

FCC ID: DO4EVOLVE and DO4WRTZ1500

EMI - TEST REPORT

- FCC Part 15.223 and FCC Part 15.247-

Test Report No. : T36888-00-02HU	21. May 2013
	Date of issue

Type / Model Name : E10 RF RFID ECO Variant

Product Description : Electronic Article Surveillance Detection System
with UHF RFID-Reader

Applicant : Checkpoint Systems, Inc.

Address : 101 Wolf Drive, Thorofare

New Jersey, USA 08086

Manufacturer : See general remarks

Address :

Licence holder : Checkpoint Systems, Inc.

Address : 101 Wolf Drive, Thorofare

New Jersey, USA 08086

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: DO4EVOLVE and DO4WRTZ1500

Contents

1	<u>TEST STANDARDS</u>	3
2	<u>SUMMARY</u>	4
3	<u>EQUIPMENT UNDER TEST</u>	6
3.1	PHOTO DOCUMENTATION OF THE EUT – SEE ATTACHMENT A	6
3.2	FERRITE LOCATIONS – SEE ATTACHMENT C	6
3.3	POWER SUPPLY SYSTEM UTILISED	7
3.4	SHORT DESCRIPTION OF THE EQUIPMENT UNDER TEST (EUT)	7
4	<u>TEST ENVIRONMENT</u>	8
4.1	ADDRESS OF THE TEST LABORATORY	8
4.2	ENVIRONMENTAL CONDITIONS	8
4.3	STATEMENT OF THE MEASUREMENT UNCERTAINTY	8
4.4	MEASUREMENT PROTOCOL FOR FCC, VCCI AND AUSTEL	8
4.5	DEVIATIONS OR EXCLUSIONS FROM THE REQUIREMENTS AND STANDARDS	9
4.6	OPERATION IN RESTRICTED BANDS	10
5	<u>TEST CONDITIONS AND RESULTS</u>	11
5.1	CONDUCTED EMISSIONS	11
5.2	FIELD STRENGTH OF THE FUNDAMENTAL WAVE	14
5.3	MAXIMUM PEAK CONDUCTED OUTPUT POWER	16
5.4	SPURIOUS EMISSIONS (MAGNETIC FIELD) 9 KHZ – 30 MHZ	18
5.5	RADIATED EMISSIONS (ELECTRIC FIELD) 30 MHZ – 1 GHZ	20
5.6	SPURIOUS RADIATED EMISSIONS IN RESTRICTED BANDS	24
5.7	MAXIMUM PERMISSIBLE EXPOSURE (MPE) – SEE ATTACHMENT B	27
6	<u>USED TEST EQUIPMENT AND ACCESSORIES</u>	28

FCC ID: DO4EVOLVE and DO4WRTZ1500

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (October, 2012)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart B - Unintentional Radiators (October, 2012)

Part 15, Subpart B, Section 15.107	AC Line conducted emissions,	Class B
Part 15, Subpart B, Section 15.109	Radiated emissions, general requirements,	Class B

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (October, 2012)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.223	Operation in the band 1.705-10 MHz §15.223(a) Radiated emissions, Fundamental & Harmonics
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

FCC ID: DO4EVOLVE and DO4WRTZ1500

2 SUMMARY

GENERAL REMARKS:

Manufacturer of the Evolve Electronic: Pikatron Feinwerktechnik GmbH & Co. KG
Raiffeisenstrasse 10
D-61250 Usingen

Manufacturer of the WRTZ-1500: RM Gerätebau
Hirschbachstr. 47
64354 Reinheim, Germany

The frequency range was scanned from 9 kHz to 10 GHz.

All emissions not reported in this test report were more than 10 dB below the specified limit.

The E10 antenna consists of following systems:

- WRTZ-1500 (FCCID: DO4WRTZ1500):

The UHF sytem is a frequency hopping system using 50 channels in the frequency band from 902 to 928 MHz. The device has a maximum of eigh external antenna ports for connection of the transmission/reception antennas for communication with RFID tags.

Measurements have been made with power settings of 30.0 dBm.

For detailed information please refer to the user manual.

It is not possible to set the EuT only in receiving mode.

- TX Antenna Double Patch:

915 MHz	Ver. Pol	Hor. Pol
Gain	4,0 dBi	5,8 dBi
Beam width		
	53 deg.	

- Evolve Family (FCCID: DO4EVOLVE):

The Evolve Electronic is a digital swept frequency hopping transmitter. The EUT hops on discrete frequencies. The hop can not stop on one of the frequencies.

In practical use both systems (E10 and WRTZ-1500) are in continuous sweep mode at the same time (simultan transmission) in the two different frequency ranges.

FCC ID: DO4EVOLVE and DO4WRTZ1500

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 30. April 2013

Testing concluded on : 02. May 2013

Checked by:

Tested by:

Klaus Gegenfurtner
Dipl. Ing. (FH)
Manager: Radio Group

Huber Markus

FCC ID: DO4EVOLVE and DO4WRTZ1500

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EuT – See Attachment A

3.2 Ferrite Locations – See Attachment C

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3.3 Power supply system utilised

Power supply voltage : 115 V / 60 Hz / 1 ϕ
 24 V / DC – Evolve Electronic
 12 V / DC – WRTZ-1500

3.4 Short description of the Equipment under Test (EuT)

The Evolve Antenna with Emerald Electronic are Electronic Article Surveillance System (EAS). The system detects target tags attached to merchandise. The targets resonate in the region of 8.2 MHz or 9.5 MHz. When an article of merchandise is purchased, the target is deactivated which causes it to no longer resonate. The Evolve Antenna's with Emerald Electronic monitors an area 3-feet on either side of the antenna in the 7.4 to 10.0 MHz range and triggers an alarm when a non-deactivated target is detected.

The WRTZ-1500 is a UHF RFID reader. It can read active and passive Tags in the frequency range from 902 to 928 MHz. 8 antenna connectors are available.

Number of tested samples: 1
 Serial number: see Photo documentation of the EuT under Point 3 / Equipment Under Test

EuT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Continuous sweep mode at 8.2 MHz Band

- TAG reading mode supplying 30.0 dBm

-

EuT configuration:

The following peripheral devices and interface cables were connected during the measurements:

- PSU (Power Supply Unit), EOS Model: ZVC65SG24E, S/N:2437, E01-A-DA18
- Standard AC mains cable Model: _____
- PSU (Power Supply Unit), XP Power Model: AHM150PS12, S/N: K12220124, #10009758 B
- Standard AC mains cable Model: _____
- Lap Top Model: Supplied by manufacturer
- Test Software Model: Supplied by manufacturer
- customer specific cables

FCC ID: DO4EVOLVE and DO4WRTZ1500

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners gmbh
Ohmstrasse 2-4
94342 Strasskirchen
Germany

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 /11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement Protocol for FCC, VCCI and AUSTEL

4.4.1 GENERAL INFORMATION

4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures in International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

In compliance with 47 CFR Part 15 Subpart A Section 15.38 testing for FCC compliance may be done following the ANSI C63.4-2003 procedures and using the CISPR 22 Limits.

FCC ID: DO4EVOLVE and DO4WRTZ1500

4.4.1.2 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2 DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with CISPR Publication 22, EN 55022 - "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4-2003 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

4.5 Deviations or Exclusions from the Requirements and Standards

The Evolve E10 is a digital swept frequency hopping transmitter. The EUT hops on discrete frequencies. The hop can not stop on one of the frequencies. It is not possible to find the "true peak" with an measuring receiver by using a average detector.

Following measurement method was used to find the "true peak".

Measurement of the fundamental – 7.4 to 10.0 MHz – was performed by setting a spectrum analyzer to "max-hold", peak detector, a 300 kHz bandwidth and a span from 6.5 MHz to 10 MHz. A resolution bandwidth of 300 kHz was used in performing the "true peak" measurements, because increasing the bandwidth above 300 kHz did not increase the detected peak of the fundamental.

Only the conducted emission test (A4), field strength of the fundamental wave (CPR1), spurious emissions (SER1) and the radiated emission test (SER2) was performed with the "E10 RF RFID ECO Variant" system. All other tests were performed with the "Emotionline E10 antenna" system which contains the same WRTZ-1500 Reader with the same test setup and same settings. For detailed information refer to the Test Report T35824-02-00HU from mikes-testingpartners gmbh.

FCC ID: DO4EVOLVE and DO4WRTZ1500**4.6 Operation in Restricted Bands**

The Evolve Electronic is a digital swept frequency hopping transmitter. The EUT hops on discrete frequencies. The discrete frequencies that can be transmitted by the EUT are as follows:

Original Emerald frequency tables Vers. 2.79:

/* Center frequency 8.2MHz +/- 410KHz */
8610, 8555, 8500, 8446, 8391, 8337, 8282, 8227, 8173, 8118, 8063, 8009, 7954, 7899, 7845, 7790

/* Center frequency 8.6MHz +/- 430KHz */
9030, 8973, 8915, 8858, 8801, 8743, 8686, 8629, 8571, 8514, 8457, 8399, 8342, 8285, 8227, 8170

/* Center frequency 9.0MHz +/- 450KHz */
9450, 9390, 9330, 9270, 9210, 9150, 9090, 9030, 8970, 8910, 8850, 8790, 8730, 8670, 8610, 8550

/* Center frequency 9.2MHz +/- 460KHz */
9660, 9599, 9537, 9476, 9415, 9353, 9292, 9231, 9169, 9108, 9047, 8985, 8924, 8863, 8801, 8740

/* Center frequency 9.5MHz +/- 480KHz */
9980, 9916, 9852, 9788, 9724, 9660, 9596, 9532, 9468, 9404, 9340, 9276, 9212, 9148, 9084, 9020

/* This table is used for multi band (8.2/9.2) skinny pulse, using PW of 4us JRG_SP */
9325, 9325, 9325, 9325, 9075, 9075, 9075, 9075, 8325, 8325, 8325, 8325, 8075, 8075, 8075, 8075

The restricted frequency bands (per FCC Part 15 Clause 15.205) in the operating frequency band of the EuT are as follows:

8.291 – 8.294 MHz
8.362 – 8.366 MHz
8.37625 – 8.38675 MHz
8.41425 – 8.41475 MHz

The transmitter is not capable of hopping into, or operating, in the restricted frequency bands and therefore complies with the restriction.

FCC ID: DO4EVOLVE and DO4WRTZ1500

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up

See Attachment C

5.1.3 Description of Measurement

The final level, expressed in dB μ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC Limit or to the CISPR limit.

To convert between dB μ V and μ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EuT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω /50 μ H (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.4 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 6.4 dB at 8.090 MHz

The requirements are **FULFILLED**.

Remarks:

FCC ID: DO4EVOLVE and DO4WRTZ1500

5.1.5 Test protocol

Test point: L1
 Operation mode: UHF Reader active – RFID active
 Remarks: FCC Requirements

Result: passed

Tested by: Huber Markus

Freq kHz	QP- L dB[μV]	D -Limit QP [dB]	Freq kHz	AV-L dB[μV]	D -Limit AV [dB]
185	43,8	20,5	185	37,4	16,9
190	44,8	19,2	190	39	15,0
250	36,5	25,3	250	29,7	22,1
285	30,7	30,0	315	29,1	20,7
360	32,6	26,1	375	31,4	17,0
500	36,8	19,2	500	33,7	12,3
565	38,4	17,6	565	35,7	10,3
815	33,1	22,9	690	29,3	16,7
940	34	22,0	940	30	16,0
1190	34,4	21,6	1190	32	14,0
1505	37	19,0	1505	35,9	10,1
1630	39,5	16,5	1630	38,6	7,4
1945	33,1	22,9	1945	31,4	14,6
2385	26,4	29,6	2385	21,1	24,9
3575	26,1	29,9	2950	16,3	29,7

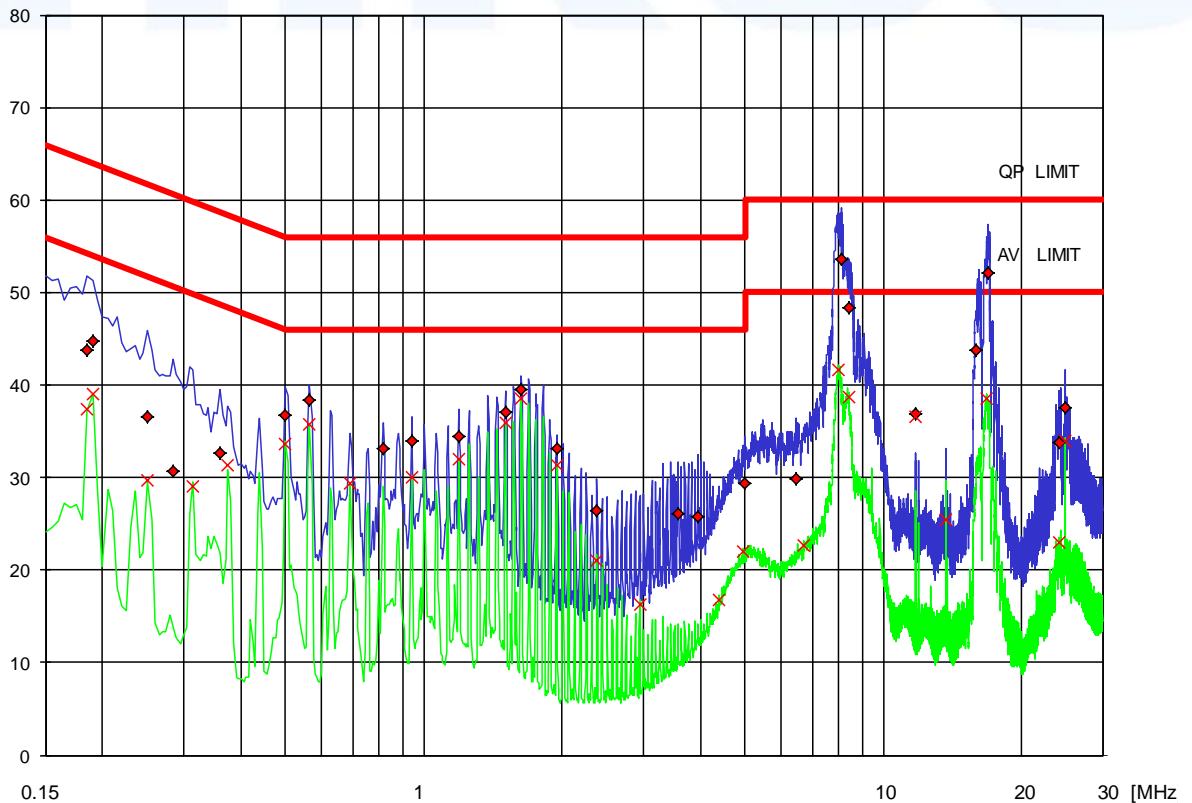
Freq kHz	QP- L dB[μV]	D -Limit QP [dB]	Freq kHz	AV-L dB[μV]	D -Limit AV [dB]
3950	25,8	30,2	4395	16,7	29,3
5000	29,4	30,6	4970	22	24,0
6470	29,8	30,2	6715	22,7	27,3
8090	53,6	6,4	7980	41,7	8,3
8420	48,4	11,6	8420	38,7	11,3
11730	36,9	23,1	11730	36,5	13,5
15885	43,7	16,3	13710	25,5	24,5
16970	52,1	7,9	16830	38,5	11,5
24215	33,8	26,2	24155	23	27,0
25000	37,6	22,4	25000	33,9	16,1

dB [μV]

Legend

PK: — AV: —

Detector: QP: ♦ AV: ×



FCC ID: DO4EVOLVE and DO4WRTZ1500

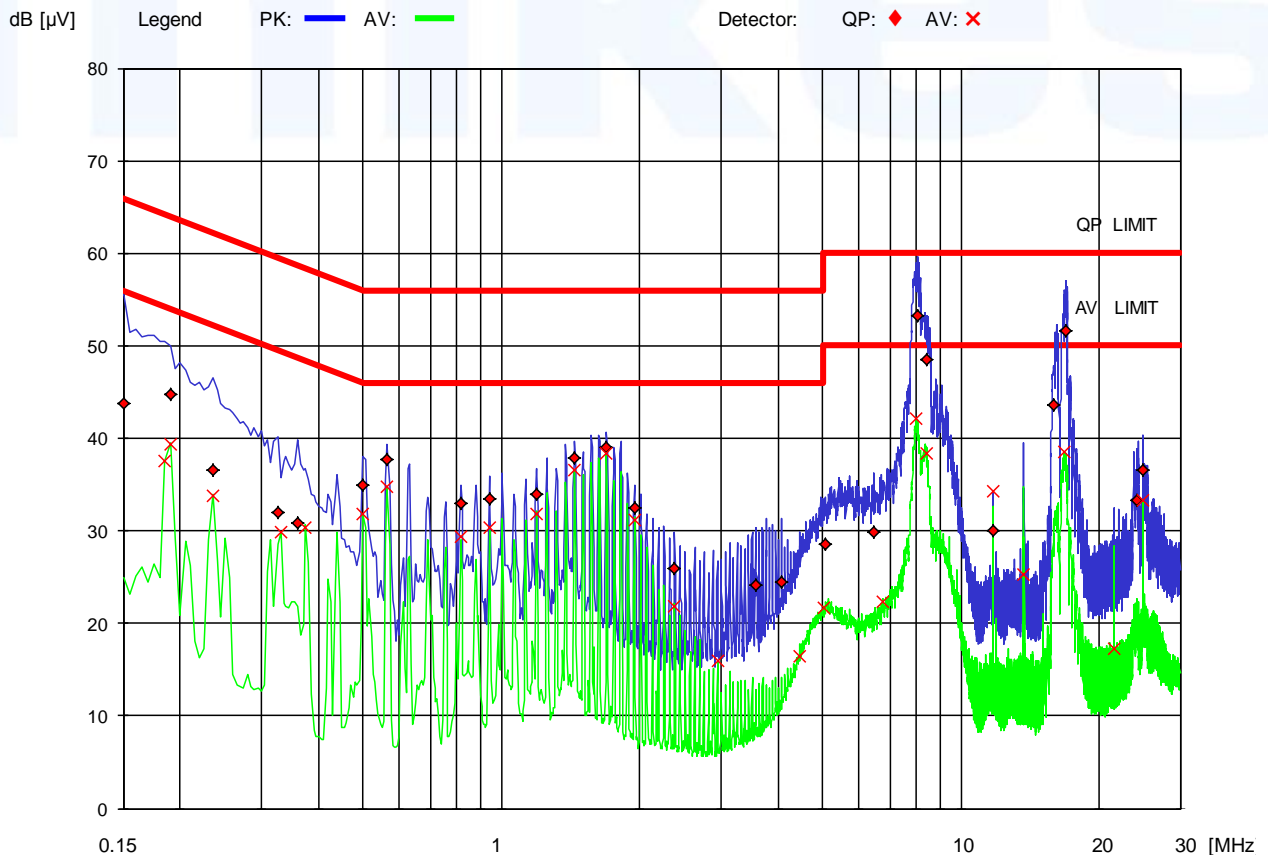
Test point: N
 Operation mode: UHF Reader active – RFID active
 Remarks: FCC Requirements

Result: passed

Tested by: Huber Markus

Freq kHz	QP- L dB[μ V]	D -Limit QP [dB]	Freq kHz	AV-L dB[μ V]	D -Limit AV [dB]
150	43,8	22,2	185	37,5	16,8
190	44,8	19,2	190	39,4	14,6
235	36,5	25,8	235	33,8	18,5
325	32	27,6	330	29,9	19,6
360	30,9	27,8	375	30,3	18,1
500	34,9	21,1	500	31,8	14,2
565	37,7	18,3	565	34,7	11,3
815	33	23,0	815	29,3	16,7
940	33,4	22,6	940	30,3	15,7
1190	34	22,0	1195	31,9	14,1
1445	37,8	18,2	1445	36,5	9,5
1695	39,1	16,9	1695	38,4	7,6
1945	32,5	23,5	1945	31,2	14,8
2385	26	30,0	2385	21,9	24,1
3575	24,2	31,8	2950	16	30,0

Freq kHz	QP- L dB[μ V]	D -Limit QP [dB]	Freq kHz	AV-L dB[μ V]	D -Limit AV [dB]
4080	24,5	31,5	4450	16,4	29,6
5080	28,5	31,5	5030	21,7	28,3
6470	29,8	30,2	6780	22,3	27,7
8060	53,3	6,7	8000	42,2	7,8
8420	48,5	11,5	8420	38,4	11,6
11730	30	30,0	11730	34,3	15,7
15885	43,6	16,4	13735	25,3	24,7
16985	51,6	8,4	16845	38,6	11,4
24245	33,3	26,7	21540	17,3	32,7
25000	36,6	23,4	25000	33,3	16,7



FCC ID: DO4EVOLVE and DO4WRTZ1500

5.2 Field strength of the fundamental wave

For test instruments and accessories used see section 6 Part CPR 1.

5.2.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.2.2 Photo documentation of the test set-up

See Attachment C

5.2.3 Description of Measurement

The magnetic field strength from the EuT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. In the case where larger measuring distances are required the results will extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with an EMI Receiver set to an average and a peak detector.

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the EMI receiver (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement was 300 kHz.

FCC ID: DO4EVOLVE and DO4WRTZ1500

5.2.4 Test result

Evolve E10:

3m Distance measured:

Frequency [MHz]	L: PK [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]	Tx1 & Tx2:
8.2	78.56	20	98.56	100.0	-1.44	31

30m Distance calculated:

Frequency [MHz]	L: PK [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
8.2	38.56	20	58.56	60.0	-1.44

Limit according to FCC Part 15 Subpart 15.223, 15.35(b)

Frequency (MHz)	Field strength of fundamental – Average Detector	
	(μ V/m)	dB (μ V/m)
1.705-10.0	100*	40*

Frequency (MHz)	Field strength of fundamental – Peak Detector	
	(μ V/m)	dB (μ V/m)
1.705-10.0	1000*	60*

* At a test distance of 30 metres

The requirements are **FULFILLED**.

Remarks:

FCC ID: DO4EVOLVE and DO4WRTZ1500**5.3 Maximum peak conducted output power**

For test instruments and accessories used see section 6 Part CPC 2.

5.3.1 Description of the test location

Test location: Shielded Room S4

5.3.2 Photo documentation of the test set-up

See Attachment C

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(2):

For frequency hopping systems operating in the 902-928 MHz band the maximum peak conducted output power shall not exceed the limit of 1 watt for systems employing at least 50 hopping channels.

5.3.4 Description of Measurement

A spectrum analyzer is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode using the assigned frequency.

Spectrum analyser settings:

RBW	300 kHz	Sweep time	5 ms (Auto)
VBW	1 MHz	Power Mode	Max. hold
Detector	Peak	Span	500 kHz

FCC ID: DO4EVOLVE and DO4WRTZ1500

5.3.5 Test result

- a) Power setting 30.0 dBm
Antenna Double Patch: antenna gain: 5.8 dBi

Channel	Frequency (MHz)	Peak Power (dBm)	Correction (dB)	Corr. Peak power (dBm)	Limit (dBm)	Delta (dB)
1	902.75	8.99	20	28.99	30.0	-1.01
25	914.75	9.02	20	29.02	30.0	-0.98
50	927.25	9.11	20	29.11	30.0	-0.89

Note: Correction means fixed attenuation of 20 dB.
Test cable loss is included in the analyzer reading (Transducer factor).

Peak Power Limit according to FCC Part 15C, Section 15.247(b)(2):

Frequency (MHz)	Hopping channels	Hop. CH carrier frequ. separation	Peak Power Limit	
			(dBm)	(W)
902-928	≥ 50		30	1.0

The requirements are **FULFILLED**.

Remarks:

FCC ID: DO4EVOLVE and DO4WRTZ1500**5.4 Spurious emissions (Magnetic field) 9 kHz – 30 MHz**

For test instruments and accessories used see section 6 Part SER 1.

5.4.1 Description of the test location

Test location: OATS1

Test distance: 10 metres

5.4.2 Photo documentation of the test set-up

See Attachment C

5.4.3 Description of Measurement

The spurious emissions from the EuT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. In the case where larger measuring distances are required the results will extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209 (d) [2].

FCC ID: DO4EVOLVE and DO4WRTZ1500

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the EMI receiver (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 300 kHz

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	Limit (dB μ V/m)	=	Delta (dB)
1.705	5	+	20	=	25	30	=	5

5.4.4 Test result

Evolve E10

Tx Frequency: 8.2 MHz Band

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.009-0.490				20				48.5 – 13.8	> 20
0.490-1.705				20				33.8 – 22.97	> 20
1.705-30.0				20				29.5	> 20

Limit according to FCC Part 15 Subpart 15.209(a), Subpart 15.223(a)

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (meters)
	(μ V/m)	dB (μ V/m)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED**.

Remarks:

FCC ID: DO4EVOLVE and DO4WRTZ1500

5.5 Radiated emissions (electric field) 30 MHz – 1 GHz

For test instruments and accessories used see section 6 Part SER 2.

5.5.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

5.5.2 Photo documentation of the test set-up

See Attachment C

5.5.3 Description of Measurement

Spurious emissions from the EuT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003. The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarization's and the EuT are rotated 360 degrees.

The final level, expressed in dB μ V/m, is arrived by taking the reading from the EMI receiver (Level dB μ V) and adding the correction factors and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver, where the correction factors are stored. This result then has the FCC or CISPR limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets at page.

The resolution bandwidth during the measurement is as follows:

30 MHz – 1000 MHz: ResBW: 120 kHz

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	Limit (dB μ V/m)	=	Delta (dB)
719	75	+	32.6	=	107.6	110	=	-2.4

FCC ID: DO4EVOLVE and DO4WRTZ1500
5.5.4 Test result

Extract of the critical values:

**Evolve E10, Tx Frequency: 8.2 MHz Dual Band, Tx1&Tx2:31
WRTZ-1500, Power setting 30.0 dBm**

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
33,3201	16,1		12,8		28,9		40,0	-11,1
40,3899	17,9		14,2		32,1		40,0	-7,9
41,6432	20,5		14,4		34,9		40,0	-5,1
42,2476	20,9		14,4		35,3		40,0	-4,7
47,7100	16,5	2,3	14,9	13,9	31,4	16,2	40,0	-8,6
48,4668	15,3		15,0		30,3		40,0	-9,7
49,9664	18,8		15,1		33,9		40,0	-6,1
50,7125	19,5		15,0		34,5		40,0	-5,5
55,6714	18,2		14,7		32,9		40,0	-7,1
56,5154	18,4		14,7		33,1		40,0	-6,9
58,2606	20,8		14,6		35,4		40,0	-4,6
59,1606	22,4	6,6	14,6	13,7	37,0	20,3	40,0	-3,0
63,6093	14,0		14,3		28,3		40,0	-11,7
71,5701	25,4		13,4		38,8		40,0	-1,2
72,6494	25,6		13,1		38,7		40,0	-1,3
95,3934	30,9		8,6		39,5		43,5	-4,0
99,8857	24,6		8,8		33,4		43,5	-10,1
127,2379	14,5		12,1		26,6		43,5	-16,9
182,8693	9,3	14,7	12,6	13,1	21,9	27,8	43,5	-15,7
193,8025	10,1	5,8	11,3	11,7	21,4	17,5	43,5	-22,1
206,7265	8,3		11,0		19,3		43,5	-24,2
214,6519	9,4	11,6	11,5	11,8	20,9	23,4	43,5	-20,1
219,7305	8,7	6,5	11,8	12,1	20,5	18,6	46,0	-25,5
230,5179	14,4	12,5	12,5	12,8	26,9	25,3	46,0	-19,1
233,1516	10,9	14,4	12,7	12,9	23,6	27,3	46,0	-18,7
236,6594	15,3		12,9		28,2		46,0	-17,8
238,4194	14,4	12,9	13,0	13,2	27,4	26,1	46,0	-18,6
241,4396	22,8	18,0	13,2	13,4	36,0	31,4	46,0	-10,0
<u>245,0764</u>	<u>26,9</u>	<u>8,0</u>	<u>13,5</u>	<u>13,7</u>	<u>40,4</u>	<u>21,7</u>	<u>46,0</u>	<u>-5,6</u>

FCC ID: DO4EVOLVE and DO4WRTZ1500

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
245,0764	26,9	8,0	13,5	13,7	40,4	21,7	46,0	-5,6
246,4290	26,3	13,0	13,6	13,7	39,9	26,7	46,0	-6,1
249,8292	20,8		13,8		34,6		46,0	-11,4
253,5748	18,3		14,0		32,3		46,0	-13,7
258,0932	26,7		14,2		40,9		46,0	-5,1
261,9529	28,9	22,4	14,4	14,4	43,3	36,8	46,0	-2,7
262,3735	27,1	22,3	14,5	14,4	41,6	36,7	46,0	-4,4
266,5103	28,6	21,2	14,7	14,6	43,3	35,8	46,0	-2,7
270,3537	24,3		14,9		39,2		46,0	-6,8
274,7236	21,3	15,8	15,1	14,9	36,4	30,7	46,0	-9,6
278,8852	25,4	13,1	15,3	15,1	40,7	28,2	46,0	-5,3
286,2487	20,0		15,7		35,7		46,0	-10,3
287,3006	18,7		15,8		34,5		46,0	-11,5
288,1480	15,9		15,8		31,7		46,0	-14,3
290,7393	22,8	20,5	16,0	15,5	38,8	36,0	46,0	-7,2
291,3915	22,7		16,0		38,7		46,0	-7,3
294,1642	24,6	20,8	16,2	15,7	40,8	36,5	46,0	-5,2
295,7642	22,5	4,9	16,3	15,7	38,8	20,6	46,0	-7,2
298,8292	23,1		16,4		39,5		46,0	-6,5
299,7222	16,6		16,5		33,1		46,0	-12,9
304,2230	15,8		16,6		32,4		46,0	-13,6
306,8759	19,6		16,6		36,2		46,0	-9,8
310,0663	19,8	16,6	16,7	16,1	36,5	32,7	46,0	-9,5
312,6893	16,2		16,8		33,0		46,0	-13,0
441,2729	13,2		20,1		33,3		46,0	-12,7
218,0423		15,2		12,0		27,2	46,0	-18,8
228,1510		12,4		12,6		25,0	46,0	-21,0

FCC ID: DO4EVOLVE and DO4WRTZ1500

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (meters)
	($\mu\text{V/m}$)	dB ($\mu\text{V/m}$)	
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
960-1000	500	54	3

The requirements are **FULFILLED**.

Remarks: The table shows an extract of the critical values.

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FCC ID: DO4EVOLVE and DO4WRTZ1500

5.6 Spurious radiated emissions in restricted bands

For test instruments and accessories used see section 6 Part **SER 1, SER 2, SER 3.**

5.6.1 Description of the test location

Test location: OATS1
Test distance: 3 metres

Test location: Anechoic Chamber A2
Test distance: 3 metres

5.6.2 Photo documentation of the test set-up

See Attachment C

5.6.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 902 to 928 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a) (see Section 15.205(c)).

5.6.4 Description of Measurement

Radiated spurious emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linear polarized antennas. The measurements are made with 120 kHz bandwidth and quasi-peak detection (200 Hz, 9 kHz up to 30 MHz). The EUT was placed on a 1.0 X 1.5 metres non-conducting table 80 centimetres above the ground plane. The set up of the equipment under test will be in accordance to ANSI C63.4. The antenna was positioned 3 metres horizontally from the EUT. To locate maximum emissions from the EUT the antenna is shifted in height from 1 to 4 metres, after the EUT is rotated 360 degrees. The measurement scan is made in horizontal and vertical polarization of the antenna. The correction factors for antenna gain and cable loss are stored in the EMI receiver and automatically added to a measurement data to display the final level in dB μ V/m.

For the radiated measurement up from 1 GHz to maximum frequency as specified in Section 15.33, a spectrum analyzer and appropriate linear polarized antennas are used. The EUT is placed on a 1.0 X 1.5 metres non-conducting table 80 centimetres above the ground plane. The set up of the EUT will be in accordance to ANSI C63.4. The antenna was positioned 3 m horizontally from the EUT. To locate maximum emissions the EUT was rotated 360 degrees in the fully anechoic chamber. The measurement scan is made in horizontal and vertical polarization of the antenna. For testing above 1 GHz, if the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported.

FCC ID: DO4EVOLVE and DO4WRTZ1500
5.6.5 Test result
5.6.5.1 Radiated emission test f < 1 GHz

In the frequency range from 9 kHz to 30 MHz no emissions in the restricted bands could be measured.

In the frequency range from 30 MHz up to 1 GHz no emissions in the restricted bands could be measured.

5.6.5.2 Radiated emission test f > 1GHz

Power setting 30.0 dBm

Antenna Double Patch: antenna gain 5.8 dBi

Frequency (GHz)	L: PK (dB μ V)	L: AV (dB μ V)	Bandwidth (kHz)	Correct. (dB)	L: PK dB(μ V/m)	L: AV dB(μ V/m)	Limit AV dB(μ V/m)	Delta (dB)
1732.0	67.4	61.2	1000	-13.7	53.7	47.5	54.0	- 6.5
2602.0	63.7	58.7	1000	-9.5	54.2	49.2	54.0	- 4.8
3472.0	65.6	59.6	1000	-9.0	56.6	50.6	54.0	-3.4

Radiated limits according to FCC Part 15C, Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (metres)
	(μ V/m)	dB(μ V/m)	
0.009 - 0.490	2400/F(kHz)		300
0.490 - 1.705	24000/F(kHz)		30
1.705 - 30	30	29,5	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

FCC ID: DO4EVOLVE and DO4WRTZ1500

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

The requirements are **FULFILLED**.

Remarks: During the test the EUT was set into TX continuous mode with normal modulation.

The measurement was performed up to the 10th harmonic (10000 MHz).

FCC ID: DO4EVOLVE and DO4WRTZ1500**5.7 Maximum permissible exposure (MPE) – See Attachment B**

For test instruments and accessories used see section 6 Part **CPC 2**.

5.7.1 Description of the test location

Test location: None

5.7.2 Applicable standard

According to FCC Part 15, Section 15.247(i):

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".

This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

5.7.3 Description of Measurement

The maximum total power input to the antenna has been measured conducted as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, the MPE can be calculated in a defined distance away from the product.

Friis transmission formula:
$$P_d = \frac{P_{out} * G}{4 * \pi * r^2}$$

where

P_d = power density (mW/cm²)

P_{out} = output power to antenna (mW)

G = gain of antenna (linear scale)

r = distance between antenna and observation point (cm)

Remarks: For detailed test result please refer Attachment B.

FCC ID: DO4EVOLVE and DO4WRTZ1500
6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used, in addition to the test accessories, are calibrated and verified regularly.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	ESCS 30	02-02/03-05-001	18/12/2013	18/12/2012		
	ESH 2 - Z 5	02-02/20-05-003	12/04/2014	12/04/2013	24/07/2013	24/01/2013
	N-1500-N	02-02/50-05-141				
	N-3000-BNCW	02-02/50-05-142				
	SP 103 /3.5-60	02-02/50-05-182				
	ESH 3 - Z 2	02-02/50-05-185			05/10/2013	05/04/2013
CPC 2	FSP 40	02-02/11-11-001	18/09/2013	18/09/2012		
	Inmet 18N50W-20 dB	02-02/50-10-001				
CPR 1	ESCI	02-02/03-05-005	03/12/2013	03/12/2012		
	HFH 2 - Z 2	02-02/24-05-020	23/08/2014	23/08/2013	14/02/2014	14/02/2013
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 1	ESCI	02-02/03-05-005	03/12/2013	03/12/2012		
	HFH 2 - Z 2	02-02/24-05-020	23/08/2014	23/08/2013	14/02/2014	14/02/2013
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 2	ESVS 30	02-02/03-05-006	26/06/2013	26/06/2012		
	VULB 9168	02-02/24-05-005	11/04/2014	11/04/2013	11/10/2013	11/04/2013
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
SER 3	FSP 30	02-02/11-05-001	18/10/2013	18/10/2012		
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	04/04/2014	04/04/2013		
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				