AN4875
Application note

STCOMET smart meter and power line communication system-on-chip G3-PLC characterization

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Introduction

This document is aimed at describing the electrical characteristics and communication performance of a power line communication (PLC) node based on the EVLKSTCOMET10-1 hardware and G3-PLC firmware operating in the CENELEC A frequency band (9 - 95 kHz).

The EVLKSTCOMET10-1 is a development kit for the STCOMET platform, exploiting the performance capability of the full-featured STCOMET10 device.

The STCOMET10 is a single device integrating a flexible power line communication (PLC) modem with a fully embedded analog front-end (AFE) and a line driver, a high performance 3-channel metrology function and a Cortex™-M4 application core.

Compliance test results are reported for electromagnetic compatibility (EMC) applicable standards, along with transmission and reception characterization measurements.

Please check for the EVLKSTCOMET10-1 hardware documentation, evaluation software and firmware libraries at st.com/powerline. For specific software or firmware releases, you may need to contact directly the STMicroelectronics sales office.

Figure 1: STCOMET development kit - EVLKSTCOMET10-1

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1 Safety recommendations

The STCOMET development kit must be used by expert technicians only. Due to the high voltage (85 - 265 V ac) present on the non-isolated parts, special care must be taken in order to avoid electric risks for people safety.

There are no protections against high voltage accidental human contact.

After a disconnection of the board from the mains all the live part must not be touched immediately because of the energized capacitors.

It is mandatory to use a mains insulation transformer to perform any tests on the high voltage sections, using test instruments like, for instance, spectrum analyzers or oscilloscopes.

Do not connect any probe to high voltage sections if the board is not isolated from the mains supply, in order to avoid damaging instruments and demonstration tools.

When configured for metering evaluation, the STCOMET development kit is not isolated and ground will be tied to the line. Do NOT connect instrument probes that can bring the earth connection to the line, thus potentially damaging the STCOMET development kit and the instruments and creating electrical risk.

STMicroelectronics assumes no responsibility for the consequences of any improper use of this development tool.

2 STCOMET smart meter and power line communication system-on-chip description

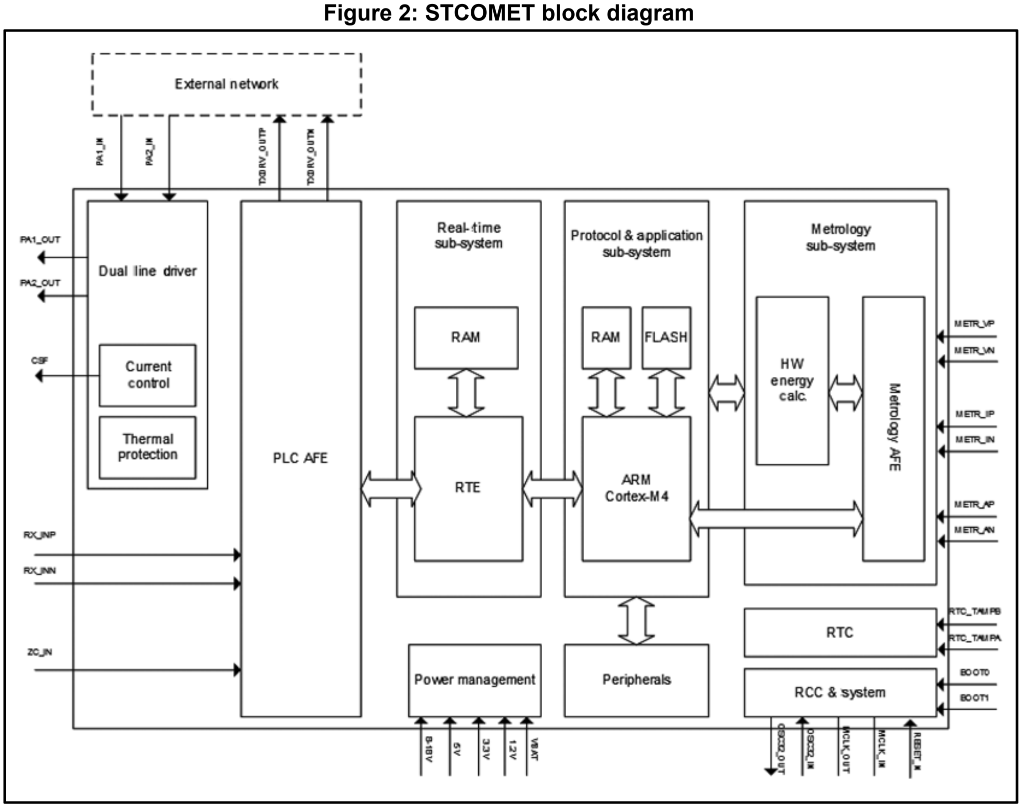
The STCOMET is a device that integrates a narrow-band power line communication (NB-PLC) modem, a high-performance application core and metrology functions.

The PLC modem architecture has been designed to target the EN50065, FCC, ARIB compliant PLC applications. Together with the application core, it enables the STCOMET platform to support the PRIME, IEC 61334-5-1, G3-PLC, IEEE 1901.2, METERS AND MORE, and other narrow-band PLC protocol specifications.

The metrology sub-system is suitable for the EN 50470-1, EN 50470-3, IEC 62053-21, IEC 62053-22, and IEC 62053-23 compliant class1, class0.5 and class0.2 AC metering applications.

For further details, please refer to point 1. in References.

Figure 2: STCOMET block diagram



3 Test equipment

The measurements results reported in this document have been obtained using the following instruments:

Table 1: Electrical instruments used for testing

Equipment designation	Equipment reference	Purpose
Spectrum analyzer	Rohde & Schwarz FSU	TX and RX signal power measurement
Spectrum analyzer	Agilent E4443A	RX Input noise power measurement
Differential active probe	Agilent 1141A	Differential, high impedance, low level signal measurements
Probe control and power module	Agilent 1142A	Agilent 1141A probe supply and control
Two-line V-network LISN (x2)	Rohde & Schwarz ENV216	Connecting DUT (STCOMET development kit) to AC mains – reference line impedance
50 Ω attenuator	Trilithic 2010926004-R	Transmitted signal attenuation
EMC-EMI filter (x3)	Schaffner FN2080-6-06	Mains noise filtering
DC power analyzer	Agilent N6705A	Power supply and current consumption measurement

4 Power supply characteristics

4.1 Three DC input supply requirements (J13)

The connector J13 is the standard connector to be used for STCOMET main board supplying. This connector is designed to couple with the VIPer26H PSU board.

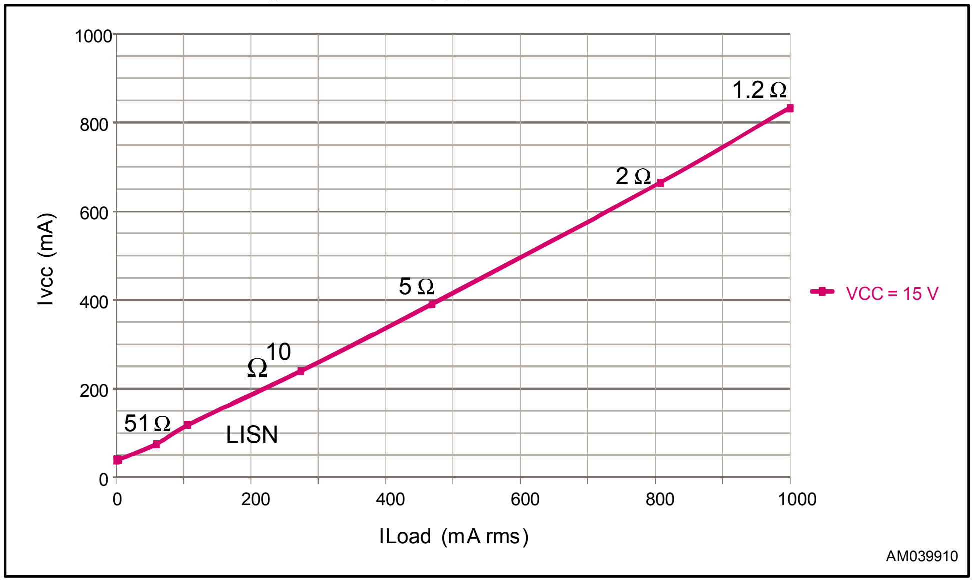
The test setup for the measurements performed in this section is described in Figure 4.

Table 2: Electrical characteristics – power supply – J13

Parameter	Value				Notes
	Min.	Typ.	Max.	Unit	
VCC power supply voltage	8	15	18	V	-
VCC power supply current absorption – RX mode	-	2.1	-	mA	-
VCC power supply current absorption – TX mode	-	40	-	mA	TX with no load
	-	119	-	mA	TX over EN50065 AMN
	-	665	-	mA	TX over 2 Ω AMN
5 V supply voltage	4.75	5	5.25	V	TX over EN50065 AMN
5 V supply current absorption – RX mode	-	60	-	mA	-
5 V supply current absorption – TX mode	-	11	-	mA	-
3V3 supply voltage	-	3.3	-	V	-
3V3 supply current absorption – RX mode	-	110	-	mA	3V3_AUX current consumption is not included in the 3V3 current.
3V3 supply current absorption – TX mode	-	95	-	mA	3V3_AUX current consumption is not included in the 3V3 current.
3V3_AUX supply current absorption	-	30	-	mA	-

The current to be supplied on the VCC is linked to the load connected to the J6 at the mains level. This relation is illustrated in Figure 3.

Figure 3: VCC supply current vs. mains load



4.2 Single DC input supply requirements (J7)

The connector J7 allows supplying the STCOMET main board with a single power supply for safe usage of the kit. In this mode, the connection to mains is not required while performing electrical tests and software/firmware development.

Note that the power consumption in this mode is not optimized.

Table 3: Electrical characteristics – power supply – J7

Parameter	Value				Notes
	Min.	Typ.	Max.	Unit	
Power supply voltage	8	-	15	V	15 V recommended for best PLC performance
Power supply current absorption – RX mode	-	191	-	mA	-
Power supply current absorption – TX mode	-	176	-	mA	TX with no load
	-	253	-	mA	TX over EN50065 AMN
	-	825	-	mA	TX over 2 Ω AMN

5 Power line characteristics

5.1 Line coupling characteristics

Table 4: Line coupling parameters

Symbol	Parameter	Value [typ.]	Unit
f_C	Center frequency	61.5	kHz
Vin	Withstanding voltage for surge and burst tests	> 4.0	kV

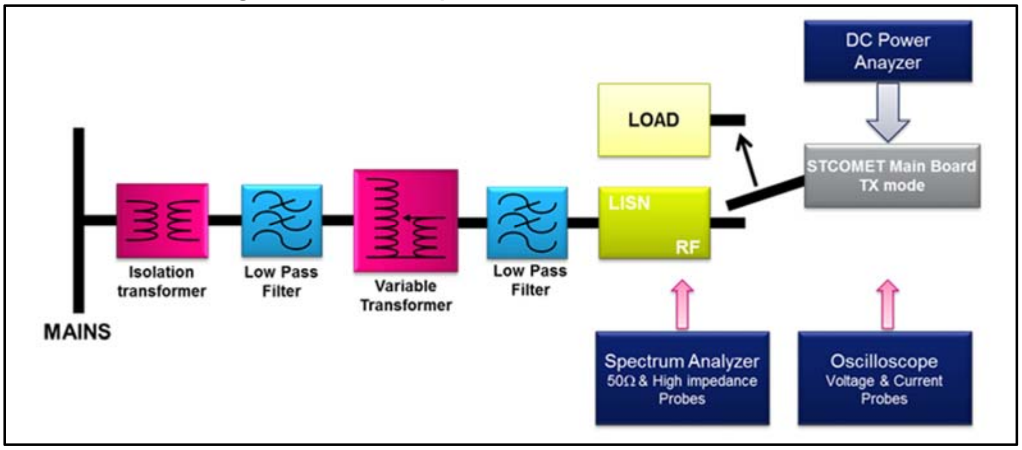
6 Transmitter characteristics

The voltages and currents in the transmission chain (line driver output, line coupling circuit and line load) vary depending on the load connected at the mains level (J6). This section is illustrating graphically the behavior of those parameters.

6.1 Test setup

Transmitter characterization has been performed using the setup illustrated in Figure 4 below.

Figure 4: Bench setup for transmission measurements



Instruments references are described in Table 1.

Low pass filters (Schaffner FN2080-6-06) attenuate noise from mains in the CENELEC-A band.

The variable transformer allows changing the mains voltage amplitude. This kind of module generates usually less noise than any AC supply.

It is recommended to configure the spectrum analyzer input coupling to DC, otherwise the power measurement for frequency below 50 kHz may be wrong.

A DC power analyzer is used to supply the STCOMET main board while measuring the current consumption.

The STCOMET development kit mains output J6 is either connected to the LISN for the spectrum analysis or to a variable load for the power consumption measurement.

6.2 Transmitter output voltage

6.2.1 VCC = 15 V

The output voltage delivered at STCOMET line driver output (PA1_OUT - PA2_OUT) and at the development kit output (J6) is given in the following figures, according to the load applied at the J6 connector, and with VCC = 15 V (typical value).

Figure 5: Transmitter output voltage (dBuV) vs. load current

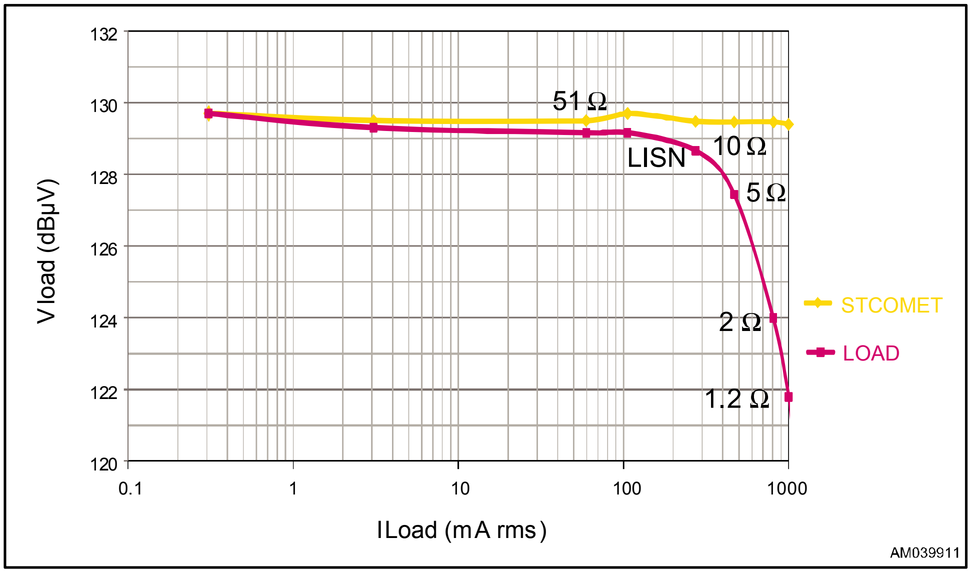


Figure 6: Transmitter output voltage (V rms) vs. load current

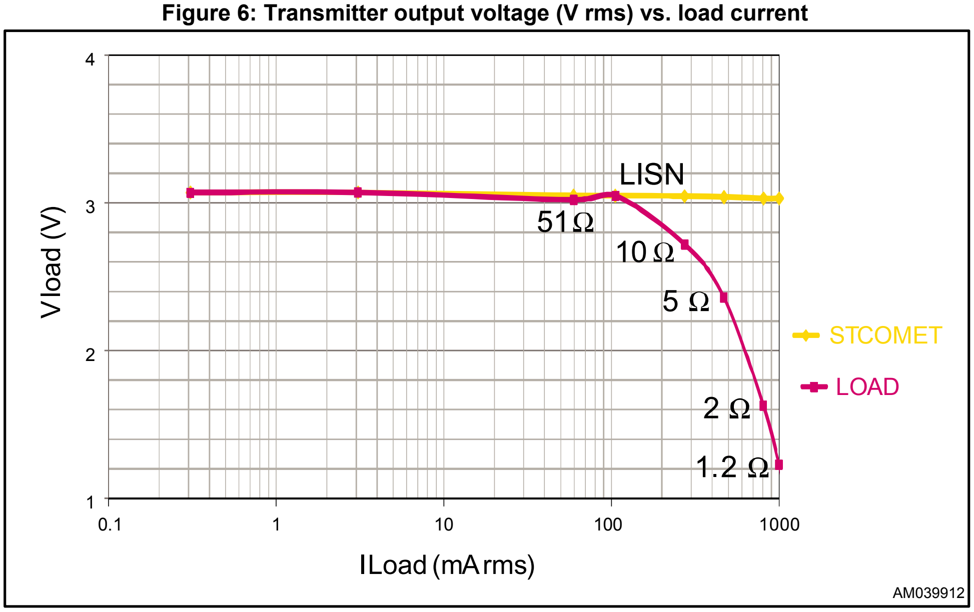
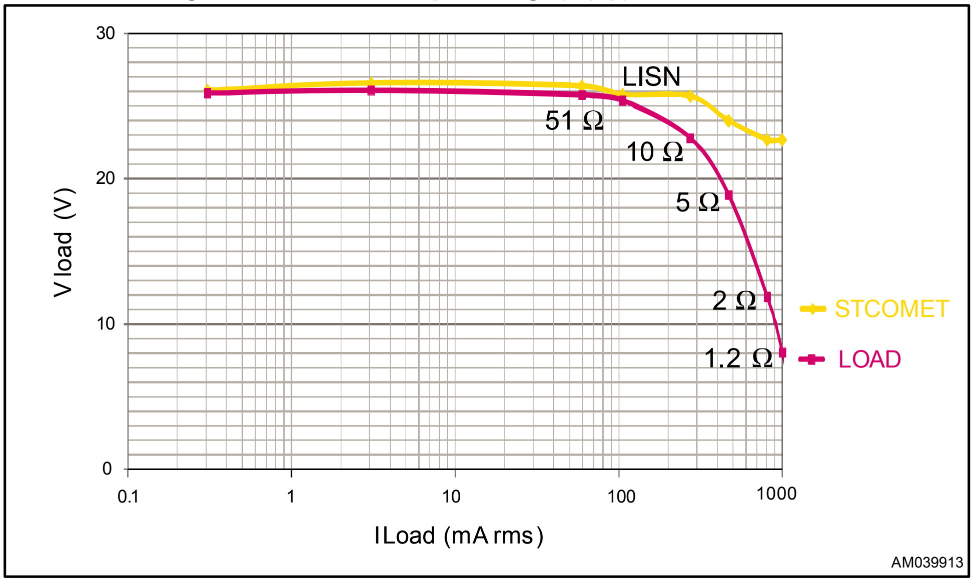


Figure 7: Transmitter output voltage (V p-p) vs. load current

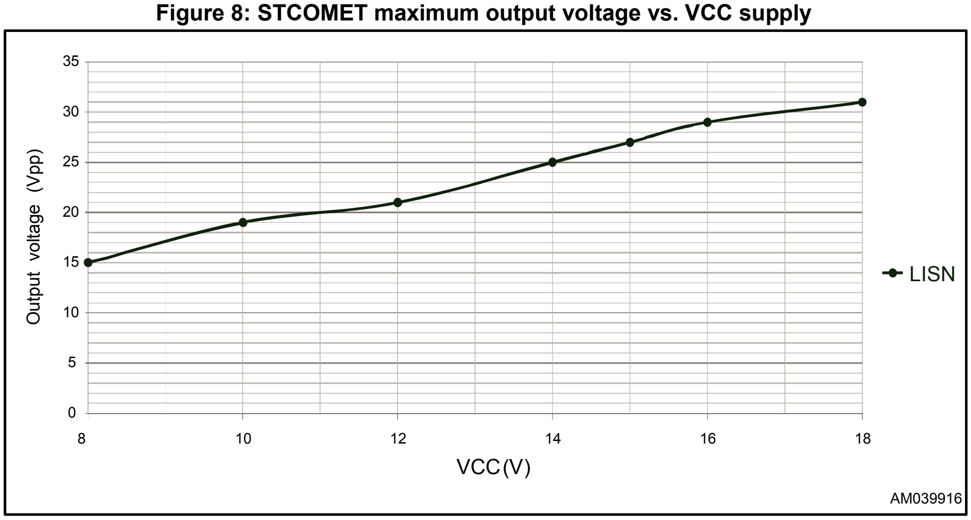


6.2.2 8 V ≤ VCC ≤ 18 V

Figure 8 below illustrates the maximum differential output voltage achievable by the STCOMET line driver versus the VCC level, when the STCOMET development kit is connected to a LISN.

The goal is to keep enough margin for the power amplifier to have a linear output.

Figure 8: STCOMET maximum output voltage vs. VCC supply



6.3 Line coupling insertion loss

Figure 10 illustrates the difference between the voltage generated by the STCOMET line driver and the voltage applied on the load. Those insertion losses are due to the coupling circuit non-negligible impedance.

Figure 9: Coupling circuit on STCOMET development kit

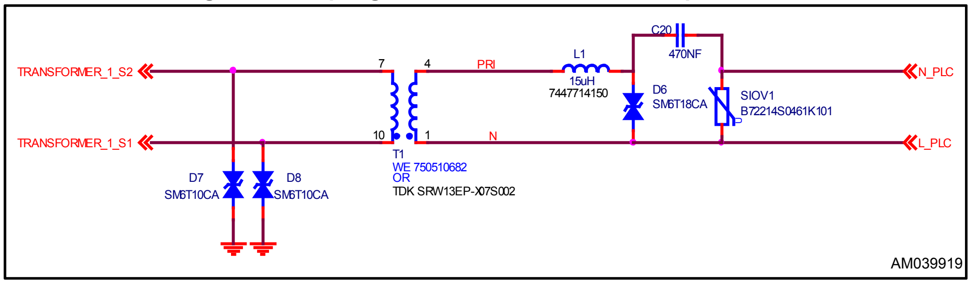
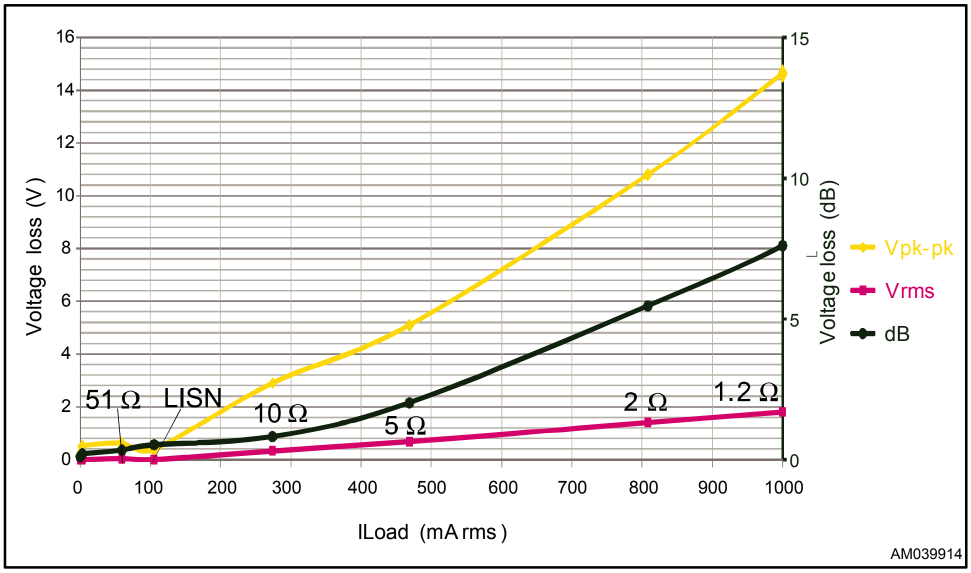


Figure 10: Line coupling loss vs. mains load



6.4 Output power

Figure 11 below illustrates the relationship between the current into the load connected at the J6 and:

- The power absorbed from the VCC supply (green trace, right Y-axis),
- The power delivered by the STCOMET line driver (yellow trace, left Y-axis),
- The power delivered to the load (pink trace, left Y-axis).

Figure 11: TX power vs. load current

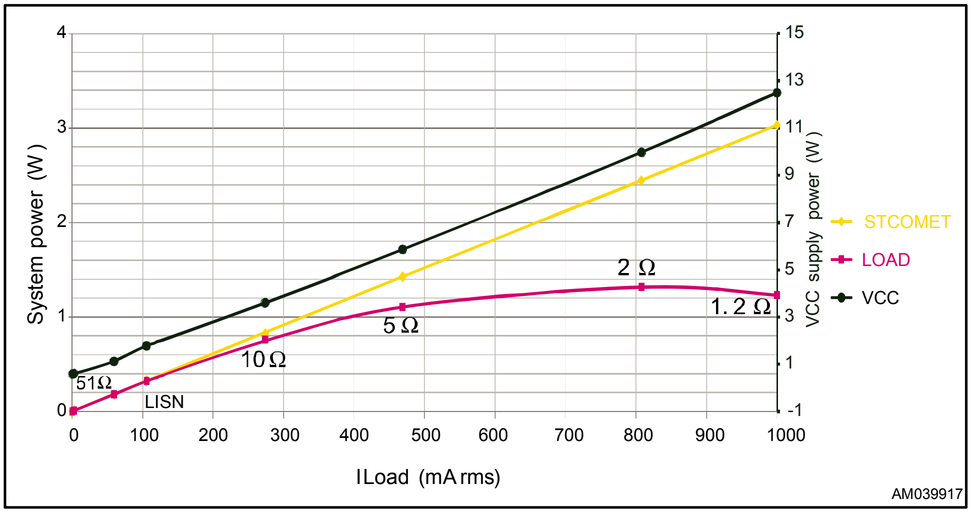
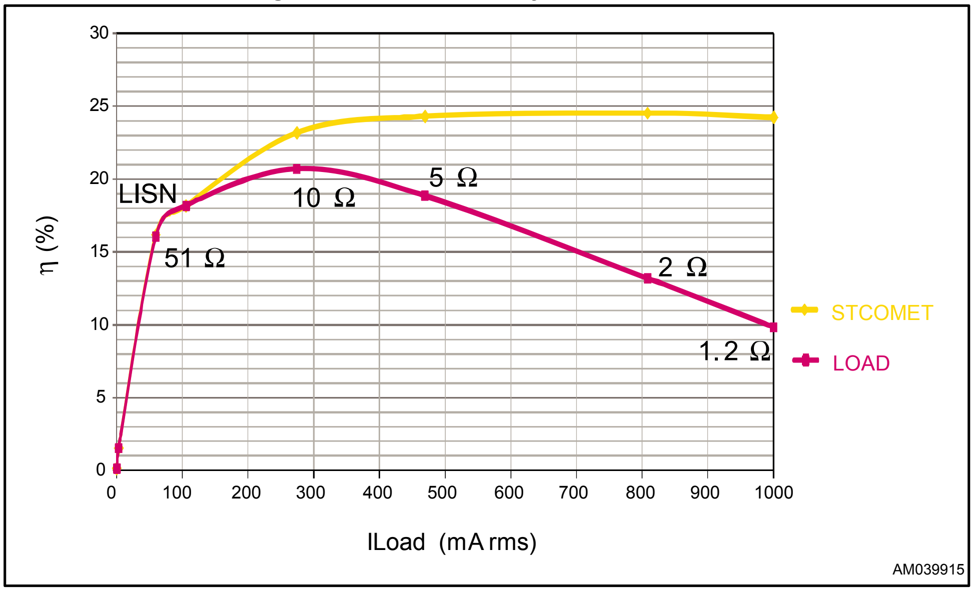


Figure 12 illustrates the efficiency of the STCOMET line driver (yellow trace) according to the load connected at the J6.

The pink trace is representing the efficiency of the full TX chain, including the losses in the coupling circuit.

Figure 12: Power efficiency vs. load current

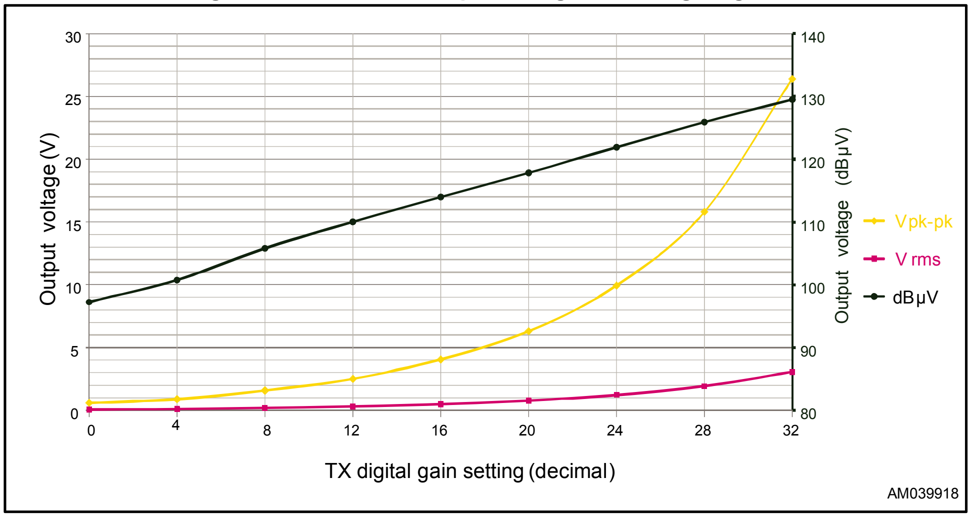


6.5 TX digital gain

Figure 13 is illustrating the STCOMET line driver output voltage according to the TX digital gain setting.

Please note that the X-axis is reporting decimal values, although the hexadecimal format is used in STCOMET settings.

Figure 13: Line driver output voltage vs. TX digital gain



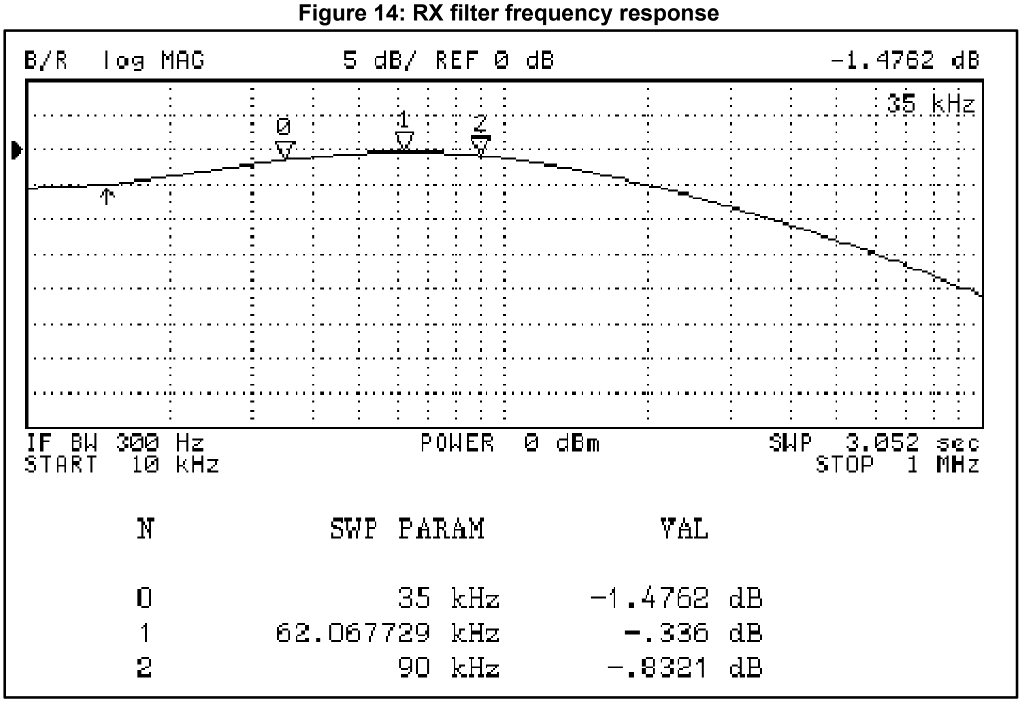
7 Receiver characteristics

7.1 Reception filter characteristics

Table 5: Reception filter parameters

Symbol	Parameter	Value [typ.]	Unit
f_C	Center frequency	60	kHz
Q	Quality factor	0.54	-
BW_{3dB}	Band-pass 3-dB bandwidth	110	kHz
$\|G_{RX}\|$	Voltage gain at f = f_C	-0.45	dB

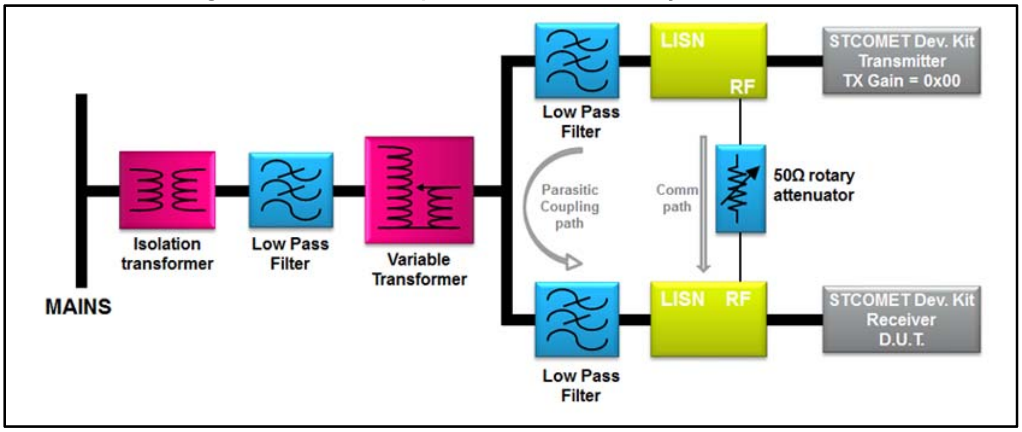
Figure 14: RX filter frequency response



7.2 Receiver sensitivity test setup

Because of the very low amplitude of the signals measured in this section, the bench setup of Figure 15 has been used in order to perform reliable measurements.

Figure 15: Bench setup for receiver sensitivity measurement



Instrument references are described in Table 1.

One STCOMET development kit is used as a transmitter for sensitivity vs. PER measurements. Its TX digital gain is set to minimum value in order to keep its output signal as low as possible and minimize the effect of the parasitic coupling path through the LISN and power supply connections.

Measurements of sensitivity vs. modulation are done according to the following procedure:

- Set attenuation = 0 dB
- Measure transmitted signal at receiver D.U.T. input (J6) = $L_{IN(0dB0}$
- Increase attenuation until PER = 5% = $Att_{5\%}$
- Calculate sensitivity = $L_{IN(0dB)}$ - $Att_{5\%}$

7.3 Input noise level

Table 6 gives the noise power measured at STCOMET RX_IN inputs, using an Agilent E4443A spectrum analyzer with an integrated low noise amplifier and the 1141A high impedance differential probe.

Table 6: Input noise level

Parameter	Condition	Main board standalone	Main board PSU included	Unit
RX_IN input noise power	CEN-A 35 - 95 kHz	12.4	31.6	dBµV
	ARIB STD-T84 35 - 400 kHz	20.5	35.7	dBµV
	G3-FCC 150 - 490 kHz	15.8	25.4	dBµV

Figures 16 and 17 come from the following calculation:

Noise power (STCOMET) = noise power (measured) – noise power (intrinsic probe)

Example for CEN-A band:

- Intrinsic probe noise = 15.0 dBµV (probe shortcut)
- Measured noise = 16.9 dBµV
- Result noise = 10 x log ($10^{17dB\mu V/10}$ - $10^{15dB\mu V/10}$) = 12.4 dBµV

Figure 16: Intrinsic probe noise CEN-A band

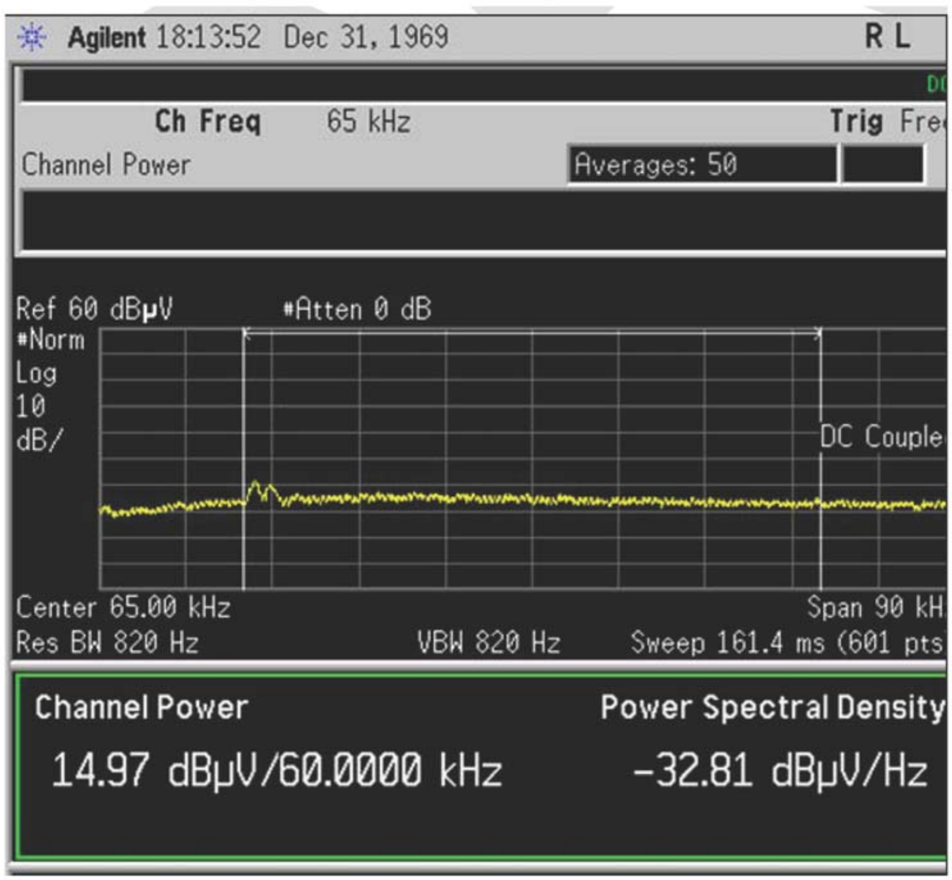
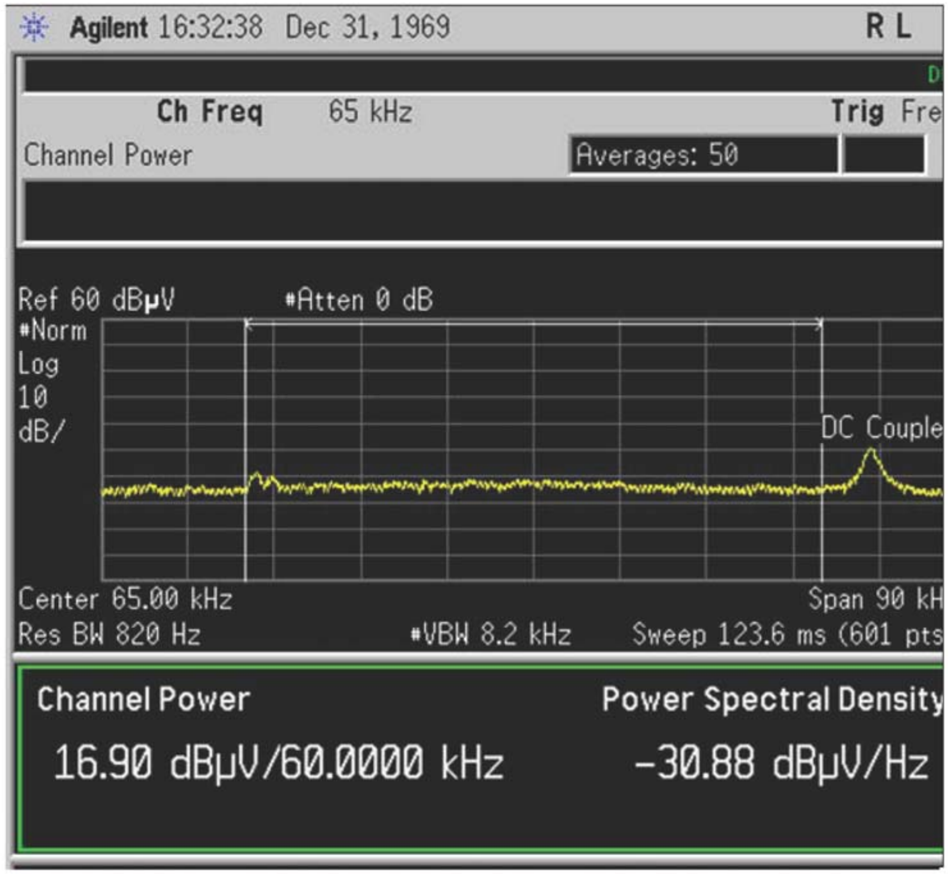


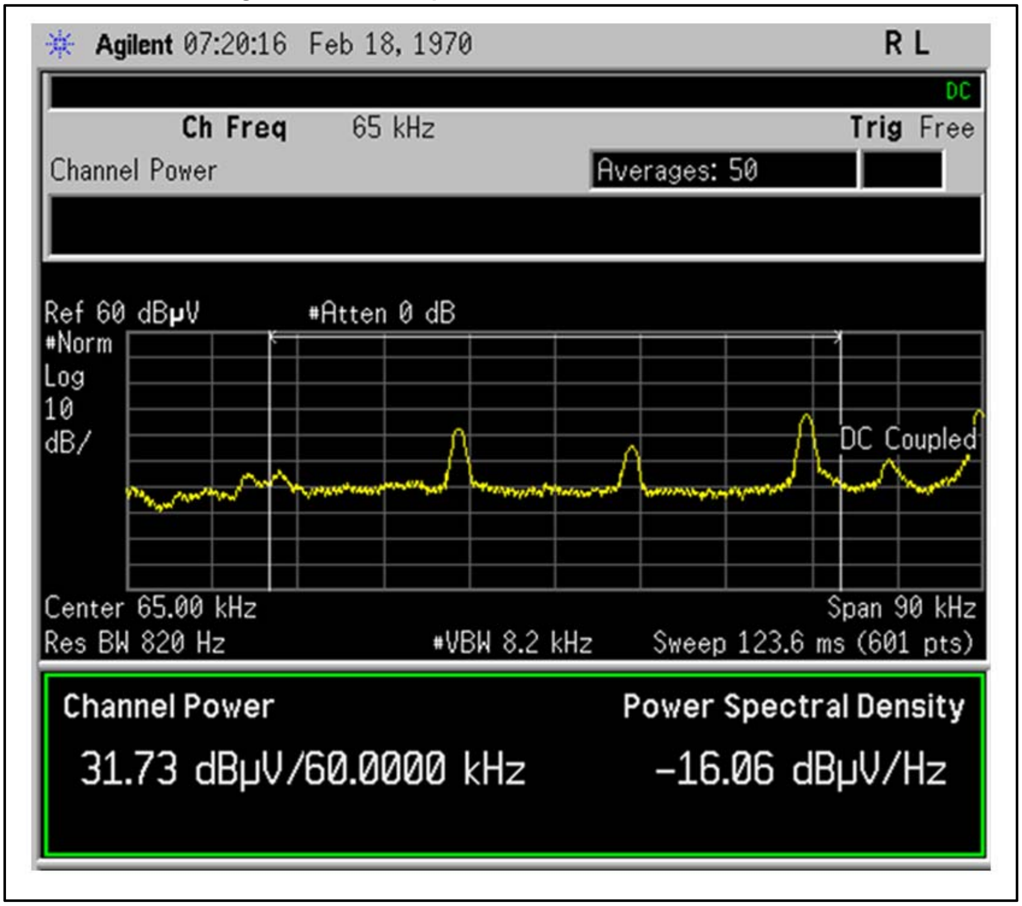
Figure 17: Measured noise in CEN-A band



Comments on reported figures:

- The noise power measured at STCOMET RX_IN inputs on the standalone main board configuration corresponds to the typical input referred noise of the STCOMET itself. We can deduce that the main board design has a limited impact on the kit sensitivity.
- The noise level measured is higher when the PSU board is used (as expected). However it is important to notice that, as shown by Figure 18 for the CEN-A band, this noise level is mainly linked to a few spurious tones affecting only specific G3-PLC subcarriers, thus giving a marginal impact on overall sensitivity (see following section).

Figure 18: CEN-A input noise level – PSU board active



7.4 Sensitivity level

Table 7 reports the minimum input signal level that can be applied to the STCOMET development kit mains connector J6, while guaranteeing a maximum PER ("Packet Error Rate") of 5%.

Table 7: STCOMET development kit sensitivity vs modulations

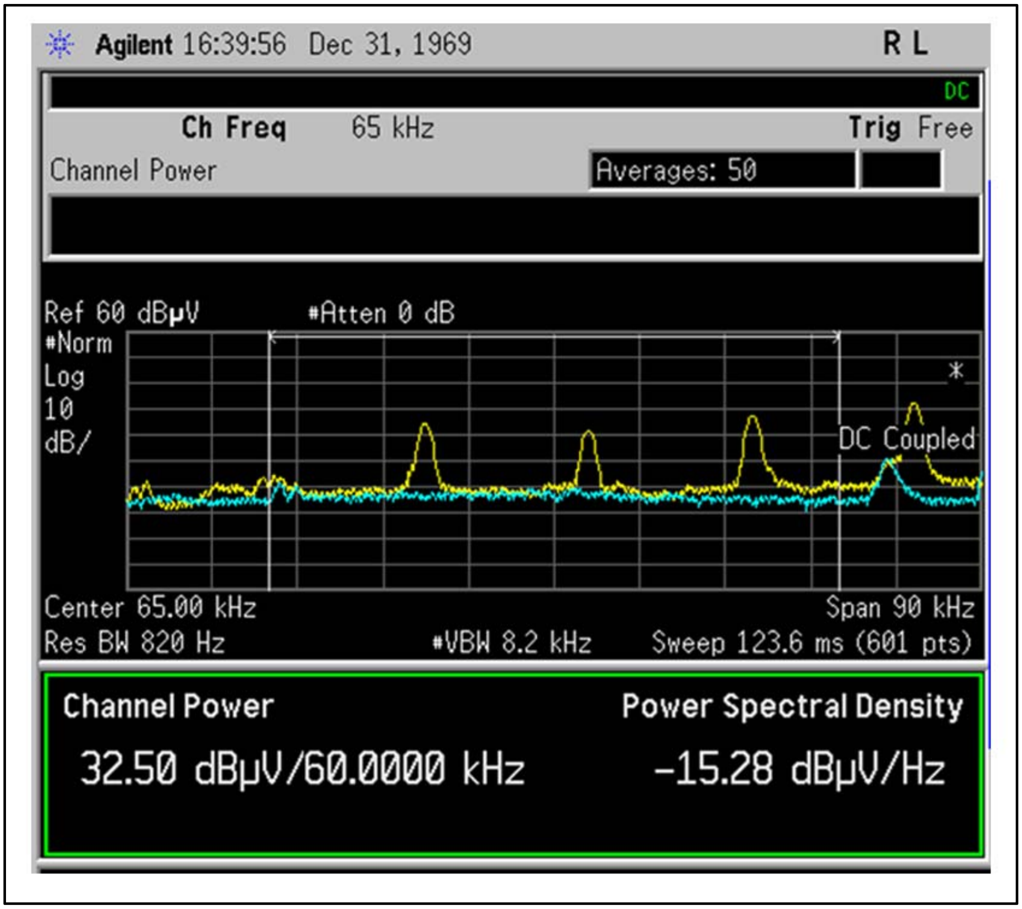
Parameter	Condition	Main board standalone	Main board PSU included	Unit
Receiver sensitivity (J6 level)	ROBO - coherent - PER < 5%	20	23	dBµV
	ROBO - differential - PER < 5%	20	24	dBµV
	BPSK - coherent - PER < 5%	23	27	dBµV
	BPSK - differential - PER < 5%	25	30	dBµV
	QPSK - coherent - PER < 5%	26	30	dBµV
	QPSK - differential - PER < 5%	28	32	dBµV
	8PSK - coherent - PER < 5%	30	34	dBµV
	8PSK - differential - PER < 5%	32	37	dBµV

It is noticeable that the PSU impact on the sensitivity is lower than its impact on the noise level measurement. For example, for ROBO coherent modulation:

- In Table 6: PSU board increases RX_IN noise level by 19.2 dB
- In Table 7: PSU board decreases sensitivity by 3 dB only

This is due to G3-PLC OFDM intrinsic signal resilience to SNR variations in the band.

Figure 19: PSU impact on input noise level - CEN-A band



In Figure 19, we can observe that the noise floor of the trace with the PSU active (yellow) is comparable with the lab PSU (blue trace). This is coherent with the sensitivity difference reported in Table 7 and shows that the noise tones have a limited impact on sensitivity.

8 EN50065 compliance tests

Table 8: List of standard tests required for EMC compliance to EN50065 – subset related to G3-PLC implementation

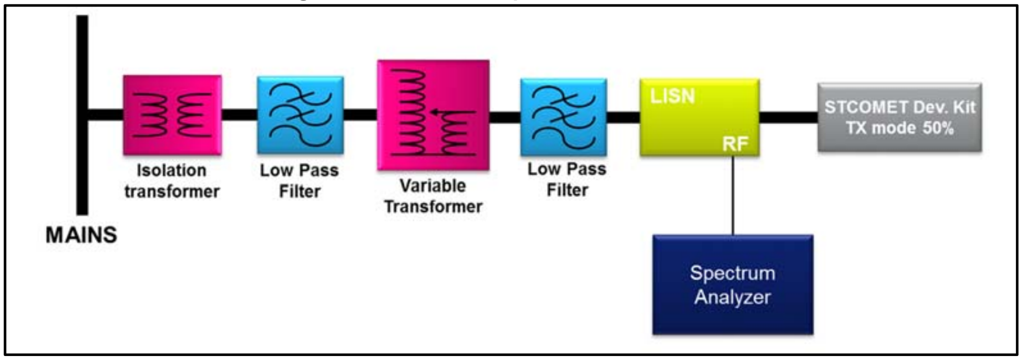
Type	Basic standard	Test	Result	Notes
PLC transmission: conducted measurement	EN 50065-1	Bandwidth measurements	PASS	-
	EN 50065-1	Maximum output levels	PASS	-
Conducted disturbance measurements	EN 50065-1, EN 55022	Conducted emissions (9 kHz – 30 MHz)	PASS	-
Radiated disturbance measurement	EN 50065-1, EN 55022	Radiated emissions (30 MHz – 1 GHz)	PASS	-
Conducted immunity	EN 61000-4-6	RF conducted signals immunity test (150 kHz – 80 MHz, 10 V rms)	PASS	In case of non-metering applications, communicating outside the CENELEC A band, please refer to the immunity requirements listed in the EN50065-2-1 document, which may set lower limits for some tests.
	EN 50065-2-3	Narrow-band signals immunity test (95 kHz - 150 kHz; 150 kHz - 30 MHz)	PASS	
	EN 61000-4-4	Fast Transients Immunity test (2 kV, 5 kHz)	PASS	
	EN 61000-4-5	Surge Immunity test (4 kV, common mode and differential mode)	PASS	
Radiated immunity	EN 61000-4-3	RF radiated signals immunity test (150 kHz - 80 MHz, 10 V rms)	PASS	In case of non-metering applications, communicating outside the CENELEC A band, please refer to the immunity requirements listed in the EN50065-2-1 document, which may set lower limits for some tests.
Input impedance measurement	EN50065-7	RX impedance	PASS	-
		TX impedance	PASS	-

8.1 EN50065-1: General requirements, frequency bands and electromagnetic disturbances

8.1.1 Test setup

The tests in this section have been performed using the following setup:

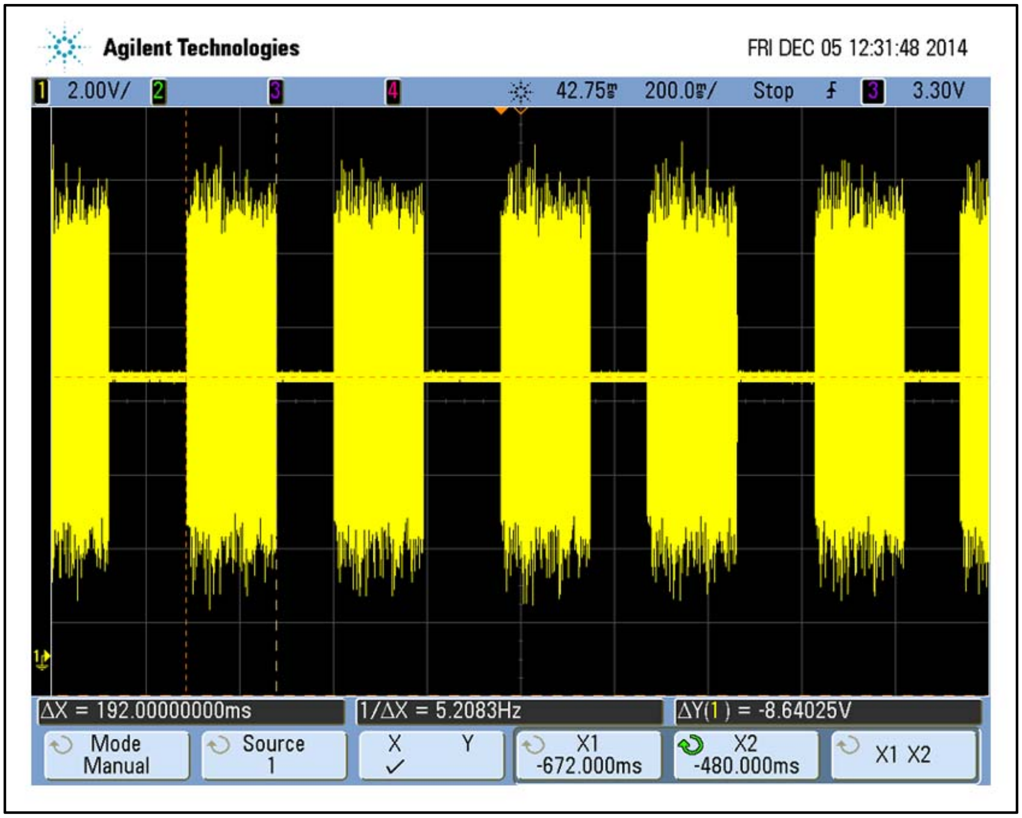
Figure 20: Bench setup for EN50065-1 tests



Instruments references are described in Table 1.

The STCOMET development kit is configured for transmitting 192 ms packets with a 50% average duty cycle as shown in Figure 21.

Figure 21: Transmitted signal for EN50065-1 tests



The STCOMET development kit settings are the following:

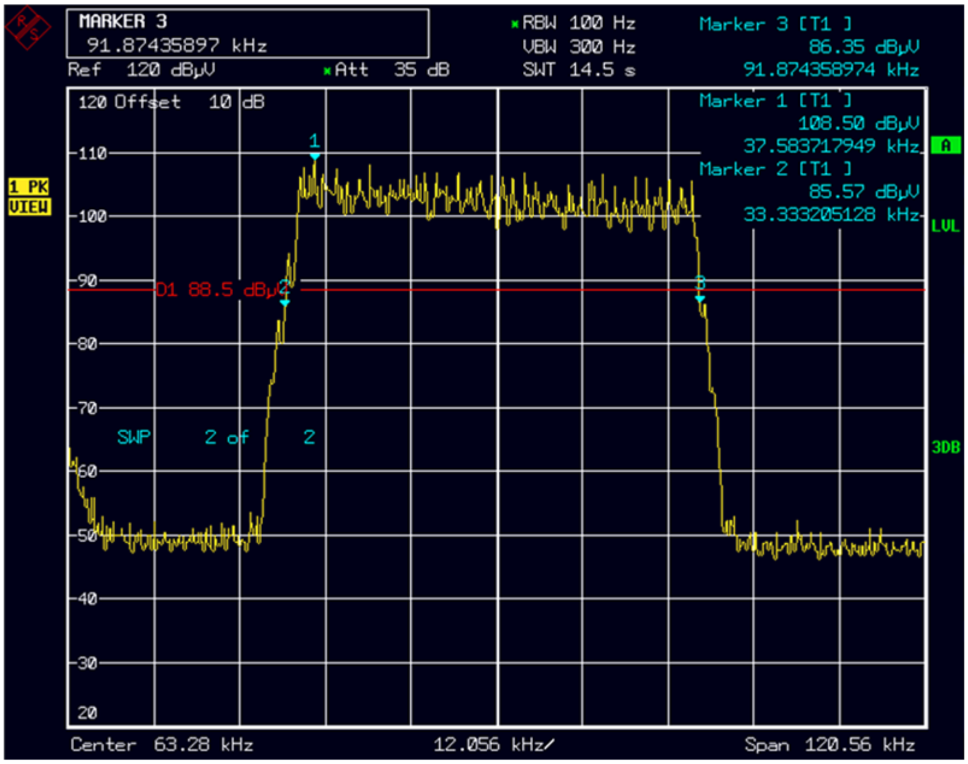
- VCC = 15 V
- TX digital gain = maximum

8.1.2 Determination of the bandwidth (EN50065-1 section 6.2.1)

Table 9: Determination of the bandwidth

Spectrum analyzer setup	Measurement results
RBW = 100 Hz Detector = PEAK MAX. Trace display = MAX. HOLD	**Signal bandwidth = 58.6 kHz** (91.87 kHz – 33.33 kHz)

Figure 22: Determination of the bandwidth (EN50065-1 section 6.2.1)



8.1.3 Determination of output level (EN50065-1 section 6.2.2)

According to the tests results in section 8.1.2 , the signal bandwidth of the STCOMET development kit is equal to 58.6 kHz with a center frequency of 62.6 kHz. Therefore, the following conclusions are valid for the execution of the tests “6.3 Maximum Outputs Levels” in EN50065-1:

- The kit operating band is 9 kHz – 95 kHz
- The kit signal is considered as a wide–band signal
- The spectrum analyzer RBW must be set to 100 kHz (unless otherwise specified).

8.1.4 Maximum output levels - sub-band above 9 kHz up to 95 kHz (EN50065-1 section 6.3.1.2)

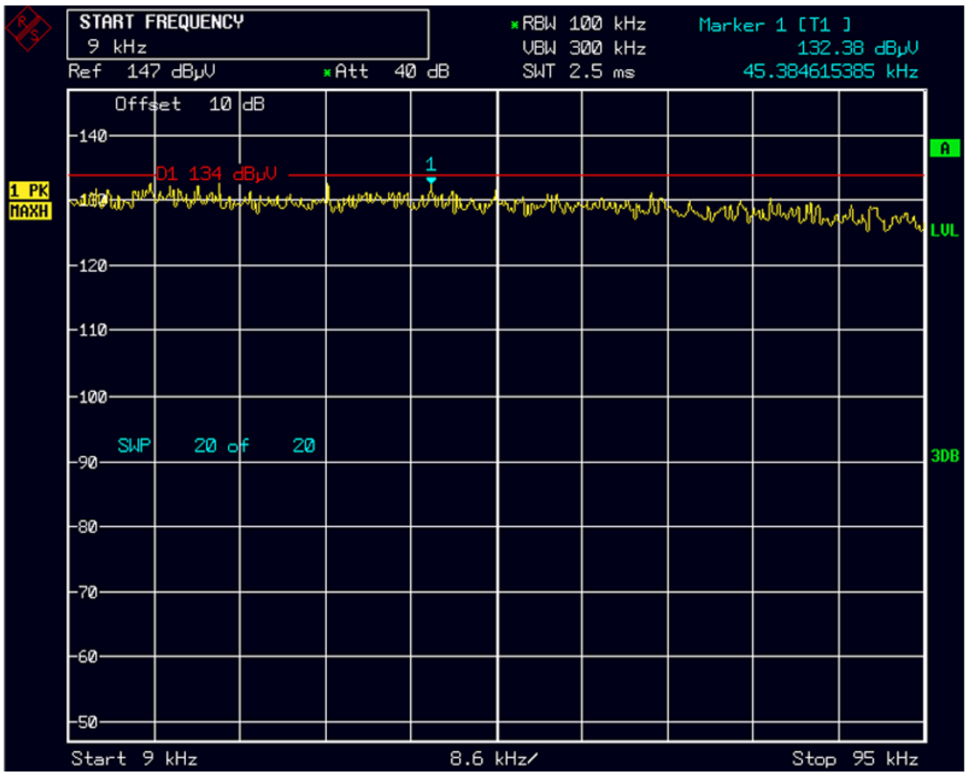
8.1.4.1 Basic test: RBW = 100 kHz (EN50065-1 section 6.3.1.2-b1)

As the transmitted signal is wide-band, the basic test shall have the following settings:

Table 10: Basic test: RBW = 100 kHz

Spectrum analyzer setup	Measurement results	Limit	Verdict
RBW = 100 kHz Detector = PEAK MAX. Trace display = MAX. HOLD	**Max. level = 132.4 dBµV**	**134 dBµV max.**	**PASS**

Figure 23: Max. output level – RBW = 100 kHz - 9 kHz to 95 kHz (EN50065-1 section 6.3.1.2)



As we can notice, the test result above is quite tight to the standard limit. This is linked to the measurement method: due to the signal bandwidth measured at 52.6 kHz, the spectrum analyzer bandwidth must be set to 100 kHz (no possible step between 50 kHz and 100 kHz). On another hand, the measurement center frequency is sweeping from 9 kHz to 95 kHz, which is very low compared to the resolution bandwidth. Consequently, a portion of the signal negative spectrum is integrated in the power measurement itself.

A second method has been used to measure the maximum output level, namely the Channel power measurement.

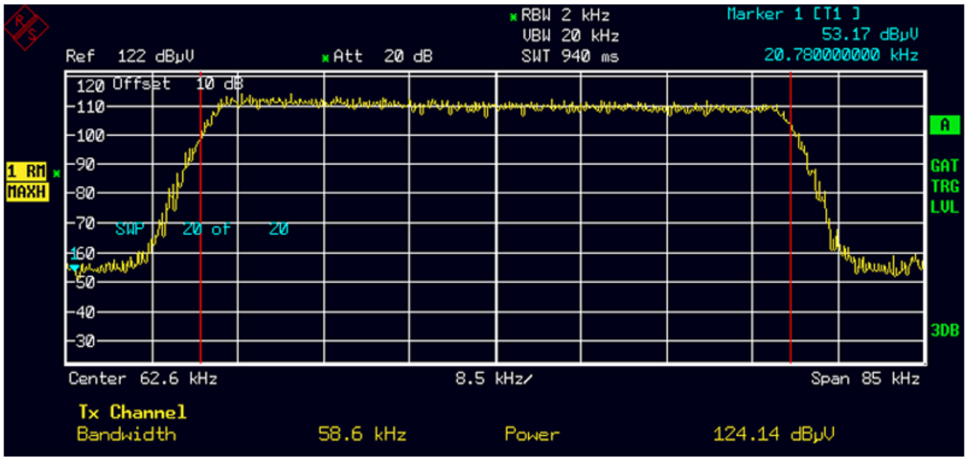
This method is using narrow resolution bandwidth (2 kHz), allowing rejecting sufficiently the negative spectrum power for measurements performed from 9 kHz to 95 kHz.

The Channel power function allows integrating the power across specified frequency bandwidth (58.6 kHz) so that the real output level is measured.

The result is illustrated in Figure 24 and the output level measured is equal to 124.14 dBµV. The margin in respect to the standard is quite comfortable.

This measurement method has been compared to a further method, using an oscilloscope, and is giving similar results.

Figure 24: Max. output level – RBW = 2 kHz - 9 kHz to 95 kHz (EN50065-1 section 6.3.1.2)



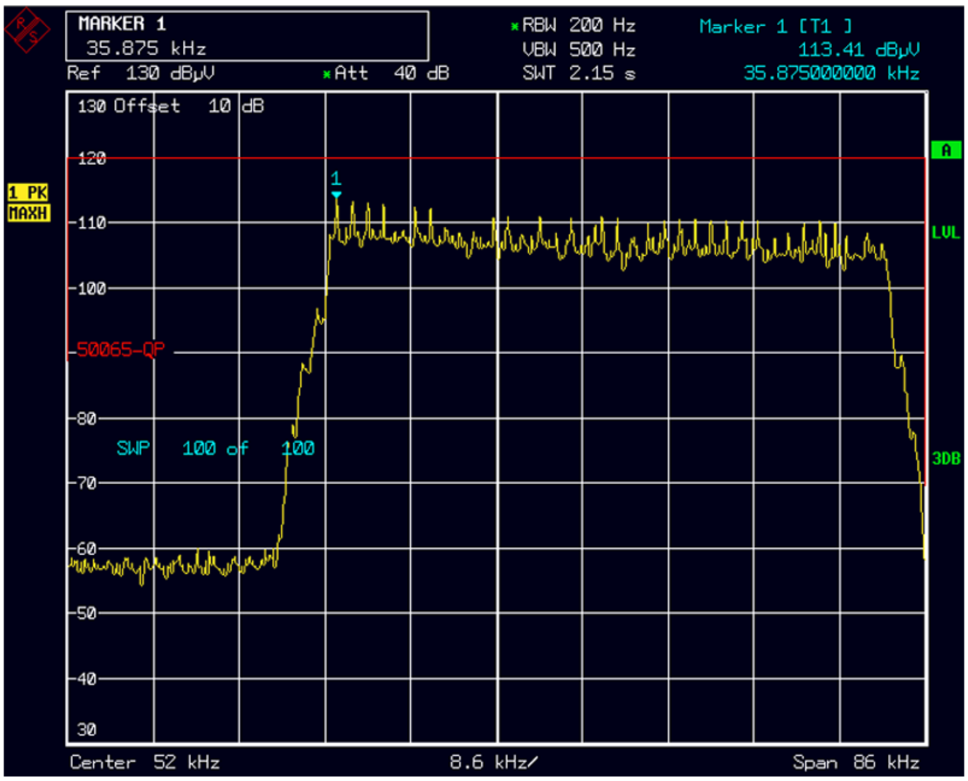
8.1.4.2 Additional test: RBW = 200 Hz (EN50065-1 section 6.3.1.2-b2)

As the transmitted signal is wide-band, the additional measurement (RBW = 200 Hz) must be executed.

Table 11: Additional test: RBW = 200 Hz

Spectrum analyzer setup	Measurement results	Limit	Verdict
RBW = 200 Hz Detector = PEAK MAX. Trace display = MAX. HOLD	**Max. level = 113.4 dBμV**	**120 dBμV max.**	**PASS**

Figure 25: Max. output level – RBW = 200 Hz – from 9 kHz to 95 kHz (EN50065-1 section 6.3.1.2)



8.1.5 Disturbance limits - application outside sub-bands (EN50065-1 section 7.1)

The STCOMET development kit operates with G3-PLC FW in the CENELEC A band (9 kHz to 95 kHz). Therefore, the disturbance tests are performed in the following bands:

- 3 kHz to 9 kHz
- 95 kHz to 150 kHz
- 150 kHz to 30 MHz

8.1.6 Conducted disturbance - frequency range from 3 kHz to 9 kHz (EN50065-1 section 7.2.1)

Table 12: Conducted disturbance - frequency range from 3 kHz to 9 kHz

Spectrum analyzer setup	Measurement results	Limit	Verdict
RBW = 100 Hz, Detector = PEAK MAX., Trace display = MAX. HOLD	**Max. level = 57.9 dBµV**	**89 dBµV max.**	**PASS**

Figure 26: LINE conducted disturbance – from 3 kHz to 9 kHz (EN50065-1 section 7.2.1)

Figure 27: NEUTRAL conducted disturbance - 3 kHz to 9 kHz (EN50065-1 section 7.2.1)

8.1.7 Conducted disturbance - frequency range from 9 kHz to 150 kHz (EN50065-1 section7.2.2)

The band from 9 kHz to 95 kHz (A band) is skipped in this test since this is the G3-PLC operating band.

Table 13: Conducted disturbance - frequency range from 9 kHz to 150 kHz

Spectrum analyzer setup	Measurement results	Limit	Verdict
Start = 95 kHz Stop = 150 kHz RBW = 200 Hz Detector = QUASI-PEAK Trace display = CLEAR WRITE	**Max. level: 48 dBµV/LINE; 48 dBµV/NEUTRAL**	**Decreasing linearly with the logarithm of frequency from (9 kHz – 89 dBµV) to (150 kHz - 66 dBµV), 95 kHz =>69.734 dBµV**	**PASS**

Figure 28: LINE conducted disturbance – from 95 kHz to 150 kHz (EN50065-1 section 7.2.2)

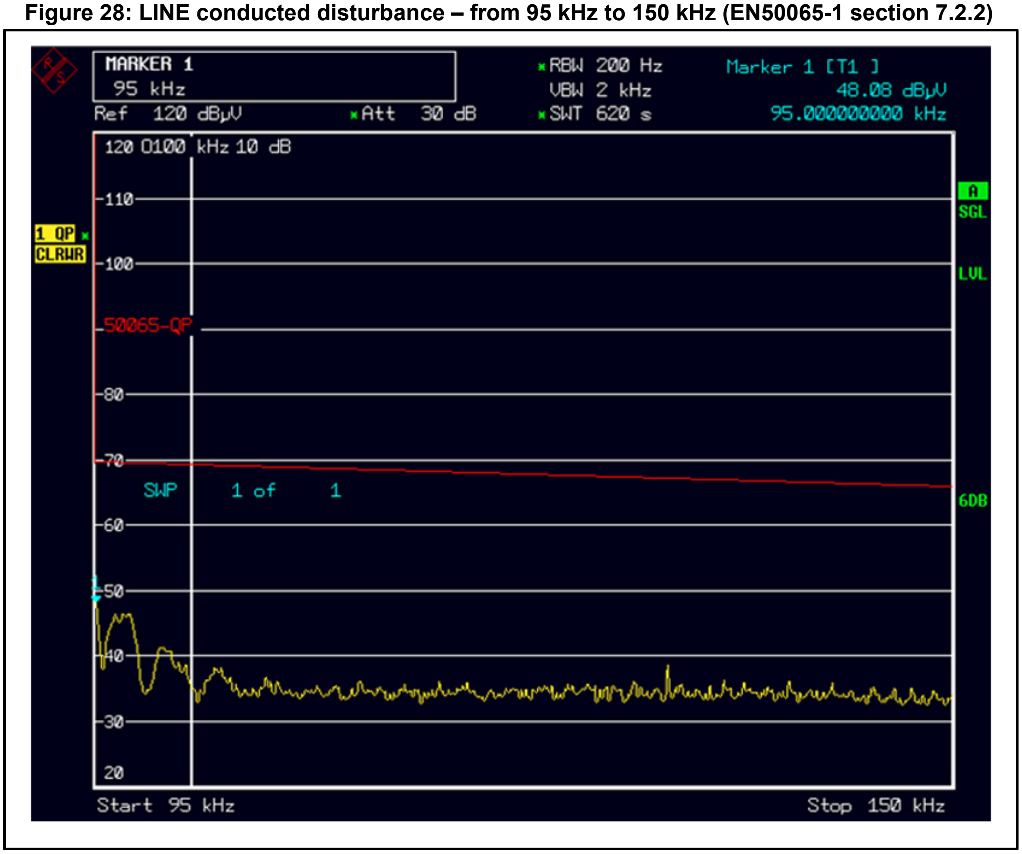
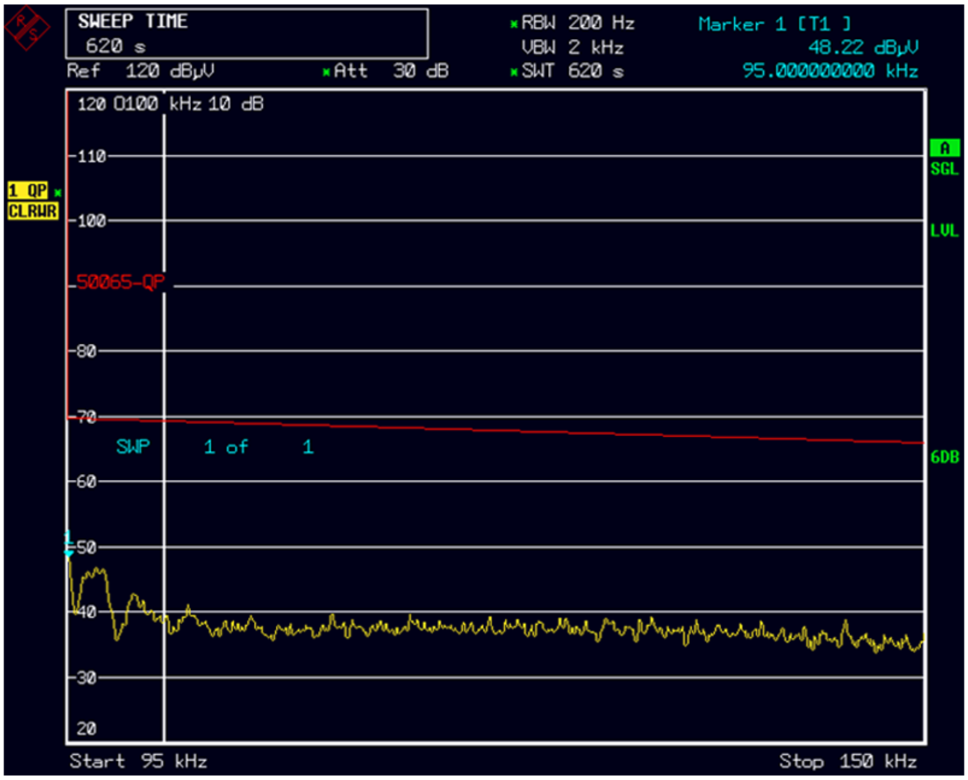


Figure 29: NEUTRAL conducted disturbance - from 95 kHz to 150 kHz (EN50065-1 section 7.2.2)



8.1.8 Conducted disturbance - frequency range from 150 kHz to 30 MHz (EN50065-1 section 7.2.3)

Two measurements are performed, with quasi-peak detector and average detector, and compared with the associated limits.

Table 14: Conducted disturbance - frequency range from 150 kHz to 30 MHz

Spectrum analyzer setup	LISN setup	Measurement results	Limit	Verdict
RBW = 9 kHz Detector = QUASI-PEAK + AVERAGE Trace display = CLEAR WRITE	150 kHz high pass filter enabled	**Max. level:** **48 dBµV/LINE;** **48 dBµV/NEUTRAL**	**Quasi-peak detector:** • **Decreasing linearly with the logarithm of frequency from (150 kHz - 66 dBµV) to (500 kHz – 56 dBµV)** • **56 dBµV from 500 kHz to 5 MHz** • **60 dBµV from 5 MHz to 30 MHz** **Average detector:** • **= Quasi-peak limits minus 10 dB**	**PASS**

Figure 30: LINE conducted disturbance – from 150 kHz to 30 MHz (EN50065-1 section 7.2.3)

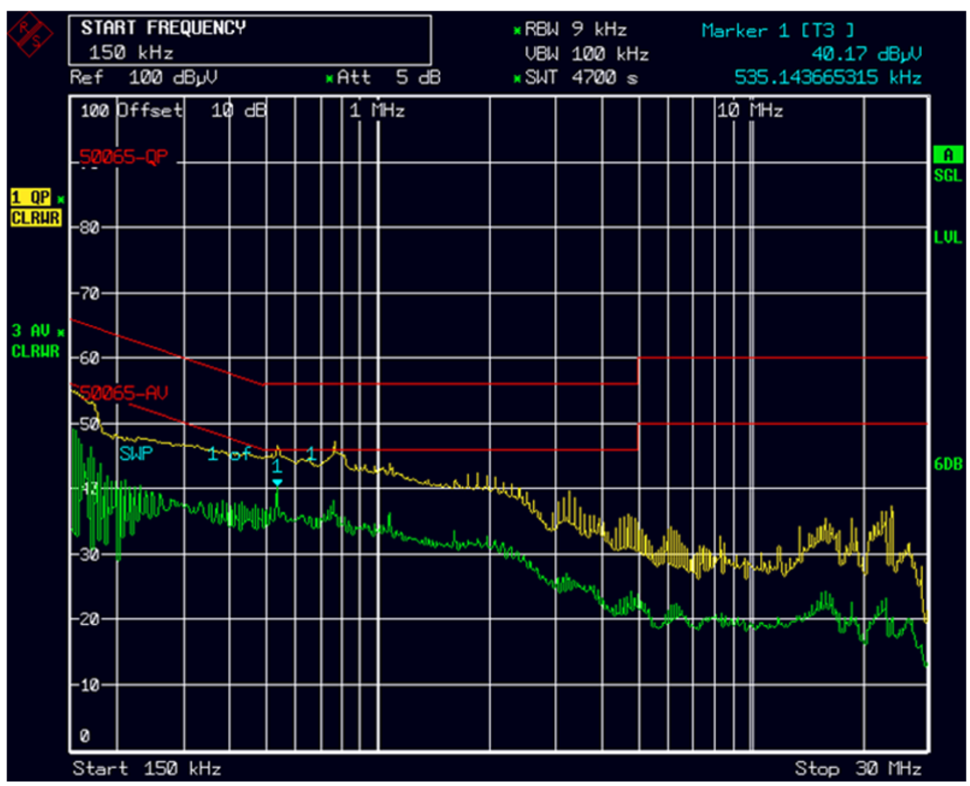
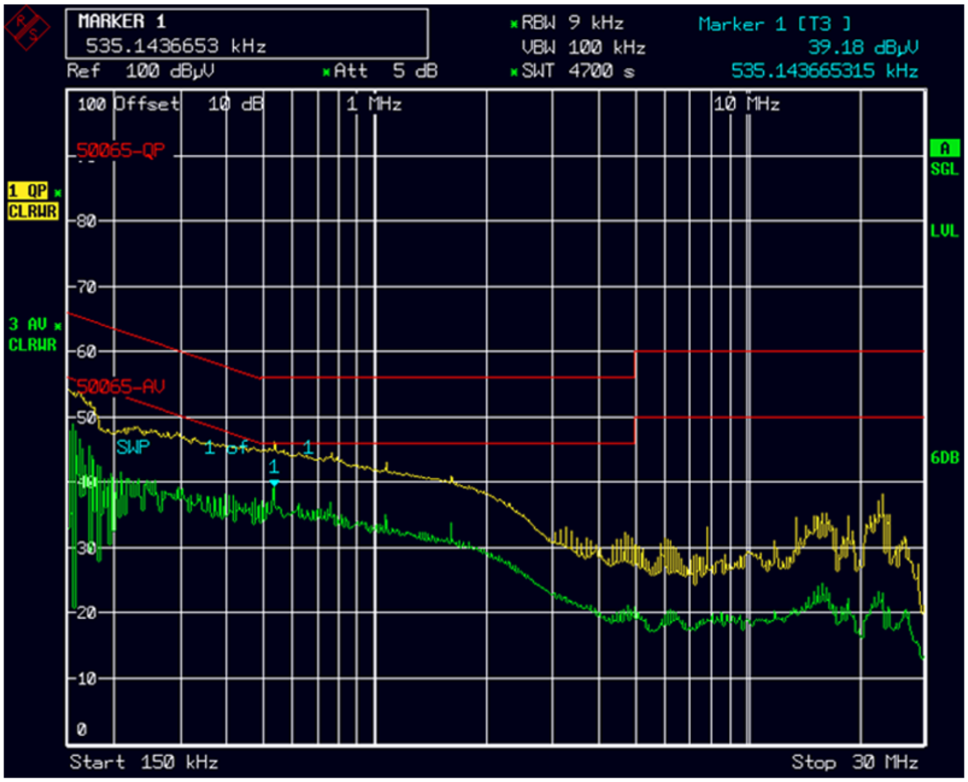


Figure 31: NEUTRAL conducted disturbance – from 150 kHz to 30 MHz (EN50065-1 section 7.2.3)



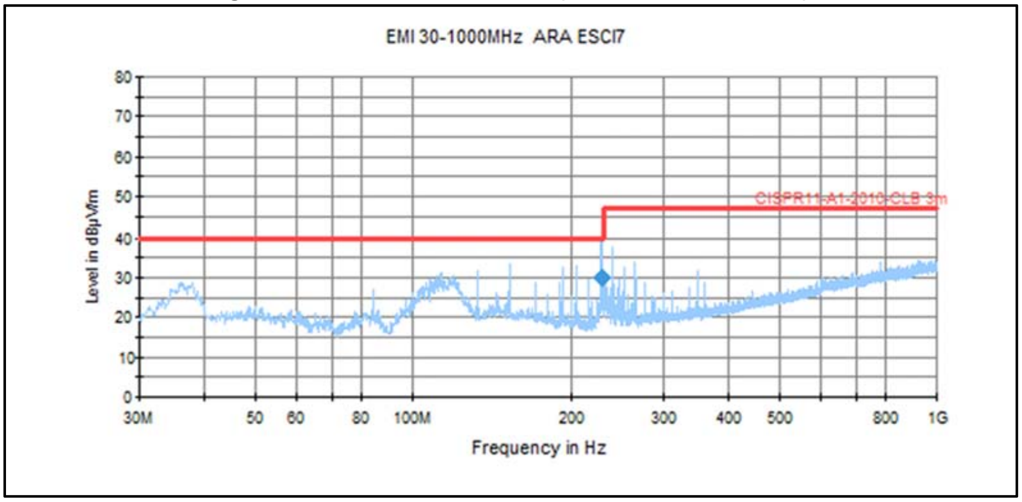
8.1.9 Radiated disturbance field strength (EN50065-1 section 7.3)

Figure 32 illustrates the radiated disturbances generated by the STCOMET development kit. The tests have been performed by an external laboratory.

Table 15: Radiated disturbance field strength

Analyzer setup	Measurement results	Limit	Verdict
Detector = QUASI-PEAK	**Max. level: 38 dBµV/LINE; 38 dBµV/NEUTRAL**	**30 to 230 MHz: 40 dBµV/m** **230 MHz to 1 GHz: 47 dBµV/m** Since the measurement distance is reduced at 3 meters, the limits are increased by a factor of **10 dB** compared to EN50065-1limits.	**PASS**

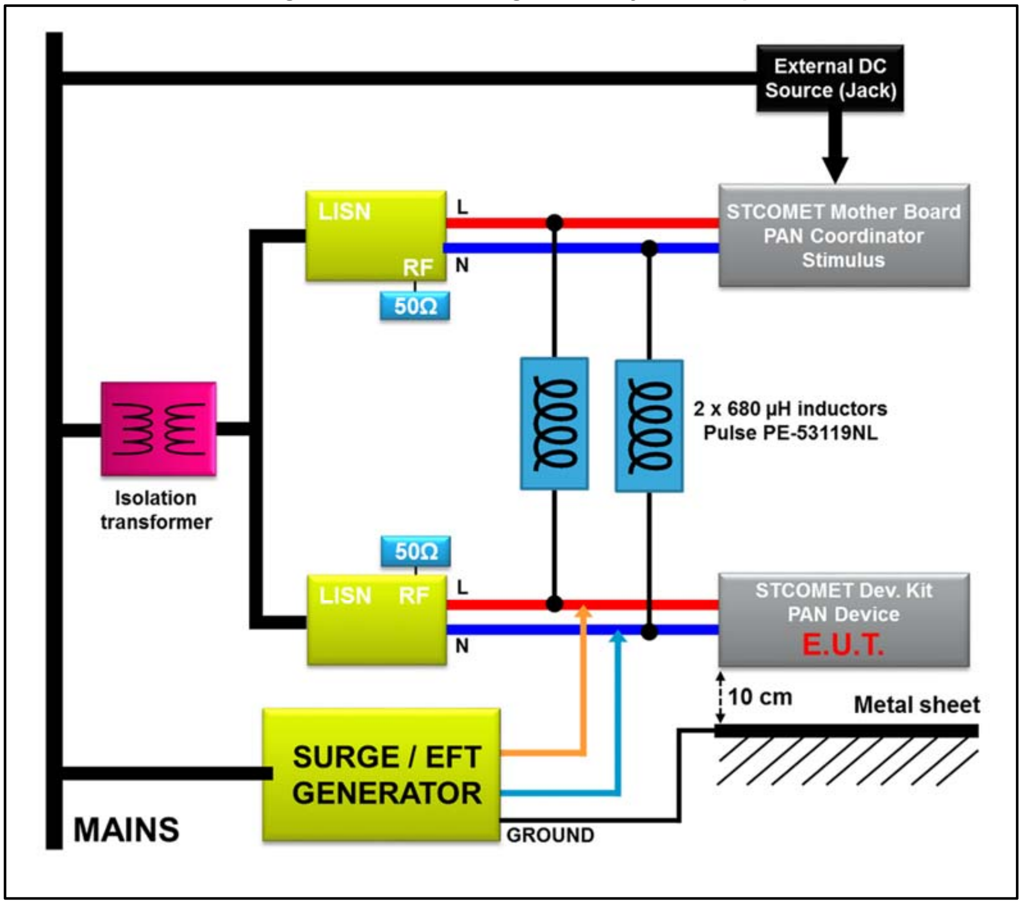
Figure 32: Radiated disturbance (EN50065-1 section 7.3)



8.2 EN50065-2-3: immunity requirements

8.2.1 Electrical Fast Transients (EFT) and Surge Immunity

Figure 33: EFT and Surge Immunity test setup



During the EFT and Surge Immunity tests, a communication is established between the E.U.T (STCOMET development kit) and the stimulus generator (STCOMET kit main board supplied by an external 15 V DC source on J7).

The stimulus acts as a PAN coordinator, and the E.U.T. acts as a PAN device. The coordinator is sending frames to the E.U.T. and expects to receive a frame answer in the reverse direction (“ping”).

The coordinator is displaying on the LCD the total number of transmitted frames and the number of error frames.

8.3 EN50065-7: equipment impedance

For a PLC node, particular attention must be paid to the impedance of the line coupling circuit. Specifically:

- In the receiving (idle) mode, the coupling impedance must be high enough to make the power line source impedance negligible and to minimize the mutual interference between different PLC nodes connected to the same network
- In the transmitting mode, the coupling impedance must be very low inside the signal bandwidth but high enough for out-of-band frequencies.

According to such requirements, the EN50065-7 standard document fixes the following constraints for the PLC node operating in the A band:

- Tx mode:
  - Free in the range from 3 to 95 kHz
  - 3 Ω from 95 to 148.5 kHz
- Rx mode:
  - 10 Ω from 3 to 9 kHz
  - 50 Ω between 9 and 95 kHz only inside the signal bandwidth (free for frequencies outside the signal bandwidth)
- 5 Ω from 95 to 148.5 kHz.

Figure 34 and Figure 35 show the input impedance magnitude vs. frequency measured in the reception and transmission mode.

The impedance magnitude values prove that the STCOMET reference design is compliant with the EN50065-7 requirements. At the same time, the line interface gives an efficient signal coupling both in the transmission and reception.

Figure 34: Input impedance – reception mode

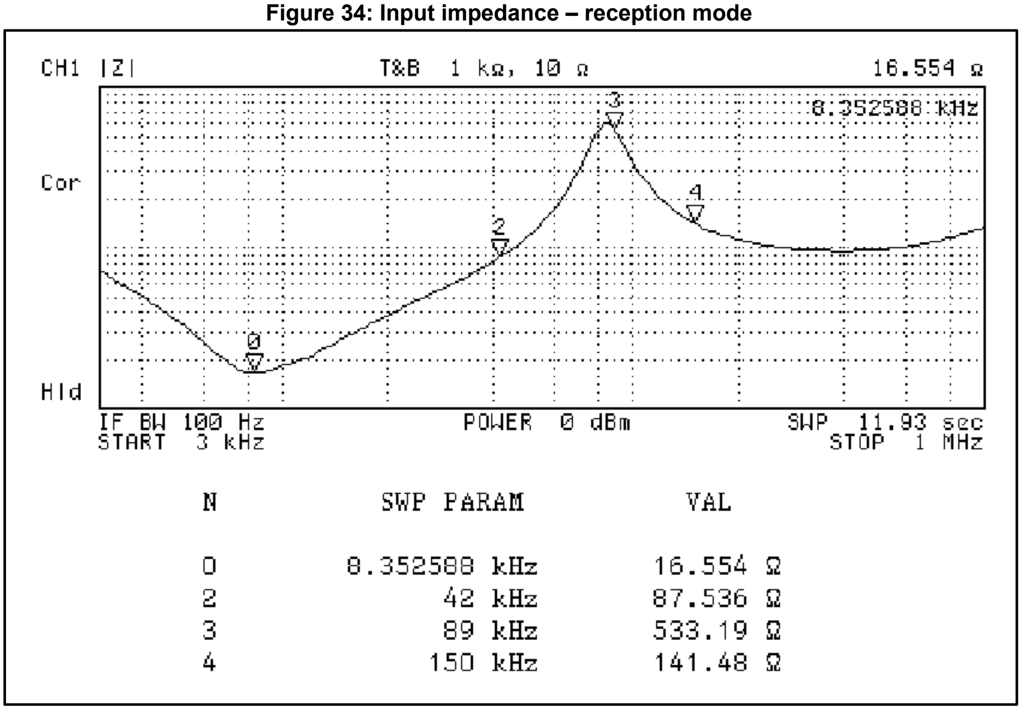
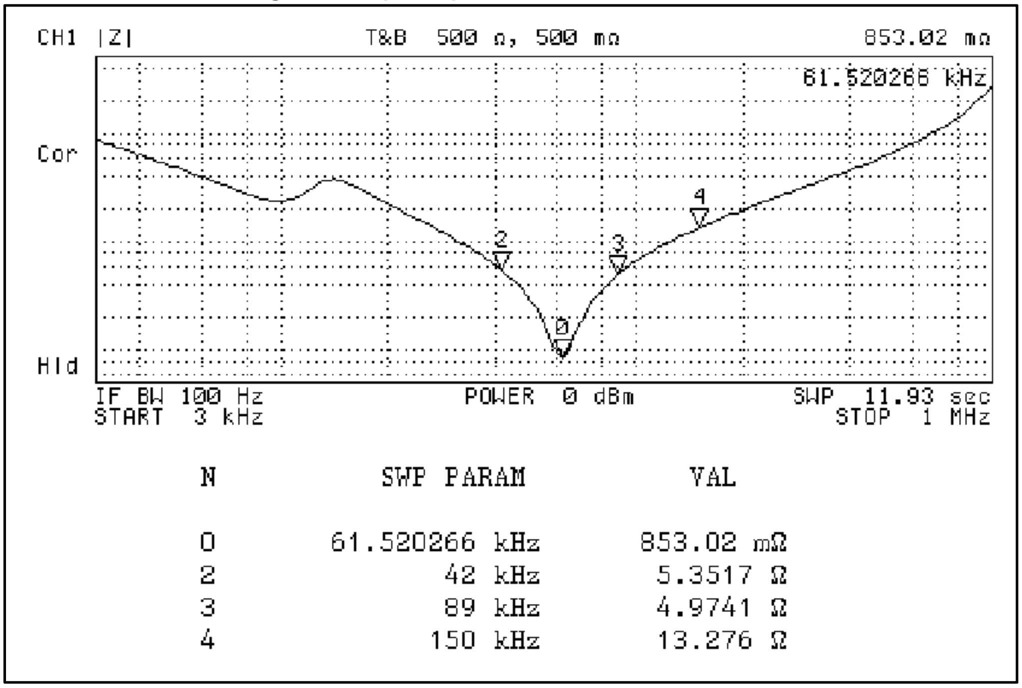


Figure 35: Input impedance - transmission mode



9 References

1. STCOMET datasheet
2. Getting started with the STCOMET platform development environment (UM1833)
3. STCOMET smart meter and power line communication system-on-chip development kit application note (AN4732)
4. STCOMET development kit schematics and PCB layout.

10 Normative references

EN50065: Signaling on low voltage electrical installations in the frequency range 3 kHz to 148.5 kHz.

- Part 1: General requirements, frequency bands and electromagnetic disturbances
- Part 2-3: Immunity requirements
- Part 4-2: Low voltage decoupling filters - Safety requirements
- Part 7: Equipment impedance.

11 Revision history

Table 16: Document revision history

Date	Version	Changes
09-Jun-2016	1	Initial release.