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THE RF SYSTEM

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I. Introduction

The components of the RF system as defined by the block diagram RC-268 comprise the feed horn, tunnel diode amplifier, mixer-IF preamplifier, and the required power supply. In the present discussion the waveguide rotating joint will also be considered as part of the RF system, leaving the horn system free of components which are limited in operation to a particular frequency band. All of the components of the RF system are located in the box of the focus of each antenna, with the exception of the power supply which is in the ground box. The components for any one antenna and their interconnections are shown in the block diagram in Fig. 1.

The classification of a number of the waveguide components as parts of the RF system, or the switched receiver system is necessarily an arbitrary one. Most of the passive waveguide components such as bends, twists and couplers have been classified under the switched receiver system, and are listed in Section A of the component list of Glint No. 206. That list, together with part A of the component list of this glint and part A of the component list of the glint describing the Local Oscillator system includes all components of the receiving system which are mounted in the front end box of each antenna. The three lists do not overlap, and each component is listed once only.

The basic purpose of the RF system is to convert the incoming RF signal to the intermediate frequency, and to provide sufficient amplification to enable the IF signal to be transmitted to the main receiving system in the laboratory without loss of signal-to-noise. The system must also accept both sidebands, and provide a low and stable noise figure. The choice between a crystal mixer followed by a low-noise broadband IF preamplifier, or a tunnel diode RF amplifier followed by a tunnel diode mixer and IF preamplifier has been discussed in some detail in Glint No. 193. The tunnel diode RF amplifier and tunnel diode mixer combination is preferable because both the noise figure and the frequency response are less dependent upon the local oscillator power level, although these components are somewhat more expensive than a crystal mixer. A tunnel diode amplifier is preferable to a traveling wave tube because of its much greater phase stability, lower power requirements, and more convenient physical size. The following are the main characteristics of the tunnel diode amplifier and mixer-pre-amplifier which have been chosen for the RF system.

Tunnel diode amplifier:

Aertech No. T7525
Frequency Response 10.69 ± 0.15 GHz
Noise Figure 5db
Gain 17db
DC Power -15v.

Tunnel diode mixer and IF preamplifier

Aertech No. Q7122
Frequency Response 8-12 GHz
Noise Figure 8.5 db (10.69 ± 0.15 GHz)
Gain, RF to IF 18 db
DC Power -15v, 9 ma
LO Power -5dbm.

The transmission system between the horn and the input of the tunnel diode amplifier consists of a number of waveguide components such as the rotating joint, a length of flexible waveguide, a length of rigid waveguide, one arm of a cross guide coupler, a waveguide twist, a mechanical waveguide switch, and a 4-inch length of stainless steel waveguide. The rotating joint has an insertion loss of 0.1 db, and the remaining components comprise a length of a little less than 3 feet of waveguide path. The attenuation of an equivalent length of brass waveguide would be about 0.2 db. If we assume a total loss of 0.5 db between the horn and the tunnel diode amplifier, the equivalent receiver noise temperature referred to the horn is 770 ^{o}K, using the figures given above for the characteristics of the amplifier and mixer.

The waveguide rotating joint is of the inline type and is one which was developed by MDL Inc. to specifications supplied by the radio astronomy group at Caltech. Its nominal frequency range is 10.0 to 10.8 GHz, and the performance is optimized at 10.69 GHz. The specifications of the joint are as follows:

MDL No. 20-1603
Frequency Range 10.0-10.8 GHz

VSWR 1.15 Wow 1.04 Insertion loss 0.15 db	10.0-10.8 GHz
VSWR 1.05 Wow 1.03 Insertion loss 0.10 db	10.69 GHz

The power supply for the RF amplifier and the IF preamplifier (-15v) should have the best possible stability. The supply chosen (Hewlett Packard No. 6101A) is one of a series in which the performance in terms of line regulation and temperature stability is about one order of magnitude better than most other low voltage power supplies.

II. Component List

A. The following components are mounted at the focus of each antenna:

Feed Horn (1)	to be designed	
Rotating Joint (1)	MDL 20-1603	$550
Flexible Waveguide		
Tunnel Diode Amplifier (1) (with waveguide input)	Aertech T7525	$2050
Mixer and IF Preamplifier (1)	Aertech Q7122	$1025

B. The following components are in the ground box at each antenna:

Power Supply (1)	Hewlett Packard 6101A	$265
Line Regulator (1)	Stabiline S429 6KVA	on hand from government surplus

III. The Front-End Box

The equipment enclosure to be located on the feed support just behind the focus of each antenna has been described in detail in Glint No. 183. All components of the RF system, the Switched Receiver system, and the Local Oscillator system which are located in the front end box will be mounted on a 19" x 19¼" rack panel. Since writing Glint 183 a small change has been made in one of the dimensions; the distance of the plane of the front surface of the rack mounting angle from the center of the input wave-guide will be 3" and not 4" as shown in the figure in Glint 183.

The walls of the front end box will be thermally insulated, and it is not yet clear whether any heating or cooling elements will be necessary for further temperature control. Until tests have been made to determine the range of temperature variations it will be assumed that the insulation will suffice for temperature control.

IV. Cables

The following cables are required between the front end box and the ground box:

DC power to tunnel diode amplifier and IF preamplifier	4 conductors
(N.B. two of the conductors are required for remote voltage sensing.)	
IF cable	coaxial
(N.B. two coaxial rotating joints, Sage No. 344 may be required in this line.)	
From the ground box to the laboratory IF cable,	coaxial.

V. Power Requirements

For the RF system the only 115 ac power required is for the - 15v power supply in the ground box. This will be supplied from a voltage regulator located in each ground box. The voltage regulator will be a Stabiline S429 and will supply all other power requirements for electronics at the antenna.

VI. Jobs to be Done

An optimum design is required for a feed horn for use with paraboloids of focal ratio of 0.3. This should enable the antennas to be used at the highest possible efficiency while yet retaining low spillover so that the effective antenna temperature is no higher than necessary. It should be remembered that although an antenna temperature of 100 °K or more is of little detriment with the receiving system described here, it may be possible to obtain lower noise amplifiers to improve the sensitivity at some future date.

Measurements should be made of the temperature variations which occur within the front end box when all components are mounted and operating.

As of this time all components have been obtained or ordered to complete two RF systems except for the feed horns. For three others only the line voltage regulators are presently in hand, and three each of all other components listed in section II above are yet to be purchased.

One front end box is now under construction. The second one should be made during the summer of 1967, and the remaining three can be constructed as the antennas on which they will be mounted are completed.

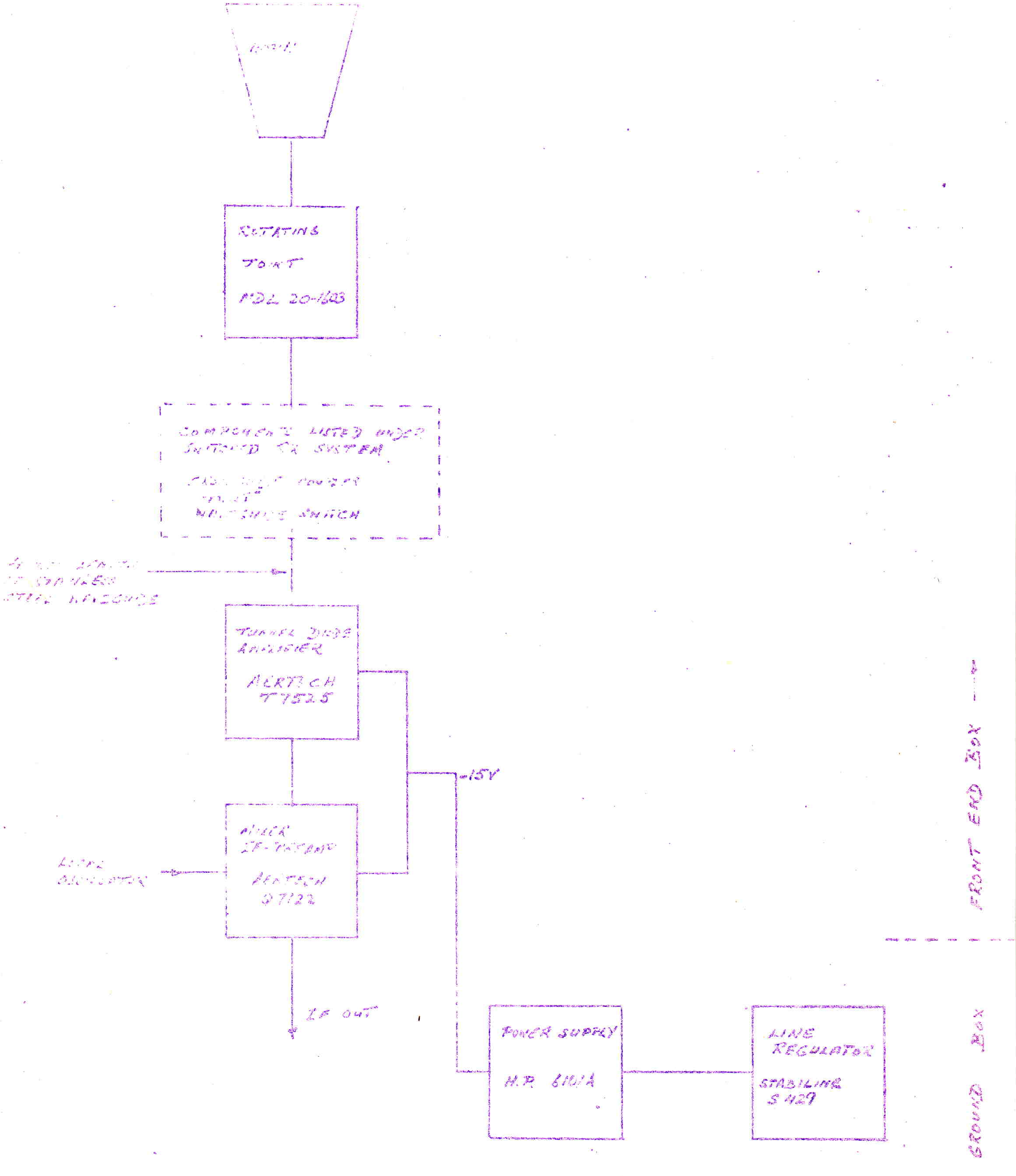

FIG. 1 R.F. SYSTEM