External Tx data	Transmit data
Trigger output	Positive pulse, 1 µs, on selected trigger

Analog output levels, like RF and demodulated RF, are 0 – 3.3 Volt.
Digital outputs inverting buffer ports, 0 – 3.3 Volt.

Fig. 2 Front panel of the SmartWave box

The test connectors are MCX female PCB-mounted connectors.

Note: Check section 7.1 Technical for other detail technical data.

5.4 Terminal / Card side

The SmartWave Box has an internal terminal to communicate with CL cards and a CL card emulator probe for communication with the CL terminal.
Both the internal terminal and the CL probe support ISO 14443 Type A and B and ISO 18092 NFCIP-1.
The CL probe is connected by a cable with the SmartWave Box, using a 6 pin FireWire connector at the backpanel of the box.

All communications with CUT and / or TUT are performed with nominal values for magnetic field strength and modulation depths, since reliable tests with other values require a, per test, calibration of these values. Tests of ISO 14443/2 will not be performed with the SmartWave Box, although the SmartWave Box facilitates these measurements with the analog RF output connectors.

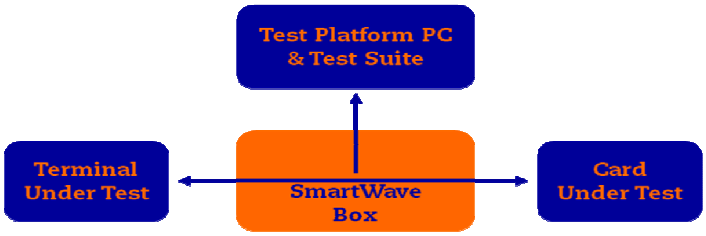
5.5 Modes of operation

The SmartWave Box has the following modes of operation:

- Analyzer mode
- Interceptor mode
- Card reader mode
- Card emulator mode
- Passive spying mode

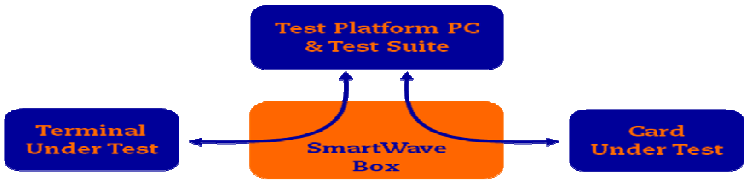
5.5.1 Analyzer mode

The CL CUT and the TUT are connected via the SmartWave Box. The SmartWave Box will resupply the RF signal driver. In addition I/O direction information, CL card power level (if supplied by the card) and timestamps are transferred to the driver.
The I/O and I/O direction information is output to high impedance connectors on the front of the SmartWave Box (Different output can be configured through API).
Power levels if available are relative otherwise it requires calibration for each test and test setup with a known (external) reference.



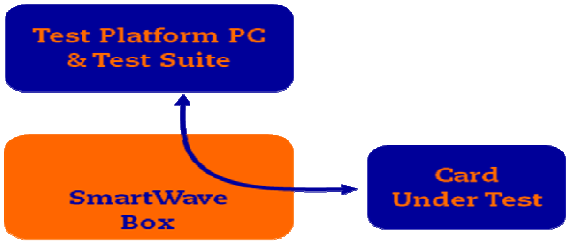
5.5.2 Interceptor mode

The interceptor mode looks the same as the Analyzer mode; however the I/O data is not directly moved between the CUT and the TUT. The data from CL card or the terminal is sent to the host computer which will send the same or modified data to the terminal or the CL card. Due to timing constraints the level 3 anti-collision is performed directly by card and terminal without host intervention, however all frames are passed to the host. After that the level 4 transfers are routed via the host computer.



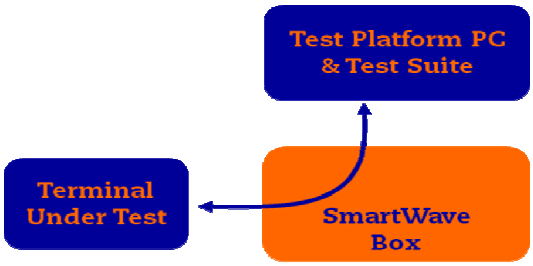
5.5.3 Card reader mode

In the card reader mode the SmartWave Box acts as an intelligent CL card reader. This enables tests with various bit rates and modulation types.
This mode can be used to perform the tests as described in ISO 10373-6 Amd.1 and ISO 23917, apart of the level 2 tests.



5.5.4 Card emulator mode

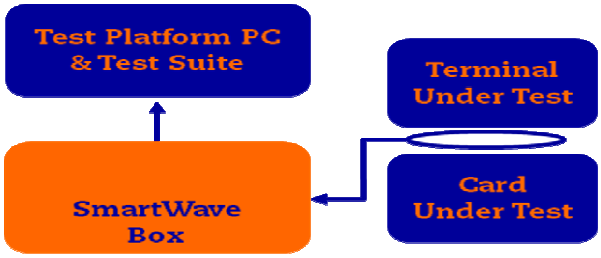
In the card emulator mode only the CL probe is used and directly controlled by the host computer.
This mode can be used to perform the tests as described in ISO 10373-6 Amd.3 and ISO 23917, apart from level 2 tests.



5.5.5 Passive spy mode

The card spying mode uses a passive pick-up coil to capture communication between a CL card and a terminal. Neither the CL card nor the terminal needs to be connected with the host computer. Care is taken to influence the CL card – terminal communication a less as possible.

Note: The passive spy mode is only available with v02.00+ hardware; active spy will be used on v01.xx boxes.
With active spy, it works using the setup like analyse mode, while the box only forwards the raw signal between CUT and TUT instead of transmitting bytes.



6 COMMUNICATING WITH THE SMARTWAVE BOX

The SmartWave Box is command driven. The host computer configures the SmartWave Box and will either passively capture data or actively interact with CL card or terminal.
The frame transfer is of a request – response type, where the host computer sends the requests and the SmartWave Box sends the response.
For some events the SmartWave Box sends unsolicited messages.

6.1 Host interface protocol

The host computer – SmartWave Box protocol is TLV (Tag, Length, Value) based, this allows easy adaptations in the future.

Every message, both from the host or from the SmartWave Box, starts with a 2 byte start frame delimiter (SFD) and ends with an end frame delimiter (EFD). The 1st byte of the SFD = 0xF3, the 2nd byte 0xA0, the 1st byte of the EFD = 0x0E, the 2nd byte 0xFD.

A command message can contain a number of TLV structures, the responses also contain more than one TLV, see below.

SFD	Tag0	Len0	Value0	Tag1	Len1	Value1		TagN	LenN	ValueN	EFD

To ease processing by 16-bit word based processors, all fields have an even length. The basic structure of a TLV field is shown below:

Length	Name	Description
2	Tag	The Tag signals value type
2	Length	This field shows the length of the following value (always even)
0 - 65534	Value	The field contains the relevant data.

NB. If the length field equals 00 00, the value field is not available.

When the data in the value field has an odd length, that length has to given in the Len field and Value field is padded with a zero byte, resulting in an even Value field length. So when 7 bytes of data (11 22 33 44 55 66 77) have to be transferred, the message will be as follows:

SFD	Tag	Length	Value	Padding	EFD
F3 A0	00 xx	00 07	11 22 33 44 55 66 77	00	0E FD

When the length of the value field exceeds 65534, the value field is split in 2 parts; the 1st part with a length of 65534 and a 2nd part containing the rest with an ‘extended data’ tag.

For example a frame with a length of 6600 0 bytes (0x101D0) to be sent to the TUT will be transferred as follow (al hex values):

SFD	Tag	Length	Value	Tag ext.	Length	Value		EFD
F3 A0	00 21	FF FE	Data (part 1)	00 80	01 D2	Data (rest)		0E FD

6.2 Tag types

The following Tag fields are defined:

Name	Value (hex)	Description
Box control command	00 00	Commands to the SmartWave Box
Box info command	00 01	Get SmartWave Box information
Box control response	00 10	Response of Box control command
Box info response	00 11	Response of Box info command
Box event	00 15	Unsolicited event from box
Box trigger timestamp	00 16	Unsolicited timestamp event of trigger moment
Terminal transmit TPDU	00 20	TPDU data to internal terminal (to be sent to CUT)
Probe transmit TPDU	00 21	TPDU data to CL probe (to be sent to TUT)
Connect	00 23	Start connection with CUT and / or TUT
Error control	00 25	Error injection control
Received antenna TPDU	00 30	TPDU data from internal terminal (received from CUT)
Received probe TPDU	00 31	TPDU data received from CL probe (received from TUT)
Connection status	00 33	Status of connection command
Timestamp	00 35	Timestamps connected to received data
Status	00 36	Status of received data
Terminal download data	00 40	Data loaded for terminal emulation
Probe download data	00 41	Data loaded for card emulation
Terminal register dump	00 42	Terminal RF chip register dump (debug only)
Probe register dump	00 43	Probe RF chip register dump (debug only)
Write PLL data	00 48	Write data to PLL (debug only)
Write DAC data	00 49	Write data to DAC (debug only)
Download data status	00 50	Status of data loaded for terminal or card emulation
Extended data	00 80	Last part of data field with more than 65534 bytes (This tag must directly follow the 1st data part)

Source and destination addressing is implicit and depends on the tag value. Tags destined for the SmartWave Box have an even high nibble for the low byte, responses have odd high nibbles of the low bytes (apart from tag 00 80).
Some messages from the host only allow for one type of tag, other messages allow a number of specified tags.
Single tag type messages only can have a single tag = 00 00, 00 01, 00 23, 00 40 and 00 41 (hex).
Multiple tag messages can have the following combinations:

- tag = 00 20 followed by 00 80 and / or 00 25 (hex)
- tag = 00 21 followed by 00 80 and / or 00 25 (hex)

Tag 00 25 can't be the first tag in a message.

Messages from the SmartWave Box with tags of 00 10, 00 11, 00 15, 00 16, 00 33 and 00 50 (hex) are single tag messages, tag 00 01 only may occur once in a message.
Tags 00 10 and 00 11 are response messages for respectively 00 00 and 00 01.

Tag 00 33 is the response of tag 00 23.
Tag 00 50 is the response status for either 00 40 or 00 41 command tags.

Messages starting with 00 30 or 00 31 (hex) are multiple tag messages and can be followed by tags 00 80, 00 35 and / or 00 36 (hex).

The SmartWave Box only reacts on messages starting with tag values 00 00, 00 01, 00 20, 00 21, 00 23, 00 40or 00 41, other tag values are quietly discarded.

The data transfers between host and SmartWave Box are Transport Protocol Data Unit (TPDU) based. That allows the transfer of level 3 and 4 frames. For level 4 also Application Protocol Data Units (APDUs) are defined. APDUs to the SmartWave Box must translated by the host into TPDUs and back.

Note: Checksums, like LRC and CRC, have to be supplied by the host computer. The checksum coming from the SmartWave Box have to be checked by the host computer.

In case of higher level tests the SmartWave Box can connect automatically with the card or terminal under test if commanded to. That allows level 4 testing without need for level 3 handling.

Note: Check the technical specification of the SmartWave Box for detail host protocol information.

7 APPENDIX

7.1 Technical Information

Power consumption	max 5.5W
Power adapter	18V/840mA
Working frequency	13.56Mhz
USB	2.0
Physical dimensions (LxWx(H1-H2))	166.5x126x(34-43)
Temperature (equipment for normal indoor use)	+55°C (max)
Weight	373g
Sound	Transducer
Probe dimension: (LxWxH)	189x58x12
Probe weight:	39g

Analog output levels (e.g. -INTERN- ANT): 0 – 3.3 Volt (max).
Digital outputs level(s): 0 – 3.3 Volt.

7.2 CE/FCC Statement

CE

This equipment has been tested and found to comply with the limits of the European Council Directive on the approximation of the member states relating to electromagnetic compatibility. (98/336/EEC) according to EN 55022 Class B.

FCC

Warning (part 15.21)

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure (OET Bulletin 65)

To comply with FCC RF exposure requirements for mobile transmitting devices, this transmitter should only be used or installed at locations where there is at least 20cm separation distance between the antenna and all persons.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

8 SUPPORT

For troubleshooting, support or more information contact Collis BV

E-mail : service@collis.nl
Telephone : + 31 71 581 3636

REFERENCES

Ref.	Title	Status	Version	Date
[1]	ISO 7816/3 Smart Card standard, electrical signals and transmission protocols		2	1997
[2]	ISO 7816/4 Smart Card standard, interindustry commands for interchange		1	1995
[3]	ISO 14443/2 CL card standard – proximity cards, RF interface power and signal interface (+ Amendment 1)		1	2001 2005
[4]	ISO 14443/3 CL card standard – proximity cards, initialization and anticollision. (+ Amendments 1 and 3)		1	2001 2005/2006
[5]	ISO 14443/4 CL card standard – proximity cards, transmission protocol (+ Amendment 1)		1	2001 2006
[6]	ISO 18092 Near Field Communication cards, interface and protocol		1	2004
[7]	ISO 10273-6 Identification cards, test methods proximity cards		1	2001
[8]	ISO 10273-6 Amendment 1 Protocol test methods for proximity cards	Final draft		
[9]	ISO 10273-6 Amendment 3 Protocol test methods for proximity coupling devices	Final draft		
[10]	ISO 10273-6 Amendment 5 Bit rates of fc/64, fc/32 and fc/16	Final draft		
[11]	ISO 23917 NFCIP-1 protocol test methods		1	2005
[12]	SmartWave Box requirement specification document	Final	1.1	29-06-2006
[13]	SmartWave Box Technical Specification			