INSTRUCTION MANUAL

TRI-PLATE LINE

MODEL EM-7310

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TRI-PLATE LINE

ELECTRO-METRICS

MODEL EM-7310

SERIAL NO: N/A

ELECTRO-METRICS CORPORATION

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WARRANTY

This Model EM-7310 Tri-Plate Line is warranted for a period of 12 months (USA only) from date of shipment against defective materials and workmanship. This warranty is limited to the repair of or replacement of defective parts and is void if unauthorized repair or modification is attempted. Repairs for damage due to misuse or abnormal operating conditions will be performed at the factory and will be billed at our commercial hourly rates. Our estimate will be provided before the work is started.

DESCRIPTION AND USE
TRI-PLATE LINE
ELECTRO-METRICS MODEL EM-7310

1.0 Introduction

The Electro-Metrics Model EM-7310 Tri-Plate Line is used in performing radiated electromagnetic immunity testing from 10 kHz to 500 MHz.

The EM-7310 Tri-Plate Line is a variation of a TEM (Transverse Electro Magnetic) Cell without sides to the cell. The unit is fundamentally a large rectangular section of coaxial cable with pyramid-shaped transitional sections at each end containing Type N connectors. The top and bottom outer plates are at ground potential and connected to the outer section of the Type N connectors. The center plate or septum is a flat sheet of metal connected to the center conductor of the Type N connectors. Four non-conductive wooden supports separate the two outer plates. Slots in the supports are used to position the septum halfway between the outer plates. Due to the lack of side walls, all testing with the tri-plate line must be performed within a shielded room or enclosure.

The equipment under test (EUT) is placed on the bottom plate for testing. The septum ***is not used*** for placement of test items since it is not design to handle heavy items.

The outer conductors and septum are constructed of 0.125 aluminum while the supports are made of balsa wood.

2.0 Specifications

2.1 Electrical

Frequency Range:	10 kHz to 500 MHz.
Impedance:	Designed to be driven by a 50Ω source and terminated in 50Ω.
Maximum Power Input:	1000 Watts.
Connectors:	Type "N", female.

2.2 Mechanical

Height:	
Top to Bottom Conductors:	63.5 cm (25.0 inches).
Bottom Conductor to Septum:	29.2 cm (11.5 inches).
Width (max.):	60.0 cm (23.6 inches).

Length (Tip-to-Tip):	312.4 cm (123 inches).
Weight:	38.6 kg (85 lbs).

3.0 Theory Of Operation

The EM-7310 is fundamentally a large rectangular section of coaxial cable that propagates a transverse electromagnetic wave. The TEM wave is characterized by orthogonal electric (E) and magnetic (H) fields that are perpendicular to the direction of wave propagation along the length of the transmission line.

Within the cell, the E and H field components of the TEM mode field structure are essentially uniform over a large percentage of the volume between the septum and outer conductor (shell of the cell). This simulates a planar field in free space where a wave impedance of 377 ohms exists.

There is no low frequency cutoff in the TEM mode, the lower limit being determined by the magnetic shielding effectiveness of the material used for constructing the tri-plate line. In the case of the EM-7310, this essentially sets the lower limit of the line at DC. However, the usable lower frequency limit is set at 10 kHz due to:

a. Available power amplifier limitations (providing a 50-ohm source below 10 kHz),

b. Difficulty in determining the effects of the tri-plate line capacitance below 10 kHz.

The upper frequency limit is determined by the physical size of the rectangular section of the line. As the frequency of the test signal increases, distortions will occur caused by resonances and multimoding. The result is an increasingly distorted and non-uniform field within the area of the tri-plate line. For the EM-7310, the overall size and size of the septum set a usable upper limit of 500 MHz. With careful monitoring of the generated fields, the line can be used up to 1 GHz

4.0 Description Input/Output Connectors

Type: Type "N" female.

Number: Two.

Location: One on each transition end section.

Function: Interfacing the Tri-Plate Line with the external field producing source.

NOTE: Either end connector can be used as the input. Since the cell is symmetrical in design and electrical function, there is no designated input or output.

5.0 Handling Precautions

The EM-7310 Tri-Plate Line is a large, heavy, and fragile unit. It must be handled very carefully to avoid damage to the unit. The following precautions should always be observed when lifting or moving the EM-7310:

a. **Never lift** the unit using the pyramid shape transitional end sections. They can be bented, changing the line performance characteristics.

b. **Never lift** the unit using the septum. This could damage it and the connections to the end connectors.

c. **Never lift** the unit using the upper plate. This could break it free from the supports.

d. **Never lift** the unit using the supports. The weight of the unit could separate it from or break it off the supports.

e. **Always lift** the unit using the bottom plate beneath the supports. This will provide the best method for lifting and moving the unit.

f. When moving the unit distances greater than 20-30 feet, use a cart with the sections between the supports resting on the cart. This will provide the greatest protection while the tri-plate line is being moved.

6.0 Setups Caveats and Precautions

The following are several setup caveats and precautions to observe when using the EM-7310 Tri-Plate Line. No setup diagrams or specific equipment usage information is provided. Test setups and equipment usage is dependent on the test standard and specification requirement being used.

6.1 General Setup Information

The following should be observed when using the EM-7310 Tri-Plate Line:

a. Either transition end connector can be used as the input. Since the cell is symmetrical in design and electrical function, there is no designated input or output.

b. Maximum height of the EUT should not exceed 1/3 of the height (29 cm/ 11.5 inches) between the bottom conductor and the septum or approx. 10 cm (4 inches).

The Tri-Plate Line allows an operator to fix the position of an EUT and its wiring harness parallel to its major axis. This ensures repeatable results during immunity testing. It also allows positioning of the EUT and its associated wiring harness similar to a normal installation.

Keeping the EUT at the maximum size or below will result in maintaining a uniform field within the test area of the tri-plate line. Test items' with a greater height then the maximum stated will distort the characteristics of the radiated field. Thus field uniformity cannot be determined with any degree of accuracy.

c. ***Do not place Test Items on the septum*****.** It is not designed to handle heavy items.

Always use the bottom plate for placement of the Equipment Under Test.

NOTE: **1) The EM-7310 Tri-Plate Line can be used up to 1 GHz. However, the power input levels required to generate selected field levels can not be accurately calculated.**

2) Always verify the levels of the fields being generated using monitoring devices such as field strength probes. This should be done at all frequencies, not just above 500 MHz.

6.2 Precautions

The following precautions should be observed when using the EM-7310 Tri-Plate Line:

a. The Tri-Plate Line by itself ***does not*** present a 50-ohm load to the signal source. Do not operate the Tri-Plate Line without a 50-ohm load (termination) connected to the unused transition end connector.

!!WARNING!!

Never operate the EM-7310 Tri-Plate Line without a 50-ohm load connected to the unit.

Always operate EM-7310 Tri-Plate Line with a 50-ohm load connected to the unit. Failure to do so, may result in damage to the amplifier being used to drive the immunity test system.

b. The EUT and associated wiring harness should be insulated from the bottom conductor. The material used should be transparent to the radiated field. Plastic foam type material is suggested.

c. Keep all other internal cabling and wiring to the EUT on or as low to the shielded room floor as possible. This will keep any potential disturbance to radiated field to a minimum.

d. Due to the lack of sides on the tri-plate line, it must always be used within a shielded room or enclosure. This is to prevent radiation emitted from the line when in use from interfering with nearby electronic or electrical devices. In addition, the fields being generated can be hazardous to test personnel.

CAUTION

Hazardous fields and voltages exist on and near the EM-7310 Tri-Plate Line when the system is being driven.

Always operate the Tri-Plate Line within a shield room or enclosure. No personnel should be allowed within the shielded room or enclosure during testing.

7.0 Determination Of Field Strength Vs Input Power

Information to determine the nominal input power required to produce the resulting field strength from the Tri-Plate Line is found in SAE (Society of Automotive Engineers, Inc.) Publication **SAE J1113-25 Revised SEP96--(R) ELECTROMAGNETIC COMPATIBILITY MEASUREMENT PROCEDURE FOR VEHICLE COMPONENTS--IMMUNITY TO RADIATED ELECTROMAGNETIC FIELDS, 10 kHz TO 500 MHz--TRI-PLATE LINE METHOD**.

The formula used to determine the field strength levels (as per SAE J1113-25):

$$\mathbf{Ev} = \sqrt{\frac{\mathbf{Pwr} \times \mathbf{Z}}{\mathbf{h}}}$$

Where:

Ev = Field Strength in Volts/meter between the septum and grounded plates of the Tri-Plate Line.

Pwr = Net RF power into the 50Ω line feeding the Tri-Plate Line.
Z = Characteristic impedance of the Tri-Plate Line. This is 71.58Ω, as calculated using the formula in Appendix B of SAE J1113-25.
h = Plate separation between the grounded plates and the active center conductor (septum) of the Tri-Plate Line.

8.0 Additional Data and Information

For any additional data or information on the setup, operation, and theory concerning the tri-plate line, refer to SAE J1113-25.

9.0 Data Supplied With EM-7310

The Electro-Metrics Model EM-7310 Tri-Plate Line is supplied with VSWR data and Impedance versus Length data. The data is presented in graph form in Figures 1.0 and 2.0.

Figure 1.0 VSWR Graph

Figure 2.0 Impedance Vs Length Graph

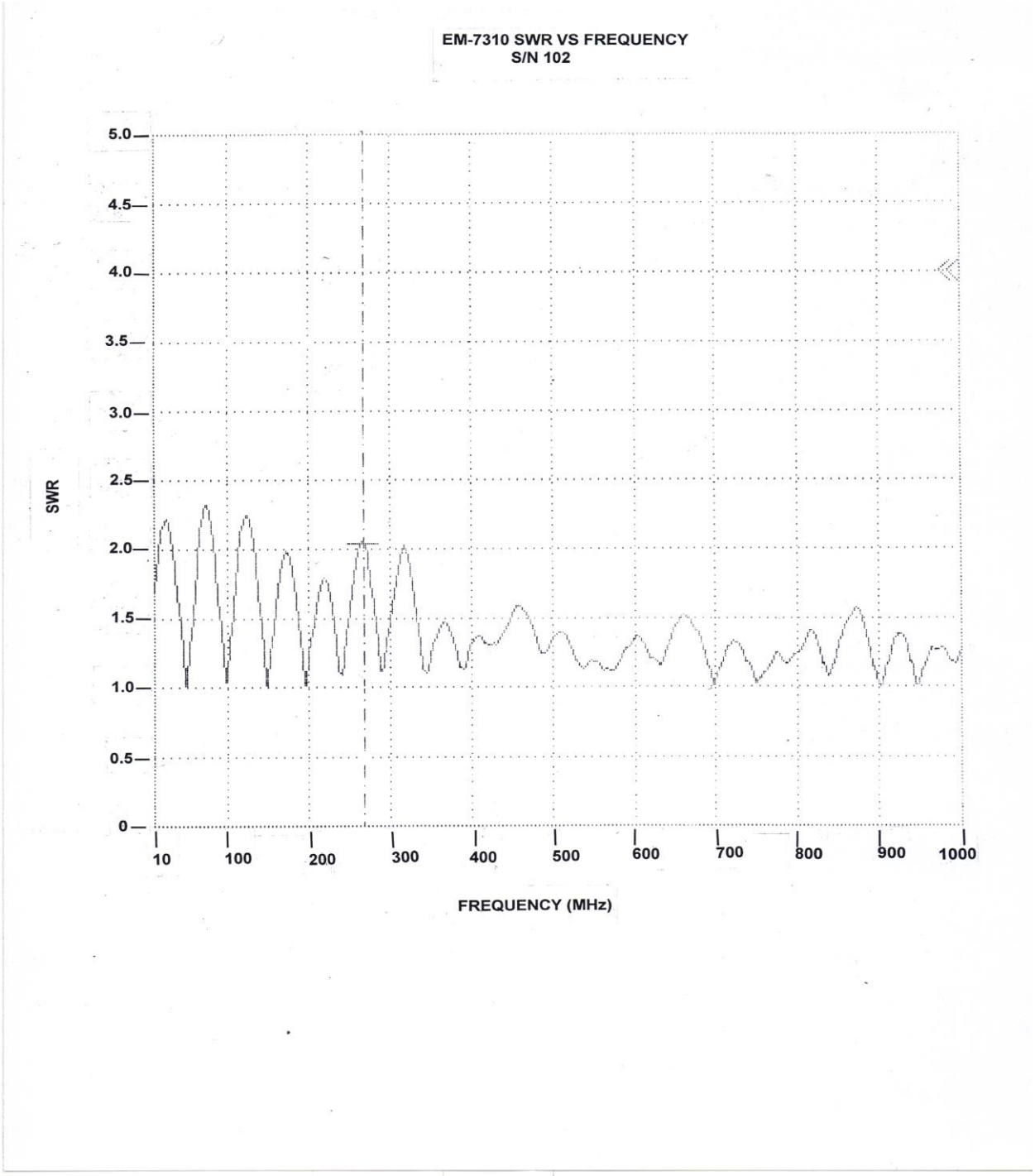

Figure 1.0

Electro-Metrics Model EM-7310
Tri-Plate Line
VSWR Graph

Figure 2.0

Electro-Metrics Model EM-7310
Tri-Plate Line
Impedance Vs Length Graph

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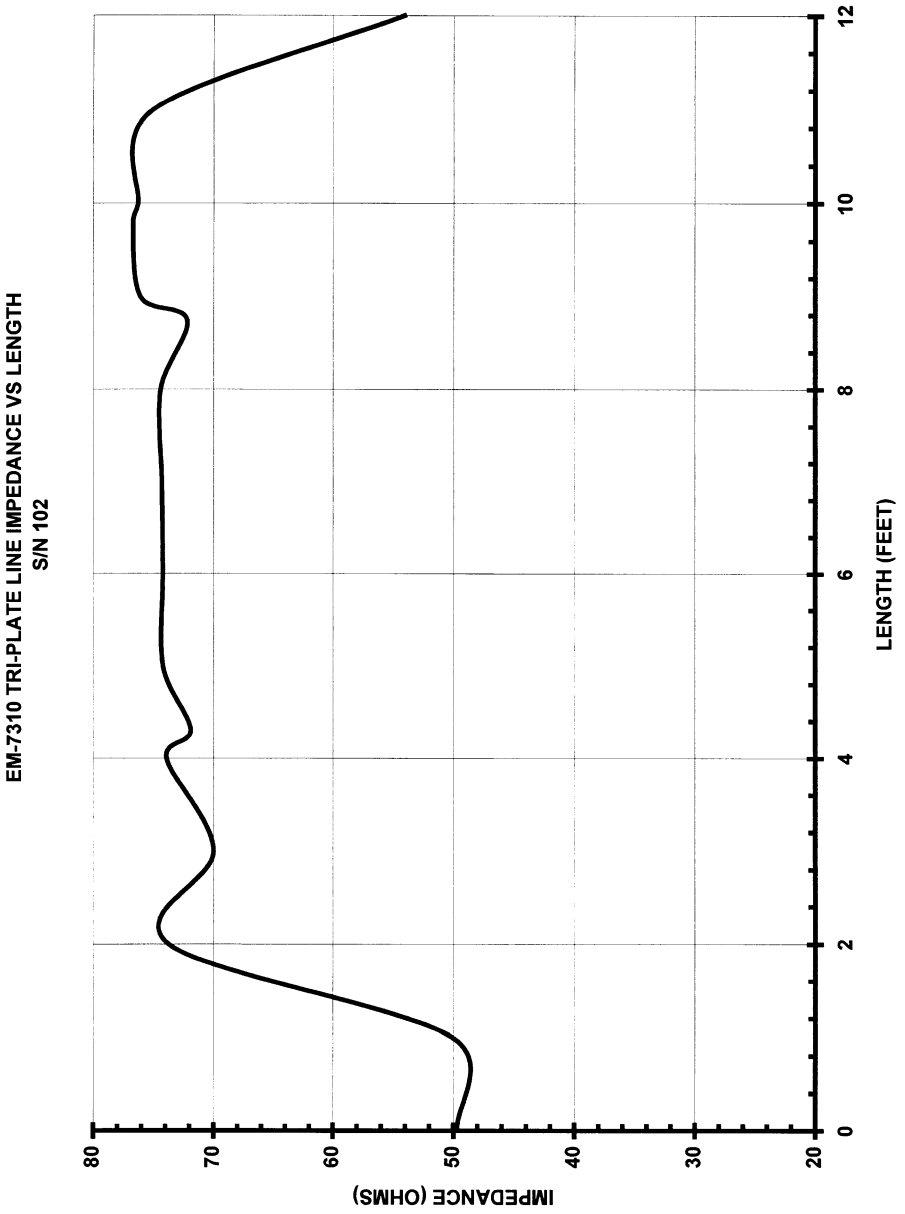
The data on which the graph is based is obtained using a Tektronix 1502C Time Domain Reflectometer.

The O (ft) point on the graph represents the Type N Connector designated as the Input Connector.

The 12 (ft) point on the graph represents the Type N Connector designated as the Output Connector.


EM-7310 TRI-PLATE LINE IMPEDANCE VS LENGTH
S/N 102
IMPEDANCE (OHMS)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
LENGTH (FEET)