RDM

Research and Development
in Microelectronics

Instrument FLT_1

a mobile and precise device that determines the luminous transmittance.

This instrument measures the fraction of light transmitted into windscreens of auto, aircraft and tank.

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Product Description (v.1.0) 2008©

Figure 1: Measuring a car windscreen with the FLT_1.

General Description

FLT_1 is a portable instrument that measures the luminous transmittance.

The luminous transmittance is the portion of visible light transmitted into a glass sample. The visible light with a wavelength λ between 380 nm and 780 nm is taken into consideration, and the UV and infrared portions of the light are disabled.

A typical use is in automotive industry such as car, aircraft and tank windscreens.
In automotive industry, USA and Japan and EU have imposed a mandatory of 70% transmission factor for the car-windscreens. This is because in clear day the sunlight deteriorates the visibility through the windscreen and decreases the 70% to 40% only. Good vision is obviously necessary for safety, and tinting of vehicle glass reduces light transmittance and therefore perceptibility.

More information can be found at UNECE (United Nations economic commission for Europe) in the document titled "Global Comparison Chart (CLEPA)", reference [1]

The instrument is fully automatic and is designed in 3 units: Master, Sender, and Receiver, as depicted in the Fig. 1.

- Master: contains a display, keyboard, PCB with a micro-controller and interfaces, two RS232 to communicate with Sender and Receiver units, and USB to communicate with PC computer to update the firmware and select the modes from the EEPROM and store calibration factors in the EEPROM. The micro-controller calculates the light transmitted into the glass sample according to the implemented algorithm, and then displays the value in term of percent on a 2" display (LCD).

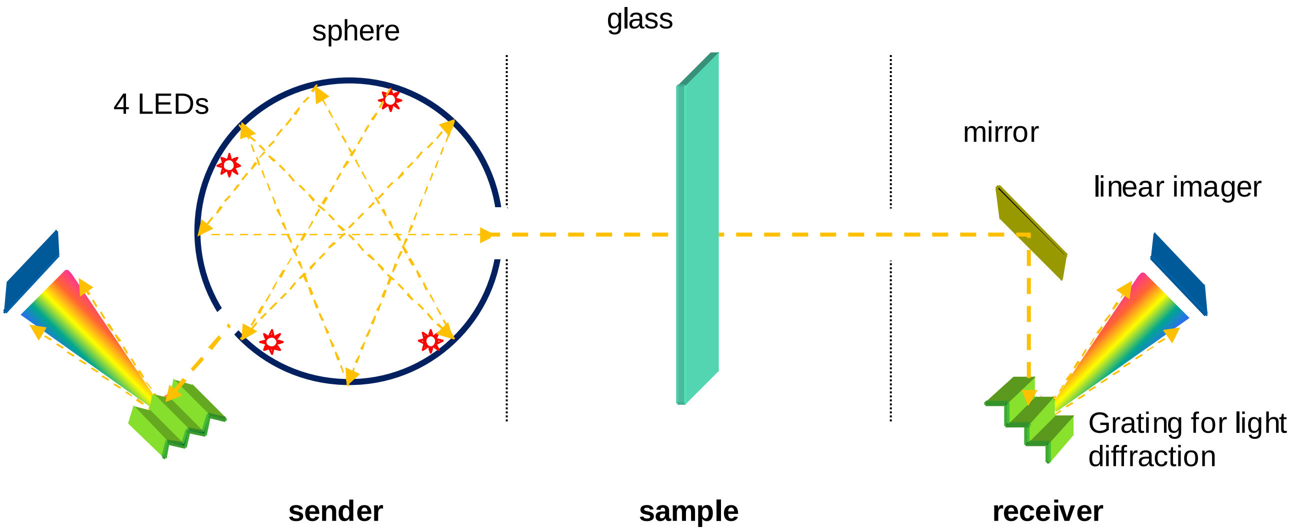

Figure 2: Architecture of the instrument.

- Sender: contains integrating sphere (known as Ulbricht sphere) for emitting uniform light, mini spectrometer for diffracting and measuring the spectrum of visible light in the sphere, PCB with micro-controller and interfaces, and RS232 plug to communicate with Master unit.
- Receiver: contains a CCD camera for the alignment to the Sender, mini spectrometer for diffracting and measuring the visible light, PCB with micro-controller and interfaces, and RS232 plug to communicate with Master unit.

The instrument is tested and has measured reference glasses with a tolerance below 0.1%, which makes it a very precise instrument. The actual package is aluminum type BOS-Ecoline from BOPLA GmbH, and the mini Spectrometer can be seen in the Hamamatsu web pages, in reference [2].

Luminous transmittance, T_λ , is an important parameter in the evaluation of glass quality in many industries such as automotive, aviation, and other applications where a minimum visibility for objects is a boundary condition.

Luminous Transmittance is by definition the light throughput of transparent materials in relation to human impression. In luminous transmittance applications, the wavelength dependent human eye sensitivity V(λ) is standardized by the CIE and is used as the basis for determining the levels of transmittance. Algorithms of Physics are evaluated and implemented in the instrument to calculate from the measured light values the T_λ .

Good reference related to light and Luminous can be found in reference [3]. A table of simulated light correction factors NLAA(P) are also provided for each wavelength λ, pixel dependence.

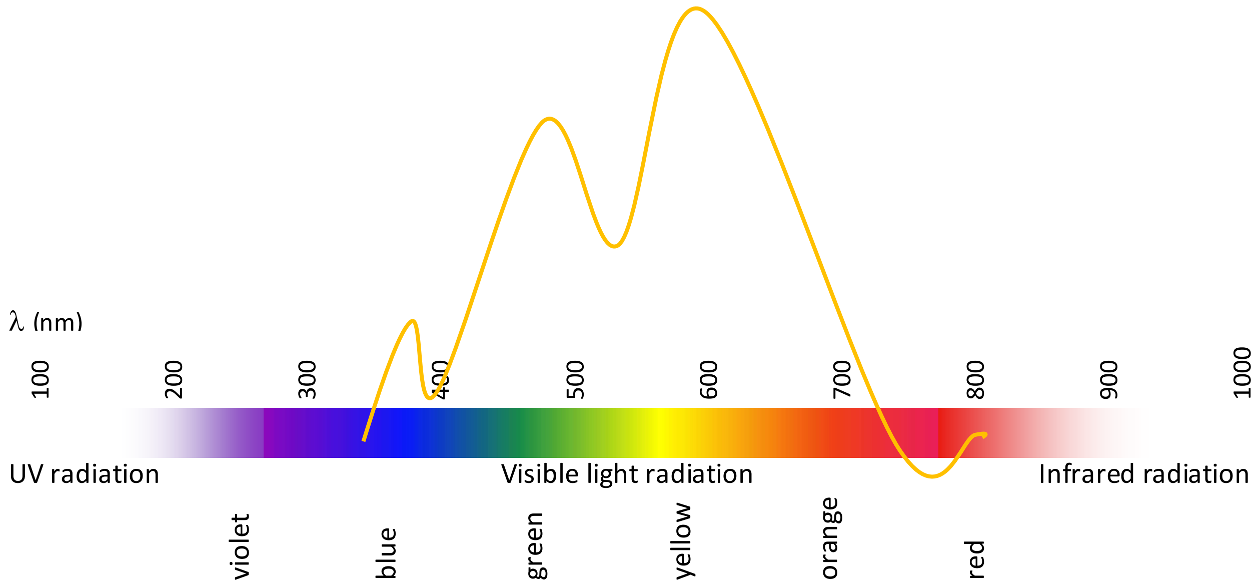

Figure 3: Spectrum of light for the used LEDs.

Algorithm for determining the luminous

$$T_{\lambda} = \frac{\int \left(\frac{S_{R.Sample}(P) \times \tau(P)}{S_{R.70}(P)} \times \frac{S_{S.70}(P)}{S_{S.Sample}(P)} \times F_K(P) \right) dP}{\int F_K(P)\,dP} \times 100$$

with:

$S_{S.70}(P)$	Signal Sender 70% (Pixel dependent)
$S_{S.Sample}(P)$	Signal Sender Sample (Pixel dependent)
$S_{R.70}(P)$	Signal Receiver 70% (Pixel dependent)
$S_{R.Sample}(P)$	Signal Receiver Sample (Pixel dependent)
$\tau(P)$	transmission of 70% filter (Pixel dependent)
$F_K(P)$	correction Factor (Pixel dependent)

$$F_K(P) = V_{(\lambda)}(P) \times NLAA(P)$$

Technical Specifications

Specification for the Controller:	
Connector	two RJ 45, RS232 (115.2 kbaud)
Display	Monochrome with blue backlight

Handling	4 keys: F70-F100; Sample; Backlight-Print; ON)
PC interface	USB 1.1
Printer interface	IrDA infrared transceiver module
Dimension (L, l, t)	230 x 72 (115) x 35 mm (9.1 x 2.8 x 1.4 inch)
Weight	400g
Power	4 batteries type AA
Specification for the Sender:	
Setup	LEDs in pulse mode synchronized with the receiver through the controller
	Integrating sphere; spot diameter 20mm; cover glass
	Spectral resolving reference detector (achromatic optic); on-line ambient light correction; simulation of NLAA
Connectors	Cat 5 (l=3m); RS232 (115.2 kbaud)
Dimension (L, l, t)	160 x 45 x 85 mm (6.3 x 1.8 x 3.4 inch)
Weight	450g
Specification for the Receiver:	
Detector	Spectral resolving detector (achromatic optic); on-line ambient light correction
Measurement geometry	Spot diameter 7 ± 1 mm; Aperture angle 0° ± <0,8°
Connector	Cat 5 (l=1m); RS232 (115.2 kbaud)
Dimension (L, l, t)	160 x 45 x 85 mm (6.3 x 1.8 x 3.4 inch)
Weight	400g

Connection and Calibration Fixture

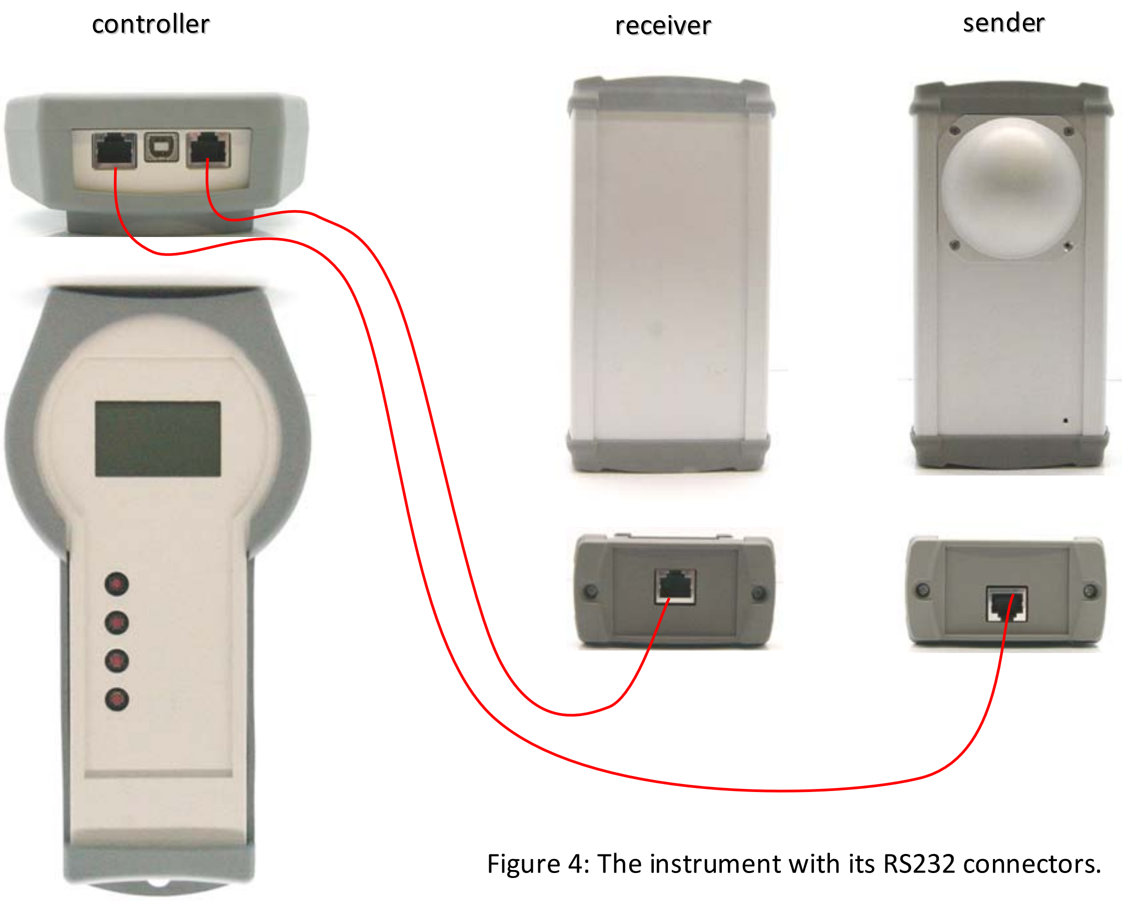

Figure 4: The instrument with its RS232 connectors.

Figure 5: Left, the sender and receiver in their safety place in the case.
Right, the arrow depicts where to place the 70% filter.

After connecting the 3 units with the RS232 cables, as shown in Fig.4, both sender and receiver units should be returned to their respective places in the case before proceeding with the calibration fixture measurements 70% and 100%, as shown in the left photo of Fig. 5. The case serves as a calibration fixture platform.

Before measuring the glass samples, the 70% and 100% measurements (the calibration fixture measurements) must be ones measured anytime the instrument is switched on.

To perform the 70% measurement, place the 70% filter between the receiver and sender units, as shown in the right photo of Fig. 5. To perform the 100% measurement remove any filter in between the sender and receiver units, only air must be between the two units.

Mode of operation

- Press ON to switch on the instrument.

The instrument initializes and displays the following instructions: "Ready".

The receiver and sender units are in their respective places inside the case. They can also be placed on a horizontal table facing each others. The instrument is ready to measure.

Attention: please remember to switch off the instrument after use to conserve Battery power by pressing and holding 3 seconds ON button. The instrument has however no auto-shutoff function.

- Measurement procedure:

Insert the 70% Filter between the sender and receiver units and press and hold 3 seconds the button F70-F100. A message is displayed on the LCD display of the master unit asking to insert the 70% filter and press to start. Then check if the filter is in place and press shortly on F70-F100 (shorter than 3 seconds).

The instrument starts the alignment procedure. Follow the instructions on the LCD and move the receiver till it gets aligned to the sender. In this procedure the CCD camera integrated in the receiver is taking 5 photos/sec, so that the user can follow the blinked point on the LCD. Up on the blinked point gets to the middle of the LCD marked with a cross, the user should stop moving the receiver according to the displayed instruction on the LCD and the instrument starts automatically measuring by flashing light. The measurement is done in few seconds and "70% Active.." is displaying. When finished the instrument checks if the receiver is still aligned to the sender to value the 70% measurement. If not, a displayed message asks to re-measure the 70%.

When finished, remove the 70% filter and press shortly the F70-F100 button (shorter than 3 seconds). The instrument performs the 100%, exactly as of 70% measurement described above but with no filter in between. When finished the instrument checks the alignment of the receiver to the sender, and if not aligned a displayed message asks to re-measure the 70% measurement. The instrument saves the 70% and 100% measurement values in its EEPROMs, because they will be used in the algorithms of Physics implemented in the microcontrollers of the instrument.

In fact, the 70% filter is delivered with the instrument, and this reference may not necessarily exhibit a luminous transmission of 70%. A deviation of ± 2% is possible due to many factors.

When ready with the 70% and 100% measurements, the user can insert the glass sample and start measuring it by pressing shortly on the Sample button. The instrument performs the measurement as described in the 70% measurement above, always alignment procedure then flashes of light to measure then check again the alignment. If the alignment is disturbed along the measurement, a displayed message asks to repeat the Sample measurement by clicking on Sample button. The measurement result of the glass sample is displayed in term of percent on the LCD.

The user can perform respectively many measurements on different glass samples by simply inserting the sample and pressing on the Sample button, with no need for any feather 70% and 100% Measurements.

The measurement procedure steps can be explained in the flow diagram in Fig. 6.

Measurement conditions

- It is not advised to perform a measurement directly under Sun light. An Error message “Overload” will be displayed if the ambient lighting condition exceeds the detector sensors saturation level, which makes the measurement impossible. A large deviation of the ambient temperature generates also error message.
- It is not advised to measure directly under an Ample. Normally the Ample flashes 50 times/s.

A Warning is displayed if the ambient lighting level is not stable. Under this bad condition the measurement result is not very accurate, but one is still capable of performing his measurement. A measurement routine is implemented to prevent from the external light flashes and corrects the measurement values.

- Sample thickness: test equipment is designed to accurately measure glass thickness up to 20 mm. Transmission measurements of samples exceeding 20 mm thickness may be erroneous.

No error message will appear if the glass sample thickness exceeds 20mm.

- Ones aligned, the receiver and sender units must stay with no move till the measurement step is achieved. Any movement during the measurement step will result in an error message.
- Avoid an ambient temperature variation above 5°C, unless new calibration fixture measurements will be needed (new 70% and 100% measurements).

All error messages are detailed in Table 1.

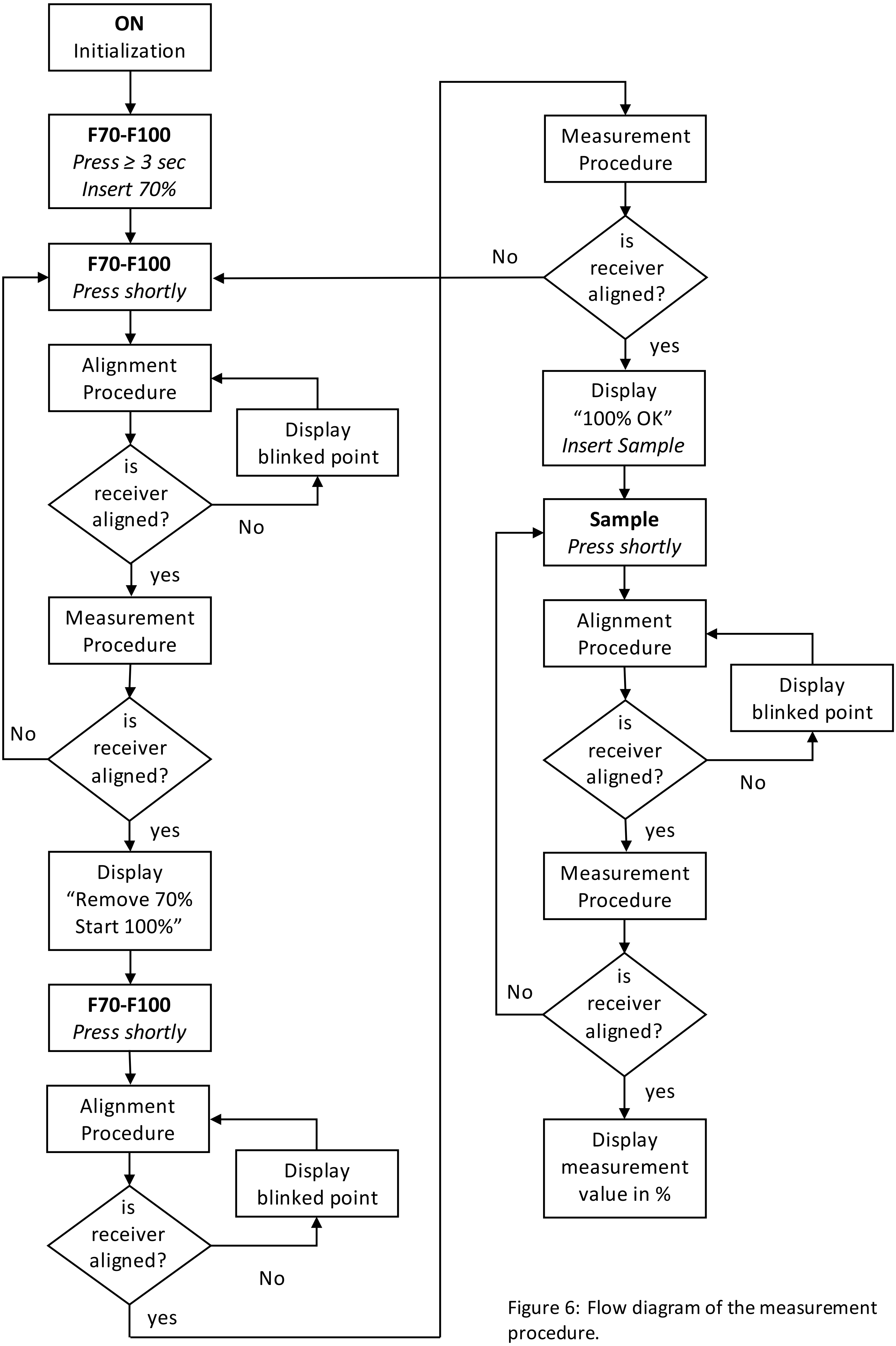

Figure 6: Flow diagram of the measurement procedure.

Table 1: Error Messages

Displayed message	**Description**
fail, Sender S̸	Sender unit is not connected to the Master
fail, Receiver R̸	Receiver unit is not connected to the Master
overload S	The Signal at the detector of Sender is above the Saturation level. If this error always occurs, then the LEDs light level needs to be lowered.
overload R	The Signal at the detector of Receiver is above the Saturation level. If this error always occurs, then the LEDs light level needs to be lowered.
noisy signal	When the level of light is low below the threshold value.
$\Delta T > 5°C$	If during measurement the temperature variation accedes 5°C (specified in the EEPROM), then the 70% measurement must be repeated.
invalid value	When the transmission value is above 100% + ε%. ε is a parameter specified in the EEPROM.
S ↯	An external flash light disturbs the Sender.
R ↯	An external flash light disturbs the Receiver.
low battery	Low battery power.

Backlight-Print

The Display of the master unit has a backlight. To switch on this backlight, click shortly on Backlight-Print button.

The System can contain a small printer as optional. This printer receives the measurement result from the master unit through an infrared interface IrDA. To print the measured value, just click on the Backlight-Print button and hold more than 3 seconds.

References

[1] http://www.unece.org/trans/main/wp29/wp29wgs/wp29grsg/grsginf/81/grsg81_inf07.pdf

[2] Mini Spectrometer TM series under the home page: http://sales.hamamatsu.com/

[3] Photometrie Seminar 20-24 Juni 2005 under the home web: www.ptb.de

Photos of the Instrument

RDM

Research and Development in Microelectronics

Product categories:

Instruments

- SBM is a spectrometer for measuring the brightness of the monitors and flat displays.
- FLT is an instrument for measuring the factor of light transmitted into glass. Typical use: qualification of car and aircraft windscreens).

Consumer electronics

- House security system.
- Electronic watches and alarm clocks.

Electronic for automotive industry

- Crash system.
- Parking and alarm system equipped with TFT display, cameras and ultrasonic sensors.

Wireless

Network operating system, as big as an auto radio.

Device for satellite

Surveillance system against projectile moving at a velocity of up to 1000 kM/h.

Fiber to the Home networking

A prototype of 128 Gbit/s/chip optical networking system, for low cost fiber optic network by using short-wavelength laser light and CMOS photoreceivers. It is a project and we are looking for sponsors and investors.

Navigation control for military

Micro-controller base control system for small motors and rotors.

IT, Software tools and Measurement routines

MET is a MOS extractor tool for the characterization of the transistors and the extraction of their technology parameters. BSIM3 and 4 are implemented in MET. We also offer measurement routines to control instruments and wafer probe-stations, so that the measurement of transistors and ICs will be fully automatic. All runs on PC platform.

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- Development of electronic devices according to specifications and timetable of our clients.
- Prototyping new ideas and conducting research in Microelectronics and Opto-electronics, in conjunction with our partners and research centers.

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