Project Telstar

Fucino Earth Station Operation Analysis

Telstar I was employed in communication experiments from the pass 1627, January 4th 1963 until February 16th, when the satellite ceased functioning for communication. During this period 23 experiments were performed, about half of which were of wideband type.

THE FUCINO EARTH STATION

The Fucino Earth Station, owned by Telespazio, has been operational, during the period when communication experiments were conducted via Telstar I, only for the reception.

The Telespazio Station is located in the Fucino Valley, about 80 miles East of Rome. Geographical coordinates are as follows: Latitude, 41° 58′ 40.55″ North; Longitude, 13° 36′ 04.21″ East.

The Station is equipped with a 30 ft steerable dish, azimuth-elevation mount, equipped with a Cassegranian sub-reflector and with a primary feed assembly consisting of a four port horn for the 4 kMc band, used both for the monopulse beacon autotrack receiver and the communication receiver.

The communication receiver consists of a two stage parametric amplifier, the first stage being liquid nitrogen refrigerated. A conversion is made to a 70 Mc IF, the IF amplifier being followed by either of two frequency following demodulators, one for the wideband experiments and one for the narrow band experiments.

The Station is also equipped with video band equipment and instrumentation and test equipment. Fig. 1 shows a general view of the Station. Fig. 2 is a block diagram of the receiving system.

EQUIPMENT PERFORMANCE

Antenna

Gain at 4170 Mc/s = 48,7 ± 0,5 db

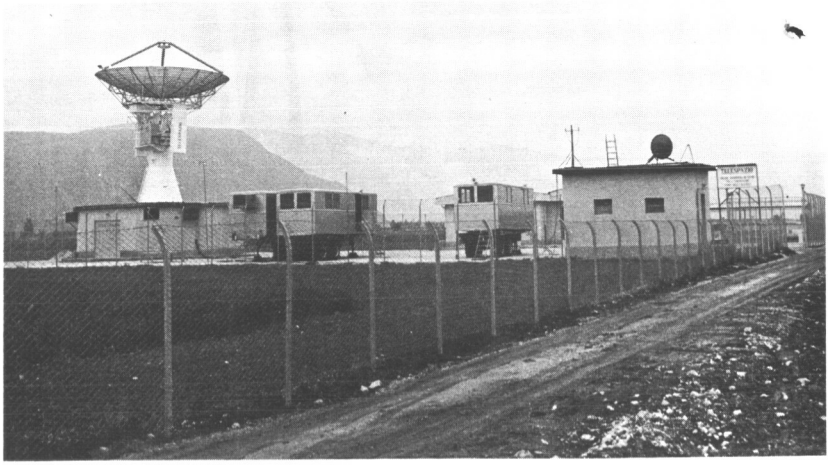

Fig. 1 — A general view of the Telespazio Station.

Communication Receiver

3 db Bandwidth	:	24 Mc/s
Noise Bandwidth	:	26 Mc/s
RF Gain	:	28 db

Reference noise temperature (dry atmosphere) : 220°K

Wideband threshold

The threshold occurs when the carrier to noise ratio equals 18 db in 1 Mc/s bandwidth. In these conditions the received power is about −97,5 dbm and the weighted video S/N is about 40 db;

Narrowband threshold

It occurs when the carrier to noise ratio equals 6,75 db for the group A (12—60 kc), 10 db for the group B (60—108 kc) in 1 Mc/s bandwidth.

In these conditions the received power is −108,5 dbm for the group A and the signal to noise ratio on the highest channel is about 35 db.

Using the CCIR emphasis and psophometrically weighting the noise, this ratio is about 41 db, to which corresponds a 80,000 pW noise in any channel. For group B the signal to noise ratio in the highest channel at the threshold is about 41,5 db; using the CCIR emphasis psophometrically weighting the noise, this ratio becomes 46 db and the relative noise 12,000 pW.

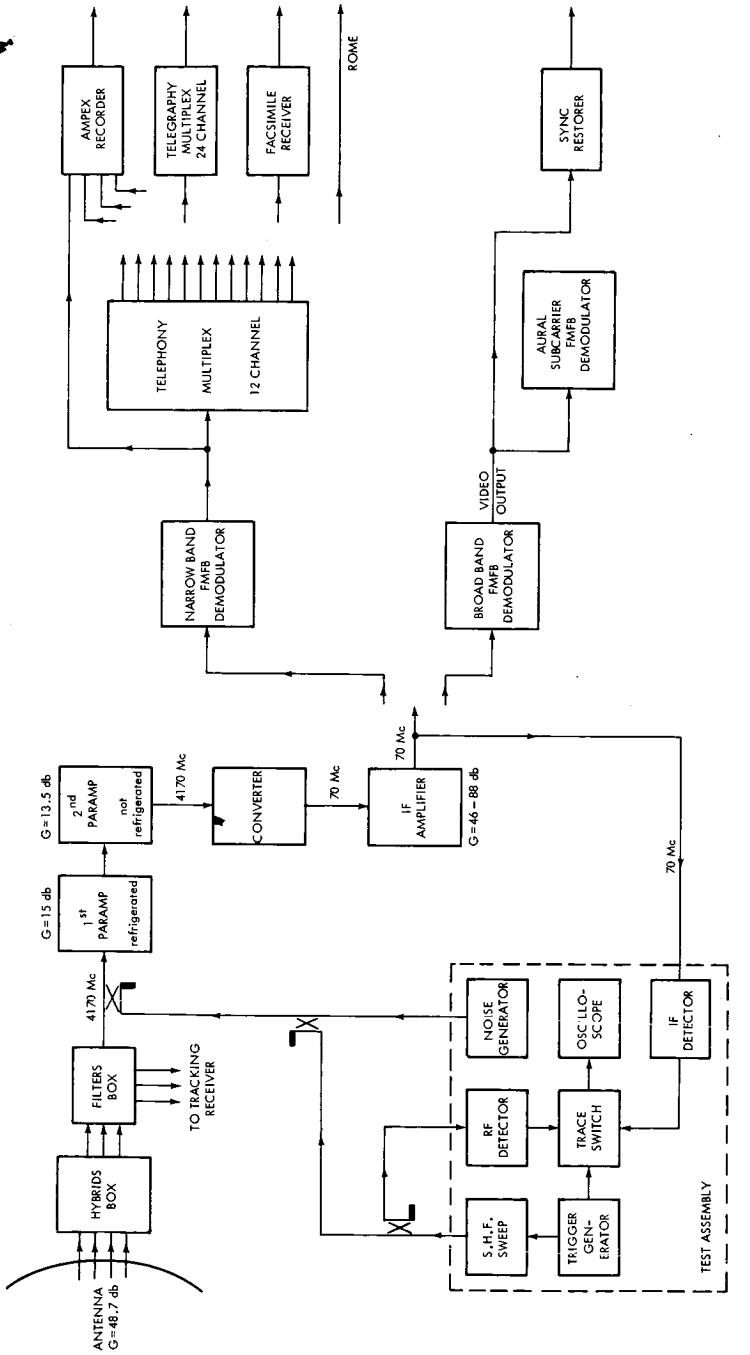

Fig. 2 — Communication receiver system.

OPERATION ANALYSIS

Noise Temperature

The reference noise temperature, measured immediately before and after every pass, varied from 220 to 260°K, depending on weather conditions.

Received Signal Strength

In Fig. 3 are shown some values of the received power, referred to a 10,000 km range. It has been assumed, as a reference for this range, a −104,5 dbm received power level, which corresponds to a satellite transmitting antenna gain of −1 db.

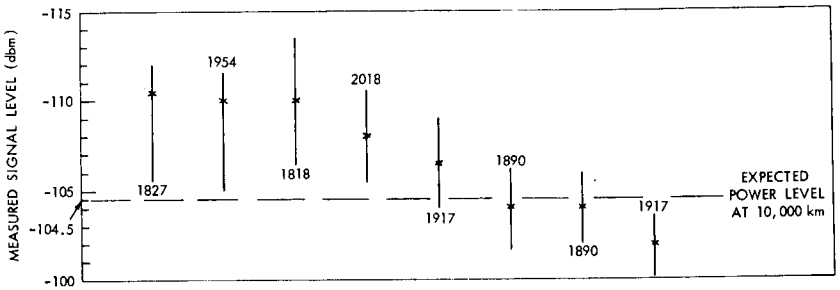

Fig. 3 — Power levels referred to the 10,000 km range.

In Figs. 4 and 5 the signal strengths received during two experiments are shown. It has been observed that the measured power differs, from the expected one, by as much as 6 db. The average is about 3 db below the expected value. These differences may be attributed to errors in the power test system, particularly for low signal levels, and also to the spacecraft look angle. The maximum measured power was −99 dbm, the minimum −110 dbm. The maximum observed spin modulation was about 2 db.

Insertion Gain

This test is typical of the loop configuration in which the Earth Station itself checks the transmitted and received signal levels.

Considering that Fucino Station is not yet equipped with the transmitter, this test is of little interest. Anyway, the results have been fairly good.

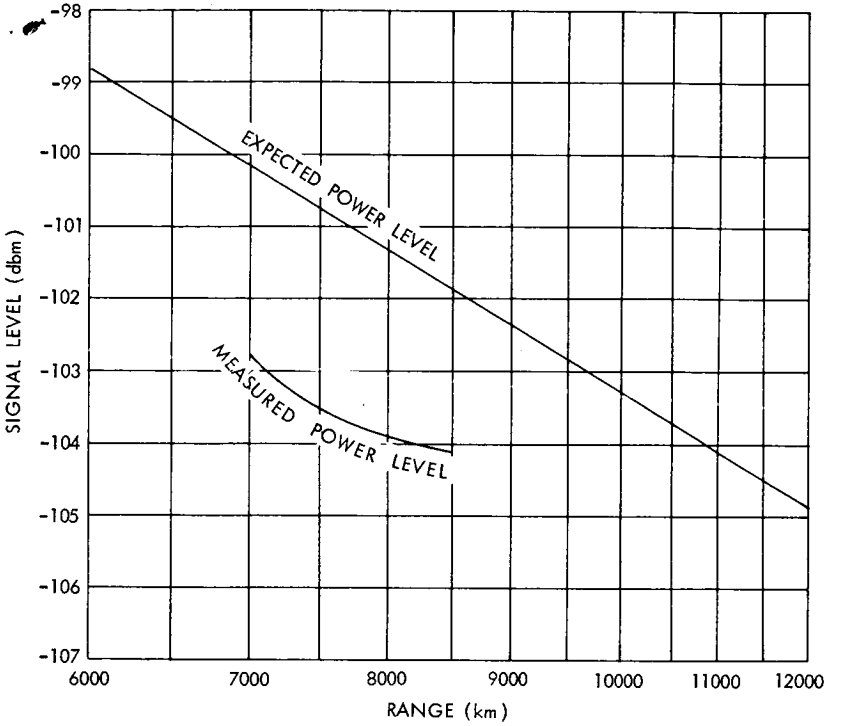

Fig. 4 — Telstar—Pass 1890: Received signal level versus range.

Continuous Random Noise

In Table I are shown some results of a typical noise test, on 12th channel, group A, performed during the Telstar I 1917 pass. This experiment has been conducted without preemphasis, and the noise has not been psophometrically weighted. The main part of the differences from expected values may be attributed to the imprecision in measurements, and also to the multiplex adjustment.

TABLE I

Measured signal strength (dbm)	Expected S/N (db)	Measured S/N (db)
−104	39	37
−101	42	38.5
− 99	44	39

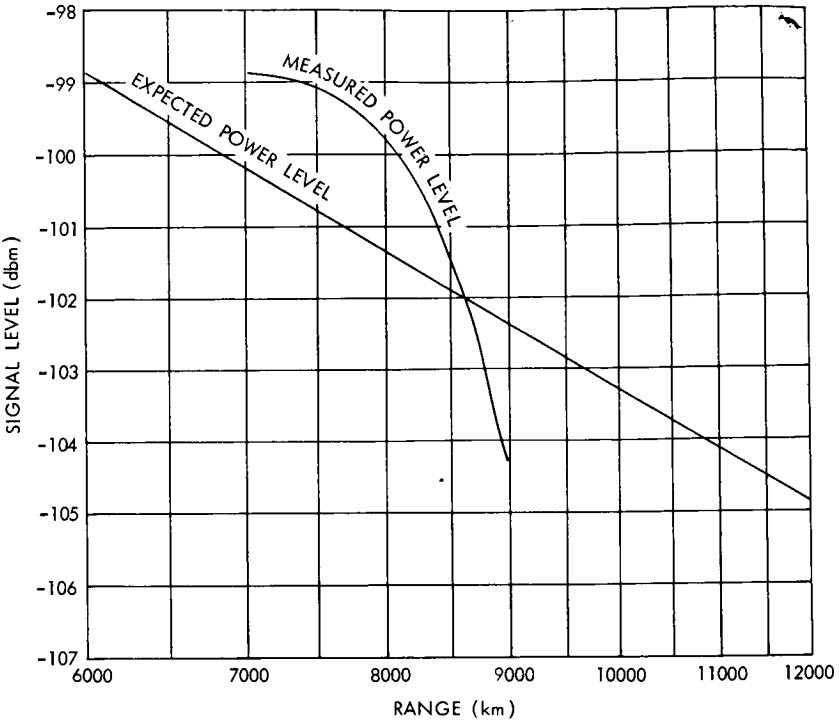

Fig. 5 — Telstar—Pass 1917: Received signal level versus range.

During these narrowband experiments voice narrations, telephone demonstrations, and teletype signals, have been received. The signal was quite always over the threshold.

Wideband Experiments

The absolutely first reception conducted by Fucino Earth Station was a TV test, the "window", transmitted from Andover, via Telstar, during the revolution 1627 of the January 4th 1963.

Several other wideband reception tests via Telstar have been successively conducted; owing to the small dimensions of our Station which had been basically dimensioned for 12 telephone channels, the signal level was always below the threshold. Nevertheless these experiments have been very useful.

TRACKING PERFORMANCE

The employed tracking system, of monopulse type, yielded good results and confirmed that, owing to its simplicity and reliability, it is very suitable.

During the first days of the experiments some difficulties in acquisition and tracking were experienced. These troubles, due to damages in the tachymetric loop, were quickly removed and, since then, the system performance was excellent.

The minimum power level for the 4080 Mc beacon acquisition is −129 dbm.