*Operational Manual*

# Broadband Isotropic Electric Field Probe 100 MHz -18 GHz

## Model 7121

ETS™
EMC TEST SYSTEMS, L.P. – An ESCO Company
E M C O

CONTROL COPY
# 1001a

**USA**
2205 Kramer Lane, Austin, Texas 78758-4047
P.O. Box 80589 Austin, Texas 78708-0589
Tel 512.835.4684 Fax 512.835.4729

**FINLAND**
Euroshield OY
Fankkeen Teollisuusalue
27510, Eura, Finland
Tel 358.2.838.3300 Fax 358.2.865.1233

**E-MAIL & INTERNET**
support@emctest.com
http://www.emctest.com



REV F - PN 399111

## Funkentstörung

## Bescheinigung des Herstellers

Hiermit wird bescheinigt, dass das Gerät Serie 7100 Isotropic, Broadband, E-Field Probe System (bestehend aus Model 7110 Data Processing/Interface Unit, Model 7120 Metering Unit and Model 7130 Probe) in Übereinstimmung mit den Bestimmungen der Vfg 1046/1984 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmung eingeräumt.

The Electro-Mechanics Co.
P. O. Box 1546
Austin, TX 78767 USA

Physical address:
12118 N. IH35, Bldg B
Austin, TX 78753 USA

In West Germany:
EMCO-Europe
Munchner Str. 2
D-8137 Berg 1
West Germany

# RFI DECLARATION

We hereby certify that the Series 7100 Isotropic, Broadband, E-Field Probe System (consisting of Model 7110 Data Processing/Interface Unit; Model 7120 Metering Unit and Model 7130 Probe) complies with the RFI suppression requirements of Vfg 1046/1984. The German Postal Service was notified that equipment is being marketed. The German Postal Service has the right to re-test the equipment and verify compliance.

The Electro-Mechanics Co.
P. O. Box 1546
Austin, TX 78767 USA

Physical address:
12118 N. IH 35, Bldg. B
Austin, TX 78753 USA

In West Germany:
ENCO-Europe
Munchner Str. 2
D-8137 Berg 1
West Germany

Table of Contents

# WARRANTY

The Electro-Mechanics Company (EMCO) warrants that our products are free from defects in materials and workmanship for a period of two years(*) from the date of shipment. If you notify us of a defect within the warranty period, we will, at our option, either repair or replace those products which prove to be defective. If applicable, we will also recalibrate the product.

There will be no charge for warranty services performed at the location we designate. You must however, prepay inbound shipping costs and any duties or taxes. We will pay outbound shipping costs for a carrier of our choice, exclusive of any duties or taxes. You may request warranty services to be performed at your location, but it is our option to do so. If we determine that warranty service can only be performed at your location, you will not be charged for our travel related costs.

This warranty does not apply to:

1. Normal wear and tear of materials
2. Consumable items such as fuses, batteries, etc.
3. Products which have been improperly installed, maintained, or used.
4. Products which have been operated outside of specifications.
5. Products which have been modified without authorization.
6. Calibration of products, unless necessitated by defects.

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

THE REMEDIES PROVIDED BY THIS WARRANTY ARE YOUR SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT ARE WE LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Please contact our Sales Department for a Return Material Authorization Number before shipping equipment to us.

(*) Exception: Model 7130 Electric Field Probe is warranted as above except for 90 days only.

CAUTION:

Model 7130 probe is a delicate instrument and should be handled with extreme care. The following is a list of "don'ts" when using and storing the probe. Mishandling the probe outside the following guidelines could cause permanent damage to the probe and void the warranty.

- Avoid physical shock to the probe such as dropping, vibration, etc.

- Avoid pulling and stretching the cable. Always connect and disconnect the probe by holding the connector's backshell.

- Do not disassemble the probe's head or connector.

- Never expose the probe to the field levels above those specified as the overload power in the specifications table.

- Avoid exposing the probe to temperatures outside the specified range.

In order to stabilize the response of the probe, at the time when the data is being read from the probe, the probe assembly (the probe's head, cable, and connector) must be completely motionless.

DESCRIPTION:

Model 7130 is a broad-band, isotropic electric field sensing probe with a wide dynamic range. It is designed to sense the E-field strength in the near and far field regions and power density only in the far field region.

SPECIFICATIONS:

| | |
|---|---|
| Type | Electric Field |
| Frequency Range | 1 MHz - 18 GHz |
| Calibrated Dynamic Range | 2 - 500 V/m<br>0.001 - 66.4 $mW/cm^2$<br>48 dB |
| Probe Calibration Accuracy | |
| 1 MHz to 1 GHz | +/- 0.5 dB |
| 1 GHz to 18 GHz | +/- 1.0 dB |
| Isotropic Response | |
| 1 MHz to 6 GHz | +/- 0.5 dB |
| 6 GHz to 18 GHz | +/- 1.2 dB |
| Frequency Sensitivity | |
| 1 MHz to 10 MHz | +/- 2.5 dB |
| 10 MHz to 1 GHz | +/- 2.0 dB |
| 1 GHz to 18 GHz | +/- 5.5 dB |
| Average Power Overload<br>(operating & not operating) | 266 $mW/cm^2$<br>1000 V/m |
| Peak Power Overload<br>(operating & not operating) | 600 $mW/cm^2$<br>1500 V/m |
| Operating Temperature | 0 - 60 Degrees C |
| Storage Temperature | 0 - 60 Degrees C |
| Size | 0.7 in (1.8 cm) diameter<br>2.6 in (6.6 cm) length |
| Cable Length | 4 ft (1.2 m) |
| Weight | 0.2 lb (0.1 kg) |

CONFIGURATION:

The probe consists of three miniature, mutually orthogonal dipoles, each deposited on a quartz substrate. The three substrates form the three sides of a prism with 60 degree angles as shown in figure 1.

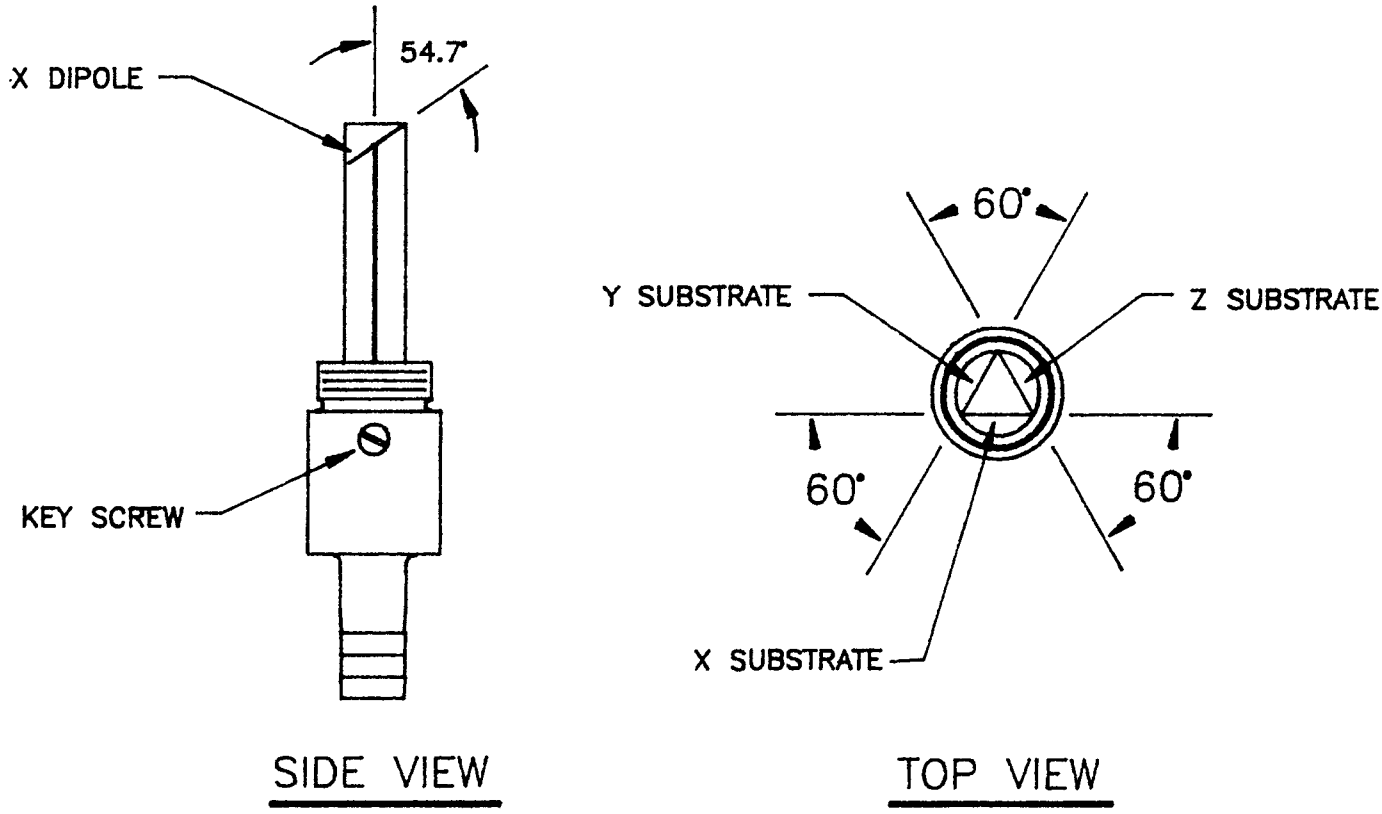


Figure 1

For notation purposes the dipoles are referred to as x, y, and z dipoles since they make a three dimensional set of mutually orthogonal axes.

The probe's cable consists of three pairs of high resistance, nonmetallic, conductive elements, shielded by a high resistance, nonmetallic, conductive tubing. This configuration minimizes the interaction of the cable with the field.

CONNECTOR PIN ASSIGNMENT:

| PIN | DESCRIPTION |
|---|---|
| 1 | x + |
| 2 | x - |
| 3 | y + |
| 4 | y - |
| 5 | z + |
| 6 | z - |
| 7 | shield |

OPERATION:

By exposing the probe to an electric field, each dipole senses one component of the field strength vector in the three dimensional space. As a result, a DC voltage level, relative to the strength of the field sensed by each dipole, is produced across the + and - pins associated with the dipole.

NOTE: FOR THE MOST STABLE AND ACCURATE MEASUREMENT OF THE PROBE'S OUTPUT VOLTAGES, THE SHIELD MUST BE CONNECTED TO THE "GROUND" OR "COMMON" NODE OF THE VOLTAGE MEASURING INSTRUMENT, AND THE PROBE ASSEMBLY (THE PROBE'S HEAD, CABLE, AND CONNECTOR) MUST BE COMPLETELY MOTIONLESS.

Each probe is calibrated at one frequency over its dynamic range at several electric field levels. The probe is then tested at selected frequencies across its operating frequency range. The dynamic range and frequency response calibration tables accompany the probe.

The dynamic range calibration table provides the output DC voltage levels and multiplication factors corresponding to the tested field levels for each dipole. The dynamic range calibration table is placed in a look-up table inside the ROM of the Model 7120 Metering Unit which accompanies the Model 7130 Probe. The metering unit, then, automatically computes and outputs the electric field levels sensed by the three dipoles. The following paragraph describes the method of computation of the electric field.

To find the electric field level, E, which produces an output voltage level, Vi in a dipole, i, simply use the equation,

$$E = Fi\ Vi\ ,$$

where Fi is the corresponding multiplication factor of dipole i, listed in the dynamic range calibration table. To calculate the electric field values (between the minimum and maximum electric field levels listed in the table) other than those which are listed in the table, use the equation,

$$E = E1 + ((Vi - V1i)\ (E2 - E1) / (V2i - V1i))\ ,$$

where V1i and V2i are the two output voltage levels of dipole i, listed in the table, which are immediately less than and greater than Vi, respectively, and E1 and E2 are their corresponding electric field values.

The frequency response calibration table provides the correction factors neccessary to calculate the true electric field values sensed by the probe at frequencies other than the dynamic range calibration frequency. To find the true electric field level, Ef, at any frequency, f, use the equation,

$$Ef = E\ CFf\ ,$$

where CFf is the correction factor at the frequency f which is listed in the frequency response calibration table. To find the factors for frequencies (between the minimum and maximum frequencies listed in the table) other than those which are listed in the table, use the equation,

$$CFf = CF1f + ((f - f1)\ (CF2f - CF1f) / (f2 - f1))\ ,$$

where f1 and f2 are the two test frequencies, listed in the table, which are immediately less than and greater than f, respectively, and CF1f and CF2f are their corresponding correction factors.

## CALIIBRATION INFORMATION

Dynamic range calibration, over the range of 2 to 500 V/m, is performed in a transverse electromagnetic (TEM) cell at the frequency of 500 MHz. Frequency response calibration is performed: (a) from 1 MHz to 1GHz in the TEM cell, and (b) from 1 GHz to 18 GHz in an anechoic chamber using 200 watt TWT amplifiers and standard gain horn antennas, at a field level which is in correlation between the TEM cell and the anechoic chamber measurements; approximately 125 V/m. The dynamic range calibration factors are placed in the ROM of the Model 7120 Metering Unit. An external frequency response calibration table containing the correction factors for the frequencies between 1 MHz and 18 GHz is provided.

## TYPICAL DATA

Refer to Figure 2 for the Typical Dynamic Range Graph. Refer to Figures 3, and 4 for the Frequency Response Graphs. Refer to Figures 5, 6, and 7 for the Isotropic Response Graphs.

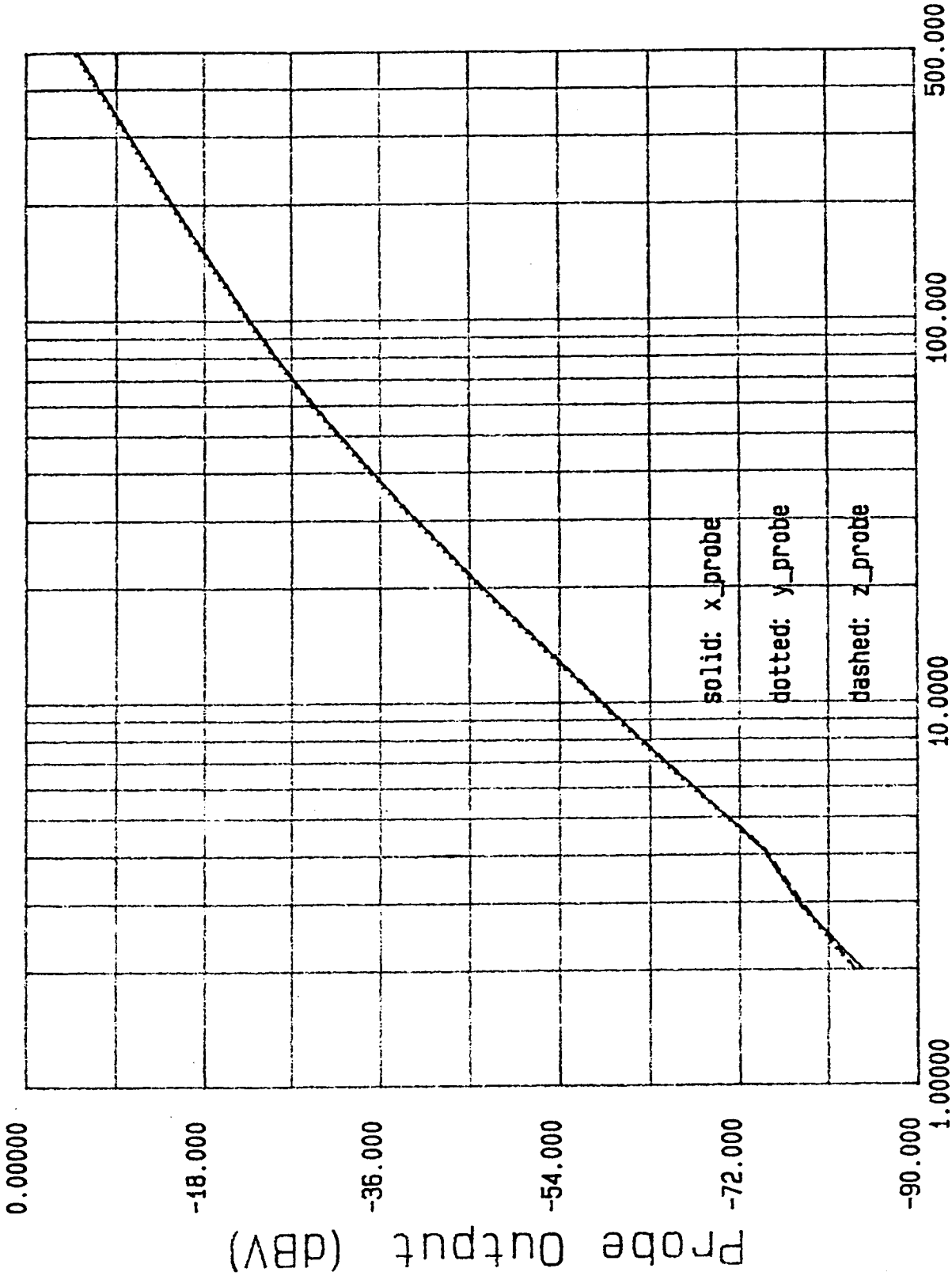


**FIGURE 2 TYPICAL DYNAMIC RANGE (AT 500 MHZ)**

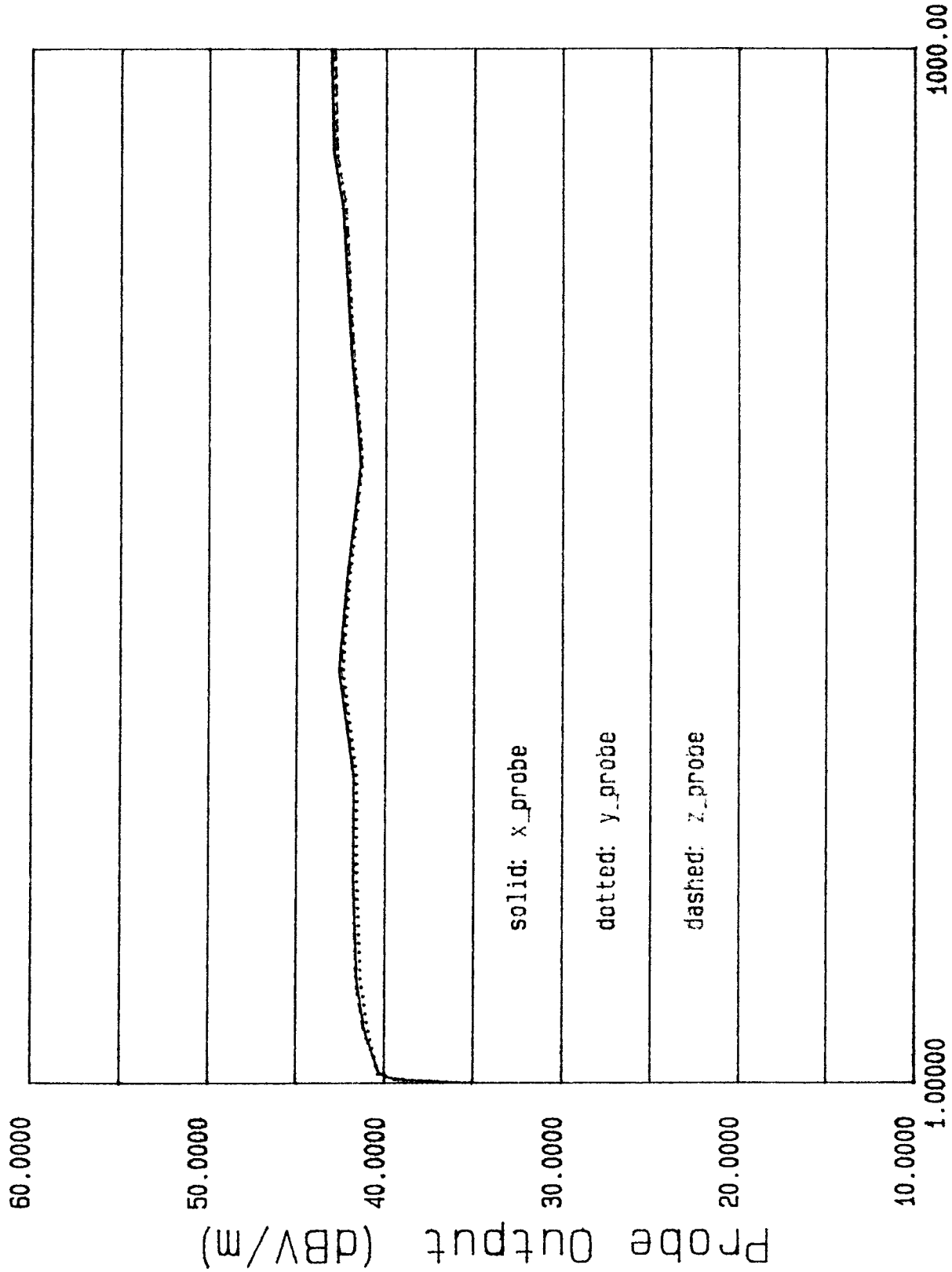


**FIGURE 3 TYPICAL FREQUENCY RESPONSE (AT 125 V/M)**

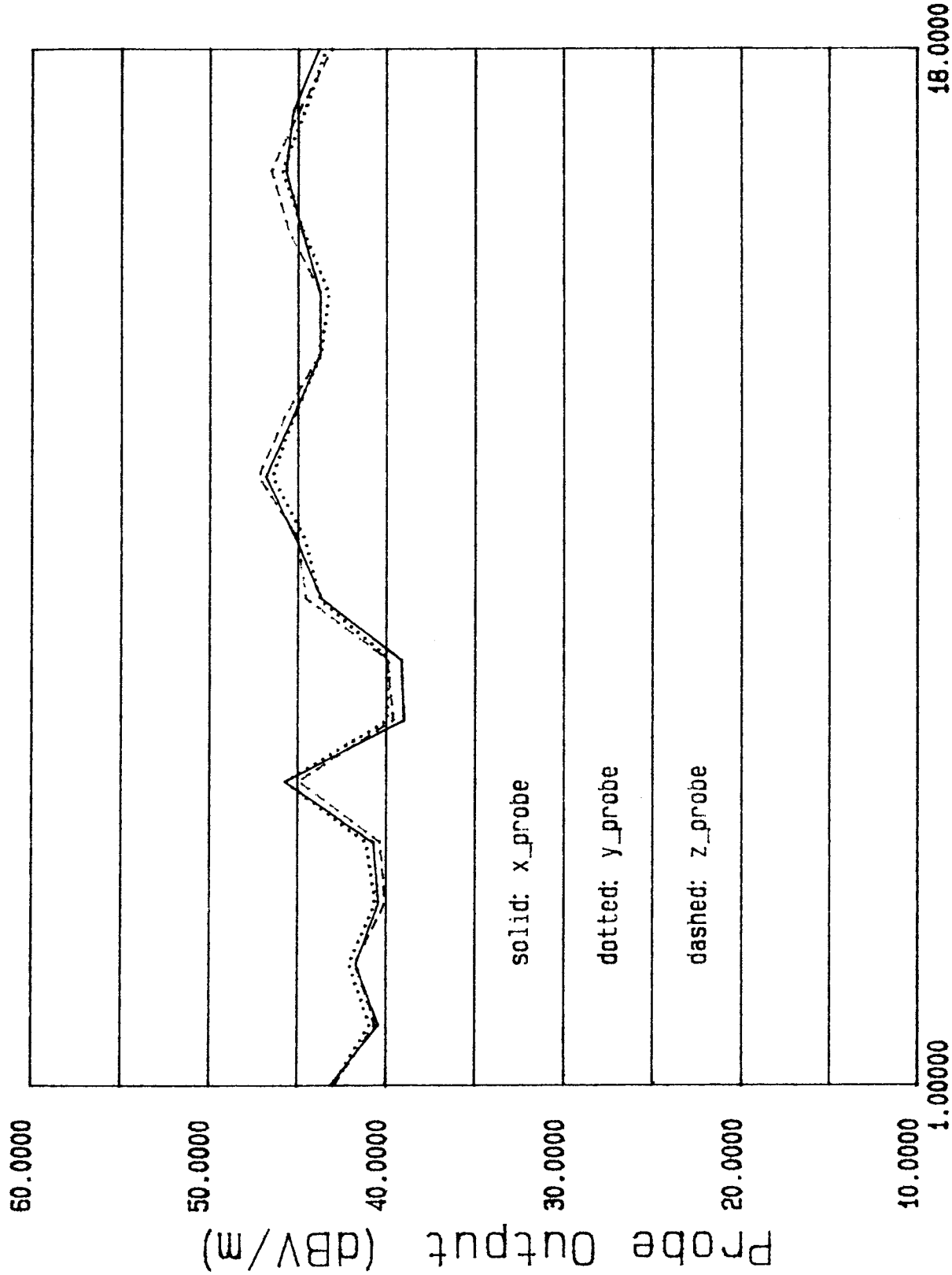


**FIGURE 4 TYPICAL FREQUENCY RESPONSE (AT 125 V/M)**

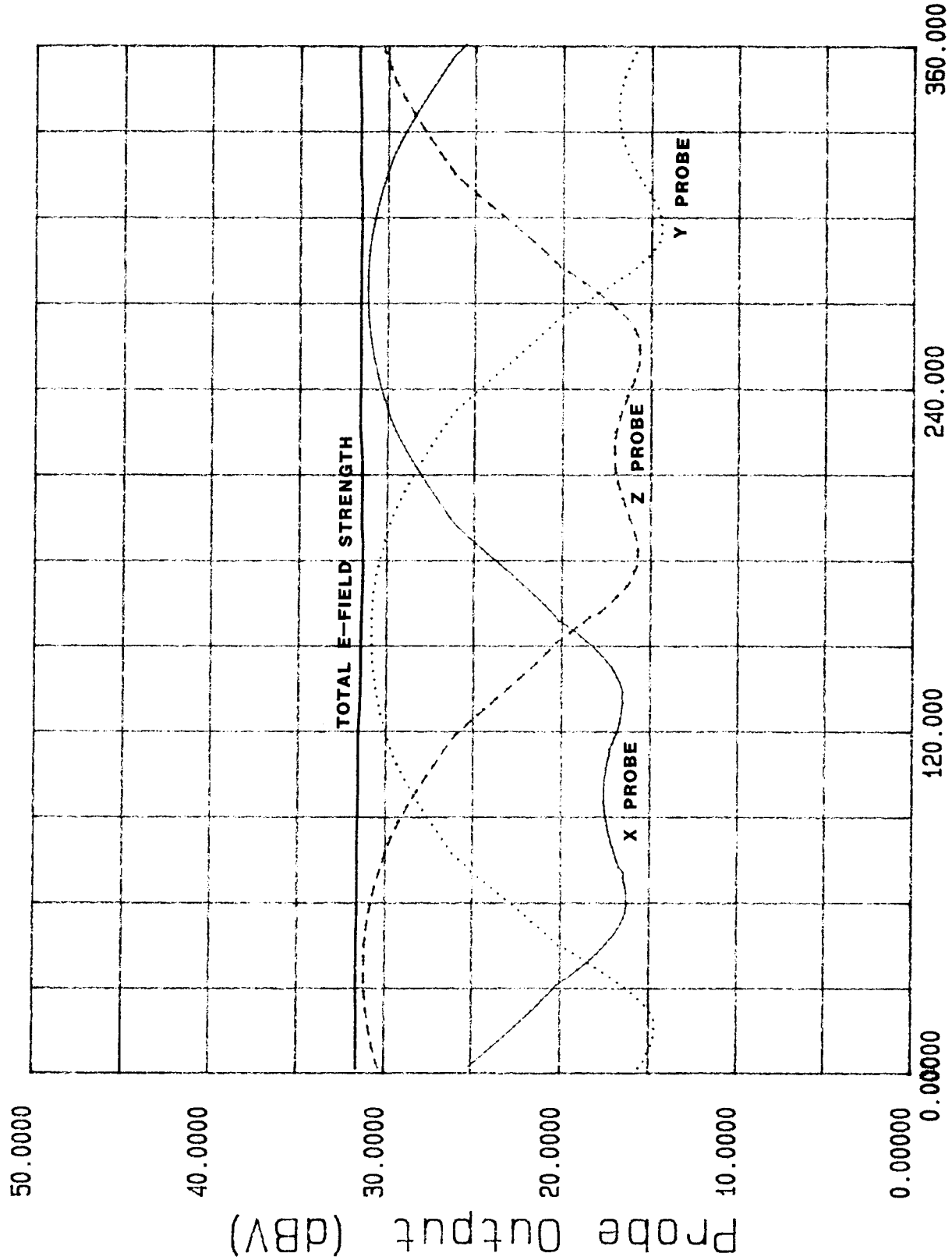


FIGURE 5 TYPICAL ISOTROPIC RESPONSE (AT 25 MHZ, 50 V/M)

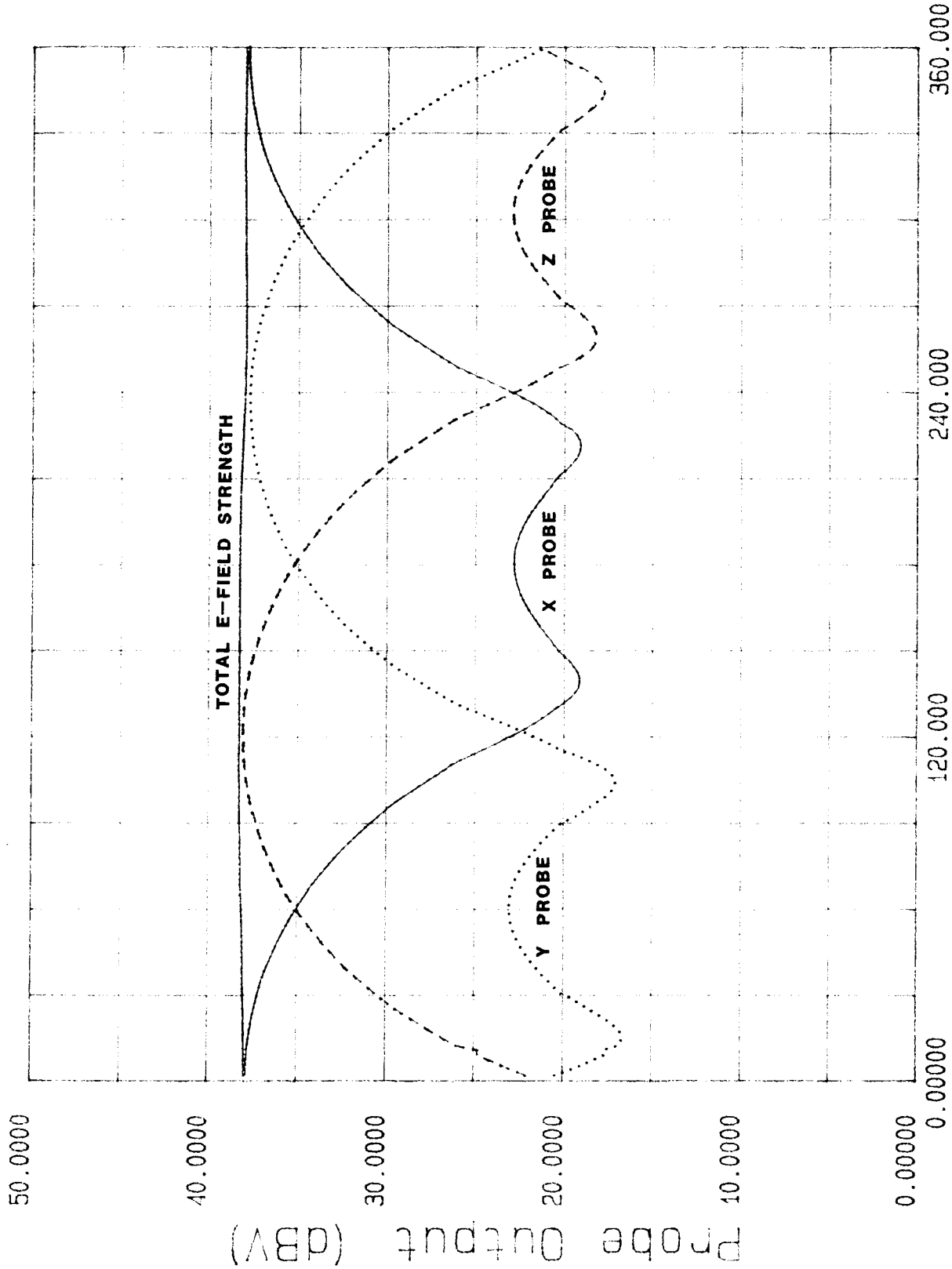


**FIGURE 6 TYPICAL ISOTROPIC RESPONSE (AT 50 MHZ, 100 V/M)**

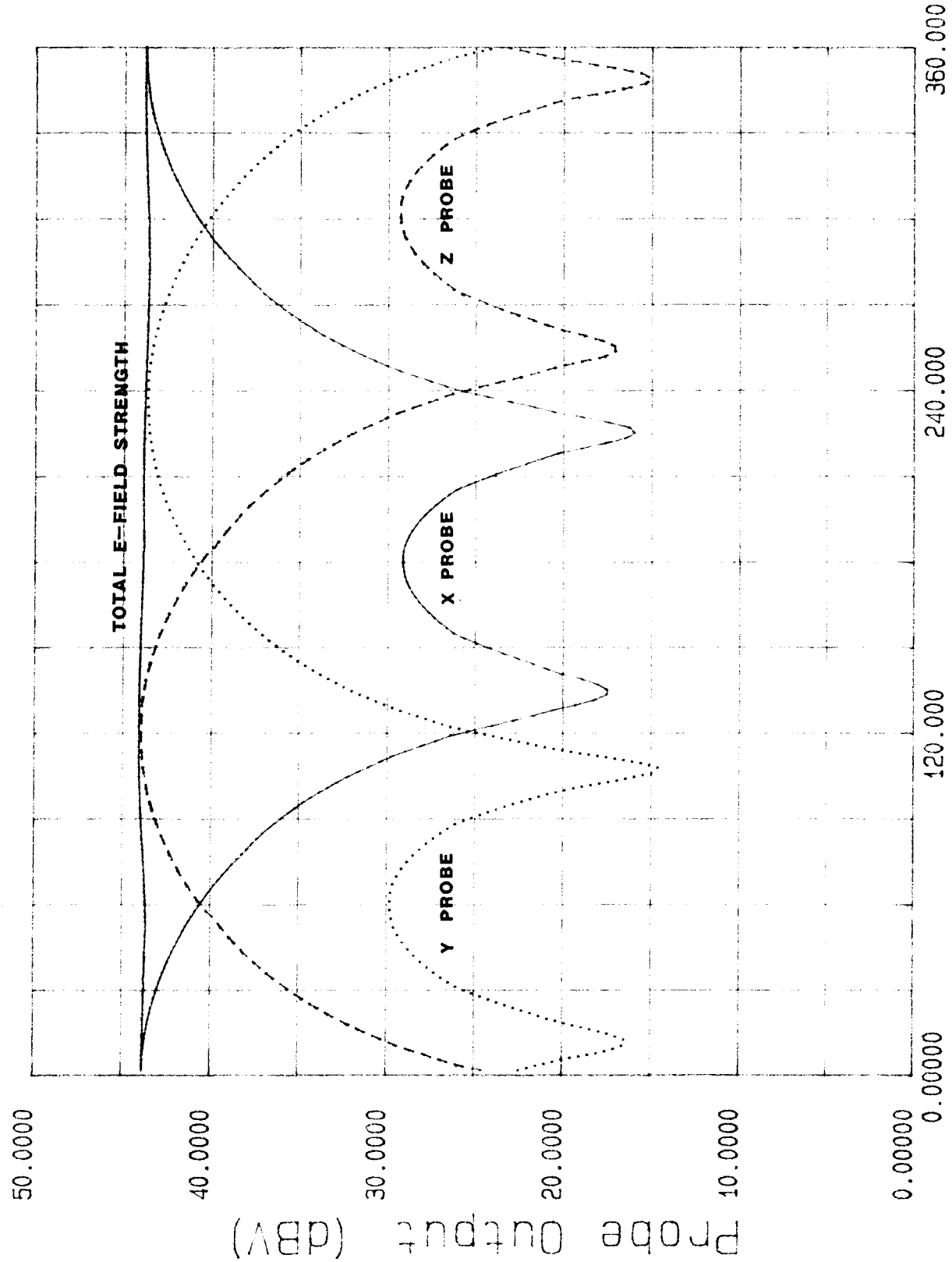


FIGURE 7 TYPICAL ISOTROPIC RESPONSE (AT 500 MHZ, 150 V/M)

APPLICATION NOTE

# MODELS 7100 AND 7145
# BROADBAND, ISOTROPIC E-FIELD
# SENSING SYSTEMS
# 1 MHz - 18 GHz

## DESCRIPTION

Models 7100 and 7145 are broadband, isotropic, electric field sensing systems. These systems are designed to measure electric field in the frequency range of 1 MHz - 18 GHz with accuracy of +/- 0.5 dB in the range of 1 MHz - 1 GHz and +/- 1.0 dB in the range of 1 GHz - 18 GHz.

## MODEL 7100 SYSTEM

Model 7100 system consists of a Model 7130 Broadband, Isotropic E-Field Probe, a Model 7120 Metering Unit, and a Model 7110 Data Processing/Interface Unit. For detailed description of these individual units please refer to their corresponding instruction manuals.

Since the Data Processing/Interface Unit can interface with 8 Metering Units at one time, the system is capable of supporting up to 7 additional (for a total of 8) Probe and Metering Units, simultaneously. This feature will allow the user to monitor the field at more than one point in the space at a time. The ability to use up to 8 probes at a time along with the standard 10 meter fiber optic output cable of each Metering Unit gives the user the capability to cover a large volume of space.

Besides front panel controls and display, the Data Processing/Interface Unit employs an IEEE-488 standard interface which facilitates automated, interactive interface with the 7100 system. The user may employ the flexible instruction set of the unit to configure and obtain field data and system status from the unit.

## MODEL 7145 SYSTEM

Model 7145 system consists of a Model 7130 Probe, a Model 7120 Metering Unit, and a Model 7140 RS-232 Adapter. For a detailed description of the RS-232 Adapter please refer to its instruction manual.

Model 7145 system is designed to facilitate the user with a simple way of monitoring the electric field strength at one point in space. Model 7140 RS-232 Adapter provides the necessary hardware and software to interface the Metering Unit with an IBM PC or compatible through the computer's COM1 serial communication

port. The user, then, may use his PC as a display to monitor the field data and the status of the system. The data and system status may also be stored onto disk of the PC for later study.

## APPLICATION

The 7100 and 7145 systems may be used in various applications which require accurate measurement of electric field strength such as susceptibility testing, electromagnetic test equipment characterization, equipment electromagnetic emission measurement, and radiation hazard measurement. The Probe and the Metering Unit measure the electric field strength in near and far zones. Besides providing the user with electric field strength measurement, the Data Processing/Interface Unit is capable of calculating and providing the user with the equivalent power density, using free space impedance (376.36 ohm), which is accurate only for far zone measurements.

Correct application of the systems is essential in obtaining measurements which meet the accuracy specification of the probe. The following are recommendations and application hints which allow the user to measure the electric field strength accurately.

- All the cartesian and polar coordinate electric field strength measurements of the probe, which may be obtained from Model 7110 Data Processing/Interface Unit or Model 7140 RS-232 Adapter are accurate within specifications at the dynamic range calibration frequency of 500 MHz. For accurate measurements (within specifications) at other frequencies, the frequency correction factors of X, Y, and Z dipoles should be applied to the individual electric field strength measurement of each dipole and the corresponding polar coordinate values, if desired, must be calculated manually. An average of the three frequency correction factors of the three dipoles may be taken and applied to the already provided total electric field strength value, R, (by Models 7110 or 7140) for a slightly degraded accuracy in the polar coordinate values. In order to obtain the frequency correction factors of the probe please refer to the Instruction Manual for Model 7130 Probe.

- For the most accurate electric field strength measurement, any one of the dipoles may be aligned with the direction of the electric field. The proper alignment is done when the length of the dipole is parallel with the electric field vector. When a dipole is aligned properly with the electric field, its output value (the electric field strength measurement) is at its peak. This peak value is the correct and most accurate measurement of the total electric field strength. Please refer

to the Instruction Manual for Model 7130 Probe for the description of the configuration of the three dipoles within the probe.

A Model 7103 Probe Holder is available as an optional accessory for the 7100 and 7145 systems. The Probe Holder is a flexible, tabulated holder for the 7130 Probe which makes it possible to align the probe in any direction within the three dimensional space with 1 degree of accuracy.

NOTE: In order to stabilize the response of the probe, at the time when the data is being read from the probe, the probe assembly (the probe's head, cable, and connector) must be completely motionless.