FINAL REPORT

BIT II MISSION 7063

24 December 1965

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1. PROGRAM OBJECTIVES.

The objective of the BIT II program is to determine if and when the AGENA vehicle is tracked by a radar operating in the 150- to 300-Mc frequency range. The BIT II system, designed to fulfill this objective, covers this VHF band with a hunt-lock on receiver which searches for strong signals having wide pulse widths characteristic of long range surveillance and tracking radars. On those signals which qualify, the system locks on to determine if the emitter is continuously tracking the vehicle. Gross parameter measurements are made during this period which enable an analyst to determine the signal characteristics for possible emitter identification.

2. MISSION SUMMARY.

2.1 Mission Highlights.

The BIT II system intercepted a signal identified as [redacted] on 24 September from 0803:19Z to 0805:16Z. The signal was detected as the vehicle passed from 53.2N/72.4E to 45.5N/74.9E at an altitude of 112 nautical miles on orbit 23. From the ground trace of the orbit and the known location of the emitter, it is concluded that this was a side lobe intercept and that the emitter did not track the AGENA vehicle.

The system also made several intercepts of the [redacted], TALL KING, and [redacted] during the passes over the USSR and China. These signals are of no interest to this mission since they did not appear to continuously track the AGENA. They do, however, serve as operational checks on the BIT II system.

The operational data showed the system to be operating under exceptionally noisy conditions which inhibited the analysis for the mission. Part of the interference was due to the Link II telemetry

2.1 -- Continued.

transmitter on the vehicle. This was on only over the U. S. tracking stations and, therefore, did not interfere with the primary mission. The predominant noise interference was probably generated within the BIT II system itself or it was due to the susceptibility of the system to noise generated both in the system and on the vehicle. Although this interference reduced the quality of the data and made the analysis more difficult, it did not prevent the identification of intercepts.

2.2 Flight Summary.

Vehicle Number	1619
Launch Date	22 September 1965
Launch Time	2135Z
Inclination	80 degrees
Apogee	211 nautical miles
Perigee	96 nautical miles
Period	90.2 minutes

3. OPERATIONAL RESULTS.

3.1 [redacted] Intercept.

[redacted]

[redacted]

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3.1 [redacted] -- Continued.

[redacted]

3.2 Other Intercepts.

[redacted]

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3. 2 -- Continued.

[redacted]

4. SYSTEM PERFORMANCE.

4. 1 System Description (See Appendix).

4. 2 Specifications.

(a)	Frequency Coverage	147 to 305 Mc
(b)	Receiver Detection Sensitivity	-62 dbm to 240 Mc -58 dbm to 305 Mc
(c)	Receiver Bandpass	5. 2 Mc @ 220 Mc
(d)	Image Rejection	48 db @ 220 Mc
(e)	Pulse Width Qualification	15 microseconds

4.2 -- Continued.

(f) Measurement Ranges

Amplitude	-62 to -37 dbm	Low Channel
	-37 to -5 dbm	High Channel
Pulse Interval	2-100 milliseconds	Low Channel
	1-35 milliseconds	High Channel
Pulse Width	20 to 2000 microseconds	
Pulse Count	50 to 1500 pps	Non Qualified
	10 to 600 pps	Qualified
Discriminator Range	+3 to -2 Mc about IF	

(g) Duration of Sweep Lock — 3.8 seconds

4.3 System Operation.

The operation of the BIT II system during this mission was characteriaed by an abnormal susceptibility to noise generated both on the vehicle and in the BIT II unit itself. As the receiver swept from 300 to 150 Mc, it would stop several times on noise and occasionally on valid signals. The false stops were characterized by no measurable readings in the amplitude and pulse width channels, random measurements in the pulse count channel, and a constant level in the frequency channel which corresponded to the center frequency of the Discriminator. The first pulse interval channel would usually saturate because one noise pulse would start the measurement but the second would not occur until after saturation at 100 milliseconds. The remaining PI channels were relatively free from the interference. The valid sweep stops could be identified because all of the measurement channels would be responding with reasonably stable readings. The influence of the noise, however, added uncertainty and inconsistencies to the measurements. It especially affected the sweep step, frequency, and pulse count measurements. Because the sweep stopped several times and the commutated wavetrain in itself was noisy, it was difficult

4.3 -- Continued.

to determine exactly which step was stopped. The frequency measurements from the Discriminator were severely affected because the noise would not allow the measurement of frequencies below the center frequency of the Discriminator. The pulse count channel was affected by the addition of noise pulses to the count of signal pulses. In spite of the system's response to the noise, it was still possible to recognize valid signal intercepts and to make approximate parameter measurements. The most serious effect was the increased difficulty of data analysis.

The problem of the system's noise susceptibility was recognized in the later systems about the time of this mission. Several corrective steps have been taken to reduce or completely eliminate the system's response to this noise. These steps include the following and were incorporated on all systems with the exception of the unit used on this mission.

(1) A pi-filter was added to the +10 volt line in the Discriminator and IF Amplifier.

(2) The +10 volt line in the IF Amplifier was re-routed to reduce the coupling of noise from the B+ line to the Amplifier.

(3) The sweep generator line was re-routed in the cable harness.

(4) Additional shielding was added in the IF Amplifier and Discriminator.

(5) The tie down rod which goes through the IF Amplifier and Calibrator was changed from metal to fiberglass to prevent it from coupling energy between the circuit sticks.

Another type of interference was noted during passes over the U. S. and Canada. The amplitude channel would suddenly jump to approximately -45 dbm and the sweep would start to double step. This condition was present during every real time read out and

4.3 -- Continued.

during stored time read in periods over U. S. tracking stations. A check with Lockheed revealed that the source of the interference was the Link II telemetry transmitter which was located next to the BIT II unit. Although the operation of the transmitter severely affects the operation of the BIT II unit, it is not a serious problem since the interference occurs only over the U. S. tracking stations. It is possible that the corrective measures noted previously will reduce the effect of the transmitter on the operation of BIT II.

APPENDIX

BIT II SYSTEM DESCRIPTION

General System Operation.

The BIT II system is carried on the aft rack of a horizontally stabilized AGENA vehicle. It flies in a tail-first orientation with the vehicle axis maintained in the orbital plane. After the vehicle is in orbit the antenna is deployed by inflating a 3-foot boom and a torus which forms a lollipop-shaped structure. The antenna, consisting of an equiangular planer spiral attached to a membrane stretched across the torus, is placed in the vertical plane (rudder position) to provide optimum coverage on both sides of the flight path. It has a nominal gain of 0 db, a beamwidth of 140 degrees and a 9-db null which occurs in the plane of the torus. Although the antenna is suitable for operation over a 150-Mc to 1000-Mc frequency range, it is only used to provide coverage in the 150- to 300-Mc band.

The BIT II receiver system includes a voltage-tuned superheterodyne receiver, circuitry for the measurement and storage of signal parameters, an electronic commutator for data sampling, and a time reference generator. The primary output of the system is a commutator wavetrain containing data on the signal amplitude, frequency, pulse width, pulse interval, and total pulse count, plus a time reference, calibration voltages, and temperature and voltage monitors. A second output, which is not normally used in the operational configuration of the system, is the receiver video. This is available to meet any future requirement for wide bandwidth signal information.

The commutator wavetrain (CWT) output of the system is connected to an IRIG channel 14 telemetry subcarrier oscillator for real time data transmission and through a relay to a narrow band tape recorder for data storage during read in over foreign areas. Channel 14, which is transmitted on the telemetry link II, provides information on the operation of the system in real time while the vehicle is passing over the telemetry and tracking stations. This information is primarily used to provide a time tie between universal time and the time reference stored on the tape recorder. Channel 14 has a center frequency of 22 kc, a bandwidth of 3300 cps and a nominal intelligence bandwidth of 330 cps. This is more than adequate bandwidth for the 75 channels per second rate of the CWT signal.

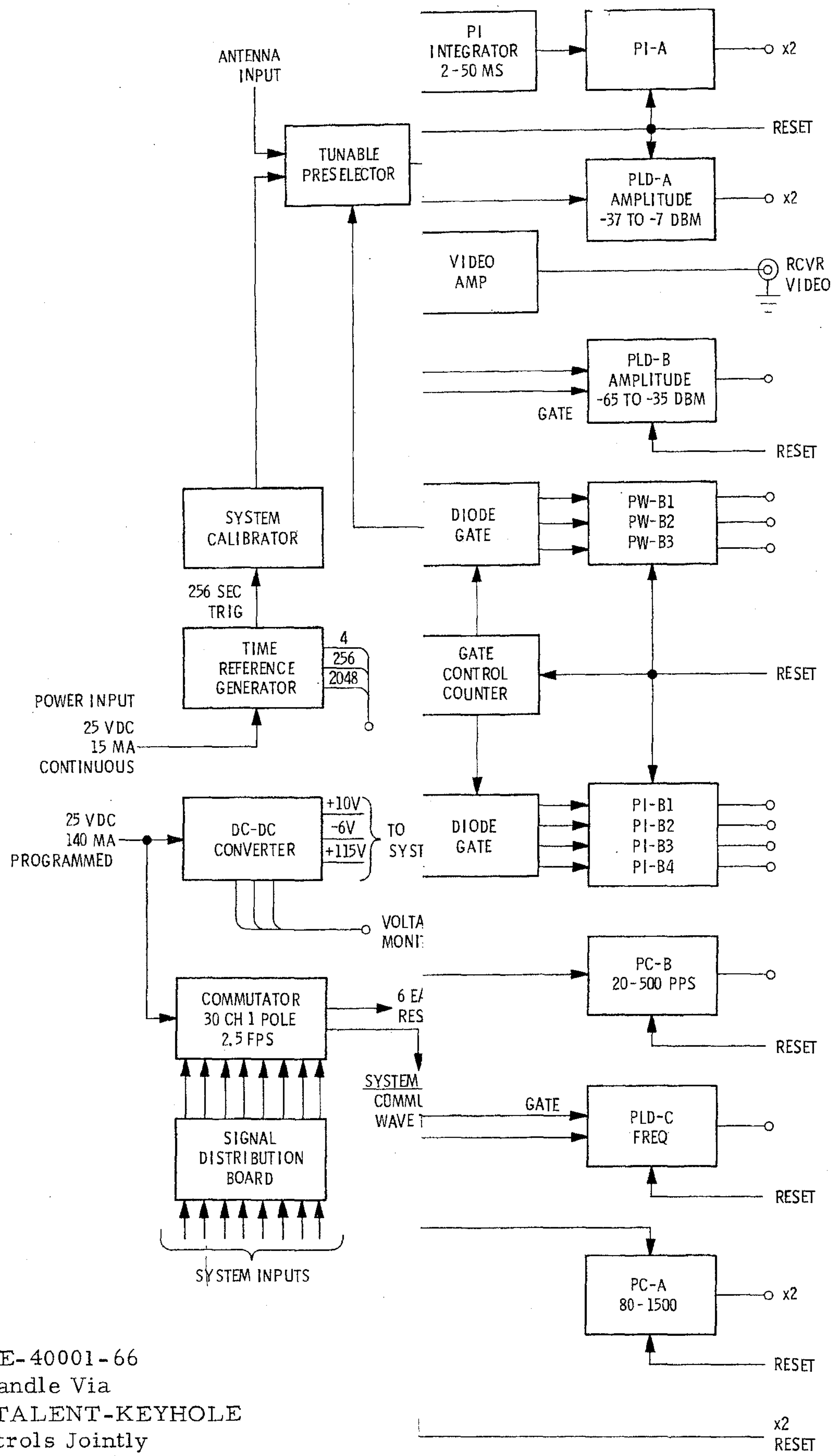
During the system operation over foreign areas, the CWT output is FM recorded on a narrow band tape recorder. This recorder, which is shared with the primary payload, has a read in capacity of approximately 200 minutes and a record frequency response of DC to 30 cps for square wave modulation. This response is marginally adequate for the CWT signal. During passes over the telemetry stations, the recorder reads out in the reverse direction at 26 times the read in rate. Thus, the tape can be completely read out in approximately 7.5 minutes. The resulting information rate is now 1950 channels per second which requires the use of a channel F subcarrier for transmission on the Link II telemetry system. Channel F has a 95-kc center frequency, a bandwidth of 28.5 kc and an information bandwidth of 2900 cps.

The operation of the entire system is controlled by five brushes on the vehicle programmer. These brushes control the operation of the BIT II receiver, the Link II telemetry transmitter, and the tape recorder. The program for the system operation is determined prior to launch and remains fixed with the exception of shifting the entire program forward or backward in time so that it coincides with the achieved orbit.

BIT II RECEIVER SYSTEM

General.

The BIT II system shown in the block diagram consists of a voltage tuned superheterodyne receiver covering the 150- to 300-Mc frequency range, logic circuitry for receiver control, data measurement and storage circuitry, a system calibrator, and support equipment which include a DC-DC converter, commutator, and a time reference



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generator. Since the purpose of the system is to provide a capability to detect high powered radar signals, the receiver is relatively insensitive and uses only pulse width as the criterion for signal qualification. As the receiver scans the frequency band in approximate 5-Mc steps, it will respond to any signal exceeding the detection threshold set at a nominal level of -60 dbm. The detected signals are checked to determine if their pulse widths exceed the pulse width criterion, nominally set at 20 μsec. If the pulse width criterion is satisfied, the receiver will stop for 4 seconds to permit continuous measurements of pulse amplitude, pulse width, pulse interval and RF frequency. The receiver then resumes its sweep in search of other signals. If the detected signal does not satisfy the PW criterion, its presence will simply be noted by a total pulse counter, PC-A, which gives an indication of the pulse density in the signal environment. A very strong pulsed signal with an amplitude greater than approximately -32 dbm will be noted in the High Video Channel where measurements are made of amplitude and pulse interval. The receiver will, however, not lock on these strong signals unless they satisfy the pulse width requirement. The parameter measurements are stored until read out by the commutator. The commutator is also used to step the sweep voltage so that all parameter measurements are synchronized with the receiver frequency tuning. A system calibrator is provided to periodically check the operation of the entire system. It generates a test signal at two crystal controlled frequencies to give a calibration check on the sweep frequency. This signal is modulated such that it also provides a one-point calibration on the amplitude, pulse width, and pulse interval measuring circuits.