TEST REPORT FOR TWINAX CABLE
(ROCKWELL TYPE MB0150-051)

Job Order 14-409

(NASA-CR-151725) TEST REPORT FOR TWINAX CABLE (ROCKWELL TYPE MB0150-051) (Lockheed Electronics Co.) 42 p HC A03/MF A01 CSCL 09C N78-25322
G3/33 Unclas 21618

Prepared By

Lockheed Electronics Company, Inc.
Systems and Services Division
Houston, Texas

Contract NAS 9-15200

For

SPACECRAFT SYSTEMS TEST
TRACKING AND COMMUNICATIONS DEVELOPMENT DIVISION

National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

April 1978

LEC-12088
SHUTTLE

TEST REPORT FOR TWINAX CABLE
(ROCKWELL TYPE MB0150-051)

Job Order 14-409

PREPARED BY

G. D. Doland, Principal Engineer
Spacecraft Systems Test Section
Lockheed Electronics Company, Inc.

APPROVED BY

LEC

A. L. Roelse, Supervisor
Spacecraft Systems Test Section

J. S. Creamer, Manager
Tracking and Communications
Systems Department

NASA

W. C. Long, Manager
Spacecraft Systems Test

Prepared By

Lockheed Electronics Company, Inc.

For

Spacecraft Systems Test

Tracking and Communications Development Division

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

April 1978

LEC-12088
SHUTTLE

1. Report No. JSC-13961	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Test Report for Twinax Cable (Rockwell Type MB0150-051)		5. Report Date April 1978 6. Performing Organization Code 625-10
7. Author(s) George D. Doland		8. Performing Organization Report No. LEC-12088
9. Performing Organization Name and Address Lockheed Electronics Company 1830 NASA Road 1 Houston, Texas 77058		10. Work Unit No. 63-1551-4409 11. Contract or Grant No. NAS 9-15200
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Lyndon B. Johnson Space Center Houston, Texas 77058		13. Type of Report and Period Covered Technical Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A series of tests performed on the twinax cable is described, and results of the tests on March 15, March 20, and March 21 are summarized.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Twinax cable Mismatched termination	Unclassified - unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified		

*For sale by the National Technical Information Service, Springfield, Virginia 22161

JSC Form 1424 (Rev Nov 75)

NASA — JSC

ACKNOWLEDGMENT

The test of the special twisted pair controlled impedance shielded cable called twinax was performed at the request of the Technical Monitor, William C. Long, Manager, Spacecraft Systems Test of the Tracking and Communications Development Division. The test was performed for the Television Section. George D. Doland of the Spacecraft Systems Test Section of Lockheed Electronics Company, Inc. (LEC), was the project engineer for the test. He conducted the test and prepared this report.

CONTENTS

TABLES

FIGURES

1. SUMMARY

A series of tests was run on the controlled impedance twisted pair shielded cable (Rockwell type MB0150-051) to determine the frequency response and effects of mismatched termination. This cable is also called twinax.

It was determined that a long length of this cable, about 100 feet, exhibits a frequency sensitive attenuation roll-off greater than 1.5 dB down at 5 MHz. It was also determined that improper termination could result in losses of 1/2 to 1 dB within the frequency range of 200 KHz to greater than 1-1/2 MHz. An extreme mismatch could result in severe attenuation greater than 10 dB in narrow bands.

The test results suggest a possible problem where mismatched connectors are used in video signal cables.

2. INTRODUCTION

2.1 PURPOSE

The purpose of the test was to measure the frequency response characteristics of the controlled impedance (Rockwell type MB0150-051) twisted pair shielded cable and to evaluate various configurations of termination, impedance matching, and grounding. This cable is used in the Space Shuttle Orbiter (SSO) for transmission of analog signals. The amplitude and phase responses of cables are very significant for the wide-band video signals used for the Shuttle television system. The band of interest covered the range from DC to 5 MHz. In the SSO, the cable is terminated in approximately 75 ohms but is routed through connectors that are not matched.

2.2 DESCRIPTION

Several different cable connection configurations were used during the test. A calibration test was conducted using a short length of cable only 2 or 3 inches long. This short cable having negligible effect provided the technique used to verify the other components. Several cable lengths were used, one short cable 1 foot in length, another short cable approximately 8 feet in length, and a long cable about 100 feet in length. In one configuration, a twinax/triax connector was used at one end of each cable and a BNC connector on the other. The two pieces could be connected together to form one cable with either BNC connectors on each end or twinax/triax connectors on each end. They were also used separately. Another test configuration consisted of the long cable with balanced type connectors driven by a balanced signal into a balanced load.

2.3 TEST SYSTEM

An automatic test system was used to perform the test. The signal source consisted of a frequency synthesizer. The signal amplitude and phase were measured using a network analyzer. Both items were controlled by a calculator as part of an automated test system. The automated test system also included a printer, a plotter, and a tape cassette memory. Accessories included 50- to 75-ohm matching units, a 75-ohm isolation transformer, cables, and feedthrough terminations.

Some of the tests used a wide-band Dynair video amplifier (type BU-1029A) with an unbalanced input and balanced output. In other tests, a pair of amplifiers was used. Dynair amplifier type BU-229A-L-O-75-B converted an unbalanced input to a balanced output, whereas the Dynair amplifier type BU-229A-L-I-75-B converted a balanced input signal to an unbalanced output. This pair of amplifiers had 75-ohm input and output impedance.

The general test configuration used is shown in figure 1-1.

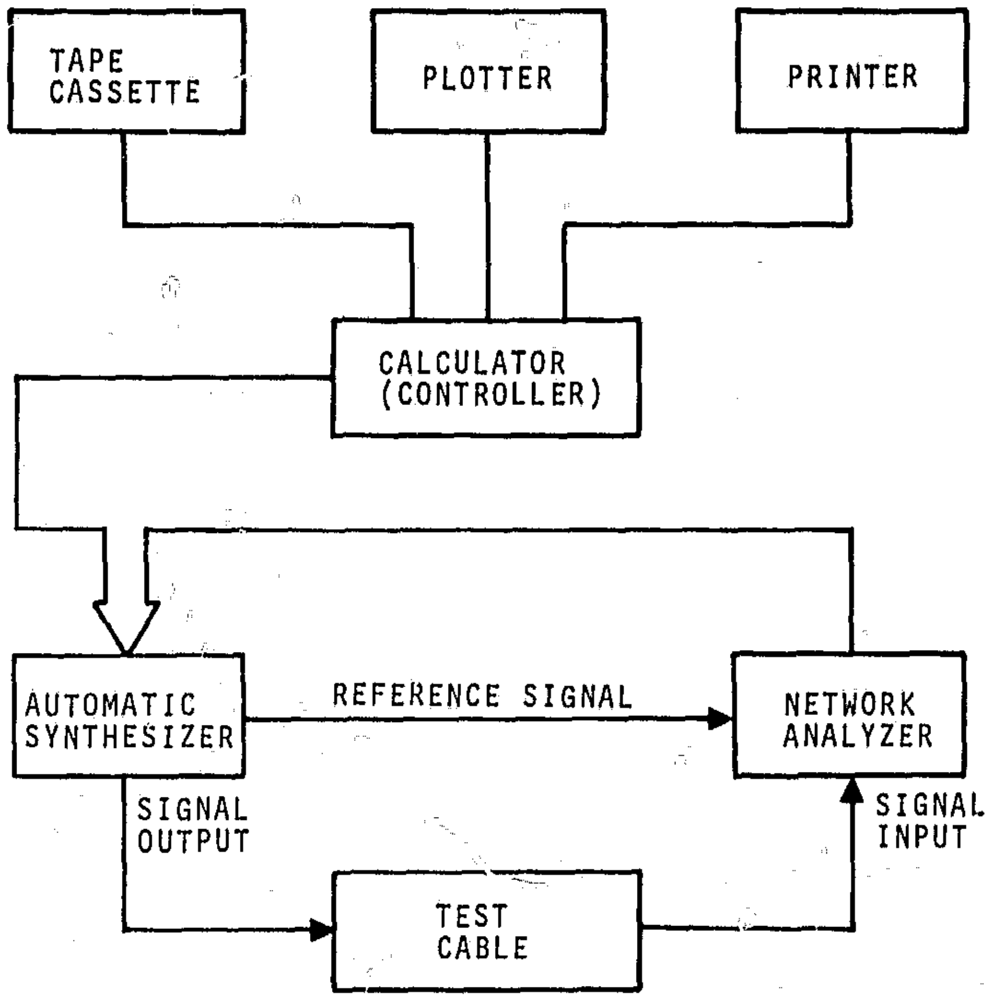

Figure 2-1.— Automatic Test System.

3. WORK PERFORMED

3.1 PRETEST PREPARATION

The general-purpose low-pass filter program for the Automatic Test System was used in performance of the test to provide a logarithmic frequency sweep. The number of points, starting frequency, and end frequency parameters were entered during the test. The frequency range covered from 50 Hz to 5 MHz, with either 101 or 104 data points. The program provided plotted data and printed data.

The other pretest preparations consisted of putting the connectors on the cable.

3.2 SUMMARY OF TESTS CONDUCTED

The test conducted included the following:

a. Cables and impedance matching devices

b. Transformer and cables

c. Cables and amplifiers

d. Cables with balanced drive and load

e. Cables with balanced drive and transformer

f. Cables with unbalanced operation

3.3 DISCUSSION OF OPERATIONS

The tests were conducted on March 15, March 20, and March 21. The initial tests were performed before the balanced driver and receiver amplifiers were available. The last test performed was a test of the amplifiers using a cable only a few inches long.

During initial tests on March 15, it was determined that the phase response was plotted incorrectly during some tests. The fault was determined and the program was altered to correct the error. Since the phase response was not used as a direct measure of performance, the tests were not repeated. The phase data for test 4 on March 15 are invalid, but the phase data for tests on March 20 and March 21 are correct as well as the other tests on March 15.

4. ANALYSIS AND INTERPRETATION OF RESULTS

4.1 REDUCED DATA SUMMARY

The first test, March 15, provided baseline data of the test setup which consisted of two 50-ohm cables and two 75- to 50-ohm matching networks, a "barrel" adapter, and a 50-ohm feedthrough termination. The cable configuration is shown in figure 4-1. The results are shown in figure 4-2. The response was down by about 0.2 dB at 5 MHz with respect to the peak response.

The second test, March 15, was similar to the first, but a 50-Hz to 20-MHz 75-ohm isolation transformer was added to the system in lieu of the "barrel" adapter as shown in figure 4-3. The response was down about 1/2 dB at 50 Hz and down about 3/4 dB at 5 MHz (fig. 4-4). This test was performed to determine the effect of the transformer that was to be used to test the cable.

The third test performed utilized a cable connected from the frequency synthesizer to the Dynair amplifier (BU-1029A) with an unbalanced 75-ohm input and a balanced 75-ohm output. A short cable about 1 foot long was connected to the transformer used in test 2. The transformer output was connected to a 75-ohm cable and terminated in a 75-ohm feedthrough terminator at the Network Analyzer. See figure 4-5. The short cable had the shield open at both ends for one test and tied to ground for a second test. In each case, the results were identical (see fig. 4-6). There was a broad 0.9 dip in the response at about 700 KHz. It was concluded that this resulted from a mismatch in the loading.

The fourth test, March 15, was the first test of the long twinax cable. The test configuration was the same as that shown in figure 4-5. In this test, the phase response is invalid. Because of the mismatch at the transformer, there was a dip of about 0.8 dB at about 200 K (see fig. 4-7). This dip could be

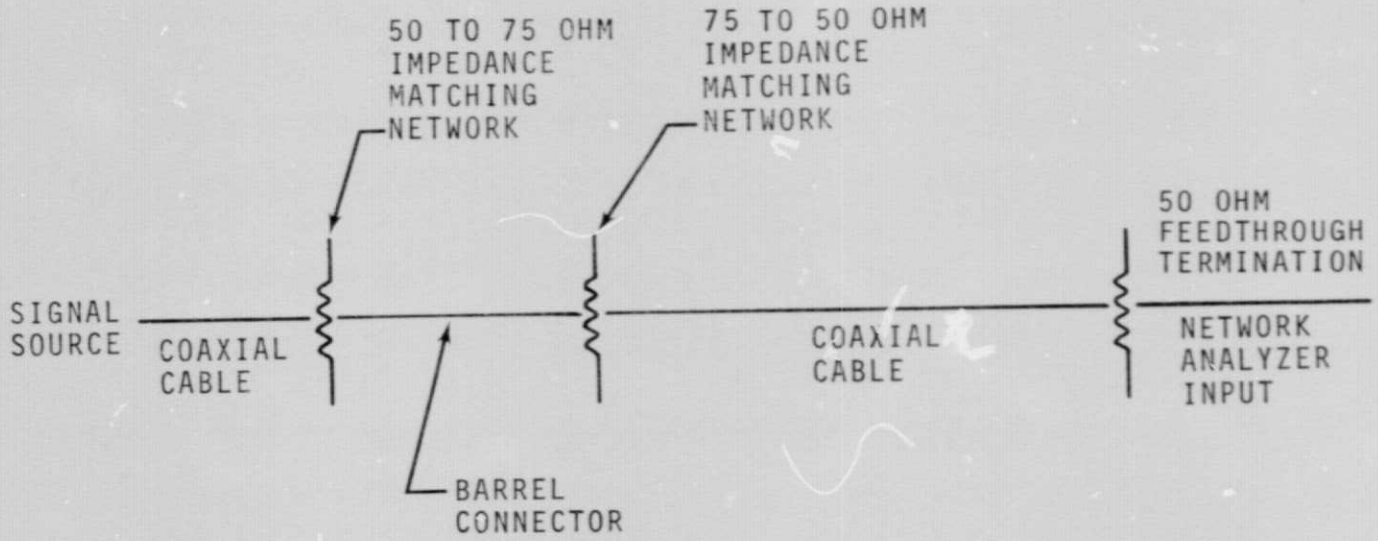

Figure 4-1.– Cable configuration.

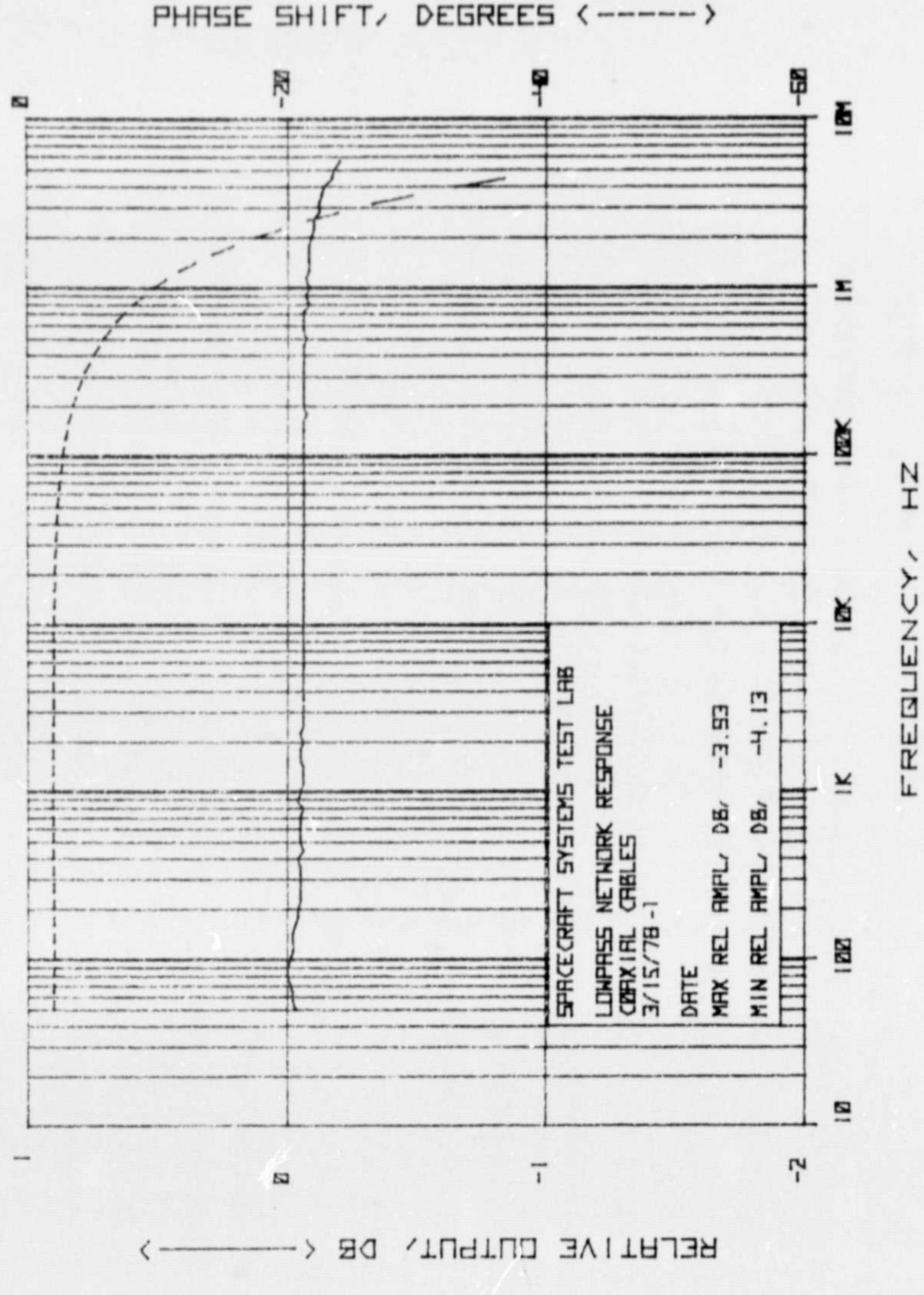

Figure 4-2.- Low-pass network response for the coaxial cables.

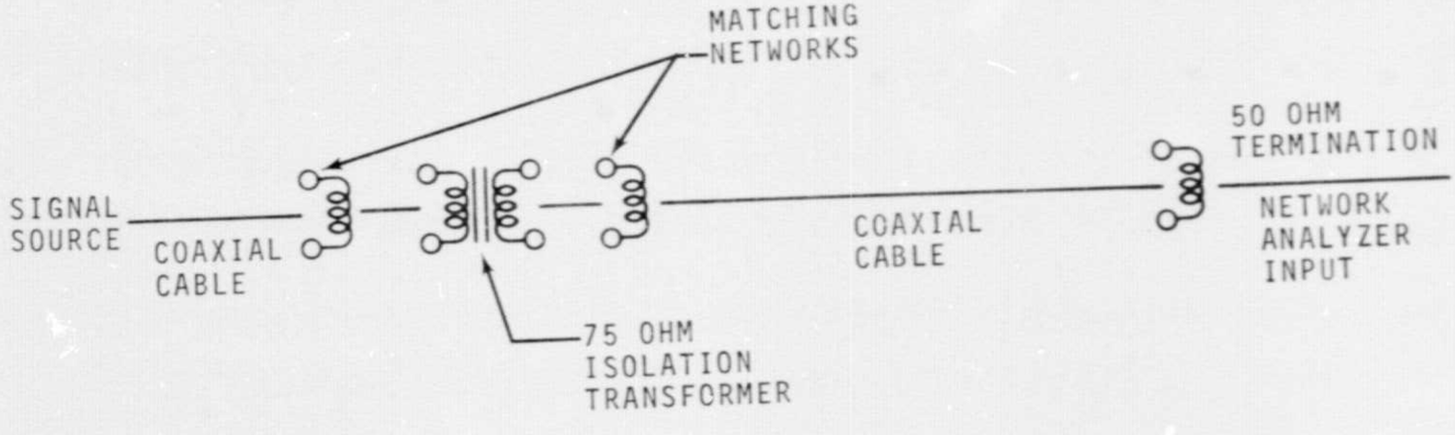

Figure 4-3.– Isolation transformer.

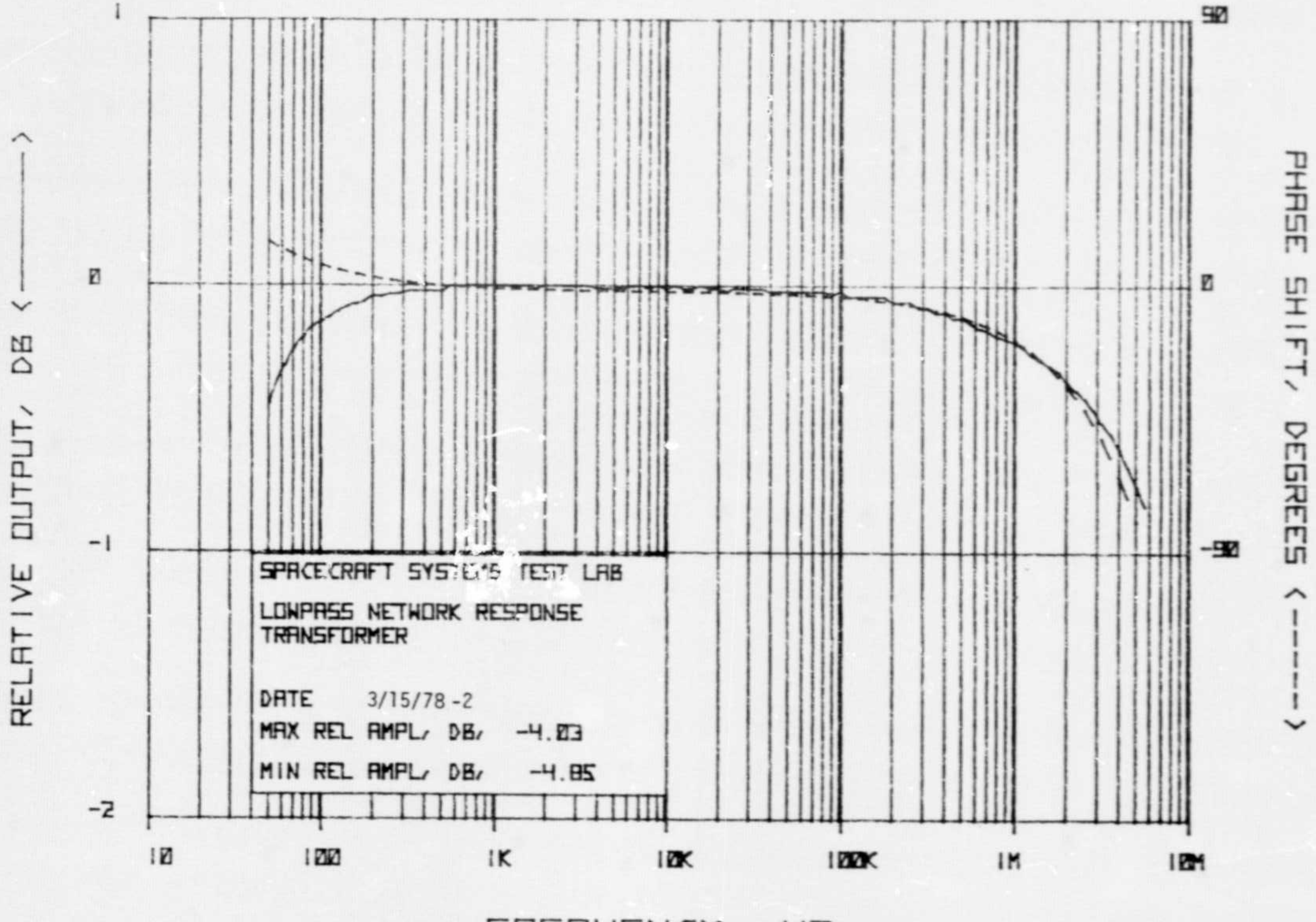

Figure 4-4.— Low-pass network response for the isolation transformer.

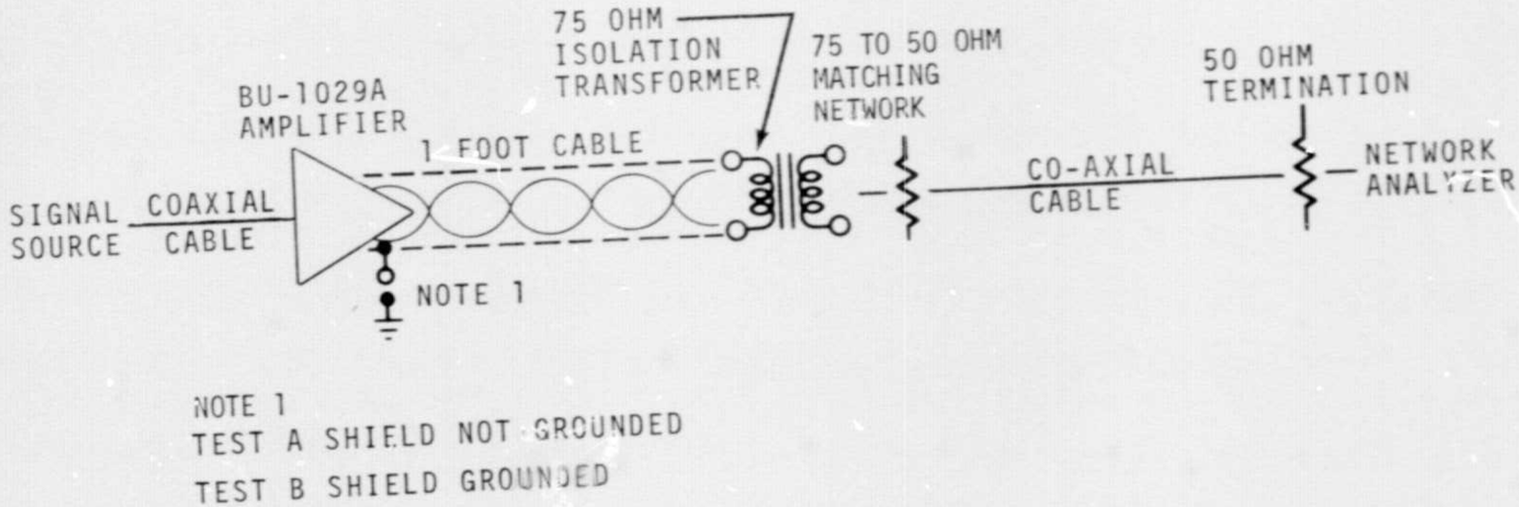

Figure 4-5.– Test configuration of the long twinax cable on March 15.

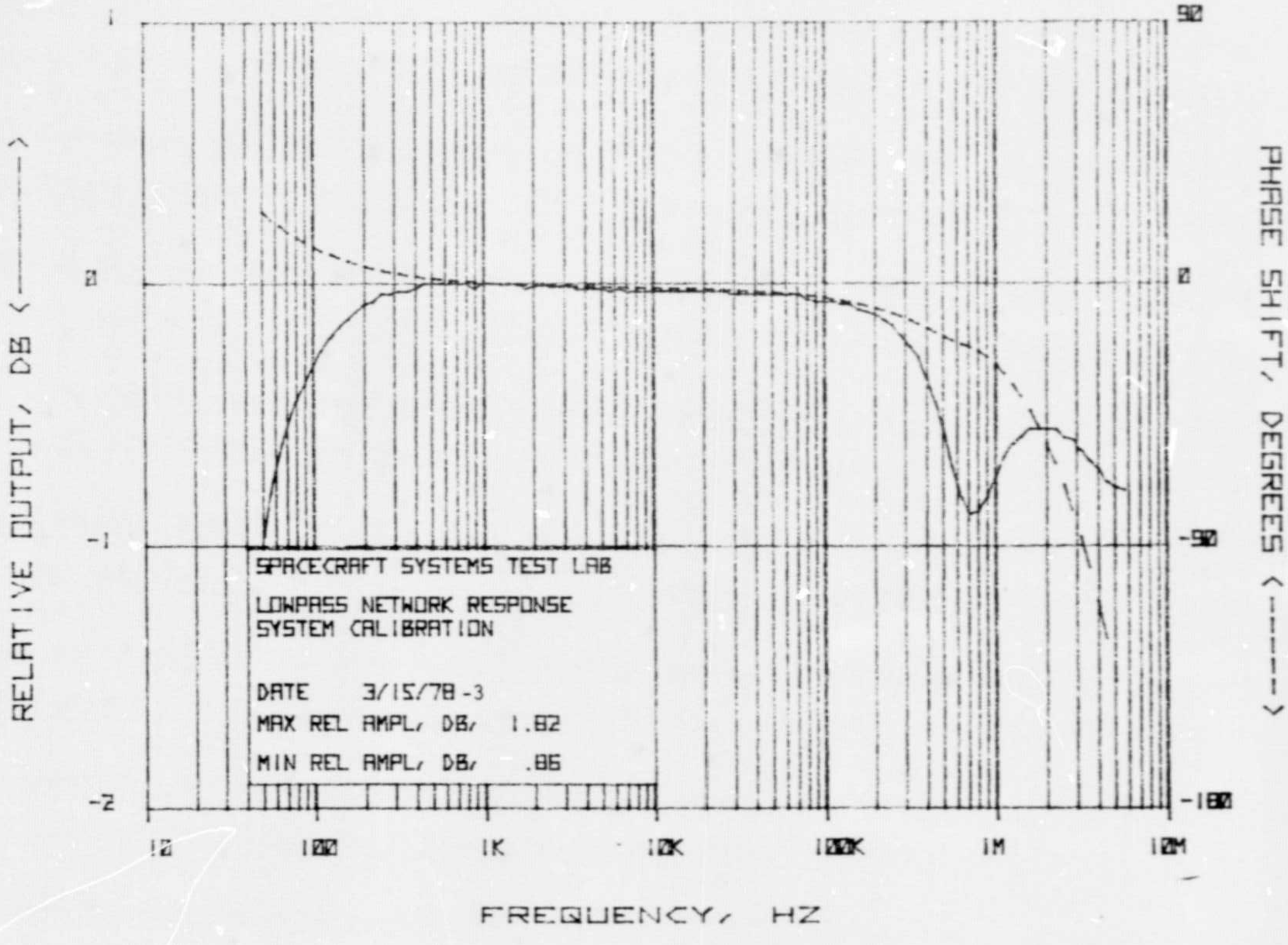

Figure 4-6.– Low-pass network response for system calibration.

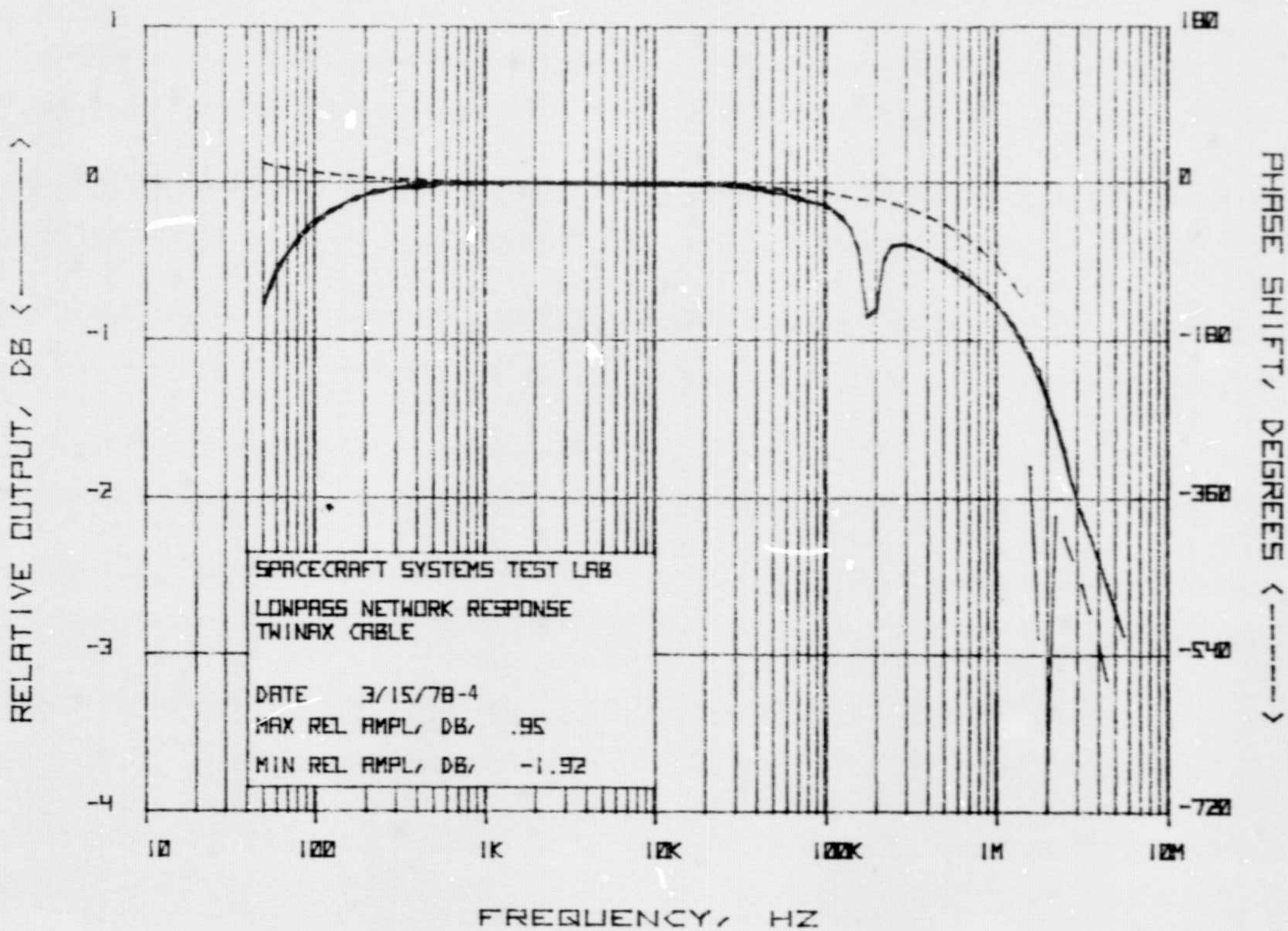

Figure 4-7.– Low-pass network response for the twinax cable.

caused by the leakage inductance of the transformer resonating with the shunt capacity.

Test 5 on March 15 was made using one of the twinax leads as the signal lead on the other as the return. The return lead was also grounded to the shield at one end; see figure 4-8. Although the cable was terminated in 75 ohms, the cable was not properly operated since grounding one of the two signal leads changes the characteristic of the cable. This is reflected by the large loss in signal at about 1.5 MHz; see figure 4-9. The phase response is also invalid.

Test 6 is similar to test 5 except that the shield is grounded at both ends; see figure 4-8. Grounding the shield at both ends did not improve performance; see figure 4-10.

Test 7 is the same as tests 5 and 6 except that the shield was floating; see figure 4-11. Floating the shield at both ends permits the voltage on the shield to assume a value midway between the two inner conductors. The characteristics of the cable are not altered, and the loss in signal amplitude at resonant points is greatly reduced. The resonant dip slightly below 2 MHz is apparently caused by the combination of the cable and connectors; see figure 4-12.

The eighth and last test on March 15 was a system test. The signal was fed from the Synthesizer to the driver amplifier having an unbalanced input and a balanced output. The cable was driven in a balanced mode with the shield grounded at the source end. The output end of the cable was connected to the transformer and changed from balanced to unbalanced. The shield was grounded at the load end. The signal out of the transformer was measured using the network analyzer; see figure 4-13. There is a small dip in the response, about 0.2 dB, at about 700 KHz; see

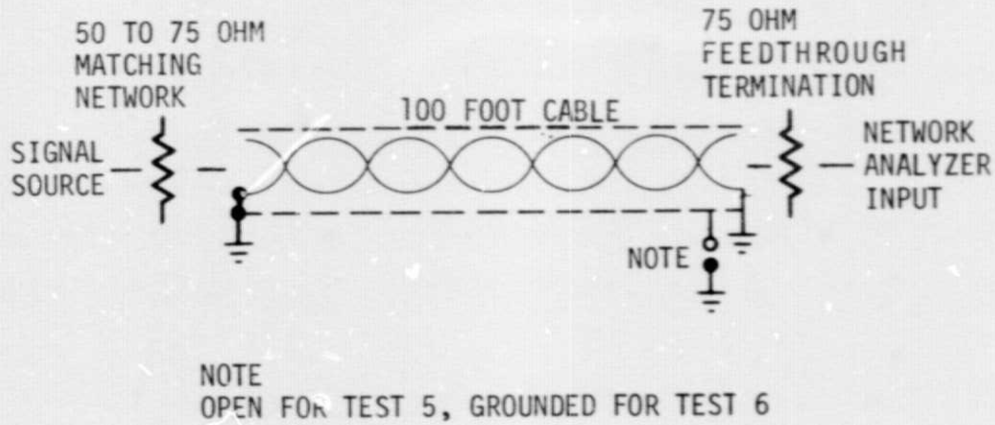

Figure 4-8.- Twinax heads during test 5.

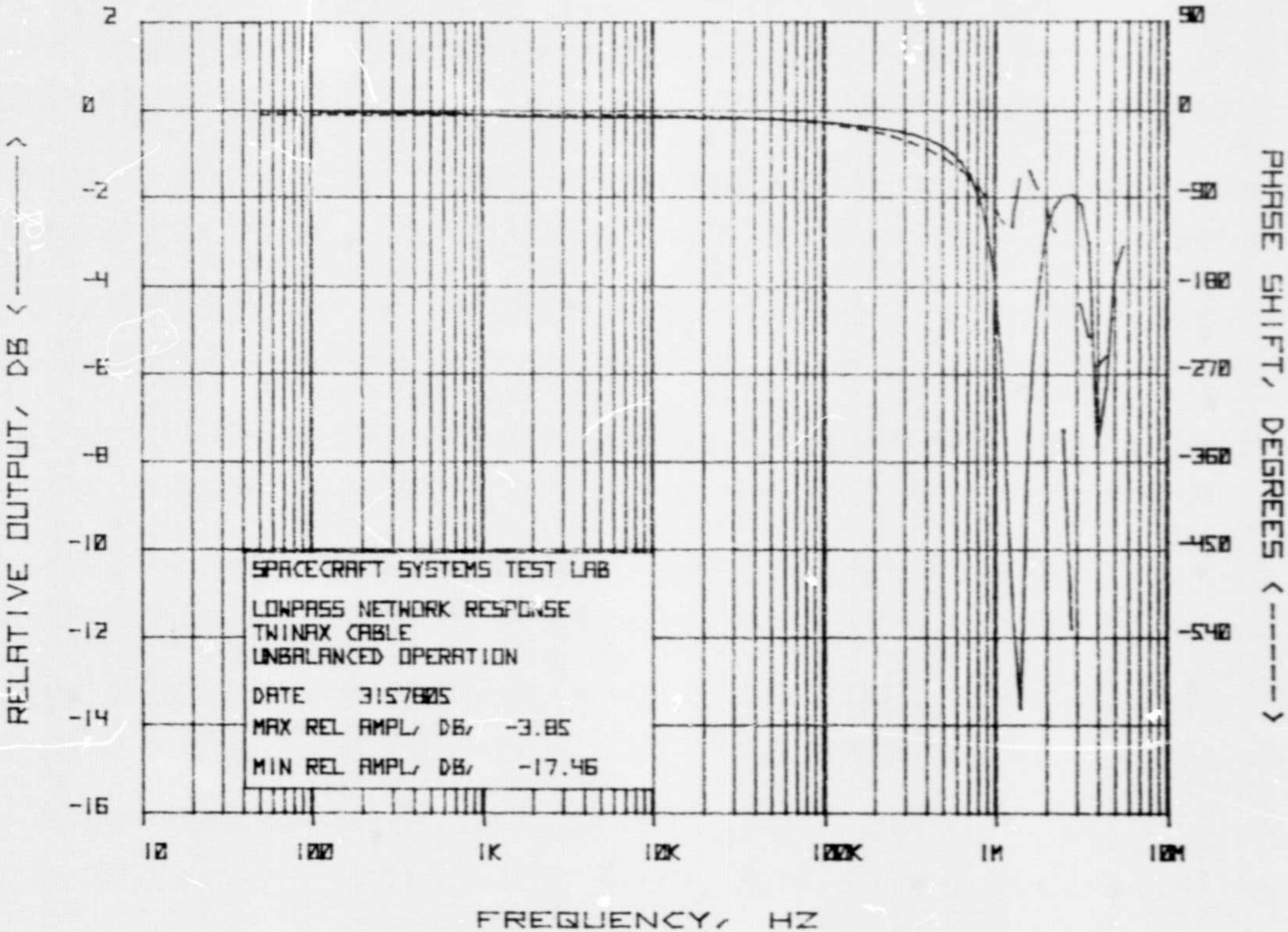

Figure 4-9.- Low-pass network response for the twinax cable having unbalanced operation.

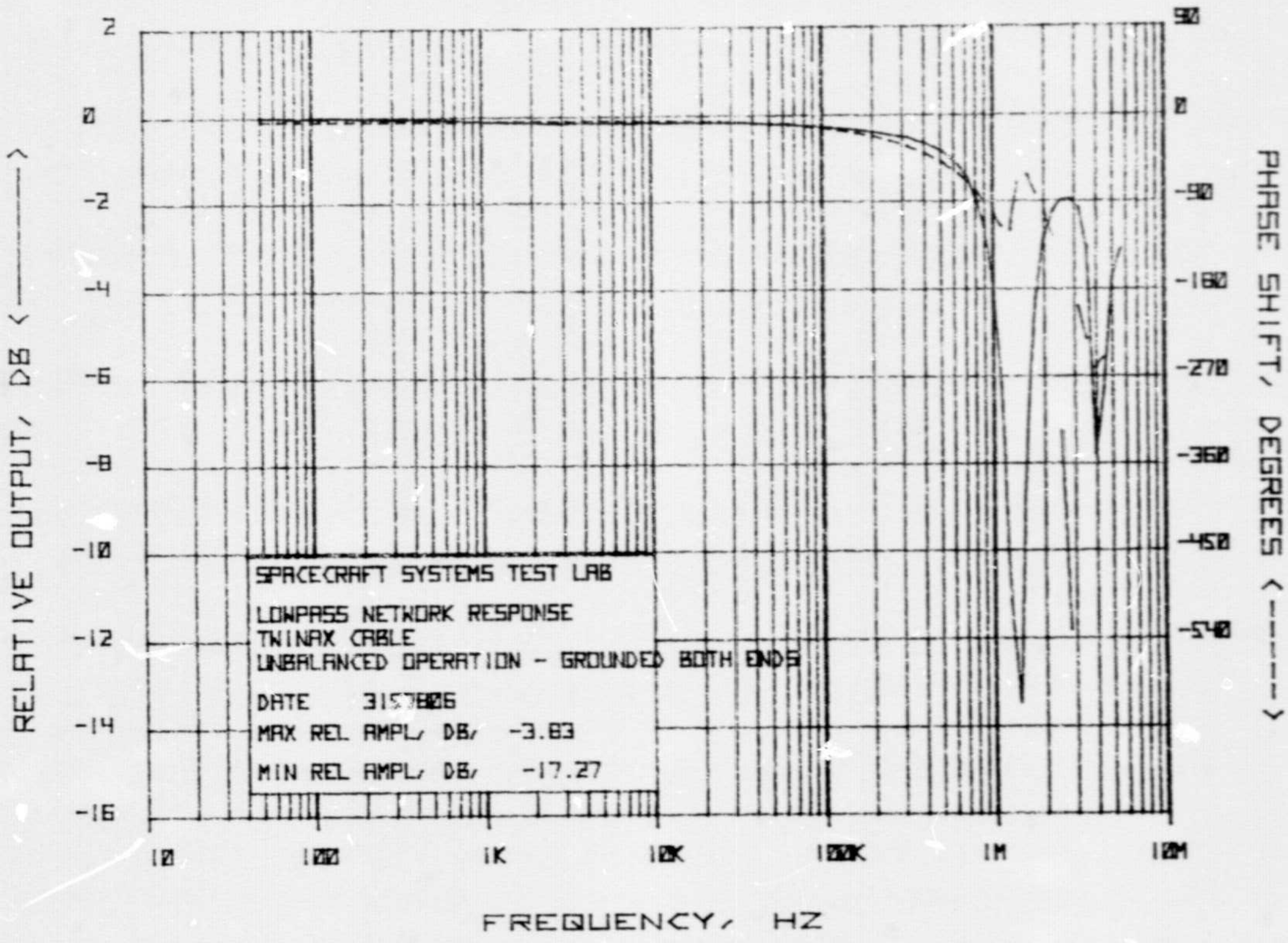

Figure 4-10.– Low-pass network response for the twinax cable having unbalanced operation and being grounded at both ends.

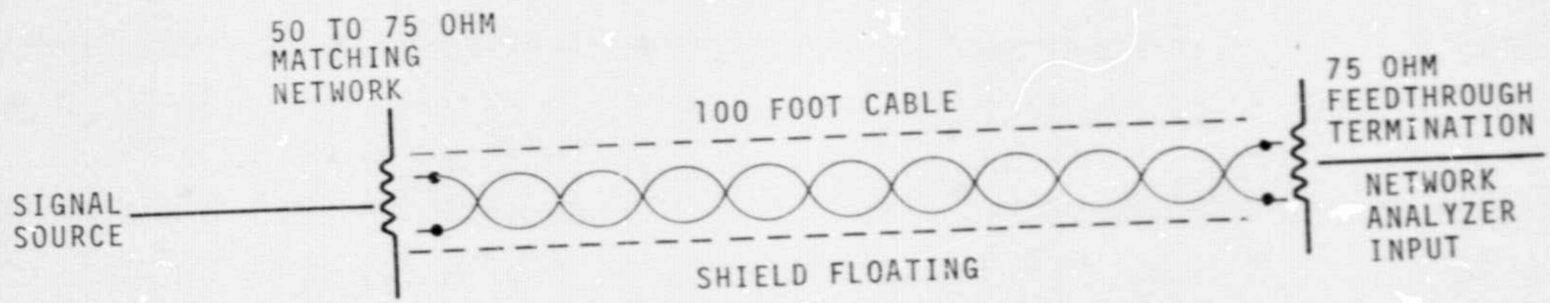

Figure 4-11.– Floating shield during test 7.

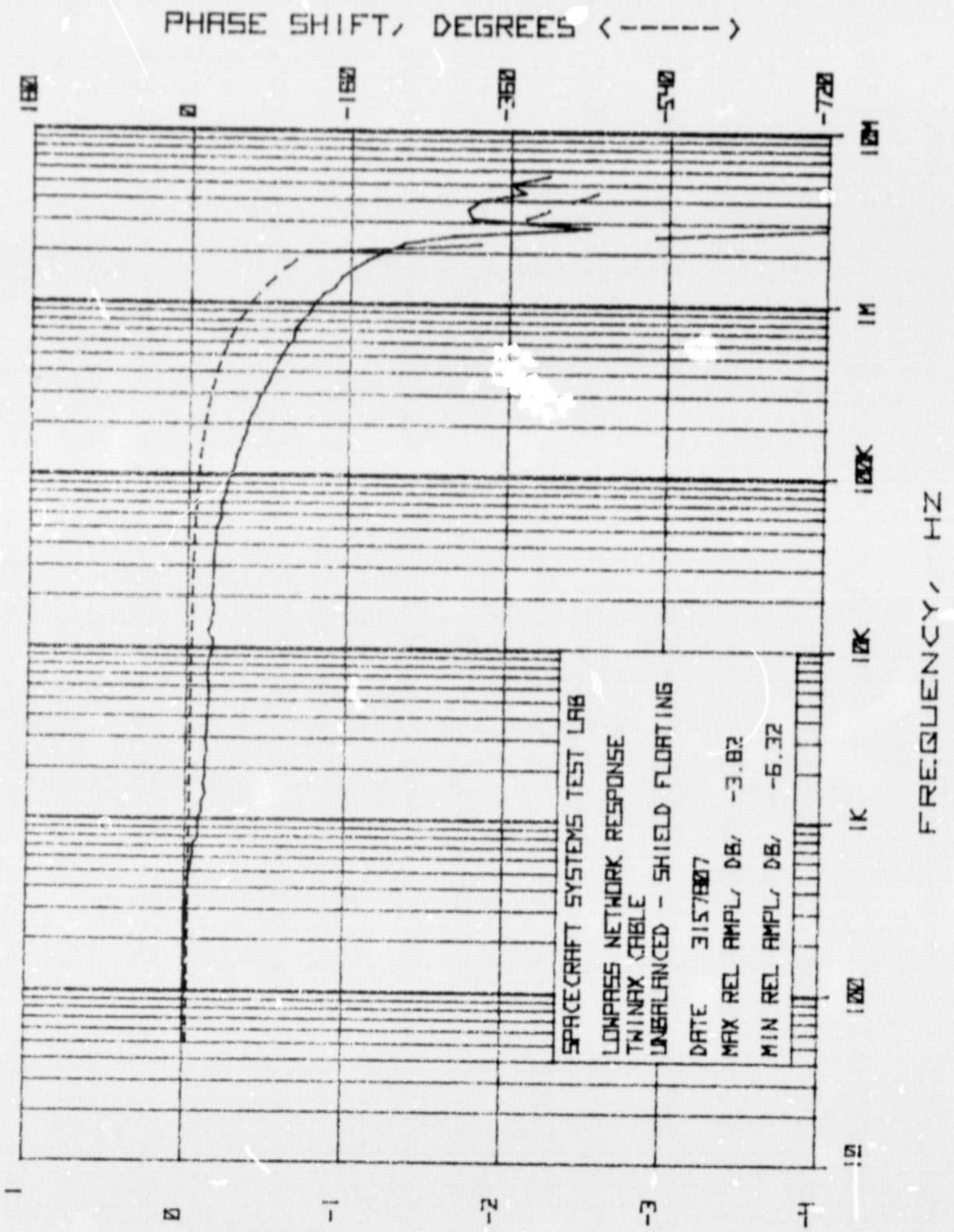

Figure 4-12.- Low-pass network response for the twinax cable having unbalanced operation and a floating shield.

ORIGINAL PAGE IS
OF POOR QUALITY

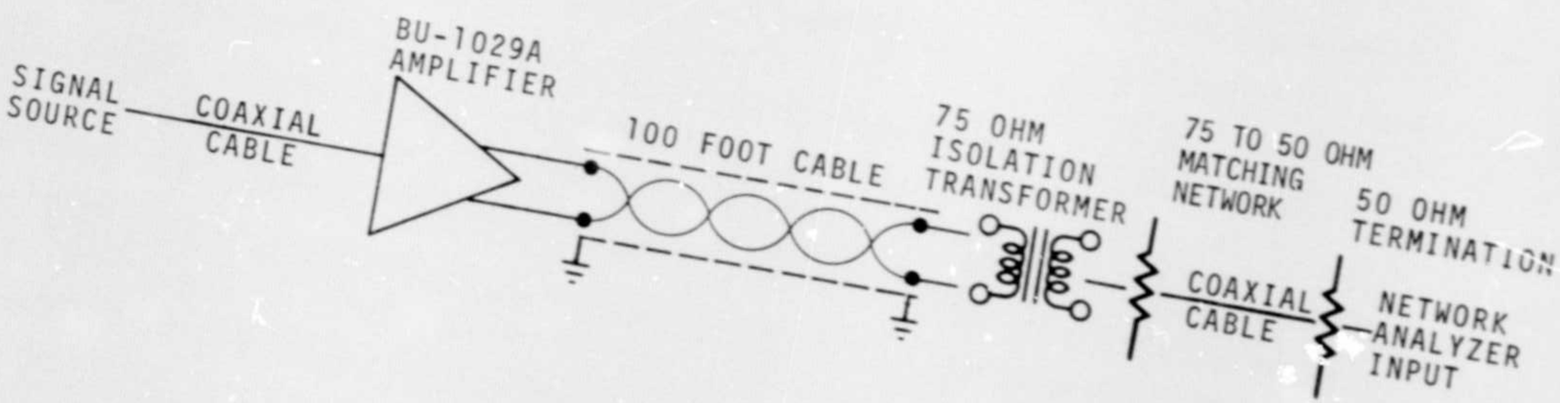

Figure 4-13.– Balanced operation.

figure 4-14. This represents the best operation using an isolation transformer. The isolation transformer with stray capacity could be the cause of the dip in the response.

The first test on March 21 was a test of the calculator program after the phase response was corrected; see figure 4-15. The test was performed using only coaxial cables and matching networks; see figure 4-1.

The second test on March 21 used the cables from the first test, the pair of amplifiers consisting of driver and receiver amplifier, and the long twinax cable; see figure 4-16. The cable is properly matched by the balanced input of the receiver amplifier, and there is no dip in the response; see figure 4-17. There is a small signal at about 120 Hz, which is about 0.1 dB high. This anomaly is attributed to 120-Hz ripple in the amplifier. The cable shows a loss of about 2 dB at 5 MHz.

The third test is similar to the second test, but a much shorter twinax cable was used. The result was less attenuation at 5 MHz, indicating that the loss is proportional to the cable length; see figure 4-18.

The fourth test was the same as the second test except that the 120-Hz ripple subtracted from the signal caused a dip at 120 Hz instead of a small peak; see figure 4-19.

A final test was run on March 21 in which a very short cable (about 3 inches) was used to connect the two amplifiers. This curve shows a loss of about 0.4 dB at 5 MHz exclusive of any long twinax cable; see figure 4-20.

Data were printed for test 3 on March 20 (table 4-1). The printed data correlated with the curve. The printed data is truncated to 0.1 dB precision.

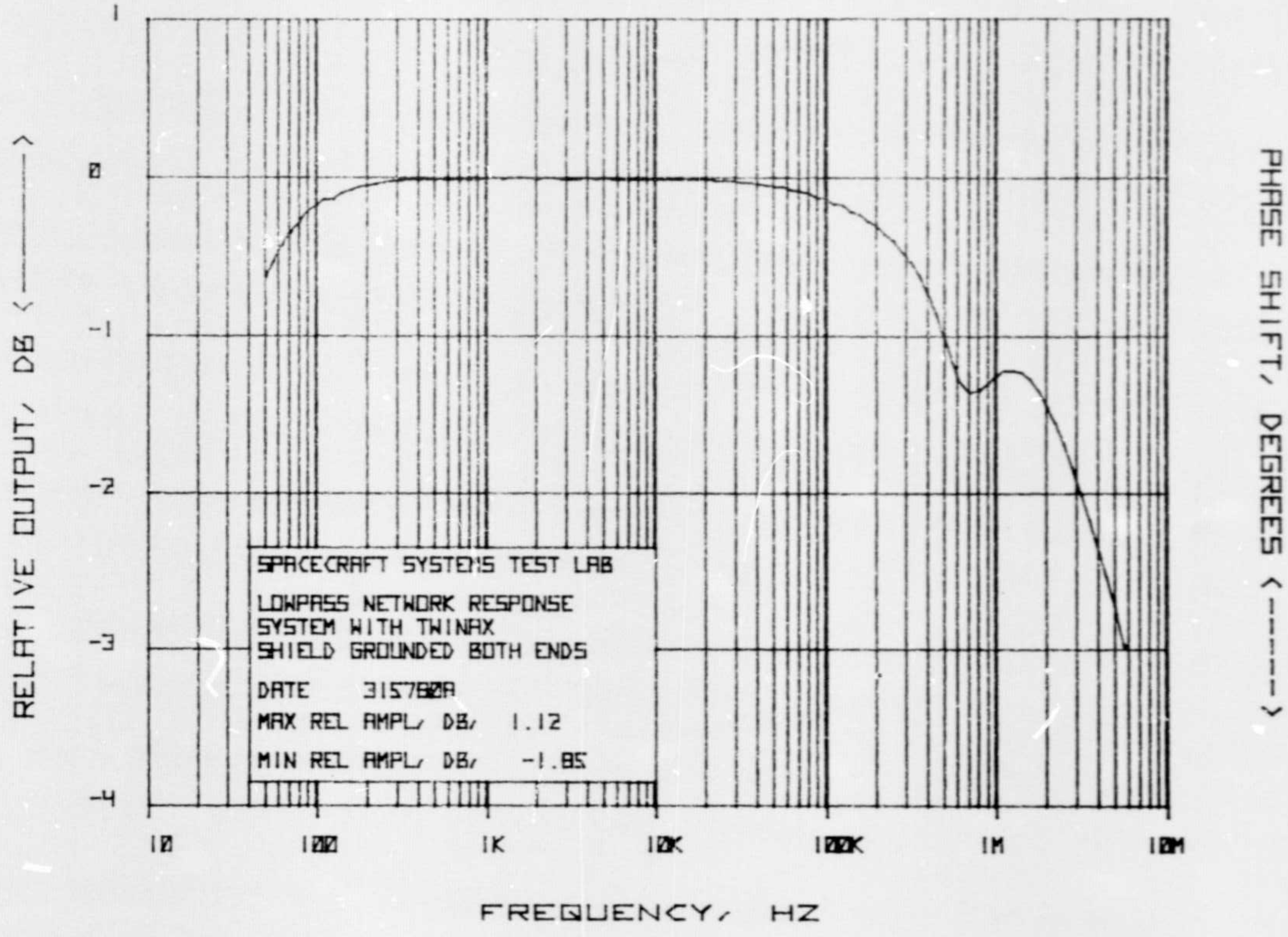

Figure 4-14.– Low-pass network response system with twinax shield grounded at both ends.

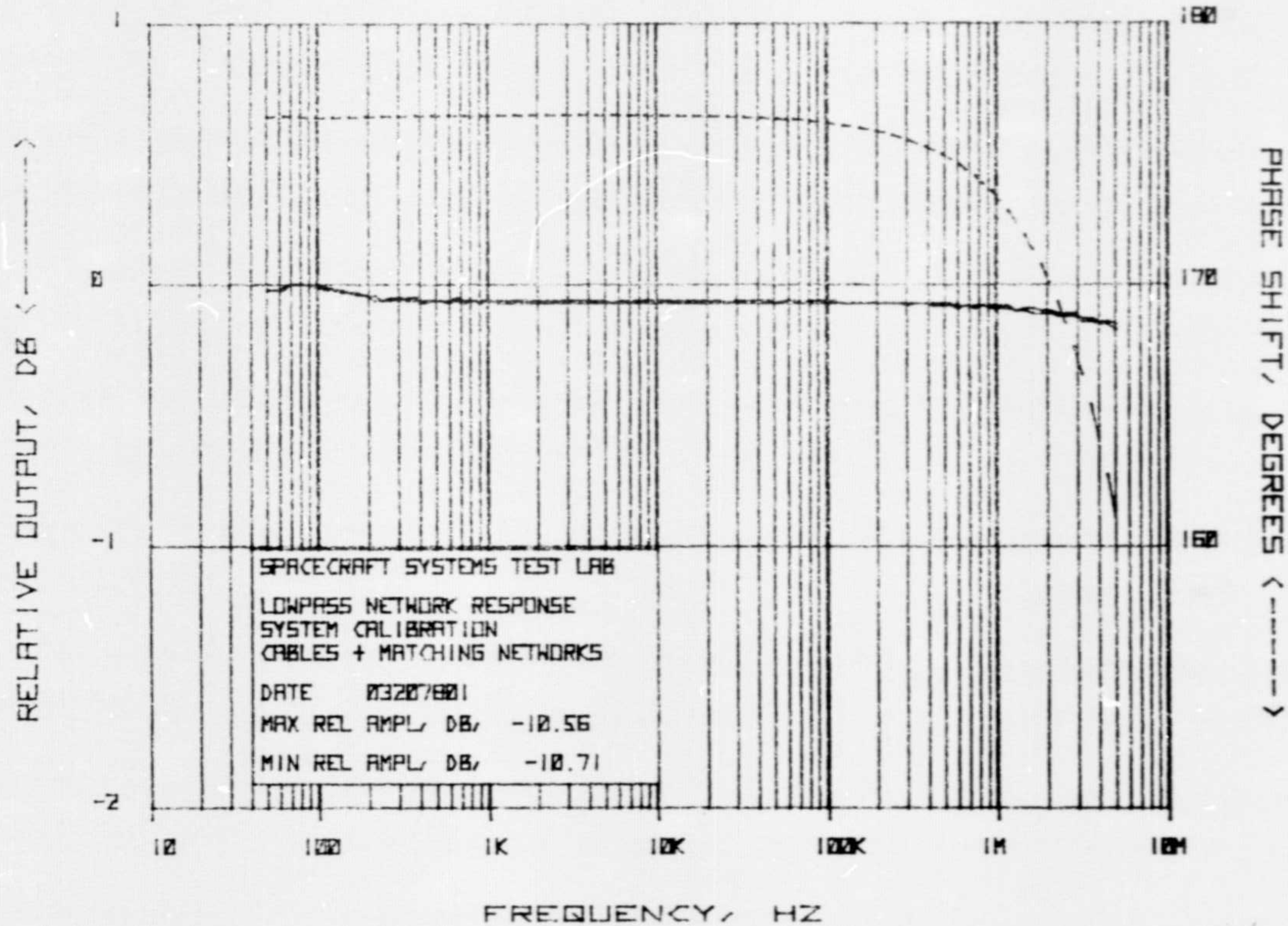

Figure 4-15.- Low-pass network response for system calibration with cables and matching networks.

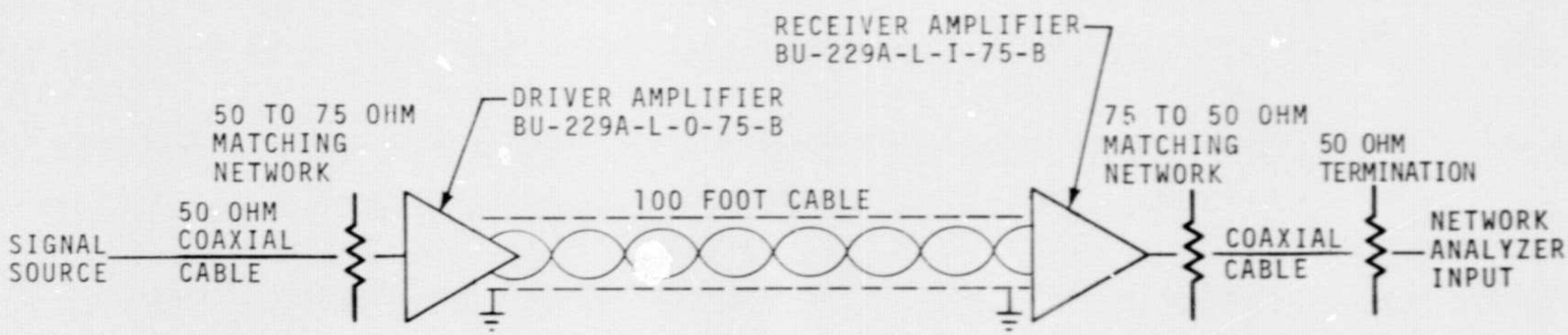

Figure 4-16.– Balanced drive and load.

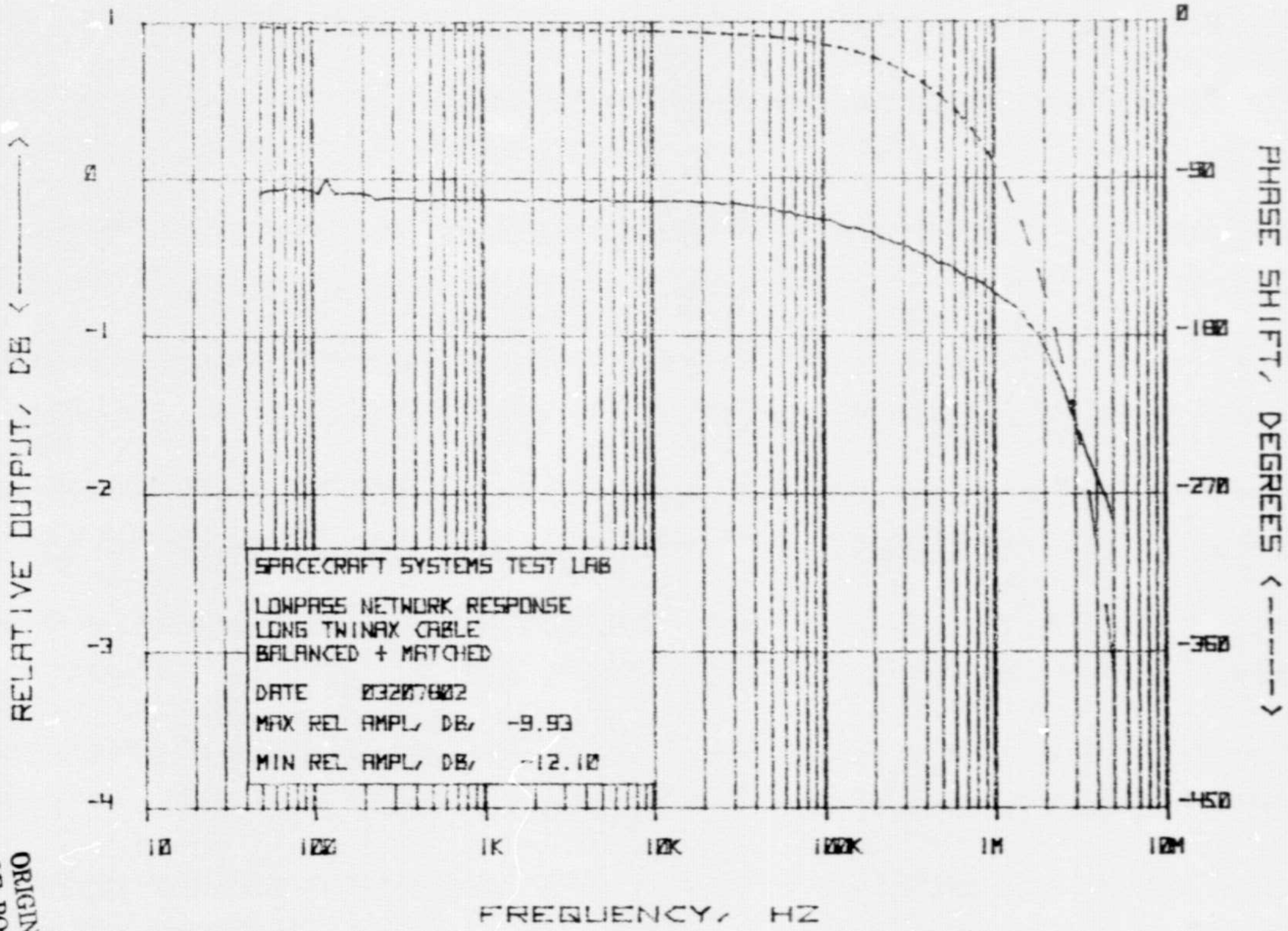

Figure 4-17.– Low-pass network response for the long twinax cable with balanced input and matching networks.

ORIGINAL PAGE IS OF POOR QUALITY

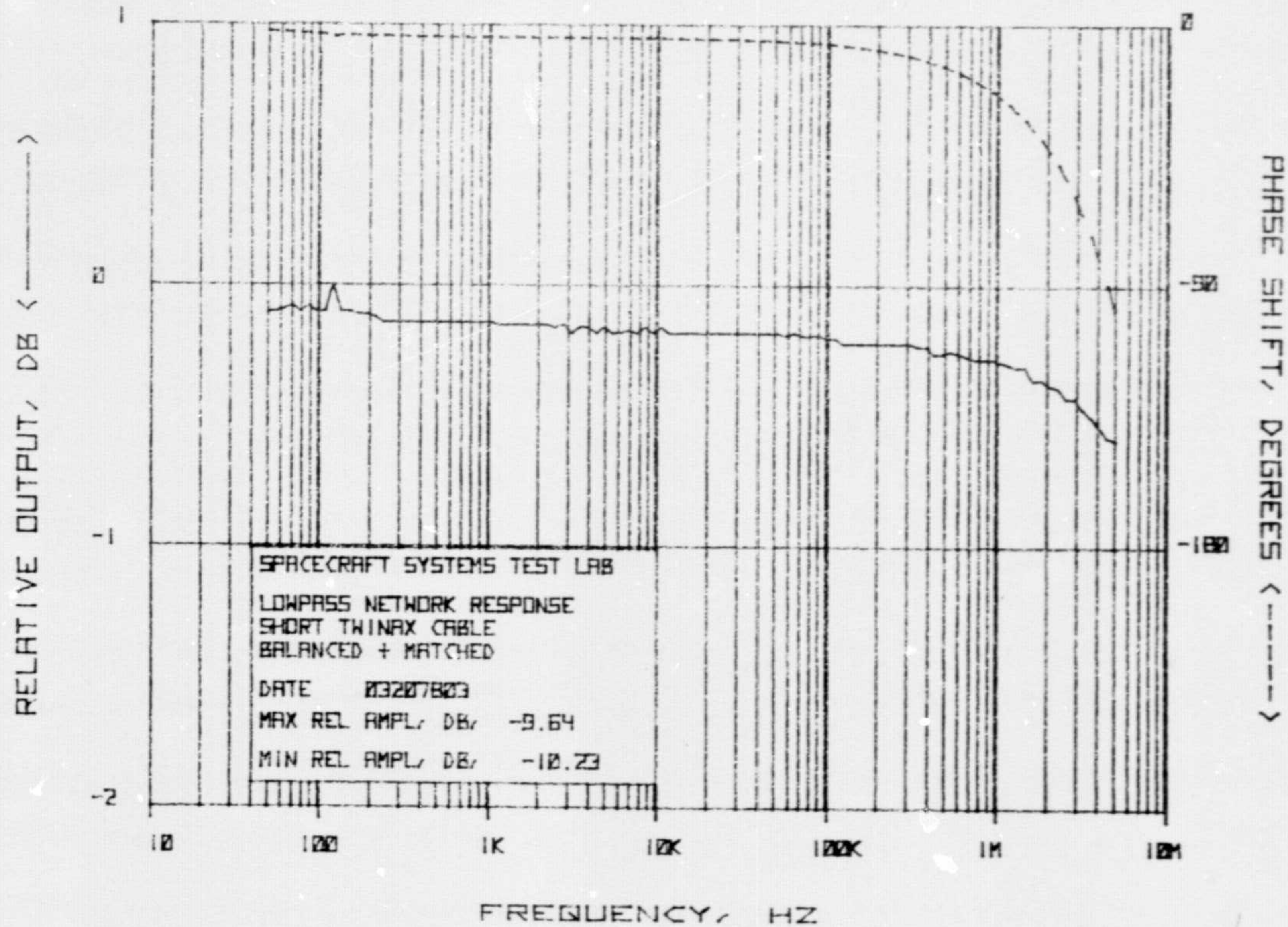

Figure 4-18.– Low-pass network response for the short twinax cable with balanced input and matching networks.

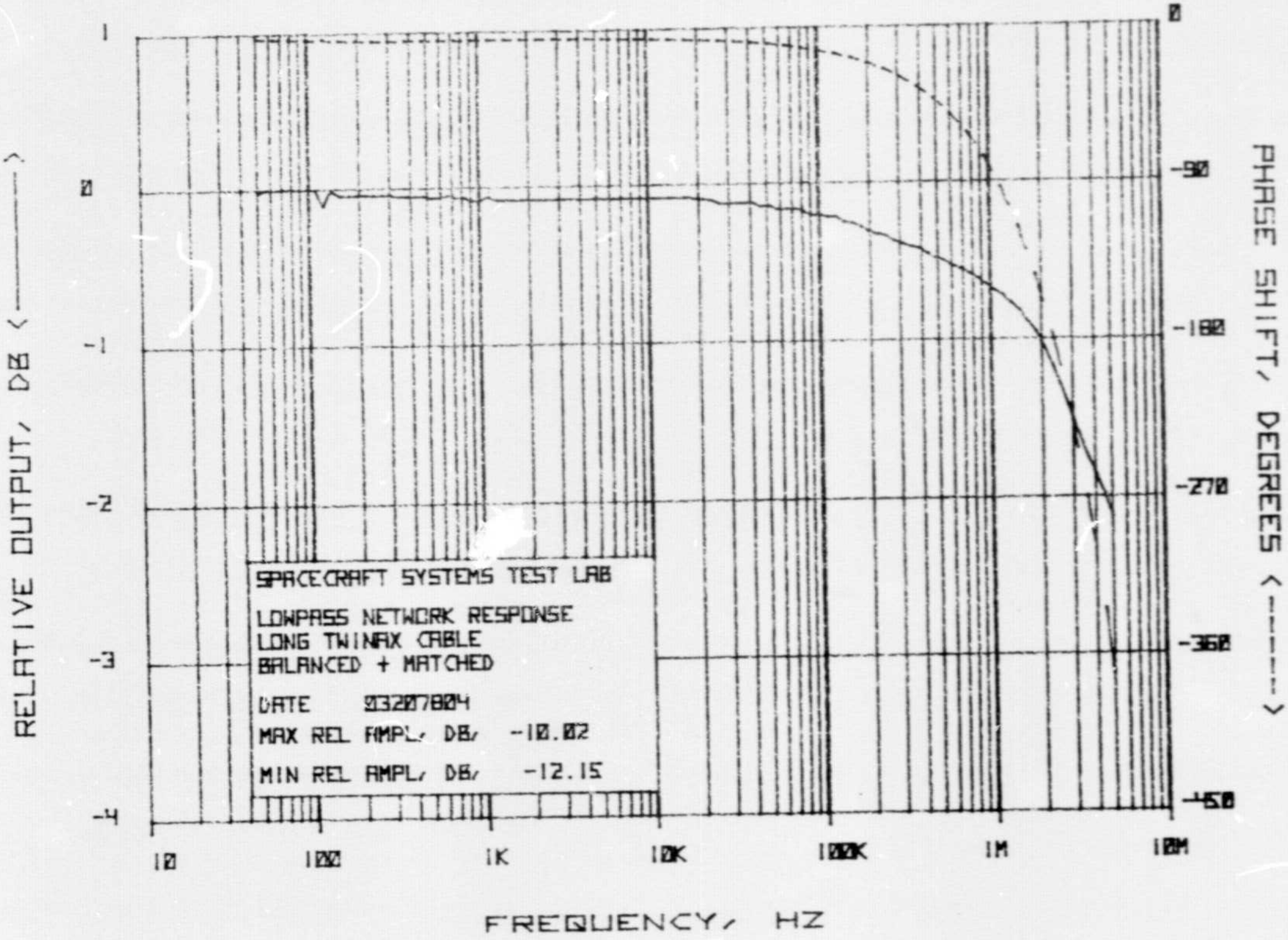

Figure 4-19.- Low-pass network response for the long twinax cable with balanced input and matching networks and a 120-Hz ripple subtracted from the signal.

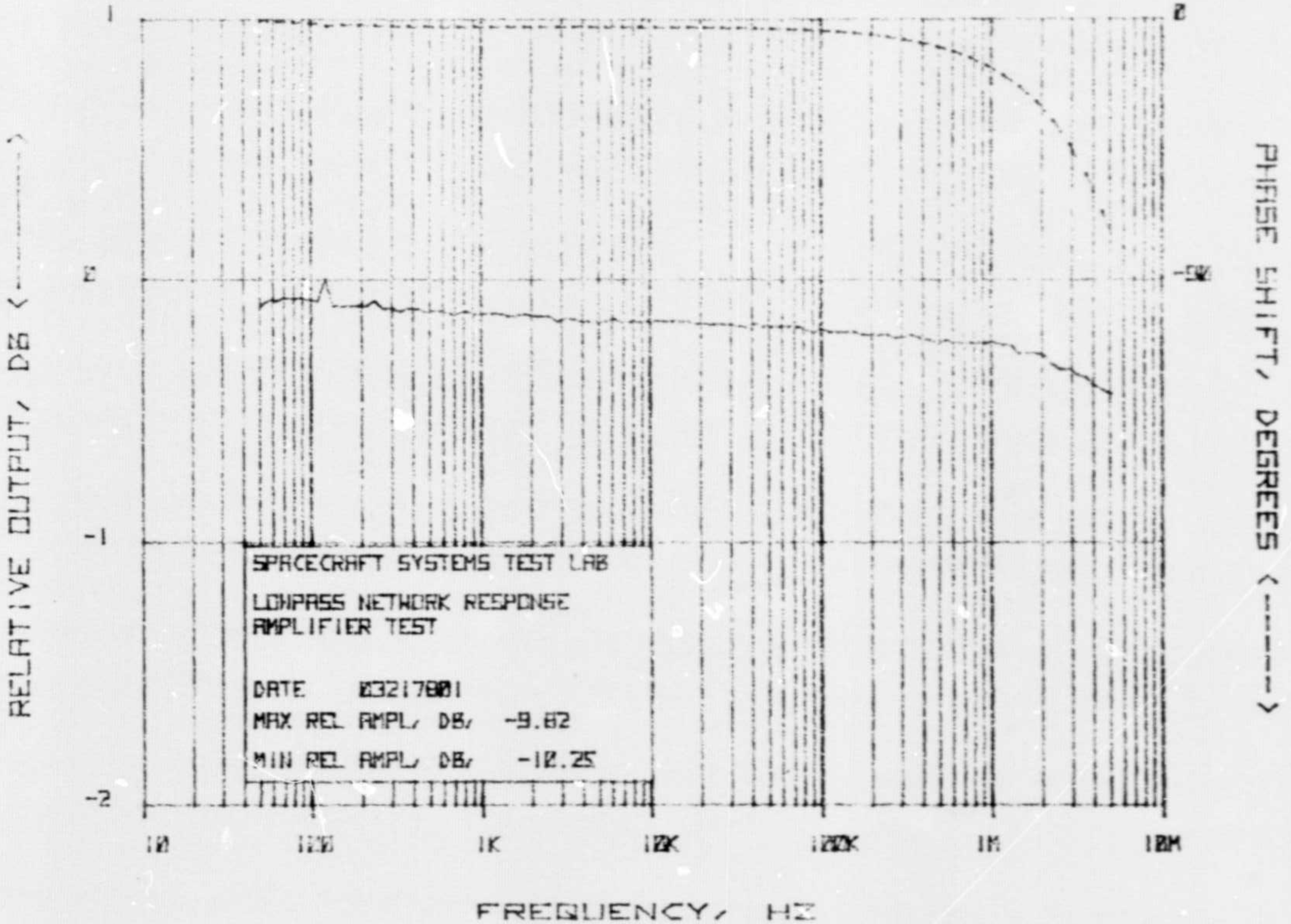

Figure 4-20.– Low-pass network response amplifier test.

TABLE 4-1.– DATA LISTING FOR TEST 3 ON MARCH 20

FREQ.,HZ	REG.	AMPL.,DB	REG.	PHASE,DEG
50.0	50	-10.0	252	-2.43
55.9	51	-10.0	253	-2.66
62.5	52	-10.0	254	-2.87
69.9	53	-10.0	255	-3.05
78.2	54	-10.0	256	-3.22
87.4	55	-10.0	257	-3.38
97.8	56	-10.0	258	-3.51
109.3	57	-10.0	259	-3.55
122.3	58	-10.1	260	-3.07
136.7	59	-10.0	261	-3.84
152.9	60	-10.1	262	-3.90
171.0	61	-10.1	263	-3.97
191.2	62	-10.1	264	-4.03
213.8	63	-10.1	265	-4.09
239.1	64	-10.1	266	-4.27
267.4	65	-10.1	267	-4.15
299.0	66	-10.1	268	-4.20
334.4	67	-10.1	269	-4.23
373.9	68	-10.1	270	-4.27
418.1	69	-10.1	271	-4.29
467.6	70	-10.1	272	-4.31
522.9	71	-10.1	273	-4.34
584.7	72	-10.1	274	-4.37
653.8	73	-10.1	275	-4.39
731.2	74	-10.1	276	-4.42
817.6	75	-10.1	277	-4.43
914.3	76	-10.1	278	-4.48
1022.5	77	-10.1	279	-4.48
1143.4	78	-10.1	280	-4.49
1278.6	79	-10.1	281	-4.50
1429.8	80	-10.1	282	-4.51
1598.9	81	-10.1	283	-4.54
1788.0	82	-10.1	284	-4.57
1999.5	83	-10.1	285	-4.59
2235.9	84	-10.1	286	-4.62
2500.3	85	-10.1	287	-4.63
2796.0	86	-10.1	288	-4.67
3126.7	87	-10.1	289	-4.70
3496.5	88	-10.1	290	-4.74

TABLE 4-1.– Continued.

FREQ.,HZ	REG.	AMPL.,DB	REG.	PHASE,DEG
3910.0	89	-10.1	291	-4.78
4372.4	90	-10.1	292	-4.81
4889.5	91	-10.1	293	-4.86
5467.7	92	-10.1	294	-4.91
6114.3	93	-10.1	295	-4.97
6837.4	94	-10.1	296	-5.04
7646.0	95	-10.1	297	-5.11
8550.3	96	-10.1	298	-5.22
9561.4	97	-10.1	299	-5.30
10692.2	98	-10.1	300	-5.42
11956.7	99	-10.1	301	-5.52
13370.7	100	-10.1	302	-5.65
14952.0	101	-10.1	303	-5.79
16720.2	102	-10.1	304	-5.95
18697.6	103	-10.1	305	-6.15
20908.8	104	-10.1	306	-6.34
23381.5	105	-10.1	307	-6.57
26146.7	106	-10.1	308	-6.82
29238.9	107	-10.1	309	-7.10
32696.7	108	-10.1	310	-7.40
36563.5	109	-10.1	311	-7.74
40887.6	110	-10.1	312	-8.12
45723.0	111	-10.2	313	-8.54
51130.3	112	-10.2	314	-9.01
57177.1	113	-10.2	315	-9.54
63939.0	114	-10.2	316	-10.11
71500.6	115	-10.2	317	-10.71
79956.4	116	-10.2	318	-11.42
89412.3	117	-10.2	319	-12.19
99986.4	118	-10.2	320	-13.04
111811.0	119	-10.2	321	-13.98
125034.0	120	-10.2	322	-15.03
139820.9	121	-10.3	323	-16.19
156356.4	122	-10.3	324	-17.46
174847.5	123	-10.3	325	-18.89
195525.3	124	-10.3	326	-20.48
218648.6	125	-10.3	327	-22.24
244506.5	126	-10.4	328	-24.22
273422.4	127	-10.4	329	-26.39

TABLE 4-1.– Concluded.

FREQ.,HZ	REG.	AMPL.,DB	REG.	PHASE,DEG
305758.0	128	-10.4	330	-28.84
341917.6	129	-10.4	331	-31.55
382353.6	130	-10.4	332	-34.59
427571.6	131	-10.5	333	-37.98
478137.2	132	-10.5	334	-41.75
534682.0	133	-10.5	335	-45.98
597915.6	134	-10.5	336	-50.69
668626.5	135	-10.6	337	-55.95
747699.8	136	-10.6	338	-61.84
836124.5	137	-10.6	339	-68.44
935006.6	138	-10.7	340	-75.79
1045582.6	139	-10.7	341	-84.02
1169235.6	140	-10.7	342	-93.23
1307512.1	141	-10.8	343	-103.54
1462141.6	142	-10.8	344	-115.05
1635057.8	143	-10.9	345	-127.90
1828423.5	144	-11.0	346	-142.32
2044657.1	145	-11.1	347	-158.27
2286403.0	146	-11.2	348	-176.08
2556865.4	147	-11.3	349	-195.80
2859246.2	148	-11.5	350	-217.76
3197387.3	149	-11.6	351	-242.16
3575517.7	150	-11.8	352	-269.34
3998366.7	151	-11.9	353	-299.78
4471222.8	152	-12.0	354	-334.20
5000000.0	153	-12.2	355	-372.50

4.2 RESOLUTION OF ANOMALIES

The only significant anomaly was the peak or dip in the response at 120 Hz using the pair of amplifiers. This has been attributed to internal power supply ripple and is not significant to the test.

The phase response was not correct for several curves. The problem in the program was corrected.

4.3 ANALYSIS PERFORMED

The results of the test were analyzed to determine the effects of unbalanced operation of the twinax cable, the system was calibrated, and the loss of the cable was determined.

4.4 RESULTS OBTAINED

The tests show a system loss of 0.2 dB for the cables and matching networks at 5 MHz and another 0.2-dB loss for the pair of amplifiers. The long cable (approximately 100 feet long) has a frequency dependent attenuation of about 1-1/2 dB at 5 MHz.

5. CONCLUSIONS

It was concluded that a smooth response without resonant dip could only be obtained when the cable is operated in a balanced mode. The shield should also be grounded at both ends for best performance.

When long cables are used for the television signals and to prevent an accumulation of losses at high frequencies throughout the system, cable compensation is desired.

Mismatch at connectors has been shown to cause losses in the signal in narrow bands in the range from 100 KHz to 2 MHz. Mismatched connectors in the flight cables are a potential source of problem. The flight cables should be tested to determine the actual performance.