IMAG

System for automatic testing image intensifier tubes

Fig. 1. Photo of IMAG-A test system

1 Why is automation needed?

Image intensifier tubes are the most important module of night vision devices. They are manufactured in big numbers (hundred of thousand per year) by a small number of manufacturers. Testing of IITs is typically done at two manufacturing levels: 1)bare tubes (including optimization of voltages of miniaturized high voltage power supply), 2)potted tubes (modules).

Tests of IITs are typically carried out using a set of 4-5 independent manually operated test stations. Testing IITs using a set of manual specialized stations is one of factors that limit speed of manufacturing IITs (time needed for measurement of a series of parameters). Further on, this manual, subjective test method decreases repeatability and accuracy of measurement of parameters of IITs. Finally, such test method increases also manufacturing costs (salaries of test team composed from at least 5-6 people).

Inframet is a world leader in field of apparatus for testing IITs. Inframet ITIP stations are used by R/D teams of majority of manufacturers of IITs worldwide. ITIP station is a computerized station that enables measurement of virtually all important parameters of IITs. However, it is still a computerized but human operated station that requires well trained operator. In addition a relatively long time is needed to make expanded testing of a single IIT. Therefore ITIP is a perfect solution for R/D department but it is not optimal for manufacturing departments.

2 What is IMAG?

IMAG is a new system for automatic testing IITs optimized for production departments of manufacturers of IITs. The system is built in form of a set of four semi independent automatic stations that cooperate with a mechanical subsystem that moves tested tubes from one station to another. The IMAG system can work 24 hour per day. It requires operator having only minimal training (insert a batch of new tubes to be tested). It is estimated that IMAG can speed up testing IITs by a factor of at least 5 times comparing to classical method based on a set of manually operated test stations. IMAG offers also decreasing costs because smaller test team is needed.

KEY FEATURES:

- Automatic testing, minimal operator input
- Fast measurement, mean time for all parameters 25 min per IIT
- Expanded list of measured parameters – 17 parameters
- Ability to test high resolution IIT up to 120 lp/mm
- Improved measurement uncertainty (7%)
- Resolution repeatability <3%
- Test report compatible with ISO/IEC17025

3 Versions

IMAG test station can be delivered in three basic versions of different design and test capabilities:

- IMAG-A: Automatic testing potted tubes
- IMAG-A+: Automatic testing potted tubes and limited manual testing bare tubes.
- IMAG-B: Automatic testing both potted tubes and bare tubes.

4 How IMAG stations works?

4.1 IMAG-A

From design point of view IMAG-A is built from 4 substation (IMAG1, IMAG2, IMAG3, IMAG4). Each substation is specialized for a set of parameters. IIT is automatically transferred between substations to enable measurement of all parameters via tube transporter. No need for operator to manually move IITs. Operator only loads potted IIT to tube input store. Test station picks tubes from magazine and after tests puts them back. Block diagram of IMAG-A as in figure below. Photo is shown in Fig. 1.

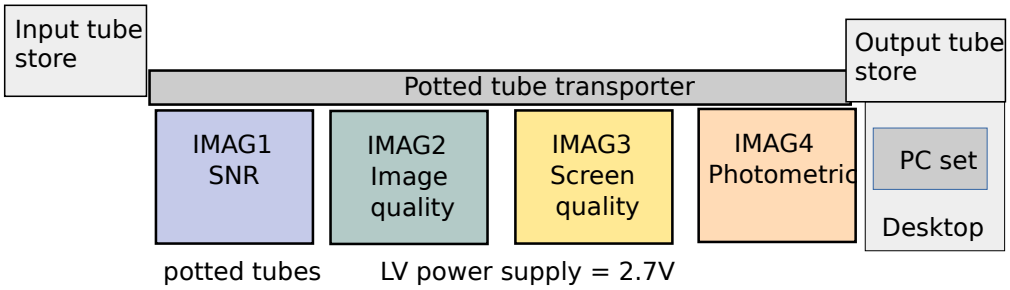

Fig. 2. Block diagram of IMAG-A system

Each substation is built from three main blocks: set of image projectors, set of measuring tools, and computer system. The projector projects images of some standard targets to tube photocathode plane of precisely controlled light flux. The measuring tools enables capturing images of output images from tested II tubes and measurement of output light intensity at the tube screen. The computer system carries out processing of data from image projector block and the measuring tools and finally calculates parameters of tested IITs. The substation are divided into following groups:

1. SNR – measurement of SNR measurement. 200 um pinhole
2. Image quality – measurement of Resolution, MTF, Image alignment and Halo
3. Screen quality – measurement of Useful cathode diameter, Multi-to-Multi Noise, Multi Boundary Noise, Magnification, Dark Spots, Bright Spots, Image Inversion
4. Photometric –measurement of Brightness gain, EBI, Maximum Output Brightness (MOB), current consumption.

4.2 IMAG-A+ station

This system can be treated as minimally modified version of IMAG-A system that enables additionally manual photocathode tests of bare image intensifier tubes (measurement of luminous sensitivity and radiometric sensitivity). It is achieved by use of additional IMAG5 substation that is manually operated. Block diagram as in Fig. 3 and photo as in Fig. 4.

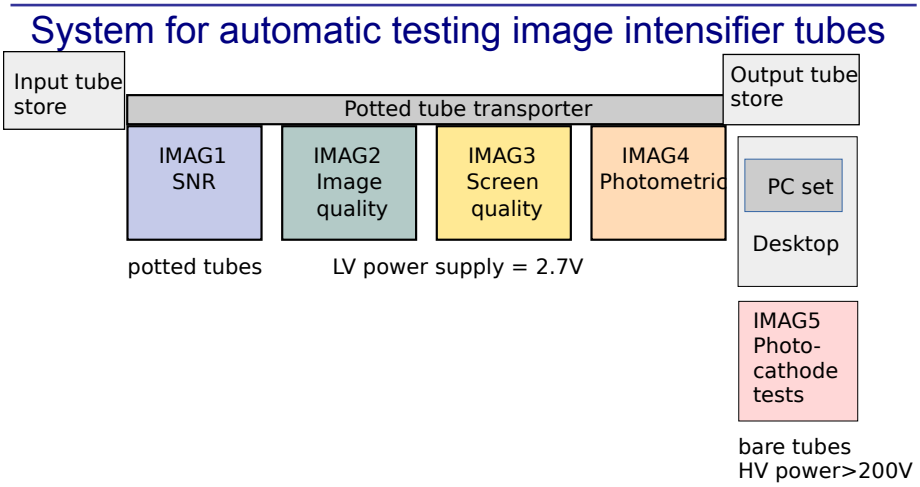

Fig. 3. Block diagram of IMAG-A+ system

Fig. 4. Photo of IMAG-A+ system

4.3 IMAG-B system

This version enables automatic testing of both potted tubes and bare tubes. Such expanded test capabilities has been achieved by following changes of original IMAG-A system:

1. There is a new tube transporter that enables transport of both potted and bare tubes.
2. Specialized set of adapters are added to enable connection of bare tubes with high voltage power supplies.
3. HVP142C high voltage power supply is added to enable to power up all channels of bare tubes
4. IMAG4 substation has been upgraded to version IMAG4EX that enables to carry out additionally photocathode tests.

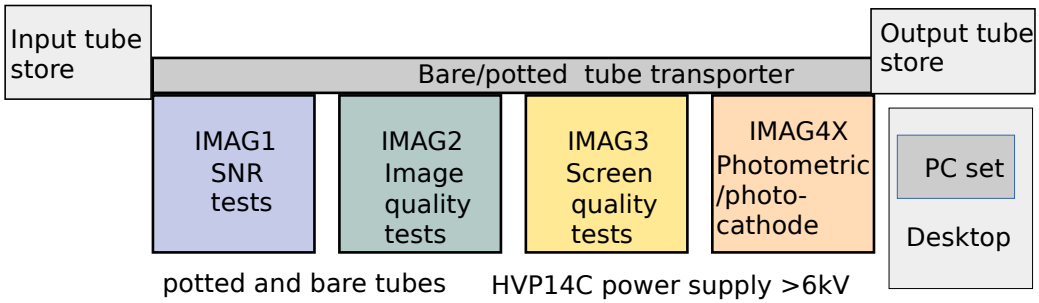

Fig. 5. Block diagram of IMAG-B system

Attention:

1. Mechanical dimensions and electrical power supply of bare IITs are not standardized. Therefore potential buyer must deliver detail information on tested bare tubes.
2. Automatic bare tube testing time are slightly lower then standard IMAG-A version due to increased time to regulate safely HV.
3. Only one type of bare tubes can be tested in one measurement series.
4. Operator is responsible for connecting electrodes of bare tubes to pins in a specialized adapter. In some cases this operation can be semi-automatic.

5 Light source

MIL standards recommend to use a calibrated tungsten filament lamp of 2856K color temperature as a radiation source. It is technically difficult to develop a reliable, long life, 2856K color temperature tungsten filament light source that enables regulation of light intensity in wide range. Therefore typical test stations for testing night vision devices offered on market are built using a single monochromatic LED light source. Such test stations are calibrated to simulate 2856K color temperature light source for one specific type of IIT, typically filmed Gen 3. Measurement accuracy significantly deteriorate when IITs of different type are tested.

IMAG test station is built using more advanced concept. The station is built using two light sources that can work in two modes: a)halogen bulb of 2856K color temperature source and b) monochromatic LED light source. Halogen source is used during measurement of photometric parameters; monochromatic LED source during measurement of imaging parameters. Therefore IMAG station enables accurate measurement of photometric parameters (like brightness gain, SNR) of all types of devices.

6 What can be tested?

Potted tubes:

IMAG test station is designed for automatic testing of potted tubes of standard photocathode dimensions (16/18/25 mm) of typical phosphor (P43, P45, P20) and of any generation (2, 2+, 3, 3+, 4).

Bare tubes:

The same as for potted tubes.

7 Recalibration

Typical recalibration period is 2 years. IMAG can be recalibrated on-site using CALIN calibration kit. There is no need to send station back to check crucial parameters.

8 Test capabilities

IMAG test station enables measurement (or checking) following parameters:

No	Substation	Parameter	Measurement range	Expanded relative uncertainty
1	IMAG1	SNR	10-35 at 0.108 mlx	8%
2	IMAG2	Resolution	4-120 lp/mm	3%
3		MTF	0-60 lp/mm	0.010 at 0-10 lp/mm 0.015 at 10-20 lp/mm 0.025 at 20-30 lp/mm 0.030 at 30-40 lp/mm 0.040 at 40-50 lp/mm 0.048 at 50-60 lp/mm
4		Image alignment	0-1.5 mm	10% or 10 μm
5		Halo	0.2-1.5mm	10%
6	IMAG3	Useful cathode diameter	10-25 mm	2%
7		Multi-Multi Pattern Noise	0-20%	10%
8		Multi-Boundary Pattern Noise	0-30%	10%
9		Dark spots	From 0.05 to 0.5 mm	12% for spots: 75μm – 150μm 8% for spots: 151μm – 500μm
10		Magnification	1 to 4	4%
11		Output brightness	0.3-20 cd/m^2	5%

12		Image inversion	0.1º-5º	0.2º (absolute value)
13		Brightness non uniformity	1:1 to 5:1	7%
14	IMAG4	Luminance gain	1000-100 000	8%
15		EBI	0.02-2 μlx	10%
16		Maximum Output Brightness	0.3-20 cd/m^2	4%
17		Tube current consumption	1-100 mA	1% or 0.3mA
18	IMAG5 or IMAG4EX	Luminous photocathode sensitivity	200 to 2000 uA/lm	7%
19		Radiant photocathode sensitivity	10 to 100 mA/W	7%

Conditions

1. Customer is to deliver detail mechanical/electrical drawings of tested bare tube.
2. Number of types of potted tubes is not limited. Max number of adapters of tested bare tubes is two.

9 Test time duration

9.1 IMAG-A

For potted tubes completed measurement sequence is done under 25 minutes. Four IITs can be tested simultaneously giving 5min/IIT or 12 IIT per hour. Test sequence can be shortened if not all parameters are required. Time table for potted tubes is shown below:

No	Substation	Category	Approximated test time [min]
1	IMAG1-IP	SNR	4
2	IMAG2-IP	Image quality	5
3	IMAG3-IP	Screen quality	6
4	IMAG4-IP	Photometric	5
	Measurement sequence:		20
	Total time per IIT		5

9.2 IMAG-A+

Potted tubes: Same as IMAG-A version. Bare tubes: approximately 45min/IIT. Measurements are performed manually on a single module.

9.3 IMAG-B

Potted tubes: Same as Standard version.

Bare tubes: approximately 30min/IIT. Four IITs can be tested simultaneously giving 8min/IIT or 8 IIT/h. Test sequence can be optimized if not all parameters are required. Time table for potted tubes is shown below:

No	Substation	Category	Time [min]
1	IMAG1-IP	SNR	6
2	IMAG2-IP	Image quality	7
3	IMAG3-IP	Screen quality	8
4	IMAG4-EX	Photometric / photocathode	9
	Measurement sequence:		30
	Total time per IIT		8

Note: It takes additional time to properly connect bare tube to pins in a specialized adapter.

Comparison of IMAG system to typical ITIP test station

The key difference between IMAG and ITIP test station is a volume of tested IITs. ITIP is manually operated station. Operator needs to set up IIT for a measurement, select proper tool for a parameter to be tested. Make sure that projector and cameras are focused correctly and navigate through measurement software. This takes a lot of time. Typically about 45 min per tube for trained observer to test all parameters. IMAG cuts this time in half with its 25min per tube. This means that twice the amount of tubes can be tested. Moreover, due to full automation, operator is not tied to a testing process and is free to perform other tasks. This is not the case for ITIP, where operator needs to be perform various task throughout whole 45 min process. Additionally, IMAG does not require trained observer to perform the measurements operator involvement is minimal. This cuts the cost significantly with even a moderate volume of IITs.

Additional benefit from automation of measurement process is increased repeatability of measurement. With human influence removed from the measurement chain, the tubes are always tested in the same way and can be retested at any time. By keeping the measurement condition the same, it is easy to check for temporal changes in measured parameters. Computers are excellent at performing mundane task, such as selecting edges of a target. This leads to increase accuracy and improved uncertainty compared to manual measurement.

10 Market situation

IMAG represent a new generation of systems for testing image intensifier tubes. There is no similar test systems at international market. This new system improves position of Inframet as a world leader in field of apparatus for testing IITs.

Version 1.4

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