EMC Compliance Testing

TI Precision Labs – ADCs

Created and Dale Li, and Art Kay

Presented by Art Kay

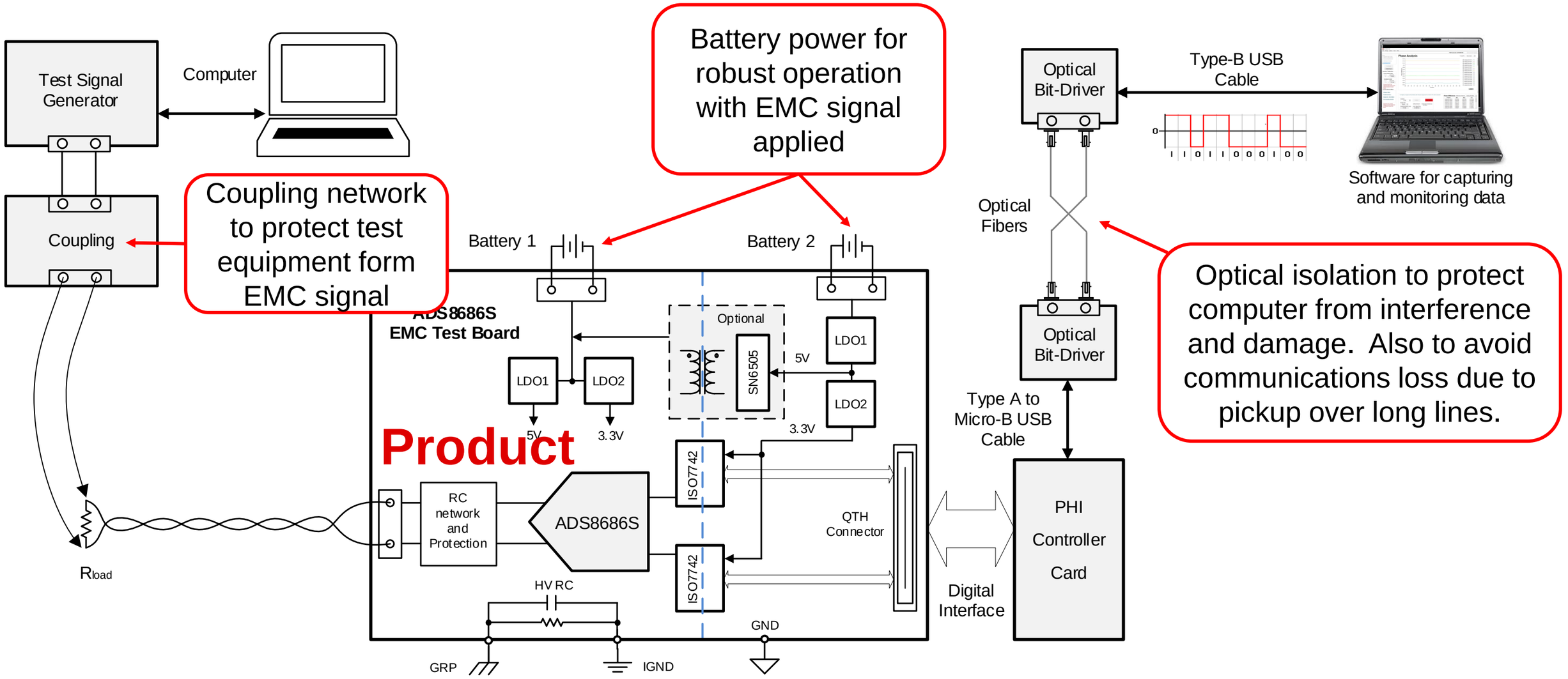
Standards covered in this discussion

- IEC 61000-4-3: Radiated Immunity (RI)
- CISPR 11: Radiated Emissions (RE)
- IEC 61000-4-6: Conducted Immunity (CI)
- IEC 61000-4-4: Electrical Fast Transients (EFT)
- IEC 61000-4-5: Surge Immunity (SI)
- IEC 61000-4-2: Electrostatic Discharge (ESD)

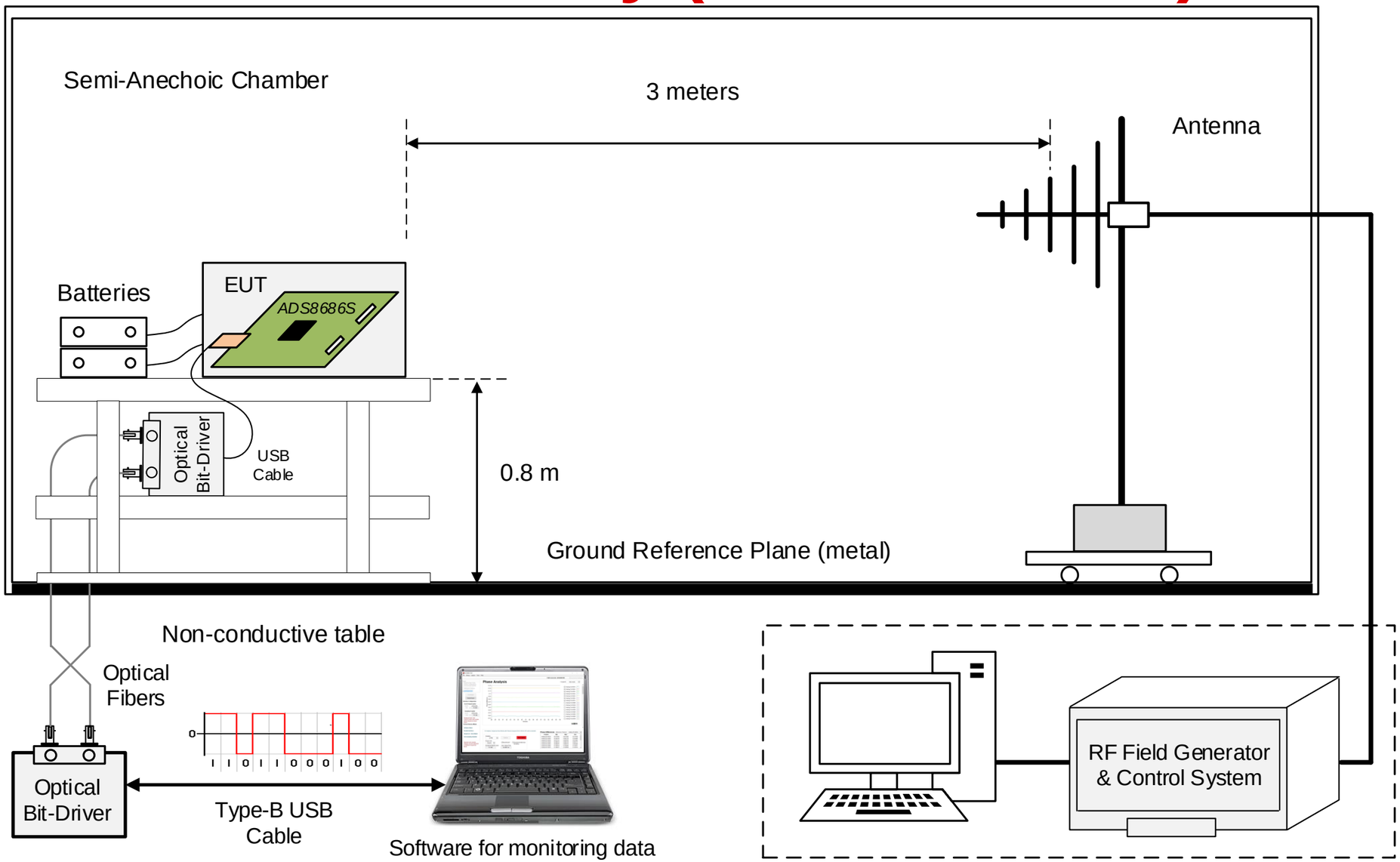
Overstress training series:
https://training.ti.com/eos-and-esd-adc

Example EMC Compliance Testing for Precision ADC Systems:
http://www.ti.com/lit/pdf/sbac230

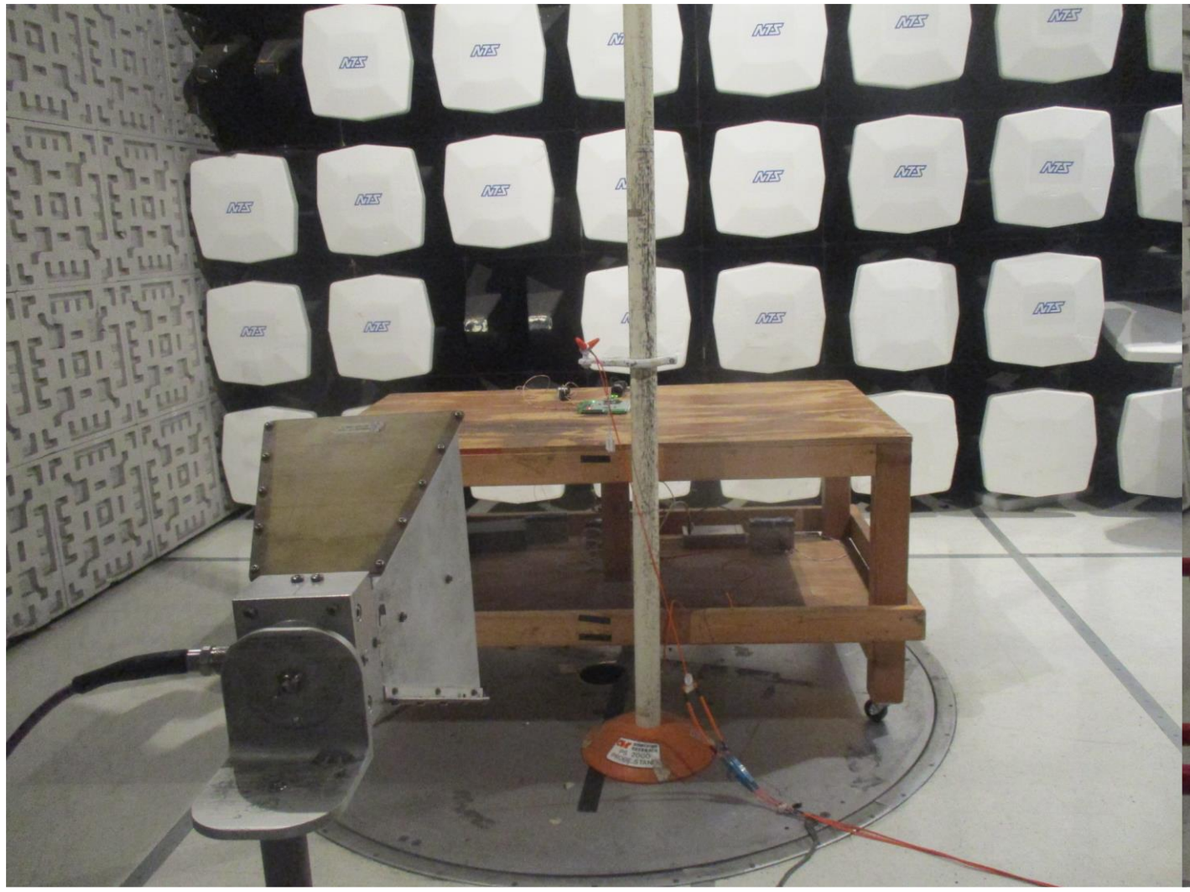
General EMC Hardware Setup



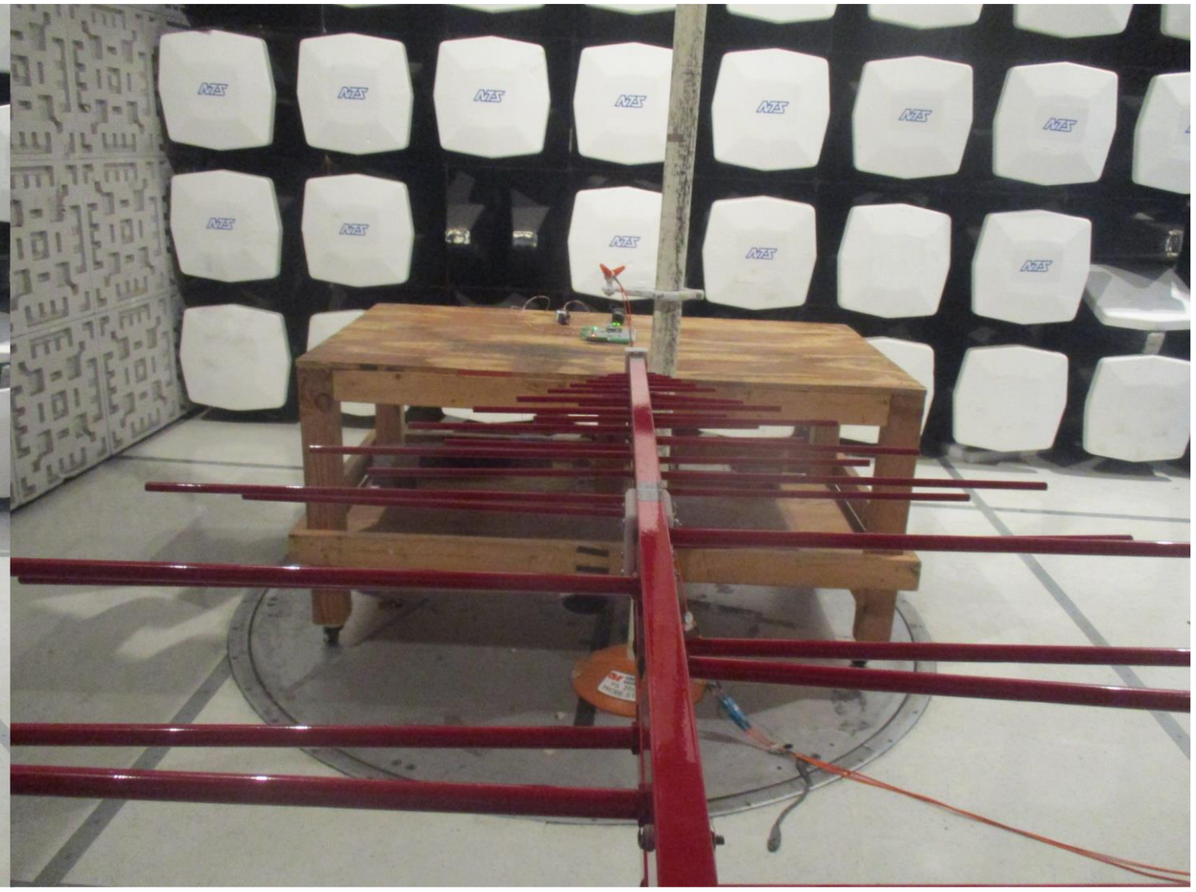
Radiated Immunity (IEC 61000-4-3)



Radiated Immunity (IEC 61000-4-3)

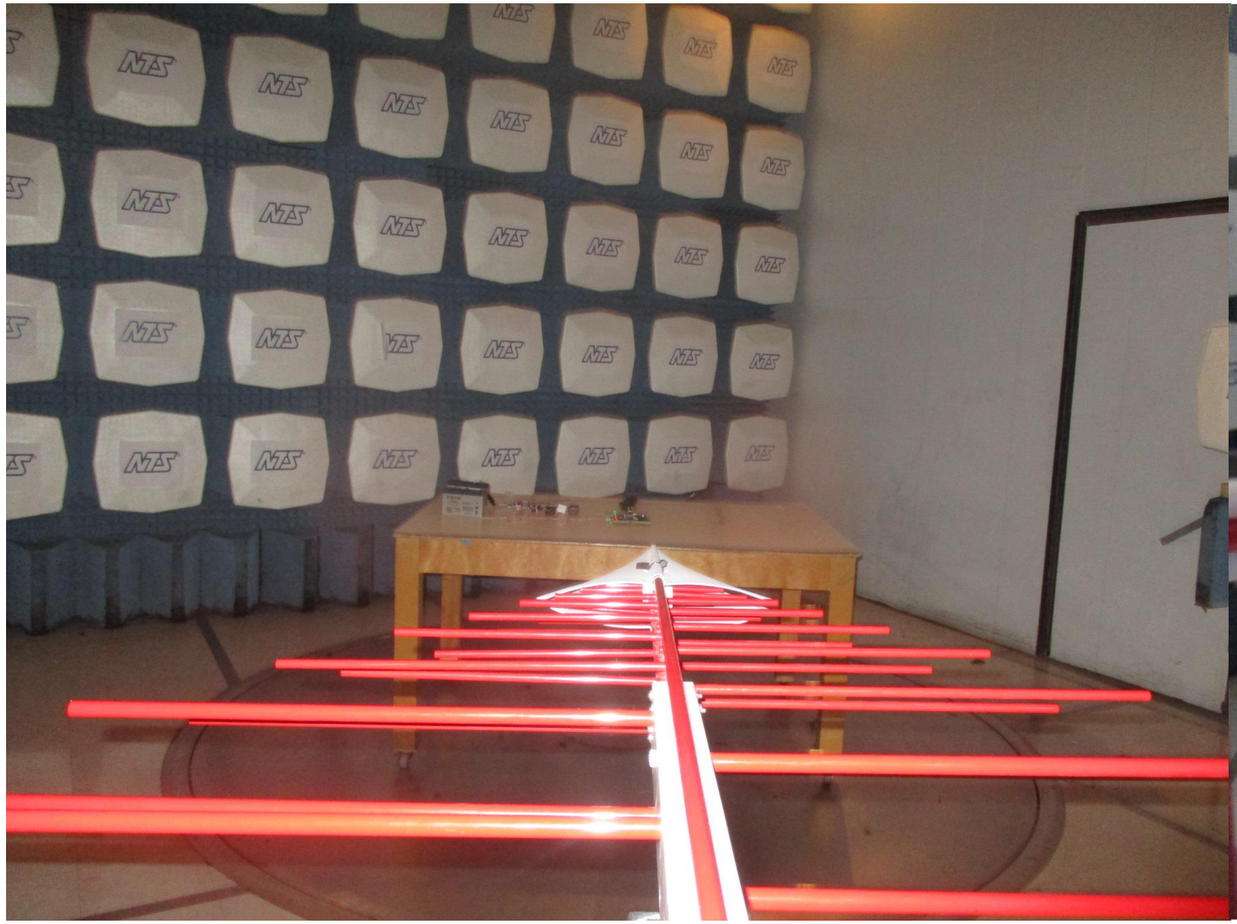


RF Immunity Test: 1 - 2.7GHz



RF Immunity Test: 80 – 1000MHz

Rotation of the antenna Polarization



Antenna Polarization: Horizontal

Antenna Polarization: Vertical

Radiated Immunity Test Limits and Conditions (IEC 61000-4-3)

Test Level	Field Strength V/m
1	1
2	3
3	10
4	30

Criteria	Description
A	Normal performance within specified limits
B	Temporary performance loss which can recover after disturbance ends
C	Temporary function or performance loss which can recover with user's intervention
D	Permanent function or performance loss due to damage or loss of data

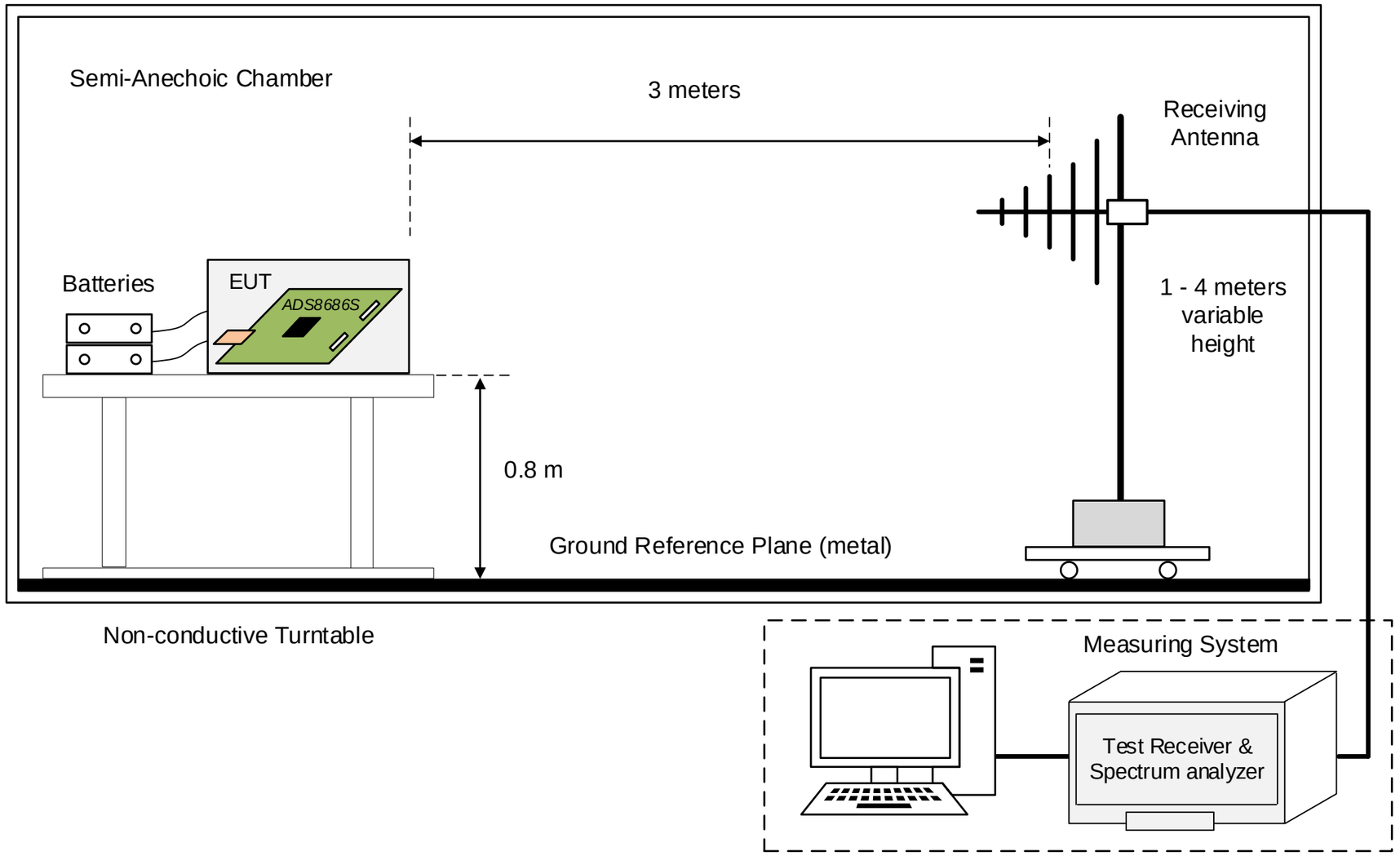
Radiated Immunity Test Results (IEC 61000-4-3)

Table 3-5. Radiated Immunity Test Result

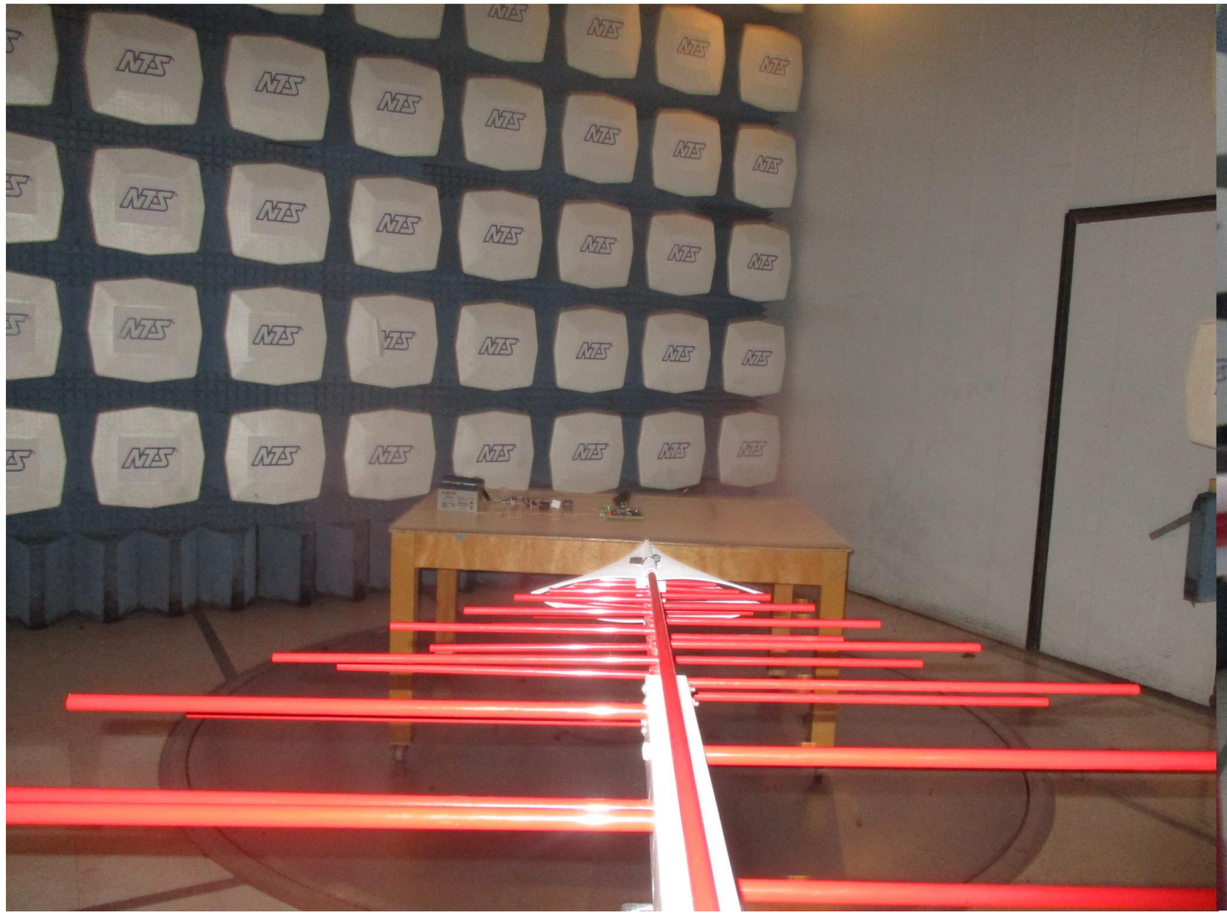
Test	IEC Standard	Test Signal			Test Level	Criterion	Test Result
		Field Strength	Frequency	Antenna Polarization			
Radiated Immunity (RI)	IEC 61000-4-3	10 V/m	80–1000 MHz	Horizontal	3	A	Pass
				Vertical		A	Pass
			1–2.7 GHz	Horizontal		A	Pass
				Vertical		A	Pass
		18 V/m	80–1000 MHz	Horizontal	> 3	A	Pass
				Vertical		A	Pass
			1–2.7 GHz	Horizontal		A	Pass
				Vertical		A	Pass

Link to EMC Compliance Test Example for ADC Systems
http://www.ti.com/lit/pdf/SBAA548

Radiated Emissions (CISPR 11)



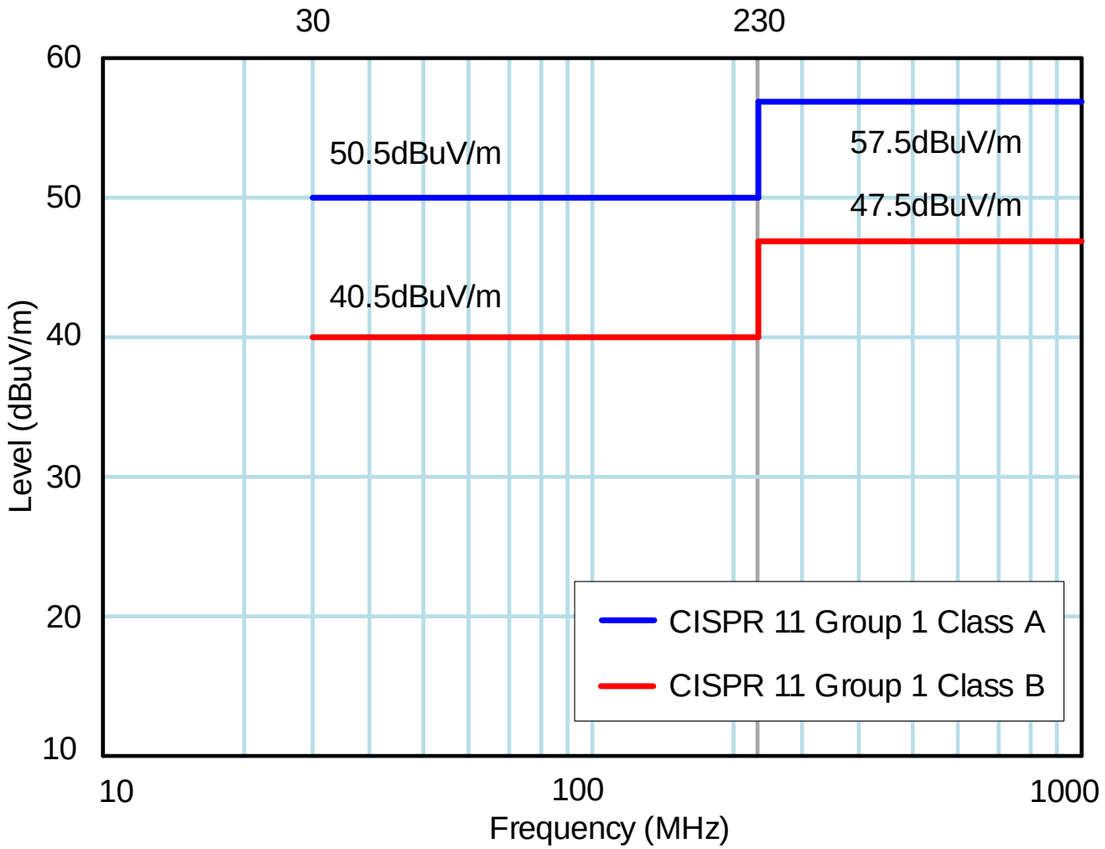
Radiated Emissions CISPR 11



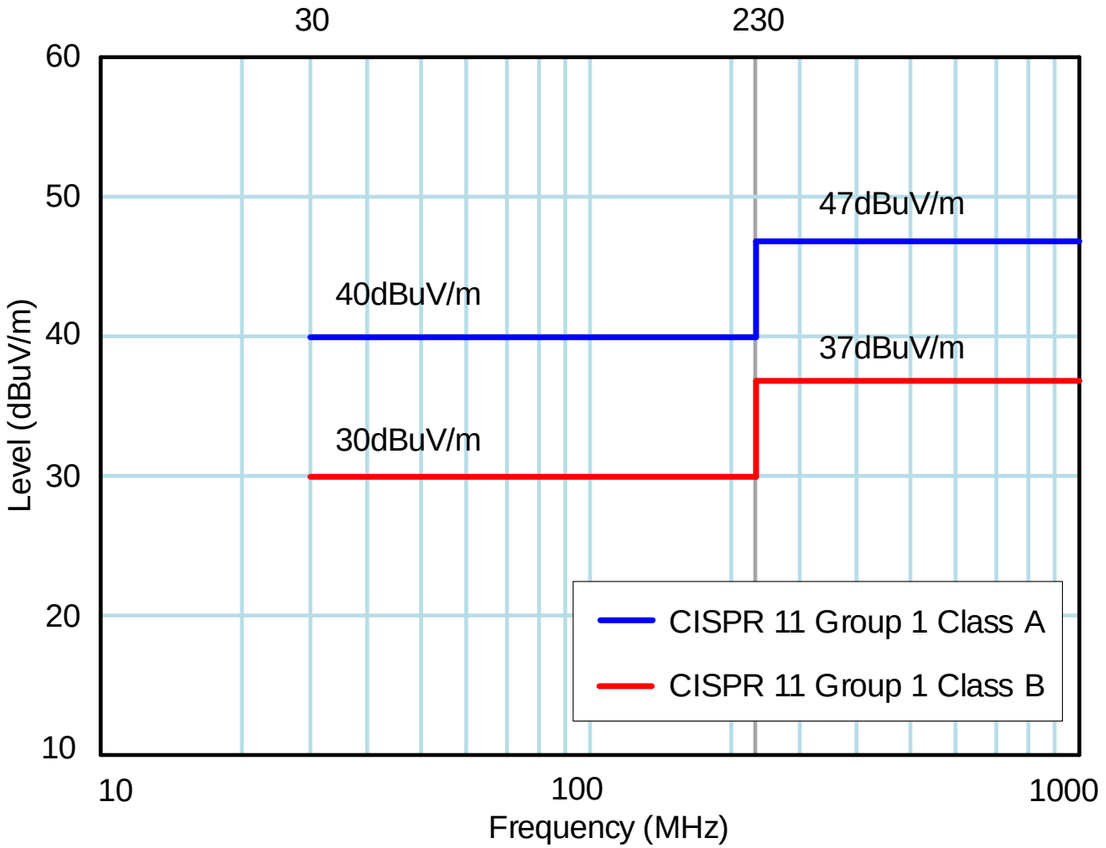
Antenna Polarization: Horizontal

Antenna Polarization: Vertical

Radiated Emissions CISPR 11

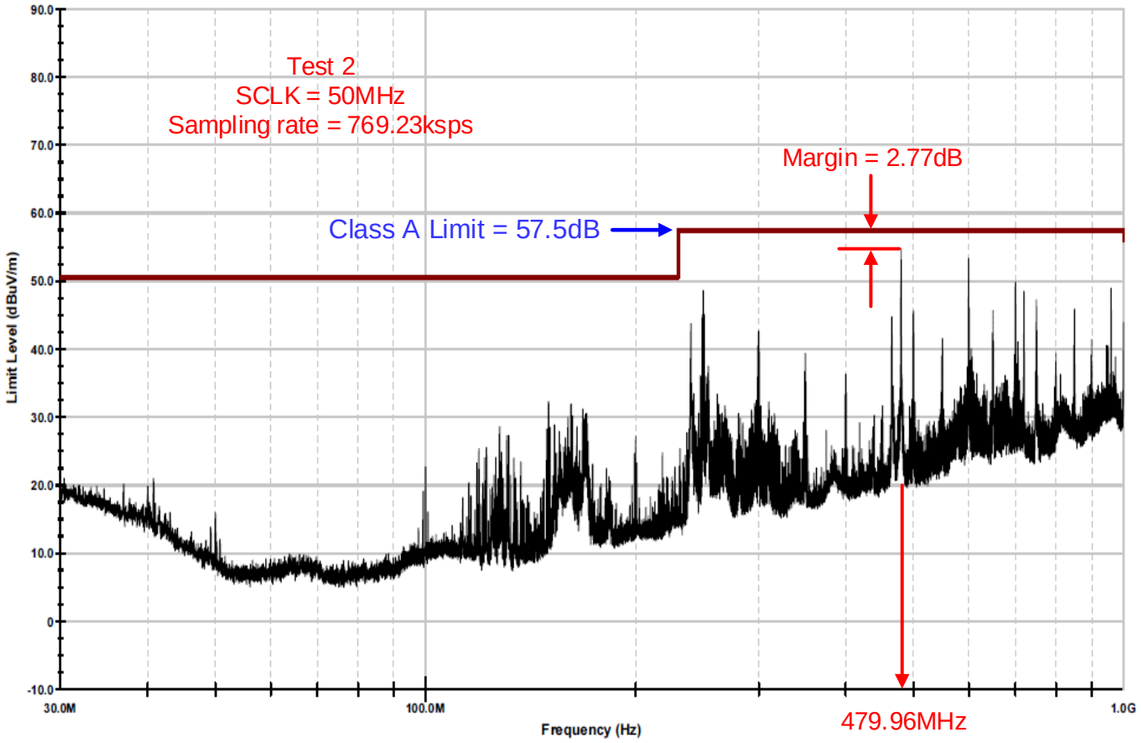


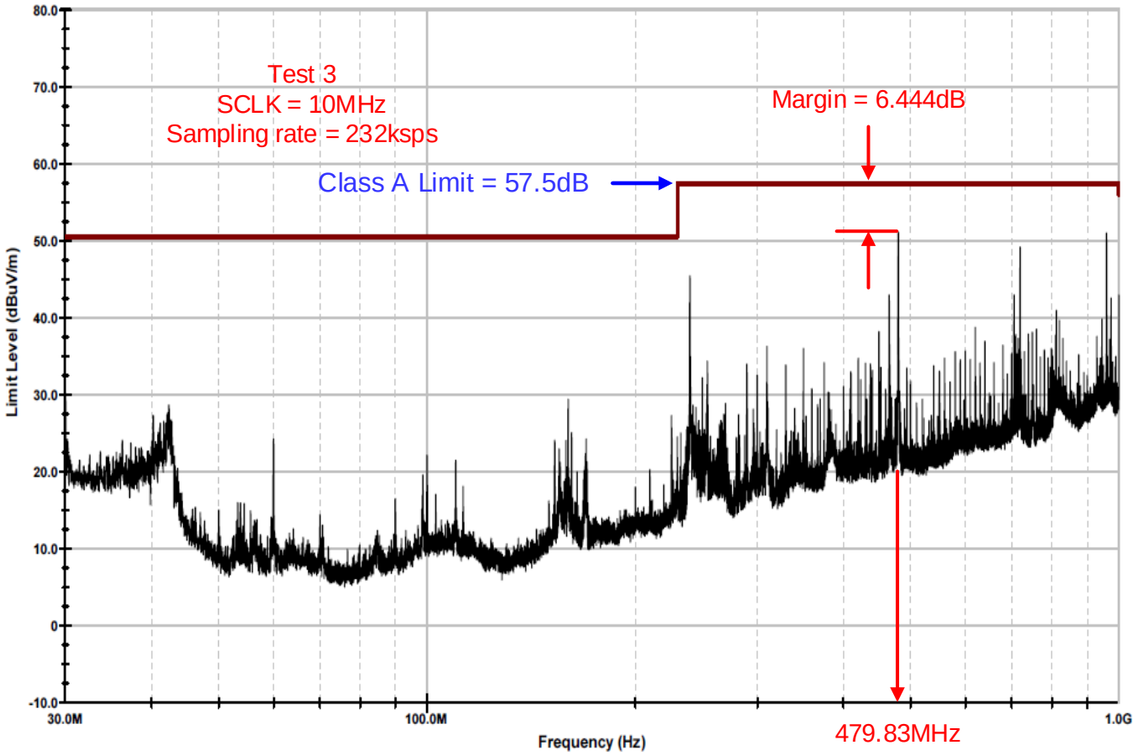
Limits for 3 m distance



Limits for 10 m distance

Radiated Emissions CISPR 11

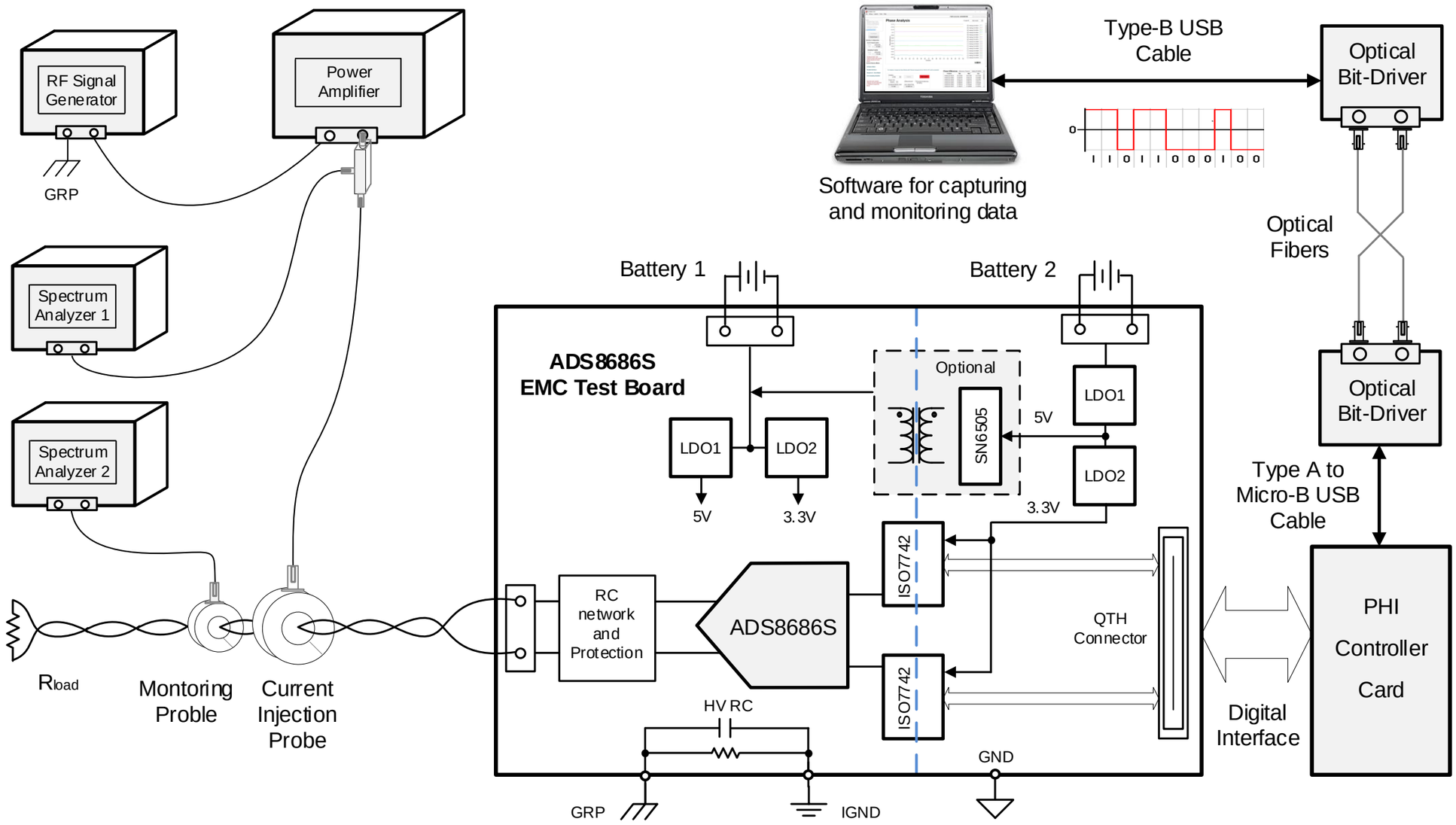




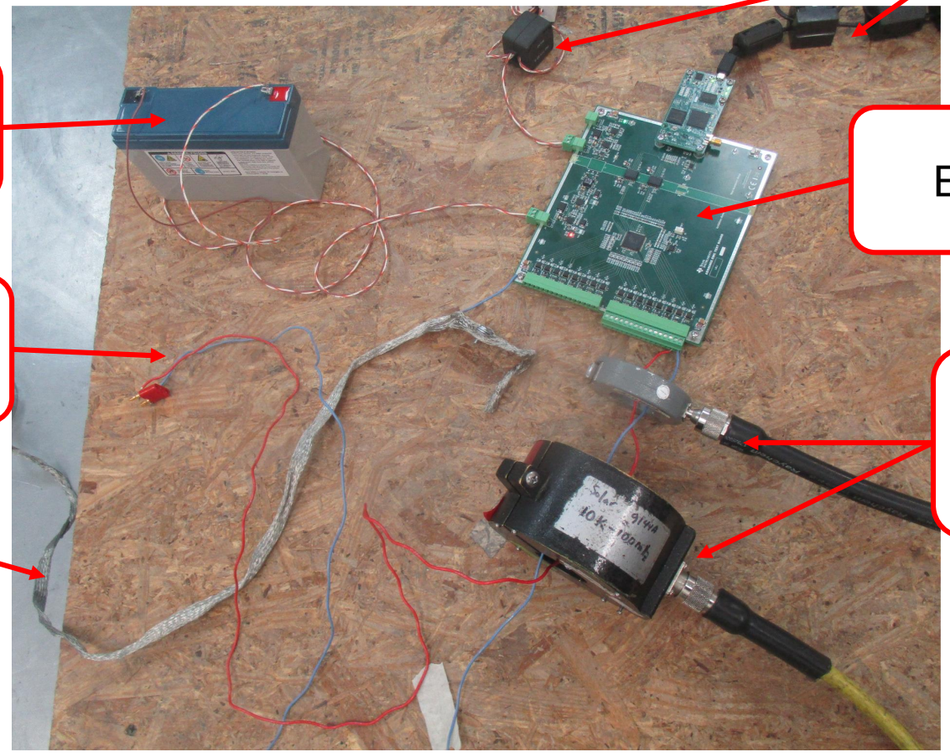
Horizontal Antenna Polarization
SCLK = 50MHz
Margin = 2.77dB

Vertical Antenna Polarization
SCLK = 10MHz
Margin = 6.4dB

Conducted Immunity (IEC 61000-4-6)



Conducted immunity



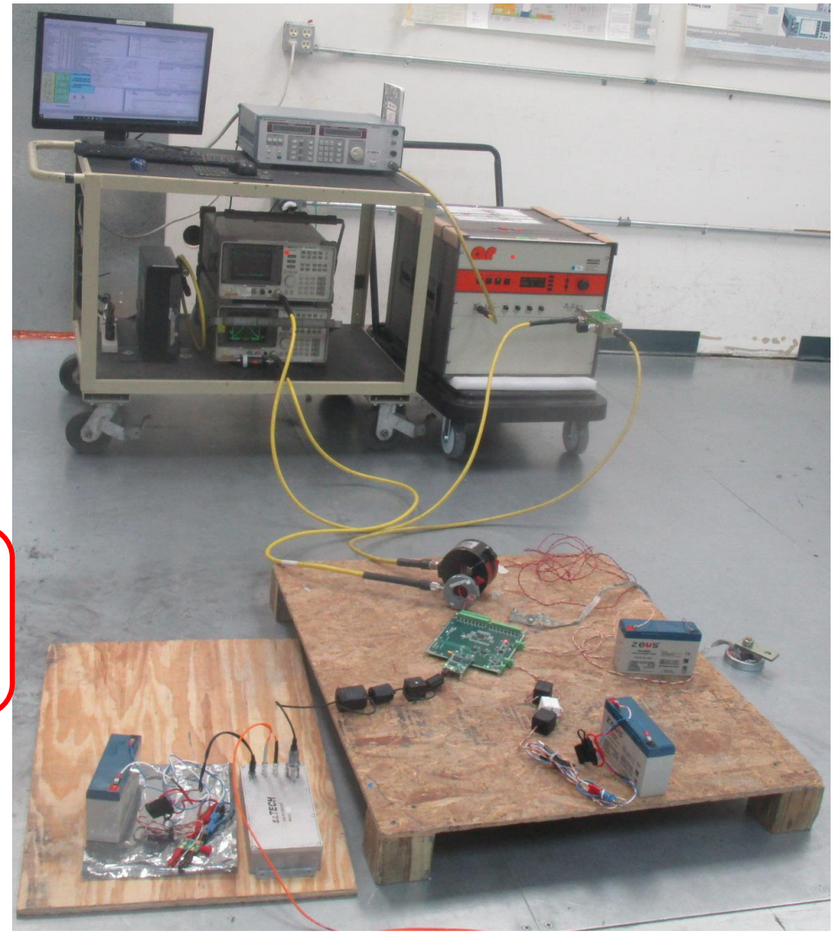
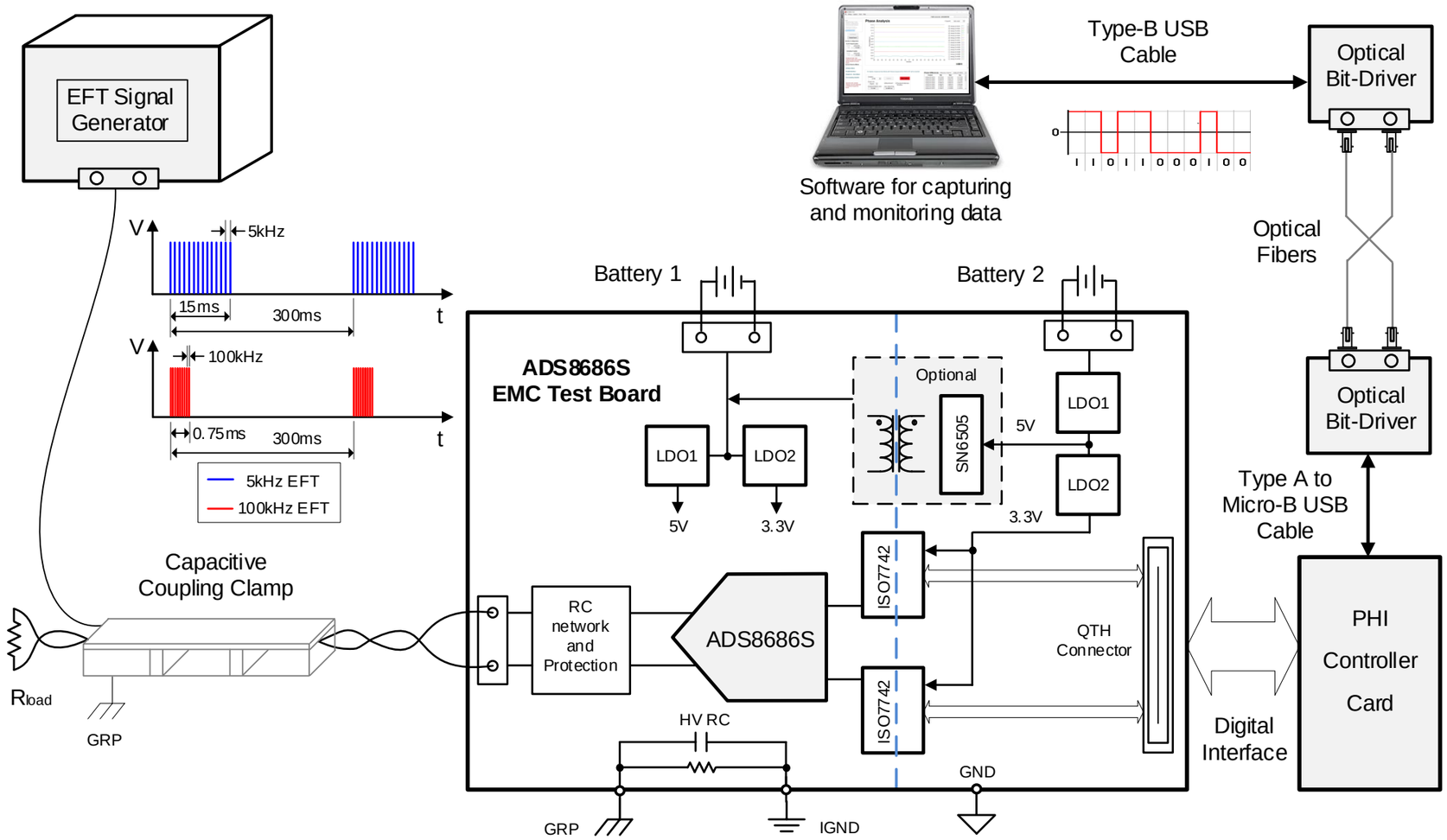


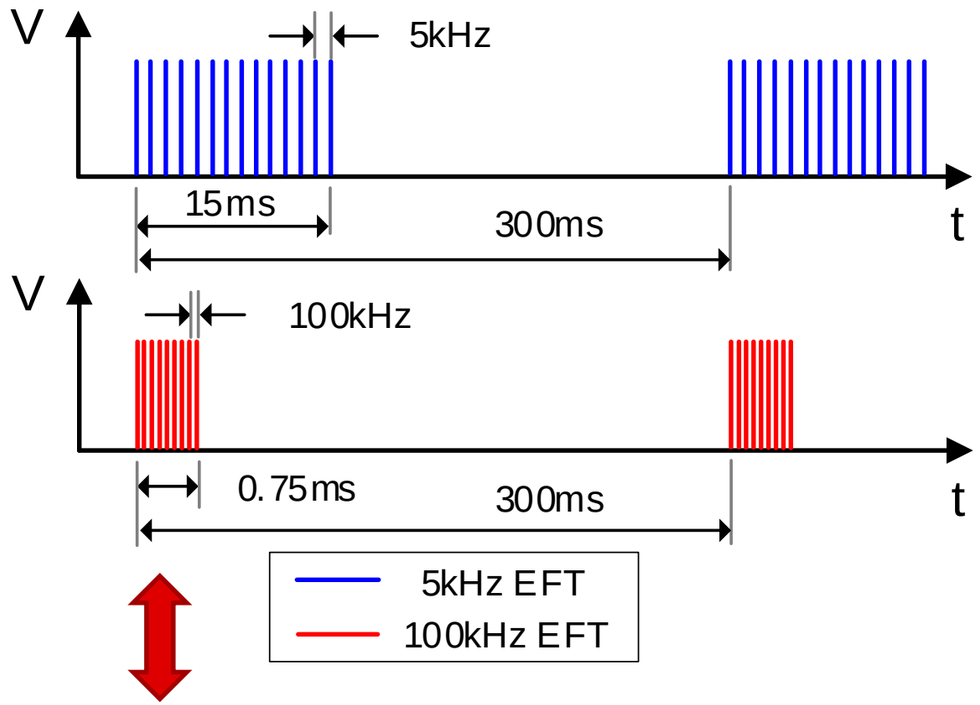
Table 3-4. Conducted Immunity Test Result

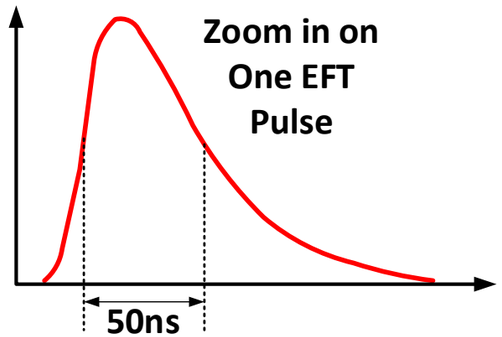
Test	IEC Standard	Test Signal		Test Level	Criterion	Test Result
		Field Strength	Frequency			
Conducted Immunity (CI)	IEC 61000-4-6	3 V/m	150 kHz–80 MHz	2	A	Pass
		10 V/m	150 kHz–80 MHz	3	A	Pass

Electrical Fast Transients (EFT), (IEC 61000-4-4)



Electrical Fast Transients (EFT), (IEC 61000-4-4)





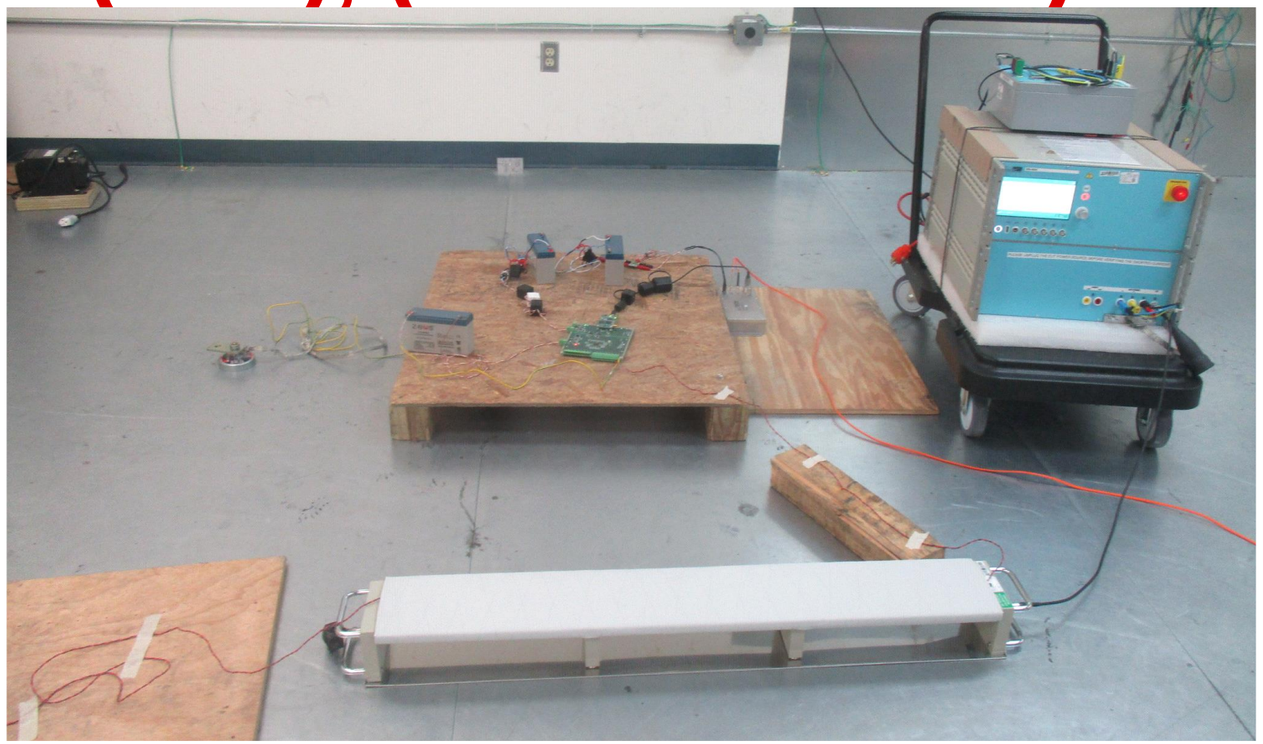
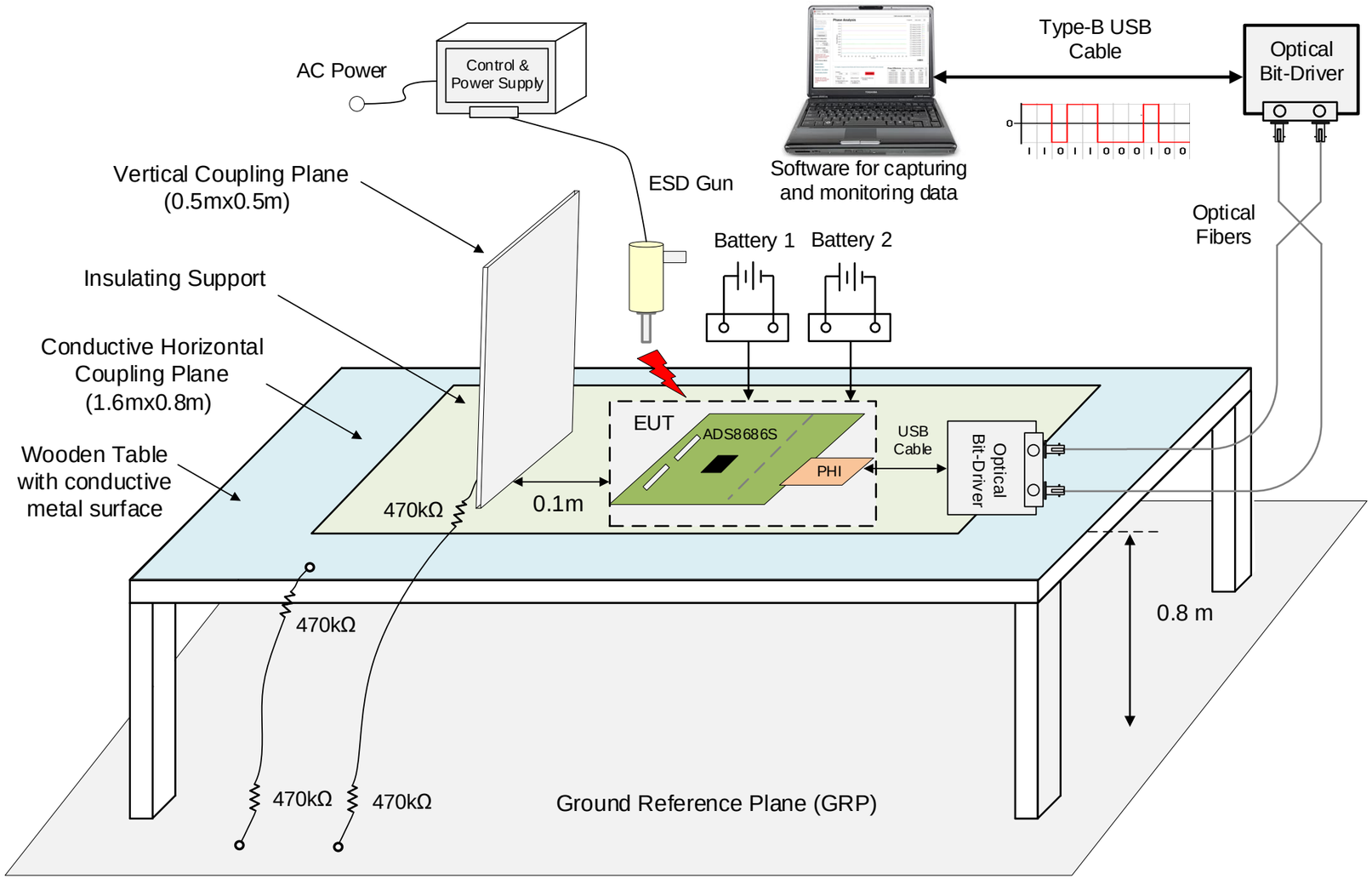


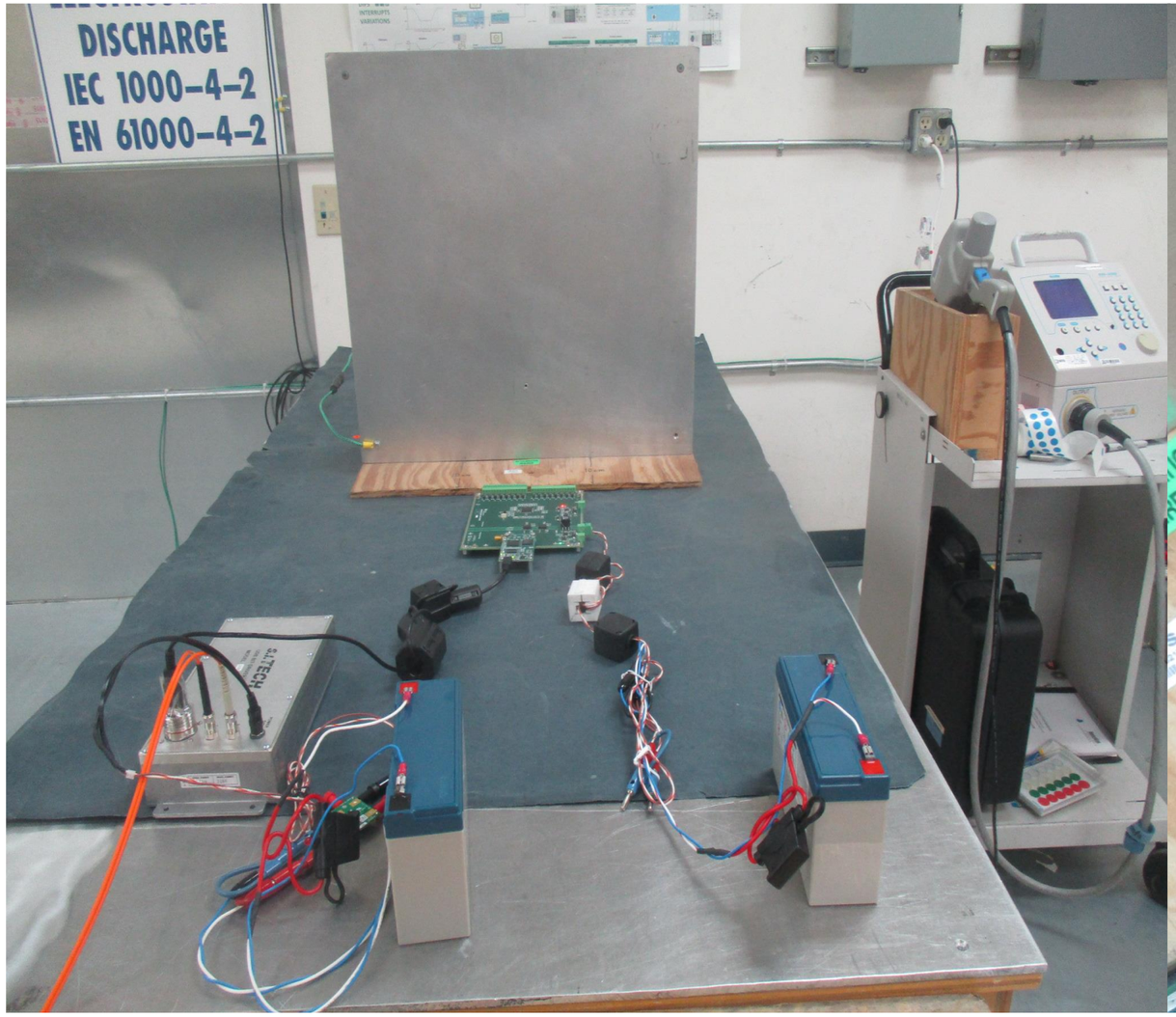
Table 3-1. EFT Test Result

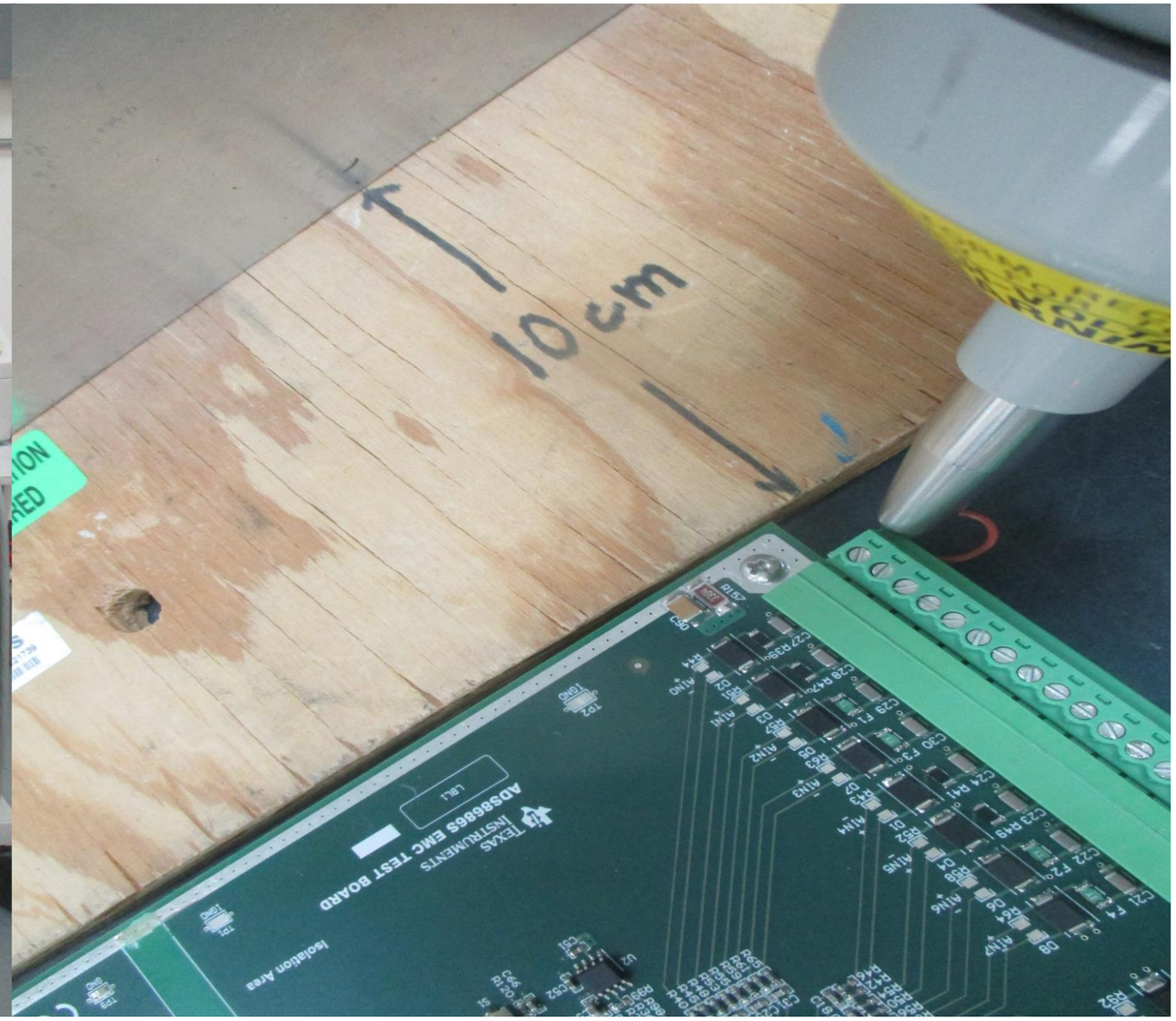
Test	IEC Standard	Test Signal		Test Level	Criterion	Test Result
		Voltage	Frequency			
EFT	IEC 61000-4-4	±1 kV	5 kHz	2	A	Pass
		±2 kV		3	B	Pass
		±4 kV		4	B	Pass
		±1 kV	100 kHz	2	A	Pass
		±2 kV		3	B	Pass
		±4 kV		4	B	Pass

Electrostatic Discharge (ESD), (IEC 61000-4-2)

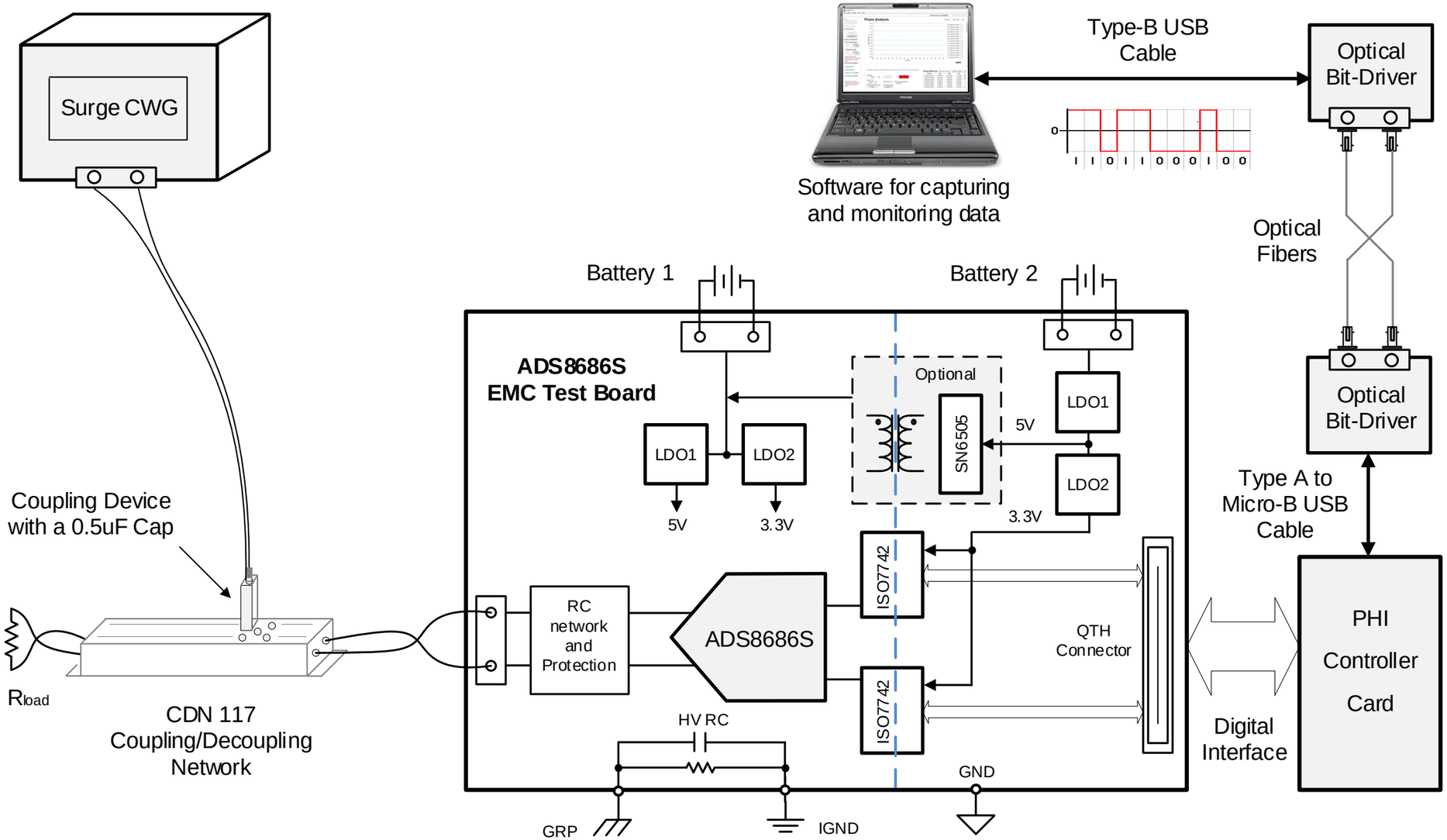


Electrostatic Discharge (ESD), (IEC 61000-4-2)





Surge IEC 61000-4-5



Surge Test Results

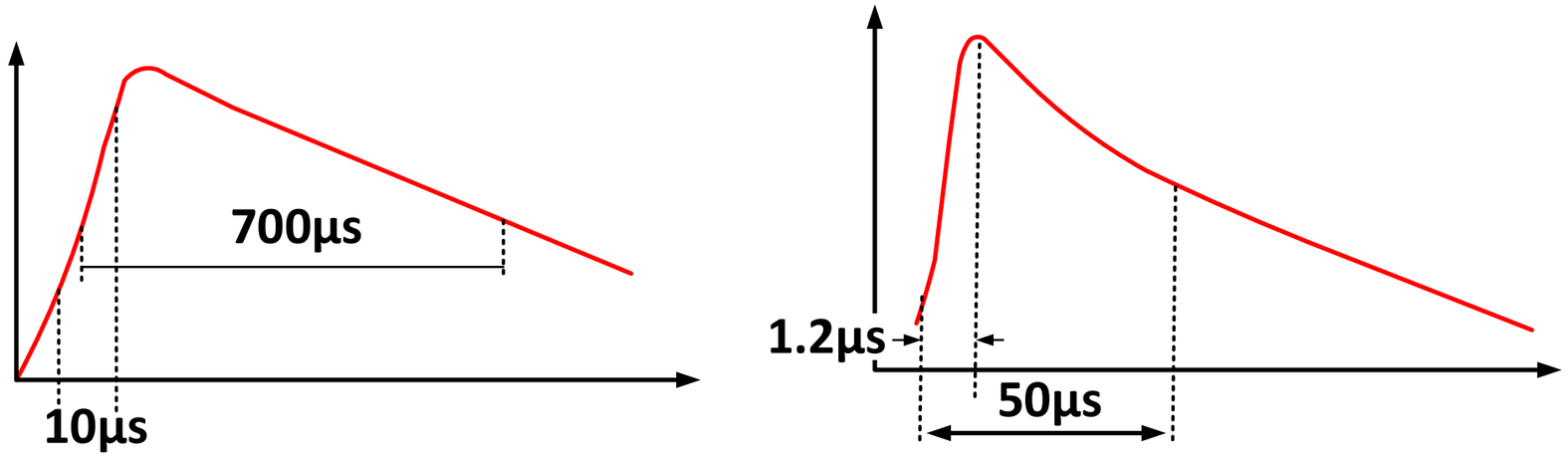
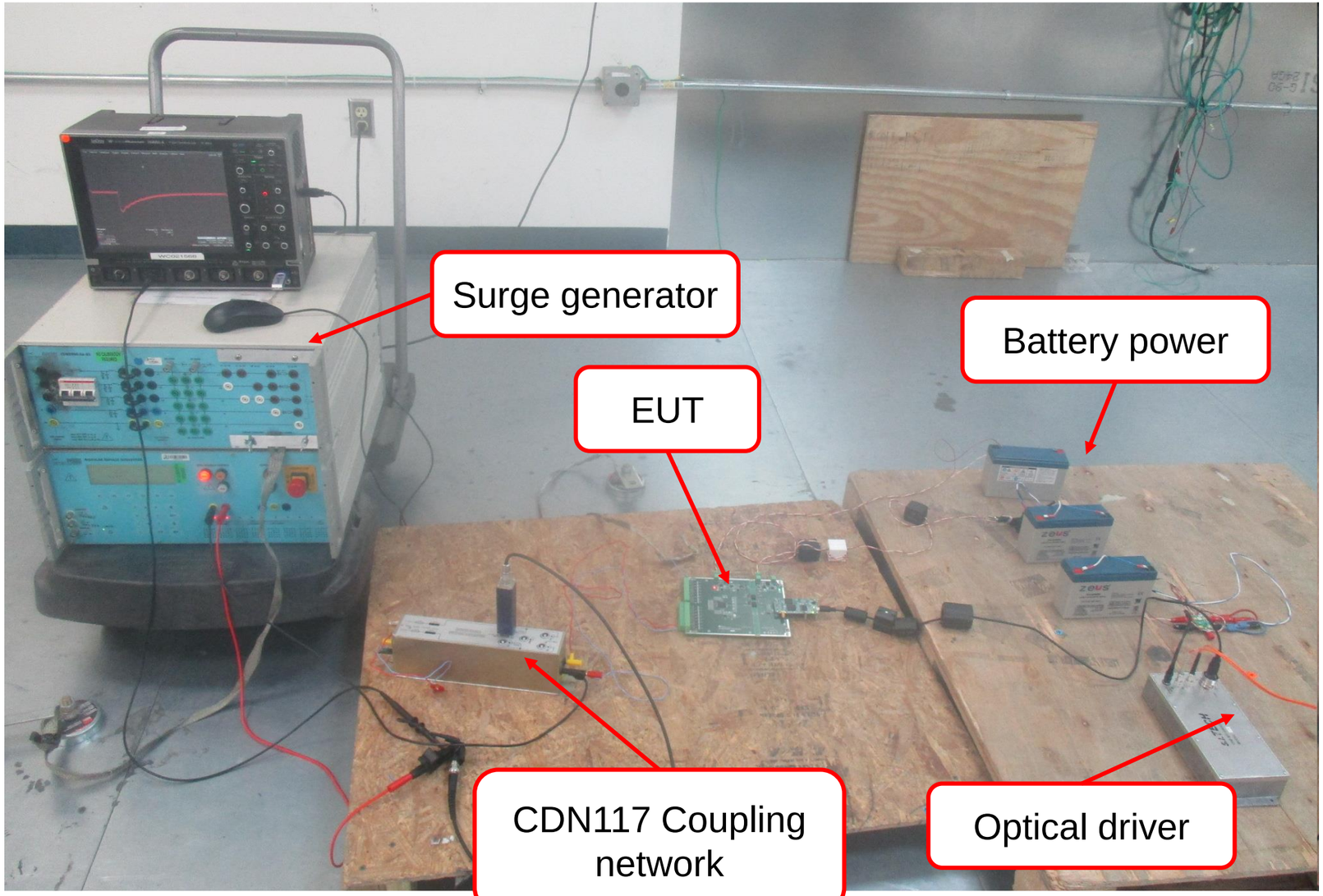


Table 3-3. Surge Test Result

Test	Standard	Type	Impedance	Test Voltage	Test Level	Criterion	Test Result
Surge	IEC 61000-4-5	Line-to-Line	42 Ω (2-Ω source impedance + 40 Ω from coupling network)	500 V	1	A	Pass
		Line-to-Ground	42 Ω (2-Ω source impedance + 40 Ω from coupling network)			B	Pass
		Line-to-Line	42 Ω (2-Ω source impedance + 40 Ω from coupling network)	1 kV	2	A	Pass
			2-Ω source impedance only(1)			B	Pass
		Line-to-Ground	42 Ω (2-Ω source impedance + 40 Ω from coupling network)			B	Pass
			2-Ω source impedance only(1)			B	Pass

(1) The test has a higher peak current (250 A for level 1 and 500 A for level 2) and is more aggressive than other tests in the table.

Surge IEC 61000-4-5



Thanks for your time!
Please try the quiz.

Quiz: EMC Compliance Testing

1. (True/False) The pulse duration for surge is longer than the pulse used in EFT, and surge emulates a lightning strike.
   a) True
   b) False

2. (True/False) TVS diodes, Schottky diodes, and gas discharge tubes are used to minimize the effects of radiated emissions.
   a) True
   b) False

Quiz: EMC Compliance Testing

3. Why is it common practice in EMC testing to use batteries for power, fiber optic communications, and ferrite beads on cables?
   a) These are requirements according to the IEC specifications.
   b) This helps protect the test equipment from damage and performance impact.

4. (True/False) The radiated emissions and radiated immunity test can use the same anechoic chamber, and antenna. The main difference is that the immunity test requires a signal generator and the emissions test requires a spectrum analyzer.
   a) True
   b) False

Thanks for your time!