CHANNEL CALIBRATION PROCEDURE

FOR

SFSI TEST STRUCTURE SYSTEM

MODEL RTMS-2001RN

CUSTOMER	University Of California Santa Barbara Crustal Studies Department
SYSTEM LOCATION	GVDA
SYSTEM S/N	207
DATE OF TEST	August 1, 2009.
PERFORMED BY (Print)	Dan Radulescu
SIGNATURE	

CHANNEL CALIBRATION PROCEDURE
FOR
SFSI TEST STRUCTURE SYSTEM

MODEL RTMS-2001RN

1.0 PURPOSE

The purpose of this procedure is the determination of the calibration factors for the entire system as described in the proposal No: DCR2006-001. The main components of the system will be checked for functionality and when needed a calibration factor will be determined. The sensors and the entire system shall be tested such that they respond within a specified range and accuracy to an input traceable to the National Bureau of Standards or an acceptable physical constant, (e.g., tilt testing of an accelerometer within the earth's gravitational field). This calibration will require temporary removal of the sensors from their normal location.

2.0 DESCRIPTION

The RTMS-2001RN system is a multi-channels Data Acquisition system which is capable of locally recording events and continuously streaming data to multiple remote clients using TCP/IP protocol. The system has a total of 32 channels with a 24-bit resolution for each channel. A total of 28 different sensors are connected to the system. First 24 channels are connected directly to the A/D input and the last 8 channels are connected to the output of an Signal conditioning module Model 163 MK manufactured by CALEX. Table A1 in Appendix A shows the correspondence between the channel number and the sensor type, Model, and Manufacturer.

3.0 REFERENCES

- Digitexx SFSI Monitoring System – System Manual
- Applied Mems Calibration Data Card
- ATA Sensors Calibration Data Card
- Entran Calibration Data Card
- Scientific Technologies Inc. Calibration Data Card
- Calex Operating Manual for 163mk Signal Conditioning

It is recommended that this calibration be performed every 12 months

4.0 SYSTEM PERFORMANCE NOTES

- Because this procedure is intended to be used by a qualified person, step-by-step instructions are not given
- Test sequence may be changed as needed for safety and /or efficiency.
- Items for which quantitative measurements cannot or need not to be made shall be reported in a qualitative mode (e.g. Yes/No).
- Any activities performed outside the normal scope of this procedure shall be documented.
- When a deficiency is observed, the technician may undertake additional testing and install factory authorized and/or factory calibrated replacement parts to restore the proper operation of the instrument.
- Calibration readings are equally valid using either the internal batteries (>11.5 VDC under load) or using an external power supply (between 12.0 and 13.0 VDC.

5.0 TEST EQUIPMENT

Instrument Type	Manufacturer	Model	Range
Digital Voltmeter	FLUKE	189	2Vdc AND 20VDC
Bubble Level	PRO PRODUCTS	PRO-INCLINOMETER	0° ÷ 180°
Tilt Table	PADU PROJECT	TT-1	± 180°

* FOR A/D check :
- VOLTAGE GENERATOR, TIMEELECTR. #1017
RANGE ± 1Vdc ± 5Vdc ± 9Vdc .

6.0 PRE-TEST CONDITIONS

- Notify the End user that the system will be taken out of normal operation conditions

(Initials)________________

- Check the overall system functionality and appearance. Document any observed anomaly. If a subassembly is not functional, document the findings, perform the repair first (if possible), and continue with the calibration

(Initials)________________

NOTES: Dxx_SN207_20090801_100304.dxx
AS FOUND EVENT

SYSTEM FUNCTIONAL

SENSOR POWER SUPPLY FUNCTIONAL

(Initials)________________

7.0 SYSTEM TEST

7.1 UNINTERRUPTIBLE POWER SUPPLY

a) Check the battery charging Indicator.
Mark FULL or indicate in % FULL (Initials) [initials]

b) Disconnect the AC power cord and wait 10 minutes.
The intermittent Battery operation sound should be present.
The battery charging indicator shall stay on the same range.

(Initials) [initials]

c) Reconnect the AC (Initials) [initials]

d) Document when the battery has been installed (dd/mm/yy) 9/13/08

NOTES:
BATTERY INSTALLED LAST YEAR
UPS FULLY FUNCTIONAL

7.2 SENSOR POWER SUPPLY

a) Check the front LEDs to be ON (Y/N) YES

b) Check the battery voltage with AC connected (>12.5V) 12.87 (V)

c) Measure the output voltage on +12V side (+12V +/- 0.1) +12.05 (V)

d) Measure the output voltage on -12V side (-12V +/-0.1) -12.05 (V)

e) Disconnect the AC and check the battery voltage (>12.3) 12.42 (V)

f) Reconnect the AC (Initials) JR

NOTES: SENSOR POWER SUPPLY FUNCTIONAL

7.3 PC INDUSTRIAL COMPUTER

a) Check the overall functionality (Initials) JR

b) Check the Server software for proper functionality (Initials) JR

c) Check the Hard Disk Space 28.3 GB ~~(MB)~~ JR

d) Download all recorded events on a memory stick (Initials) JR

e) Check for OS updates and perform the OS update (Initials) JR

f) Simulate AC power Loss and observe that the System comes UP and is operational (Initials) JR

NOTES: OS MAINTAINED BY UCSB
AC POWER LOSS TESTED OK
ALL EVENT FILES JUN 1, 2009 TO AUG 1, 2009
DOWNLOADED.

7.4 A/D CALIBRATION CHECK

Using a voltage reference source, check the A/D reading connecting the source to each channel. Record in the table bellow the value read by each channel

CHANNEL #	VOLTAGE REFERENCE [v]	A/D READING [V]	COMMENTS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			

NOTES: SEE APPENDIX B FOR DETAILED VALUES
THIS TIME I USED ONLY ±5Vdc TO CHECK
AT THE MIDDLE OF THE FULSCALE

7.5 SENSOR CALIBRATION

ACCELEROMETERS

CHANNEL #	SENSOR MODEL	SENSOR S/N	CALIBRATION [V/g]	
			AS FOUND	AS LEFT
1	Triaxial Accelerometer X-axis	254	1.223	1.223
2	Triaxial Accelerometer Y-axis	254	1.220	1.220
3	Triaxial Accelerometer Z-axis	254	1.206	1.206
4	Triaxial Accelerometer X-axis	255	1.192	1.192
5	Triaxial Accelerometer Y-axis	255	1.203	1.203
6	Triaxial Accelerometer Z-axis	255	1.194	1.194.
7	Uniaxial Accelerometer Z-axis	317	1.216	1.216
8	Uniaxial Accelerometer Z-axis	316	1.226	1.226
9	Uniaxial Accelerometer X-axis	314	1.200	1.200
10	Uniaxial Accelerometer Z-axis	312	1.207	1.207
11	Uniaxial Accelerometer Z-axis	318	1.200	1.200
12	Uniaxial Accelerometer X-axis	320	1.204	1.204
13	Uniaxial Accelerometer X-axis (Shaker)	321 *	1.185	1.185
14	Triaxial Downhole Accelerometer X-axis	0101 **	1.204	1.204
15	Triaxial Downhole Accelerometer Y-axis	0101 **	1.237	1.237
16	Triaxial Downhole Accelerometer Z-axis	0101 **	1.242	1.242

NOTES: * NOT CALIBRATED COULD NOT REMOVE FROM SHAKER REPORTED VALUE TAKEN FROM LAST CALIBRATION

** DOWNHOLE NOT CALIBRATED
REPORTED VALUES ARE FROM INITIAL FACTORY CALIBRATION CERTIFICATE

THREE (3) ACCELEROMETERS ON-SITE SPARES
S/N: 313 S = 1.2063 V/g
S/N: 315 S = 1.210 V/g
S/N: 319 S = 1.2018 V/g

ROTATION

CHANNEL #	SENSOR MODEL	SENSOR S/N	CALIBRATION [DEGREE/SEC]	
			AS FOUND	AS LEFT
17	ARS-09			
18	ARS-09			
19	ARS-09			

NOTES: SENSOR NOT REMOVED TO KEEP STATISTICAL DATA COLLECTION CONSISTENT

SENSOR STAND-BY READINGS ARE NORMAL

PORE PRESURE

CHANNEL #	SENSOR MODEL	SENSOR S/N	CALIBRATION [ ]	
			AS FOUND	AS LEFT
20				

NOTES: NOT CALIBRATED

MEAN VALUE: 3.4388V

SOIL PRESURE

CHANNEL #	SENSOR MODEL	SENSOR S/N	CALIBRATION [mV/PSI]	
			AS FOUND	AS LEFT
25	EPX-V01-100P	04E04EM-D28	1.2393	1.2393
26	EPX-V01-100P	04A03F05-K10	1.5969	1.5969
27	EPX-V01-100P	04A03F05-K08	1.3403	1.3403
28	EPX-V01-100P	04E04E11-D27	1.1244	1.1244

NOTES: TEST FILE FOR PRESSURE SENSORS. DXX_SN207_20090801_111834.DXX
FUNCTIONALITY CHECK ONLY. CAL VALUES TAKEN FROM FACT. CAL CERT.

RELATIVE DISPLACEMENT

CHANNEL #	SENSOR MODEL	SENSOR S/N	CALIBRATION [V/inch]	
			AS FOUND	AS LEFT
29	DT-30-B	03-2823	0.0655	0.0655
30	DT-30-B	03-2826	0.0721	0.0721
31	DT-30-B	03-2824	0.0659	0.0659
32	DT-30-B	03-2825	0.0672	0.0672

NOTES: CALIBRATION FILE:
NXXSN207_20090801_113223.Axx

8.0 FINAL STEPS

- Change the batteries from the UPS and SENSOR POWER SUPPLY if they are three (3) years old or more. If the batteries are not purchased, make a note and change them at the first maintenance visit.

  (Initials) DR

- Return the system to functional state (Initials) DR
- Attach Final record to this document (Initials) DR
- List all test equipment (Initials) DR
- Inform the end user that the system is functional (Initials) DR
- Prepare the site (close the hat and the equipment) (Initials) DR

NOTES:

SYSTEM FUNCTIONAL

9.0 SUMMARY (Comments, Parts replaced, Deficiencies, etc.)

SYSTEM LEFT FUNCTIONAL

10.0 CERTIFICATION

All items included in this procedure have been performed unless noted above and were found or have been adjusted to be within the range required by this procedure.

(yes/no) YES

(Signature)

DAN RADULESCU

(Print)

11.0 ACTION REQUIRED (IF ANY)

UCSB TO CHECK PORE PRESSURE SENSOR

APPENDIX A

Correspondence between the channel number and sensor type

Table A1

Channel #	Sensor Type	Model / Manufacturer
1	Triaxial Accelerometer X-axis	SF3000 / AppliedMems
2	Triaxial Accelerometer Y-axis	SF3000 / AppliedMems
3	Triaxial Accelerometer Z-axis	SF3000 / AppliedMems
4	Triaxial Accelerometer X-axis	SF3000 / AppliedMems
5	Triaxial Accelerometer Y-axis	SF3000 / AppliedMems
6	Triaxial Accelerometer Z-axis	SF3000 / AppliedMems
7	Uniaxial Accelerometer Z-axis	SF3000 / AppliedMems
8	Uniaxial Accelerometer Z-axis	SF3000 / AppliedMems
9	Uniaxial Accelerometer X-axis	SF3000 / AppliedMems
10	Uniaxial Accelerometer Z-axis	SF3000 / AppliedMems
11	Uniaxial Accelerometer Z-axis	SF3000 / AppliedMems
12	Uniaxial Accelerometer X-axis	SF3000 / AppliedMems
13	Uniaxial Accelerometer X-axis (Shaker)	SF3000 / AppliedMems
14	Triaxial Downhole Accelerometer X-axis	D110-DH / Digitexx
15	Triaxial Downhole Accelerometer Y-axis	D110-DH / Digitexx
16	Triaxial Downhole Accelerometer Z-axis	D110-DH / Digitexx
17	Rotation Sensor X-X	ARS-09 / ATA Sensors
18	Rotation Sensor Y-Y	ARS-09 / ATA Sensors
19	Rotation Sensor Z-Z	ARS-09 / ATA Sensors
20	Pore Pressure	
21	Spare channel	
22	Spare channel	
23	Spare channel	
24	Spare channel	
25	Soil Pressure Z-axis *	EPX-V01-100P / ENTRAN
26	Soil Pressure Z-axis *	EPX-V01-100P / ENTRAN
27	Soil Pressure Z-axis *	EPX-V01-100P / ENTRAN
28	Soil Pressure Z-axis *	EPX-V01-100P / ENTRAN
29	Relative Displacement Transducer Z-axis *	DT-30-B / STI
30	Relative Displacement Transducer Z-axis *	DT-30-B / STI
31	Relative Displacement Transducer Z-axis *	DT-30-B / STI
32	Relative Displacement Transducer Z-axis *	DT-30-B / STI

NOTE:

- Connected to the A/D Input through a Signal Conditioning board Model 163MK manufactured by CALEX

APPENDIX B

Recommended Calibration Methods

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L / 254 X-axis S
CH.1

The following readings shall be taken in the indicated order:

1.	Horizontal	+0.023 [V]
2.	tilt to +30 degrees	+0.629 [V]
3.	tilt to +90 degrees	+1.251 [V]
4.	tilt back to horizontal	+0.025 [V]
5.	tilt to -30 degrees	-0.594 [V]
6.	tilt to -90 degrees	-1.195 [V]
7.	tilt back to horizontal	+0.024 [V]

CALIBRATION FACTOR 1.223 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ______________

The following readings shall be taken in the indicated order:

N/A

1.	Horizontal	________[V]
2.	tilt to +60 degrees	________[V]
3.	tilt to +90 degrees	________[V]
4.	Continue to Horizontal	________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L/254 Y-axis
CH. 2

The following readings shall be taken in the indicated order:

1. Horizontal -0.019 [V]
2. tilt to +30 degrees +0.591 [V]
3. tilt to +90 degrees +1.206 [V]
4. tilt back to horizontal -0.019 [V]
5. tilt to -30 degrees -0.629 [V]
6. tilt to -90 degrees 1.239 [V]
7. tilt back to horizontal -0.018 [V]

CALIBRATION FACTOR 1.220 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A.

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ____________

The following readings shall be taken in the indicated order:

1. Horizontal ________[V]
2. tilt to +30 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. tilt back to horizontal ________[V]
5. tilt to -30 degrees ________[V]
6. tilt to -90 degrees ________[V]
7. tilt back to horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000 L/254/Z axis ch. 3

The following readings shall be taken in the indicated order:

1. Horizontal +1.263 [V]
2. tilt to +60 degrees +0.630 [V]
3. tilt to +90 degrees +0.052 [V]
4. Continue to Horizontal −1.179 [V]

CALIBRATION FACTOR 1.206 [V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF 3000L/255/x-axis ch.4

The following readings shall be taken in the indicated order:

1. Horizontal +0.051 [V]
2. tilt to +30 degrees +0.618 [V]
3. tilt to +90 degrees +1.247 [V]
4. tilt back to horizontal +0.054 [V]
5. tilt to -30 degrees -0.574 [V]
6. tilt to -90 degrees -1.137 [V]
7. tilt back to horizontal +0.052 [V]

CALIBRATION FACTOR 1.192 [V/g]

{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]

Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF 3000L / 255 / Y axis ch. 5

The following readings shall be taken in the indicated order:

1. Horizontal +0.021 [V]
2. tilt to +30 degrees +0.632 [V]
3. tilt to +90 degrees +1.226 [V]
4. tilt back to horizontal +0.022 [V]
5. tilt to -30 degrees −0.571 [V]
6. tilt to -90 degrees -1.180 [V]
7. tilt back to horizontal 0.022 [V]

CALIBRATION FACTOR 1.203 [V/g]

{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ____________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]

Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ~~SF3000L/255~~

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +30 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. tilt back to horizontal ________[V]
5. tilt to -30 degrees ________[V]
6. tilt to -90 degrees ________[V]
7. tilt back to horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L/255/Z axis

The following readings shall be taken in the indicated order:

1. Horizontal +1.169 [V]
2. tilt to +60 degrees +0.582 [V]
3. tilt to +90 degrees +0.004 [V]
4. Continue to Horizontal -1.219 [V]

CALIBRATION FACTOR 1.194 [V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF 3000L / 317 / UNIAXIAL CH. 7.

The following readings shall be taken in the indicated order:

1. Horizontal +0.089 [V]
2. tilt to +30 degrees +0.694 [V]
3. tilt to +90 degrees +1.322 [V]
4. tilt back to horizontal +0.092 [V]
5. tilt to -30 degrees -0.522 [V]
6. tilt to -90 degrees -1.110 [V]
7. tilt back to horizontal +0.092 [V]

CALIBRATION FACTOR 1.216 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ____________

The following readings shall be taken in the indicated order:

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

N/A.

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L / 316 / UNIAXIAL ch. 8

The following readings shall be taken in the indicated order:

1.	Horizontal	+0.088 [V]
2.	tilt to +30 degrees	+0.711 [V]
3.	tilt to +90 degrees	+1.319 [V]
4.	tilt back to horizontal	+0.089 [V]
5.	tilt to -30 degrees	−0.515 [V]
6.	tilt to -90 degrees	−1.133 [V]
7.	tilt back to horizontal	+0.088 [V]

CALIBRATION FACTOR 1.226 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ______________

The following readings shall be taken in the indicated order:

N/A.

1.	Horizontal	________[V]
2.	tilt to +60 degrees	________[V]
3.	tilt to +90 degrees	________[V]
4.	Continue to Horizontal	________[V]

CALIBRATION FACTOR _______[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L / 314 / UNIAXIAL CH. 9

The following readings shall be taken in the indicated order:

1. Horizontal -0.028 [V]
2. tilt to +30 degrees +0.600 [V]
3. tilt to +90 degrees +1.171 [V]
4. tilt back to horizontal -0.029 [V]
5. tilt to -30 degrees -0.629 [V]
6. tilt to -90 degrees -1.229 [V]
7. tilt back to horizontal -0.029 [V]

CALIBRATION FACTOR 1.200 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF 3000L/312 UNIAXIAL CH. 10.

The following readings shall be taken in the indicated order:

1. Horizontal -0.047 [V]
2. tilt to +30 degrees +0.545 [V]
3. tilt to +90 degrees +1.156 [V]
4. tilt back to horizontal -0.049 [V]
5. tilt to -30 degrees 0.604 [V]
6. tilt to -90 degrees -1.258 [V]
7. tilt back to horizontal -0.049 [V]

CALIBRATION FACTOR 1.207 [V/g]

{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ____________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]

Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L / 318 UNIAXIAL CH.11

The following readings shall be taken in the indicated order:

1. Horizontal +0.003 [V]
2. tilt to +30 degrees +0.602 [V]
3. tilt to +90 degrees + 1.202 [V]
4. tilt back to horizontal +0.002 [V]
5. tilt to -30 degrees −0.600 [V]
6. tilt to -90 degrees − 1.198 [V]
7. tilt back to horizontal +0.002 [V]

CALIBRATION FACTOR 1.200 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF 3000L / 320 / UNIAXIAL CH. 12

The following readings shall be taken in the indicated order:

1. Horizontal	+0.225	[V]
2. tilt to +30 degrees	+0.833	[V]
3. tilt to +90 degrees	+1.427	[V]
4. tilt back to horizontal	+0.228	[V]
5. tilt to -30 degrees	-0.376	[V]
6. tilt to -90 degrees	-0.981	[V]
7. tilt back to horizontal	+0.228	[V]

CALIBRATION FACTOR 1.204 [V/g]

{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal	________	[V]
2. tilt to +60 degrees	________	[V]
3. tilt to +90 degrees	________	[V]
4. Continue to Horizontal	________	[V]

CALIBRATION FACTOR ________ [V/g]

Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER SF3000L/315/UNIAXIAL SPARE

The following readings shall be taken in the indicated order:

1. Horizontal -0.0154 [V]
2. tilt to +30 degrees -0.644 [V]
3. tilt to +90 degrees -1.2304 [V]
4. tilt back to horizontal -0.015 [V]
5. tilt to -30 degrees +0.602 [V]
6. tilt to -90 degrees +1.189 [V]
7. tilt back to horizontal -0.015 [V]

CALIBRATION FACTOR 1.210 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A.

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ~~ST 2000L~~ / 313 / SPARE UNIAXIAL

The following readings shall be taken in the indicated order:

1.	Horizontal	+0.0031 [V]
2.	tilt to +30 degrees	−0.6228 [V]
3.	tilt to +90 degrees	−1.210 [V]
4.	tilt back to horizontal	0.002 [V]
5.	tilt to -30 degrees	+ 0.601 [V]
6.	tilt to -90 degrees	+1.202 [V]
7.	tilt back to horizontal	0.002 [V]

CALIBRATION FACTOR 1.206 [V/g]

{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

1.	Horizontal	________[V]
2.	tilt to +60 degrees	________[V]
3.	tilt to +90 degrees	________[V]
4.	Continue to Horizontal	________[V]

N/A

CALIBRATION FACTOR ________[V/g]

Read 3 – Read 1

ACCELEROMETERS

Each unit (uniaxial or triaxial that can be removed temporarily for calibration will be calibrated using a tilt table).

For the horizontal axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ST3000L / 319 / UNIAXIAL SPARE

The following readings shall be taken in the indicated order:

1. Horizontal +0.116 [V]
2. tilt to +30 degrees −0.510 [V]
3. tilt to +90 degrees −1.101 [V]
4. tilt back to horizontal +0.120 [V]
5. tilt to -30 degrees +0.211 [V]
6. tilt to -90 degrees +1.302 [V]
7. tilt back to horizontal +0.118 [V]

CALIBRATION FACTOR 1.2012 [V/g]
{(Read3 – Read1) + (Read6 – Read4)} / 2

For the vertical axis:

The unit shall be placed on a tilt table which has been leveled and checked with a mechanical angular device.

MODEL / SERIAL NUMBER ________

The following readings shall be taken in the indicated order:

N/A

1. Horizontal ________[V]
2. tilt to +60 degrees ________[V]
3. tilt to +90 degrees ________[V]
4. Continue to Horizontal ________[V]

CALIBRATION FACTOR ________[V/g]
Read 3 – Read 1

RELATIVE DISPLACEMENT

MODEL / SERIAL NUMBER DT-30-B/03-2823 CH. 29.

Take a metallic pin with the Diameter = 0.316”

Measure the exact diameter of the pin using the caliper **[D1]** 0.332 [in]

Start the system to take a record
Filename of the record AxxSN207_20090801_113223.Dxx.

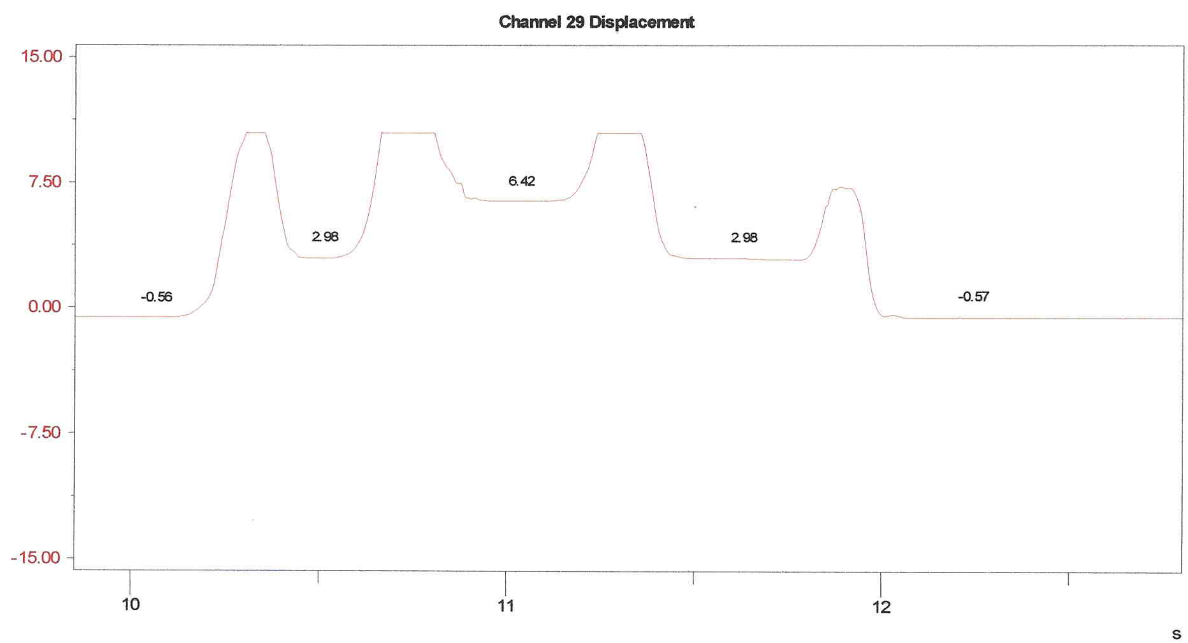
Turn the string (wire) of the sensor once
Around the metal pin and wait 10 seconds (Initials)

Turn the string (wire) of the sensor one more turn
Around the metal pin and wait 10 seconds (Initials)

Un-wind one turn of the wire from the metal pin
and wait 10 seconds (Initials)

Un-wind the last turn of the wire from the metal pin
Wait 10 seconds and stop the recording (Initials)

Typical record should look like this:



CAL RECORD DONE FOR CH. 29.

Starting from the left we have five readings (READ1, READ2, READ3, READ4, READ5.

RECORD The overall Channel amplification factor **AF =** 50.36

COMPUTE: **OUT [V] = ((READ2 – READ1) + (READ3 – READ1)/2) / (2 * AF)**

COMPUTE THE CIRCLE LENGTH OF THE PIN

L [IN] = PI * (D1 + D2) (where D2 is the diameter of the wire) 1.0585

CAL FACTOR [V/inch] = OUT[V] / L[in]) 0.0655 V/in.

Print a separate page for each sensor

ch.29.

RELATIVE DISPLACEMENT

MODEL / SERIAL NUMBER DT-30-B/03-2826
CH.30

Take a metallic pin with the Diameter = 0.316”

Measure the exact diameter of the pin
using the caliper **[D1]** 0.332 [in]

Start the system to take a record
Filename of the record DxxSN207_20090801_113223.Dxx

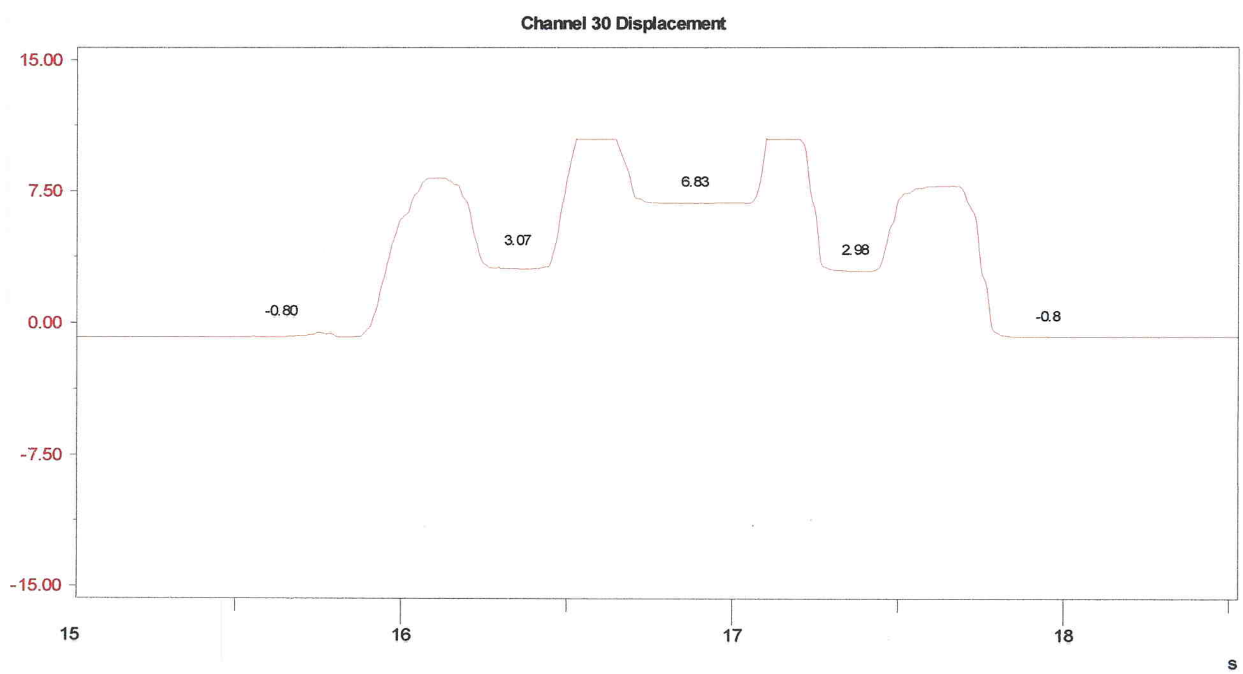
Turn the string (wire) of the sensor once
Around the metal pin and wait 10 seconds (Initials)________

Turn the string (wire) of the sensor one more turn
Around the metal pin and wait 10 seconds (Initials)________

Un-wind one turn of the wire from the metal pin
and wait 10 seconds (Initials)________

Un-wind the last turn of the wire from the metal pin
Wait 10 seconds and stop the recording (Initials)________

Typical record should look like this:



CAL RECORD DONE FOR CH.30

Starting from the left we have five readings (READ1, READ2, READ3, READ4, READ5.

RECORD The overall Channel amplification factor **AF =** 50.10

COMPUTE: **OUT [V] = ((READ2 – READ1) + (READ3 – READ1)/2) / (2 * AF)**

COMPUTE THE CIRCLE LENGTH OF THE PIN
L [IN] = PI * (D1 + D2) (where D2 is the diameter of the wire) 1.0585

CAL FACTOR [V/inch] = OUT[V] / L[in]) 0.0721 V/IN.

Print a separate page for each sensor

RELATIVE DISPLACEMENT

MODEL / SERIAL NUMBER DS-30-B/03-2824
CH.31

Take a metallic pin with the Diameter = 0.316"

Measure the exact diameter of the pin using the caliper **[D1]** 0.332 [in]

Start the system to take a record
Filename of the record DaxSN202_20090801_113223.Dax

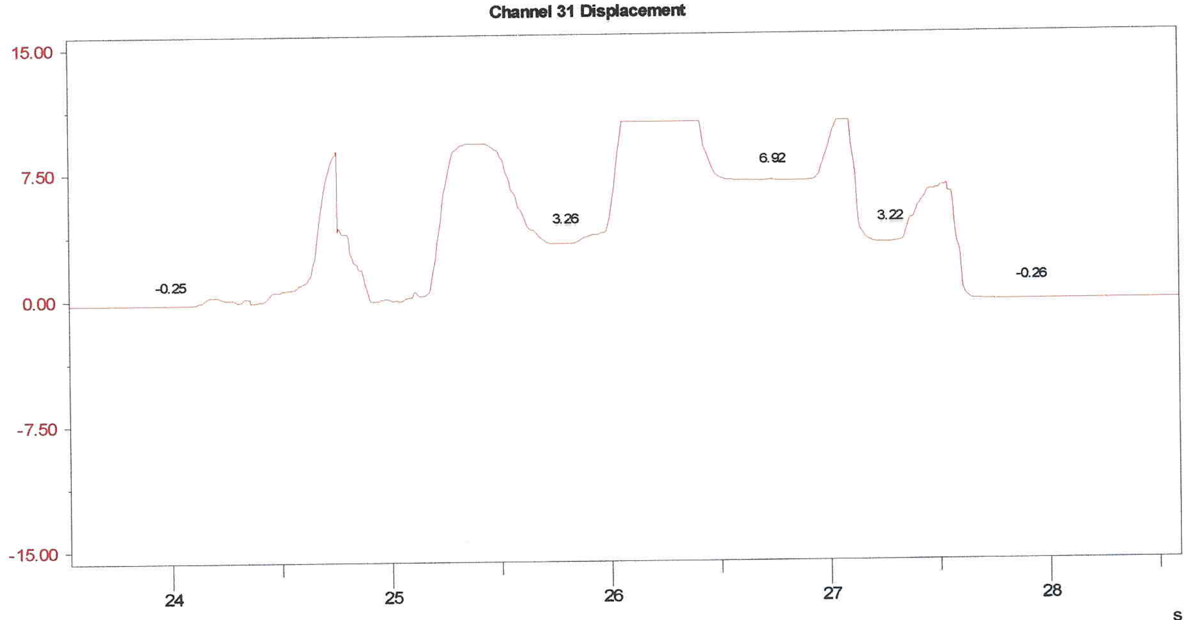
Turn the string (wire) of the sensor once
Around the metal pin and wait 10 seconds (Initials) DR

Turn the string (wire) of the sensor one more turn
Around the metal pin and wait 10 seconds (Initials) DR

Un-wind one turn of the wire from the metal pin
and wait 10 seconds (Initials) DR

Un-wind the last turn of the wire from the metal pin
Wait 10 seconds and stop the recording (Initials) DR

Typical record should look like this:



CAL RECORD DONE FOR CH.31

Starting from the left we have five readings (READ1, READ2, READ3, READ4, READ5.

RECORD The overall Channel amplification factor **AF** = 50.05

COMPUTE: **OUT [V] = ((READ2 – READ1) + (READ3 – READ1)/2) / (2 * AF)**

COMPUTE THE CIRCLE LENGTH OF THE PIN

L [IN] = PI * (D1 + D2) (where D2 is the diameter of the wire) 1.0585

CAL FACTOR [V/inch] = OUT[V] / L[in]) 0.0659 V/IN.

Print a separate page for each sensor

RELATIVE DISPLACEMENT

MODEL / SERIAL NUMBER DS-30-~~B~~/03-2825 CH.32

Take a metallic pin with the Diameter = 0.316"

Measure the exact diameter of the pin using the caliper **[D1]** 0.332 [in]

Start the system to take a record
Filename of the record DKK SN 207_20090801_113223.DKK.

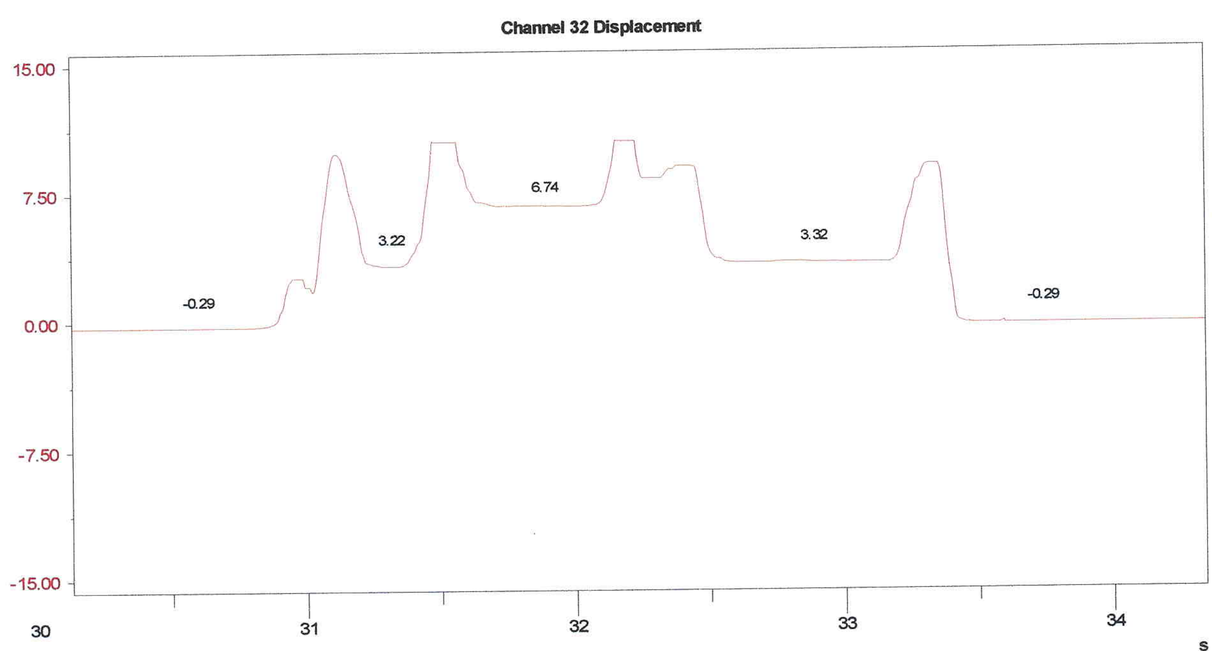
Turn the string (wire) of the sensor once
Around the metal pin and wait 10 seconds (Initials) DK

Turn the string (wire) of the sensor one more turn
Around the metal pin and wait 10 seconds (Initials) DK

Un-wind one turn of the wire from the metal pin
and wait 10 seconds (Initials) DK

Un-wind the last turn of the wire from the metal pin
Wait 10 seconds and stop the recording (Initials) DK

Typical record should look like this:



CAL RECORD DONE FOR CH. 32

Starting from the left we have five readings (READ1, READ2, READ3, READ4, READ5.

RECORD The overall Channel amplification factor **AF =** 50.05

COMPUTE: **OUT [V] = ((READ2 – READ1) + (READ3 – READ1)/2) / (2 * AF)**

COMPUTE THE CIRCLE LENGTH OF THE PIN
L [IN] = PI * (D1 + D2) (where D2 is the diameter of the wire) 1.0585

CAL FACTOR [V/inch] = OUT[V] / L[in]) 0.0672 V/in.

Print a separate page for each sensor

A/D CHANNEL CALIBRATION

Use one calibrated digital voltmeter and a reference voltage source. Remember that the A/D is set for +/-10V full-scale and it is a 24-bit resolution. This calibration is relative since the calibrated source must be one order of magnitude higher than the device to be calibrated. In our case we check each channel for correct functionality. The reading taken with a regular Digital Voltmeter will have the mV precision and the A/D shall have the same reading up to milivolts. A+/-2mV is acceptable due to possible electrical noise during reading. The unit is calibrated under field conditions not under laboratory conditions.

For first 24 channels of the system, disconnect the existing sensor cable from the connector panel and connect the voltage source between PIN A and PIN B. Take a reading with the Digital Voltmeter and with the A/D Server software (set the calibration factor temporarily to 981. so the reading will be in volts. Record both readings in the table below:

±5.0005

Channel #	Zero Reading	1V IN ±10mV		5V IN ±10mV		9V IN ±10mV		Comments
		REF	A/D	-5 REF	+5 A/D	REF	A/D	
1				-5.006	+5.006			
2				-5.009	+5.009			
3				-4.985	+4.986			
4				-4.996	+4.995			
5				-4.984	+4.982			
6				-4.963	+4.965			
7				-4.994	+4.996			
8				-5.001	+5.002			
9				-4.992	+4.994			
10				-4.981	+4.981			
11				-4.982	+4.984			
12				-4.981	+9.981			
13				-4.986	+4.986			
14				-4.981	+4.983			
15				-4.972	+4.972			
16				-4.971	+4.972			
17				-4.982	+4.980			
18				-4.978	+4.979			
19				-4.978	+4.978			
20				-4.974	+4.974			
21				-4.976	+4.977			
22				-4.978	+4.978			
23				-4.976	+4.976			
24				-4.980	+4.980			

CHECKED LAST YEAR FOR SYMETRY DONE ONLY MID-SCALE

Initials____

A/D CHANNEL CALIBRATION

For channels 25 through 32, connect the reference voltage source to the second Connector Panel at the BNC connector for each channel located at the top of the panels. Record the readings in the table bellow
For this channels check the amplification factor of the 163MK Signal conditioning

±5.0005

Channel #	Zero Reading	1V IN ±10mV		5V IN ±10mV		9V IN ±10mV		Comments
		REF	A/D	− REF	+ A/D	REF	A/D	
25				−4.991	+4.990			
26				−4.983	+4.983			
27				−5.002	+5.002			
28				−5.004	+5.006			
29				−4.985	+4.984			
30				−4.981	+4.981			
31				−4.981	+4.981			
32				−4.982	+4.982			

Initials________

163MK Amplification Factor

Channel #	INPUT VOLTAGE [mV]	OUTPUT VOLTAGE [mV]	GAIN	COMMENTS
25	12	605.03	50.42	Ch is good. Sensor is pegged.
26	12	593.5	49.458	
27	12	600.1	50.008	
28	12	599.11	49.926	
29	12	604.3	50.358	
30	12	601.21	50.101	
31	12	600.6	50.05	
32	12	600.6	50.05	

Initials________