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## ELECTROMAGNETIC COMPATIBILITY (EMC / EMI)

**TEST REPORT REF.** EMCKP3930A  
**PROJECT NO.** EMCK3930  
**DATE OF ISSUE** 2019-08-07

**REF. DOCUMENTS** MIL-STD-1275E: 22 March 2013  
CHARACTERISTICS OF 28 VOLT DC  
ELECTRICAL SYSTEMS IN MILITARY VEHICLES

**EQUIPMENT UNDER TEST (E.U.T.)** Project MOTS-Server

**TEST RESULTS** See test list on page 5

**CLIENT** Thales Suisse SA  
Binzstrasse 18  
8045 Zurich  
Switzerland

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1. TEST REPORT APPROVAL

Test performed by: Christoph Hauser, Head EMC-Testcenter 2019-05-28  
Name / Function Signature Date

Test performed by: Max Hunziker, GM Technics / QA 2019-07-17  
Name / Function Signature Date

Test report reviewed by: Christoph Hauser, Head EMC-Testcenter 2019-08-07  
Name / Function Signature Date

Test report approved by: Max Hunziker, GM Technics / QA 2019-08-07  
Name / Function Signature Date

REVISION INDEX

Document Number	Issue date	Replaces	No. of revised pages
EMCKP3930A	2019-08-07	---	---



2. REFERENCED REQUIREMENTS

The tests allowed to prove whether the EUT complies with characteristics of 28 Volt DC Electrical Systems in military vehicles.

3. CONFIGURATION OF TESTED EQUIPMENT

All tests were carried out at the Conducted Test Site.

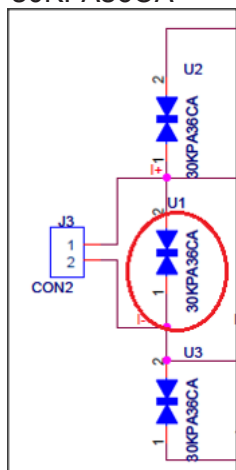
Electrical Device Under Test (EUT):

EUT:	Project MOTS-Server
SERIAL NO:	SR201903080101
TYPE:	HORUS200
OPERATION MODE:	Normal operation
TEST SETUP:	MIL-STD-1275E
SUPPORT EQUIPMENT:	MOTS-Server control software
POWER:	Fed by 28 VDC Power supply

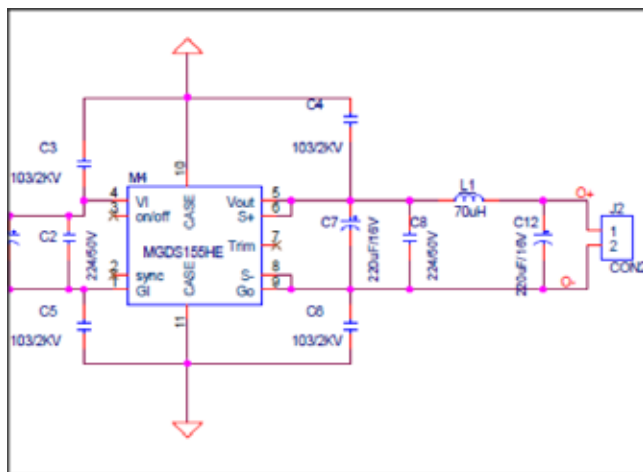
3.1 MODIFICATION INCORPORATED IN EUT

For the retest of the tests no. 5.1 and 5.2 (imported Voltage spikes and surges) the following modifications were implemented:

TVS-Diode 30KPA102CA instead of 30KPA36CA



Additional inductivity L1 (70 µH)



3.2 TEST CONDITIONS

Test conditions have been in accordance with "Referenced documents".

Temperature:	+26.0 °C	Requirement: +23 °C ± 5 °C
Relative Humidity:	49 %	Requirement: 0 % to 90 %
Atmospheric pressure:	965 hPa	Requirement: 800 hPa (800 mbar) to 1020 hPa (1020 mbar)

3.3 FUNCTIONAL TESTS

Functional tests and surveillance checked by software and measuring of disturbances at the power supply output by DOS.



4. SUMMARY OF TEST RESULTS / TEST LIST / WITNESSING

MIL-STD-1275E

TEST NO.	TEST	LEVEL / LIMIT	TEST DATE	PASSED	FAILED	COMMENTS
5.1	§ 5.1.2 Starting operation	Figure 6	2019-05-28	PASSED	-	-
5.2	§ 5.1.3.1.2 Emitted voltage spikes § 5.1.3.2.2 Voltage surges	Figure 7 Figure 8	2019-05-28 2019-05-28	PASSED PASSED	- -	- -
5.3	§ 5.1.3.1.1 Voltage spikes im-ported into EUT	Figure 3: ± 250 V / 100 kHz to 500 kHz	2019-07-17	PASSED	-	-
5.4	§ 5.1.3.2.1 Voltage surges im-ported into EUT	Figure 4: 100 V / 50 msec	2019-07-17	PASSED	-	-
5.5	§ 5.1.1.2 Voltage ripple	MIL-STD 461 / CS101 extended to 250 kHz	2019-05-28	PASSED	-	-

**Witnessing:**

Mr. Ignaz ACKERMANN, Thales Suisse SA  
Mr. Tommy GMÜNDER, Thales Suisse SA  
Mr. Reto SCHREPPERS, Thales Suisse SA  
Mr. Markus ARTHO, Thales Suisse SA

**Test date**

2019-05-28  
2019-05-28  
2019-07-17  
2019-07-17



5. TEST LIST

5.1 Starting operation according to MIL-STD-1275E, § 5.1.2

Para a) b) c)

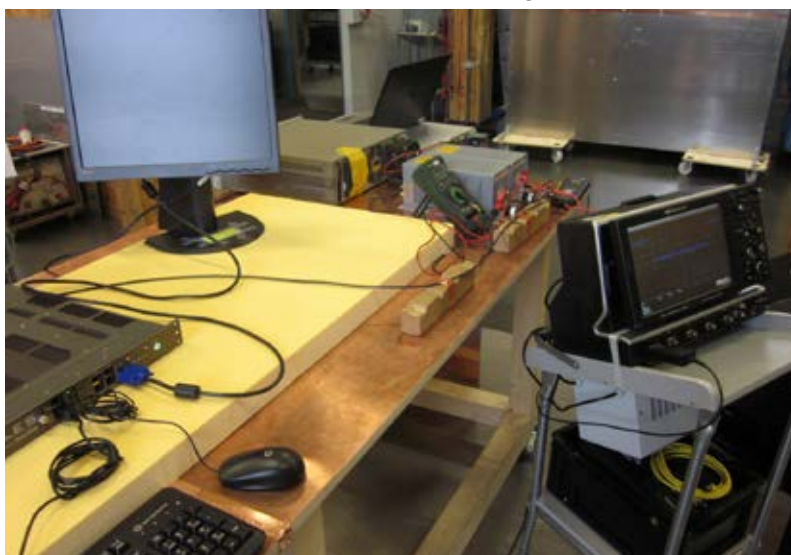
Inv. ID	Instrument	Manufacturer	Type	Date of Calibration	Due Date of Calibration
0278	Control Software	Argantix	KDCGui-KDC80-187	Cal not reqd	Cal not reqd
0277	DC Power Source	Argantix	KDC80-62-FT-400-IF	2018-06-08	2019-06-07
1155	Digital Storage Oscilloscope	Teledyne LeCroy	WR610ZI	2019-04-05	2020-04-05
0033	Differential Probe	Teledyne LeCroy	HVD3106	2019-03-13	2020-03-12

**Calibration procedures:**

The calibration routine is performed according to the requirements of Swiss Calibration Service (SCS) and manufacturers.

d) **Test setup**

In accordance with MIL-STD-1275E, § 5.1.2 Starting operation





- e) **Antenna Factors**  
Not applicable
  
- f) **Impedance of Line Impedance Stabilization Network (LISN)**  
Not applicable
  
- g) **Measured levels of emission**  
Not applicable
  
- h) **Recording and graphs**  
See appendix 1
  
- j) **Used suppression devices**  
None
  
- i) **Susceptibility compliance**  
See next page
  
- k) **Sample calculation**  
None
  
- l) **Success Criterion**  
Any deviation from normal operation, even an intermittent anomaly, such that it eventually returns to normal operation, shall be recognized as a failure of the EUT.



**Susceptibility compliance**

Engineer: Christoph Hauser

Date: 2019-05-28

Equipment nomenclature: Project MOTS-Server  
 Serial number: SR201903080101  
 Type: HORUS200

Test method: Standard MIL-STD-1275E

Type of measurement: Conducted

Measurement point: See paragraph d) 28 VDC Power line

Frequency range of test: Voltage dips

Operation mode: Normal operation

Description of test signal: In accordance with § 5.1.2, Figure 6

Test equipment used: In accordance with paragraph a), b), c)

Pulse form	Meets limits		Description of degradation	Max. test signal applied if not susceptible	Note
	Yes ?	No ?			
Steady State Voltage: 28 VDC I.E.S.: ≤ 12 VDC, Duration 1 sec Cranking Level ≤ 16 VDC: Duration 30 sec	Yes			12 / 16 VDC	





**5.2 Emitted voltage spikes according to MIL-STD-1275E, § 5.1.3.1.2  
Emitted voltage surges according to MIL-STD-1275E, § 5.1.3.2.2**

Para a) b) c)

Inv. ID	Instrument	Manufacturer	Type	Date of Calibration	Due Date of Calibration
1430	System Power Supply	HP	6032A	2019-05-13	2020-05-12
1155	Digital Storage Oscilloscope	Teledyne LeCroy	WR610ZI	2019-04-05	2020-04-05
0033	Differential Probe	Teledyne LeCroy	HVD3106	2019-03-13	2020-03-12
41	LISN	Rohde&Schwarz	ESH3-Z6	2019-01-14	2020-01-13
137	LISN	Rohde&Schwarz	ESH3-Z6	2019-01-14	2020-01-13

**Calibration procedures:**

The calibration routine is performed according to the requirements of Swiss Calibration Service (SCS) and manufacturers.





**e) Antenna Factors**

Not applicable

**f) Impedance of Line Impedance Stabilization Network (LISN)**

According to MIL-STD-1275E (5  $\mu$ H)

**g) Measured levels of emission**

Not applicable

**h) Recording and graphs**

See appendix 2

**j) Used suppression devices**

None

**i) Susceptibility compliance**

Not applicable

**k) Sample calculation**

None

**l) Success Criterion**

The voltage spikes of the 28 VDC power supply of the EUT shall not exceed the limit according to § 5.1.3.1.2, Figure 7:  $\pm 250$  V to 100 V at 1 msec.

The voltage surges of the 28 VDC power supply of the EUT shall not exceed the limit according to § 5.1.3.2.2, Figure 8: +100 V at 50 ms to 33 V at 500 msec to 1000 msec



### 5.3 Voltage spikes imported into EUT according to MIL-STD-1275E, § 5.1.3.1.1

Para a) b) c)

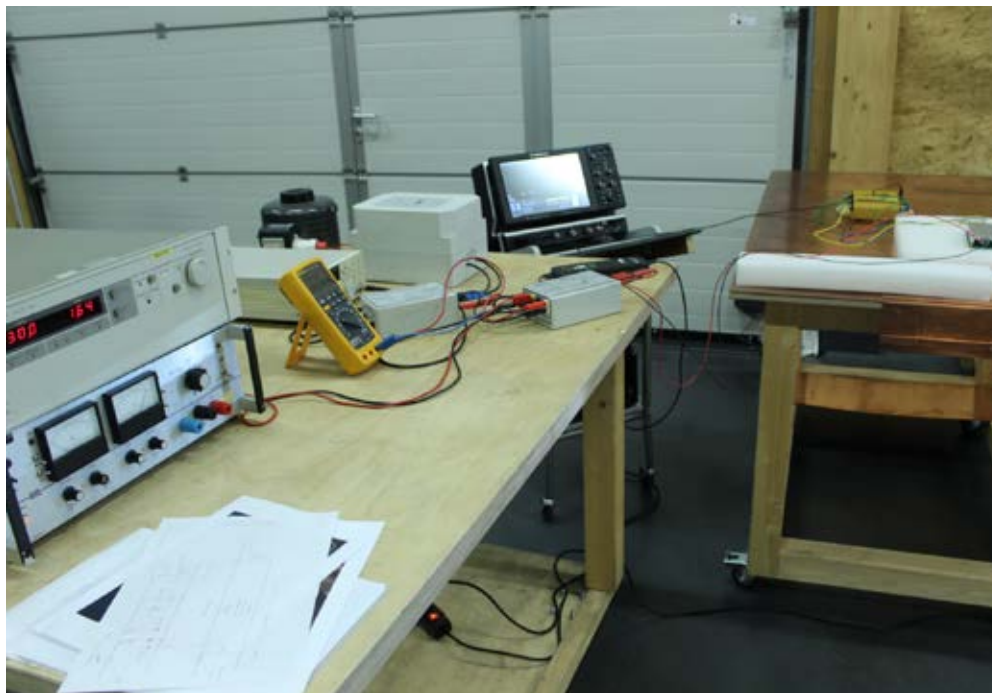
Inv. ID	Instrument	Manufacturer	Type	Date of Calibration	Due Date of Calibration
0280	Arbitrary Waveform Generator	Pragmatic	2416A	2019-05-06	2020-05-05
0064	Digital Multimeter	Fluke	89 IV	2019-04-04	2020-04-03
1155	Digital Storage Oscilloscope	Teledyne LeCroy	WR610ZI	2019-04-05	2020-04-05
0033	Differential Probe	Teledyne LeCroy	HVD3106	2019-03-13	2020-03-12
0405	Safety Transformer, Variac	Filec	2422 529 0007	2019-01-08	2020-01-07
0401	Test Box	EMC-Testcenter AG	Box „Imported Spike Test Circuit“	2019-01-08	2020-01-07
0402	Test Box	EMC-Testcenter AG	Box „High Voltage Supply“	2019-01-08	2020-01-07
0401	Test Box	EMC-Testcenter AG	Box „High Voltage Transformer“	2019-01-08	2020-01-07
1430	System Power Supply	HP	6032A	2019-05-13	2020-05-12

#### Calibration procedures:

The calibration routine is performed according to the requirements of Swiss Calibration Service (SCS) and manufacturers.

#### d) Test setup

In accordance with MIL-STD-1275E, § 5.3.3.1.1, Figure 9





**e) Antenna Factors**

Not applicable

**f) Impedance of Line Impedance Stabilization Network (LISN)**

Not applicable

**g) Measured levels of emission**

Not applicable

**h) Recording and graphs**

See appendix 3

**j) Used suppression devices**

None

**i) Susceptibility compliance**

See next page

**k) Sample calculation**

None

**l) Success Criterion**

The voltage spikes imposed according to § 5.1.3.1.1, Figure 7 shall not damage the EUT components nor affect the normal operation of the EUT. Any deviation from normal operation, even an intermittent anomaly, such that it eventually returns to normal operation, shall be recognized as a failure of the EUT.



Susceptibility compliance

Engineer: Max Hunziker
Date: 2019-07-17
Equipment nomenclature: Project MOTS-Server (only power supply used)
Serial number: SR201903080101
Type: HORUS200
Test method: Standard MIL-STD-1275E
Type of measurement: Conducted
Measurement point: See paragraph d) 28 VDC Power line
Frequency range of test: Voltage spikes
Operation mode: Normal operation
Description of test signal: In accordance with § 5.1.3.1.1, Figure 7: Voltage spike: ± 250V, tr=50ns, Min. 50 Spikes each polarity, 1 sec. interval, oscillating frequency between 100kHz ... 500kHz

Test equipment used: In accordance with paragraph a), b), c)

Table with 5 columns: Pulse form, Meets limits (Yes/No), Description of degradation, Max. test signal applied if not susceptible, Note. Row 1: Spike: tr=50ns, Osc, freq. 100 ... 500kHz, Yes, |, |, ± 250 V, ≥ 50 Spikes



**5.4 Voltage surges imported into EUT according to MIL-STD-1275E, § 5.1.3.2.1**

Para a) b) c)

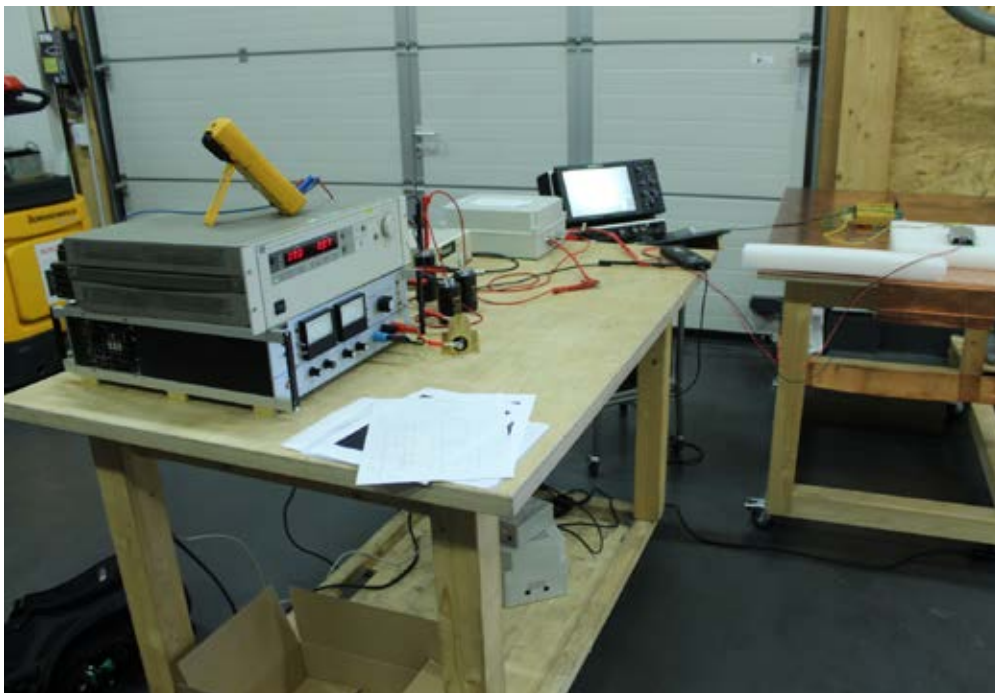
Inv. ID	Instrument	Manufacturer	Type	Date of Calibration	Due Date of Calibration
0280	Arbitrary Waveform Generator	Pragmatic	2416A	2019-05-06	2020-05-05
0064	Digital Multimeter	Fluke	89 IV	2019-04-04	2020-04-03
1155	Digital Storage Oscilloscope	Teledyne LeCroy	WR610ZI	2019-04-05	2020-04-05
0033	Differential Probe	Teledyne LeCroy	HVD3106	2019-03-13	2020-03-12
404	Test Box	EMC-Testcenter	Box „Imported Surge Test Circuit“	2019-01-08	2020-01-07
1430	System Power Supply, 60 V/50 A/1000 W	HP	6032A	2019-05-13	2020-05-12
1431	Power Supply, 70 V/10 A	Dr. K. Witmer	Model TG 70/20	2019-05-13	2020-05-12

**Calibration procedures:**

The calibration routine is performed according to the requirements of Swiss Calibration Service (SCS) and manufacturers.

**d) Test setup**

In accordance with MIL-STD-1275E, § 5.3.3.2.1 Figure 11.





**e) Antenna Factors**

Not applicable

**f) Impedance of Line Impedance Stabilization Network (LISN)**

Not applicable

**g) Measured levels of emission**

Not applicable

**h) Recording and graphs**

See appendix 4

**j) Used suppression devices**

None

**i) Susceptibility compliance**

See next page

**k) Sample calculation**

None

**l) Success Criterion**

The voltage surges imposed according to § 5.1.3.2.1, Figure 8, shall not damage the EUT components nor affect the normal operation of the EUT. Any deviation from normal operation, even an intermittent anomaly, such that it eventually returns to normal operation, shall be recognized as a failure of the EUT.





**Susceptibility compliance**

Engineer: Max Hunziker

Date: 2019-07-17

Equipment nomenclature: Project MOTS-Server (only power supply used)  
 Serial number: SR201903080101  
 Type: HORUS200

Test method: Standard MIL-STD-1275E

Type of measurement: Conducted

Measurement point: See paragraph d) 28 VDC Power line

Frequency range of test: Surges

Operation mode: Normal operation

Description of test signal: In accordance with § 5.1.3.2.1, Figure 8: Voltage surge: +100 V, 50 ms duration, 5 Surges with 5 sec. delay between pulses

Test equipment used: In accordance with paragraph a), b), c)

Pulse form	Meets limits		Description of degradation	Max. test signal applied if not susceptible	Note
	Yes ?	No ?			
Surge 50 ms	Yes			+100V	≥ 5 Surges





**5.5 Voltage ripple according to MIL-STD-1275E, § 5.1.1.2**

Para a) b) c)

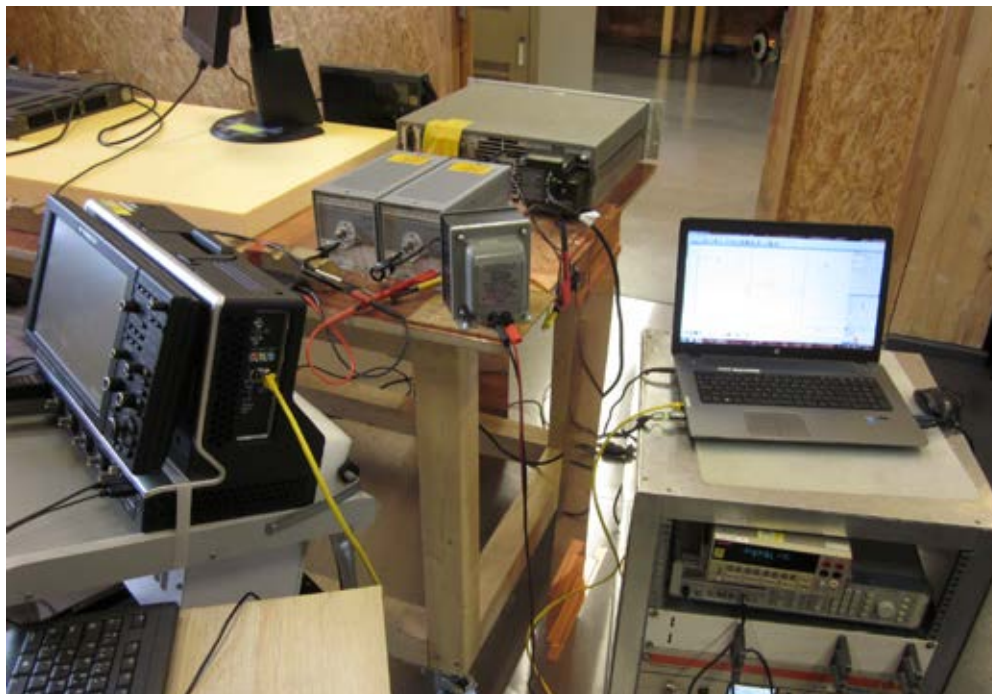
Inv. ID	Instrument	Manufacturer	Type	Date of Calibration	Due Date of Calibration
1242	Susceptibility Software (CTS-S)	Rohde&Schwarz	EMC32 v10.20	Cal not reqd	Cal not reqd
438	Audio-Signal Generator	Rohde&Schwarz	APN06	2018-11-14	2019-11-13
353	Audio Amplifier	Amplifier Research	350AH1	2019-03-11	2020-03-10
140	Audio Isolation Transformer	Solar Electronics Co.	6220-1A	2019-05-03	2020-05-02
1155	Digital Storage Oscilloscope	Teledyne LeCroy	WR610ZI	2019-04-05	2020-04-05
0033	Differential Probe	Teledyne LeCroy	HVD3106	2019-03-13	2020-03-12
1430	System Power Supply	HP	6032A	2019-05-13	2020-05-12
41	LISN	Rohde&Schwarz	ESH3-Z6	2019-01-14	2020-01-13
137	LISN	Rohde&Schwarz	ESH3-Z6	2019-01-14	2020-01-13

**Calibration procedures:**

The calibration routine is performed according to the requirements of Swiss Calibration Service (SCS) and manufacturers.

**d) Test setup**

In accordance with MIL-STD 461 CS101.





- e) **Antenna Factors**  
Not applicable
  
- f) **Impedance of Line Impedance Stabilization Network (LISN)**  
According to MIL-STD-1275E
  
- g) **Measured levels of emission**  
Not applicable
  
- h) **Recording and graphs**  
See appendix 5
  
- j) **Used suppression devices**  
None
  
- i) **Susceptibility compliance**  
See next page
  
- k) **Sample calculation**  
None
  
- l) **Success Criterion**  
The ripple voltage imposed according to MIL-STD 461 Figure CS101-1, Curve no. 2 and CS101-2 with the same values used at 150 kHz extended to 250 kHz shall not damage the EUT components nor affect the normal operation of the EUT. Any deviation from normal operation, even an intermittent anomaly, such that it eventually returns to normal operation, shall be recognized as a failure of the EUT.



**Susceptibility compliance**

Engineer: Christoph Hauser  
Date: 2019-05-28  
Equipment nomenclature: Project MOTS-Server  
Serial number: SR201903080101  
Type: HORUS200  
Test method: Standard MIL-STD-1275E, § 5.1.1.2  
Type of measurement: Conducted  
Measurement point: See paragraph d) 28 VDC Power line  
Frequency range of test: 30 Hz to 250 kHz  
Operation mode: Normal operation  
Description of test signal: In accordance with MIL-STD 461 Figures CS101-1, Curve no. 2 and CS101-2 with the same values used at 150 kHz extended to 250 kHz.  
Test equipment used: In accordance with paragraph a), b), c)

Frequency	Meets limits		Description of degradation	Max. test signal applied if not susceptible	Note
	Yes ?	No ?			
30 Hz - 5 kHz	Yes			126 dB $\mu$ V	
5 kHz - 150 kHz	Yes			126 - 96.5 dB $\mu$ V	
150 kHz - 230 kHz	Yes			96.5 dB $\mu$ V	



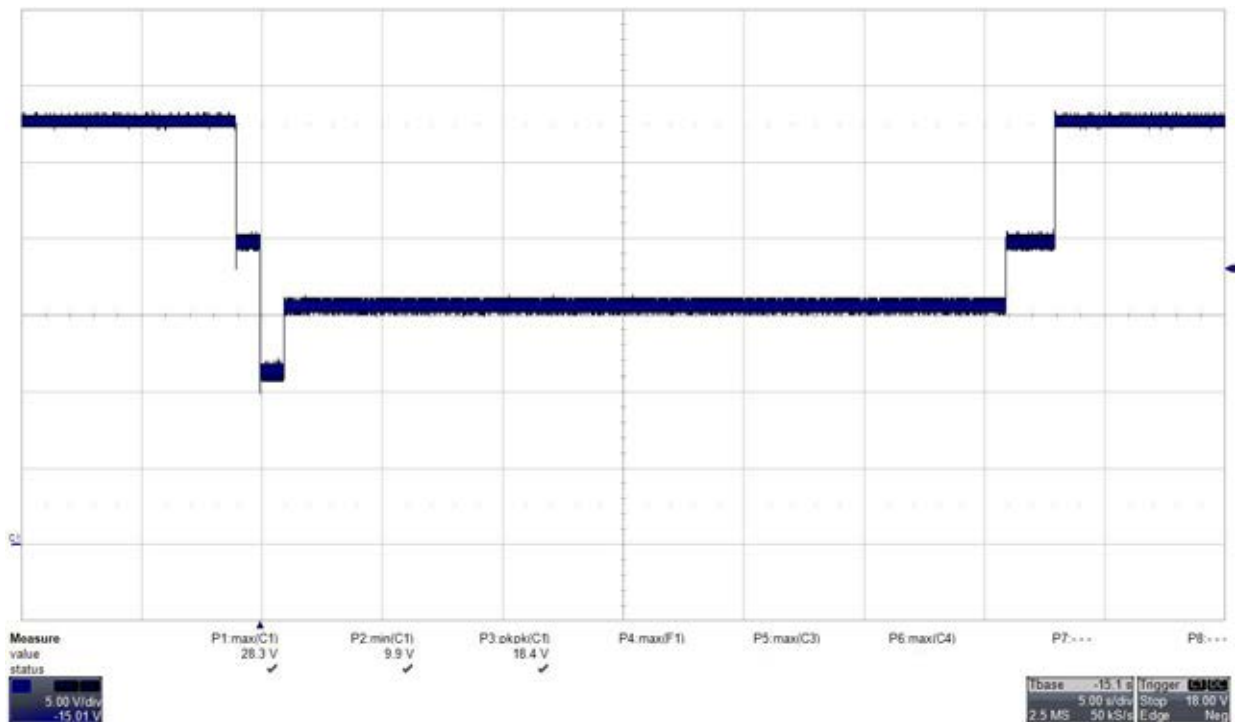
## 6. Appendices



# Appendix 1

Starting operation according to MIL-STD-1275E, § 5.1.2 Figure 6

- 1 DIAGRAM



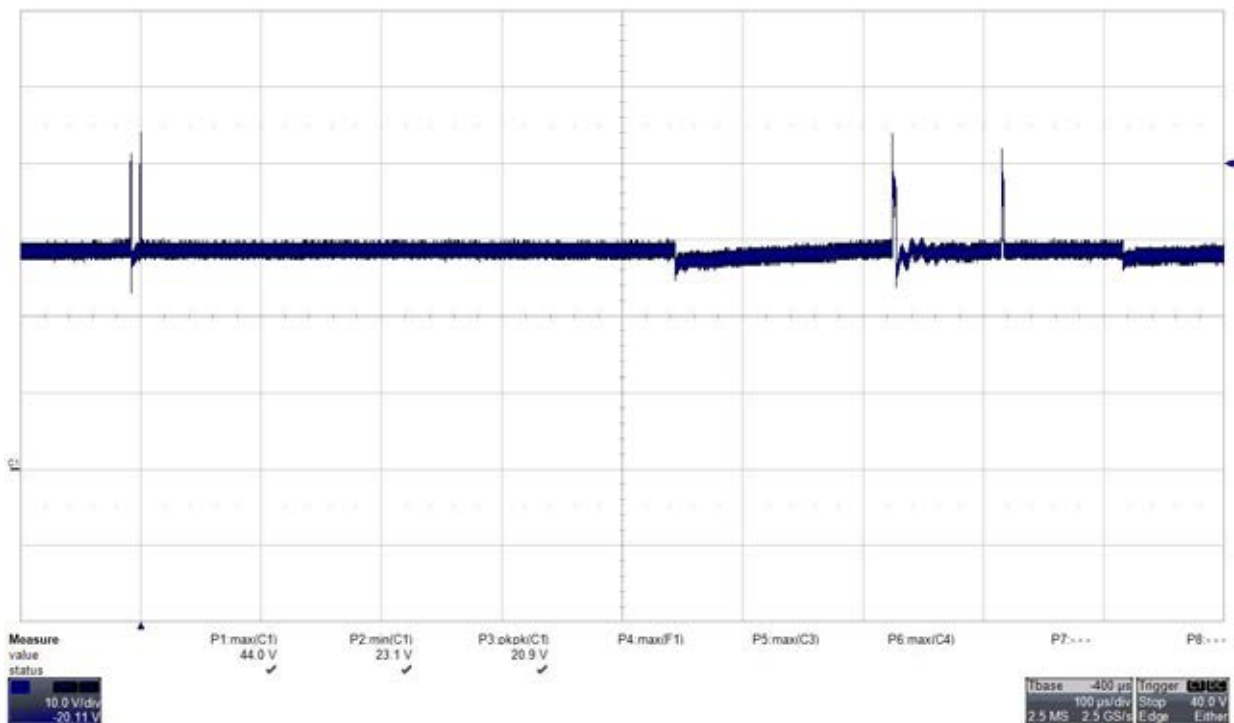
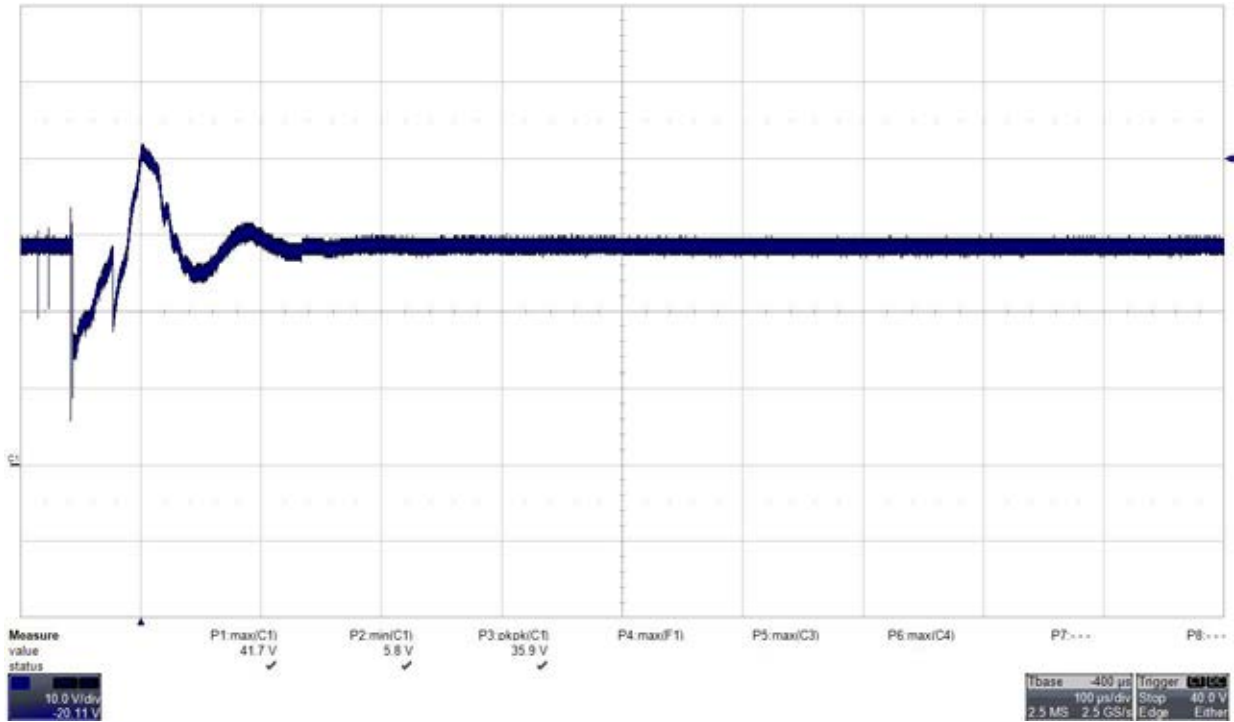


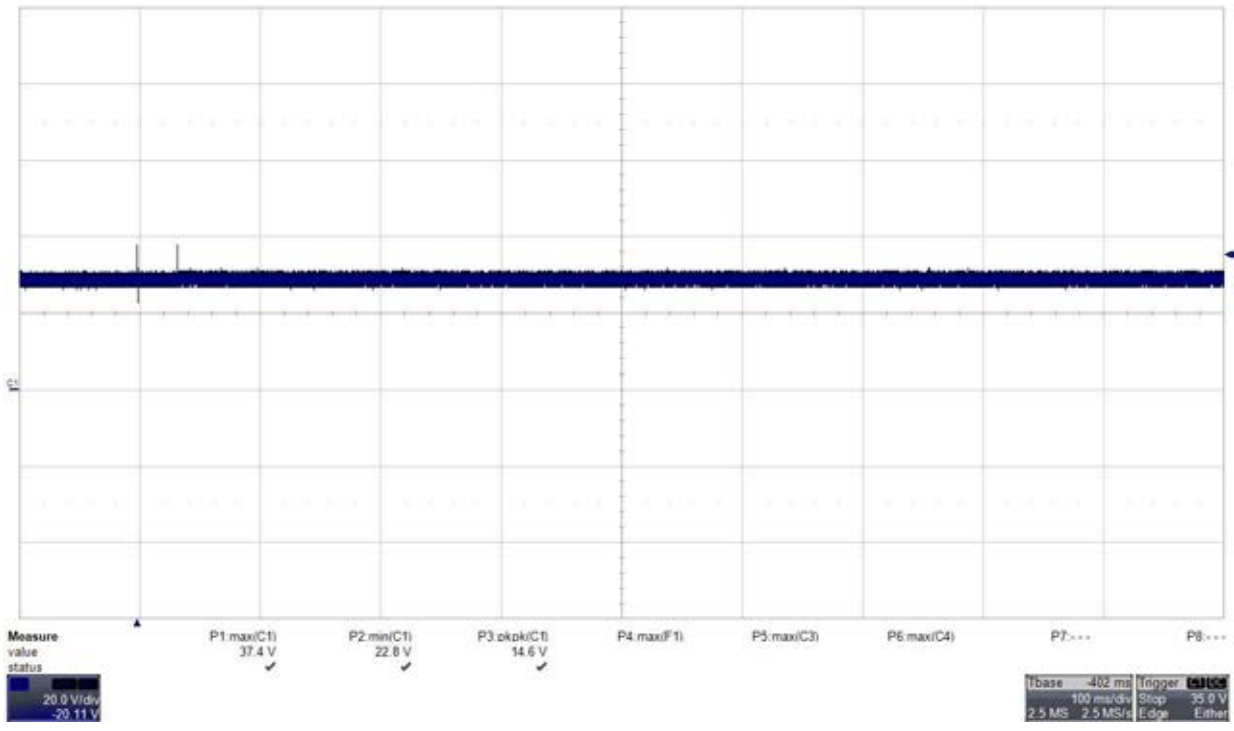
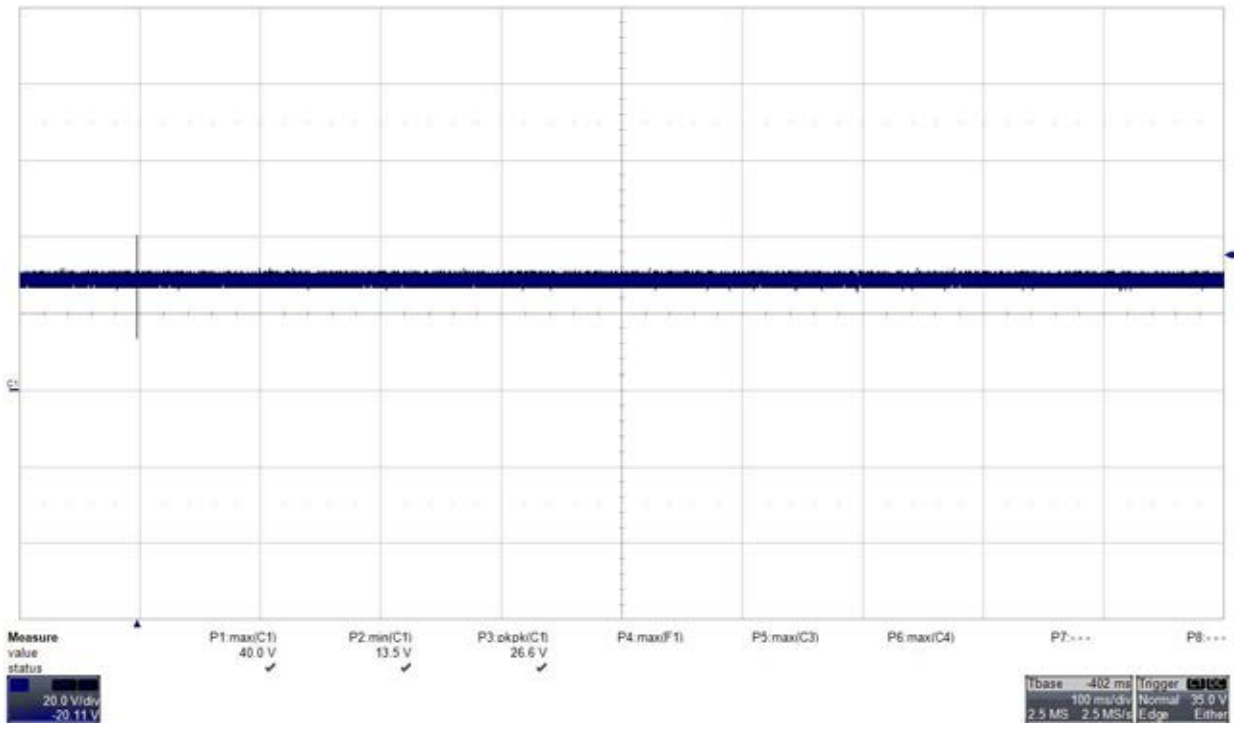
## Appendix 2

Emitted voltage spikes according to MIL-STD-1275E, § 5.1.3.1.2 Figure 7

Emitted voltage spikes according to MIL-STD-1275E, § 5.1.3.2.2 Figure 8

- 4 DIAGRAMS





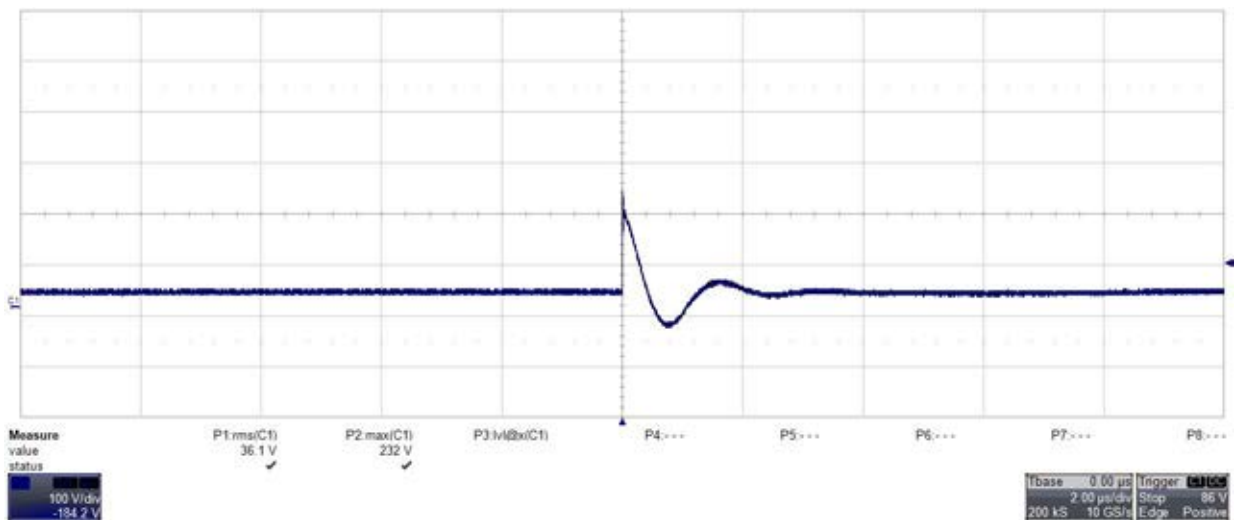


### Appendix 3

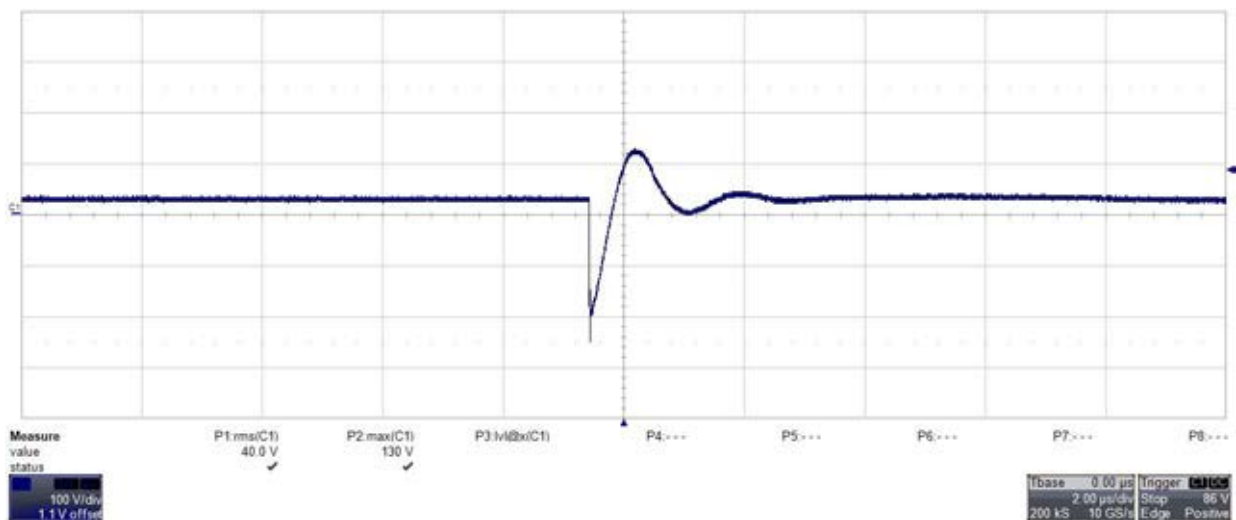
Voltage spikes imported into EUT according to MIL-STD-1275E, § 5.1.3.1.1

2 DIAGRAMS

#### Injection of positive Pulse



#### Injection of negative Pulse





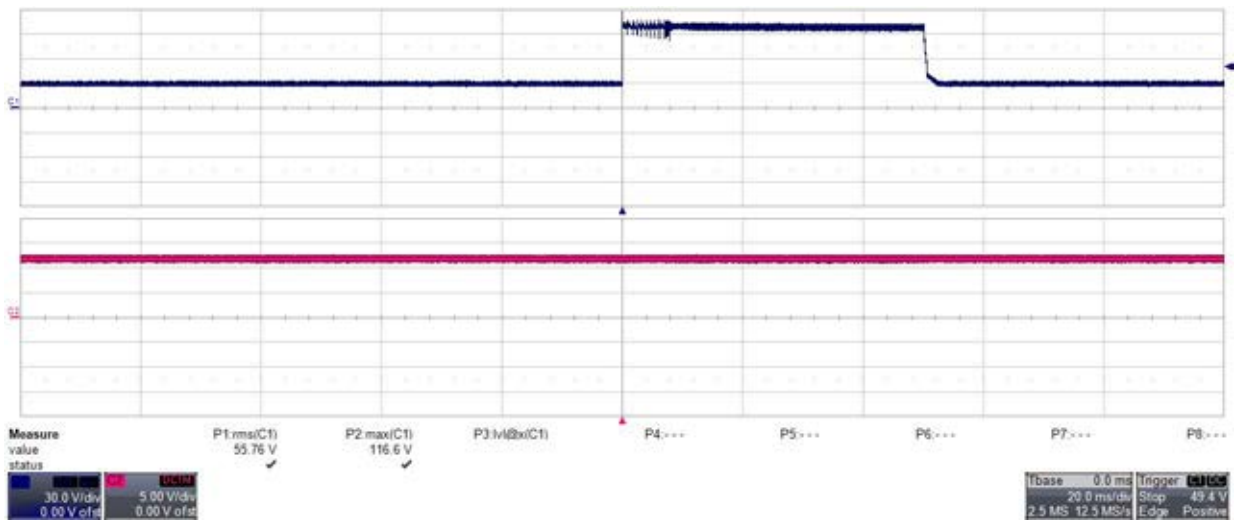


## Appendix 4

Voltage surges imported into EUT according to MIL-STD-1275E, § 5.1.3.2.1

1 DIAGRAM

Injection of voltage surge, surveillance of output voltage of EUT





## **Appendix 5**

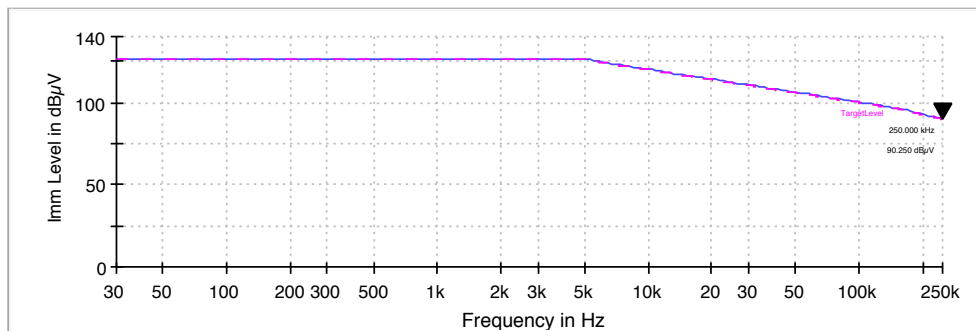
**Voltage ripple according to MIL-STD-1275E, § 5.1.1.2**

2 DIAGRAMS



### Common Information

Customer: Thales Suisse SA, 8045 Zürich / SWITZERLAND  
 E.U.T.: HORUS200  
 Operating Conditions: Powered with 23 VDC  
 Standard: MIL-STD-1275E, (MIL-STD-461F, CS101, 30 Hz - 250 kHz, Curve #2)  
 Injection point: Power Input 23 VDC  
 Test facility: CTS  
 Engineer: Christoph Hauser  
 Project ID: EMCK3930



### EMS Scan Template: CS\_MIL-STD461F\_CS101\_DC\_30Hz-150kHz [EMS Conducted]

Hardware Setup: EMS conducted\CS\_MIL-STD461F\_CS101\_30-150kHz  
 EMC Test Standard: Automotive/MIL

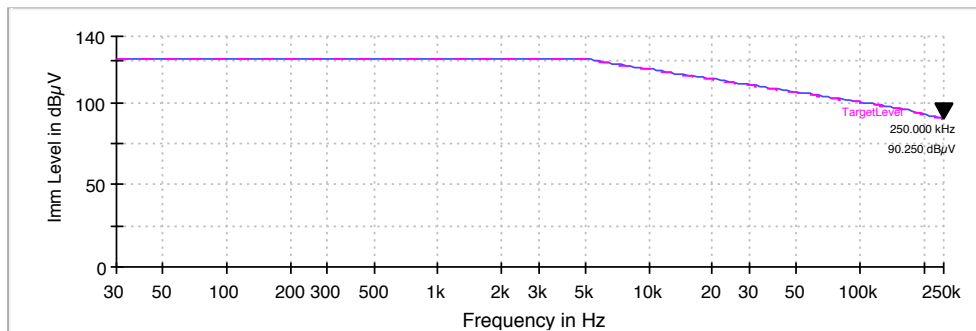
General Settings:  
 Immunity Level Unit: dBµV  
 AM Level Conservation: CW-Carrier = AM-Carrier  
 Level On: Substitution Method: EMS Conducted\CAL\_MIL-STD\_CS101 Curve 2\_Gain 40 P  
 Power Control: Generator Level : Measure Power Levels

Excluded Frequency Bands:  
 Subrange 1:  
 Frequency Subrange: 30Hz - 250kHz  
 Step Size: 5% LOG  
 Immunity Shape Table: CONDUCTED\Immunity Shape\MIL-STD461F\_CS101\_CURVE 2\_30-150kHz  
 Modulation: Modulation Off  
 Dwell Time: 1s  
 Level Shift: 0dB



### Common Information

Customer: Thales Suisse SA, 8045 Zürich / SWITZERLAND  
E.U.T.: HORUS200  
Operating Conditions: Powered with 30VDC  
Standard: MIL-STD-1275E, (MIL-STD-461F, CS101, 30 Hz - 250 kHz, Curve #2)  
Injection point: Power Input 30VDC  
Test facility: CTS  
Engineer: Christoph Hauser  
Project ID: EMCK3930



### EMS Scan Template: CS\_MIL-STD461F\_CS101\_DC\_30Hz-150kHz [EMS Conducted]

Hardware Setup: EMS conducted\CS\_MIL-STD461F\_CS101\_30-150kHz  
EMC Test Standard: Automotive/MIL

General Settings:  
Immunity Level Unit: dBµV  
AM Level Conservation: CW-Carrier = AM-Carrier  
Level On: Substitution Method: EMS Conducted\CAL\_MIL-STD\_CS101 Curve 2\_Gain 40 P  
Power Control: Generator Level : Measure Power Levels

Excluded Frequency Bands:  
Subrange 1:  
Frequency Subrange: 30Hz - 250kHz  
Step Size: 5% LOG  
Immunity Shape Table: CONDUCTED\Immunity Shape\MIL-STD461F\_CS101\_CURVE 2\_30-150kHz  
Modulation: Modulation Off  
Dwell Time: 1s  
Level Shift: 0dB

dBµV