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Environment conditions for Inframet test systems

Report A34/21

Warsaw, 2021

1 Introduction

Inframet manufactures a long series of systems for testing testing electro-optical surveillance systems (thermal imagers, night vision devices, VIS-NIR cameras, SWIR imagers, laser range finders, laser designators, multi-sensors systems, fused systems, UV cameras, optical sights) and main blocks of such systems (image intensifier tubes, IR FPA/CCD/CMOS imaging sensors, optical objectives). In all cases these are precision measuring systems that must be properly installed and used in proper environment conditions in order to generate accurate test results.

Requirements on environment/work conditions of Inframet test systems can be divided into seven groups:

1. ambient temperature/air flow,
2. vibration level,
3. ambient light,
4. power voltage,
5. air cleanliness
6. electromagnetic interference,
7. humidity.

It should be noted that level of requirements vary a lot depending no only on type of test systems but also on performance parameters of tested device (for example Nequist spatial frequency of tested imager, divergence angle of LRFs).

2 Ambient temperature

Inframet test systems are without several exceptions laboratory class test equipment supposed to be used at typical laboratory temperatures from about 18ºC to about 24ºC and such ambient temperatures are recommended. However, Inframet test systems typically can work in much wider temperature range from about 5ºC to about 35ºC. In detail, absolute value of ambient temperature is often not important in situation when stability of ambient temperature can be critical.

Modern thermal imagers are capable to detect temperature differences at level as low as 10mK. Therefore systems for testing thermal imagers are sensitive to fast changes of ambient temperature that generate so called offset phenomenon (thermal imager can see target even when blackbody differential temperature is zero). Therefore it is important to keep temperature changes in test room as slow as possible.

Inframet recommends following rules for minimization of ambient temperature changes of the test system:

1. Use large size test room (ambient temperature of large rooms typically changes slowly)
2. Limit number of people of the test team (human is also a source of heat and a large group will change ambient temperature of the test room),
3. Avoid presence of heating/cooling system in test room that generates temporally/spatially variable temperature gradients on the test system (ideal situation: no heating/cooling system),
4. If heating/cooling system is necessary then please avoid systems working in chopped mode. Systems with fixed (slowly changing) power that generate thermal equilibrium conditions are recommended,
5. Increase distance from heating/cooling system to the test system (it is logical that heating/cooling system will change temperature of the test system more if the distance is short),
6. Avoid air flows in the test room (fans of air-conditioning system or even partially open window/doors can generate air flows that can change temperature and thermal gradient of the test system),
7. Increase time interval between time point when the tests have been started from time point when both test system and tested imager have been switched on (electronics of both test system and tested imager work as heaters that can generate changes of thermal gradient of the test system).

Inframet test systems use compact thermally insulated MRW wheel to minimize influence of variation of ambient temperature on results of testing thermal imagers. User can also always do tests at both positive and negative contrast that are recommended by international standards to correct offset phenomenon. Therefore Inframet test system will work even when these recommendations are slightly non fulfilled. However, in case of strong differences between recommended conditions and real work conditions measurement accuracy can be reduced.

Please note that these rules are valid only for systems for testing thermal imagers, IR FPA sensors and blackbodies. Requirements in case of other test systems are much more relaxed.

3 Vibration level

Great majority of Inframet test systems are systems for testing imagers or imaging sensors. Such systems are potentially sensitive to vibrations present in test rooms that generate vibrations of tested imagers or optical elements of test systems. The latter vibrations will finally generate following defects:

1. blurring of image generated by tested imagers

2. slow angular movements of images generated by tested imagers.

The first defect one is especially dangerous because it deteriorate measurement results of performance parameters of imagers like MTF or resolution.

The second defect can cause problems when measuring boresight errors and when measurements are taken at some time intervals.

Test results of laser systems can be also sensitive to vibration levels (especially measurement of divergence angle or boresight errors) but typically laser test systems are less sensitive to vibrations than systems for testing imagers.

There is always some level of vibrations of floor of the test room due to different reasons including walking of test crew. These vibrations will always generate some temporal changes of angular position of image seen by tested imager. The level of these angular changes depend both on intensity of vibrations of the floor and of performance of platform where the test system and tested imager are located. High quality antivibration table can very significantly reduce influence of floor vibrations on the image vibration.

However, it should be emphasized that real requirements on level of floor vibration and vibration suppression platform for tested imager and test system depends mostly on specifications of tested imagers.

Angular pixel size of imagers offered on the market vary from about 0.01mrad to 10mrad. It is logical that vibration of output image at level say 0.1mrad will be totally negligible when testing imagers of angular pixel size over about 1 mrad but will be critical when testing imagers of pixel size below 0.1 mrad.

Therefore user of Inframet test system should determine what is the imager having the smallest angular pixel size and later to determine requirements on protection against vibration using the rules below:

1. Imagers of very short range (very wide FOV)
   Pixel angular size [mrad] of tested imager is over 2.5mrad.
   In case of such imagers no special recommendations on test room. Any heavy stable flat table is suitable to work as platform for both test system and tested imager.
2. Imagers of short range (wide FOV)
   Pixel angular size [mrad] of tested imager is in range 0.5 to 2.5mrad.
   In case of such imagers the room where are located heavy machines generating strong vibrations should be avoided but still any heavy stable flat table is suitable to work as platform for both test system and tested imager. Typical office conditions are acceptable. The room can be located at any floor.
3. Imagers of medium range (medium FOV)
   Pixel angular size [mrad] of tested imager is in range 0.1-0.5 mrad.
   It is recommended to use laboratory room where there is no heavy machinery generating vibrations and/or numerous humans. Typical laboratory conditions are acceptable. The room can be located at any floor. However, it is recommended to use optical anti vibration table as platform for both test system and imager.
4. Imagers of long range (narrow FOV)
   Pixel angular size [mrad] of tested imager is in range 0.02-0.1 mrad.
   It is required to use laboratory room where there is no machinery generating vibrations and/or numerous humans. The room should be located at ground floor. It is required to use optical anti-vibration table as platform for both test system and imager.
5. Imagers of very long range (very narrow FOV)
   Pixel angular size [mrad] of tested imager is in range below 0.02 mrad.
   It is required to use special laboratory room where there of low vibrations where are few humans. The room must be located at ground/basement floor. It is required to use optical anti-vibration table as platform for both test system and imager. The optical table should be located on a foundation that is separated from rest of room. The latter requirement is especially important if the tested imager is located on a separate table from the table where test system is located. It is recommended to avoid buildings that are at short distance to heavy traffic streets or railways.

4 Ambient light

Inframet test systems can be divided into three groups:

1. Test systems non sensitive to typical ambient light (solar light, artificial visible sources): systems for testing thermal imagers, laser systems, IR optics, IR FPA
2. Test systems of limited sensitivity to typical ambient light (solar light, artificial visible sources): systems for testing day level VIS-NIR cameras, VIS-NIR optics, SWIR imagers, UV cameras, VIS-SWIR sensors,
3. Test systems very sensivitive to typical ambient light (solar light, artificial visible sources): systems for nigh vision devices, image intensifier tubes, nigh level VIS-NIR cameras.

In case of first two group of test systems mostly general with laboratory lighting requirements are valid:

- Light should be illuminated uniformly over the room or at least at the installation area of Inframet's testing systems.
- The lighting system must prevent glare effect causing discomfort to test team,
- Temporal variations should be limited as much as possible in order to should not affect to operator's vision.

Recommended illumination in the room where Inframet test systems are located is in range about 300 lx to 1000 lx.

The specific requirement is for case of measuring subjective image quality parameters of imaging systems like MRTD, MDTD, MRC or resolution. In such a case it is recommended that test team must be able to adjust the light illumination level in the room to level when best measurement results are obtained.

Test systems from the third group should be located in special dark room of regulated illumination where if needed ambient illumination can be reduced to level not higher than 1 mlx. Attention: this is strictly required that customer must have such a test room.

Work in such low illumination conditions is depressing for human operators. Therefore Inframet typically delivers special light sources that enable to increase illumination at room conditions to level about 1-3lx without noticeable reduction of test accuracy.

5 Power voltage

Inframet testing system are powered by 230V/50Hz ±10% according to European standards, all devices have protecting circuit boards. However, almost all Inframet test systems can be also powered from 110V/60Hz ±10% mains.

The voltage of electric line must be stable, if not it is required to use a voltage stabilizer before supplying power to the testing systems. Unstable voltage of power supply can lead to error in measurement result, shorten testing system life and more importantly, damage the testing system.

Protective earth terminal of the Inframet device must be connected to the protective conductor of the (mains) power cord. Any non connection of the protective (grounding) conductor or disconnection of the protective earth terminal can cause a potential shock hazard that could result in personal injury. It is customer responsibility to ensure proper conditions of electric powering.

The power supply plug is type E. That means the plug has two round pins (diameter 4.8mm, centers spaced 19mm apart) and a hole for the earth pin. Inframet customer should buy an appropriate adapter to use such type E plug in local conditions or change the power cable to cable suitable for local conditions.	

Attention: these rules do not refer to systems powered from three phase power mains.

6 Air cleanness

It is an ideal situation if Inframet test systems are installed in a room that fulfil requirements air cleanness not lower than ISO 8. However, it is still fine if test systems work in typical laboratory conditions (ISO 9). Inframet test systems can work even in conditions over ISO 9 but such conditions can be damaging to test systems: dust can remain on optical surfaces, decreasing the mirror reflectivity and system transmittance, affecting the measurement accuracy. In longer term dusty conditions can shorten life time of Inframet test systems.

Class	Maximum particles/m^3 [a]						FED STD 209E equivalent
	≥0.1 µm	≥0.2 µm	≥0.3 µm	≥0.5 µm	≥1 µm	≥5 µm	
ISO 1	10[b]	[d]	[d]	[d]	[d]	[e]	
ISO 2	100	24[b]	10[b]	[d]	[d]	[e]	
ISO 3	1,000	237	102	35[b]	[d]	[e]	Class 1
ISO 4	10,000	2,370	1,020	352	83[b]	[e]	Class 10
ISO 5	100,000	23,700	10,200	3,520	832	[d,e,f]	Class 100
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	Class 1,000
ISO 7	[c]	[c]	[c]	352,000	83,200	2,930	Class 10,000
ISO 8	[c]	[c]	[c]	3,520,000	832,000	29,300	Class 100,000
ISO 9	[c]	[c]	[c]	35,200,000	8,320,000	293,000	Room air

7 Electromagnetic interference

Inframet testing systems are designed to measure low level electric signals. Because of application high precision amplifiers, measuring analog signals, and analog to digital converters it is highly recommended that working environment must be free from EM interference's, both conducted EMI and radiated EMI. Electromagnetic interference's may be caused by out of date or malfunctioned devices that are working at the same mains line as Inframet testing systems. Devices that may produce EMI are: high voltage or high power switching power supplies (for example motor drivers, industrial machines etc.) or high power radiation sources (antennas).

In general, it is expected that the mains in the test room and all electric devices used in the test room are compliant to EN61000 standard (or at least EN61000-4-2,3,4,5,6,8,11, light industry level, criteria A).

If customer notice any unusual behavior of Inframet devices such as unstable readouts, video noise, power supply voltage drops, should check if all devices that could cause electromagnetic interference are turned off from the mains.

It is not recommended to connect Inframet devices to mains of EMI emission higher than specified by that standard.

8 Humidity

Inframet testing systems work best in conditions of medium level of relative humidity. Recommended level of humidity in installation room is 30-60%. However, Inframet systems can work in conditions of humidity up to 95% , but condensation of water vapor must be avoided. Room having very dry air (below 10%) should be also avoided due tendency to generate electric fields on surfaces of electronic elements.

9 Special cases

The requirements presented in previous sections refer to Inframet typical laboratory class test systems. However, Inframet can deliver on special demand systems optimized for use at harsh environmental conditions. Next, Inframet typically offers stationary class test systems. However, Inframet can deliver on special demand portable/mobile test systems optimized for use at field/depot conditions.

In case of any questions please contact Inframet.