ISSUE	05							
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HIGH PRECISION

7 WAVELENGTHS COATING TEST

CT7

USER MANUAL

	NAME AND FUNCTION	DATE	SIGNATURE
PREPARED BY	P. Woszczyk,	2015-06-15	
CHECKED BY	D. Malaise,	2015-06-15	
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Document Change Log

Issue	Date	Modified Pages	Rationale
1	2011-04-14	All	Document Creation Applicable for Instruments: SN : 10001, 10002, 10003,10004, 10005, Software versions: CT7_DSP: v 1.0.2 built 2011-04-28 CT7 OLED v 1.0.2 built 2011-04-29 CT7 Console v 1.00 built 2010-05-01 and later.
2	2012-10-15	Start-up procedure CT7-Console description New functions Battery management	New version of CT7 Console Software New version of CT7 DSP firmware Applicable for Instruments SN: 12006-and later Software versions: CT7_DSP: v 1.2.02 built 2012-09-25 CT7 OLED v 1.2.02 built 2012-09-21 CT7 Console v 1.2.01 built 2012-09-30 and later.
3	2014-07-10	Improved performances Minor changes in menus Specification (Annex 1)	New, high precision, optical head. Applicable to instrument 120000 and later with Precision Optical Head Applicable for firmware: CT7_DSP: v 1.3.05 built 2014-05-21 CT7 OLED v 1.2.11 built 2014-05-16 CT7 Console v 1.3.00 built 2014-05-02 and later.
4	2014-08-25	Firmware upload procedure added	Idem.
5	2015-06-15	Introduction of Li-Ion Battery	PowerOn procedure and Battery Maintenance Chapters: CT7_DSP: v 1.5.00 built 2015-06-15 CT7 OLED v 1.2.11 built 2014-05-16 CT7 Console v 1.5.00 built 2015-06-15 and later.

Table of Contents

1 <u>Objective</u>

This document provides description of CT7 reflectometer/scatterometer to the depth necessary for the user to effectively work with the instrument.

2 <u>Scope</u>

This document is applicable for the instrument model manufactured since 2015. The operation in *Normal mode* (end-user) is described.

3   The CT7 instrument

3.1   Introduction

The CT7 is dedicated to monitoring of the coating's quality of the high grade optical surfaces.

In essence, CT7 is an optical caliper that can be set to fit your laboratory measurements and repeat them at the remote telescope mirror location.

The current model takes benefit of new high precision optical head providing repeatability of 0.01% (short term).

CT7 measures the specular reflection and scattering using seven wavelengths spanning from UV to near IR.

Measurements are performed with a countdown of few seconds, enabling gently placement of the instrument on the precious mirror surface.

Configurations of the instrument and data retrieval are facilitated by PC application **CT7 Console.**
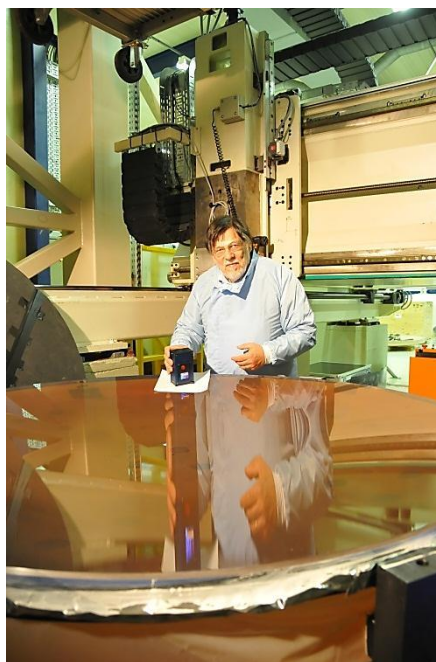
Daniel Malaise demonstrating CT7 at AMOS premises.

3.2   CT7 Features brief

3.2.1   CT7 Instrument

1. CT7 measures **optical reflection and scattering at 8° incidence for 365 to 970nm** in 7 bands
2. The measurement is performed with instrument standing on the measured mirror.
3. The results are displayed and stored to non-volatile memory.
4. **CT7 may be calibrated to user supplied reference targets** ("soft" mirror and scattering target values)
5. All measurements are time-stamped thanks to the real time clock.
6. CT7 is built to protect the measured mirror.
7. An USB connection allows for data retrieval to PC.
8. All CT7 functions are available from PC and/or from instrument front panel
9. CT7 may operate without batteries on the USB power
10. The instrument has three power modes: ACTIVE, SLEEP and CHARGE.
11. Auto OFF feature protects the batteries against accidental discharge.
12. Two parallel Li-Ion cells , 14500-size (~AA)size, power the instrument.
13. Charging of AA cells is primarily performed by built-in charger powered from USB connector of the PC , thus charge current is limited to 500mA
14. Charge is performed only when CT7 is not active

3.2.2   CT7 Console software

Small display and simple joystick as data entry interface is definitely not adequate to enter texts, names and figures necessary for user friendly options of CT7. For this reason, a PC based interface application *CT7-Console* was created.

The main purpose of this application is:
1. Data retrieval
2. CT7 configuration
3. CT7 laboratory operation

CT7-Console provides following functions:

1.1. USER level instrument control
    1.1.1. Data retrieval and handling of measurement results (export).
    1.1.2. Device management by user: configuration view, diagnosis, and up- and down-load of the user configuration (Measurements **Carts:** named series of measurements).
    1.1.3. Calibration to reference target sample values
    1.1.4. Firmware update
1.2. PROCESSING
    1.2.1. Sorting and saving data (*)
1.3. EXPERT level instrument control (*not recommended for standard user*)
    1.3.1. Setting and testing the device at the factory.
    1.3.2. Down- and up-load factory configuration.
   1.3.3. Manage LED driver parameters

(*) the exported data are saved in .csv format (Excel compatible), so further data processing and graphical presentations can be done with specialized software.

4   CT7 Concepts

4.1   Quick Start. First measurement.

Note: CT7 is designed as instrument not requiring frequent calibration. Nevertheless, we **recommend verifying the validity of calibration after delivery and when instrument is subjected to important temperature change**. Simply measure the Calibration Target provided with the instrument. If the obtained differences are within 0.1%, the calibration is valid.

- The CT7 is normally in sleep mode and can be awakened by pressing both: the ON Button on the top of the instrument and navigation switch **up**.
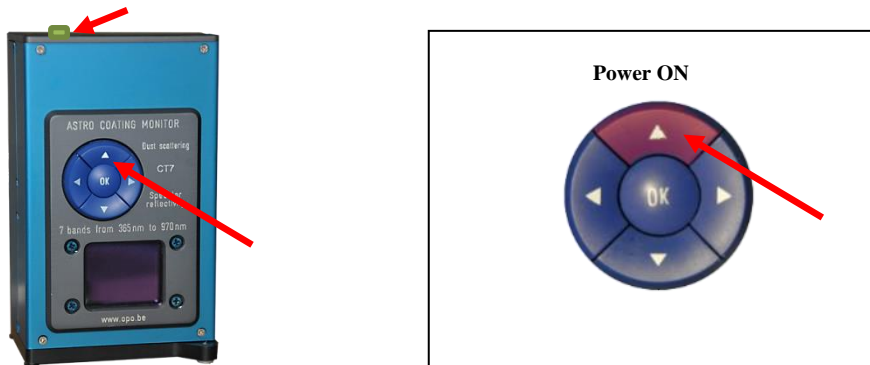
Power ON

- At the first Power ON , if necessary, the instrument prompts for time setting. (Only when the time introduced, CT7 is ready for the measurements.)
- CT7 is ready to perform quick "One click" measurement with the active **Cart** of wavelength selection. By default, the NORMAL measurement configuration is active i.e. 7 bands in Reflectivity and Dust
- The MEASURE option is highlighted and may by triggered when pressing the joystick (**Enter**).

- **Trigger the measure still keeping CT7 in your hand : you have 5 seconds to place the instrument gently on the mirror.**
- After the measurement, the results are displayed and stored with the *time stamp* and *Cart ID*.
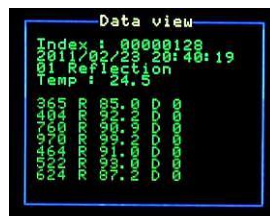
- Pressing joystick (ENTER) returns to the menu.

The measurements are performed as specified by a user's **Cart** *indicating the wavelengths and type of measurements to be performed and bearing an identifier. The user can create and select as many* **Carts** *as needed(64). Carts are created or suppressed from PC application CT7-Console. The new instrument comes with a default permanent* **Cart** *list starting with NORMAL that provides all measurements at all wavelength.*

4.1.1   Single measurement in brief

In current use the measure sequence is following:

- **Power up CT7 (Press ON button and joystick UP)**
- **Keeping it in hand, go to MEASURE option and trigger it. You have 5 seconds before the measurement starts (with on-screen countdown)**
- **Place CT7 gently on the mirror**
- **When the measurement is finished, and the results show-up, pick up carefully CT7**
- **Perform your measurements repeating the above steps**
- **Once in the office, connect to PC , run CT7-Console and power-up CT7, activate SERVICE/PC-Link mode**
- **Retrieve data from CT7 to archive file**
- **Sort data by date, by cart, than export to Excel and finish your report with usual edition tools**

4.1.2   Professional work-flow

- **Install CT7 Console provided on CT7 Flash Disk on your PC, and start it**
- **Connect CT7, awake it and activate SERVICE/ PC-Link mode**
- **Indicate the COM port to be used (at first connection)**
- **Open Measurement Configuration Management**
- **Read Configuration from CT7**
- **Edit table: selecting wavelengths to be used and give names to CARTs for specific mirrors. The CART name will help you to sort-out the data for specific mirror.**
- **Write Configuration to CT7**
- **Disconnect by closing CT7-Console**
- **Now you are ready to monitor the mirrors. Select the active CART in menu MEASURE/ Sel. Cart. Perform your measurements following single measurement flow**

Notes:
 You may always review results using menu **Report/Data** of CT7

4.2   CT7 design protects telescope mirror

4.2.1   Contact of CT7 with telescope mirror

As the instrument measures specular reflectivity, its angular position with respect to the normal to the mirror's surface must be exact, and this can only be achieved by a three point isostatic contact. The actual contact is provided by three spherical touching feet made out of white Teflon. Teflon can in no way mark the mirror's substrate, but it can mark the coating especially if rubbed. The **delayed start** allows the operator to lay gently the CT7 on the mirror after starting the measurement and remove it after measurement without the need to touch it while it sits on the coating. Moreover, the small incidence angle of the measuring beams makes the result little sensitive to the measurement distance so that **the instrument can stand on an optical tissue**. This tissue (paper or cloth) must provide an opening for the beam (25 mm hole) and should be of equal thickness (+/-0.05 mm) under the three feet.
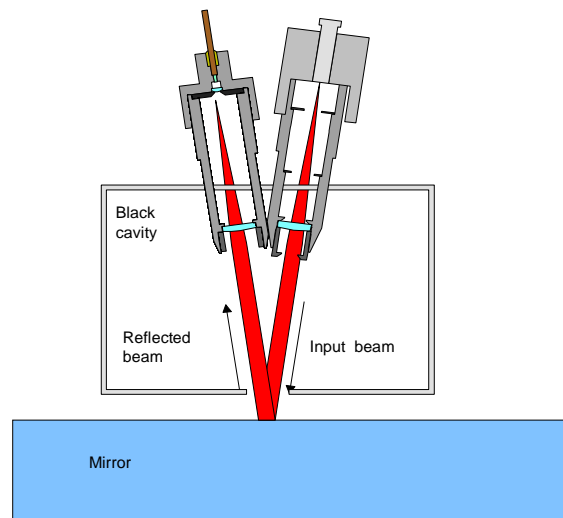
Optical scheme of CT7

Taking a measurement with mirror protecting tissue.

4.2.2   Delayed Start

By default, triggering "measure" option invokes a 5 seconds delay before the measurement actually starts.
The objective of this feature is protection of the mirror. The **user can set-up and trigger the measurement still holding CT7 in his hands**. When everything is ready, he may carefully place it on fragile telescope mirror, avoiding rubbing of the surface.

The remaining time before measurement is indicated by a countdown on the display and a beep every second. The delay timer may be set to a value between 0 and 99 seconds.

Count down: 5 seconds before the measurement becomes RED

The time-to-measure is color coded:

- **BLUE** – more than 5 seconds to measure
- **RED** - less than 5 seconds
- **YELLOW** star (*)– measurement in process
- **GREEN** -results table – measure done.

/see the full sequence – para *6.1.1 MEASURE* /

4.2.3   Wavelengths selection: Carts and Customized measurements

The user can select 0 to 7 wavelengths to be used for measurement of reflection and 0 ..7 for scattering.
However, at least one wavelength shall be selected either in reflectivity or in scattering.
Once customized, given configuration may be named and saved.
User can store up to 64 named *Carts* of customized measurements. The Carts are created, deleted and edited from **CT7-Console.** /see para *4.3.2. PC Software: CT7 Console* /

The aim of the **Cart** operation is the following: assuming that the user has a number of telescopes to monitor and that each of them has several mirrors, he can prepare dedicated **Cart** for each mirror .

Index	Name	R 365nm	R 404nm	R 760nm	R 970nm	R 464nm	R 522nm	R 624nm	D 365nm	D 404nm	D 760nm	D 970nm	D 464nm	D 522nm	D 624nm
0	Normal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	Reflection	✓	✓	✓	✓	✓	✓	✓							
2	UV 365nm	✓													
3	UV 404nm		✓												
4	IR 760nm			✓											
17	D.Red 624nm														✓
18	Mirror T01/1		✓		✓			✓		✓		✓			✓
19	Mirror Vis		✓		✓	✓	✓	✓		✓		✓	✓	✓	✓
20	Mirror IR			✓	✓			✓			✓	✓			✓
21	Mirror UV	✓	✓			✓			✓	✓			✓		
22															

Cart selection list: R-reflection measurements, D- DUST measurements

Even after a long time, without noting anything, the user unloading the CT7 memory in its PC will be able to extract all measurements pertaining to any mirror of a particular telescope and trace its evolution with time (through the date and time attached to each measurement). In this example, we have chosen to select the same measurement sequence for each mirror of the same telescope but this is not requested.
The **Cart** operation is a powerful and simple way of keeping order and uniformity among measurements on the long term.

4.3   CT7 instrument interfaces

4.3.1   Viewing the results

The user can recall the results by selecting the View Results option. The most recent results are displayed first, and can be scrolled back and forward with the joystick.

4.3.2   PC Software: CT7 Console

The PC software is described in section *7 CT7-Console* .
The main functions are:
   4.   Data retrieval
   5.   CT7 configuration
   6.   CT7 laboratory operation

4.3.3   Display

CT7 is menu operated. Menu system is inspired by DSLR cameras.
On the left side of the display, there is a category menu with pictograms, on the right side, for selected category, a sub menu presents text options.
In contradiction to LCD displays, this active organic LED display is fully operational in negative temperatures.

4.3.4   Joystick/Navigation Switch

The user selects options from the menu, thanks to a 5 position joystick (left- right, up – down, Enter =OK).
In addition, the joystick provides the Power-On function.

4.3.5   Beep

The operations are confirmed by a short acoustic beep.

4.3.6   USB connector

This is a data interface and an integrated battery charger power connection.
W connected to a PC, it will provide power for battery charging and give access to the PC operation of the instrument when the latter is set to **PC-link** mode.

4.3.1   Battery protection –switch off at low voltage

Battery is protected against uncontrolled discharge, potentially destructive.
If left unattended, the CT7 will switch OFF after programmed time of 1 to 10 minutes.
In operation, before any action, the battery voltage is measured. If the voltage is dangerously low, after a series of 5 beeps, CT7 will switch off.

5   CT7 Operation

5.1   CT7 description

The following drawing shows the main features of CT7:

CT-7 Instrument.
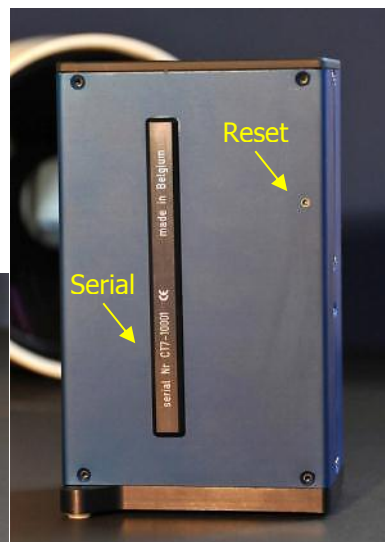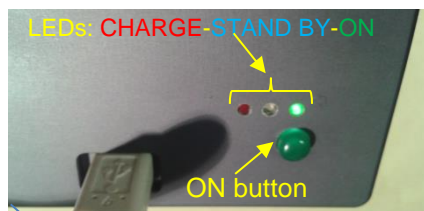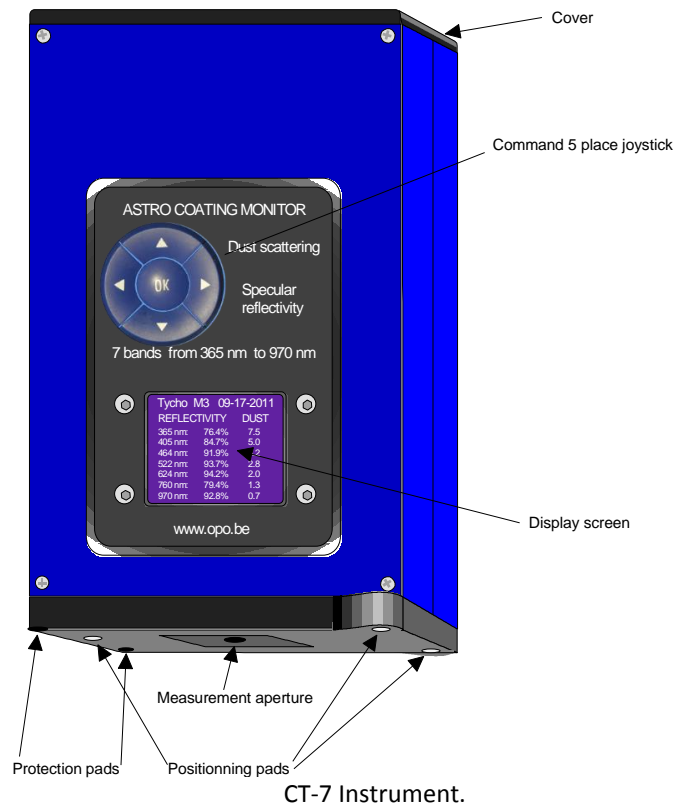
On the top cover you find an access for the <**mini USB-B**> connector for connection CT7 to a PC (power and data connection).
On the back side, there is a 1 mm hole that gives a protected access to a **RESET** switch.
Also on the back side you may find the **Serial Number** of the instrument. The same number is returned by soft to CT7 Console.

5.2   CT7 basics

5.2.1   Power ON

When performing actual measurements, usually CT7 is not connected to a PC. On Battery, to start, press ON button on the top of the CT7 and simultaneously push the joystick **UP**
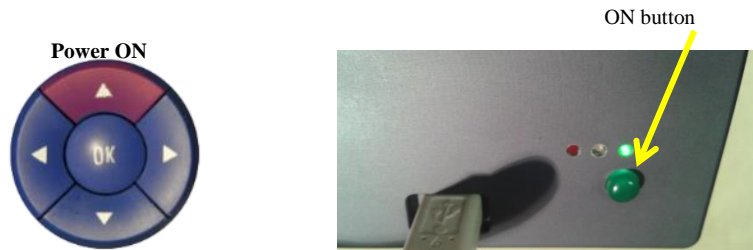
Pressing shortly joystick will toggle the supply ON (green LED lights immediately) and initiate processor start-up. After a delay of few seconds, the **Start-up screen** will show up. A couple of seconds later, CT-7 *date and time* will be displayed.

Press UP   ..   backlight appears promptly …   Start Screen a few seconds later   …   end finally .. the Time.

After next few seconds, the ONE CLICK menu will appear.

NOTE: It is vital to set correctly the date and time. If the date and time is not set, the result indexing is not working corrctly. The CT7 will prevent you from making the measurements and communicating with PC.

 Time NOT SET >> Go to MEASURE / DATE TIME and set *date and time* or, much easier way: set the date from user friendly interface of **CT7-CONSOLE**.

5.3 Working with menus

The CT7 Interfaces are limited to
1. Color Display
2. Five way Joystick
3. USB connector

In the field operation, the user selects options from the menu with the joystick.
Most of the customization, requiring typing of text data, shall be performed from a PC.

Pressing joystick LEFT activates left column menu of pictograms representing higher level options:

- One Click   *fastest way to measure*
- Measure   *measure and related parameters*
- Report   *data reviewing*
- Service   **PC LINK** *and utility functions*
- Factory   *test and configuration functions*

Once the required menu is selected, pressing ENTER/OK opens the list of the lower level options on the right side.

The following paragraphs explain the available functions.

6   CT7 Menu reference

6.1   One Click menu

Easy operations without settings.

This menu is initiated by awakening the instrument; one can return to this menu from another one by pressing the joystick **LEFT** and selecting the first menu in the left column with the **Up** and **DOWN** positions of the joystick.

6.1.1   MEASURE

At power up **MEASURE** is highlighted on the **One Click** screen: you are ready to perform a measurement using the last CART selected , or by default NORMAL. Press OK to initiate the measurement. During "time delay" seconds you shall position the instrument on the mirror before the measurement actually starts. (see also *6.4.3 Delay ms*).

- The time to measure is counted down on the screen (blue figures).
- 5 seconds before the measurements the color changes to red.
- During the measurement a yellow star is displayed.

The following screens illustrate the sequence:

-    Countdown "Blue"   - Countdown "Red"   - Measure in process   - Results

Press **ENTER to go to the next measurement.** Screen **ONE CLICK** appears and you can continue making successive measurements; you can also shift to **Meas.*10** or to **Low noise** type of measurement by selecting the one you want with up and down strokes of the joystick.

6.1.2   Meas.*10

 CT7 performs and memorize the basic measurement 10 times and displays the last one on the screen.

6.1.3   Sleep

The last place on the **One Click** menu is **Sleep** . Entering **Sleep** will shut down the instrument.

6.2   Measure menu

Operations with settings

Selected as the second position in the list on the left of the screen; then go back to the right in order to navigate among the four operation options of the **Measure** menu. (Left – Down – Right)

6.2.1   Measure

Measure operation is the same as on the **One Click** menu. Before start of a measurement, the operator is prompted for selection of CART for wavelength selection. The selected Cart becomes default for later operations.

6.2.2   Sel. CART

Sel. CART operation allows selecting as default a CART without making a measurement from a list of pre-defined CARTS.
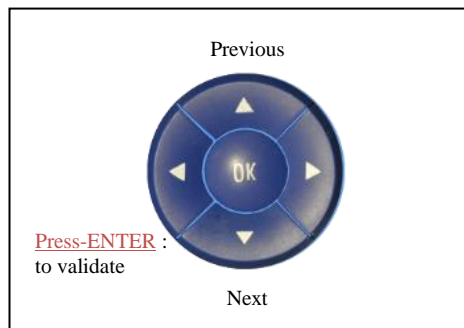
New CARTs or any modifications can only be introduced from CT7 Console.

After a new **CART** has been selected, the measurement with this CART can be immediately initiated from the same menu by entering **Measure** (one Up). When the measure is finished, the result is shown in **Data View**
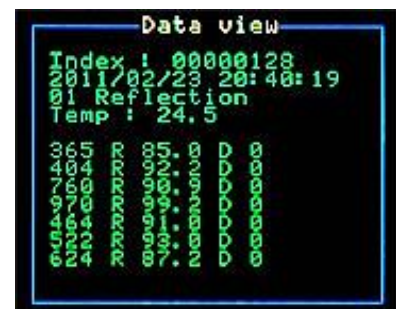
6.2.3 Date Time

Date Time operation allows setting or resetting the date and the time. Pressing the joystick LEFT activates setting and entering the selected values (red highlight).
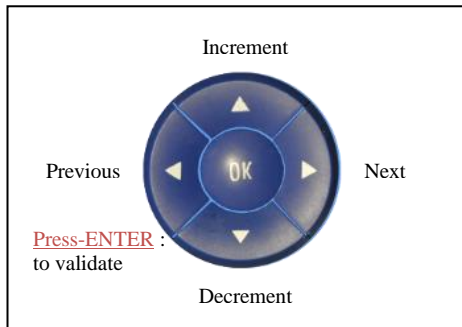
Pressing ENTER finish the date and time edition – red highlight disappears.
Pressing ENTER again, takes us back to MEASURE menu.

*Note: There is button **COPY PC-Time to CT7 (**on CT7 Console / Device Management panel) allowing one to copy PC time and date to CT in one –click.*

6.2.4 Calibrate

Place CT7 at the calibration target (MIRROR), activate menu **MEASURE / Calibrate.**

Usually calibration is performed when one suspects any pollution or if time elapsed since the last calibration is estimated too long, or if some measured values are suspect.

The instrument performs calibration in sequence:
1. 5 second countdown,
2. Repeat 8 times the measurement of an known mirror.
3. Compute and display coefficients for proofing.
4. Store in nonvolatile memory.

The reference values and actual coefficients may be read and modified in CT7 Console Device Management window.

DUST calibration may be conducted only from CT7-Console.

Note: CT7 may be referenced to local calibration values by changing reference target values in CT7 Console / Device Management, and writing them back to the CT7 instrument. See para. 8.1 Soft Calibration Target values for details.

6.3 Report menu

Reviewing data relative to measures

Choose the **Report** menu by navigating in the left column and entering the selected third place (Left – Down – Right).

6.3.1 Data

Data operation allows displaying the results that are memorized in the instrument.
The data pertaining to the last measurement are shown upon entering the **Data** operation.
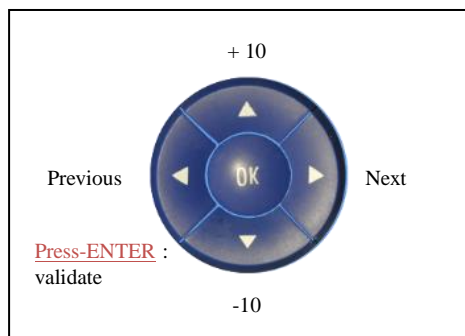
When the screen shows a measurement data, other measurement can be displayed by navigating with the joystick: **LEF**T for displaying the previous measurement, **RIGHT** for displaying the next, **UP** will move 10 measurements later, and **DOWN** ten measurements before the displayed one. Measurements can be identified by their index and date.

6.3.2 Calib

Calibration coefficients are displayed.
Below the coefficients, there are:
-calibration temperature of reflection channel (for temperature correction)
-date of reflection calibration (Refl:)
-date of dust calibration (Dust:)

Note: OPO has devised a VW jig allowing direct absolute calibration of a gauge just before using it. This is the only procedure that allows checking the calibration of the instrument and correcting it if needed.

6.3.3   Info

This operation will display general information about the instrument as it appears on the screen hereunder.

The list provides following parameters:

Actual CART #
Number of measurements in the memory (since last CLEAR)
Absolute counter of the measurements since assembly of the instrument
Language selected 0=English
Delay after Trigger before start of the actual measurements (in seconds)
Delay before Automatic Sleep (in minutes)
Flash addr – base address of data block in internal FLASH memory
Serial number of the CT7 instrument (same as on the back of the housing)

Flash Addr: - The base address of block of memory actually used . The results, even for hundreds of measurement, are quite limited in volume: several kilobytes. CT7 changes periodically position of data block within its huge 2Gbytes flash data memory to avoid (hypothetic) flash memory burn-out.

6.4 Service menu

User settable parameters and monitoring

6.4.1 PC Link

PC Link operation is used to connect the instrument to a PC. The PC program   **CT7 Console** must run and the USB connection done before this operation can be executed. The connection is validated by a mark in the case "**PC connected"** on the left bottom of the PC screen).

Once this operation has been entered, the autonomous operation of CT7 is disabled (the joystick is not operating anymore. The display shows **UIF LOCKED**. (User Interface Locked)

This status can be reversed by **closing the CT7 Console program** on the PC or by **resetting the instrument** using the reset switch at the rear of CT7.

Note: This mode may be used for long term test of CT7, ant the instrument is assumed to be powered by PC via USB, so the Automatic SLEEP function is disabled. However, some PC with active power saving may shut down or hibernate after some time, switching off the USB. In such case CT7 will remain ON and heavy battery discharge may occur. (See "CT7 does not power up" troubleshooting).

6.4.2 Battery

Get the battery voltage and remaining energy estimation.

NOTE: use this percentage as indication, not a measure.

6.4.3   Delay Ms.

Wait time for **Delayed MEASURE.** Set the delay **in seconds** before the measurement starts after pushing the measurement start button.
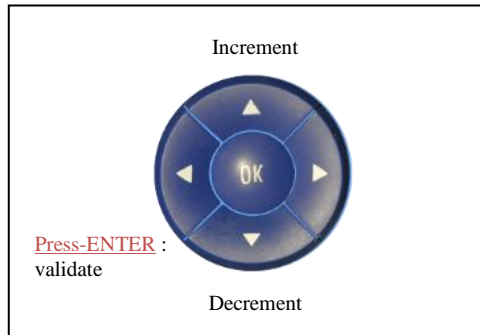
6.4.4   Delay Sl.

Delay for **SLEEP** function. This operation allows resetting the delay in **minutes** before the instrument goes to sleep after the last touch to the joystick.
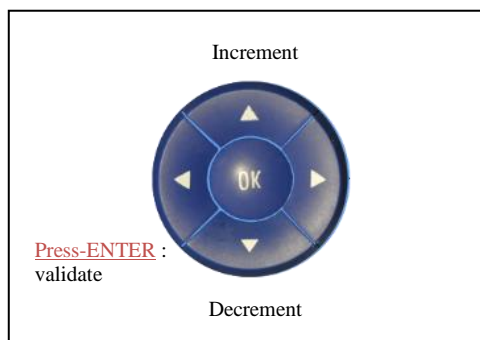
Before going to sleep, a beeping count-down will show for ten seconds.

NOTE: automatic sleep count-down is disabled in following actions: "Status"," Meas 1/Minute", and "UIF-Locked". Potentially a deep discharge of the battery may occur!

6.5   Factory menu

Internal settings and housekeeping.

6.5.1   Francais/English – Language toggle
Choice allows toggling between French and English versions of menus.

6.5.2   Status

This operation displays various household data of the instrument the list of which is on the left of the screen.

Temp1 – Detector temperature
Temp2 – Battery temperature
V0 –LED supply: 8.4V
V1 –DSP supply: 3.3V
V2 –USB supply voltage
V3 -Battery voltage (Li Ion: 3V low – 4.2V Fully Charged)
V4 -Digital Supply: 5V
V5- Analog Supply: 5V
V6 -Aux DSP supply: 3.3V
V7 –DC-DC supply (from battery: or USB)

(*) with poor cable (i.e. V_USB <=4.2V) charger is not operating correctly.
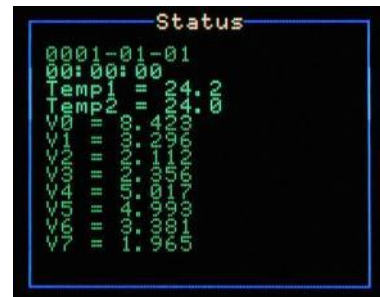
6.5.3   Meas/1 min

Meas/1 min : the instrument is set to perform and record one measurement per minute in endless loop. The measurements are done using the active CART. This function is used for performing thermal and battery life tests.
Note: Automatic SLEEP function is disabled in this mode. Battery discharge may occur if not powered with USB

6.5.4   Version

Display the serial number of the instrument and the versions of the operating software.

There are two software versions.
CT7 is powered by two processors: one for OLED display
handles user interface and a second one, a DSP, for acquisition
and processing.

7   CT7-Console

The main functions of this PC interface are:
1. Data retrieval
2. CT7 configuration
3. CT7 laboratory operation

7.1   Installation

7.1.1   Components

Following elements shall be installed on the PC:

- USB driver
- .net Framework necessary for installation (automatic download)
- CT7-Console itself

CT7 installer, together with documentation, is provided on a USB Flash Drive.

NOTE: provided USB Flash stick is just a memory to ease the first steps with CT7.   CT7 does not require hardware key for operation. Same contents may be downloaded from support www.

7.1.2   Win7 (-32 and -64) Installation

The installation is performed in only two steps:

- Let Windows7 to find and install USB driver
- Run CT-7 Console setup

Now, let's have a look in details:

Let Win 7 to install driver:
Power ON the CT7 instrument and connect to USB port of the PC - after few seconds the CT7 device will be available and COM port created (see Hint 3 below).

Install CT7-Console:
Download from http://www.a1pixel.pl/CT7/ct7-download.html the latest version of CT7-Console package, extract the contents of CT7.zip to yours "My Documents" folder.

A following structure is created:
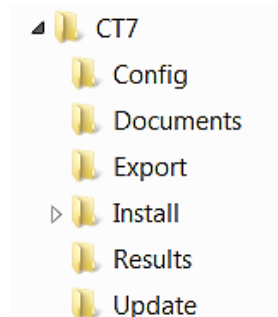
Go to **Install** folder and run **Setup.**

Start using the software.

Do not forget to switch CT7 into PC-Link mode (using it's joystick and menu),   select the Communication port and you may enjoy the connection.

Hints:

1. Setup aborts if a previous installation performed from a different location is detected. Go to *Control Panel/Programs and features*, and remove the previous version manually.

2. If the driver is not correctly installed, or CT7 is not connected to PC you will most probably get error "No Communication Port Available". Windows creates dynamically the port when CT7 is connected (and powered).

3. Typical message during automatic CT7 driver installation:

7.1.3   Windows XP and Vista (-32) Installation

The installation is performed in only two steps:

- Download and install USB driver
- Download and Run CT-7 Console setup

The PC shall have internet access for downloading the ".net v 3.5" framework during setup.

Now, let's have a look in details:

Install driver:

The USB driver shall be installed manually prior to connection of the instrument.

Download from http://www.a1pixel.pl/CT7/ct7-download.html the latest version of CT7 driver, extract from ZIP and start Setup

Power ON the CT7 instrument and connect to USB port of the PC - after few seconds the CT7 device will be available and COM port created (see Hint 2 below).

Install CT7-Console:
Download from http://www.a1pixel.pl/CT7/ct7-download.html the latest version of CT7-Console package, extract the contents of CT7.zip to yours "My Documents" folder.

A following structure is created:
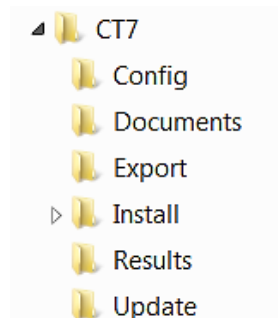
Go to **Install** folder and run **Setup.**

If necessary, the ".NET framework" will be automatically downloaded (from Microsoft) during the setup of CT7 Console.

Start using the software.

Do not forget to switch CT7 into PC-Link mode (using it's joystick and menu: SERVICE/PC-LINK),   select the Communication port and you may enjoy the connection.

Hints:

1. Setup aborts if a previous installation performed from a different location is detected. Go to *Control Panel/Programs and features*, and remove the previous version manually.

2. If the driver is not correctly installed, or CT7 is not connected to PC you will most probably get error "No Communication Port Available". Windows creates dynamically the port when CT7 is connected (and powered).

7.2   CT7-Console reference

7.2.1   Platform

The software is tested on following platforms: XP-32, Vista-32, Win7-32, Win7-64,

Note: At XP and Vista systems .Net 3.5 is necessary (downloaded from Microsoft-Update www during installation). Win7 includes .Net 3.5.

7.2.2   USB connection

The USB interface is built around FTDI FT232D chip configured for *serial port- on-USB*. Windows recognizes this device and creates virtual COM port when CT7 is connected and switched ON.

Win XP and Vista: USB driver shall be installed manually from Ct7\Install folder
Win7: USB driver is downloaded automatically from Microsoft Update.

7.2.3   CT7 file system

However it is possible to change the folders' locations at ABOUT panel or with save/open file menus, we recommend using the following folder structure:

Folder	Description
CT7	
Config	Storage of CT7 instrument's configuration files (CARTS, parameters)
Documents	Folder of User Manual
Export	Folder for exporting data from Instrument (Data Panel)
Install	CT7Console Installation (setup.exe)
Results	Folder for storing Result Archives and results logged from PC
Update	Updates of firmware: CT7_DSP.bin and Display OLED: CT7.bin

7.2.4   Color convention

Name	Refl Calib coeff	Refl T coef[%]	Refl Target value	Refl LED mod	Refl. Ref PG	Refl. Ref Att	Refl Signal PG	Refl Signal Att	Refl Repeat	Dust Calib coeff	Dust T coef [%]	Dust Target value	Dust LED mod.	Dust Ref PG	Dust Ref Att	Dust Signal PG	Dust Signal Att	Dust noise offset	Dust Repeat	Led DC
365nm	1.0168	0.07100	100.000	1.000	28	1	1	1	1	1.000	0.00000	10.000	1.200	12	1	12	1	0.000	1	160
404nm	1.0277	0.02070	100.000	1.000	26	1	1	1	1	1.000	0.00000	10.000	0.800	12	1	12	1	0.000	1	160
464nm	1.2174	0.02940	100.000	1.000	30	1	2	1	2	1.000	0.00000	10.000	1.000	12	1	12	1	0.000	1	160
522nm	1.3505	0.02720	100.000	1.000	30	1	2	1	4	1.000	0.00000	10.000	0.800	12	1	12	1	0.000	1	160
624nm	1.2161	0.04840	100.000	1.000	30	1	8	1	12	1.000	0.00000	10.000	1.000	12	1	12	1	0.000	1	160
760nm	1.2893	0.02540	100.000	1.000	30	1	1	1	1	1.000	0.00000	10.000	0.800	12	1	12	1	0.000	1	160
970nm	1.5192	0.10210	100.000	1.000	30	1	6	1	12	1.000	0.00000	10.000	1.000	12	1	12	1	0.000	1	160

REFLECTION (data, parameters, config, etc.)- green   DUST (data, parameters, config., etc.) - yellow

7.2.5   Instant Help

The user interface provides instant help. When the coursor is hanging over a function button or dialog for about 5 seconds, an instant help text appears.
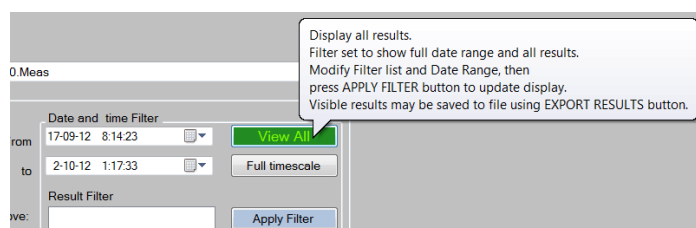
7.2.6   CT7-Console start

At CT7 Console start, the following screen appears:
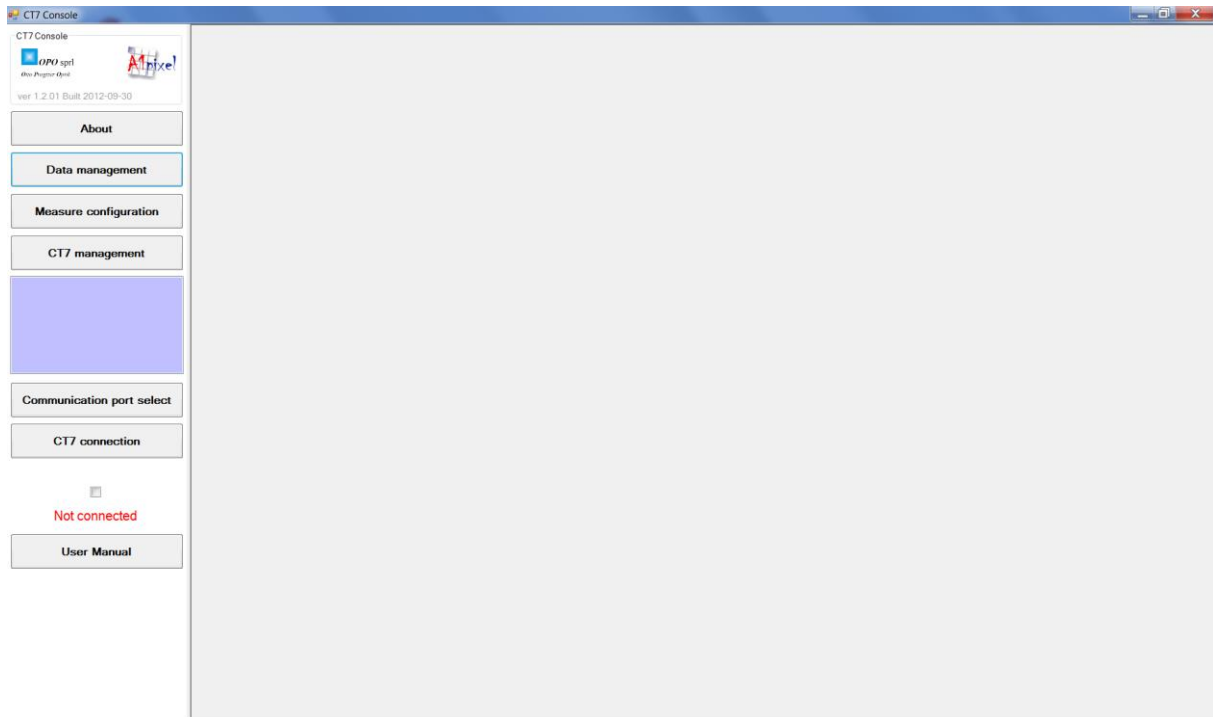
The main part of the screen is empty. Following function panels may be called by buttons in the left column of the screen:

- About   /version , authors, program mode, file structure, updates /
- Data handling   /readout of data from instrument, filtering and export /
- Measurements configuration   /selection of wavelength for measurements, editing carts /
- CT7 management   /maintenance functions and parameter edition /
- User Manual   /opens .pdf document in a new window/

You should observe in the lower left corner of the PC screen the case "**connected/non-connected**" shown as **"Connected to CT7".** CT7 must be in SERVICE/PC-link state, indicated by message *UIF (user interface) locked,*

The **DATA MANAGENT panel** is fully operational also without CT7 connected.

7.2.7   About

This page contains

- Current software version
- Information on the software version and manufacturers OPO and A1Pixel address.
- Handling of the mode: Normal/ Advanced/ Expert. Mode defines the access to low level functions, parameters and diagnostics.
- CT7 file system configuration
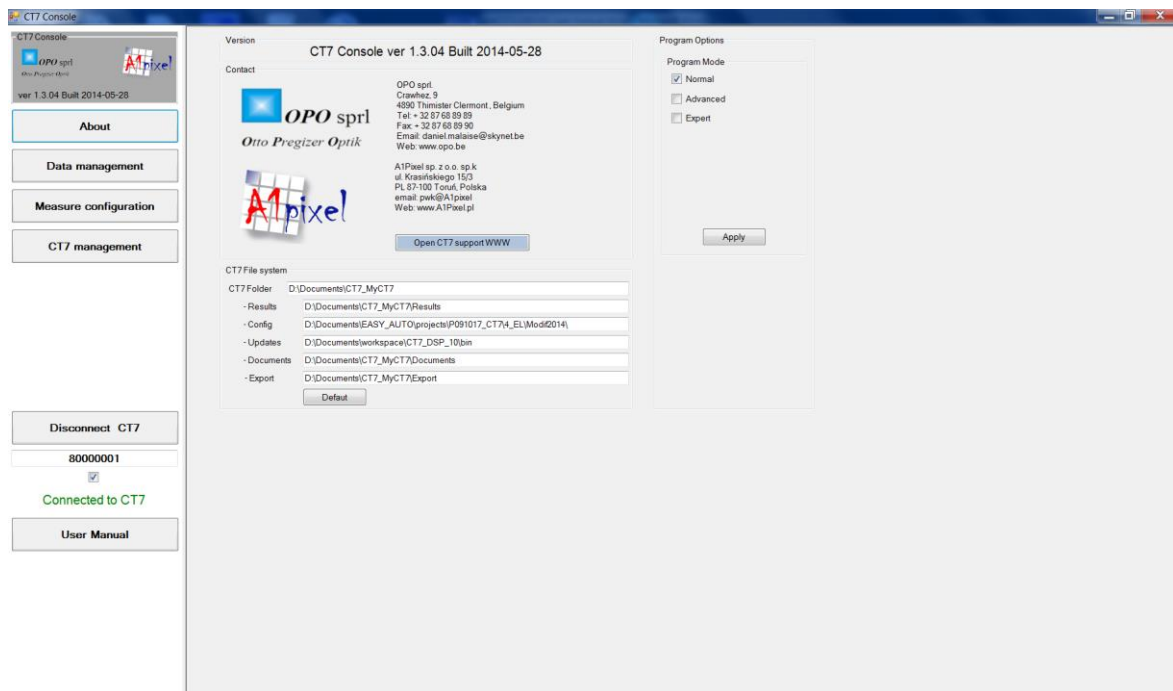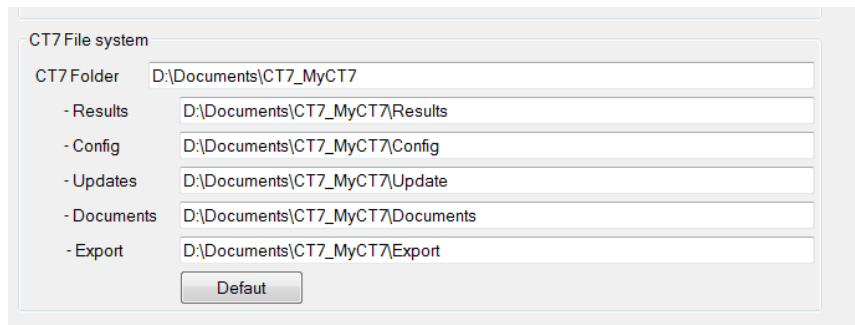
7.2.7.1   Support www page.

On the support www, which opens up after pressing the button, the latest versions information and download may be found. The Tech-Notes provides additional, practical answers to users' questions.

There is no automatic update check.

7.2.7.2   CT7 File system
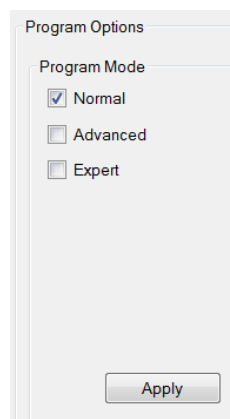
The sample file system is given here. Please observe that CT7 folder is not Documents\CT7\.. – you are absolutely free to keep the files in any folder you wish, even not on the same disk. However in the manual we describe all operations for the default structure, so it is easier to follow the instructions if you use a similar structure.

We suggest using such tree:

Config   Storage of CT7 instrument's configuration files (CARTS, parameters)

Documents   Folder of User Manual

Export   Folder for exporting data from Instrument (Data Panel)

Install   CT7Console Installation (setup.exe)

Results   Folder for storing Result Archives and results logged from PC

Update   Updates of firmware: CT7_DSP.bin and Display OLED: CT7.bin

7.2.7.3   Program mode

The difference between program modes is a number of available functions, specially for CT7 Management.
Normal program mode is typical end-user mode with data management and houkeeping monitoring functions.
Advanced – additional functions for internal parameters edition are available.
Expert – all features, including factory setup, testing and peripherial devices.

Advanced and Expert modes are not described in this document. In case of need of in-deep diagnostics instructions will be provided by support team.

7.2.8 Data handling

This entry initiates a function allowing manipulating the data, retrieving data from the instrument and saving them into the PC etc. Note that only the data recorded off line in the CT7 are concerned here; data recorded in PC mode are directly entered in a PC file and do not transit through the CT7.

It is operated through a self-explanatory screen as it appears below.
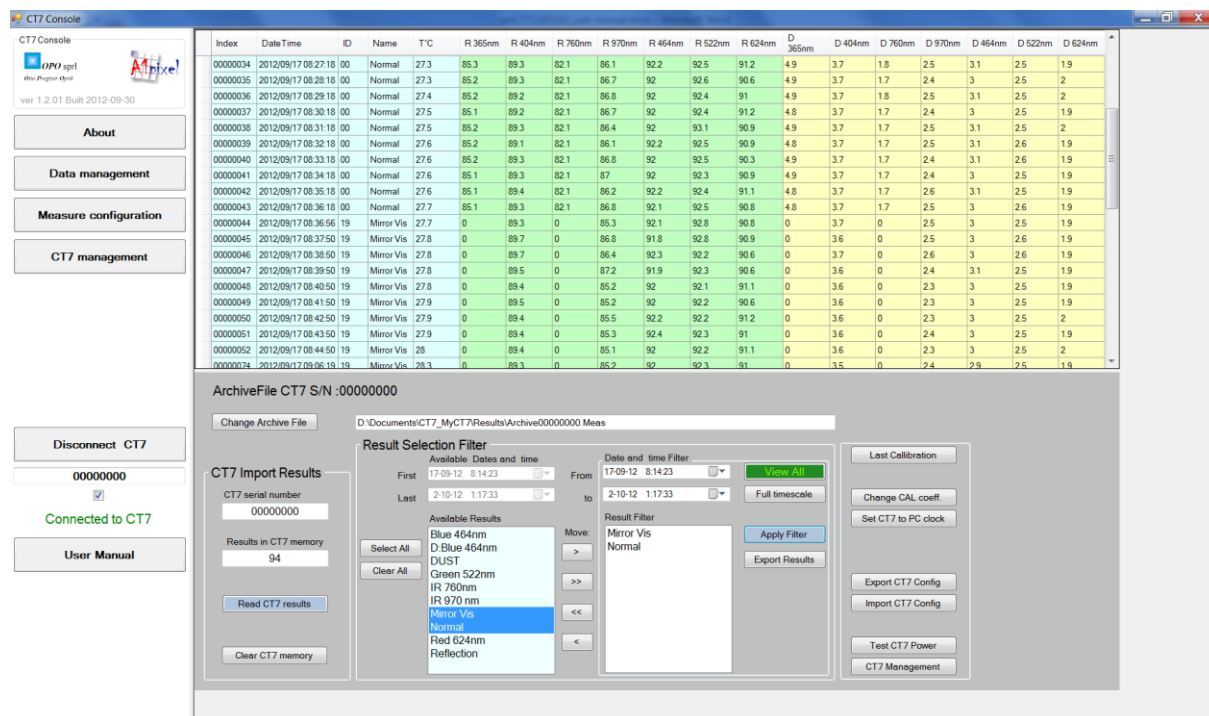
You have to define and save a folder to keep the data of the CT7 that is connected to the PC; once defined, each time the same instrument is connected, and it will open the defined folder and if data are read out from the CT7 new data will be appended to the previous ones in the folder.

7.2.8.1   Reading the results from CT7

In order to read new data from the CT7 you have to push the button **Read measurements** from CT7. Only new measurements will be appended to the folder.
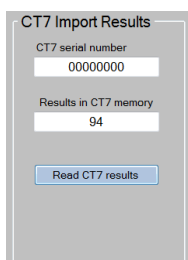
Finish the operation and accept the data by pressing **Archive results**.

7.2.8.2   Result Filter

For selecting, comparing particular CART results, you should work with **Result Selection Filter.**

In the left column available results are displayed, in the right one – the selected ones.

To see all results in the file press **View All** button (green).

- Select date range defined in the two dialogs at the top right of **Result Selection Filter** box :

- Select results by their name from a list of available cart names.
- The Available list is limited in time between two selected dates. Select data names in the "**Available list"** (left box) and toggle them to the Selected list (right box) using the appropriate button in between the two boxes (>); if you want to select all available data, use the >> button. The reverse buttons are used to suppress data names from the Select list.

- Once you have completed the selection you want, you may inspect the selected data (by pressing **Apply Filter**).

- Export the selected measurements for further handling by pressing **Export Results** button.

7.2.8.3   Mini CT7-Management pane

Some most common CT7-Management functions have been mirrored here for your connivance.

Please refer to CT-Management paragraphs for more in-depth description.
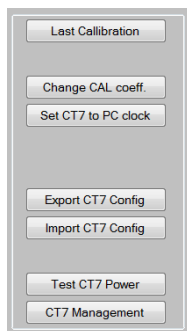
- Recall last calibration values and dates

- Go to CT7 Management to modify any parameter, in particular Target mirror or scattering sample value
- Set the real time clock of CT7 to actual time of PC

- Read all parameters from CT7 and save them to a .txt configuration file
- Import to CT7 parameters set from a configuration file

- Test the quality of USB power source and internal voltages
- Go to CT7 Management panel

7.2.9   Working with data

7.2.9.1   Archive file

The data from the Instrument may be retrieved to the PC and stored to the archive file. This file contains ALL the measurements retrieved from CT7.

The archive file is watermarked with CT7 serial number so it is not possible to mixt results from different instruments in one file. On the other hand more than one file may be created for one instrument.

It is possible to work offline with archive file.

7.2.9.2   Data sorting

The viewer of CT-7 console allows sorting data by date and by cart.

7.2.9.3   Exporting data

The selected data lines may be stored in CVS format for further processing in EXCEL.
Eventually a conversion DATA/ Text to columns may be necessary (delimited by tabulation).
 Excel provides full interface for graphic data presentation and report creation.

7.2.9.4   Data format

The fields in exported CVS file are separated with tabulation sign.
The record is terminated by a Carriage Return.

<div align="center">Time stamp; Cart; R1; R2; R3; R4;.. R7; S1; S2; .. S7; CR</div>

Note: The user may select or not specific wavelengths for given CART. The results for not used bands are replaced by a place holder: zero "0"

Where:
Time Stamp   *yyyy/mm/dd hh:mm:ss*

Cart: the name given for selection of wavelength used for this measurement

Rx   - reflection for given emitter in %
Sx   – scattering (DUST) index for given emitter in %

Decimal separator: dot .

NOTE: In certain countries once .cvs data is uploaded to Excel, the dots shall be replaced by commas before Excel recognize data as numbers.

7.2.10 Measurement Configuration

This function allows the user to define modify or cancel measurement CARTs, read the CARTs that are memorized in the CT7 and load CARTs in the CT7 memory.

These tasks are managed and performed through a graphic interface as shown below.

- Loading from an external file
- Saving in an external file
- Reading from CT
- Writing to CT7

The first two commands allow exchanging lists of CARTs between an external folder that you have defined and a CT7 instrument. This might be useful when several CT7 must work with the same choice of CARTs for instance.

The last two commands allow exchanging a list of CARTs between the PC and any CT7 instrument.

In the list, each line is a CART for which you may chose a name and select any combination of measurements. There should be at least one measurement on each CART.

The first CART, *NORMAL* (# 0) contains all measurement and cannot be modified or removed.
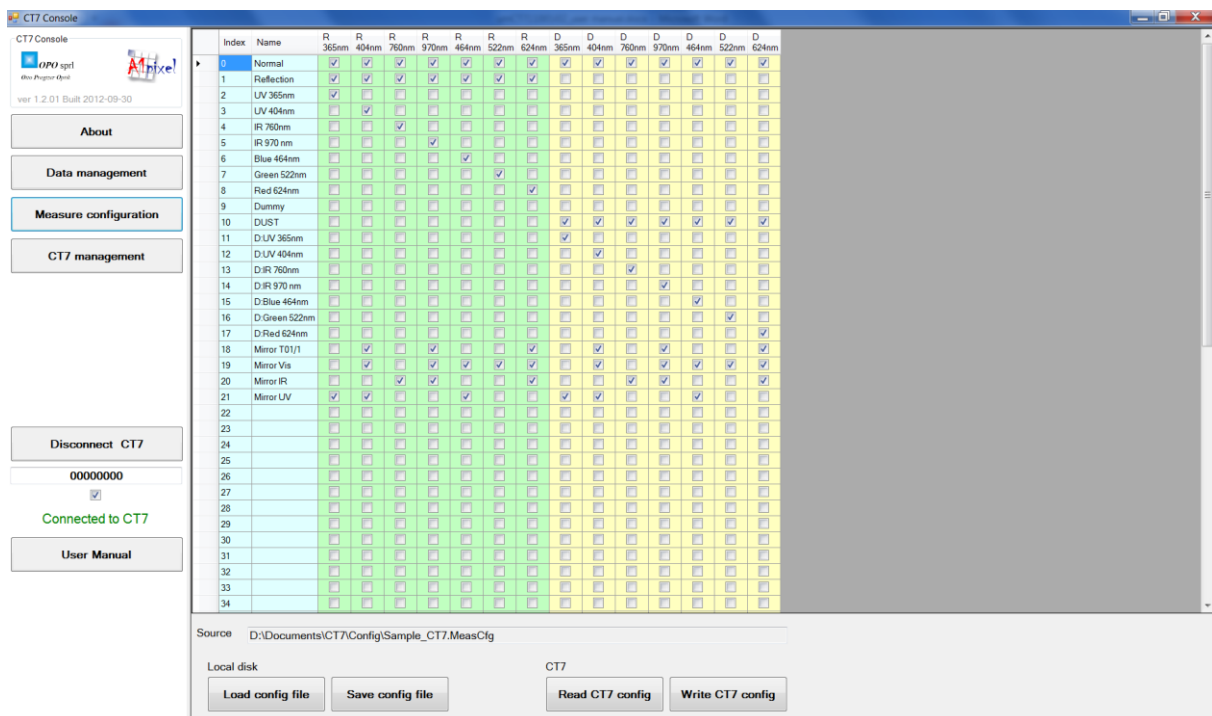
7.2.11 CT7 management

This screen allows to perform measurements, calibration and to introduce parameters into the CT7. This is done through a graphic interface shown below.

When **log** checkbox is checked, the displayed data is saved to a log file .cvs .
The results are always appended to log file. No file is re-written.
Single and continuous measurements are logged in the same way.
Continuous measure allows endless measurements loop with **Interval** time between the measurements.

The check-boxes allows to show/hide columns of results. No data is lost, the fugures may be recalled at any time.

See the next paragraphs for description of available functions.

Hint: You may copy data from screen to clipboard and paste them to Excel.

Note:
The measurements initiated from PC are not stored to internal CT7 memory.
They are not included into result archive file, but they may be logged to log file or copied to Excel from screen.

7.2.12 CT7 Management Parameters Table

The large table in the bottom part of the page contains all parameters crucial for CT7 precision.
In the NORMAL mode writing is disabled except of nominal values for reflection and diffusion targets used for calibration. The two columns with darker background: *Refl Target value* and *Dust Target value* can be written to flash memory of CT7 with buttons:

Write Mirror Target   Write Dust Target

as explained in section 8.1 Soft Calibration Target values.
The others parameters are:

Name	Refl Calib coeff	Refl T coef[%]	Refl Target value	Refl LED mod	Refl. Ref PG	Refl. Ref Att	Refl Signal PG	Refl Signal Att	Refl Repeat	Dust Calib coeff	Dust T coef [%]	Dust Target value	Dust LED mod.	Dust Ref PG	Dust Ref Att	Dust Signal PG	Dust Signal Att	Dust noise offset	Dust Repeat	Led DC
365nm	1.0168	0.07100	100.000	1.000	28	1	1	1	1	1.000	0.00000	10.000	1.200	12	1	12	1	0.000	1	160

Parameter	description
	REFLECTION Channel
Refl Calib Coeff	Calibration coefficient (calculated during calibration)
Refl T coef[%]	Thermal coefficient
Refl Target value	Nominal value of the reference target (mirror) in % - **user settable**
Refl LED mod	% of LED current amplitude to be used for modulation
Refl Ref PG	Analog Programmable Gain of the DSP processor for the reference channel
Refl Ref Att	Analog programmable attenuation of signal at DSP input for the reference channel
Refl Signal PG	Analog Programmable Gain of the DSP processor for the signal channel
Refl Signal Att	Analog programmable attenuation of signal at DSP input for the signal channel
Refl Repeat	Number of basic measurement blocks to use for the measure
	Dust Channel
Dust Calib Coef[%]	Calibration coefficient (calculated during calibration)
Dust T coef [%]	Thermal coefficient
Dust Target value	Nominal value of the reference target (diffuser) in % - **user settable**
Dust LED mod	% of LED current amplitude to be used for modulation
Dust Ref PG	Analog Programmable Gain of the DSP processor for the reference channel
Dust Ref Att	Analog programmable attenuation of signal at DSP input for the reference channel
Dust Signal PG	Analog Programmable Gain of the DSP processor for the signal channel
Dust Signal Att	Analog programmable attenuation of signal at DSP input for the signal channel
Dust repeat	Number of basic measurement blocks to use for the measure
Dust Noise offset	Noise offset floor of the channel
	Common
LED DC	DC current (bias) for the LED (Full amplitude in 254 steps)

7.2.13 CT7 Management Function Buttons
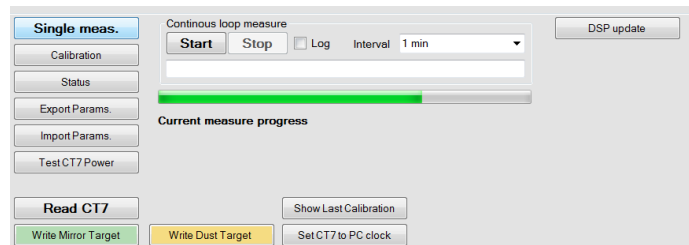
7.2.13.1 Single meas.

When pressed, the measure defined by selected on MEAS MANAGEMENT panel *cart* is performed once.

7.2.13.2 Calibration

Perform calibration – see para. *8.2.3 Calibration from CT7-Console*.

7.2.13.3 Status

This function retrieves internal voltage and software versions from CT7.
See para *8.3.3 Testing USB cable with CT7Console* for discussion of voltages.
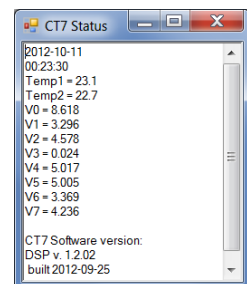
7.2.13.4 Export Params/Import Params

This pair of functions allow saving (export) and loading (import) all CT7 parameters. The configuration file contains the data in a *.ini* style file and may be imported as a whole or only for selected parameters.

The file contains parameters and diagnostic information about CT7 and CT7-Console. Only parameters grouped in blocks:
```
[CONSOLE]
[Channels]
[DSPchannels]
[DSPparams]
```
are uploaded.

Selective import of parameters is discussed in para. *8.1 Soft Calibration Target values* .

It is important to remember that the parameter shall be preceded by his group header. CT7 Console will not start to look after this parameter until the group header is read. Use as a model the sample config file in *Annex 3 - Configuration file (Export/Import)*

7.2.13.5 Test CT7 Power

Performs test of CT7 power system and returns results with comments. This function is discussed in para. *8.3.38.3.3 Testing USB cable with CT7Console.*

7.2.13.6   Read CT7

Reads all parameters from CT7 and display them on screen.

7.2.13.7   Write Mirror Target/Write Dust Target

You may manually edit columns of target coefficients for reflection and dust. These buttons write their respective columns to CT7. Another way to change these parameters is a use of **Import Params** function – see para. *8.1 Soft Calibration Target values.*

7.2.13.8   Show last calibration

Recalls target sample parameters and the last calibration date stored in CT7 flash memory.
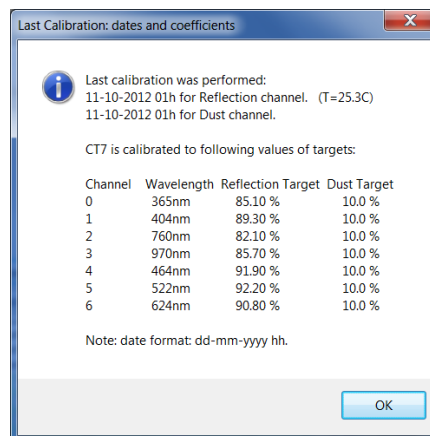
Note: Strictly speaking the target values are the ones actually in the memory, possibly the ones used to find the calibrations coefficients have been overwritten. In case of doubt, check the target coefficients and re-calibrate.

7.2.13.9   Set CT7 To PC Clock

This function get *time & date* from PC clock and adjust CT7 real time clock to this value. Very useful when changing the battery,

7.2.13.10   Start/Stop

Starts / stops the measurements defined by selected on MEAS MANAGEMENT panel *cart* is performed in a loop with *interval* period.

7.2.13.11   Log

When checked, all the results appearing in the results grid are logged to a file in append mode.

7.2.13.12   Interval

Selection of interval of LOOP MEASURE. When START is pressed the measure defined by selected on MEAS MANAGEMENT panel *cart* is performed each *interval* seconds/minutes.

7.2.13.13   DSP Update

Upload update of DSP firmware to CT7-Instrument. The uploaded file MUST be named CT7_DSP.bin.
The process lasts literally few second. A progress-bar shows the status. The user is guided by messages poping-up at each step. The upload ends with restart of CT7, and automatic re-connection to PC.
In case of problems reset CT7 by pressing with a pen-tip the hidden RESET switch at the back, restart and connect to PC normally.
HINT: We recommend exporting the parameters before updating DSP firmware.

7.2.14 Connecting to CT7

To use the PC-Link mode at CT7, you must:

- Connect the **CT7** with PC *(USB cable)*
- Awake **CT7**, activate **PC-link** (para *6.4.1 PC Link*) *(With the left menu (LEFT) select SERVICE (DOWN - DOWN); then select (RIGHT) and Enter the PC-Link function.)*
- Run the **CT7 Console** program on PC,

Especially for the first time connection, you should observe in the lower left corner of the PC screen the case "**connected/non-connected**" shown as **"connected".** If this is not the case, probably the time-out message will pop-up CONNECTION PROBLEM.
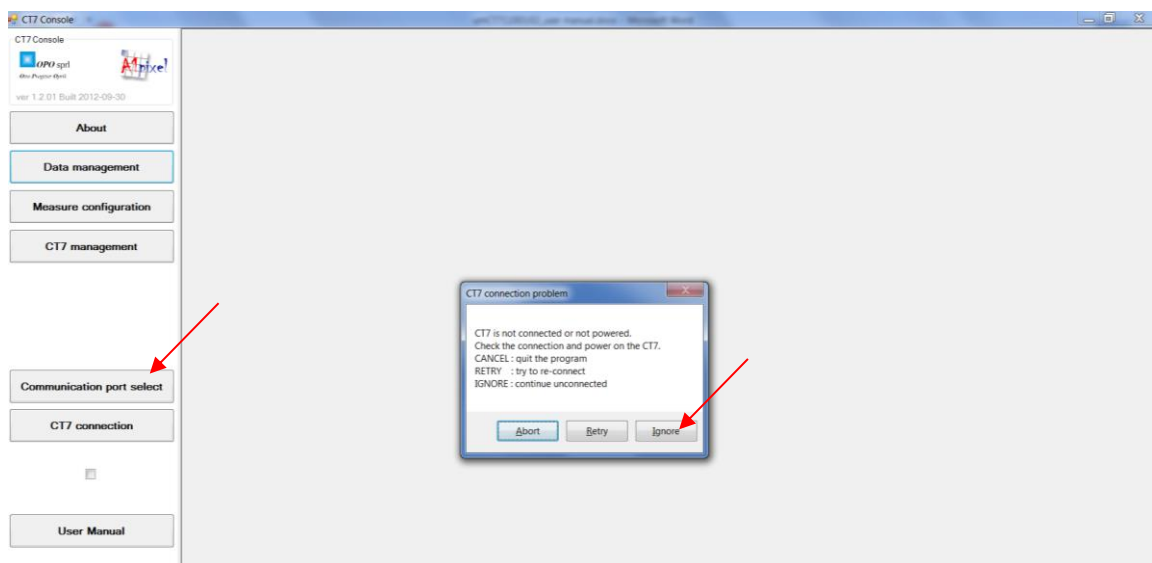
Press **Ignore** to acknowledge this message and push the button **Communication Port Select.**
A list of active COM ports appears. Most probably the CT7 port is the last one.
Select it and press ACCEPT button:
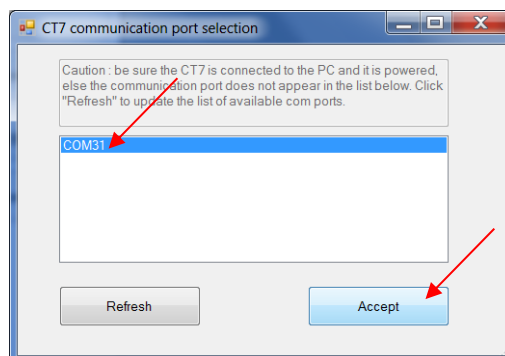
Than try again the connection to CT7 – press **CT7 Connection** button. If connection is established, at the left bottom of the screen a message **Connected to CT7** will appear. The COM port number is stored, and the next time the connection will be transparent.
In case of persisting connection problem see troubleshooting.

8 Maitenance

8.1 Soft Calibration Target values

CT7 has no intrinsic reflectivity reference. The construction of the instrument and measurement technique ensures very high precision and stability of measured ratio of source intensity and returned signal.
This ratio is converted to reflectivity value by dividing it by *calibration coefficient* which is found by measuring the known mirror in CALIBRATION operation.
For user convenience, a first surface AL mirror is provided as calibration reflectivity target.
(see also para 8.2.1 Calibration Target)
Note: At delivery CT7 will be loaded with parameters of provided reference mirror. This parameters may slightly vary from values given in this manual.

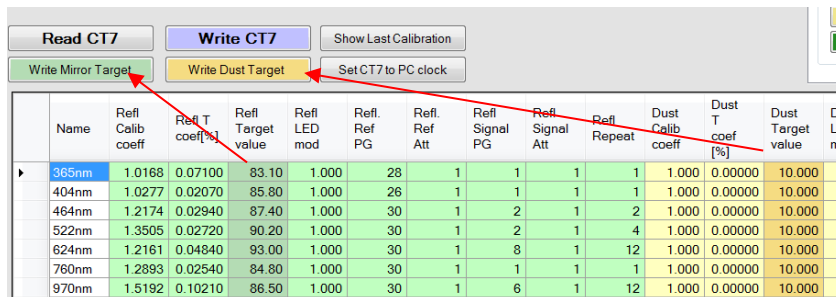| Name	Refl Calib coeff	Refl T coeff[%]	Refl Target value	Refl LED mod	Refl. Ref PG	Refl. Ref Att	Refl Signal PG	Refl Signal Att	Refl Repeat	Dust Calib coeff	Dust T coef [%]	Dust Target value
365nm	1.0168	0.07100	83.10	1.000	28	1	1	1	1	1.000	0.00000	10.000
404nm	1.0277	0.02070	85.80	1.000	26	1	1	1	1	1.000	0.00000	10.000
464nm	1.2174	0.02940	87.40	1.000	30	1	2	1	2	1.000	0.00000	10.000
522nm	1.3505	0.02720	90.20	1.000	30	1	2	1	4	1.000	0.00000	10.000
624nm	1.2161	0.04840	93.00	1.000	30	1	8	1	12	1.000	0.00000	10.000
760nm	1.2893	0.02540	84.80	1.000	30	1	1	1	1	1.000	0.00000	10.000
970nm	1.5192	0.10210	86.50	1.000	30	1	6	1	12	1.000	0.00000	10.000

The columns of Target values may be edited and uploaded to CT7 with **Write Mirror Target** and **Write Dust Target** buttons respectively. After changing values you must perform CALIBRATION on your sample.
The change of target values may be performed with **IMPORT Param**. Function by importing your text file, named for example *MyTargetMirror.txt*, including just following lines:

[Channels]
RTcoef={83.1;85.8;87.4;90.2;93.0;84.4;86.7}

The figures are the reflectivity values of Al mirrors respectively for wavelengths of 365nm, 404nm, 464nm, 522nm, 624nm, 760nm, 970nm.

Similar formula for dust target:
[Channels]
DTcoef ={10.0; 10.0; 10.0; 10.0; 10.0; 10.0; 10.0}

The CT7/Config folder contains file CT7_MirrorCoefficientsSample.txt. Importing this file will change only calibration target reflectivity values. Simply replace our data by yours (yellow line), Import the file to CT7 and perform **Calibration** on your sample.

```
;CT7 Parameters file
; This is a sample file allowing changing and keeping the reference of reflectivity
values used for calibration of CT7
; The list of channels is given as a reminder of wavelength sequence
; You may replace reflectivity values of RTcoef (OPO Al mirror) by your values.
; Importing this file to CT7 will change only one column in parameters table and
CT7 flash memory
; Note:
;1. The keywords: [Channels], RTcoef  are obligatory,  ";" is a comment sign
;2. You must use a DOT "." as decimal separator
;
[Channels]
;Channels={365nm;404nm;460nm;522nm;630nm;760nm;970nm}
RTcoef={82.6;83.1;85.2;89.9;90.5;83.8;89.5}
```

8.2 Calibration

CT7 returns reflectivity values based on ratio of emitted and received light multiplied by *calibration coefficient* specific for each wavelength. The calibration process determines the scale for the measurements providing known point on 0 to 100% linear characteristics of CT7 channels. After calibration CT7 will provide the results according to this scale.
The measurement method, construction of the instrument and procesing algorithm were engineered in such way that only optical path degradation (dust, scratches, ageing) may change the reading.
A calibration target mirror with reflectivity measured in our labs is provided as physical reference (note: even this reference is subjected to ageing and degradations).

The instrument may be calibrated with provided reference mirror (see next paragraphe) or with your own, known mirror. See chapter 8.1 *Soft Calibration Target values* to learn how to set CT7 to your laboratory values.

8.2.1 Calibration Target

With the instrument a calibration mirror is provided.
The reference reflectivity values were measured with Strong's WV setup.

channel	R365	R404	R460	R522	R630	R760	R970
uncertainty	0.2%	0.3%	0.1%	0.4%	0.2%	0.2%	0.5%
value	82.6%	83.1%	85.2%	89.9%	90.5%	83.8%	89.5%

Note: Optical references are not invariable. The reflection properties may change even if stored in good conditions. Periodic validation of target properties with laboratory equipment is recommended.

8.2.2 Calibration from navigation switch (stand alone)

Usually calibration is performed when one suspects any pollution or if time elapsed since the last calibration is estimated too long, or if some measured values are suspect.
Activate Menu **MEASURE / Calibrate** and place CT7 at the calibration target (there is 5 seconds delay).
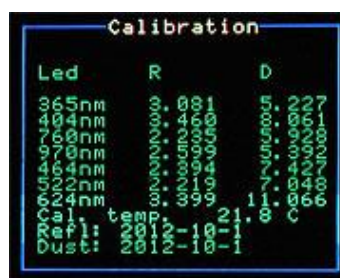
Note: OPO has devised a VW jig allowing direct absolute calibration of a gauge just before using it. This is the only procedure that allows checking the calibration of the instrument and correcting it if needed.

8.2.3   Calibration from CT7-Console (from PC)
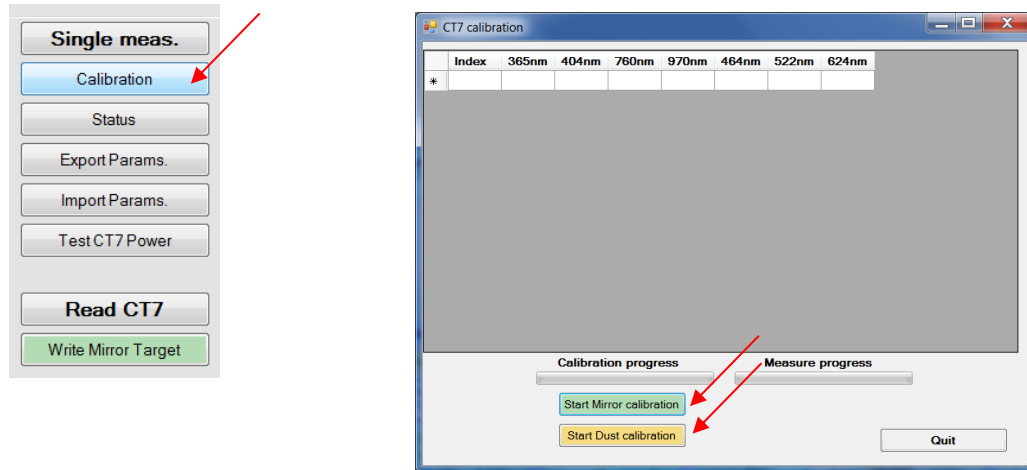
Calibration starts by pressing CALIBRATION button on CT7-MANAGEMENT panel. Then you can choose between calibrations of reflection (mirror target) or dust (scattering target). You are again prompted for confirmation that the right calibration target is in front of CT7 – once confirmed, the calibration starts.

CT7 performs the measurement of ratio *reference signal/ target signal* and calculates the coefficients allowing fitting arbitrary ratio measurement to the known values of target samples.

8.3   Battery
8.3.1   Battery Charge

CT7 uses two protected Li-Ion 3.7V 900mAh in format 14500 (~AA) cells connected in parallel as a source of energy. Batteries Li Ion 800-1200mAh are also suitable but increasing their capacity will increase the charge time above 4h.

Any USB socket of a PC is able to provide current up to 500mA. Hence, full charging of empty CT7 accumulators may last **up to 3-4 hours**. The internal CT7 fuse (resettable) provides protection of the power source.

The state of charge can be checked thanks to STATUS function: V3 is the battery voltage. When V3=2.8V, the batteries are empty, at 4.2V they are fully charged.

CT7 is charging only in OFF state. If connected to PC and operating the charger is disabled and CT7 powered directly from USB socket. The current sourcing capacity of USB2 is too small to supply and charge in the same time.

The state of the instrument is indicated by 3 LED on the top of the CT7:
- Green: ON
- Blue: Charge ended / Stand-by.
- RED: Charge

CT7 in charge.

Note: that some USB cables are not suitable for supplying power. Exactly like for hard drives, a short, low impedance connection is required. The internal monitoring of CT7 helps to verify supply quality. See 8.3.3 Testing USB cable with CT7Console)

8.3.2   External power source

Since 2012, the CT7 works with dual supply: battery or USB connector. If the 5V power is provided to USB connector, CT7 does not need a battery to work.

In a laboratory use, operated from PC, batteries serve only to keep the clock running when CT7 is not connected.

HINT: The monitoring of telescopes' mirrors is not everyday task, it may happen that CT7 has discharged while waiting for weeks for being used, and the technical time slot for monitoring is "just now" for only several minutes.   In such situation ANY device providing power to USB may be used as external power source for CT7: a laptop, an external battery pack like Belkin Power Pack 2000.
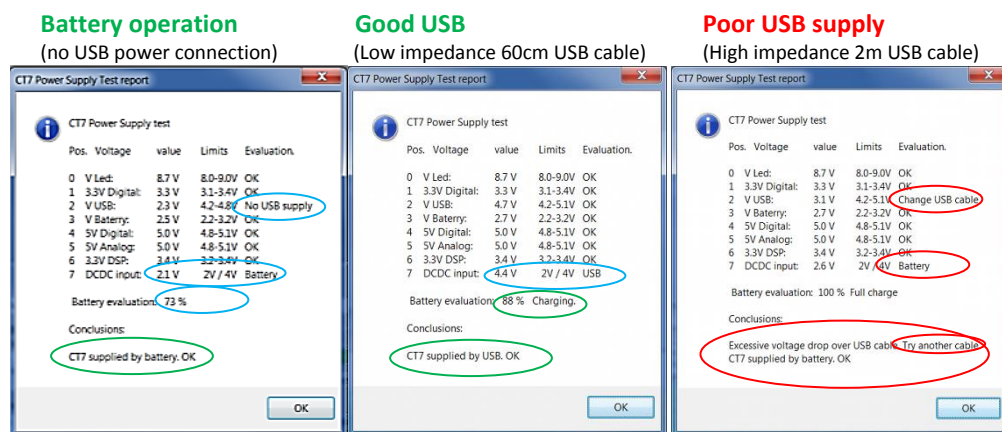

Power Pack 2000 (Belkin)
Power Pack is **not** delivered with CT7 instrument.

8.3.3   Testing USB cable with CT7Console

The battery and other internal voltages may be tested from Data-Management or CT7-Management panel by pressing the button:

Test CT7 Power

Power test reports for battery, "good" USB and "bad" USB cables.:

Battery operation (no USB power connection) **Good USB** (Low impedance 60cm USB cable) **Poor USB supply** (High impedance 2m USB cable)

NOTE :   Exaple of voltages and evaluation for NiMh batteries !!!

The poor USB cable generates alarms for more than one voltage. *Brown voltage* means "already not sufficient supply but not yet blackout".

 Please note *Charging* state for battery evaluation in Good USB cable report.

8.3.4   Checking the USB cable with CT7

Thanks to internal monitoring of the CT7 we may measure the voltage drop over the USB cable.
It can be done with PC as in the previous paragraph, or from the CT7 menu. Go to menu FACTORY/STATUS, observe V2 which is USB entry voltage:

Battery   **Bad USB cable**   **Good USB cable**
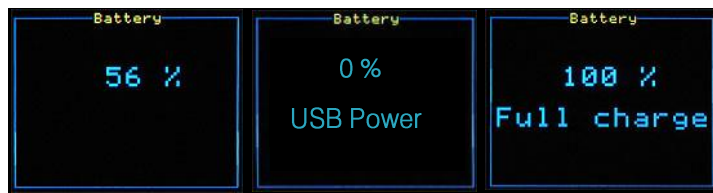   V2 = 3.845   V2 = 4.041

Depending on the cable (assuming with high probability that USB socket provides 5.0V) the entry voltage may vary. For a "very good" cable we may observe 4.7-4.8 V.
The minimum acceptable value of V2 is 4.0V.
Status function gives slightly lower values than CT7Console evaluation in CT7 Power Test.

8.3.5   Quality of the power source

When connected to a power source, the battery state response shall contain the word **USB Power** or **Full Charge.**
The state of the charger is indicated by LEDs on the top of CT7.

8.3.6   Changing the battery

Battery change sequence:
- Unscrew the instrument bottom cover
- Gently remove (let them drop-out) old batteries
- Place new Protected Li-Ion 900mA (800-1200 cells.
- Take care about polarity: Minus to spring contact.
- Both Batteries are heading the same direction: "+" to cover
- Gently introduce cover pins into the connector
- Press the cover and place the screws
- Replace the screws.
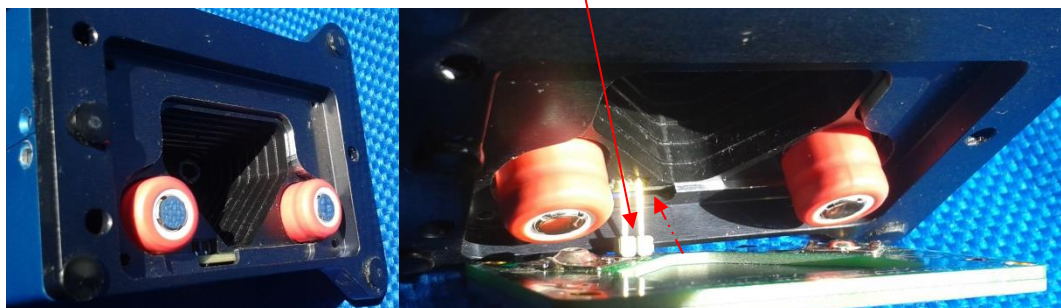
NOTE: Li-Ion batteries are placed heading BOTH "+" to the cover.
NOTE: We recommend changing the batteries every 2 years.

8.4   CT7 Firmware update

8.4.1   Procedure

The procedure is straightforward and takes just about 1 minute.

1. Get new version of **CT7_DSP.bin** from support www (link) and place it in **CT7\update** folder
2. Connect **CT7** to PC **CT7-Console**
3. At **CT7-Console** go to **CT7 Management** panel and click **DSP update** button
4. In a *file-open dialog* select the new firmware (*), press OPEN
5. Observe progress bar. A message "*DSP upload success*" pops-up : click OK
6. Finish upload with CR7 restart to activate the new firmware
    a. A message informs you that CT7 will be switched off to activate uploaded version: click OK
    b. CT7 is switched off, you have to power it up by pressing UP button of the CT7 navigation switch. CT7 goes directly to PC-link mode. *"UIF Locked"* is displayed on CT7.
    c. Now click OK on the PC CT7 Console message "Switch on CT7 and then press OK"
7. You may check the new version in the report generated by **CT7 Management**: **ExportParams.** Function

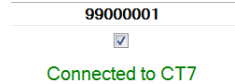(*) firmware <u>must</u> be named CT7_DSP.bin

8.4.2   Step by step firmware update procedure

Step	CT7 instrument	PC-CT7 console

1   Get new version of firmware

Download CT7.zip from support www ([link](#)), extract all to CT7 folder or just extract CT&-DSP.bin and place it in **CT7\update** folder

2   Connect CT7 to PC **CT7-Console**

99000001

☑

Connected to CT7

3   At **CT7-Console** go to **CT7 Management** panel and press **DSP update** button
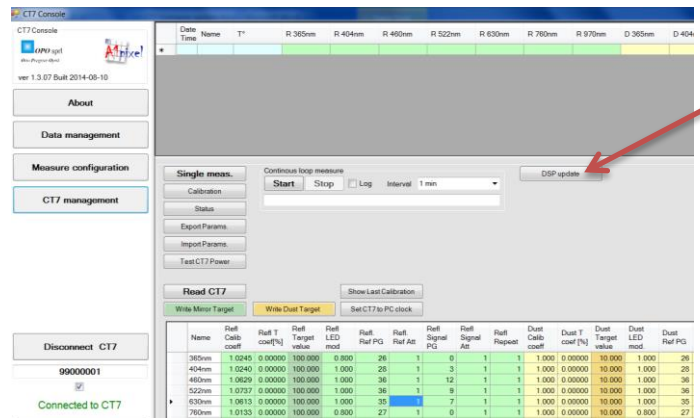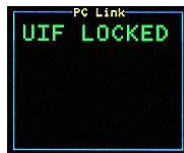
Click button *DSP update*

4   In a *file-open dialog* select the new firmware; click OPEN

5   Observe progress bar. A message "*DSP upload success*" pops-up : click OK

DSP update successful.
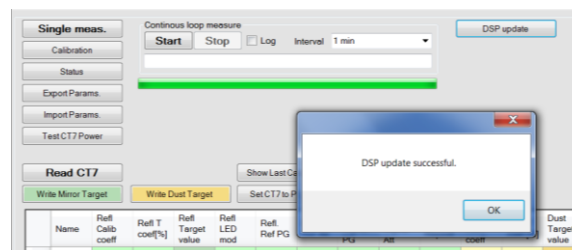
Click OK

6   Finish upload with restart of CT7
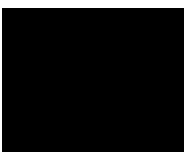
CT7 is switched OFF by PC-Console

Warning

CT7 will be restarted to activate uploaded software.

OK
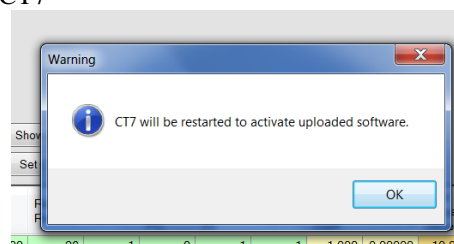
Click OK.
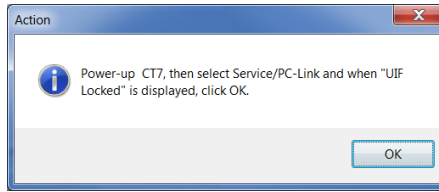
Press UP buttom.   Wait for CT7 displaying "UIF Locked" and click OK

Done.

8.4.3   Firmware upload verification:

Select FACTORY / Version option from menu:

Verify DSP software version:

9   Delivrables

CT7 box contents:
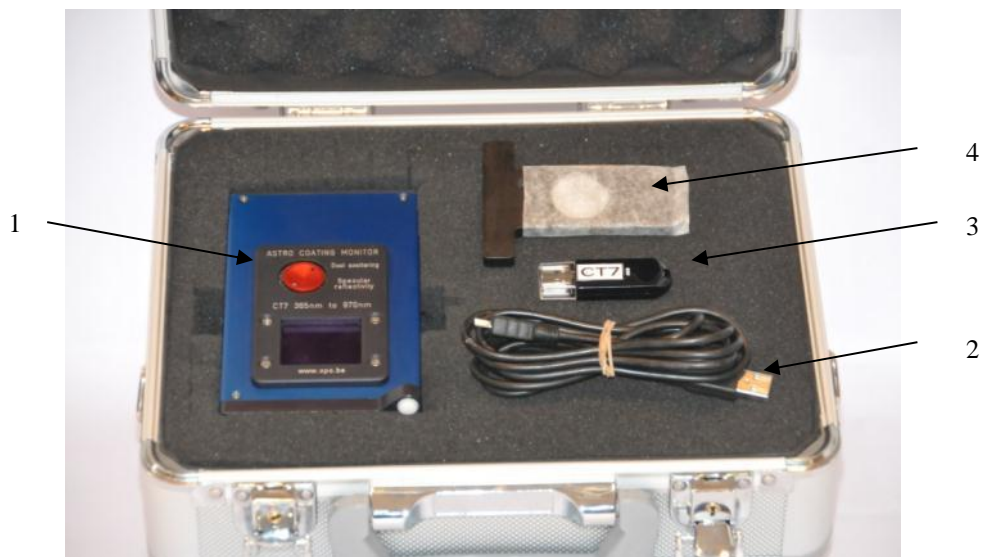
1. CT7 (with batteries)
2. Cable USB
3. USB Flash memory (Install and documentation)(*)
4. calibration mirror (**)

   (*) – Optional, latest downloads are available at support page (see para. 14 Annex 4 - Support) the "soft" delivery helps us to provide the user always with the latest version of documentation and PC application
   (**)- Optional

10 Abréviations

Cart   - The name given for selection of wavelengths used for a measurement
FWHM   - Full Width Half Maximum
TBC   - To Be Confirmed
TBD   - To Be Defined
USB   - Universal Serial Bus

11 Annex 1 - CT7 Charateristisc

CT7 Accuracy

Accuracy of reflectivity is given for reflectivity>50%

Wavelength	365	405	464	522	624	760	970
Bandpass	10	15	25	30	30	40	50
Absolute accuracy*	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.5%
Repeatability**	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.03%

* Absolute accuracy obtained using the VW jig for calibrating the gauge.
 ** for a single measurement

	Parameter	Value	Comments
1	Repeatability	See table above	Short term (5 min)
2	Thermal Stability	± 0.05%/°C	% full range
3	Incidence angle	8°	
4	Reflection wavelengths	365nm, 404nm, 464nm, 522nm, 624nm, 760nm, 970nm	Sources are LED
5	Scattering (DUST) index wavelengths	Same as reflection	Sources are LED
6	Detectors	UV Enhanced Silicon Photodiodes	
7	Operating temperature	-15 .. +40 °C	Note : CT7 may need recalibration at actual temperature Batteries may show reduction of capacity at low temperatures.
8	Storage temperature	-20°C +60°C	Not operating.
9	Power consumption	5V, Current limited to 500mA 500 -350mA when in charge 450mA when ON	Limited by construction. Protected by resettable fuse
10	Battery	2x 14500 LiIon 800mAh 3.7V	800-1200 mAh are also suitable
11	Charge	About 3.5h	From USB socket, CT7 switched OFF
12	Battery practical capacity	Minimum 75 measures Reflection, 3 days in stand-by	Fully charged, new battery
13	Power/data connector	Mini USB, type B	
14	Dimensions	73 x 85 x 147 mm	
15	Mass	700g	

12 Annex 2 - Troubleshooting

	Problem	Most probable Cause	Solution / notes
1	POWER: CT7 does not power–up	Battery discharged	connect to USB power, CT7 should start once powered, Check STATUS V3 (Vbat). V3 shall be above 3.0V to power up. CT7 may operate on USB power without batteries.
2	POWER: CT7 switch off during operation	Battery discharged	Charge the battery with USB, try to see Status voltage V3. V3 shall be above 3.0V to power up.
3	CONNECTION: CT-7 Console does not connect in automatic way to the connected instrument	Virtual COM port number has changed	CT-7 instrument dialogues with PC using a virtual COM port. CT-7 console stores the last used port and tries to connect using the same the next time CT7 is connected. Open SELECT PORT option and REFRESH list of ports. Try to Select the last port at the first try (most probably this is CT7 port), if co connection is obtained than follow with others
4	CONNECTION: CT-7 Console does not connect in automatic way to the connected instrument, interface seems to be frozen	CT-7 is in "false UIF" mode – the processors of the OLED Display and DSP are desynchronized	RESET CT7, go to PC-link mode again. OBSERVE: at CT7_Console SELECT-PORT a list of COM ports before and after connecting CT7 USB cable (do not forget to refresh the list) – a new port shall appear.
5	BATTERY CHARGE After long charge from PC (CT7 is OFF), the battery discharge rapidly	1.Wrong USB cable. The serial resistance is too high, producing significant voltage drop over the cable. 2. Damaged battery	Use USB cable suitable for high current devices, like hard drive. These cables are relatively short and thick. 1. Observe V2 at STATUS – this is USB socket voltage, if is less than 4.2V the CT7 will not charge the battery 2. Check BATTERY – if only percentage "x%" is displayed the charger will not operate with this cable. You shall see: " *x% USB Pwr*"
6	Results are NaN, +inf.	Division by 0 in processing. The codec (ADC) of the DSP has been set to incorrect configuration and returns 0.	Import last known good configuration file (or the sample one). Use *CT7-Console/CT7 Management panel/Import Parameters*
7	Low Battery CT7 emits a series of beeps and shuts down	Low battery . CT7 protects the battery against excessive discharge and disconnects the battery	Connect USB power to continue work with CT7. Leave CT7 connected (and OFF) until the BLUE led lights-up indicating full battery charge.

13 Annex 3 - Configuration file (Export/Import)

The example of configuration file generated by **Export Parameters** function:

```
;CT7 Parameters file
file_ver=1.3.00
file_date=10-07-2014 19:05
[CT7Console]
ConsoleSerial=ver 1.3.05
ConsoleBuiltDate=Built 2014-07-09
[CT7version]
serial=99000001
DSPversion=DSP v. 1.3.06
DSPBuiltDate= built 2014-06-05
OLEDversion=1.2.11
OLEDBuiltDate=2014-05-16
OLEDGversion=NA
[CONSOLE]
LED_DC=160
LEDcurrent=0.8
RrefTarget=56000
RsigTarget=48000
RPGALimit=36
RLEDLimit=0.85
DrefTarget=56000
DsigTarget=35000
DPGALimit=36
DLEDLimit=0.85
[Channels]
Channels={365nm;404nm;460nm;522nm;630nm;760nm;970nm}
Rcal={1.0202;1.0281;1.0549;1.0599;1.0532;1.0112;1.0247}
TRcal={0.04995;0.00883;0.01103;0.01233;0.01968;0.02404;0.06927}
RTcoef={82.6;83.1;85.2;89.9;90.5;83.8;89.5}
RModul={1;1;1;1;1;0.8;1}
RMCount={1;1;1;1;1;1;1}
Dcal={1;1;1;1;1;1;1}
TDcal={0;0;0;0;0;0;0}
DTCoef={10;10;10;10;10;10;10}
DModul={1;1;1;1;1;0.8;1}
DNOparam={0;0;0;0;0;0;0}
DMCount={1;1;1;1;1;1;1}

[DSPchannels]
GRRcoef={26;28;36;36;35;27;30}
GRScoef={0;3;12;9;7;0;10}
GDRcoef={26;28;36;36;35;27;30}
GDScoef={0;3;12;9;7;0;10}
IRRcoef={1;1;1;1;1;1;1}
IRScoef={1;1;1;1;1;1;1}
IDRcoef={1;1;1;1;1;1;1}
IDScoef={1;1;1;1;1;1;1}
LEDdc={180;160;180;180;160;180;200}
[DSPparams]
DSPFilter=1
DSPFinePhaseR=0
DSPDSPCoarseDelayR_R=0
DSPCoarseDelayR_S=0
DSPFinePhaseD=0
DSPCoarseDelayD_R=0
DSPCoarseDelayD_S=10
[status]
Vbat=2.77
Tbat=25.6
TDet=25.6
TLED=27.5
VxADC={8.63;3.3;4.72;2.95;4.96;5;3.36;4.33}
CT7Index=0
CT7time=20-07-2014 19:05
LastRcalib=09-07-2014 11 h
LastDcalib=09-07-2014 14 h
LastRCalibT=21.3 CLastDCalibT=22.2 C
[CT7Registers]
ConsoleVer=ver 1.3.05
CT7Folder=D:\Documents\CT7_MyCT7
ResultsFolder=D:\Documents\CT7_MyCT7\Results
ConfigFolder=D:\Documents\EASY_AUTO\projects\P091017_CT7\4_EL\Modif2014\
UpdateFolder=D:\Documents\workspace\CT7_DSP_10\bin
DocFolder=D:\Documents\CT7_MyCT7\Documents
ExportFolder=D:\Documents\CT7_MyCT7\Export
HelpFile=D:\Documents\CT7_MyCT7\Documents\umCT711001i02_user manual.pdf
UpdateDSPFile=D:\Documents\workspace\CT7_DSP_10\bin\CT7_DSP.bin
UpdateOLEDFile=NA
ExportFile=D:\Documents\CT7_MyCT7\Export\CT7DATAwitherror.CSV
MeasureFile=D:\Documents\CT7_MyCT7\Results\Archive0Archive0012000.Meas
MeasureConfigFile=D:\Documents\CT7\Config\Sample_CT7_LABO.MeasCfg
LogFile=D:\Documents\CT7_MyCT7\Results\CT7_9902-TEST7.csv
SupportWWW=http://www.a1pixel.pl/CT7/index.html
ComPort=COM27
```

14 Annex 4 - Support

Additional information:

- CT7 Presentation
- Actual version
- Firmware update   (download)
- CT7 Console update (download)
- User Manual (download)
- Technical notes

may be found at www.a1pixel.pl/CT7/index.html   in CT7 user area.

For any issue not covered by this document you may contact:

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In particular OPO covers the following topics:
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In particularA1Pixel covers the following topics:
system, electronics and software design, over-all operation scenario, software flow, updates, repair.