HMT7748R4 - EMC Report

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1 Introduction

This document serves to provide a test reference for EMC measurements performed on the HMT7748B GENIE IO-Link DEVICE DUAL PHY. Testing is intended to be focused on the performance of the HMT7748B only, and not the EM142A demonstrator module, but by performing tests in this way a reference sensor module is also established.

1.1 References

[1] **IO-Link Communication Specification, Version 1.1.2** October 2015

[2] **IEC 60947-5-2 Low-voltage switchgear and control gear** Part 5-2: Control circuit devices and switching elements – Proximity switches

[3] **Electrical switching relays**, reference: CEI/IEC 60255-5:2000 Electrical relays Part 5: Insulation coordination for measuring relays and protection equipment
Requirements and tests

[4] **Electrical equipment for measurement, control and laboratory use** - EMC requirements - Part 1: General requirements. Reference IEC 61326-1

[5] **Electrostatic discharge immunity test,** reference IEC 61000-4-2

[6] **Radiated, radio-frequency, electromagnetic field immunity test**, reference IEC 61000-4-3

[7] **Electrical fast transient/burst immunity test,** reference IEC 61000-4-4

[8] **Surge immunity test,** reference IEC 61000-4-5

[9] **Immunity to conducted disturbances, induced by radio-frequency fields,** reference IEC 61000-4-6

[10] **Power frequency magnetic field immunity test,** reference IEC 61000-4-8

[11] **Industrial communication networks - Fieldbus specifications** - Part 2: Physical layer specification and service definition, reference IEC 61158-2

[12] **HMT7748 GENIE IO-Link DEVICE DUAL PHY,** datasheet

2 Test Information

Tester:	R.D.Edgerley
File:	HMT77484_VALIDREPORT_EMC_revA.pdf
Test period:	20 Aug 2019 24. Oct 2019, Nov 2019
Test sample:	HMT77484 GENIE IO-LINK DEVICE DUAL PHY
Test hardware:	EM141A GENIE Explorer II [Demonstrator]
Test hardware revision:	0
Test software revision:	HMT IO-Link ministack 1.0.3 EMC App (Multi Byte, 38.4 & 230.4kBaud)
Test hardware sample ID:	EMC01, EMC02, EMC03, EMC04
Test requirement:	IEC 61326-1
Test specification:	IEC 61000-4-2 (2001-04) IEC 61000-4-3 (2008-04) IEC 61000-4-4 (2004-07) IEC 61000-4-5 (2005-11) IEC 61000-4-6 (2006-05) IEC 61000-4-8 (2001-03)
Last modification:	**8 June 2020**

3 Test vehicle

The test vehicle, seen in Fig. 1, is an EM142A IO-Link sensor demonstrator module from HMT, placed inside a metallic housing. The sensor and its M8 connector are electrically isolated from the housing via shrink wrap, thereby ensuring potential damage to the device (both HMT7748 and EM141A) does not occur due to a high voltage discharge between the housing and the PCB.

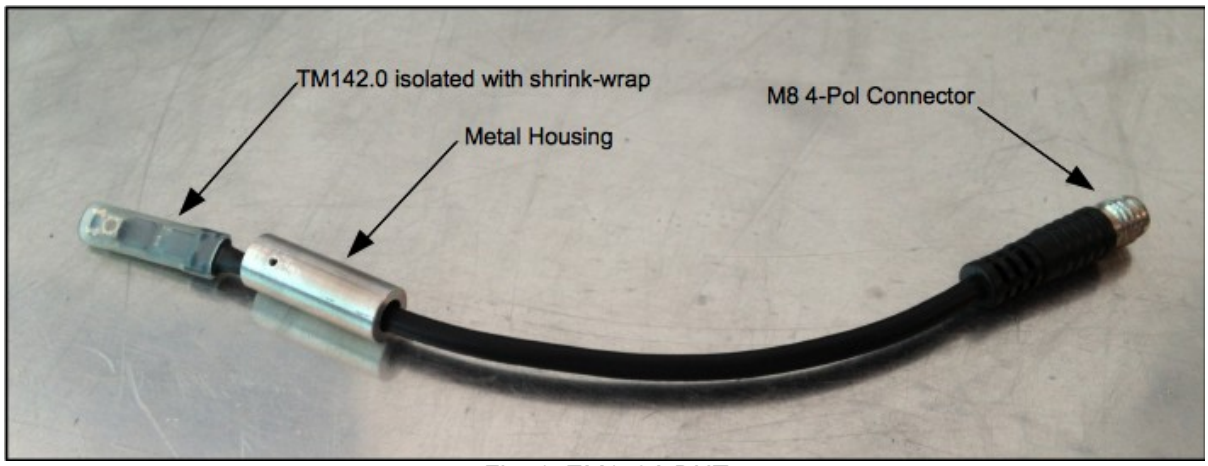

Fig. 1: EM142A DUT

The device is configured as a sensor in push-pull configuration, where a potentiometer (analogue stimulus) is

used to switch the output state once the pre-defined input threshold level as been reached. A push-button switch (digital stimulus) has also been implemented with a similar set-up to the potentiometer, as a simple means of verifying that the device output stage is functional.

The device is operating at 3.3V (pin V5V floating) and the DCDC converter is enabled. A complete list of components used in the testing, along with the default configuration of the DUT, can be found in Table 1 and Table 2.

3.1 EMC test, default external components

Unless otherwise stated, each DUT has the following external components (see [12])

Component	Comment	Value	Unit
C_{V3V3}	Lin. Reg. capacitor	4.7	µF
C_{V5V}	Lin. Reg. capacitor	4.7	µF
C_{DOUT}	Stabilisation capacitor	10	nF
C_{DCDC}	DCDC Reg. capacitor	2.2	µF
L_{DCDC}	DCDC Reg. capacitor	220	µH
C_{BLK}	Blocking capacitor on VPLUS	220	nF
C_{EMC_CQ}	EMC blocking capacitor on CQ	470	pF
C_{EMC_DIO}	EMC blocking capacitor on DIO	470	pF
† R_{LOAD_HS}	Load across CQ or DIO high-side switch	220 (160mA @ 35V)	Ω
† External load connected between the VPLUS and CQ (or DIO) lines.			

Table 1: External components (HMT7748 specific only)

3.2 Default state of device at start-up

Unless otherwise states, each DUT has the following configuration at start-up:

Setting	Comment	Value	Unit
Supply	Test supply voltage on VPLUS	35	V
Sensor	device configuration	SIO push-pull	-
Baud rate	IO-Link communication baud rates	38.4/230.4 (COM2/COM3)	kBd
Cycle Time	IO-Link communication cycle time	3	ms
M-Sequence	M-Sequence configuration	TYPE_2_V (1in/1out,1 on-demand)	-
Output state 1	CQ channel	low (low-side-switch = '1')	-
Output state 2	DIO channel	low (low-side-switch = '1')	-
Load (SIO only)	Load across output channel high-side switch	160	mA
V5V	5V regulator output	floating	-
VDIG	Digital supply voltage	3.3	V
V_{POT_THRESH}	Potentiometer value at which output switches state from LS='1' to HS='1'	80	hex
V_{POT_SET}	Potentiometer set value. (0.2V below V_{POT_THRESH})	41	hex
Push-button	Digital sensor stimulus	low	-
DCDC:FSET	DCDC regulator frequency	1	MHz

DCDC:VSET	DCDC target output (default)	8.6	V
CCTL:SCT	Short-circuit thresholds	190	mA
LED	Current controlled LED's	Active	-

Table 2: Device default state at start-up

4 Test conditions

The device is tested with the housing connected in two configurations (1) earthed and (2) floating. In the case where it is floating, the housing is discharged between test impulses.

The DUT is placed 10cm above refGND for all measurements.

Temperature: 24.2°C, Relative Humidity: 33%, Pressure 1008 hPa - Unless otherwise stated.

4.1 SIO Mode

The EM142A is connected with unshielded (IO-Link standard) cable of various lengths (test specific) and a decoupled power supply. Where output signals are to be monitored for transitions >1ms (e.g. EFT), a decoupled oscilloscope is used.

4.2 IO-Link Mode

The EM142A is connected with unshielded (IO-Link standard) cable of 20m to a MESCO EMC Test Master and COM mode interface box (see Fig. 2).

The EMC Master test tool consists of a hand-held unit and various interchangeable interface modules for the different communication rates (COM1-COM3). Operating state, error counters and baud rates are displayed via dual LED and LCD displays.

Fig. 2: MESCO EMC Test master

4.3 Performance criteria

Sections 4.3.1 and 4.3.2 outline the different performance criteria required for both SIO and IO-Link tests. The applicable criteria is test-specific, and will be defined at the start of each test in this document. The required EMC tests to be performed on the device as required by IO-Link operation, defined by [1], are listed in Table 1.

4.3.1 SIO Mode

Criteria A (IEC 61326-1): During the test, normal performance within specification limits. No switching allowed.

Criteria B (IEC 61326-1): During testing, temporary degradation, or loss of function or performance which is self-recovering. The measured value may exceed the tolerances. After testing, normal performance within the given tolerances is required.

4.3.2 IO-Link Mode

The following information is an extract from the IO-Link communication specification V1.1.1. See [1] for further details.

Criteria A: The SDCI operating at an average cycle time as specified in Table 3, shall not show more than six detected M-sequence errors within the number of M-sequences given in Table 3. No interruption of communication is permitted.

Transmission rate [kbit/s]	Device		Maximum Number of M-Sequence errors (see Note 2)
	t_{cyc} [T_{BIT}]	Number of M-Sequences of Type_0 read (4 octets). (see Note 1)	
38.4	100 (2.61ms)	500 (10'000)	6
230.4	100 (0.44ms)	800 (16'000)	6
Note 1: The numbers of M-sequences are calculated according to the algorithm in (2) and rounded up. The larger number of M-sequences (in brackets) are required if a certain test (for example fast transients/ burst) applies interferences only with a burst/cycle ratio (see Table 1) Note 2. The maximum number of M-Sequence errors will be referred to as 'IF' (Interfered Frames) or 'MF' (Missed Frames) in this document. If both IF and MF error occur in a transmission, the sum of the two will be used to as the maximum number of M-Sequence errors detected.			

Table 3: EMC Test conditions for SDCI

The performance criteria A in Table 3 is derived from requirements specified in [1] in respect to interference susceptibility and error rates (citation; "*frames"* translates into "messages" within this standard):

- *Only 1 undetected erroneous frame in 20 years at 1'600 frames/s*
- *The ratio of undetected to detected frames shall not exceed 10^{-6}*
- *EMC tests shall not show more than 6 erroneous frames within 100'000 frames*

With SDCI, the first requirement transforms into the equation (1). This equation allows determining a value of BEP. The equation can be resolved in a numerical way.

$$F20 \cdot R(BEP) \leq 1 \quad \text{.....(1)}$$

Where:

F20 = *Number of messages in 20 years*

R(BEP) = *Residual error probability of the checksum and parity mechanism*

BEP = *Bit error probability*

The objective of the EMC test is to prove that the BEP of the SDCI communication meets the value determined in the first step. The maximum number of detected perturbed messages is chosen to be 6 here for practical reasons. The number of required SDCI test messages can be determined with the help of equation (2) and the value of BEP determined in (1).

$$NoTF \geqslant \frac{1}{BEP} \cdot \frac{1}{BitPerF} \cdot NopErr \quad \text{.....(2)}$$

Where:

NoTF = *Number of test messages*

BitPerF = *Number of bit per message*

NopErr = *Maximum number of detected perturbed messages = 6*

Equation (2) is only valid under the assumption that messages with 1 bit error are more frequent than messages with more bit errors. An M-sequence consists of two messages. Therefore, the calculated number of test messages has to be divided by 2 to provide the numbers of M-sequences for Table 3.

Criteria B: The error rate of criteria A shall also be satisfied after but not during the test. No change of actual operating state (e.g. permanent loss of communication) or stored data is allowed.

4.4 Required immunity tests for IO-Link

Table 4 specifies the EMC tests to be performed.

Phenomena	Test Level	Performance criteria	Constraints
Electrostatic discharges (ESD) IEC 61000-4-2	Contact discharge: ± 4 kV	B	See Note 1
Radio-frequency electromagnetic field. Amplitude modulated IEC 61000-4-3	80 MHz – 1 000 MHz 10 V/m 1 400 MHz – 2 000 MHz 3 V/m 2 000 MHz – 2 700 MHz 1 V/m	A	See Note 1 and Note 2
Fast transients (Burst) IEC 61000-4-4	± 1 kV	A	5 kHz only. The number of M-sequences in Table 2 shall be increased by a factor of 20 due to the burst/cycle ratio 15 ms/300 ms. See Note 3
	± 2 kV	B	
Surge IEC 61000-4-5	Not required for an SDCI link (SDCI link is limited to 20 m)		-
Radio-frequency common mode IEC 61000-4-6	0,15 MHz – 80 MHz 10 VEMF	A	See Note 2 and Note 4

Note 1: As this phenomenon influences the entire device under test, an existing device specific product standard takes precedence over the test levels specified here.

Note 2: The test shall be performed with a step size of 1% and a dwell of 1s. If a single M-sequence error occurs at a certain frequency, that frequency shall be tested until the number of M-sequences according to Table 2 has been transmitted or until 6 M-sequence errors have occurred.

Note 3: Depending on the transmission rate the test time varies. The test time shall be at least one minute (with the transmitted M-sequences and the permitted errors increased accordingly).

Note 4: This phenomenon is expected to influence most probably the DUTs internal analog signal processing and only with a very small probability the functionality of the SDCI communication. Therefore an existing device specific product standard takes precedence over the test levels specified here.

Table 4: EMC Test levels according to [1]

5 HMT7748 - EMC measurement results

5.1 Electrical Fast Transients (Burst)

5.1.1 *Relevant standard and interpretation*

IEC 61000-4-4

For the purposes of this standard, the four wire cable to the device has to be considered as a power cable, rather than a data cable, as at least two of the conductors, GND and VPLUS are potentially exposed to inductive switching events. The CQ conductor is only directly exposed to disconnection of its own load, but has a large capacitive coupling to the other conductors. The ±2kV limit is applicable, level 3, "typical industrial environment."

For pure IO-Link communication the conductors are considered as data cables, and the ±1kV level is required.

5.1.2 *Waveform characteristic*

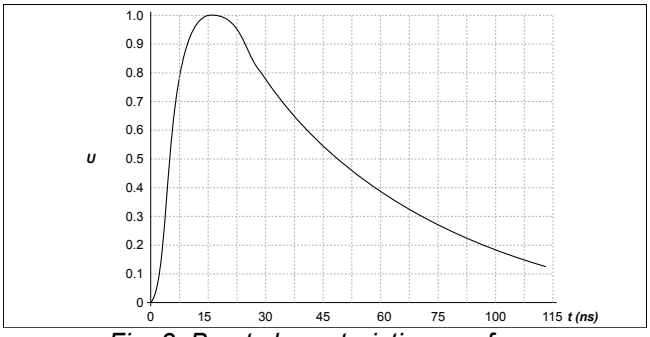

Fig. 3: Burst characteristic waveform

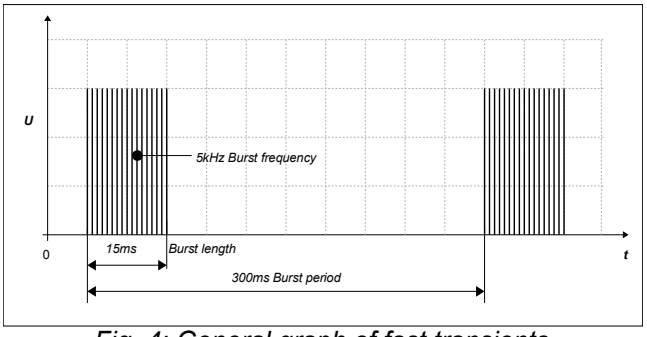

Fig. 4: General graph of fast transients

5.1.3 *Set-up*

5.1.4 *Equipment used*

Equipment used in IO-Link Mode	Equipment used in SIO Mode
• Voltcraft VLP 2403pro PSU	• Agilent 546A Oscilloscope
• Schlöder SFT 1400	• EM-Test EFT 503
• MESCO EMC Test Master	• EA-PS2332-052 PSU

Table 5: Equipment list – Burst

5.1.5 *Applied test procedure*

±500V - ±4kV, burst of 15ms at 5kHz with a period of 300ms. Test time for each polarity and voltage is 60 seconds for SIO mode, and 120 seconds for IO-Link mode.

A test time of 120 seconds, an M-Sequence of type 2.5 and a min cycle time of 3ms, results in a total of 130'000 IO-Link telegrams exchanged between the EMC test master and the device.

5.1.6 *Applied performance criteria*

In SIO mode the switch input of the EM142A is set in both open and closed states, and the output on the CQ line is monitored with a suitably decoupled oscilloscope.

In IO-Link mode, the device is monitored with the MESCO EMC Test Master, checking for the successful exchange of data throughout testing.

Reference	Mode	Test level	Applicable Performance Criteria	Comment
[1]	IO-Link	±1kV	A	Measured error rates at COM2 and COM3
		±2kV	B	Functional after stimulus
[2]	SIO	±2kV	B	Disturbance of output not exceeding 1ms

Table 6 Burst performance criteria

5.1.7 Test results

Housing	Polarity	SIO Mode		IO-Link Mode (COM2/COM3)			Device ID
		Reached (B) [kV]	Highest Test [kV]	Reached (A) [kV]	Reached (B) [kV]	Highest Test [kV]	
Earthed	+	4.0	4.0	1.0	4.0	4.0	EMC01,4
	-	4.0	4.0	1.0	4.0	4.0	EMC01,4
Floating	+	4.0	4.0	1.0	4.0	4.0	EMC01,4
	-	4.0	4.0	1.0	4.0	4.0	EMC01,4
At 38.4kBaud (tCYC=2.61ms), the worst case pass (i.e. highest number if IF's detected) was found to be at ±2kV for both earth connected and floating. The number of IF's detected in 130'000 telegrams in this case was 8, which, according to Table 2, equates to < 1 IF's for every 16'000 telegrams sent. This is well below the permitted number of 6. Testing at ±4.0kV resulted in 10 IF's for every 16'000 telegrams.							

Table 7: HMT7748 test results - burst

5.1.8 Remarks

The device performs well under the test conditions. Both COM2/3 meet the minimum requirements defined in the norm. COM3, however, was not as robust as COM1. Significantly more IF/com-abort's were recorded. This is noted to be the case on other comparable IO-Link devices, as the cycle time at COM3 is significantly less i.e. 2.61ms vs. 0.44ms.

5.1.9 Conclusions

Test pass. No significant observations to report.

TEST PASS

5.2 Application ESD

5.2.1 *Relevant standard and interpretation*

IEC 61000-4-2

The test is applied using contact discharge only (330Ω/150pF source), at different voltages levels (max ±8kV) and for both positive and negative pulse applications.

5.2.2 Characteristic waveform

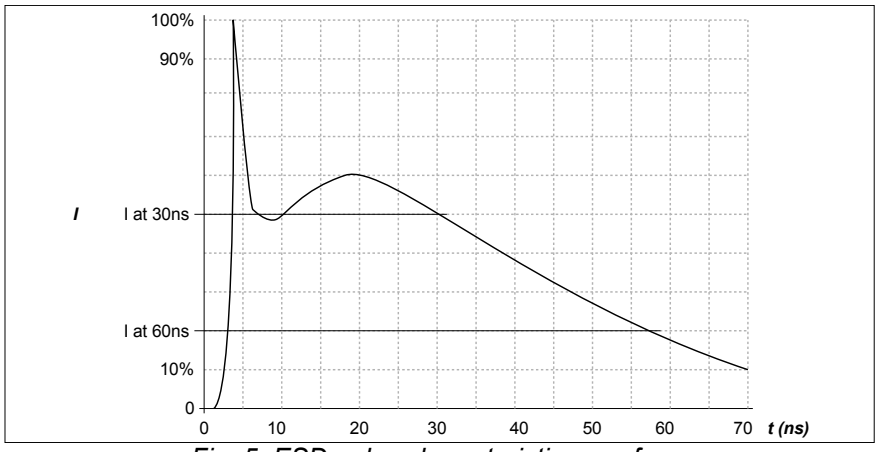

Fig. 5: ESD pulse characteristic waveform

5.2.3 Set-up

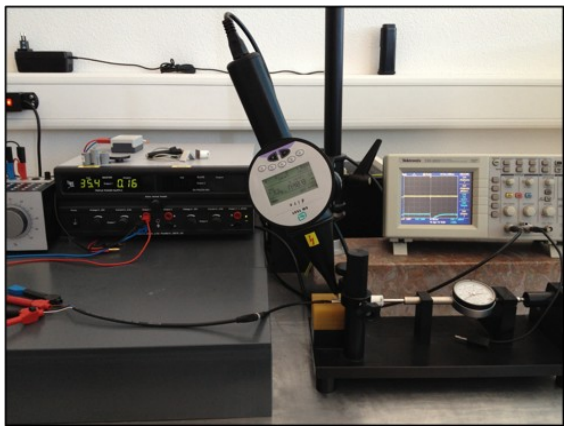

Fig. 6: Test Equipment and Set-up

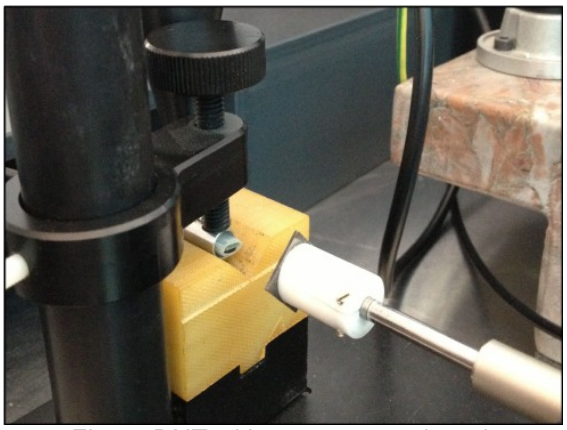

Fig. 7: DUT without connected earth

5.2.4 Equipment used

Equipment used in IO-Link Mode	Equipment used in SIO Mode
• ESD30 ESD Generator	• Tektronix TDS2022 Oscilloscope
• IEC-Finger	• Dito EM-Test ESD
• ESD discharge device	• EA-PS2332-052 PSU

Table 8: Equipment list - ESD

5.2.5 Applied test procedure

Contact discharge of ±8kV (Level 4) most severe, onto the horizontal coupling plane and directly to the metal housing of the DUT. SIO mode 10 pulses of each polarity, with 5 seconds dwell between pulse application. IO-Link mode 30 pulses, with 1 second dwell.

5.2.6 Applied performance criteria

In SIO mode the switch input of the TM142 is set in both open and closed states, and the output on the CQ line is monitored with a suitably decoupled oscilloscope.

In IO-Link mode, the device is monitored with the MESCO EMC Test Master, checking for the successful exchange of data after a discharge.

Reference	Mode	Test level	Applicable Performance Criteria	Comment
[1]	IO-Link	±4kV	B	Functional after stimulus
[2]	SIO	±8kV	B	Disturbance of output not exceeding 1ms

Table 9 Application ESD performance criteria

5.2.7 Test results

Housing	Polarity	SIO Mode		IO-Link Mode			Device ID
		Reached (B) [kV]	Highest Test [kV]	Reached (A) [kV]	Tested (B) [kV]	Highest Test [kV]	
Earthed	+	8kV	8kV	6kV	6kV	6kV	EMC01,4
	-	8kV	8kV	6kV	6kV	6kV	EMC01,4
Floating	+	8kV	8kV	6kV	6kV	6kV	EMC01,4
	-	8kV	8kV	6kV	6kV	6kV	EMC01,4

Table 10: HMT7748 test results – Application ESD

5.2.8 Remarks

none

5.2.9 Conclusions

Test pass for both SIO mode and IO-Link mode. No significant observations to report.

TEST PASSED

5.3 Conducted RF immunity

5.3.1 *Relevant standards and interpretation*

IEC 61000-4-6

This test is applied only in common mode on all of the conductors in the cable, and at a much lower level ($10V_{RMS}$, or at $20V_{RMS}$) than the EFT test (1-2kV). It therefore does not create electrical stress on the device. It will introduce couplings due to differential capacitances of different nodes to earth. This is primarily a problem with PCB tracks rather than on IC tracks and should have limited impact on the output stage of the IC, or even on band-gap/POR functionality.

5.3.2 *Set-up (SIO-Mode)*

Cable length ca. 10cm from coupling and decoupling network to DUT.

5.3.3 *Set-up (IO-Link Mode)*

Cable length ca. 10cm from coupling and decoupling network to DUT.

5.3.4 *Equipment used*

Equipment used in IO-Link Mode	Equipment used in SIO Mode
• HUBERT EMCL-20 EM Clamp	• TESCO NSG4070
• Schlöder CDG 6000	• TESCO coupling/decoupling network
• MESCO System EMC Test Master	• EA-PS2332-052 PSU
• LeCroy Waverunner Oscilloscope	• PC and test software
• Laboratory PSU PS2403D	• -
• Coupling Network CDN-M1	• -
• COM2, COM3 interface box	• -

Table 11: Equipment list – Conducted RF immunity

5.3.5 *Applied test procedure*

Test level set to both $10V_{RMS}$ and $20V_{RMS}$ in SIO mode and at $10V_{RMS}$ in IO-Link mode. Frequency range of 0.150MHz – 80MHz in SIO and up to 250MHz in IO-Link, in increments of 1%. Common mode amplitude modulated coupling on all conductor in the cable to a depth of 80% by a sinusoidal signal of 1000Hz. 2 second signal application for each step. Test fully automated. Earthed tests are performed twice: once directly to earth and once directly to the signal clamp.

5.3.6 *Applied performance criteria*

In SIO mode the switch input of the TM142 is set in both open and closed states, and the output on the CQ line is monitored via the test software.

In IO-Link mode, the device is monitored with the MESCO EMC Test Master, checking for the successful exchange of data throughout testing.

Reference	Mode	Req. Level	Performance	Comment
[1]	IO-Link	0,15 – 80 MHz 10 VEMF	A (2)	Measured error rates at COM2 and COM3
[2]	SIO	3V VEMF	B	Disturbance of output not exceeding 1ms

Table 12 Applied performance criteria - conducted RF immunity

5.3.7 Test results

Housing	SIO Mode			IO-Link Mode COM2, COM3			Device ID
	Reached (B) [MHz]	Highest Test [MHz]	Disturbances	Reached (A) [MHz]	Highest Test [MHz]	Errors Detected [IF, MF]	
Earthed	80	80	none at $20V_{RMS}$	230	230	0,0 at $10V_{RMS}$	EMC01,4
	80	80	none at $20V_{RMS}$	230	230	0,0 at $10V_{RMS}$	EMC01,4
Floating	80	80	none at $20V_{RMS}$	230	230	0,0 at $10V_{RMS}$	EMC01,4
	80	80	none at $20V_{RMS}$	230	230	0,0 at $10V_{RMS}$	EMC01,4

Table 13: HMT7748 test results - Conducted RF immunity

5.3.8 Remarks

None.

5.3.9 Conclusions

Test pass for both SIO mode and IO-Link mode. IO-Link mode is tested with an injected RF field far in excess of the required 80MHz without any interfered frames of missed frames.

TEST PASSED

5.4 Surge

5.4.1 Relevant standards and interpretation

IEC 61000-4-5 (Base norm surge immunity testing definition)

A 1kV/50µs pulse applied over 500Ω according to CEI/IEC 60255-5:2000 is applied to each conductor in the cable, with three pulses of each polarity.

5.4.2 Characteristic waveform

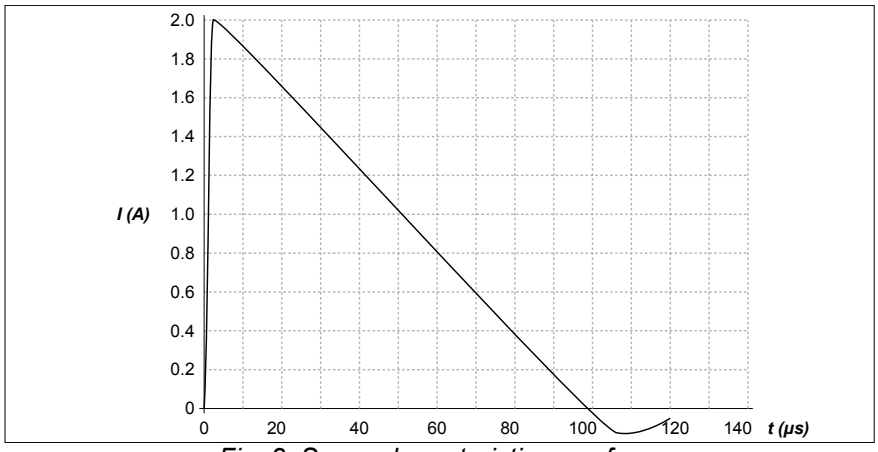

Fig. 8: Surge characteristic waveform

5.4.3 Set-up

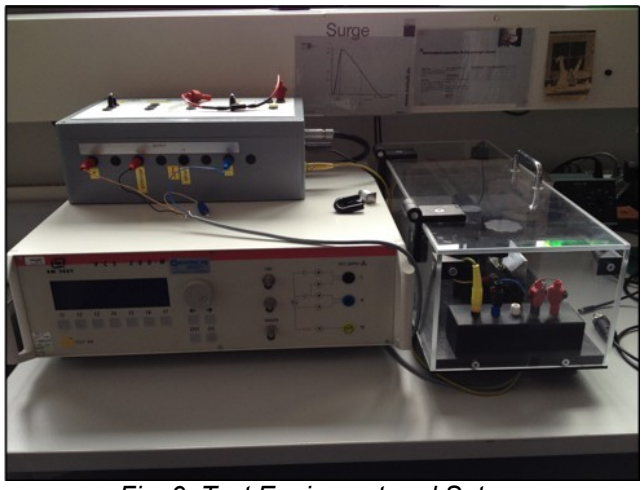

Fig. 9: Test Equipment and Set-up

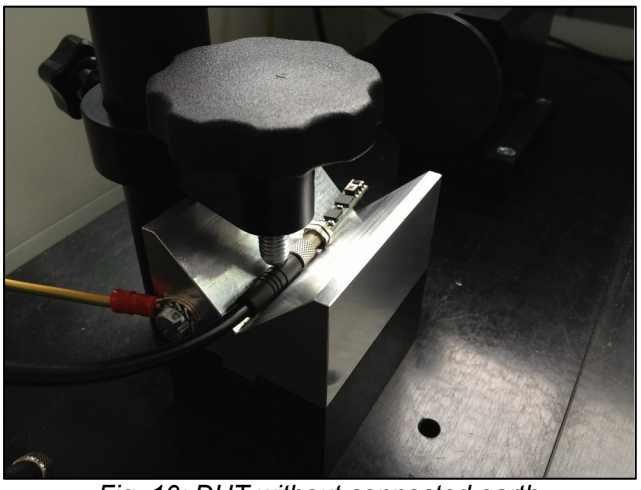

Fig. 10: DUT without connected earth

5.4.4 Equipment used:

Equipment used in IO-Link Mode	Equipment used in SIO Mode
• n/a	• EM Test VSC 500M
• n/a	• EM Test CNV 504A
• n/a	• EA-PS2332-052 PSU
• n/a	• Fluke Multimeter

Table 14: Equipment list - Surge

5.4.5 Applied test procedure

(Unpowered)

The device is unpowered and both communication channels (CQ and DIO) are tested towards the supplies (VPLUS and PGND) to the required 1000V/500Ω for all combinations for any pair of the four conductors, and then further until device failure. The voltage applied to the device is set by the EM surge test equipment, and the current by a 492Ω series resistor. The surge pulse, Fig. 8, is applied in each combination 6 times in total, first 3+, then 3-, with a 5 second dwell between each pulse application.

(Powered)

The device is powered and the LS switch (CQ and DIO) is active. Both communication channels (CQ and DIO) are tested towards the supplies (VPLUS and PGND) to the required 1000V/500Ω for all combinations for any pair of the four conductors, and then further until device failure. The voltage applied to the device is set by the EM surge test equipment, and the current by a 492Ω series resistor. The surge pulse, Fig. 8, is applied in each combination 6 times in total, first 3+, then 3-, with a 5 second dwell between each pulse application.

5.4.6 Applied performance criteria

Reference	Mode	Test level	Performance	Comment
[3]	SIO	The parameters are as follows: – front time: 1,2 µs ± 30 %; – time to half-value: 50 µs ± 20 %; – output impedance: 500 Ω ± 10 %;	A	Function resumes after event

Table 15: Performance criteria – Surge

5.4.7 Test results

(Powered/Unpowered)

Following a surge impulse of 1000V/492Ω(2.0A) and then at **1600V/492Ω(3.25A)**, both channels survived without any issues and the device function resumes. The current on the supply was monitored and the output stage was tested by establishing communication with a Balluff USB master. A total of 4 devices were tested like this. Device failure was detected at 1800V/492Ω(3.66A).

5.4.8 Further test results (HMT Lab)

Additional testing was also performed in the HMT lab. Fig. 11 shows the experimental setup for the elevated current pulse measurements, and Fig. 12 the stimulus waveform. Current pulses of 100mA<I<3.5A were generated by varying the input gate voltage of the FQP50N06 FET. Device heating of ca. 25°C is expected for a current of 1A, a forward voltage of 40V and a pulse length of 50µs.

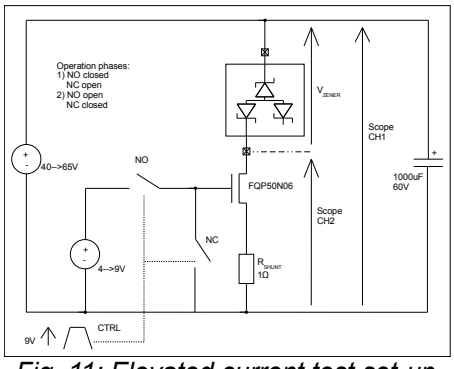

Fig. 11: Elevated current test set-up

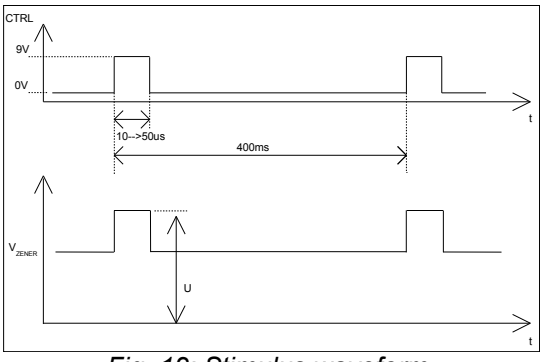

Fig. 12: Stimulus waveform

The protection elements failed above 3A, ca. 42V at 10µs. This is ca.1.5 times the energy of the 2A pulse defined by automotive norm IEC60255-5(2A/50us), suggesting that the device is capable of supporting such a pulse at both room temperature and starting at 150°C. Lab measurements made over temperature also confirm this.

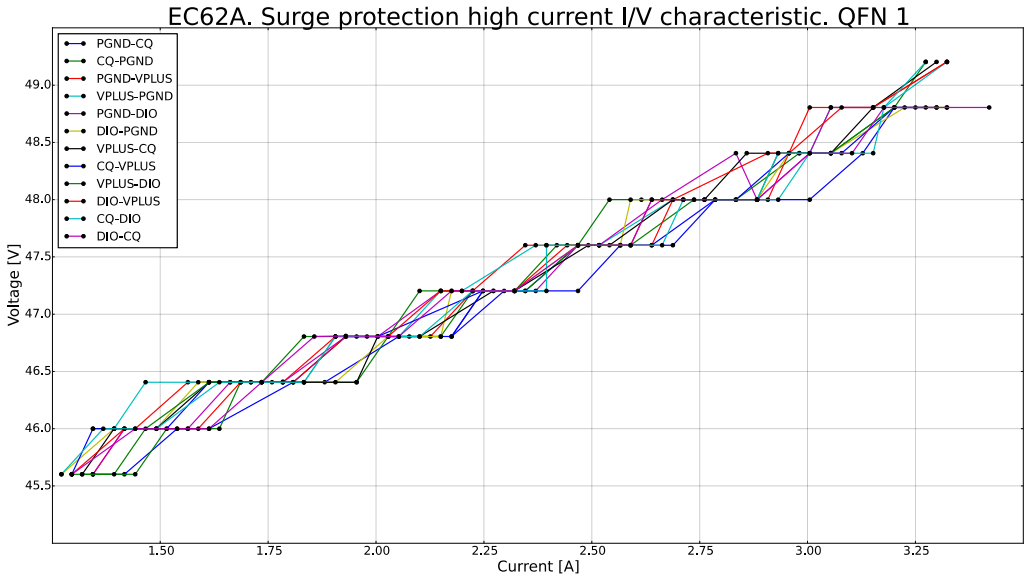

Fig. 13 Surge protection elevated current behaviour - QFN

5.4.9 Remarks

None

5.4.10 Conclusions

The device passes both powered and unpowered surge tests with a comfortable margin. No significant observations to report.

TEST PASSED

5.5 Radiated RF immunity

5.5.1 Relevant standard and interpretation

IEC 61000-4-3

5.5.2 Set-up

Date: 26.11.2019, Temperature: 21°C, Relative humidity: 41%, Pressure: 985 hPa

The uniform field area is calibrated according to EN 61000-4-3:2006. The field magnitude over the defined area is within – 0 dB to + 6 dB of nominal value over 75% of the surface (100% of the surface for the minimal area size of 4 points). The EUT was placed on non-conducting platform the top of which is 0,8 m above the metal ground plane.

EUT distance from antenna / nominal field level: 1.2 m / 10 V/m (80 MHz – 1 GHz) 2.17 m / 10 V/m (1 GHz – 2.7 GHz).

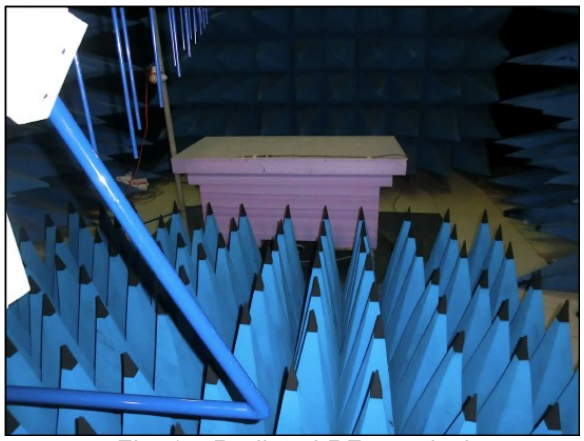

Fig. 14: Radiated RF - vertical

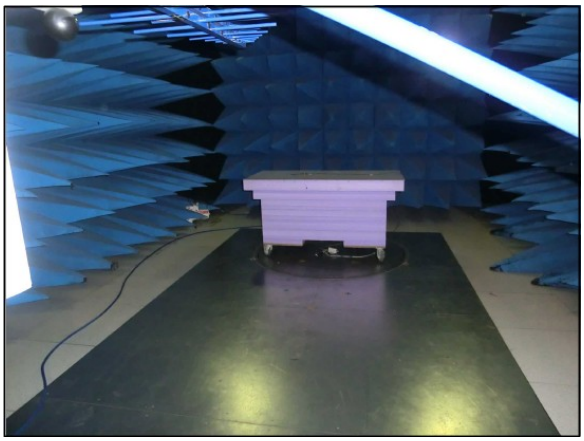

Fig. 15: Radiated RF - horizontal

5.5.3 *Equipment used*:

Equipment used in IO-Link Mode	Equipment used in IO-Link Mode
• Semi – Anechoic Room	• Rhode & Schwarz NRVS PSU
• Table	• Rhode & Schwarz NRV-Z4 RF Power probe
• HP 83630B Sweep Generator	• Amplifier Research 25S1G4 RF amplifier
• Amplifier Research 250W100A RF amplifier	• Amplifier Research DC7144A directional coupler
• Amplifier Reasearch DC6180 directional coupler	• Chase CBL6111A Bilog Antenna
• Rhode & Schwarz NRVS PSU	• EMCO 3115 Horn antenna

Table 16: Equipment list – Radiated RF immunity

5.5.4 *Auxiliary Equipment used:*

Equipment used in IO-Link Mode	Equipment used in IO-Link Mode
• EMC Tester (MESCO)	• Fluke Multimeter (MESCO)
• DC PSU SN A7040087 (LCIE)	• Rhode & Schwarz NRV-Z4 RF Power probe

Table 17: Equipment list – Radiated RF immunity

5.5.5 Applied test procedure

The frequency ranges is swept with a modulated signal to a depth of 80% by a sinusoidal signal of 1kHz, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. A step size of 1% is used. The dwell time of the amplitude modulated carrier at each frequency is 1 second. The test is performed with the generating antenna facing each side of the DUT.

5.5.6 Performance criteria

In IO-Link mode, the device is monitored with the MESCO EMC Test Master, checking for the successful exchange of data throughout testing. A 20m IO-Link cable is used.

Reference	Mode	Test level	Performance	Comment
[1]	IO-Link	80 – 1000 MHz 10 V/m AM 80% @ 1kHz 2000 – 2700 MHz 10 V/m AM 80% @ 1kHz	A A	Measured error rates at COM3 Measured error rates at COM3

Table 18 Radiated RF immunity performance requirements

5.5.7 Test results

Operating Mode	Illuminated Side	Frequency Range	Polarity	Level [V/m]	Result / Performance Criteria
IO-Link COM3	Front Side	80 – 1000 MHz 10 V/m AM 80% @ 1kHz	Horizontal	10	0 Fehler / A
IO-Link COM3	Front Side	80 – 1000 MHz 10 V/m AM 80% @ 1kHz	Vertical	10	0 Fehler / A
IO-Link COM3	Front Side	1000 – 6000 MHz 10 V/m AM 80% @ 1kHz	Horizontal	10	0 Fehler / A
IO-Link COM3	Front Side	1000 – 6000 MHz 10 V/m AM 80% @ 1kHz	Vertical	10	0 Fehler / A

Table 19 HMT7748 test results – Radiated RF immunity

5.5.8 Conclusions

Device performs well under the test conditions. Both 38kBaud (EMC01) and 230kBaud (EMC03) samples successfully completed the test. No significant observations to report.

TEST PASSED

5.6 Radiated RF emissions

5.6.1 Relevant standard and interpretation

EN 55011 :2009 + A1 : 2010

5.6.2 Set-up

Date: 26.11.2019, Temperature: 21°C, Relative humidity: 41%, Pressure: 985 hPa

The measurements were carried out in an anechoic chamber. The EUT is placed 3m away from the antenna, which itself is placed between 0.8m above the conducting ground plane. The EUT's azimuth is set between 0° and 360°.

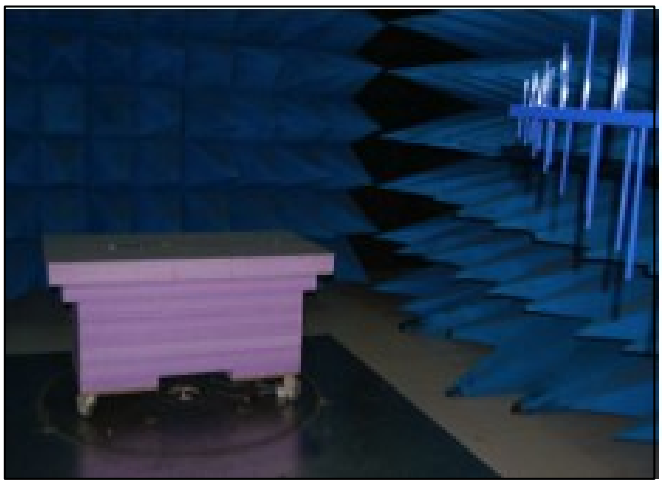

Fig. 16 Radiated RF emissions

5.6.3 Equipment used

Equipment used in IO-Link Mode	Equipment used in IO-Link Mode
• Semi – Anechoic Room	• ADE CMD11 RF Preamplifier
• Table	• Chase CBL6111A Bilog antenna
• Rhode & Schwarz ESCI RF Receiver	• Avantest R3261D Spectrum Analyser

Table 20: Equipment list - Radiated RF emissions

5.6.4 Applied test procedure

Attenuator set to Auto, Pre Amp switched Off, Bandwidth set to 120 kHz, Detector: QP, Test Time 1sec and the frequency swept from 30MHz to 6GHz.

5.6.5 Performance criteria

Reference	Mode	Test level	Performance	Comment
[2]	IO-Link			Operation at 230.4kBaud in accordance to CISPR 11 for Environment A, IEC 61000-3-2 and IEC 61000-3-3

Table 21 Radiated RF emissions performance requirements

5.6.6 Test results

	QP Levels – Vertical polarisation			QP Levels – Horizontal polarisation			
Frequency [MHz]	QP Level [dBµV]	QP Limit [dBµV/m]	QP Margin [dB]	QP Level [dBµV]	QP Limit [dBµV]	QP Margin [dB]	Result
33.65	35.3	40	4.7	*	*	*	Pass
38.75	35.8	40	4.2	*	*	*	Pass
81.55	33.1	40	6.9	30.4	40	9.6	Pass
notes: *nt = not tested							

Table 22 HMT7748 test results – Radiated RF emissions for 230kBaud

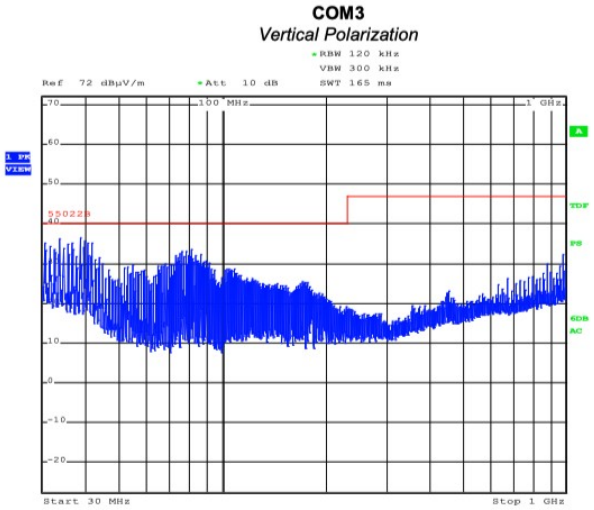

Fig. 17: 230kBaud, Vertical Polarisation

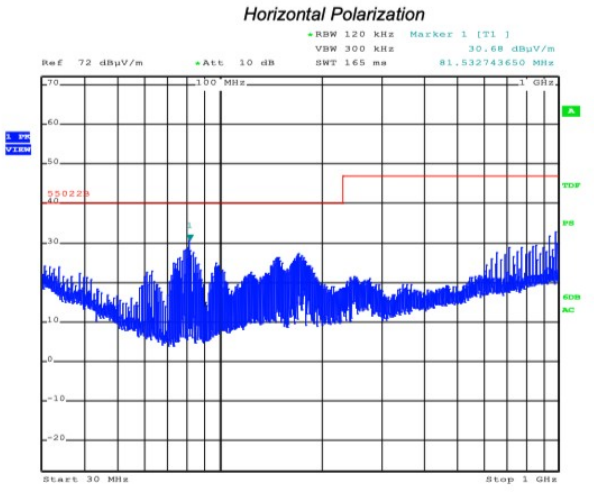

Fig. 18 230kBaud, Horizontal Polarisation

	QP Levels – Vertical polarisation			QP Levels – Horizontal polarisation			
Frequency [MHz]	QP Level [dBµV]	QP Limit [dBµV/m]	QP Margin [dB]	QP Level [dBµV]	QP Limit [dBµV]	QP Margin [dB]	Result
35.55	26.02	40	13.98	No significant frequency has been observed			Pass
38.65	26.22	40	13.78	No significant frequency has been observed			Pass
notes: none							

Table 23 HMT7748 test results – Radiated RF emissions for 38kBaud

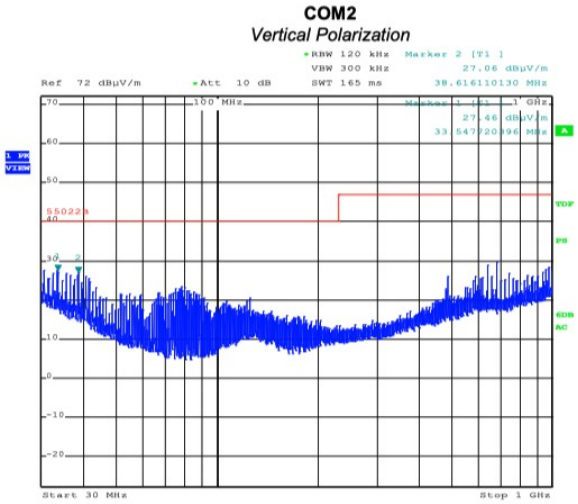

Fig. 19: 38.4kBaud, Vertical Polarisation

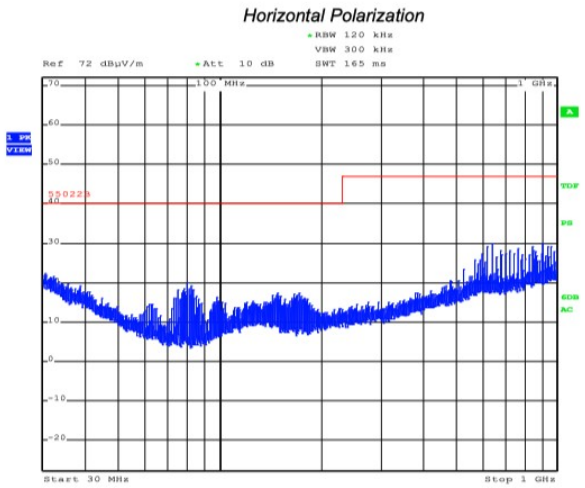

Fig. 20 38.4kBaud, Horizontal Polarisation

5.6.7 Conclusions

Test passed. No significant observations to report.

TEST PASSED

6 Revision follow-up

Rev.	Chapter	Status	Comment
A	All	C	Document released
A	Heading	M	Minor typo correction
Status: C=Created, M=Modified, A=Added, D=Deleted			

Table 24: Revision follow-up