Bendix
Aerospace
Systems Division

MILEY

NO.	REV. NO.
ASTIR TM-28	
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DATE 14 Sept. 1973	

A16 TRANSMITTER B SWITCH (26 March 1973)

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SUMMARY

A review of telemetry data did not reveal the cause of the transmitter A anomaly. Data indicates transmitter A was operating 4 to 6 db below nominal operating output power at the time of switch over and that input power was up by 8%. All telemetry data reviewed was stable giving no indication of power changes. During the 4-26 March 1973 period, data dropout occurred only at Lunar Night with the transmitter baseplate temperature at approximately 51 - 53°F. Transmitter switch over to transmitter B occurred 21 hours after lunar sunset with the baseplate temperature at 53°F and decreasing slightly. No direct evidence was obtained to support a modulator failure. Most probable cause of failure is due to either modulator failure or low output power.

INTRODUCTION

At 0926 GMT (actual 0919 GMT) on 26 March 1973 Apollo 16 ALSEP transmitter B was selected by mission control. Switch over was implemented after a series of data dropouts, beginning 4 March 1973 and reported by several remote sites of the STDN, which gradually worsened until Ascension Island reported, "multiple PCM sync errors and further data (PCM) degradation" just prior to switching. The reported data dropouts were unlike those previously reported[1] relative to other ALSEP Stations in that the received signal strength remained constant at -141 dbm. Degradation during the 4-26 March period was described by remote sites in several ways:

a) Data exhibited intermittent PCM data amplitude hits from 1717 to 1830 Z (4 March). Signal strength steady at 141.5 dbm and no decom dropouts.

b) Random data breakup was observed but did not affect decom lock. (2209 Z, 6 March S/S-142.5 Z dbm)

c) Data quality was intermittently poor. A collapsing of the bit stream occurs that varies in length approx 4 to 5 bits to as many as 30 bits. Fluctuations were associated with HSP printouts of "PCM sync error". No cyclic rate of occurrence noted. (6-7 March S/S - 142 dbm).

1. Cause of previous dropouts noted on several ALSEP is due to an unknown propogation disturbance. See GSFC Report of June 1971 by R. M. Christiansen

d) Random break up of data 0800 thru 0803 (7 March S/S-141 dbm)

e) The USB section noticed the received wave train was only modulated about 10% - - - decoms still maintained good lock. Same site later reports; "Data degraded to point where the decoms have intermittent dropouts". Still later; ALSEP OPS advised of multiple PCM sync errors and further data degradation. (0115 - 0910, 25 March S/S-141 dbm)

ANALYSIS

Replay of the Apollo 16 ALSEP data was requested via JSC for the 3/4, 3/6, 3/7 and 3/26/73 periods to determine if there were other indications of transmitter malfunction such as power shifts. Remote site data indicated a 6 db shift of -141 dbm to -135 dbm subsequent to transmitter switchover which is too large a delta if transmitter A was operating at full output. Ascension Island personnel were also contacted to obtain additional information regarding indication of modulation failure. They indicated the statement, "Receiver wave train was only modulated about 10%" was intended to mean the detected PCM data from the receiver was modulated at a low frequency rate with the data amplitude being 10% normal amplitude. Estimated frequency of the modulation was 30 HZ.

Analysis of the replayed data indicated all parameters were constant during the period in question. Table 1 provides a summary of the data. Transmitter A was operating at a low output power of less than 27 dbm. The PCM count for this parameter was 102 which is off scale low for the calibration data used to correct telemetry units to engineering units. Performance data was obtained from JSC for the first Lunar Night operation and was:

Transmitter A Performance Day 121 (1972)

Heat Sink Temperature	53.5^{o}F
Output Power	29.1 dbm
Input Power	419 milliamp

Transmitter A output power was thus degraded by greater than 2 db but input power had increased by approximately 37 milliamp. Preflight data for this transmitter was 30.6 dbm with an input power of approximately 422 milliamp.

The preflight data for transmitter B was 31.1 dbm. This is in good agreement with the telemetry point noted on 26 March of 31.3 dbm.

The above data along with the final transmitter A output power data is in partial agreement with remote site reports of 6 db shift in received signal strength. The output of A is therefore some where between 4 - 6 db below that of B and is therefore close to 26 dbm; a degradation of 4.6 db from preflight.

Because of the relatively large loss of power of transmitter A an investigation was made to determine if the cause of the anomaly was due to weak signal strength. Determination of link margin is difficult to calculate because sufficient data is not available to determine libration and other unknown propogation disturbance losses (See Footnote 1).

ALSEP Performance Summary Report of 7 September 1973, however, states the signal strength of transmitter B varied during the report period from -134.5 to -142.0 dbm. Using the switchover received signal strength of -135 dbm for B implies there is at least 7 db or greater margin from -135 dbm and that transmitter A probably had a positive margin of greater than 1-2 db at switchover.

The above implication assumes that the reported lower value of -142 db was measured at Ascension Island which may not be the case. Relative signal strength from site to site varies 1-2 db typically.

A test was run with the qual Central Station to determine behavior of the detected PCM at the point near PCM sync loss with reduced rf from the transmitter. Generally as sync loss is approached the PCM was amplitude modulated. However, its behavior did not appear to fully fit the description given by the remote sites and probably is a function of the type of receiver employed.

CONCLUSIONS AND RECOMMENDATION

A definite mode of failure was not determined from the data available. Failure orgin appears to be at the transmitter itself as evidenced by a low output power verified by downlink TM and remote site signal strength data. The failure appears to be either a modulator failure or some unknow failure which reduces transmitter output power without a corresponding drop of input power. A possible cause for modulator failure is the Johanson capacitor reference designation C3 (Ref. dwg. 2344601). This style capacitor was a noted problem area during design and developement. No single component failure was identified which would reduce transmitter output power without a corresponding change in input power.

Present data indicates transmitter A degraded, perhaps, due to a long term degradation mechanism. The problem also appears to be some what temperature sensitive having occurred during lunar night. Since there is no evidence of significant power deltas while operating A, there appears to be no reason for not operating this transmitter in the future if need be. If transmitter B fails, it is recommended that operation of A be attempted during lunar day if negative results are obtained during night time operation.

Parameter	4 March 17:15:00
Reserve Power)5 (HK 8)	116-138 (1.41 amp-1.06
Transmitter A Temp. (baseplate) AT 24 (HK19)	77 (51° F)
+29V AE07 (HK20)	210 (29.14V)
Transmitter A Output Power AE15 (HK 51)	102 (< 27dbr
+5V ~ 10 (HK 65)	220 (5.21V)
Transmitter B Output Power AE 16 (HK 66)	0 (-)
Transmitter A Input Current AE 17 (HK 81)	188-190 (<462 - 45
Transmitter B Input current AE 18 (HK 22)	0 (0)

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Number	Originated by:	Reference Document(s)
28	Organization: Bendix - Houston	ALSEP PSRM's
Date: 12 Apr 73	Name: R. Miley	

Short Title: A16 Transmitter B Switch (26 March 73)

Study/Task Description:

At 0926 G.m.t., 26 March 1973, Apollo 16 ALSEP transmitter "B" and processor "Y" were selected by command at the direction of mission control.

1. Determine the cause of and evaluate implications of transmitter "A" operations from 5-26 March 1973; and,

2. Once the cause is established, define the potential impact on future long term operation of transmitter "A". Is return to transmitter "A" recommended?

Scheduled Completion Date	Output(s)
Interim 1 Jul 73 ☐ Final TBD	As Required

Authorization

NASA [signatures] BENDIX [signature]

Results (use supplementary sheets as necessary):

Completion Date	Approvals	Distribution:	
☐ Interim ______	NASA ______	P. D. Gerke	W. Tosh
☐ Final ______	Bendix ______	W. Eichelman	R. Miley
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