



From the desk of Jim Kaness

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## DESIGN PLAN

### PALMDALE SITE-7 L-BAND TRACKER

Rev. 9/30/1999

#### INTRODUCTION

This design plan is a “living document” intended as a record of system design requirements, and proposed approaches to implementation of those requirements. It will be updated as appropriate and issued each Friday.

#### ABOUT THIS WEEK’S ISSUE

- Installation is complete. This is the final issue.
- **Issues for discussion are presented in boldface type, for emphasis.**

Installation of a government furnished EMP L-Band telemetry tracking antenna for the Air Force at Site-7, Palmdale, CA consists of the following major efforts:

1. Mechanical and electrical system design. **DONE**
2. 40 foot tower and foundation to support the tracker, adjacent to the Scoot-N-Hide. **DONE**
3. Installation of the tracker atop the tower. **DONE**
4. Underground cable installation from the tracker to Building 780. **DONE**
5. Installation of the tracker control unit and TM receivers. **DONE**
6. Splicing control and video cables. **DONE**
7. Telephone cable from Building 780 to the Scoot-N-Hide. **DONE**
8. Installation of video and control cabling to/from the two video camera(s). **DONE**
9. Installation of a 2<sup>nd</sup> video camera near the tower. **DONE**
10. Installation of an Omni-directional L-band TM antenna on the tower. **DONE**
11. Test and verification of proper operation of all the above. **DONE**

## **SYSTEM CALIBRATION AND OPERATOR TRAINING**

The listed items should be completed before the system is operationally ready. CSC personnel from EAFB building 5790 are experienced and equipped to perform the following tasks:

- **Install 50-watt 250-volt bulb in pedestal (bulb is in bldg. 780).**
- **Plug 4-inch hole under pedestal to keep out birds (foam can is in 780).**
- **Calibrate tracker.**
- **Calibrate receivers with boresight antenna.**
- **Provide training to Site-7 operating personnel.**

## **DOCUMENTATION**

In addition to this Design Plan, technical manuals and drawings for the tracker, the Microdyne receivers and accessories, the video cameras and their accessories, and the fiber modules have been placed on the shelf in the control room, building 780, Site-7, Palmdale.

## **TOWER**

A 40-foot high, 3-leg tower has been installed by ERI adjacent to the Scoot-N-Hide. The tower safety cable is installed. Cables are clamped and, where required, tie-wrapped with stainless-steel tie-wraps.

## **CONDUIT**

A 4-inch inside diameter conduit has been installed underground from the tower base to the control room in building 780. The pull-box on the outside wall of 780 has two hasps for padlocking. The conduit is 339 cable-feet long.

## **TRACKER (GFE)**

The EMP 100-8 tracker is designed for two-axis pointing and auto-track operation at L- and S-band frequencies from 1430 to 2390 MHz. The tracker, EMP P/N 1210005, S/N 1216-002, CONTR F04611-86-D-0120 is installed on the tower. Run/safe switch is installed on the tower. Stow pins are removed. The tracker is fully operational.

## TRACKER POWER

The tracker is designed for 115/208 Vrms, Three Phase, (4-pole or Wye configured) 60 Hz power at 10 Amps per leg maximum. This power comes from Panel LA-1, Breakers 9, 11, and 13 in the Scoot-N-Hide, and is routed in rigid metal conduit over the roof (inside) and up the tower to the tracker. EMP advises this power may be left on continuously. A duplex AC outlet, connected to phase-A (black) is installed near the base of the tower for installation and testing use. Color code is as follows:

<u>PANEL LA-1</u>			<u>PEDESTAL</u>
<u>BREAKER</u>	<u>COLOR</u>	<u>PHASE</u>	<u>TERMINAL</u>
9	Black	A	1
11	Red	B	2
13	Blue	C	3
Neutral	White	Neutral	4
Ground	Green	Ground	Pedestal Ground

## TRACKER CONTROL CABLE (GFE)

The tracker control cable is a custom built cable containing 47 wires and 32 shields. It is made from 31 separate shielded, jacketed cables custom molded into a single physical cable. The cable for the tracker to be utilized has a 55-pin MS connector on the ACU6 end, and spade lugs on the pedestal end. Cable OD is 1.25 inches. Connector OD is 1.6 inches.

## ANTENNA CONTROL UNIT (GFE)

The ACU6 antenna control unit provides all positioning control to the tracker pedestal. The unit is installed and connected to the TM receivers. EMP advises the ACU6 may be turned on and off as required for use. The pedestal antenna will remain in its previous position until commanded to go elsewhere. The ACU is fully operational.

## HANDWHEEL/JOYSTICK CONTROL PANEL (GFE)

This optional (EMP confirmed) equipment connects to the ACU6 to provide for manual analog positioning of the antenna. A two-axis joystick and two handwheels (rotary knobs) are provided. These options provide more intuitive manual control of antenna position than do the pushbuttons on the ACU6. Unit is fully operational.

## COMMANDED ANGLE DISPLAY (GFE)

This optional (EMP confirmed) unit provides digital displays of the ordered azimuth and elevation pointing angles of the antenna, as does the ACU6, and also provides an analog display of tracking antenna position error. Unit is fully operational.

## TRACKER MANUAL (7 JULY 87) REFERENCE PAGES

Pedestal Mounting Details	Page 3-2
Installation & Alignment Tools List	Page 3-4
System Block Diagram	Page 5-2
Detail System Block Diagram	Page 5-5
TM Receiver Interface Requirements	Page 7-12

## TRACKER MANUAL (18 NOV 89) REFERENCE PAGES

System Characteristics	Page 1-5
Antenna Systems Characteristics	Page 1-8
Pedestal Characteristics	Page 1-10
Component Part Numbers	Page 1-11
System Block Diagram	Page 1-13
LNA Specifications	Page 2-5

### OMNI ANTENNA

ERI installed an L-band omnidirectional antenna, TIL-TEK model TA-1451, on the tower with a JCA model 12-2403-T LNA, powered over the coax from building 780, using a Bias-T and 12VDC power supply. The LNA feeds Andrew EFX2-50 Heliac cable to building 780. The omni heliac is grounded for lightning at the tower base and at the 780 building entrance. The omni antenna is fully operational.

### L-BAND TERMINATION IN BUILDING 780

The L-band RF signals in building 780 are terminated directly into the Microdyne receivers. TM data output from the tracker combiner, and the omni receiver is available and identified at the patch panel at the top of the rack for distribution by Site-7 personnel. L-band signals have been received on all three receivers. The two EFX2-50 cables from the tracker are grounded for lightning at the tower base and at the 780 building entrance.

### TELEMETRY RECEIVER (GFE)

The Microdyne 1200 single-channel TM receivers are equipped with L-band tuners for reception of the 1430 to 1480 MHz signals of interest. Three L-band tuners have been received from the Navy (exchanged for 3 AF P-band tuners) and have been checked out at EAFB. This exchange saved \$17,000. The receivers are fully operational.

### VIDEO CAMERA (GFE)

The tracker includes a Cohu model 1865-5100/0000 Color CCD camera, serial #140890. ERI installed the Cohu camera control cable from the tracker to the GFE Cohu 2383-200 camera control panel, serial #142793, in building 780. The video is identified and available from the video fiber termination box via a six-foot long RG-59 cable connected to the Panasonic 3-channel monitor provided by Site-7. Reusing existing cable saved \$1000. This camera is fully operational.

The CA294 cable from the tracker video camera routes through a Cohu custom designed, weatherproof video box where the video coax is broken out and the video put on fiber. This box also includes the video/fiber transmitter for the 2<sup>nd</sup> camera, powered from 120 VAC picked off the AC power wires to the camera. These items are mounted in a NEMA-4X box, size 16 x 14 x 6-inches. Cables enter up through the 14 x 6-inch bottom of the box.

### FIBER TERMINATION

A GFE 48-fiber cable is installed from the Scoot-N-Hide to building 780 for the two video signals. 12 of the fibers are terminated- at both ends- with ST connectors for

connection to the video fiber modules, using Siecor FAN-BT25-12 fan-out kits and ST connectors applied with UV-cured epoxy on the loose-tube fibers. In building 780 the fiber is terminated in a wall-mounted box which contains the fiber video receivers. The tracker video is on the “rose” colored fiber, and the scoot-n-hide video is on the “aqua” colored fiber. The remaining ten fibers are available for future assignment.

#### SECOND VIDEO CAMERA

A Cohu model 1335-2000/Z06G color CCD video camera, with zoom lens and Pelco PT-570P pan/tilt mount, is installed on the south-east corner of the Scoot-N-Hide. A sun-shield keeps this camera from overheating by direct sun exposure. The video is put on fiber for transmission to building 780. AC power for the fiber transmitter is picked off the camera cable inside the Cohu video box on the tower. The video is identified and available from the video fiber receiver via a six-foot long RG-59 cable connected to the Panasonic 3-channel monitor provided by Site-7. This camera is fully operational.

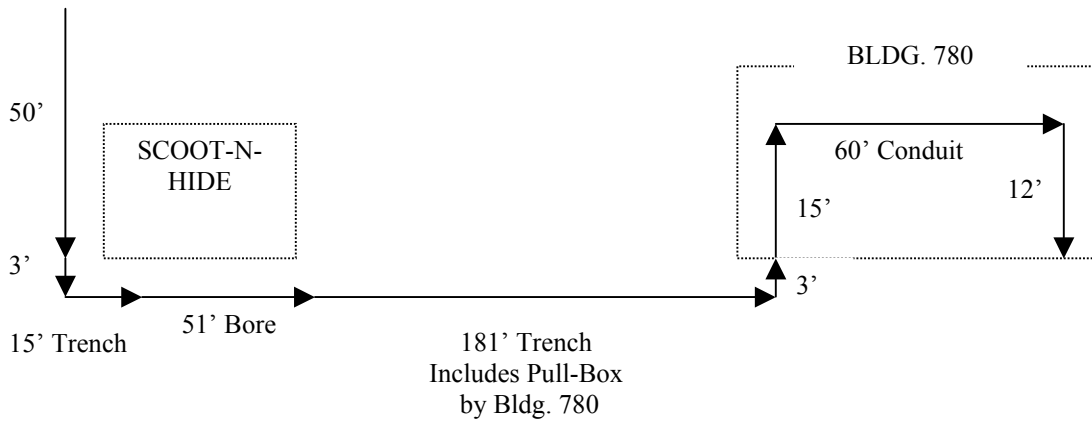
#### TELEPHONE SERVICE

A 25-pair telephone cable is installed from building 780 to the north-west corner of the Scoot-N-Hide to provide for base telephone service. Site-7 personnel are terminating the phone cable.

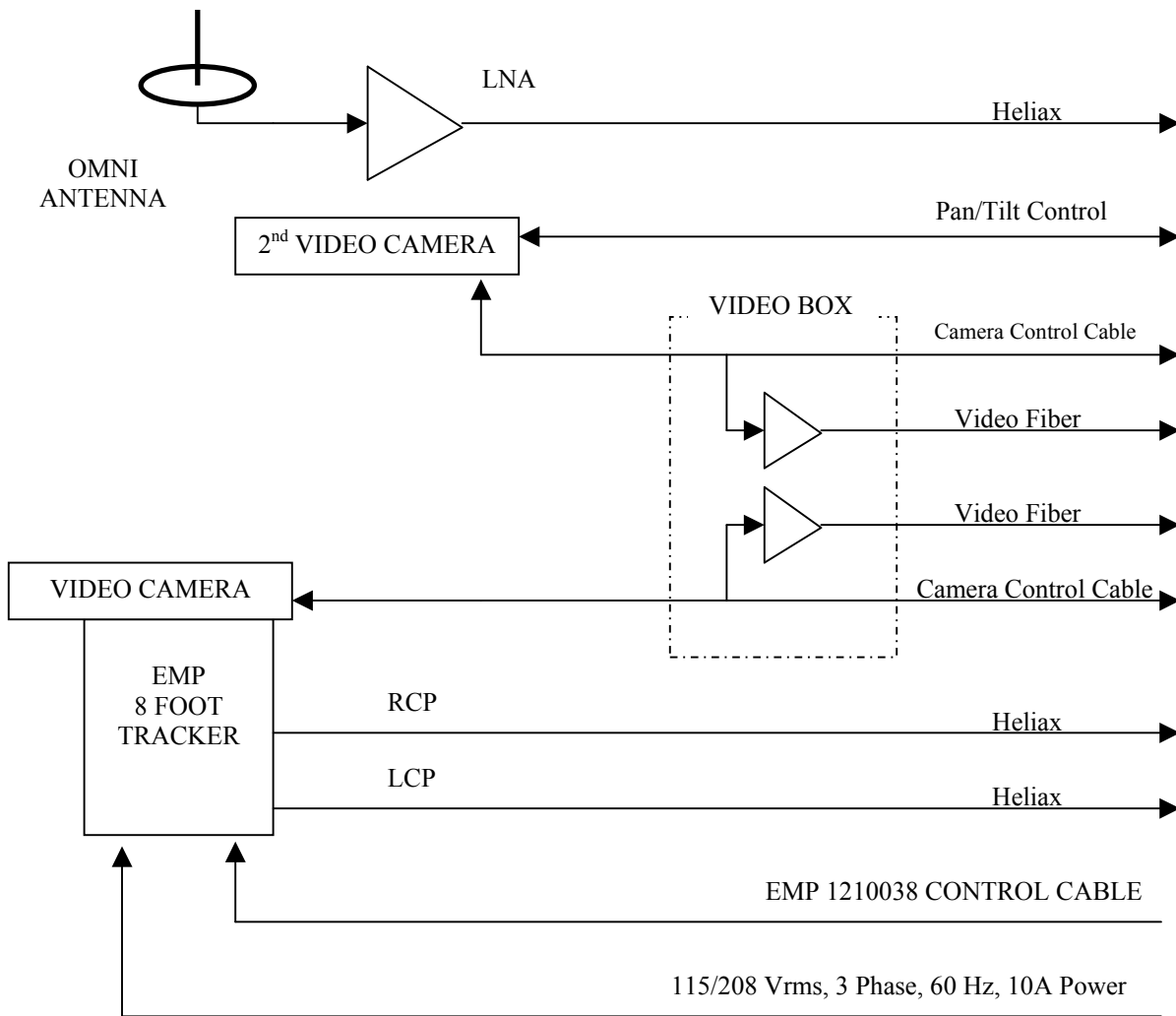
## CABLE AND CONDUIT RUNS

INSTALLED CONDUIT LENGTH IS 339 FEET from tower base to ceiling of Control Room in Bldg. 780.

INSTALLED CABLE LENGTH OF 400 FEET IS REQUIRED FROM TRACKER TO CONTROL ROOM to allow slack for pedestal termination, and connection to equipment in Bldg. 780.

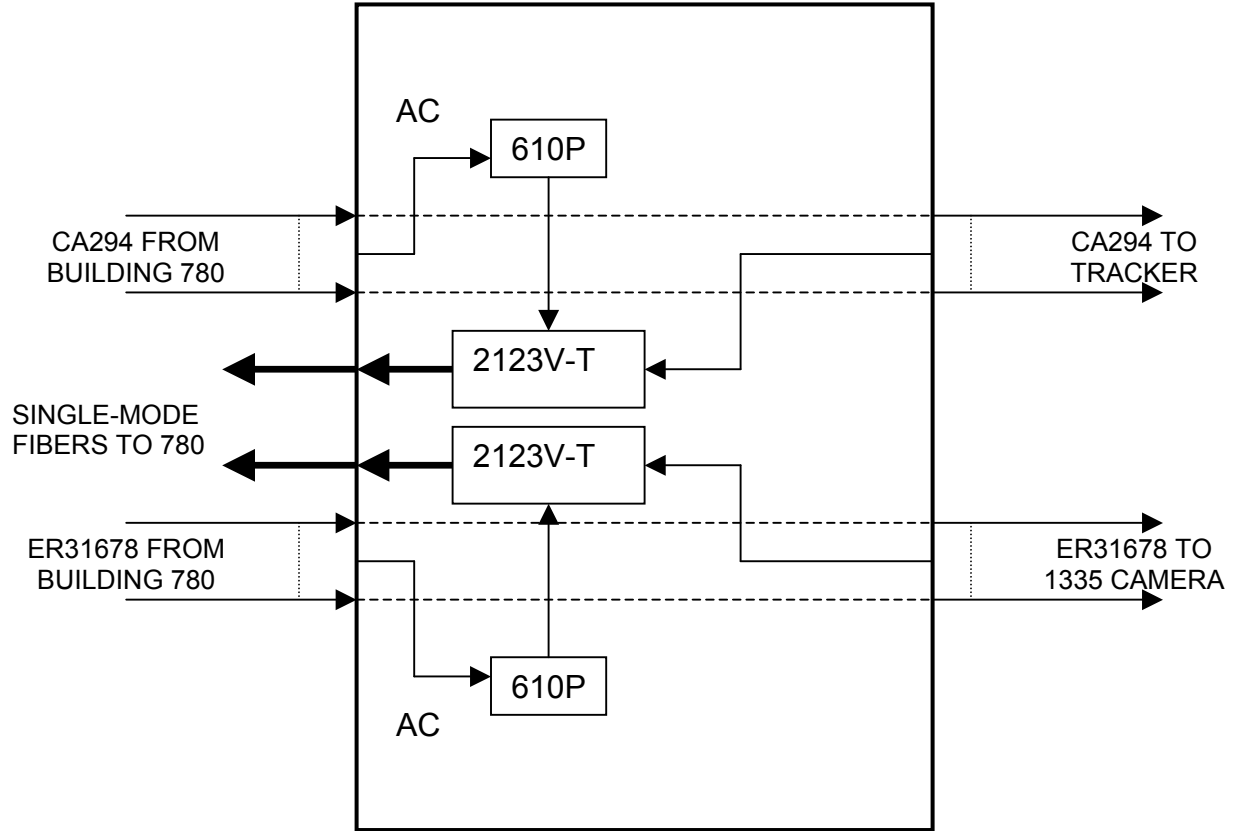


PALMDALE BLOCK DIAGRAM  
TRACKER END



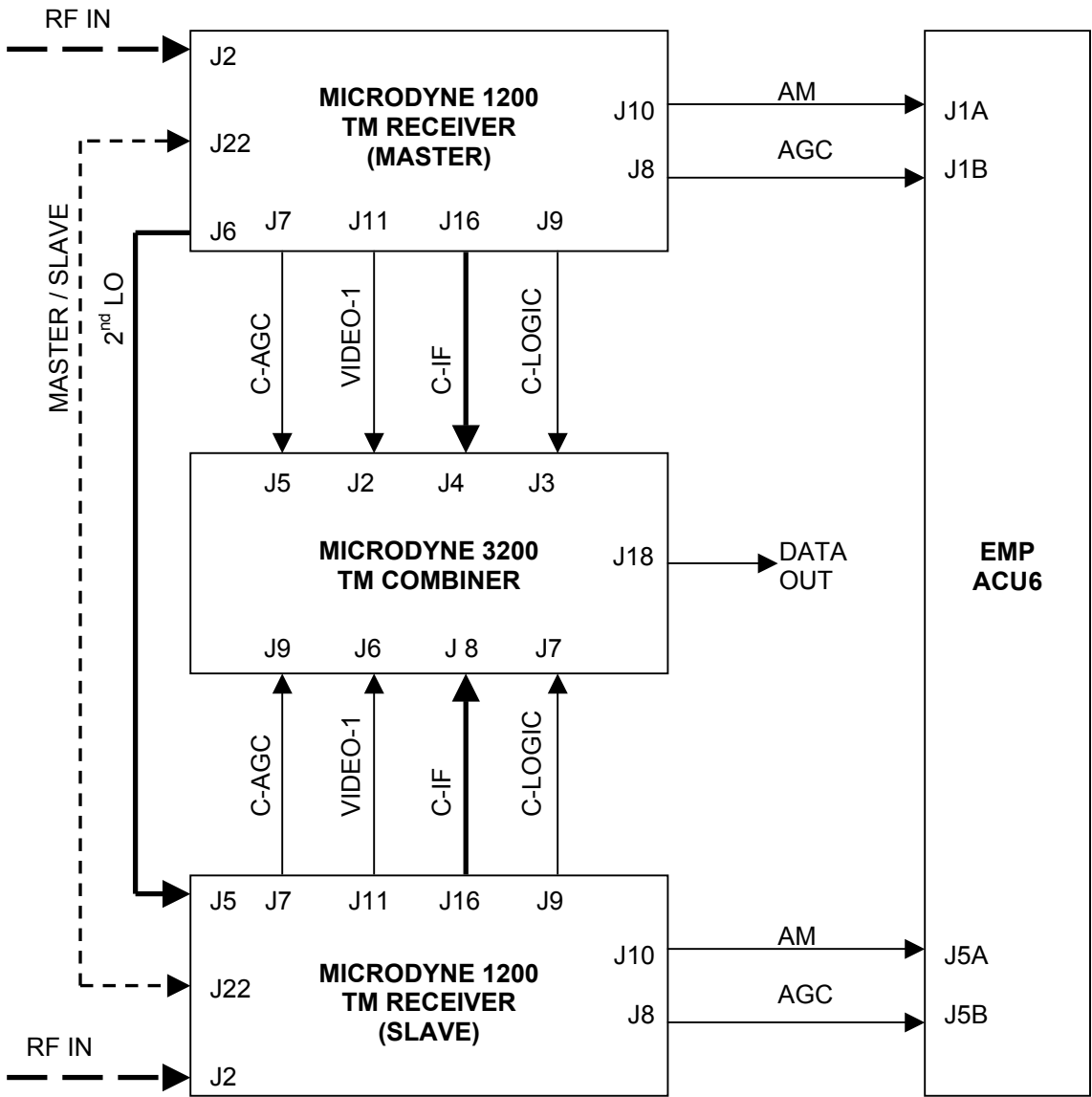
  
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**NEMA-4X VIDEO BOX (COHU)**  
16" x 14" x 6"



  
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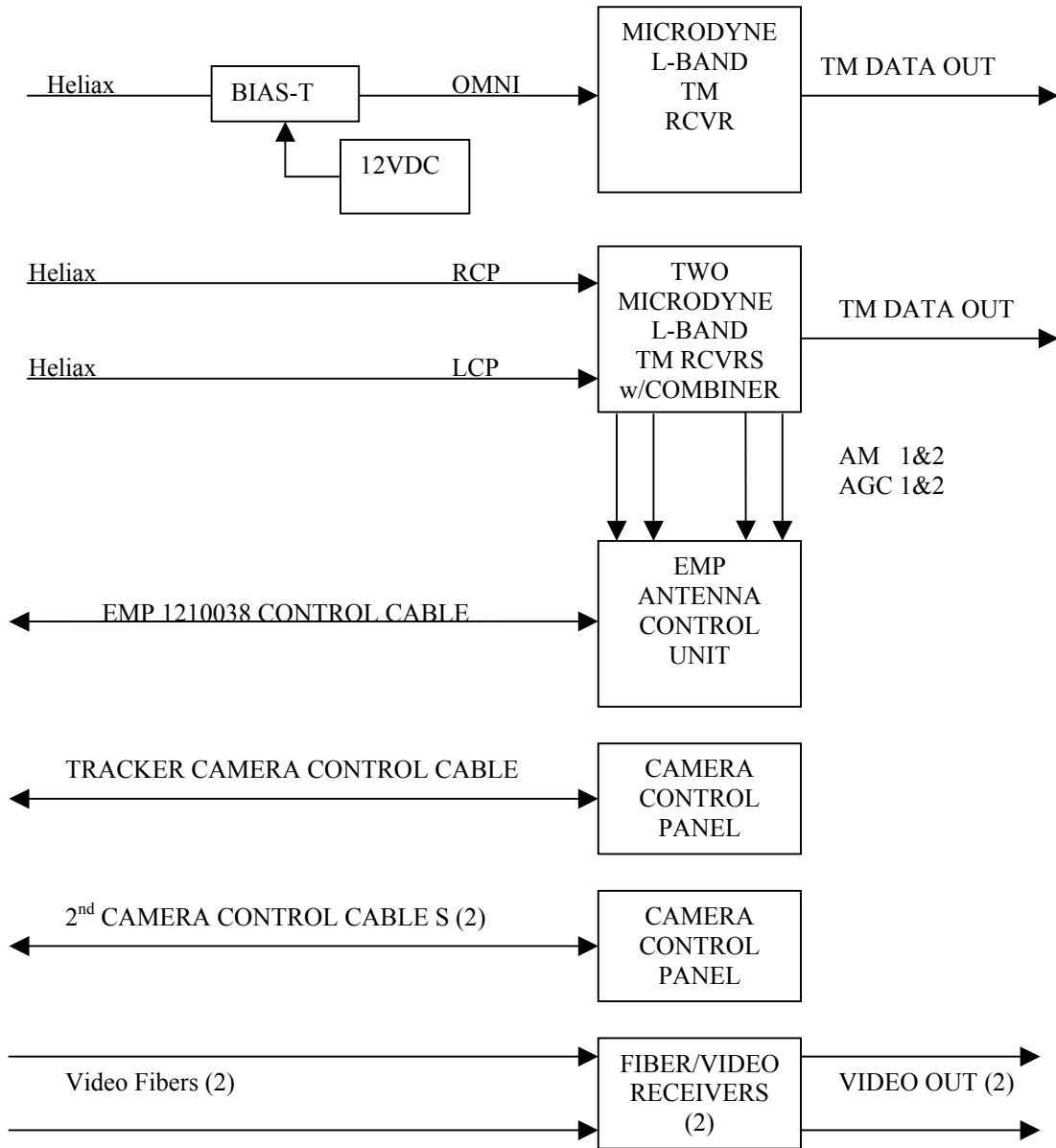
PALMDALE  
TM RECEIVER - COMBINER - ACU6



- 50 ohm Heliax/N
- 50 ohm RG-58/BNC
- 75 ohm RG-59/BNC
- DB-15 DATA

  
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PALMDALE BLOCK DIAGRAM  
BLDG 780 END



  
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## TRACKER LINK BUDGET

<b>PATH (miles)</b>	<b>0.10</b>	<b>1.00</b>	<b>10.00</b>	<b>100.00</b>	<b>300.00</b>	<b>1000.00</b>
TX frequency (MHz)	1460.00	1460.00	1460.00	1460.00	1460.00	1460.00
Signal BW = Noise BW (MHz)	1.00	1.00	1.00	1.00	1.00	1.00
TX Power (dbm)	40.00	40.00	40.00	40.00	40.00	40.00
TX Antenna gain (db)	0.00	0.00	0.00	0.00	0.00	0.00

<b>8' TRACKER (3 LNA's)</b>	<b>Acq. Aid</b>	<b>Dish &gt;</b>				
Free space loss (db)	79.87	99.87	119.87	139.87	149.41	159.87
RX antenna gain (db)	10.50	28.30	28.30	28.30	28.30	28.30
RX signal at dish (dbm)	-29.37	-31.57	-51.57	-71.57	-81.11	-91.57
RX coupling loss (db)	3.00	3.00	3.00	3.00	3.00	3.00
RX input to LNA (dbm)	-32.37	-34.57	-54.57	-74.57	-84.11	-94.57
LNA noise figure (db)	1.20	1.20	1.20	1.20	1.20	1.20
LNA input noise (dbm)	-112.80	-112.80	-112.80	-112.80	-112.80	-112.80
LNA gain (db)	43.00	43.00	43.00	43.00	43.00	43.00
LNA output (dbm)	10.63	8.43	-11.57	-31.57	-41.11	-51.57
Cable & Slipping loss (db)	5.00	5.00	5.00	5.00	5.00	5.00
Coax signal input (dbm)	5.63	3.43	-16.57	-36.57	-46.11	-56.57
Coax loss (db)	18.52	18.52	18.52	18.52	18.52	18.52
Coax output (dbm)	-12.89	-15.09	-35.09	-55.09	-64.63	-75.09
Coax noise output (dbm)	-93.32	-93.32	-93.32	-93.32	-93.32	-93.32
Coax output S/N (db)	80.43	78.23	58.23	38.23	28.69	18.23
Pad (db)	0.00	0.00	0.00	0.00	0.00	0.00
Microdyne RF input (dbm)	-12.89	-15.09	-35.09	-55.09	-64.63	-75.09
Microdyne noise figure (db)	12.00	12.00	12.00	12.00	12.00	12.00
Microdyne input noise (db)	-102.00	-102.00	-102.00	-102.00	-102.00	-102.00
Equivalent input noises (dbm)	-92.76	-92.76	-92.76	-92.76	-92.76	-92.76
Microdyne S/N (db)	79.88	77.68	57.68	37.68	28.13	17.68

### NOTES

- 1. Path lengths from 500 feet (0.1 mile) to 300 miles are operational.**
2. ACU6 switches to Acquisition Aid antenna at less than 1-mile range..

## OMNI LINK BUDGET (with LNA)

<b>PATH (miles)</b>	<b>0.01</b>	<b>0.10</b>	<b>1.00</b>	<b>10.00</b>	<b>30.00</b>	<b>100.00</b>
TX frequency (MHz)	1460.00	1460.00	1460.00	1460.00	1460.00	1460.00
Signal BW = Noise BW (MHz)	1.00	1.00	1.00	1.00	1.00	1.00
TX Power (dbm)	40.00	40.00	40.00	40.00	40.00	40.00
TX Antenna gain (db)	0.00	0.00	0.00	0.00	0.00	0.00

	<b>OMNI with LNA</b>	<b>EFX2-50 Heliax</b>				
Free space loss (db)	59.87	79.87	99.87	119.87	129.41	139.87
RX antenna gain (db)	7.00	7.00	7.00	7.00	7.00	7.00
RX signal at omni (dbm)	-12.87	-32.87	-52.87	-72.87	-82.41	-92.87
RX coupling loss (db)	1.00	1.00	1.00	1.00	1.00	1.00
RX input to LNA (dbm)	-13.87	-33.87	-53.87	-73.87	-83.41	-93.87
LNA noise figure (db)	3.00	3.00	3.00	3.00	3.00	3.00
LNA input noise (dbm)	-111.00	-111.00	-111.00	-111.00	-111.00	-111.00
LNA gain (db)	24.00	24.00	24.00	24.00	24.00	24.00
LNA output (dbm)	10.13	-9.87	-29.87	-49.87	-59.41	-69.87
Coax loss (db)	18.52	18.52	18.52	18.52	18.52	18.52
Coax noise output (dbm)	-105.52	-105.52	-105.52	-105.52	-105.52	-105.52
Coax output S/N (db)	97.13	77.13	57.13	37.13	27.59	17.13
Microdyne RF input (dbm)	-8.39	-28.39	-48.39	-68.39	-77.93	-88.39
Microdyne noise figure (db)	12.00	12.00	12.00	12.00	12.00	12.00
Microdyne input noise (db)	-102.00	-102.00	-102.00	-102.00	-102.00	-102.00
Equivalent input noises (dbm)	-100.40	-100.40	-100.40	-100.40	-100.40	-100.40
Microdyne S/N (db)	92.01	72.01	52.01	32.01	22.47	12.01

### NOTES

3. Path lengths from 50 feet (0/01 mile) to 30 miles are operational.
4. Boxed entries are less than 20db Signal/Noise ratio.
5. Uses JCA model 12-2403-T LNA with 24db gain.