

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0072
CALIBRATION DATE: 12-Jun-11

SLOCUM PAYLOAD CTD
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = -5.054446e-005

a1 = 2.974220e-004

a2 = -3.835449e-006

a3 = 1.842517e-007

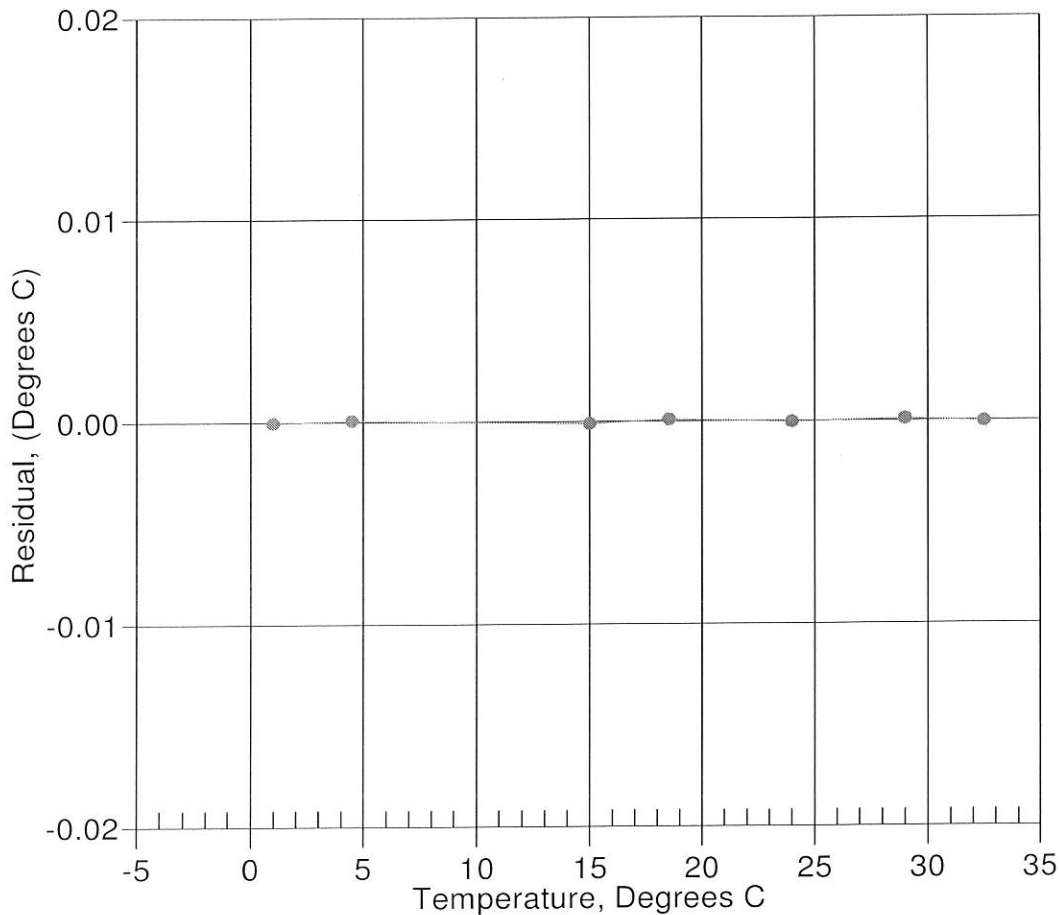
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0001	572145.9	1.0001	-0.0000
4.5000	488872.4	4.5001	0.0001
15.0000	311064.5	14.9999	-0.0001
18.5000	269231.1	18.5001	0.0001
24.0001	215862.0	24.0001	-0.0000
29.0001	177670.9	29.0002	0.0001
32.5001	155555.4	32.5001	-0.0000

Temperature ITS-90 = $1 / \{ a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature

Date, Delta T (mdeg C)

12-Jun-11 -0.00



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CALIBRATION DATE: 12-Jun-11

SLOCUM PAYLOAD CTD
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.036652e+000
h = 1.674012e-001
i = -4.518691e-004
j = 6.002554e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 4.0092e-007

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2494.11	0.00000	0.00000
1.0001	34.8094	2.97544	4906.93	2.97544	-0.00000
4.5000	34.7889	3.28239	5090.79	3.28240	0.00000
15.0000	34.7446	4.26375	5637.85	4.26375	-0.00000
18.5000	34.7353	4.60878	5817.75	4.60879	0.00001
24.0001	34.7250	5.16655	6097.06	5.16654	-0.00001
29.0001	34.7193	5.68823	6346.91	5.68823	0.00000
32.5001	34.7163	6.06053	6519.18	6.06053	0.00000

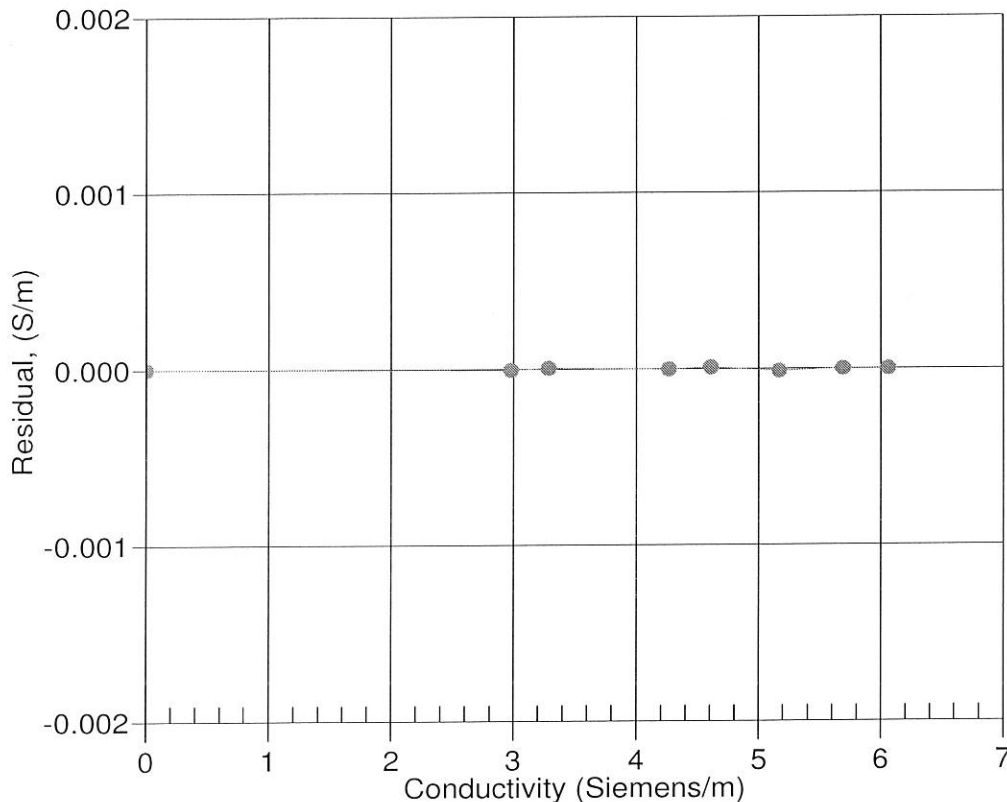
$$f = \text{INST FREQ} * \text{sqrt}(1.0 + \text{WBOTC} * t) / 1000.0$$

$$\text{Conductivity} = (g + hf^2 + if^3 + jf^4) / (1 + \delta t + \epsilon p) \text{ Siemens/meter}$$

t = temperature[°C]; p = pressure[decibars]; δ = CTcor; ϵ = CPcor;

Residual = instrument conductivity - bath conductivity

Date, Slope Correction



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SENSOR SERIAL NUMBER: 0072
CALIBRATION DATE: 09-Jun-11

SLOCUM PAYLOAD CTD
PRESSURE CALIBRATION DATA
1450 psia S/N 3274632

COEFFICIENTS:

PA0 = 3.063302e-001
PA1 = 4.947301e-003
PA2 = -2.471960e-011
PTEMPA0 = -6.956441e+001
PTEMPA1 = 5.055836e-002
PTEMPA2 = -3.767756e-007

PTCA0 = 5.246583e+005
PTCA1 = 6.597581e+000
PTCA2 = -1.807690e-001
PTCB0 = 2.528963e+001
PTCB1 = -2.750000e-004
PTCB2 = 0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.68	527628.0	1800.0	14.71	0.00
314.96	588313.0	1802.0	314.90	-0.00
614.97	648991.0	1803.0	614.88	-0.01
914.95	709710.0	1803.0	914.88	-0.01
1215.05	770477.0	1803.0	1214.93	-0.01
1464.92	821133.0	1815.0	1464.93	0.00
1214.85	770482.0	1815.0	1214.96	0.01
914.84	709721.0	1815.0	914.94	0.01
614.86	649003.0	1815.0	614.94	0.01
314.88	588319.0	1815.0	314.94	0.00
14.68	527619.0	1816.0	14.67	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2050	527602.20
29.00	1979	527624.40
24.00	1877	527641.30
18.50	1765	527642.20
15.00	1694	527636.50
4.50	1481	527607.80
1.00	1411	527590.30

TEMP (ITS90)	SPAN (mV)
-5.00	25.29
35.00	25.28

$$y = \text{thermistor output}; t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$$

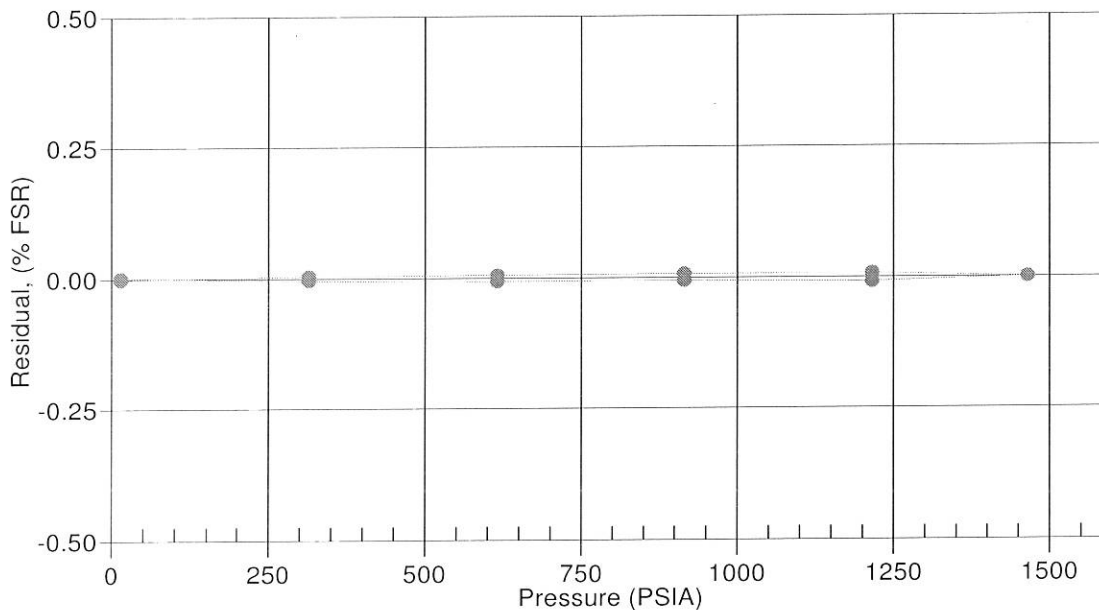
$$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$$

$$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$$

$$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$$

Date, Avg Delta P %FS

● 09-Jun-11 -0.00



ECO Chlorophyll Fluorometer Characterization Sheet

Date: 10/19/2011

S/N: FLBBCDSLK-2374

Chlorophyll concentration expressed in $\mu\text{g/l}$ can be derived using the equation:

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark counts})$$

	Digital
Dark counts	54 counts
Scale Factor (SF)	0.0073 $\mu\text{g/l/count}$
Maximum Output	4130 counts
Resolution	1.1 counts
Ambient temperature during characterization	22.3 °C

Dark Counts: Signal output of the meter in clean water with black tape over detector.

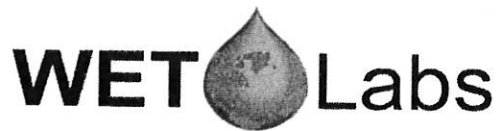
SF: Determined using the following equation: $\text{SF} = x + (\text{output} - \text{dark counts})$, where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations in-situ is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

PO Box 518
620 Applegate St.
Philomath, OR 97370



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www.wetlabs.com

ECO CDOM Fluorometer Characterization Sheet

Date: 10/19/2011

S/N: FLBBCDSLK-2374

CDOM concentration expressed in ppb can be derived using the equation:

$$\text{CDOM (ppb)} = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

Dark Counts	Digital
Scale Factor (SF)	56 counts
Maximum Output	0.0918 ppb/count
Resolution	4130 counts
	0.7 counts
Ambient temperature during characterization	22.3 °C

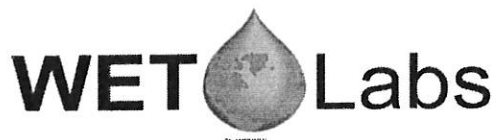
Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: $SF = x + (\text{output} - \text{dark counts})$, where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

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Scattering Meter Calibration Sheet

10/19/2011

Wavelength: 700

S/N FLBBCDSLK-2374

Use the following equation to obtain either digital or analog "scaled" output values:

$$\beta(\theta_c) \text{ m}^{-1} \text{ sr}^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

• Scale Factor for 700 nm	=	1.699E-06 (m ⁻¹ sr ⁻¹)/counts
• Output	=	meter output counts
• Dark Counts	=	38 counts
Instrument Resolution	=	1.2 counts

Definitions:

- **Scale Factor:** Calibration scale factor, $\beta(\theta_c)/\text{counts}$. Refer to User's Guide for derivation.
 - **Output:** Measured signal output of the scattering meter.
 - **Dark Counts:** Signal obtained by covering detector with black tape and submersing sensor in water.
- Instrument Resolution: Standard deviation of 1 minute of collected data.



AANDERAA DATA INSTRUMENTS

TEST & SPECIFICATIONS

Form No. 712, Feb2006

Layout No: 1308E, 1299G
Circuit Diagram No: 1.04
Program Version: 3, Build: 24

Product: Oxygen Optode 5013W
Serial No: 1412

1. Visual and Mechanical Checks:

- 1.1. O-ring surface
- 1.2. Soldering quality
- 1.3. Visual surface
- 1.4. Pressure test (60MPa)
- 1.5. Galvanic isolation between housing and electronics

2. Current Drain and Voltages:

- | | |
|--|-------------|
| 2.1. Average current drain at 0.5Hz sampling (Max: 38mA) | 32 mA |
| 2.2. Current drain in sleep (Max: 300 μ A) | 246 μ A |
| 2.3. DSP voltage, IC5.1 (3.3 \pm 0.15V) | 3.26 V |
| 2.4. Excitation driver voltage, IC1.1 (3.3 \pm 0.15V) | 3.32 V |
| 2.5. Flash/RS232 driver voltage, IC7.4 (5 \pm 0.2V) | 5.08 V |

3. Receiver test:

- | | |
|--|---------|
| 3.1. Average of Receiver readings (0 \pm 50mV) | -3 mV |
| 3.2. Standard Deviation of Receiver readings (Max: 10mV) | 2.14 mV |

4. Performance Test in Air, 0°C Temperature:

- | | |
|--|-----------|
| 4.1. Amplitude measurement (Blue: 220 – 470mV) | 382.61 mV |
| 4.2. Phase measurement (Blue: 30 \pm 5) | 34.8 ° |
| 4.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.005 ° |
| 4.4. Temperature measurement: (700 \pm 300mV) | 641.91 mV |

5. Performance Test in Air, 20°C Temperature:

- | | |
|--|-----------|
| 5.1. Amplitude measurement (Blue: 290 – 470mV) | 386.63 mV |
| 5.2. Phase measurement (Blue: 25 \pm 5°) | 30.8 ° |
| 5.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.009 ° |
| 5.4. Temperature measurement: (100 \pm 300mV) | 66.43 mV |

6. Performance Test in Air, 40°C Temperature:

- | | |
|--|------------|
| 6.1. Amplitude measurement (Blue: 320 – 500mV) | 369.84 mV |
| 6.2. Phase measurement (Blue: 22 \pm 5°) | 26.8 ° |
| 6.3. Standard deviation of Phase measurement: (Max: 0.02°) | 0.002 ° |
| 6.4. Temperature measurement: (-500 \pm 300mV) | -521.06 mV |

Date: 15 February 2011

Sign:

Jan Øyvind Trellevik

Jan Øyvind Trellevik,
Production Engineer

AANDERAA DATA INSTRUMENTS AS



CALIBRATION CERTIFICATE

Form No. 710, Dec 2005

AANDERAA DATA INSTRUMENTS

Sensing Foil Batch No: 5009
Certificate No:

Product: Oxygen Optode 5013W
Serial No: 1412
Calibration Date: 10 February 2011

This is to certify that this product has been calibrated using the following instruments:

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	0.97	11.91	23.85	35.87
Reading (mV)	722.04	370.04	-29.89	-402.77

Giving these coefficients

Index	0	1	2	3
TempCoef	2.29450E01	-3.03012E-02	2.78996E-06	-4.12765E-09

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 µM ¹⁾	0 - 120%
Accuracy ¹⁾ :	< ±8µM or ±5% (whichever is greater)	±5%
Resolution:	< 1 µM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings²⁾:

	Air Saturated Water	Zero Solution (Na ₂ SO ₃)
Phase reading (°)	3.29719E+01	6.66870E+01
Temperature reading (°C)	9.91207E+00	1.96563E+01
Air Pressure (hPa)	9.98115E+02	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-5.66633E00	1.19140E00	0.00000E00	0.00000E00

¹⁾ Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt

²⁾ The calibration is performed in fresh water and the salinity setting is set to: 0

Date: 11 February 2011

Sign:

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS



CALIBRATION CERTIFICATE

Form No. 621, Dec 2005

AANDERAA DATA INSTRUMENTS

Certificate No: 3853_5009_40331
Batch No: 5009

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 2 June 2010

Calibration points and phase readings (degrees)

Temperature (°C)	3.97	10.93	20.15	29.32	38.39	
Pressure (hPa)	977.00	977.00	977.00	977.00	977.00	
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.16	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	26.31	24.64	23.19

Giving these coefficients ¹⁾

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

¹⁾ Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.

Date: 2/24/2011

Sign:

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS



P E R S I S T O R
Instruments Inc.

153-A Lovells Ln, Marstons Mills, MA 02648
Tel: 508-420-1600 Fax: 508-420-1656
www.persistor.com Info@persistor.com

Data Acquisition and Storage Solutions for Industry and Science

Persistor Instruments part number
Serial Number

SSCF2GBI
25209

This card has been tested and is certified by Persistor Instruments for use with Persistor products.
The characteristics of this part are: SiliconDrive, CompactFlash, 2 GB, Industrial Temp (-40 to +85 C)

Card Check Program CF21M SN 06163
Software:1.42, Build:Aug 3 2007, Fixture:1.11

Cert #: 25209
Tester: RWK
Date: Monday, May 02, 2011 03:30 PM
Capacity: 2098446336
Model: SILICONSYSTEMS INC 2GB
Firmware: "241-0230"
Config: 0000044AH

Card SN: CB525502725009163X02SILICONSYSTEMS INC 2GB
Side code: 52720/3500
File Path: C:\May2011\002G_2GB.015
CF2 SN: 06163
BIA SN: 01158
PicoDOS: 4.03r1
BIOS: 4.03r1

--- READ ---

Repaired: 0
Read bytes/sec: 922049
Read Current Max (5V): 13.51 mA
Read Current Avg (5V): 6.81 mA
Idle Current (3V): 239 uA

--- FDISK/FORMAT ---

FDISKed: Yes
FORMATED: Yes
--- SPEED ---

MB5VWriteNoOpt (bytes/sec): 558317
MB5VReadNoOpt (bytes/sec): 570995
MB5VWriteZoom (bytes/sec): 661228
MB5VReadZoom (bytes/sec): 573651
MB3VWriteNoOpt (bytes/sec): 531220
MB3VReadNoOpt (bytes/sec): 570933
MB3VWriteZoom (bytes/sec): 661354
MB3VReadZoom (bytes/sec): 573243
P A S S E D



Persistor Instruments part number
Serial Number

SSCF2GBI
25214

This card has been tested and is certified by Persistor Instruments for use with Persistor products.
The characteristics of this part are: SiliconDrive, CompactFlash, 2 GB, Industrial Temp (-40 to +85 C)

Card Check Program CF21M SN 06163
Software:1.42, Build:Aug 3 2007, Fixture:1.11

Cert #: 25214
Tester: RWK
Date: Monday, May 02, 2011 03:35 PM
Capacity: 2098446336
Model: SILICONSYSTEMS INC 2GB
Firmware: "241-0230"
Config: 0000044AH

Card SN: CB525802725009161P0HSILICONSYSTEMS INC 2GB
Side code: 52720/3500
File Path: C:\May2011\002G_2GB.020
CF2 SN: 06163
BIA SN: 01158
PicoDOS: 4.03r1
BIOS: 4.03r1


--- READ ---

Repaired: 0
Read bytes/sec: 922032
Read Current Max (5V): 13.30 mA
Read Current Avg (5V): 6.75 mA
Idle Current (3V): 219 uA

--- FDISK/FORMAT ---

FDISKed: Yes
FORMATED: Yes
--- SPEED ---

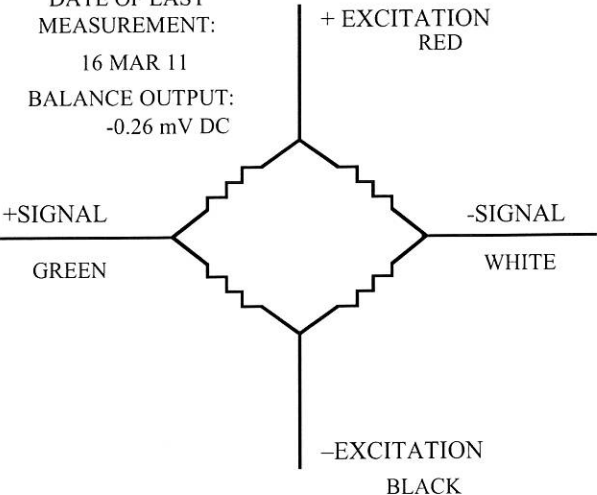
MB5VWriteNoOpt (bytes/sec): 556215
MB5VReadNoOpt (bytes/sec): 570933
MB5VWriteZoom (bytes/sec): 636581
MB5VReadZoom (bytes/sec): 573682
MB3VWriteNoOpt (bytes/sec): 468973
MB3VReadNoOpt (bytes/sec): 571027
MB3VWriteZoom (bytes/sec): 642510
MB3VReadZoom (bytes/sec): 573306
P A S S E D

	PRESSURE TRANSDUCER CALIBRATION DATA	
	<i>Customer</i> TELEDYNE BENTHOS	<i>Date</i> 7 APR 11
	<i>Model Number</i> MP50A-2000A	<i>Serial Number</i> 86517

<i>Diaphragm Materials</i> TITANIUM	<i>Excitation</i> 5 VDC	<i>Pressure Range</i> 2000 PSIA	<i>Excitation Type</i> CONSTANT VOLTAGE
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Pressure Calibration Data all readings are in mV DC						<i>Date of Pressure Calibration</i> 11 MAR 11
Pressure	Increase	Decrease	Ideal	Linearity (%FS)	Hysteresis (%FS)	<i>STATIC ERROR BAND</i> ± 0.22% FS BFSL
0 PSIA	-0.35	-0.45	-0.35		0.10%	
1000 PSIA	51.50	51.21	51.05	0.44%	0.28%	
2000 PSIA	102.45		102.45			
SENSITIVITY	102.80					

Thermal Calibration Data all readings are in mV DC						<i>Date of Thermal Calibration</i> 11 MAR 11
	Low Temp.	Ambient	High Temp.	Temperature Range	Thermal Balance Shift	Thermal Sensitivity Shift
Temperature	30 °F	75 °F	130 °F			
0 PSIA	-0.55	-0.44	-0.29	30°F to 75°F	0.11%FS	1.15%FS
2000 PSIA	101.83	103.12	103.09	75°F to 130°F	0.15%FS	-0.18%FS
Sensitivity	102.38	103.56	103.38	AVERAGE	± 0.001% FS/°F	± 0.006% FS/°F

Notes	DATE OF LAST MEASUREMENT: 16 MAR 11 BALANCE OUTPUT: -0.26 mV DC
	
	INPUT RESISTANCE 1594 Ohms OUTPUT RESISTANCE 782 Ohms

<i>Data Entered and Reviewed By</i> Dennis Adkinson	<i>Date Data Entered</i> 18 March 2011
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