ST test system

Tester of SWIR imagers

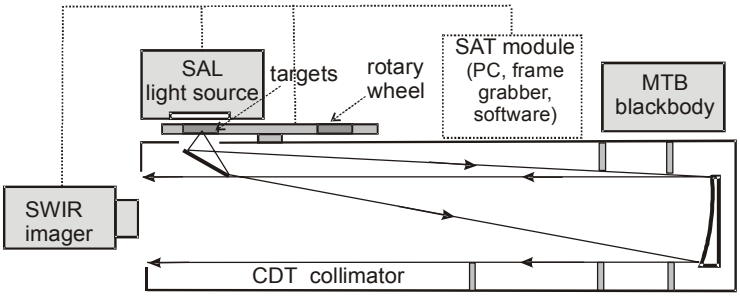

Fig. 1. Block diagram of ST test system

Fig. 2. Photo of the ST200 test system

BASIC INFORMATION:

SWIR imagers (short wavelength infrared) are an important group of surveillance electro-optical imagers due several reasons. First, advances in InGaAs technology enabled design of relatively low cost SWIR imagers. Second, InGaAs imagers are very sensitive and can generate images of observed scenery even at dark nights. Third, SWIR imagers are less vulnerable to bad atmospheric conditions than TV cameras working in visible/near infrared band. Fourth, SWIR imagers can generate hi-res images even if they are built using much smaller optics than used for design of thermal imagers.

SWIR imagers use typically radiation reflected by observed targets to create images of these targets similarly to TV cameras. SWIR imagers can also use thermal radiation emitted by observed targets to create images of these targets like thermal imagers. Due these features SWIR can be tested using both methodology for testing TV cameras or methodology for testing thermal imagers. Parameters of InGaAs FPAs can be also used to characterize SWIR imagers.

Inframet proposes to characterize SWIR imagers by three ways: a)measurement of parameters typical for TV cameras (Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity), b) measurement of parameters typical for thermal imagers (MRT, MDT, MTF, NETD, FPN, non uniformity, distortion, FOV), c) measurement of parameters of InGaAs FPA module (Mean Detectivity, Noise Equivalent Irradiance, Dynamic range).

ST test system is in general a variable target measuring system that uses a series of different targets to project their images into direction of a tested SWIR imager. The imager generates distorted copies of the projected images. Quality of the images generated by the imager is evaluated by human observers or by software and its important characteristics of SWIR imagers are measured. The ST test system consists of a reflective off axis collimator, broadband light source, medium temperature blackbody, motorized rotary wheel, a set of targets, a bandpass filter, PC, frame grabber, and test software.

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FEATURES:

- Ability to simulate three different scenarios: A)reflected polychromatic radiation configuration (system based on SAL light source), B)emitted radiation configuration (system using MTB blackbody), C)monochromatic source configuration (SAL light sources with a monochromatic bandpass filter)
- Enable testing SWIR imagers of optical aperture as big as 100 mm
- Ability to simulate both darn night and very bright day conditions
- Ability to simulate targets of temperature up to 600ºC
- Modules: CDT 1000 collimator, SAL light source, MTB-2D blackbody, MRW-8 motorized rotary wheel, set of targets, 1550 nm bandpass filter, PC, frame grabber, MTB Control program, SAL Control program, TAS-S program
- Computerized test system, semi-automatic measurement of important parameters of SWIR imagers
- Semi-automatic measurement of all important parameters of SWIR imagers
  - Mode I: Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity
  - Mode II: MRT, MDT, MTF, NETD, FPN
  - Mode III: Mean Detectivity, Noise Equivalent Irradiance, Noise, Dynamic range

SPECIFICATIONS

Collimator			**Light source**	
Collimator type	reflective, off-axis		Aperture	40 mm
Clear aperture	From 100 mm to 200 mm		Light source type	Dual: 1)polychromatic halogen type, 2)monochromatic LED
Focal length	Depends on model		Halogen spectral band	400-2200 nm
Spectral range	At least 0.4-15 µm		Halogen color temperature	Approximately 2856K at 450-1700nm band
Spatial resolution	not less than 160 lp/mrad		Halogen Dynamic	0.02 mcd/m^2 - 3000 cd/ m^2
Coating	Aluminum – collimating mirror, gold-flat mirror		Halogen regulation method	Opto-mechanic, continuous
Field of view	Depends on model		LED wavelength	1060nm
Rotary wheel			LED source dynamic	10000:1
Model	MRW-8		**Blackbody**	
Number of holes for targets	8		Aperture	50 mm
Control type	motorized, digital		Absolute temperature range	50ºC to 600ºC
Targets			Temperature uniformity	<0.005xT
Diameter	54 mm (for wheel holes)		Settling time	<30 min
Targets for reflective mode	Set of 5 variable contrast USAF targets, FOV/distortion target, edge target		Regulation resolution/ stability	0.01ºC/ 0.05ºC
Targets for emissive mode	set of eight 4-bar, set of eight pinhole targets, FOV/distortion target, IR edge target		Computer control	RS-232 (USB 2.0)
			Power supply	115-230VAC 50/60Hz

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VERSIONS:

ST test systems are modular test systems that can be delivered in form of different versions of different configurations, test capabilities and price. The basic division of ST series system is based on output aperture of the collimator (Table 1).

Table 1. Division of ST systems based on the collimator aperture

System aperture code	Collimator output aperture
ST100	100 mm
ST150	150 mm
ST200	200 mm
ST 250	250 mm
ST X	>250mm (optional custom designed)

The rule of thumb for choosing proper aperture is following:

- Acceptable situation: the collimator aperture must be bigger than aperture of optics of tested imager
- Recommended situation: the collimator aperture must be bigger by at least 10% than aperture of tested imager (it is easier to align tested imager).

Collimator aperture is only one of a series of technical parameters that should be determined to optimize ST system for required applications. We need also to determine:

1. Mode of work (radiation source),
2. Acceptable electronic image formats of tested SWIR imager,
3. Boresighting capabilities.
4. Simulated light conditions

Therefore collimator aperture code and additional code composed from three letters are used to describe precisely parameters of ST series systems. Definitions of three letter code are shown in Tab.2. The columns 1-3 present what letters are to be chosen to define precisely required version of ST test system.

As we see in this table by changing letters from A to C we increase test capabilities of ST test system but also the cost is increased.

Tab. 2. Definitions of the code used to describe versions of ST test system

Code	**1**	**2**	**3**
	Mode of work	**Electronic image format**	**Boresight**
A	Only Mode A (reflected radiation)	Standard analog video (PAL/NTSC)	No boresight capabilities
B	Mode A (reflected radiation) and mode B (emissive radiation)	Additional software accepting USB 2.0/3.0	Measurement of aligning errors of zoom/step FOV objective
C	As ta level B but additionally Mode C (monochromatic light)	Additional frame grabber: CL, GigE, LVDS, CVBS, YpbPr, CoaXPress, HD-SDI, HD-CVI, HD-TVI, AHD, DVI, HDMI, Fire Wire or other	As in level B but additionally measurement of aligning errors relative to reference optical axis of thermal imagers or TV cameras

Detail interpretation of the codes is presented below:

1)Mode of work

As it was mentioned earlier ST system can work in three modes:

A)reflected polychromatic radiation configuration,

B)emitted radiation configuration (system using MTB blackbody),

C)monochromatic source configuration.

To simplify it can be said that:

Mode A is achieved when SAL light source is used as a source of image projector.

Mode B is achieved when MTB medium temperature blackbody is used.

Mode C is achieved when SAL light source with internal monochromatic filter is used as a source of image projector.

In fact different software, and different set of targets are used by ST system working in these three modes.

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Mode A is used to test performance of non-cooled, or single stage cooled InGaAs imagers (majority of SWIR imagers) sensitive up to about 1700-2000nm that use light emitted by Sun, moon, stars reflected by targets of interest to create image of such targets.
Mode B is used to test performance of cooled SWIR imagers of extended spectral band up to 2500nm. These images are capable to see warm targets of temperate over say 70-150C. This ability can be useful for different applications (non contact temperature measurement, detection of hot missiles, etc).
Mode III is used to simulate conditions used to measure parameters of SWIR FPA. These FPA are typically measured using monochromatic light.
2) Image formats
Acceptable image formats are determined by number, and type of frame grabber, and acquisition software.
a) - Frame grabber accepting images in standard analog video format (PAL/NTSC) is delivered.
b) - TAS software is modified to accept cideo in USB 2.0/3.0 format. Attention: Camera should be compatible with MS DirectX.
c) - Second frame grabber is delivered: Customer can choose from a long series of frame grabbers: analog HD/SD TV (CVBS, RGB, YpbPr), LVDS or RS-422, Camera Link, CoaXPress, GigE, IEEE 1394 (Fire Wire), SDI, DVI, HDMI. It is expected that customers know parameters of tested camera needed to configure earlier mentioned frame grabbers.
Attention: More frame grabbers can be optionally delivered. Please contact Inframet with your specific requirements
3) Boresighting
A) No boresight capabilities
B) Measurement of aligning errors of zoom/step FOV objective
C) measurement of aligning errors zoom/step FOV objective of SWIR imager and additionally measurement of alignment errors of SWIR imager relative to optical axis of thermal imagers or TV cameras.

Example: ST 100 -AAA test station means the ST test station of the following features:
1)aperture of the collimator =100mm, 2) capable to work only in reflective mode (only SAL light source), 3)standard analog frame grabber, 4)no boresight capabilities.

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