A MULTIBAND SHUTTLE SUPPORT AND TELEMETRY ANTENNA

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This paper describes the requirements, design, implementation and results of a program to modify an existing 35 FT. (10.7 Meter) Diameter Reflector Antenna to provide simultaneous multiband receive, track and transmit capabilities. The primary mission of the modified antenna is to provide up and down link communications with the space shuttle during launch from the WSMC at Vandenberg AFB in California. Secondary missions include ongoing support of WSMC telemetry functions.

The performance allocations established to support these missions are summarized in Table I. Here, we see that the system must provide capability in five frequency bands over the range of 1435 to 2400 MHz; it must receive and track with right and left circular (simultaneously) polarization over four of these bands and transmit with switchable circular polarization in one band.

The sidelobe requirement, combined with the total operating bandwidth and efficiencies, made the choice of a Newtonian Geometry almost mandatory. The high average power requirement of the transmit channel dictates the use of a waveguide transmission line for that function. The complexity of the power dividing waveguide network required to excite a four-horn arrangement led to the use of a five-element feed geometry. On the other hand, the extreme bandwidth coverage and the autotrack requirements restrict the use of waveguide feed horns because of the resultant effective track element spacing.

These conflicts caused a great deal of concern during the design phase of this program. Fortunately, the performance requirements were such that, in the end, they could be avoided.

The relief came from the comparatively low G/T requirement of the lowest frequency band; this is a full 9 dB less than one might expect on the basis of simply scaling frequency.

The solution then became one of using a waveguide feed horn assembly for the upper four frequency bands (1700 to 2400 MHz) while summing the outputs of the four track elements to obtain the data channel in the lowest band.

Several tasks were realized to accomplish this.

1. The center horn was shrunk to a minimum acceptable dimension (designed for cut-off at 1675 MHz) at the aperture.

2. The track elements were designed for a broad band (1435-2400 MHz) impedance match with a good axial ratio (<3 dB over band).

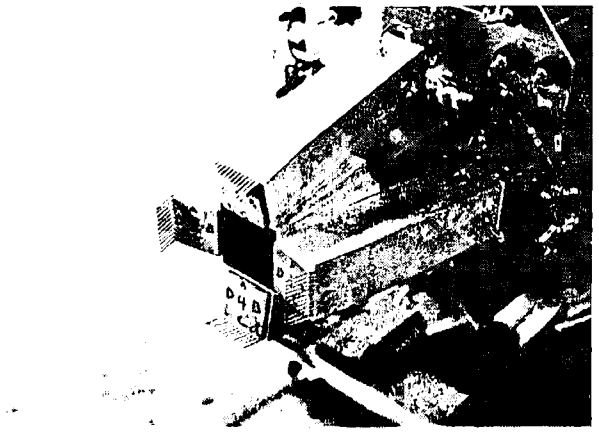
3. The track element size was reduced (dielectric loading) to move the effective phase centers close enough to provide a good tracking null at the highest operating frequencies.

The proximity of the high-power transmit channel to the very sensitive receive channel components necessitated the use of filtering and multiplexing that provided high levels of isolation between them. The isolation provided at the transmit frequencies at the transmit input is more than 140 dB to all of the receive LNA's. At the receive frequencies, this isolation is greater than 120 dB.

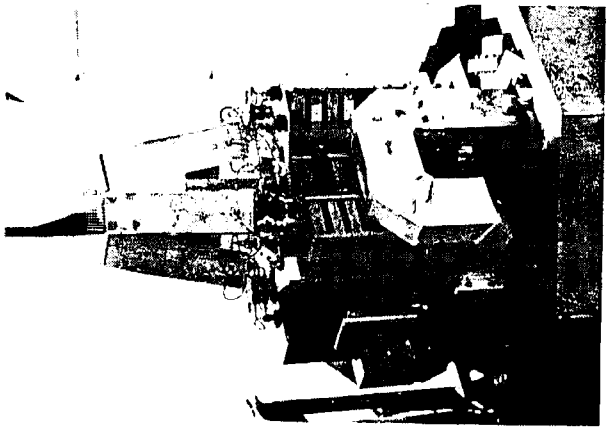
At this time (February 1985), all major subassemblies have been fabricated and tested in the laboratory. The individual design requirements have been met. Final assembly (See Figures 1 and 2) is scheduled for completion in March. Final installation and test is scheduled for the April/May time frame. The data from this testing will be available for distribution and discussion at the August Symposium.

TABLE I
PERFORMANCE ALLOCATIONS

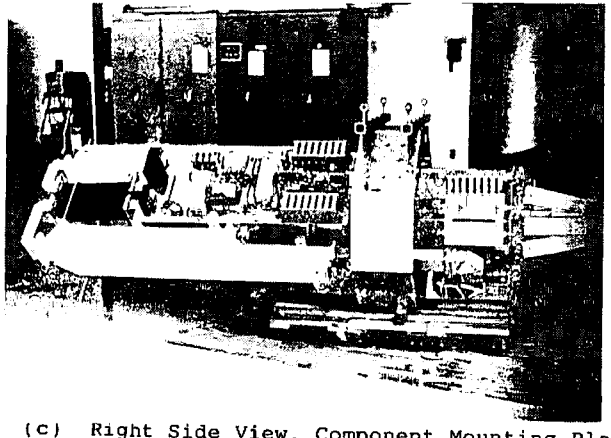
	FREQUENCY BAND (MHz)				
	1435 1540	1700 1850	2025 2120	2200 2300	2300 2400
Gain (dBiC) (Minimum)	-	-	44.0	-	-
Beamwidth (Deg.) (Minimum)	1.2	1.0	0.9	0.8	0.8
Sidelobe (-dB/Pk) (Maximum)	20	20	20	20	20
Polarization	Simultaneous RCP/LCP		Switchable RCP or LCP	Simultaneous RCP/LCP	
Axial Ratio (dB) (Maximum)	1.5	1.5	1.5	1.5	1.5
G/T (dB/°k)	8	13	-	21	21
Power Handling (Watts)	-	-	10,000	-	-



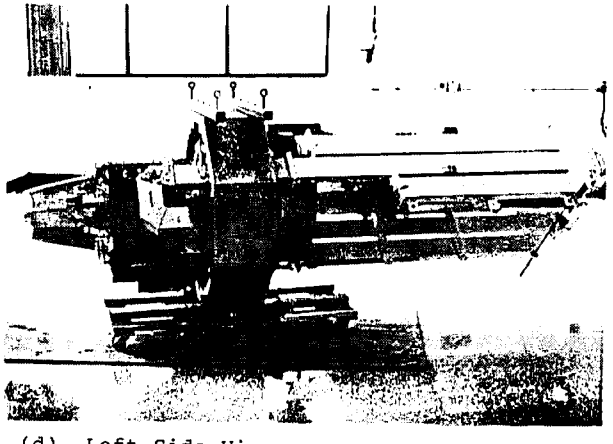
(a) Feed Horns



(b) Feed Horns, T_X Polarization Switch, Band Rej. Filters



(c) Right Side View, Component Mounting Plate



(d) Left Side View

FIGURE 1

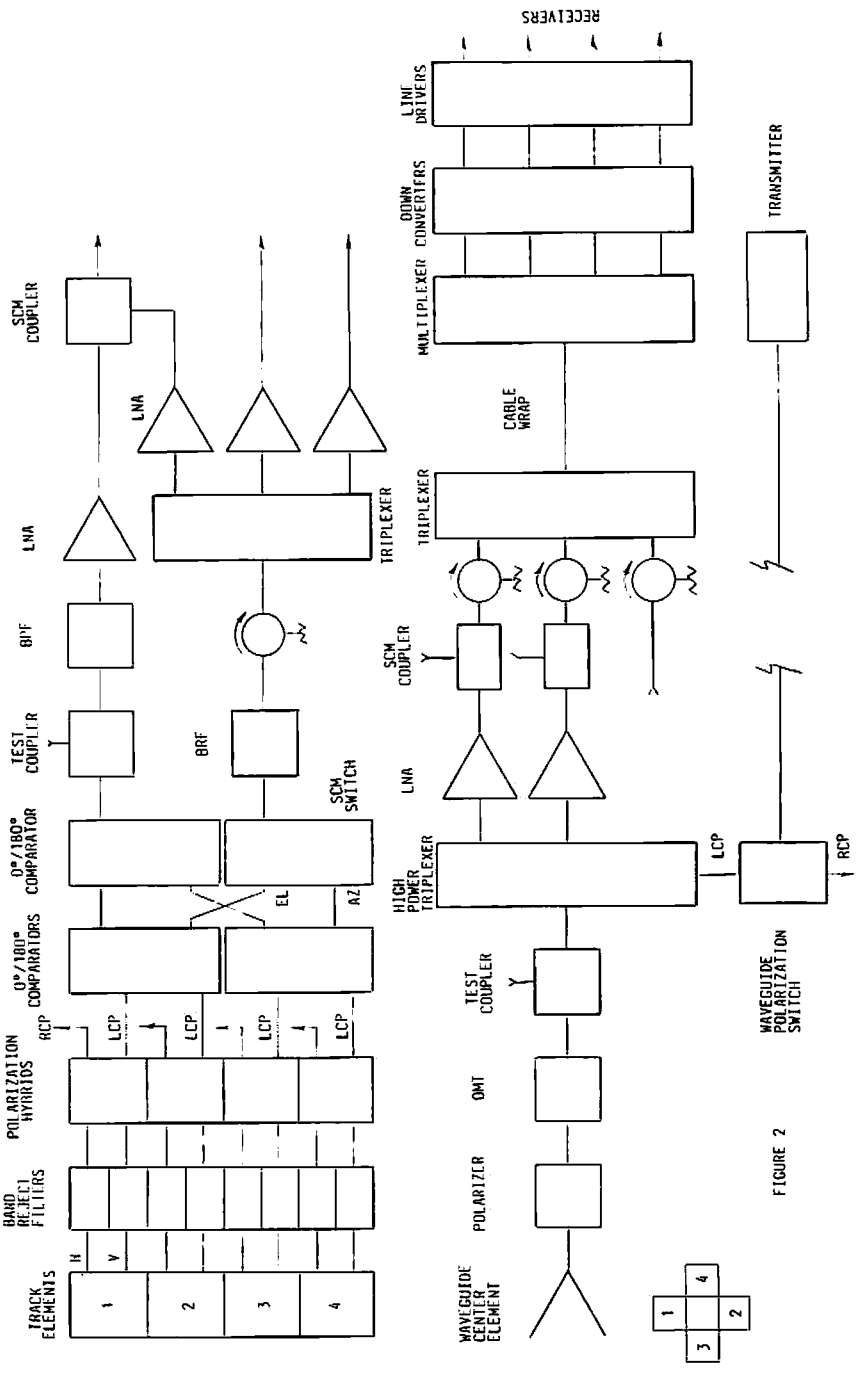

RECEIVERS
LINE DRIVERS
DOWN CONVERTERS
MULTIPLEXER
CABLE WRAP
TRANSMITTER
SCM COUPLER
LNA
TRIPLEXER
BPF
TEST COUPLER
BRF
SCM SWITCH
0°/180° COMPARATOR
0°/180° COMPARATORS
POLARIZATION HYBRIDS
BAND REJECT FILTERS
TRACK ELEMENTS
HIGH POWER TRIPLEXER
LCP
RCP
WAVEGUIDE POLARIZATION SWITCH
OMT
POLARIZER
WAVEGUIDE CENTER ELEMENT
EL
AZ
H
V
1
2
3
4

FIGURE 2