STANAG No. 4349
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT

SUBJECT: MEASUREMENT OF THE MINIMUM RESOLVABLE TEMPERATURE DIFFERENCE (MRTD) OF THERMAL CAMERAS

Promulgated on 9 August 1995

for G.B. FERRARI
Major-General, ITAF
Chairman, MAS

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature
1	MAS/186-LP/1D/4349 v. 14.06.96	10.05.01	

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "The declaration by which a nation formally accepts the content of this Standardization Agreement".

5. Implementation is "The fulfilment by a nation of its obligations under this Standardization Agreement".

6. Reservation is "The stated qualification by a nation which describes that part of this Standardization Agreement which it cannot implement or can implement only with limitations".

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page iii gives the details of ratification and implementation of this agreement. If no details are shown, it signifies that the nation has not yet notified the tasking authority of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

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ARMY

NATO STANDARDIZATION AGREEMENT (STANAG)

MEASUREMENT OF THE MINIMUM RESOLVABLE TEMPERATURE DIFFERENCE (MRTD) OF THERMAL CAMERAS

Annex: MRTD Results Sheet

Related Documents: None

AIM

1. This STANAG serves to establish the conditions under which the minimum resolvable temperature difference (MRTD) of thermal imagers is to be measured at a given temperature and in the centre of the field of view.

VALIDITY

2. The measurement procedure described applies only to thermal imagers where the MRTD concept is defined, i.e. for properly sampled systems. The applicable spectral ranges are 3 - 5 μm or 8 - 14 μm respectively or parts of these ranges.

AGREEMENT

3. Participating nations agree that the measurement procedure established in the following paragraphs will apply when measuring MRTD of thermal imagers.

DEFINITION OF MRTD

4. The MRTD is the minimum temperature difference which allows an observer to resolve a test pattern in accordance with a given criterion. MRTD is a function of spatial frequency of the test pattern. It depends on the measurement temperature, and may depend on the orientation of the test pattern.

NOTE 1 : The MRTD measured at a given temperature can be converted to the MRTD at other temperatures, if necessary. The conversion factor depends on the spectral response of the thermal imager and has to be determined in each case.

MEASUREMENT CONDITIONS

5.1. The observer shall have normal visual acuity (post-correction defects less than ± 0.25 dioptres) and good colour vision and be experienced in this type of measurement.

5.2. The test pattern shall be a plate containing four (4) rectangular slots, forming a square of four (4) bars and three (3) spaces as shown in Figure 1. The test pattern is positioned in front of a black body, the temperature of which can be varied, giving a temperature difference (Δ T) between the bars and the spaces.

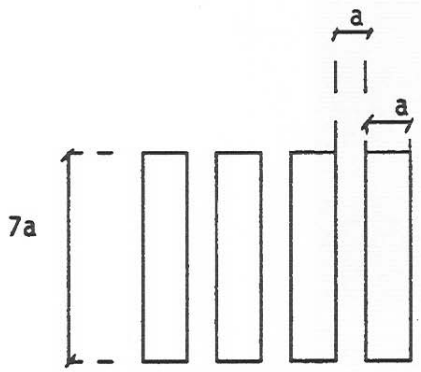


Figure 1

5.2.1. The spatial frequency of the resolving power measurement targets must be within ± 5% of the nominal value.

5.2.2. The emissivities of the test pattern and the black body must both be at least 0.95.

5.2.3. The back body must make it possible to achieve temperature differences of ± 10 °C. The accuracy must be 0.5% generally, and 0.01 °C for Δ Ts between 0 °C and ± 2 °C.

5.2.4. Any variation in temperature across the useful area of the test pattern shall be so small as not to be detectable on the image by the observer.

5.2.5. The measurement temperature is that of the test pattern, which should be 20 +/- 2 °C unless otherwise specified.

5.3. The transmission losses between the test pattern and the imager and the emissivities of the test pattern and the black body should be known and taken into account when results are calculated.

5.4. In carrying out the measurements the observer may optimise results by altering both the illumination level in the room and any settings on the imager, adjusting the distance of his eye from the display, and slightly altering the position of the test pattern within the field of view. If a monitor is used, it must be of the type normally used with that imager, and it is recommended that, once set up, it should not be adjusted during measurement.

MEASUREMENTS

6.1. Starting from an invisible test pattern, the method is based on the determination of the temperature difference (+ or -) required to make the test pattern visible. Owing to limitations in the test equipment, the indicated temperature differences may not be the true temperature differences between test pattern and black body. Therefore the following procedure is recommended to establish the MRTD : starting with the temperatures of the test pattern and black body approximately equal (see Note 2), the temperature of the black body shall increase until the test pattern appears in positive contrast (hot bars). When the observer can just resolve the test pattern, the temperature difference (ΔT_+) is recorded. The black body temperature is then reduced causing the test pattern to disappear, and then to reappear with negative contrast (cold bars). When the observer can just resolve the test pattern again the temperature difference (ΔT_-) is recorded (see Note 3). The two measurements must be taken without delay so that temperature drift is avoided (see Note 4).

Note 2 : The procedure can be speeded up by starting with a temperature difference between the test pattern and the black body of 0.8 . ΔT, both for positive and negative contrast.

Note 3 : If it can be established that the temperature drift is negligible, both positive and negative contrast measurement need be made only for the lowest spatial frequencies, in order to determine the " Δ T offset" of the test equipment. This " Δ T offset" is then calculated as the mean of the temperature differences for the positive and negative contrasts (that is, " Δ T offset" = $0.5 [\Delta T_+ + \Delta T_-]$), and its value is then substracted from the temperature differences measured for a single contrast for each of the remaining spatial frequencies in the test run. Positive contrast measurements for these frequencies are recommended.

Note 4 : It is proposed that the black body temperature be varied in steps as follows :

Δ T	Proposed step	Δ T	Proposed step
Below 0.5 °C	0.01 °C	2.0 °C to 4.0 °C	0.10 °C
0.5 °C to 1.0 °C	0.02 °C	4.0 °C to 8.0 °C	0.20 °C
1.0 °C to 2.0 °C	0.05 °C	More than 8.0 °C	0.40 °C

6.2. It is recommended that the MRTD be measured with horizontal and vertical orientation of the bars. Any other orientation is optional.

6.3. The criterion to be used for resolution is that it should be possible to see four bars (not just some modulation) on the display, although it is not necessary that all of each of the four bars be visible at the same time.

6.4. Measurements shall be taken at a minimum of four (4) spatial frequencies distributed approximately uniformly over the useful range of the imager. A minimum of three (3) measurements shall be taken for each pair of contrasts, at each spatial frequency, in each orientation, by each observer. Measurements shall be taken until stable results are observed. A single observer may be used, although multiple observers are recommended.

EXPLOITATION OF RESULTS

7.1. If positive and negative contrasts have been measured, the individual MRTD value is :

$$\left| \frac{\Delta T+ \; - \; \Delta T-}{2} \right|$$

7.2. The MRTD results shall be tabulated (see Annex) and plotted on a graph (with a logarithmic scale for temperature differences and a linear scale for spatial frequencies) for each observer and each orientation. The measurement conditions, values used for calculation and all the results must be shown. Any significant deviation or rejection of results must be explained.

IMPLEMENTATION OF THE AGREEMENT

8. This STANAG is implemented by a nation when orders have been issued to the concerned personnel to apply the MRTD measurement procedure described in this agreement.

ANNEX A to
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MRTD RESULTS SHEET

Imager _____

Field of view _____ Measurement temperature _____ °C,

Test Pattern Orientation : Horizontal/Vertical/Other _____

Observer _____ Date _____

Comments _____

_____

_____

_____

Spatial Frequency	Δ T+	Δ T-	0,5 (Δ T+ - Δ T-)	MRTD