

METRIC

A-A52575A
October 31, 2003
SUPERSEDING
A-A-52575
July 10, 1998

COMMERCIAL ITEM DESCRIPTION
THEODOLITES, SURVEYING, DIRECTION, FIRST-ORDER
WITH ACCESSORIES, TRIPOD, AND CASES

The General Services Administration has authorized the use of this Commercial Item Description (CID) as a replacement for MIL-T-52035, for all federal agencies. The original issue of this CID replaced MIL-T-52035.

1. SCOPE. This document covers two types of illuminated, first-order theodolites with accessories, cases, and tripod.
2. CLASSIFICATION. The theodolite will be one of the following types, as specified (see 7.3):
 - Type I - Auto-reading digital direction type
 - Type II - Optical-reading direction-type

3. SALIENT CHARACTERISTICS.

3.1 Description. Each theodolite shall be a direction-type instrument capable of first-order accuracy (see 7.6). Each theodolite, including telescope, horizontal and vertical circles, circle reading system, leveling device, integral illumination system, and tribrach, shall weigh not more than 11.8 kg. Each theodolite shall be furnished with a carrying case and theodolite cover. When specified each theodolite shall be furnished with a transport case, winterization kit, an auto-collimation eyepiece, and a tripod (see 7.3).

Beneficial comments, recommendations, additions, deletions, clarifications etc., and any other data which may improve this document should be sent to: ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS, U.S. ARMY TOPOGRAPHIC ENGINEERING CENTER, ATTN CEERD-TS, 7701 TELEGRAPH ROAD, ALEXANDRIA, VA 22315-3864.

AMSC N/A

FSC 6675

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3.2 Theodolite characteristics. The theodolite shall be an auto-reading digital or an optical-reading direction-type.

3.2.1 Telescope. The telescope shall be centered over the vertical axis. The telescope shall have a means for illuminating the reticle and a means for controlling the illumination intensity. The telescope shall display an erect image. The reticle shall have a pattern similar to figure 1. The optical quality of the telescope shall be such that at night, stars of at least the 5th magnitude can be observed.

3.2.1.1 Telescope eyepiece. The eyepiece shall contain a diopter scale plainly marked in plus or minus units, and shall have an index mark referencing the setting. When focusing on the reticle, the eyepiece shall operate with a firmness that will retain the focus without binding or backlash. The telescope eyepiece shall accept the eyepiece prism and interchange with the auto-collimation eyepiece.

3.2.1.1.1 Elbow eyepiece. Unless otherwise specified (see 7.3), the elbow eyepiece shall enable an operator to observe vertical angles to the zenith and to observe an azimuth mark, with the telescope in either the direct or reverse position. The eyepiece shall give an erect image of the reading scales.

3.2.1.1.2 Telescope eyepiece prism. The telescope shall be provided with an eyepiece prism that shall permit favorable positioning for viewing without disturbing the focus of the telescope eyepiece. The eyepiece prism shall permit observation of ground points and angles with the telescope in the direct and reversed position. The eyepiece shall give an erect image of the reading scales.

3.2.1.1.3 Solar filter. Unless otherwise specified (see 7.3), a solar filter shall be provided. The solar filter shall be attachable without tools.

3.2.1.1.4 Auto-collimation eyepiece. When specified (see 7.3), an auto-collimation eyepiece shall be furnished. The eyepiece shall be interchangeable with the standard eyepiece. There shall be no reduction in magnification or optical qualities with the auto-collimation eyepiece installed.

3.2.2 Optical plummet. The optical plummet shall produce a clear image throughout the operating range. The reticle pattern shall produce an image, which is concentric with the vertical axis of the instrument.

3.2.3 Circles identification. The images, or read out, from the horizontal and vertical circles shall be identified.

3.2.4 Microscope. For type II, a microscope shall be provided to view the horizontal and vertical circles and breakdown scales, simultaneously. The images of the horizontal and vertical circles, index lines and breakdown scales shall appear erect and in the same plane. The micrometer shall be graduated at intervals of not more than 0.5 second of arc and shall serve for both horizontal and vertical circles.

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3.2.5 Microprocessor and control/display panel (for type I only).

3.2.5.1 Microprocessor. The microprocessor shall have a nonvolatile memory with sufficient capacity to store all data, constants, operating parameters, and sufficient random access memory to perform required data reductions.

3.2.5.2 Control/display panel. The panel shall contain all function keys, an alphanumeric display unit, and a means to record and process data. All keys shall be clearly identified as to function. Receptacles shall be labeled according to function. Warning and indicator lights required for operation of the instrument shall also be located on the panel. The panel shall automatically display horizontal and vertical angles at a precision and repeatability required to satisfy first order accuracies.

3.2.6 Levels. The instrument shall be equipped with a leveling capability which allows the instrument to be setup and operated at the required accuracies.

3.2.6.1 Vertical circle indexing. Vertical circle indexing for type II shall be controlled by a self-indexing device, unless an altitude level is specified (see 7.3).

3.2.6.2 Self-indexing device. The self-indexing device for type II shall be damped so that oscillation is stopped in not greater than 5 seconds of time. The device shall be accurate to within 10 seconds of arc..

3.2.6.3 Altitude level. On type II theodolites, when specified (see 7.3), the altitude level for indexing the vertical circle shall have a sensitivity not to exceed 12 seconds, ± 2 seconds for each 2 mm and shall be adjustable.

3.2.7 Tribrach. The tribrach shall consist of the leveling screws, base plate, and a device for locking the theodolite assembly. The base plate shall have at its center a 5/8-inch nut of the unified coarse thread series (.625-11 UNC-2B) for compatibility with existing equipment.

3.2.8 Illumination. The theodolite shall be illuminated by natural and artificial means.

3.2.8.1 Natural illumination. For type II, natural illumination shall be provided for the vertical and horizontal circles by a single adjustable mirror. Moving or adjusting the illumination shall not cause a change of more than 0.5 seconds of arc. Type I theodolites shall be readable in any ambient light conditions.

3.2.8.2 Artificial illumination. Lighting shall be provided for the horizontal and vertical circles, the micrometer scales, the reticles, the altitude level, the striding level, and the auto-collimation eyepiece, when furnished (see 7.3). The light intensity shall be adjustable.

3.2.8.3 Hand lamp. For type II theodolites, when specified (see 7.3), a hand lamp shall be provided and shall connect to a receptacle on the battery case. The hand lamp shall have a switch and a connecting cord not less than 1.5 meters long.

3.2.8.4 Battery and lighting accessory case. For type II theodolites, when specified (see 7.3), a battery and lighting accessory case shall be provided. The case shall provide mounting for

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batteries and contain two power receptacles. One receptacle shall be equipped with a rheostat with a marked "OFF" position, while the other receptacle shall provide continuous voltage. The case shall provide space for storage of the hand lamp, connector cords, and any spares. The case shall have a provision for mounting on the tripod. The case when dropped, at any operating temperature, from a height of six feet to a hard floor shall not be damaged and operate as specified.

3.2.9. Power system.

3.2.9.1 Power. Type II theodolites shall operate from an internal or external battery and shall contain built-in protection against reverse polarity from the power source, including a battery compartment that precludes improper battery insertion.

3.2.9.2 System power. System power, through multiple battery packs, shall be provided to support not less than 500 angle measurements and provide no less than eight hours of measuring time at 20°C.

3.2.9.3 Auxiliary power. Type I theodolites shall also operate from external 12-volt DC batteries, providing the same operating capability as with the internal power source. An external power cable shall be provided with the system that shall not be less than 6 meters in length and shall terminate in automotive type battery clamps which are identified by a "+" and "-".

3.2.9.4 Battery charger. System batteries shall be rechargeable using 110/220 volts, 50/60 Hz, charger that shall be supplied with the system. The battery charger shall be capable of concurrently charging at least two battery packs or a built-in battery charger shall be furnished with each battery pack. The battery shall not be damaged nor lose capacity when charged continuously from the charger.

3.2.10 Cases and covers.

3.2.10.1 Theodolite cover. A lightweight flexible waterproof cover shall be furnished to protect the theodolite from rain and dust. The cover shall withstand the environmental conditions specified herein without damage.

3.2.10.2 Carrying case. A dust-proof and moisture-proof carrying case to protect the theodolite from damage shall be provided. The case shall contain a desiccant adequate to the size of the container. The theodolite shall be fastened within the case to prevent it falling out when the case is opened. The case shall have heavy duty catches for closing. If form inserts are used, the inserts shall be removable for cleaning. The weight of the carrying case shall not exceed 4.1 kg.

3.2.10.3 Transport case. When specified (see 7.3), a reusable transport case that shall house and protect the theodolite in its carrying case during transport, shipment, and storage shall be provided. The case shall weigh not more than 15 kg. The case shall have removable inserts contoured to fit snugly around the carrying case. The case shall have carrying handle(s) and lock(s) or clamp(s). All hardware shall be of corrosion resistant metal or of metal treated to resist corrosion.

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3.2.11 Winterization kit. When specified (see 7.3), a winterization kit shall be furnished with the theodolite. The winterization kit, at a minimum, shall include covers for all control knobs and leveling screws, as well as shields for any telescope, microscope, and optical plummet eyepieces. The winterization kit shall be furnished for type II theodolites for operation below -20°C . A winterization kit shall be furnished for type I theodolites capable of warming the instrument to operating temperature (see 3.3.1) from -32°C within 25 minutes and from -43°C within 45 minutes.

3.2.11.1 Carrying case. A soft water-repellant carrying case for the winterization kit shall be provided. The case shall include belt loops or handles. The case shall be dimensioned and arranged to provide orderly storage for the items of the winterization kit.

3.2.12 Treatment and painting. Unless otherwise specified, (see 7.3), the color shall be lusterless army green. Untreated, exposed, exterior surfaces of the theodolite, cases, and accessories shall be treated and painted the same as those items the manufacturer offers for sale commercially.

3.2.13 Tripod. When specified (see 7.3), a ridged, no-extension leg-type tripod shall be furnished as follows:

- The tripod legs shall be hinged to a metal head plate. The hinges and head plate shall be of nonmagnetic metal. Hinge tension shall be adjustable. The legs shall be seated in a metal shoe.
- The tripod legs shall be of seasoned hardwood. The wood shall be free of knots and the slope of the grain shall not exceed 20 mm in 300 mm.
- A reusable means shall be provided for holding the legs together when not in use.
- Unless otherwise specified (see 7.3), a metal protection cap shall be furnished for the head of the tripod.
- The weight of the tripod shall not exceed 9.0 kg (approximately 20 lbs).

3.2.14 Trivet. When specified (see 7.3), a trivet shall be provided for setting up the theodolite on piers or towers.

3.2.14.1 Trivet carrying case. When specified (see 7.3), a carrying case for the trivet shall be provided to protect the trivet from shock and vibration. The case and trivet shall not weigh more than 9.0 kg (approximately 20 lbs).

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3.2.15 Tools and accessories. When specified (see 7.3), the following items shall be furnished with each theodolite:

<u>Item</u>	<u>Quantity</u>
Lens brush	1
Chamois skin (20 x 20 cm)	1
Container of lubricant	1
Recommended tools	1 set
Lens tissue	1 pkg
Orangewood sticks (commercial grade)	1 pkg
Manual, theodolite instruction, with protective cover, (contractor's standard)	1

The contractor may add items to this list as required for field maintenance and adjustments. All tools and accessories shall be contained in a case.

3.3 Environmental requirements.

3.3.1 Operating temperature range. The instrument shall determine azimuths to the specified accuracy within an ambient temperature range of -40°C to 52°C .

3.3.2 Storage temperature range. The instrument shall not be damaged, or operational requirements degraded, by storage at temperatures as low as -46°C for 6 hours and as high as 68°C for 4 hours without solar radiation.

3.3.3 Solar radiation. The instrument shall operate as specified and not be degraded by the full impact of solar radiation of 1135 watts per square meter ($360\text{ BTU}/\text{ft}^2/\text{hr}$) at an air temperature of 52°C for 4 hours.

3.3.4 Humidity. The instrument shall operate as specified and not be degraded when subjected to a 95 percent relative humidity at any operating or storage temperature.

3.3.5 Fungus and moisture resistance. Electrical circuitry and components that are susceptible to fungus and moisture damage shall be hermetically sealed or otherwise coated for protection.

3.3.6 Rainfall.

3.3.6.1 Assembled instrument. When assembled and in the normal operating position, the instruments shall not be damaged or show any signs of moisture penetration after exposure to

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wind driven rainfall of 7.5 ± 2.5 cm per hour, from any direction, and at any angle from vertical to 45 degrees from vertical, for a period of 5 minutes.

3.3.6.2 Cases. The carrying case and transport case shall each meet the rainfall requirements of 3.3.6.1 for a period of not less than one hour.

3.3.7 Blowing dust. The instrument shall endure a blowing dust environment in the storage mode without damage or degradation of operational requirements. The small particle procedure (dust and fine sand) shall be conducted in a dust and sand chamber to determine the effects of dust and sand on the instrument while in its transit case. The test shall be conducted with the following criteria:

- a. The air velocities used shall vary between a minimum of 1.5 m/s to maintain test conditions to a maximum velocity of 8.9 m/s.
- b. The dust composition shall be consistent with red china clay or silicon flour.
- c. The dust concentration shall be maintained at 10.6 ± 7 g/m³.
- d. The instrument shall be oriented so that all surfaces shall face the blowing dust.
- e. The blowing dust test shall be conducted for 6 hours at 23°C, and for 6 hours at 50°C.

3.3.8 Blowing sand. The instrument shall endure a blowing sand environment in the storage mode without damage or degradation of operational requirements. The large particle procedure shall be conducted in a dust and sand chamber to determine the effects of blowing sand on the instrument while in its transit case. The test shall be conducted with the following criteria:

- a. The air velocities used shall be 18 to 29 m/s.
- b. The suggested sand composition (at least 95% silicate oxide by weight) is as follows:
 - 1.00% shall be retained by a 20 mesh screen.
 - 2.00% shall be retained by a 30 mesh screen.
 - 15.00% shall be retained by a 40 mesh screen.
 - 37.00% shall be retained by a 50 mesh screen.
 - 30.00% shall be retained by a 70 mesh screen.
 - 15.00% shall be retained by a 100 mesh screen.
- c. The sand concentration for natural conditions shall be 2.2 ± 0.5 g/m³.
- d. The instruments shall be oriented so that all surfaces shall face the blowing sand for 90 minutes per surface.
- e. The blowing sand test shall be conducted at 50°C.

3.3.9 Vibration. The instrument shall be constructed so that parts do not become loose, permanent settings do not shift, and no degradation in performance is caused when stored in carrying cases and subjected to 5 minutes of vibration on each axis. The test bed shall produce an 0.8 mm, double amplitude, orbital path at 5 to 52 cycles per second.

3.3.10 Shock. The instruments shall be constructed so that parts do not become loose, permanent settings do not shift, and no degradation in performance is caused when stored in carrying cases and subjected to one flat vertical drop at a height of 152 mm on to a level wood floor. Instruments stored in carrying cases and transport cases shall suffer no degradation in performance when dropped from 305 mm on a level concrete floor.

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3.3.11 Electromagnetic interference. Type I theodolites shall have design characteristics for the control of electromagnetic interference emission and susceptibility.

3.3.11.1 Conducted emissions. Conducted emissions (CE) on power leads and returns that obtain power from sources not part of the unit shall not exceed the values in figure 2 for a frequency scan from 10 kHz to 10 MHz.

3.3.11.2 Conducted susceptibility. Conducted susceptibility (CS) on all interconnecting cables, including power cables, shall not exceed the values in figure 3 for a frequency spectrum scan from 10 kHz to 10 MHz. Use curve A for frequency ranges 10 kHz to 2 MHz and curve B for frequency ranges from 2 MHz to 10 MHz.

3.3.11.3 Radiated emissions. Radiated emissions (RE) from the instrument and all interconnecting cables shall not exceed the values in figure 4 for frequency spectrums scan from 2 MHz to 18 GHz. Testing is required up to 1 GHz, or 10 times the highest intentionally generated frequency within the instrument, whichever is greater. Measurements beyond 18 GHz are not required.

3.3.11.4 Radiated susceptibility. Radiated susceptibility (RS) shall not exceed 50 volts/meter for frequency spectrums scan from 2 MHz to 18 GHz. The requirements shall be met for vertically polarized fields up to 30 MHz and for both horizontally and vertically polarized fields above 30 MHz. Circular polarized fields are not acceptable.

4. REGULATORY REQUIREMENTS.

4.1 Recovered materials. The offeror/contractor is encouraged to use recovered materials (see 7.4.1) to the maximum practicable extent, in accordance with the Federal Acquisition Regulation (FAR).

5. QUALITY ASSURANCE PROVISIONS. The supplier shall comply with the following for certification and acceptability.

5.1 Product conformance. The products provided shall meet the salient characteristics of this commercial item description, conform to the producer's own drawings, specifications, standards, and quality assurance practices, and be the same product offered for sale in the commercial market. The Government reserves the right to require proof of such conformance.

5.2 Market acceptability. The instrument offered shall be of the latest model of the standard product of the supplier and shall have been used in the field for at least one year by commercial organizations.

5.3 Examination. Each instrument shall be examined for compliance with the requirements specified in 3.2 through 3.3. Any modification necessary following failure to meet the specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all examinations of performance and dimensional requirements.

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Non-compliance with any specified requirement, or the presence of one or more defects lessening maximum efficiency shall constitute cause for rejection.

6. **PACKAGING.** Preservation, packing, and marking shall be as specified in the contract or order.

7. **NOTES.**

7.1 Intended Use. The theodolite with accessories is intended for use in precise geodetic surveying and for triangulation and astronomic work where first-order results are required.

7.2 Conformance statement. When this commercial item description is used for procurement the product conformance clause should appear in the solicitation.

7.3 Acquisition Requirements.

- a. Title, number, and date of this document.
- b. Type of theodolite required.
- c. When an elbow eyepiece is not required (see 3.2.1.1.1).
- d. When a solar filter is not required (see 3.2.1.1.3).
- e. When an auto-collimation eyepiece is required (see 3.2.1.1.4).
- f. When an altitude level is required see 3.2.5.3).
- g. When a hand lamp is required (see 3.2.7.3).
- h. When a battery lighting and accessory case is required (see 3.2.7.4).
- i. When a transport case is required (see 3.2.9.3).
- j. When a winterization kit is required (see 3.2.10).
- k. Color requirement (see 3.2.11).
- l. When a tripod is required (see 3.2.12).
- m. When a tripod metal protection cap is required (see 3.2.12).
- n. When a trivet is required (see 3.2.13.)
- o. When a trivet carrying case is required (see 3.2.13.1).
- p. When tools and accessories are required (see 3.2.12).
- q. Level of packaging required.

7.4 Definitions. The following definitions apply for this document.

7.4.1 Recovered materials. For the purpose of this requirement, recovered materials are those that have been collected from solid waste and reprocessed to become a source of raw materials, as distinguished from virgin raw materials. Used, rebuilt, or remanufactured components, pieces and parts shall not be incorporated in the instrument.

7.4.2 Stabilization. Stabilization is a 2°C differential between the ambient temperature and the instrument.

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7.5 Subject term (key word) listing.

geodetic survey
optical reading
triangulation

7.6 First-order accuracy. The probable error allowed for first-order astronomic observations is: latitude, ± 0.2 second, longitude, ± 0.2 second; azimuth for triangulation, ± 0.3 second, and azimuth for traverse, ± 0.5 second. Further information regarding first-order accuracy will be found in Standards and Specifications for Geodetic Control Networks, DMS NO. ST 031, available from the National Geodetic Information Branch (N/CG17x2), NOAA, Rockville, MD 20852.

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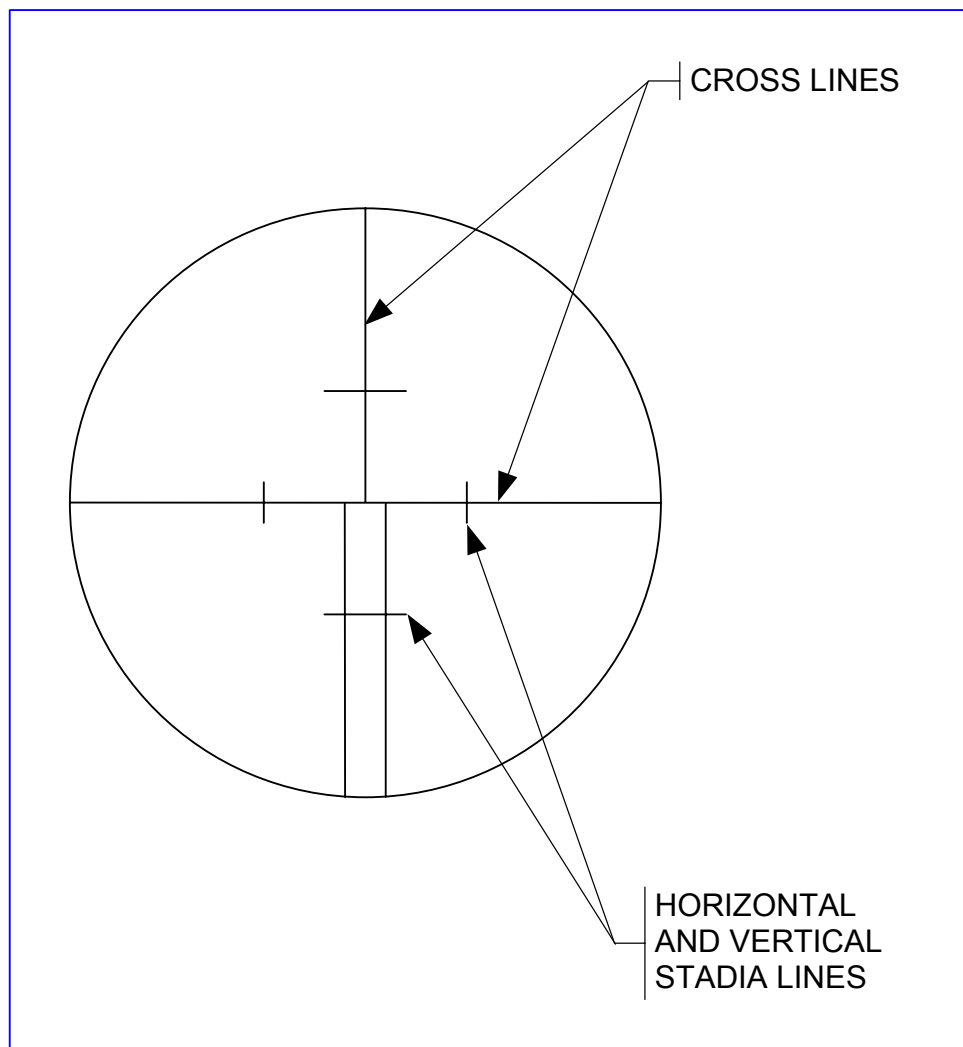


Figure 1. Reticle pattern for theodolite.
(Illustrative example only)

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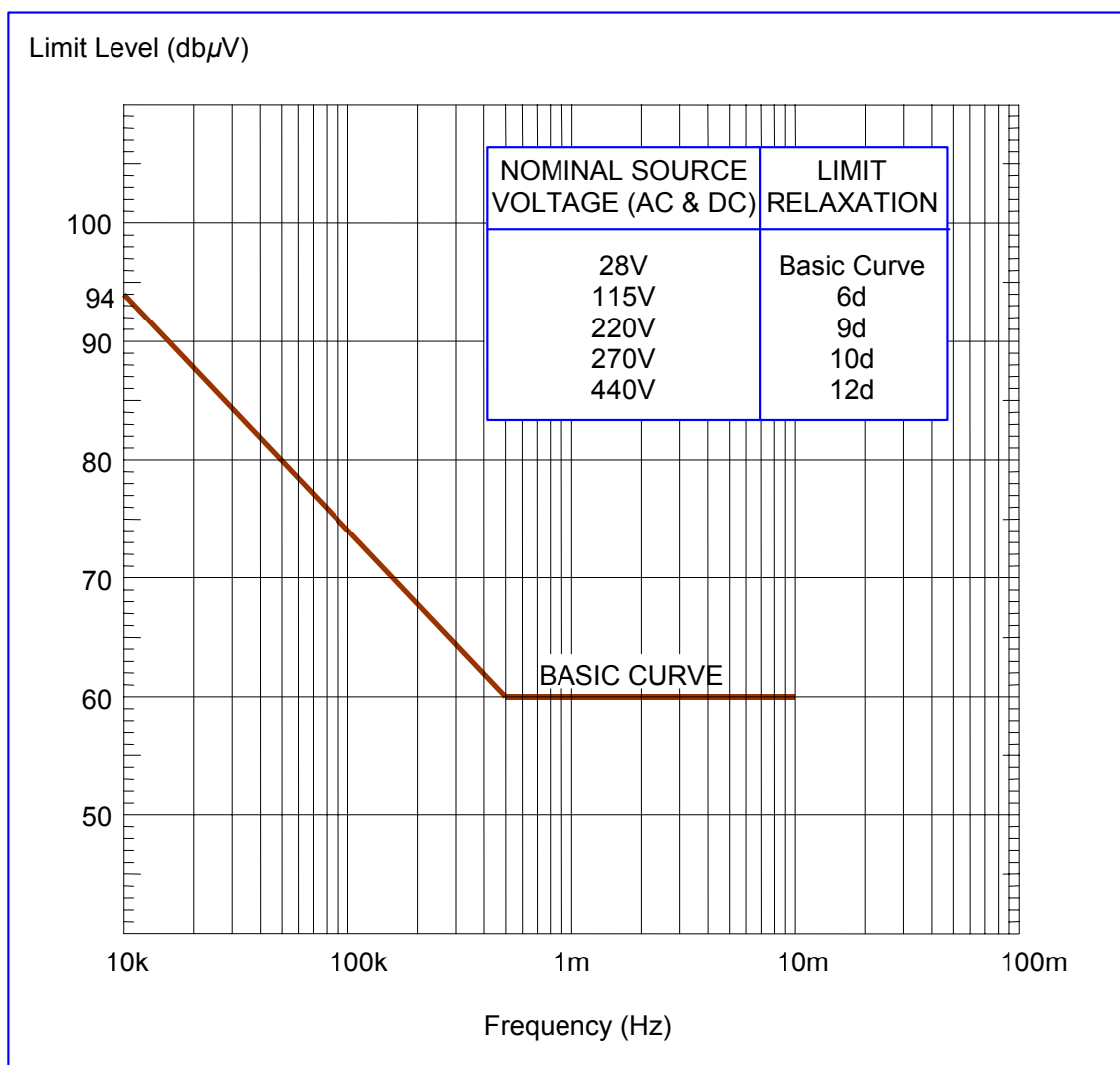
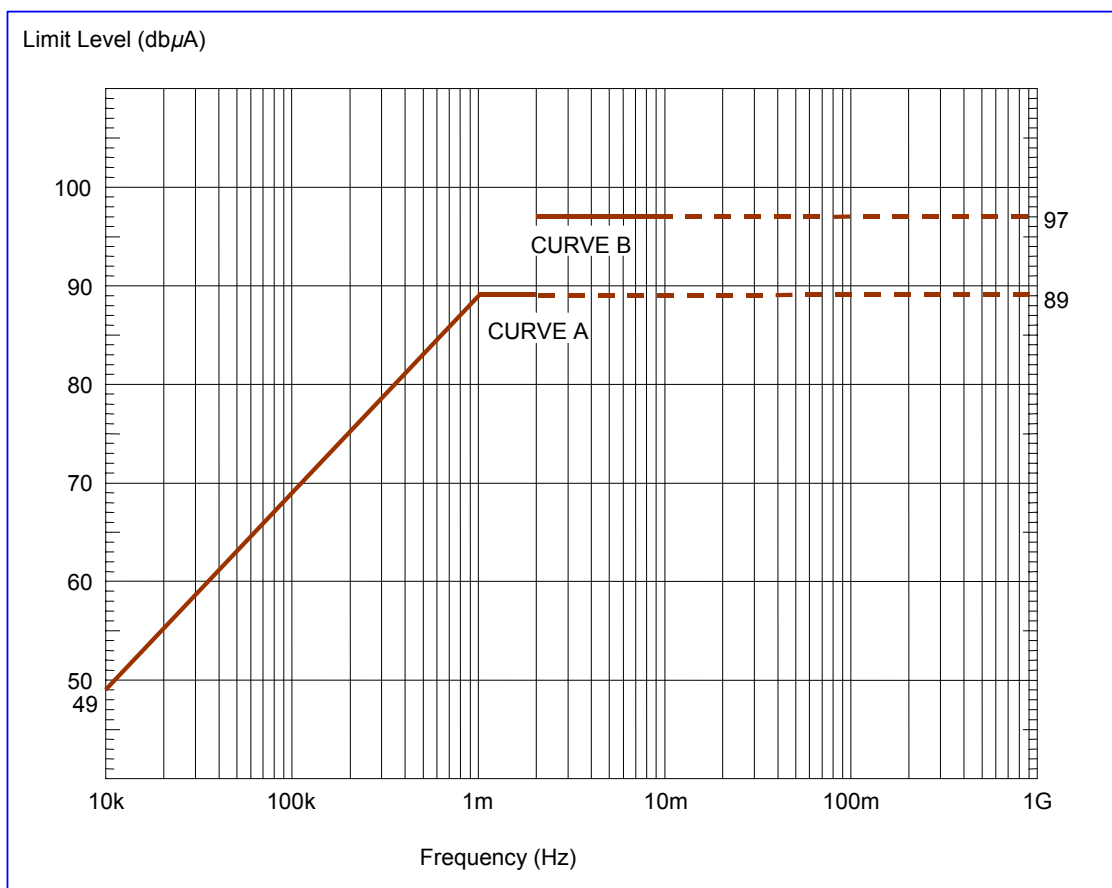
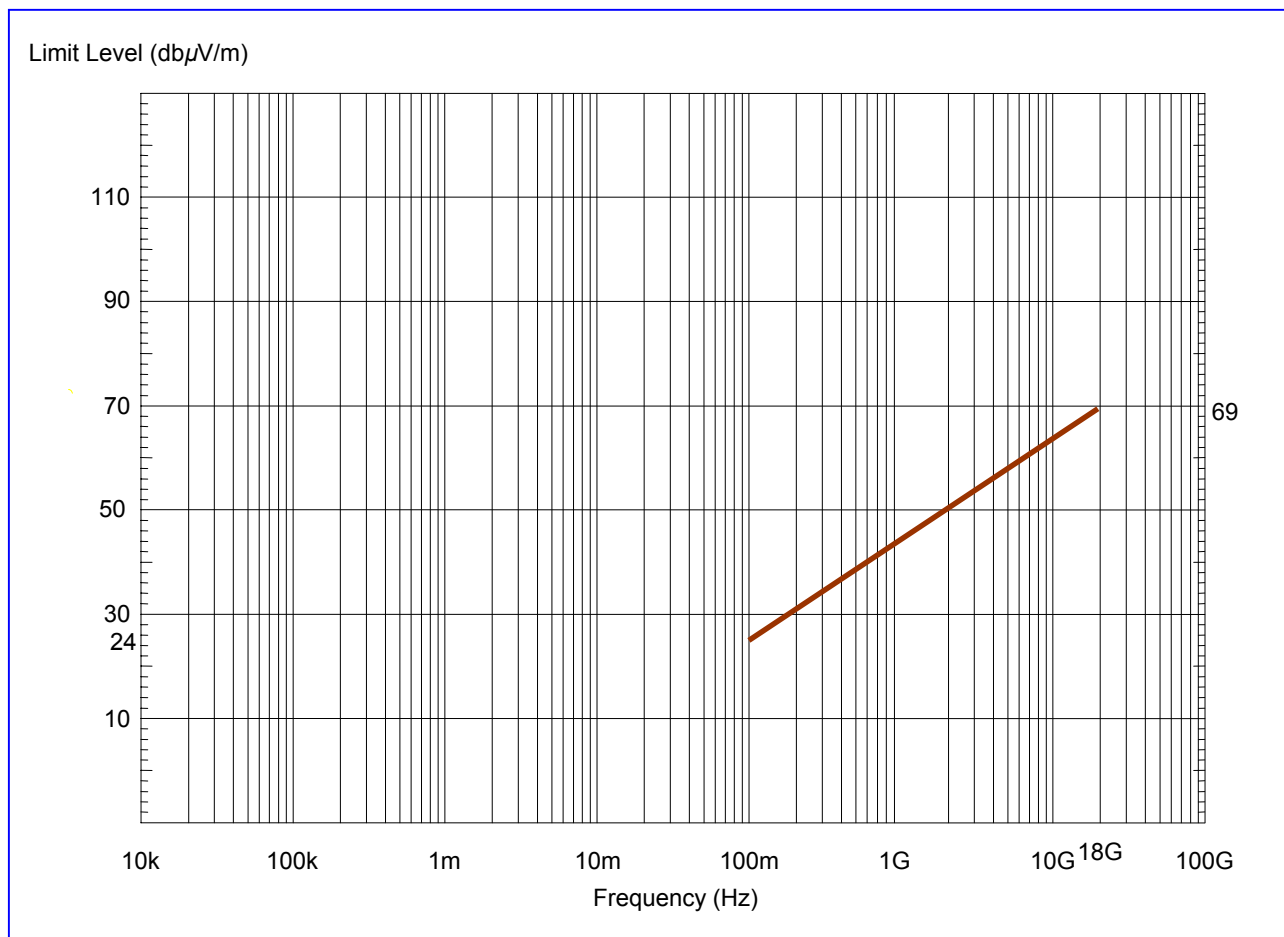


Figure 2. Conducted emissions limit

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Figure 3. Conducted susceptibility limits.

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Figure 4. Radiated emission limit

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Custodians:

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3. DOCUMENT TITLE THEODOLITES, SURVEYING, DIRECTION: FIRST ORDER WITH ACCESSORIES, TRIPOD, AND CASES		
4. NATURE OF CHANGE <i>(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed)</i>		
5. REASON FOR RECOMMENDATION		
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