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Technical Note 29

Measurement of modulated sources

Measurement of modulated sources

Modern light sources (lamps, luminaires, displays, projection systems) are often modulated. Examples are LED lamps dimmed by PWM and TV screens with their repetition rate. The effects are called Temporal Light Artifacts (TLA) and can be registered visually (flicker, stroboscopic effects). For details see: CIE TN 006:2016 (http://files.cie.co.at/883_CIE_TN_006-2016.pdf).

Light measuring devices become more and more sensitive, so they are also affected by TLA. The measuring time (more precisely the integration time) is often very short and can be in the range of the repetition rate of the DUT. This can lead to problems with the measurements, which for the user is particularly evident in terms of repeatability. Especially the radiometric and photometric values are affected, the color values are less due to their relative nature.

There exist three solutions to overcome this problem:

1. Averaging

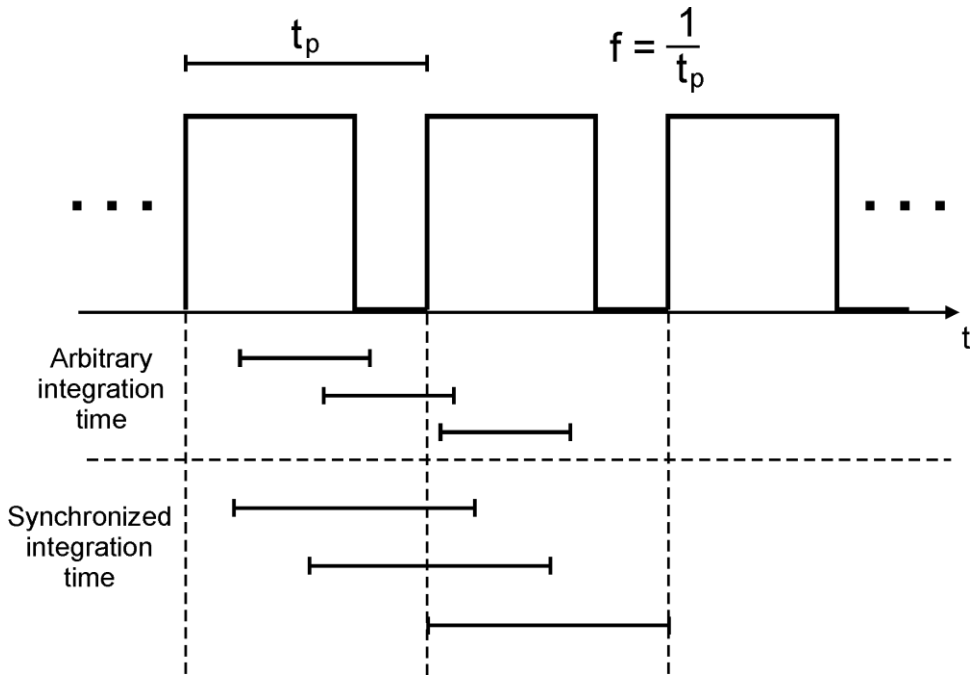
It is possible to proceed several measurements instead of one and to average them. This will equalize the modulation effect and make the results more stable.

2. Attenuation

The integration time will be extended by inserting a neutral density filter into the measuring path, either located in a filter wheel or in a cap to be attached on the device. The integration time will be much longer than the repetition rate of the DUT and hence the problem will be avoided.

3. Synchronization

It is possible to synchronize the integration time to the repetition rate of the source. The integration time can be equal to the period time or to multiples of it, depending when a proper exposure will be achieved.



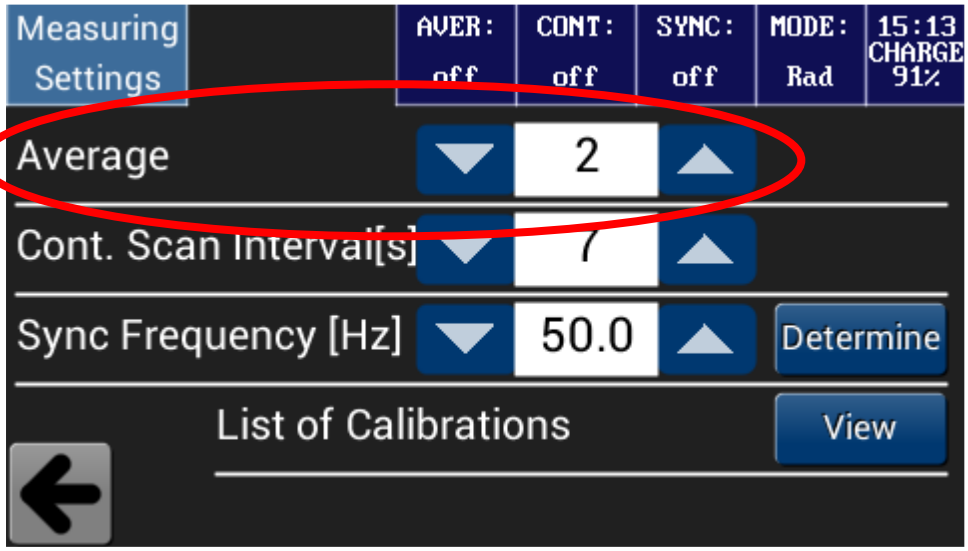
All three methods are compared in the following table:

Method	Averaging	Attenuation	Synchronization
Procedure	Multiple Repetition of the measurement scans, at least 10 times	Reduction of source intensity	Integration time only in steps of the period time of source
Integration time	as adapted	New adaption to attenuated signal	Adaptation in steps of the period time
Measuring time	Significantly increased (dark signal scans must be averaged too)	Significantly increased	Not significantly effected
Remarks		Needs mechanical effort (filter wheel or cap)	Knnowledge of frequency is necessary

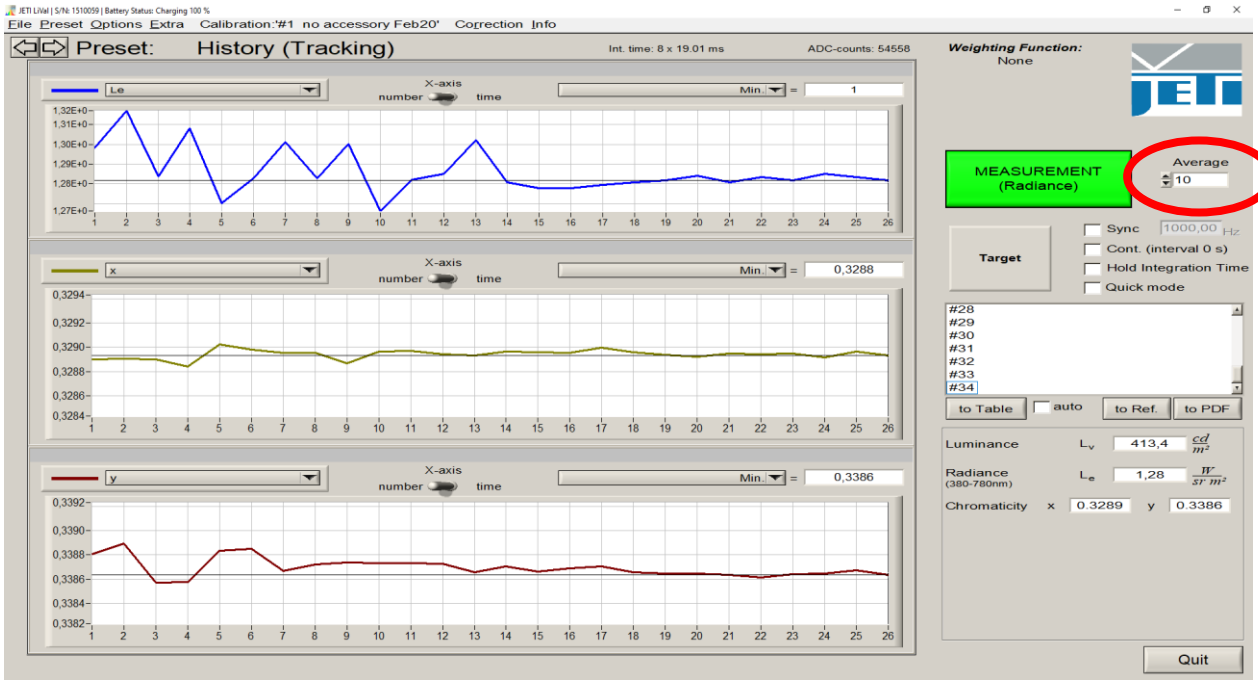
Using JETI devices

All three methods can be applied when measuring with specbos 1211-2 as well as spectraval 15x1.

Averaging is possible in the software JETI LiVal as well as in the display program of spectraval 1511.



Setting of the number of averages in the display program of spectraval 1511



Screen shot of the history diagrams of JETI LiVal: Measurement of a LED modulated with 80 Hz – Scan 1 -13 with 1 average and scan 14 – 26 with 10 averages (Integration time = 19.01 ms)

It is not necessary to average the light measurements only, but also the related dark measurements due to the laws of statistics.

One can also use **attenuation** filters for the devices. They are mounted in caps to be attached to the measuring head and available densities are OD1 (attenuation of 10 times) and OD2 (attenuation of 100 times). If such filters are used it is always necessary to apply the related calibration file. Therefore, it is necessary to return a device for calibration when ordering such filter separately.

specbos 1211-2 with attenuation filter cap

Part numbers of the filter caps

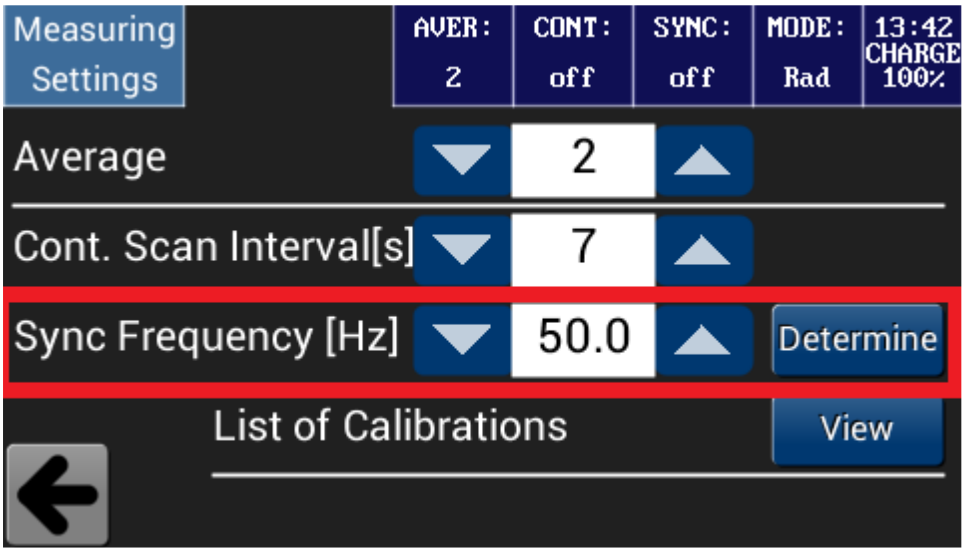
Filter type	**specbos 1211-2**	**specbos 1211UV-2**	**spectraval 15x1**
OD 1.0	ACC 010OD1.0	ACC 010UVOD1.0	ACC 033 OD1.0
OD 2.0	ACC 010OD2.0	ACC 010UVOD2.0	ACC 033 OD2.0

Finally, the **synchronization** method can be applied. It is necessary to know the modulation frequency in this case. If it is known, it can be typed in into the software. If not, it must be measured.

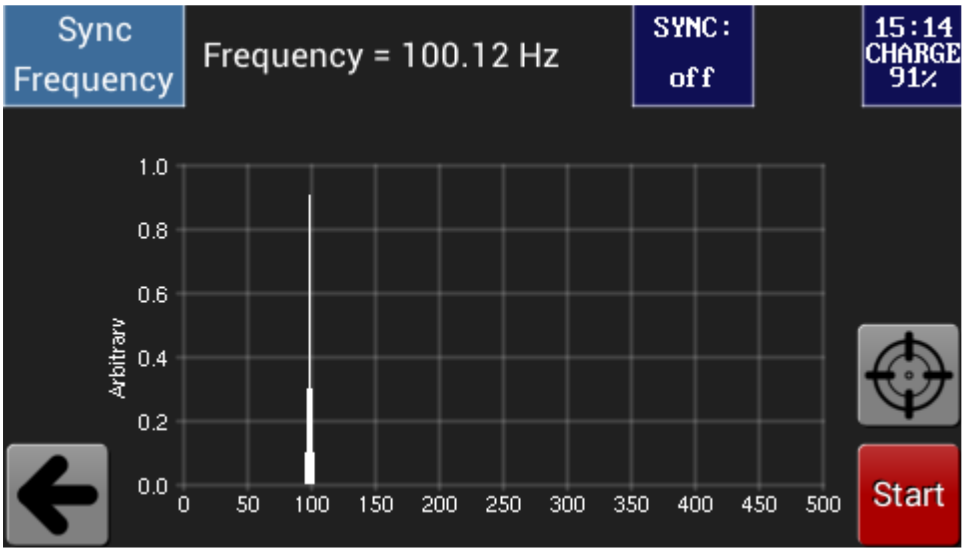
specbos 1211-2 has an additional integral detector in its front face, which can be used for such measurements.

Front face of specbos 1211-2 with hole for sync detector (left oft he measuring head)

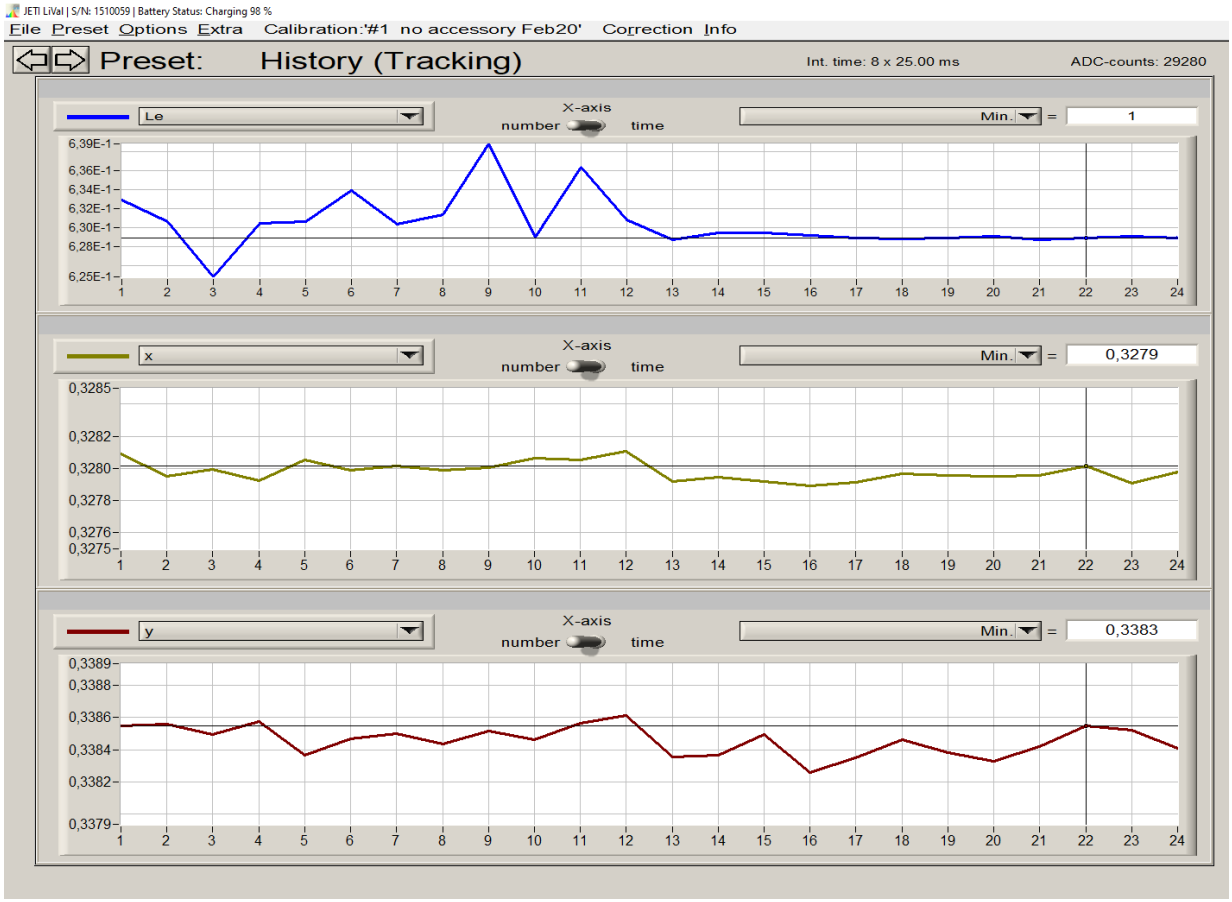
specbos 15x1 measures the frequency directly with the spectrometer in a special read out mode (fast measurements and read out of the spectrum as one integral value). This method is implemented in an optimized procedure from firmware version specfirm 1.10.6.



Frequency measurement in display software of spectraval 1511



Result of frequency measurement in display software of spectraval 1511



Measurement of a source modulated with 80 Hz. Measurement 1 – 12 without synchronization and measurement 13 – 24 with synchronization

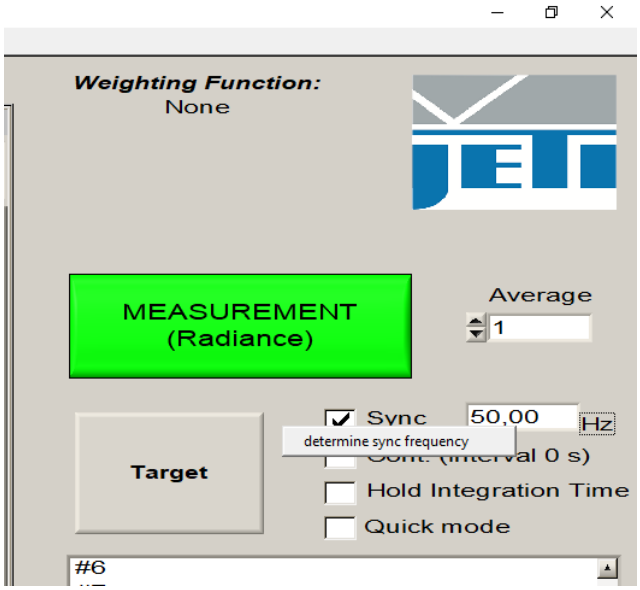
All JETI device have implemented a special mode for the case that the integration time set to one period time already ends in overexposure. Then the DivCyc mode will be used – the integration time will be divided into smaller portions until no portion suffers from over

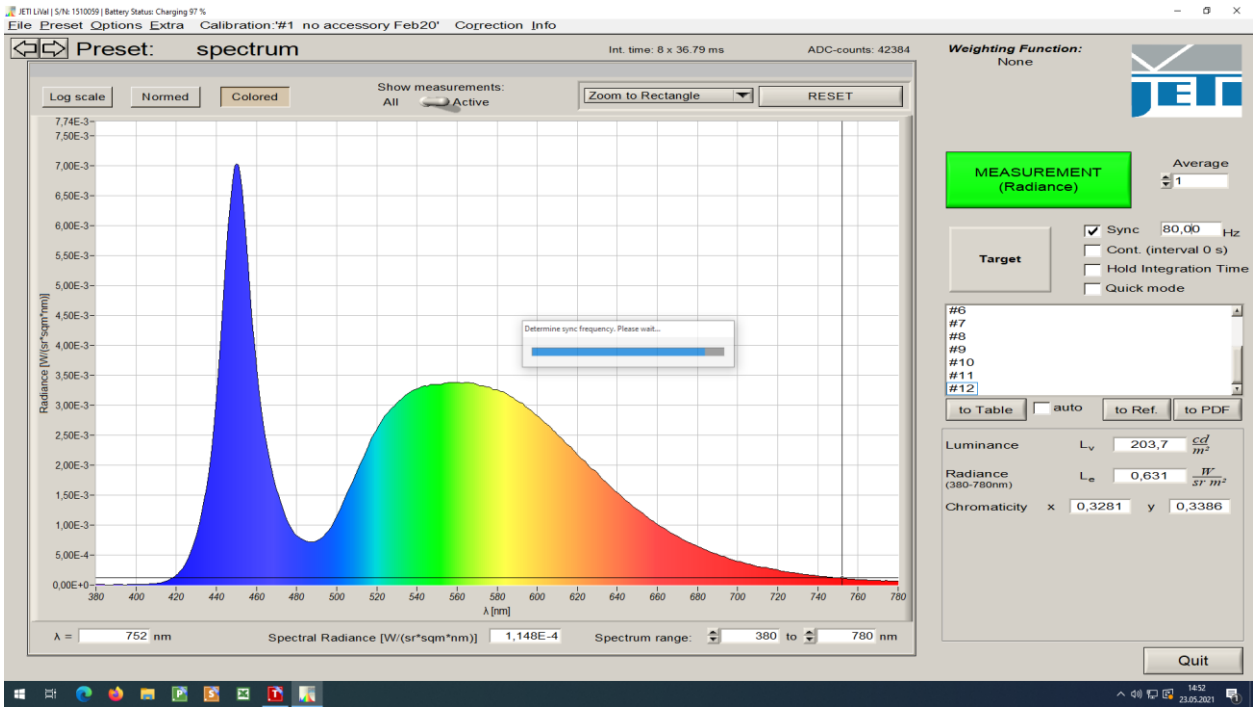
exposure. The individual partial measurements are designed that the result in a full period of the source when added. The final spectrum will be calculated from the addition of all individual measurements.

This mode has a peculiarity – in contradiction to other measurements the measuring time will rise in case of higher intensities.

The procedure for synchronized measurements is as follows:

1. Switch on the source and set it to maximum brightness (lamp, luminaire) or 100 % white (display)
2. Direct the meter towards the source
3. Measure the frequency (right mouse click into the sync frequency spectrum followed by OK)
4. Use the measured value for the following spectral measurements





Additional hints for frequency measurement

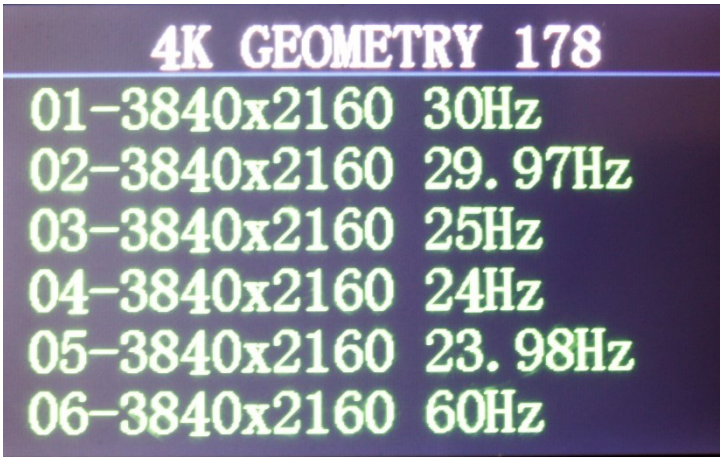
Some sources create problems with the frequency measurement, e.g. digital projectors with filter wheel.

Sometimes a source set to full brightness is not modulated and the frequency measurement will fail. This is possible in case of 100 % PWM setting of a lamp/ luminaire or 100 % white setting of a display.

The first measure in such cases is to set the source to a slightly lower brightness, e.g. 90 %.

If there arise problems with the frequency measurement of digital projectors, especially Laser based ones, it is recommended to use one of the primaries, set to 100 %. It is possible that the white setting gives a non regular modulation due to the interference of the modulation of the primaries and the filter wheel.

If the frequency measurement fails at all, then it is recommended to use the frequency of the video signal, because normally multiples of this frequency will be applied to a panel.



Resolution and frequency setting of the Murideo SixG pattern generator