MEASUREMENT AND TECHNICAL REPORT ON THE TIRIS TRANSPONDER

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Project 10-2333-039
Report Number EMCR 99/096

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1.0 GENERAL INFORMATION

1.1 Product Description

The vehicle transponder is a battery operated radio frequency identification device that is designed to be used in conjunction with LUHF reader system (FCC ID: A92LUHF approved 1997). The transponder is activated by entering a localized coded electromagnetic field at 134.2 kHz and replies at 902.8 MHz. The unit operates at 902.8 MHz under FCC Part 15, Subpart C, "Intentional Radiator," paragraphs 15.209 and 15.249. A detailed description of the transponder is presented in Attachments 1 and 2.

1.2 Related Grants

The transponder was tested in a stand-alone configuration.

1.3 Tested System Details

The transponder is a battery-operated device with no cables. The unit is turned on by entering a localized coded electromagnetic field at 134.2 kHz and this energy activates the circuitry to respond at 902.8 MHz. After the RFID transaction is completed, the transponder and battery goes into a sleep mode until initiated again. Minimum battery life is three years. The Model number and FCC ID number of the tested unit is shown in Table 1.1 below.

TABLE 1.1
COMPONENTS IN THE TEST CONFIGURATION

Model Number	FCC ID	Cable Description
RI-TRP-VUSA	A92FPTVEH	No cables

1.4 Test Methodology

Radiated testing was performed according to the procedure in ANSI C63.4-1992 and the limits prescribed in CFR 47, FCC 15.249/15.209, inside a semi-anechoic chamber. Radiated testing was performed at an antenna to EUT distance of 3 meters for frequencies below 1 GHz. Above 1 GHz testing was performed at a distance of 1 meter and a correction factor added to normalize the test distance to 3 meters.

1.5 Test Facility

The Open Area Test Site and Conducted Measurement Facility used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning these test sites are found in the report entitled, "Description of Measurement Facility," dated 28 April 1997, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 12, 1997, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

2.0 PRODUCT LABELING

2.1 FCC ID Label

The transponder is too small to include the complete wording. The following FCC ID identifier will be molded into the plastic housing of the production transponder:

FCC ID: A92FPTVEH

The full FCC wording will be printed in the literature distributed with the vehicle transponder to the user as described below:

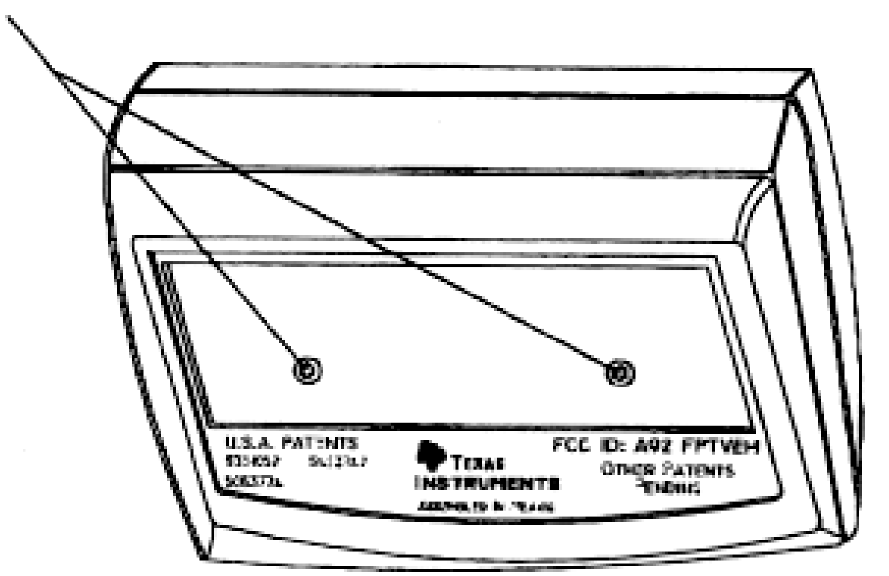
> FCC ID: A92FPTVEH
>
> This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Also, the following information will be included:

NO Modifications: Modifications to this device shall not be made without the written consent of Texas Instruments Incorporated. Unauthorized modifications may void the authority granted under Federal Communications Commission Rules permitting the operation of this device.

2.2 Location of Identifier on EUT

The identifier is located on the bottom side of the transponder case as shown below.



3.0 SYSTEM TEST CONFIGURATION

3.1 Justification

The TIRIS Transponder was tested with broadband dipoles (30 MHz to 1000 MHz) and the EMCO 3115 Dual Ridge Horn (1 to 18 GHz), in both the vertical and horizontal polarizations for highest fundamental, harmonics, and spurious emissions. The fundamental frequency was also measured manually using a Log Periodic Dipole antenna.

Radiated signature scans from 30 MHz to 1000 MHz and the manual measurement of the fundamental frequency were made at 3 meters in a shielded anechoic chamber. Radiated emission scans from 1 GHz to 10 GHz were made at 1 meter in the shielded anechoic chamber.

3.2 EUT Exercise

The transponder is powered by a 3-volt lithium battery. The transponder was configured to emit its normal reply signal in the absence of the system interrogation unit. Operability of the unit was confirmed by witnessing the response shown on the system LED indicators.

3.3 Special Accessories

No special accessories were used.

3.4 Equipment Modification

No modifications were made to the EUT during testing.

3.5 Configuration of Tested System

Refer to Section 5 for photographs of the EUT tested.

4.0 BLOCK DIAGRAM OF THE TRANSPONDER

A block diagram of the transponder is in the technical documentation attached to this report.

5.0 RADIATED MEASUREMENT PHOTOS

6.0 RADIATED EMISSION DATA

The data below are the corrected highest level EME measurements taken from the following radiated data sheets. The data sheets include the emission frequencies and the corrected level.

6.1 Radiated Measurement Data

Automated frequency scans for spurious and harmonic emissions were made of the spectrum from 30 MHz to 1000 MHz at 3 meters. Manual measurements were made of the fundamental frequency of 902.8 MHz at 3 meters. Additionally, the spectrum from 1 GHz to 10 GHz was investigated for harmonics and spurious emissions at 1 meter. The 2nd harmonic at 1805.6 MHz, the third harmonic at 2078.4 MHz and the fourth harmonic at 3611.2 MHz were evident.

The frequency stability of the transponder was verified during spectrum investigation. From the time of first turn on (with a new battery installed), to the completion of testing, no discernable change was noted in the frequency or power output.

The measurement level of the fundamental is shown in Table 6.1.

TABLE 6.1
MEASUREMENTS OF FUNDAMENTAL FREQUENCY

Judgment: EUT Passed By 35.8 dB		
Frequency (MHz)	Corrected Level[1] dB(? V/m)	Limit 3 Meters dB(? V/m)
902.8	58.2	94

[1] All readings are peak manual measurements made with a spectrum analyzer.

Measurements of spurious emissions above 1000 MHz were made with the antenna at 1 meter. The worse case emissions are given in Table 6.2. A peak signature scan is provided in the Appendix.

TABLE 6.2
MEASUREMENTS OF SPURIOUS EMISSIONS ABOVE 30 MHz

Judgment: EUT Passed By 7.2 dB		
Frequency (MHz)	Corrected Level [1] dB(? V/m)	Limit dB(? V/m)
1805.6	46.8	54
2708.4	34.1	54
3611.2	41.1	54

[1] All readings are peak manual measurements made with a spectrum analyzer.

6.2 Test Instrumentation for Radiated Measurements

Scans were made in an RF semi-anechoic chamber 28' long x 16' wide x 16' high with its interior lined on the ceiling and four walls with pyramidal absorber material up to four feet in length. Measurements were made with a spectrum analyzer. The list of test instrumentation used to perform the testing is shown in Table 6.3.

TABLE 6.3
RADIATED TEST INSTRUMENTATION

Type	Manufacturer/Model No.	Serial No.	Cal Due
Low Noise Pre-Amp	SwRI	101 LNA	NCR
RF Signal Generator	HP 8350	2120A00685	27 JUL 99
Spectrum Analyzer	HP 8566B	3026A19187	27 NOV 99
Dual Ridge Horn Antenna	EMCO 3115	2043	06 JAN 00
Log Periodic Dipole Antenna	EMCO 2010	182	29 APR 00
Dipole Antenna	Electro-Metrics DB-2	147	VERIFIED
Dipole Antenna	Electro-Metrics DB-3	148	VERIFIED
Dipole Antenna	Electro-Metrics DB-4	0191966	VERIFIED
Amplifier	SwRI UTC10-221-1	9112SN15	VERIFIED

6.3 Field Strength Calculation

The field strength was calculated by adding the antenna factor and cable factor, and subtracting the amplifier gain (when used) from the measured reading. The basic equation with a sample calculation is provided below:

FS = AA + AF + CF + AG + DF

Where FS = Field Strength
AA = Analyzer Peak Amplitude
AF = Antenna Factor
CF+AG = Cable Attenuation + Amplifier Gain
DF = 3 meter to 1 meter conversion factor (above 1 GHz only)

For example, reducing the measured value of the second harmonic frequency of 1805.6 MHz, vertical polarization, from the enclosed spectrum analyzer plot, yields:

+62.1dBμV
+26.0 dB(1/m)
-31.8 dB (CF/AG factor)
-9.5 dB(DF)(above 1 GHz only)
FS = 46.8 dBμV/m

THE equation to convert dBμV/m to its corresponding level in μV/m is as follows:

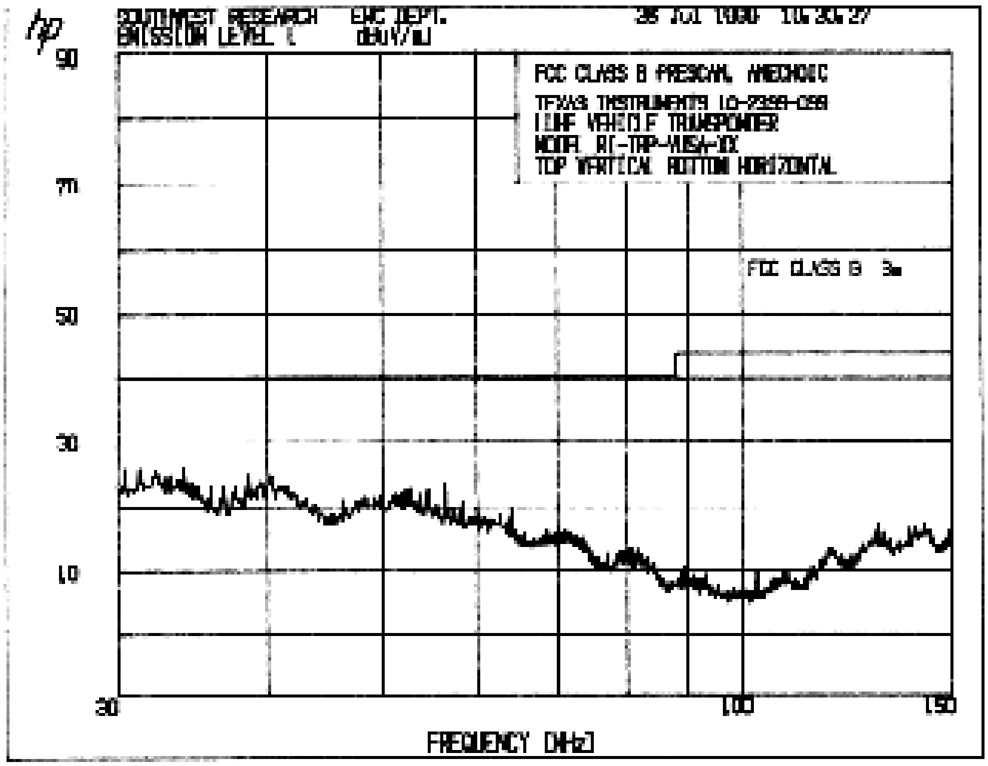
antilog[(dBμV/m)/20]   antilog[(46.8 dBμV/m)/20] = 269.2 μV/m

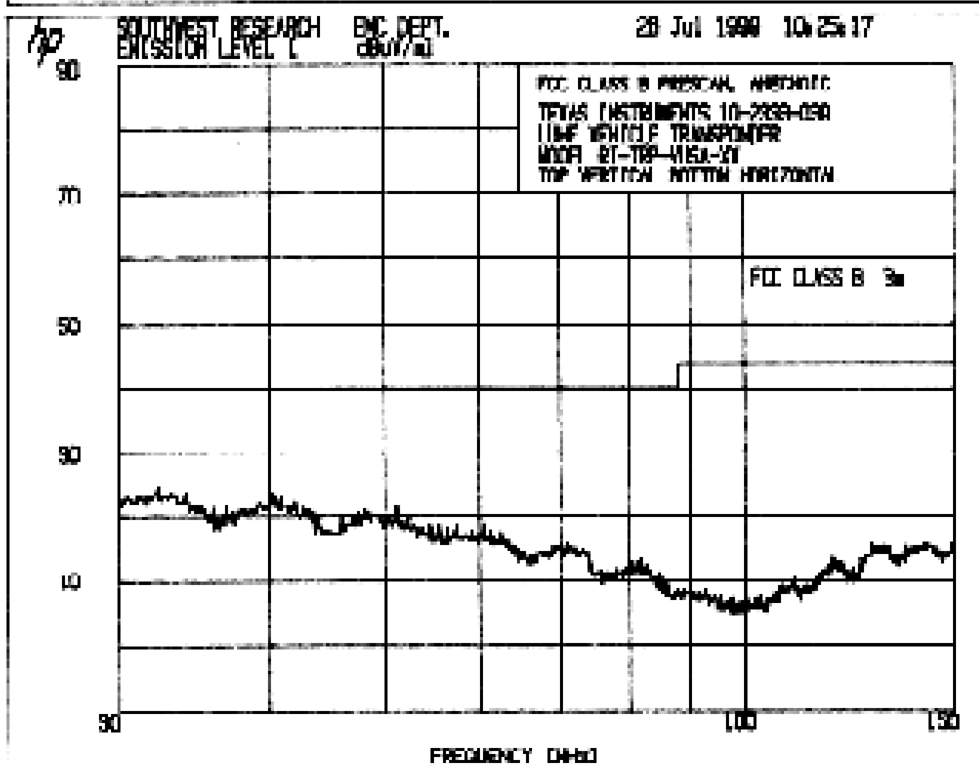
7.0 Photos of Tested EUT

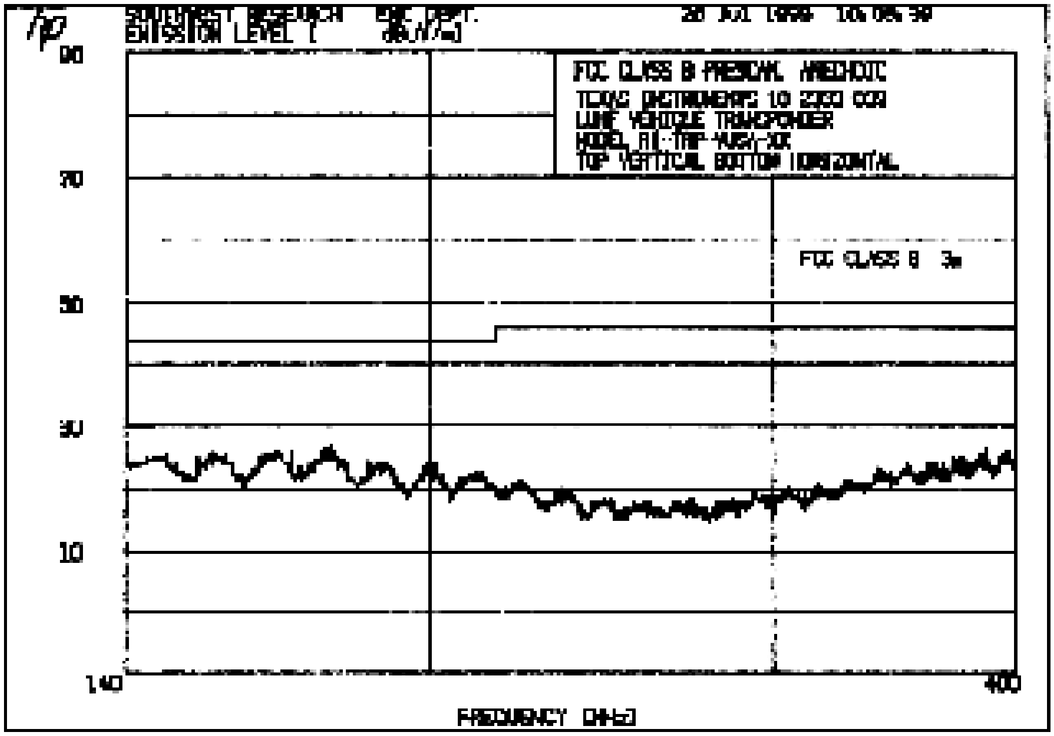
The photos of the EUT are provided in Attachment 5.

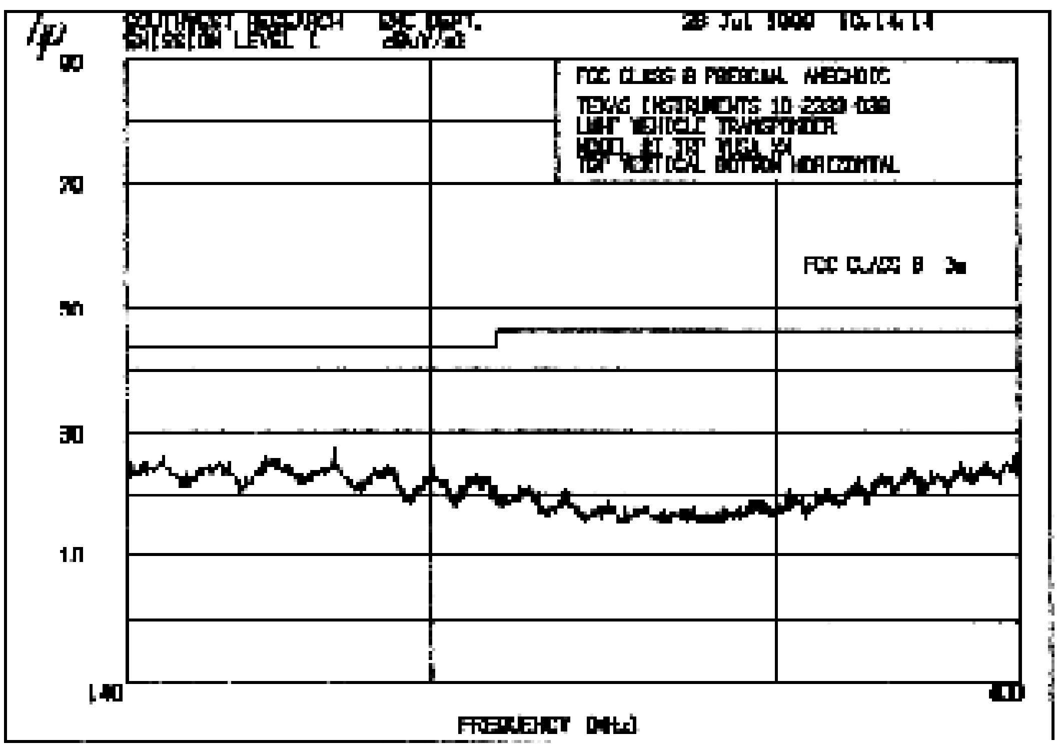
APPENDIX

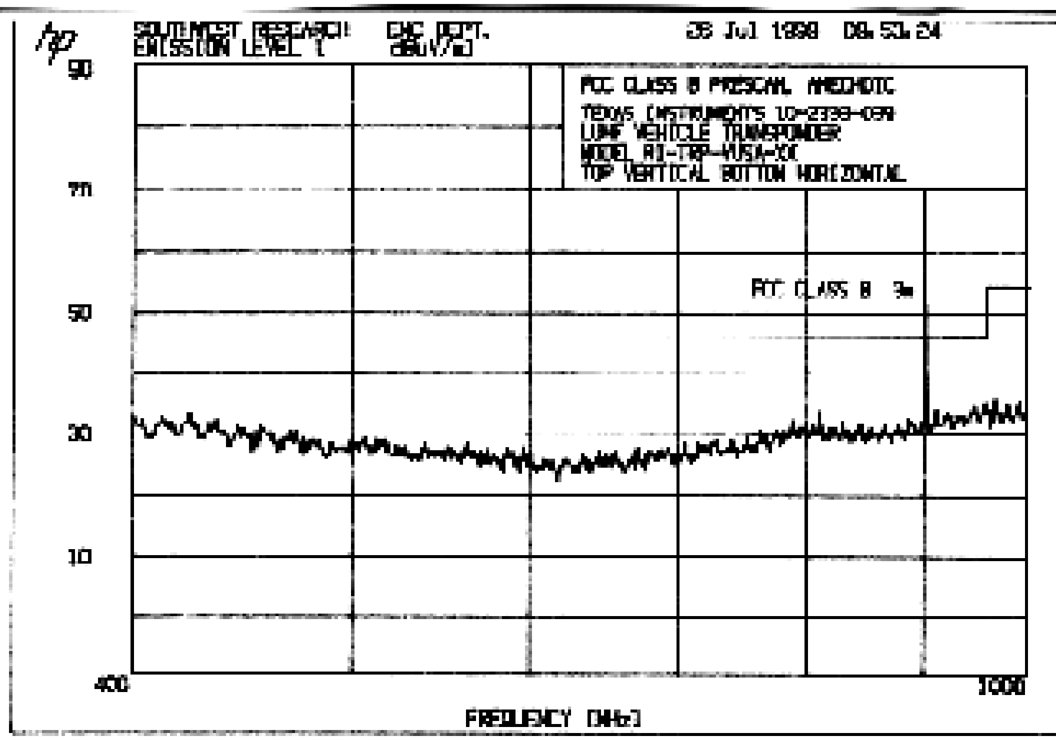
RADIATED SIGNATURE MEASUREMENTS PLOTS

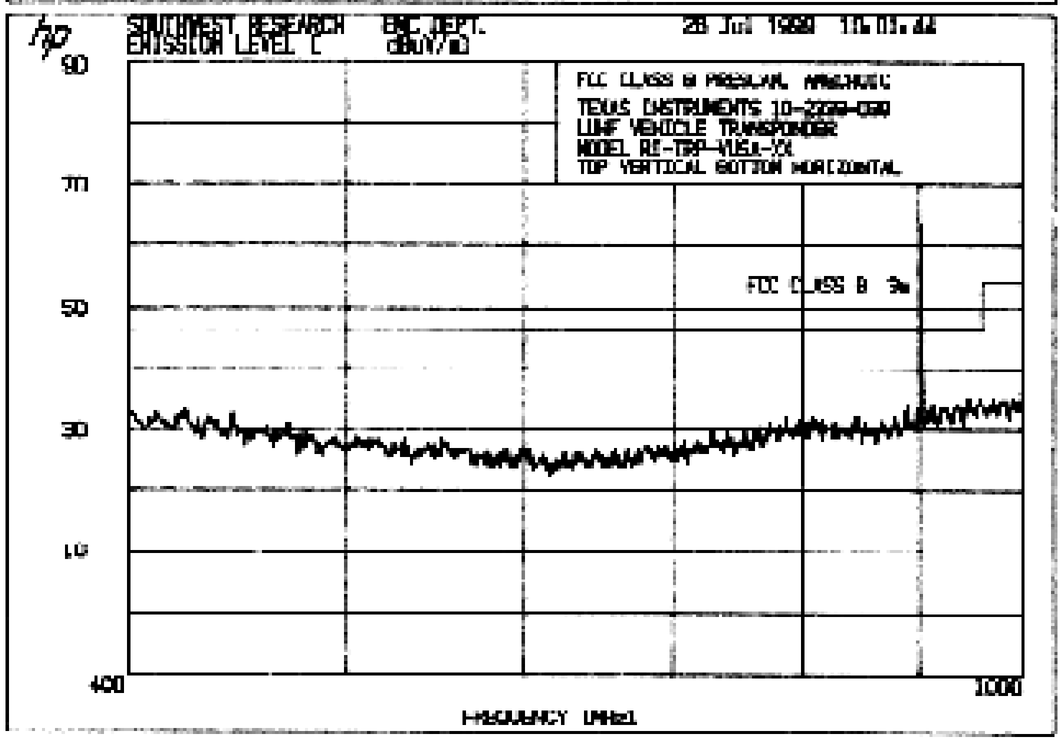

SOUTHWEST RESEARCH
EMC DEPT.
EMISSION LEVEL
FCC CLASS B PRESCAN, ANECHOIC
UHF VEHICLE TRANSPONDER
TOP VERTICAL BOTTOM HORIZONTAL
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]

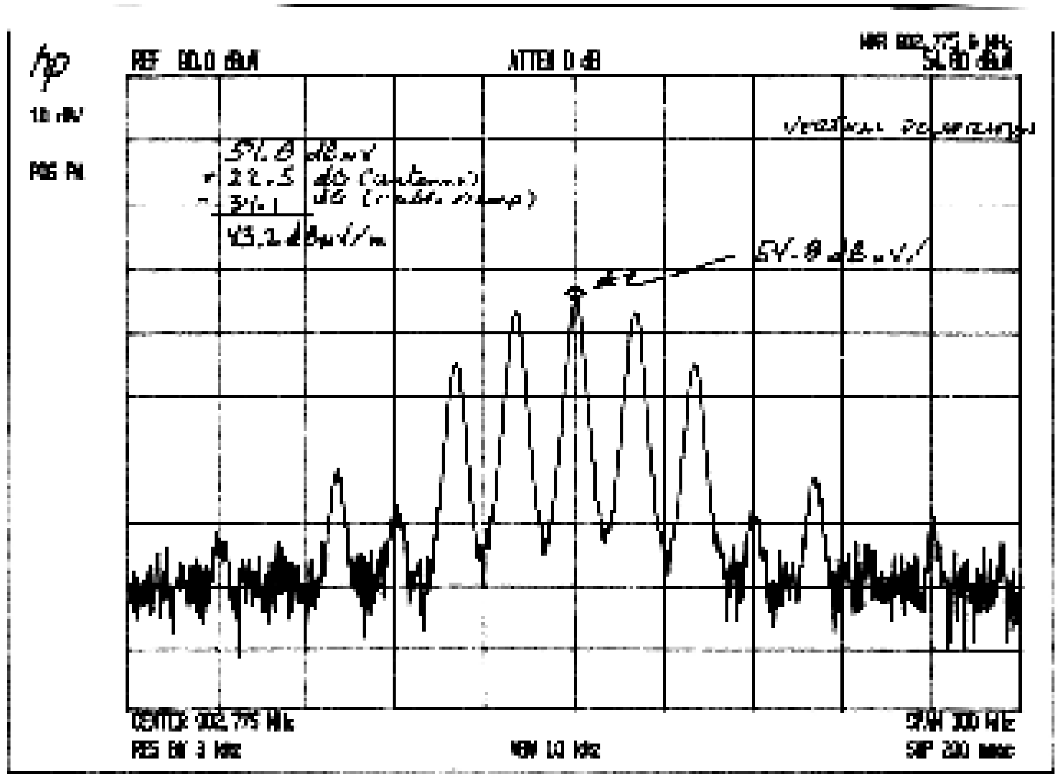

SOUTHWEST RESEARCH
EMC DEPT.
EMISSION LEVEL
FCC CLASS B 3m
90
50
100
150
FREQUENCY [MHz]

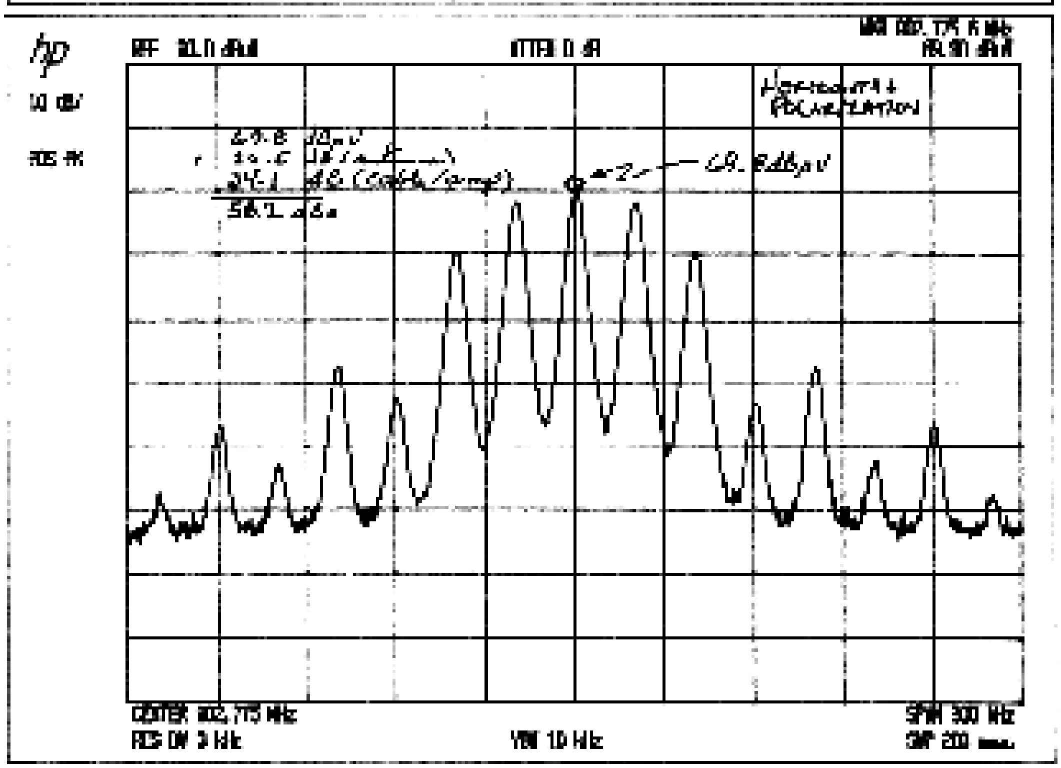

SOUTHWEST RESEARCH
EMISSION LEVEL
FCC CLASS B PRESCAN ANECHOIC
TOP VERTICAL BOTTOM HORIZONTAL
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY (MHz)

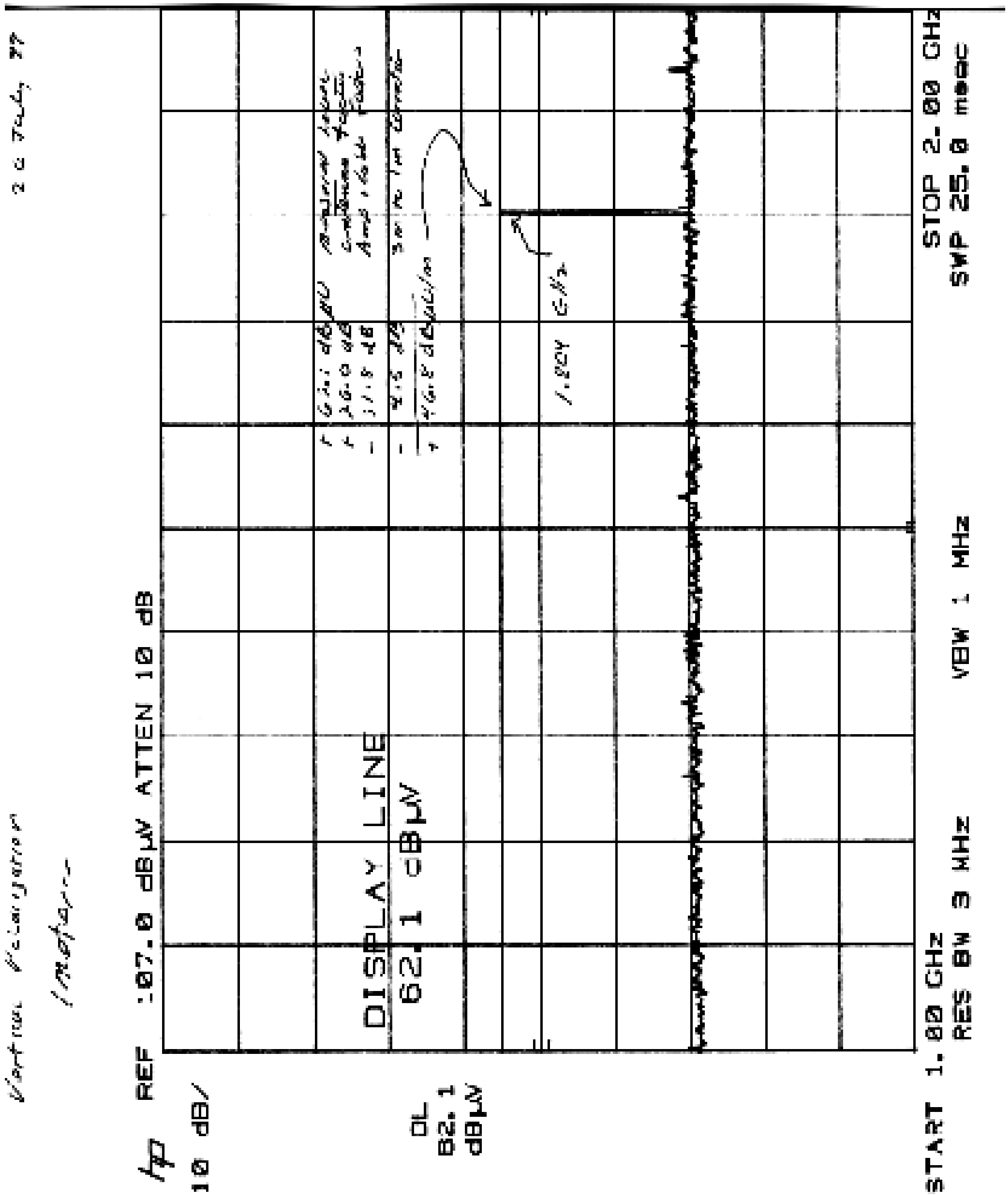

SOUTHWEST RESEARCH
EMC DEPT.
FCC CLASS B PRESCAN ANECHOIC
LIGHT VEHICLE TRANSPONDER
TOP VERTICAL BOTTOM HORIZONTAL
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY (MHz)

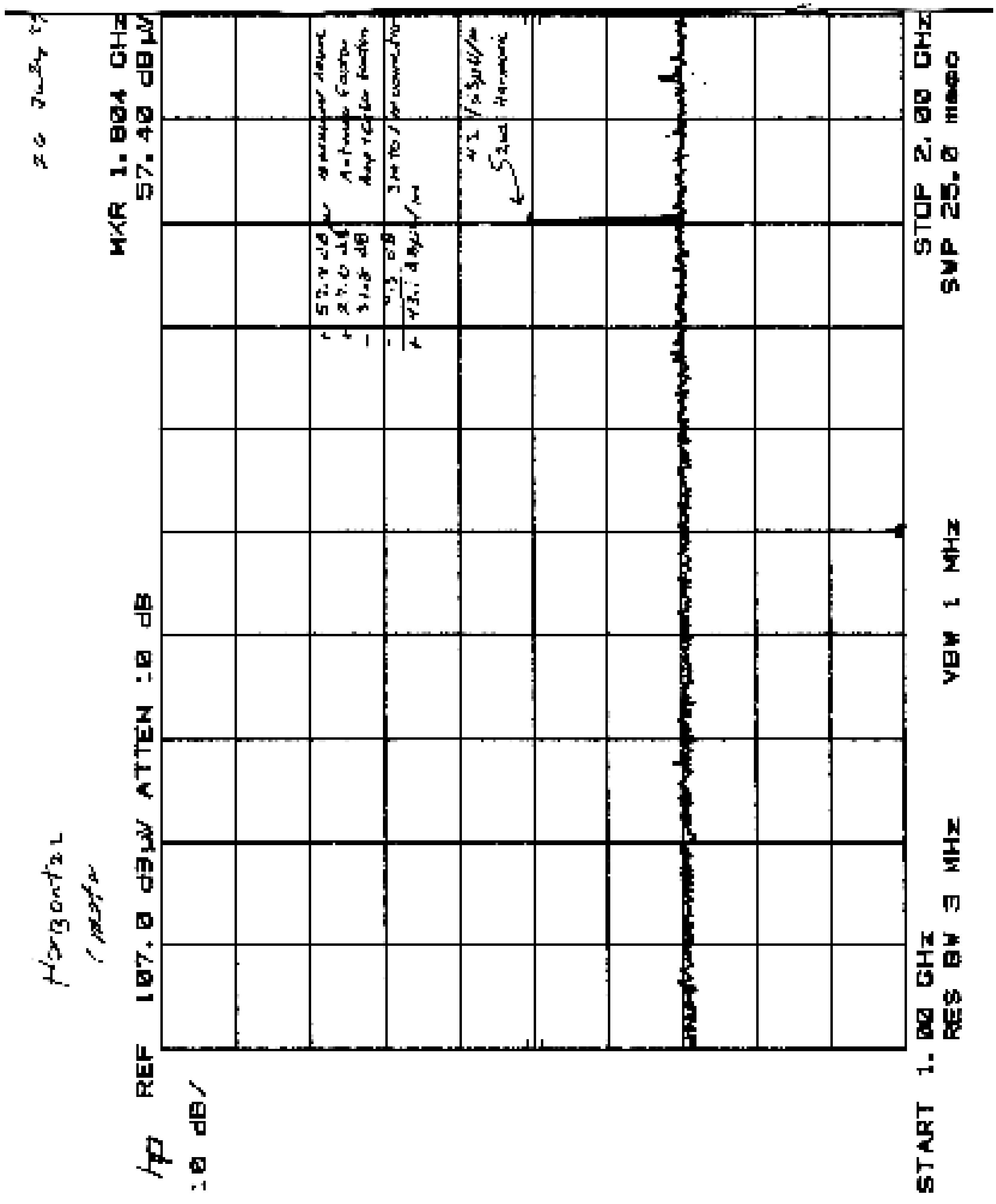

SOUTHWEST RESEARCH EMC DEPT.
EMISSION LEVEL L dBuV/m
28 Jul 1998 08:51:24
FCC CLASS B PRESCAN, ANECHOIC
TEXAS INSTRUMENTS 10-2333-039
LUHF VEHICLE TRANSPONDER
MODEL RI-TRP-VUSA-XX
TOP VERTICAL BOTTOM HORIZONTAL
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY (MHz)

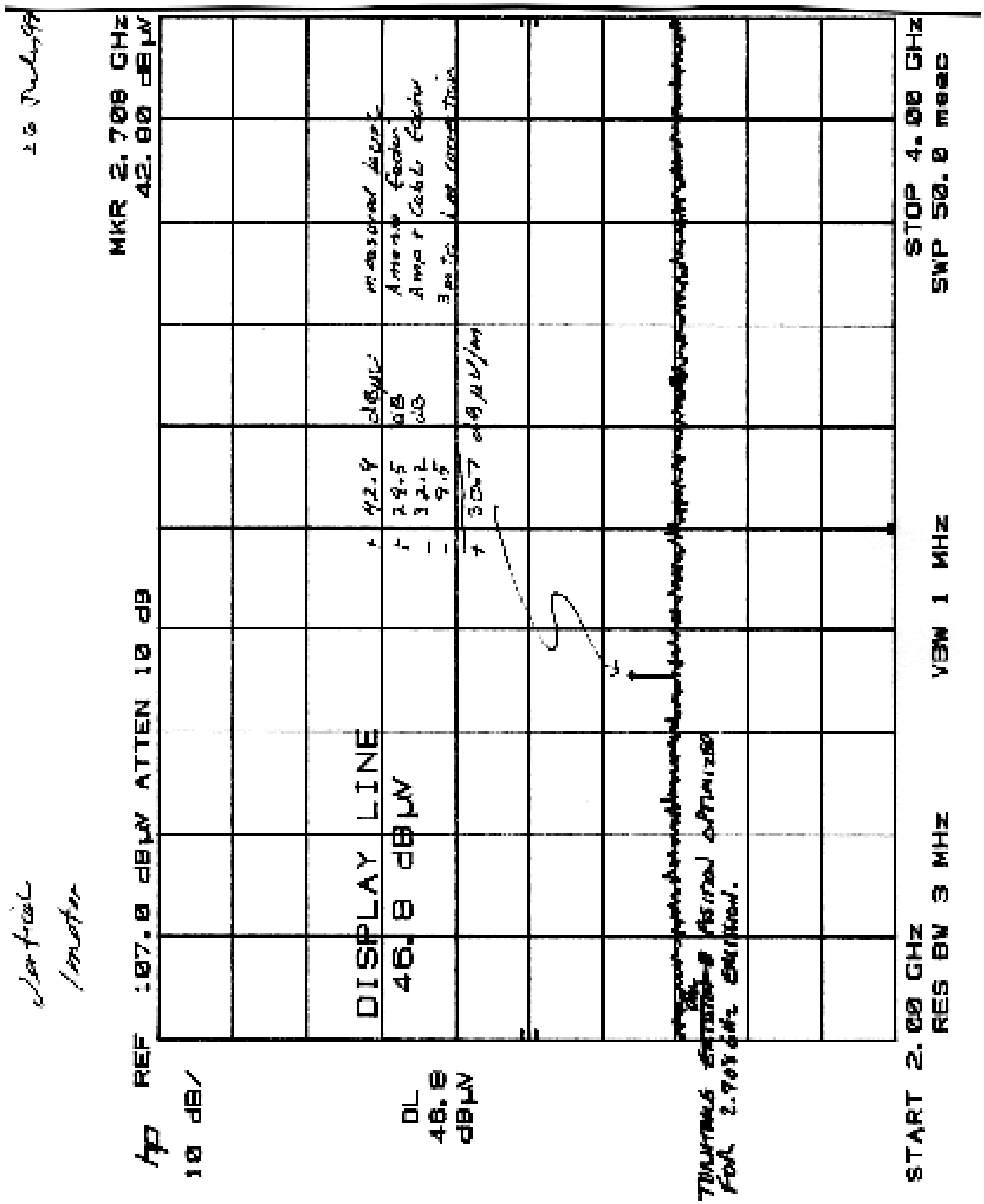

SOUTHWEST RESEARCH EMC DEPT.
EMISSION LEVEL L dBuV/m
28 Jul 1998 10:01:44
FCC CLASS B PRESCAN, ANECHOIC
TEXAS INSTRUMENTS 10-2333-039
LUHF VEHICLE TRANSPONDER
MODEL RI-TRP-VUSA-XX
TOP VERTICAL BOTTOM HORIZONTAL
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY (MHz)

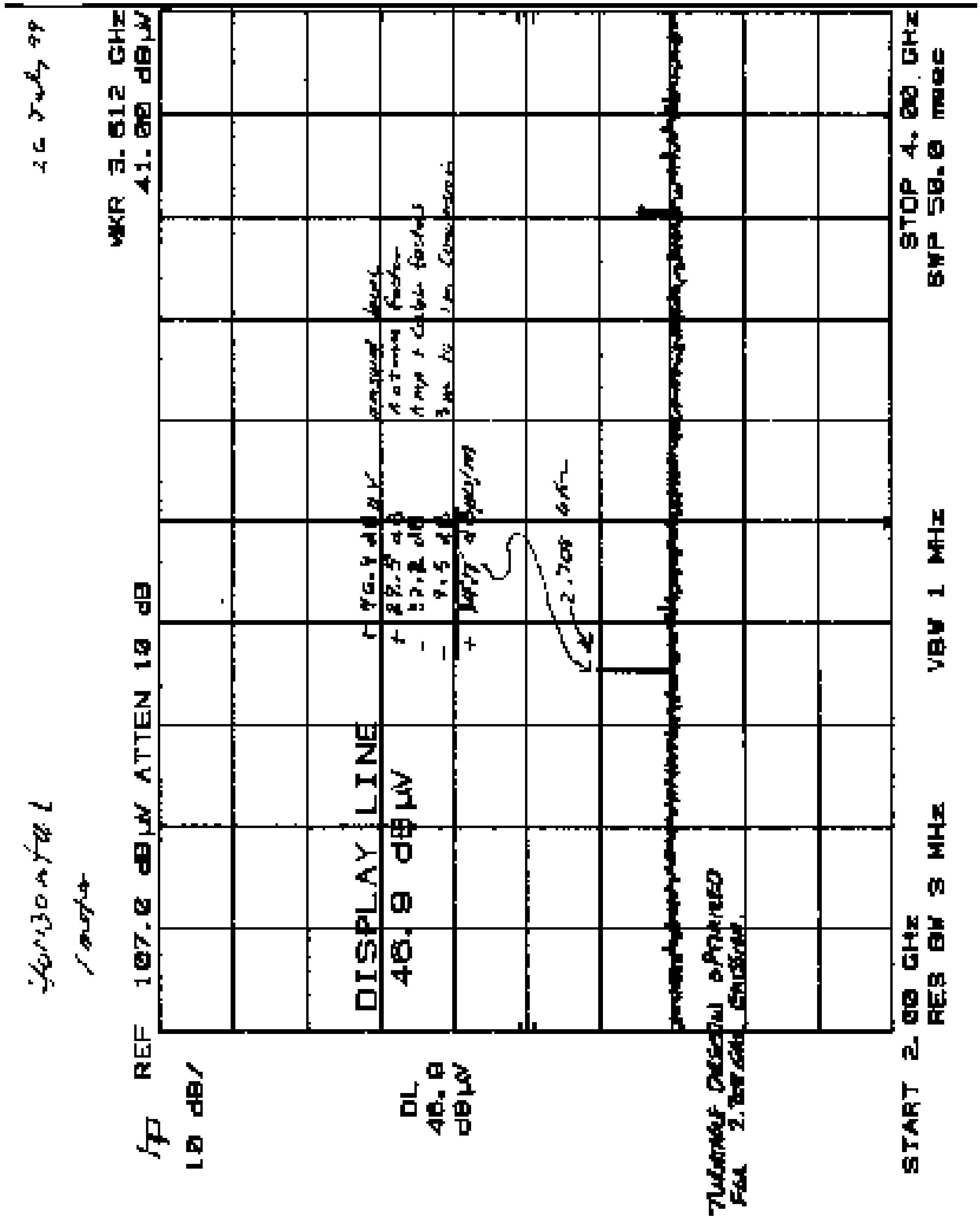

REF 80.0 dBµV
ATTEN 0 dB
10 dB/
POS PK
VERTICAL POLARIZATION
CENTER 902.775 MHz
SPAN 300 kHz
RES BW 3 kHz
VBW 10 kHz
SWP 200 msec

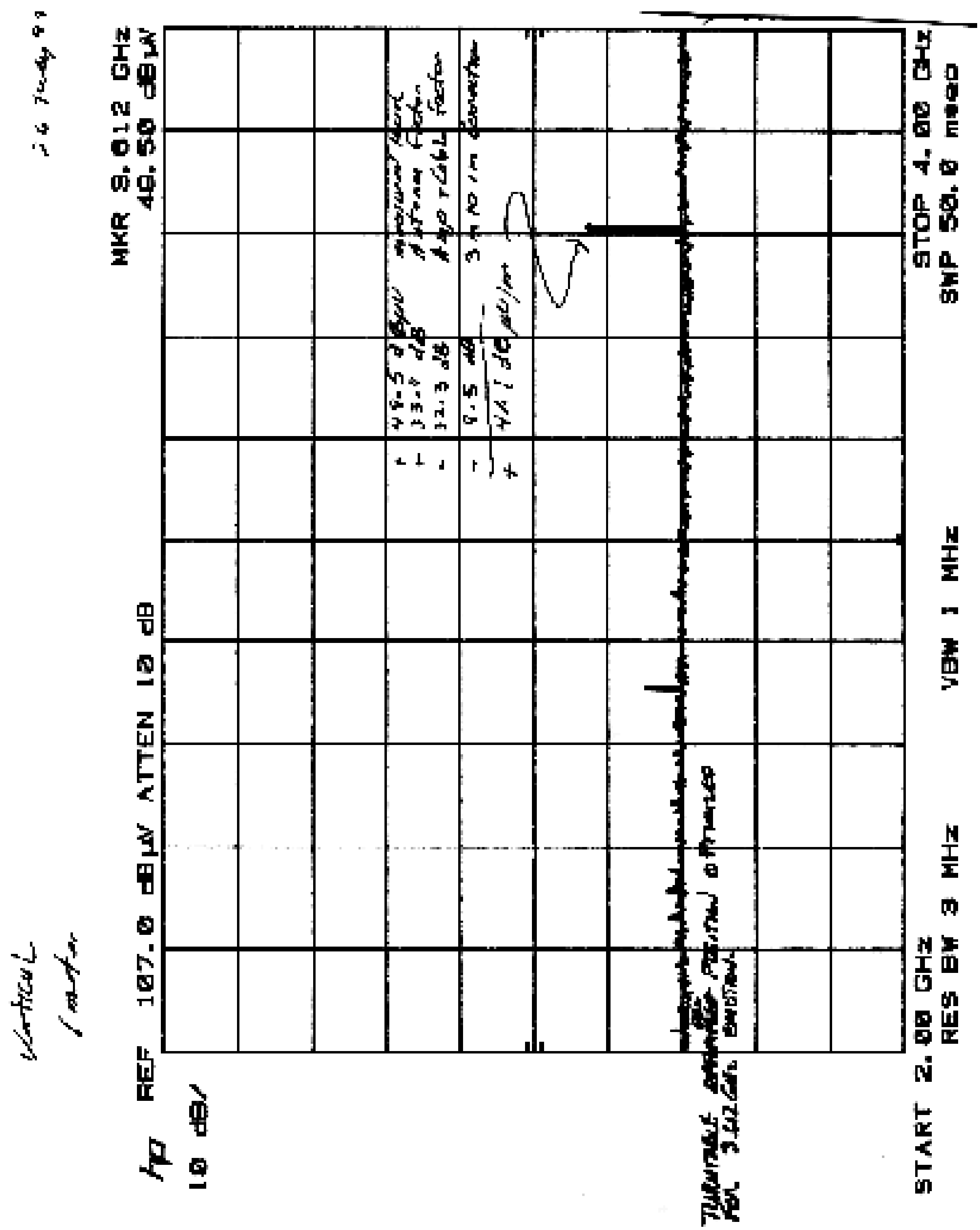

REF 80.0 dBµV
ATTEN 0 dB
10 dB/
POS PK
HORIZONTAL POLARIZATION
CENTER 902.775 MHz
SPAN 300 kHz
RES BW 3 kHz
VBW 10 kHz
SWP 200 msec

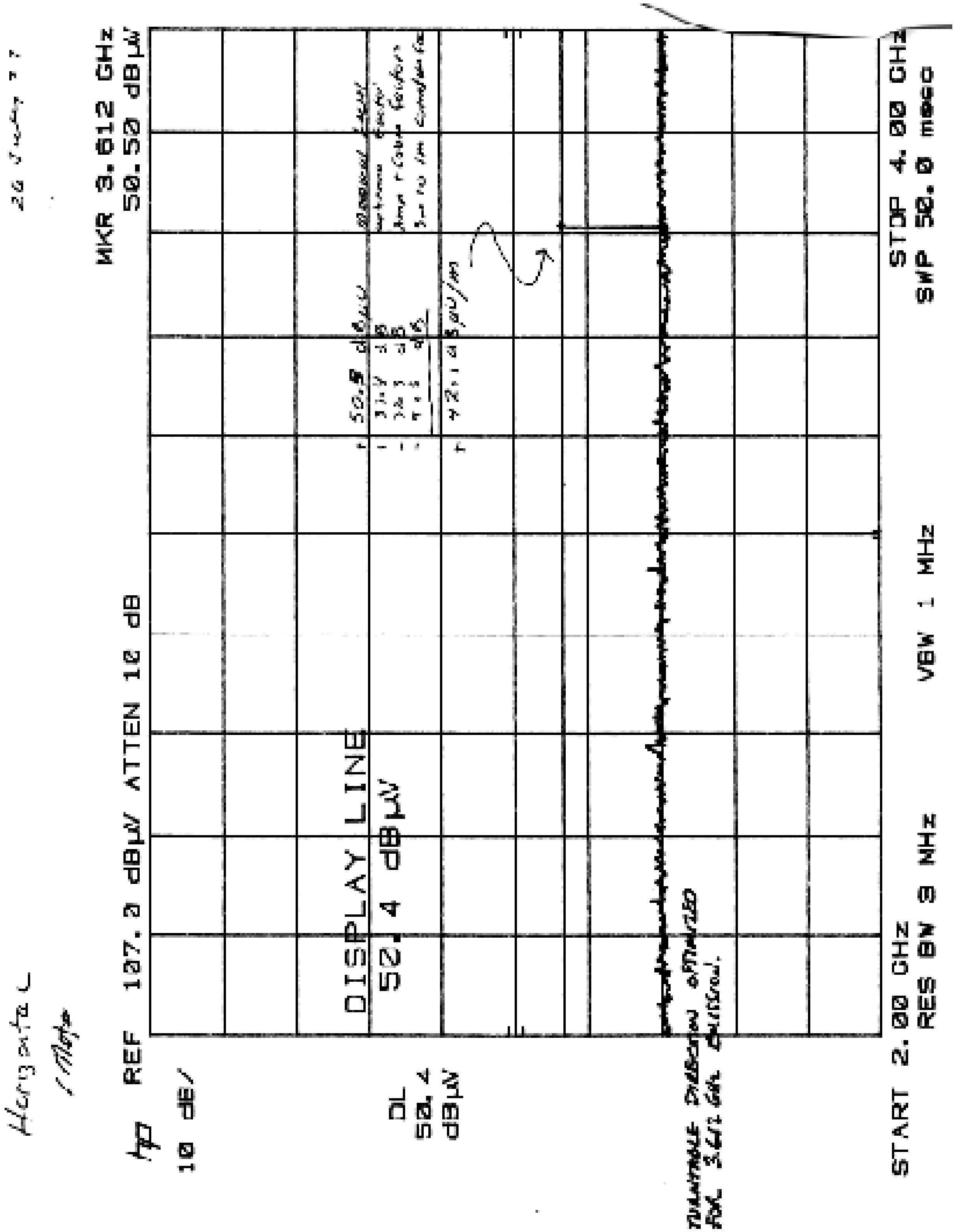

REF 107.0 dBµV ATTEN 10 dB
10 dB/
DL
82.1
dBµV
DISPLAY LINE
62.1 dBµV
START 1.00 GHz
RES BW 3 MHz
VBW 1 MHz
STOP 2.00 GHz
SWP 25.0 msec

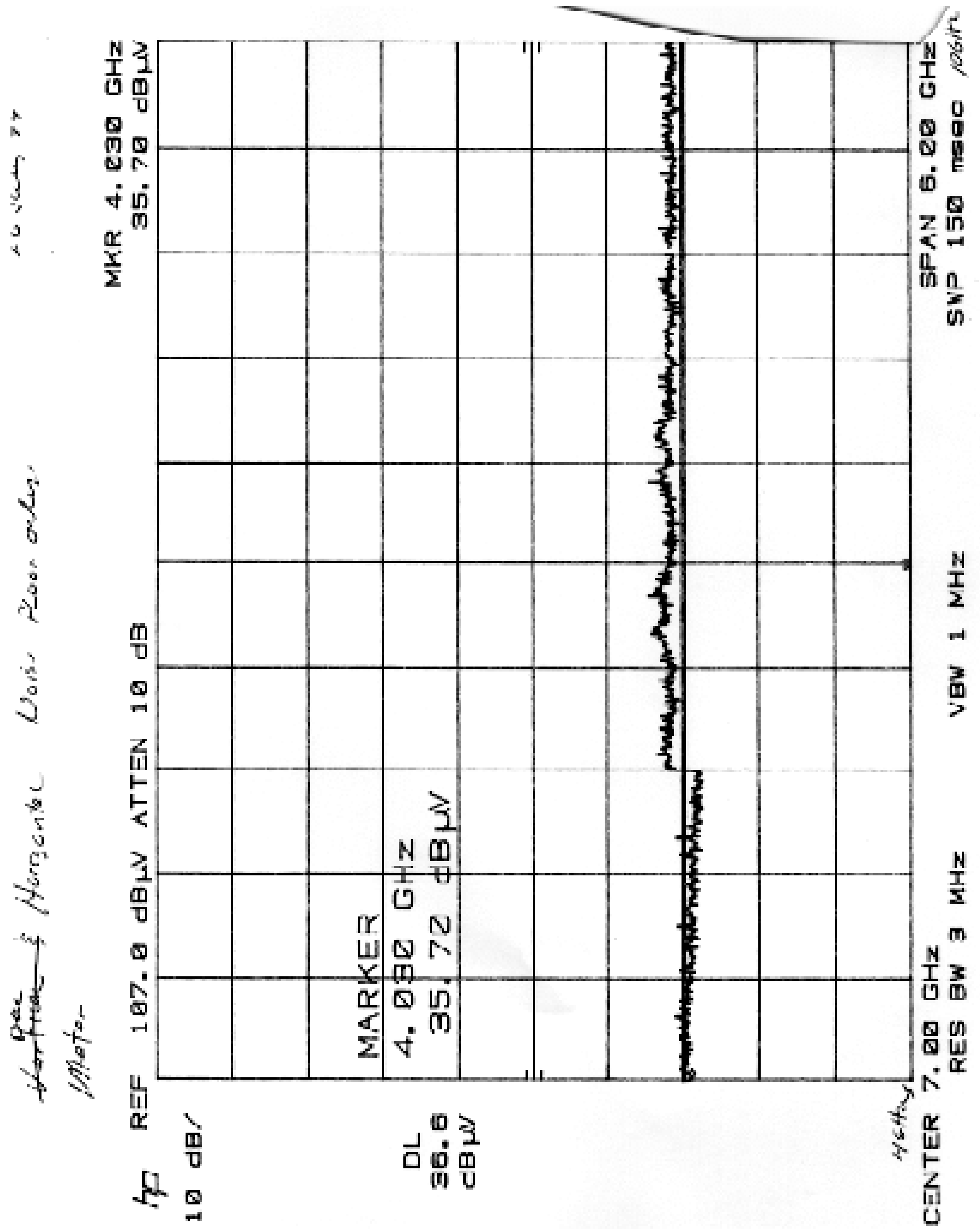

MKR 1.804 GHz
57.40 dBµV
REF 107.0 dBµV ATTEN 10 dB
10 dB/
START 1.00 GHz
RES BW 3 MHz
VBW 1 MHz
STOP 2.00 GHz
SWP 25.0 msec

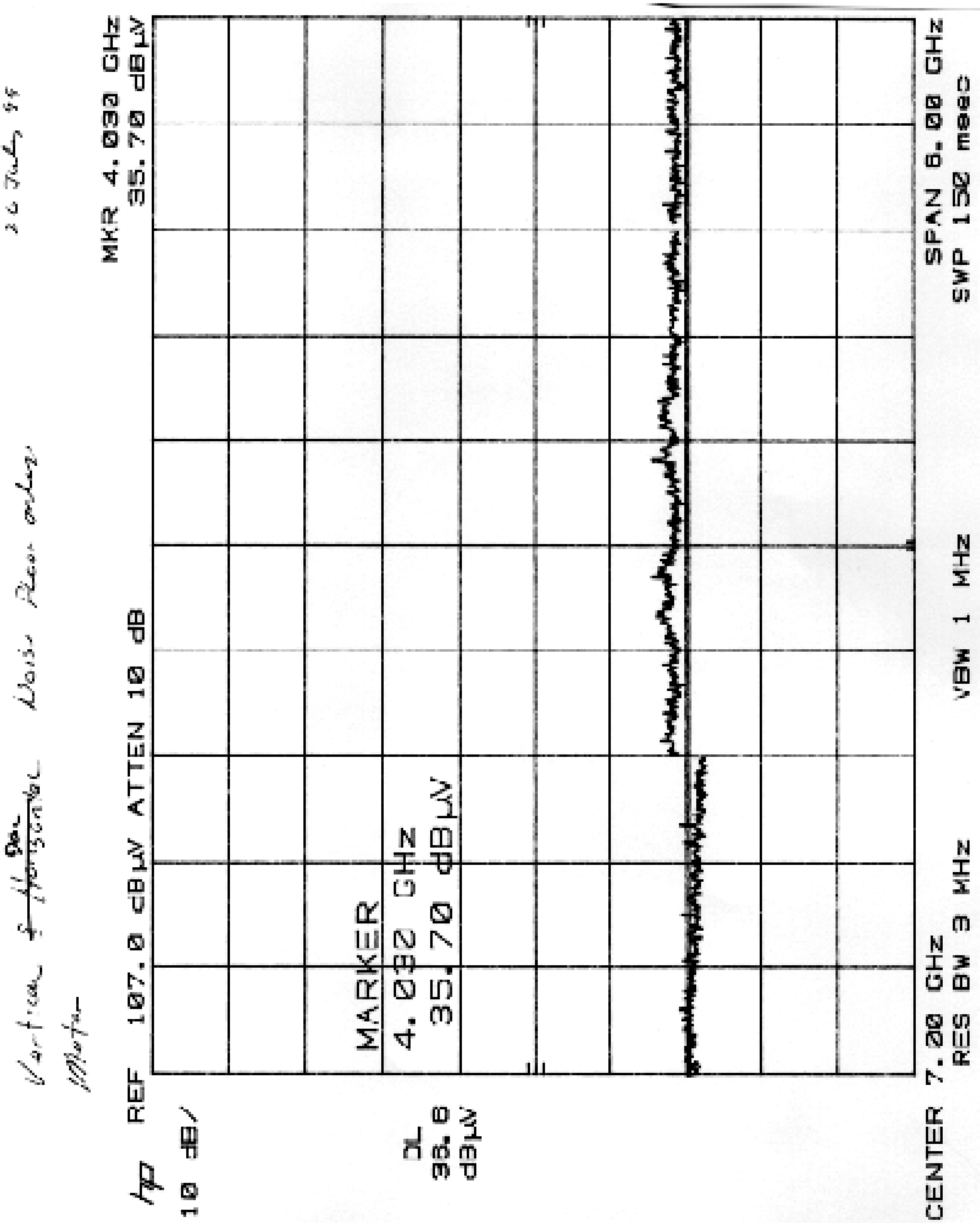

REF 107.0 dBµV ATTEN 10 dB
MKR 2.708 GHz
42.00 dBµV
10 dB/
DL
46.8
dBµV
DISPLAY LINE
46.8 dBµV
START 2.00 GHz
RES BW 3 MHz
VBW 1 MHz
STOP 4.00 GHz
SWP 50.0 msec


REF 107.0 dBµV ATTEN 10 dB
MKR 3.612 GHz
41.00 dBµV
10 dB/
DISPLAY LINE
46.0 dBµV
DL
46.0
dBµV
START 2.00 GHz
RES BW 3 MHz
VBW 1 MHz
STOP 4.00 GHz
SWP 50.0 msec


REF 107.0 dBμV ATTEN 10 dB
10 dB/
MKR 3.012 GHz
40.50 dBμV
START 2.00 GHz
RES BW 3 MHz
VBW 1 MHz
STOP 4.00 GHz
SWP 50.0 msec


MKR 3.612 GHz
50.50 dBµV
REF 107.0 dBµV ATTEN 10 dB
10 dB/
DL
52.4
dBµV
DISPLAY LINE
52.4 dBµV
START 2.00 GHz
STOP 4.00 GHz
RES BW 3 MHz
VBW 1 MHz
SWP 50.0 msec


REF 107.0 dBµV ATTEN 10 dB
MKR 4.030 GHz
35.70 dBµV
10 dB/
DL
36.6
dBµV
MARKER
4.030 GHz
35.72 dBµV
CENTER 7.00 GHz
SPAN 6.00 GHz
RES BW 3 MHz
VBW 1 MHz
SWP 150 msec



REF 107.0 dBµV ATTEN 10 dB
MKR 4.030 GHz
35.70 dBµV
10 dB/
DL
38.8
dBµV
MARKER
4.032 GHz
35.70 dBµV
CENTER 7.00 GHz
SPAN 6.00 GHz
RES BW 3 MHz
VBW 1 MHz
SWP 150 msec

ATTACHMENT 1

DESCRIPTION AND BLOCK DIAGRAM

ATTACHMENT 2

TRANSPONDER HARDWARE SPECIFICATIONS

ATTACHMENT 3

TRANSPONDER SOFTWARE SPECIFICATIONS

ATTACHMENT 4

TECHNICAL DOCUMENTATION (SCHEMATICS)

CONFIDENTIAL

ATTACHMENT 5

PHOTOS OF TESTED EUT

ATTACHMENT 6

PARTS LIST (BILL OF MATERIALS)