Environmental Performance using DLP® NIRscan™ Nano

About Test Results

For many applications, performance under extreme or varying environmental conditions must be maintained. Standard requirements for NIR spectrometers include wavelength repeatability to be on the order of 10 percent of the instrument's resolution.[1] Any variability observed could be caused by many parts of the system: variation in the optics, mechanics, or noise differences over temperature. To show stability of the DLP NIRscan Nano evaluation module (EVM), a unit was tested for wavelength variation in a temperature and humidity chamber.

Related Documentation from Texas Instruments

- DLPC150 Data Sheet: *DLPC150 DLP® Digital Controller for Advanced Light Control*, TI literature number DLPS048
- DLP2010NIR Data Sheet: *DLP2010NIR (0.2 WVGA Near-Infrared DMD)*, TI literature number DLPS059
- Programmer's Guide: *DLPC150 Programmer's Guide*, TI literature number DLPU031
- Application Note: *Texas Instruments DLP® Spectrometer Design Considerations*, TI literature number DLPA049
- Application Note: *Flexible Trade-offs in Maximizing SNR and Resolution in TI DLP® Technology-Based Spectrometer Systems*, TI literature number DLPA066
- Selection Guide: *TI DLP® Technology for Spectroscopy*, TI literature number DLPT020

If You Need Assistance

Refer to the DLP Products and MEMS TI E2E Community support forums

Experimental Setup

An argon low-pressure discharge wavelength calibration lamp whose spectrum is shown in Figure 1 was placed outside the temperature and humidity chamber, and fiber coupled into the spectrometer which was placed inside the controlled chamber. Three separate experiments were run. In the first experiment, the temperature was varied while the dew point was held constant at 9.5°C. Similarly, the second experiment varied the temperature while holding the dew point constant at 18°C. In the third experiment, the relative humidity was held constant while varying the temperature, such that the absolute humidity was directly proportional to temperature. A diagram of the experimental setup can be seen in Figure 2 below.

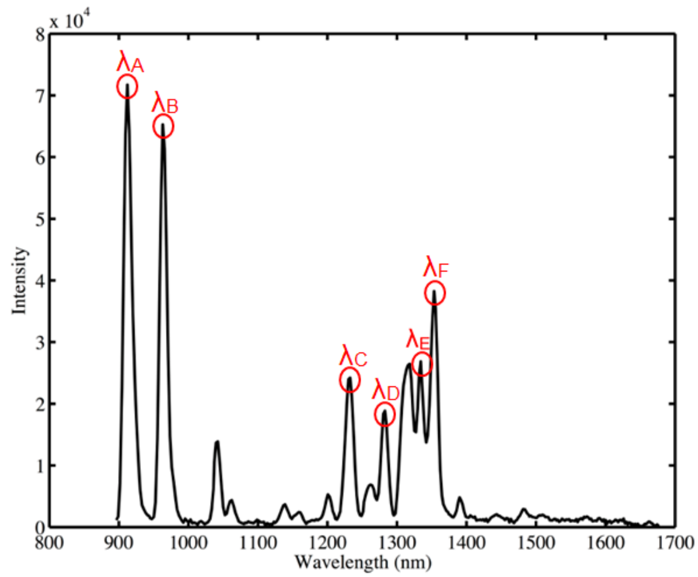

Figure 1: The spectrum of the argon test source

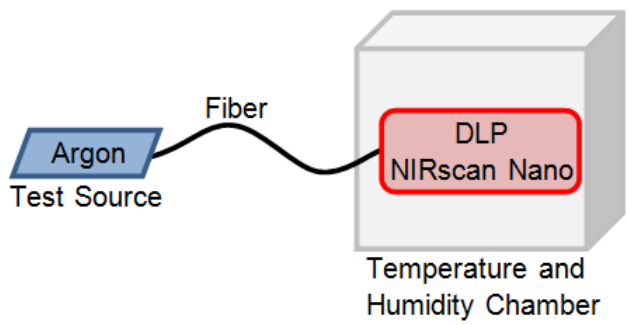

Figure 2: Experimental setup diagram

For each of the three experiments, the argon spectrum was scanned multiple times. The first scan was used as the reference values for the six peak wavelengths. The subsequent scans were measured at the different environmental conditions and used to calculate the variations from the reference values. To abide by the 10 percent standard presented earlier, the variation needs to be on the order of ±0.8nm or less.

		Reference		Test				Variation		
		T_1		T_2	T_3	T_4		V_1	V_2	V_3
Wavelength Peaks	λ_A	M_{A1}		M_{A2}	M_{A3}	M_{A4}		M_{A2}-M_{A1}	M_{A3}-M_{A1}	M_{A4}-M_{A1}
	λ_B	M_{B1}		M_{B2}	M_{B3}	M_{B4}		M_{B2}-M_{B1}	M_{B3}-M_{B1}	M_{B4}-M_{B1}
	λ_C	M_{C1}	…	M_{C2}	M_{C3}	M_{C4}	…	M_{C2}-M_{C1}	M_{C3}-M_{C1}	M_{C4}-M_{C1}
	λ_D	M_{D1}		M_{D2}	M_{D3}	M_{D4}		M_{D2}-M_{D1}	M_{D3}-M_{D1}	M_{D4}-M_{D1}
	λ_E	M_{E1}		M_{E2}	M_{E3}	M_{E4}		M_{E2}-M_{E1}	M_{E3}-M_{E1}	M_{E4}-M_{E1}
	λ_F	M_{F1}		M_{F2}	M_{F3}	M_{F4}		M_{F2}-M_{F1}	M_{F3}-M_{F1}	M_{F4}-M_{F1}

Figure 3: Example measurements for each experiment

Performance Results

Two experiments were conducted at constant dew points of 9.5°C and 18°C. Because the dew points were held constant, this tested the wavelength stability over temperature independent of water vapor content of the air. The distribution of the peak locations are shown in Figures 4 and 5. The variations were observed to be much better than the ≤±0.8nm target.

The third experiment was conducted where relative humidity was held constant and the temperature was varied over a wider range. In this series, the absolute humidity was increasing along with the temperature at each data point. The results are shown in Figure 6, with the variations again well within the ≤±0.8nm goal.

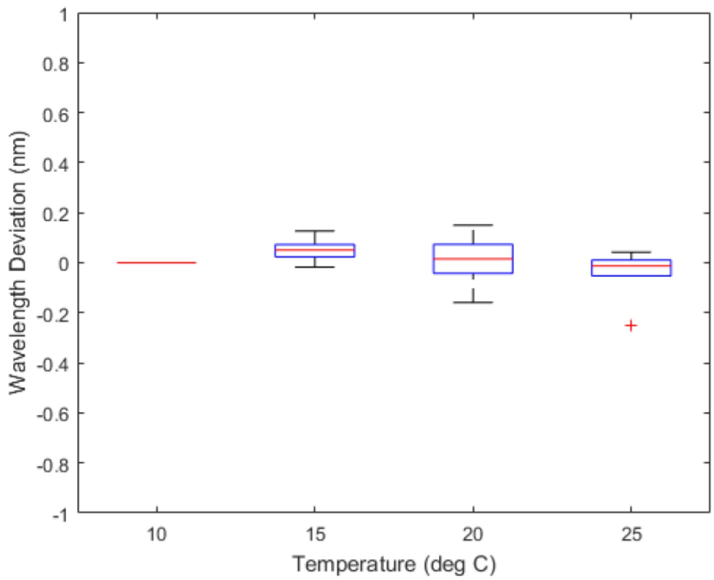

Figure 2: Wavelength location variation vs temperature at 9.5°C dew point

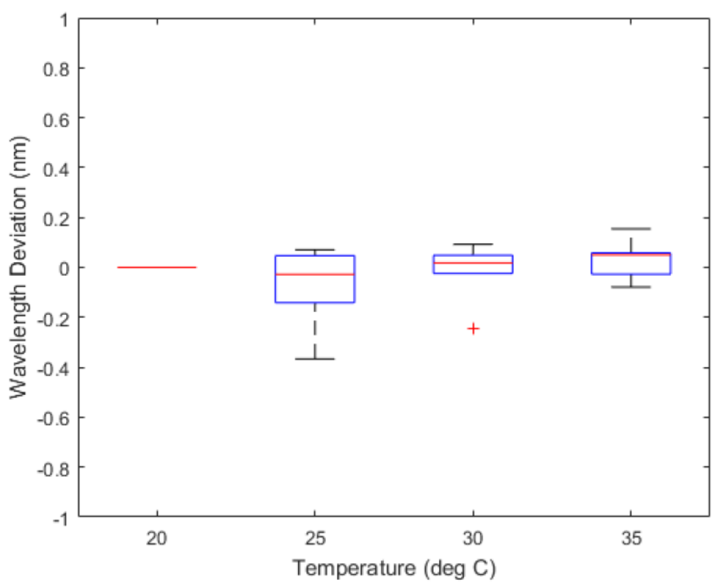

Figure 3: Wavelength location variation vs temperature at 18°C dew point

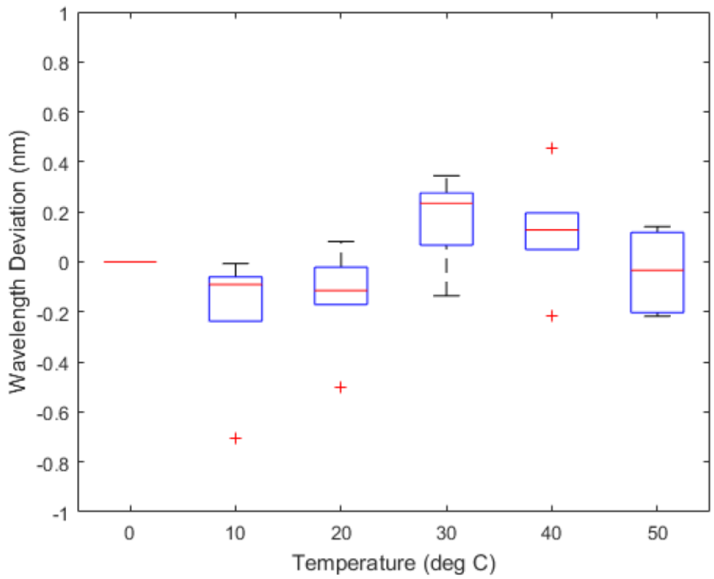

Figure 4: Wavelength location variation vs temperature with 60% relative humidity

Conclusion

The CMOS based, landed MEMS digital micromirror device (DMD) architecture in the DLP NIRscan Nano EVM has been shown to provide stabile wavelength accuracy in this compact system over the wide range of temperatures and humidities tested here. NIR spectrometer applications which have previously been hampered from the market by high cost or questionable field performance now have a platform available that combines the best in handheld, portable performance.

REFERENCES

[1] Haibach, F. G., “Getting the best results from nir measurements,” tech. rep., BaySpec Incorporated (2014).

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