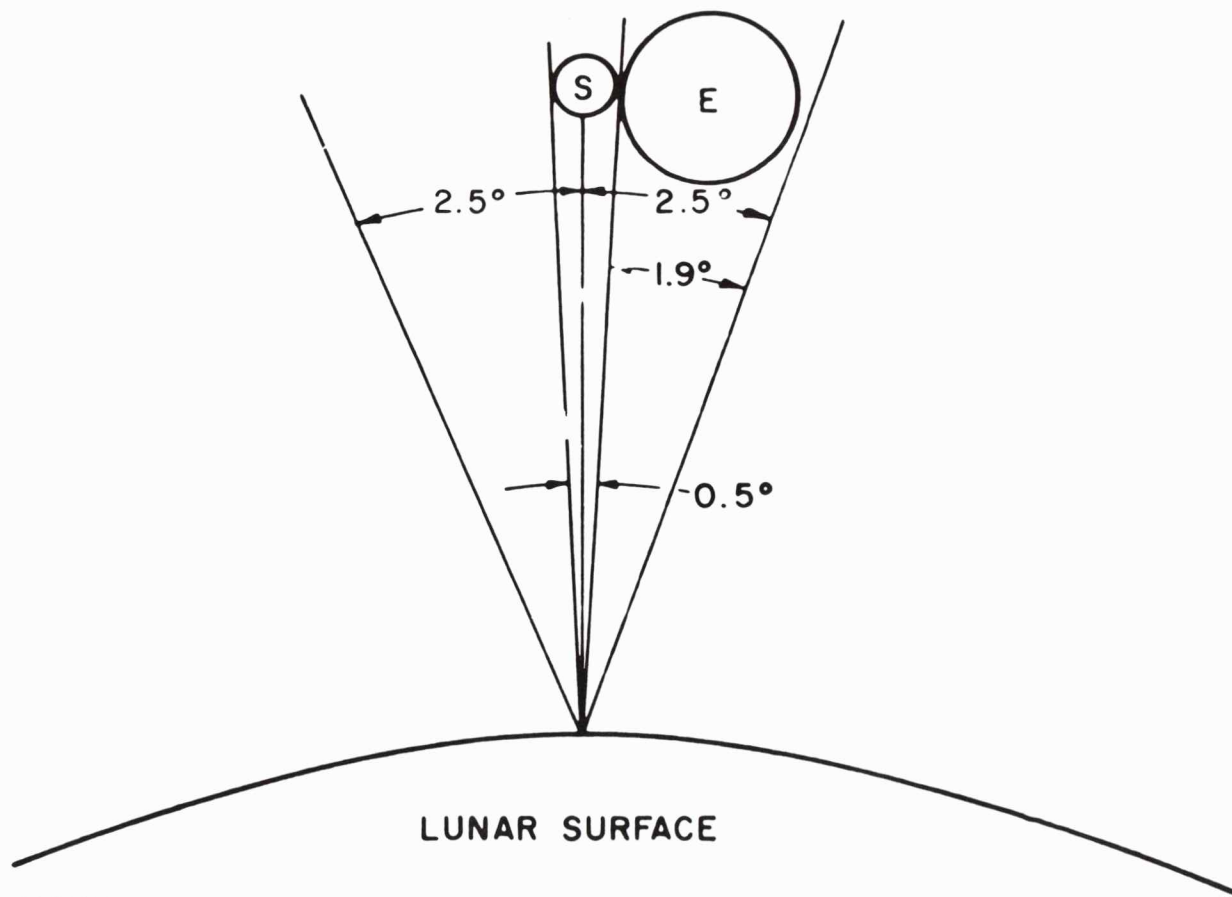
NOMINAL CASE LINK MARGIN SUMMARY

LINK PARAMETER	PMI/WB	PMI/NB*	FM/TV	UPLINK
TRANSMITTER POWER:	7.4w	7.4w	9.1w	10kw
EFFECTIVE ANT. GAIN:	9.5db	9.5db	23.5db	50.5db
EFFECTIVE RADIATED POWER (EIRP INCL ALL CKT LOSSES)	14.9dbw	14.9dbw	31.4dbw	90.5dbw
TOTAL RECEIVED POWER: (INCL ALL CKT. LOSSES)				
85 FT. DISH (52.5 db)	-142.9w	-142.9w	-127.7w	-
210 FT. DISH (60.0db)	-	-	-120.2w	-
LCRU L.G. (6.5 db FOR $\pm 30^\circ$)				-118.5dbw
LCRU H.G. (18.5db FOR $\pm 5^\circ$)				-101.5dbw
MARGINS (db):				
CARRIER	+19.5	+29.4	+10.0/+2.5	+28.0/+11.2
1.25 MHZ SUBCARRIER	+3.9	-	+3.5	-
124 KHZ SUBCARRIER	-	-	-	+40.0/+23.3
70 KHZ SUBCARRIER	-	-	-	+34.4
VOICE CHANNEL	+12.2	+3.3	+11.8	+54.4/+34.8
3.9 KHZ SUBCARRIER	+14.9	+4.4	+14.5	-
5.4 KHZ SUBCARRIER	+11.6	+3.9	+11.2	-
7.35 KHZ SUBCARRIER	+9.9	+4.7	+9.5	-
10.5 KHZ SUBCARRIER	+6.6	+4.6	+6.2	-
14.5 KHZ SUBCARRIER	+6.5	+3.6	+6.1	-
VIDEO CHANNEL			+11.0/+3.5	

* PM2/NB ALL MARGINS 1.0db GREATER THAN PMI/NB



LCRU HIGH GAIN ANTENNA EARTH/SUN VIEW ANGLES



NOTE:

1. CASE SHOWN IS PRE EARTH/SOLAR ECLIPSE WITH MAXIMUM SOLAR ENERGY VIEWED BY ANTENNA.
2. VIEW ANGLES DENOTE CONES



LCRU SYSTEM NOISE TEMPERATURES (SUN CASE)

NOISE SOURCE CONTRIBUTIONS

ANTENNA GAIN

20 dB	34 dB	23 dB
(1)	(2)	(3)

Sun ($100,000^{\circ}\text{K}$ at S-Band)

54	1340	112
----	------	-----

Earth (290°K at S-Band)

4	120	11
---	-----	----

Moon (Back Spillover, 24°K)

35	35	35
----	----	----

Space (4°K)

<u>4</u>	<u>4</u>	<u>4</u>
----------	----------	----------

T_e , total effective noise temperature:

97	1499	162
----	------	-----

(1) No change to system temperature; negligible

(2) Adds 1150°K to system temperature of 1537°K ; reduces margin by approximately 2.5 dB

(3) No change to system temperature; negligible

SUN CASE T_e

For $h/R \geq 3$, and $G \geq 3$,

$$T_e = \frac{GT}{4 [(h/R) + 1]^2}$$

h = Distance from antenna to the surface of the planet (1.50×10^8 km to sun)

R = planet radius (6.96×10^5 km, sun)

G = Antenna Gain

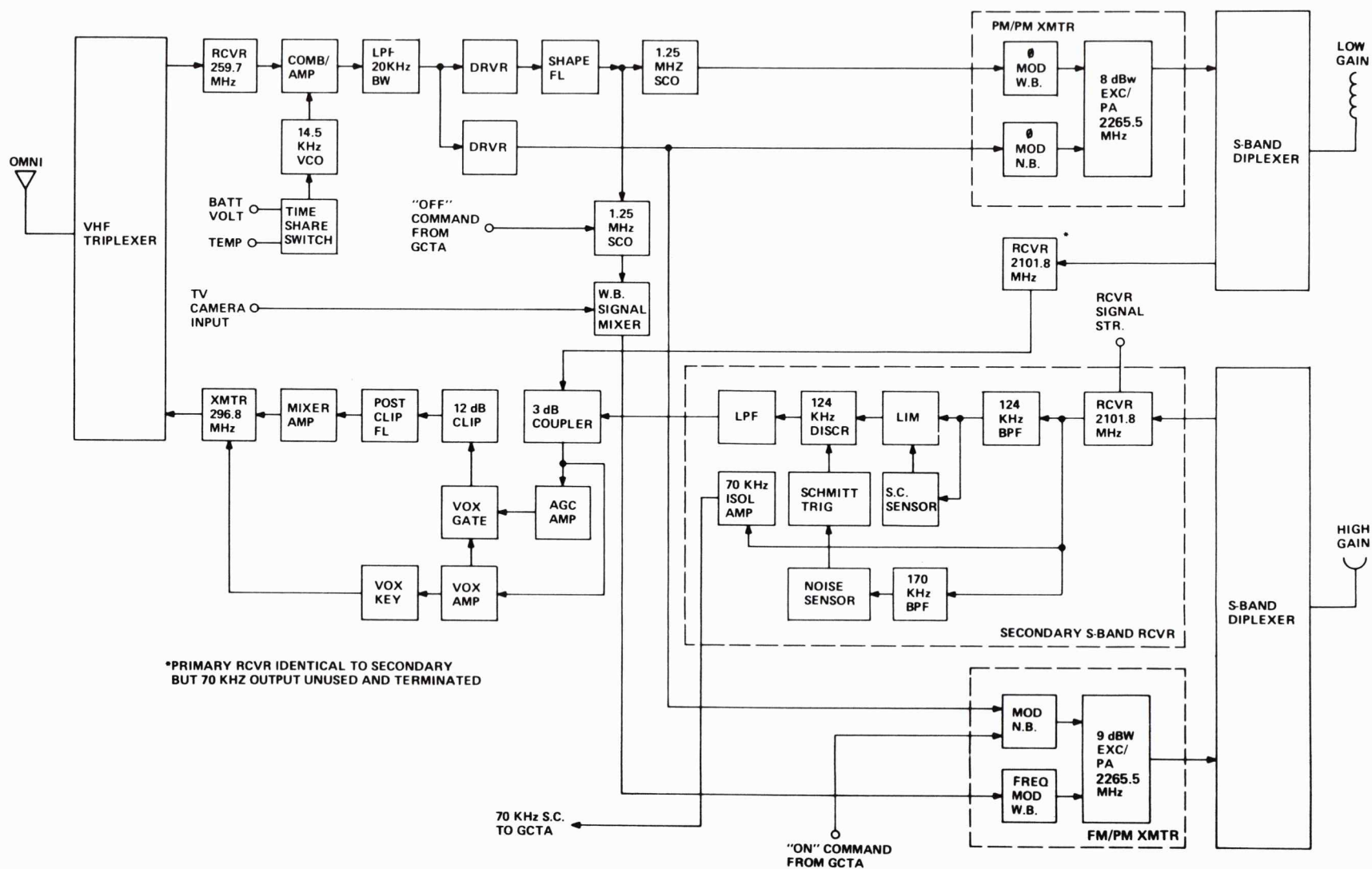
T = Planetary temperature

T_e = Effective Noise Temperature

Reference: "Reference Data for Radio Engineers", ITT, Fifth Edition; p. 34-2, equ. (5).



LCRU SUBSYSTEM CONFIGURATION





LCRU SUBSYSTEM BASELINE DESIGN

PRIMARY DOWN-LINK FM/PM

- VHF SIGNAL FROM EVC-1 RECEIVED OVER OMNI ANTENNA
- VHF RECEIVER EVCS OUTPUT COMBINED WITH LCRU STATUS DATA
- LCRU STATUS DATA BASEPLATE TEMPERATURE AND BATTERY VOLTAGE TIME SHARES 14.5 KHZ VCO FOR DOWN LINK TELEMETRY
- BASEBAND SIGNAL LEVELS FROM EVCS DEPENDENT ON VHF AM RECEIVER AGC (± 1 DB). NO ADDITIONAL PRE-CONDITIONING PROVIDED TO RESET MODULATION INDEX RATIOS
- BASEBAND FILTERED TO 20 KHZ BANDWIDTH
- FM MODE VOICE AND DATA BASEBAND SHAPED TO REQUIRED FM INDICES, VOICE CHANNEL LEVEL REDUCED 5 DB RELATIVE TO 700 HZ.
- BASEBAND - VOICE AND DATA SIGNALS FREQUENCY MODULATED ON 1.25 MHZ SUBCARRIER. BASEBAND LEVEL SET TO INDICES REQUIREMENTS OF SUBCARRIER OSCILLATOR.
- 1.25 MHZ SUBCARRIER PHASE MODULATED ON S-BAND 2265.5 MHZ CARRIER
- SEPARATE 1.25 MHZ SUBCARRIER OSCILLATORS EMPLOYED TO SIMPLIFY SIGNAL SWITCHING, MINIMIZE SINGLE POINT FAILURE AND ENABLE MATCHING OF MODULATION LEVELS OF WIDE BAND PM TRANSMITTER AND FM TRANSMITTER INDIVIDUALLY.
- SIGNAL SWITCHING PROVIDED VIA DC LINES TO INDIVIDUAL MODULATORS AND TO 1.25 MHZ SUB-CARRIER OSCILLATORS
- FM MODE 1.25 MHZ SUBCARRIER COMMANDED ON-OFF DURING REMOTE TV.
- S-BAND TRANSCEIVERS AND ANTENNAS HARDLINED TO COMPANION DIPLEXERS TO AVOID COAXIAL SWITCHING
- VHF MODULES AND VHF OMNI HARDLINED TO VHF DIPLEXER TO AVOID COAXIAL SWITCHING



LCRU SUBSYSTEM BASELINE DESIGN

SECONDARY DOWN-LINK PM BASEBAND

- VHF SIGNAL FROM EVC-1 RECEIVED OVER OMNI ANTENNA
- VHF RECEIVER EVCS OUTPUT COMBINED WITH LCRU STATUS DATA
- LCRU STATUS DATA BASEPLATE TEMPERATURE AND BATTERY VOLTAGE TIME SHARES 14.5 KHZ VCO FOR DOWN LINK TELEMETRY
- BASEBAND SIGNAL LEVELS FROM EVCS DEPENDENT ON VHF AM RECEIVER AGC (± 1 DB) PRE-CONDITIONING PROVIDED TO RESET MODULATION INDEX RATIOS.
- BASEBAND FILTERED TO 20 KHZ BANDWIDTH
- BASEBAND (VOICE-DATA) SIGNAL LEVEL SET TO NOMINAL INDICES BASED ON PM MODULATION SENSITIVITY OF S-BAND TRANSMITTER.
- BASEBAND PHASE MODULATED ON S-BAND 2265.5 MHZ CARRIER
- BACK-UP MODE (PM MODULATOR OF FM/PM TRANSMITTER, SAME MODULATION CONFIGURATION AS SECONDARY MODE



LCRU SUBSYSTEM BASELINE DESIGN

TV/DATA DOWN-LINK FM/FM

- VHF SIGNAL FROM EVC-1 RECEIVED OVER OMNI ANTENNA
- VHF RECEIVER EVCS OUTPUT COMBINED WITH LCRU STATUS DATA
- LCRU STATUS DATA BASEPLATE TEMPERATURE AND BATTERY VOLTAGE TIME SHARES 14.5 KHz VCO FOR DOWN LINK TELEMETRY
- BASEBAND SIGNAL LEVELS FROM EVCS DEPENDENT ON VHF AM RECEIVER AGC (± 1 db)
NO ADDITIONAL PRE-CONDITIONING PROVIDED TO RESET MODULATION INDEX RATIOS
- BASEBAND FILTERED TO 20 KHz BANDWIDTH
- FM MODE VOICE AND DATA BASEBAND SHAPED TO REQUIRED FM INDICES, VOICE CHANNEL LEVEL REDUCED 5 db RELATIVE TO 700 Hz
- BASEBAND - VOICE AND DATA SIGNALS FREQUENCY MODULATED ON 1.25 MHz SUBCARRIER. BASEBAND LEVEL SET TO MODULATION SENSITIVITY OF 1.23 MHz SUBCARRIER OSCILLATOR
- BASEBAND FREQUENCY MODULATED ON COMPANION 1.25 MHz SUBCARRIER OSCILLATOR OF FM TRANSMITTER
- TELEVISION BASEBAND AND 1.25 MHz SUBCARRIER COMBINED IN PREMODULATION MIXER
- COMPOSITE TV AND SUBCARRIER FREQUENCY MODULATED ON 2265.5 MHz CARRIER
- FM/FM MODE TRANSMISSION HARDLINED TO HIGH GAIN ANTENNA



LCRU SUBSYSTEM BASELINE DESIGN

UPLINK

- S-BAND 2101.8 MHZ CARRIER FROM MSFN RECEIVED VIA LOW GAIN OR HIGH GAIN ANTENNA
- S-BAND RECEIVER INPUT DIVIDED INTO TWO SUBCARRIERS, 124 KHZ AND 70 KHZ
- 124 KHZ SUBCARRIER DEMODULATED BY SECOND DISCRIMINATOR
- BASEBAND VOICE FILTERED TO 3 KHZ.
- SQUELCH CONTROL GATES OUTPUT BASED ON LOW S. C. SNR, OR LOW CARRIER SNR
- 70 KHZ SUBCARRIER HARDLINED TO GROUND CONTROLLED TELEVISION ASSEMBLY
- VOICE BASEBAND OUTPUTS BOTH RECEIVERS CONNECTED THROUGH 3 DB COUPLER
- VOICE BASEBAND IS AGC'D AND LEVEL GATED BY VOX
- VOICE CLIPPED 12 DB FOR COMPATIBILITY LM/EVCS VHF LINK
- CLIPPING NOISE FILTERED
- VHF TRANSMISSION CONTROLLED BY VOX KEY, VOX OPERATES BASED ON PRESENCE OF UPLINK VOICE
- VOICE AMPLITUDE MODULATED 70% AM FOR COMPATIBILITY WITH EVCS 296.8 MHZ RECEIVERS
- VHF TRANSMITTER HARDLINED TO TRIPLEXER TO AVOID COAXIAL SWITCHING
- RECEIVED SIGNAL STRENGTH HARDLINED TO LCRU CONTROL PANEL INDICATOR
- TRANSMISSION TO EVA-1 AND EVA-2 OVER VHF OMNI



DEGRADATION FACTORS DOWN LINK: FM

	FREQUENCY TOLERANCE	INTER-MOD DISTORTION	LINEARITY	LEVEL, $\pm \%$	FREQUENCY RESPONSE	DEVIATION SENSITIVITY
AM RECEIVER	$\pm 0.003\%$ N/A	23 DB BELOW DESIRED TONE	N/A	± 1.3 DB VS. TEMPERATURE, 0°F TO 140°F ; PRACTICAL VARIATION: ± 1.0 DB	WITHIN 0.3 DB AND -1.4 DB OVER 300 HZ TO 20 KHZ BANDWIDTH	N/A
BB CONDITIONER	N/A	40 DB BELOW DESIRED TONE	N/A	N/A	-0.4 DB AT 300 HZ; 0 DB WITHIN 1.0 K HZ TO 9 K HZ; -1.0 DB AT 15 K HZ	N/A
SHAPE FILTER	N/A	NEGLIGIBLE EFFECT	N/A	NEGLIGIBLE EFFECT*	± 0.5 DB FROM 300 H TO 3 K HZ; ± 0.2 DB FROM 3.6 K HZ TO 16 K HZ	N/A
1.25 MHZ VCO	NO INPUT SIGNAL: $\pm 0.25\%$ OF 1.25 MHZ OVER DESIGN BANDWIDTH: $\pm 0.5\%$	30 DB BELOW LEVEL OF APPLIED TONE	$\pm 0.15\%$ FROM THE BEST STRAIGHT LINE FOR DEVIATIONS UP TO ± 15 K HZ	3.0 V PEAK-TO-PEAK* $\pm 5\%$ WHEN TERMINATED IN A 50 OHM LOAD	WITHIN ± 1.0 DB OVER 300 HZ TO 15.6 K HZ; WITHIN ± 0.5 DB OVER 3.6 K HZ TO 15.6 K HZ	15 K HZ/VOLT $\pm 5\%$
FM TRANSMITTER	LONG TERM STABILITY $\pm 0.01\%$ FOR FM MODE	34 DB BELOW THE PEAK OF EITHER TONE WHEN THE CARRIER IS DEVIATED TO A PEAK OF ± 2.5 MHZ	$\pm 3\%$ FROM THE BEST STRAIGHT LINE UP TO ± 2.5 MHZ DEVIATIONS	N/A	± 1.0 DB OVER DC TO 3 MHZ	2.0 MHZ/V $\pm 10\%$ FOR DEVIATIONS UP TO 2.5 MHZ
14.5 KHZ VCO	IRIG STANDARD $\pm 7.5\%$	N/A	N/A	3.0 V PEAK-TO-PEAK* $\pm 5\%$ WHEN TERMINATED IN A 47 K OHM LOAD	N/A	N/A
WB MIXER	N/A	NEGLIGIBLE EFFECT	NEGLIGIBLE EFFECT	NEGLIGIBLE EFFECT*	FLAT WITHIN ± 0.2 DB FROM DC TO 3 MHZ	N/A

*ADJUSTABLE



DEGRADATION FACTORS DOWN LINK: PM, WB OR NB

	FREQUENCY TOLERANCE	INTER-MOD DISTORTION	LINEARITY	LEVEL, $\pm$ %	FREQUENCY RESPONSE	DEVIATION SENSITIVITY
AM RECEIVER	$\pm 0.003\%$ N/A	23 DB BELOW DESIRED TONE	N/A	± 1.3 DB VS. TEMPERATURE, 0°F TO 100°F ; PRACTICAL VARIATION: ± 1.0 DB	WITHIN 0.3 DB AND -1.4 DB OVER 300 HZ TO 20 KHZ BANDWIDTH	N/A
BB CONDITIONER	N/A	40 DB BELOW DESIRED TONE	N/A	N/A	-0.4 DB AT 300 HZ 0 DB WITHIN 1.0 KHZ TO 9 KHZ; -1.0 DB AT 15 KHZ	N/A
SHAPE FILTER	N/A	NEGLIGIBLE EFFECT	N/A	NEGLIGIBLE EFFECT*	NEGLIGIBLE EFFECT	N/A
1.25 MHZ VCO	NO INPUT SIGNAL: $\pm 0.25\%$ OF 1.25 MHZ OVER DESIGN BANDWIDTH: $\pm 0.5\%$	30 DB BELOW LEVEL OF APPLIED TONE	$\pm 0.15\%$ FROM THE BEST STRAIGHT LINE FOR DEVIATIONS UP TO ± 15 KHZ	3.0 V PEAK-TO-PEAK* $\pm 5\%$ WHEN TERMINATED IN A 50 OHM LOAD	WITHIN ± 1.0 DB OVER 300 HZ TO 15.6 KHZ; WITHIN ± 0.5 DB OVER 3.6 KHZ TO 15.6 KHZ	15 KHZ PER VOLT, $\pm 5\%$
PM TRANSMITTER	$\pm 0.003\%$	TOTAL 26 DB WITHIN 0.3 KHZ TO 20 KHZ BANDWIDTH	$\pm 3\%$ FROM BSL UP TO ± 2.5 RAD	N/A	± 0.5 DB OVER 200 HZ TO 20 KHZ BANDWIDTH	N/A
14.5 KHZ VCO	IRIG STANDARD $\pm 7.5\%$	N/A	N/A	3.0 V PEAK-TO-PEAK* $\pm 5\%$ WHEN TERMINATED INTO A 47 K OHM LOAD	N/A	N/A

*ADJUSTABLE



DESIGN STATUS

1. ENGINEERING MODEL

Operation capability is established for all five modes for both uplink and downlink operation. Performance evaluation over temperature range will start after CDR.

2. MECHANICAL MOCK-UP LCRU AND ANCILLARY ITEMS

Complete LRV vibration test support at Kent, Washington. Data will be used to support in-house vibration testing. Mock-up will be converted to crew training model.

3. THERMAL MOCK-UP LCRU

Supporting solar Radiation Tests at MSC. Data to date confirms thermal analysis projections, and confirms acceptability of battery heat sink design.



DESIGN STATUS

4. LCRU DRAWINGS

- a. LCRU case and subsystem drawings complete. To be signed-off and released after CDR approval.
- b. LCRU subassembly drawings signed-off final.
- c. Stowage Container drawings are preliminary. To be finalized after CDR.

5. DVT #1 STATUS

- a. LCRU subassemblies near completion of fabrication. Test will start this week on cordwood assemblies.
- b. Case fab will start after CDR when drawings are signed-off.

6. FLIGHT STATUS

- a. Electrical components are released for all LCRU subassemblies.
- b. Fab will be released after CDR.

7. LCRU SYSTEM TEST

First system test position in operation. It is supporting EM test program.



LCRU SUBSYSTEM DESCRIPTION

GENERAL

Pressurized Case	7.5 PSIA/100% Nitrogen
Redundancy	Duplication of Critical Subassemblies (Except VHF)
Power	Internal or External Option
Operational Modes	Five Modes
Deployment	Quick Simple Deployment of Preambled Units
Human Factors	Clearly Marked Functions, Positive Lock/Unlock, Positive Action Detents.
Crew Action Requirements	Minimized due to Pre-Assembly - Limited to Antenna Pointing, Mode Switching, Occasional Blanket Adjustment.
Thermal Design	Enables Operation in Lunar Environment Over 5° to 60° Sun Angles.

MECHANICAL

Weight (including antennas and cables)	70 lbs. maximum
Size (LCRU Unit)	22 x 13 x 5.625
Mechanical Compatibility	LM/LRV/TV



LCRU SUBSYSTEM DESCRIPTION (CONT.)

ELECTRICAL

DOWNLINK

VHF Input Frequency	259.7 MHz
VHF Input Power	0 dbm to -90 dbm
S -Band Transmit Frequency	2265.5 MHz
S-Band Transmit Power	8 W or 6 W to Antenna
Antenna Gain (high gain)	23 db (5° beamwidth)
Antenna Gain (low gain)	6.5 db (60° beamwidth)
Data	TV, EVCS Voice, EVCS Subcarriers, and LCRU Telemetry.

UPLINK

S-Band Receive Frequency	2101.8 MHz
S-Band Receive Sensitivity	-98 dbm
VHF Transmit Frequency	296.8 MHz
VHF Transmit Power	0.5 W to Antenna
VHF Antenna Gain	-3 db
Data	Voice & TV Commands



LCRU SUBSYSTEM DESCRIPTION (CONT.)

ENVIRONMENTAL

Temperature	35°F to 120°F (Modules Tested 0°F to 160°F)
Vibration (operational)	.25g sine 2-20 Hz
Vibration (stowed)	22.8g RMS
Shock (stowed)	30g Sawtooth



EM TEST STATUS

1. EM tests started 9/1/70.
2. Gross adjusted VHF output DTV for downlink subcarrier deviation and ran amplitude response over range of VHF input levels.
3. Gross adjusted uplink levels for 70% modulation from VHF transmitter.
4. Verified operation capability of PM 1 narrowband, PM 1 wideband, PM 2 narrowband, FM TV and TV standby modes for both uplink and downlink operation at room temperature.
5. Ran RF frequency response of FM/TV vs DC input level.
6. Verified satisfactory TV downlink performance and TV/LCRU compatibility.
7. Verified satisfactory EVCS/LCRU performance compatibility.
8. Temperature test data and finalization of level and deviation adjustments will be performed after CDR.



LCRU PERFORMANCE CAPABILITY

SUBASSEMBLY COMPATIBILITY DESIGN

LCRU is constructed and tested to optimize "end to end" relay subsystem performance over operational temperature range.

TV INTERFACE COMPATIBILITY

- A. LCRU design is capable of meeting TV ICD performance requirements.
- B. Close coordination with RCA AED offers maximum TV compatibility.



LCRU PERFORMANCE CAPABILITY, CONT.

LM INTERFACE COMPATIBILITY

- a. LCRU design meets LM ICD requirements. (Except vibration maybe a problem)
- b. LCRU, spare batteries, and stowage container mounting provisions on LM MESA have been coordinated with GAC and are satisfactory.



LCRU PERFORMANCE CAPABILITY (CONT.)

LRV INTERFACE COMPATABILITY

- A. Mechanical, thermal, and electrical design conforms with known LRV ICD requirements.
- B. EMI/grounding scheme eliminates ground currents.
- C. Operation from LRV power is an optional capability.
- D. Pre-assembly of High Gain Antenna assembly and Low Gain Antenna assembly minimizes crew operations.
- E. TV mounting on LRV is identical with HGA mounting for maximum design similarity.
- F. Quick release of LCRU from mounting legs and provision of handle permits minimum deployment time for hand carry mode.
- G. Quick disconnect mechanism on LGA permits rapid deployment on LCRU for hand carry mode.



LCRU PERFORMANCE CAPABILITY, CONT.
LCRU EM PERFORMANCE COMPATIBILITY
WITH LCRU SUBASSEMBLY SPECIFICATION

<u>REQUIREMENT</u>	<u>ACHIEVED</u>
PM/PM Transmitter Performance (6 Watts, min. power output)	X
FM/PM Transmitter Performance (8 Watts, min. power output)	X
VHF Transmitter Performance (.5 Watts, min. power output)	X
VHF Receiver Performance (-106 dbm sensitivity)	X
VHF Triplexer Performance (Tx/Rx isolation)	X
S-Band Diplexer Performance (Tx/Rx isolation)	X
Downlink Signal Processor Performance	X
Telemetry Requirements (temperature and voltage)	X
Uplink Signal Processor Requirements (VHF transmitter control)	X
VHF Antenna Performance	X
Low Gain Antenna Performance	X
HGA Performance (23 db gain)	X



LCRU PERFORMANCE CAPABILITY, CONT.

Although the LCRU packaging is tight and consistent with space packaging techniques, manufacturability of the LCRU and its subassemblies has been implemented to the maximum extent and maintainability provisions (test point accessibility, DTV accessibility, etc.) has been optimized. LCRU failure modes have been analyzed and eliminated to the maximum extent possible consistent with program requirements.



LCRU EMI CONTROL REQUIREMENTS

1. MSC-IESD 19-3A

POWER LINE CONDUCTED EMISSIONS, 30 Hz TO 25 MHz *

RADIATED EMISSIONS' 150 kHz TO 10 GHz *

R.F. RADIATED SUSCEPTIBILITY, 150 kHz TO 10 GHz

A.F. CONDUCTED SUSCEPTIBILITY, POWER LINES, EXCEPT MODIFIED TO 0.6 VOLT RMS (L.R.V.
RIPPLE REQUIREMENT)

RECEIVER TWO-SIGNAL INTERMODULATION (SUSCEPTIBILITY)

2. IRIG 106-69

ANTENNA CONDUCTED SPURIOUS EMISSIONS

RECEIVERS (TRANSMITTERS KEY-UP)

TRANSMITTERS

RECEIVER FRONT-END REJECTION (SPURIOUS RESPONSES)

* DEVIATIONS FOR SHORT DURATION INTERFERENCE EMISSIONS PER MSC-IESD 19-3A, APPLICABLE AS FOLLOW

1) POWER ON/OFF, S-BAND PRIM/SEC RCVR. SWITCHING; NO LIMIT

2) MODE SWITCHING, PANEL METER SWITCHING; + 20 dB.



LCRU EMI DESIGN FEATURES

1. SHIELDING

SUBASSEMBLIES ALL INDIVIDUALLY SHIELDED CASES

LCRU CASE: SHIELDED EQUIPMENT AREA, PRESSURIZED COMPARTMENT
HOGGED OUT ALUMINUM, 5 SIDES

BOTTOM COVER: 1/8 INCH ALUMINUM

1 INCH FASTENER SPACING

CONTACTS 0.15 INCH PERIPHERAL SURFACE

SHIELDING EFFECTIVENESS MAINTAINED AT APERATURES

RF CONNECTORS--STAR WASHERS

31 PIN CONNECTOR--STAR WASHER

BATTERY/FRONT PANEL AREA, PRESENTLY SHIELDING NOT
MAINTAINED, ONLY SOURCES SWITCHES AND CONTROLS

CABLES, INTERNAL WIRING:

LRV/TV CABLE, OVERALL SHIELD

VIDEO, 70 kHz SIGNALS SHIELDED

SEMI RIGID COAX, S-BAND

COAX VHF

SHIELDED WIRING INTERCONNECTING SIGNALS

ROUTING, MINIMIZE COUPLING

2. FILTERING

SIGNAL CONTENT ROLLED OFF AT CIRCUIT LEVEL

DC POWER INPUT TO SUBASSEMBLIES FILTERED AT SUBASSEMBLY LEVEL

DC/DC CONVERTER EMI FILTERS ON INPUT AND OUTPUTS

LRV/TV INPUT/OUTPUT LINES BARRIER MOUNTED FILTERS AT FRONT PANEL CONNECTOR

TRIPLEXER/DIPLEXERS BARRIER MOUNTED

SERIES REGULATOR



LCRU EMI DESIGN FEATURES (CONT.)

3. GROUNDING/BONDING/INTERFACES

- GROUNDING - BASED ON APPROACH USED ON EVC'S
LCRU CHASSIS ISOLATED FROM LRV EXCEPT BY DC POWER RETURN
ELIMINATES POSSIBILITY OF EXTERNAL GROUND LOOPS
DC RETURNS AND SIGNAL RETURNS GROUNDED TO LCRU CHASSIS
SEPARATE DC AND CHASSIS GROUND WIRES
- BONDING - LCRU CASE AND SHELF: CLEAN SURFACE IRIDITE 198135
SPOT WELDED GROUND TERMINALS
CONNECTORS: STAR WASHERS
SUBASSEMBLIES: THREADED MOUNTINGS
IRIDITE, TIN PLATED, GOLD, SILVER
EVALUATION TESTING, ENGINEERING MODEL
- INTERFACES - LRV - CABLE SHIELD AND DC RETURN GROUNDED AT LRV
TV - CABLE SHIELD ISOLATED CHASSIS ISOLATED - LRV
ANTENNAS - ISOLATED FROM LRV

4. EMISSION AND SUSCEPTIBILITY CONTROL

EMISSION SOURCES

DC-DC CONVERTER
S-BAND TRANSMITTER
VHF TRANSMITTER
SIGNAL PROCESSORS

SENSITIVE SUBASSEMBLIES

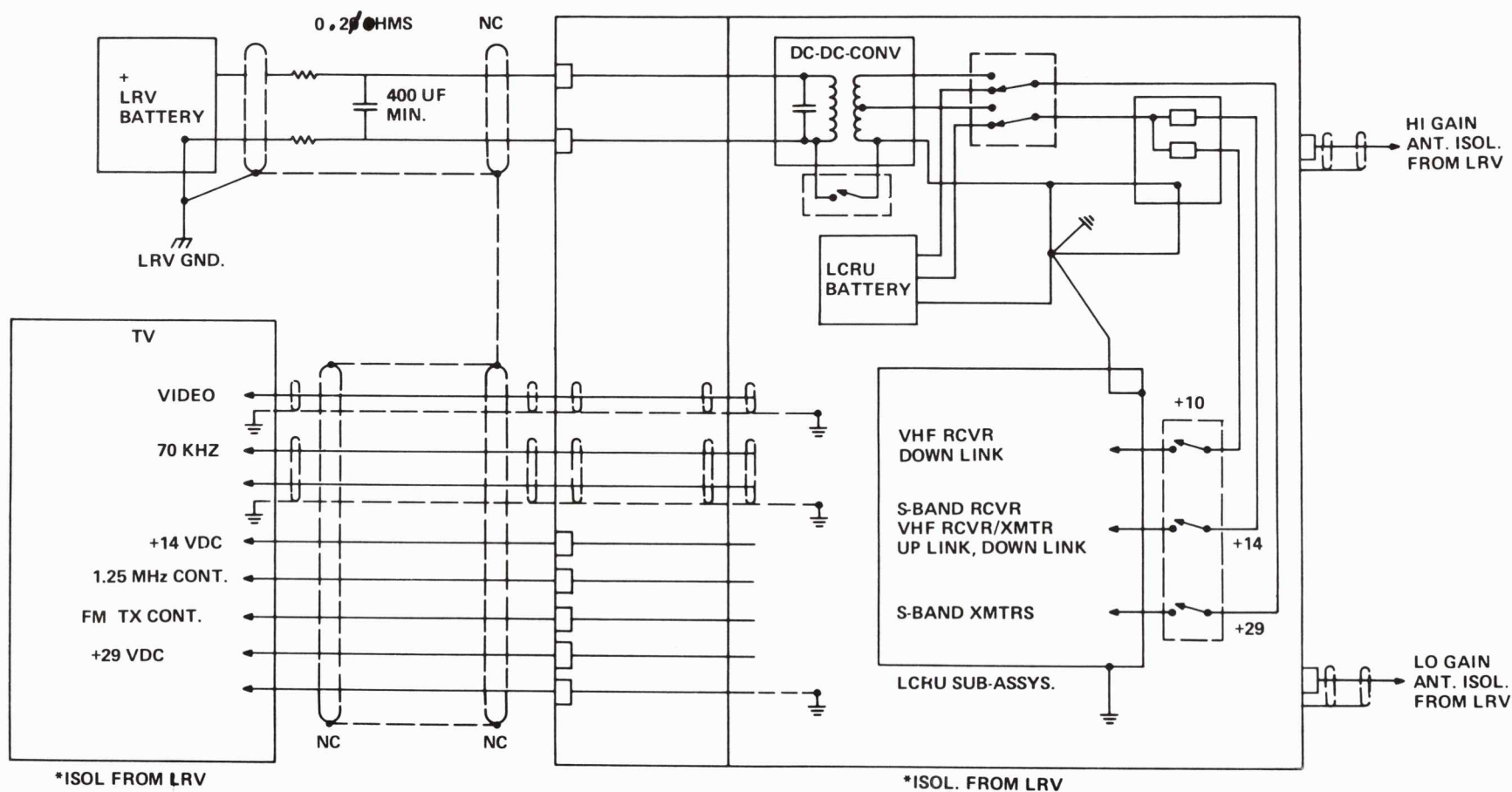
VHF RECEIVER
S-BAND RECEIVERS

SPURIOUS EMISSIONS AND RESPONSES

VHF	TRIPLEXER	}	--EXISTING EVC'S DESIGN, EMI TESTED, KNOWN CHARACTERISTICS.
	TRANSMITTER		
	RECEIVER	}	--EMISSIONS, RESPONSES, ISOLATION, ADEQUATELY SPECIFIED
S-BAND	DIPLEXER		
	TRANSMITTERS		
	RECEIVER		



LCRU/LRV/TV INTERFACES AND GROUNDING

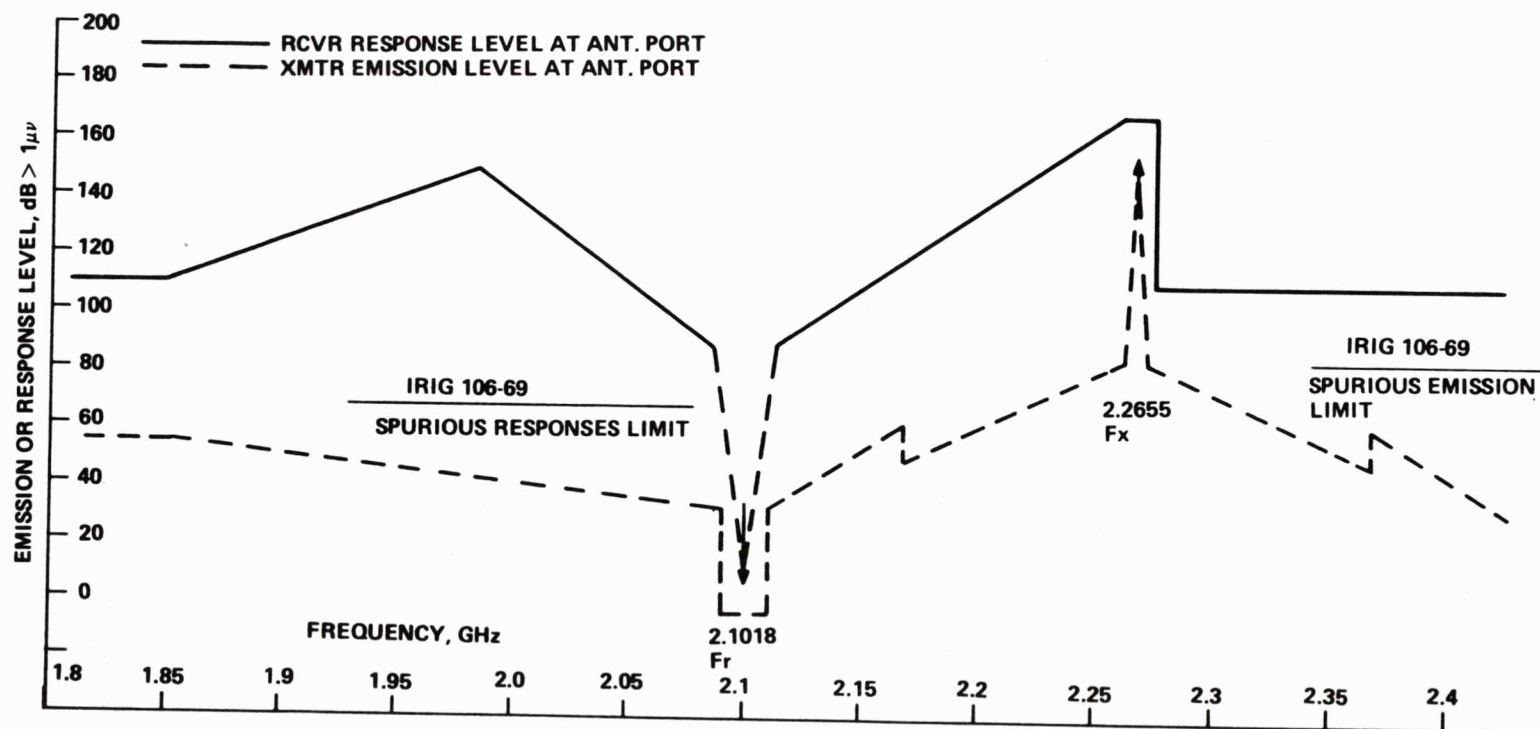




1. 14.5 KHz OSC. OUT, TEMP, VOLT, FM MOD IN: SHIELDED, WITH SHIELD GROUNDED AT BOTH ENDS
2. S-BAND RCVR TO UP-LINK; SHIELDED WITH SHIELD GROUNDED AT S-BAND END ONLY.



S-BAND EMISSIONS AND RESPONSES





EMI TESTING

1. EVALUATION TESTING

INFORMAL, LIMITED TO SPECIFIC TESTS OF CONCERN
CONFIDENCE, EARLY PROBLEM AWARENESS
ENGINEERING MODEL

2. DESIGN VERIFICATION TESTING

FORMAL, COMPLETE
TEST PROCEDURE, REPORT SUBMITTAL
SUBASSEMBLIES, REQUIREMENTS SPECIFIED

PLANS, REPORTS

LCRU - SUMMARY IN CONTROL PLAN
PROCEDURE DRAFT COMPLETION FOLLOWING EVALUATION TEST
REPORT, SPECIFIC RECOMMENDATIONS REGARDING NON-COMPLIANCE

3. QUALIFICATION TESTING

FORMAL, LIMITED BASED ON RESULTS OF DVT TEST
TEST PROCEDURE, REPORT



EMI SUMMARY

1. EMI REQUIREMENTS DEFINED

MSC-IESD 19-3A
I 106-69

2. EMI DESIGN FEATURES

UNIT AND SUBASSEMBLY SHIELDING AND FILTERING
GROUNDING, BASED ON PREVIOUS PROVEN APPROACH, COMPATIBLE WITH HEAT TRANSFER REQUIREMENTS
COMPLETELY ISOLATED INTERNAL BATTERY OPERATION

SELF COMPATIBILITY
VHF EQUIPMENTS, EXISTING DESIGN
S-BAND EQUIPMENTS, EMISSIONS/RESPONSES/ISOLATION ADEQUATELY SPECIFIED
VHF/S-BAND

3. TESTING

EARLY INDICATION OF DESIGN ADEQUACY
DEMONSTRATE COMPLIANCE WITH REQUIREMENTS
BASED ON OVERALL PROGRAM SCHEDULES

4. ANTICIPATED EFFECTIVENESS

COMPLIANCE WITH MSC-IESD 19-3A AND IRIG 106-69 ANTICIPATED
NO INCOMPATIBILITY

DESIGN TECHNIQUES FLEXIBLE ENOUGH TO INCORPORATE MODIFICATIONS IF REQUIRED



TRIPLEXER
RANTEC P/N MT-329 RCA P/N 8547878

TEST <u>PARAMETER</u>	<u>LIMIT</u>	<u>S/N 34</u>
VSWR @ 259.7 MHz	1.30 MAX	< 1.2
@ 296.8 MHz	1.30 MAX	< 1.2
LOSS @ 259.7 MHz	2 DB MAX	1.7 DB
@ 296.8 MHz	2 DB MAX	1.3 DB
ISOLATION		
ANT/REC @ 296.8	35 DB MIN	> 45 DB
TRAN/ANT @ 259.7	35 DB MIN	> 45 DB
WEIGHT		
	5 OZ MAX	4 OZ



VHF ANTENNA

MOTOROLA, INC. P/N 85-25933K03

<u>TEST PARAMETER</u>	<u>LIMIT</u>	<u>S/N 1</u>	<u>S/N 2</u>	<u>S/N 3</u>
VSWR @ 259.7 MHz	1.25 MAX	1.20	1.18	1.17
@ 296.8 MHz	2.30 MAX	2.20	2.25	2.25
GAIN				
@ 259.7 MHz				
PATTERN PEAK	-0.5 DB MIN	1.7 DB	+1.9 DB	+1.7 DB
90 DEG	-3.0 DB MIN	-2.1 DB	-2.3 DB	-2.3 DB
@ 296.8 MHz				
PATTERN PEAK	-1.0 DB MIN	+1.3 DB	+1.3 DB	+1.5 DB
90 DEG	-5.0 DB MIN	-2.9 DB	-2.9 DB	-2.6 DB
WEIGHT	4 OZ MAX	3.24 OZ	3.24 OZ	3.23 OZ



DIPLEXER

WAVECOM P/N S218-E

RCA 8151102 (EM)

<u>TEST PARAMETER</u>	<u>LIMIT</u>	<u>S/N 15</u>	<u>S/N 16</u>
VSWR @ 2101.8			
ANT PORT	1.3 MAX.	1.06	1.06
REC PORT	1.3 MAX	1.09	1.09
VSWR @ 2265.5			
ANT PORT	1.3 MAX	1.05	1.05
TRAN PORT	1.3 MAX	1.04	1.03
ANT/REC LOSS	0.85 DB MAX	0.60 DB	0.60 DB
TRAN/ANT LOSS	0.60 DB MAX	0.40 DB	0.40 DB
ISOLATION			
ANT/REC @ 2265.5	80 DB	90	92
TRAN/ANT @ 2101.8	60 DB	69	69



LCRU VHF AM RCVR

Frequency

Operating Frequency	259.7 MHz
LO Stability	0.003%
IF Frequency	30.0 MHz
IF Bandwidth, 6 dB	70 KHz Min.
60 dB	240 KHz Max.

Input Signal AM Modulation

Audio, 200 Hz to 3.0 KHz	36.5%
3.9 KHz Sub-carrier	8.4%
5.4 KHz Sub-carrier	9.3%
7.35 KHz Sub-carrier	16.2%
10.50 KHz Sub-carrier	19.0%

General Requirements

Audio Sensitivity for 30% 1KHz AM in 17 KHz BW	-132 dBW with a 10dB S/N Min.
	-96 dBW with a 35dB S/N Min.
Harmonic Distortion @ 70% AM	5% Max.
2 Tone IM @ 90% Total AM in Audio Band	23 dB below audio
Dynamic Range,	-139 dBW to -23 dBW
RF Input Connector	Sealelectro. right angle, male

Signal Outputs

WB-PM MOD to Downlink Sig. Processor

Connector	Through term.
Drive Impedance	100 ohms
3.9 KHz Sub-carrier Output	81 MV _{rms} @ 30K ohm load

NB-PM MOD to XMTR's (Two)

Connector	Through term.
Drive Impedance	100 ohms
3.9 KHz sub-carrier Output	81 MV _{rms} @ 1K ohms, 30 pf load

14.5 KHz Sub-carrier Input

Input Impedance	47.0K ohms
Input Connector	Through term.
Sub-carrier Input NB-PM	15 MV _{rms}
Sub-carrier Input WB-PM	30 MV _{rms}

DC Power Requirements

Input DC Voltage	14.0 VDC $\pm$ 0.1 volts
Input DC Voltage	10.0 VDC $\pm$ 0.1 volts
Input Current, 14 VDC	40.0 MA Max.
10 VDC	35.0 MA Max.
ON/OFF Control	Prime Power

Volume

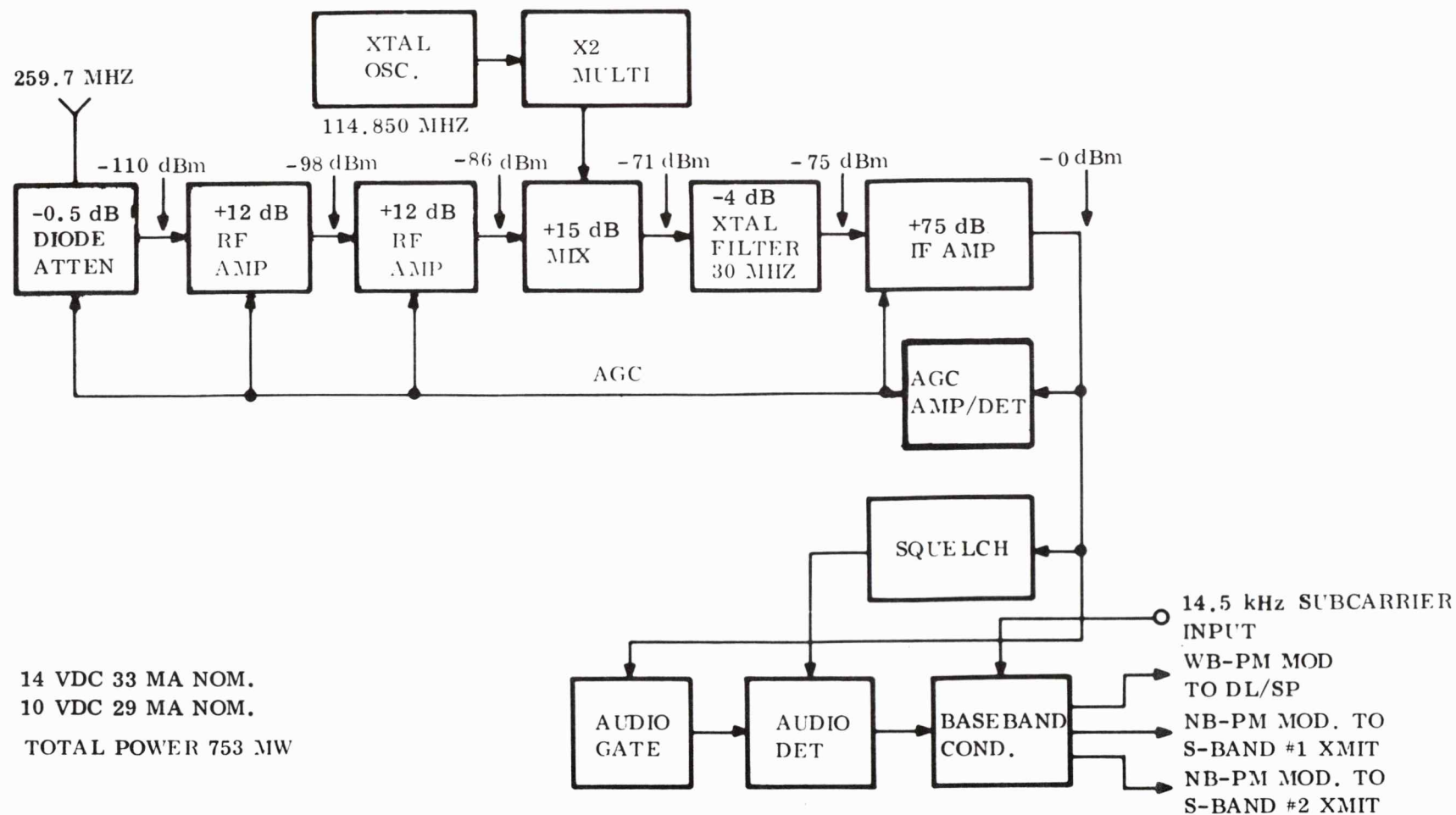
Max Design Envelope Excluding Connectors	5.04 x 1.54 x 1.60 in.
Volume	12.4 cu. in.

Weight

Projected Weight	8.0 ounces
------------------	------------

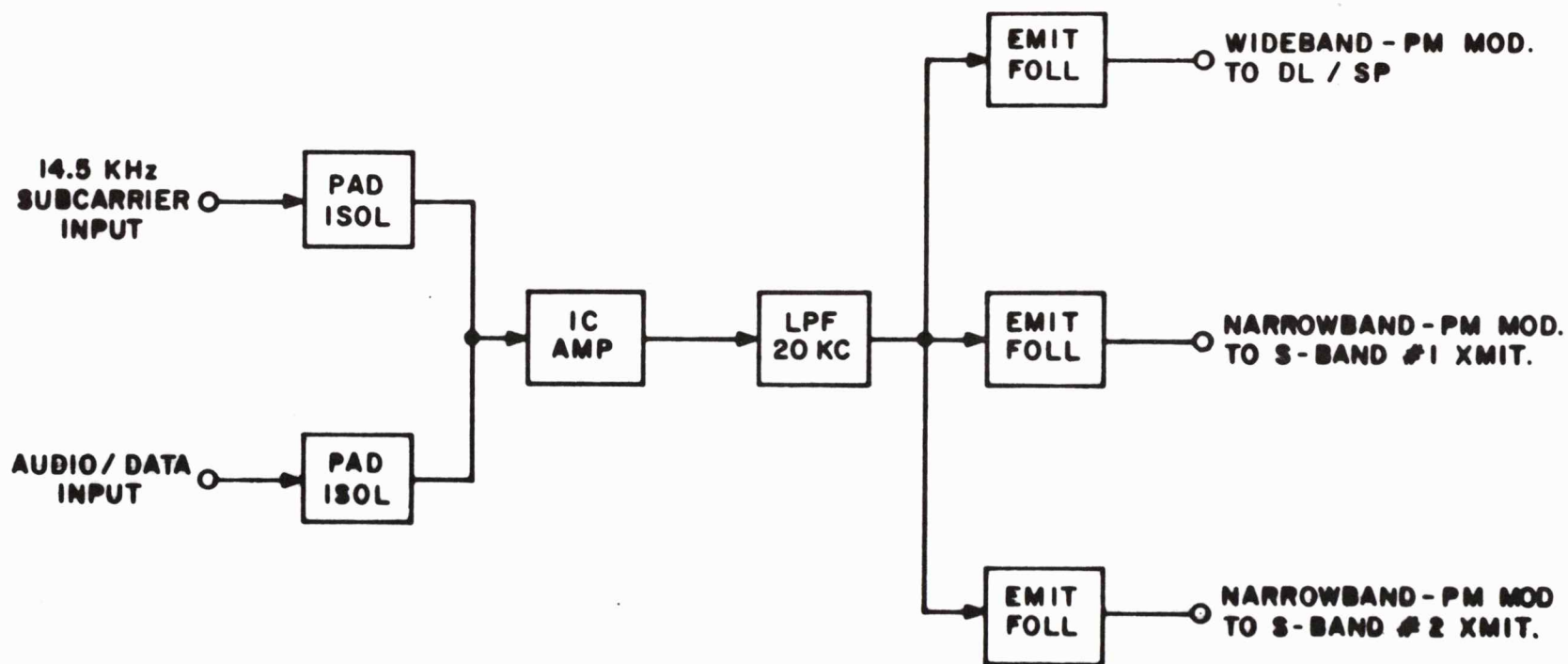


259.7 MHz VHF AM RECEIVER

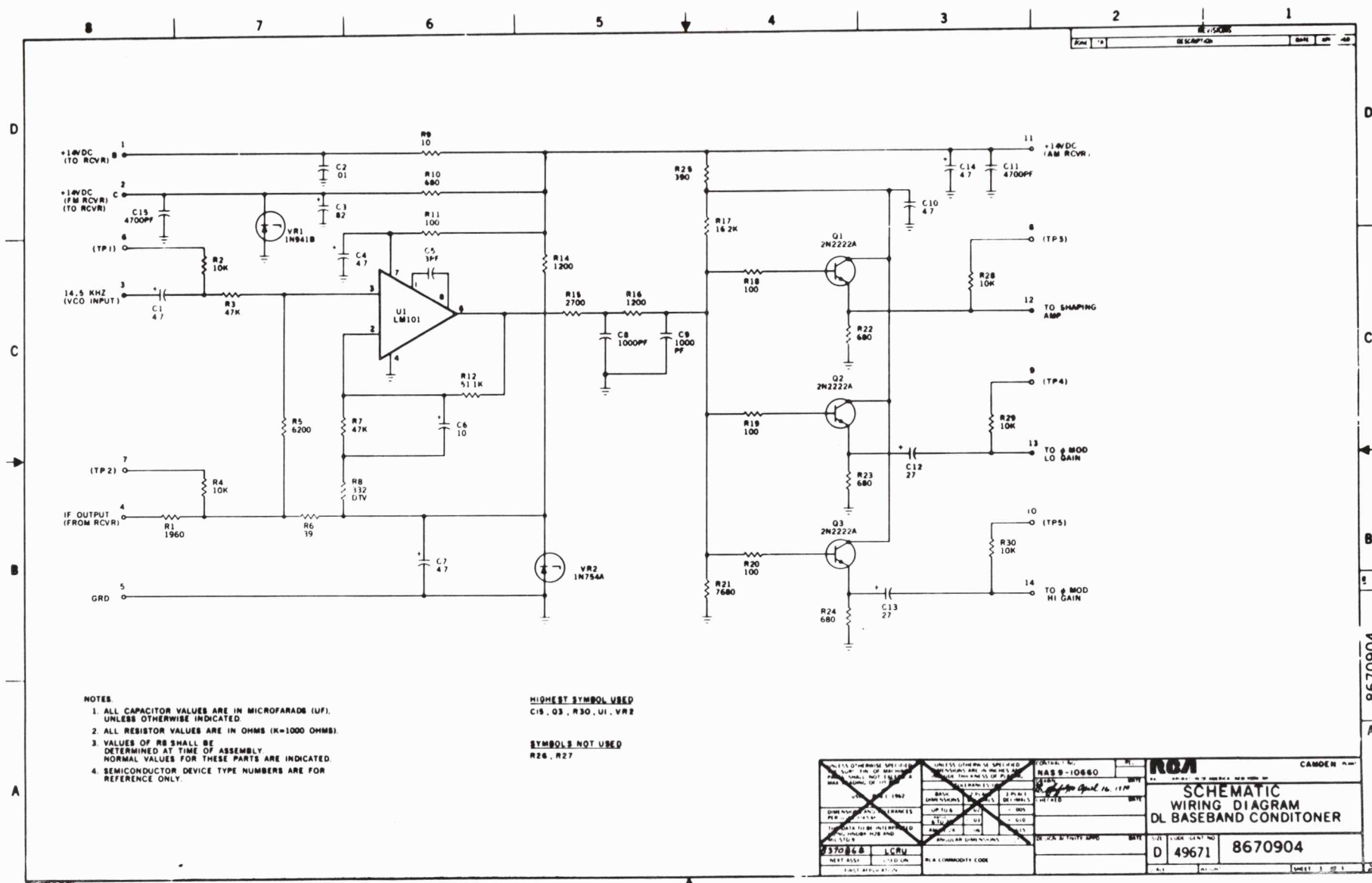




DOWN LINK BASEBAND CONDITIONER BLOCK DIAGRAM



RCA



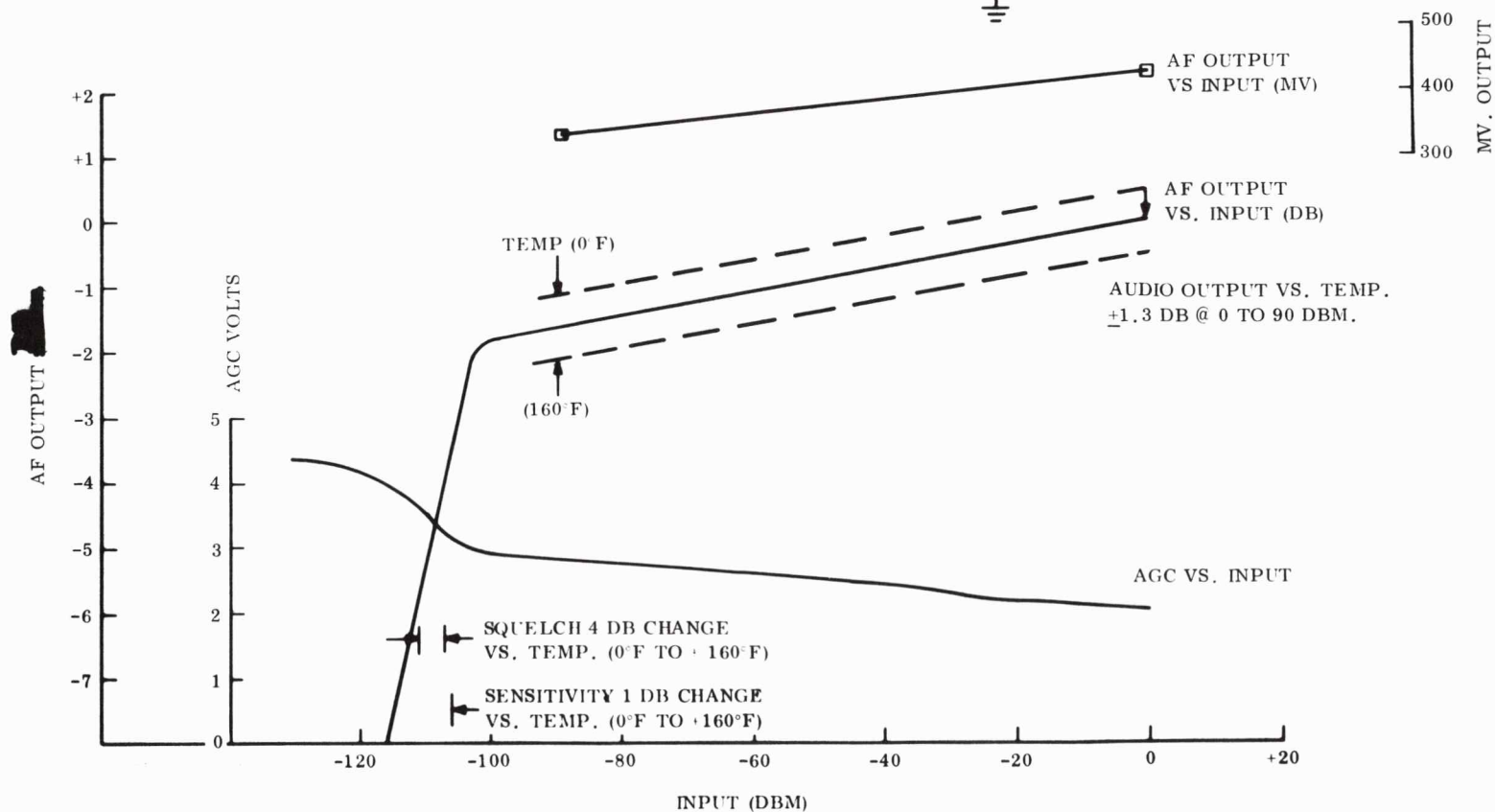
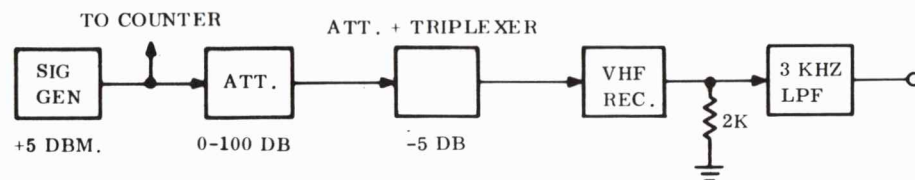


VHF. AM. RECEIVER (259.7 MHz) ENGINEERING MODEL

		TEST DATA		
FUNCTION	REQUIRED	0° F	ROOM	160° F
POWER +14V +10V	40 MA MAX. 35 MA MAX.		33 MA. 29 MA.	
AUDIO OUTPUT (-90 dbm INPUT) (-40 dbm INPUT) (0 dbm. INPUT)	350 MV LIMIT (0 to -90 dbm) ±1.5 db	0 —	-0.8 db REF. 0 db. +0.8 db	-0.5 —
SQUELCH OPER. "OFF" "ON"	LIMIT (109 ± 3 dbm)	-110.5 dbm -109 dbm	-110 dbm -108 dbm	-109 dbm -107 dbm
SENSITIVITY 3 KHz, L.P.F. AT OUTPUT (-106 dbm INPUT) 20 KHz, L.P.F. AT OUTPUT (-106 dbm INPUT) (30%, 1 KHz MOD.)	LIMIT 13 db MIN.	14.8 db —	14.0 db 8.0 db	14.0 db —
BANDWIDTH	(6 db.) 70 KHz MIN.		88 KHz	
RESPONSE 300 Hz MOD. 1 KHz MOD. 10 KHz MOD.	LIMIT ± 1 db.		-0.3 db REF. 0 db +0.2 db.	
HARMONIC DISTORTION (-55 dbm INPUT)	LIMIT 5%	4%	4%	4%

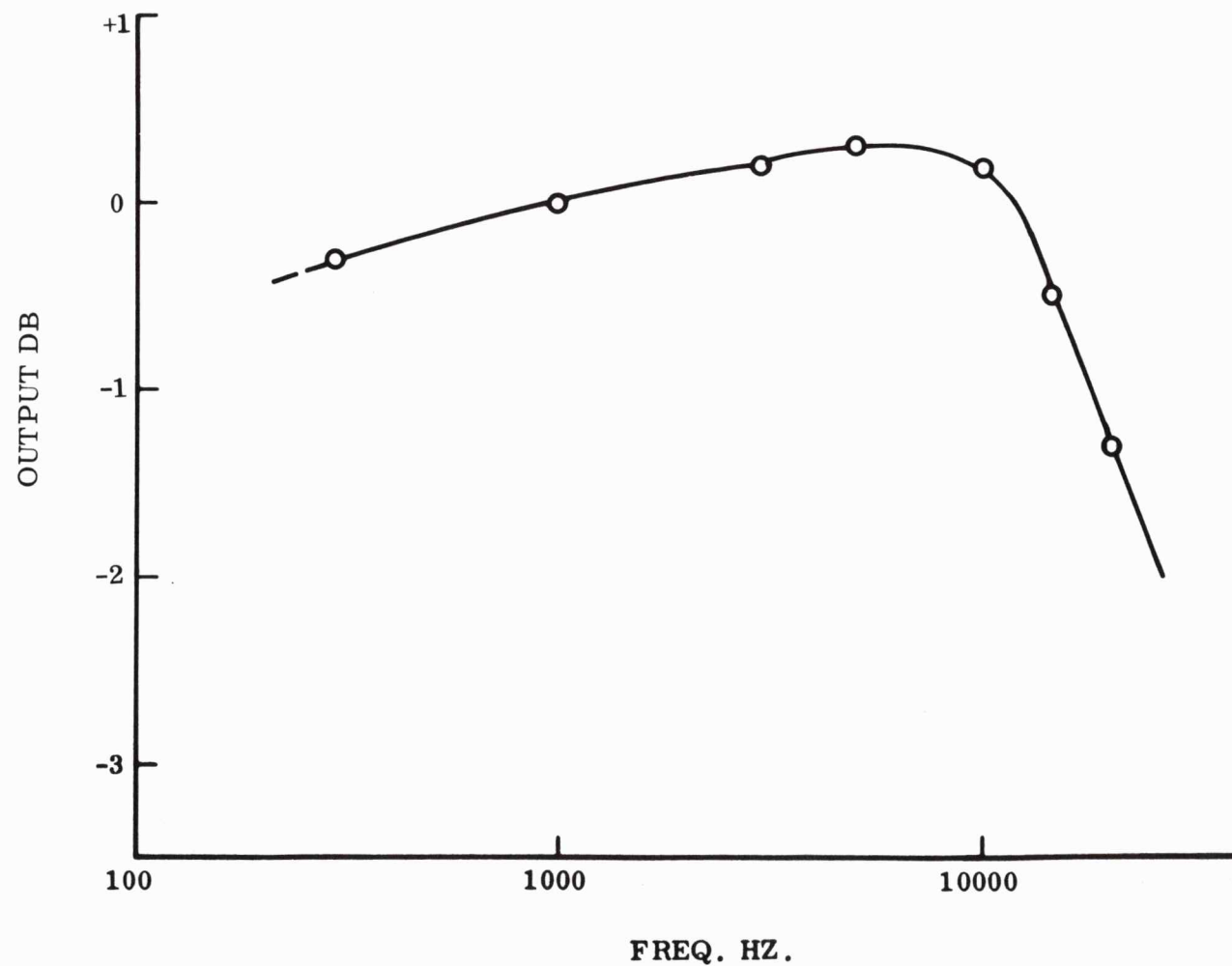


OVERALL VHF REC. (ENG. MODEL)





OVERALL VHF RECEIVER (ENG. MODEL) FREQUENCY RESPONSE





LCRU VHF AM TRANSMITTER

Frequency

Operating Frequency
Frequency Stability

296.8 MHz
 $\pm 0.003\%$

RF Output

Connector

Sealelectro Bulkhead female Rec.
50 - 043 - 0000

Output Impedance
OC and SC protection
RF Power (CW)

50 ohms nominal
4 hours no damage
0.580 watts nominal
0.500 watts minimum
40 dB min.
VOX operated

AM Modulation

Percent modulation
Range
Sensitivity

70% AM (1.14 Vrms)
300 Hz to 4.0 kHz
1.6 Vrms Sine wave input, 100% AM nominal,
subject to DTV adjustment

Input Impedance
Frequency Response, 1 kHz Ref. @ 300 Hz
@ 3.0 kHz

10 K ohms nominal
 ± 2 dB
 ± 1 dB

Modulation Linearity
Harmonic Distortion @ 70% AM, 300 Hz-3.0 kHz

$\pm 10\%$ of BSL
10% Max.

DC Power Requirements

Input DC Voltage
Input DC current CW
70%, 1 kHz AM

+14.0 VDC ± 0.1 volts
280 MA Max.
360 MA Max.

Volume

Volume
Max Design Envelope excluding connectors

9.2 cu. in.
5.0 x 1.19 x 1.55 in.

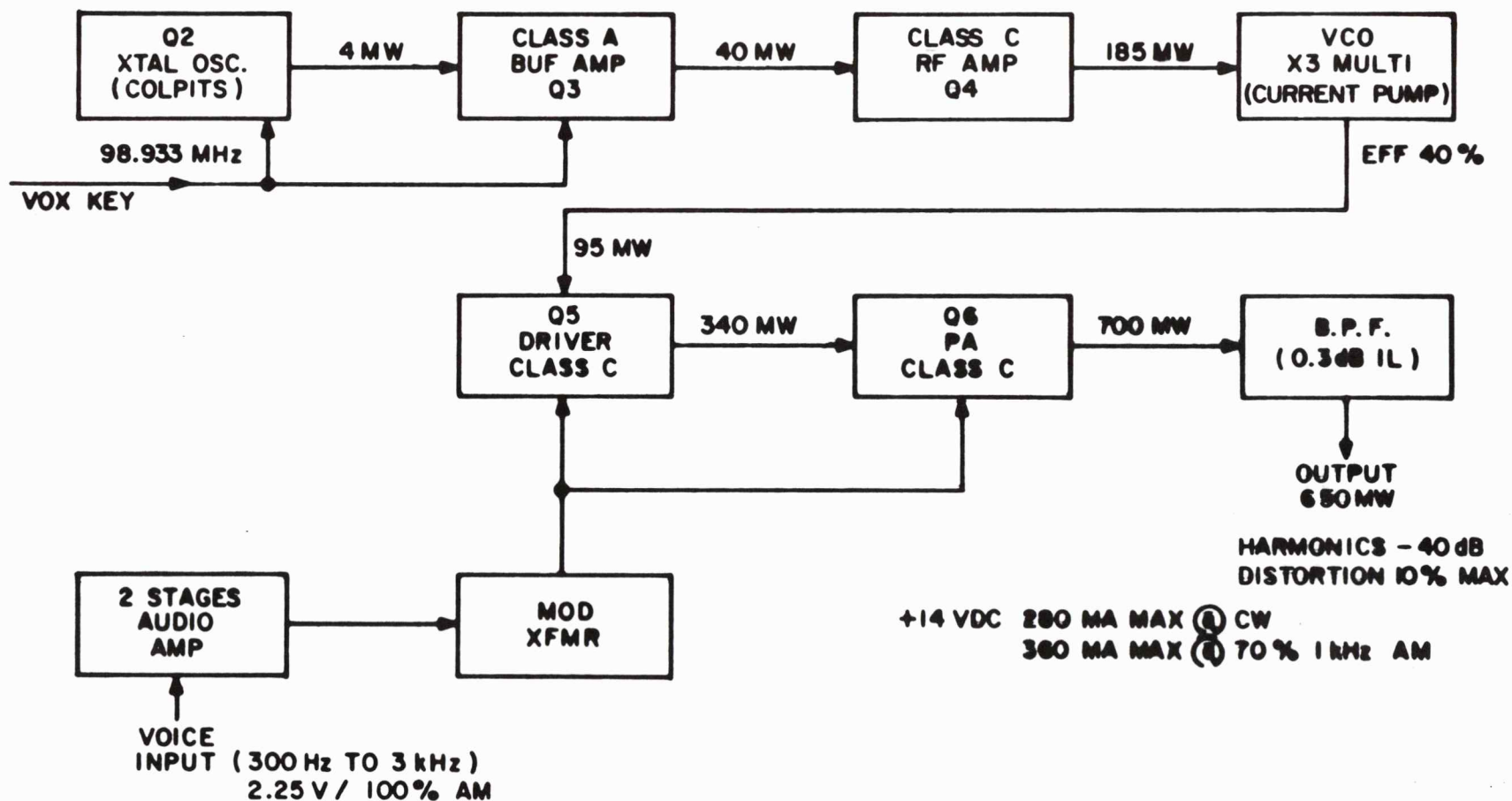
Weight

Projected Weight

8.0 ozs.

RCA

VHF AM TRANSMITTER (296.8 MHz)





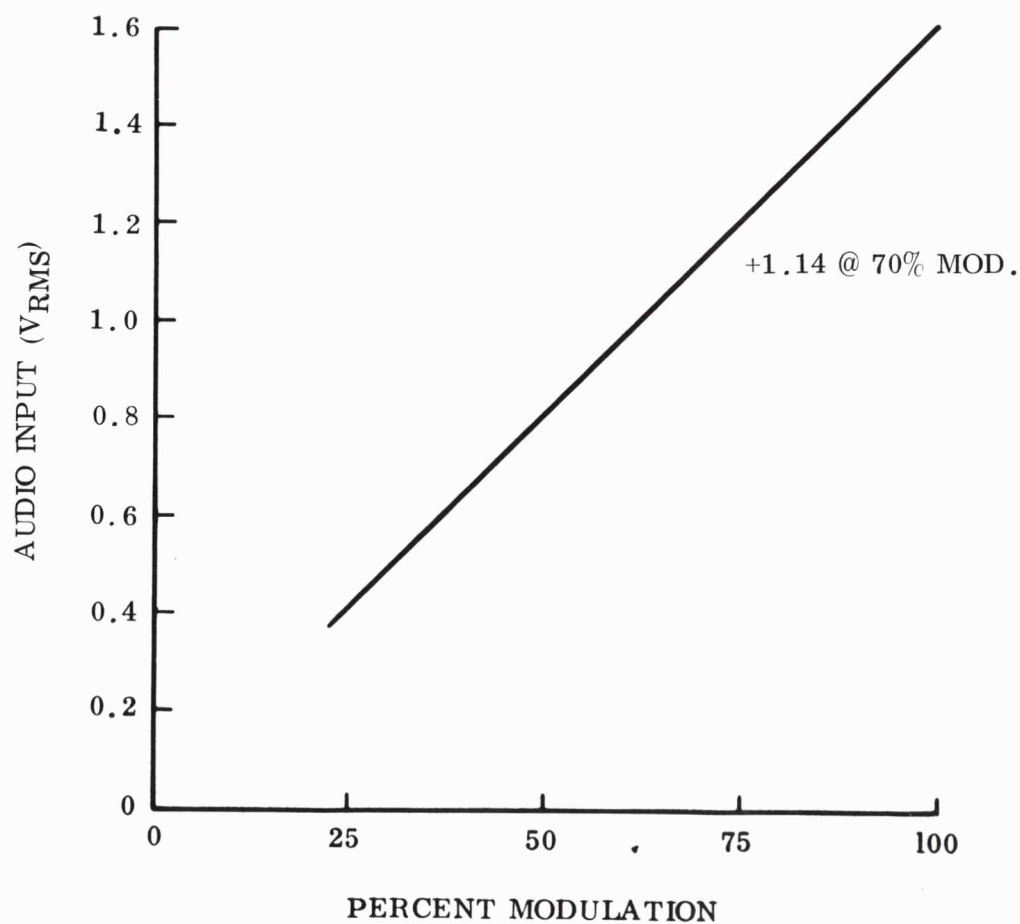
VHF. AM. TRANSMITTER (296.8 MHz.) ENGINEERING MODEL

		TEST DATA		
FUNCTION	REQUIRED	0° F	ROOM	160° F
KEYER OPERATION	CHECK	✓	✓	✓
POWER OUTPUT	500 MW. MIN.	700	640	520
CENTER FREQUENCY	296.8 MHz $\pm$ 9 KHz	+3.9	+1.8	-0.7
DC CURRENT	360 MA. MAX. (260 NOMINAL)	235	245	240
MOD. LINEARITY	V REF. (50%) 22.5 to 27.5% 67.5 to 82.5%	0.89 25% 0.45V 76.4% 1.3V	0.81 25% 0.405V 76.4% 1.21V	0.75 25% 0.36V 76.4% 1.13V
HARMONIC DISTORTION	10% MAX.			
1 KHz		7.0	4.1	2.8
3 KHz		2.9	3.9	2.4
SIGNAL TO NOISE	-40 db. MIN.	-50	-50	-50
FREQ. RESPONSE				
3 KHz	± 1 db	0	0	+0.3
300 Hz	± 2 db	-1	-0.8	-1.1



VHF AM TRANSMITTER (ENG. MOD.)

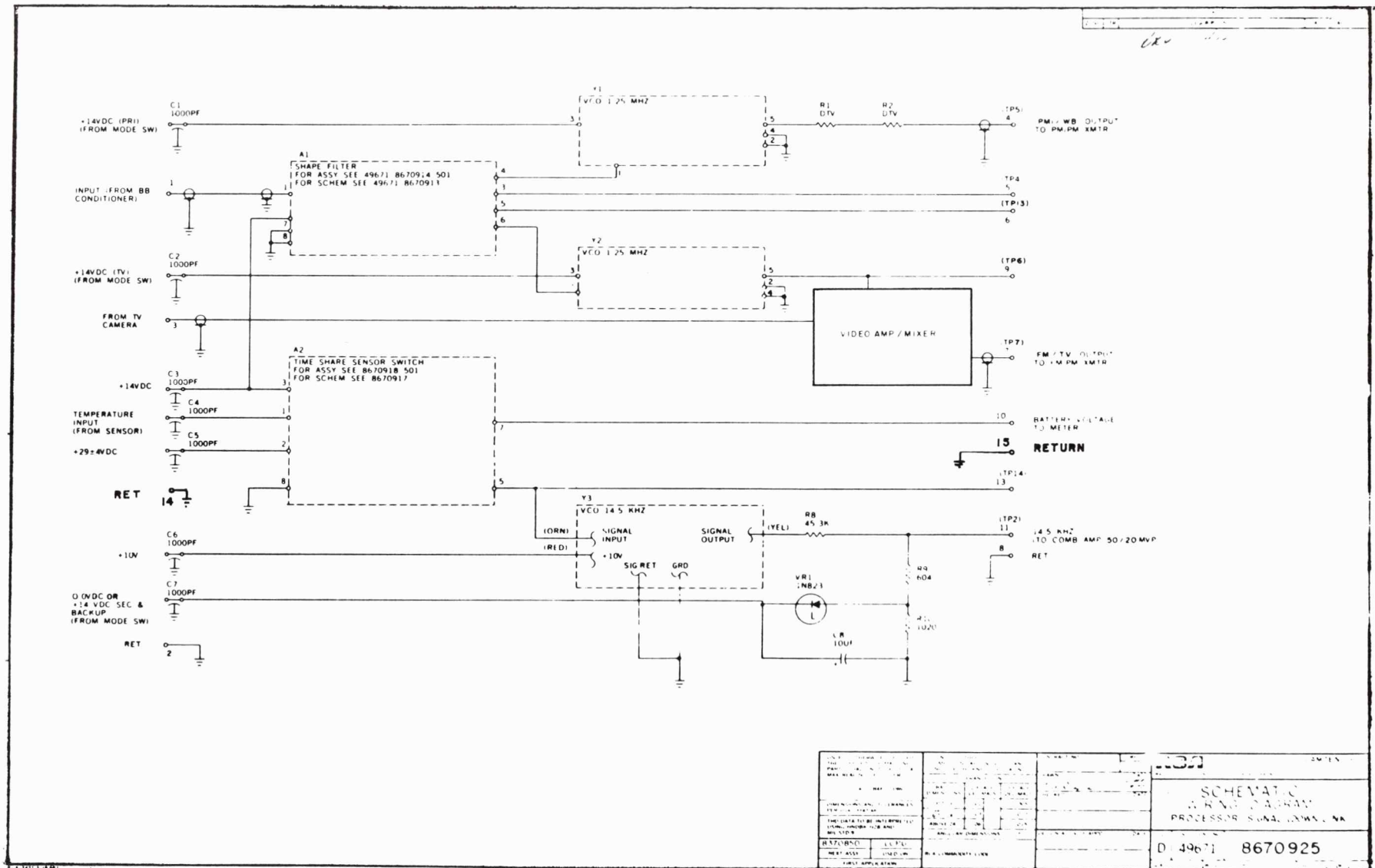
(AUDIO INPUT VS. % MOD.)



RCA

PROCESSOR SIGNAL (DOWN LINK)

7-78



DATE: 10/1/78 BY: L. R. N. G. N. A. R. A. Y. CHECKED: 10/1/78 APPROVED: 10/1/78		PARTS LIST: 1. 1000PF 2. 1000PF 3. 1000PF 4. 1000PF 5. 1000PF 6. 1000PF 7. 1000PF 8. 1000PF 9. 1000PF 10. 1000PF 11. 1000PF 12. 1000PF 13. 1000PF 14. 1000PF 15. 1000PF 16. 1000PF 17. 1000PF 18. 1000PF 19. 1000PF 20. 1000PF 21. 1000PF 22. 1000PF 23. 1000PF 24. 1000PF 25. 1000PF 26. 1000PF 27. 1000PF 28. 1000PF 29. 1000PF 30. 1000PF 31. 1000PF 32. 1000PF 33. 1000PF 34. 1000PF 35. 1000PF 36. 1000PF 37. 1000PF 38. 1000PF 39. 1000PF 40. 1000PF 41. 1000PF 42. 1000PF 43. 1000PF 44. 1000PF 45. 1000PF 46. 1000PF 47. 1000PF 48. 1000PF 49. 1000PF 50. 1000PF 51. 1000PF 52. 1000PF 53. 1000PF 54. 1000PF 55. 1000PF 56. 1000PF 57. 1000PF 58. 1000PF 59. 1000PF 60. 1000PF 61. 1000PF 62. 1000PF 63. 1000PF 64. 1000PF 65. 1000PF 66. 1000PF 67. 1000PF 68. 1000PF 69. 1000PF 70. 1000PF 71. 1000PF 72. 1000PF 73. 1000PF 74. 1000PF 75. 1000PF 76. 1000PF 77. 1000PF 78. 1000PF 79. 1000PF 80. 1000PF 81. 1000PF 82. 1000PF 83. 1000PF 84. 1000PF 85. 1000PF 86. 1000PF 87. 1000PF 88. 1000PF 89. 1000PF 90. 1000PF 91. 1000PF 92. 1000PF 93. 1000PF 94. 1000PF 95. 1000PF 96. 1000PF 97. 1000PF 98. 1000PF 99. 1000PF 100. 1000PF		COMMENTS: 1. 1000PF 2. 1000PF 3. 1000PF 4. 1000PF 5. 1000PF 6. 1000PF 7. 1000PF 8. 1000PF 9. 1000PF 10. 1000PF 11. 1000PF 12. 1000PF 13. 1000PF 14. 1000PF 15. 1000PF 16. 1000PF 17. 1000PF 18. 1000PF 19. 1000PF 20. 1000PF 21. 1000PF 22. 1000PF 23. 1000PF 24. 1000PF 25. 1000PF 26. 1000PF 27. 1000PF 28. 1000PF 29. 1000PF 30. 1000PF 31. 1000PF 32. 1000PF 33. 1000PF 34. 1000PF 35. 1000PF 36. 1000PF 37. 1000PF 38. 1000PF 39. 1000PF 40. 1000PF 41. 1000PF 42. 1000PF 43. 1000PF 44. 1000PF 45. 1000PF 46. 1000PF 47. 1000PF 48. 1000PF 49. 1000PF 50. 1000PF 51. 1000PF 52. 1000PF 53. 1000PF 54. 1000PF 55. 1000PF 56. 1000PF 57. 1000PF 58. 1000PF 59. 1000PF 60. 1000PF 61. 1000PF 62. 1000PF 63. 1000PF 64. 1000PF 65. 1000PF 66. 1000PF 67. 1000PF 68. 1000PF 69. 1000PF 70. 1000PF 71. 1000PF 72. 1000PF 73. 1000PF 74. 1000PF 75. 1000PF 76. 1000PF 77. 1000PF 78. 1000PF 79. 1000PF 80. 1000PF 81. 1000PF 82. 1000PF 83. 1000PF 84. 1000PF 85. 1000PF 86. 1000PF 87. 1000PF 88. 1000PF 89. 1000PF 90. 1000PF 91. 1000PF 92. 1000PF 93. 1000PF 94. 1000PF 95. 1000PF 96. 1000PF 97. 1000PF 98. 1000PF 99. 1000PF 100. 1000PF	
SCHEMATIC L. R. N. G. N. A. R. A. Y. PROCESSOR SIGNAL (DOWN LINK)		D 49671 8670925			



SIGNAL PROCESSOR, DOWN LINK ENGINEERING MODEL

ASSY 8370853

SCH 8670925

		TEST DATA		
FUNCTION	REQ.	0° F	ROOM	160° F
<u>POWER</u>				
14 V	140 ma $\pm$ 10%	130-148	130-148	130-148
10 V	7 ma MAX	5.5	5.7	5.8
<u>TIME SHARE SW.</u>				
TEMPERATURE ON	10 $\pm$ 1 SEC.	9.8	10.6	10.8
BAT. VOLT. ON	20 $\pm$ 2 SEC. (AT ROOM TEMP. ONLY)	18.7	20.3	21.1
<u>VOLT. SEN. OUT</u>				
4.75 V	33.0 $\pm$ 0.5 V IN	33.338	33.404	33.379
2.50 V	29.0 $\pm$ 0.5 V IN	29.374	29.355	29.290
1.40 V	27.0 $\pm$ 0.5 V IN	27.367	27.288	27.121
<u>THERMAL SEN.</u>				
160° F	4.77 - 5.00 V		4.956	
80° F	2.40 - 2.50 V		2.467	
30° F	0.85 - 0.95 V		0.930	
0° F	REF. ONLY		0.401	
<u>14.5 KHz VCO</u>				
<u>OUTPUT LEVEL</u>				
OV SW.	50 MVP $\pm$ 8.5%	52.5	50.2	51.0
+14 V SW.	20 MVP $\pm$ 8.5%	20.8	19.95	20.1
<u>FREQ.</u>				
0.00 V MOD.	13.390 - 13.434	13.400 KHz	13.403 KHz	13.411 KHz
2.50 V MOD.	14.478 - 14.522	14.497 KHz	14.490 KHz	14.496 KHz
5.00 V MOD.	15.566 - 15.610	15.586 KHz	15.572 KHz	15.570 KHz

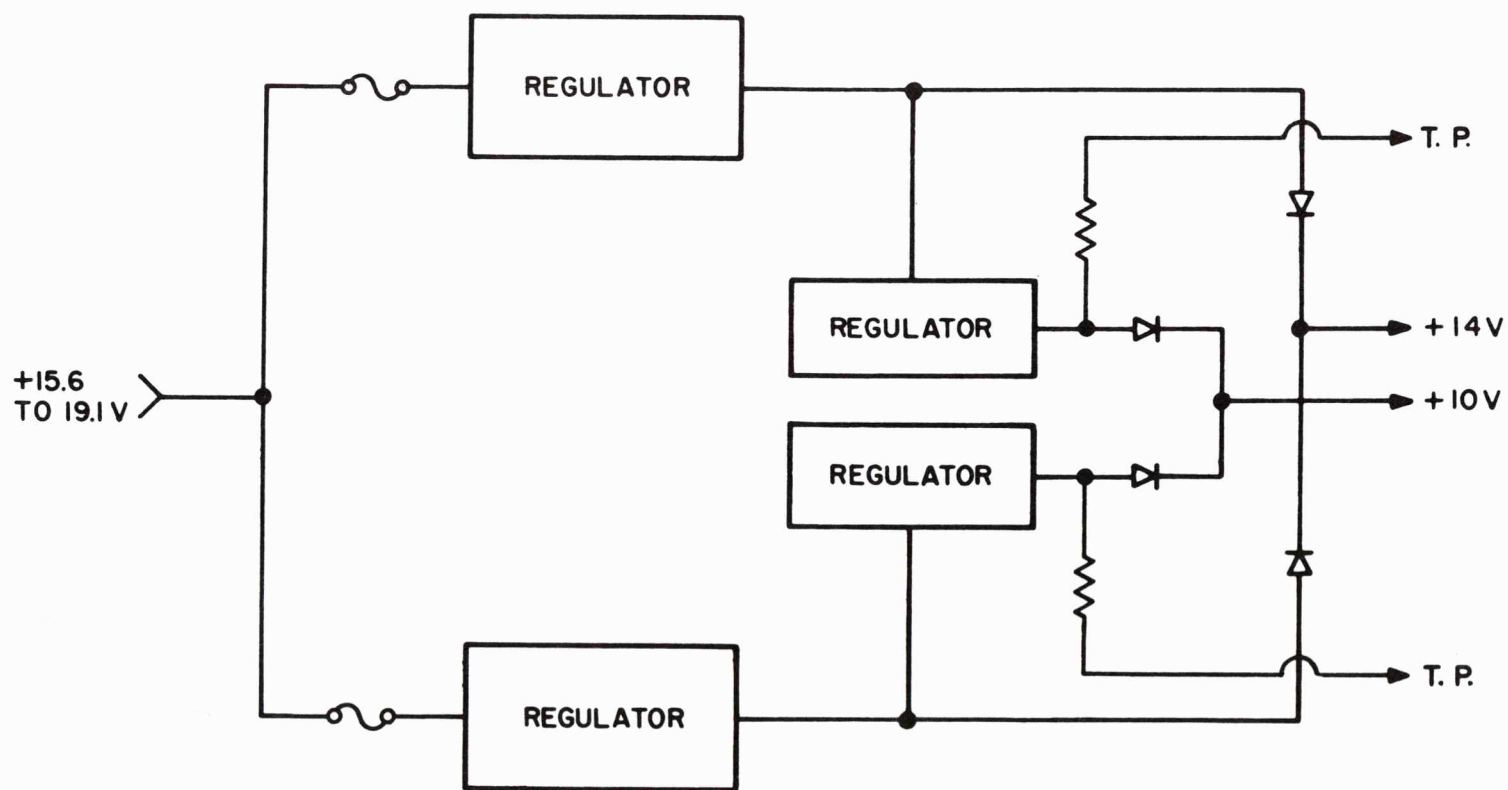


SIGNAL PROCESSOR, DOWN LINK ENGINEERING MODEL

FUNCTION	REQ.	TEST DATA		
		0° F	ROOM	160° F
PM 1/WB OUT. FREQ. LEVEL	1.25 MHz $\pm$ 0.15% 1.01 VP NOM.	1249950 0.96 VP	1250930 0.98 VP	1248520 1.06 VP
RMS DEVIATION @ 1 KHz @ 3.9 KHz	4.5 KHz @ 0.545 VN. 1.97 KHz @ 0.127 -VN	0.513 V 0.119 V	0.513 V 0.119 V	0.513 V 0.119 V
FM/TV OUT. 1.25 MHz VCO LEVEL FREQ.	400 mv P-P NOM. 1.25 MHz $\pm$ 0.15%	410 mv 1249750	412 mv 1250330	434 mv 1248660
RMS DEVIATION @ 1 KHz @ 3.9 KHz	4.5 KHz @ 0.545 VN 1.97 KHz @ 0.127 VN	0.513 V 0.119 V	0.513 V 0.119 V	0.513 V 0.119 V
TV OUT (0-1 VN) D.C. OUT VOLTAGE GAIN LINEARITY NOISE OUTPUT FREQ. RES.	0.550 V NOM @ 0.5 VIN 1.70 NOM. $\pm$ 3% @ 2 MHz 10 mv RMS MAX.	0.422 1.732 $\pm$ 2% <3 mv	0.471 1.727 $\pm$ 2% <2 mv	0.515 1.726 $\pm$ 2% <2.5 mv
100 KHz 1 MHz 2 MHz 3 MHz	REF. $\pm$ 1 db $\pm$ 1 db $\pm$ 1 db	REF. +0.20 +0.60 +0.60	REF. +0.26 +0.60 +0.71	REF. +0.36 +0.60 +0.71



REGULATOR, VOLTAGE REDUNDANT





REGULATOR, VOLTAGE, REDUNDANT ENGINEERING MODEL

SCHEMATIC NO. 8670922

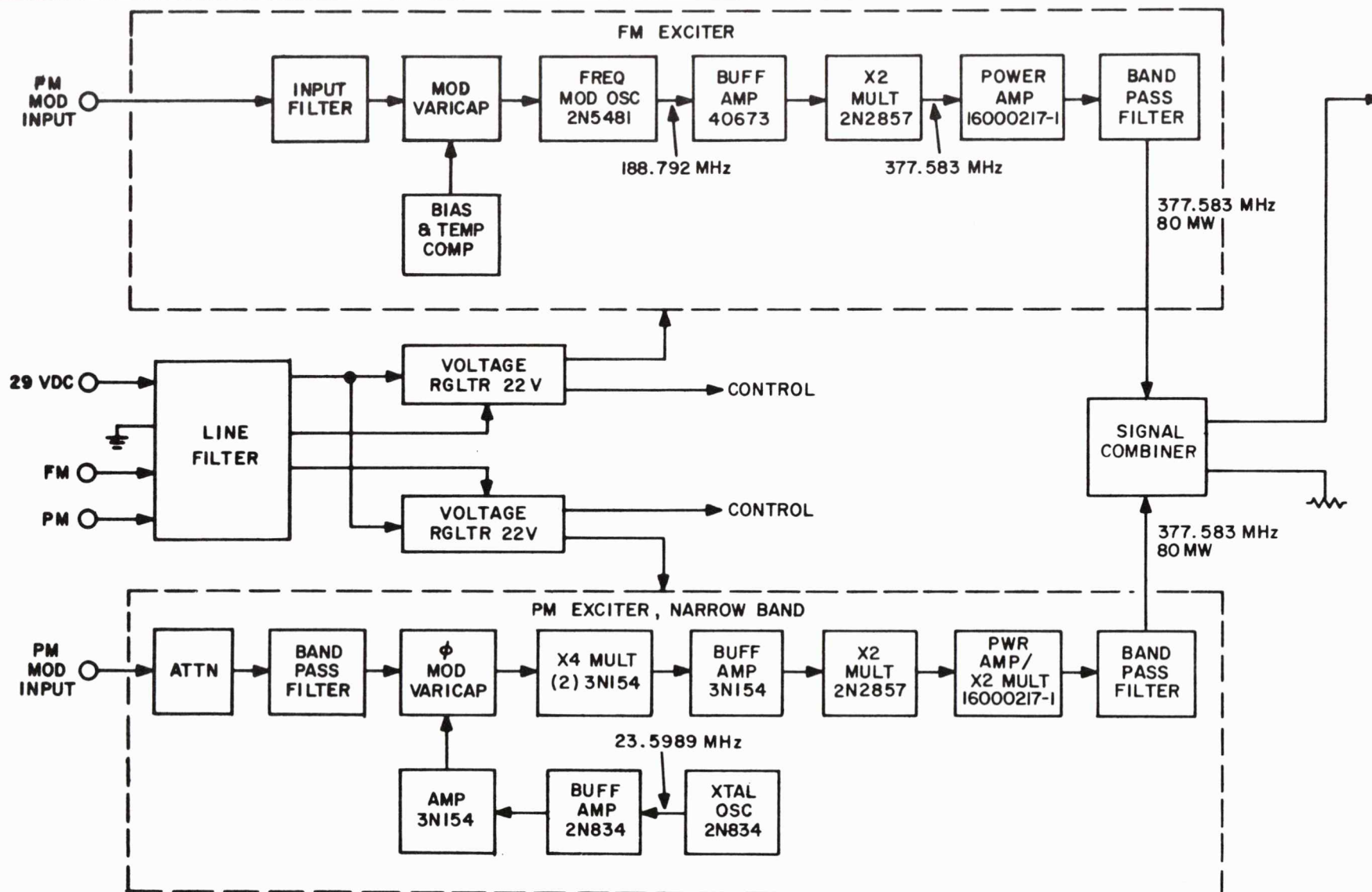
ASSEMBLY NO. 8370872

		TEST DATA		
FUNCTION	REQ.	0° F	ROOM	160° F
<u>10V OUTPUT</u>				
15.6V IN				
50 MA LOAD	+10 $\pm$ 0.1V	9.94	10.02	10.07
100 MA LOAD	+10 $\pm$ 0.1V	9.90	9.99	10.03
19.1V IN				
50 MA LOAD	+10 $\pm$ 0.1V	9.94	10.02	10.07
100 MA LOAD	+10 $\pm$ 0.1V	9.90	9.99	10.03
<u>14V OUTPUT</u>				
15.6V IN				
.250 A LOAD	+14 $\pm$ 0.1V	14.05	14.06	14.09
.500 A LOAD	+14 $\pm$ 0.1V	14.02	14.02	14.04
1.00 A LOAD	+14 $\pm$ 0.1V	13.98	13.98	13.99
19.1V IN				
.250 A LOAD	+14 $\pm$ 0.1V	14.06	14.08	14.10
.500 A LOAD	+14 $\pm$ 0.1V	14.03	14.04	14.06
1.00 A LOAD	+14 $\pm$ 0.1V	13.99	14.00	14.02
<u>TEST POINTS*</u>				
16V @ TER. #1				
TER. #6	>10 V	10.5 V	10.5 V	10.5 V
TER. #7	0 V	0 V	0 V	0 V
16V @ TER. #2				
TER. #6	0 V	0	0	0
TER. #7	>10 V	10.5 V	10.5 V	10.5 V

*USE VOLTMETER WITH INPUT RESISTANCE EQUAL TO OR GREATER THAN 10 MEG OHMS

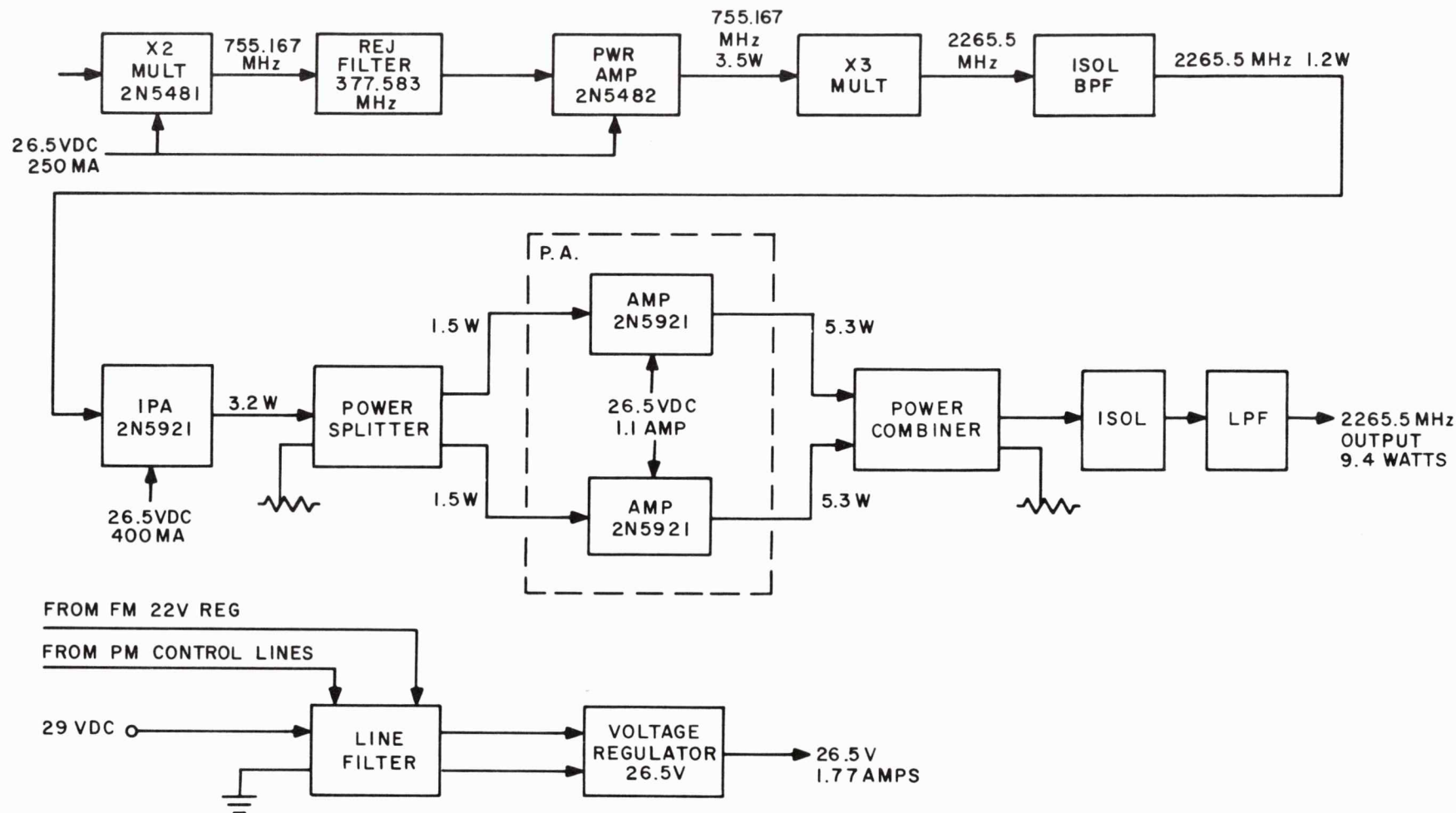


LCRU FM/PM S-BAND EXCITER



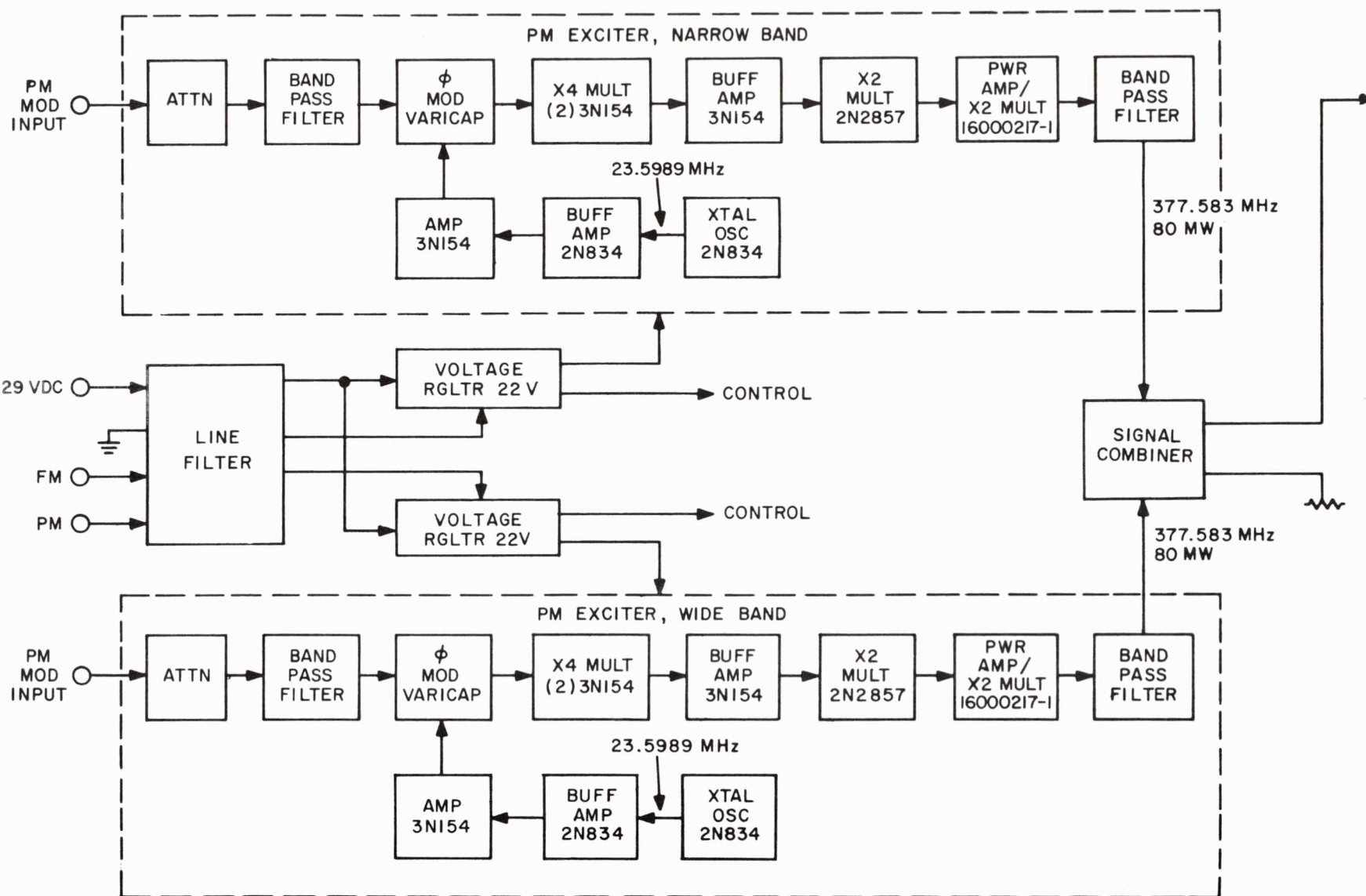


LCRU FM/PM S-BAND TRANSMITTER POWER STAGES



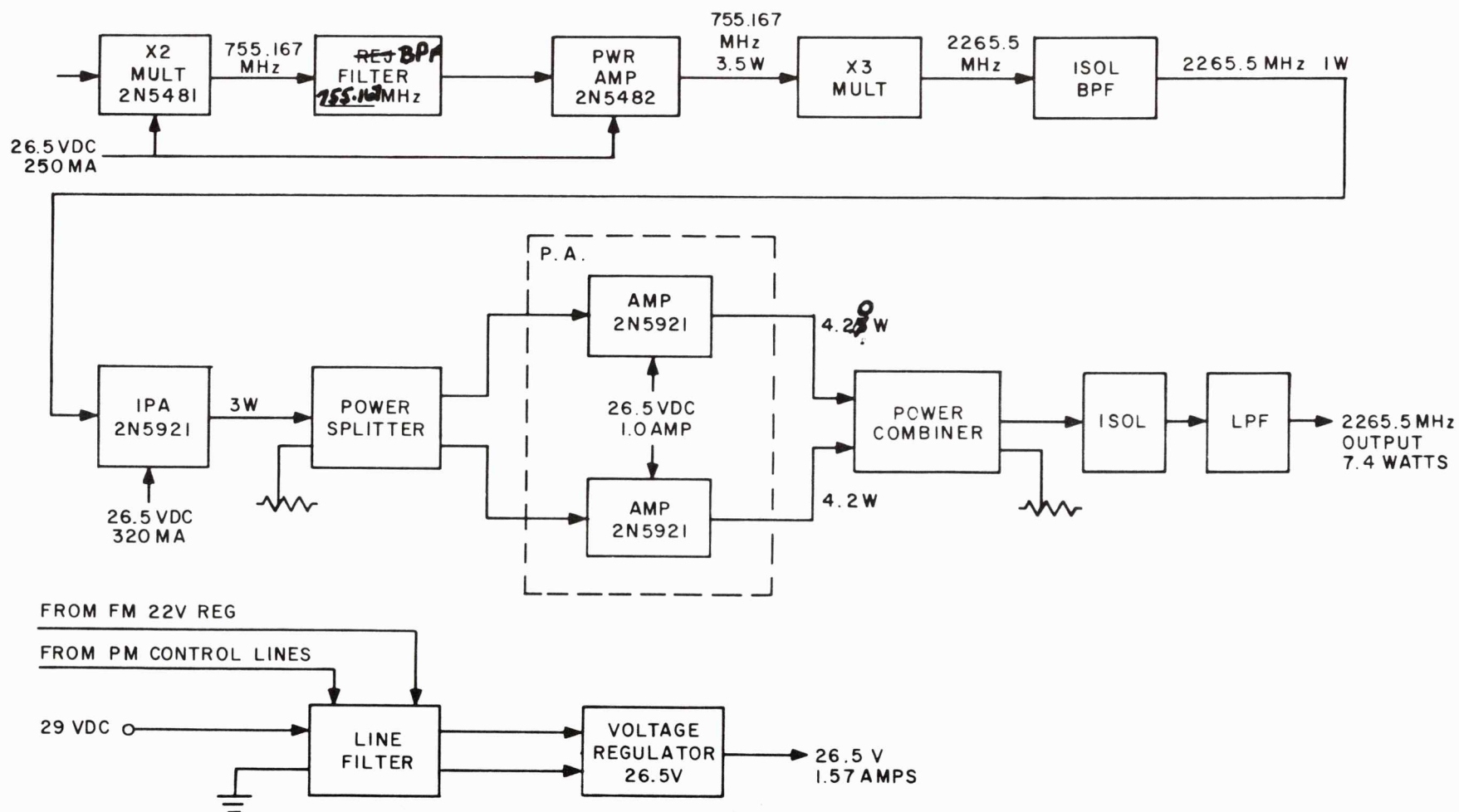


LCRU PM/PM S-BAND EXCITER





LCRU PM/PM S-BAND TRANSMITTER POWER STAGES





FM/PM TRANSMITTER CHARACTERISTICS

<u>FREQUENCY</u>	
OPERATING FREQUENCY	2265.5
FREQUENCY STABILITY, EITHER MODULATOR, ONE YEAR	0.003%(PM), $\pm 0.02\%$ (FM)
RF BANDWIDTH	(15 MHZ MIN.)
<u>RF OUTPUT</u>	
OUTPUT CONNECTOR	MOD. AMERICON 2054-0000
OUTPUT IMPEDANCE	50 OHMS NOMINAL
OUTPUT VSWR	1.3 TO 1
RF POWER	10 WATTS (8.4 WATTS MINIMUM)
<u>S-BAND MODULATORS</u>	
<u>FM MODULATION</u>	
CONNECTOR	± 2.5 MHZ PEAK
RANGE	SEAELECTRO 50-075-0019
SENSITIVITY	DC - 3 MHZ
INPUT	2.0 MHZ/VOLT PEAK $\pm 10\%$
	100 OHMS $\pm 10\%$ + 50 PF MAX.,
	DC COUPLED
	.55 VOLTS DC)
	5% MAX.
	1 KHZ RMS/200 HZ
	5 KHZ RMS
	34 DB MIN.
	± 1 DB DC - 3 MHZ
	3% UP TO 2.5 MHZ DEV.
	2%
	± 2 RAD PEAK
	SEAELECTRO 50-075-0019
	200 HZ - 20 KHZ
	2 RAD/VOLT $\pm 10\%$ UP TO 2 RADIAN
	PEAK
	1000 OHMS $\pm 10\%$ + 50 PF MAX.
	4° RMS NON VIBRATING
	5% MAX.
	26 DB MIN.
	27 - 33 VDC, 29 VDC NOMINAL
	1.85A MAX.
	PRIME POWER, 29 VDC, 10 MA MAX.
	INCLUDED IN UNIT FOR TEST ONLY
	44.5 CUBIC INCHES MAX.
	44 OZ. MAX.
<u>PM MODULATION</u>	
CONNECTOR	
RANGE	
SENSITIVITY	
INPUT IMPEDANCE	
PHASE NOISE	
INCIDENTAL AM	
2 TONE IM @ 2.5 RAD COMBINED DEVIATION	
<u>POWER SUPPLY</u>	
POWER SUPPLY VOLTAGE	
DC CURRENT REQUIREMENT	
FM/PM MODULATOR CONTROL	
REVERSED POLARITY PROTECTION	
<u>VOLUME</u>	
<u>WEIGHT</u>	



PM/PM TRANSMITTER CHARACTERISTICS

FREQUENCY

OPERATING FREQUENCY

2265.5 MHZ

FREQUENCY STABILITY, ONE YEAR

0.003%

RF BANDWIDTH

(15 MHZ MIN.)

RF OUTPUT

CONNECTOR

MOD. AMERICON 2054-0000

OUTPUT IMPEDANCE

50 OHMS NOMINAL

OUTPUT VSWR

1.3 TO 1

RF POWER

8.0 WATTS (6.6 WATTS MIN.)

INCIDENTAL AM

5% MAX.

NB-PM MODULATION

CONNECTOR

SEAELECTRO 50-075-0019

RANGE

200 HZ - 20 KHZ

MODULATION SENSITIVITY

2 RADIAN/VOLT PEAK $\pm 10\%$ UP
TO 2 RADIAN PEAK

INPUT IMPEDANCE

1000 OHMS $\pm 10\%$, 30 PF MAX.

FREQUENCY RESPONSE

± 0.5 DB, 200-20,000 HZ

DEVIATION LINEARITY

3% UP TO 2.5 RADIAN PEAK

PHASE NOISE

4 RMS NON-VIBRATION

2 TONE IM @ 2.5 RAD. COMBINED DEVIATION

26 DB MIN.

WB-PM MODULATION

CONNECTOR

SEAELECTRO 50-075-0019

RANGE

1.19 MHZ TO 1.31 MHZ

FREQUENCY RESPONSE

± 0.5 DB 1.19-1.31 MHZ

DEVIATION LINEARITY

3% UP TO 2.0 RADIAN PEAK

INPUT IMPEDANCE

50 OHMS $\pm 10\%$, 50 PF MAX.

MODULATION SENSITIVITY

1.85 RADIAN/VOLT $\pm 10\%$ UP
TO 2 RADIAN PEAK

2 TONE IM @ 2.0 RAD. DEV. IN 200-20,000 HZ BAND

40 DB MIN.

PHASE NOISE

4° RMS NON-VIBRATING

POWER SUPPLY

POWER SUPPLY VOLTAGE

27 - 33 VDC, 29 VDC NOMINAL

DC CURRENT REQUIREMENT

1.65 AMP MAX.

MODULATOR CONTROL

PRIME POWER, 29 VDC, 10 MA MAX.

REVERSED POLARITY PROTECTION

INCLUDED IN UNIT FOR TEST ONLY

VOLUME

44.5 CU IN MAX.

WEIGHT

44 OZ. MAX.



S-BAND TRANSMITTERS

AREAS OF INTEREST

1. Critical Design Review
2. DVT parts procurement.
3. Procurement of Flight Model Parts
4. Engineering models delivery.
5. Humidity - Transmitters exhibit a drop of .4 dB in power output when subjected to high humidity
6. Assembly of Transmitters - The design of the PA necessitates workmanship practices which are contrary to NASA specifications, i.e., five leads to a terminal - leads soldered directly to a solder joint of a Johanson Capacitor - low temp. solder, etc.

COMMENTS

- a. Completed.
- a. All parts are in house and assembly is in process.
- a. All parts ordered. Personal attention by RCA personnel in the Conic Purchasing Dept. is taking place with calls to vendors as to meeting promise dates and in house screening when date goes beyond safe limits.
- a. Units have had the frequency change to 2265.5 MHz and are in the LCRU unit.

Recommendations are to do one of the following:

- a. Entirely seal Transmitter unit.
- b. Bake Transmitter at 85°C for 12 hours prior to sealing LCRU unit.
- c. Keep Transmitters in controlled atmosphere until sealing of LCRU.

Recommendations are to do the following:

- a. Wherever these practices can be eliminated, it shall be changed.
- b. A critical inspection shall be made following vibration DVT testing of the S-Band Transmitter

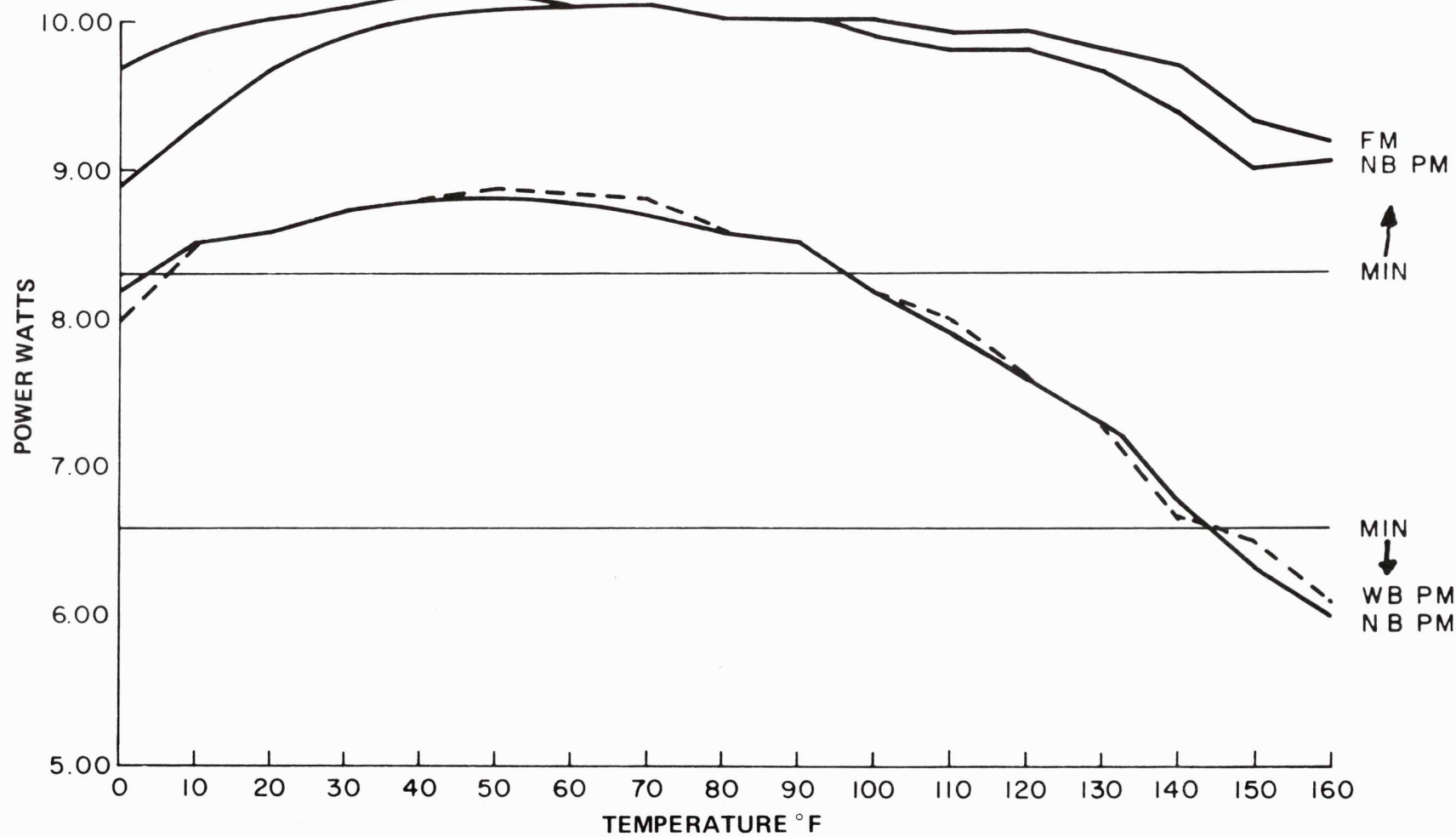


ENGINEERING MODEL CHARACTERISTICS

	<u>FM</u>	<u>NBPM</u>	<u>NBPM</u>	<u>WBPM</u>
INPUT CURRENTS	1.83 AMPS	1.83 AMPS	1.65 AMPS	1.67 AMPS
OUTPUT POWER	9.7 WATTS	10.0 WATTS	9.3 WATTS	9.3 WATTS
INPUT POWER	53.0 W.	53.0 W	47.8 W	48.4 W
EFFICIENCY	18.2%	18.8%	19.4%	19.2%



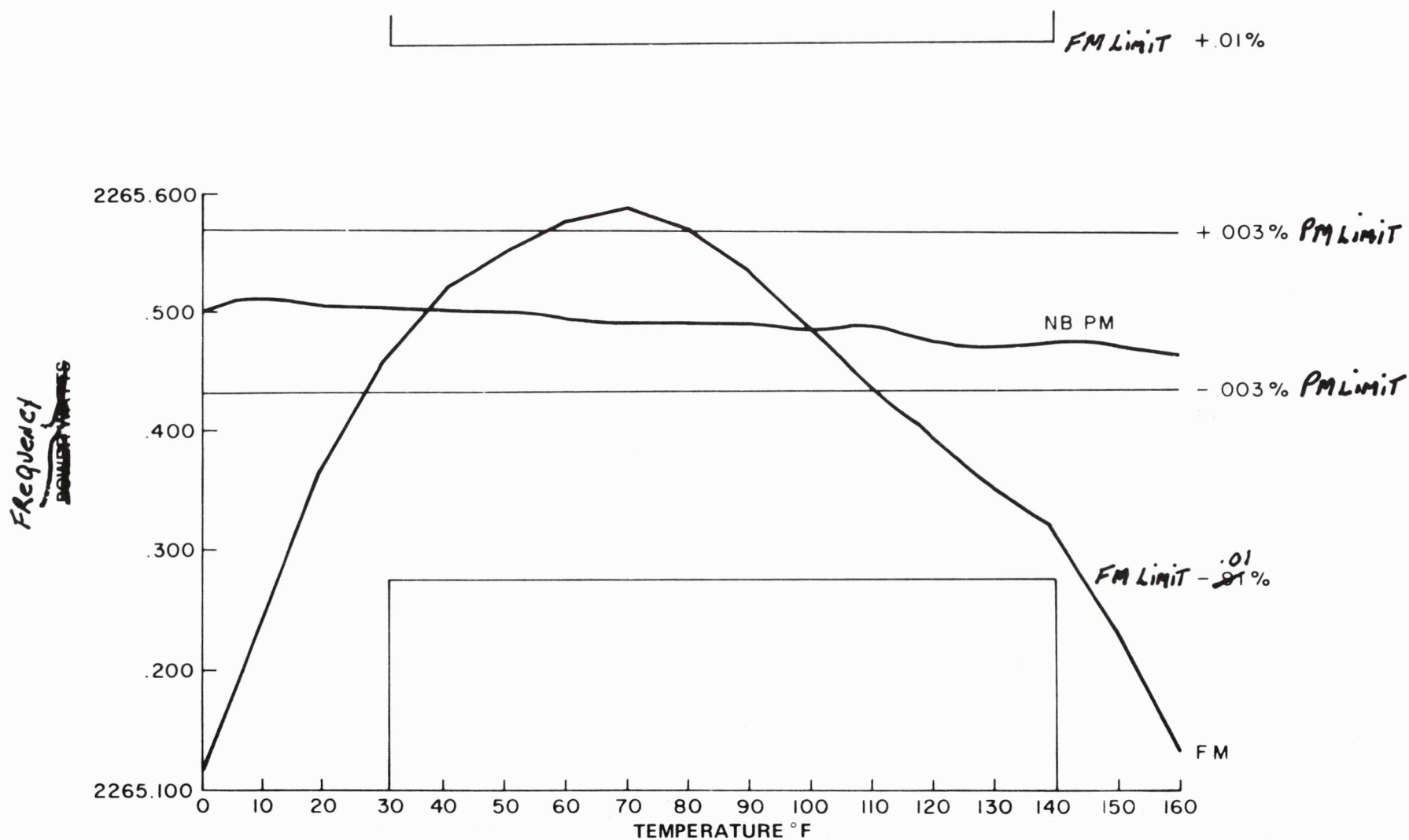
S-BAND TRANSMITTER POWER VS TEMP





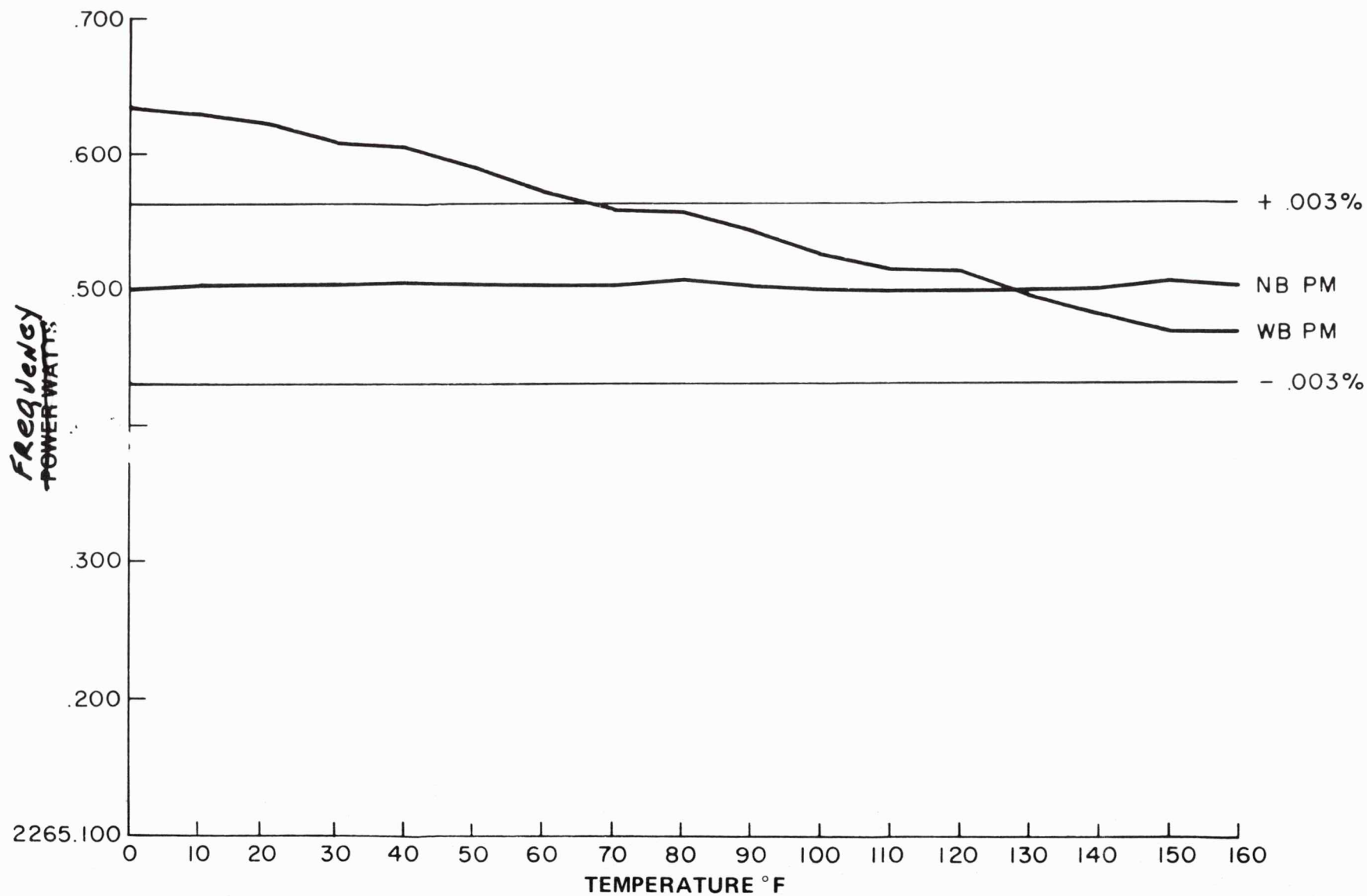
S-BAND TRANSMITTER FREQUENCY VS TEMP

7-92





S-BAND TRANSMITTER FREQUENCY VS TEMP

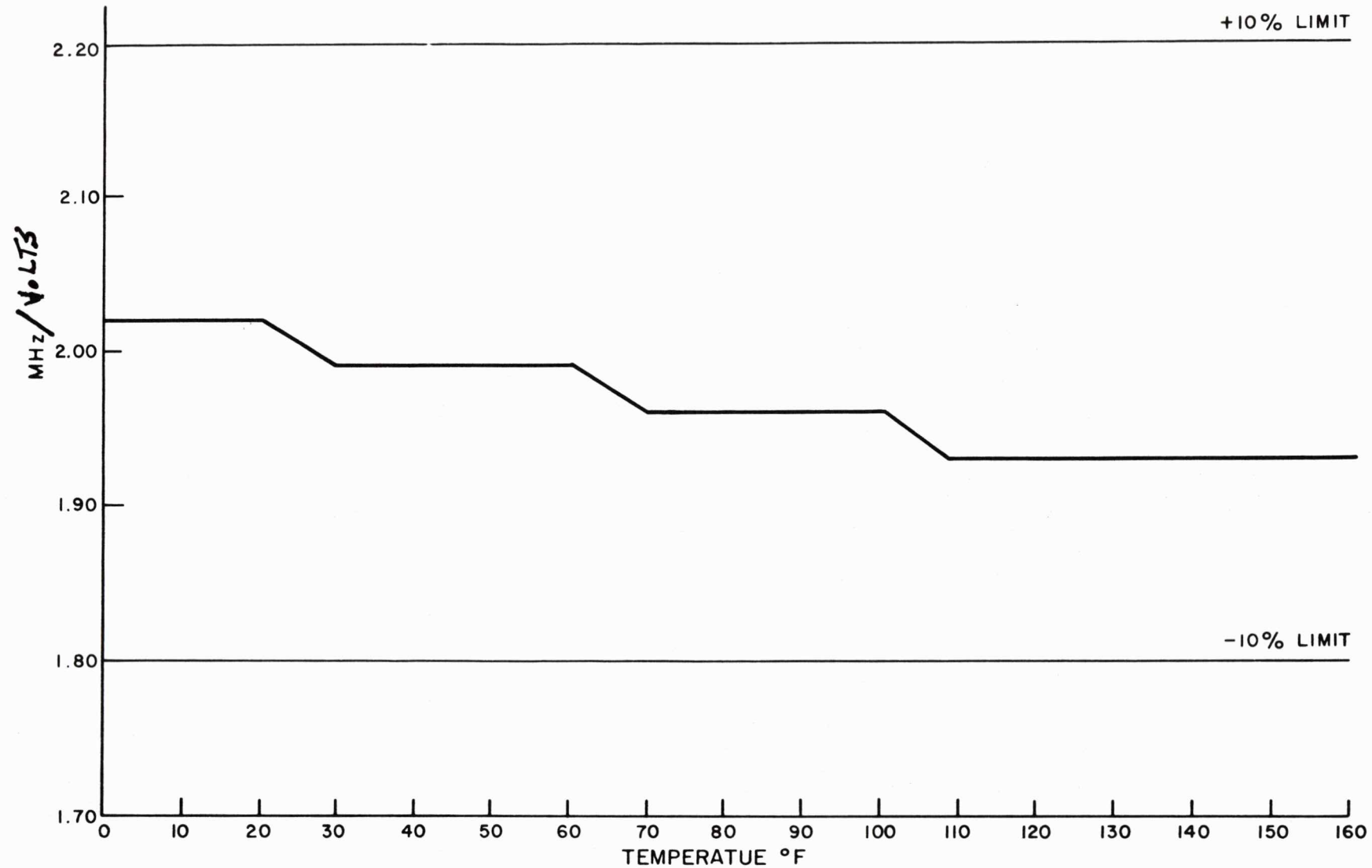




S-BAND TRANSMITTER

DEVIATION SENSITIVITY VS TEMPERATURE

FM TRANSMITTER

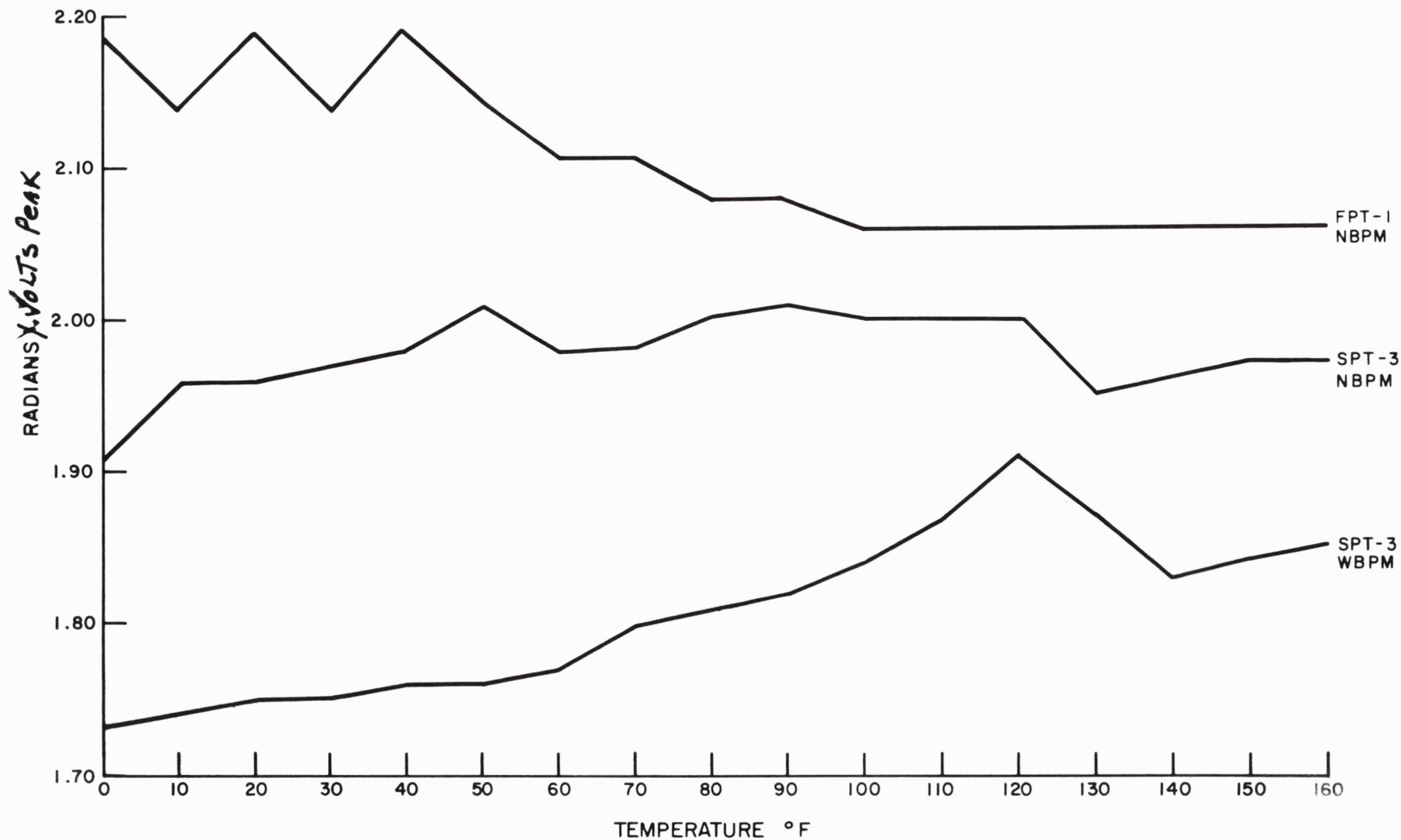




S-BAND TRANSMITTER

DEVIATION SENSITIVITY VS TEMPERATURE

7-95





REVIEW ITEM DISPOSITION - S-BAND FM/PM TRANSMITTER - PCDR-3

ITEM

1. Provide rationale on use of an IFM spec. rather than an IPM spec. for WB PM
2. ECN needed for frequency change
3. Provide failure analysis rationale of Low Power Output vs 80% humidity spec.
4. Provide rationale for 2.0 rad peak in para. 3.4.6.3.2 but 2.5 rad peak in para. 3.4.6.3.3

COMMENTS

This was a direct result of following the Motorola specification on the LEM Transceiver.

ECN Complete.

The humidity affects the beryllium wafer heat sink to which the Power Transistor 2N5921 is mounted.

The 2.0 radians peak was chosen as a practical peak value since the total of all sub-carriers comes to 2.8 radians when all sub-carriers are in phase but this in an unlikely situation. The need for 2.5 radians in para. 3.4.6.3.3 is to check beyond the 2.0 limit for fall off.

S-BAND FM/PM TRANSMITTER - PCDR-5

1. Need ECN on frequency change and .01% FM frequency stability.
2. Need max. design limitation for FM deviation and frequency response under tolerances somewhat wider than allowed in para. 3.4.6.3 and 3.4.6.4

ECN Complete.

Conic Corp. has been contacted for this information and will be forwarded as received.



S-BAND TRANSMITTER DEVIATION LINEARITY

NBPM MODE SPT-3

Freq.	5 KHz	2 KHz	10 KHz	20 KHz
V in	V out	V out	V out	V out
6	.6	.6	.6	.6
5	.5	.5	.5	.5
4	.4	.4	.4	.4
3	.3	.3	.3	.3
2	.2	.2	.2	.2
1	.1	.1	.1	.1
.5	.05	.05	.05	.05
.2	.02	.02	.02	.02
.1	.01	.01	.01	.01
.05	.005	-	.005	.005

WBPM SPT-3

	1.25 KHz
V in	V out
.3	3.0
.2	2.0
.1	1.0
.05	.5
.02	.2
.01	.098
.005	.046

PM MODE FPT-1

Freq	5 KHz	2 KHz	10 KHz	20 KHz
V in	V out	V out	V out	V out
6	.6	.6	.6	.6
5	.5	.5	.5	.5
4	.4	.4	.4	.4
3	.3	.3	.3	.3
2	.2	.2	.2	.2
1	.1	.1	.1	.1
.5	.05	.05	.05	.05
.2	.02	-	.02	.02
.1	.01	-	.01	.01

FM MODE FPT-1

Freq.	2.5 KHz	25 KHz	250 KHz	2.5 MHz
V in	V out	V out	V out	V out
0.1	.10	.10	.10	.10
0.2	.20	.20	.20	.20
0.3	.30	.30	.30	.30
0.4	.40	.40	.40	.40
0.5	.50	.50	.50	.50
0.6	.60	.60	.60	.60
0.7	.69	.68	.69	.70
0.8	.78	.78	.78	.80

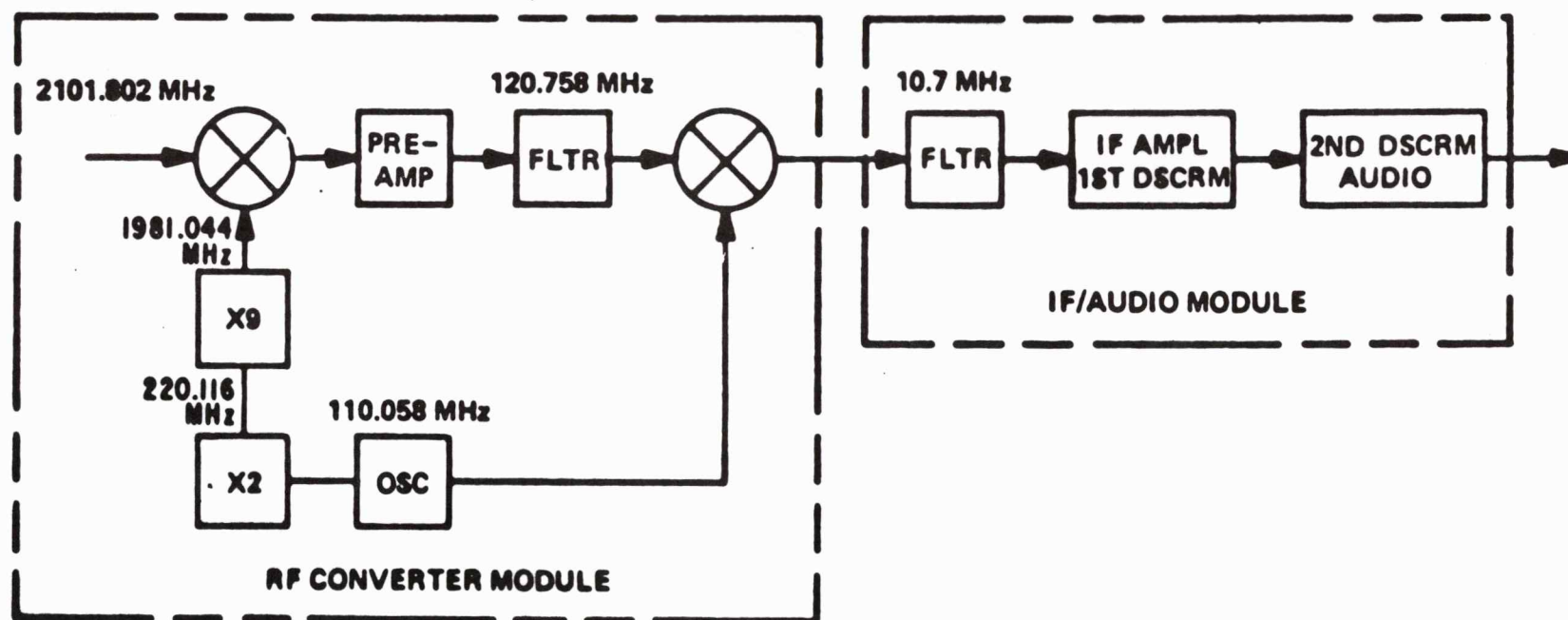


MAJOR SPECIFICATION REQUIREMENTS

	<u>SPECIFICATION</u>	<u>ENG. MODEL MEASURED</u>
FREQUENCY LOCAL OSCILLATOR STABILITY	2101.802 MHZ, $\pm 0.0015\%$ (NASA) $\pm 0.003\%$	$\pm 0.0018\%$
SENSITIVITY	26.7 DB S+N AT -128 DBW (RCA) N	32.6 DB S+N/N
NOISE FIGURE	---	8 DB NOMINAL
AUDIO OUTPUT LEVEL	1.5 VRMS $\pm 10\%$ (NASA)	1.57 VRMS -128 DBW TO -95 DBW
HARMONIC DISTORTION	3% MAX. (RCA)	1.81%
SQUELCH	ON DECREASING SIGNAL - 131 DBW OR BELOW (RCA) ON INCREASING SIGNAL -127 DBW OR BELOW (RCA) MAX. UNSQUELCHED NOISE -21 DBM MAX. (RCA)	-131 DBW -129 DBW -22.5 DBM
70 KHZ OUTPUT LEVEL	0.7 V TO 3.5 V PEAK-TO-PEAK 2.0 V NOM. (NASA) 5 K LOAD	2.5 V _{p-p}
70 KHZ OUTPUT IMPEDANCE	75 TO 115 OHMS (RCA)	89-93 OHMS
POWER REQUIREMENTS	14 V ± 0.1 VDC LESS THAN 150 MA (RCA)	138 MA
VOLUME	35 CU. IN. (NASA)	27.5 CU. IN.
WEIGHT	24 OZ. (NASA)	22.5 OZ.
TEMPERATURE	OPERATING 0°F TO 160°F (RCA) STORAGE -65°F TO 185°F (RCA)	DVT TEST

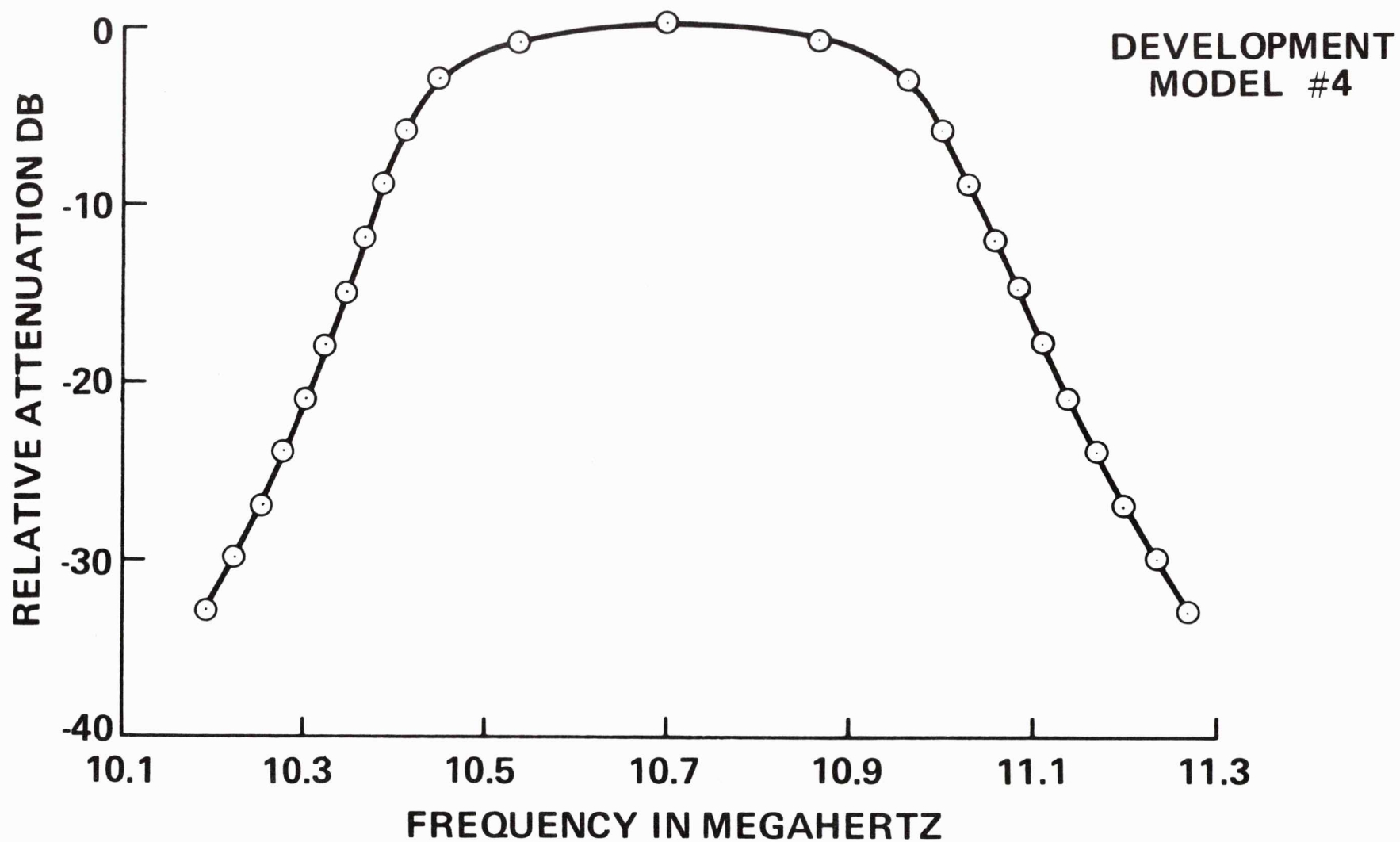


LGRU RECEIVER BLOCK DIAGRAM



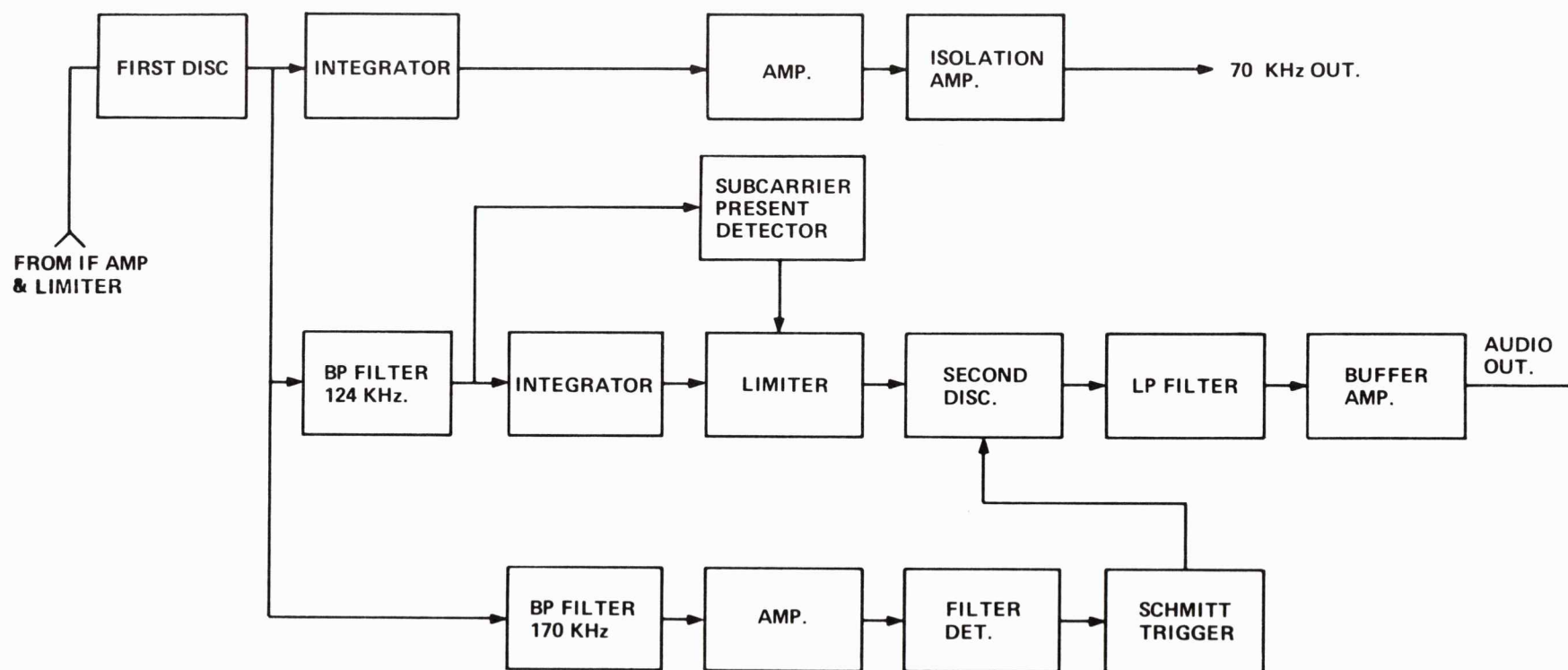


SECOND I.F. FILTER RESPONSE





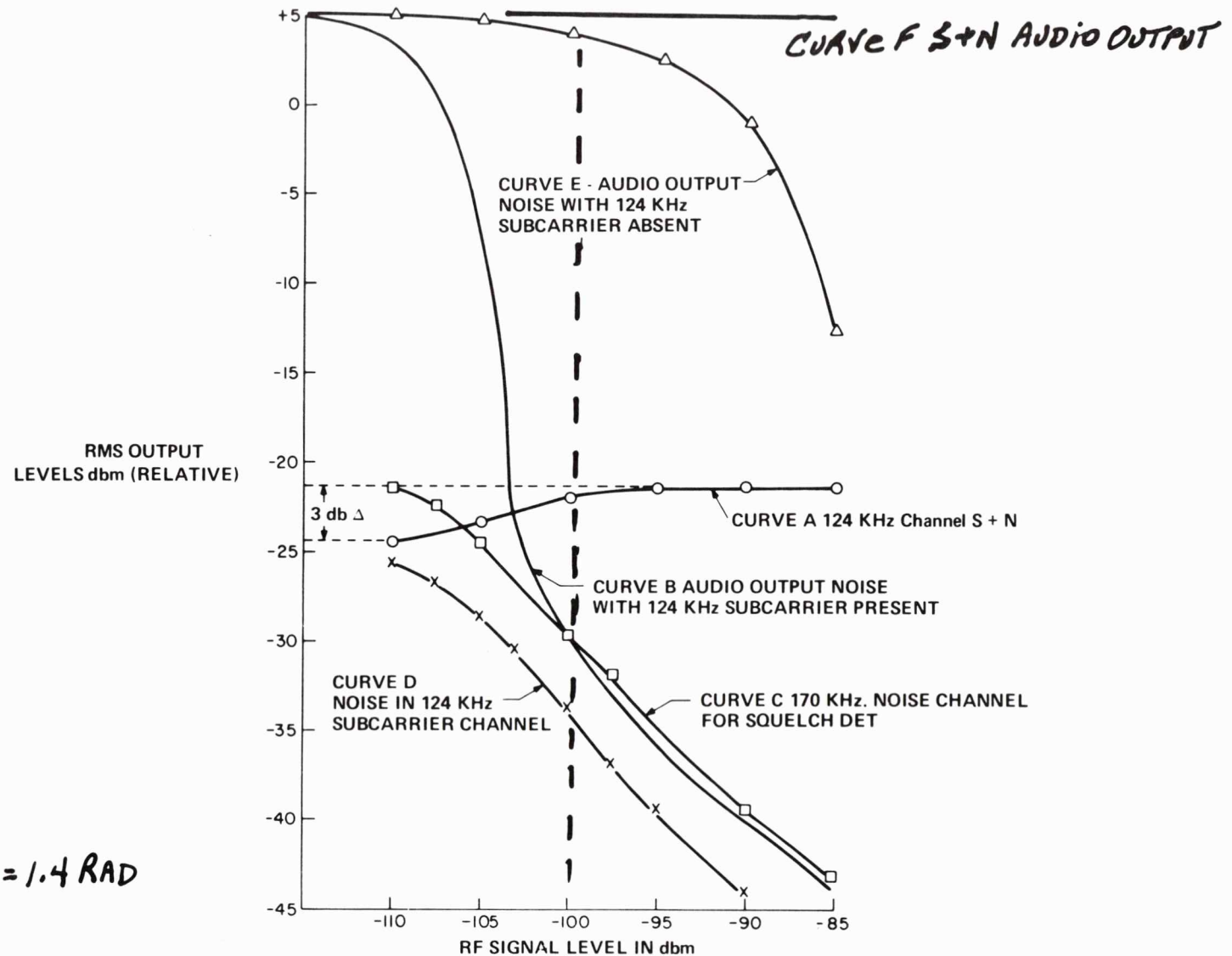
BLOCK DIAGRAM LCRU RECEIVER (SUBCARRIER-AUDIO)





SQUELCH ANALYSIS

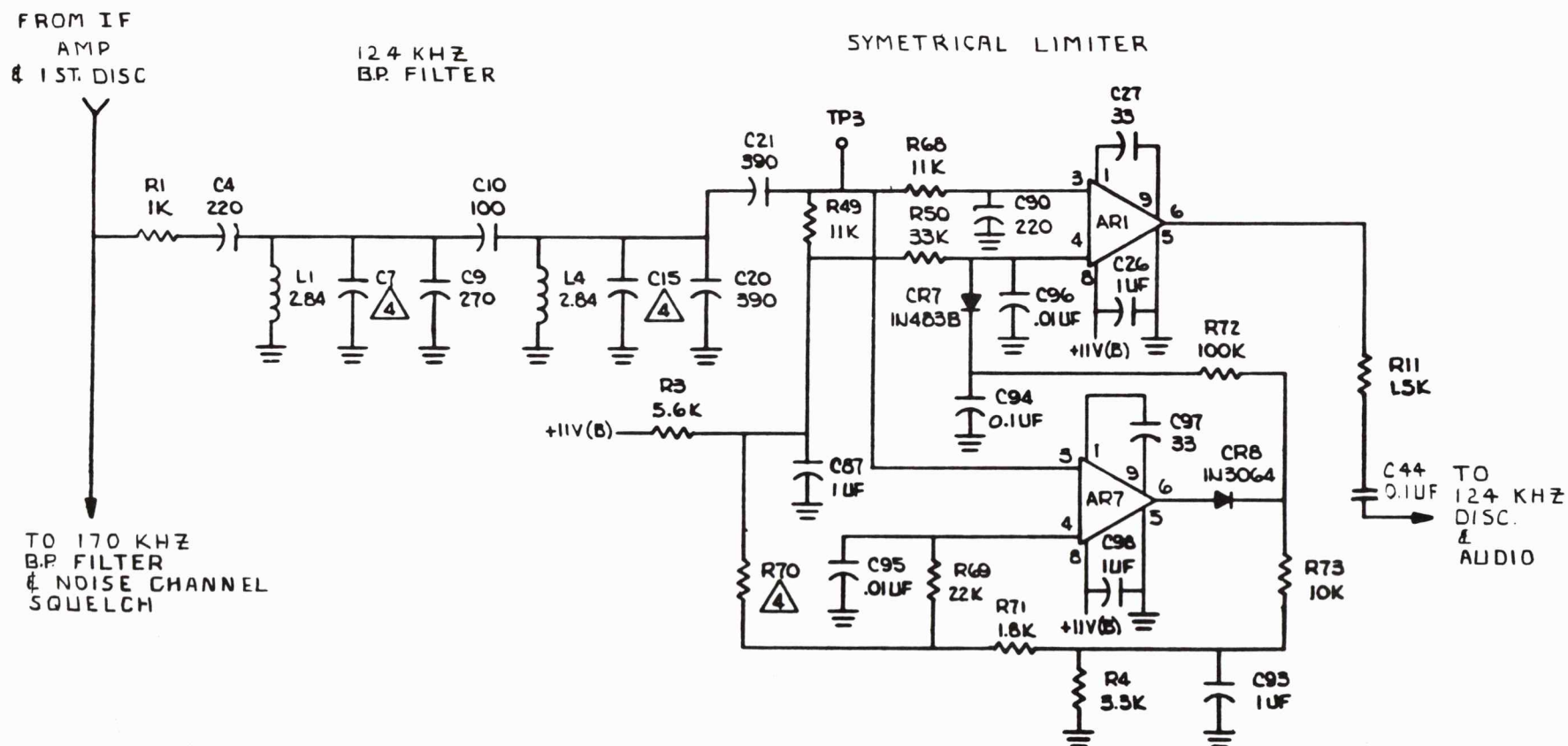
7-102





REVISED CIRCUIT FOR SUB-CARRIER SQUELCH

7-103





SQUELCH PERFORMANCE DATA

ENG. MODEL #1
1.0 Radian Deviation

~~0°F Ambient +160°F~~

	0°F	AMBIENT	+160°F	
IN CREASING RF	-103	-102	-102	dbm
INCREASING RF	-101	-100	- 99	dbm
HIGHEST NOISE LEVEL	-25.5	-24.6	-22.5	dbm

ENG. MODEL #2
1.0 Radian Deviation

~~0°F Ambient +160°F~~

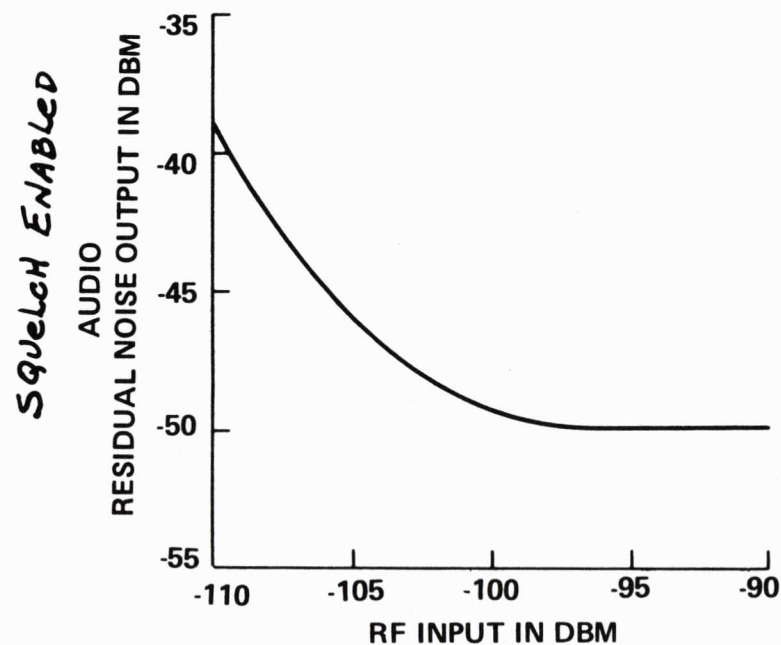
	0°F	AMBIENT	+160°F	
IN CREASING RF	-101	-101	-102.5	dbm
INCREASING RF	-100	- 99	-100	dbm
HIGHEST NOISE LEVEL	-27.5	-30.1	-23.5	dbm

1. SQUELCH DESIGN ALLOWS OPERATION TO AT LEAST -131 db W
2. PREVENTS HIGH NOISE LEVELS FROM BEING TRANSMITTED TO CREW
3. MAINTAINS RF, IF, AND 1ST DISCRIMINATOR COMMONALITY TO ALSEP
4. IMPLEMENTATION CAUSED MINIMUM SCHEDULE AND COST IMPACT.
5. MAINTAINED SAME CASE OUTLINE DIMENSIONS AND ELECTRICAL INTER-FACES



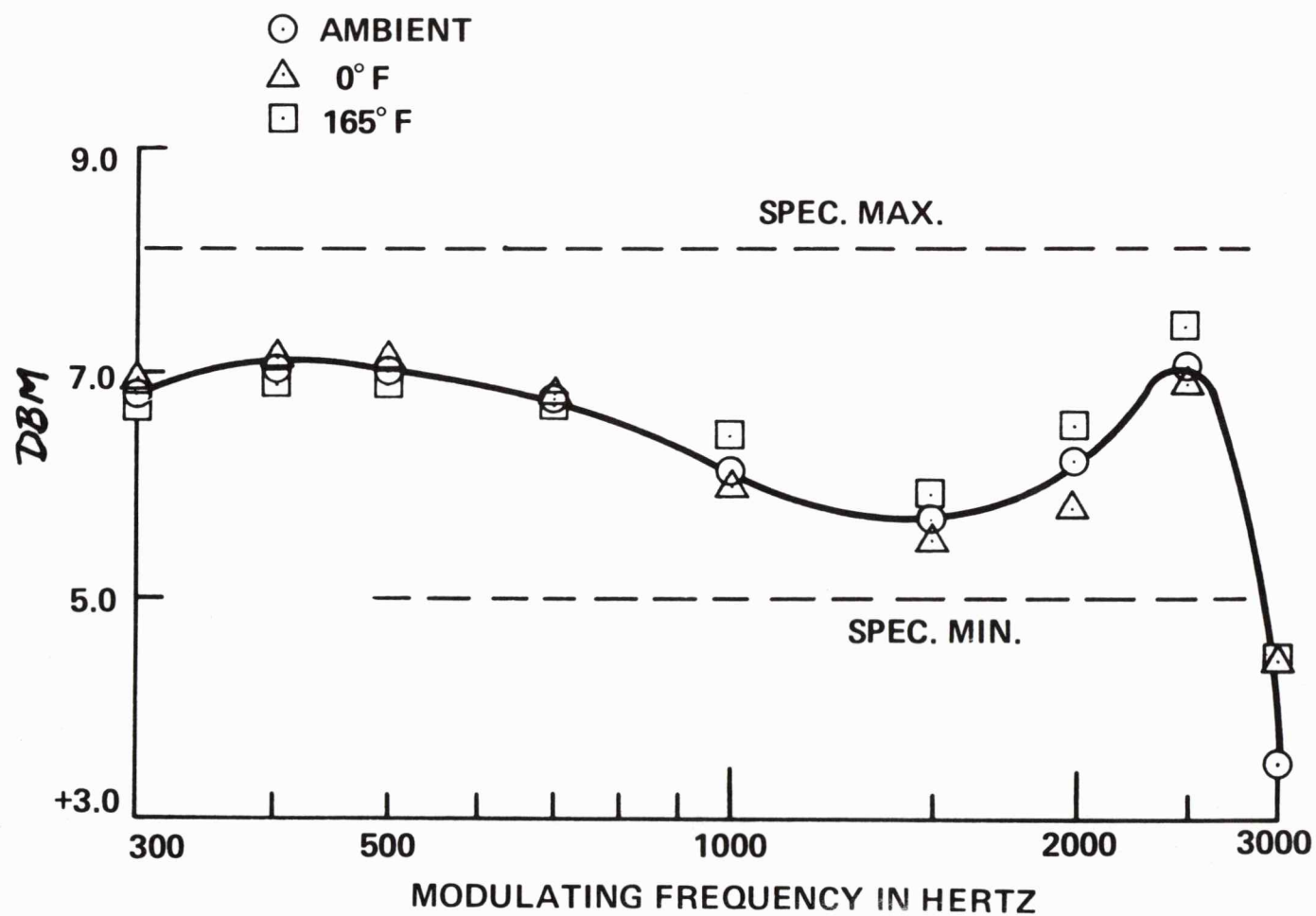
OUTPUT NOISE LEVEL, NO SUBCARRIER

ENGR MODEL NO. 1

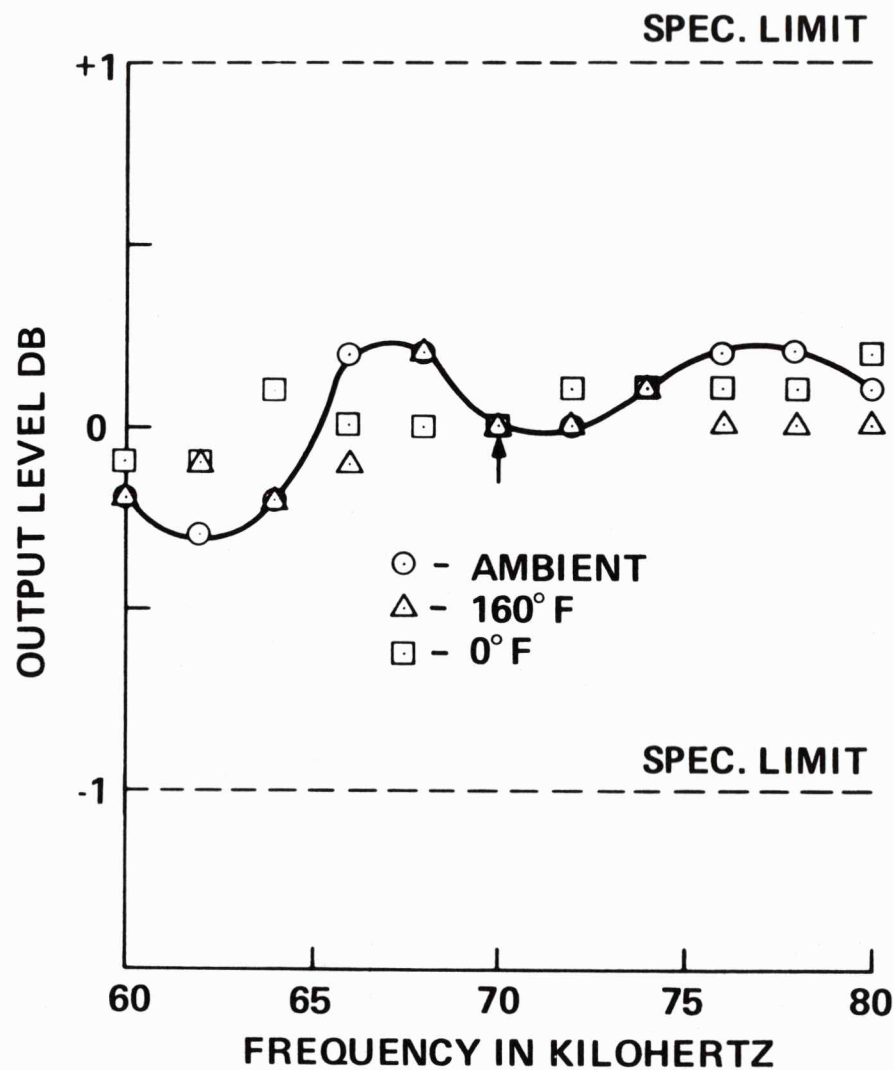




AUDIO FREQUENCY RESPONSE EM-2



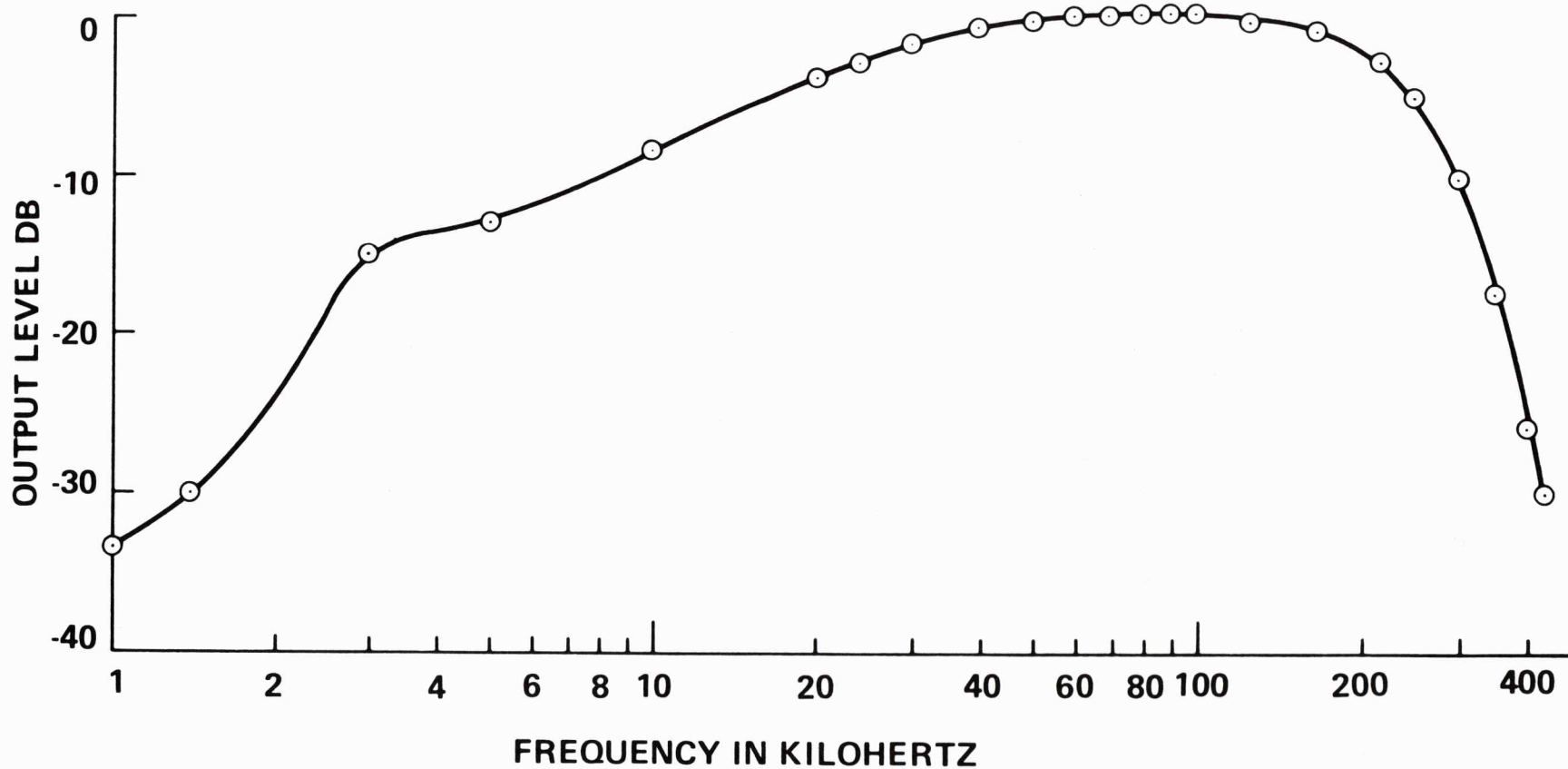
RCA 70 KHZ BAND PASS CHARACTERISTIC EM-2





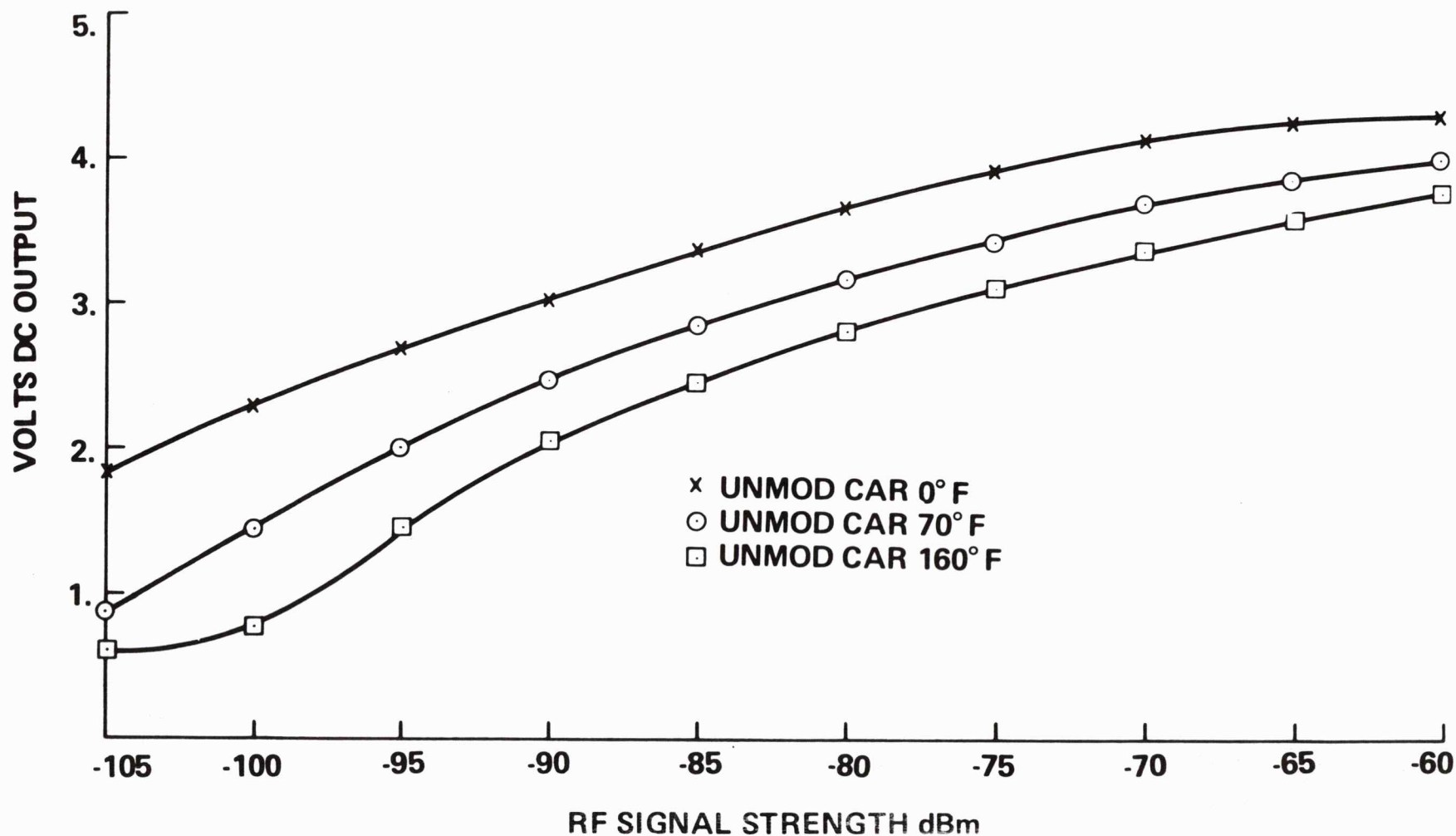
BAND PASS CHARACTERISTIC

70 KHz SUBCARRIER CHANNEL EM-2





SIGNAL STRENGTH OUTPUT





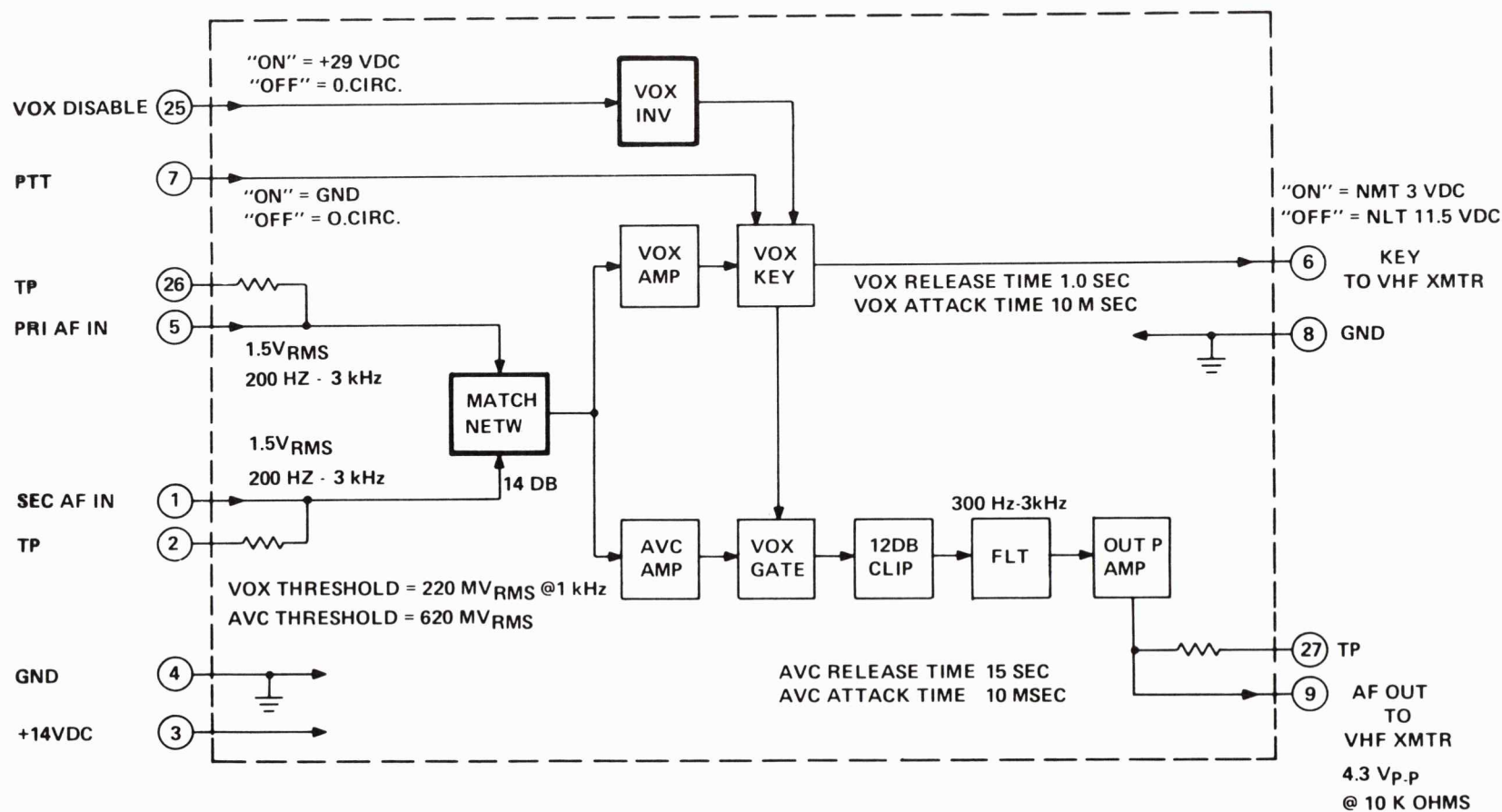
REVIEW ITEMS PCDR-4

S-BAND RECEIVER

<u>ITEM</u>		<u>COMMENT</u>
A.	1. AUDIO OUTPUT LEVEL	INCORPORATED BY ECN
	2. DYNAMIC RANGE	CHANGE WOULD CAUSE SIGNIFICANT ALLIED DOCUMENTATION REWORK RECOMMEND LEAVE AS IS.
	3. SQUELCH CHANGES	INCORPORATED BY ECN
	4. 70 KHZ IMPEDANCE	INCORPORATED BY ECN
	5. 70 KHZ OUTPUT LEVEL	INCORPORATED BY ECN
	6. SIGNAL STRENGTH RANGE	INCORPORATED BY ECN
	7. SIGNAL STRENGTH CAL DATA ACCURACY	INCORPORATED BY ECN
	8. POLARITY REVERSAL	IN SPEC
	9. AUDIO OUTPUT FREQ. RESPONSE	INCORPORATED BY ECN
	10. 70 KHZ OUTPUT FREQ. RESPONSE	INCORPORATED BY ECN
	11. UPLINK MODE COMBINATION	
	e.g. 8 _{0.8} ±10% 1.1±10% RADIANS	INCORPORATED BY ECN
B.	1. PARAMETERS IN 3.4.4.2, 3.4.4.3, 3.4.5.1 ARE TO BE MEASURED IN NON-MISSION RF INPUT LEVELS	-95 dbw RF INPUT LEVEL PERMITS ACCURATE TEST MEASUREMENT OF PARAMETERS INDEPENDENT OF S/N RATIO.
	2. EMI CONDUCTED SUSCEPTIBILITY DOES NOT INCLUDE REDUCED LEVEL AUDIO NOISE	LCRU SYSTEM CONFIGURATION PRECLUDES RECEIVER AUDIO SUSCEPTIBILITY e.g., S-BAND RECEIVER FILTERING/REGULATOR LCRU FILTERING/REGULATOR TO BATTERY/ DC-DC CONVERTER COMBINATIONS



UP-LINK SIGNAL PROCESSOR



RCA UPLINK SIGNAL PROCESSOR CHARACTERISTICS

AUDIO INPUTS (TWO)

Input Connector	Through terminal
Input Impedance	NLT 1000 ohms
AF Input Level @ 1000 Hz	1.5 Vrms $\pm 10\%$ @ 1200 ohms
AF Drive Impedance	20 ohms max.
AF Range	200 Hz to 3.0 kHz
Input Attenuation	14 db

VOX OPERATION

VOX Threshold, 1 kHz Test Signal	0.22 Vrms ± 1 db @ input
VOX Release Time	1 ± 0.4 sec. (over temp. limits)
AF/VOX Attack Time	10 msec max.

AF OPERATION

AVC Release Time	15 sec. ± 5 sec.
AVC Knee, 1 kHz	0.620 Vrms ± 1.0 db @ input
AVC Range	5 Vrms @ input
Nominal Clipping	12 db
Frequency Response.	1 kHz Ref.
	300 Hz
	3 kHz
	6 kHz
Harmonic Distortion @ 1 kHz	NMT -1.0 db
	NMT -3.0 db
	NLT -3.0 db
	8% max.

AF OUTPUT

AF Output Level, Clipped 12 db	
@ 1 kHz, 1.5 Vrms input	4.3 ± 0.6 V _{pp} @ 10 K Ohm load
Output Drive Impedance	Approx. 10 ohms, capacity coupled
Noise Output for VOX Disabled	
Output	-35 db below audio

TRANSMITTER KEY

Type of Operation	VOX operated
Output Volt. for Transmitter "ON"	NMT + 3.0 VDC
Output Volt. for Transmitter "OFF"	NLT + 11.5 VDC
Input Voltage to Disable VOX	+29 VDC

DC POWER REQUIREMENTS

Input DC Voltage	14 VDC ± 0.1 Volts
Input DC Current	18 MA max.

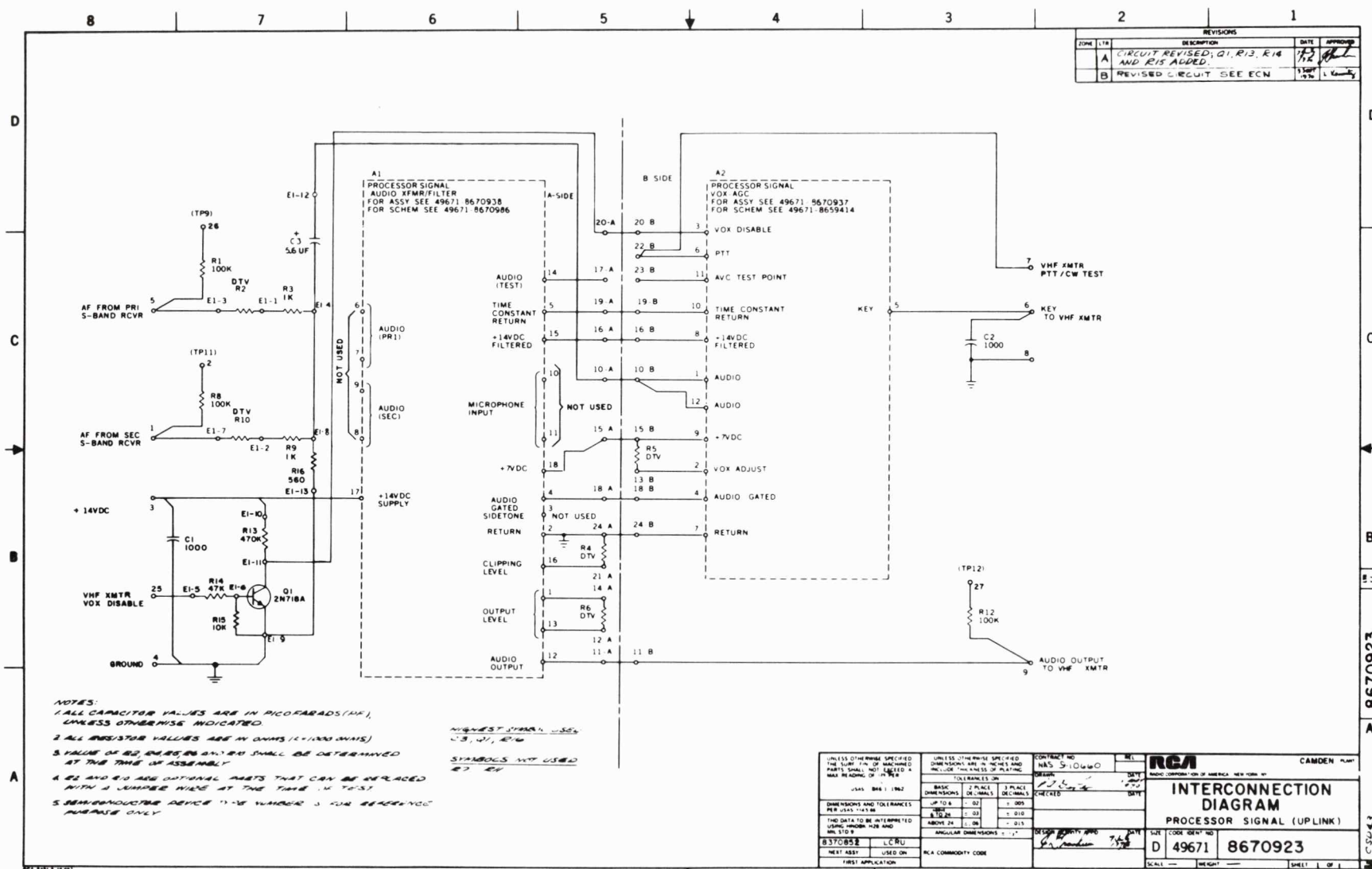
SIZE

Maximum Design Envelope Including	2.72 x 3.20 x 1.06 in.
Terminals And Mounting Feet	
Volume	9.22 cu. in.

WEIGHT

Measured Weight W/O Cover	0.30 lbs
---------------------------	----------

7-113



7-114

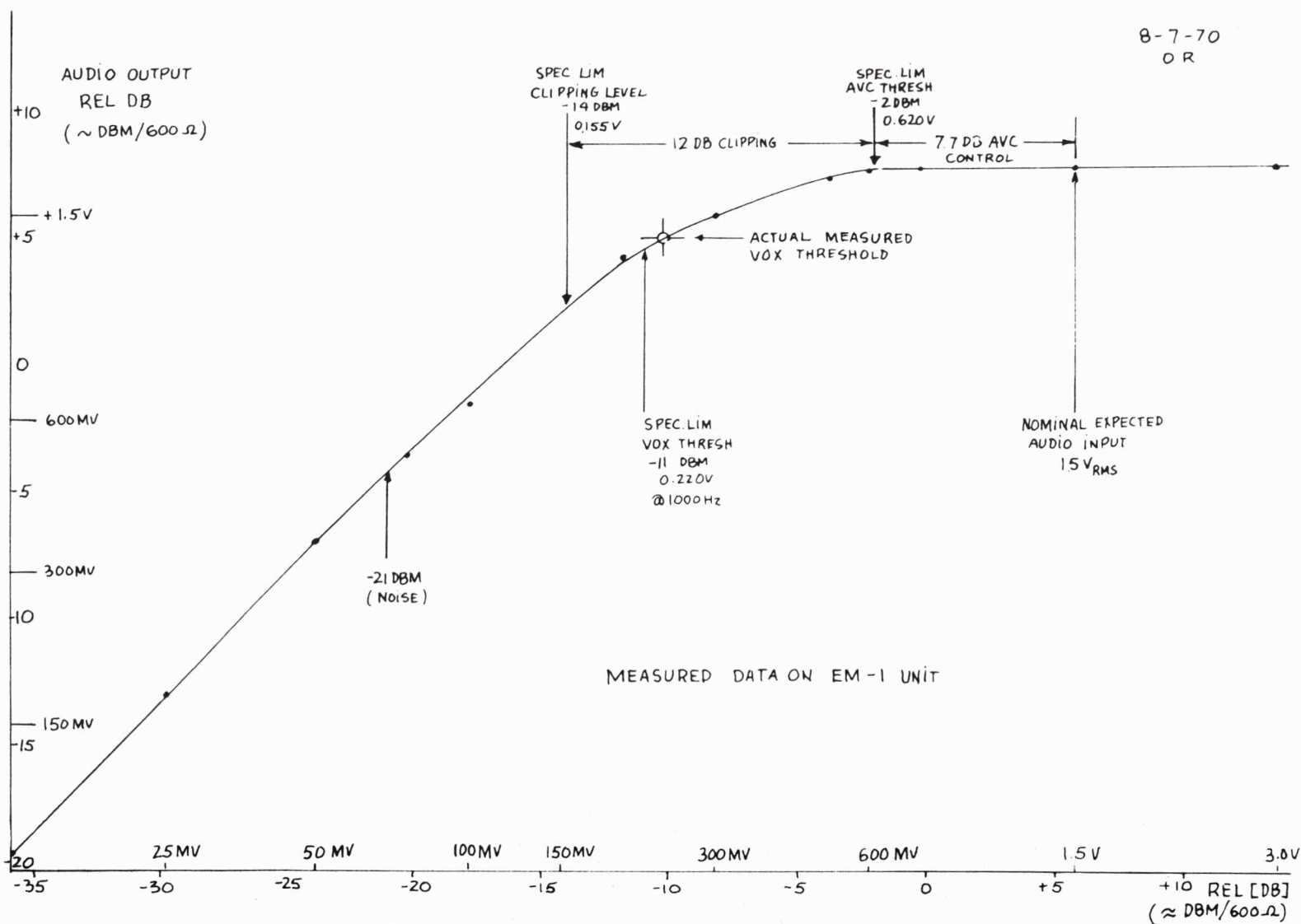




1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----



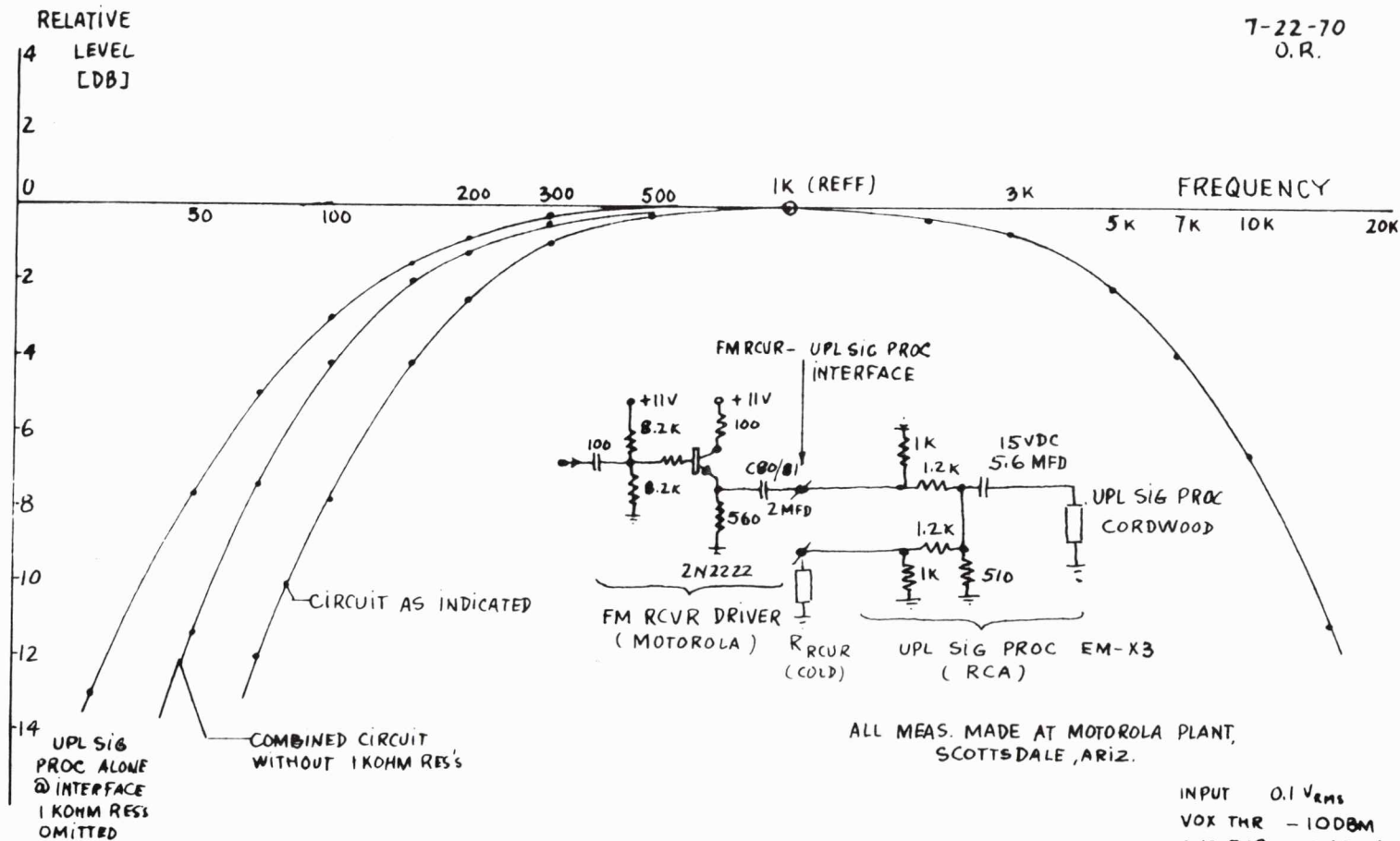
UPLINK SIGNAL PROCESSOR





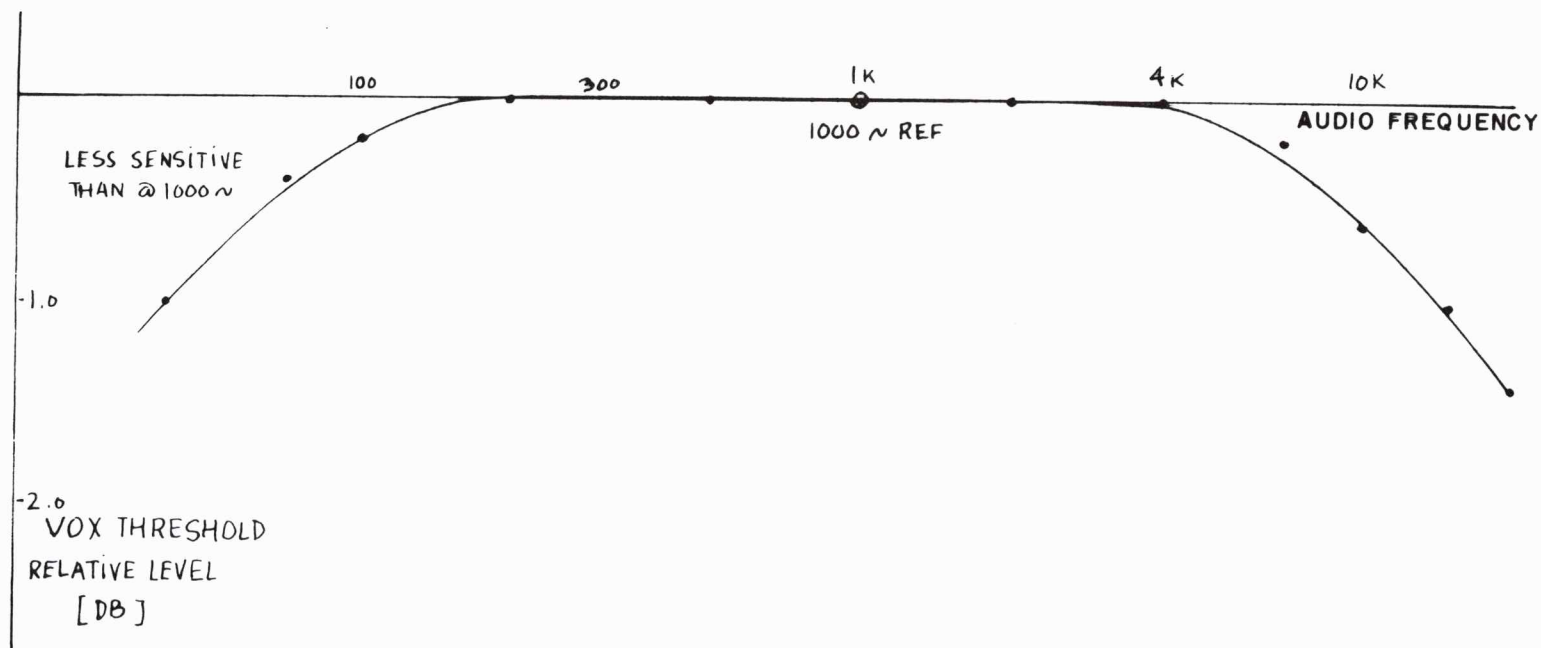
UPLINK SIG. PROC AF RESPONSE

7-22-70
O.R.





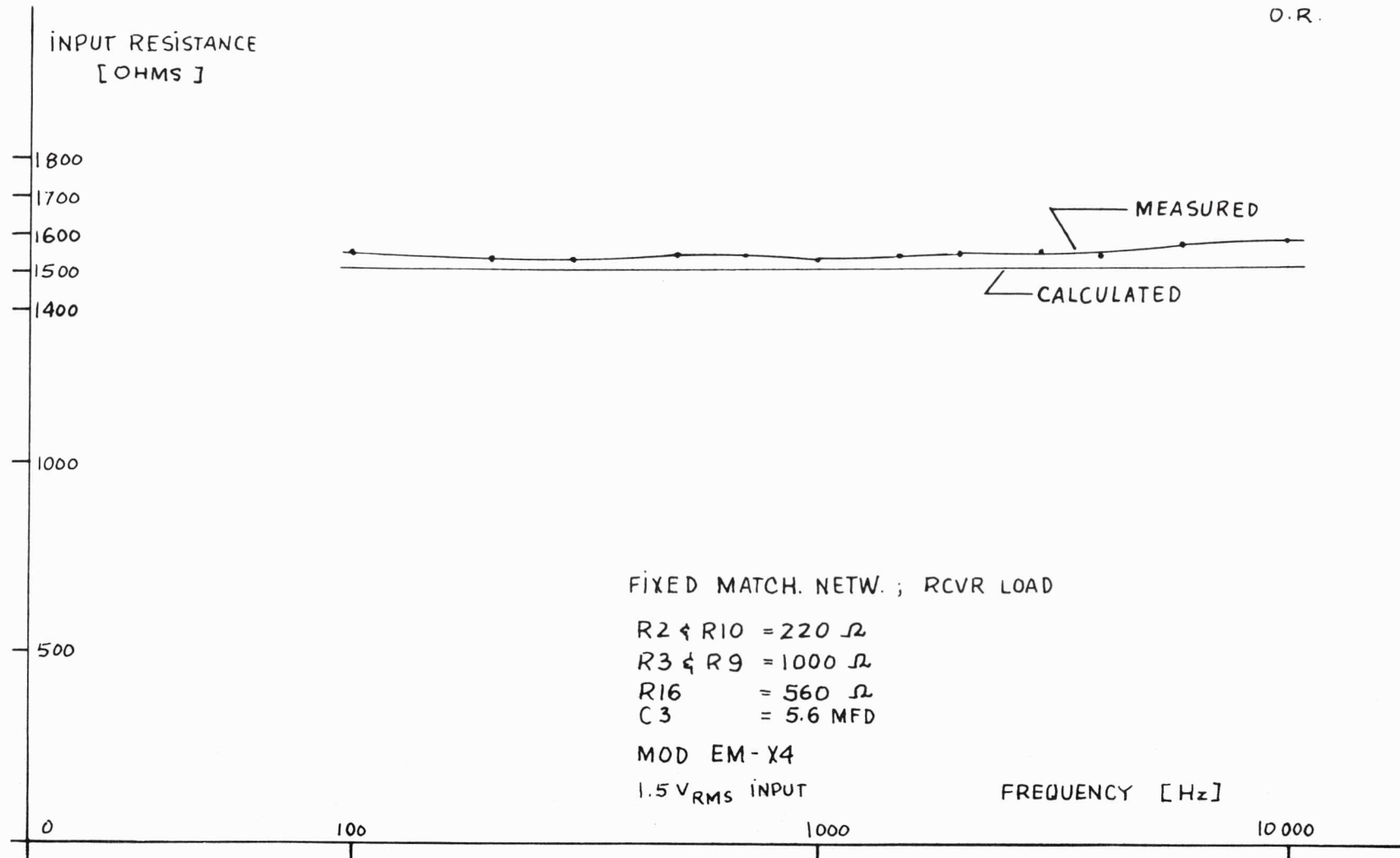
VOX THRESHOLD RESPONSE MOD EM-X3





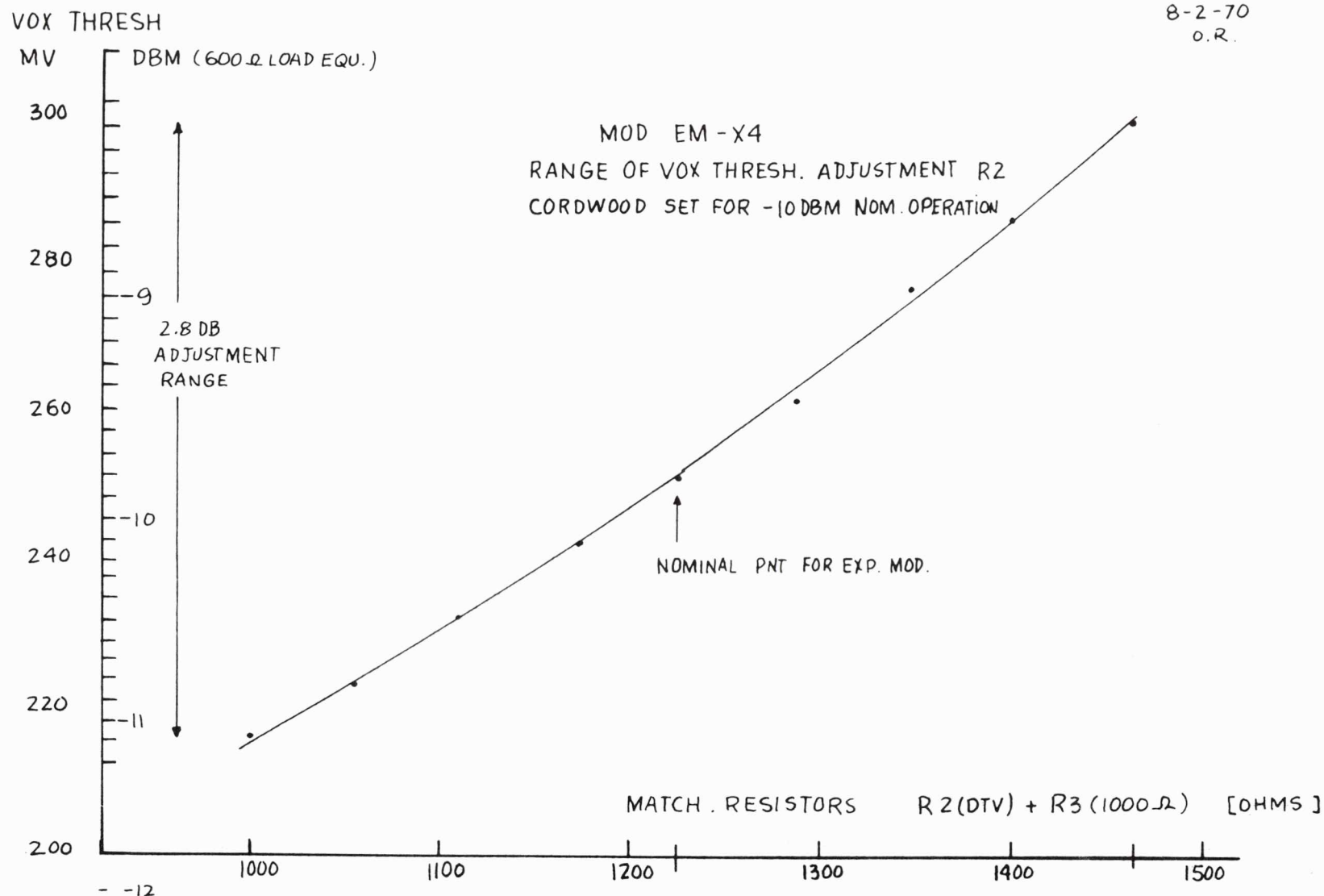
UPLINK SIGNAL PROCESSOR INPUT RESISTANCE

8-1-70
O.R.





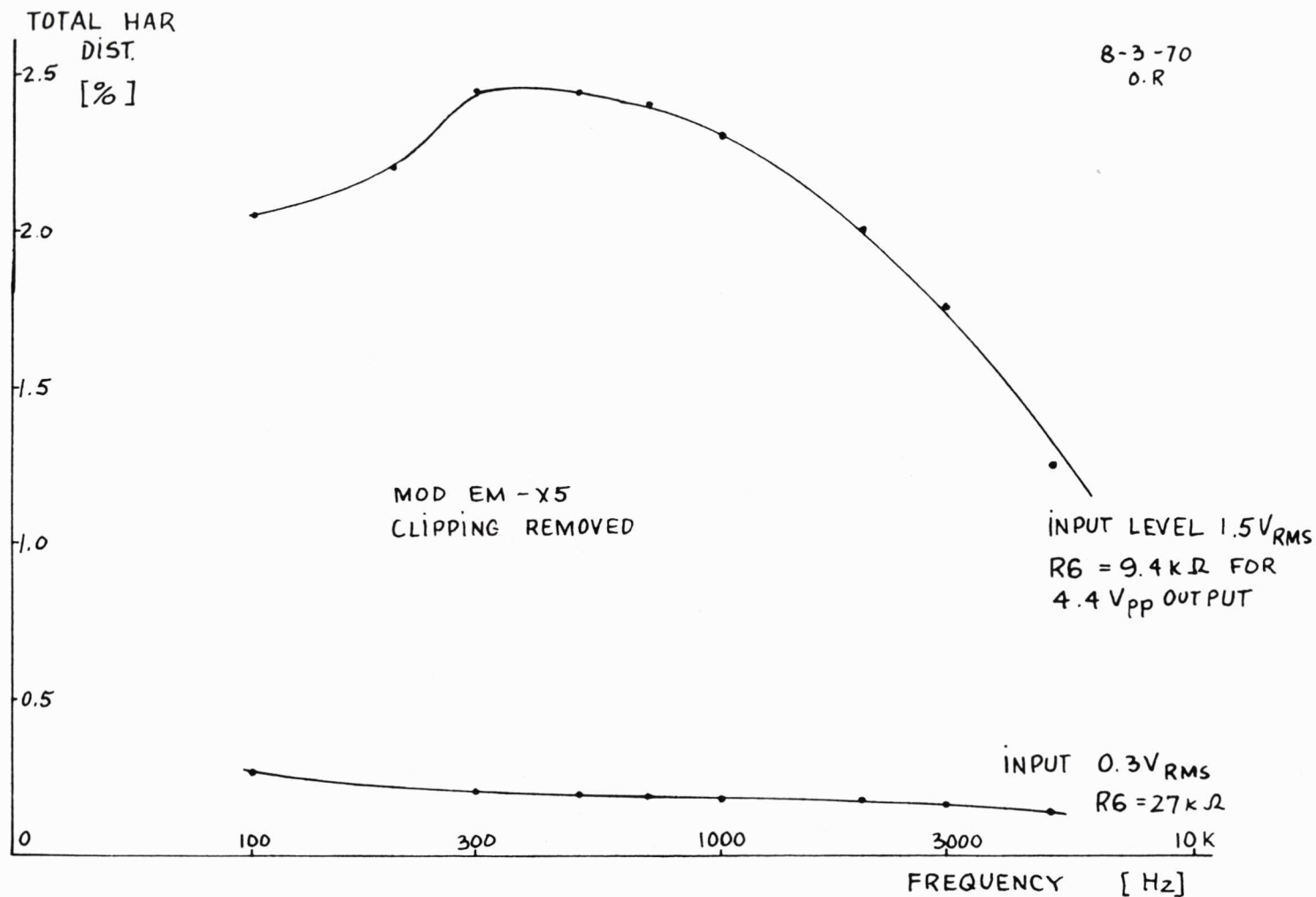
UPLINK SIGNAL PROCESSOR VOX THRESHOLD RANGE





UPLINK SIGNAL PROCESSOR

HARMONIC DISTORTION VS FREQUENCY





UP-LINK SIG. PROCESSOR EM-1

TEST SUMMARY

TEST	MEASUREMENT	LIMITS
TEMPERATURE	ROOM AMBIENT (+23°C)	—
INPUT CURRENT	11 MA	18 MA MAX
VOX THRESH PRI (SEC. O.C.)	0.235 Vrms	0.245 V MAX 0.195 V MIN
VOX THRESH SEC (PRI O.C)	0.232 Vrms	0.245 V MAX 0.195 V MIN
AVC THRESH ('KNEE')	0.590 Vrms	0.695 V MAX 0.550 V MIN
VOX RELEASE TIME	0.96 SEC	1.0 ± 0.4 SEC
VOX ATTACK TIME	2 mSEC	10 mSEC MAX
CLIPPING LEVEL @ 400 Hz	0.160 Vrms	.195 V MAX .125 V MIN
AF OUTPUT	4.5 V _{pp}	4.3 V _{pp} ± 0.6 V
FREQUENCY RESPONSE		
1 kHz	0 DB	REFF
300 Hz	-0.3 DB	NMT -1.0 DB
3000 Hz	-1.2 DB	NMT -3.0 DB
6000 Hz	-4.4 DB	NLT -3.0 DB
HARMONIC DIST	0.8%	8%
PTT/KEY "OFF"	+13.4 VDC	+11.5 VDC MIN
"ON"	+ 0.6 VDC	+ 3.0 VDC MAX
VOX DISABLE, AF OUT	17.5 mV	25 mV MAX
TEST POINTS	CHECK	

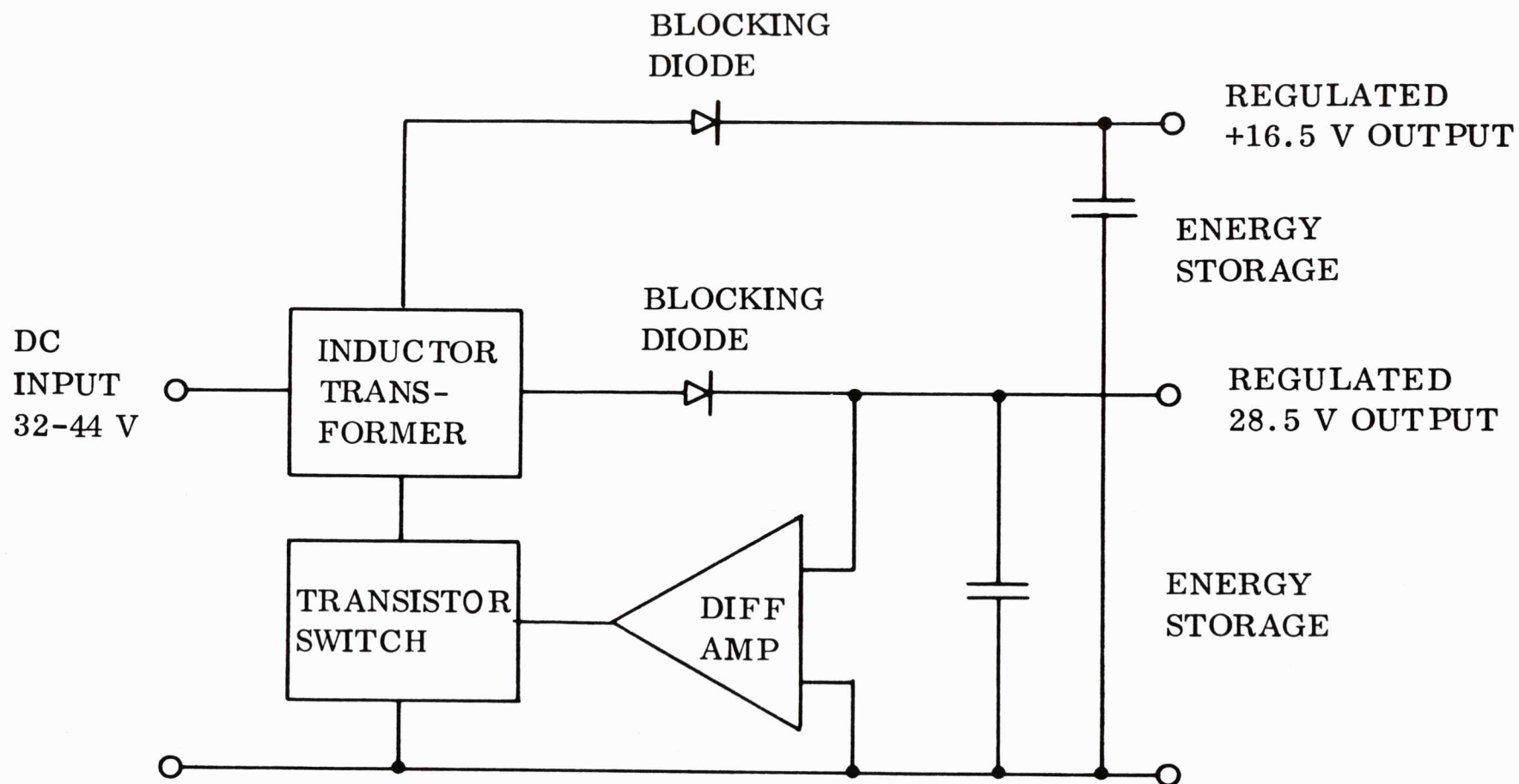


DC-DC CONVERTER SPECIFICATIONS

<u>SPECIFICATION</u>	<u>LIMITS</u>
INPUT VOLTAGE	32-44V (LRV BATTERY)
OUTPUT VOLTAGE REGULATION	+28.5V $\pm$ 4% @ 1.0 TO 2.7 AMPS +16.5V $\pm$ 4% @ 0.3 TO 0.6 AMPS
EFFICIENCY	80% MINIMUM @ 28.5V + 2.7 AMPS AND 16.5V + 0.6 AMP OUTPUTS
FREQUENCY OF OPERATION	17 kHz MINIMUM
RIPPLE	28.5V OUTPUT - 80 MV P TO P 16.5V OUTPUT - 50 MV P TO P
OVERLOAD PROTECTION	REQUIRED (WITH AUTOMATIC RECOVERY).
AMBIENT TEMPERATURE	0° F TO + 160° F
VOLUME	35.3 CU. IN. MAXIMUM
WEIGHT	40 OZ. MAXIMUM

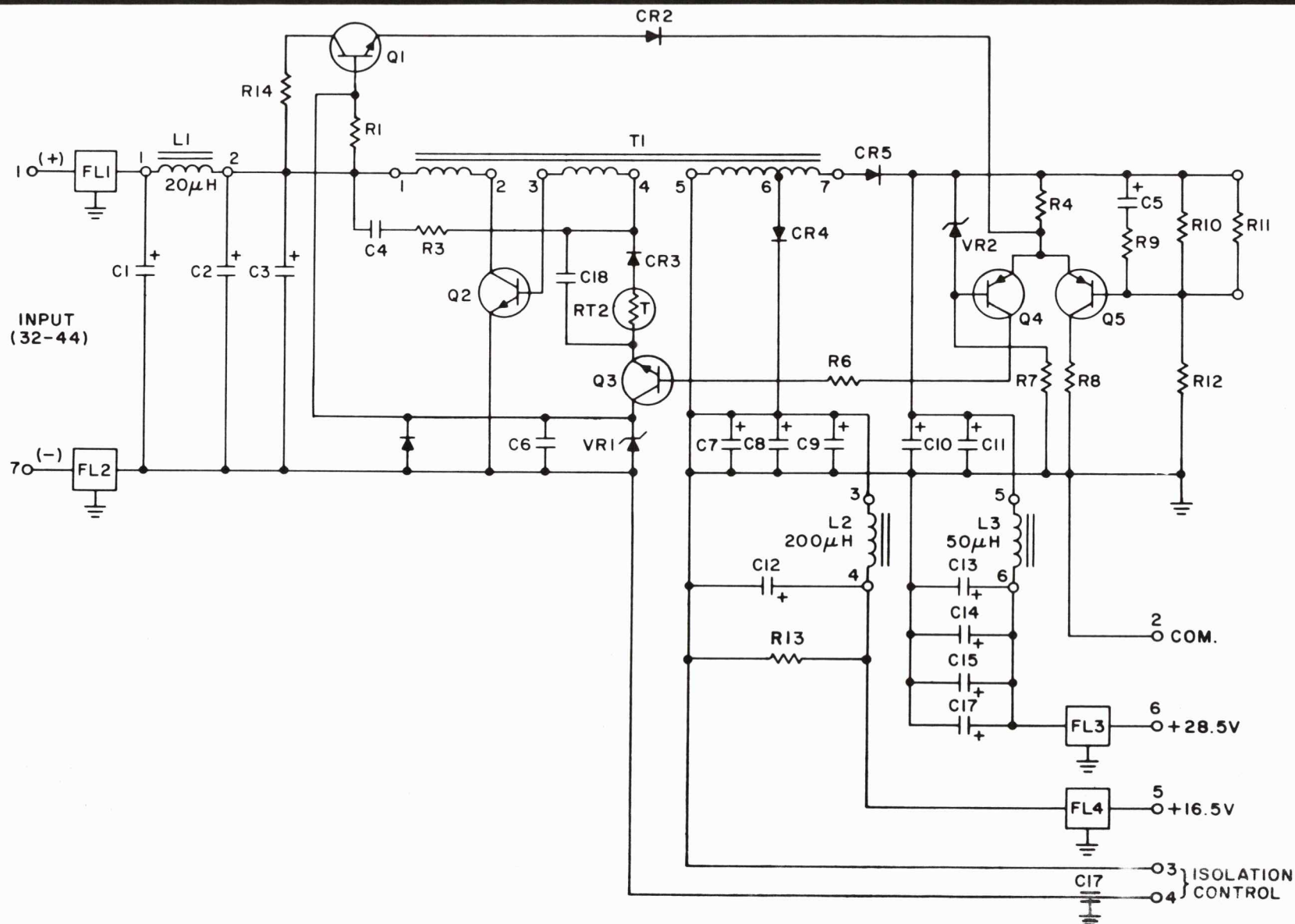


DC-DC POWER CONVERTER, BLOCK DIAGRAM





LCRU DC-DC POWER CONVERTER SCHEMATIC DIAGRAM



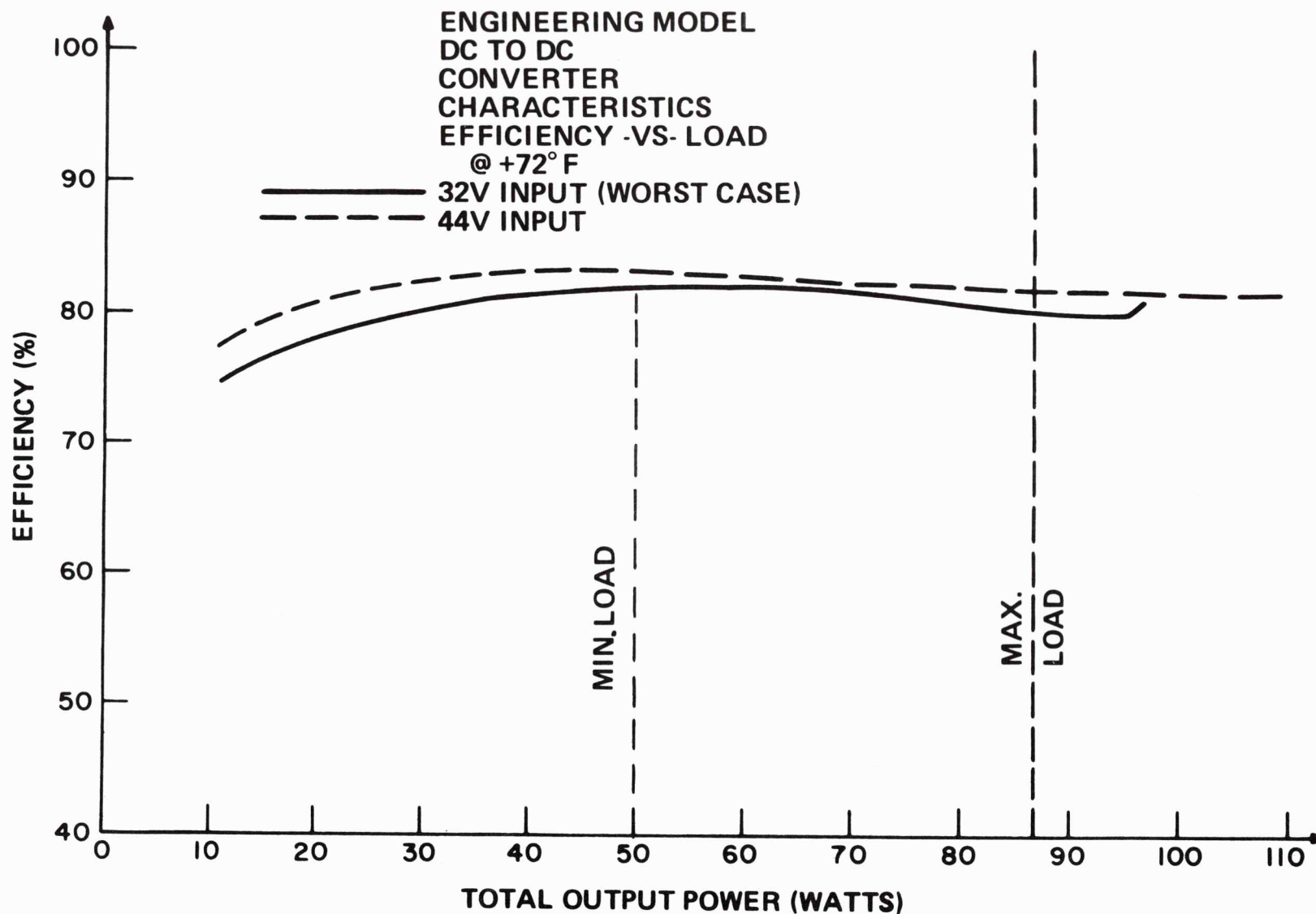


DC-DC CONVERTER BREADBOARD TEST DATA

<u>TEST PARAMETER</u>	<u>LIMITS</u>	<u>+160°F</u>	<u>72°F</u>	<u>0°F</u>
REGULATION - 32 V _{IN}				
28.5 V OUTPUT @ MIN. LOAD	±4% (27.36 to 29.64 V)	28.83	28.84	--
28.5 V OUTPUT @ MAX. LOAD		28.49	28.51	28.44
16.5 V OUTPUT @ MIN. LOAD	±4% (15.84 to 17.16 V)	15.99	16.00	--
16.5 V OUTPUT @ MAX. LOAD		16.37	16.33	16.23
REGULATION - 44 V _{IN}				
28.5 V OUTPUT @ MIN. LOAD	±4% (27.36 to 29.64 V)	28.84	28.83	--
28.5 V OUTPUT @ MAX. LOAD		28.53	28.55	28.50
16.5 V OUTPUT @ MIN. LOAD	±4% (15.84 to 17.16 V)	15.97	15.95	--
16.5 V OUTPUT @ MAX. LOAD		16.35	16.32	16.22



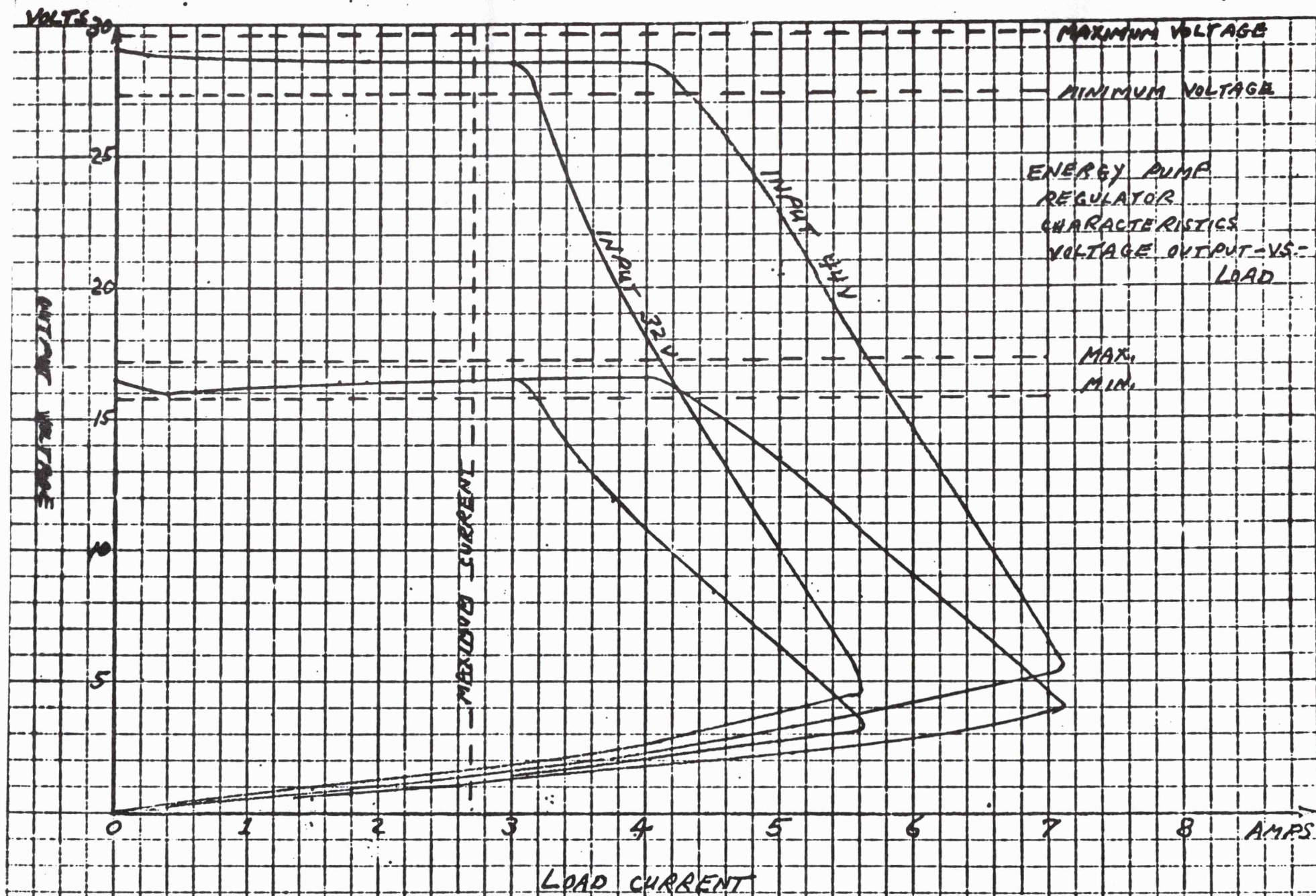
ENGINEERING MODEL DC TO DC CONVERTER – CHARACTERISTICS





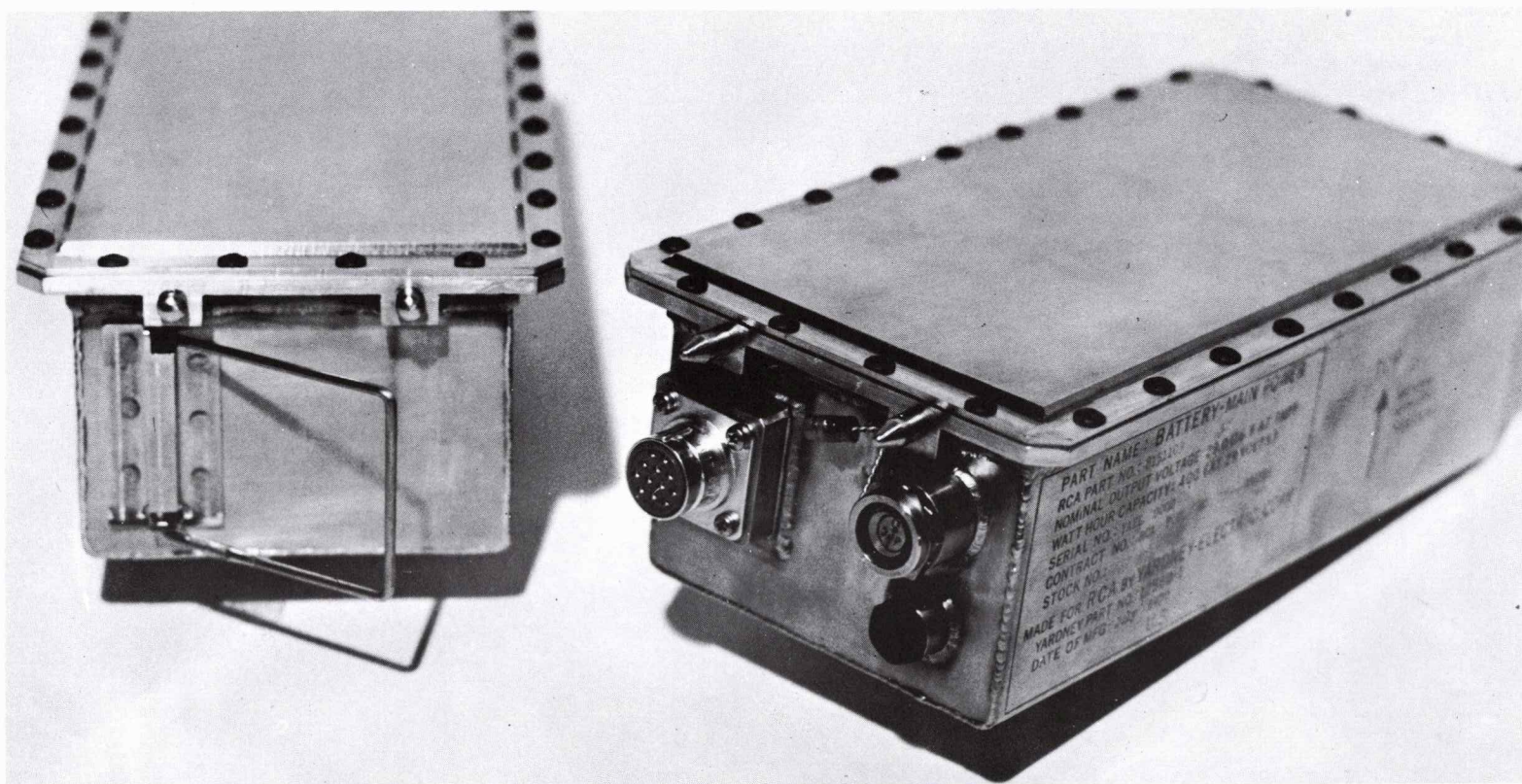
DC-DC CONVERTER ENGINEERING MODEL TEST DATA (ROOM TEMPERATURE)

<u>TEST PARAMETER</u>	<u>LIMITS</u>	<u>32 V_{INPUT}</u>	<u>44 V_{INPUT}</u>
REGULATION:			
28.5 V OUTPUT @ MIN. LOAD	±4% (27.36 TO 29.36V)	28.90 V	28.90 V
28.5 V OUTPUT @ MAX. LOAD		28.60 V	28.61 V
16.5 V OUTPUT @ MIN. LOAD	±4% (15.84 TO 17.16)	16.06 V	15.98 V
16.5 V OUTPUT @ MAX. LOAD		16.43 V	16.45 V
EFFICIENCY @ MAX. LOAD	80%	80.0%	81.7%
FREQUENCY OF OPERATION	17 kHz MIN.	20.8 kHz MIN.	20.8 kHz MIN.
OUTPUT RIPPLE			
28.5 V OUTPUT @ MAX. LOAD	80 MV P-P	40 MV	35 MV
16.5 V OUTPUT @ MAX. LOAD	50 MV P-P	35 MV	30 MV
WEIGHT	40 OZ.	30 OZ.	





LCRU BATTERY ENGINEERING AND THERMAL MODELS



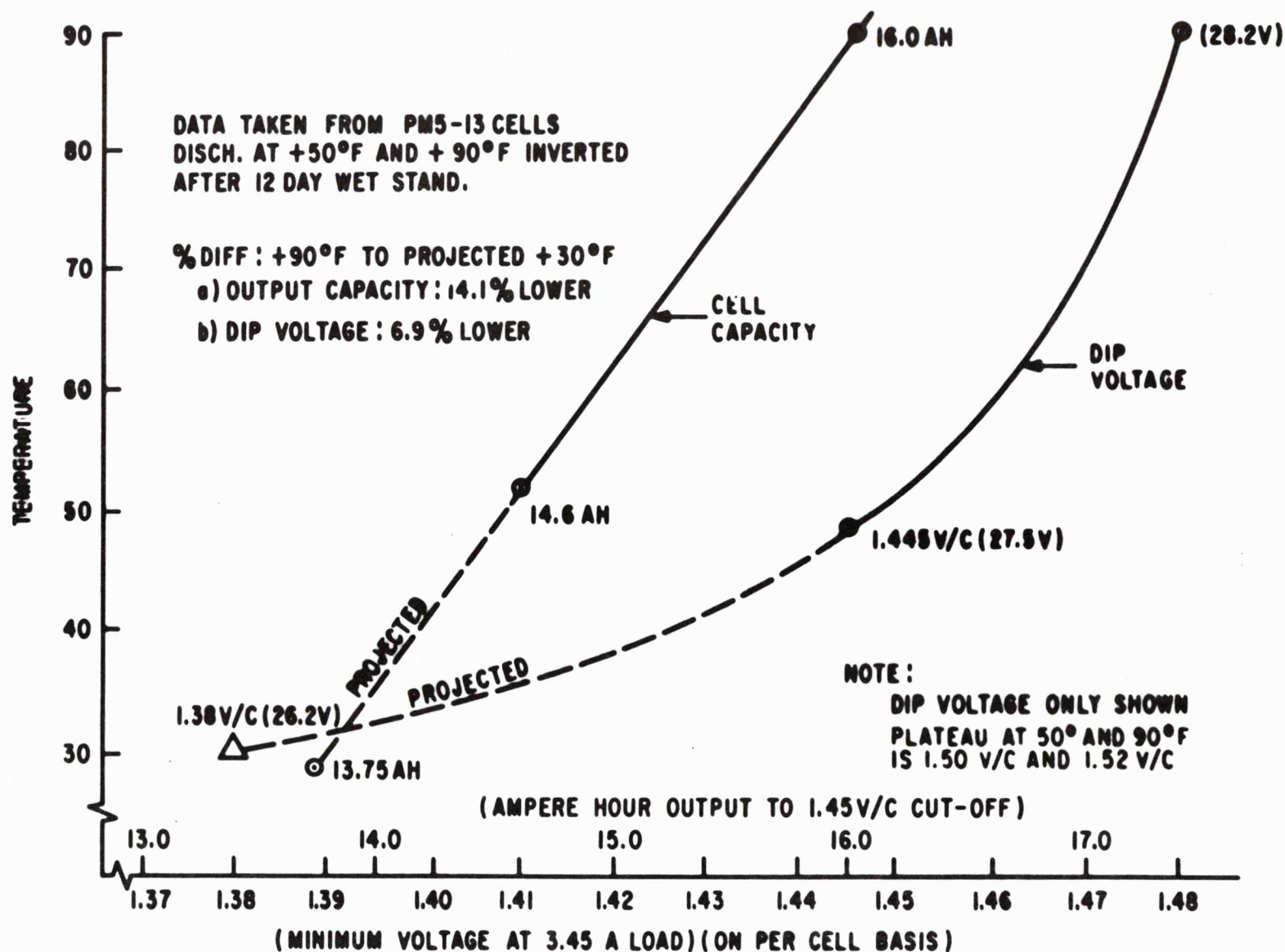


BATTERY CHARACTERISTICS

VOLTAGE:	29V ⁺⁴ / ₋₂	TAP AT 16.8V ^{+2.3} / _{-1.2}
PEAK VOLTAGE:	35.10V MIN 24 HRS AFTER ACTIVATION	
RATING	FULL	TAP
NOM VOLTAGE	29.0V	16.8V
NOM CURRENT	3.10A	0.6A
NOM POWER	90W	10W
CAPACITY	400 WH FOR 27.0/15.6V MIN	
AMB PRESSURE DRY	14.7 PSIA NOM 10 ⁻⁴ MM HG TO 21.0 PSIA	
ACTIVATED	14.7 PSIA - 13 DAYS 10 ⁻⁴ MM HG - 8 DAYS	
OPERATING TEMP	35° F TO 130° F NOT TO EXCEED 100° F FOR 1ST 30 MIN TURN-ON AT 35° F	
STORAGE DURATION DRY	3 YRS MIN	
ACTIVATED	21 DAYS 8 HRS	
TEMP DRY	25 TO 105° F	
ACTIVATED	13 DAYS CYCLED OVER 50° F TO 80° F FOLLOWED BY 158 HRS WITH THE TEMP LINEARLY RISING FROM 80 TO 120 AND 42 HRS AT 120° F	
CONNECTOR TYPE	DEUTSCH DM5606 125-689	
SIZE	4.7 X 9.4 X 4.65	
WEIGHT (WET)	9.4 POUNDS MAX	

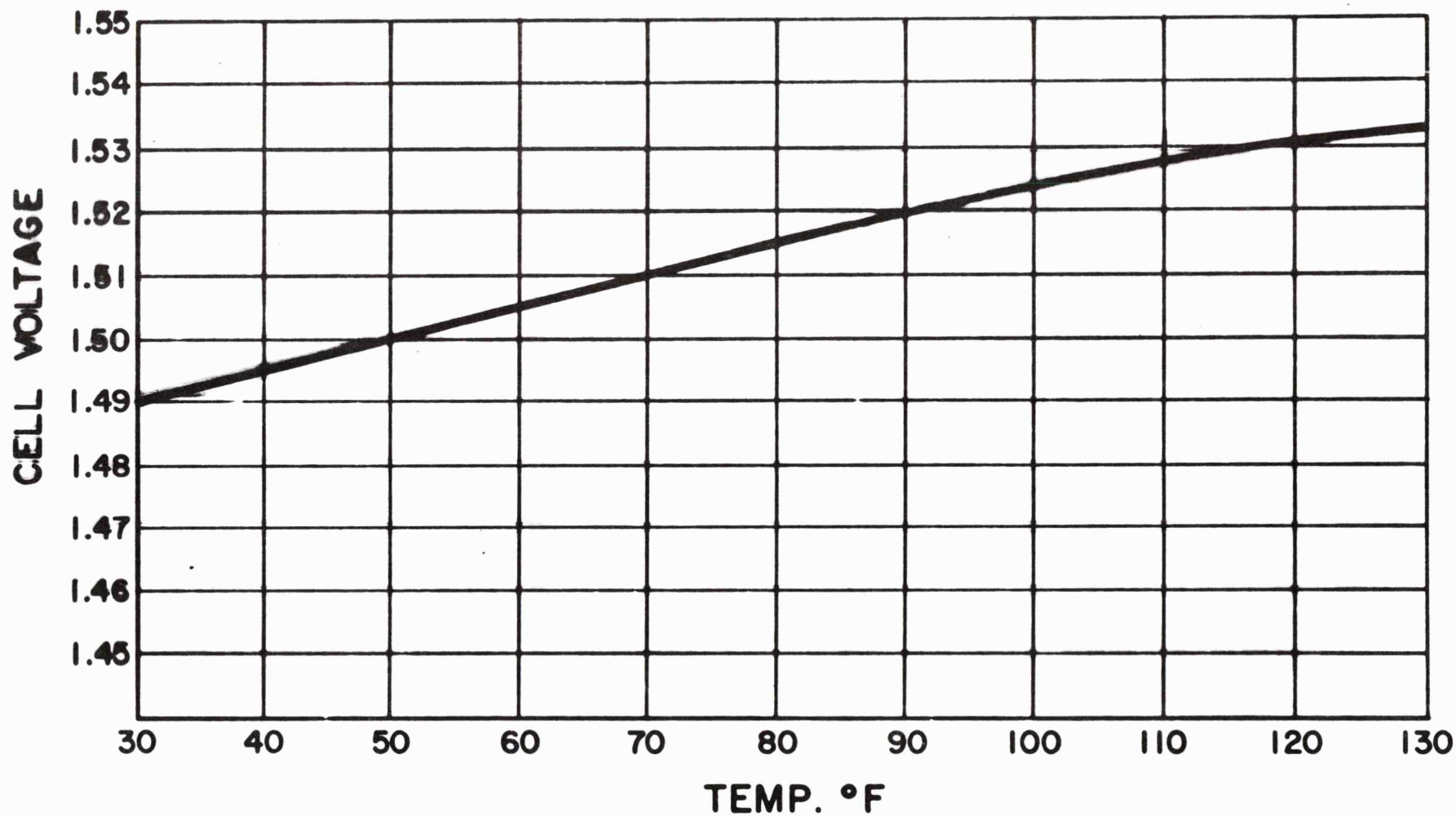


CELL CAPACITY AND DIP VOLTAGE vs. TEMPERATURE



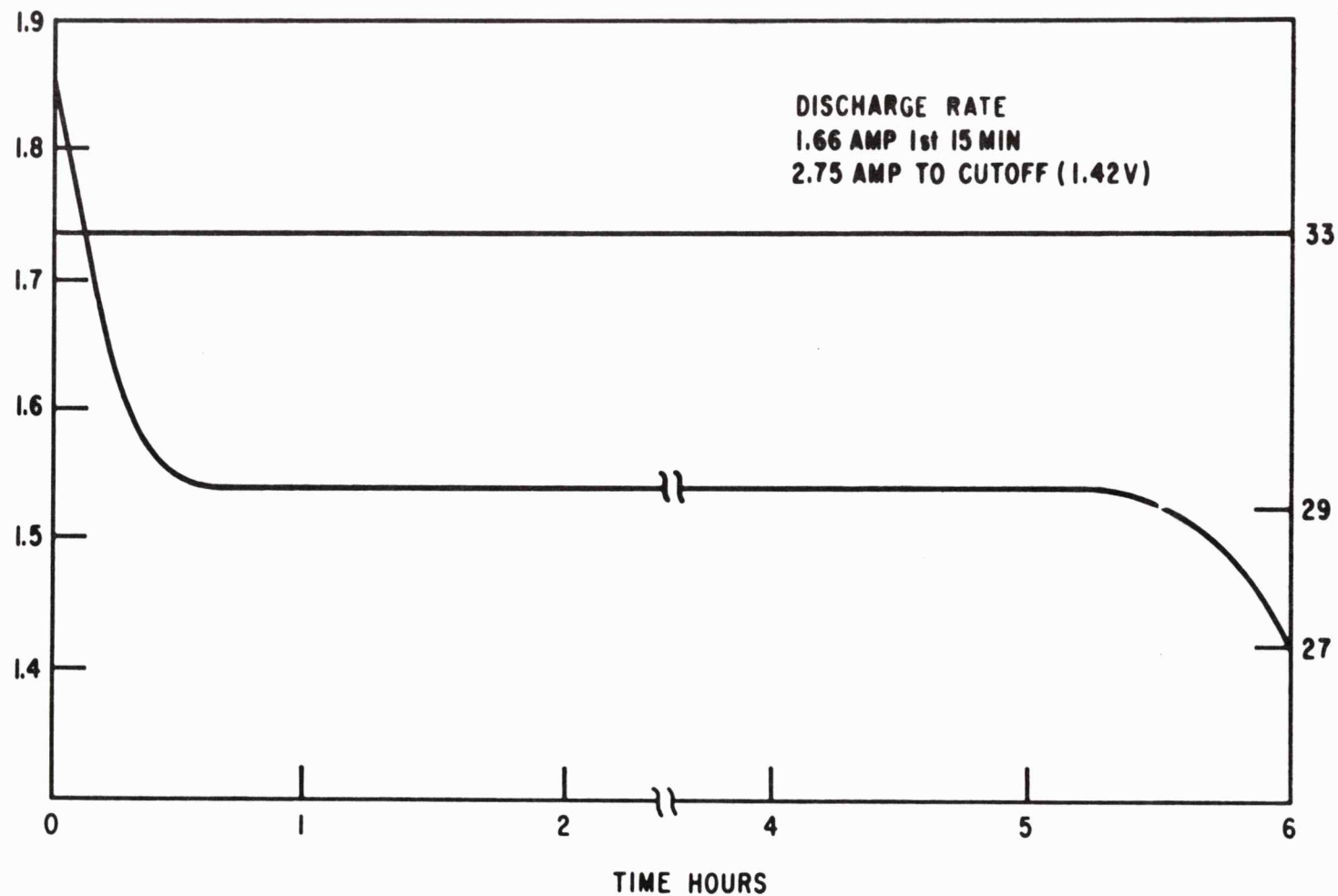


PLATEAU VOLTAGE CHANGE VS TEMP. PM 5-13 CELL





YARDNEY PM5-13 CELL VOLTAGE VS TIME





PRIMARY BATTERY TEST

TYPE OF CELL: EM 4 (13) - 1		CODE NO: 2370-B		WET STAND TIME: 1 HOUR	
ACTIVATION STAND - O.C.V.					
BATT. No.		BATT. No.		BATT. No.	
CELL NO.	DATE:	CELL NO.	DATE:	CELL NO.	DATE:
0770		0870		0370	
TEST PROCEDURE:		TEST PROCEDURE:		TEST PROCEDURE:	
ACTIVATION TIME	O.C.V.	ACTIVATION TIME	O.C.V.	ACTIVATION TIME	O.C.V.
11.5	1.89	11.5	1.88	12.5	1.87
12.5	1.85	12.5	1.85	13.5	1.87
13.5	1.84	13.5	1.84	14.5	1.87
14.5	1.85	14.5	1.85	15.5	1.87
15.5	1.85	15.5	1.85	16.5	1.87
Ref #	18434	Ref #	18434	Ref #	18434
J.O.	70.0190	J.O.	70.0190	J.O.	70.0192
Net Wt	153.8	Net Wt	154	Net Wt	155.3
Dry Wt	130.02	Dry Wt	130.05	Dry Wt	131.8
Net	23.78	Net	23.95	Net	23.5
17 cc	"B" = 23.7 cc.	17 cc	"B" = 23.7 cc.	17 cc	"B" = 23.7 cc.
	1.395		1.395		1.395
cc KOH		cc KOH		cc KOH	

ARISE

CELL NO.	DATE:	CELL NO.	DATE:	CELL NO.	DATE:	CELL NO.	DATE:	CELL NO.	DATE:
TIME	VOLTAGE	TIME	VOLTAGE	TIME	VOLTAGE	TIME	VOLTAGE	TIME	VOLTAGE
0+	1.85	0+	1.85	0	1.86				
1'	1.71	1'	1.68	1	1.69				
5'	1.69	5'	1.66	5	1.67				
10'	1.68	10'	1.65	10	1.65				
20'	1.67	20'	1.64	20	1.62				
40'	1.60	40'	1.58	40	1.56				
60'	1.52	60'	1.53	60	1.51				
80'	1.52	80'	1.52	80	1.49				
100'	1.52	100'	1.52	100	1.49				
120'	1.52	120'	1.52	120	1.49				
140'	1.52	140'	1.52	140	1.49				
160'	1.52	160'	1.52	160	1.49				
180'	1.52	180'	1.51	180	1.48				
200'	1.52	200'	1.51	200	1.48	282.10' - 1.45V			
220'	1.51	220'	1.50	220	1.47	16.4			
240'	1.51	240'	1.50	240	1.46				
260'	1.50	260'	1.48	260	1.46				
275'	1.49	275'	1.48	275	1.46				

TEST CONDITIONS

TEST PROCEDURE NO. 05(13)-1	TEMPERATURE:	CURRENT PROFILE:	CHARACTERISTICS:	CAPACITY:	REMARKS:
INITIAL PRESSURE: -----					
RESIDUAL PRESSURE: -----		3.6 AMPS	1.15 V		
ELECTROLYTE QUANTITY: 17 CC					
TYPE OF KOH: "B"	R.T.	to	Minimum for	275'	
NET KOH IN CELL: -----					
BLEEDING TIME: -----					275' Discharge



BATTERY IMPEDANCE

<u>CPS</u>	<u>OHMS</u>							
Δ T	<u>Fresh.</u>	<u>1 Hr.</u>	<u>8 Days</u>	<u>.5 Hr.</u>	<u>.5 Hr.</u>	<u>.5 Hr.</u>	<u>24 Hr.</u>	<u>.5 Hr.</u>
10	.137	.53	.33	.19	.16	.15	.18	.16
100	.166	.46	.22	.16	.15	.13	.17	.15
1000	.137	.41	.21	.16	.16	.15	.17	.16
10,000	.324	.46	.29	.24	.26	.26	.28	.23
100,000	.460		.87	.86	.86	.88	.88	.88

Impedance based on 1 cell measurement multiplied by (19)

DC Resistance

.5  Oxide Phase

1.5  Peroxide Phase



LCRU BATTERY - PCDR 14, 23, 24

- 14-1 WET STAND CONDITIONS: Para. 3.2.1.3.2
Corrected by Rev. A
- 14-2 TURN ON AT +35⁰ F
Rev. A procedure requires turn on at +35⁰ F as part of Qual Test
(Para. 4.1.3c)
- 14-3 MIN. OF 35.10 VOLTS
Yardney will accept req for 5 days - Main concern appears to be instrumentation and stabilization.
- 14-4 Para. 3.2.2.4.2
+4; -2 will be corrected to +4, -2 in Rev. B
Entire para. is not required.
RCA willing to delete 2.2.2.4.2
- 14-5 DIELECTRIC REQUIREMENTS
PLSS originally not hard potted therefore there was a danger of spillage short to case between the cell cases to the side and bottom. We are hard potted, completely sealing the terminals and cell cases except for valves - more than 20 megs.
- 14-6 Para. 3.2.2.7.1 - "ZERO LEAKAGE"
No bubbles over a 10 min. period
- 14-7 Para. 3.2.2.7.1 - FLOW OF .000723 LBS/MIN.
1. Part is a qualified valve from PLSS Battery - This establishes the test flow rates.
2. Evaluation during T.I. with Yardney specifically covered this area to establish the flow rate is adequate.



LCRU BATTERY - PCDR 14, 23, 24

14-8 BURST PRESSURE

Cell - Calculated at 30 psi during cell ATP - Tested at 16 psi

Case - Calculated at 52 psi - tested to 8.1 psi during ATP

PLSS Case is similar. burst pressure about 50 psi tested/calculated

14-9 SIMULATED MISSION PROFILES:

Rev. A provide time and temp. profiles. DVT Procedure provides a simulated load profile.

14-10 CELL LOT TESTING

The PLSS Cell has a lot acceptance procedure. However, wet stand and environments are not used.



PRODUCTION INSPECTION TEST PROCEDURE FOR YARDNEY PM5(13)-1 REV. C" CELL ASSEMBLY

1. MECHANICAL INSPECTION

EACH CELL MUST:

1.1 COMPLY WITH YARDNEY CELL ASSEMBLY DRAWING NO. 10731 AND BE INSPECTED VISUALLY FOR GOOD WORKMANSHIP.

1.2 BE TESTED FOR AIR LEAKAGE (APPLY AIR PRESSURE OF 16.5 PSIG THROUGH CELL VENT). PRESSURE SHOULD NOT DROP BELOW 16.2 PSIG ONE MINUTE AFTER PRESSURE CONNECTION IS CLOSED.

IMPORTANT: CELL(s) MUST BE PHYSICALLY RESTRICTED PRIOR & DURING LEAK TEST.

2. ELECTRICAL TEST

2.1 SELECT CELLS FOR TEST ACCORDING TO FOLLOWING SCHEDULE: (A LOT IS CONSIDERED THE ENTIRE PRODUCTION OF A SINGLE TYPE OF CELL WITHIN A PERIOD OF 30 DAYS.)

<u>SIZE OF PRODUCTION LOT</u>	<u>NUMBER OF CELLS FOR TESTING</u>
UNDER 100 CELLS	1 PER 50 CELLS OR FRACTION THEREOF
BETWEEN 101 AND 500 CELLS	1 PER 100 CELLS OR FRACTION THEREOF
BETWEEN 501 AND 1000 CELLS	1 PER 200 CELLS OR FRACTION THEREOF
OVER 1000 CELLS	1 PER 500 CELLS OR FRACTION THEREOF

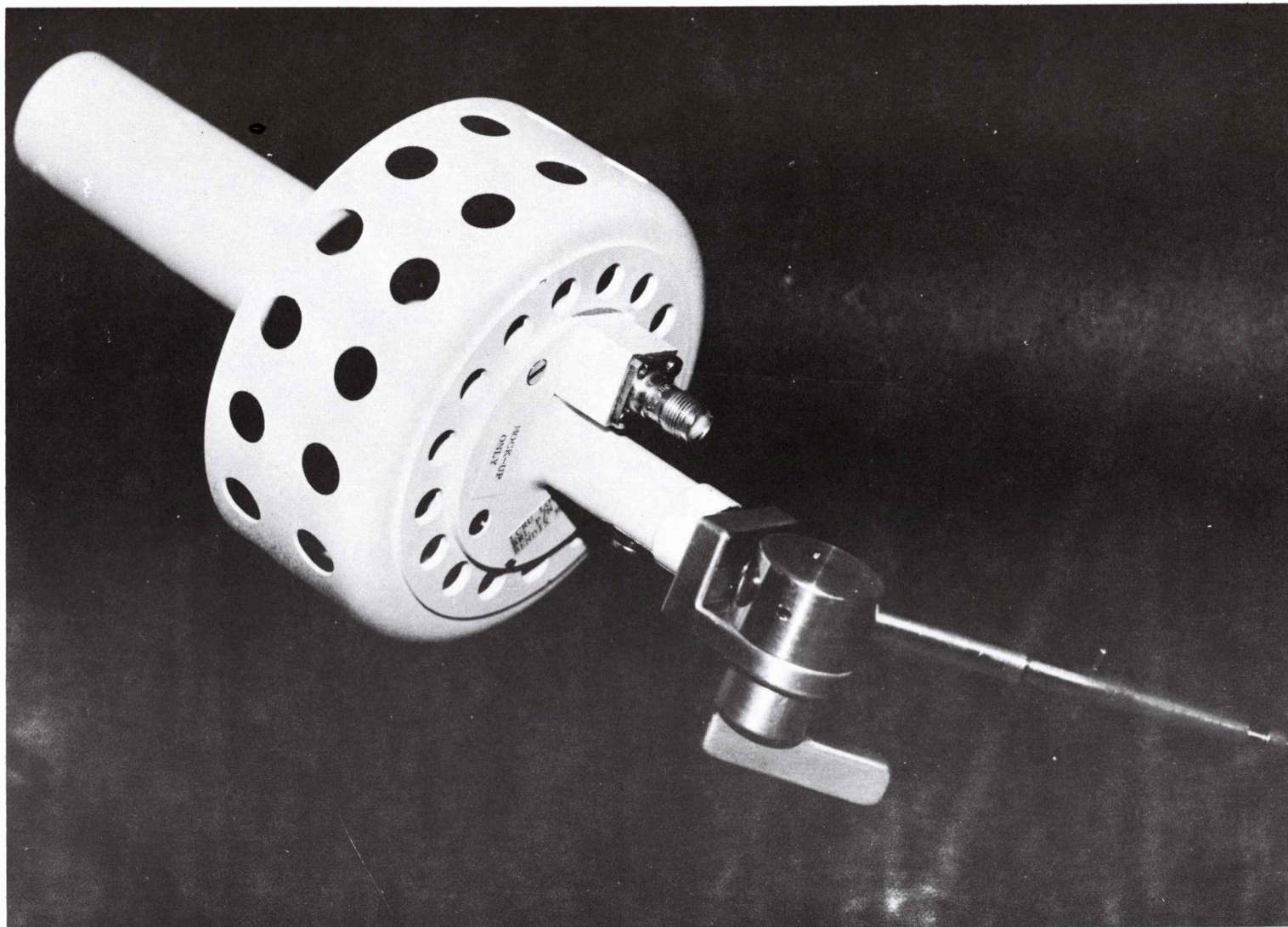
2.2 ADD 17.0-17.5CC OF YARDNEY ELECTROLYTE TYPE "B" TO EACH TEST CELL. SOAK FOR FOUR (4) HOURS.

2.3 USING SUITABLE RECORDING EQUIPMENT FOR MONITORING VOLTAGE AND CURRENT, DISCHARGE AT 3.6 AMPS TO 1.45 VOLTS. THE MINIMUM DISCHARGE TIME SHOULD BE 275 MINUTES AT A CELL VOLTAGE OF 1.45V MINIMUM FOR THE 275 MINUTE DISCHARGE.

3. THE LOTS OF CELLS SHALL BE CONSIDERED ACCEPTABLE FOR SHIPMENT IF ALL CELLS PASS THE REQUIREMENTS OF PARAGRAPH 1 AND THE ELECTRICAL TEST CELLS PASS THE REQUIREMENTS OF PARAGRAPH 2.

RCA

LGA AND POINTING ASSY (MOCK-UP)





S-BAND LOW GAIN ANTENNA CHARACTERISTICS

FREQUENCY BAND	TRANSMIT	2265.5 MHz $\pm$ 10 MHz
	RECEIVE	2101.802 MHz $\pm$ 10 MHz
VSWR	TRANSMIT	1.5 MAX
	RECEIVE	2.0 MAX
AXIAL RATIO		2.0 db ON AXIS
POWER CAPABILITY		4 db MAX $\pm$ 30 DEG OF AXIS
		15 WATTS
CONNECTOR TYPE		TNC
GAIN	AT 2265.5 MHz	6.5 db MIN $\pm$ 38 DEG
	AT 2101.802 MHz	6.0 db MIN $\pm$ 30 DEG
		-5 db MIN $\pm$ 57.5 DEG
ELECTRICAL AXIS RELATIVE TO MECHANICAL AXIS		$\pm$ 3 DEG FOR 60 DEG CONE
		$\pm$ 5 DEG FOR 115 DEG CONE
SIDELobe LEVEL		MORE THAN 12 db BELOW MAIN
WEIGHT		0.82 POUNDS MAX
DIMENSIONS		9.5 IN MAX VERT/5.2 IN MAX HOR

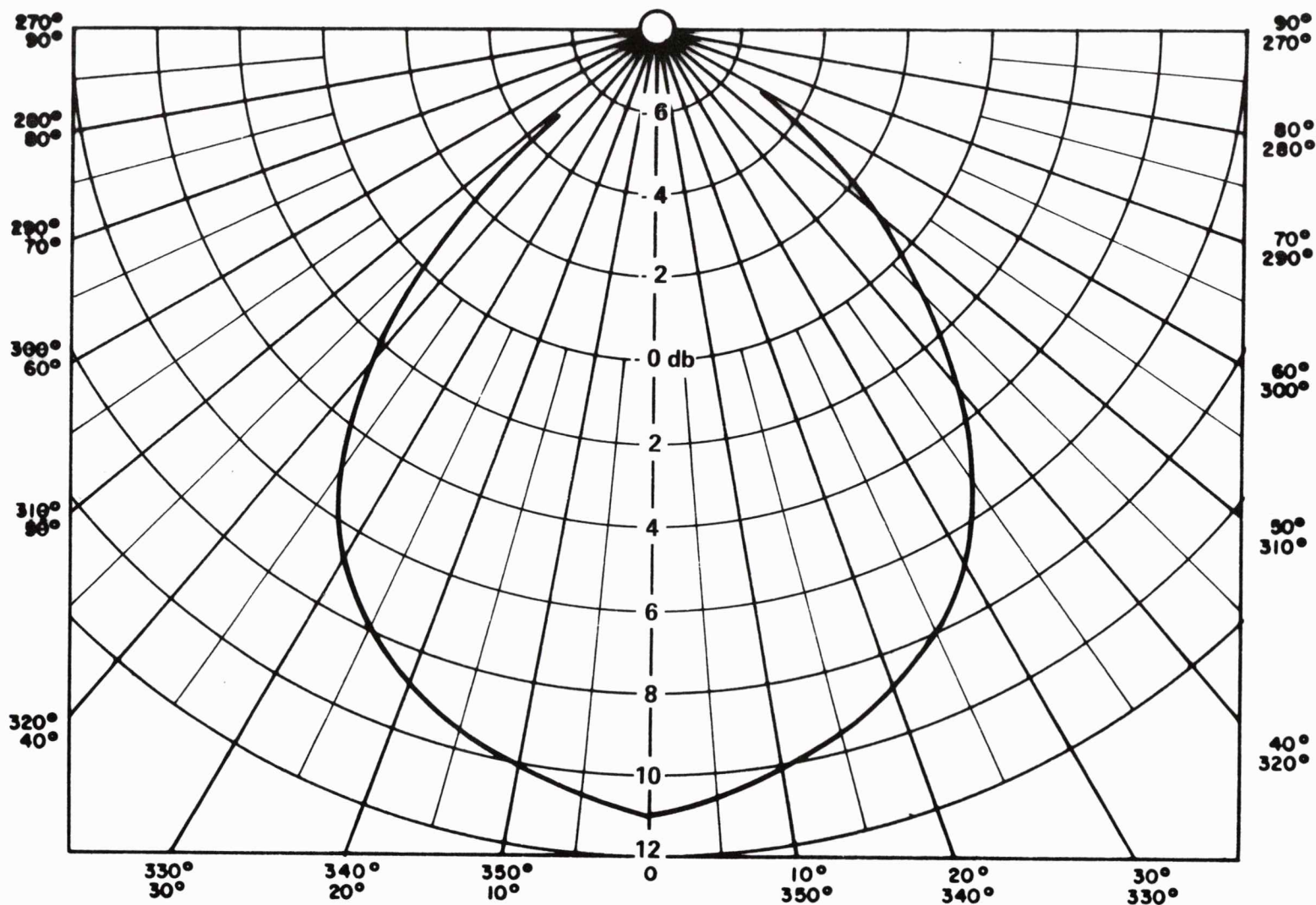


S BAND LOW GAIN ANTENNA
(MEASURED DATA)

	2272 MHz		2101 MHz	
	MEASURED	SPEC	MEASURED	SPEC
GAIN AT 60 DEG BW AT 115 DEG BW	6.9 db N/A	6.5 db MIN N/A	6.8 db -4.1 db	6.0 db MIN -5.0 db MIN
BORESIGHT ERROR AT 60 DEG BW AT 115 DEG BW	-3 DEG -3DEG	± 3 DEG MAX ±5 DEG MAX	-3 DEG -3 DEG	±3 DEG MAX ±5 DEG MAX
AXIAL RATIO ON AXIS ±30 DEG	0.8 db 3.0 db	2.0 db MAX 4.0 db MAX	1.0 db 2.8 db	2.0 db MAX 4.0 db MAX

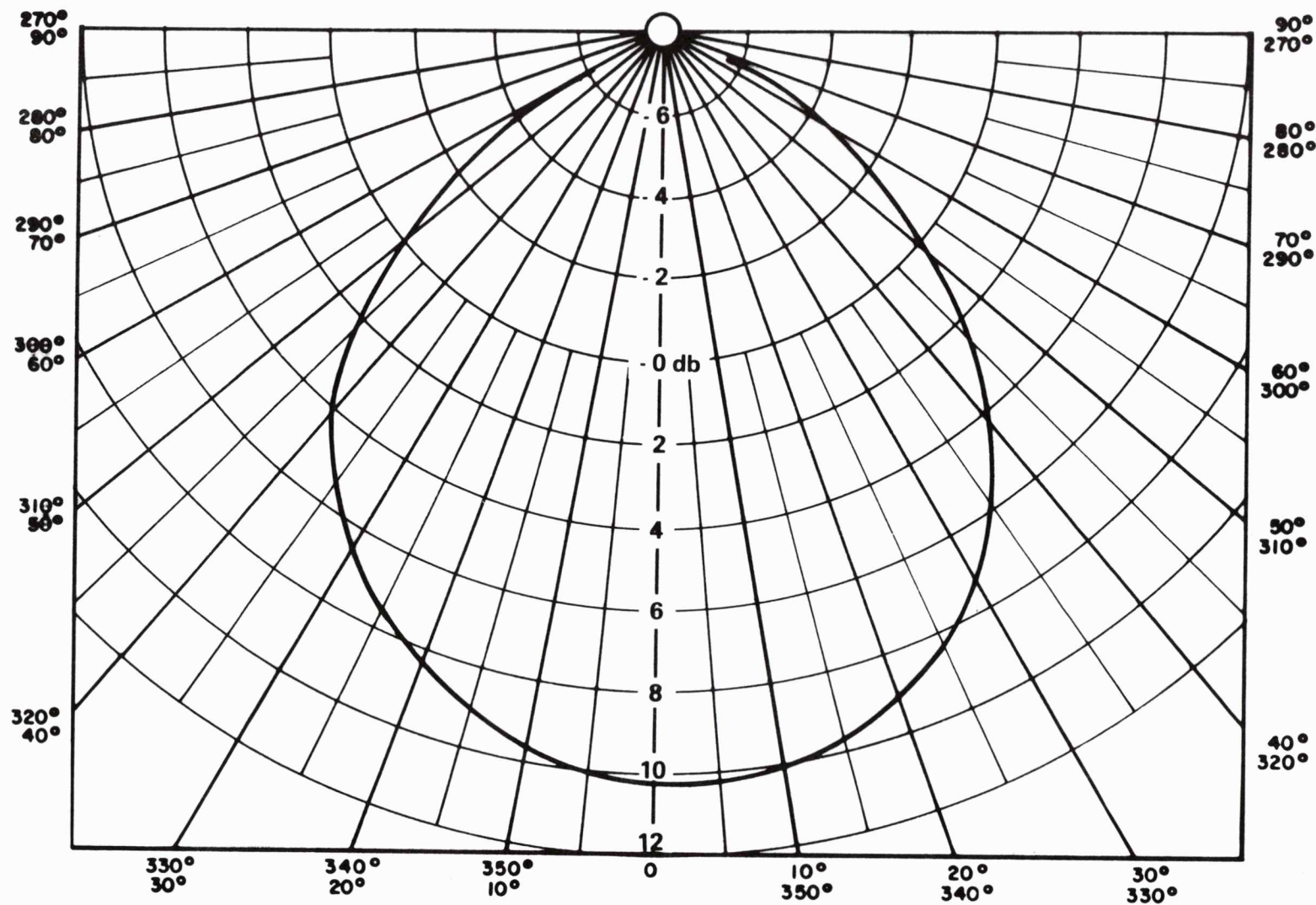
RCA

$F_T = 2272 \text{ MHz}$
 CIRCULAR POLARIZATION
 S - BAND LOW GAIN ANTENNA



RCA

FR = 2101
CIRCULAR POLARIZATION
S - BAND LOW GAIN ANTENNA





PERFORMANCE SUMMARY

LCRU ANTENNA, ENGINEERING MODEL

		R.C.A. Spec.		BRL Measured						UNIT
		F _T	F _R	F _T			F _R			
				-10MHz	0	+10MHz	-10MHz	0	+10MHz	
1	Gain, R.H. Cir. Polar. 60° Cone 0° ± 3° Axis Shift	+6.5 Min.	+6.0 Min.	7.0/ 7.3	6.9/ 7.1	6.8/ 7.0	6.6/ 6.9	6.6/ 7.0	6.8/ 7.0	DB
2	Gain, R.H. Cir. Polar. 115° Cone 0° ± 5° Axis Shift	-	-5 Min.	-	-	-	4.0/ 4.3	4.1/ 4.6	4.2/ 4.6	DB
3	Axial Ratio on Axis	2.0 Max.	2.0 Max.	.5/ 1.0	.5/ 1.2	.5/ 1.3	.4/ 1.1	.4/ .8	.4/ .9	DB
4	Axial Ratio Within 60° Cone	4.0 Max.	4.0 Max.	2.9/ 2.6	3.4/ 2.3	3.3/ 2.5	2.2/ 3.0	2.1/ 3.0	2.0/ 3.1	DB
5	Sidelobe Level R.H. Circ. Polar.	-12 Min.	-12 Min.	20.1/ 22.6	19.9/ 22.5	19.7/ 22.6	19/ 21.5	19.2/ 21.3	19.9/ 21.9	DB
6	Beam Squint	-	-	-1/ -2.5	-1/ -2.5	-1/ -2.5	-1.5/ -3.0	-1.5/ -3.5	+5/ -3.5	DEG.
7	VSWR Input Impedance with 50 Ohm Reference	1.5 Max.	2.0 Max.	1.21	1.22	1.23	1.20	1.19	1.17	-
8	Gain R.H. Circ. Polar. at Optical Boresight	-	-	11.0	10.9	10.8	10.2	10.3	10.3	DB
9	Dimension, Overall Length	9.5 Max.		9.315						Inch.
10	Ground Plane Dia.	5.5 Max.		5.081						Inch.
11	Weight Overall	.82 Max.		.64						Lbs.

Note 1. Max./Min. values are shown of four pattern cuts, every 45 degrees around the boresight direction.

Note 2. The 60° cone gain is defined as the maximum gain at the edge of a 60° cone centered within 3 degrees of the mechanical boresight direction of the antenna.

Note 3. The 115° cone gain is defined as the maximum gain at the edge of a 115° cone centered within 5 degrees of the mechanical boresight direction of the antenna.



LOW GAIN ANTENNA PCDR-9, 22

9-1

RECONNECTOR

Rev. A/O&M - Reference (GRFF 4080-0027, Bendix PT 2175452)

Establishes Straight Connector.

Rev. B will pick up details.

9-2

TRANSMIT FREQUENCY CHANGE

Rev. A provide update.

9-3

DELETION OF T.V. ATP

RCA considers this a pertinent test.

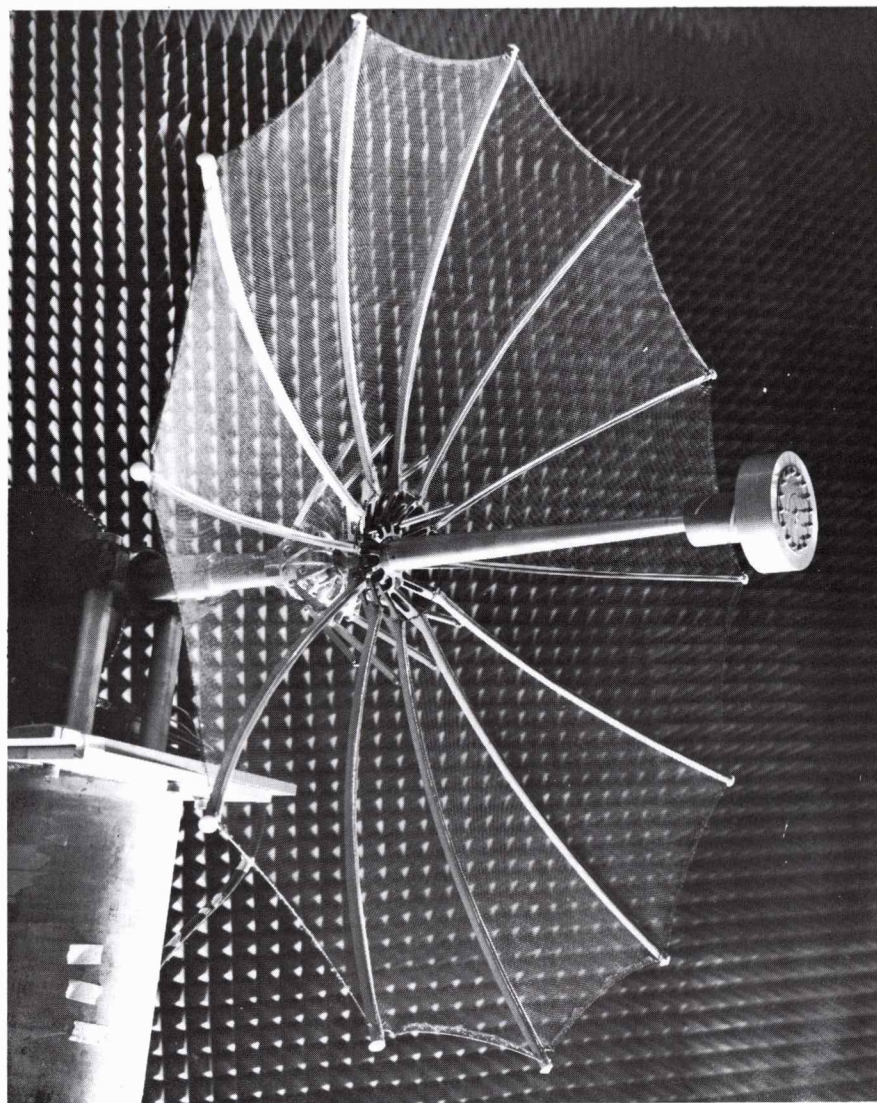
22-1

Sec. 3.1.7 of 8555260

+250°/90° Sun Angle will be changed to 220°/60° Sun Angle
to consistant with para. 3.4.4.1 and para. 4.1.4.2

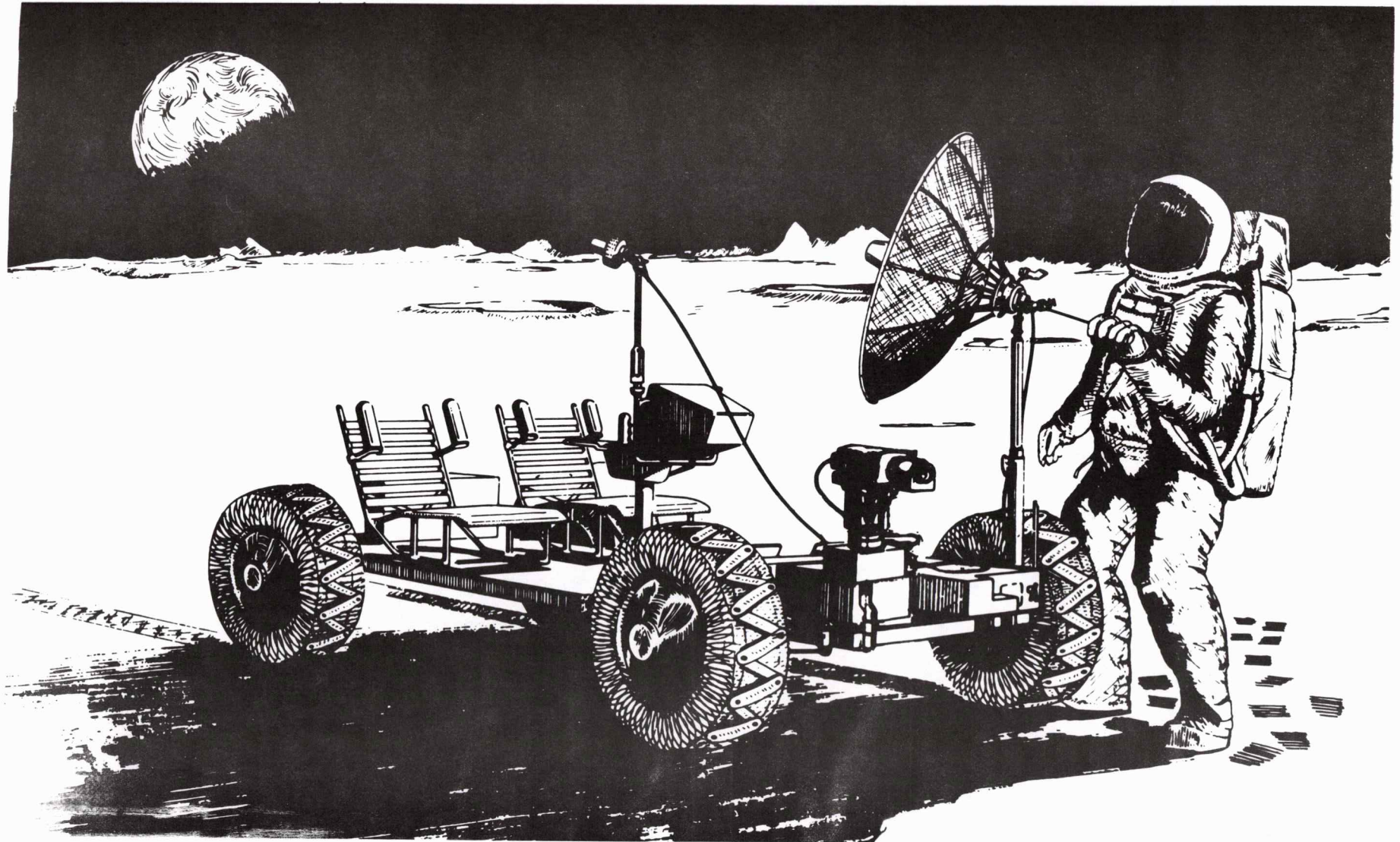
RCA

HGA ENGINEERING MODEL ON TEST RANGE



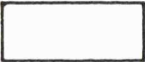
RCA

LRV INTERFACE

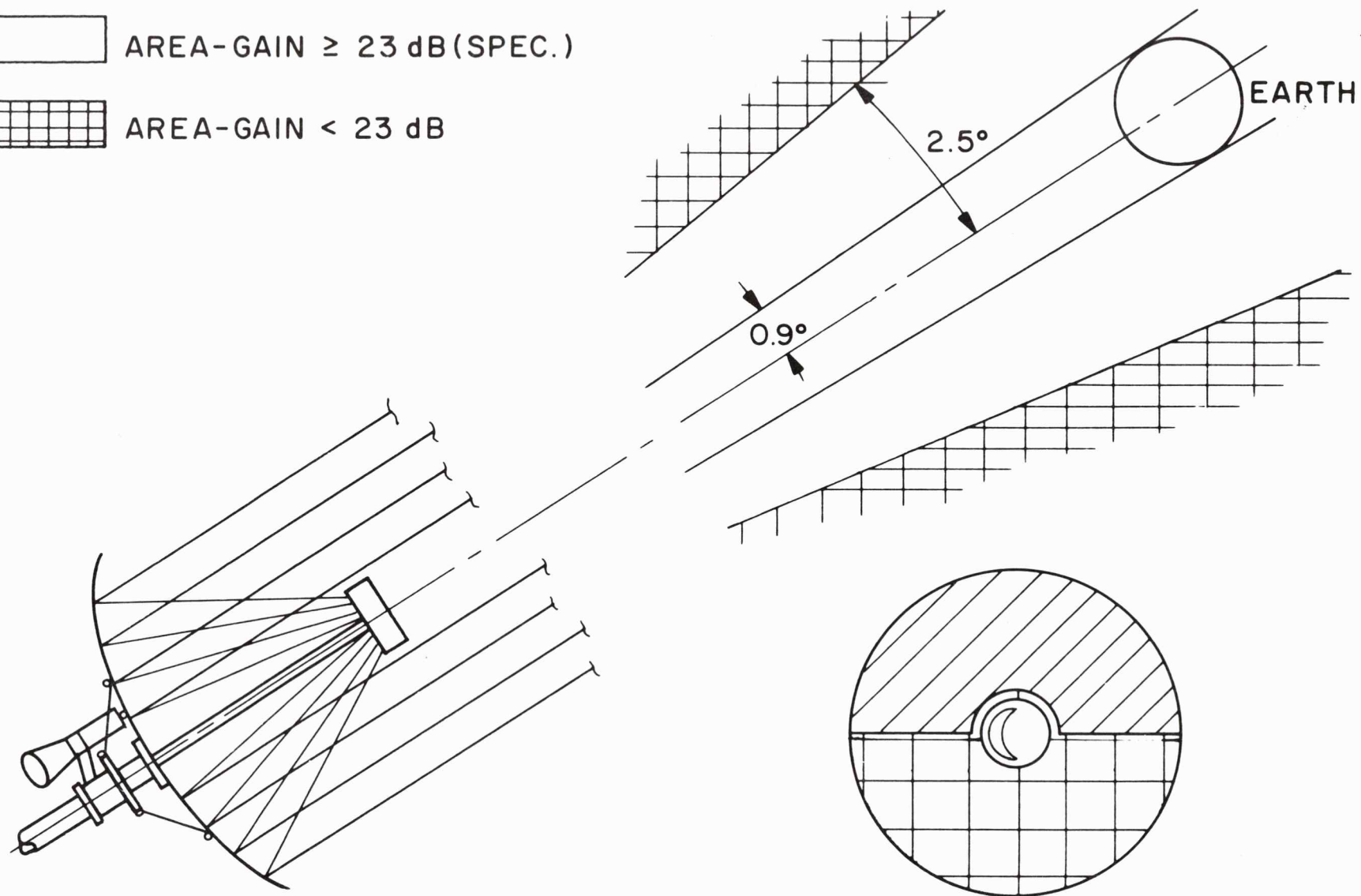


RCA

HGA ANTENNA

 AREA-GAIN ≥ 23 dB (SPEC.)

 AREA-GAIN < 23 dB





LCRU HIGH GAIN ANTENNA SCHEDULE

		1970				1971					
		SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	
1	ENGINEERING MODEL	▼									1
2											2
3	DVT TEST		▼		▼						3
4											4
5	DVT REPORT				▼						5
6											6
7	DVT #2				▼						7
8											8
9	DVT #3					▼					9
10											10
11	QUAL TEST					▼	▼				11
12											12
13	QUAL TEST MODEL						▼				13
14											14
15	QUAL TEST REPORT						▼				15
16											16
17	FLIGHT MODEL # 1							▼			17
18											18
19	# 2								▼		19
20											20
21	# 3								▼		21
22											22
23	# 4									▼	23
24											24
25	# 5									▼	25
26											26
27											27
28											28
29											29
30											30
31											31
32											32
33											33
34											34
35											35



LUNAR COMMUNICATION RELAY UNIT

ACTION ITEM LOG

HIGH GAIN ANTENNA

ITEM NO.	ITEM DESCRIPTION/ACTION REQUIRED	RESP.	DUE DATE	CLOSE DATE	REMARKS
1	CHANGE SCD 8555262 TO REFLECT ELLIPTICITY -TRANSMIT 3 db @ $\pm 2\frac{1}{2}^\circ$ BW, RECEIVE of 5 db @ $\pm 2\frac{1}{2}^\circ$ BW, CHANGE GAIN, TRANSMIT TO 23 db MIN @ $\pm 2\frac{1}{2}^\circ$ BW AND GAIN, RECEIVE TO 22 db MIN @ $\pm 2\frac{1}{2}^\circ$ BW.	CSD	9/4	9/10	ECN REV. B
2	FURNISH MAXIMUM DIMENSIONS OF STOWED ANTENNA.	M & SR	9/2	9/2	
3	CHANGE TO MECHANICAL INTERFACE DRAWING OF 8555262 TO INCLUDE ANGULAR RELATION BETWEEN KEYS, SIGHT AND MAST, SHOW INCREASE IN LENGTH DUE TO SIGHT BRACKET AND SHOW LOCATION OF BRACKET.	CSD	9/4	9/10	ECN REV. B
4	SPECIFICATION AND MECHANICAL INTERFACE TO BE UPDATED TO REFLECT NEW STOWAGE CONTAINER MECHANICAL INTERFACE.	CSD	9/4	9/10	ECN REV. B
5	DESIGN GOAL AND DESIGN LIMIT WEIGHTS FOR ANTENNA AND SIGHT TO BE FURNISHED.	M & SR	9/2	9/2	4.3 LBS.
6	INVESTIGATE POSSIBILITY OF COMBINING ALL PRE-ASSEMBLY ITEMS IN STOWAGE CONTAINERS AND RUN ONLY ONE TEST.	CSD	9/15	9/4	
7	REQUEST SPEC. CHANGE TO INCREASE MAX. DIAMETER OF DEPLOYED ANTENNA TO 38-5/8".	CSD	9/4	9/10	ECN REV. B ISSUED
8	DETERMINE STRAIN RELIEF REQUIREMENTS ON CABLE ATTACHED TO ANTENNA. ASCERTAIN POSSIBLE CHANGES TO VIBRATION AND FURNISH M & SR.	CSD	9/4	9/9	
9	DETERMINE EFFECT OF CABLE STRAIN RELIEF ON VIBRATION ANALYSIS	M & SR	9/14		
10	UPDATE VIBRATION ANALYSIS TO INCLUDE REAR MOUNTED SIGHT.	M & SR	9/11	Resched. 9/14	VERIFICATION OF NEW MAST INTERFACE VIBRATION REQUIRED FOR INPUT VIBRATION LEVELS
11	CONFIRM TIME LINE TEMPERATURE PROFILE.	CSD	9/4	9/2	ALSO ECN REV. B
12	FURNISH TIME-TEMPERATURE CURVE FOR ND4 FILTER FOR SUN HEATING EFFECT.	ATL	9/4	9/4	
13	INVOKE REV. A OF 8555262 TO M & SR OFFICIALLY.	CSD	8/27	8/28	
14	SUPPLY DELIVERY AND COST INFORMATION TO DCSD TO JUSTIFY THE REQUEST TO CHANGE TO OBJECTIVE LENS FROM A CEMENTED COMPOSITE TO AN AIR GAP LENS.	ATL	9/4	9/4	NO IMPACT



PCDR-10 ITEMS

<u>ITEM</u>	<u>ACTION TAKEN</u>
SCD HAS NOT BEEN UPDATED	8555262 CHANGED
1. WEIGHT 3.75 LBS (INCLUDES SIGHT WT. OF 1.25 LBS)	ECN REV. B ISSUED (4.3 LBS INCLUDING SIGHT AND MOUNTING BRACKET)
2. FREQUENCY CHANGE 2272.5 TO 2265.5 MHZ	ECN REV. A ISSUED
3. AXIAL RATIO 3.0 DB MAX @ F_T . 5.0 DB MAX. @ $F_R \pm 2.5^\circ$ BW	ECN REV. B ISSUED
4. GAIN BEAMWIDTH $\pm 2.5^\circ$ MIN.	ECN REV. B ISSUED
5. MAX. DIAMETER 38-5/8 IN.	ECN REV. B ISSUED
6. DELETION OF THERMAL-VAC FOR ATP	ECN REV. A ISSUED
7. RECEIVE GAIN 22 DB MIN.	ECN REV. B ISSUED



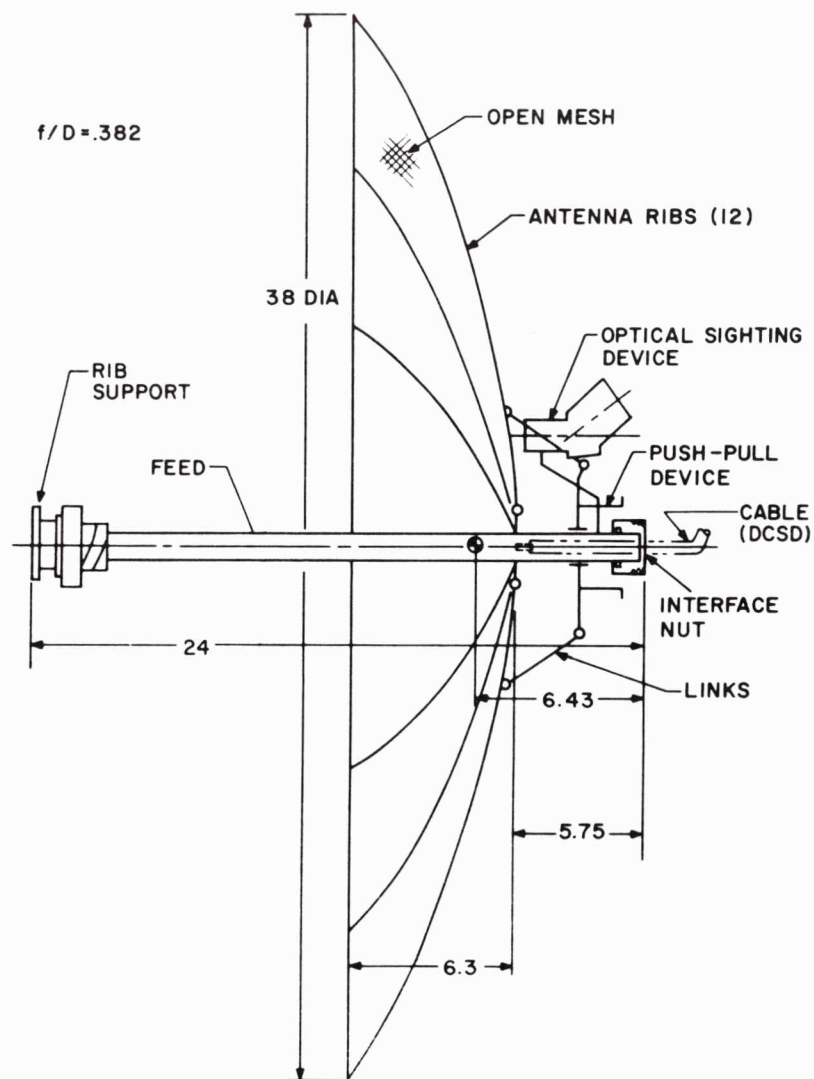
SPECIFICATION

<u>PARAMETER</u>	<u>PRESENT</u>	<u>FORMER</u>
DIAMETER	38-5/8 "	-
FREQUENCY, TRANSMIT	2265.5 $\pm$ 10 MHz	2272.5 $\pm$ 10 MHz
FREQUENCY, RECEIVE	2101.802 $\pm$ 10 MHz	-
POLARIZATION	RH	-
ELLIPTICITY, TRANSMIT	3 dB, $\pm$ 2.5° BW	2 dB, $\pm$ 2° BW
ELLIPTICITY, RECEIVE	5 dB, $\pm$ 2.5° BW	2 dB, $\pm$ 2° BW
GAIN, TRANSMIT	23 dB, $\pm$ 2.5° BW	23 dB, $\pm$ 2.2° BW
GAIN, RECEIVE	22 dB, $\pm$ 2.5° BW	18.5 dB, $\pm$ 2.5° BW
SIDE LOBE LEVEL	16 dB	-
VSWR, TRANSMIT	1.2	-
VSWR, RECEIVE	1.5	-
IMPEDANCE	50 OHM	-
POWER HANDLING	15 W CW	-

<u>INTERNAL PERFORMANCE SPECS</u>	<u>PRESENT</u>	<u>FORMER</u>
<u>OVERALL</u>		
EFFECTIVE F/D	0.4	-
EFFICIENCY	0.5	-
<u>REFLECTOR</u>		
EFFECTIVE DIA.	36.4"	-
SURFACE TOLERANCE	0.146" RMS	-
<u>FEED</u>		
10 DB BEAMWIDTH	135°	-
ELLIPTICITY	1 dB	-

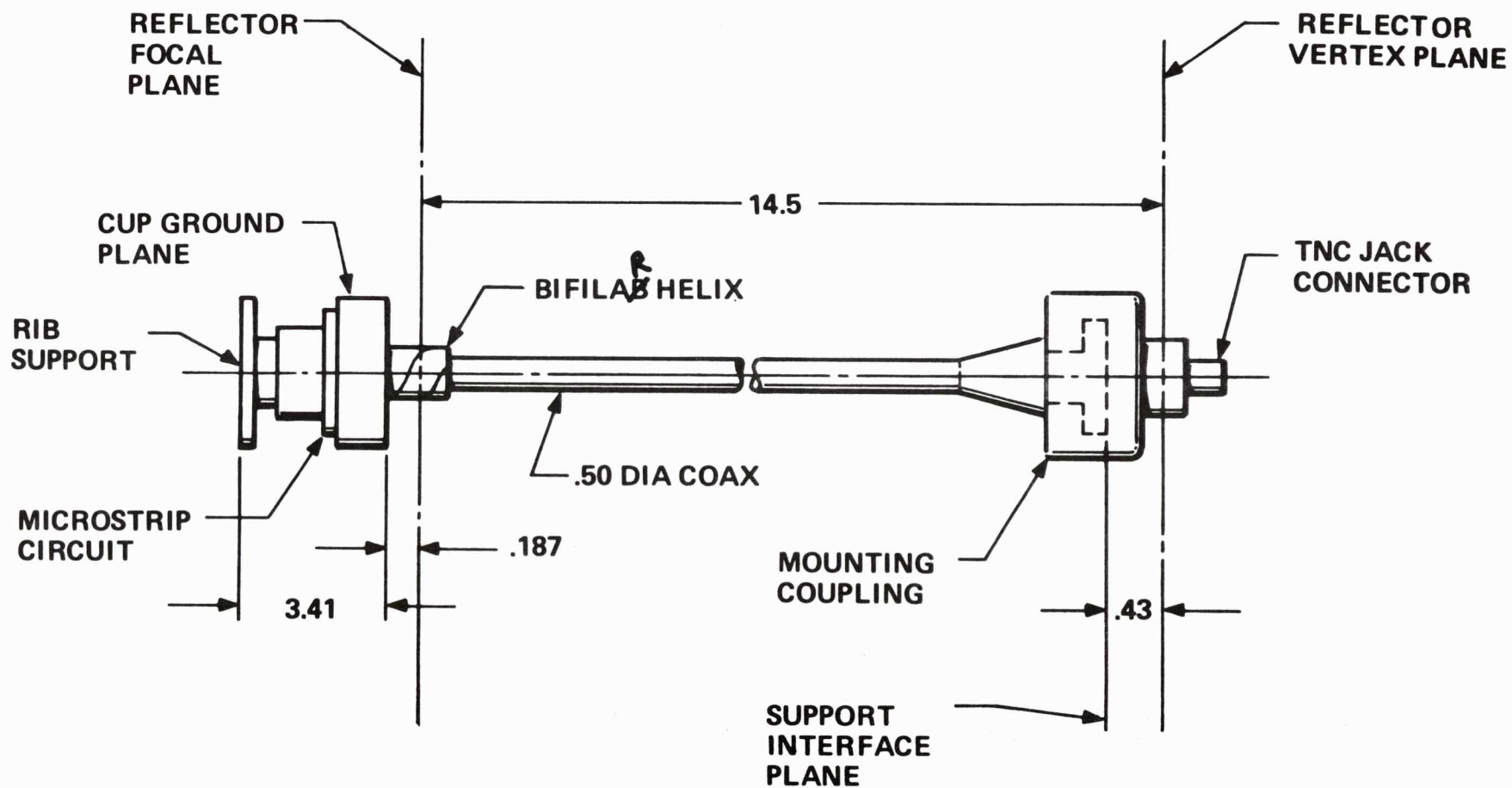


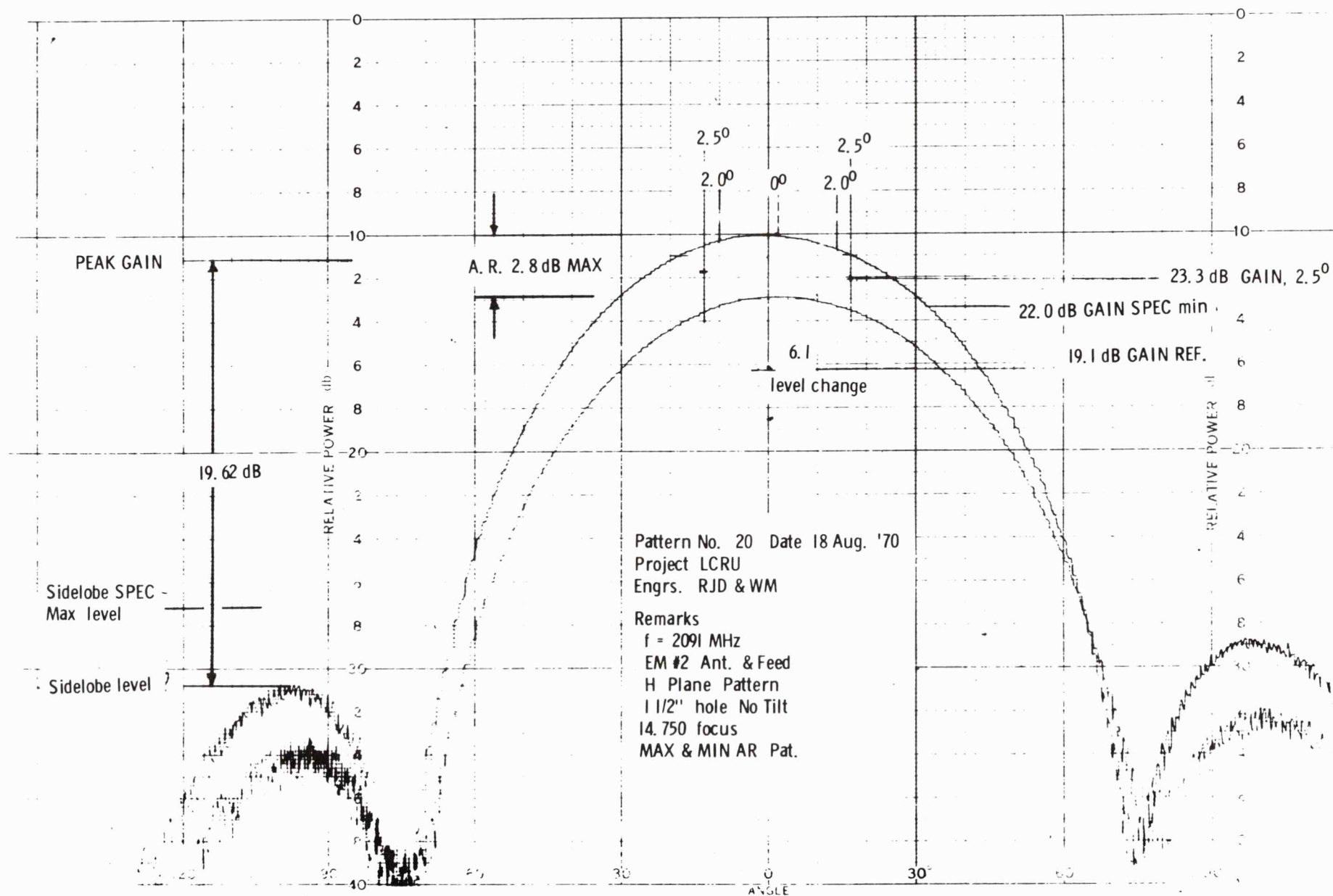
ANTENNA IN DEPLOYED CONFIGURATION

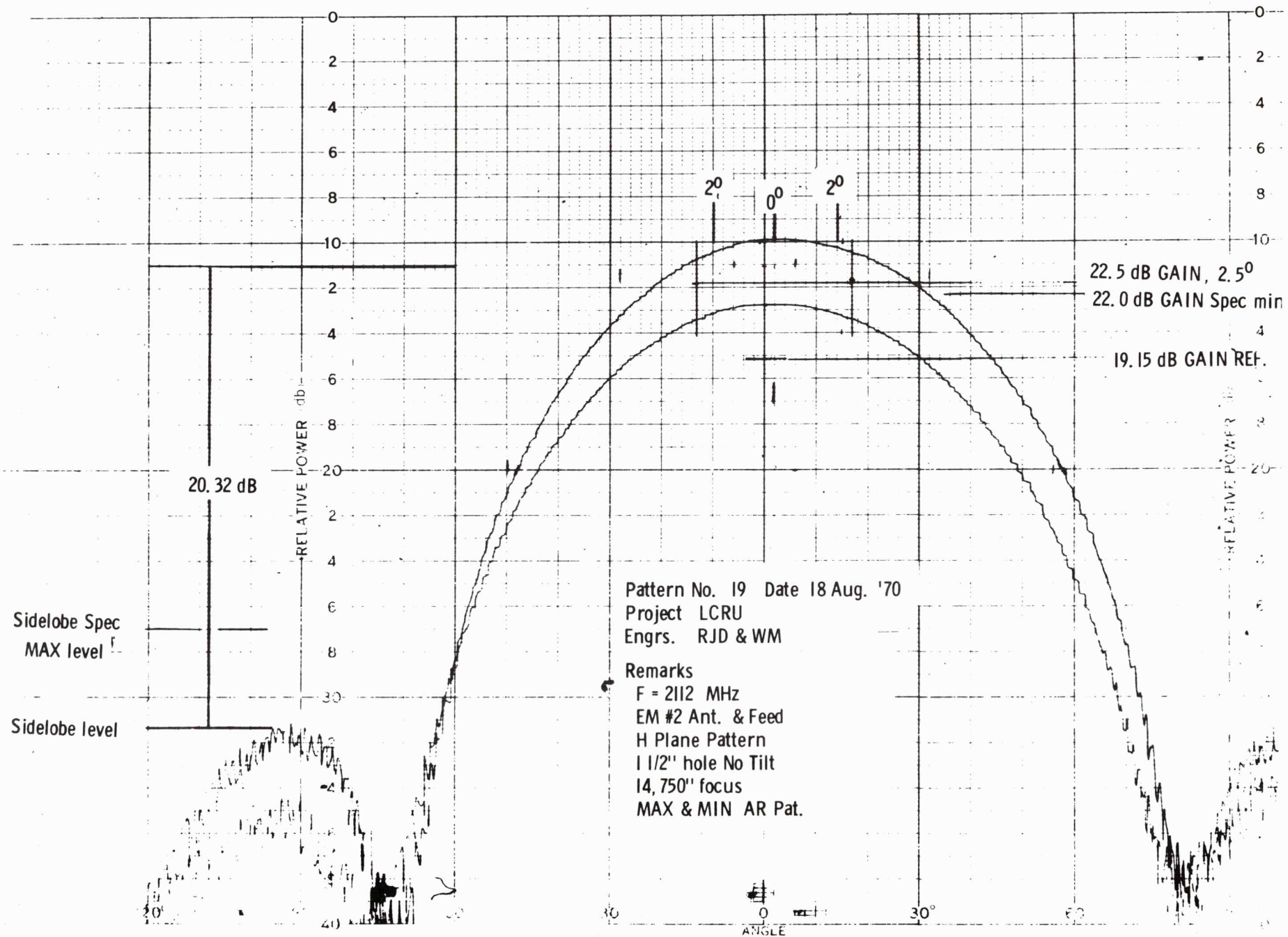


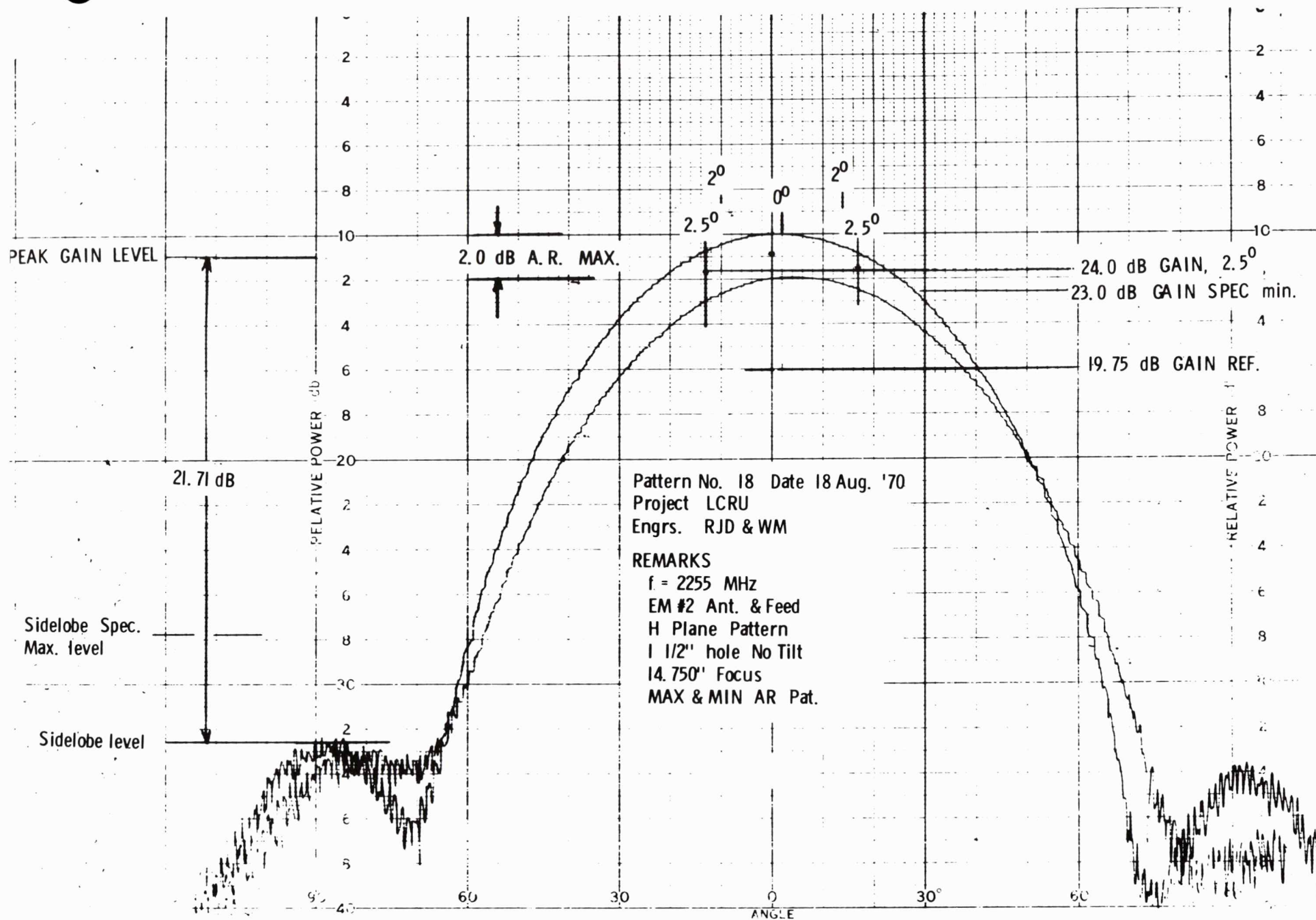


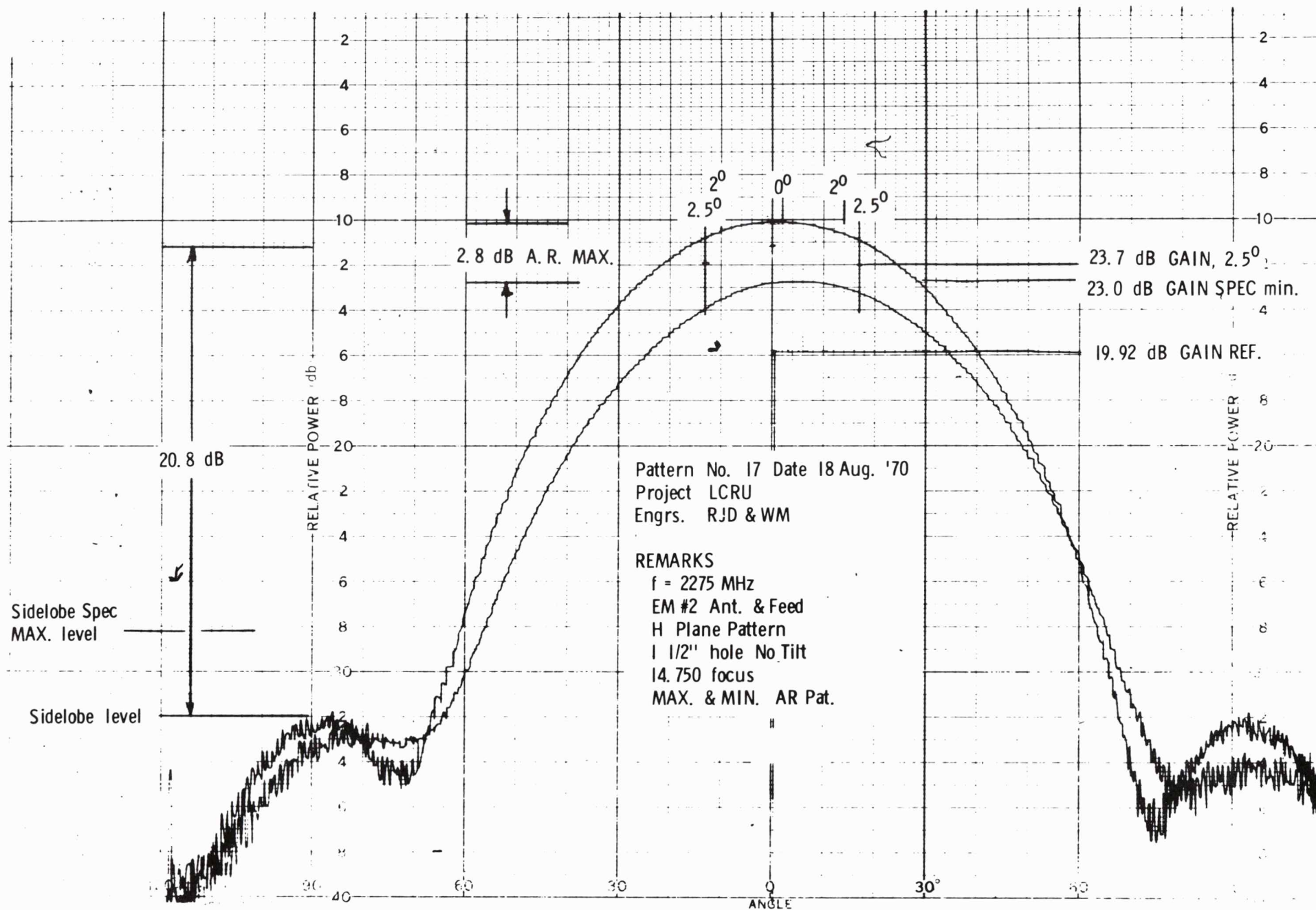
LCRU FEED ASSEMBLY

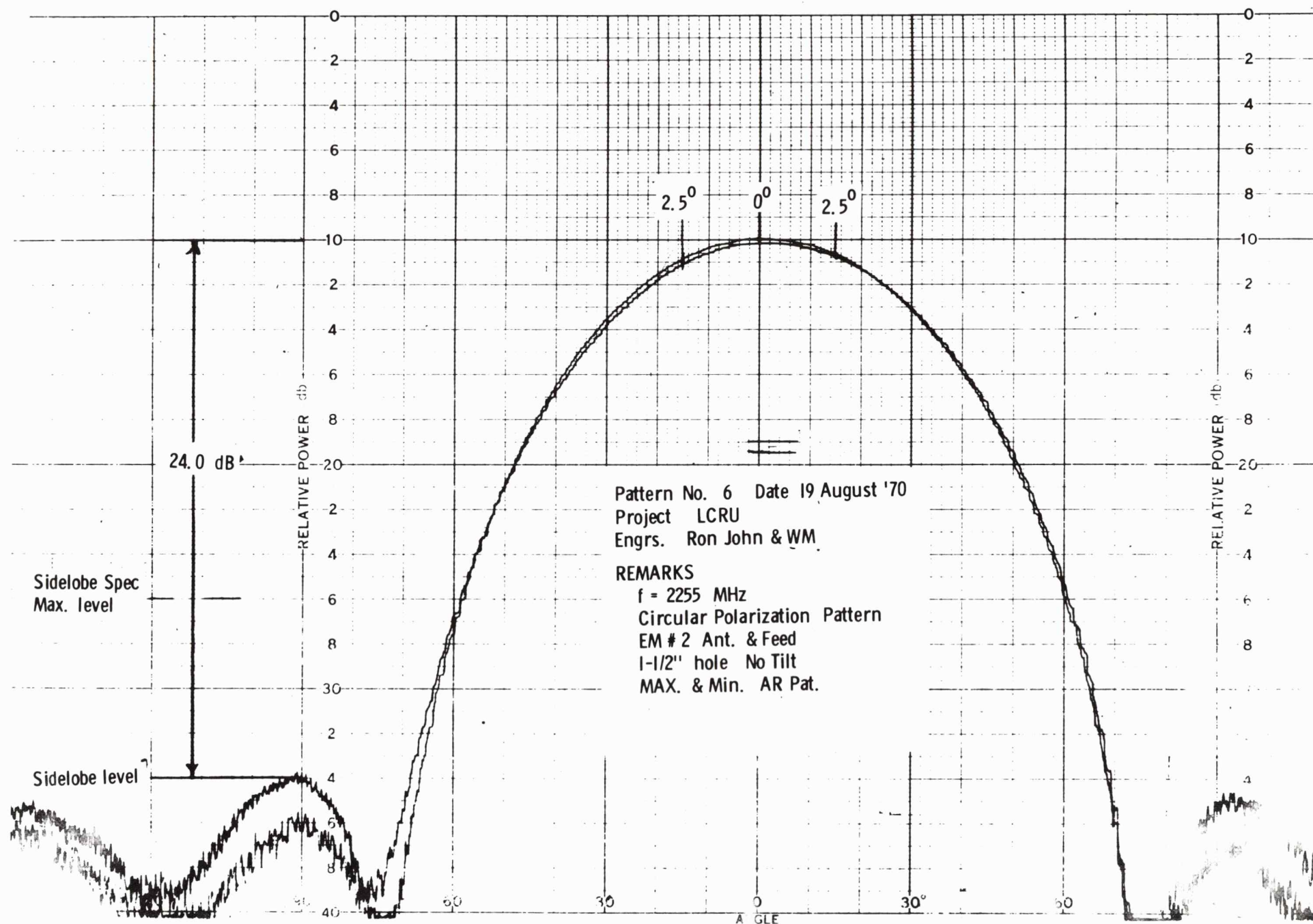


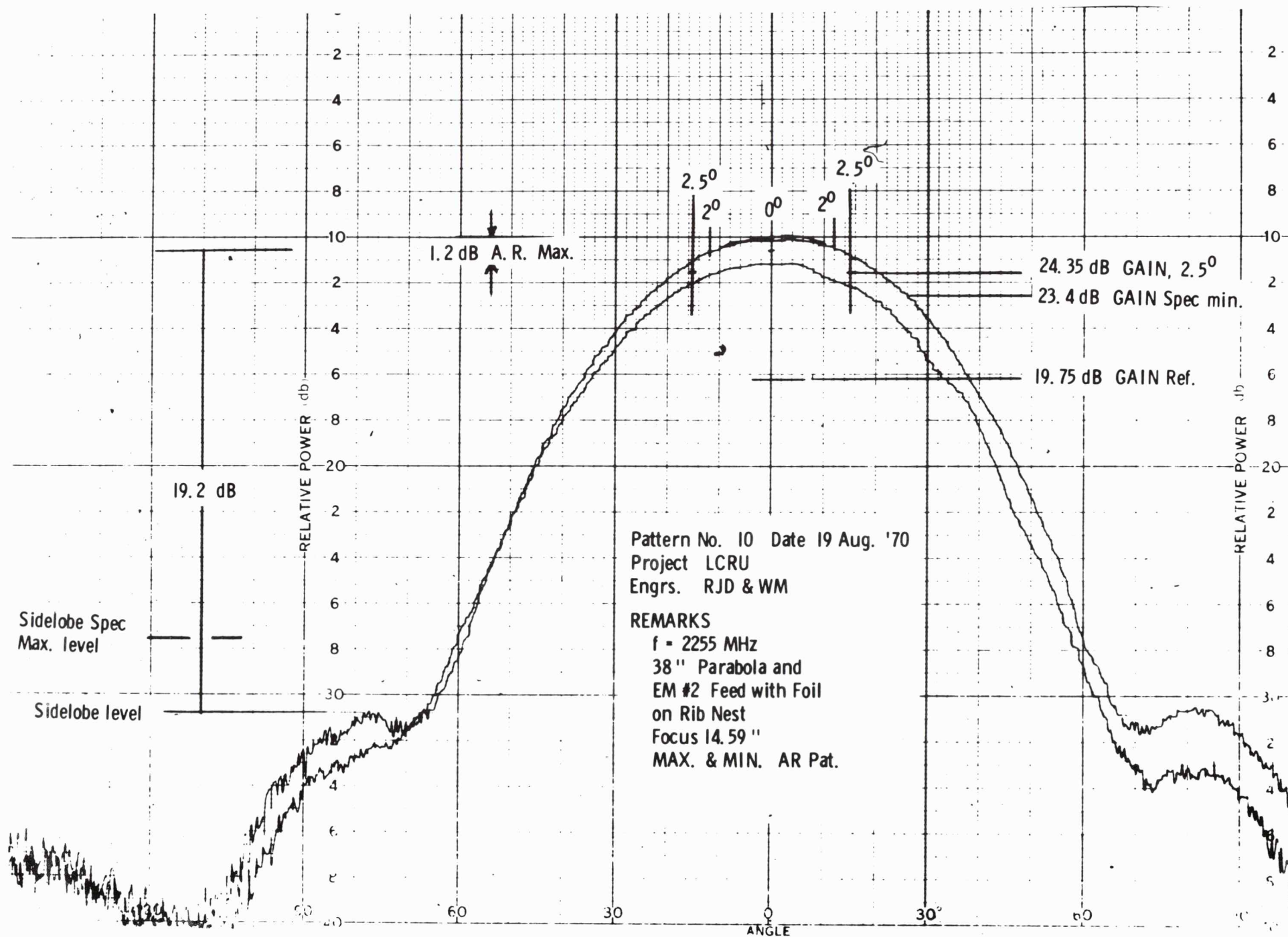














PRELIMINARY LCRU ANTENNA PERFORMANCE TABLE

	RECEIVE		TRANSMIT		REMARKS
FREQ MHz	2091	2112	2255	2275	
EM #2					
dB GAIN AT $\pm 2.5^0$	23.3	22.5	24.0	23.7	FIGURE 4-3-1-1 TO 4-3-1-4
PROPOSED SPEC	22	22	23	23	
dB AR, $\pm 2.5^0$ BAND	2.8	2.8	2.0	2.8	FIGURE 4-3-1-1 TO 4-3-1-4
PROPOSED SPEC	5.0	5.0	3.0	3.0	
dB SIDELobe LEVEL	22	23	24	22	FIGURE 4-3-2-1 TO 4-3-2-4
PROPOSED SPEC	16	16	16	16	
VSWR	TBM*	TBM*	1.1	1.1	BREADBOARD MATCH
PROPOSED SPEC	1.5	1.5	1.2	1.2	
BORESIGHT	FM**	FM**	FM**	FM**	SIGHT TO BE MOUNTED
PROPOSED SPEC	$\pm 0.8^0$	$\pm 0.8^0$	$\pm 0.8^0$	$\pm 0.8^0$	

* TO BE MATCHED

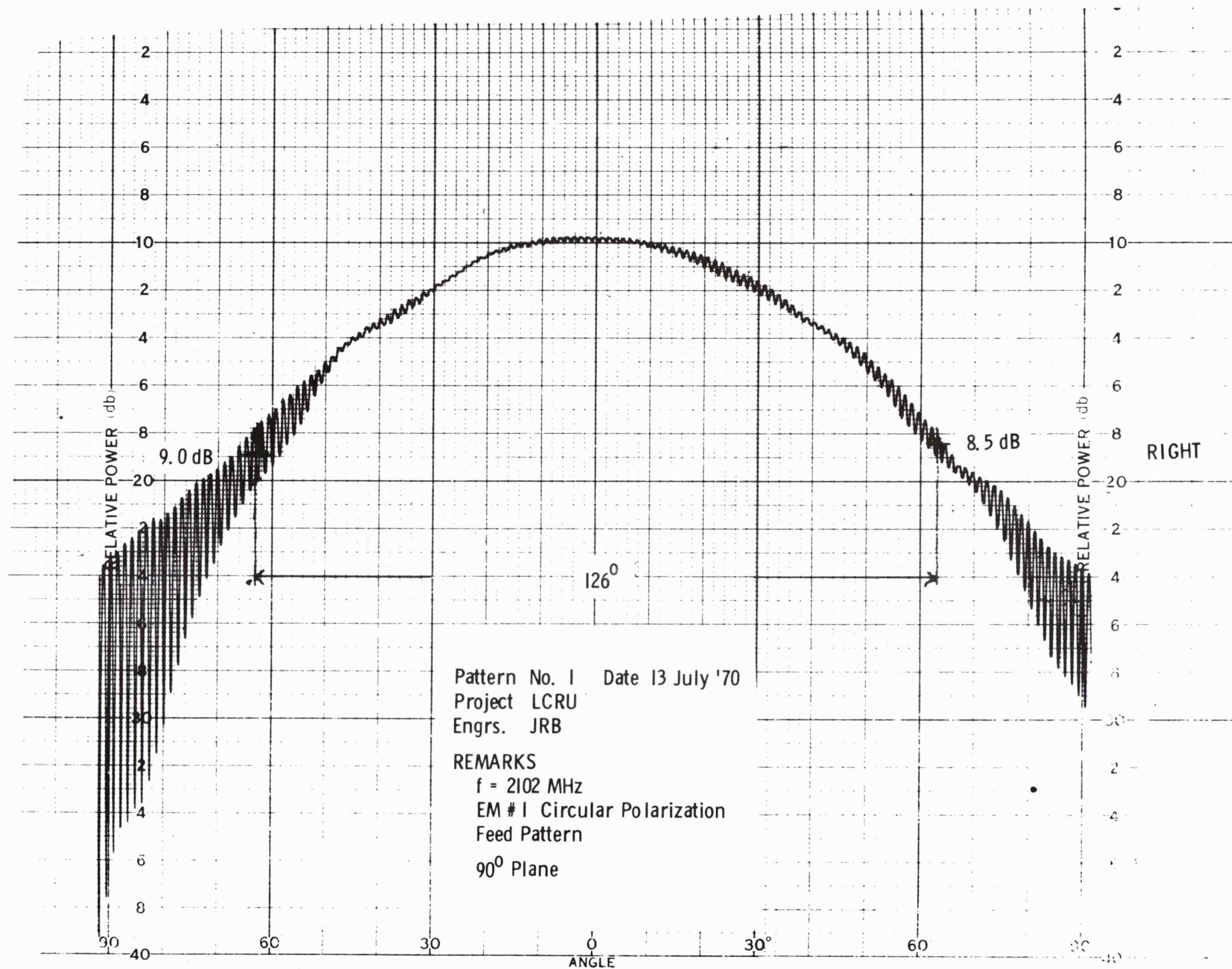
** FUTURE MEASUREMENT

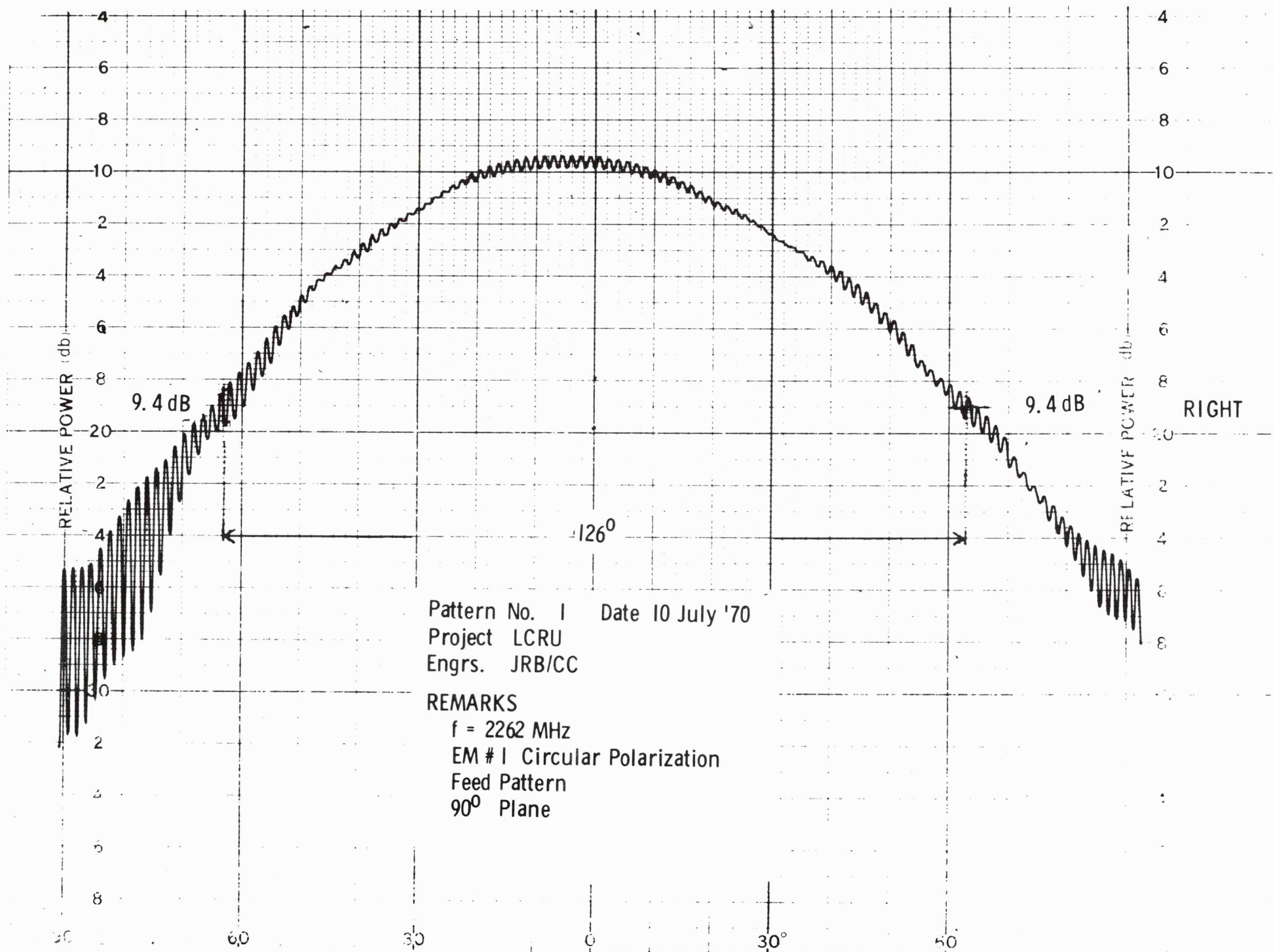


LCRU
HIGH GAIN ANTENNA

POLARIZATION ELLIPTICITY		COUPLING LOSS	
GROUND STATION	FIELD STATION	MAX. DB	MIN. DB
DB	DB		
2	1	0.13	0.01
2	2	0.11	0.00
2	3	Δ DB	0.02
2	4		0.05
2	5		0.10
2	6		0.20
2	7		0.30

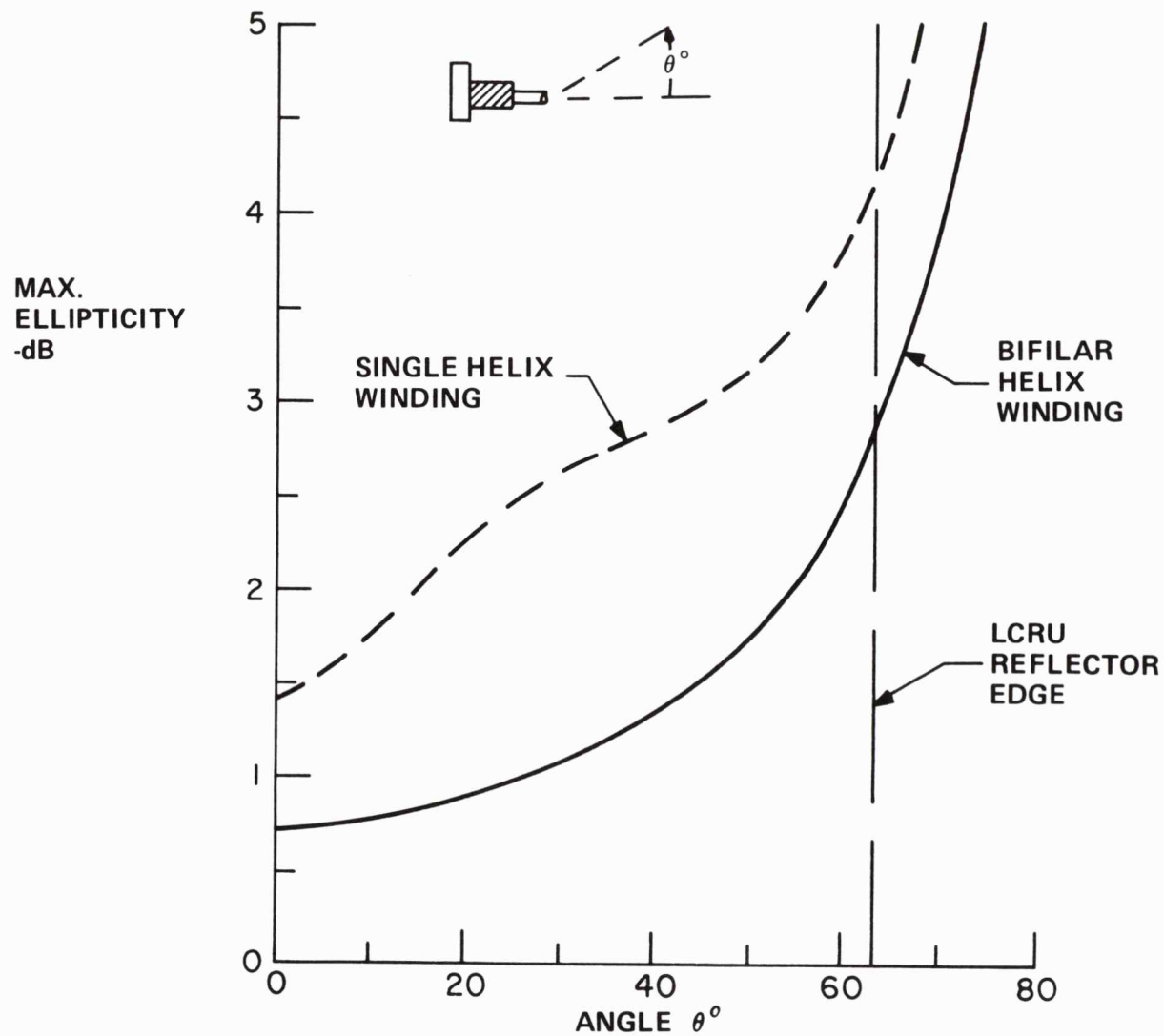
ANTENNA GAIN FROM 2.5° BEAMWIDTH TO
2.2° BEAMWIDTH = 0.2 DB.







LCRU PRIMARY FEED ELLIPTICITY





AXIAL RATIO PROBLEM

		FAR-FIELD MAGNITUDE	RELATIVE PHASE CHANGE
PRIMARY FEED BACKLOBE			0 0
PRIMARY FEED RADIATION			
FIRST PARABOLA REFLECTION			2d 2d
PRIMARY FEED RE-RADIATION			
SECOND PARABOLA REFLECTION			4d 4d

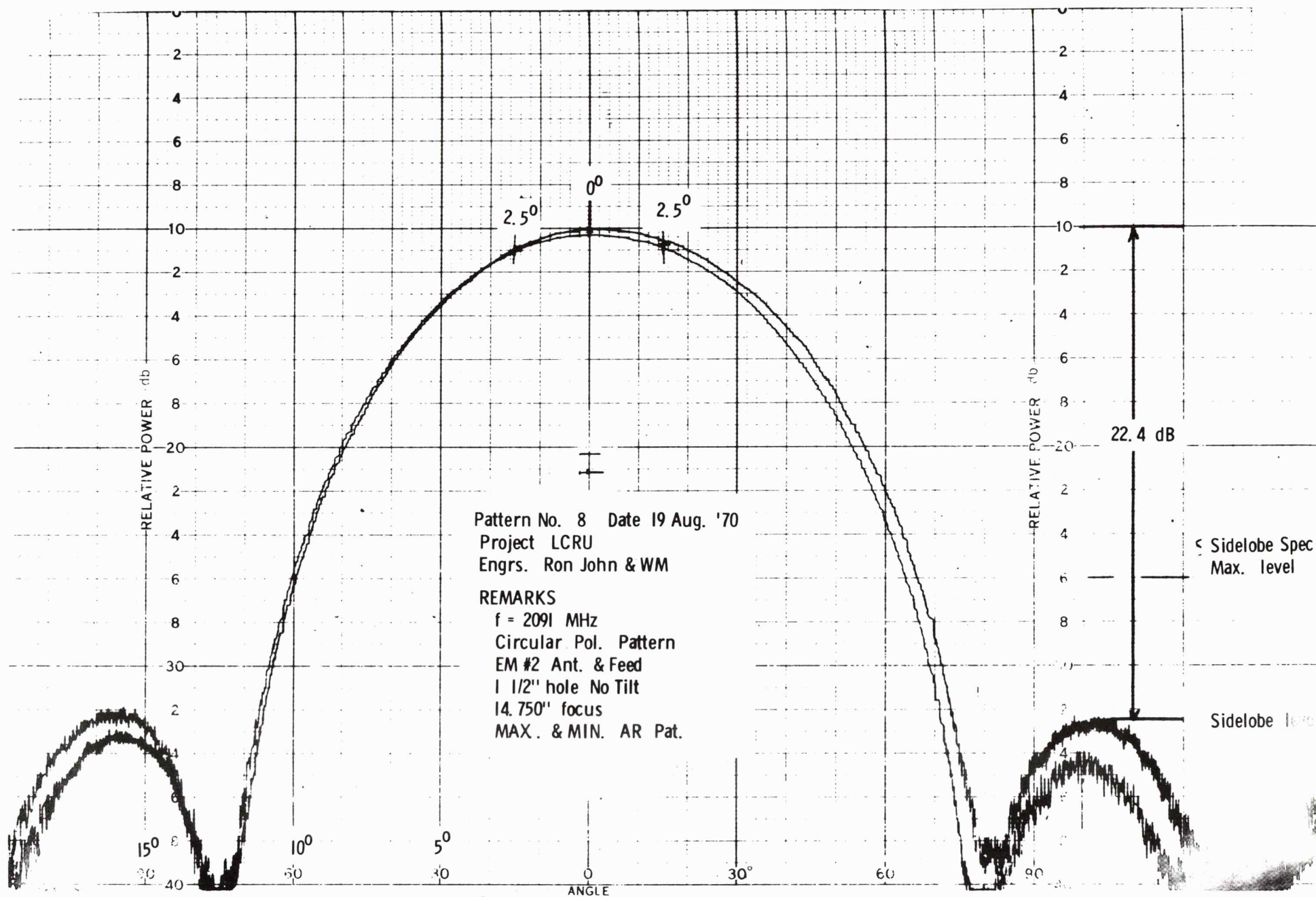


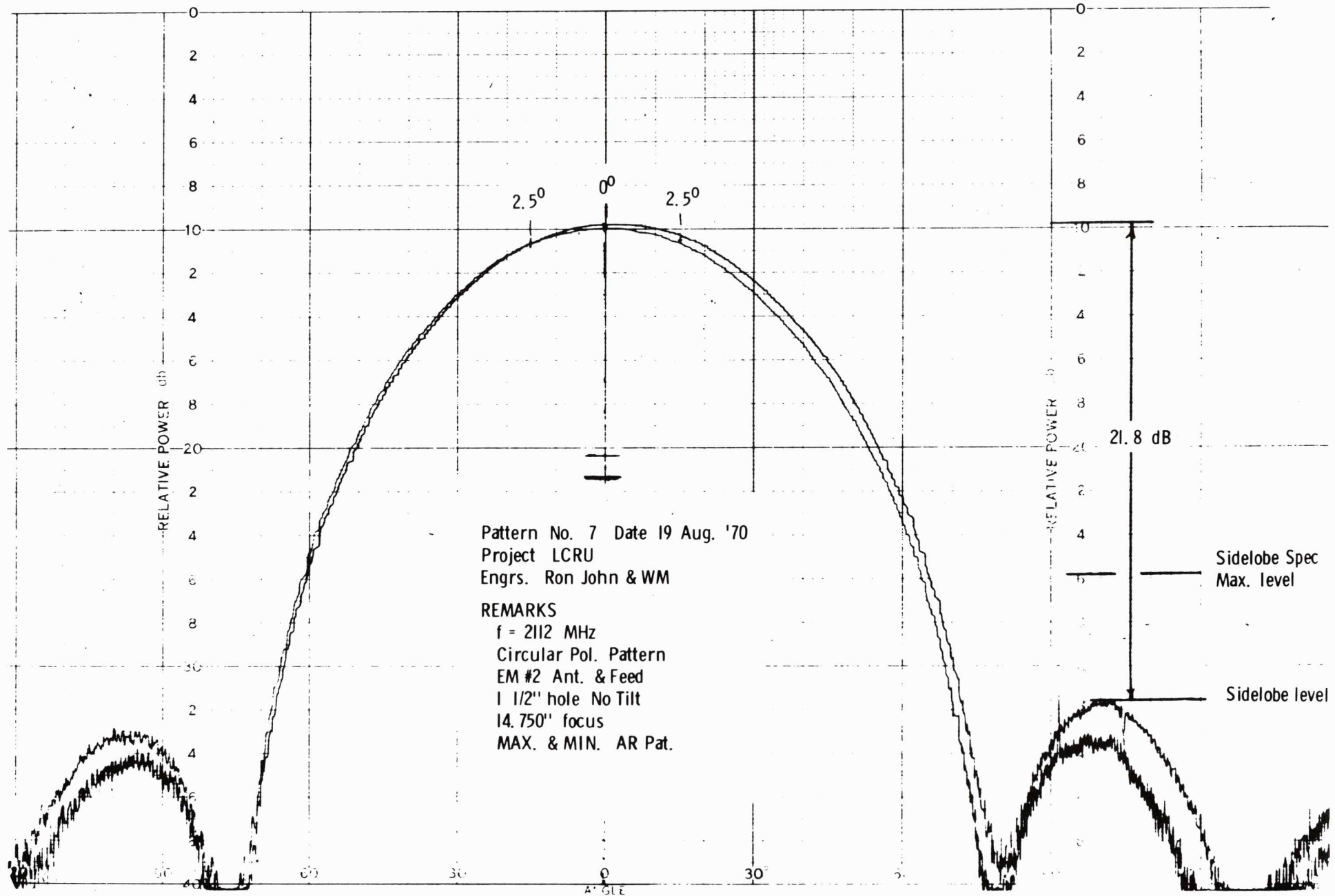
EXPERIMENTS TO SOLVE A.R. PROBLEM

- VERTEX HOLE SIZE
- GEOMETRY OF VERTEX REGION
- RADIAL WIRE REFLECTOR AT VERTEX REGION
- DIPOLE COMPENSATOR
- MODIFYING HELIX PITCH
- CHANGING CUP REFLECTOR SIZE
- REFLECTOR BEHIND PRIMARY FEED
- CHANGING DISTANCE OF FEED FROM VERTEX

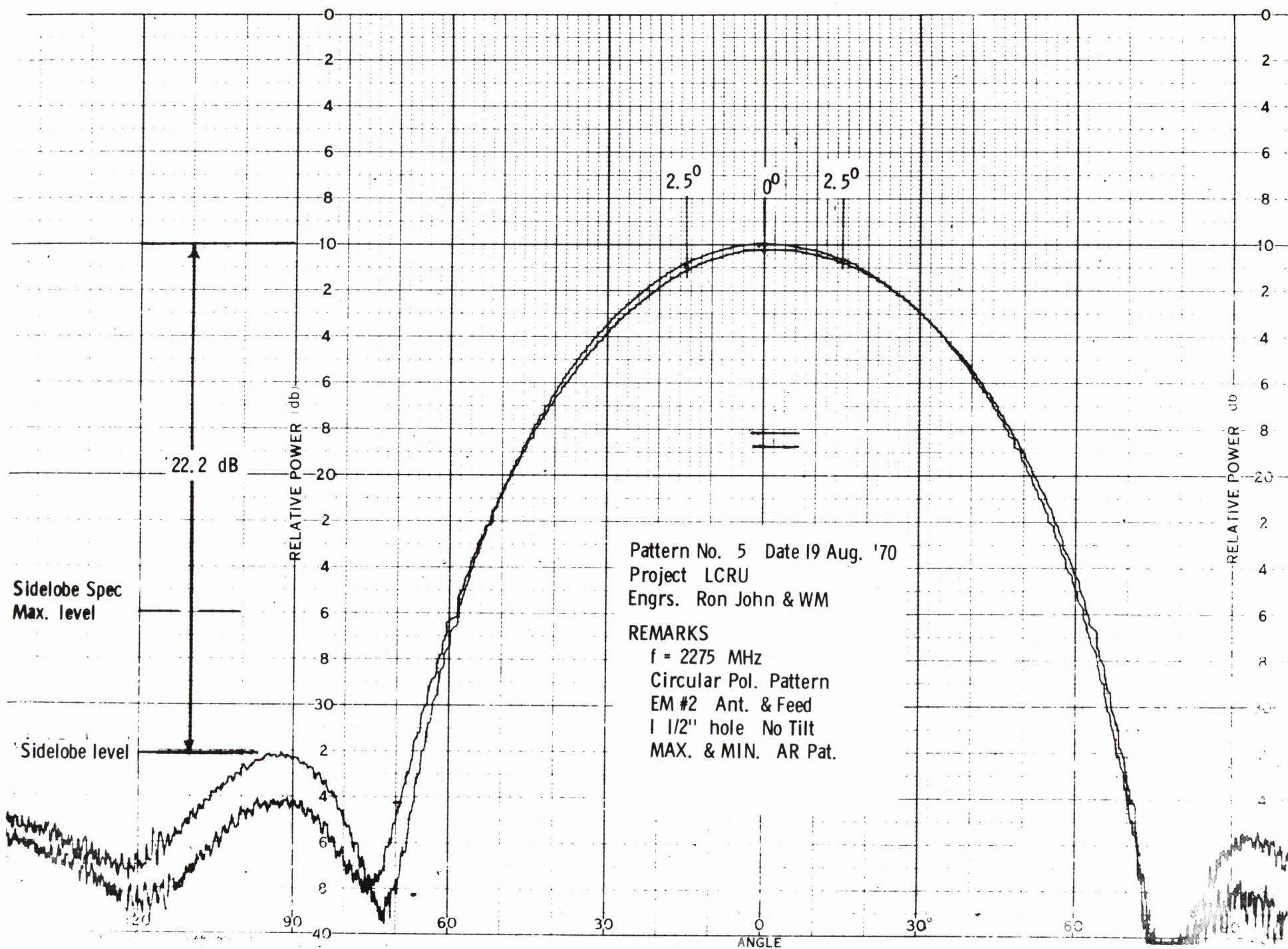
FINAL DESIGN

- FILLING VERTEX HOLE WITH MESH HAVING PARABOLIC CONTOUR
- OPTIMUM FEED LOCATION
- REFLECTOR BEHIND FEED

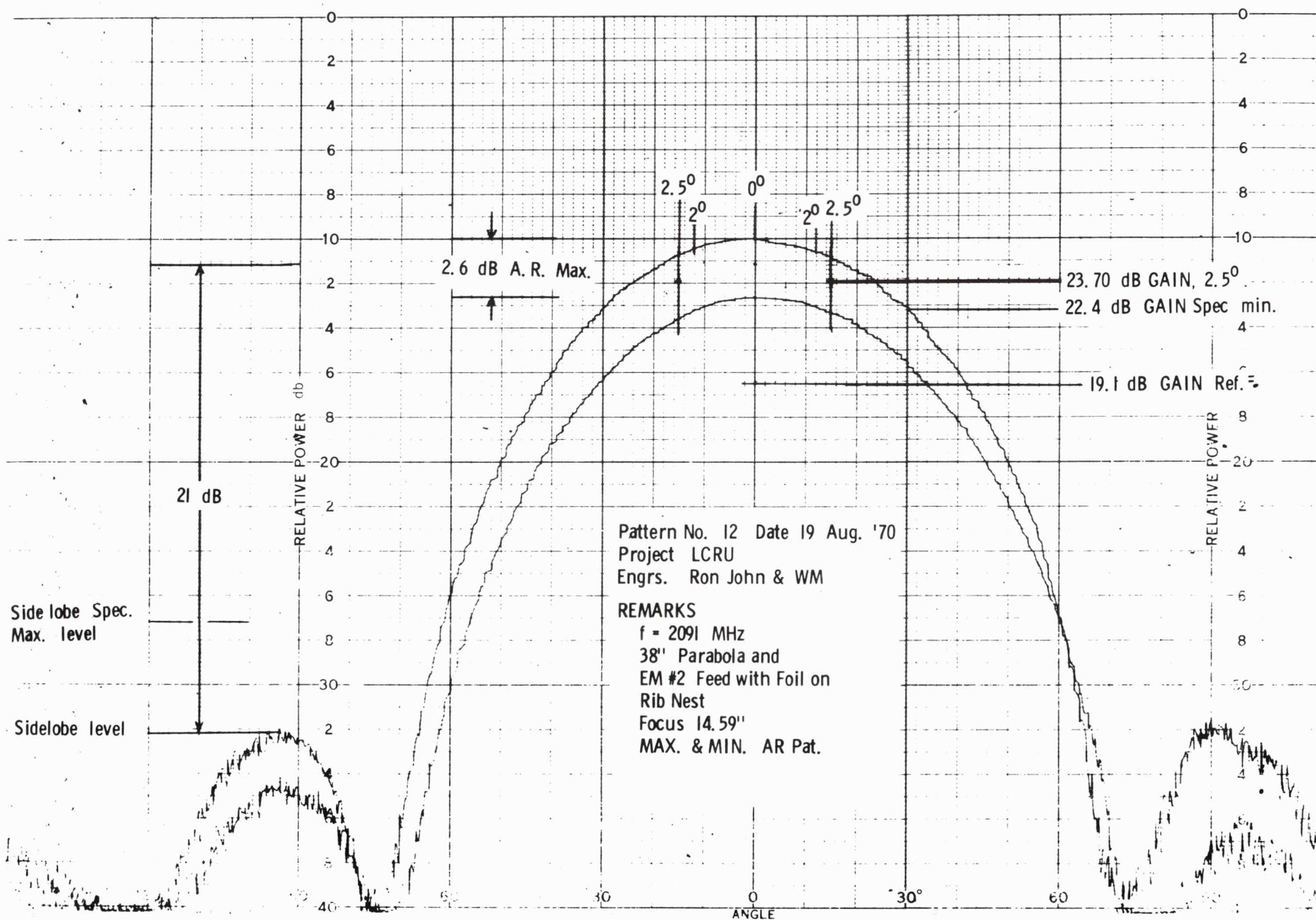




7-170

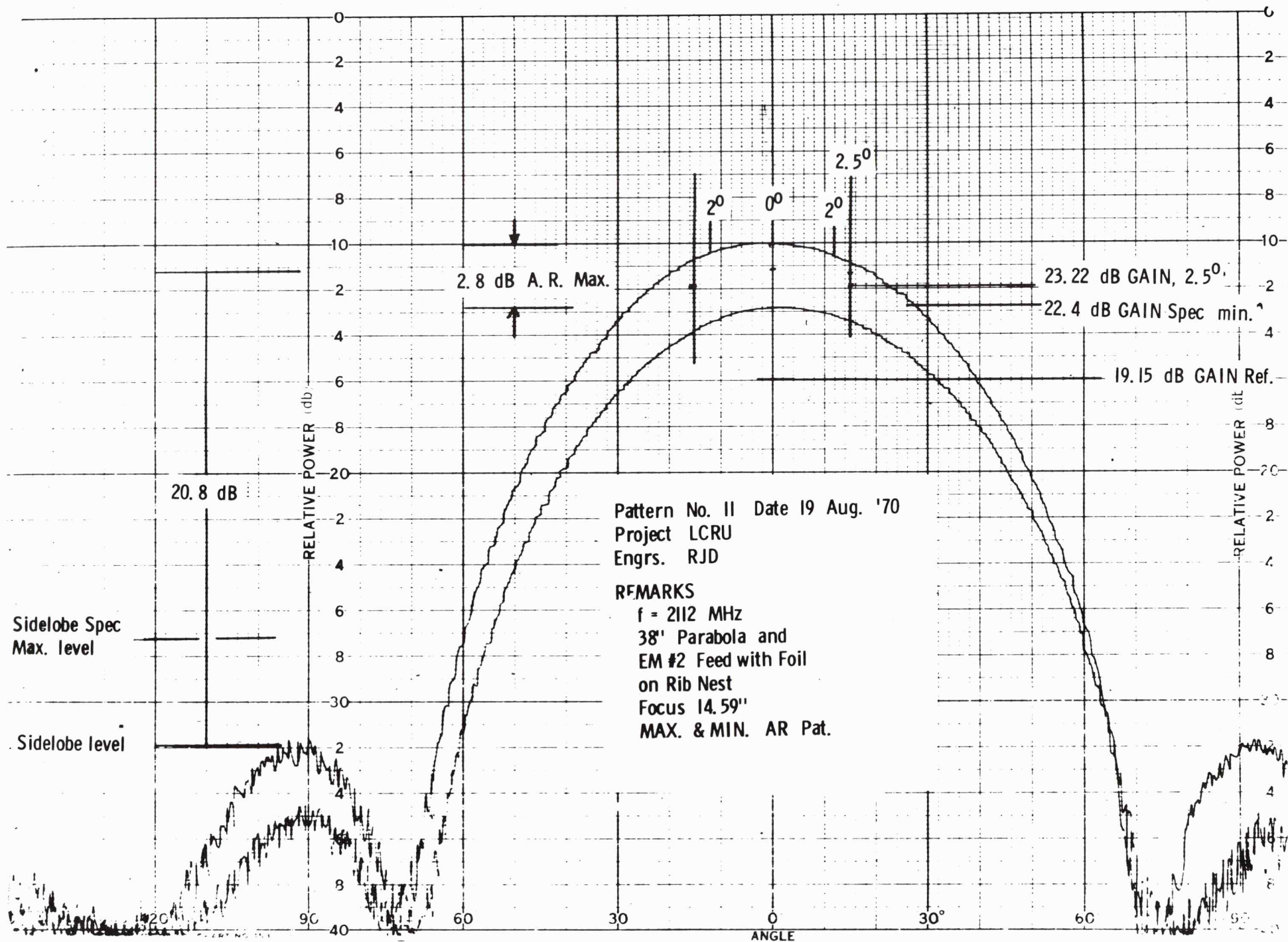


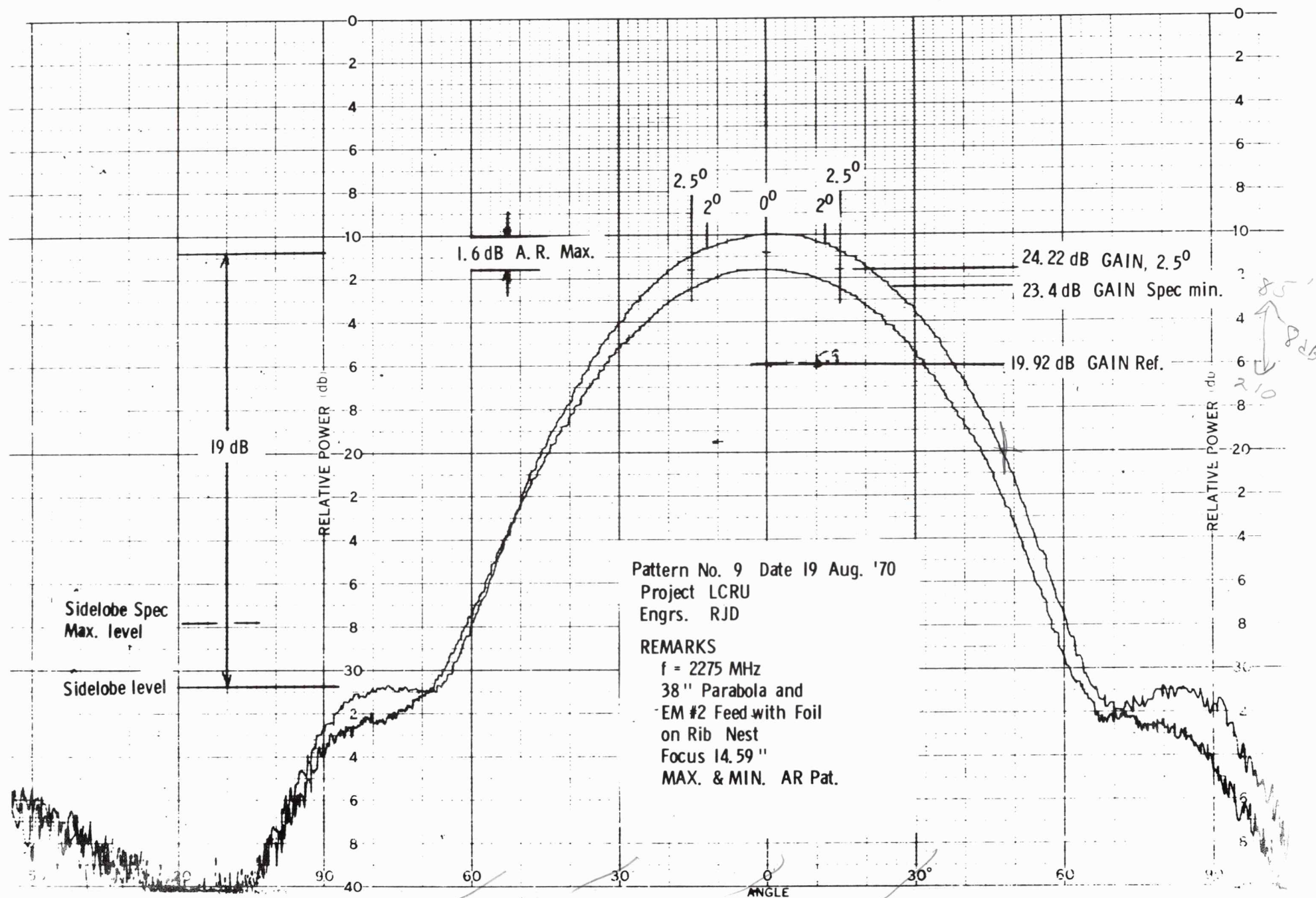
7-171



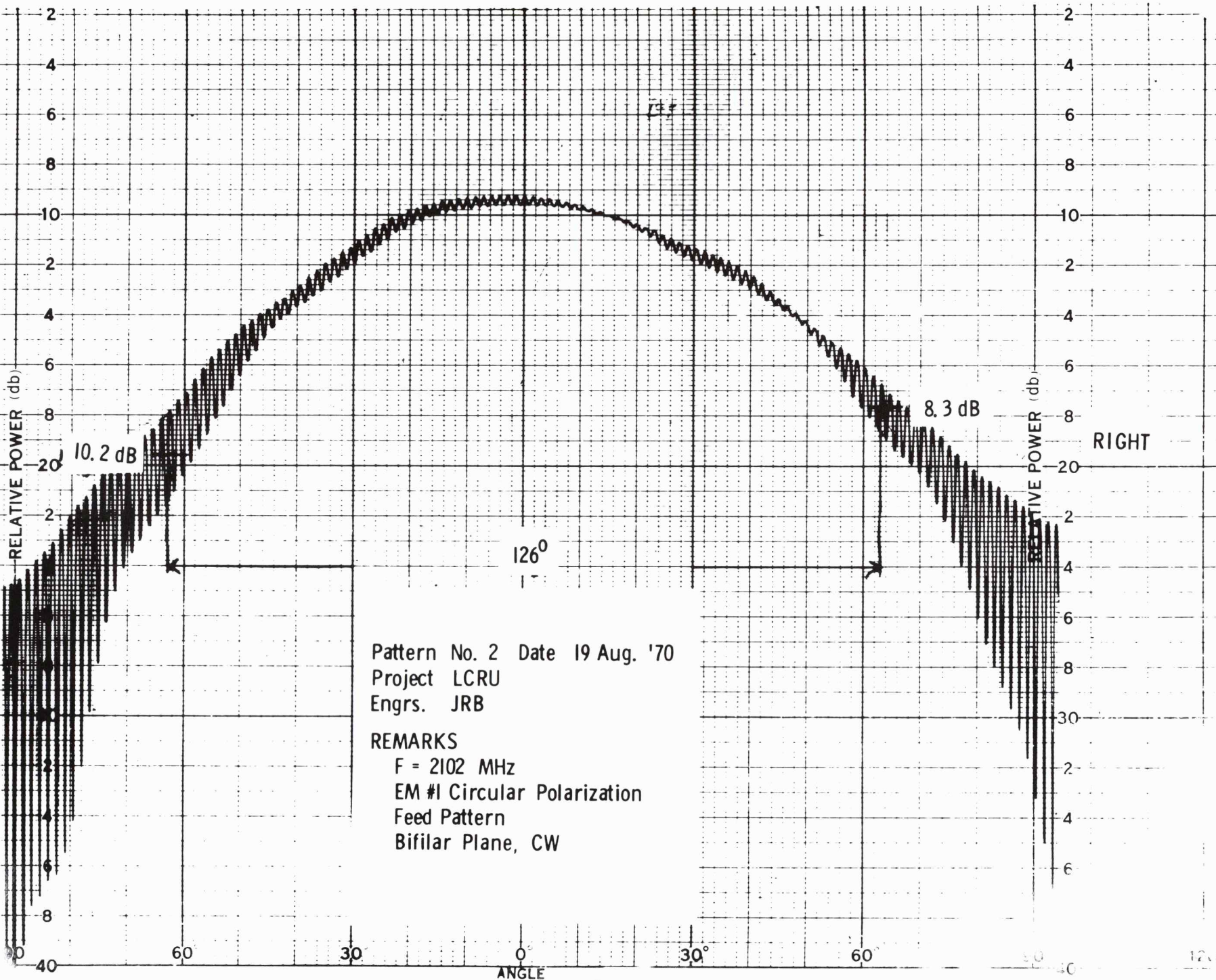
Pattern No. 12 Date 19 Aug. '70
Project LCRU
Engrs. Ron John & WM

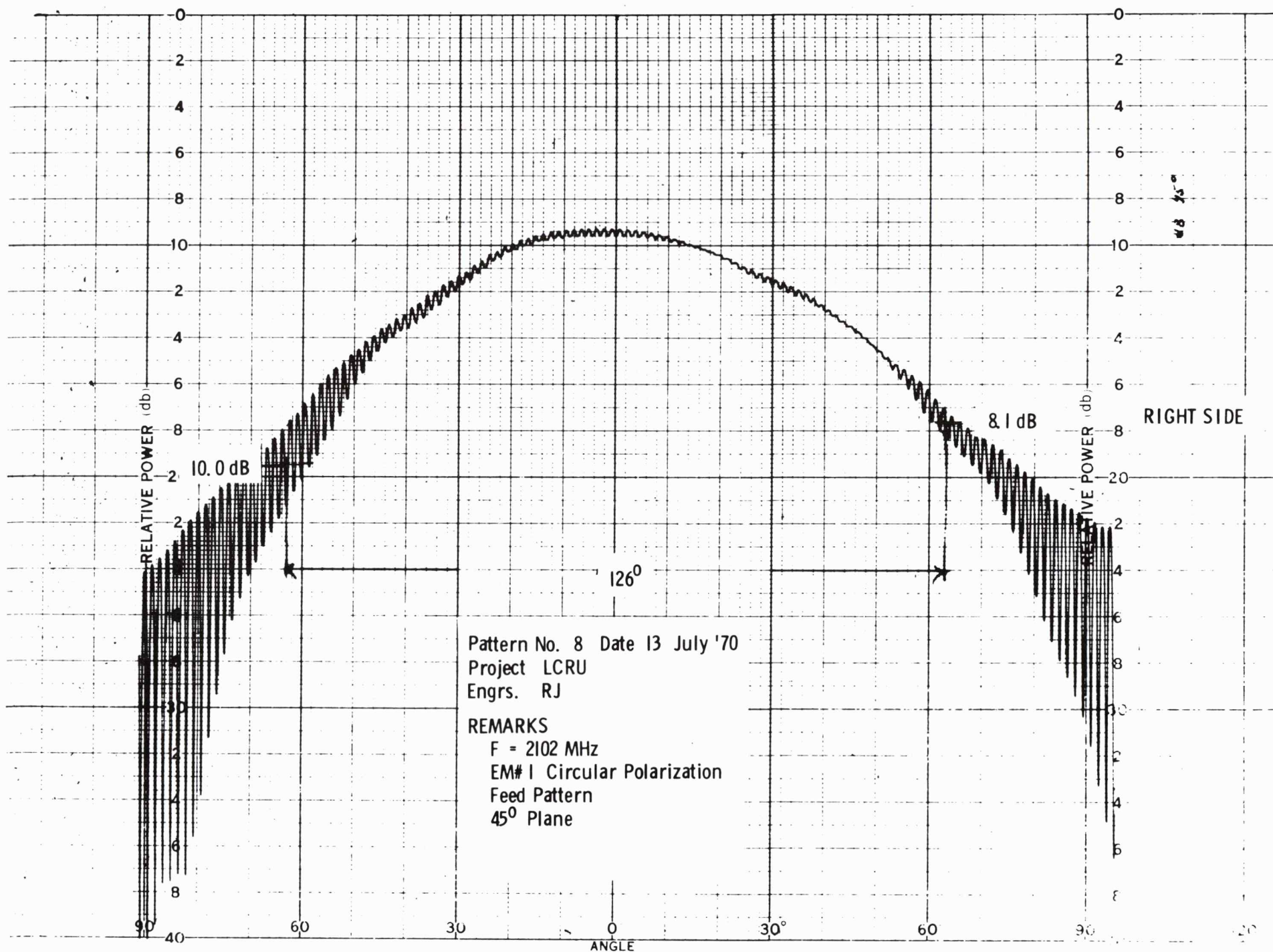
REMARKS
f = 2091 MHz
38" Parabola and
EM #2 Feed with Foil on
Rib Nest
Focus 14.59"
MAX. & MIN. AR Pat.

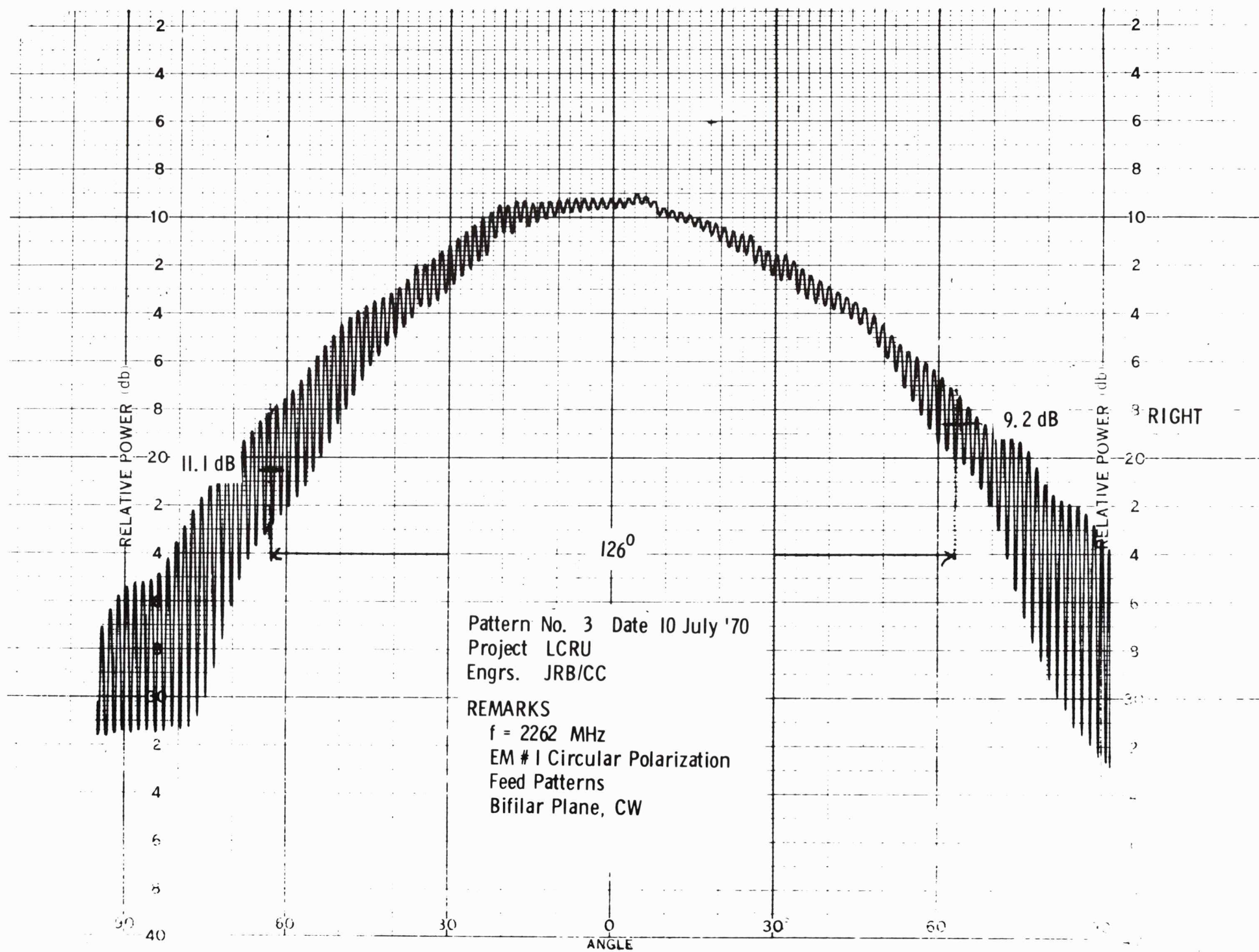




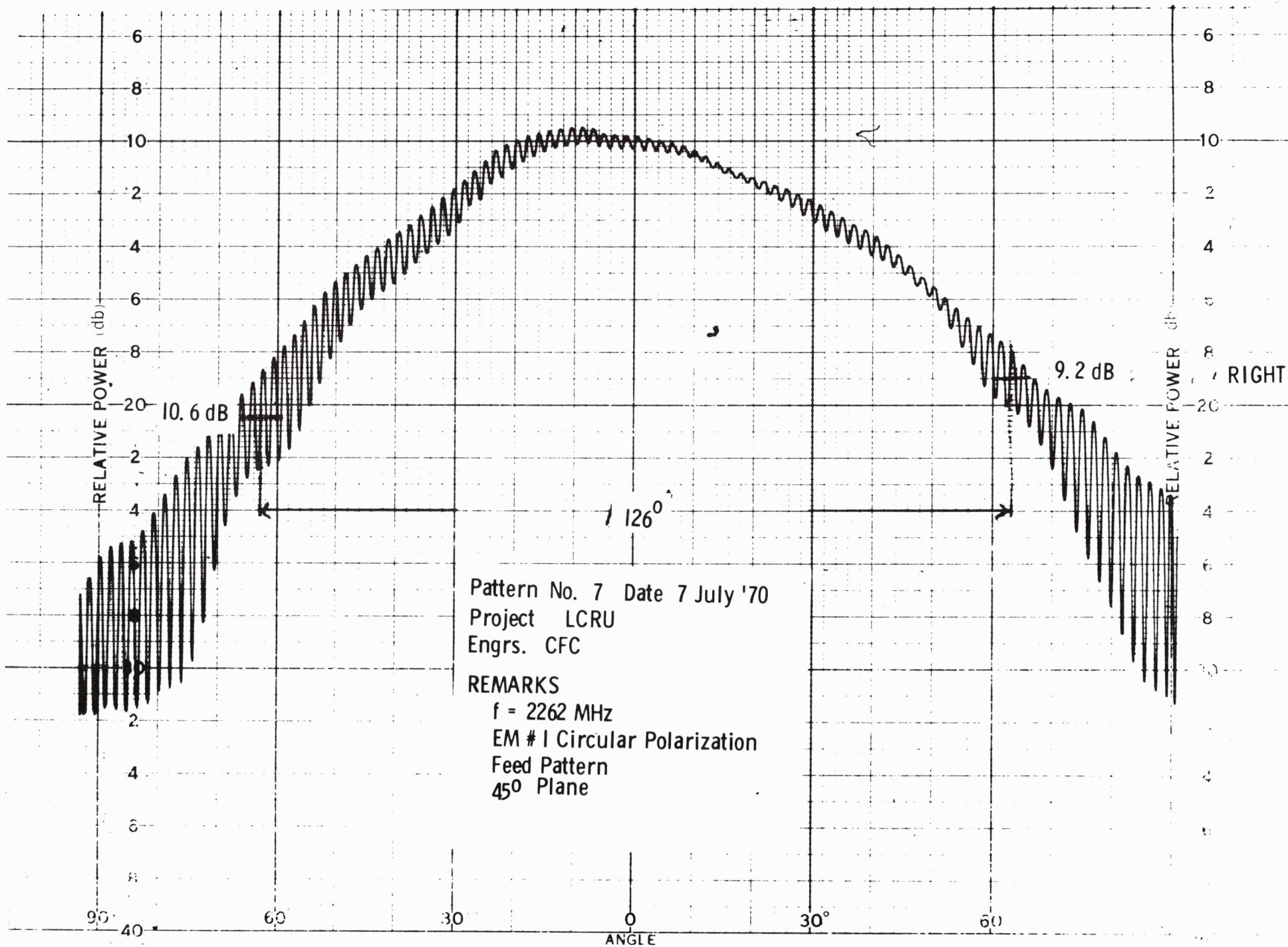
7-171





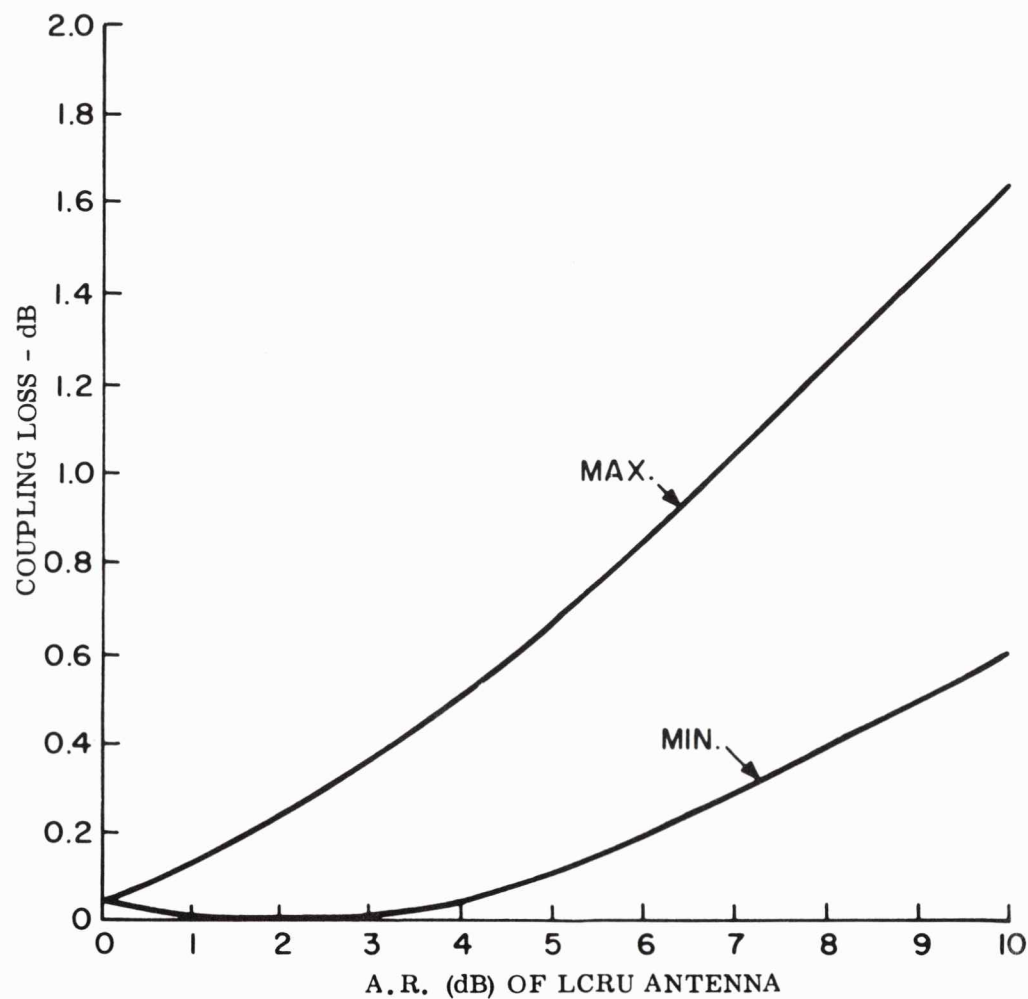


7-177





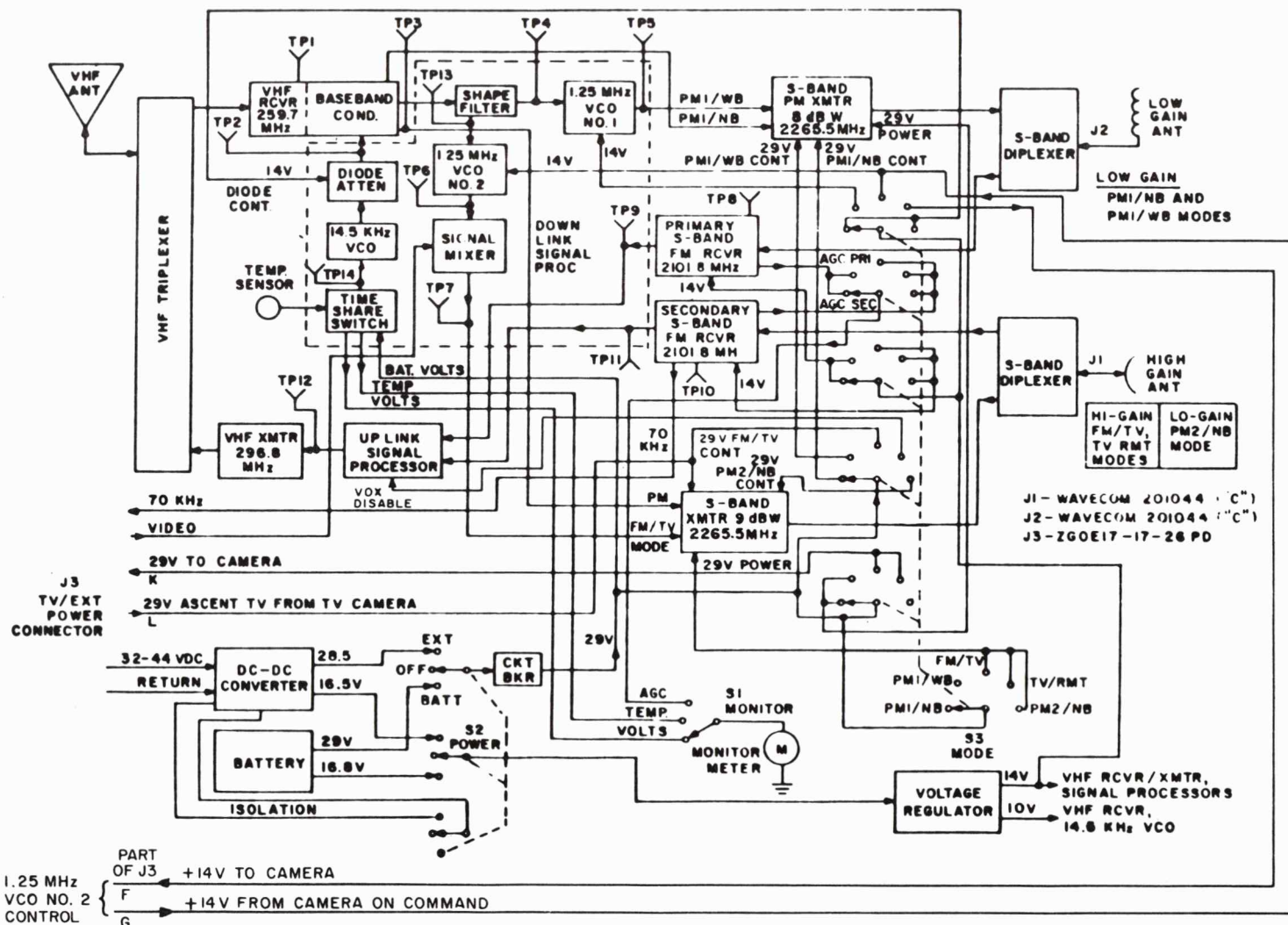
LCRU HIGH GAIN ANTENNA



POLARIZATION COUPLING LOSS
FOR 2 DB A.R. AT
EARTH ANTENNA

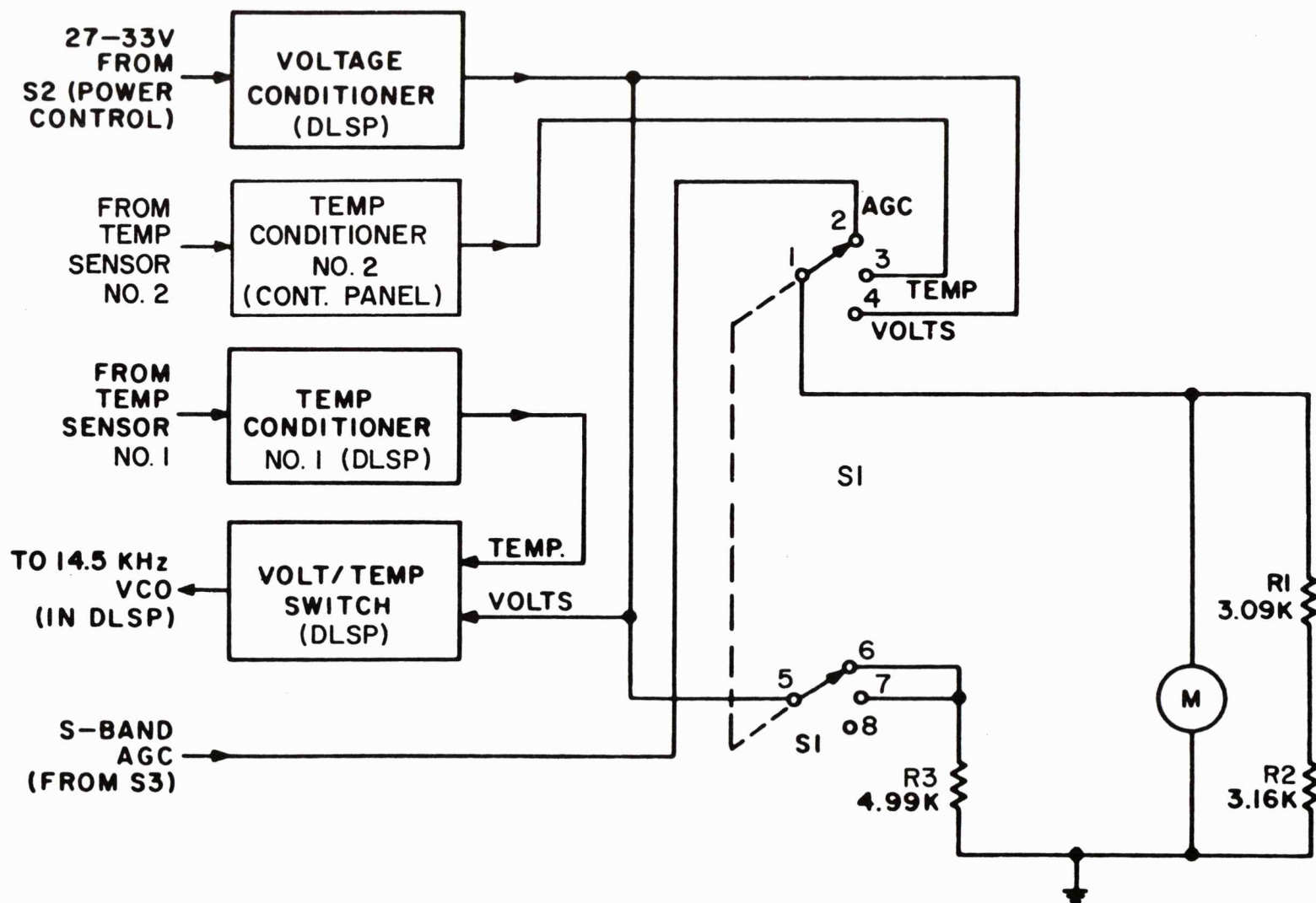


LCRU BLOCK DIAGRAM



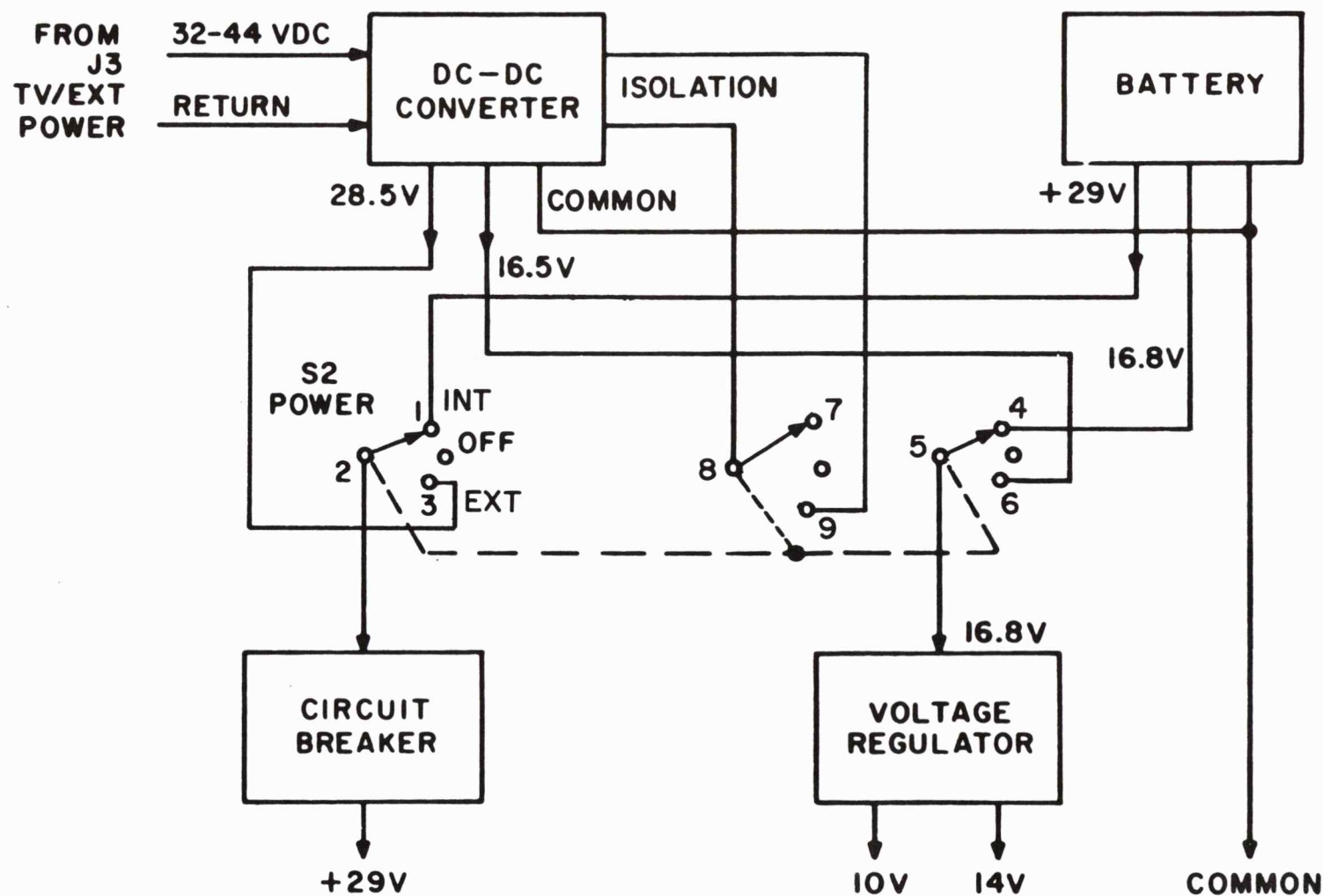


MONITOR SWITCHING



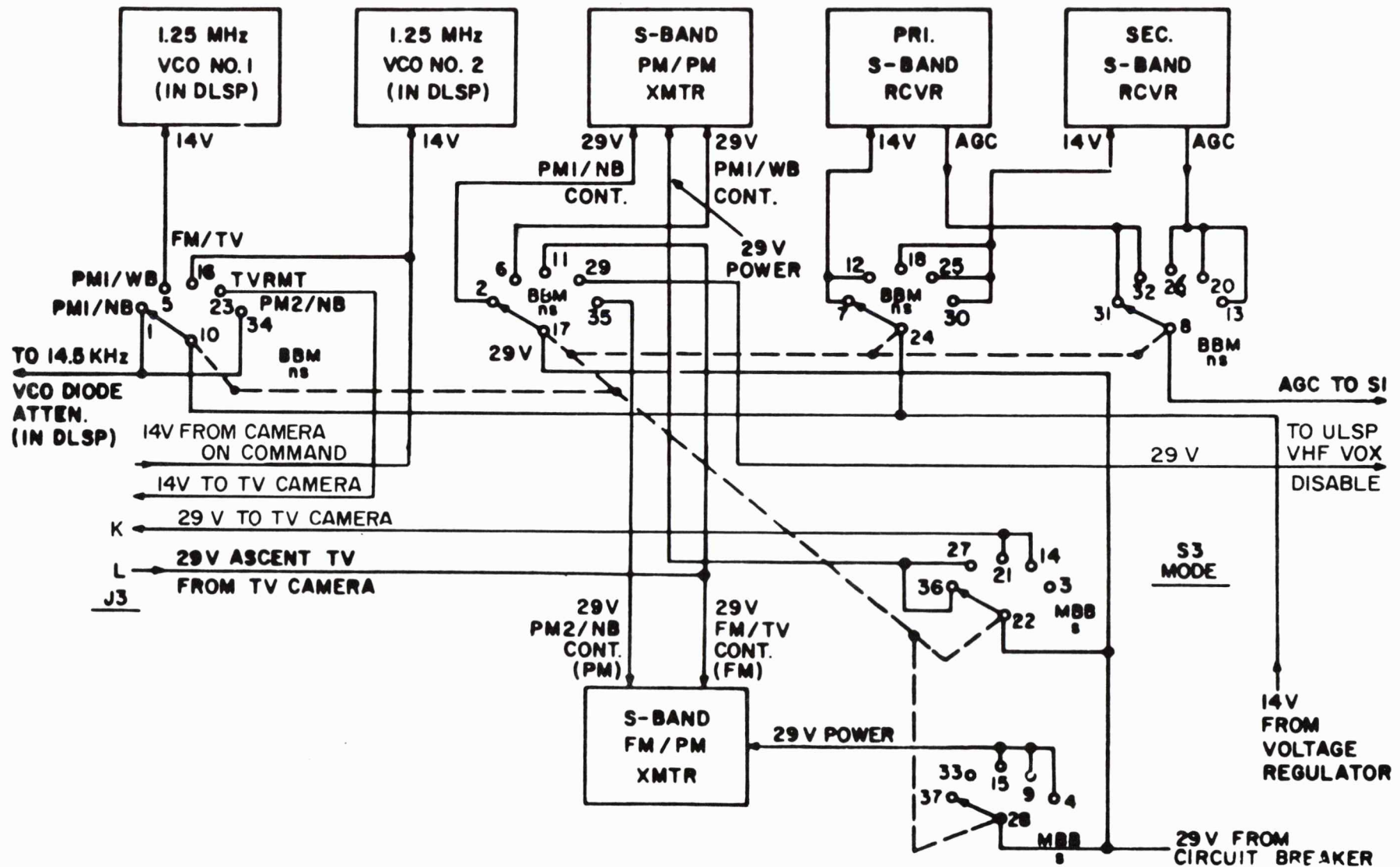


LCRU POWER SWITCHING





MODE SWITCHING



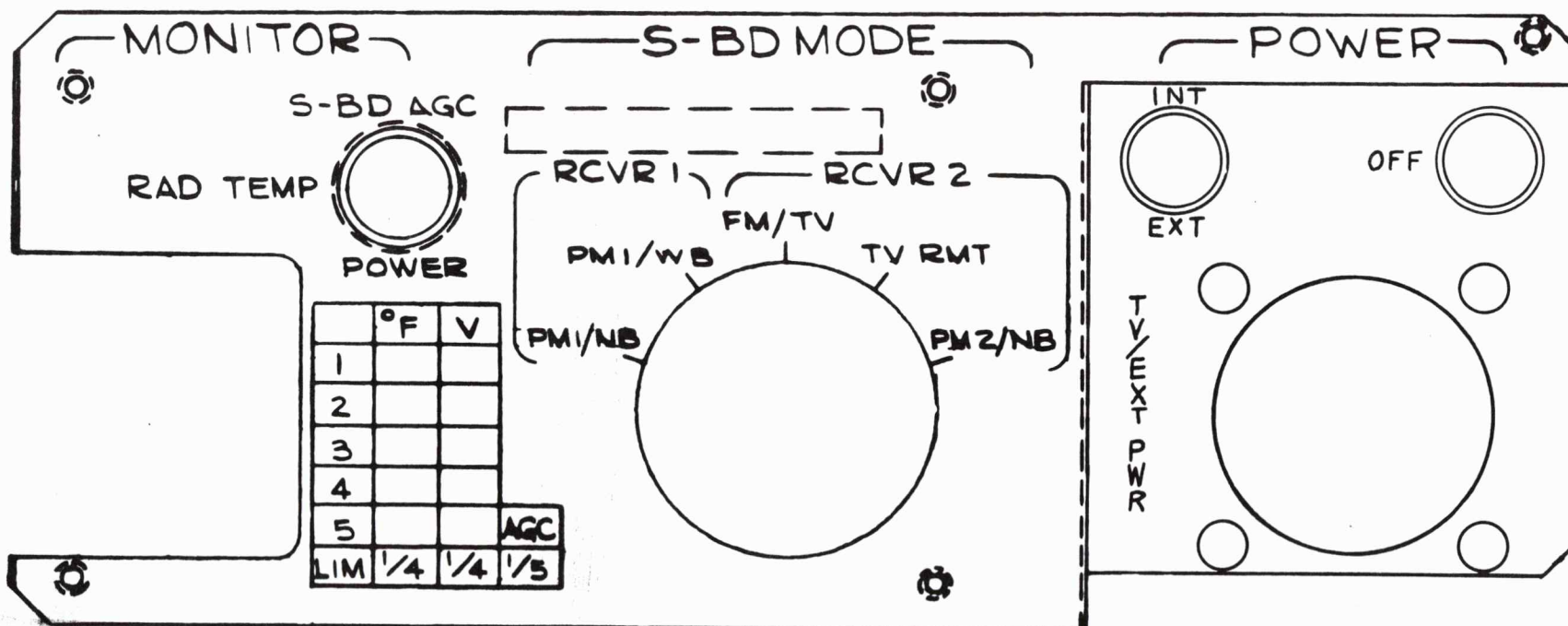


INTEGRATION TECHNIQUES

- 1 - EMI FILTERS IN SUBASSEMBLIES AND ZG FILTER BOX.
- 2 - SHIELDED WIRE AND COAX CABLE.
 - A - AUDIO AND RF
 - B - TEMPERATURE AND VOLTAGE OUTPUTS TO METER (IN PRESSURIZED COMPARTMENT).
 - C - VIDEO AND 70 KHz
 - D - EXTERNAL POWER TO DC/DC CONVERTER
- 3 - SEMI-RIGID CABLE FOR LOW LOSS AT S-BAND
- 4 - CARBON GREASE FOR GOOD BONDING OF SUBASSEMBLIES
- 5 - BONDING VERIFICATION USING SHALLCROSS BRIDGE
- 6 - RF CABLES – SPECIFICATION CONTROL DRAWINGS – CONTROL ATTENUATION AND VSWR
- 7 - MAIN GROUND TERMINAL E2 WELDED TO CASE
- 8 - SECONDARY GROUND TERMINALS E3 and E4 WELDED TO MOUNTING SHELF AND WIRED TO E2.
- 9 - GROUND LEAD FROM E4 TO EACH SUBASSEMBLY IN SEQUENCE

RCA

COVER PLATE CONTROL PANEL





RL FRONT PANEL COVER PLATE STATUS

- Drawing complete for procurement of Cover Plate.
- Certification required from vendor for:
 - Brightness
 - Color
 - Amount of Radio-Activity
 - Wipe Test
- Specification Control Drawing for Radioluminous Paint and its Application has been prepared.



RL STATUS

- RCA Radiological Personnel have been familiarized with LCRU RL requirements.
- New Jersey State Radiation Protection Code and AEC Regulations will apply in handling of RL material in Camden plant.
- RCA Personnel will be indoctrinated in applicable safety measures.
- Special precautions will be in force during environmental testing.
- QA Plan will include Requirement for MSC Form 1625 - Radioactive Material Transfer Receipt - with each LCRU as part of Data package.

RCA

RL STATUS

MSC has notified RCA AEC-license number is 42-09388-01 CMA Amendment 18, allowing licensee to possess a maximum of 500 Curies of PR 147.

MSC has provided to RCA MSC Radiological Health Manual and MSC material Transfer Forms.

RCA AEC by-product material License number is 29-07325-04 allowing 1 curie of radio-active material in plant.

Amendment to increase quantity to 5 curies is in process.



MONITOR METER

RCA 8151104-1001

SENSITIVITY	5 VDC/0.2 MA FULL SCALE
SCALE MARKING	0, 1, 2, 3, 4, 5 OVER 225 DEG
SEALING	HERMETIC
ACCURACY	±5% OF FULL SCALE
TERMINALS	SOLDER TYPE
NUMERALS, INDICES AND LIGHT BAND BEHIND POINTER	RADIO LUMINESCENT MATERIAL 3M PROMETHIUM 147 MICROSPHERE MIXTURE
SIZE	1.735 IN SQ X 2.90 IN LONG
WEIGHT	0.47 POUNDS
VENDOR	WESTON INSTRUMENTS



**MONITOR TOGGLE SWITCH
(AGC/RAD TEMP/POWER)
RCA 8555254-1002**

NUMBER OF POLES	2
OPERATION	ON-ON-ON
CLASSIFICATION	30 VDC RESISTIVE 15 AMP INDUCTIVE 10 AMP
CONTACT RESISTANCE	0.06 OHM MAX
LEAK RATE	NO GREATER THAN 10^{-8} CC/SEC AT 1 ATMOS DIFFERENTIAL
OPERATING FORCE	1 POUND MIN/8 POUND MAX
VENDOR	TEXAS INSTRUMENTS 22LS2-7
SIZE	1.203 X 1.358 X 2.700 IN. LONG
WEIGHT	0.15 POUNDS MAX



**POWER TOGGLE SWITCH
(INT/OFF/EXT)
RCA 8555254-1001**

NUMBER OF POLES	3
OPERATION	MAINTAIN-OFF-MAINTAIN
LOCK	CENTER (OFF) POSITION
CLASSIFICATION	30 Vdc RESISTIVE 15 AMP INDUCTIVE 10 AMP
CONTACT RESISTANCE	0.06 OHM MAX
LEAK RATE	NO GREATER THAN 1×10^{-8} CC/SEC @ 1 ATMOS DIFFERENTIAL
OPERATING FORCE	3-7 LBS POUNDS
PULLOUT TO CHANGE POSITION	0.09 POUNDS MAX
VENDOR	TEXAS INSTRUMENTS/PT NO 13LS3-41
SIZE	1.400 X 1.500 IN X 3.010 IN. LONG
WEIGHT	0.2 POUNDS



ROTARY SWITCH

RCA 8555253-1001

NUMBER OF POLES	6
NUMBER OF POSITIONS	5
NUMBER OF DECKS	3
DETENT ANGLE	36 DEG WITH STOP
LEAK RATE	1×10^{-8} CC/SEC AT 1 ATMOSPHERE DIFF
OPERATING FORCE	48-96 IN-OZ (3-6 INCH POUNDS)
CIRCUIT RESISTANCE	40 MILLIOHMS MAX
CURRENT CARRYING CAP	28 VDC/3 AMP RESISTIVE
MAKE/BREAK RATING	28 VDC/2 AMP RESISTIVE
VENDOR	DAVEN 37010
WEIGHT	0.5 POUNDS MAX.
SIZE	1.25 DIAM/2.75 LONG



CIRCUIT BREAKER RCA 8555264-1001

NUMBER POLES	1
NOMINAL AMPS	7.5
VOLTAGE DROP	0.2V
ULTIMATE TRIP CURRENT MAX MIN	10.9/11.2 A AT 77 DEG F 8.63 A
TRIP TIME AT 77 DEG F (MIN-MAX)	15-40 SEC AT 200% NOM CURRENT
MANUAL OPERATE FORCE	PULL OUT 8 LBS MAX/2 LBS MIN RESET 10 LBS
VENDOR	MECHANICAL PRODUCTS 700-085 -7.5
WEIGHT	1.6 OZ MAX
SIZE (REAR PROJECTION)	1.09 X 0.687 X 1.84 INCH
TRIP INDICATOR	CLOSED 0.86 IN/OPEN 1.06 IN

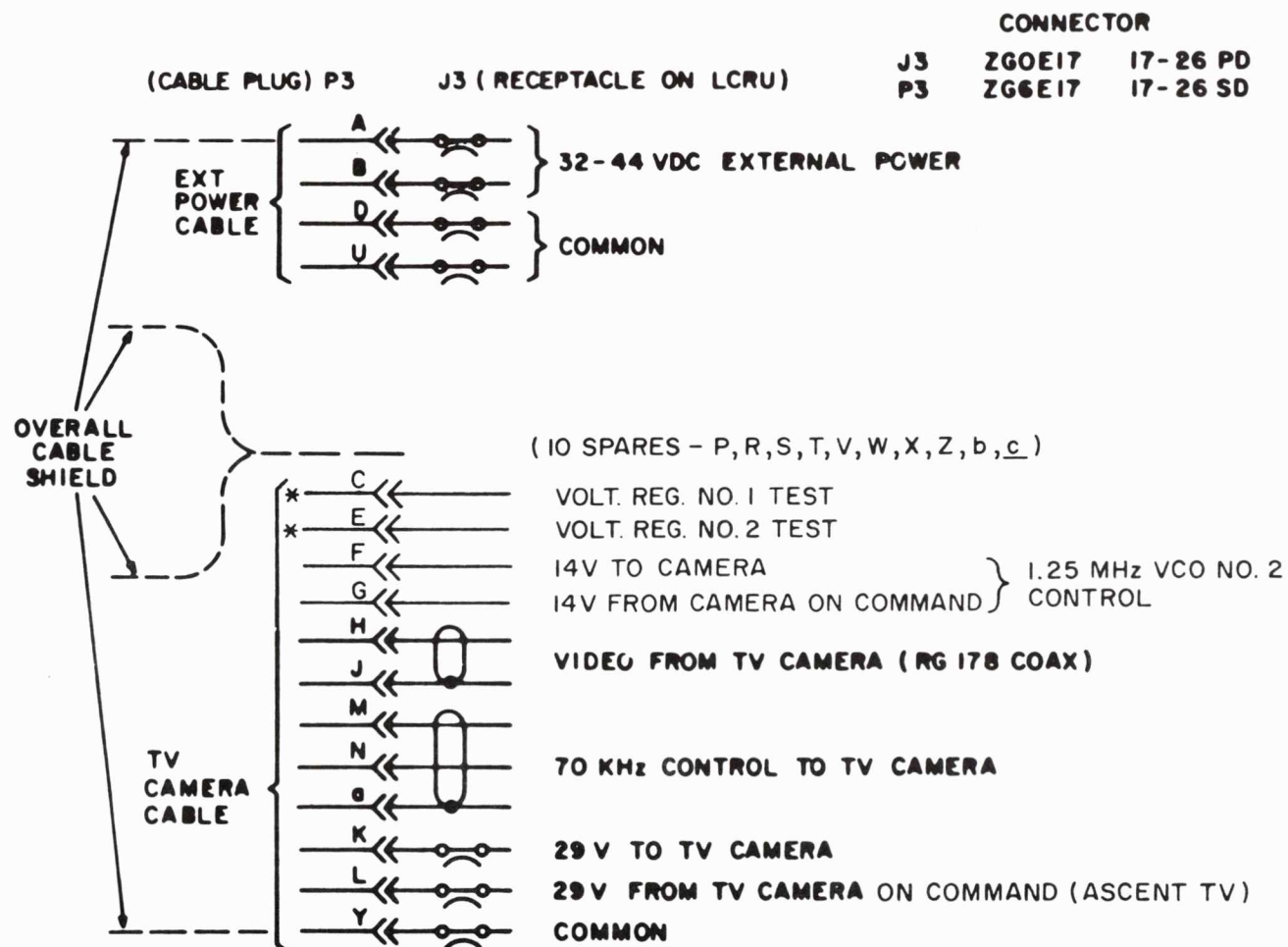


LCRU POWER REQUIREMENTS – WATTS

SUBASSEMBLY	PM1/NB	PM1/WB	FM/TV	TV RMT (STANDBY)	PM2/NB
VHF RECEIVER	1.17	1.17	1.17	1.17	1.17
VHF TRANSMITTER	4.10	4.10	4.10	.35	4.10
S-BAND RECEIVER	1.00	1.00	1.00	1.00	1.00
PM/PM TRANSMITTER	47.8	47.8	0.29	0.29	0.29
FM/PM TRANSMITTER	0.29	0.29	53.7	0.29	53.7
UP LINK SIGNAL PROCESSOR	0.15	0.15	0.15	0.15	0.15
DOWN LINK " "	1.76	2.46	2.46	2.46	1.76
VOLTAGE REGULATOR	2.29	2.42	2.42	1.67	2.29
CAMERA ASSEMBLY (STILL)	--	--	(21.0)	6.00	--
CAMERA ASSEMBLY (IN MOTION)	--	--	21.0+2.0		
TOTAL WATTS AT NOMINAL BATTERY VOLTAGE	58.6 58.3	59.4 59.1	88.3 88.0	13.38 13.09	64.5 64.2
POWER REQUIREMENTS USING EXTERNAL POWER					
LCRU	58.6 58.3	59.4 59.1	88.3 88.0	13.38 13.09	64.5 64.2
DC DC CONVERTER	11.7 14.6	11.9 14.8	22.1 22.0	3.35 3.28	10.1 16.0
TOTAL WATTS	73.3 72.9	74.3 73.9	110.4 110.0	16.73 16.37	80.6 80.2



TV / EXT POWER INTERFACE



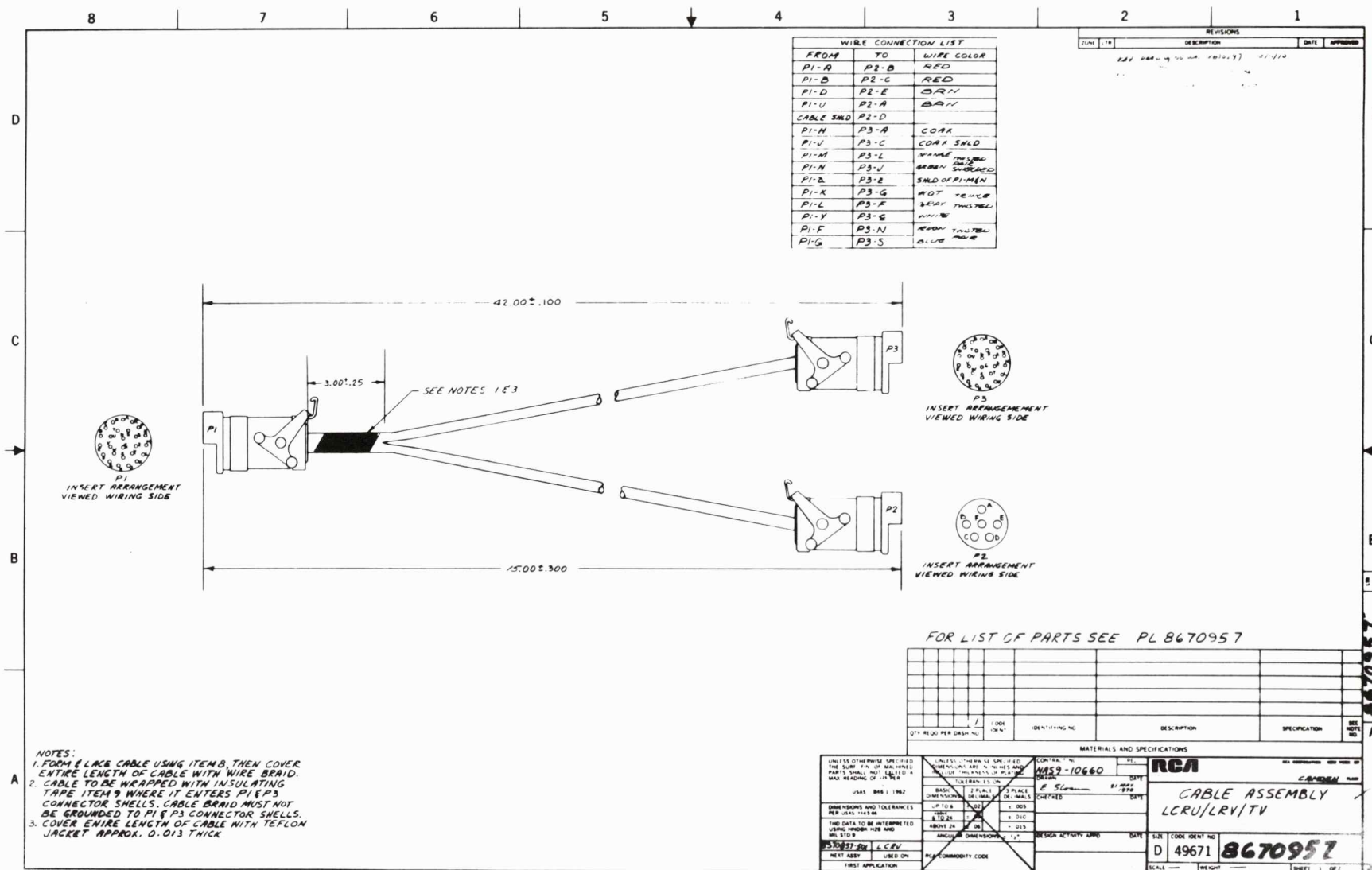
NOTE: OVERALL CABLE SHIELD NOT GROUNDED AT LCRU OR TV CAMERA, BUT GROUNDED AT LRV.

* TEST POINTS. NO WIRES IN CABLE..

CABLE ASSEMBLY

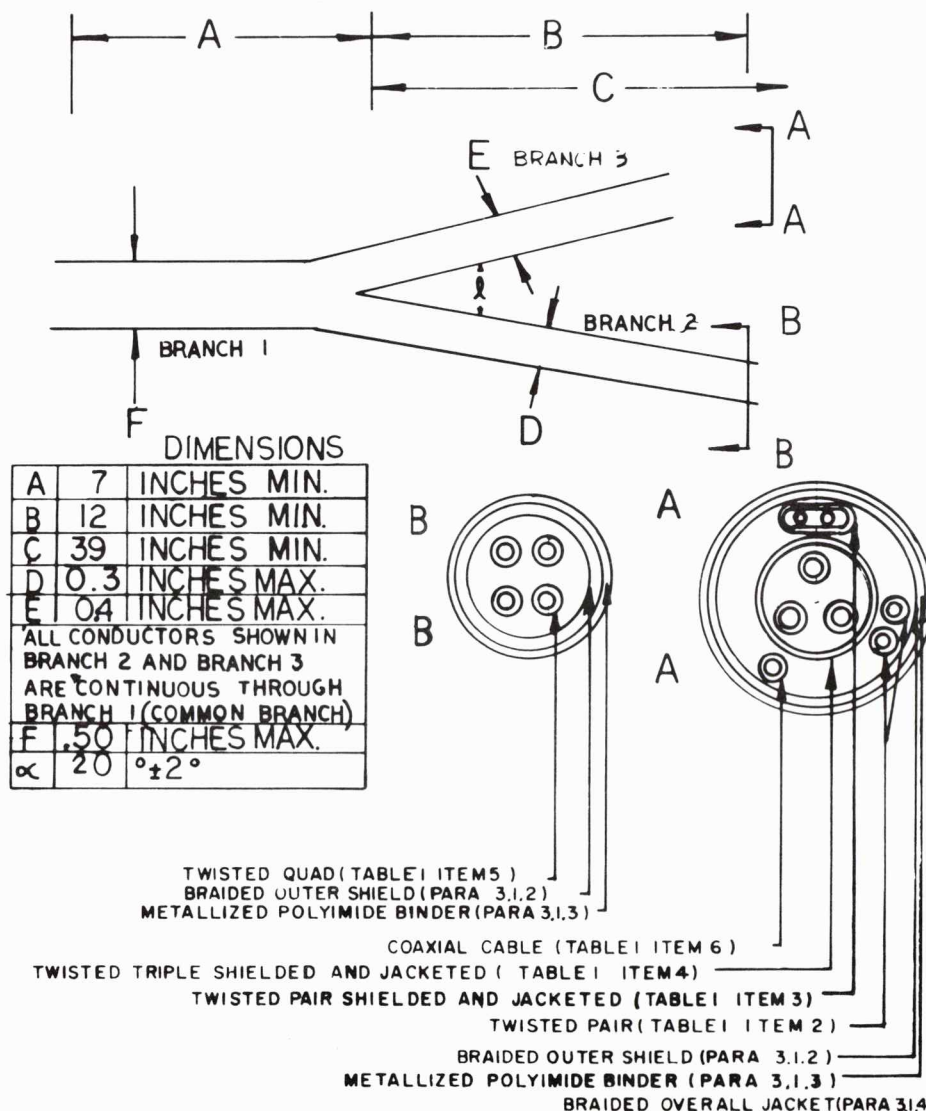
LCRU/LRV/TV

8670957



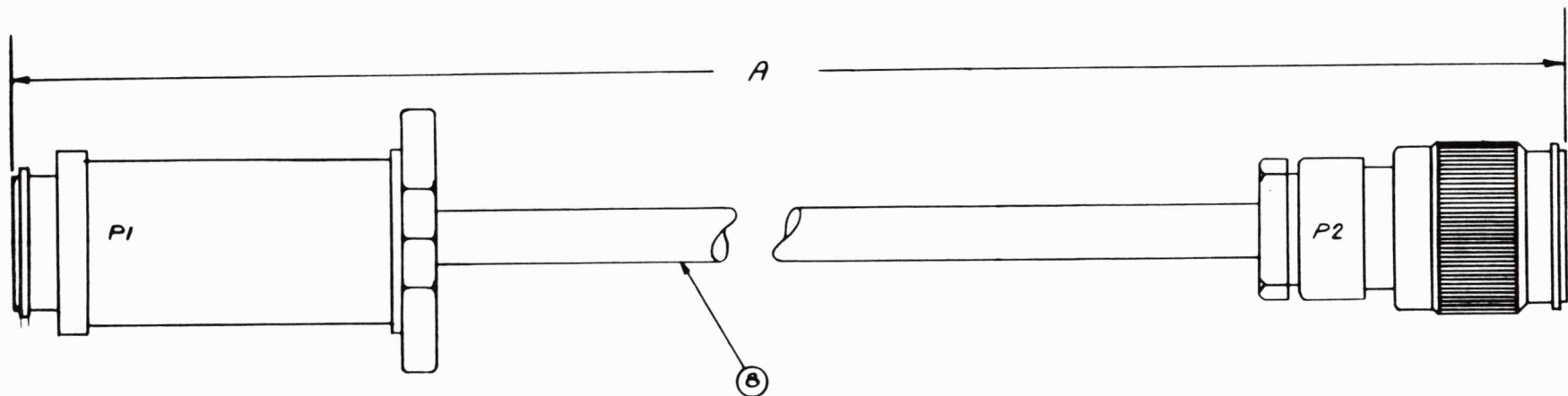


LCRU/LRV/TV CABLE CONSTRUCTION



RCA

CABLE ASSY ANTENNA S-BAND HI & LOW GAIN 8670967



7-197

ELECTRICAL REQUIREMENTS		
GROUPS	501/503	502/504
ATTENUATION(db)	1.10 MAX	1.40 MAX
VSWR	1.10 MAX	1.16 MAX
FREQ (MHZ)	2100.5-2266.5	2100.5-2266.5

DIM "A"	
GROUP	GROUP
501/503	502/504
84.00 $\pm$ 1.00	96.00 $\pm$ 1.00