GENESYS 30 Spectrophotometer

User Guide

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Thermo SCIENTIFIC

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WARNING Avoid an explosion or fire hazard. This instrument or accessory is not designed for use in an explosive atmosphere.

For Research Use Only. This instrument or accessory is not a medical device and is not intended to be used for the prevention, diagnosis, treatment or cure of disease.

GENESYS 30 User Guide

The Thermo Scientific™ GENESYS™ 30 visible spectrophotometer is designed to measure transmittance and absorbance in the range 325 nm to 1100 nm. Typical samples are contained in a square plastic or glass cuvette with a pathlength of 10 mm. Sample holders that support measurement of solutions in test tubes or longer cuvettes, and limited options for measuring transmitting solid samples, are also available.

The spectrophotometer incorporates control software capable of displaying absorbance or transmittance data as single wavelength measurements or as a wavelength scan. It can also perform simple mathematical operations on data obtained at one or multiple wavelengths and present the results of these calculations. Additionally, the software supports quantitative analyses using either a user-entered calibration factor or establishment of a calibration equation using between one and six measured standard solutions.

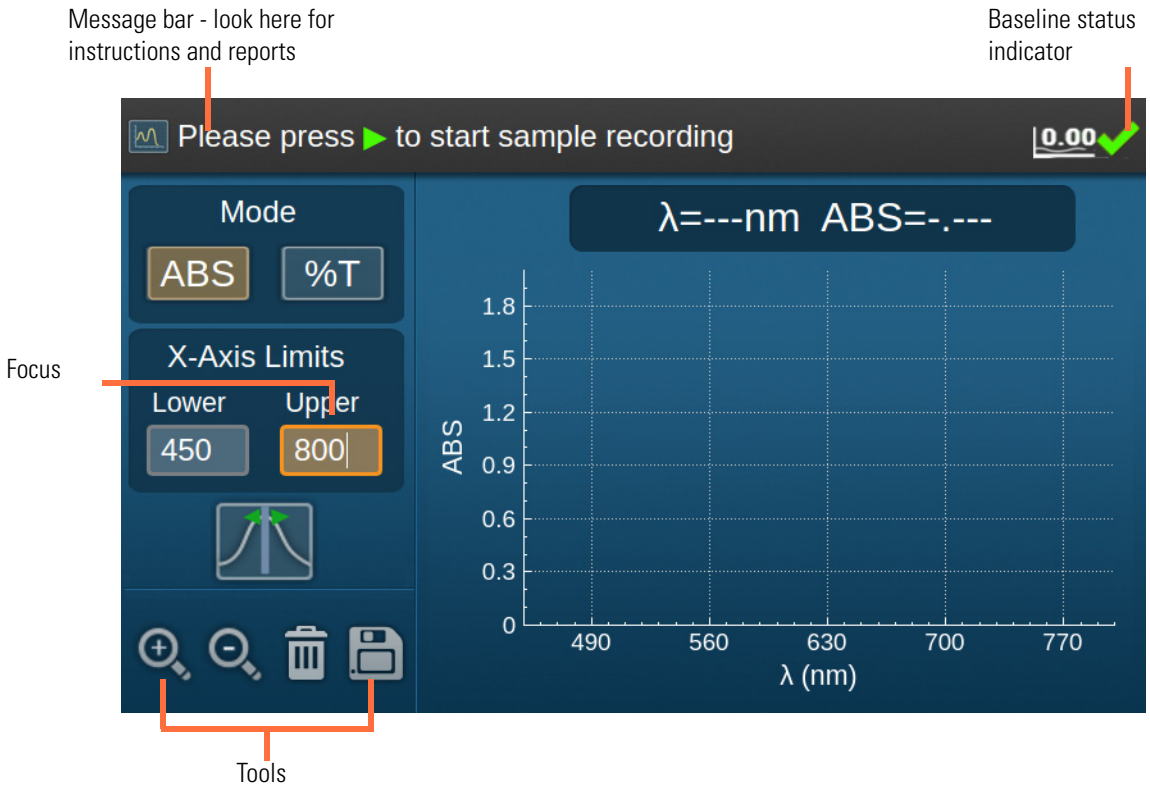
Data from the spectrophotometer's measurements are displayed on a high resolution color screen (32 bit, 800 x 480 pixels) and may also be printed using an optional thermal printer accessory or saved to a flash memory device through a USB port conveniently located on the front of the instrument.

All aspects of the users' interactions with the GENESYS 30 visible spectrophotometer have been carefully considered and accommodated in the design of the instrument. Accessibility of the sample compartment, layout and labeling of the keypad, and placement of the tools and features in the software are all optimized to provide the best possible user experience for the instrument user.

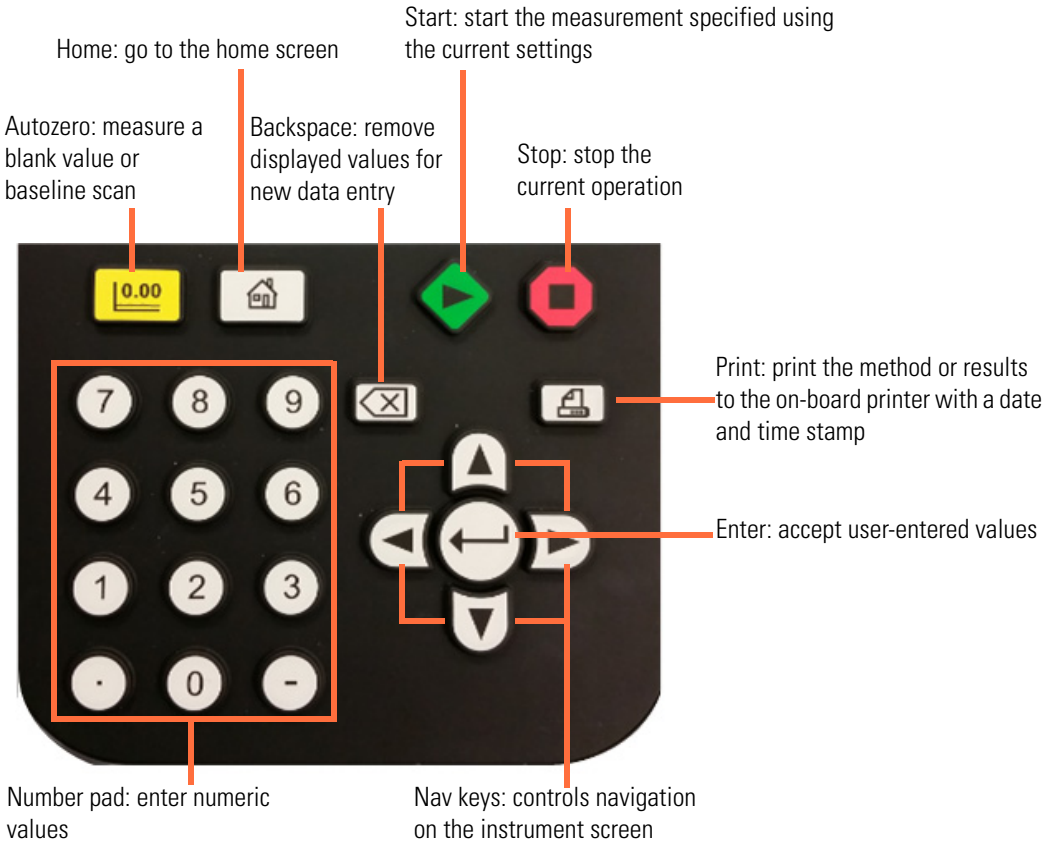
Table of Contents

Terminology

Field	An area on the screen is where you can enter a value.
Tool	An icon on the screen where you can select something either to choose a setting or to make something happen.
Navigate	Press ◀ ▶ ▲ ▼ to move the focus between tools and fields on the screen.
Focus	The field or tool that is selected is described as being "in focus." It is indicated by an orange line around it.
Select	To select a tool or field, navigate to it and press ↵ .
Save Tool 	Some applications allow the user to save methods to an on-board method library or to a USB memory device. Methods saved to a USB memory device can be transfered to other GENESYS 30 instruments or archived on a PC. The Scan, Fixed and Quant applications also support saving tables of data directly to a USB memory device for off line storage or processing. When you select the save tool, a dialog box will prompt you to choose whether to save the method or the data and direct you through the necessary steps to name methods before saving. Method files are saved with user-specified names. Data files are automatically named as Scan_, Fixed_, or Quant_ followed by a date and time stamp. Data files cannot be saved with a user-specified name.



About the Keypad



Important features of your software:

Press Autozero to record a blank value in Live Display, Fixed, OD600, Analyzer and Quant modes. Record a baseline in Scan mode.

Press the Home key to return to the home page at any time. If going to the home menu will cause you to lose result data, the software will warn you and give you the opportunity to cancel the action before going to Home.

When the number in a field is highlighted you can simply start keying in numbers and it will be over-written.

If there is a line cursor between or next to the value, you need to use ⌫ to erase digits one by one. Also, if you erase a value completely and then press ↵, the value that was in the cell before you erased it will be restored.

- In any text or number entry fields ⌫ causes one character or number to be erased per press.
- In alerts or dialogs where the user is not entering numeric or text data and there is a **Cancel** button displayed on the screen, pressing ⌫ on the keypad has the same effect as navigating to **Cancel** and pressing ↵.

In addition to starting measurements in data modes, the start button acts as short-cut to load a method when in the Library.

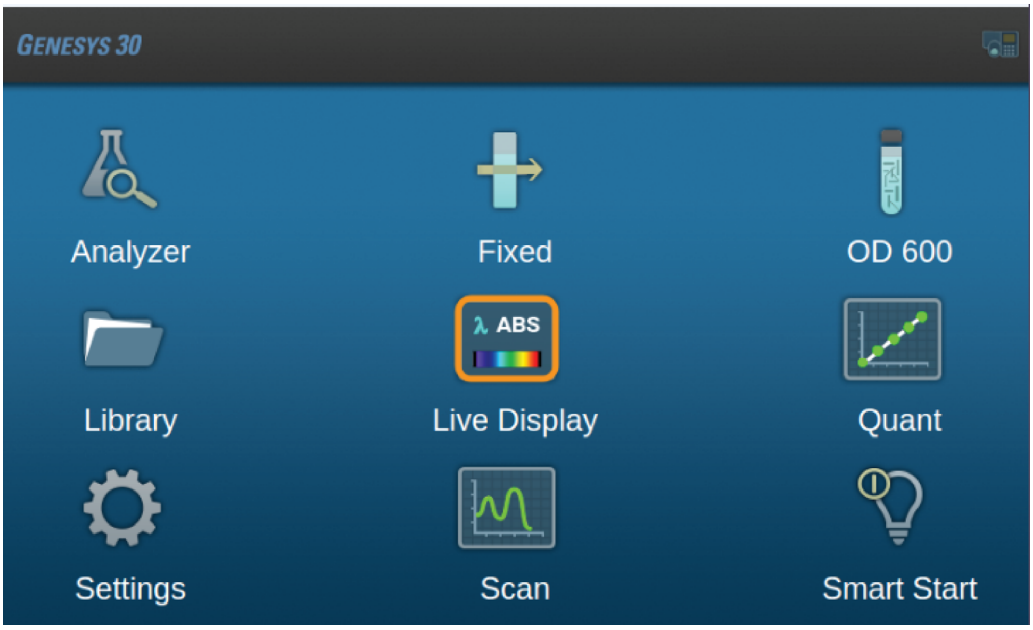
Note: If you press the measure button when the blank/baseline is not valid the software plays the unhappy tone through the speaker and flashes the blank indicator three times.

Stop

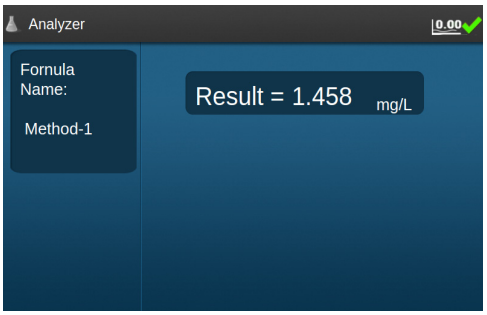
Print

Enter

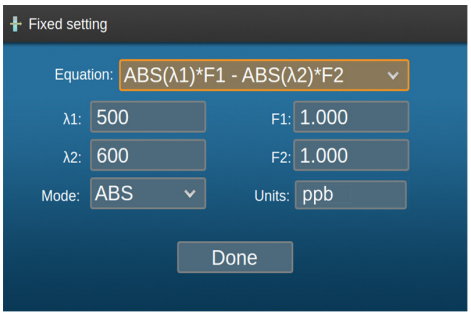
About the Home Page



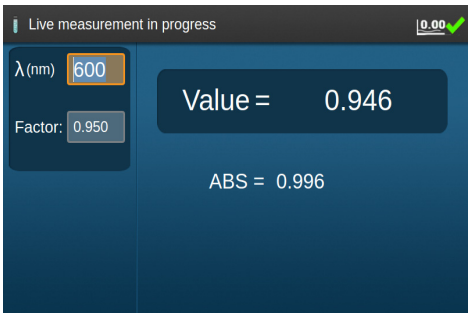
Options are clearly labeled with the name of the measurement modes or functions that they execute. Use the nav keys to select the desired application and press ↵ to start it.



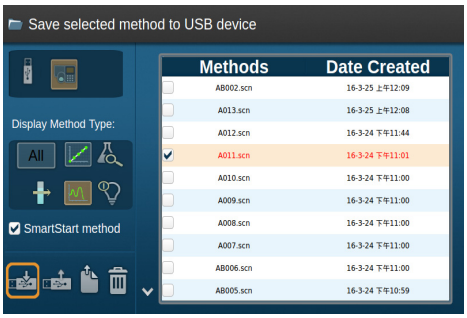
See Analyzer for detailed information.



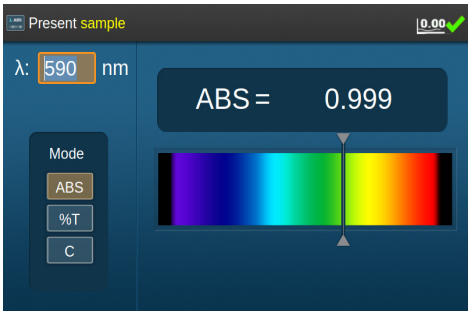
See Fixed for detailed information.



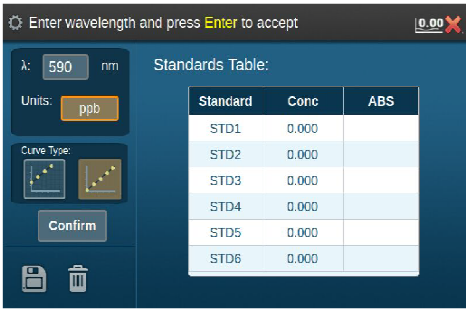
See OD600 for detailed information



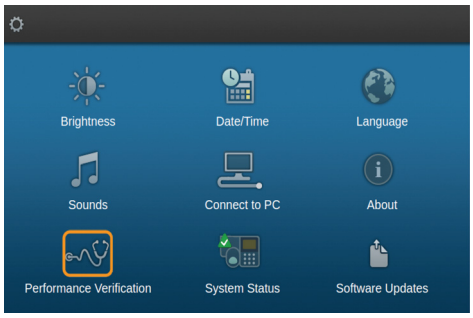
Load or transfer saved methods in the on-board memory or an inserted USB memory device. See Library for detailed information.



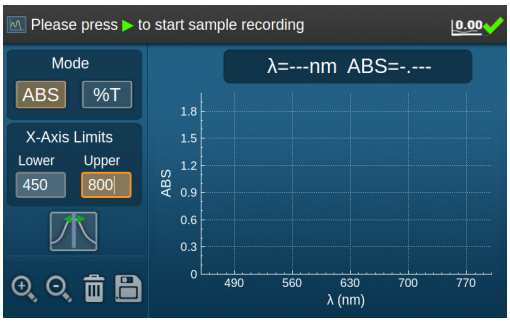
See Live Display for detailed information.



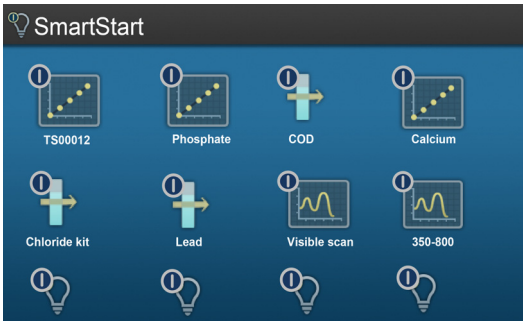
See Quant for detailed information.



Access the various functional settings for instrument behavior including connecting to a computer running control software. See Settings for detailed information.

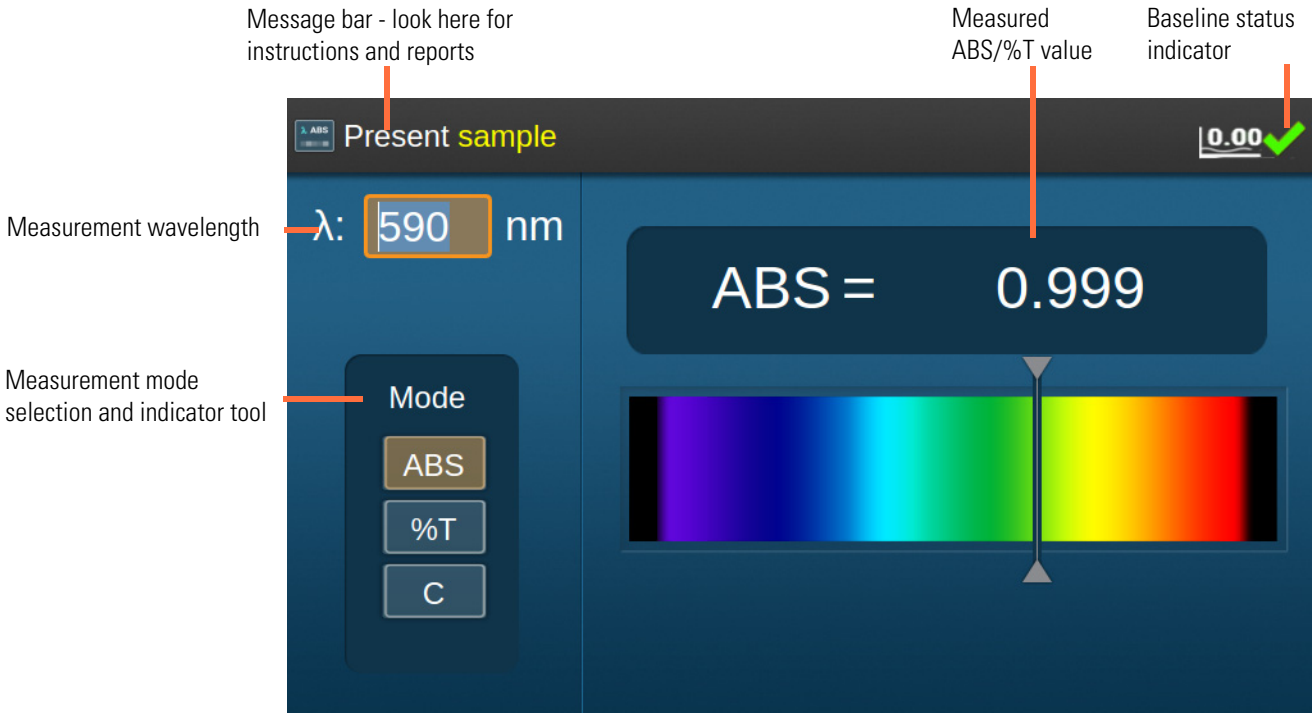


See Scan for detailed information.



You may choose to save selected methods to a special SmartStart™ menu which will be displayed instead of the home screen at start-up. This home screen option brings you to that same SmartStart menu.

Live Display



Live Display shows a continuously updating value for the transmittance, absorbance or concentration of a sample. The instrument takes a new measurement every two (2) seconds. The value on the screen flashes to indicate that a new reading is being displayed.

%Transmittance or Absorbance Measurements

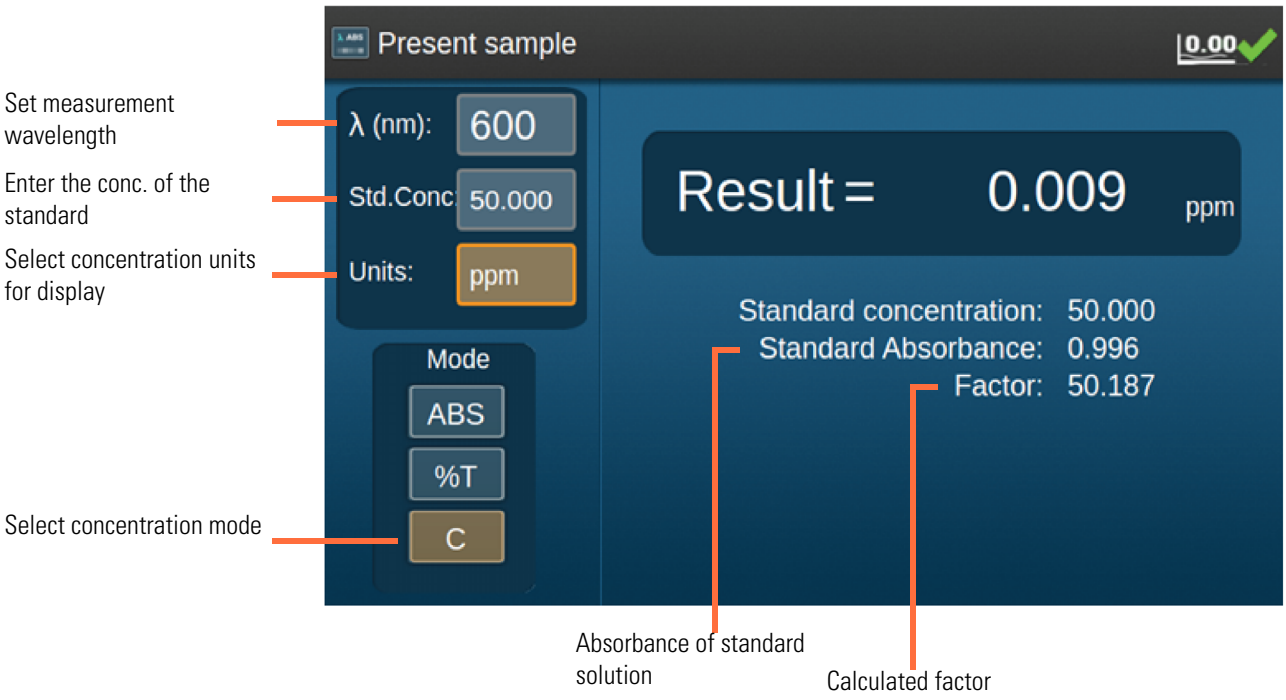
1. Select a measurement wavelength.
2. Select the **Mode** (%T or ABS).
3. Place a cuvette with a blank in the measurement position, close the lid and press  .
4. Remove the blank cuvette, place the sample cuvette in the measurement position and close the lid.

   Live measurements begin automatically.

   The %T or ABS value is displayed on the screen.
5. To make measurements of additional samples, simply put the cuvette with the new sample in the measurement position, close the lid and wait for the displayed value to flash to indicate that the measurement has been made.

> **Tip** If you are using the test tube holder you may not need to close the lid when making measurements.

Concentration Measurements

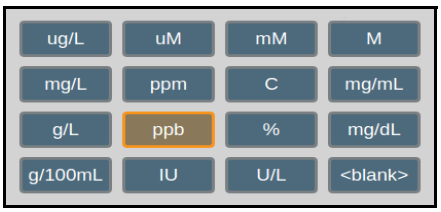


Concentration measurements are based on measurement of a single standard solution of known concentration. The instrument calculates a calibration based upon the absorbance of the known standard and the assumption that there is zero absorbance at zero concentration. A Factor is calculated from the data such that

`Concentration = Factor x Absorbance`

❖ To perform a concentration measurement:

1. Select a measurement wavelength.
2. Set the **Mode** to **C.**
3. Select the units from the pop-up grid.



   Follow the directions in the message bar.

4. Place a cuvette with a blank solution in the measurement position and press  .
5. Type the standard concentration in the **Std. Conc**. box and press ↵ to confirm.

6. Present and measure your standard as instructed in the message bar.

   The software immediately begins live display of concentration and the message bar prompts you to present your sample.

7. Remove the blank cuvette, place the sample cuvette in the measurement position, and close the lid.

   The **Result** field shows a live display of calculated concentration. Continue presenting additional samples. The display updates every two seconds. The Result value flashes to indicate that a new reading has been recorded.

   Below the Result field, the software displays the standard concentration, the measured absorbance of the standard, and the calculated factor.

8. Press  to stop live measurements, clear the calibration, and re-measure the standard solution.

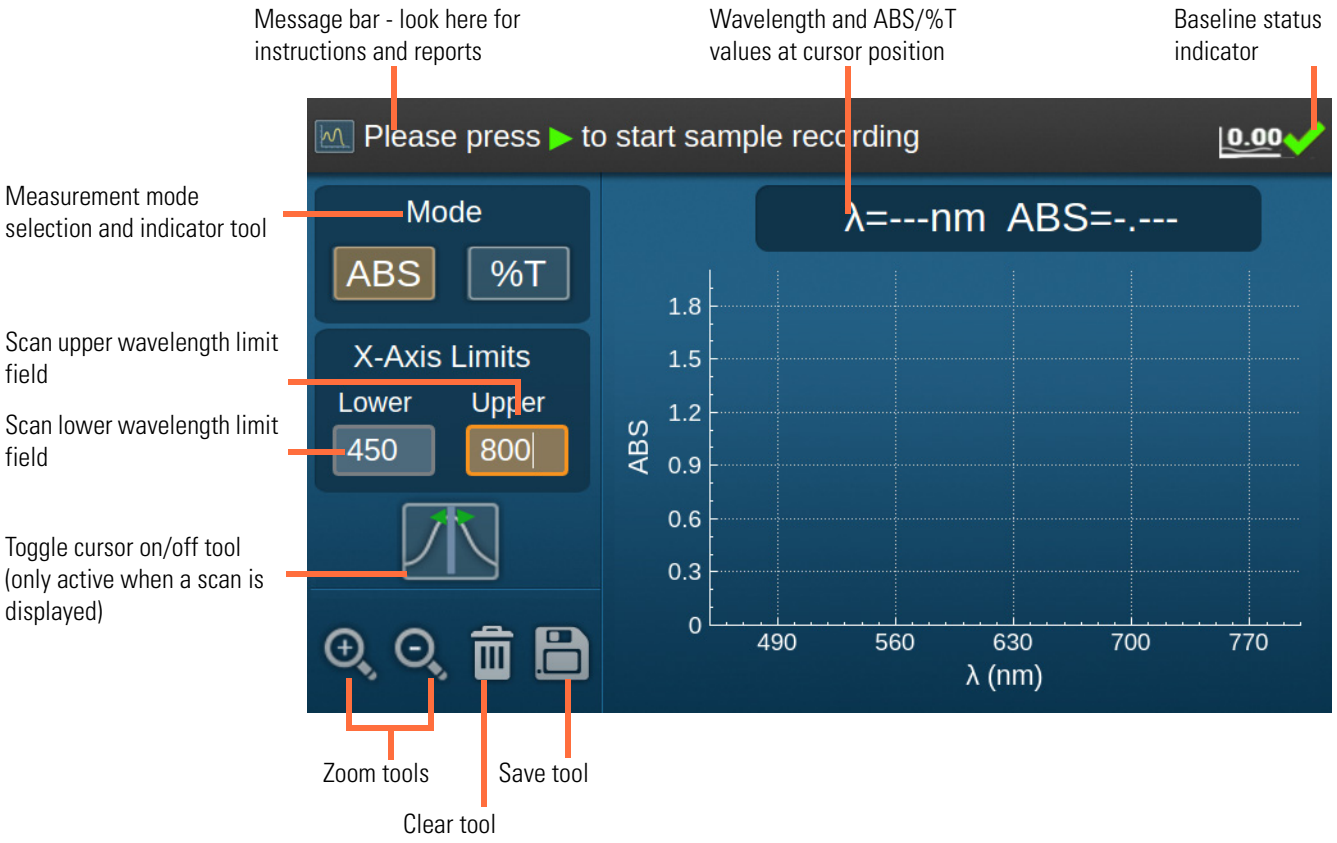
❖ To print the displayed value

If your instrument is equipped with a printer accessory, you can press  to print the currently displayed value with a time and date stamp. In concentration mode, the information displayed below the **Result** field is also printed.

GENESYS 30 does not support saving Live Display methods to the library because the parameters of the measurement are so simple.

Live display measurements are transient and are not stored in memory, so it is also not possible to save Live Display data electronically. Users requiring a tabular record of absorbance vs. time may opt to purchase VISION*lite*™ software to run a kinetics experiment from an attached Windows™ computer.

Scan



❖ To record a scan

1. Select the data mode, ABS or %T.
2. Enter the lower and upper scan limits (minimum scan range is 100 nm).
3. Place a cuvette with a blank in the measurement position, close the lid and press  .
4. Remove the blank cuvette, place the sample cuvette in the measurement position, close the lid and press  .

   The scan plot y-axis autoscales as the data is collected.

   The current measurement wavelength and ABS/%T are displayed as the scan is recorded.

❖ To analyze and store scan data

1. After the scan completes, the focus will move to the cursor tool  .
2. Use the  or  to move the cursor line left and right.

   Press once for a 1 nm increment, or hold to scroll.

   The cursor position and corresponding ABS/%T value are displayed above the spectrum plot.
3. Use  to zoom in or out.

   When zooming in, the screen centers on the cursor line.
4. Select  to clear the plot area.

❖ To save and print

Data files can only be saved to a USB memory device. The on-board library is exclusively for Method files. Data files are named as Scan_<time and date> for easy identification and include method information and a time and date stamp.

1. Select  to save your data to a file on a USB memory device.

   Data is saved as text files that can be opened by any computer spreadsheet or word-processing application. Method files may be saved to the on-board Library or a USB memory device. You can specify your own filename for a method.

   For detailed information see the section on saving data and methods.
2. If your instrument is equipped with a printer accessory, you can print your results.

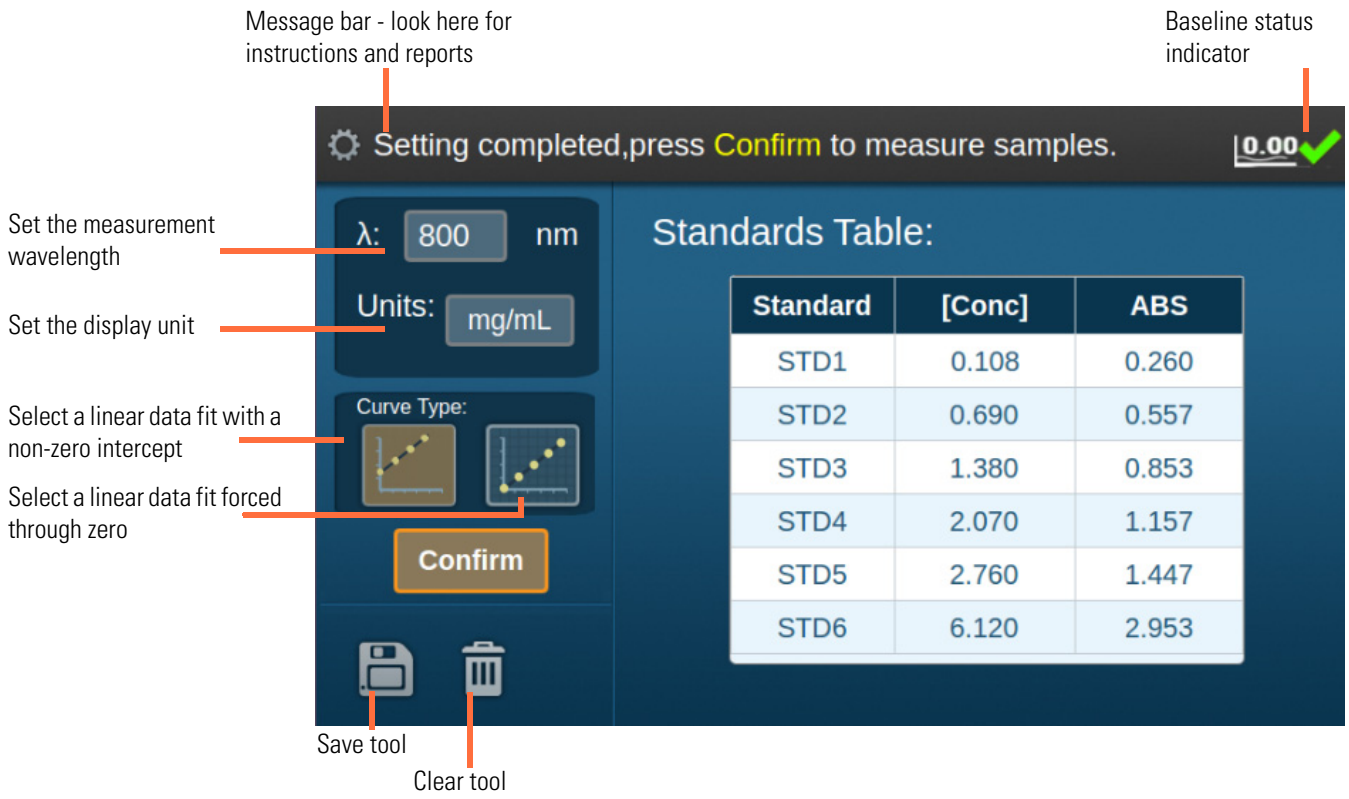
   Select  to print your data to the printer.

   Printed data includes a time and date stamp.

   See Optional Accessories for detailed information on installing and loading the optional printer accessory.
3. Select  to clear the scan plot.

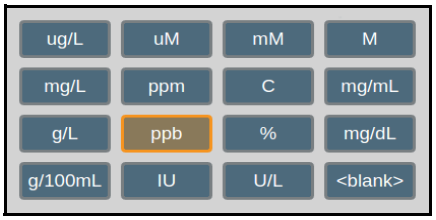
   You will be prompted to save your data before it is discarded.

Quant



The GENESYS 30 Quant application supports up to six standard solutions and offers linear fits with the option to force the line through zero.

1. Set the analytical wavelength.
   a. Navigate to the Units tool and press ↵ .
   b. Select the units from the pop-up grid.



2. Enter the concentrations of your standard solutions.

   Any number of standards up to 6 is allowed.

3. Navigate to the **Conc** field for STD1.

   Use the keypad to enter the concentration of STD1 and press ↵ to accept the value. The focus moves to the field for STD2.

4. Enter the concentrations for all your standards; navigate to Confirm and press ↵ .

   Follow the directions displayed in the message bar.

5. Place a cuvette with a blank solution in the measurement position and press 0.00 .

6. Present and measure your standards in order as instructed in the message bar.

   Tip If you wish to re-measure a standard, navigate back to the Conc field for that standard and follow the directions in the message bar.

   After you measure the last standard, the focus will move to Confirm . Press 0.00 to accept the calibration data.

   Tip You can save your method at any time by navigating to and selecting . If you have measured all the standards listed in the table you may save the method as calibrated or uncalibrated. If any of the standards has not yet been measured you can only save the method as an uncalibrated method.

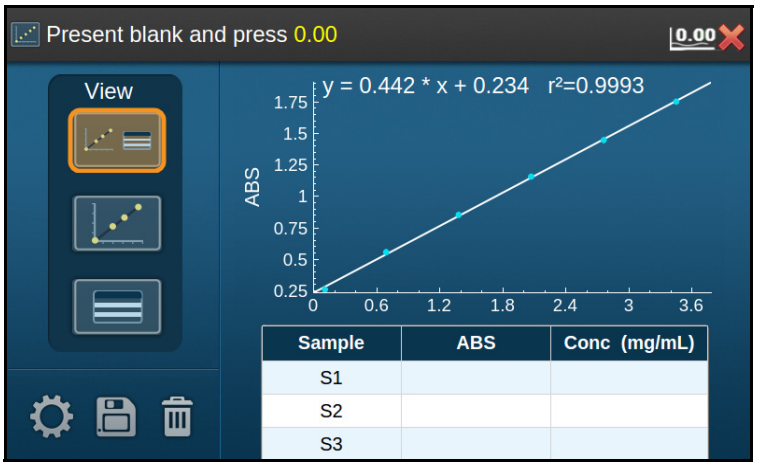
   The screen moves to the Quant working screen.

   Tip Select to go back to the calibration screen and re-measure a standard if the graph shows that your data does not represent a good enough fit.

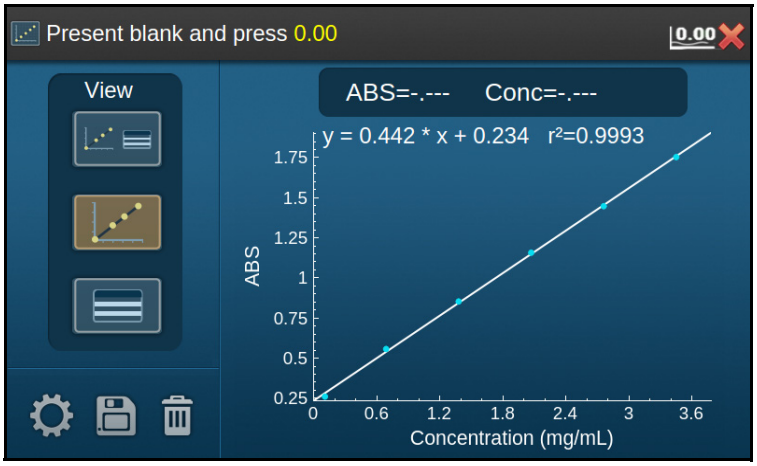
   Follow the instructions in the message bar to measure your samples.

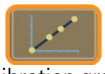
The application supports a data table with entries for up to ten samples. Samples are labeled S1 through S10. Once the data table is full you must clear it before you can measure additional samples.

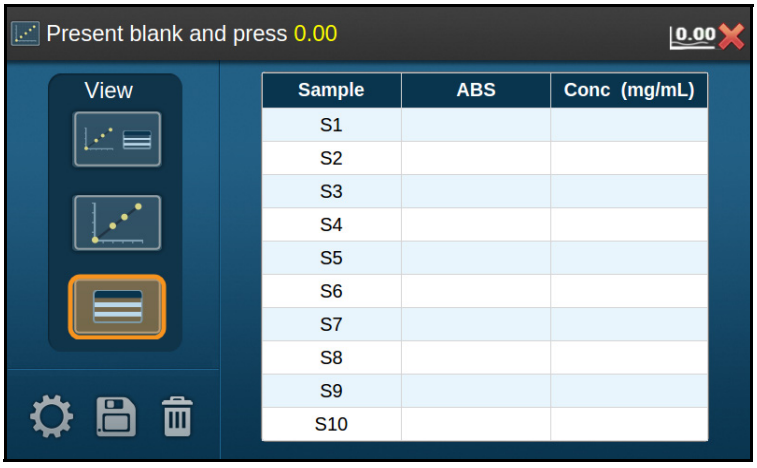
You can choose to view your data in any of three formats



Select  to view or print the calibration graph and sample data table



Select  to view the calibration graph or print the calibration graph and standard data



Select  to view or print the results in table format

❖ To save and print

GENESYS 30 provides the option to save your data directly to a USB memory device inserted into the USB-A port on the front of the instrument. Data files are named as Quant_<time and date> for easy identification and include method information and a time and date stamp.

1. Select  to save your data to a file on a USB memory device.

   Data is saved as text files that can be opened by any computer spreadsheet or word-processing application. Method files may be saved to the on-board Library or a USB memory device. You can specify your own filename for a method.

   For detailed information see the section on saving data and methods.

2. If your instrument is equipped with a printer accessory, you can print your results.

   Select  to print your data to the printer.

   Printed data includes a time and date stamp.

   See Optional Accessories for detailed information on installing and loading the optional printer accessory.

3. Select  to clear the data table.

   You will be prompted to save your data before it is discarded.

Fixed

Fixed Mode

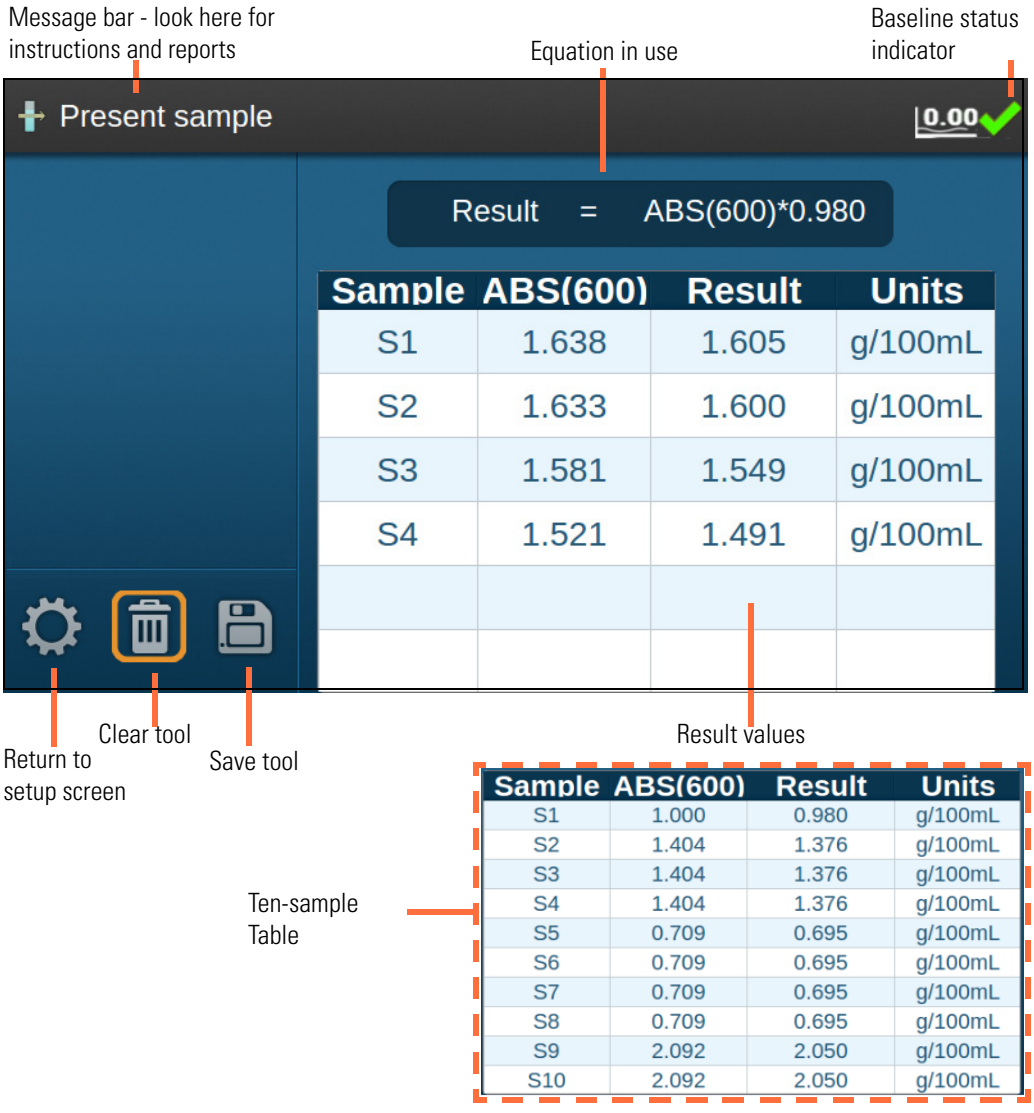
❖ **To run a fixed measurement**

1. Select an **Equation** from the drop-down menu.
2. Set the measurement wavelength(s) and factor(s).
3. Select the **Mode** (ABS or %T).
4. Select the concentration **Units**.
5. Select Done.
6. Place a cuvette with a blank in the measurement position, close the lid and press 0.00.

7. Remove the blank cuvette, place the sample cuvette in the measurement position, close the lid and press  .

Tip

- Initially, six rows of sample data are displayed. On measuring the sixth sample an additional four rows appear.
- Samples are labeled S1 through S10. Once the data table is full, save or print your data, then clear the data table to measure additional samples.



GENESYS 30 provides the option to save your data directly to a USB memory device inserted into the USB-A port on the front of the instrument. Data files are named as Fixed_<time and date> for easy identification and include method information and a time and date stamp.

❖ To save and print

1. Select  to save your data to a file on a USB memory device.

   Data is saved as text files that can be opened by any computer spreadsheet or word-processing application. Method files may be saved to the on-board Library or a USB memory device. You can specify your own filename for a method.

   For detailed information see the section on saving data and methods.

2. If your instrument is equipped with a printer accessory, you can print your results.

   Select  to print your data to the printer.

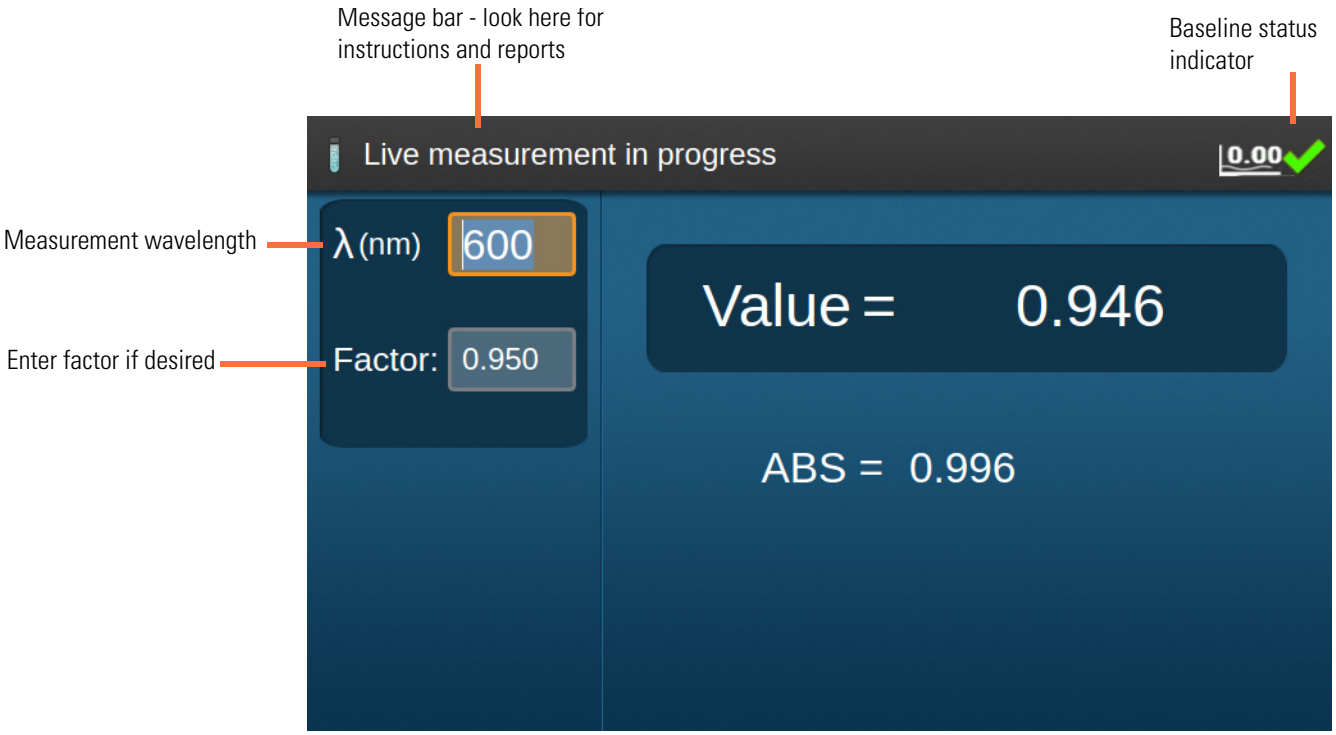
   Printed data includes a time and date stamp.

   See Optional Accessories for detailed information on installing and loading the optional printer accessory.

3. Select  to clear the data table.

   You will be prompted to save your data before it is discarded.

OD600



Measurement wavelength: Default is 600 nm, but some users make cell count measurements at different wavelengths and may wish to change it.

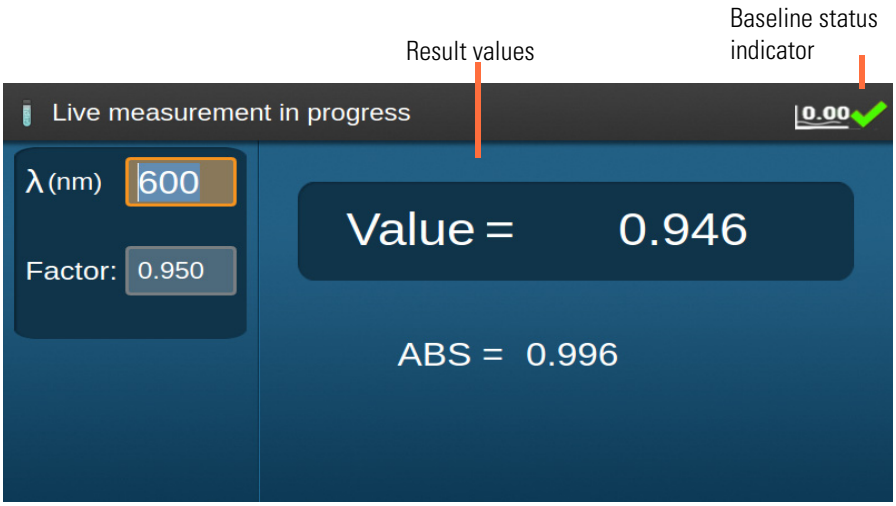
Factors in OD600: When measuring the "absorbance" of a suspension of cells, you are really measuring the attenuation of the beam due to scattering. It is not the same as colorimetry. The impact of scattering on the measured amount of transmitted light depends on a number of factors, including the overall optical design of the spectrophotometer. Differences in the designs of different spectrophotometers mean that the measured "absorbance" of a cell suspension is not expected to be the same on all instruments. The difference can be accounted for by multiplying data by a uniform factor. If you want to display the results obtained on your GENESYS 30 on the same scale reported by another instrument, simply measure the same sample on both instruments and calculate the number by which you would need to multiply the GENESYS 30 result to yield the value on the other instrument. It is best to do this over a range of cell concentrations and use an average number as your factor because you may see some variation from data point to data point.

Enter the result of your calculation as the factor when you run the OD600 application on the GENESYS 30 and the result shown in the Value field will be scaled to your old or other instrument. The "raw" absorbance value is also shown on the screen.

❖ To run an OD600 measurement

1. Change the wavelength if you want to measure at a different wavelength (e.g., OD590).
2. Enter a factor if desired.
3. Place a cuvette with a blank in the measurement position, close the lid and press 

.
4. Remove the blank cuvette, place the sample cuvette in the measurement position, close the lid and press  .



Note OD600 is a Live Display mode. The reading will update automatically every 2 seconds. Insert additional samples as desired, close the lid and wait for the reported Value to flash to indicate that it has updated.

5. Press  to end the experiment.

❖ To print the displayed value

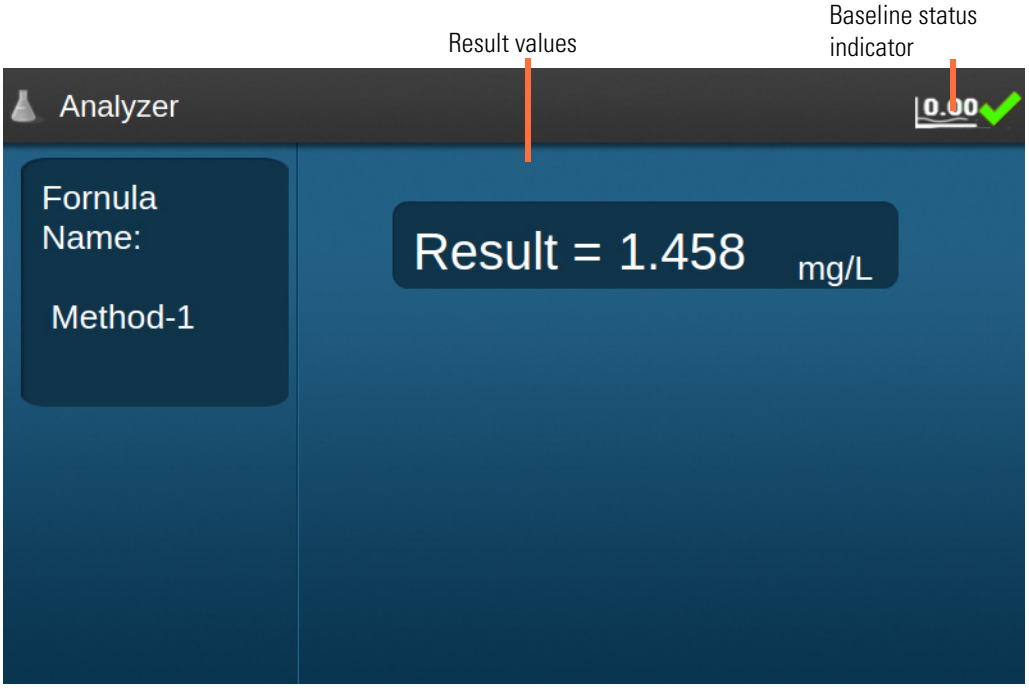
If your instrument is equipped with a printer accessory, you can press  to print the currently displayed value with a time and date stamp.

GENESYS 30 does not support saving OD600 methods to the library because the parameters of the measurement are so simple.

Live display measurements are transient and are not stored in memory, so it is also not possible to save OD600 data electronically. Users requiring a tabular record of absorbance vs. time may opt to purchase VISION*lite* software to run a kinetics experiment from an attached Windows computer.

See Optional Accessories for detailed information on installing and loading the optional printer accessory.

Analyzer



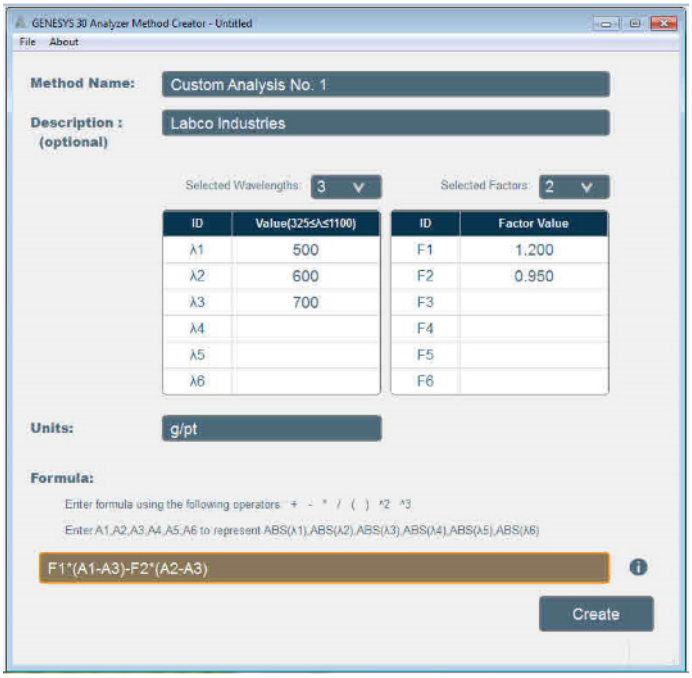
The Analyzer mode allows the user to customize a method using absorbance measurements at up to six wavelengths, up to six numerical factors and a variety of common mathematical operators including square and cube functions. Methods are designed using a Windows application installable from the USB memory device included with the instrument. The saved method file can be loaded onto the GENESYS 30 using the Library, or run directly from the USB memory device. Analyzer methods can be included on the SmartStart menu.

The Analyzer working mode is a Live Display mode where only the name of the method, the calculated result and the user's chosen unit are displayed. This design is intended to help to simplify operation and reduce transcription errors. With only one value displayed on the screen, it is impossible to copy down the wrong number. Printing is enabled in the Analyzer mode, with the time index, result value and unit being printed.

Analyzer methods can also be used to provide a simple user interface for very simple methods, such as those involving a single wavelength and factor, where a preprogrammed live display interface is preferred for the operational environment.

Analyzer Method Creator Windows Application

This application is only available in English language.



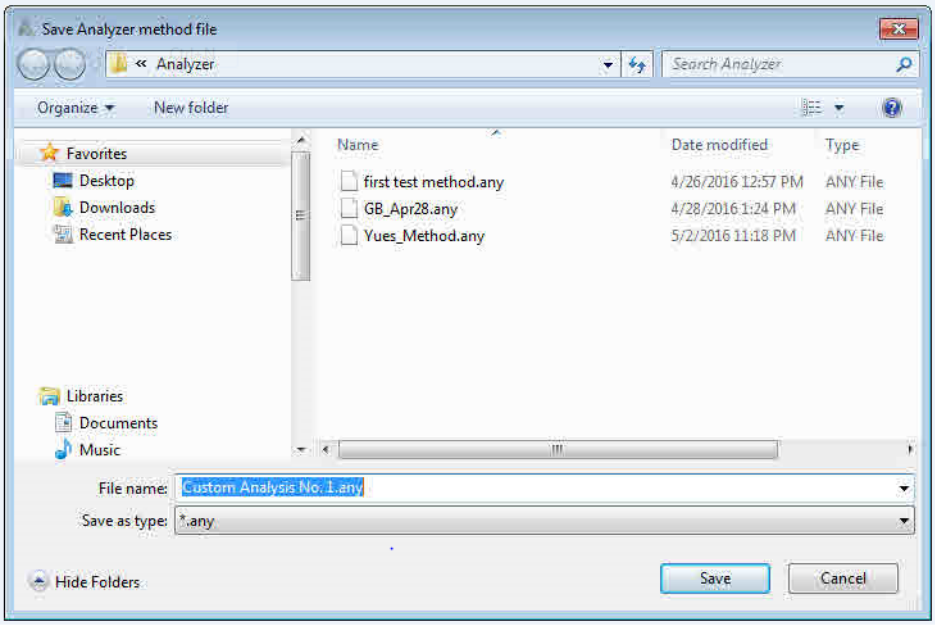
1. Complete the **Method Name** and **Description** fields as indicated.
2. Choose the number of wavelengths required and the number of factors.
3. Enter the wavelengths and the factor values.
4. Enter your desired unit.

   This unit is text that will be displayed next to the result on the working screen.
5. Enter your formula.

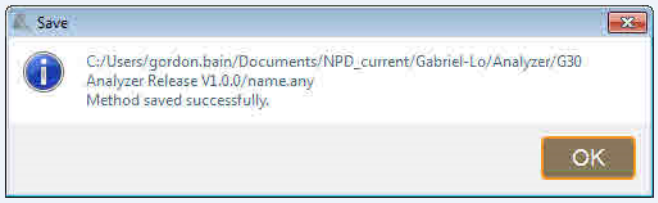
   An = sign is not required.

   The interpreter understands the associative law and brackets. Use **A1** for **absorbance at λ1**. The analyzer does not support use of transmittance values.
6. Click  to check that your formula does not contain errors.

7. Click Create to save your new method.



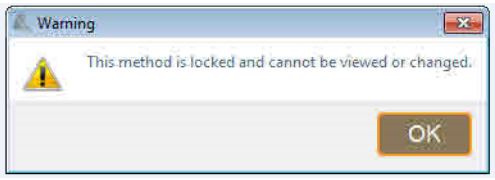
8. A confirmation dialog is displayed after the method has been saved.



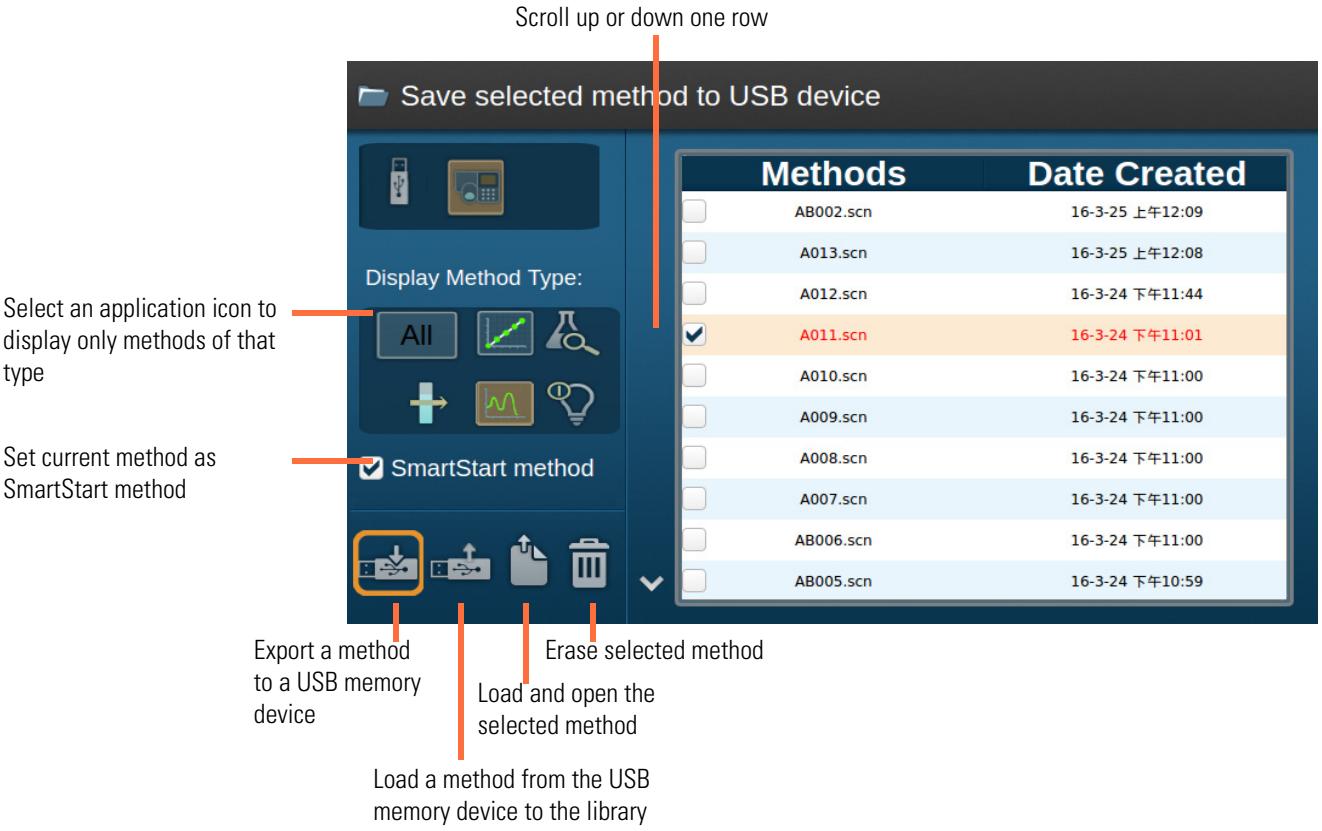
9. Transfer the method to your GENESYS 30 using a USB memory device.

Method files may be loaded into the Windows application and edited using the **Open** selection under the File menu.

If you wish to prevent future edits to a method, choose the **Save As Locked Method** option. If a user attempts to open and edit a locked method this will be prevented and an alert displayed:



Library



Show methods in an inserted USB memory device

Show methods in the on-board library

Methods can be transferred between to a USB memory device and the on-board library

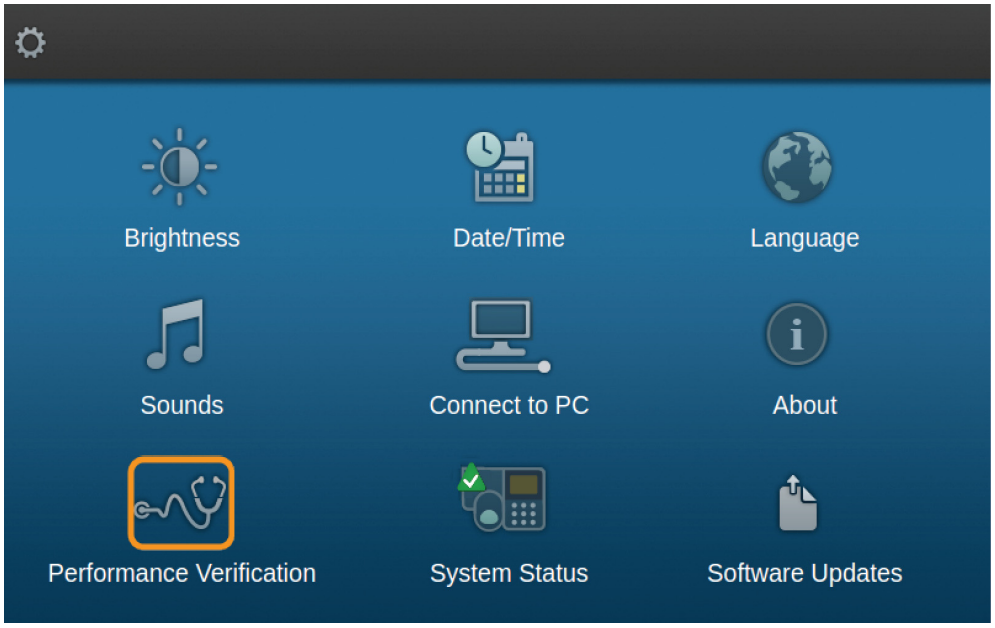
- If a USB memory device is not present in the USB port, you will be prompted to insert a drive
- To select a method, navigate to it and press ↵ ; a ☑ appears in the box next to the method name of the selected method
- Methods will be exported to the GENESYS 30 Methods folder off the root directory of the USB memory device
- If the method already exists on the memory device the user will be prompted to “Overwrite” the method file with an **OK** or **Cancel** option
- When the export is completed a Pass or Fail message will be displayed

To load and run a method, navigate to it and press .

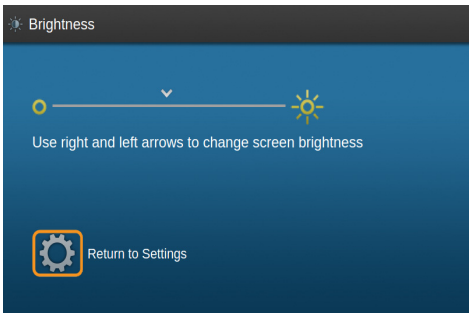
You can also load the selected method by navigating to and pressing .

- If you select the **Delete** button, the currently selected method will be deleted from the selected storage location
- You will be prompted to confirm that you want to delete the method before it is erased. Erased methods cannot be recovered.

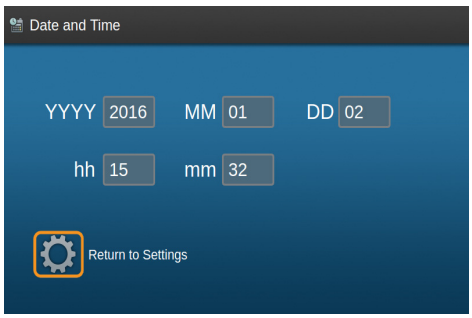
Settings



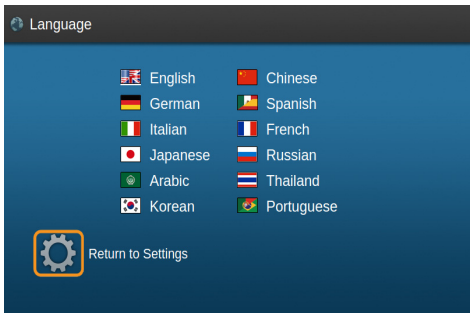
The Settings tools are clearly labeled and in most cases require no explanation



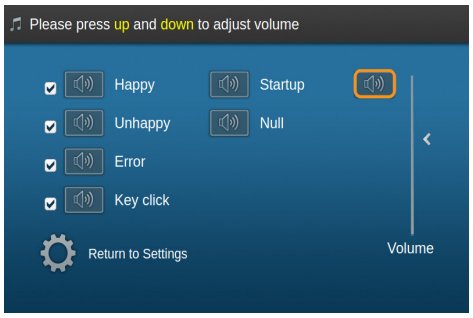
Follow instructions on the screen



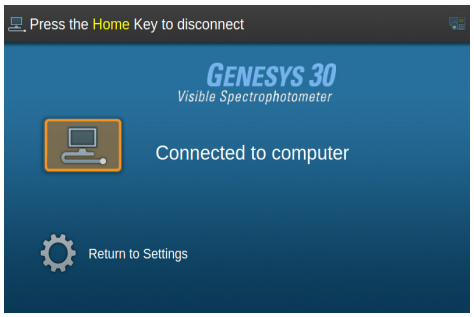
Set the current date and time using the navigation arrows and numeric keypad



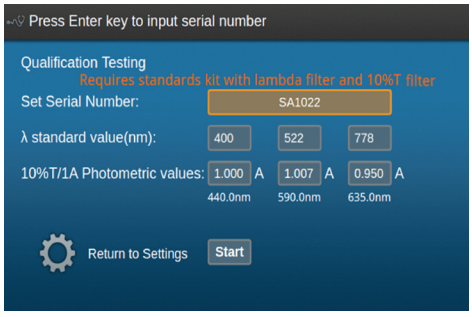
Navigate to the desired screen language and press ↵



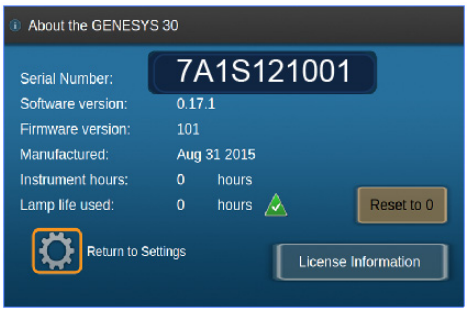
Turn sounds on or off and set the sound volume



Connect to a Windows PC with VISION*lite* software to run the instrument remotely



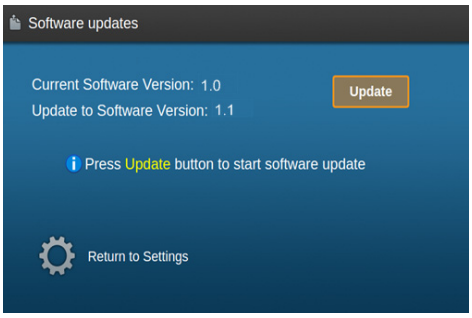
See Performance Verification for details.



The information on this screen is useful to technical support and repair personnel.

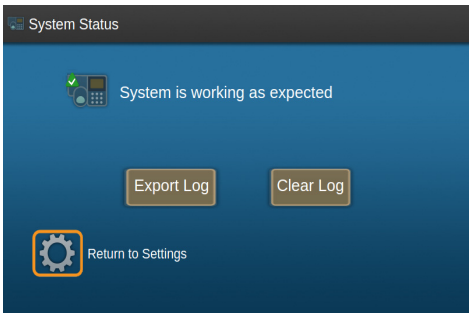
Use the lamp life indicator to determine when to purchase a new lamp. Lamps typically last over 1000 hours, but lamp power reduces with age and performance may suffer as the lamp nears burn-out.

When you change a lamp, select the **Reset to 0** option. Do not select this option unless you have installed a new lamp.



Updates to the GENESYS 30 instrument software will be available from time to time and can be downloaded from the Thermo Fisher Scientific Web Site. Updates may include new features, additions or improvements to the language set, or improvements to the capability or function of the software.

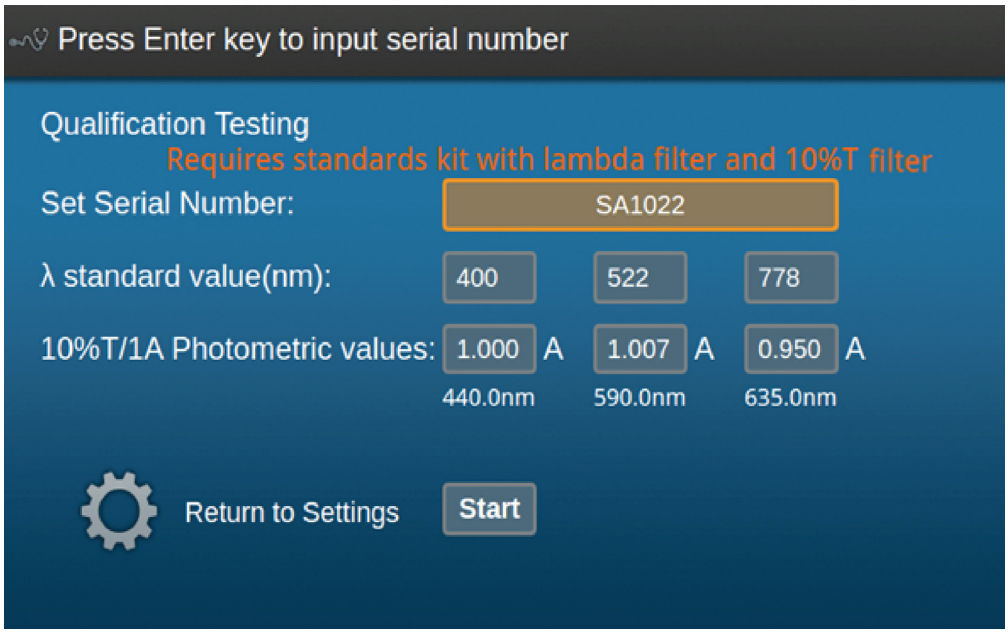
Save the downloaded software file to a USB memory device, insert the device into the USB port on the front of your GENESYS 30, and choose the **Software Update** option. The instrument may require up to 30 seconds to detect and evaluate the upgrade file. Follow the instructions on the screen to install the software update.



The GENESYS 30 will log the results of all the tests that it does upon startup and any errors that are reported to the user. When you call us for support to address a problem with your instrument, the technician will ask you to place a USB memory device in the instrument and go to the "Export Log" function, which will save that log to the USB memory device. You can then email the log to the Thermo Scientific support agent. After a problem has been resolved, our technical support agent may advise you to clear the log. Do not clear the log unless advised to do so. It can store many months of information and deliver a lot of useful information describing the general health of your instrument.

Be assured, NO information concerning customer samples is stored in this log. The log contains instrument status information only.

Performance Verification



The GENESYS 30 Performance Verification application helps you to perform some simple performance tests to verify that your instrument is performing correctly. If a spectrophotometer goes to the correct wavelength and measures the absorbance correctly it is fundamentally working correctly.

Two filters are required to perform the Performance Verification tests. Both are contained in the SPECTRONIC Standards 2 Kit, available from your Thermo Scientific distributor.

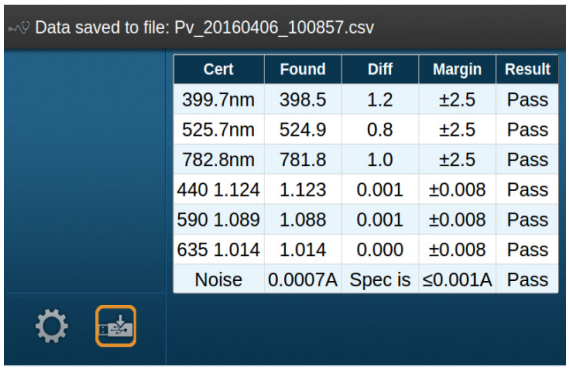
- A lambda filter, labeled λ - this filter has three peaks in transmittance space
- A 10%T or 1A neutral density (gray glass) filter calibrated for absorbance at 440, 590 and 635 nm

1. Enter the serial number of your filter set and the calibration information indicated into the fields on the screen.
2. Select  and follow the instructions on the screen carefully.

The GENESYS 30 will perform tests for:

- Wavelength accuracy
- Photometric accuracy
- Photometric noise at 0A

and display a report of the measured data with pass/fail evaluations calculated according to the sum of the instrument specification and the calibration uncertainty of the standards.



Data files can be saved to a USB memory device. Data files are named as Pv_<time and date> for easy identification and include a time and date stamp.

❖ To save and print

1. Select  to save your data to a file on a USB memory device.

   Data is saved as text files that can be opened by any computer spreadsheet or word-processing application. Method files may be saved to the on-board Library or a USB memory device. You can specify your own filename for a method.

   For detailed information see the section on saving data and methods.

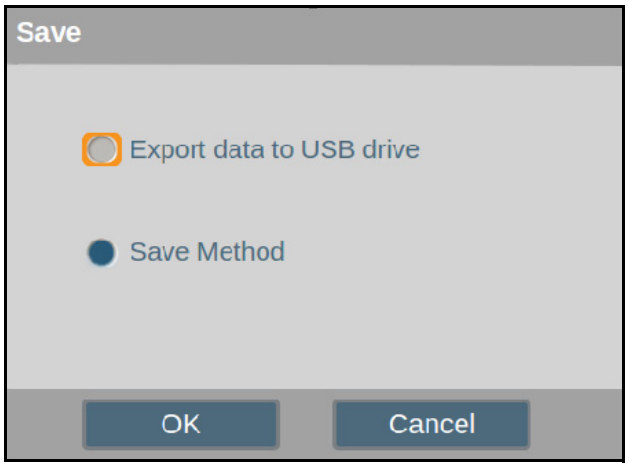
2. If your instrument is equipped with a printer accessory, you can print your results.

   Select  to print your data to the printer.

   Printed data includes a time and date stamp.

Saving Data and Methods

When you select  , you will be prompted to save either your data or your method.



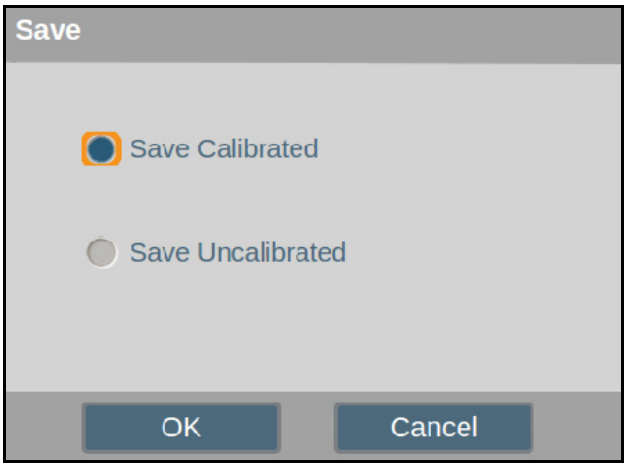
Saving your data to a USB drive—The file is saved with an automatically generated filename consisting of the measurement type and a time and date stamp, e.g. Scan_20160325_152122.csv

USB device data directory listing in Windows

Note The file format depends on the language selection in the settings menu.

- In language regions where a period or dot is used as a decimal separator, the files are saved as CSV format.
- In language regions where a comma is used as a decimal separator, the files are saved as TSV format (tab separated values). If your computer does not show an association to a particular application for the TSV file type, right-click on the file icon and select **Open with** from the menu; select **Choose default program**. Choose your preferred program in the dialog that opens. You will be able to double-click the files to open them directly in the future.

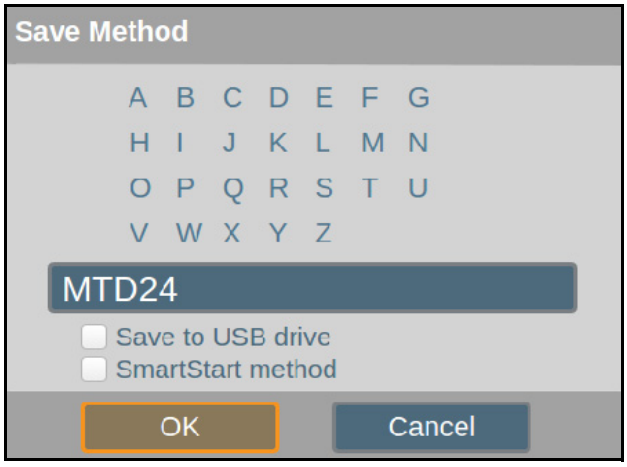
Saving your method—For Quant, you will be prompted to choose whether to save the method calibrated or uncalibrated.



For all method types, in the **Save Method** dialog, enter a name for the method using the alphabet keyboard on the screen and the numeric keypad. Navigate to each letter and press ↵ to add it to the filename, or press the desired number button on the keypad.

Note

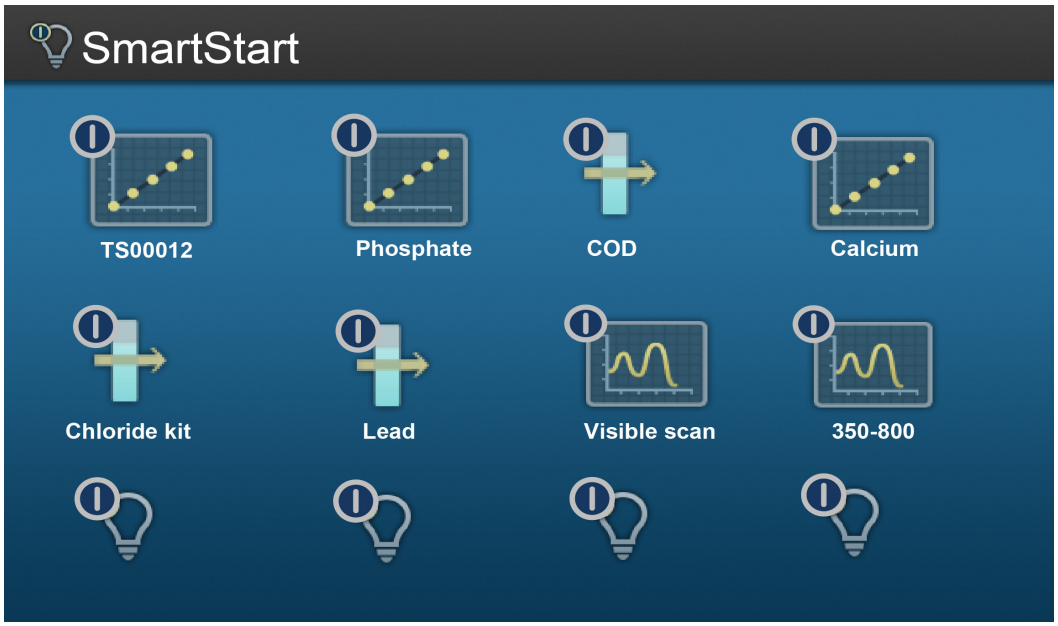
- Latin is the only character set supported at this time.
- Filenames of up to 12 characters are supported.



The default save location for methods is the library in the GENESYS 30 internal memory. Select the appropriate check box to save the method to a USB stick or to label it as a SmartStart method.

- Stored methods can be loaded using the Library function.
- Stored data can be viewed on your computer using a spreadsheet or text reading program.

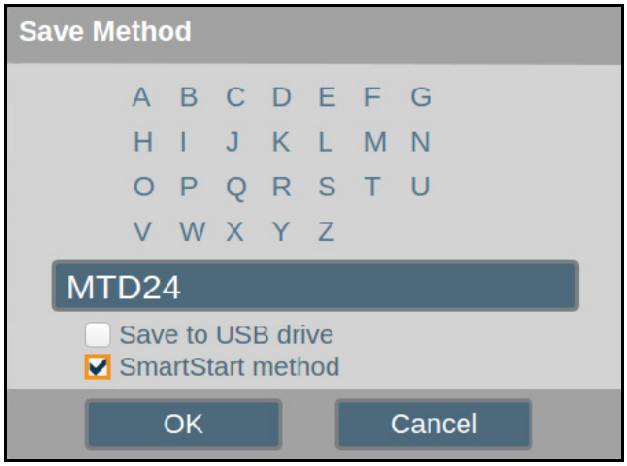
SmartStart



Alternatively, you can mark the method for inclusion in the SmartStart menu in the Library. The instrument features a SmartStart menu option. If methods have been saved to the SmartStart menu, this screen will be shown instead of the Home screen when the instrument is powered On. The SmartStart menu can also be accessed from the Home screen.

The SmartStart menu enables you to access commonly used methods quickly and with relatively few key presses.

To add a method to the SmartStart menu, save the method from within the particular application and select the **Save to SmartStart** box. The method will be saved to the internal library and will appear on the Smart Start menu.



❖ **To remove a file from the SmartStart menu**

1. In the Library, set the filter to  .
2. Select the method that you wish to remove from the SmartStart menu and uncheck the box at the left side of the screen that marks it as a SmartStart method.

> **Note** Deleting a method from the Library will also delete it from the SmartStart menu.

Optional Accessories

Printer

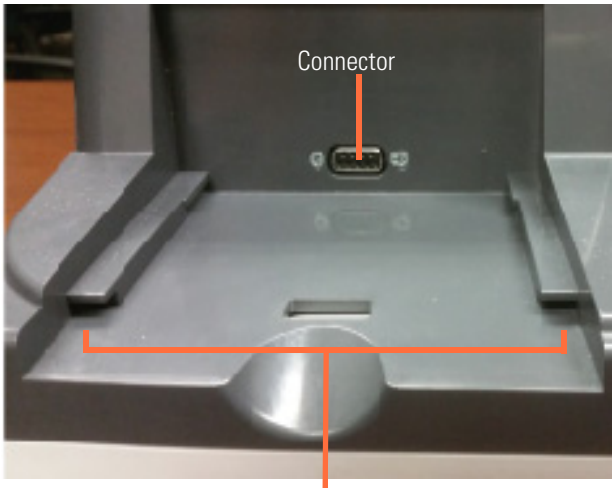
1. Remove the printer housing cover.

   Use the finger hold, pull towards you and lift.

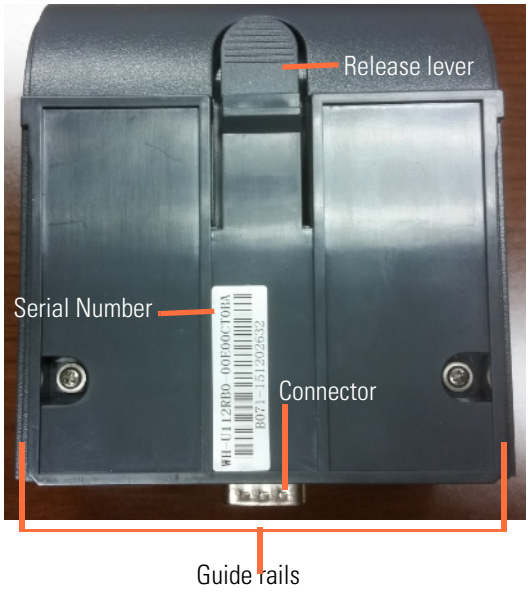
2. Load paper into the optional printer.

3. Insert printer into GENESYS 30.

Back of GENESYS 30



Bottom of printer



a. Align the guide rail on the printer with the guide rail on the GENESYS 30.

b. Push the printer forward until the connectors are fully connected.

You will hear a snap when the connectors have engaged properly.

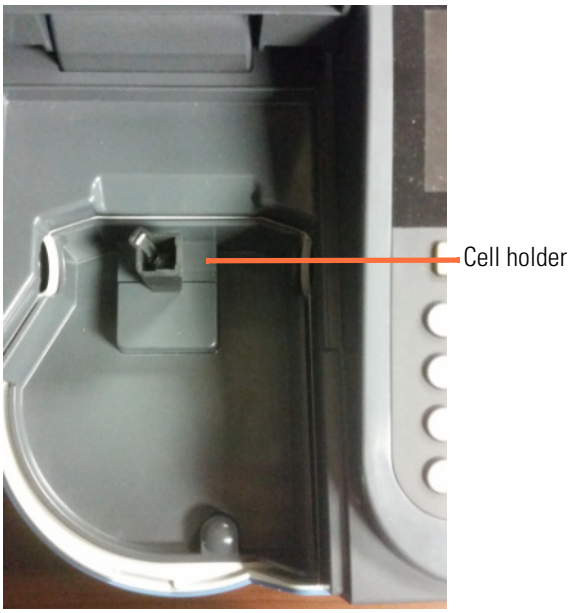
Slide forward

Printer fully engaged

Single Cell Holder

Your GENESYS 30 comes with a standard single cell holder already installed in the sample compartment. The cell holder is held in place with two magnets.

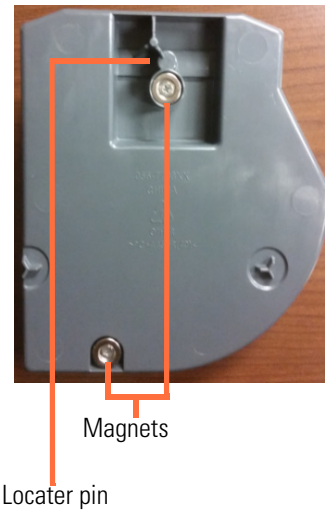
To remove the cell holder, lift up on the cell holder.



To reinstall the sample holder, align the locater pin with the pin hole and gently set into place.

Sample holder removed

Bottom of sample holder



Additional sample holders can be purchased to support other kinds of samples such as test-tubes or long-path cells. These sample holders are attached in the same way as the standard cell holder.

The individual cell holders are held to the sample compartment tray by a single slotted screw. The GENESYS 30 uses the same cell holder accessories as other instruments in the GENESYS line. Standard GENESYS accessories can be positioned in the GENESYS 30 sample tray by removing the supplied 10 mm cell holder and replacing it with another accessory.

Halogen Lamp

The lamp source lifetime is approximately 1,000 hours.

❖ **To replace the halogen lamp**