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PC Tool
True Color Sensor

BFS000L

Manual

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1.   General Advice

The True Color Sensor is generally <u>not conceived for the use as a safety critical component</u> in machines and assets and in particular not for the utilization in the medical sector Please note that the use in these sectors is inadmissible.

Please observe the required safety precautions when handling with ESD-sensitive components (EN 61340-5-1, EN 61340-5-2)!

The module may only be installed or replaced by skilled personnel!

The internal luminous source of white light is very powerful. Please beware of looking directly into the aperture of the light source at the module or in the connected light guides, respectively.

"This sensor is optimized for the detection of objects. An absolute color measurement is not possible."

When entering numbers including a decimal point only a point will be accepted (e.g. 94.4).

The sensor allows the detection of objects in shorter and larger distances. The minimum and maximum distances cannot be defined very accurate because they depend on the used optic and various terms and conditions. Those conditions, on the other hand, can be compensated in a wide range by the adjustable sensitivity.

For the Angle no general statement can be given, but the optic should not be adjusted perpendicular to the product in any case. A guideline value for the angle is 22.5° (for coaxial light guides).

"The sensor achieves its full accuracy after a turn on time of at least 20 minutes under constant environmental conditions. The duration of the turn on time depends on the environmental conditions."

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2. Safety- and Warning Notices

⚠ These photoelectric sensors may not be used in applications where personal safety depends on proper function of the devices (not safety designed per EU machine guideline). Read these instructions carefully before putting the device into service.

⚠ The assembly, maintenance or the exchange of the sensor may take place only via trained, qualified personnel!

⚠ The sensor has protection class 1 (non-fused grounding). The sensor must be professionally earthed via the earth conductor at the sensor (marked with symbol: ⏚).

⚠ Free group according to IEC 62471:2006-07.

DO NOT LOOK INTO THE LIGHT BEAN! Danger of glare and irritation!

The sensor must be installed that no direct looking into the light source is possible even during operation.

3. True Color Sensor Tool

The BFS33M PC Tool serves for the commissioning and parameterization of the True Color Sensor. The picture shown below displays the main dialog of the tool after starting.
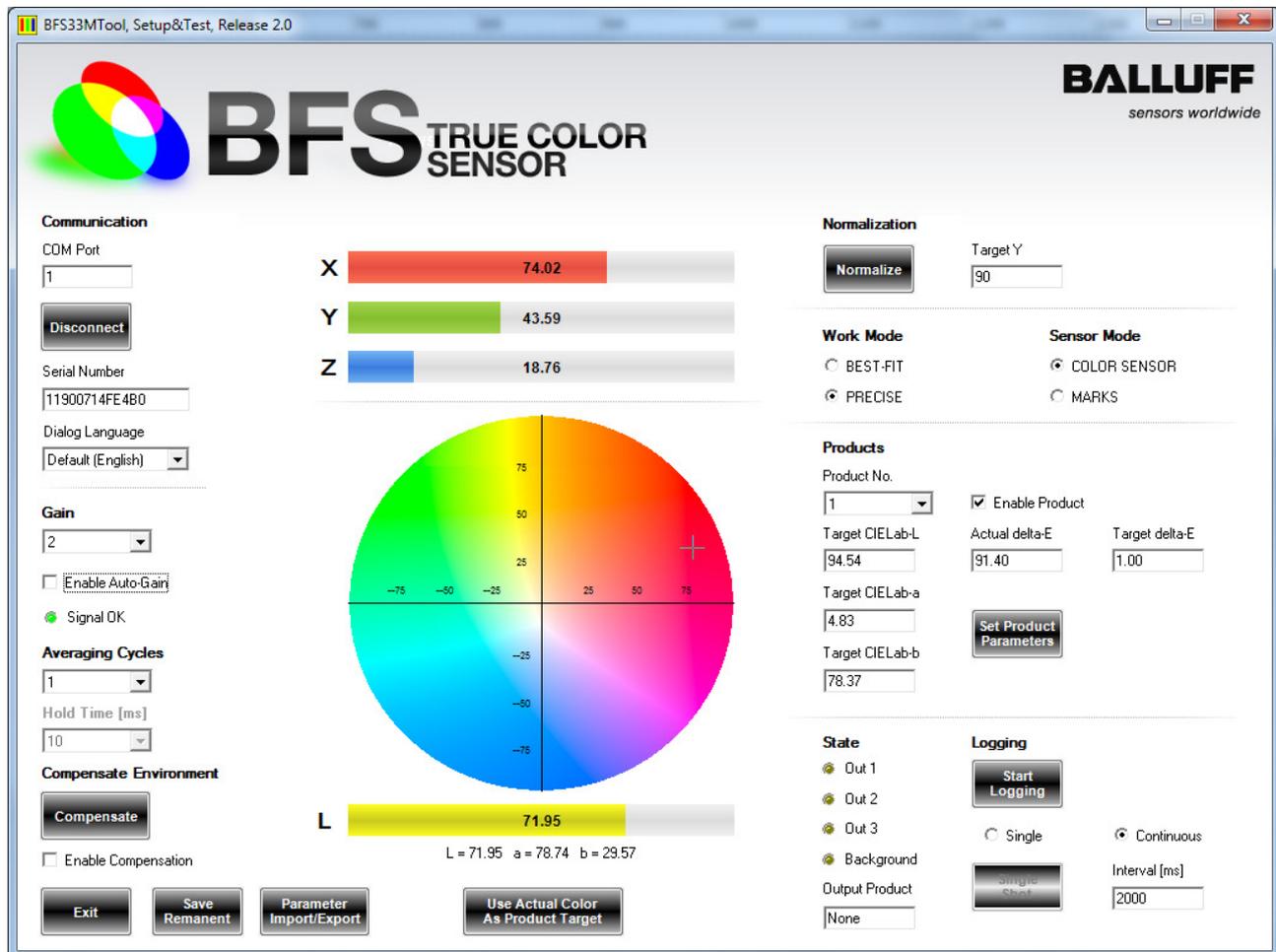
Figure 1 Dialog PC Tool

Note: When entering numbers including a decimal point only a point will be accepted (e.g. 94.4).

3.1.1. The group *Communication*

Before a communication to the sensor can be established the serial interface of the sensor must be connected to the PC. At the edit field '*COM Port*' the number of the serial interface must be entered and the button 'Connect' must be pressed. The tool will try to establish a communication to the sensor. If the connection has been established successfully a dialog is displayed that is showing the actual serial number and the firmware version of the connected sensor.
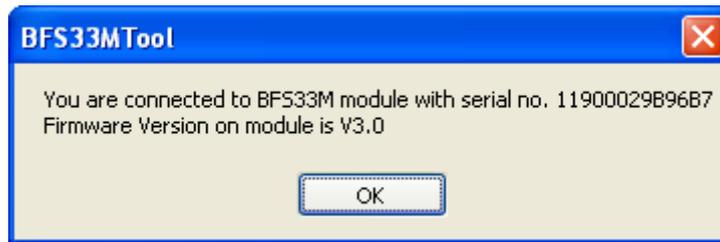
Afterwards all controls will be updated according to the actual settings. In addition the serial number of the connected sensor will be shown at the field '*Serial Number*'. Later on the serial number will be used e.g. when logging measurement values, to give the log file a unique name.

In general the CIEL Color Sensor works in a 'free running' mode. Measurement values from the sensor will be read continuously with a frequency of about 3Hz and displayed at the PC Tool.

The text on the button '*Connect*' will change to '*Disconnect*' after successful connection to the sensor. When pressing the button once again the communication is suspended and the text on the button will change to '*Connect*'. All activities at the PC tool regarding the sensor will be interrupted in that case.

The checkbox *'Dialog Language'* is used to select the language that should be used for displaying text within the main dialog and additional dialog windows. The checkbox contains the available languages for those language specific text files have been found at the program directory when starting the tool. Per default the language 'English' is always available even if there are no language specific files at the program directory. After selecting a new language at the checkbox all displayed text inside of the tool will change immediately to the corresponding texts from the language specific file.

When starting the PC tool it scans for the file *'LastSettings.txt'* at the program directory. Inside of this file the last settings for *'COM Port'* and *'Dialog Language'* are saved. If the file is available at the program directory when starting the PC tool the parameters will be used as default values for *'COM Port'* and *'Dialog Language'*. When closing the tool the actual settings of those settings will be saved to the file *'LastSettings.txt'*.

3.1.2. The group *Gain*

The amplification of the sensor can be adjusted manually via the combo box '*Gain*'. For an optimum setting of the gain value the brightest product must be presented in front of the light guide of the sensor. With that the gain should be changed to the highest value were no '*Overload*' of the sensor signal occurs. The '*Overload*' of the sensor signal is represented by the virtual LED '*Signal OK*' shown below the combo box. As long as no '*Overload*' is present the color of the LED is green. In case of an Overload the color of the LED changes to red.

As reference point for the brightest product the display bar of the Intensity (Y value) can be used.

When activating the checkbox '*Enable Auto-Gain*' the gain will be changed automatically for each product. In principle the use of the automatic gain setting is recommended. Exceptions only apply for applications that need the maximum processing speed of the sensor and where large changes of the intensity within a very short time occur at the same time. Apart from that the automatic gain setting needs no additional calculation time as long as no overload occurs from one measurement cycle to another (on the basis of a stabilized measuring condition).

Note: Activating the automatic gain setting is not available in sensor mode 'MARKS' (see **chapter 3.1.7**)!

3.1.3. The group *Averaging Cycles*

The checkbox '*Averaging Cycles*' serves for the parameterization of the averaging that should be considered during measuring the values with the sensor. The values at the checkbox are selected in such a way that for each next step the noise of the sensor signal is cut to the half. At the same time thereby however the signal delay rises itself whereby the time for a stable signal output is extended. Finally the best result for the setting of the average values must result from the compromise between the available process time and the necessary accuracy.

Note: Selecting the averaging cycles is not possible in sensor mode 'MARKS' (see **chapter 3.1.7**)!

3.1.4. The group *Compensate Environment*

Die function '*Compensate Environment*' can be used for application where the sensor could receive 'scattered light' from its own light source. That means reflected light from the light source that is not influenced by the product itself directly. A good example for that is the using of an optic where sender and receiver will use the same optical path. The 'scattering' of the light inside of the optic caused by the lenses and the housing of the optic leads to it that the receiver will 'receive' more or less light reflected from the own light source even if the optic 'looks' into the empty. This part of 'scattered light' leads to a kind of offset that makes all colors more achromatic. In addition one can easily present that the information signal of the actual product in relation the scattered light becomes worst the further away the optic is arranged from the product.

The Environment Compensation can be uniquely used now to compensate those unwanted effects. The compensation is permanently stored on the sensor. It must be repeated only then if e.g. optical components or light guides were exchanged.

The Environment Compensation is started by pressing the button '*Compensate*'. It must be observed that the sensor 'looks' into the empty and no product is in front of the optic or the light guide while processing the Environment Compensation. The tool automatically executes the necessary steps for the compensation and saves the data on the sensor.

The Environment Compensation becomes however only active by selection of the box '*Enable Compensation*'. The sensor uses the last saved compensation values if '*Enable Compensation*' has been activated. If the compensation is not enabled the sensor will **not** use the saved compensation data. With

each change of the status of the box *'Enable Compensation'* the actual status for the release of the compensation will be saved on the sensor.

Note: The environment compensation is not possible in sensor mode 'MARKS' (see **chapter 3.1.7**)!

3.1.5. The bar line displays *X, Y, Z* and the *'Normalize'* function

The bar line displays shown here present the actual measured sensor values as Tristimulus values. The Tristimulus values build the base for the conversion of the actual measurement values to the CIELab color space. For the (simplified) calculation a normalized Tristimulus input range from 0…100 will be assumed. However the internal range of the values depends on many factors. In practice considerable effects depending on the used light guide, optics and the measuring distance are to be called.

The Tristimulus values will be used for the evaluation of the test results only in an indirect way – there are no limits or tolerances that depend on the Tristimulus values. Besides from that these values are strictly linear. This does not apply on the CIELab values. For that reason the Tristimulus values are better suitable to e.g. to derive the degree of saturation of the sensor.

For the reason that the calculation to the CIELab color space must work all the time and in addition to adapt to different measuring conditions and applications, usually <u>at first</u> after mounting of all determining components a so called normalization must be established. Target of the normalization is to enforce a defined intensity result for a defined measuring condition.

Typically white balance cards with well-known reference values will be used for that. Such an absolute calibration is only necessary if the CIELab measurement values should match measurement values from other devices as exact as possible. Often such references could not be used because e.g. the contour of the product does not permit the mounting of such a reference. For that reason the normalization can be set to 'arbitrary' target values with the help of the PC tool. That makes it possible e.g. to create a '*Golden Product*' where an intensity value is assumed that can be estimated from a grey scale. A '*100% White*' would have a target value of 100, a 50% white (a light grey) would have a target value of 50.For a standard non-glossy paper a value of around 90 can be assumed.

After defining the reference a stable measuring condition for the reference must be set up. After that the intended Tristimulus-Y intensity value must be entered at the field '*Target Y*' and the button '*Normalize*' must be pressed afterwards. After a few seconds the normalization will be finished. If the shown Tristimulus Y-Channel value is now identical to the intended value the normalization was successful.

Note: In contrast to most other parameters the normalization is automatically permanently saved on the sensor. In addition we recommend using higher values for the averaging cycles for the normalization independent from the setting for the averaging cycles used later on. After a successful normalization the product parameters can be determined.

3.1.6. The group *Work Mode*

The group offers the possibility for selecting between the work modes '*BEST-FIT*' and '*PRECISE*'. Both modes will be described in the following. When selecting a work mode that mode is immediately activated on the sensor but the selection will **not** be saved permanently on the sensor.

Work Mode

○ BEST-FIT

◉ PRECISE

In '*BEST-FIT*' mode the sensor does not consider any defined product tolerances. The sensor always internally processes the parameters of all <u>active</u> products and as a results returns the product number to which the actual values best fit. For the determination of the best fitting product the Delta-E between the actual measured values and the target values for any saved product are calculated. If more than one of the saved products shows the exact same variation to the actual values, then the lowest of those product numbers is returned. **In this mode always one product will be detected as best fitting product, independent from the given product parameters!**

The work mode 'BEST-FIT' is best suited for the selection of objects out of several (known products). In an automation process it can e.g. be tested if an object with the correct color is fed in to the process, without checking if the exact color shade is met. Thus this mode is suitable also very well for sorting tasks.

In '*PRECISE*' mode a specific product number as test result is only given if the actual values of the sensor lie with the given tolerances for that product. If the actual values are inside of the tolerances of multiple products then no clearly correlation to a product is possible. In that case none of the digital outputs (Out 1...3) will be set. If the actual values are lying outside of the tolerances of any saved product, no product number is detected and the digital outputs (Out 1…3) are reset. The corresponding digital outputs are only set if the actual values are lying inside the tolerances of exactly one product. The tolerances the products are given with the product parameter '*Delta-E*' (see **chapter 3.1.8**).

The '*PRECISE*' mode is best suited e.g. for quality inspection of test objects, because here the tolerances for color and intensity must fit in order to detect on object of that kind.

3.1.7. The group *Sensor Mode*

Beginning with firmware version V3.3 the sensor offers the possibility for two different sensor modes. When selecting a sensor mode that mode is immediately activated on the sensor but the selection will **not** be saved permanently on the sensor.

The mode *'COLOR SENSOR'* is the default mode that provides all the options described in the other chapters. This mode is identical to the mode used with previous firmware versions. Thus this mode is not described further in this chapter.

Sensor Mode

◉ COLOR SENSOR

○ MARKS

The new mode *'MARKS'* which is described in detail in this chapter, because of its special characteristics. The characteristics of this mode are referenced in other chapters if they differ from the default mode.

With sensor mode *'MARKS'* the sensor parameters are automatically adapted for a minimum measurement time and thus the fastest possible measurement frequency. This mode is specially optimized for the detection of colored marks.

As the sensor mode *'MARKS'* uses very fast measurement times, it is possible to set a hold time for the digital outputs, so that a change of the outputs can be reliably detected by a superordinate controller. The selection of a hold time is restricted for that mode. That means for mode *'COLOR SENSOR'* using a hold a time is not possible.

The hold time affects in a way that the digital outputs remain active for a predetermined hold time (in milliseconds) even if the status of the outputs must be changed due to the currently measured color and the actual product parameters. After the defined hold time the status of the outputs may change correspondingly. By selecting the entry *'Off'* at the combo box for the hold time the 'delaying' of the digital outputs is disabled. That means the status of the digital outputs immediately follows the status of the sensor.

The sensor mode 'MARKS' can be used in both work modes *'BEST-FIT'* and *'PRECISE'*. The number of available products is limited to one. In work mode *'BEST-FIT'* even the selection of product 'Background' is possible. This is because in *'BEST-FIT'* mode always one product will be detected as best fitting product, independent from the given product parameters.

3.1.8. The group *Products*
The dialog elements of this group serve for the parameterization of the product parameters as well as for the indication of the entered product parameters.

The parameter can be entered for the corresponding products and for the product '*Background*'. The particular product is selected via the corresponding text at the combo box '*Product No.*'. The edit fields '*Target CIELab-L*', '*Target CIELab-a*' and '*Target CIELab-b*' show the last saved CIELab values for the selected product. The field *'Actual delta-E'* displays the '*color*' error of the actual measured value of the sensor regarding the saved measurement value for that product. The parameter '*Target delta-E*' does have only an impact for the '*PRECISE*' work mode (see **chapter 3.1.6**) and can be edited only if that mode is active. The parameter serves for setting a tolerance values (Delta-E) that must be met for that product.

The button '*Set Product Parameters*' is used for transferring the product parameters to the sensor. The product parameters then will be immediately activated for the corresponding product. The parameter will

not be permanently saved on the sensor. That means if the sensor is switched off the changes will be lost. For saving the parameters permanently on the sensor the button '*Save Remanent*' must be pressed.

> *Note: 'Set Product Parameters' is necessary only if CIELab target values should be given. If the actual product is used for teaching the button 'Use Actual Color As Product Target' can be used. In PRECISE mode an additional tolerance must be given which can only be done manually, In the case the button 'Set Product Parameters' must be pressed.*

The parameters can be changed by manually entering CIELab values at the edit fields or by using the actual values of the sensor. For using the actual sensor values as product parameters for the selected product the button '*Use Actual Color As Product Target*' must be pressed. With that the actual sensor values will be transferred to the edit fields and the product parameters will be saved immediately to the sensor. The product parameter will **not** be saved permanently on the sensor.

During the test for the correlation of the actual measured values regarding the saved product parameters and determination of the product that fits the best, only those products are considered were the parameter '*Enable Product*' has been active when saving the product parameters.

The special product *'Background'* is used for setting up the product parameters for the background. If the product *'Background'* has been determined as the product that 'best fits' the actual measurement values, none of the digital outputs (Out 1…3) of the sensor will be set. In '*BEST-FIT*' work mode this product e.g. can be used to detect that 'no' object is present in front of the sensor. In '*PRECISE*' mode it e.g. can be used to define 'areas' within the actual values of an object should not lie in any case.

3.1.9. The group *Logging*

The logging of the actual measurement values of the sensor can be started by pressing the button '*Start Logging*'. The text on the button will change to '*Stop Logging*' and the log function will be active. By pressing the button once again the log function is stopped and the text on the button will change back to '*Start Logging*'.

When starting the log function the selection of the mode for the log function (*'Continuous'* or *'Single'*) is recognized. If mode *'Continuous'* is active a new line with the actual measurement values is added to the log file each time the interval time given with parameter *'Interval'* expires. If mode *'Single'* is active a new line with the actual measurement values is added to the log file each time the button *'Single Shot'* is pressed. The button is enabled only if the mode *'Single'* is active. The selection between the modes is disabled while the log function has been started.

With each start of the log function a new log file is created whose filename among others is built from the actual date and time and the serial number of the connected sensor. The log file at first contains multiple header lines with the actual setup product parameters. Whereupon followed by new lines with the actual sensor values updated periodically (for mode *'Continuous'*) or when the button *'Single Shot'* is pressed (for mode *'Single'*). The log files will be saved in the so called CSV format. With that it is possible to use the log files with e.g. Microsoft Excel for further processing.

3.1.10. The group *State*

The virtual LEDs (Out 1…3) correspond to the status of the digital outputs of the sensor. These outputs are always set regarding the product that is actually detected as 'best fit' product from the sensor. For the test only products will be considered that has been marked as active during the parameterization of the product (Parameter '*Enable Product*').

The actual product number of the product detected as 'best fit' product from the sensor is shown at the field '*Output Product*'. This field represents thereby also the decoded output combination.

The correlation of the bit coded product number to the corresponding digital outputs (Out 1…3) can be taken from the following table.

Product No.	Bit Code	Out 3	Out 2	Out 1
Background	0000	0	0	0
1	0001	0	0	1
2	0010	0	1	0
3	0011	0	1	1
4	0100	1	0	0
5	0101	1	0	1
6	0110	1	1	0
7	0111	1	1	1

Table 1 : Correlation of product number to digital outputs

For applications were a direct assignment of a detected product number to a specific digital output is desired the products 1, 2 and 4 can be used, because for those products only one digital output (Out 1…3) is active at a time. In that case all other products must be marked as inactive (Parameter '*Enable Product*' **not active**).

If the product '*Background*' has been determined as the product that 'best fits' the actual measurement values the virtual LED '*Background*' will be active and all other LEDs (Out 1…3) will be off. In that case all digital outputs of the sensor (Out 1…3) will be reset.

Note: In sensor mode 'MARKS' (see **chapter 3.1.7**) the status of the digital outputs may not change immediately, but only after a specified hold time.

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3.1.11.   Import and Export of Module Parameters

The PC tool offers the possibility for creating a backup of all module specific sensor parameters. Those backups can be used to restore those parameters on the sensor at a later point of time. After pressing the button *'Parameter Import/Export'* at the main window the following dialog is shown.
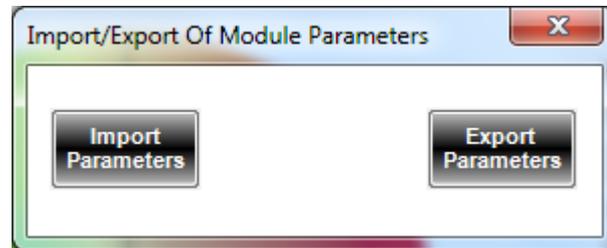
Figure 2 Dialog Import/Export of Module Parameters

The import of module parameters is achieved by pressing the button *'Import Parameters'*. For exporting module parameters the button *'Export Parameters'* must be pressed. Both actions always refer to the module currently connected to the PC tool.

With the import of module parameters a dialog is opened for selecting a file with previously saved parameters. After selecting a file the parameters will be read from the file. When accepting the shown security query the parameters will be transferred to the sensor and permanently stored there. **With that all previously parameters on the sensor will be overwritten!**

When exporting the parameters the actual module parameters will be read from the sensor and saved to a readable text file. The file name is predefined with a default name built from actual date, time and serial number. This file name can be changed according to own demands. The file always uses the file extension *'*.par'*.

3.1.12.   Other operational and display elements

The diagram shows the actual measurement values from the sensor as CIELab values. The CIELab-a and the CIELab-b value will be displayed as a cross inside of the diagram. The CIELab-L value is shown at the bar line display below the diagram. In addition the actual CIELab value are displayed as numeric values below the bar line display.

Attention! After changing the gain, the Work Mode, the Sensor Mode, the product parameters, the averaging cycles or the hold time the values are NOT permanently saved on the sensor. If the sensor is switched off then the changed settings will be lost. For the permanent saving of the values on the sensor the button 'Save Permanent' must be pressed. With that the settings will be saved preserved if the sensor is switched off.

By clicking the button 'Exit', the program is terminated.