IEEE Std 187-1990
(Revision of IEEE Std 187-1951)

IEEE Standard on Radio Receivers: Open Field Method of Measurement of Spurious Radiation from FM and Television Broadcast Receivers

Sponsor
Standards Committee
of the
IEEE Electromagnetic Compatibility Society

Approved August 15, 1990
IEEE Standards Board

Abstract: IEEE Std 187-1990, *IEEE Standard on Radio Receivers: Open Field Method of Measurement of Spurious Radiation from FM and Television Broadcast Receivers,* describes the potential sources of spurious radiation from frequency modulation and television broadcast receivers and sets up methods of measurement. This standard is not intended to apply to equipment other than FM and television broadcast receivers.
Keywords: field-strength meter, frequency modulation, open field measurement, spurious radiation, television broadcast receivers

ISBN 1-55937-062-9

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08555-1331
USA

Foreword

(This Foreword is not a part of IEEE Std 187-1990, IEEE Standard on Radio Receivers: Open Field Method of Measurement of Spurious Radiation from FM and Television Broadcast Receivers.)

When it became necessary to revise and update IEEE Std 187-1951, the task was taken on by Dr. R. Sato, representative of the Tokyo Chapter of the IEEE Electromagnetic Compatibility Society at the Standards Committee Meeting in 1981.

Dr. Sato organized his working group in Japan, and since then, the members have worked toward the prime objective of developing measurement procedures to enable design engineers to test for spurious radiation with high accuracy and reproducibility during the course of chassis design.

The EMC Society and the working group are indebted to Dr. Sato for his leadership and coordination of the effort to review and revise the standard.

At the time this standard was completed, the working group had the following membership:

Risaburo Sato, *Chair*

Y. Akao	N. Kaburagi	A. Sugiura
H. Echigo	H. Kuronuma	D. L. Traver
S. Gentile	Y. Nagasawa	
T. Iki	M. Okamura	

The following individuals contributed review and comments:

E. L. Bronaugh	Y. Endo	R. M. Showers
G. Capraro	T. Harada	E. Skomal
W. E. Cory	D. N. Heirman	K. Soh
M. L. Crawford	H. R. Hofmann	R. Taylor
G. Dash	E. E. Janson	L. W. Thomas, Sr.
H. Davis	E. D. Knowles	A. Wall
H. W. Denny	G. Kunkel	D. E. Weinberg

The EMC Society Standards Committee, which balloted and approved this document for submission to the IEEE Standards Board, had the following membership:

E. L. Bronaugh	D. N. Heirman	L. W. Thomas, Sr.
W. E. Cory	E. D. Knowles	D. E. Weinberg
G. Dash	J. Parker	E. Skomal
H. W. Denny	R. Sato	A. Wall
S. Gentile	R. M. Showers	

The final conditions for approval of this standard were met on August 15, 1990. This standard was conditionally approved by the IEEE Standards Board on May 31, 1990, with the following membership:

Marco W. Migliaro, *Chair*
James M. Daly, *Vice Chair*
Andrew G. Salem, *Secretary*

Dennis Bodson	Kenneth D. Hendrix	L. Bruce McClung
Paul L. Borrill	John W. Horch	Donald T. Michael*
Fletcher J. Buckley	Joseph L. Koepfinger*	Stig Nilsson
Allen L. Clapp	Irving Kolodny	Roy T. Oishi
Stephen R. Dillon	Michael A. Lawler	Gary S. Robinson
Donald C. Fleckenstein	Donald J. Loughry	Terrance R. Whittemore
Jay Forster*	John E. May, Jr.	Donald W. Zipse
Thomas L. Hannan	Lawrence V. McCall	

*Member Emeritus

CLAUSE PAGE

1. Introduction 1

1.1 References 1
1.2 Definitions 1

2. Sources of Spurious Radiation 2

3. Modes of Spurious Radiation for Spurious Signals 2

4. Method of Measurement 2

4.1 General 2
4.2 Equipment Required and Setup Details 3
4.3 Measurements to Be Made 10
4.4 Method of Measurement 12

This page is intentionally blank.

IEEE Standard on Radio Receivers: Open Field Method of Measurement of Spurious Radiation from FM and Television Broadcast Receivers

1. Introduction

Spurious radiations from the local oscillator of modern broadcast radio receivers of the superheterodyne type are possible sources of interference with other radio services. In addition, in the case of television broadcast receivers, there may be radiation from sources other than the local oscillator.

This standard describes the potential sources of spurious radiation from frequency modulation (FM) and television broadcast receivers and sets up methods of measurement. This standard is not intended to apply to equipment other than FM and television broadcast receivers.

1.1 References

This standard shall be used in conjunction with the following publications:

[1] C63.2-1987, American National Standard Specifications for Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz (ANSI).[1]

[2] IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms—4th ed. (ANSI).[2]

[3] IEEE Std 213-1987, IEEE Standard Procedure for Measuring Conducted Emissions in the Range of 300 kHz to 25 MHz from Television and FM Broadcast Receivers to Power Lines (ANSI).

1.2 Definitions

Definitions in this standard are in accordance with IEEE Std 100-1988 [2].[3]

[1]This publication is available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018 or from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.
[2]IEEE publications are available from the Institute of Electrical and Electronics Engineers.
[3]The numbers in brackets correspond to those of the references listed in 1.1.

2. Sources of Spurious Radiation

Possible sources of spurious radiation may be as follows:

1) The local oscillator circuits, which may radiate fundamental, harmonics, and intermodulation products formed from the local oscillator fundamental and harmonics
2) Intermediate frequency amplifier, which may radiate spurious signals at the fundamental and harmonics of the intermediate frequency
3) In some television receivers, the high-voltage circuits for the cathode-ray tube incorporating radio frequency oscillators, which may be a potential source of radiation at fundamental and harmonic frequencies
4) In television receivers, the sweep circuits, which may radiate harmonics of their fundamental frequencies
5) In television receivers, the video amplifier and any nonlinear circuit element that may produce signals by demodulation of radio or intermediate frequency signals
6) Digital circuits incorporated for a channel display or any other digital control unit, or both

3. Modes of Spurious Radiation for Spurious Signals

Possible modes of spurious radiation from sources enumerated in Section 2. may occur as follows:

1) Spurious radiation signals emanating from any internal source, such as those described in Section 2., may appear on the receiver antenna terminal(s) and be radiated from antenna systems(s) attached thereto. Such signals may be balanced or unbalanced to ground.
2) Radiation from the sources enumerated in Section 2. may appear in the vicinity of the receiver due to direct electric fields or magnetic fields or both, created by the components assembled on or within the chassis or by cavity resonance.
3) Radiation from any of the sources may be propagated through the power supply cord and any peripherals that may be attached to the receiver. Such radiation may be due to balanced or unbalanced current in the power cord or connection leads. This standard does not cover the radiation measurement of this type.

NOTE — See IEEE Std 213-1987 [3], or latest revision thereof, for details.

4. Method of Measurement

4.1 General

This standard defines a system whereby the radiation described in Sections 2. and 3. may be measured. It also establishes operating conditions and equipment specifications necessary for accomplishing these measurements. In this method, the receiver and measuring equipment are set up under reproducible conditions as described below, and the field strength of the various radiations is measured under specified conditions. This method is applicable to the measurement of spurious radiation in the frequency range of 30 to 1000 MHz from those sources producing an appreciable field at 3 m. For radiation in other bands, other methods of measurement may be necessary.

4.2 Equipment Required and Setup Details

4.2.1 Receiver Platform and Antenna

A nonconducting antenna mast shall be at the center of rotation of the platform upon which the receiver under test is placed. For convenience, it may be desirable to have the mast and the platform rotatable as a unit. A fixed-length

horizontally polarized dipole antenna shall be at a height of 4 m above ground. The antenna shall be constructed of 0.013 m outside diameter tubing. A transmission line of the type and characteristic impedance, for which the receiver under test is designed, shall be attached to this dipole at its center and be vertically positioned under the center of the dipole with the plane of the maximum cross-section dimension of the transmission line parallel to the dipole. Further construction details are given in Figs l(a) to l(d). This transmission line shall be secured to the mast to prevent unexpected error, which may be produced by movement of the transmission line.

When testing receivers designed for use with unbalanced shielded transmission line, the antenna terminal of the receiver shall be connected to the transmission line through a balanced-to-unbalanced transformer of the type specified by the manufacturer. In such a case, the insertion loss of the balanced-to-unbalanced transformer used shall be small enough so that the connection does not affect the measurement. If the receiver is designed to operate from either an unbalanced transmission line or a balanced line, the latter shall be used in these measurements. The balanced transmission line shall not be shielded.

The receiver under test shall be placed on a rotatable nonconducting table, the top of which is 0.8 m above ground, as shown in Fig 2. The plane of the front panel of the cabinet shall be parallel to the dipole, and the center of the cabinet shall be directly below of the center of the dipole. In the event that the receiver under test does not fit on the table, such as may be the situation for console receivers, the height of the table may be 0.4 m above ground.

4.2.1.1

For VHF television receivers, the dipole antenna shall measure 2.24 m from end to end. For UHF television receivers, the length shall be 0.3 m from end to end. Further construction details are given in Figs 1(a) to 1(d).

4.2.1.2

For frequency modulation receivers operating in the frequency range of 88 to 108 MHz, having a terminal or terminals for an external antenna, the dipole antenna shall be 1.47 m from end to end.

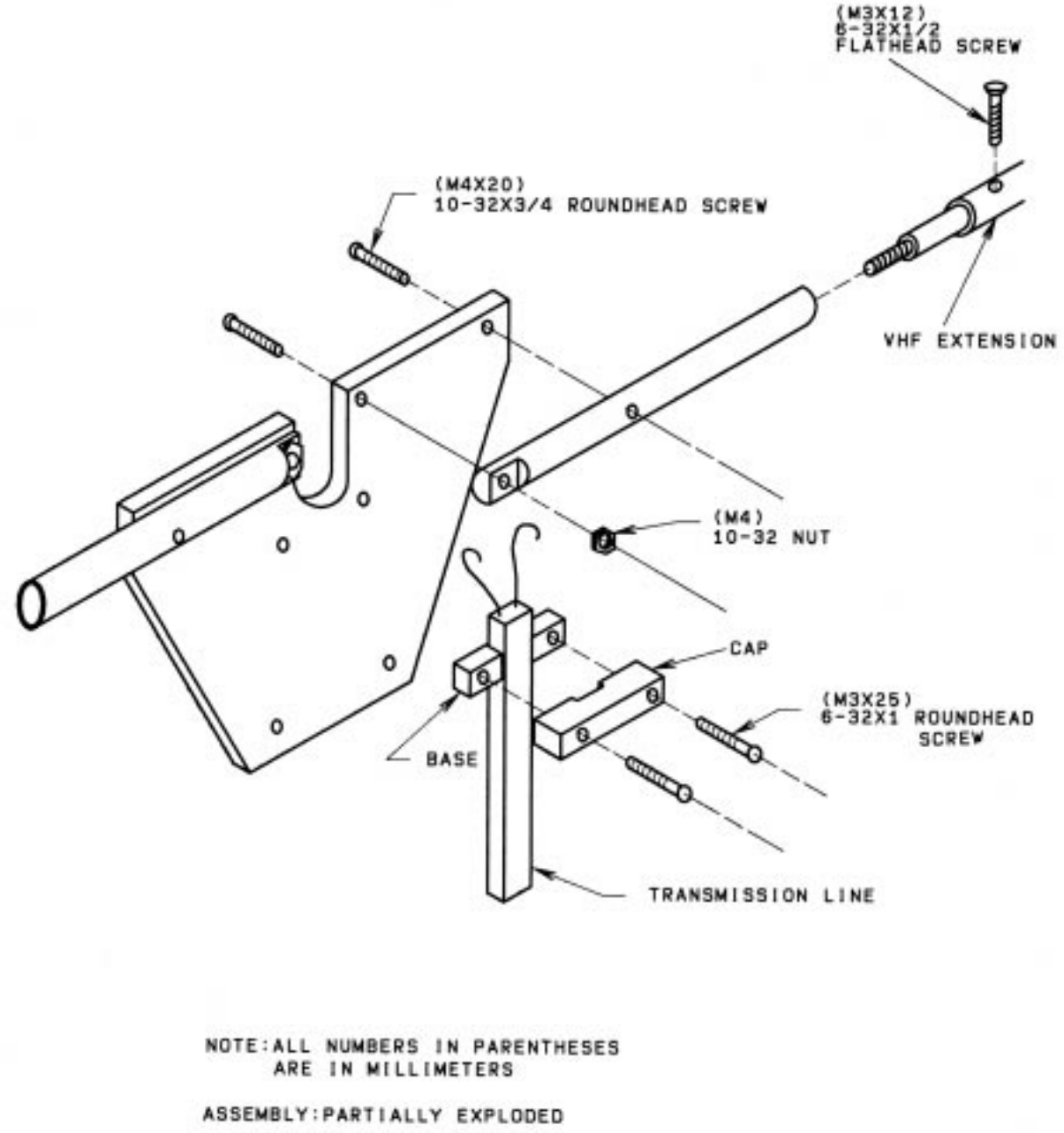


Figure 1(a) —Construction Details

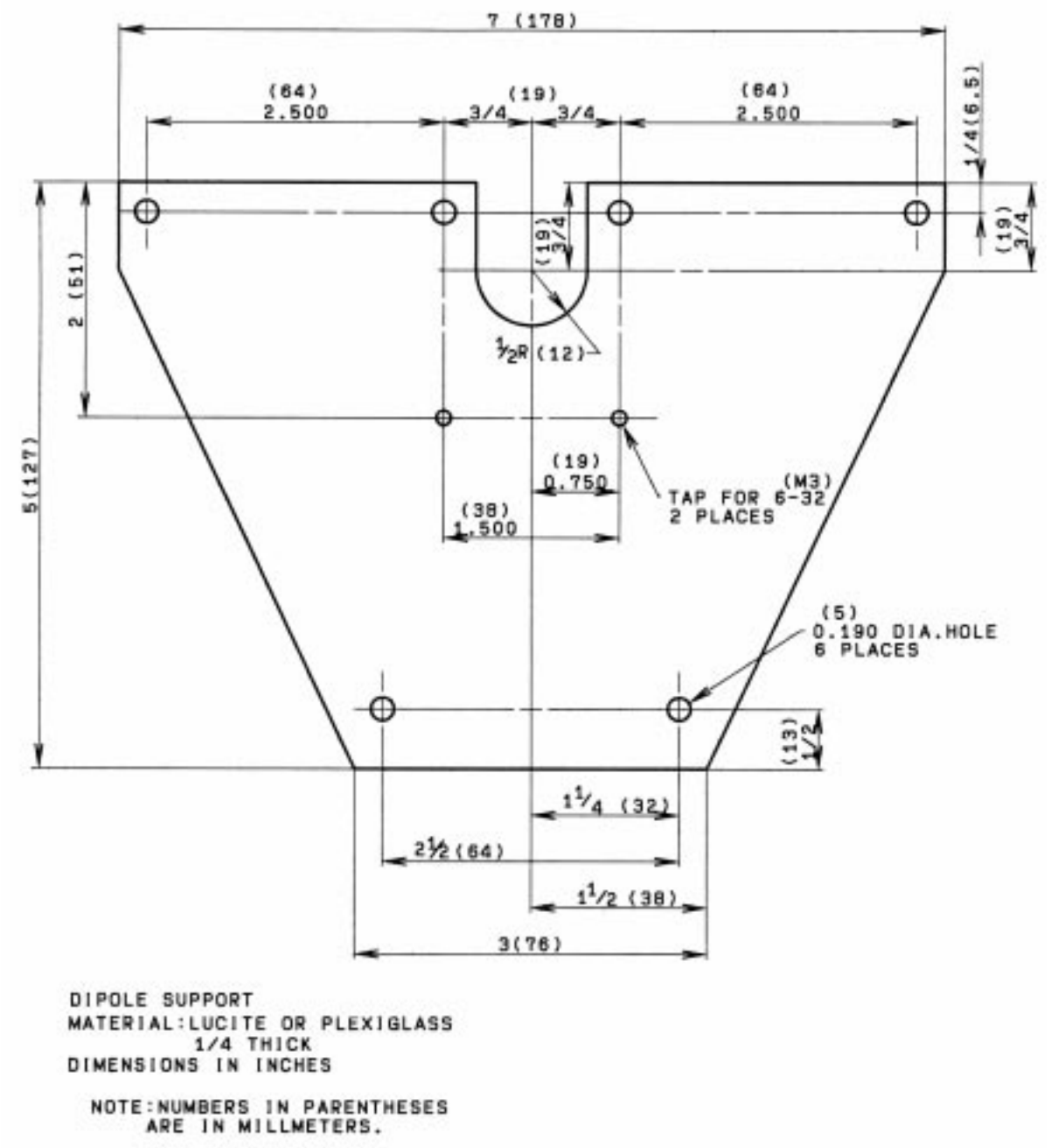
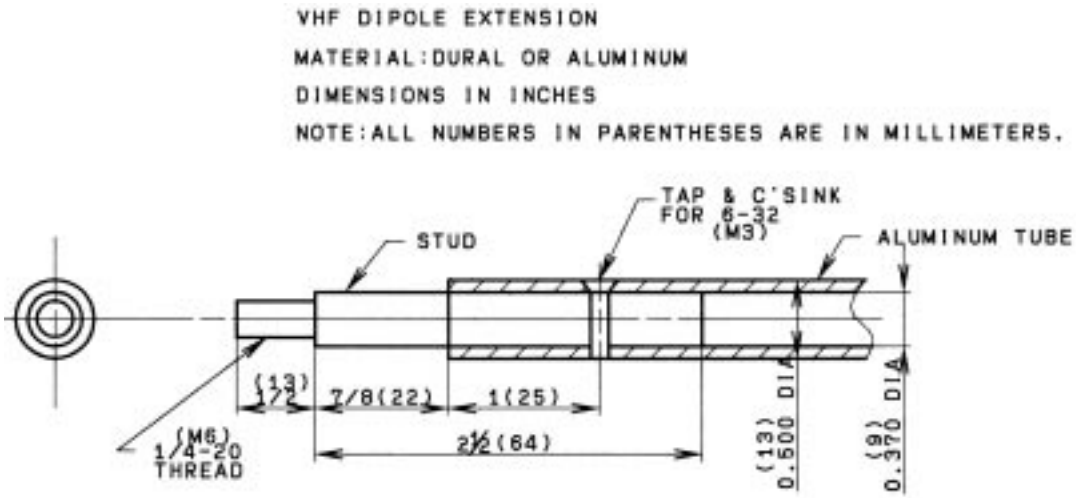


Figure 1(b) —Construction Details



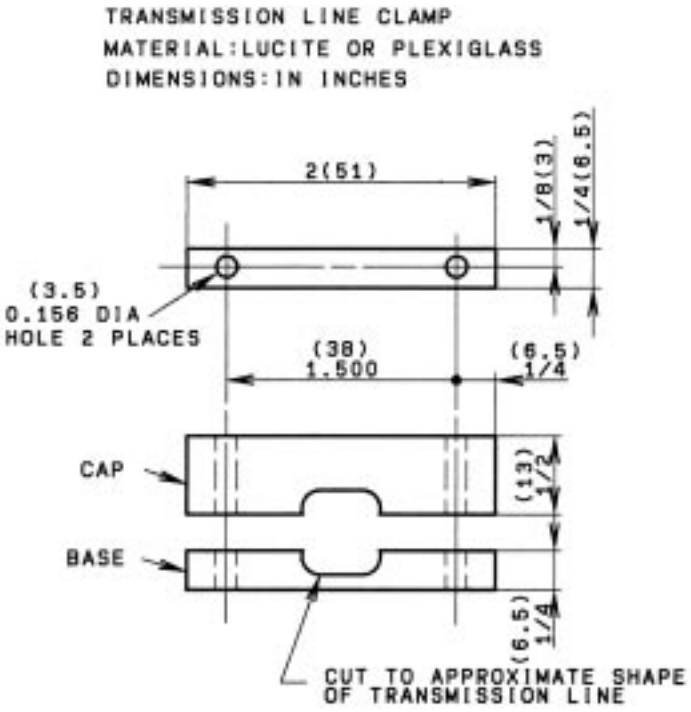


Figure 1(c) —Construction Details

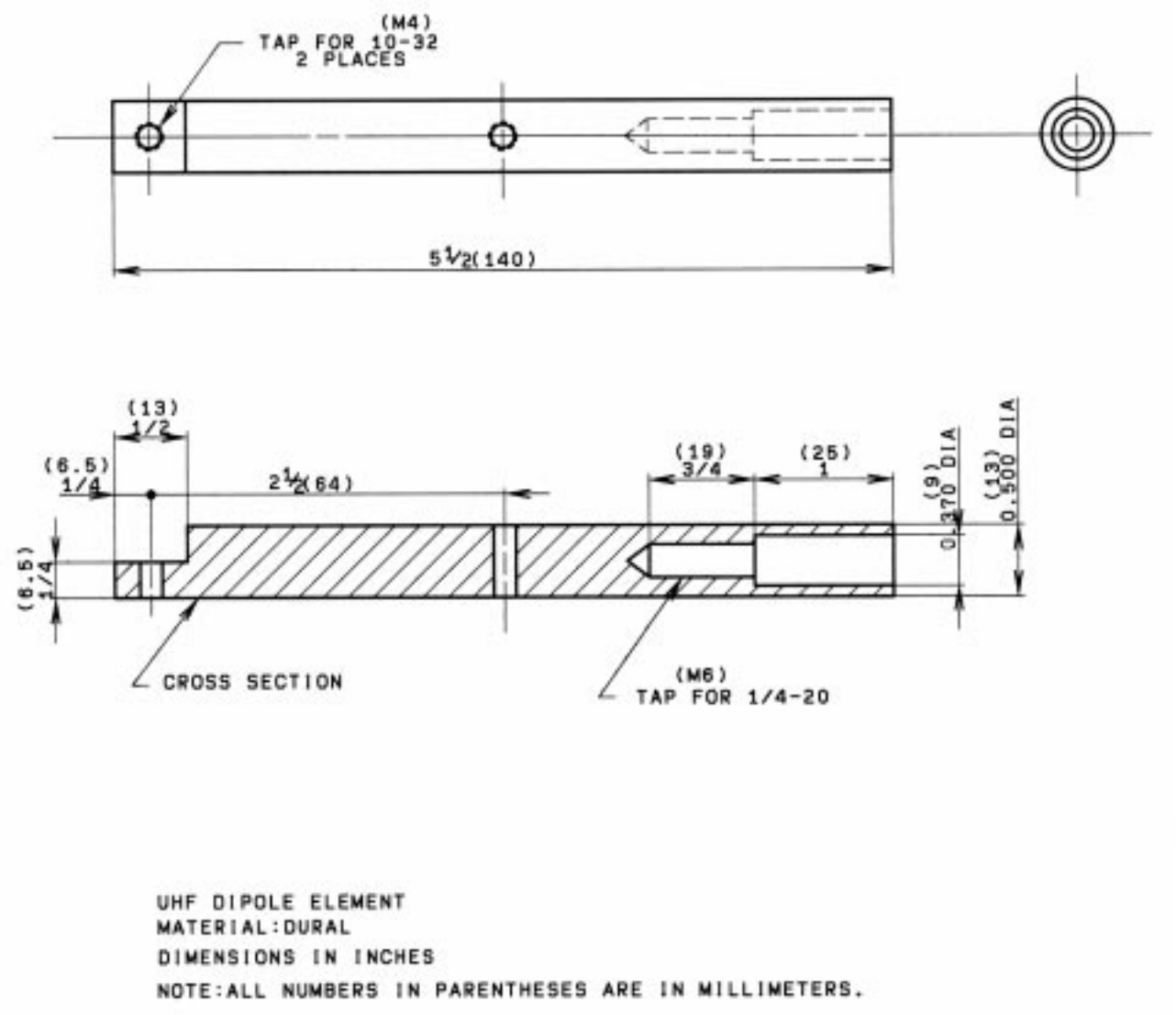


Figure 1(d) —Construction Details

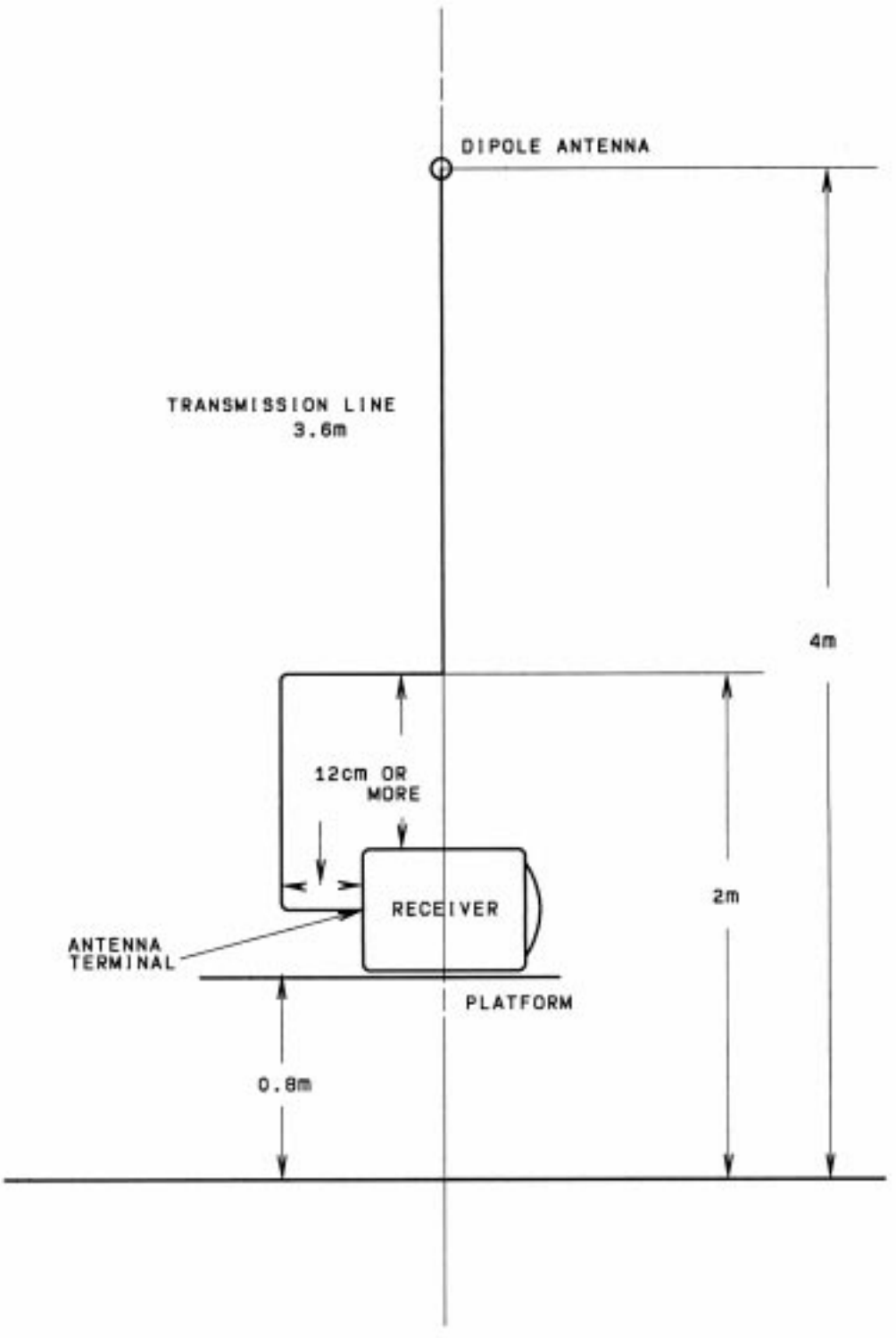


Figure 2 —Possible Method of Routing the Transmission Line

4.2.1.3

The transmission line shall be 3.60 m long and shall proceed horizontally directly back from the antenna terminal(s) of the receiver, then vertically up to the height of 2 m above ground, and then horizontally to a position directly under the center of the dipole antenna. After the first bend, it shall not approach closer than 0.12 m to the cabinet at any point. Fig 2 illustrates a possible method of routing the transmission line.

4.2.2 Field-Strength Meter

A field-strength meter conforming to ANSI C63.2-1987 [1], or latest revision thereof, shall be used. Other measuring equipment may be used if the measurements correlate to those obtained by the field-strength meter as specified in ANSI C63.2-1987.

4.2.3 Field-Strength Meter Antenna

The antenna used with this meter shall be a half-wave tuned dipole antenna capable of being adjusted for horizontal or vertical polarization. Other types of antennas may be used, provided that measurement using such an antenna can be correlated with that obtained by a half-wave tuned dipole antenna.

4.2.4 Distance Considerations

The field-strength meter antenna shall be located at a distance of 3 m horizontally from the center of the antenna of the receiver under test. The transmission line from the field-strength meter antenna shall be routed horizontally for a distance of at least 0.6 m in a direction directly away from the receiver under test, then dropped vertically to the ground. The field-strength meter should be placed for minimum effects on the measurement, for example, as shown in Fig 3.

Provisions shall be incorporated whereby the height of the antenna above ground may be varied from 1 m to 4 m.

If a 3 m distance measurement is not practical, a 10 m or a 30 m distance measurement may be used, provided that an inverse proportionality factor of 20 dB/decade is used and the field-strength meter antenna height is varied from 1 to 4 m above ground (3 or 10 m distances) or 2 to 6 m (30 m distance) searching for highest maximum.

4.2.5 Power Supply

Power lines to both the receiver under test and the field-strength meter shall be buried to a depth of 0.3 m or more in open field measurements not employing a metallic ground plane. The power outlet at each location shall be at the top of a metal conduit that extends not more than 0.4 m above the level of the ground. The receiver location shall not be more than 0.3 m from the vertical axis of the antenna. The power supply cord of the receiver under test shall be oriented vertically and shall be as short as possible. Any excess length shall be bundled in a serpentine fashion 30 to 40 cm length as close as possible to the plug end. Adequate isolation shall be incorporated in the supply line to the receiver so that a negligible amount of signal will appear at the field-strength meter from this source. Each side of the line shall be bypassed to the conduit at the receiver outlet.

NOTE — Cables do not need to be buried if placed underneath a metallic ground plane.

4.2.5.1

Unless otherwise specified, the line voltage shall be maintained in all measurements at within 5% of the line voltage specified by the manufacturer for use during normal receiver operation.

4.2.6 Measurement Site

At the measurement site, an environment is required that assures valid repeatable measurement results. For radiation measurement, testing is normally conducted in an open, fiat area characteristic of cleared, level terrain. Such a site shall be void of buildings, electric lines, fences, trees, etc., and free from underground cables, pipelines, etc., except as required for the measuring equipment and the receiver under test. It is recommended that the measurement site employ a wire-mesh ground screen or metal plane having dimensions of 6 m × 9 m as shown in Fig 3. No extraneous metallic objects having any dimension in excess of 5 cm shall be in the vicinity of the receiver under measurement or the field-strength meter. Alternative sites may be used, provided that the measurements at the site correlate with those obtained in an open site having environmental conditions as described in this subsection.

4.3 Measurements to Be Made

4.3.1

The receiver under test shall be tested with the specified transmission line and dipole antenna. A second set of measurements shall also be made with the balanced line connection reversed at the receiver terminals or baluns.

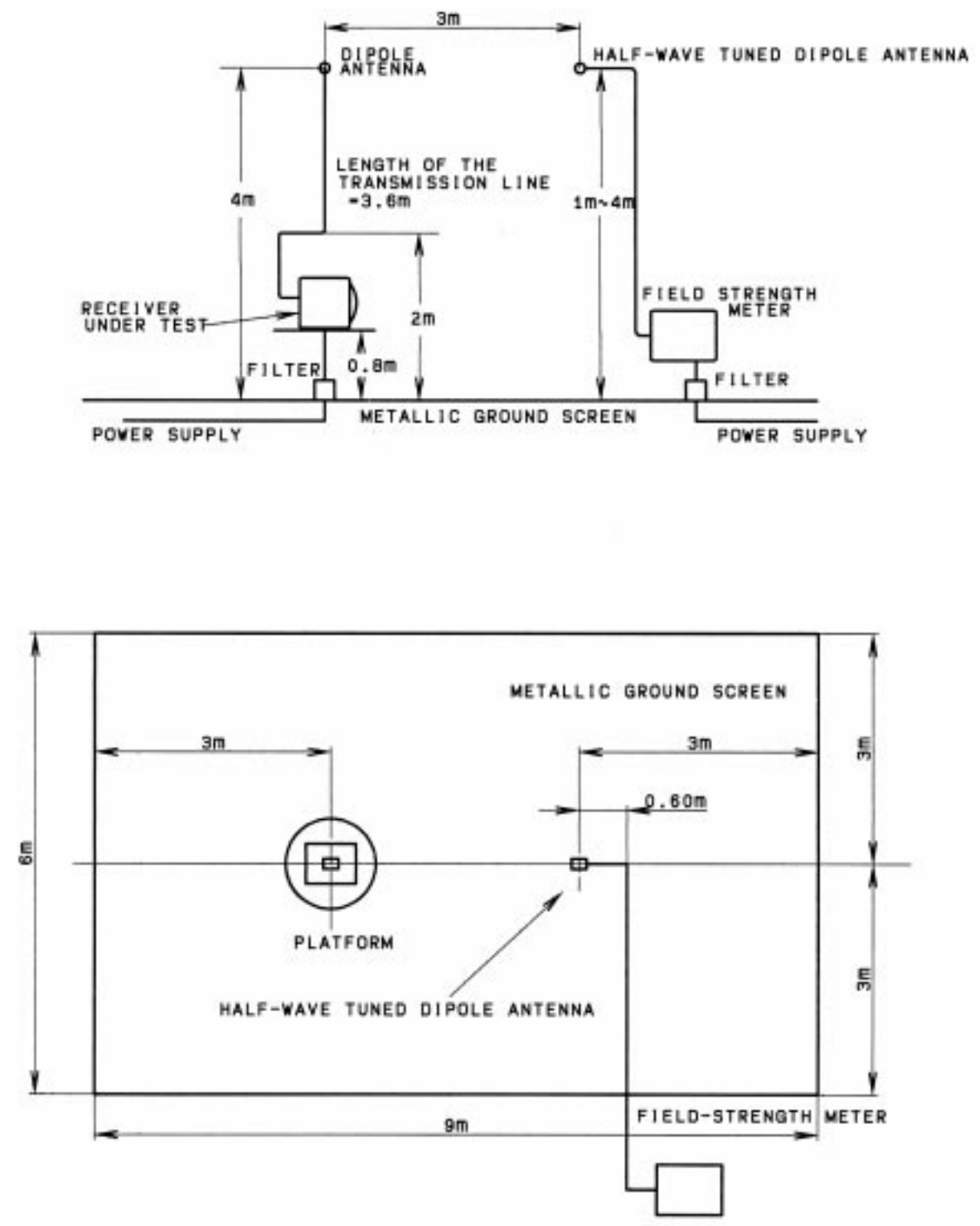


Figure 3 —Open Field Measurement at 3 Meter Site

4.3.2

If the receiver is supplied with a built-in antenna, measurements shall also be made with this antenna connected to the antenna terminal(s). If adjustments are provided for turning the built-in antenna, they shall be set at the position that

produces maximum radiation. If it can be demonstrated that the disconnected dipole antenna and transmission line mounted on the platform affect the field strength, they shall be removed for this test.

4.3.3

For measuring direct chassis radiation, the receiver shall be tested with the antenna terminal(s) terminated in a noninductive resistor or resistors equal to the impedance for which the receiver is designed. The antenna and transmission line shall be removed to ensure that they do not affect the field strength to be measured.

4.4 Method of Measurement

The receiver under test shall be checked over the frequency range to which it is intended to be tuned, i.e., from 30 MHz to 1000 MHz. The number of test frequencies shall be adequate to ensure measurement of maximum emission levels within this range.

In the case of automatic tuning receivers, such as scanning receivers, the desired signal may be fed to the receiver under test by means of a radiated field in order to fix its local oscillator at a certain frequency to be measured. In this measurement, precaution must be taken so as not to affect the measurement due to the existence of the signal.

The field-strength meter shall be tuned to the frequency of the spurious radiation being measured. The antenna shall be aligned for horizontal polarization with its broadside to the receiver under test. The receiver and its dipole antenna shall be rotated together about a vertical axis until maximum signal at the field-strength meter is obtained.

The antenna of the field-strength meter is now varied in elevation between 1 and 4 m above ground (for 3 or 10 m separation) or between 2 and 6 m (for 30 m separation), holding its broadside to the receiver under test. The maximum reading of the field strength observed is recorded as an emission of the receiver under test.

These tests are now repeated with the receiver antenna terminals reversed, as described in 4.3.1. These tests shall be repeated with the field-strength meter antenna aligned for vertical polarization. Care should be taken that the lowest tip of the dipole is kept 25 cm or more from the ground plane.