GLM-2000

User Manual

GLM-2000 User Manual SP101018.101

October 2012

As part of our continuous product improvement policy, we are always pleased to receive your comments and suggestions about how we should develop our product range. We believe that the manual is an important part of the product and would welcome your feedback, particularly relating to any omissions or inaccuracies you may discover.

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EC Declaration of Conformity

MKS Instruments UK Ltd declares that the:

GLM-2000 Solar wafer metrology tool

Is in accordance with the following directives:

2004/108/EEC Electromagnetic Compatibility Directive
EN 61326-1:2006 Electrical equipment for measurement, control & laboratory use.
Basic level compliance for use in laboratory environments with conditions in Table 1 from the standard.

IEC-62471 Lamp Safety Standard
No hazard for IR-A LEDS

2006/95/EC Low Voltage Directive
EN 61010-1:2006 Safety requirements for electrical equipment for measurement, control & laboratory use.

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

Signed:

J.A. Smith
VP Analytical Solutions Group
16th May 2011

CE 09

Table 1: Conditions for basic immunity from data corruption as per EN 61326-1:2006

Port	Phenomenon	Basic standard	Test value	Perform-ance criteria
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV/4 kV contact/air	B
	EM field	IEC 61000-4-3	3 V/m (80 MHz to 1 GHz) 3 V/m (1,4 GHz to 2 GHz) 1 V/m (2,0 GHz to 2,7 GHz)	A
AC power (including protective earth)	Voltage dip	IEC 61000-4-11	0 % during half cycle 0 % during 1 cycle 70 % during 25/30[e)] cycles	B B C
	Short interruptions	IEC 61000-4-11	0 % during 250/300[e)] cycles	C
	Burst	IEC 61000-4-4	1 kV (5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV[a)]/1 kV[b)]	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A
DC power[d)] (including protective earth)	Burst	IEC 61000-4-4	1 kV(5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV[a)]/1 kV[b)]	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A
I/O signal/control (including lines connected to functional earth port)	Burst	IEC 61000-4-4	0,5 kV[d)](5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	1 kV[b), c)]	B
	Conducted RF	IEC 61000-4-6	3 V[d)] (150 kHz to 80 MHz)	A
I/O signal/control connected directly to mains supply	Burst	IEC 61000-4-4	1 kV(5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV[a)]/1 kV[b)]	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A

a) Line to line.
b) Line to earth (ground).
c) Only in the case of long-distance lines (see 3.6).
d) Only in the case of lines >3 m.
e) 25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test.

Additional Installation Maintenance and Operating Instructions

In order to comply with European regulations, the following procedures must be followed:

A) INSTALLATION

1. The installation procedures given in the operating and technical manuals must be followed in addition to these instructions.

2. The mains power cable must conform to local regulations and must have a protective earth (PE) conductor securely connected to the power plug protective earth contact.

3. Only cables supplied with the equipment may be used for interconnections.

4. Cables attached to all signal and control ports must have a length of less than 3 meters. If greater length is required, MKS Instruments Ltd. must be contacted for technical guidance on possible EMC and safety issues.

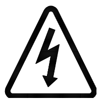
B) OPERATION

1. The equipment is not authorised for use as a critical component in a life support or safety critical system without the express written approval of MKS Instruments Ltd.

2. All instructions given in the operating manual must be followed.

3. Adjustments are strictly limited to those accessible from the control panel and computer keyboard and only when running software supplied by MKS Instruments Ltd.

C) MAINTENANCE



WARNING-DANGEROUS VOLTAGES EXIST INSIDE THE EQUIPMENT

1. Maintenance functions must only be carried out by competent persons.

2. During the warranty period, faulty equipment must be returned to MKS Instruments, Spectra Products Ltd., unless special arrangements are made.

3. There are no user serviceable parts in the electronic equipment. Certain components are EMC and safety critical and must not be substituted. Replacement parts are available from MKS Instruments, Spectra Products Ltd.

4. Equipment enclosures embody certain special fastenings and bonding devices that affect EMC and safety performance. These must be correctly re-fitted after servicing.

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Overview

The GLM-2000 is the latest innovation in silicon wafer photovoltaic metrology technology from MKS Instruments. Designed to measure wafer sheet resistance and photo-conductance properties including PC rise and fall as well as steady state conditions in a non-contact manner.

Installation:

Items shipped:

- GLM 2000 “Bench Top Unit”
- A RoHS grounded Power supply, UK, US, or Asia Adapter
- USB to RS232 Serial Adapter cable (Supports only accompanying adapter)
- 3m RS232 cable
- Wafer adapters
- Software installation CD

Install USB Serial Adapter driver

MKS offers support for only the adapter shipped with unit, other drivers and communication cable adapters not supported

- Download driver from http://www.ftdichip.com/Drivers/VCP.htm and follow setup wizard
- Select wizard for PC and follow “on-screen” instructions

Power Up GLM 2000

1. Plug RoHS power supply to GLM 2000 power jack
2. Flip rear panel power switch into the "on" position, confirm with front panel green LED light.

- Note: for power down reverse instructions above

Communication to PC

1. Connect Serial to USB adapter cable to PC USB port

2. Connect Serial connect to GLM 2000 (shown above)

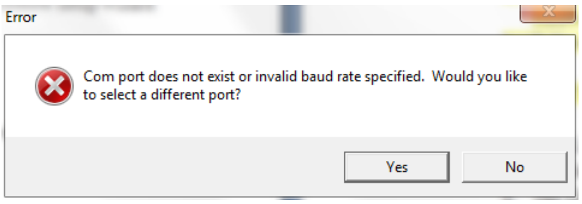
- CAUTION: apply light force to connect and use screw connector to pull into position and proper electrical contact

Load GLM Vision application software to PC

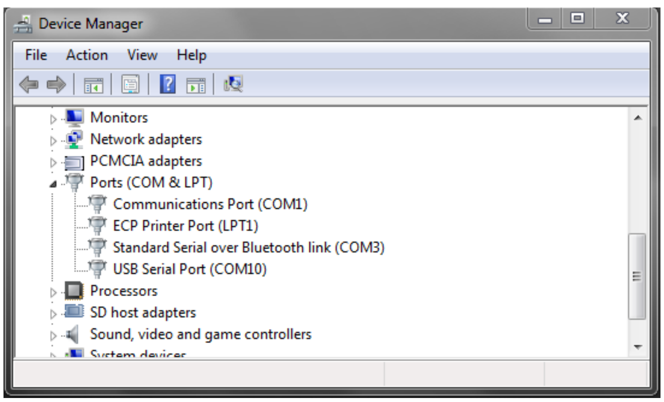
1. Insert the CD shipped with the instrument package. Windows operating systems supported include XP, Vista, Server 2008 and 7 in either 32bit or 64bit versions.
2. Follow the on-screen instructions

Run MKS GLM Vision application

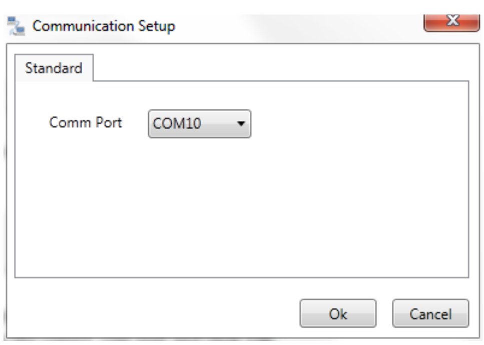
1. Double click shortcut icon on the desktop to open application, or the link in the Start Menu/Programs/MKS Instruments/GLM Vision
2. The GLM Vision window will appear or a dialogue window stating Comm Port could not be found, would you like to select a different one? If the dialog appears and you have already configured the com port, check the cables and connections. If you need to set the com port, click Yes.



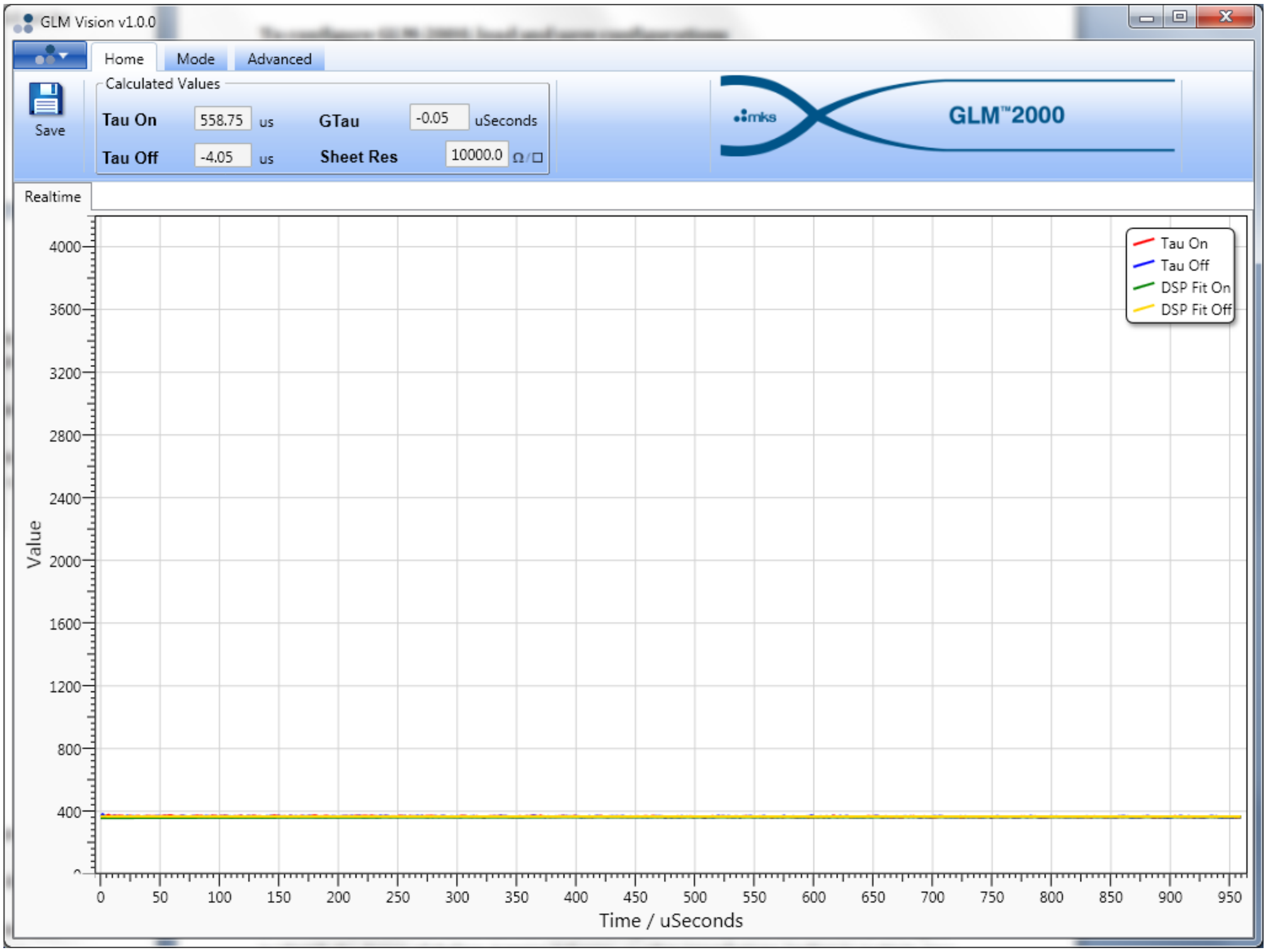
HINT: The USB adaptor comm. port number can be seen by checking the Windows Device Manager. Select the correct com port and click OK.



3. Select the correct com port and click OK.



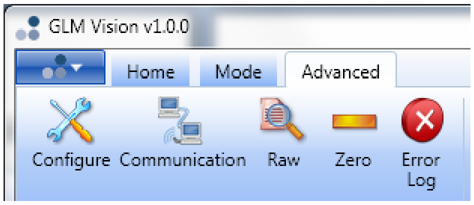
4. a flat noise free line, with no wafer inserted into tray.

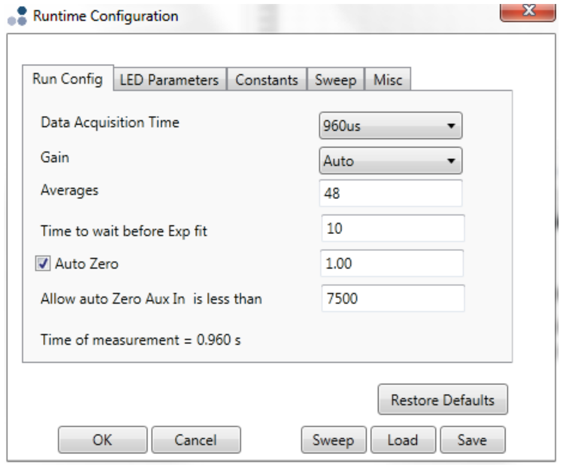


To configure GLM-2000, load and save configurations

1. The GLM-2000 was calibrated and configured when assembled and the factory default settings are stored in a reserved part of the embedded processor's memory.
2. The default parameters provide good quality data for most wafer types. If an MKS engineer has developed customized settings for your application they can be loaded from the Configure dialog box.
3. The Appendix has a more detailed explanation of all the configuration parameters and how the instrument can be recalibrated.
4. The factory defaults can be restored at any point by choosing the Restore Defaults button.

5. The configuration dialog box is accessed using the Configure button on the tool-bar of the Advanced tab:

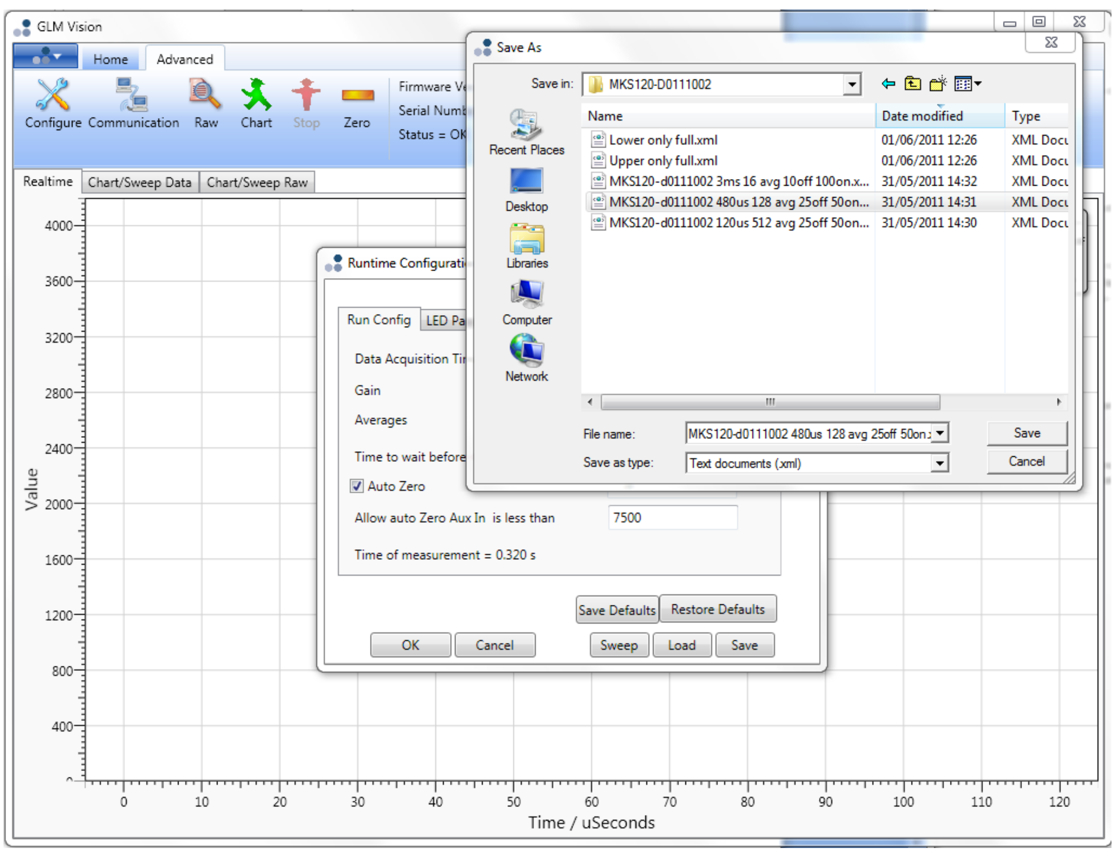




6. Load a saved Configuration by selecting the button called “Load” (as shown the figure above).

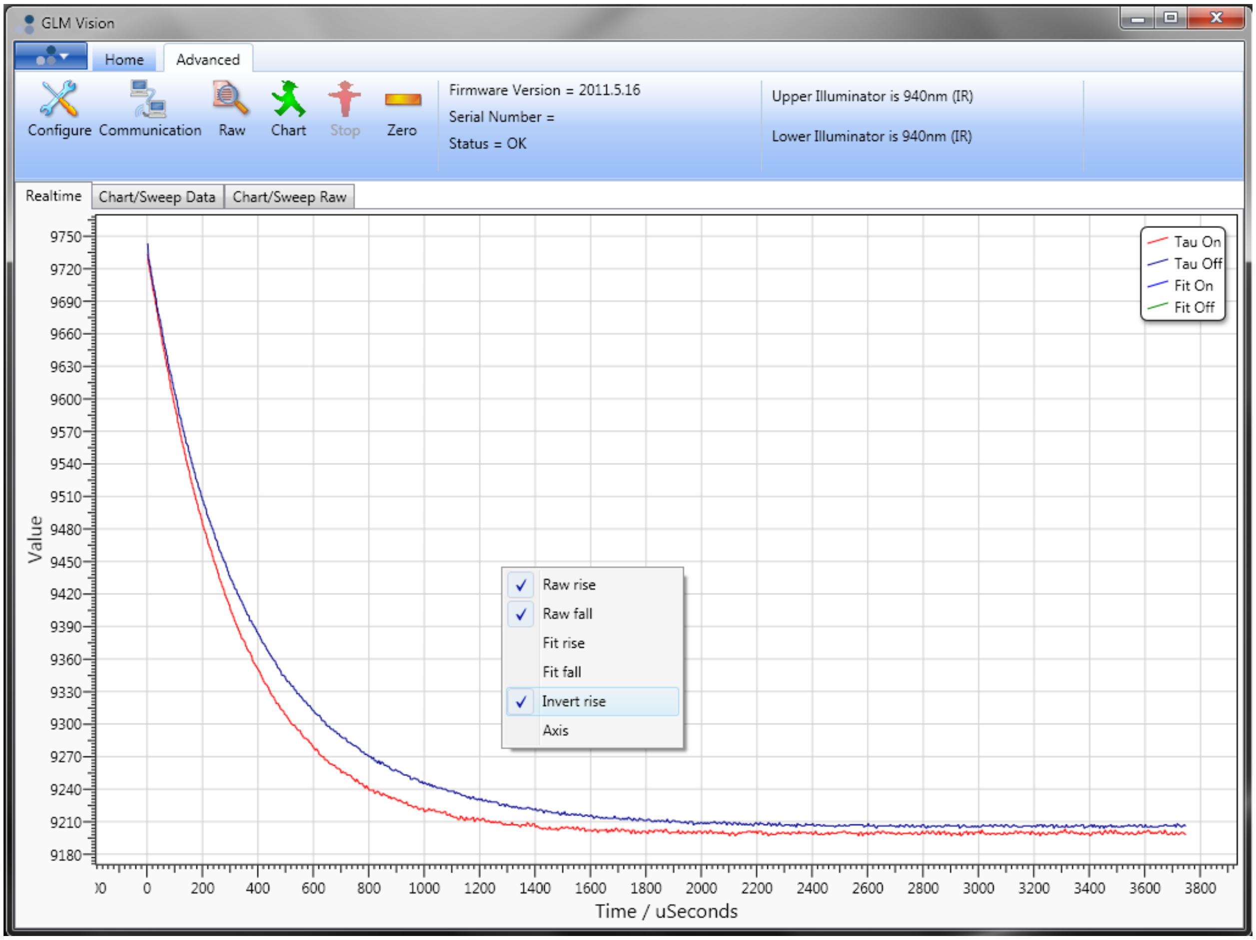
7. To change a parameter, edit the value in the box or choose an option from the drop down list. The values are applied to the GLM-2000 when the OK button is pressed.

8. If there are a set of optimized configuration parameters that need to be saved for future use, this can be done by selecting the Save button. A standard Windows save dialog is presented to create an XML file with the current Configuration.



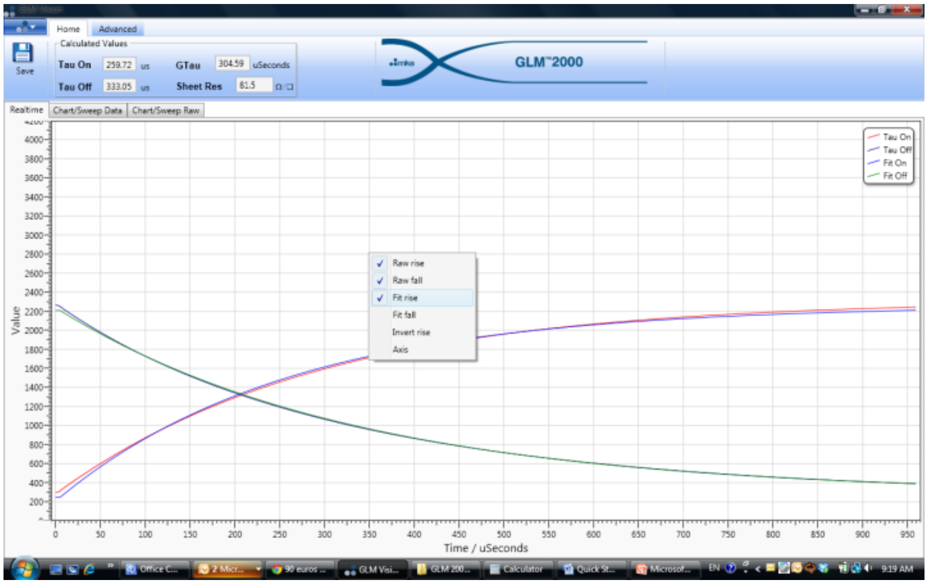
Choosing what to display on the Realtime chart

1. Right Mouse Button Click on the GLM Vision Realtime graphical display
2. Select values you want to display, typically select the following, rise & fall data along with the fitted values
3. Note you can also invert the Tau-On (Rise) signal to overlay onto the Tau-Off (Fall) signal to identify the degree of shallow trapping behavior, or other imperfections leading to multiple time constant decay behavior (multiple exponential fit).



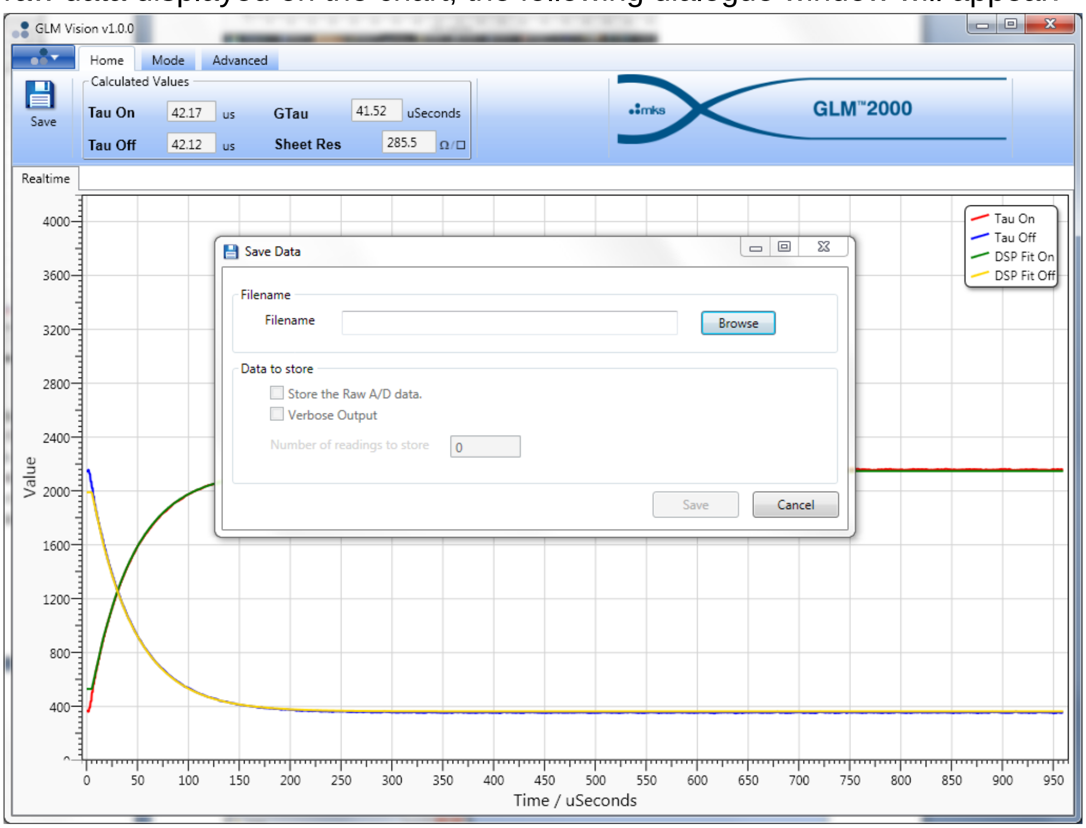
4. Visually inspect that the fitted data has good visual correspondence to data by selecting “DSP Fit On” and “DSP Fit Off”, these are the fits from the embedded processor which are based on making a linear regression fit on the natural log of each measured point. The PC Fit Rise and Fall lines can also be shown which are calculated by the desktop software on the raw data without first applying a natural log to each point. The PC Fit data is updated only every few seconds due to the time required to transfer the raw data and the longer processing required to get an exponential fit on data that has not first been converted.

5. If not, adjust the “Time to wait=[set new value]” in the Run Config tab of the Configuration dialog box to appropriate start time in µsec



Saving data files

1. Click on the Save Icon on the Home tab when you want to export the calculated or raw data displayed on the chart, the following dialogue window will appear.



2. Select the file name and file store path\location manually or by browsing directory using “browse” button

3. By default GLM Vision will store just the fitted data into a csv file format, checking "Store the Raw A/D data" will also include the raw data as seen on the screen

4. To obtain a more comprehensive export of data with all of the fitting parameters, check the Verbose Output tick-box.

5. Furthermore you can select how many readings to record by entering a number in the field, leaving the field at zero will continuously save data until the Save icon is pressed again to stop.

6. The default will continue to record readings and append to the defined file name until the save button is deselected by clicking the "save" button a second time. Note active data recording is apparent because the "save" button appears with a red color block. If a number of readings to save has been defined in the Save dialog box, the Save icon will automatically revert to before when the correct number of saved data points is reached.

7. The file formats saved are:

a. Wafer Name_CALC.csv

b. Wafer Name_ RAW_ON.csv

c. Wafer Name_ RAW_OFF.csv

NB: All csv files have a header with information on the unit and method used:

Column Name	Format
Date/Time	dd/mm/yyyy_hh:mm:ss
Serial Number	MKS120-yxxxxxxx
File Type	Calculated = 1, Raw = 2
File Version	Integer usually 1
Data Resolution	Interleaved or Full
Data Acquisition Time	120us, 240us, 480us, 960us, 3ms, 30ms
Averages	1-4096
Time to wait before Exp fit	0-100
K Factor	Double value
Thickness	1-2000um
LED Upper Off	0-4095
LED Upper On	0-4095
LED Lower Off	0-4095
LED Lower On	0-4095
Upper Range	0 = None, 1 = Low, 2 = Medium, 3 = High
Lower Range	0 = None, 1 = Low, 2 = Medium, 3 = High

The CALC data then has one row per reading for the following values:

Column Name	Format
Time	dd/mm/yyyy_hh:mm:ss
Relative time	
Identifier	0-65535

GTau 16 bit	-65535 to 65535
Temp	0 to 100 C
Aux In Zero	0 to 65535
DSP Rise T	0 to 65535
DSP Fall T	0 to 65535
DSP Rise R^2	-1000 to 1000
DSP Fall R^2	-1000 to 1000
Status	1 = sleep; 0 = alive
GTau uSeimens	> 0
GTau uSeconds	> 0
Rise Single T1	0 to 65535 (Null if disabled)
Rise Single M1	0 to 65535(Null if disabled)
Rise Single DC	0 to 65535(Null if disabled)
Rise Single R^2 Log	-1 to 1(Null if disabled)
Rise Double T1	0 to -65535(Null if disabled)
Rise Double T2	0 to 65535(Null if disabled)
Rise Double M1	0 to 65535(Null if disabled)
Rise Double M2	0 to 65535(Null if disabled)
Rise Double DC	0 to 65535(Null if disabled)
Rise Double R^2 Log	-1 to 1(Null if disabled)
Fall Single T1	0 to 65535(Null if disabled)
Fall Single M1	0 to 65535(Null if disabled)
Fall Single DC	0 to 65535(Null if disabled)
Fall Single R^2 Log	-1 to 1(Null if disabled)
Fall Double T1	0 to -65535(Null if disabled)
Fall Double T2	0 to 65535(Null if disabled)
Fall Double M1	0 to 65535(Null if disabled)
Fall Double M2	0 to 65535(Null if disabled)
Fall Double DC	0 to 65535(Null if disabled)
Fall Double R^2 Log	-1 to 1(Null if disabled)
LED On Upper Counts	0 to 65535
LED On Lower Counts	0 to 65535
LED Off Upper Counts	0 to 65535
LED Off Lower Counts	0 to 65535
LED On Upper mW	0 to 1000
LED On Lower mW	0 to 1000
LED Off Upper mW	0 to 1000
LED Off Lower mW	0 to 1000
Upper Range	Low, med, high
Lower Range	Low, med, high

The Verbose Output contains the following additional information:

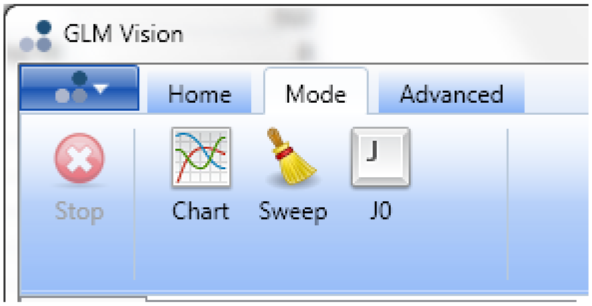
Column Name	Format
GTau 12bits	-4096 to 4096
PD Upper On	0 to 65535

PD Upper Off	0 to 65535
PD Lower On	0 to -65535
PD Lower Off	0 to 65535
MO Gain	1, 2, 4, 8, 16, 32
AuxIn On	0 to 65535
AuxIn Off	0 to 65535
DSP Fit Mag Rise	0 to 65535
DSP Fit Mag Fall	0 to 65535
Steady State On	0 to 4095
Steady State Off	0 to 4095
PD Zero Upper	0 to 65535
PD Zero Lower	0 to 65535
LED Lower On Lower PD	0 to 65535
LED Lower On Upper PD	0 to 65535
LED Upper On Lower PD	0 to 65535
LED Upper On Upper PD	0 to 65535
DSP Number Rise Points	0 to 1500
DSP Number Fall Points	0 to 1500
Single Number Rise Points	0 to 1500(Null if disabled)
Single Number Fall Points	0 to 1500(Null if disabled)
Double Number Rise Points	0 to 1500(Null if disabled)
Double Number Fall Points	0 to 1500(Null if disabled)
DSP Rise RMS	0 to 65535
DSP Fall RMS	0 to 65535
Single Rise R^2 Lin	-1 to 1(Null if disabled)
Single Rise RMS Log	0 to 1000(Null if disabled)
Single Rise RMS Lin	0 to 1000(Null if disabled)
Single Fall R^2 Lin	-1 to 1(Null if disabled)
Single Fall RMS Log	0 to 1000(Null if disabled)
Single Fall RMS Lin	0 to 1000(Null if disabled)
Double Rise R^2 Lin	-1 to 1(Null if disabled)
Double Rise RMS Log	0 to 1000(Null if disabled)
Double Rise RMS Lin	0 to 1000(Null if disabled)
Double Fall R^2 Lin	-1 to 1(Null if disabled)
Double Fall RMS Log	0 to 1000(Null if disabled)
Double Fall RMS Lin	0 to 1000(Null if disabled)

These same values can also be viewed in real time in the Raw dialog box accessed from the Advanced tab of the GLM Vision software (See Appendix).

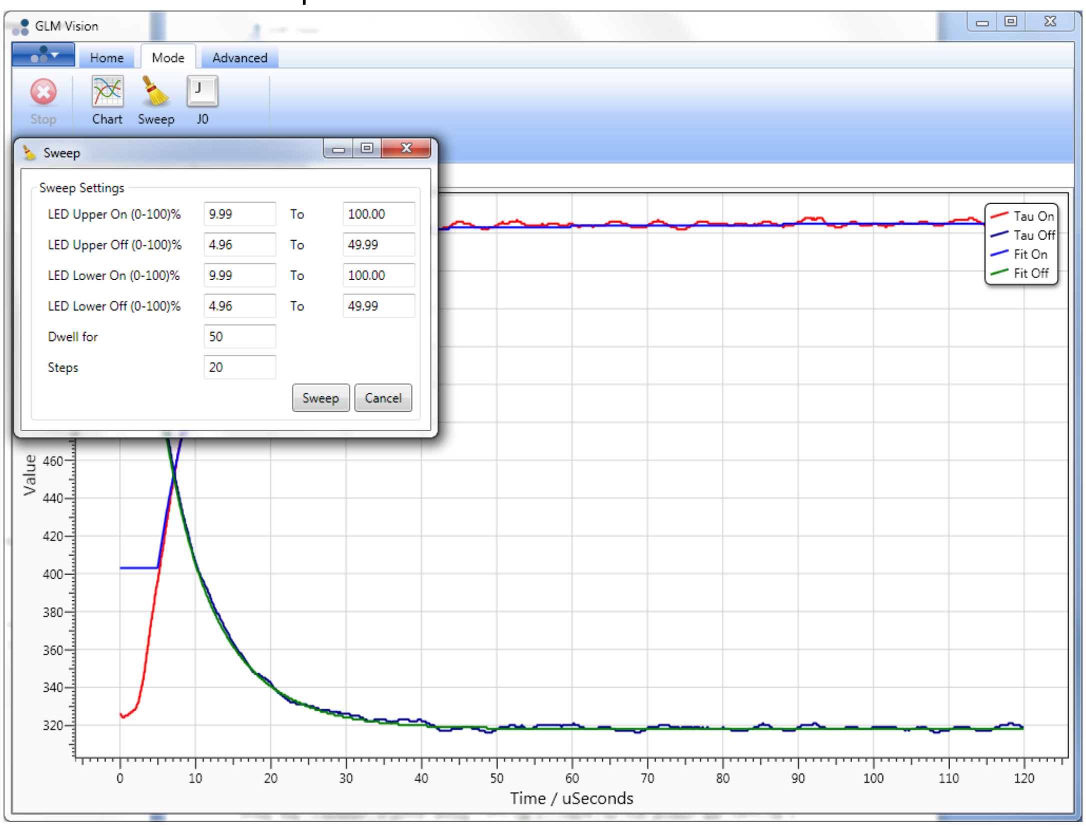
The RAW_ON and RAW_OFF data shows the 1500 analog to digital count readings for each Tau on and Tau off curve displayed respectively. The time between each count reading is the Data Acquisition Time shown in the header divided by 1500.

Modes of data acquisition

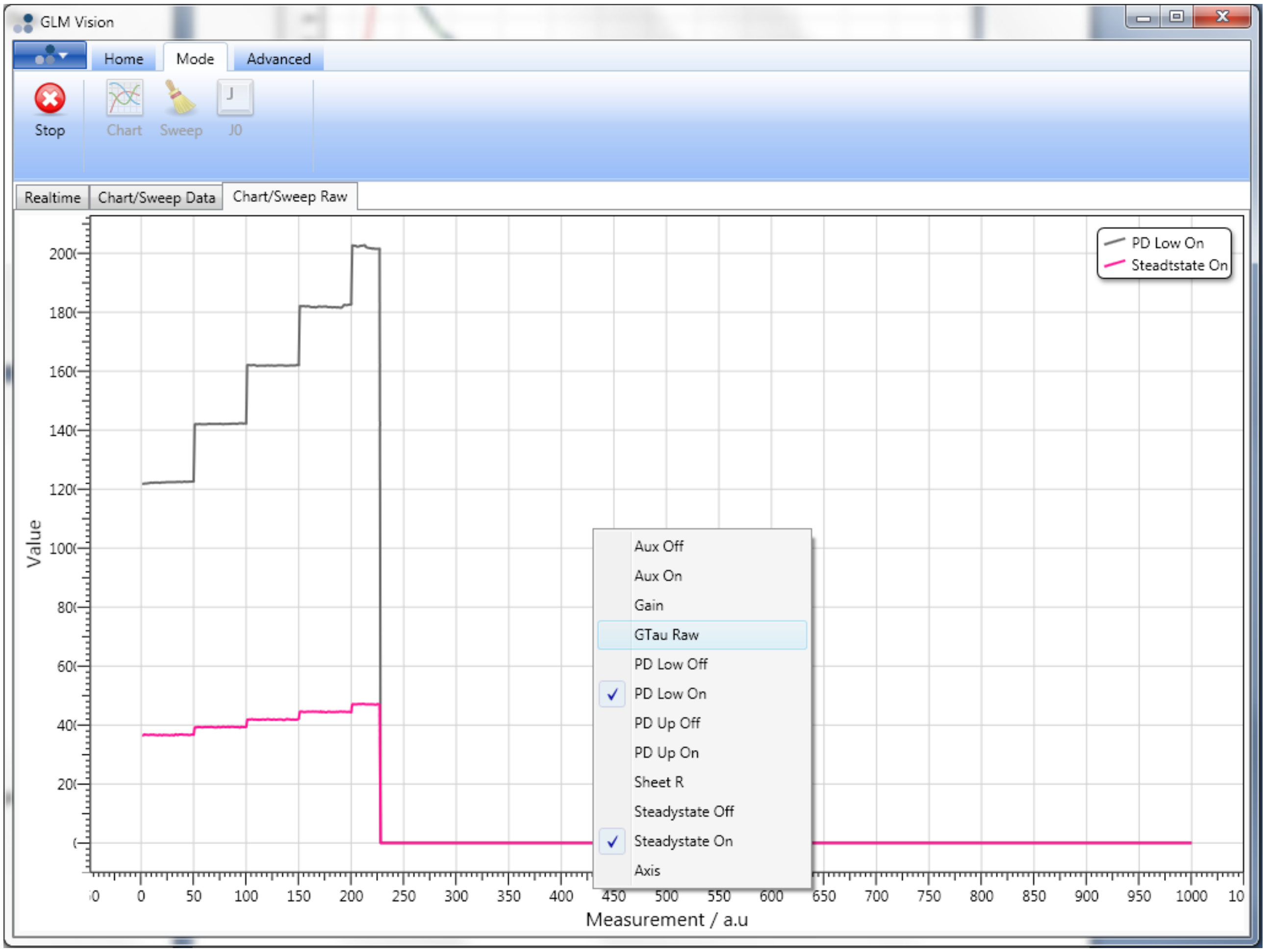


Sweep

1. Select the Mode Tab→Sweep button on tool bar
2. The Sweep conditions for the currently loaded Configuration file will be shown. These can be edited and generall dwell for=1 and Steps=25 is sufficient to run a least-squares fit routine to find slope and offset.



3. Example of displayed data, vertical axis is the value for whatever is chosen to display from the available choices. All data is collected but the display shows only what has been selected form the right hand mouse button context menu on the graph, the horizontal is sweep step.



NB: When collecting Sweep data it is advisable to used a fixed Gain as step changes in gain are not then visible in the sweep data.

4. To abort the collection of sweep data part way through click on the Stop button. The GUI will ask if you want to save the data. At the end of a sweep the GUI will also ask if you want to save the data as a CSV file.

5. The CSV format carries metadata about the GLM-2000 unit used and the following data in columns with each row of data being a measurement based on the the loaded configuration so the total number of rows is the Dwells*Steps.

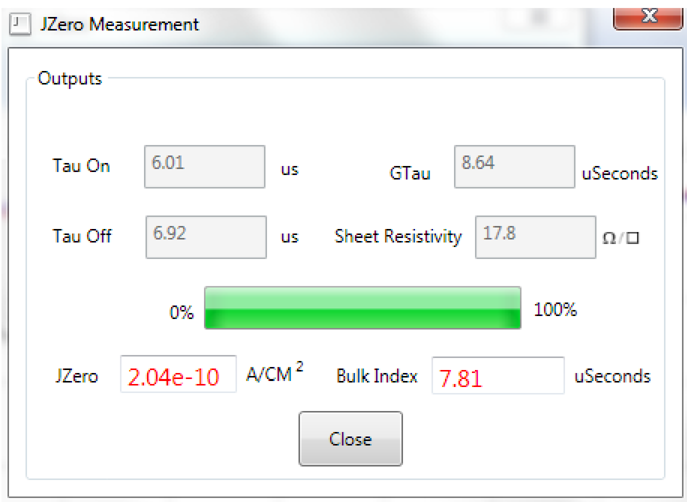
Index	Number from Dwells*Steps
LED Lower Off	12bit DAC value
LED Lower On	12bit DAC value
LED Upper Off	12bit DAC value
LED Upper On	12bit DAC value
Tau On	PC Rise, µseconds (**tau**)
Tau Off	PC Fall, µseconds (**tau**)
GTau	In user defined units
GTau 16bit	16 bit A2D of steady state PC
Sheet Resistivity	In user defined units
Zero	16 bit A2D of zero offset
Detector lower off	16 bit A2D when LED OFF
Detector lower on	16 bit A2D when LED ON
Detector upper off	16 bit A2D when LED OFF
Detector upper on	16 bit A2D when LED ON
Temperature	Internal sensor on processor PCB (°C)
Fit fall	Multiplier (**M**) for PC Rise exponential on graph
Fit rise	Multiplier (**M**) for PC Fall exponential on graph
Steady state off	12 bit A2D of RF Error steady state LED Off (**C**)
Steady state on	12 bit A2D of RF Error steady state LED On (**C**)
Aux In On	16 bit A2D of RF Error steady state LED On
Aux In Off	16 bit A2D of RF Error steady state LED Off
GTau AuxIn	16 bit raw Gtau (On-Off)
Gain	Gain used for 12 bit A2D
Graph Equation	Y = **M** * exp(-t/**tau**) +/- **C**

Jzero

1. Select the Mode Tab→J0 button on tool bar

2. Several properties can be inferred or calculated by logging Lifetime versus injection level curves or carriers per cubic centimeter. For example emitter saturation currents (J_{oe} or J Zero) and the lifetime of the can be calculated by considering the inverse effective lifetime over a predetermined injection range. The parameter is determined by calculating a least squares fitted line to the inverse PCD (seconds) versus the injection level in units of the number of excess carriers per cubic centimeter (#/cc).

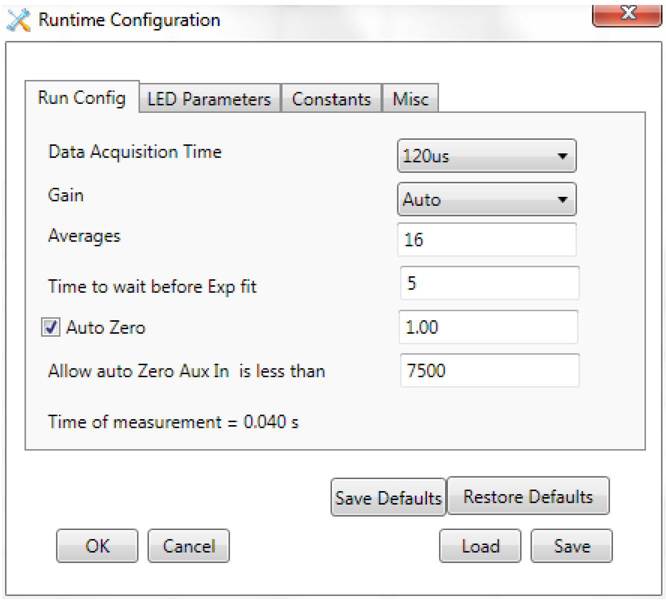
3. With the instrument warmed up and zeroed, when a wafer is inserted and the J0 button clicked a fixed routine varies the LED power and collects data over approximately 20 seconds to generate the two parameters Jzero and the Bulk Index which is a parameters related to the interpolated lifetime of the bulk material at zero illumination.



Appendix

Configuration parameters dialog:

Run Config



Data acquisition time:
The window chosen should be appropriate for the carrier lifetime of the wafers being measured. The most accurate data will be obtained by choosing a time that is less than two times the expected PCR/PCD lifetime of the wafer.
The minimum window is 120µs and this can be used to estimate the best time choice for the highest quality data.

Gain:
Normally this should be left at Auto and the most appropriate gain will be used to get the best signal to noise for the analog to digital converters.
NB: When collecting Sweep data it is advisable to used a fixed Gain as step changes in gain are not then visible in the sweep data.

Averages:
This is the number of LED on/off cycles to average together before fitting the exponential curves and calculating the sheet resistance and GTau values.
NB: The data acquisition time and averages parameter denote the total data acquisition time. The calculated measurement time for one reading is shown at the bottom of the dialog box.

Time to wait before Exp fit:
The initial few microseconds of data collection when the LED is switched will be a convolution of the response time of the wafer AND the response time of the circuit that

determines the conductivity of the wafer (the MO board). The time constant of the MO board is ~2.5µs which is why the accuracy of the Tau-on (PCR) and Tau-off (PCD) is poorer than for the GTau steady state short lifetime wafers when calibrated for the equivalence of µs PCR/PCD (see calibration section).
To prevent the initial convolution of the MO board time constant from effecting the curve fit of the PCR/PCD exponential, the software can be configured to not start the fit until some µs after the LED has switched, typically values between 3 and 10 µs should be used.

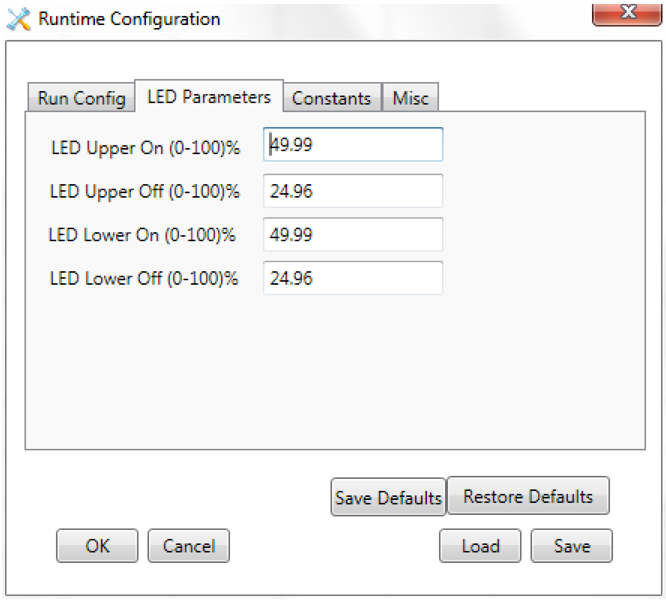
Auto Zero:
The accuracy of the Sheet Resistance or Conductivity measurement is dependent on the zero value measured for the Aux In (the voltage measured on the MO board that is directly proportional to the wafer sheet resistance). For convenience, it is possible to have the GLM-2000 automatically re-zero the Aux In when a wafer is not present. In order to detect when a wafer is not present the GLM-2000 uses the combination of two parameters:

- That the measured Gtau value is less than a trigger value (typically 0.5 to 5 raw digital counts) – this indicates that no photo-active material is present in the sensor head.
- That the Aux In measured digital value is significantly less than a value that would indicate the present of a non photo-conductive wafer which might be used for sheet resistance measurement only (typically <8000 but normally ~1.2-1.5 times the Aux In zero reading).

The software re-zeros if both of the above conditions have been met for the current reading and previous 10 readings. The multiple reading check is to prevent the re-zeroing of the instrument accidentally while a wafer is being inserted.

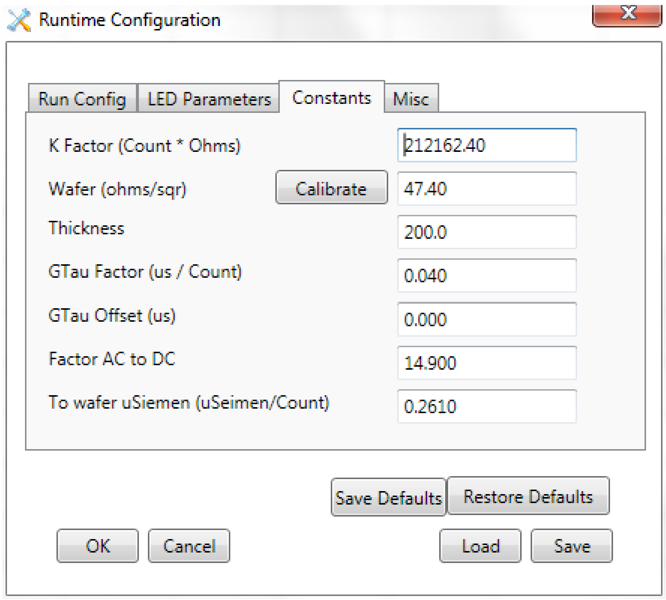
NB: If a long acquisition window and/or large numbers of averages are used then the time taken for the auto-zero to be triggered may be inconveniently long. Consider reducing the acquisition window to the minimum necessary for the lifetime of the wafer and reducing the number of measurements to be averaged. As a general rule, longer lifetime wafers have much stronger signals and so require fewer averages anyway to get good signal to noise levels.

LED Parameters



The On and Off powers for the LEDs are set here. When values are entered, the software will set the closest digital value for the chosen power, when re-opening the dialog box this will show a value that is the closest digital fit to the chosen power (a 12 bit digital to analog convertor is used).
If the GLM-2000 unit is a dual wavelength LED system (i.e. GLM-2000-GIR) this dialog can be used to set up configurations for NIR (lower) or Green (upper) only or to use both. The best configuration for a particular wafer can be determined experimentally and MKS applications engineers are available to assist in the design of experiments to optimize data collection.

Constants



Set K constant for sheet resistance reference and single point calibration

1. Insert a known non-diffused sheet resistance standard, and the measured or expected thickness of the calibration wafer.
2. Select the button "Calibrate"
3. Remove wafer for 15secs, and reinsert to confirm calibration value on GLM Vision screen by reading off the Sheet Resistance field in tool bar (found in Home tab in GLM Vision software).
4. If reading is incorrect, check that the instrument has re-zeroed (using auto-zero or manually press the zero button on the Advanced tab) then repeat a. to c. above
5. Select save button to save your new recipe for "constants" to be loaded in future dates
6. Note this saved version of "Constants" is also simultaneously rewritten to EEPROM memory for future sessions. In the event flash memory is over written by other users, merely re-select your recipe from file to reestablish original calibrated values.

GTau photoconductance calibration to microsecond

1. The GTau microsecond equivalence calibration will change with different LED parameters and wafer surface properties.

2. A different calibration factor will be required for each method with different LED powers so each Configuration with different powers will need to be saved and a calibration factor defined if the steady state GTau equivalent microsecond unit is to be used.

3. A different calibration factor will be required for each method for different wafer surface types so each Configuration with different powers will need to be saved and a calibration factor defined if the steady state GTau equivalent microsecond unit is to be used.

4. Choose a reference wafer of the same type you will be using the saved Configuration to measure.

5. Enter the reference wafer into GLM 2000 tray and open the Configure dialog, on the Misc. tab make sure that the GTau Display choice is “uSeconds”.

6. Switch the main GLM Vision screen back to the Home tab and monitor the Tau-on reading and Gtau reading.

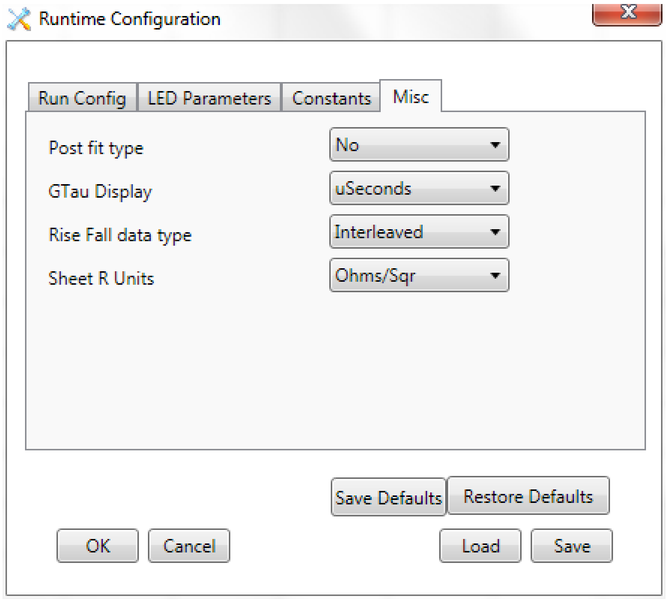
7. For default conditions (50% LED-on 25% LED-off on raw cut wafers) the GTau factor is approximately 0.04 µs/count. Change this value whilst monitoring Tau-on and GTau (uSeconds) until they agree.

8. Press the Save button to permanently save the calibration to the current configuration method.

NB: The GTau offset should not be changed from zero unless indicated by an MKS Applications Engineer.

NB: The AC to DC and uSiemen/count factors are defined at the factory and should only be changed if any parts are exchanged in the unit or under the instruction of an MKS Applications Engineer.

Misc.



Post fit type:
The raw data displayed on the GLM Vision chart can have a line of fit displayed which is by default the fitting parameters defined by the DSP on the GLM 2000. This is the single exponential used to show the calculated Tau-on and Tau-off data. In order to calculate the fit very quickly, the final steady state readings are used as part of the calculation. This means that if the photoconductance rise or decay is not a simple single process, the fitting and therefore reported value will be a convolution of the multiple processes.
The raw data can additionally be used to calculate the exponentials through an iterative algorithm using the more powerful desktop PC processor with more memory available. This calculation is not fast enough to obtain data at the speeds possible with the DSP but it does allow first order fitting to just the first part of the curve and second order fitting to look for multiple photoconductance processes.
The choice of Post fit type is No (No fitting), Single Exp (a best single fit exponential value is calculated) and Double Exp (where the best fit is found using two exponential constants).

GTau display:
The calculated GTau can be displayed as raw analog to digital counts, as uSiemen calibrated at the factory or uSeconds equivalence which is user calibrated based on their chosen method and wafer type.

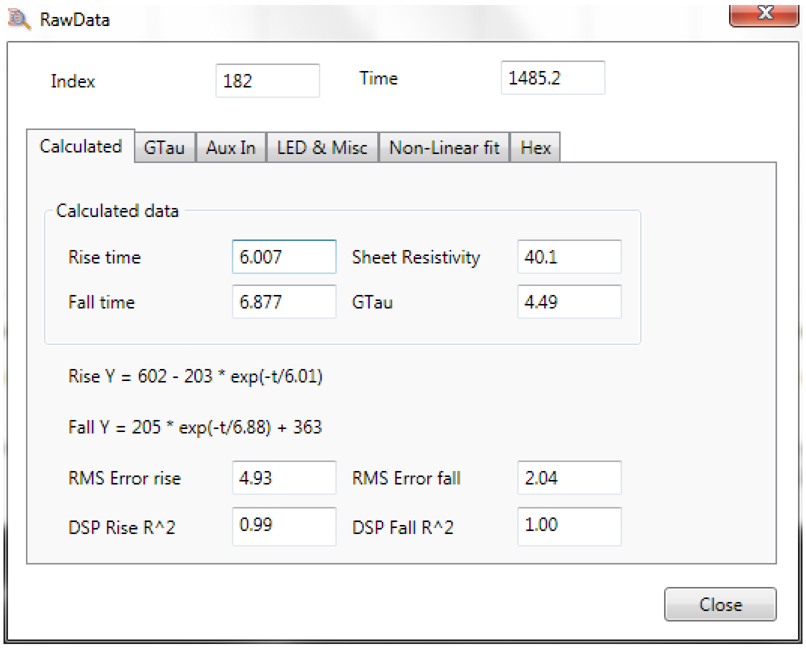
Rise Fall data type:
The raw data is transferred from the GLM-2000 to the desktop PC once every approximately 4 seconds depending on the length of the acquisition window and the number of averages chosen for the calculated fitting. By default, Interleaved copies across half the points for the rise and fall (2 times 750 points) which is enough for the post-fitting algorithm to calculate the single or double exponential. To get all 1500 points for rise and

fall, Full can be selected but this will reduce the update time. For applications where the fastest possible stream of calculated values (i.e. Tau-on (rise), Tau-off (fall), GTau (steady state) and Sheet resistance/conductivity) choosing None will stop the transfer of raw data and the saved data will then we a constant stream of un-interrupted numerical data useful for in-line applications where the wafers are being transferred through the GLM-2000 on an automated line.
The raw rise and fall data can also be seen for the upper or lower photo-diode detectors. This is mostly used for instrument diagnostics by an MKS technician.

Sheet R units:
The choice between ohms per square or square Siemens can be made here, the chosen unit is used for the display on the Home/Calculated Values section of the GLM-Vision screen.

Raw Data dialog.

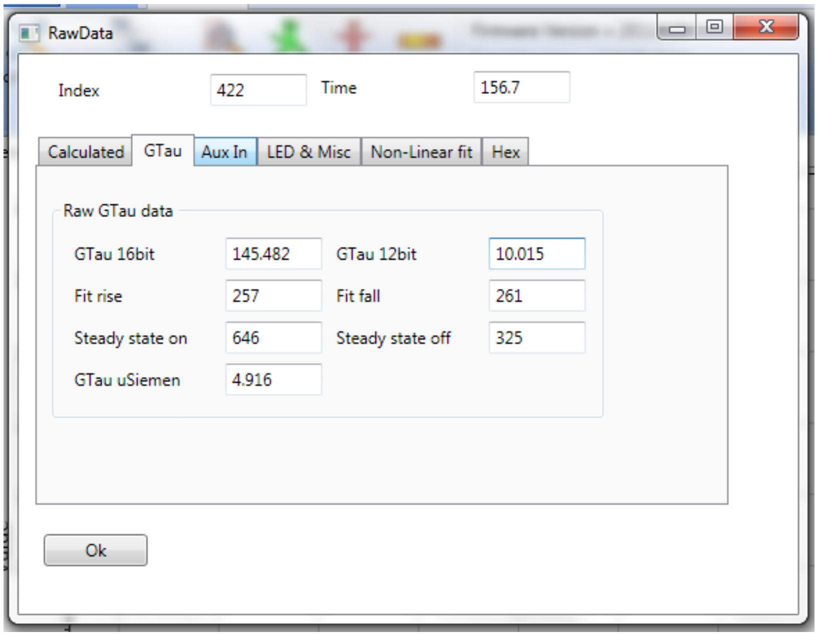
Calculated



The calculated data is the same as displayed on the GLM Vision Home page but with the addition of the full single exponential equation derived by the embedded DSP and the quality of fit data which are the RMS error and R^2 correlation coefficients based on the fit of the logarithm of the rise and fall analog to digital count values.

WARNING: The quality of the linear fit equation to the logarithmically derived values from the raw A2D counts will appear better than the fit shown by the off-line processing by the desktop computer which is a logarithmic fit to the raw data. This compromise of the DSP performing a linear fit to log data is to allow for the fastest possible processing of the data. This limitation will be most noticeable with wafers of very small charge carrier lifetimes or charge carrier creation and combination processes which have second order effects.

GTau



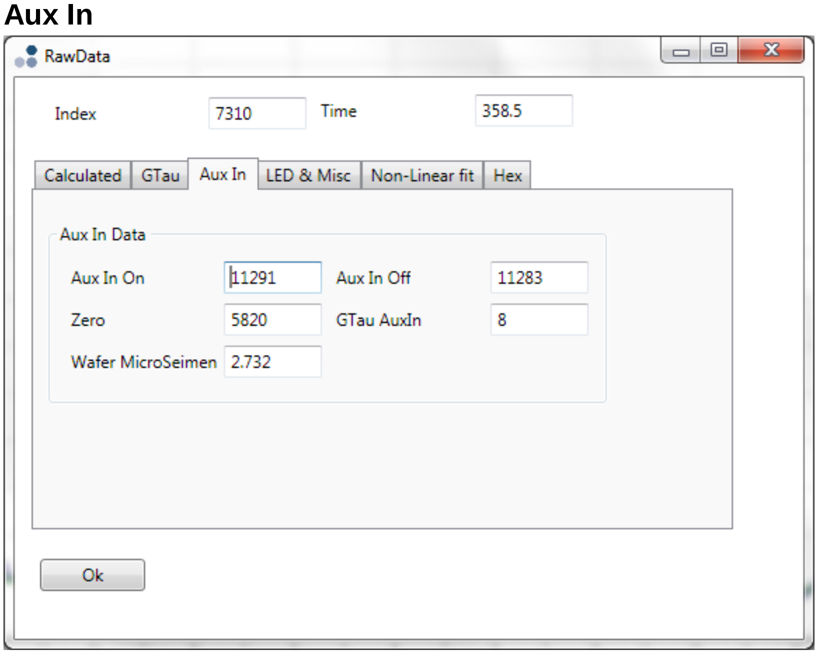
GTau 16 bit is the 16bit analog to digital count value used to derive the GTau value displayed on the Home page or CSV as “Raw”.

The 12bit GTau reading is only used in the PC Rise and Fall fitting algorithm in the DSP after the raw values have been converted to natural logs – the value is not used for the GTau calculation.

The Fit Rise/Fall and Steady State On/Off values are the fitting parameters from the DSP from the equations displayed on the Calculated page of the Raw dialog.

The GTau uSieman is the value calculated from the GTau raw using the calibration constant set in the Configure dialog.

Aux In



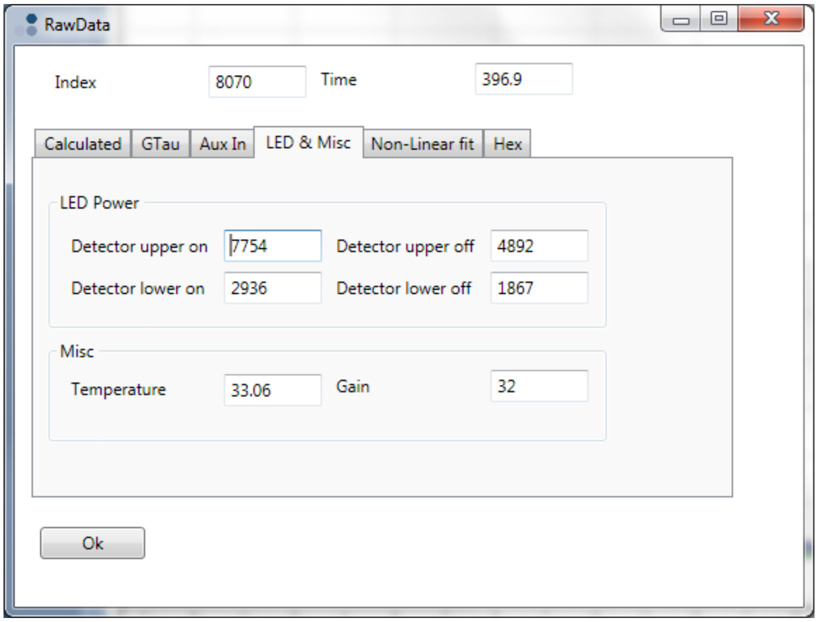
The Aux In On/Off values are the 16bit analog to digital values when the LED is High or Low.

The zero is the constant value with no wafer present which is removed prior to calculating the sheet resistance of the wafer.

GTau AuxIn is the difference between Aux In On and Off.

Wafer MicroSiemen is the calculated value from the calibration constant defined in the Configure dialog.

LED & Misc

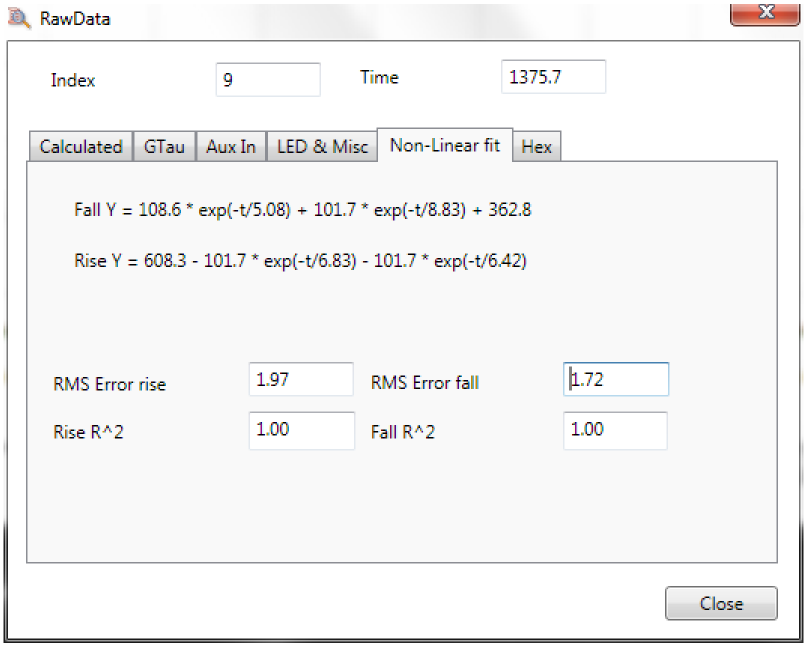


The LED Power values are 16bit A2D readings of the upper and lower photodiodes when the LEDs are high (On) or low (Off). When a wafer has just been reomved, for a given configuration these should remain constant.

HINT: It would be good practice to record these values weekly or monthly with a set configuration and no wafer present. Any sudden change might indicate that the protective film on the lower ferrite core has become dirty and needs replacing or that an LED has failed. Over time, a slow degradation of the LED power is expected and in normal use this should be <1% per month.

NB: In a future version of software and firmware this process is likely to be automated and the photodiode values even used to maintain a constant LED power to reduce aging effects.

Non-linear fit



The Non-Linear fit data is only populated if the Configure dialog's Misc./Post Fit type is set to Single or Double exponential. The linear domain rise and fall equations are displayed along with the RMS error and R^2 correlation coefficients.