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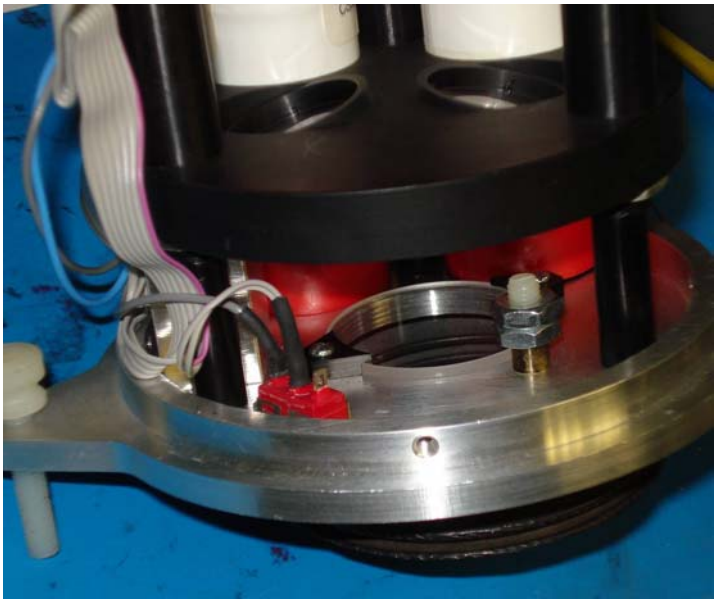
D&S Technical Note 09-3

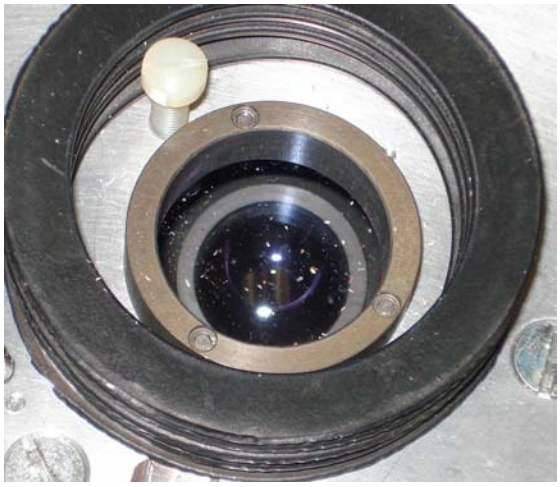
Portable Specular Reflectometer 15R-USB Advanced Features

Measurement Port Window – A port window is available to prevent accumulation of dust in the interior of the instrument. The window mounts as shown below on the inside just above the port. The mount uses threaded holes in the base plate that are present on all units so that the window is available as an upgrade. The window material is Magnesium Fluoride antireflection coated for optimum transmittance at the 660 nm wavelength of the red LED source.



Instrument with the outer shell removed showing the port window installed

Note that some scattering of light by dust on the lenses and the window is tolerated and accounted for by calibration to the reflectance of the working standard (either the standard supplied or another mirror). The working standard however must be clean in order to properly compare to the sample to be measured. The photo below shows excessive dust artificially applied to the window to test for offset.

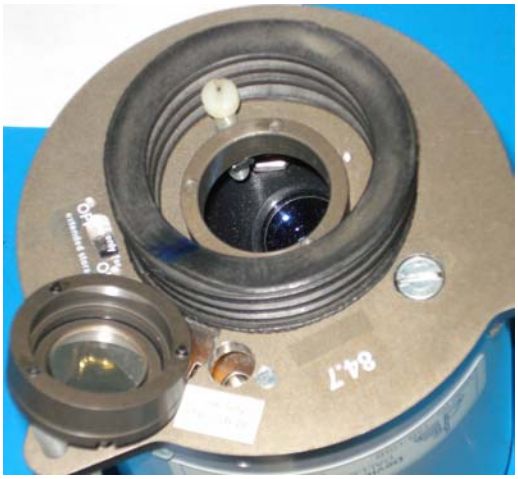


Even with this level of dust, the change in offset is not readable on the instrument (<0.05% reflectance). This dust level does result in about a 1% decrease in the reflectance reading of the standard on the 25 mrad aperture. This difference would be adjusted out by the gain calibration however it is recommended that the window be cleaned periodically with dry air and that it not be touched to avoid finger prints.

Since the angle of incidence of the source beam is 15 degrees the presence of the window displaces the optimum location of the reflecting surface. Ideally, the path of the reflected beam from the standard and the unknown sample to be measured is the same and passes through the optical center of the receiving lens. To accommodate the window, the mirror standard surface is mounted slightly further from the base and the central support leg in its extended position, is longer by the same amount.

Quick connect reflectance standard – A quick connect reflectance standard is available to make it possible to very quickly check calibration in the field. The construction is similar to the usual reflectance standard however it is split into two separate pieces held together by magnets.

Alignment pins are arranged in an asymmetric pattern to ensure that a repeatable orientation of the mirror is achieved. Repeatability of the alignment has been verified down to the 15 mrad minimum aperture size recommended for use with the mirror standard. For optional aperture sizes smaller than 15 mrad, an external working standard mirror is recommended.



The upper half of the standard threads into the base of the instrument and should remain in place. When not in use the lower half of the standard can be stored on a magnetic mount on the top of the instrument where it is protected from dust.

Support Locking Nuts – For applications where it is possible to prealign the instrument and ensure that the orientation of the instrument with the mirror to be measured can be repeated precisely, locking nuts can be used on the two outer support legs to fix the alignment. The third (central) support is designed to be friction tight and should not require locking. Locking nuts with nylon washers are supplied with new production and upgraded units for installation by the user. If it can be determined for a particular application that the alignment is accurate enough with the outer supports locked it is possible to make a large number of measurements quickly.

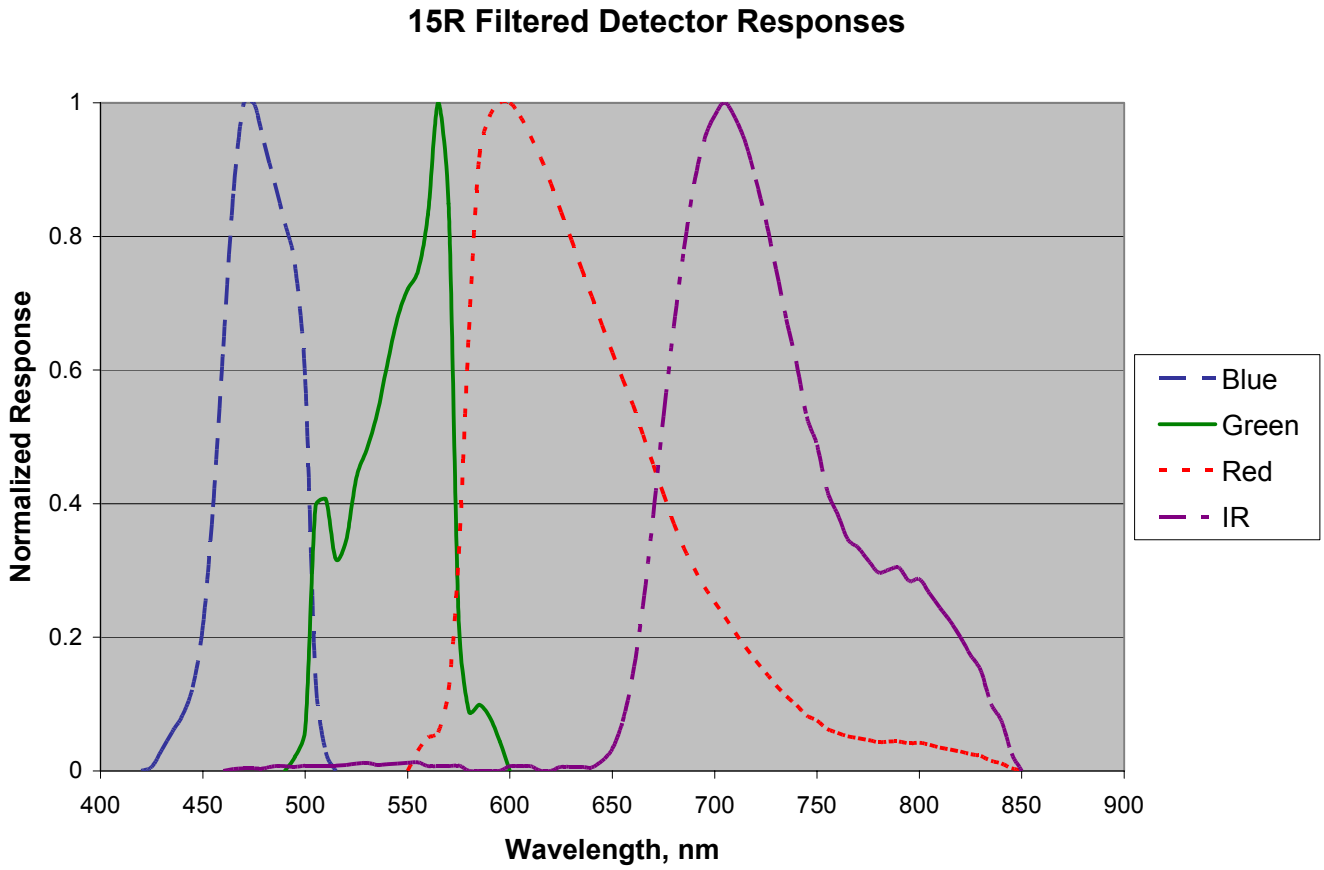
7 Milliradian Aperture – A 7 mrad aperture option is available and is normally installed in place of the 46 mrad aperture at location 3 on the thumbwheel. Because of the precision alignment required the standard supplied with the instrument cannot be used for calibration with this aperture. A customer supplied external reference mirror that is known to be highly specular is required for calibration. For additional information refer to Technical Note TN 88-1, 7 MRAD aperture for the Portable Specular Reflectometer Model 15R.

15RWin.exe Control Panel v1.1, 15R Flashware v1.1 (09/15/09) – Updated firmware and control panel software adds two new features to the 15R-USB, tracking of the gain adjust setting and temperature drift compensation. Gain adjust tracking was a requested feature for the purpose of detecting and preventing falsification of test data. The concern was that an operator could calibrate to a wrong value and thus obtain higher than actual reflectance values. By keeping track of the range of the gain adjustment during a series of measurements it is possible to detect perhaps the most obvious method of falsifying data. The range is tracked as a minimum to maximum percentage and can be viewed and reset from the 15R Windows Control Panel application. The minimum and maximum values for the reference voltage are checked and recorded each time a data point is acquired. There will be a small range of gain that will be normal over a period of time operating the instrument but it should be possible to detect misuse.

Temperature drift compensation was also added with this release making the gain setting more stable during a measurement session. With this added feature it may be possible to run a full series of measurements without repeating the calibration. With the gain adjust tracking it would also be possible to verify that the calibration was not adjusted during the sequence of measurements. Of course other sources of gain drift would have to be negligible during the session. For example, short term gain drift due to accumulation of dust on the port window would have to be determined to be negligible.

Multiple Wavelength Option – It has been proposed to implement a multiple wavelength option with a white LED source and a filter wheel to select wavelength. The filter wheel would fit between the aperture and detector thumbwheels. This option has been investigated and it is believed to be feasible but it has not been implemented. There is room for five filters elements on the wheel. The filters that have been proposed are blue, green and red wideband dichroic filters that would cover the visible range. It is likely possible to isolate the visible and near IR portion beyond about 650 nm with an IR longpass filter. The fifth position would be filled with a neutral density filter to provide reflectance for the full spectrum of the white LED.

The aggregate spectral response with a particular filter in place is the product of the LED output, the filter response and the silicon photodiode response. So, the response for each filter selection would be a relatively broad bandpass at each wavelength with not too much overlap. The figure below shows the approximate response with the blue, green, red and IR filters in position.



The measurement would involve selecting the filter wheel position and adjusting to the reflectance value of the standard for the particular distribution of wavelengths. Firmware on the 15R-USB board would adjust for the different detector output ranges with each filter selected.