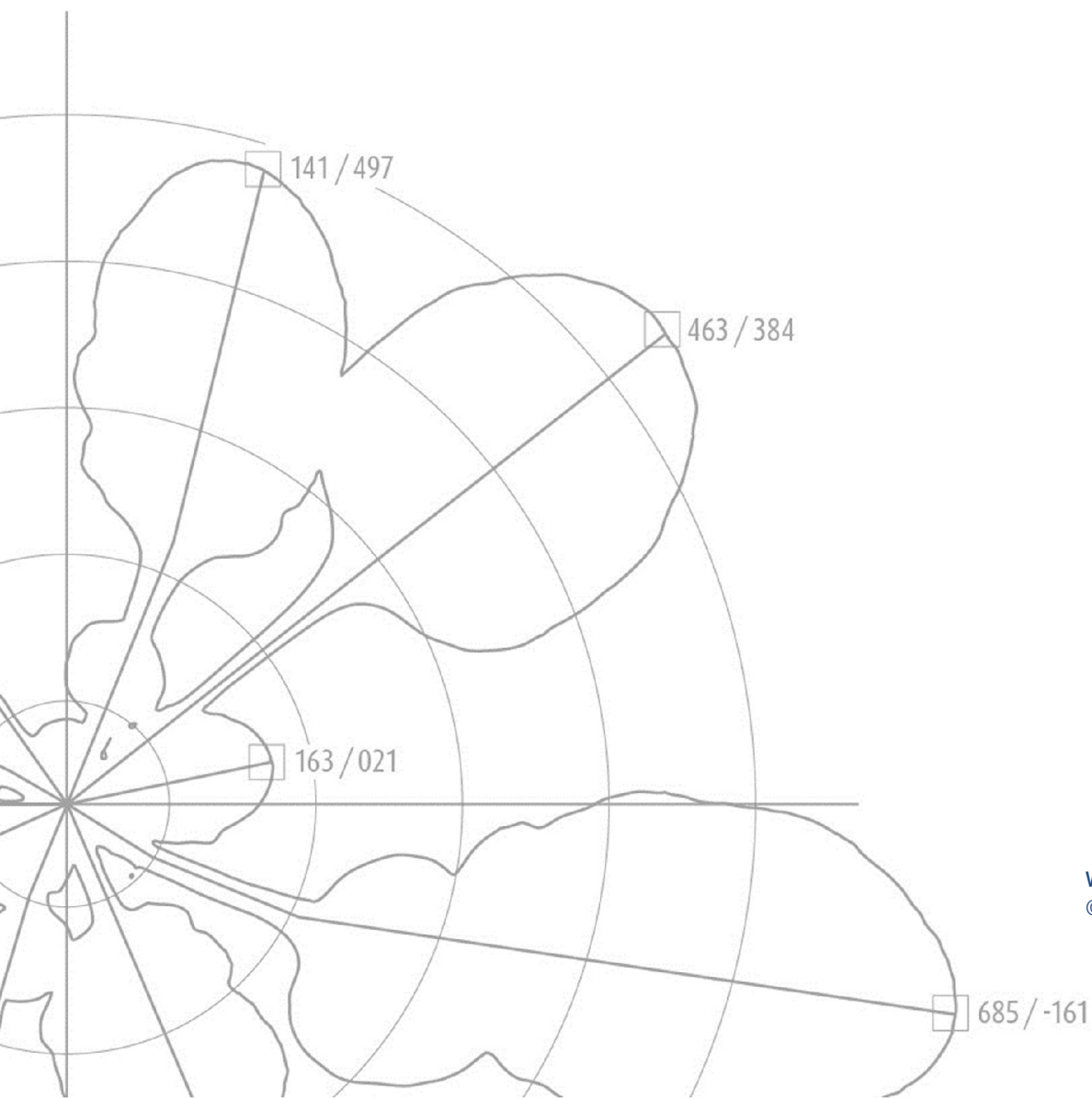




»» 09001-Sensor Accuracy

Sensor documentation for the multi sensor platform

Specification, Manufacturer information and details



Version 1: Monday, 05 September 2016
©LemnaTec 2016

NDVI (Top)

(633.2nm & 799.7nm)

Manufacturer:

Skye Instruments Ltd
21, Ddale Enterprise Park
Llandrindad Wells
Powyr LD1 6DF
United Kingdom

Model: SKR 1860NDA



Specification:

Range: 4 channels individually chosen at time of ordering between 400-2400 nm. Bandwidths from 5nm to several 100 nm

Construction: Plain anodised aluminium housing Cosine correcting head for incident. Waterproof rating IP65, fully weatherproof. Regular maintenance required to keep light collecting surfaces clean and free from obstruction, e.g. dust, moisture, algae etc

Filters: Metal interference and/or glass depending on wavelengths & bandwidths chosen, to military spec.

Detector: Silicon photodiode

Cable: Screened military specification. 3m. Standard length.

Temperature Range: -35 to +75 °C

Humidity Range: 0-100%

Output: SKR 1860D/ND - current output (nA) which varies with filters used.

Power supply: SKR 1860D/ND not required

Linearity: Better than 0.2% of scaled range.

Response Time: SKR 1860D/ND - typically less than 100 nanoseconds.

Mounting: M6 x 7mm tapped hole in base. Sensor supplied with M6 x 16mm screw + 4x 1.5mm washers to suit panel thicknesses of 3-10mm

Hardware integration:

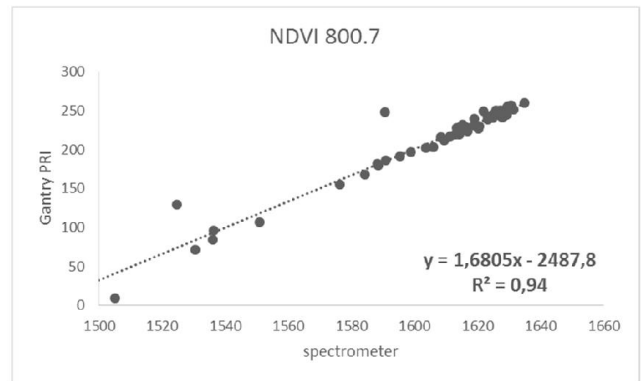
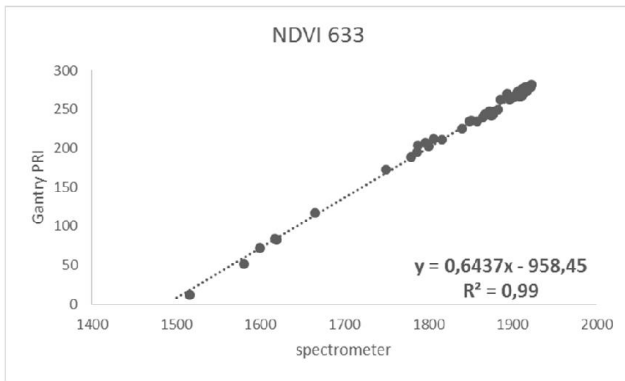
as shown in Operating Manual



Test results & Analysis:

- Data acquisition:** Basis are 64 measurements during 22 days of June and July 2016 coming from the PRI (TOP) sensor of the gantry system.
- Reference Data:** Reference data is coming from the gantry spectrometer
- Purpose:** Analysis shows the correlation between these two sensors. RMSE and MAPE are not possible as we compare measurements of different aperture angle and different spectral resolution

NDVI 633			NDVI 800,7		
R ²	Limit	Unit	R ²	Limit	Unit
0,99	0,7	degrees	0,94	0,7	μmol/sm ²



Calibration details:

Certificate no: 1860NDA / 117 / 0915
 Serial number: SKR 1860ND / A 45952
 Date of calibration: 01/09/2015
 Lamp reference: SK5

Calibration typically better than 5%. Note that this error is to some dependant on bandwidth - wide Bandwidths will be less subject to error than very low bandwidth channels.

Recalibration:

It is recommended that this unit is recalibrated within two years of the above calibration date.



PRI (Top)

(531.2nm & 568.9nm)

Manufacturer:

Skye Instruments Ltd
21, Ddale Enterprise Park
Llandrindad Wells
Powyr LD1 6DF
United Kingdom



Model: SKR 1860NDA

Specification:

- Range:** 4 channels individually chosen at time of ordering between 400-2400 nm. Bandwidths from 5nm to several 100 nm
- Construction:** Plain anodised aluminium housing Cosine correcting head for incident. Waterproof rating IP65, fully weatherproof. Regular maintenance required to keep light collecting surfaces clean and free from obstruction, e.g. dust, moisture, algae etc
- Filters:** Metal interference and/or glass depending on wavelengths & bandwidths chosen, to military spec.
- Detector:** Silicon photodiode
- Cable:** Screened military specification. 3m. Standard length.
- Temperature Range: -35 to +75 °C
- Humidity Range: 0-100%
- Output:** SKR 1860D/ND - current output (nA) which varies with filters used.
- Power supply:** SKR 1860D/ND not required
- Linearity:** Better than 0.2% of scaled range.
- Response Time:** SKR 1860D/ND - typically less than 100 nanoseconds.
- Mounting:** M6 x 7mm tapped hole in base. Sensor supplied with M6 x 16mm screw + 4x 1.5mm washers to suit panel thicknesses of 3-10mm

Hardware integration:

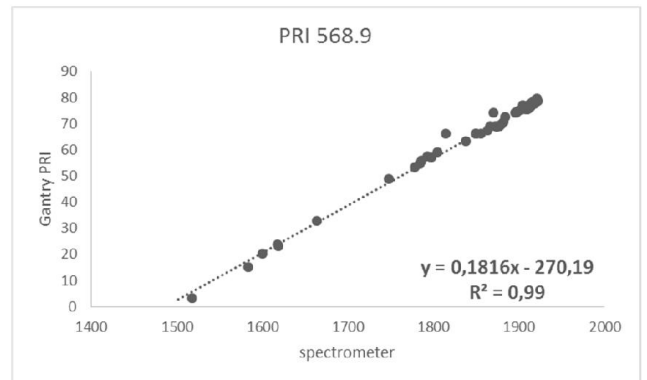
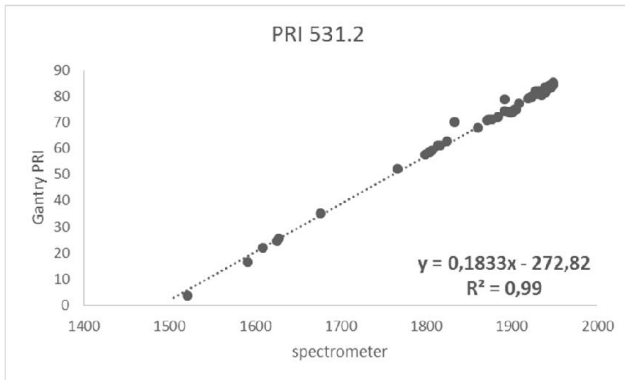
as shown in Operating Manual



Test results & Analysis:

- Data acquisition:** Basis are 64 measurements during 22 days of June and July 2016 coming from the PRI (TOP) sensor of the gantry system.
- Reference Data:** Reference data is coming from the gantry spectrometer
- Purpose:** Analysis shows the correlation between these two sensors. RMSE and MAPE are not possible as we compare measurements of different aperture angle and different spectral resolution

PRI 531.2			PRI 568.9		
R ²	Limit	Unit	R ²	Limit	Unit
0.99	0.7	°C	0.99	0.7	m/s



Calibration details:

Certificate no: 1860NDA / 117 / 0915
 Serial number: SKR 1860ND / A 45953
 Date of calibration: 01/09/2015
 Lamp reference: SK5

Calibration typically better than 5%. Note that this error is to some dependant on bandwidth - wide Bandwidths will be less subject to error than very low bandwidth channels.

Recalibration:

It is recommended that this unit is recalibrated within two years of the above calibration date.



Thies Weather station:

Manufacturer:

Adolf Thies GmbH & CO. KG
 Hauptstraße 76
 Box 3536+3541
 37083 Göttingen
 Germany



Specification:

Wind speed	Measuring range	0.01 m/s...60 m/s Scaling of analogue output freely selectable	
	Accuracy	≤ 5 m/s	± 0.3 m/s (rms - mean over 360°)
		5...60m/s:	± 3 % of measured value (rms -mean over 360°)
	Resolution	0.1 m/s:	in telegrams 1, 2, 3, 5, 6
0.01 m/s:		in telegram 14	
Wind direction	Measuring range	0...360°	
	Accuracy	± 2.0° with WS > 2 m/s	
	Resolution	1°:	in telegrams 1, 2, 3, 4, 6
0.1°:		in telegrams 5, 14	
Virtual temperature	Measuring range	-40°C ...+80°C	
	Accuracy	± 0.5 K	
	Resolution	0.1 K	
Air temperature	Measuring range	-40°C ...+80°C	
	Accuracy	± 0.3 K @ 25°C, ± 1.0 K above -40°C ...+80°C	
	Resolution	0.1 K	
	Long-term stability	< 0.04 K per year	
Air humidity, relative	Measuring range	0% ...100% relative humidity	
	Accuracy	± 1.8% of 10% ...90%, ± 3.0% of 0% ...100%	
	Long-term stability	< 0.5% per year	
	Resolution	0.1%	
Air pressure	Measuring range	300 hPa ...1100 hPa	
	Accuracy	± 0.25 hPa at +10...+35°C	
		± 1 hPa at -20...+60°C	
	Resolution	0.1 hPa	
Long-term stability	< ± 1 hPa per year		
Brightness	Measuring range	1 lux ...150 klux	
	Accuracy	0,3% of relative measured value	
	Resolution	approx. 0,3% of measuring value	
Precipitation	Measuring ranges:		
	Intensities	0.001 mm/h ... 999 mm/h	
	Resolution intensity	0.001 mm/h	
	Daily total	0.01 mm ... 999 mm	
	Resolution daily total	0.01 mm	
	Droplet size	0.25 mm to 5.0mm, large as hail	
	Accuracy with precipitation	with 95% of the precipitations deviations less than 15% compared with Thies Laser Precipitation Monitor (Reference)	
Type of precipitation	Rain, snow, sleet, ice crystals, hail		

Data output digital	Interface	RS 485 / RS 422 Electrically isolated from supply
	Baud rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 selectable
	Output	Instantaneous values, sliding means from 100 msec to 2 min in increments of 100 msec freely selectable
	Output rate	One per 10 msec to one per 60 seconds in increments of 1 msec freely selectable
	Protocol	ASCII- Thies-Format and MODBUS RTU
Data output analogue	Electrical outputs	0... 10 V Electrically isolated from supply Permissible burden on voltage output: $\geq 2000\Omega$
	Output	Instantaneous values, sliding means from 100 msec to 2 min in increments of 100 msec freely selectable
	Output rate	Update rate 10 msec
	Resolution	16 bit
	General	Internal measuring rate
Bus mode		Bus mode with up to 99 devices possible
Firmware update		Firmware update in full duplex mode via RS422
Temperature range		Operating temperature -30 ... +70°C Storage temperature -55 ... +80°C
Operating voltage		Supply without cover heating 6V...40 V DC or 10...28 V AC 50Hz / 60Hz typ. 50 mA @ 24V
Operating voltage		Supply with cover heating 24 V AC/DC $\pm 15\%$, 25 VA typically @ 24 V nominal (execution only 4.9200.00.00x, 4.9202.00.00x)
Type of protection		IP 67 (when mounted correctly, see section "Preparation for operation")
Housing		4.92xx.xx.xxx Plastic: LEXAN (polycarbonate, UV-stabilised) impact and weather-resistant
Mounting		e.g. on mast tube R1½" (\varnothing 48.3 mm)
Type of connection		19-pin plug connection
Weight	approx. 900g (full version)	

Hardware integration:

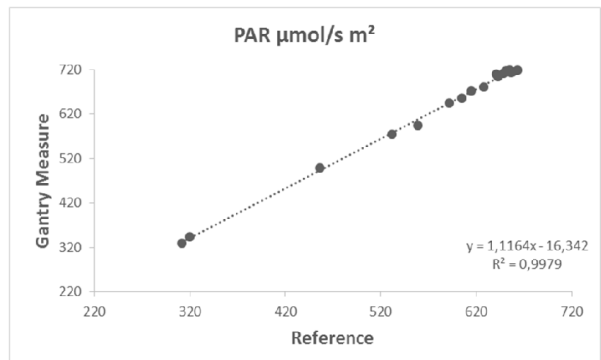
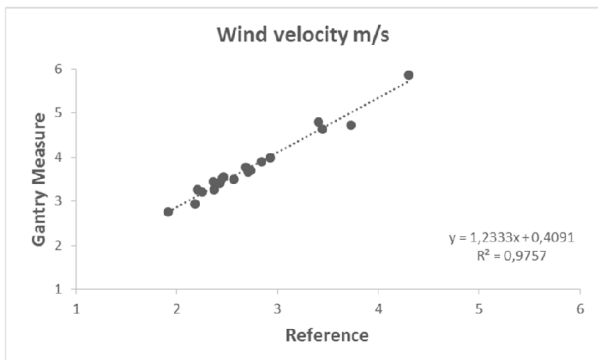
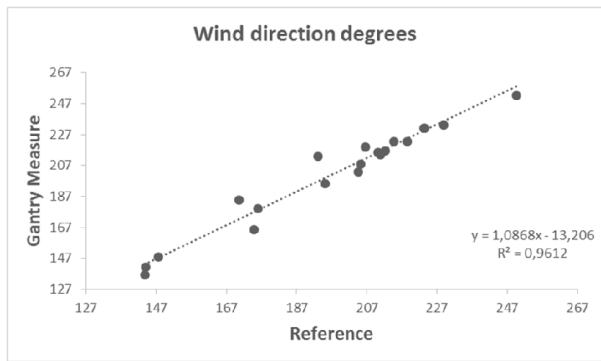
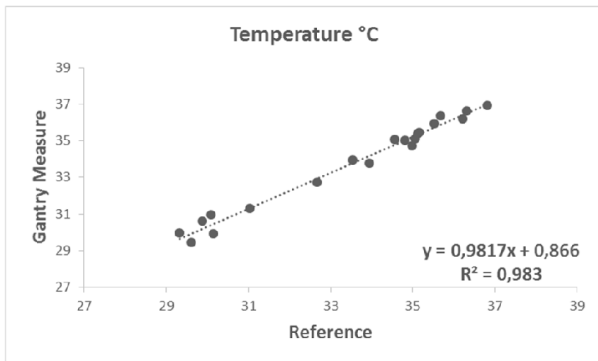
as shown in Operating Manual

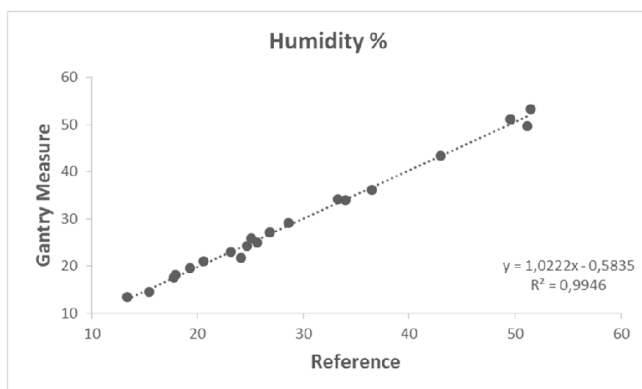


Test results & Analysis:

- Data acquisition:** Basis are twenty measurements during June and July 2016 coming from the weather station of the gantry system.
- Reference Data:** Reference data is coming from an external weather station from the university.
- Analysis:** Analysis shows three different error measurements to classify the sensor accuracy (R^2 , RMSE & MAPE)

Temperature				Wind Velocity			
RMSE	Limit	MAPE	Limit	RMSE	Limit	MAPE	Limit
0,34	5°	-0,01	5%	1,05	5m/s	-0,39	5%
R ²	Limit	Unit		R ²	Limit	Unit	
0,98	0,7	°C		0,98	0,7	m/s	
Wind Direction				PAR			
RMSE	Limit	MAPE	Limit	RMSE	Limit	MAPE	Limit
6,09	45	-0,02	5%	52,40	150	-0,09	5%
R ²	Limit	Unit		R ²	Limit	Unit	
0,96	0,7	degrees		0,99	0,7	µmol/sm ²	
Humidity							
RMSE	Limit	MAPE	Limit				
0,68	25	0,00	5%				
R ²	Limit	Unit					
0,99	0,7	%					





Calibration details:

...

Recalibration:

It is recommended that this unit is recalibrated within two years of the above calibration date.