RBSP EFW BEB
Bench Test Procedure

University of California, Berkeley
Revision F
8/18/2010

Test Conductor ______________________
Start Date/Time ______________________
BEB S/N ______________________
GSE SciCal SVN Revision ______________________
BIB S/N[1] ______________________

Required Signatures:

Digitally signed by Rachel Hochman
Date: 2010.09.28 10:20:56 -07'00'

Rachel Hochman, RBSP EFW BEB Engineer

Jorg Fischer
2010.09.28
13:14:26 -07'00'

Jorg Fischer, RBSP EFW MAM

Michael Ludlam
2010.09.28
10:24:05 -07'00'

Michael Ludlam, RBSP EFW Systems Engineer

[1] Located on front panel of BIB.

Change Record

Date	Revision	Description
2/26/10	A	Flight Release
6/14/10	B	Second Draft
7/15/10	C	Modified to include GSE scritpting
8/3/10	D	Further changes to procedure to reflect GSE scripts
8/9/10	E	Formatting changes
8/18/10	F	One connector at a time.

1. Equipment Needed/ Calibration Information (This equipment comprises the BIB SciCal GSE rack):

7 triple-output power supplies:

+/- 10VA, 5VD	ID: KR64304318	Due Date: 4/13/2011
FGND1	ID: KR73609061	Due Date: 3/24/2011
FGND2	ID: KR83915821	Due Date: 3/24/2011
FGND3	ID: KR92921909	Due Date: 3/24/2011
FGND4	ID: MY40028750	Due Date: 3/24/2011
FGND5	ID: KR01128856	Due Date: 3/24/2011
FGND6	ID: KR73608886	Due Date: 4/13/2011

4 High Voltage power supplies (Bertan Series 225 or equivalent, set to +/-225V)

BEB+225V	ID: 0073	Due Date: 6/3/2011
BEB-225V	PMC: 0328	Due Date: 6/24/2011
DC+225	PMC: 0058	Due Date: 6/24/2011
DC-225	PMC: 0327	Due Date: 6/24/2011

1 Oscilloscope with 3 channels (or more) and FFT function
PMC: 0096 Due Date: 2/22/2011

1 20 X voltage amplifier (FLC A400D or equivalent)
PMC: Due Date:

1 Electrometer (Keithley 6517A or equivalent)
PMC: 0282 Due Date: 2/22/2011

1 Data acquisition/switch unit (Agilent 34970A)
ID: US37010135 Due Date: 4/13/2011

1 Signal generator (SRS DS345)
PMC: 0087 Cal Date: 2/22/2011

3 Connector Savers for BEB front panel connectors

Custom devices:

1 GSE Backplane Harness[2]
1 BEB Harness[3]
2 1/333 Voltage Dividers[4]
1 RBSP GSE laptop
1 Mixed GSE Backplane

[2] See appendix for schematic
[3] See appendix for schematic
[4] See appendix for schematic

1.1. Software Needed

The steps listed in this procedure are implemented in a Python script named ex01_board_level.py. This script uses the scical.py module, which provides access to the SciCal GSE rack hardware. Ensure you have the latest version of these files by either checking out a fresh copy from:
https://efw.ssl.berkeley.edu/svn/GSE/101_BEB_Science_Calibration/software/
Or by running 'svn update' on your local copy.
Python (v2.5 for XP or v2.6 for Vista/7) is required to run the script.

The Opal Kelly FrontPanel drivers are required in order to communicate with the BIB. You can download the driver installation package from:
https://efw.ssl.berkeley.edu/svn/GSE/004_downloads/OpalKelly/
Use version 3.0 for Windows XP; 3.1 for Windows Vista/7.

1.2 Safe-to-Mate

Perform a safe-to-mate by putting an extender card on the connector where the BEB will go, turning on the power, and verifying that the correct voltages are on the correct pins according to the backplane schematic (in the appendix).

2. TURN ON

This test turns on the power to the BEB in the specified order and measures the currents; it then allows the user to make sure the currents are within range.

2.1	With all power supplies and test equipment powered off, insert the BEB into the VME chassis.	
2.2	On the GSE laptop, locate the test script folder, right click 'ex01_board_level.py', and select 'Edit with IDLE'. The Python editor window will open.	
2.3	Press F5 to load the script into the Python interpreter. The script will attempt to locate the SciCal GSE hardware. Record any error messages presented by the script.	Any error messages? ___________

2.4	Note the SVN revision reported by the script. Record this value in the field called “GSE SciCal SVN Revision” on page 1 of this procedure.	Revision:____________
2.5	Record the log output location reported by the script (e.g., 20100803_090526)	Location:____________
2.6	In the log type: **`print “BEB S/N x is inserted”`** where x is the serial number of the BEB you are testing.	
2.7	Before powering on, put the BEB harness 26 pin connector on the top BEB connector, 706, making sure there is a connector saver between 706 and the harness.	
2.8	Turn on AC power to all test equipment and set the current limits on all supplies by running **`step(1)`** in the Python interpreter. The current limits are in the log file.	
2.9	Turn on the +/-10VA and +5VD supplies by running **`step(2)`**	
2.10	Turn on all floaters by running **`step(3)`**	
2.11	Load the GSE and set the DACs to midrange by running **`step(4)`**	
2.12	Turn on the BEB +/-225V by running **`step(5)`**	
2.13	Record currents in a table by running **`step(6)`**. The currents will be recorded to the log file and to a file in the output directory[5] called ‘table_001_turn_on_current_readings.csv’.	
2.14	Verify the currents are in range. If they are not in range, turn off the supplies in reverse order by running **`shutdown()`**[6]. **Note**: If you re-run any steps that generate output files (e.g., **`step(6)`**), the files will get overwritten[7]. So back them up first, or rename them, or restart the python interpreter to create a new output location.	

[5] You can quickly view the contents of the current output directory by running **`showme()`.**
[6] If you run `shutdown()`, you do not have to re-run `step(1)`, you can start again at `step(2)`.
[7] Make sure the file is closed before re-running, or you will get an error.

*A Note on Powering Off/ Powering On

If at any point in the test you must turn all the power to the GSE rack off, run **`shutdown()`**, followed by **`ac_power(all,off)`**. These steps turn off the power to the BEB and then turn off the power supplies themselves. To power on again, one can run steps 1-5.

If you do power off and power back on, you will start a new log file, and in each log file, make sure to type: **`print “BEB S/N x is inserted”`** That way each log file will have a record of which board is being tested.

3. MEASURE DC OFFSETS AND EMFISIS VERIFICATION

This test measures the DC offsets on each circuit on each channel. It then allows the user to view the offsets in a table to verify that each offset is sufficiently small (<40mV). Additionally, the user can apply a signal to each Vsphere and make sure the Emfisis circuit is working properly.

3.1	Measure the voltage offsets on bias, usher, and guard by running **`step(7, 706)`**. All offsets should be <40mV. Verify by viewing the output file 'table 002_DC_offsets.csv'. Note that Bias_n is called Vsphere_n.
3.2	Run **`step(9,706)`** , which does the following: -Configures the signal generator for 2Vpp, 10KHz, which you can verify by looking at channel 4 on the scope. -For each of two channels (n=1,2, m=other channel of the pair), apply the signal to VSPHEREn and ground VSPHEREm. Record the EMFISIS amplitude and phase shift wrt the signal generator. This step uses matrix configurations 5 and 6, and scope configuration 4. The data will be recorded to: 'table_003_EMFISIS_function_verification.csv'

4. VERIFY DAC AND MUX SETTINGS

This test uses the GSE to command the DACs to different values and then measures the actually voltage on each DAC and the voltage on the MUX output. The user can view a table of the results to verify that the commands result in the proper voltages.

4.1	Run **`step(12,706).`** This does the following: For CHAN in BIASn, USHERn, GUARDn (n=1-2): For VAL in 0x0000, 0x3FFF, 0x7FFF, 0xAFFF, 0xFFFF: • Set DAC CHAN to VAL, others to 0x7FFF (0V). • Select the MUX channel corresponding to CHAN. • Probe and record voltage at CHAN. • Probe and record MUX output at BEB HSKP line referenced to AGND. This step invokes matrix configuration 1[8]. The data will be recorded to: ' table_004_DAC_setting_verification.csv'

[8] The configuration numbers refers to specific switch matrix configurations. These can be found in the appendix.

5. VERIFY DC GAIN

This test is designed to input a DC voltage on Vsphere and measure the resulting voltage on each DAC. DC gain for each circuit can be calculated by the user by viewing the resulting spreadsheet.

5.1	Run **`step(14,706)`**. This step does the following:
	
	Reset the switch matrix and set DACs to 0V
	For CH in VSPHEREn (n=1-2):
	    Record power supply currents
	    For V in [+223, +200, +100, +50, +10, +5, +1, +.5, 0, -.5, -1, -5, -10, -50, -100, -200, -223]:
	        • Set DC power supply to V and connect to CH.
	        • Measure voltage at VSPHEREn, FGNDn, BIASn, USHERn, GUARDn.
	
	This step uses matrix configurations 7,8,9, and 10 and scope configuration 6.
	
	The data will be recorded in two output files:
	' table_005-N_DC_gain_chanN.csv', where N = 1-2.

6. VERIFY FREQUENCY RESPONSE

This test is designed to measure frequency response, comparing the output on each of bias, usher, guard, and floating ground to the high-amplitude signal going into Vsphere.

6.1	Run **`step(15,706)`**. This does the following: Set up signal generator and 20X amplifier to produce a 100Vpp signal. For FREQ in [1, 10, 50, 80, 100, 300, 500, 800, 1000, 3000, 5000, 8000, 10000, 50000, 100000]: For SIG in [FGNDn, BIASn, USHERn, GUARDn] (n=1-2): • Connect VSPHEREn to 100Vpp signal, ground the other VSPHERE. • Connect VSPHEREn to scope CH3 via 1/333 divider. • Connect SIG to scope CH2 via 1/333 divider. • Measure amplitude of SIG and phase of SIG relative to VSPHERE. This step uses matrix configurations 11-18, and scope configuration 6. The data will be recorded in two output files: ‘ table_006-N_freq_response_chanN’, where N = 1-2.

7. EMFISIS DISTORTION

This test is designed to measure the harmonic distortion on the emfisis channel at $2f_o$ *and* $3f_o$*, the output file will contain* ΔdB *from* f_0 *to* $2f_0$ *and* $3f_0$*, as well as a snapshot of the scope screen.*

7.1	Run **`step(16,706)`**. This does the following:
	
	Set the signal generator to 5Vpp, 100Hz.
	Recall oscilloscope saved configuration 7.
	
	For ch = [1-2]:
	    For n = 1,2, m = the other in the pair:
	        • Connect signal to VSPHEREn, ground VSPHEREm.
	        • Measure amplitude of VSPHEREn and EMFISISch.
	        • Measure the phase shift of EMFISISch wrt VSPHEREn.
	        • Measure distortion (ΔdB at $2f_0$ and $3f_0$) of EMFISISch, capture scope screen to disk.
	
	This step uses matrix configurations 5 and 6, and scope configuration 7.
	
	The data will be recorded in the output file:
	'table_007-EMFISIS_Distortion.csv'

8. EMFISIS FREQUENCY RESPONSE

This test is designed to measure the frequency response of the Emfisis circuit when a signal is going into one or the other of the Vspheres. Common mode rejection is also being measured when there is a signal into both Vspheres.

8.1	Run **`step(17,706)`**. This does the following:
	
	Set the signal generator to 5Vpp.
	
	For ch = [1-2]:
	    Record supply currents: +/-10VA, BEB +/-225V, 5VD
	    For CFG in [1,2,3]:
	        For FREQ in [1, 10, 25, 50, 80, 100, 500, 1000, 5000, 10000, 50000, 100000, 400000, 500000, 1000000]:
	            o Connect signal to VSPHERE1, ground VSPHERE2, followed by signal to VSPHERE2, ground VSPHERE1, and finally signal to both.
	            o Measure the amplitude and phase shift of EMFISISch wrt VSPHEREn.
	
	Note: In order to make accurate measurements the cables and the BEB must be shielded. You may not be able to use breakout boxes at higher frequencies.
	
	This step uses matrix configurations 5, 6, 19, and scope configuration 8.
	
	The data will be recorded in the output file:
	‘ table_008-EMFISIS_12_freq_response’

9. VERIFY AC TEST LINES OPERATION

In this test, one can verify the operation of the AC test lines by putting a signal onto the test line with commanding through the GSE and measuring the output on the BEB front panel connector for two different frequencies.

9.1	Run **`step(18,706)`**. This does the following:
	
	For ch = [1-2]:
	    For n = [1,2], m = other in the pair:
	        Turn on ACTESTn, turn off ACTESTm
	        For FREQ in [128Hz, 1000Hz]:
	            Measure ACTESTn amplitude on scope CH2
	
	This step uses matrix configurations 20 and 21, and scope configuration 9.
	
	The data will be recorded in the output file: 'table_009-ACTEST_verification.csv'

10. Repeat the tests for BEB connector 707.

10.1	Run the command **`shutdown()`** in order to turn the power off to the BEB.
10.2	Move the harness to connector 707 on the BEB, making sure there is a connector saver between 707 and the harness.
10.3	Re-run **`step (2)`**, **`step(3)`**, **`step(4)`**, and **`step(5)`** to turn the power back onto the BEB.
10.4	Run **`step(6)`** to measure the current consumption of each power supply. The currents will be appended to the log file: 'table_001_turn_on_current_readings.csv'
10.5	Measure the voltage offsets on bias, usher, and guard by running **`step(7, 707)`**. Results will be appended to 'table 002_DC_offsets.csv'.
10.6	Conduct the EMFISIS verification test by running **`step(9,707)`**. The data will be appended to: 'table_003_EMFISIS_function_verification.csv'
10.7	Verify DAC and MUX setting by running **`step(12,707).`** The data will be appended to: ' table_004_DAC_setting_verification.csv'
10.8	Verify the DC gain by running **`step(14,707)`**. The data will be recorded in two output files: ' table_005-N_DC_gain_chanN.csv', where N = 3-4.
10.9	Verify the frequency response by running **`step(15,707)`**. The data will be recorded in two output files: ' table_006-N_freq_response_chanN', where N = 3-4.
10.10	Measure EMFISIS distortion by running **`step(16,707)`**. The data will be appended to the output file: 'table_007-EMFISIS_Distortion.csv'
10.11	Measure the EMFISIS frequency response by running **`step(17,707).`** The data will be appended in the output file: ' table_008-EMFISIS_12_freq_response'
10.12	Verify the AC test lines operation by running **`step(18,707)`**. The data will be appended to the output file: 'table_009-ACTEST_verification.csv'

11. Repeat the tests for BEB connector 708.

11.1	Run the command **`shutdown()`** in order to turn the power off to the BEB.
11.2	Move the harness to connector 708 on the BEB, making sure there is a connector saver between 708 and the harness.
11.3	Re-run **`step (2)`**, **`step(3)`**, **`step(4)`**, and **`step(5)`** to turn the power back onto the BEB.
11.4	Run **`step(6)`** to measure the current consumption of each power supply. The currents will be appended to the log file: 'table_001_turn_on_current_readings.csv'
11.5	Measure the voltage offsets on bias, usher, and guard by running **`step(7, 708)`**. Results will be appended to 'table 002_DC_offsets.csv'.
11.6	Conduct the EMFISIS verification test by running **`step(9,708)`**. The data will be appended to: 'table_003_EMFISIS_function_verification.csv'
11.7	Verify DAC and MUX setting by running **`step(12,708).`** The data will be appended to: ' table_004_DAC_setting_verification.csv'
11.8	Verify the DC gain by running **`step(14,708)`**. The data will be recorded in two output files: ' table_005-N_DC_gain_chanN.csv', where N = 5-6.
11.9	Verify the frequency response by running **`step(15,708)`**. The data will be recorded in two output files: ' table_006-N_freq_response_chanN', where N = 5-6.
11.10	Measure EMFISIS distortion by running **`step(16,708)`**. The data will be appended to the output file: 'table_007-EMFISIS_Distortion.csv'
11.11	Measure the EMFISIS frequency response by running **`step(17,708).`** The data will be appended in the output file: ' table_008-EMFISIS_12_freq_response'
11.12	Verify the AC test lines operation by running **`step(18,708)`**. The data will be appended to the output file: 'table_009-ACTEST_verification.csv'

SIGN OFF

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RBSP Systems Engineer, Michael Ludlam

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RBSP MAM, Jorg Fischer

APPENDIX

Matrix Configuration Document

Scope Saved Configurations List

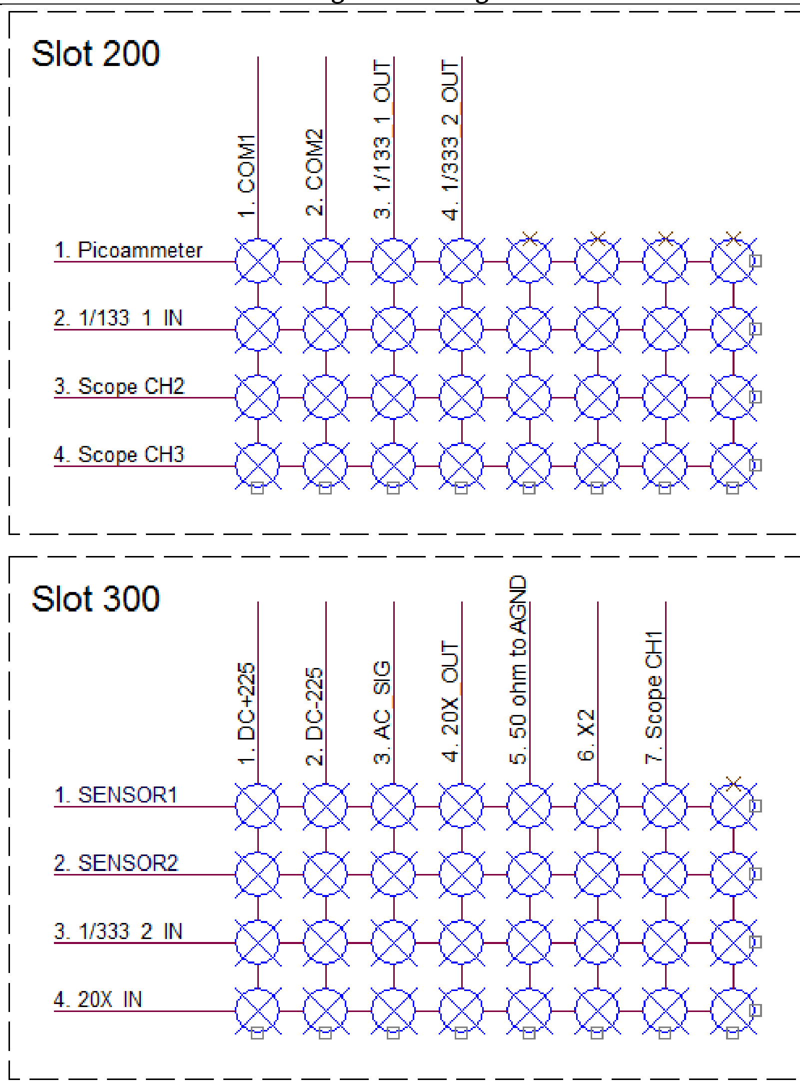
SciCal Rack Diagram

SciCal Harness Schematic

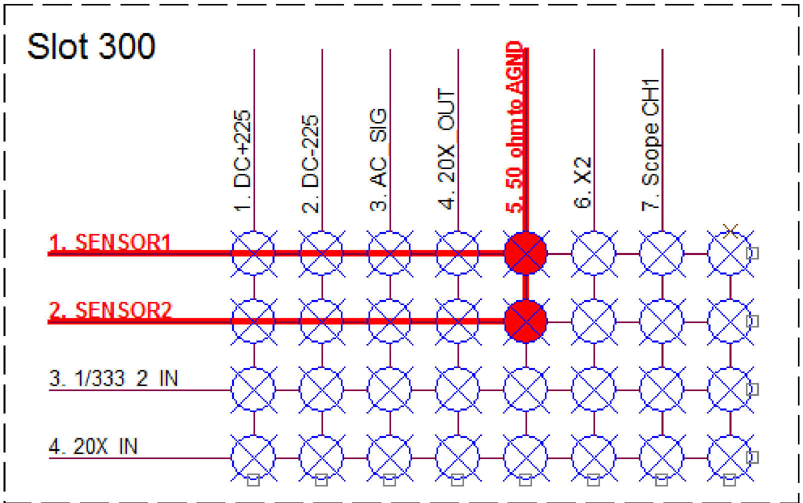
Backplane Schematic

Le Menu (rev 9/28/2010)

This document lists possible configurations for the RBSP EFW BEB Science Calibration rack switch matrix (Agilent E34970A). Each configuration has a number, and that number can be used with the configure_matrix() function in the scical.py module to invoke the configuration.

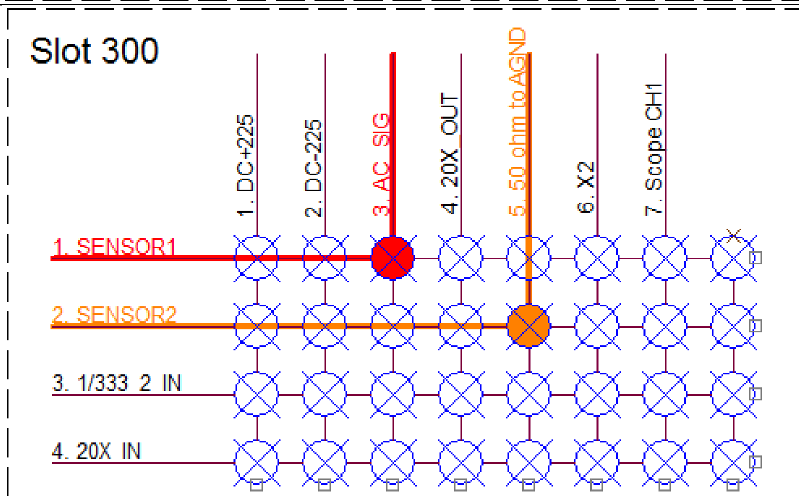
Cfg. #	Configuration Diagram	Description
0.		Default config. All switches open.

1.



Both sensors grounded.

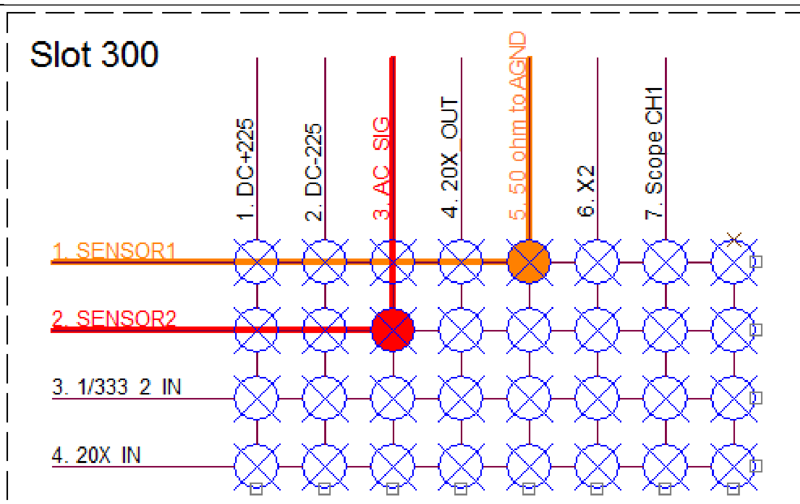
2.



SENSOR1 connected to AC_SIG (DS345 output),

SENSOR2 grounded.

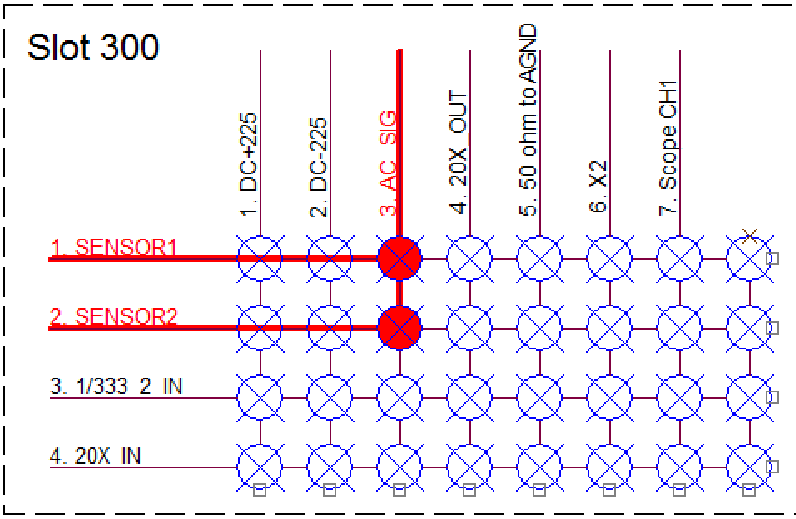
3.



SENSOR2 connected to AC_SIG (DS345 output),

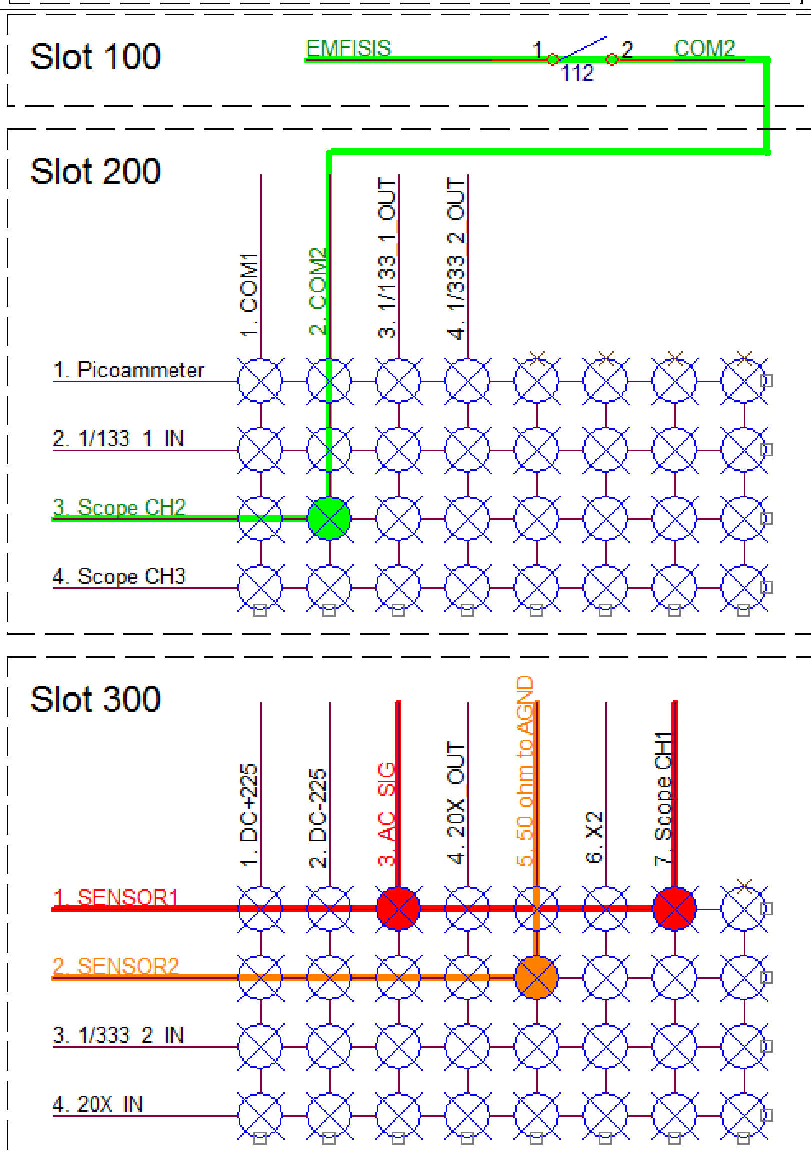
SENSOR1 grounded.

4.



Both SENSOR1 and SENSOR2 connected to AC_SIG.

5.

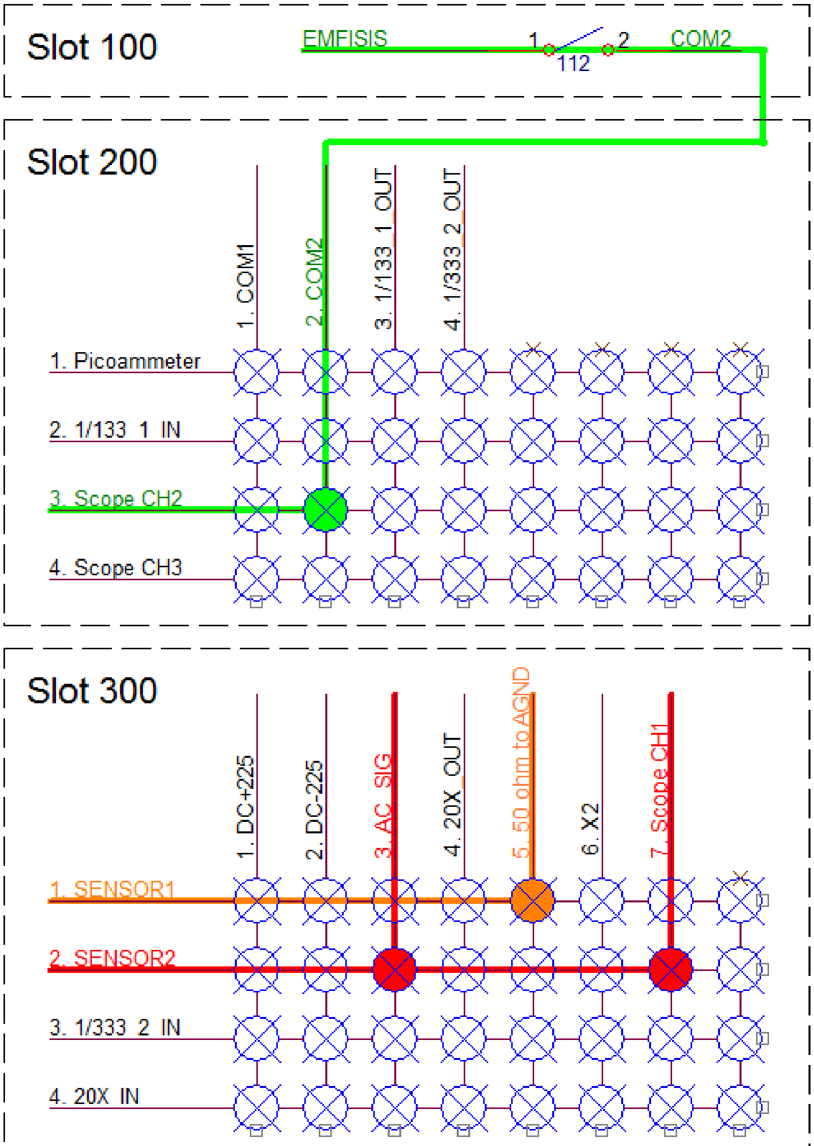


EMFISIS to Scope CH2

AC_SIG to SENSOR1 and Scope CH1

SENSOR2 to 50ohm GND.

6.

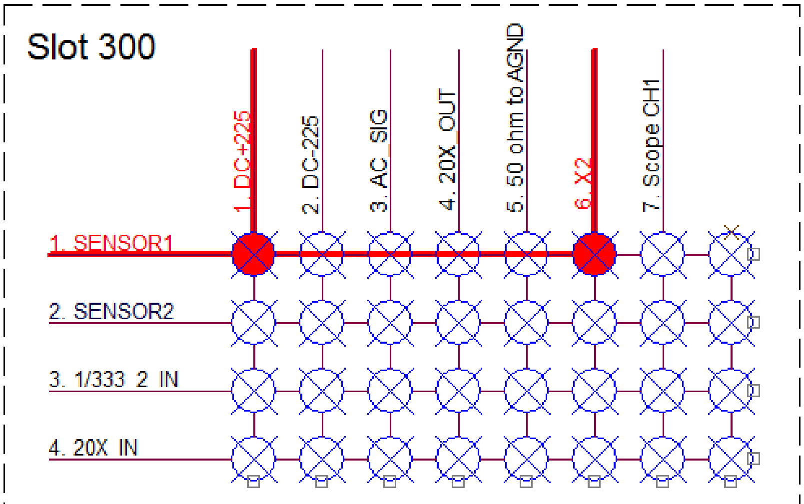


EMFISIS to Scope CH2

AC_SIG to SENSOR2 and Scope CH1

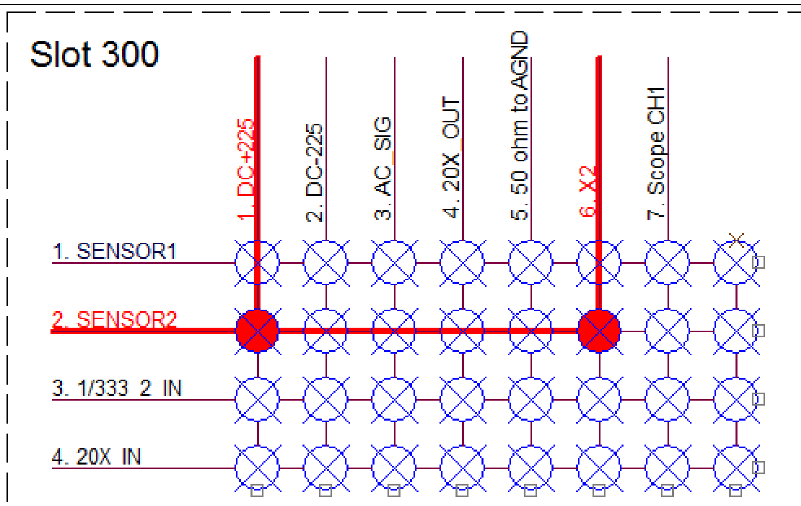
SENSOR1 to 50ohm GND.

7.



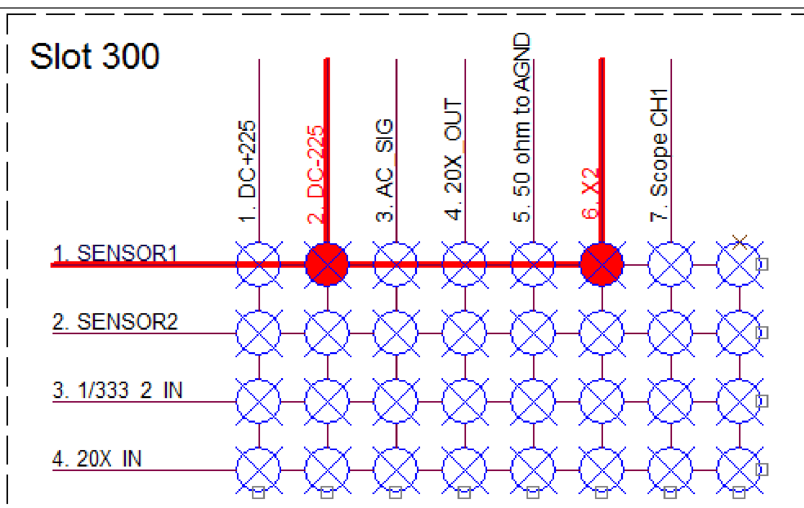
DC+225 to SENSOR1 and X2

8.



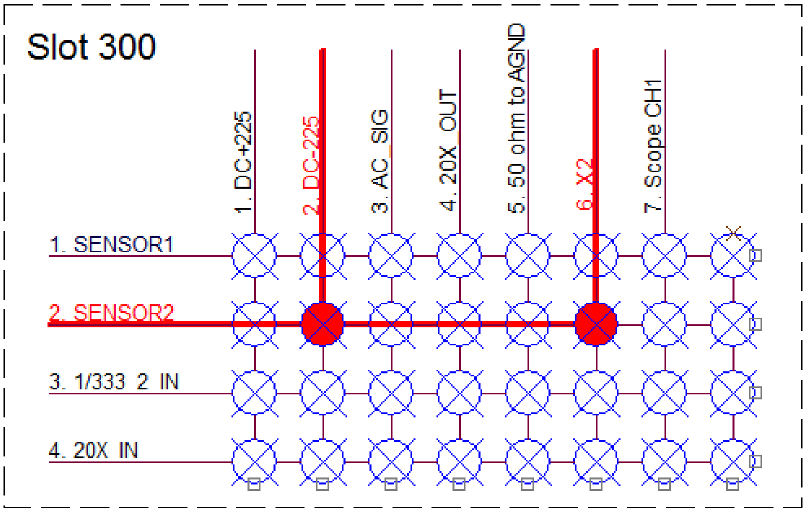
DC+225 to SENSOR2 and X2

9.



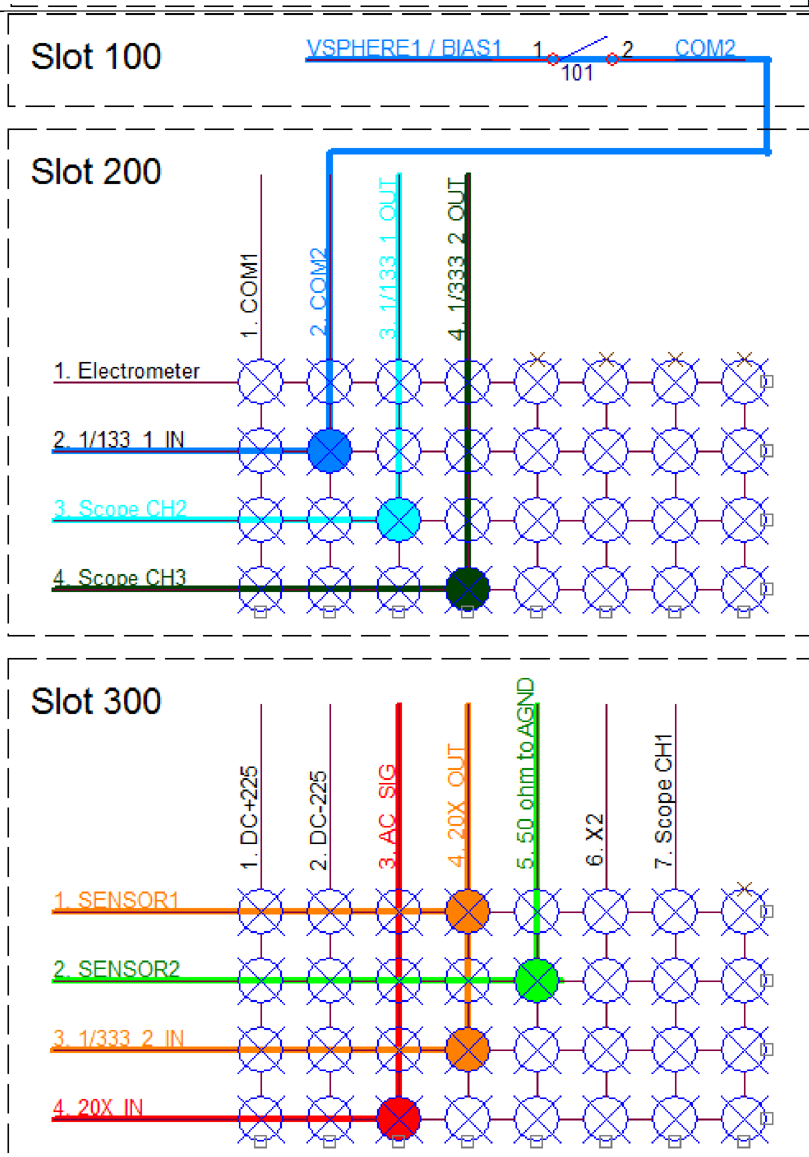
DC-225 to SENSOR1 and X2

10.



DC-225 to SENSOR2 and X2

11.



BIAS1 to 1/333_1_IN

1/333_1_OUT to Scope CH2

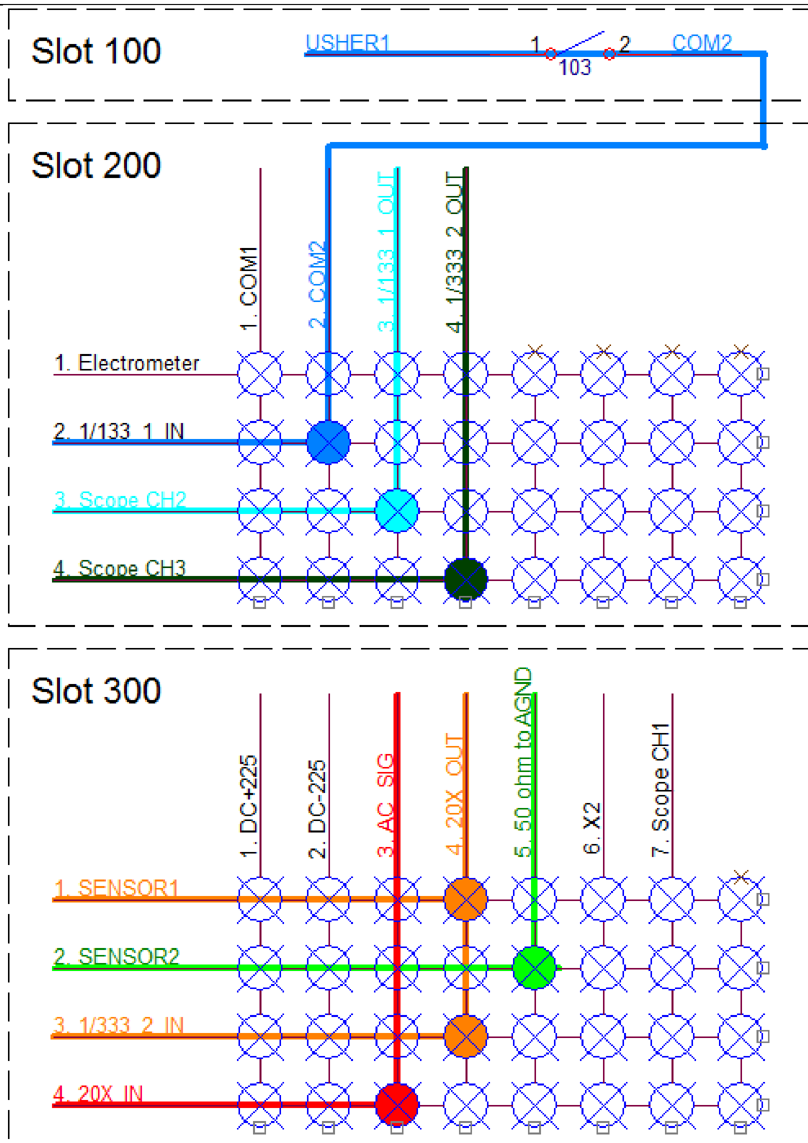
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR1 and 1/333_2_IN

SENSOR2 grounded

12.



USHER1 to 1/333_1_IN

1/333_1_OUT to Scope CH2

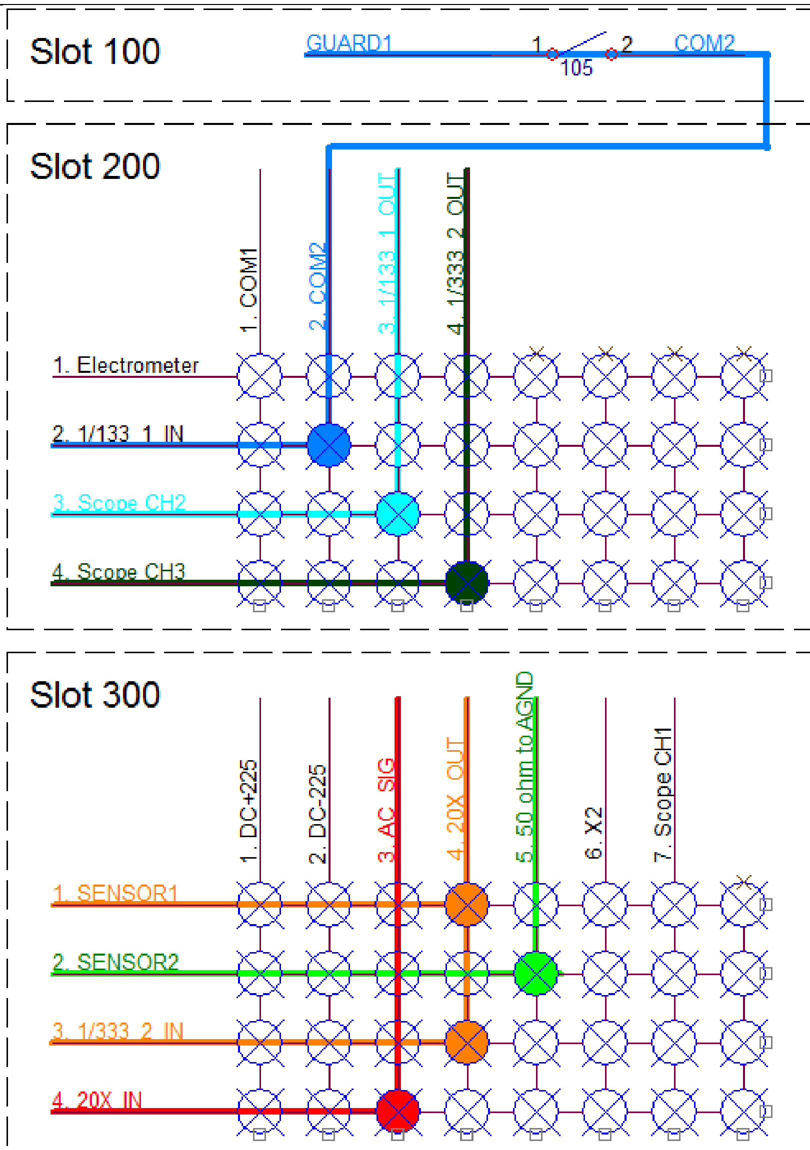
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR1 and 1/333_2_IN

SENSOR2 grounded

13.



GUARD1 to 1/333_1_IN

1/333_1_OUT to Scope CH2

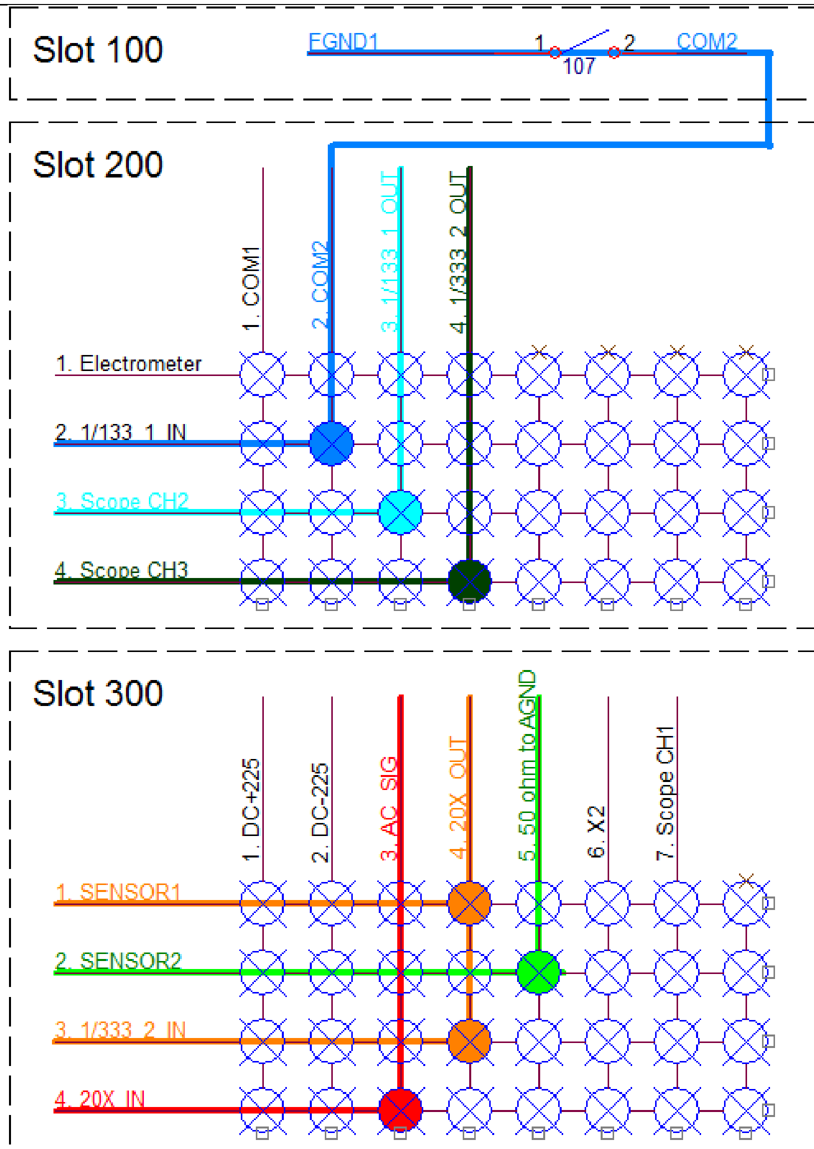
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR1 and 1/333_2_IN

SENSOR2 grounded

14.



FGND1 to 1/333_1_IN

1/333_1_OUT to Scope CH2

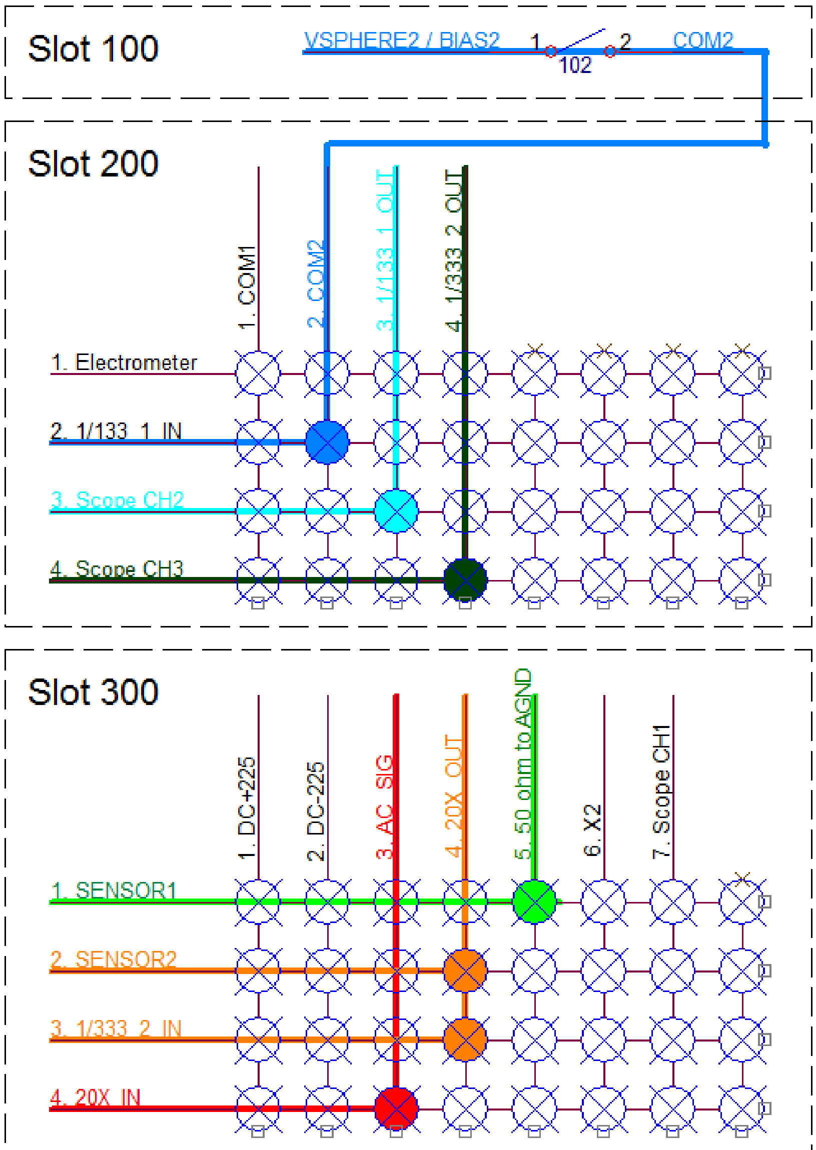
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR1 and 1/333_2_IN

SENSOR2 grounded

15.



BIAS2 to 1/333_1_IN

1/333_1_OUT to Scope CH2

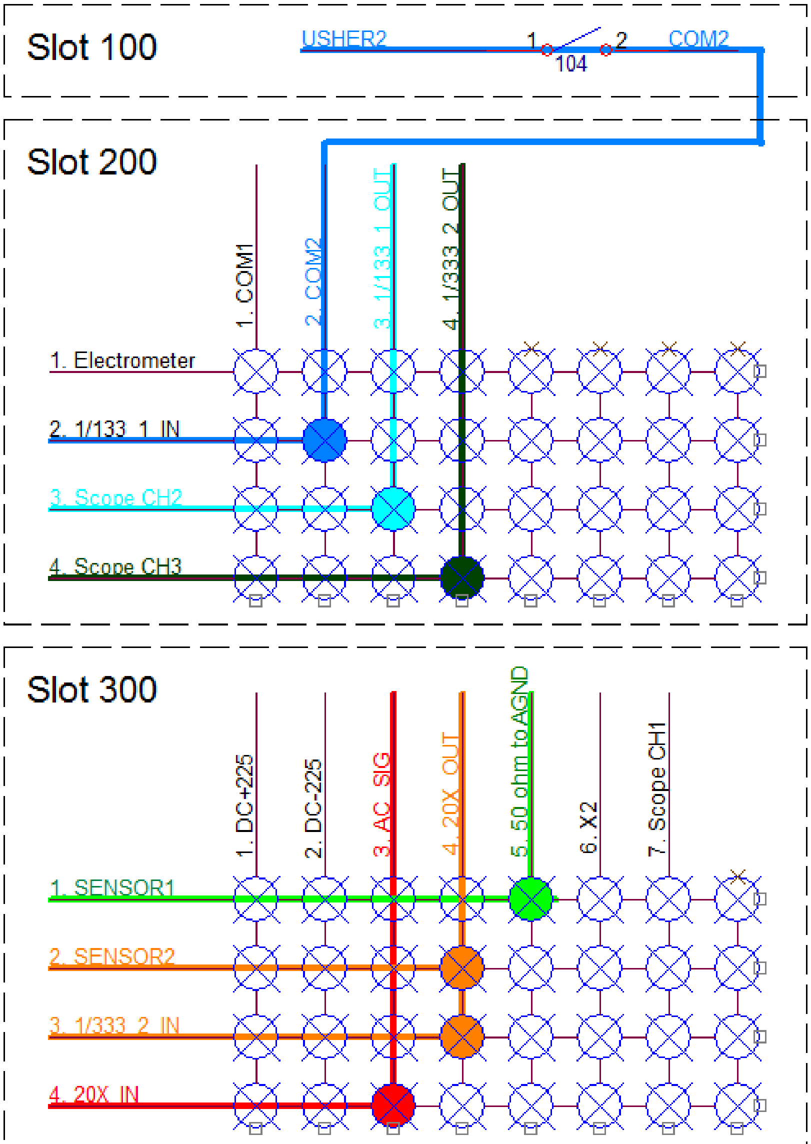
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR2 and 1/333_2_IN

SENSOR1 grounded

16.



USHER2 to 1/333_1_IN

1/333_1_OUT to Scope CH2

1/333_2_OUT to Scope CH3

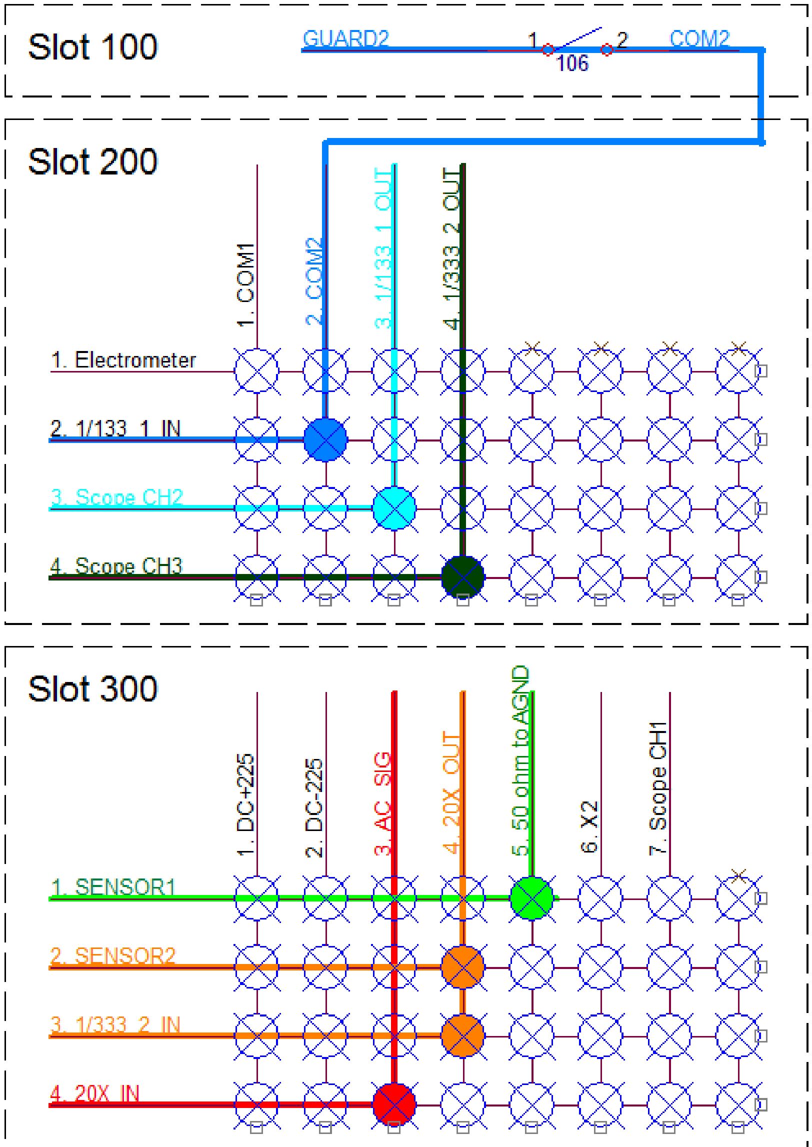
AC_SIG to 20X_IN

20X_OUT to SENSOR2 and 1/333_2_IN

SENSOR1 grounded

SENSOR1 grounded

17.



GUARD2 to 1/333_1_IN

1/333_1_OUT to Scope CH2

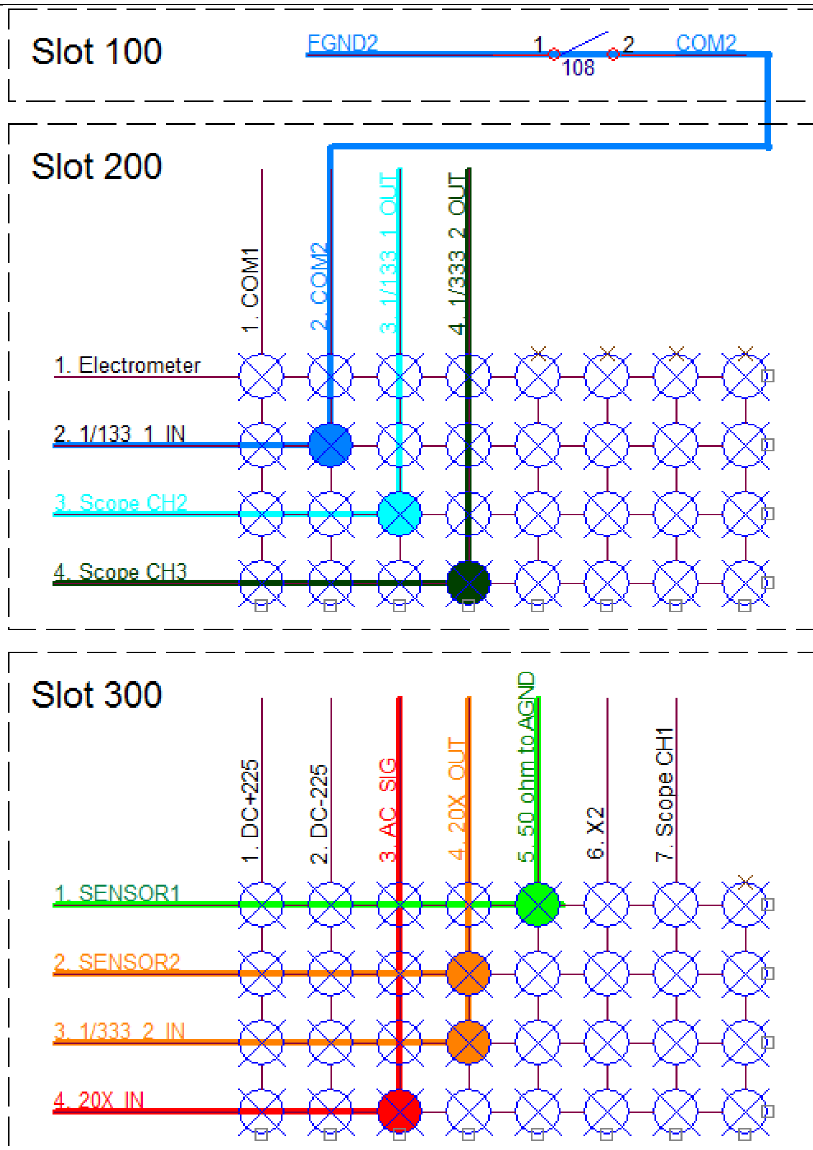
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR2 and 1/333_2_IN

SENSOR1 grounded

18.



FGND2 to 1/333_1_IN

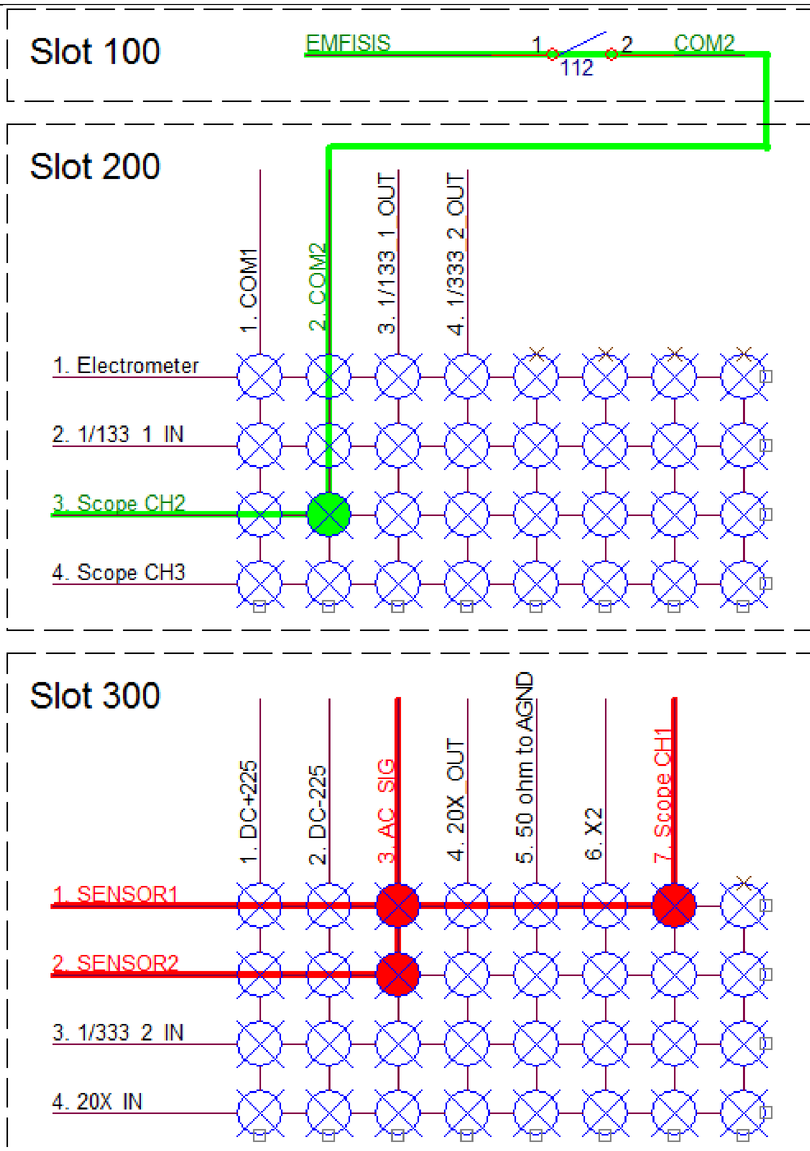
1/333_1_OUT to Scope CH2

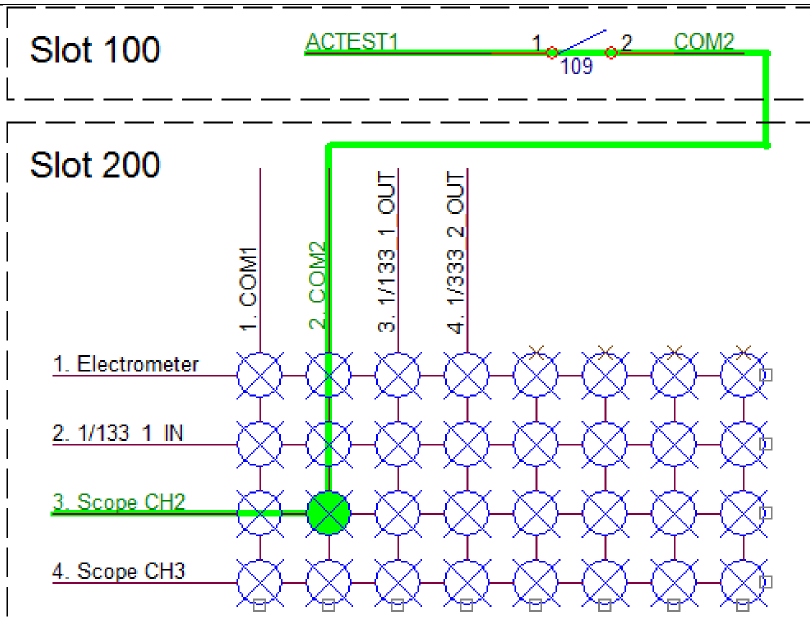
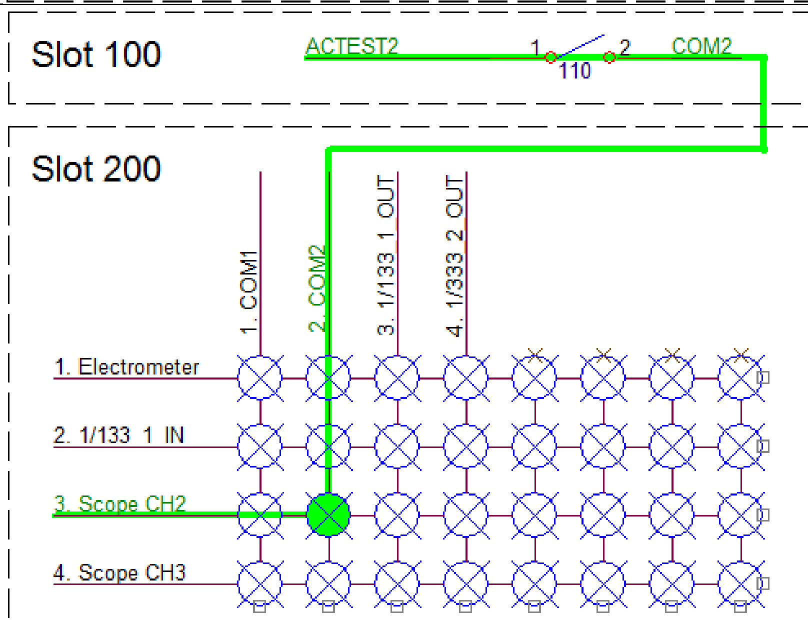
1/333_2_OUT to Scope CH3

AC_SIG to 20X_IN

20X_OUT to SENSOR2 and 1/333_2_IN

SENSOR1 grounded

19.		EMFISIS to Scope CH2 AC_SIG to SENSOR1, SENSOR2, and Scope CH1. (similar to configs 5 and 6)

20.		ACTEST1 to Scope CH2
21.		ACTEST2 to Scope CH2

Scope Saved Configuration List

Scope saved config 4:
CH1 = EMFISIS
CH2 = AC_SIG
MEAS1 = Phase CH1->CH2
MEAS2 = Amp CH1
MEAS3 = Amp CH2

Scope saved config 6:
CH2 = BIAS, USHER, GUARD, FGND
CH3 = 20X_OUT (AC_SIG x20)
MEAS1 = Phase CH3->CH2
MEAS2 = Ampl CH2
MEAS3 = Ampl CH3

Scope saved configuration 7:
CH2 = EMFISIS
CH1 = AC_SIG
MEAS1 = CH1->CH2 phase
MEAS2 = CH1 ampl (VSPHERE)
MEAS3 = CH2 ampl (EMFISIS)
MATH = FFT on CH2

Scope saved config 8:
CH1 = VSPHERE
CH2 = EMFISIS
MEAS1 = Phase EMFISIS wrt VSPHERE
MEAS2 = Ampl CH1
MEAS3 = Ampl CH2

Scope config 9:
CH2 = ACTEST1, ACTEST2
MEAS1 = CH2 freq
MEAS3 = CH2 amplitude