RF-IDT User Manual

RF-IDT USER MANUAL

Version 3.5

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1 Introduction

1.1 About this device

The CTR RF-IDT system is a Surface Acoustic Wave (SAW)-based wireless high-frequency FM identification and sensing system. The transponders are entirely passive SAW devices consisting of a tag, in which the ID information is embedded, and an antenna. The reader unit sends a continuous frequency sweep signal in the ISM S-band. The passive SAW device receives this signal, converts it into an acoustic surface wave on a piezoelectric crystal, modulates it with the code information and then returns the signal. Beside the ID code the transponder can also provide temperature information. One total read cycle takes less than 500 ms. A direct line of sight between the reader and transponder is not required; the tag can also be read - though possibly at a reduced transmission range - through most non-metallic materials.

CTR RF-IDT SAW Demonstration/Evaluation Kit

2 Safety Instructions

This product has been manufactured in accordance with state of the art practice and conforms to recognized safety regulations. Nevertheless, there are dangers associated with the use of the equipment *even for its intended purpose*. You should therefore carefully read and apply the following safety information.

Install and operate this equipment only if it is in perfect condition and only in accordance with this manual. Do not use the equipment if it is damaged.

> WHEN USED FOR THE INTENDED USE AND IN ACCORDANCE TO THE PROVISIONS OF THIS USER MANUAL, THIS EQUIPMENT COMPLIES WITH **EC-DIRECTIVE 99/5/EG**, **PART 15 OF THE US FFC-RULES**, AND THE JAPANESE **RADIO LAWS, ARTICLE 2, CLAUSE 1, ITEM 8**.
>
> **THIS DEVICE IS NOT SOLD TO THE GENERAL PUBLIC AND WILL REQUIRE PROFESSIONAL INSTALLATION.** ANY CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE MANUFACTURER

The user is hereby expressly advised that this device may exceed permissible RF power radiation levels when used with antennae with high gain. This may affect other devices within the transmission range of the antenna.[1] To ascertain that your system will comply to legal limitations please observe the exemplary calculation of the emitted RF power on page 21 of this manual.

Caution: All cable connections on the module will require the use of Loc-Tite to ensure that all fittings are joined securely and in order to maintain FCC conformity.

Caution: All antenna ports not in use must be equipped with the enclosed terminating resistors.

Caution when plugging in the power supply. The instrument is supplied with low DC voltage and has no separate power switch; hence, the system is "on" as soon as plugged in.

[1] Please observe the country-specific regulations and limits applicable to your seat of application.

2.1 Symbols Used

 Important Advice

 Electromagnetic Radiation

 Fire Risks

 Dangerous Voltages

 Explosion Hazard

 Important Additional Information

 Electrostatically Sensitive Components

2.2 General Safety Instructions

1. Read and understand all safety and operating instructions before installing and operating the device.
2. Keep these instructions. Store this manual in a place that can be accessed at any time by any person involved in installation, operation or maintenance of the device.
3. Heed all warnings, both on the device and in the operating instructions.
4. Install in accordance with the manufacturer's instructions only.
5. Only use attachments, accessories and connecting cables supplied or released by the manufacturer.
6. When disconnecting a cable, pull on its connector and not on the cable itself. Keep the connector evenly aligned to avoid bending any connector pins.
7. Never bend the antenna cable beyond its limits or expose it to mechanical loads.
8. When replacement parts are required, use the replacement parts specified by the manufacturer only. Unauthorized substitutions may cause damage to the device and result in fire, electric shock, or other hazards, and are not covered by the manufacturer’s warranty.

2.3 Terms of Proper Use

- The CTR SAW reader was developed and produced exclusively for reading the CTR SAW-tags. Any other use of this device constitutes abuse and would render the user’s authority to install and operate the device invalid.
- *Please observe the provisions of this manual strictly, in particular those regarding the proper setting of the RF power output (Section 7.3)*. The manufacturer will refuse any liability for violating country-specific regulations for radiated power resulting from incorrect settings of the attenuator parameters.

- *Operate the reader device only according to this user manual.* The manufacturer will refuse any liability for direct and consequential damage resulting from misuse or use violating any provisions of this manual.
- *Do not undertake changes or modifications to the reader not expressively approved by the manufacturer.* Such changes could void the user's authority to operate this equipment. The manufacturer will refuse any liability for direct and consequential damage resulting from unauthorised changes or modifications to the SAW reader systems or its components.
- *THE MANUFACTURER IS NOT RESPONSIBLE FOR ANY RADIO OR TV INTERFERENCE CAUSED BY UNAUTHORISED MODIFICATIONS TO THIS EQUIPMENT. ANY SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.*

3 Product Description

3.1 SAW Reader

3.1.1 Front Plane

Front plane of the SAW reader

Sub-D: PC interface (female RS-232 plug)

LED 1: *Signal O.K.*; the LED will light up if a tag is within range

LED 2: *Power O.K.*; the LED indicates whether the device is on

RF 1-4: Connector for the antennae. When selecting a cable please observe that increasing the length of the wire reduces the signal strength and therefore the range of the device. This is also true for the choice of the antenna – low gain antennas have shorter ranges than those with higher gains.

3.1.2 Back Plane

Back plane of the SAW reader

Power Connector: Please use the enclosed 12 V DC power supply only.

3.2 Technical Specifications

3.2.1 SAW Tag

Please refer to the data sheet accompanying the respective SAW tag.

3.2.2 Reader Unit

Parameter	Value
Operation Principle	FSCW
Frequency Range	2.4 GHz – 2.48 GHz (ISM-S band)
Output Power (@ antenna port)[2]	≤ 10 dBm (user adjustable)
Power Supply	DC 12 V; 2.5 A External: 100-240 VAC, 47-63 Hz
Protection Class	IP54
Size (W x H x L)	115 x 96 x 210 mm
Weight	1.2 kg
Operating Temperature	0 °C to +50 °C
Storage Temperature	-25 °C to +70 °C
Permissible Humidity	≤ 80 % non-condensing

3.3 Warranty and Liability

CTR warrants that this device is free from material of production defects at the time of delivery and will operate faultlessly if operated correctly and in accordance to the provision set down in this user manual.

The warranty period is six month from the day of delivery.

This warranty includes the repair of all damage to the device that occurs within the warranty period and is caused by material or production defects. We reserve the right to either repair the faulty device or replace it with an adequate new device.

The warranty does not include compensation of direct or consequential damage, in particular not when caused by non-observance of the provisions in this user manual, incorrect connection, operation with incorrect settings, inappropriate handling or misuse of the device.

Any wider liability is excluded to the extent permissible by applicable law!

[2] Refer to appendix 9 for selected country-specific regulations.

4 Installation

4.1 Installation Environment

This device is designed for use in an indoor environment only. Operation is only permitted at ambient temperatures between 0 °C (32 F) and +50 °C (122 F).
Please do not install the reader near heat radiation sources such as radiators, heat registers, stoves, etc. or other heat sources.

The maximum permissible air humidity is 80 % (non-condensing). Never expose the device to severe changes in temperature as otherwise condensation may occur inside the device and cause damage. Never store or operate in chemically aggressive atmospheres.

The SAW reader device has been designed for protection class IP54. Do not install or use this device under water or in a splash water environment.

Do not install the device in a flammable environment.

Never use the device in potentially explosive areas.

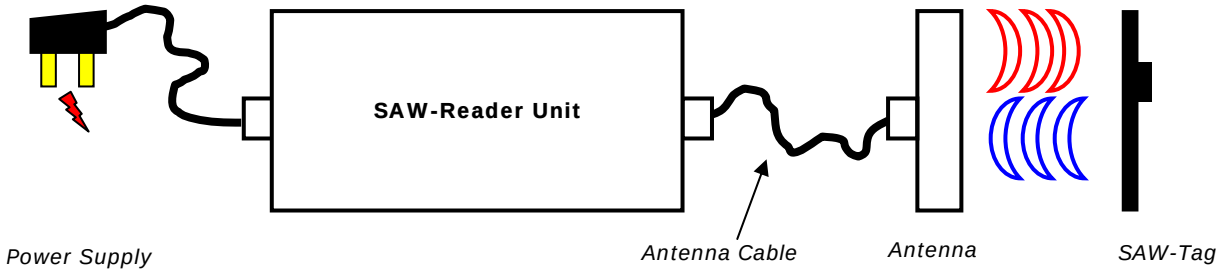
The device should not be used in the immediate vicinity of electrical devices (such as medical units, monitors, telephones, wireless LAN, televisions and energy-saver lamps), magnetic data carriers, or metallic objects, as this may result in reduced transmission/reading ranges. Avoid such conditions if possible.

Do not expose the device in a location to severe vibration or shock.

If two or more SAW-tags are in the range of the antenna the temperature can not be measured correctly and only the ID of the "stronger" tag will be displayed.

4.2 Hardware Installation

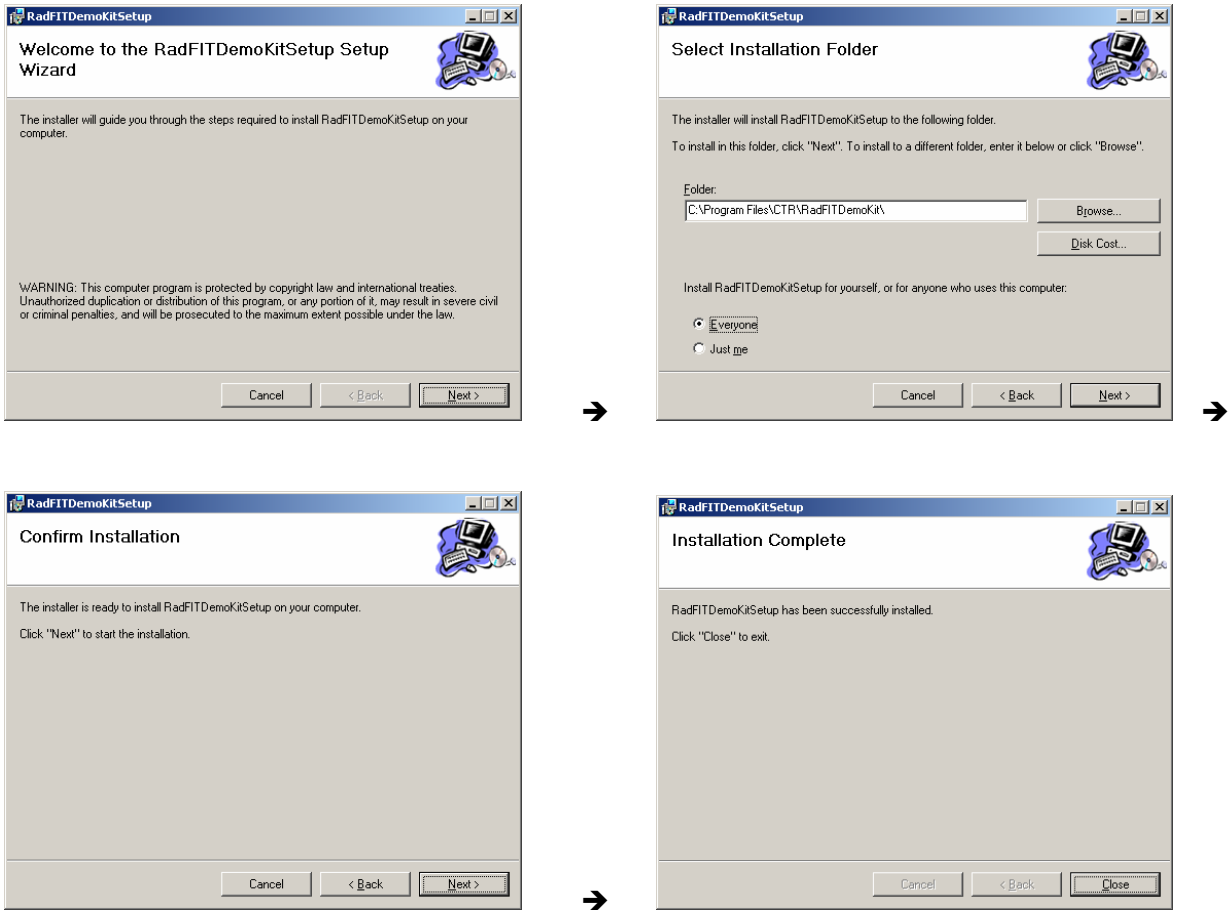
- Unpack all components.
- Connect the antenna(e) to the reader unit.
- Connect the power supply to the reader unit.
- Before plugging in the power supply, the configuration should have the following configuration:



4.3 Software Installation

☞ The SAW reader control & driving software *RadFIT* requires MS Windows 2000 SP 4 or above, or MS Windows XP, SP2 or above, as operating system.

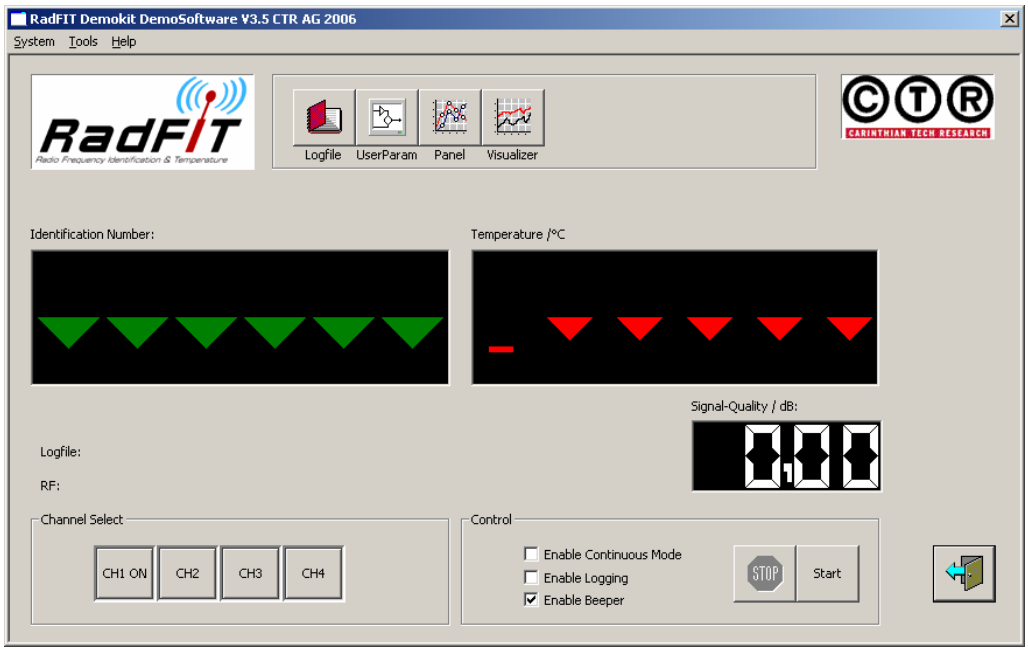
After inserting the installation CD-ROM, please double-click *SETUP.EXE* in Explorer. This will initiate the installation routine that will guide you through the installation process. Please follow the instructions of the installation assistant.



☞ The RadFIT software is available as English language version only.

4.4 Execute *RadFIT*

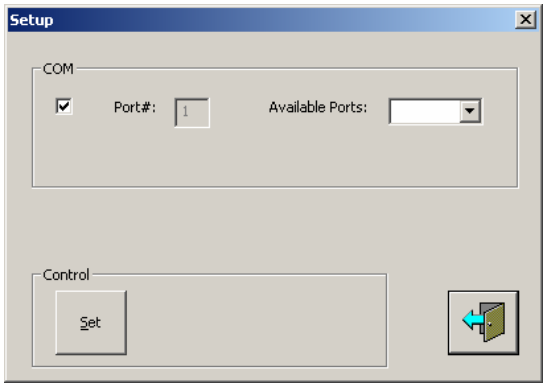
After successful installation, the *RadFIT* icon will appear on the desktop. Please double click the icon to start the program. The following main window will appear:



RadFIT main window

4.5 PC Interface Selection

Before measuring the device - PC interface has to be configured. Selecting the item *Setup* in the *System* menu will open the following configuration window, which enables the user to select the PC interface for the SAW reading device.



PC Interface Configuration Window

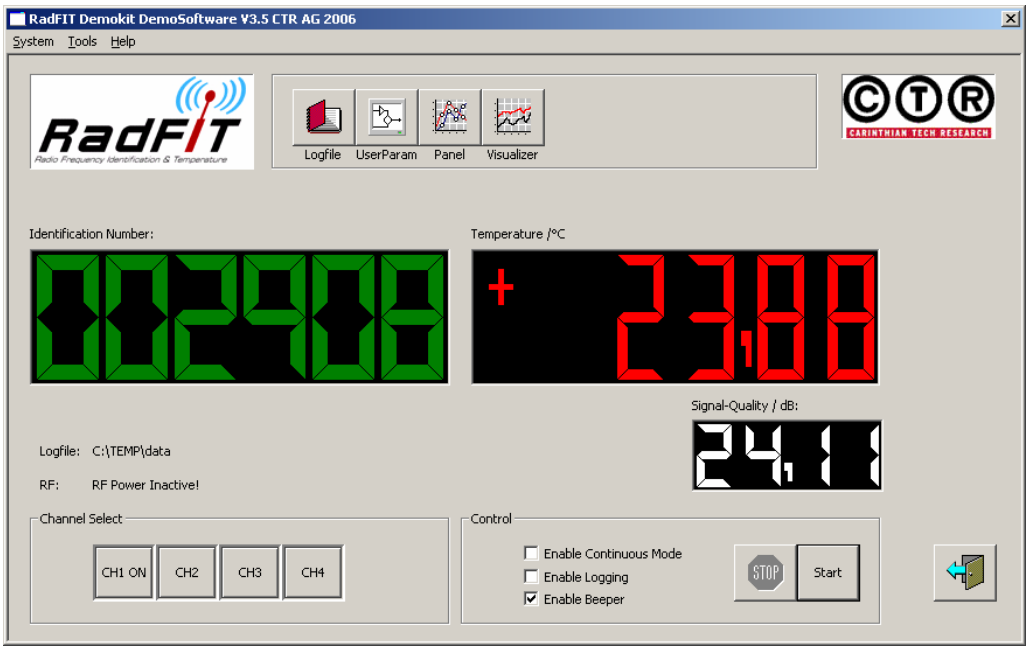
Please select the serial interface[3] (COM-port) the SAW device has been connected to and confirm the selection with *Set*.

[3] In case you use a serial-to-USB adapter instead of a COM-port, you'll need to first install the software delivered with the adapter. This should give you an additional (virtual) COM-port that can be selected here.

4.6 Single-Channel Measurements

The reader has four channel connectors (RF1 – RF4), with each connector assigned to the corresponding channel CH1 – CH4. Depending on which connector the send/receive antenna(s) have been connected to, please select the appropriate corresponding channels in the "*Channel Select*" control box. This channel is now the active measurement channel[4].

The measurement is initiated by pressing the *Start* button. The software supports both the acquisition of single measurement or measuring continuously in *Continuous Mode.* If the Continuous Mode has been activated by selecting the *Enable Continuous Mode* control in the *Control* box, the selected channel is repeatedly read until the measurement is stopped by pressing the *Stop* button. Irrespective of the measurement mode the identification (ID) number is displayed in green and the temperature reading in red[5].



RadFIT main window, showing exemplary data of a read tag

The *Control* box furthermore allows to activate/deactivate an acoustic operation control (*beeper)* and *data logging*. With activated data logging, temperature and ID readings are saved as ASCII data into a log-file. The currently active path and file name are displayed above the Channel Select box and can be changed by pressing the *Logfile* button.

Supplementary to the main readings, the current *Signal-Quality* value is displayed in white. The Signal-Quality reading reflects the strength of the received signal (see Section 4.7.2.1) and enables the user to assess the quality of the currently received measurement signals. This value can thus be used to optimise e.g the antenna - transponder alignment. Please note that the signal quality readings are updated with each measurement sweep and will also be displayed the signal quality is to low to allow for reliable ID- or sensor readings.

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[4] For simultaneously measuring more than one channel please use the *Panel View* function (see section **Error! Reference source not found.**).

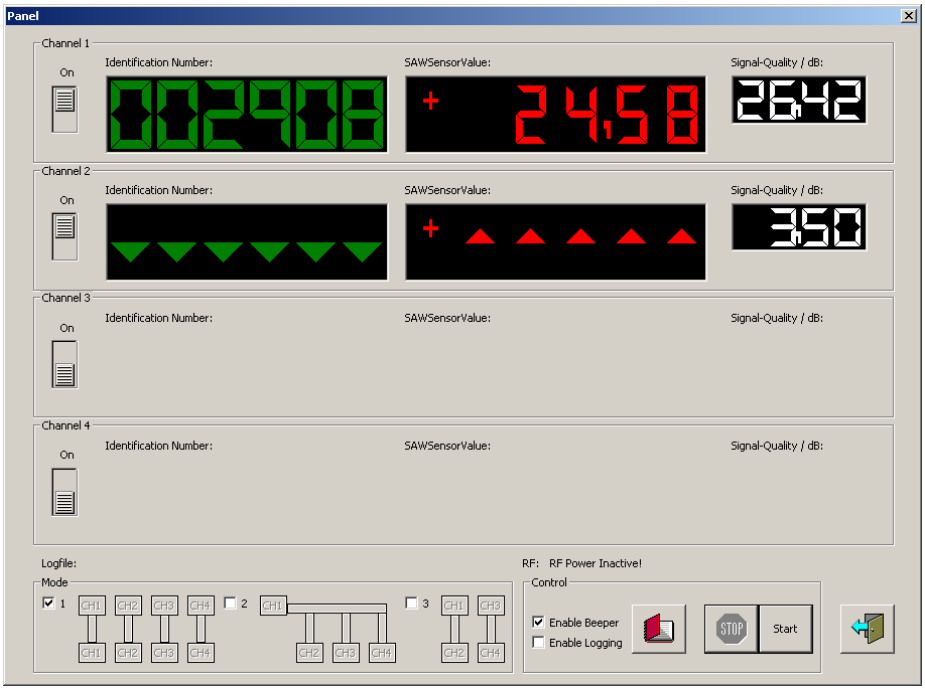
[5] If no tag is within reading distance, or if the signal quality is too low to allow for a reliable reading, no readings will be shown for ID code and temperature.

4.7 Extended Operation Modes

In addition to the main window, the following alternative software views, e.g. for multi-channel measurements, can be selected:

4.7.1 Panel View

Pressing the *Panel* button in the RadFIT main window cause the following window to open:



RadFIT "Panel View" window

In Panel View allows measuring multiple channels in parallel. Also, it is possible to choose between three different antenna configuration modes:

Mode 1:
Each channel acts both as transmitter and receiver channel. The channels are successively stepped through. Channels can be activated or deactivated independently using the *On* switch on the left side of the panel.

Mode 2:
Channel 1 acts as transmitter, channels 2-4 are receiving channels.
ID and temperature displays for channel 1 will be hidden in this mode.

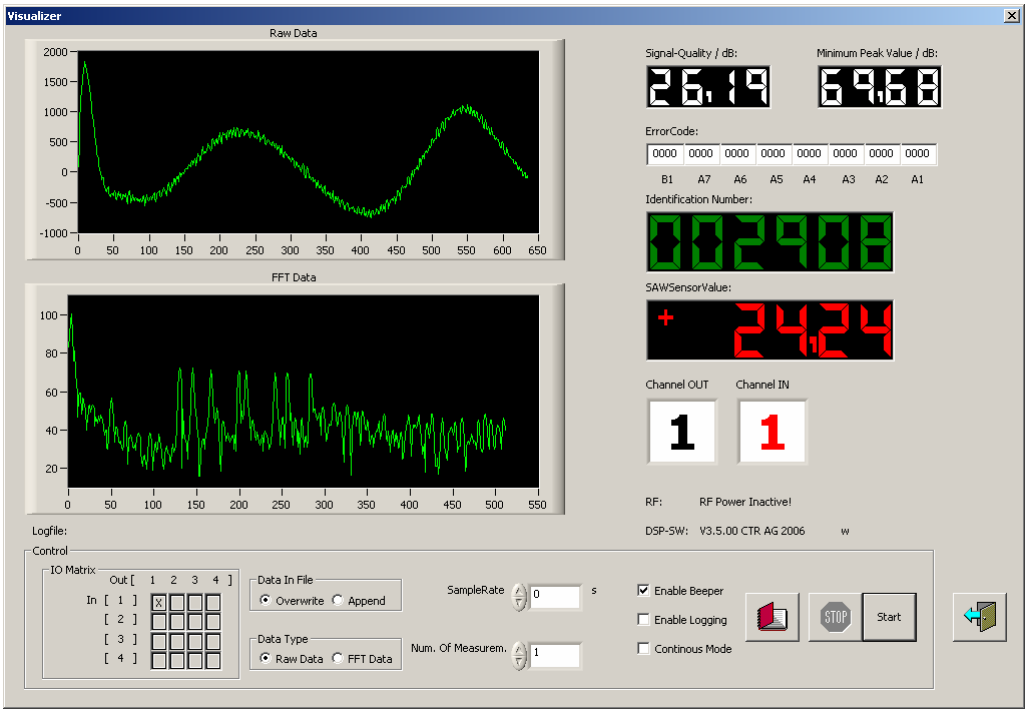
Mode 3:
Channels 1 and 3 act as transmitters, channels 2 and 4 are receivers.

The measurement is initiated by pressing the *Start* button. Data acquisition in panel mode is always performed in continuous measuring mode and will continue until the *Stop* button is pressed. In analogy to the main window it is possible to activate or deactivate the beeper and data logging into a log file. The path and name of the LOG-file can be changed by pressing the icon to the left of the *Stop* button.

Data logging into a log file is only available when working in Mode 1; for data logging with other antenna configurations please use the *Visualizer View*.

4.7.2 *Visualizer View*

Pressing the *Visualizer* button in the RadFIT main window will open the following window:



RadFIT "Visualizer View" window

In this view, the upper graph shows the measured raw data, while the lower graph gives the results of the FFT analysis. The signal in the diagram can be zoomed by drawing a region of interest with the mouse pointer.

The *IO matrix* allows selecting any possible antenna configuration. If more than one IO-combination has been selected, the various combinations are successively measured and the results displayed.

☞ The Visualizer View is primarily intended for system adjustment and optimisation, not for routine measurements.

4.7.2.1 Signal quality

The value in the field *Signal Quality* is a measure for the quality of the HF signal. The value is a logarithmic scale and noted in dB. The higher the value, the better the signal quality. A good signal is in the range of 25 dB and above; weak signal levels below 20 dB can lead to occasional blackouts of radio transmission.

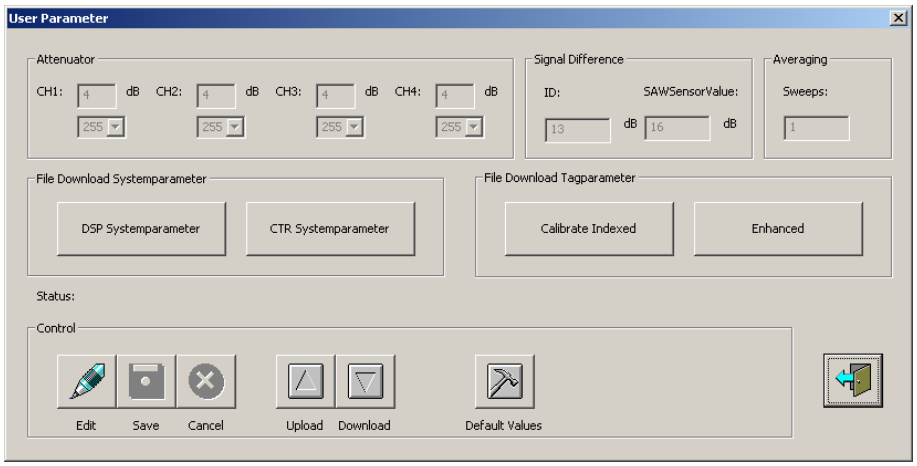
4.7.2.2 Minimum Signal Level

The value in the field "Minimum Peak Value" refers to the level of the weakest signal peak. The value is related to one digit of the ADC, in logarithmic scale and noted in dB.

4.8 Setting User-specific Parameters

Pressing the *UserParam* button will open an editing menu allowing to edit antenna port output powers, signal quality display limits and sweep averaging settings. This allows the user to optimise the SAW measurements to application-specific requirements.

In addition, this menu permits installing or updating configuration files („bin-files") provided by the manufacturer[6].



Edit menu for setting the user parameter

By pressing *Edit* in the *Control* box it is possible to edit the following parameters:

- *Attenuator*: This parameter enables the users to set damping factors to control the output power at the single antenna ports. Each channel can be parameterised individually and independently of the other channels, allowing for different antenna configurations to be connected to the instrument. Please see also Sections 7.3 and 9**Error! Reference source not found.** for more information on how to choose proper settings for these parameters. The values can be selected from a pull-down menu, featuring damping values from 0 dB to 15 dB. In addition, it is possible to select the value *255 dB*, which will deactivate this channel.
- *SignalDifference*: The SignalDifference parameters allow setting individual limits for displaying the ID (*ID*) and sensor readings (*SAWSensorValue*). During measuring with the SAW reader device, the measured ID- or SAW sensor readings (e.g. temperature) are displayed and recorded into the log-file only if the signal quality exceeds the respective threshold limit defined here. Typically, these thresholds are set as low as necessary for reliable data acquisition under given application conditions.
  TIP: Although it is possible to set the SignalDifference values to low values, including 0 dB, the manufacturer strongly warns against using SignalDifference values less than 13 dB for ID and less than 16 dB for SAWSensorValue. Under certain circumstances, such low settings may cause the instrument to display incorrect or strongly hopping readings. This is not a malfunction of the SAW reader device!

[6] These files, containing e.g. DSP updates, customer-specific data evaluation procedures, sensor calibration functions, etc., are supplied by the manufacturer only. In case you require such an enhancement / update, please contact the manufacturer. A detailed description on how to install the file(s) provided will be delivered with the files.

- *Averaging*: To enhance signal quality, and thereby e.g. increase the transmission range, signal averaging over successive measuring cycles can be applied.
  Averaging can be set from 1 to 128 sweeps. Please not that activating averaging will also influence the measurement time resolution!

Pressing *DefaultValues* will reset all parameters to the following pre-set default values:

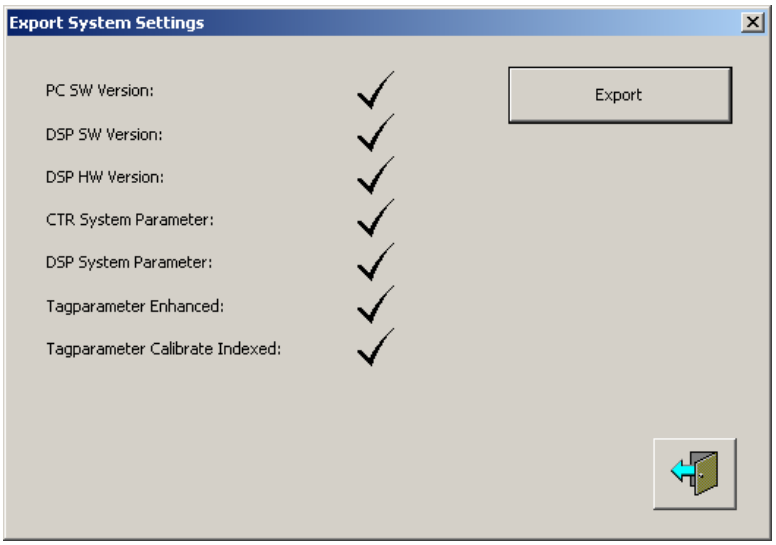
Attenuator:	**4 dB** (all channels, [7])
SignalDifference:	ID: **13 dB**; SAWSensorValue: **16 dB**
Averaging Sweeps:	**1**

After entering the required values, as well as after resetting them to the default, the values have first to be stored locally using the *Save* button and then transferred into the SAW reader device by means of the *Download* button.

The button *Upload* reads and displays the current settings of the SAW reader unit.

4.9 Export System Settings

It may become necessary, in particular for system servicing, to store all system settings into a file that can be transmitted to the manufacturer. To do that, please choose the item *Export* in the menu *Help*. This will cause the following window to open:



System Settings Export window

By pressing the *Export* button a bin-file is created containing the systems specific settings at a freely selectable storing location.

[7] default value for localised Japanese version: 6 dB

5 Service and Error Handling

5.1 General

Apart from a fuse the SAW reader unit contains no components that can be serviced by the end user. With exception of said fuse, the SAW reader and all enclosed components may exclusively be serviced by the manufacturer.

☞ In case errors should occur, please follow the instructions in this section closely. Do not carry out any fault finding measurements other than the ones described here.

☞ In case of uncertainty about an error and its proper handling, please contact the manufacturer. To simplify matters, please provide the serial number of the SAW reader, as shown on the device label, when contacting the manufacturer.

5.2 Error Analysis

5.2.1 The Power LED does not illuminate

- Check whether all cables are correctly connected, in particular the power supply to the instrument and the mains, and if the proper voltage is supplied by the main socket.
- If you can not find any error there, please disconnect the power supply from the mains and the SAW reader. Then unscrew the upper screws at the front and back of the instrument and open the top cover. Check the fuse. If necessary, replace the spent fuse with an identical new fuse and close the instrument.
- In case the fuse is OK, please send the SAW reader unit and its power supply to the manufacturer for fault analysis, maintenance and/or repair.

5.2.2 The PC can not find the reader unit

- Check if the power cable is connected to the reader unit and the Power LED is lit.
- Check whether the communication cable is connected to the reader unit.
- Check if the correct COM-Port has been selected.
- Contact the manufacturer.

5.2.3 No ID or temperature readings are being displayed

- Has the correct channel been selected and the *Start* button been pressed?
- Check whether the antenna has been correctly connected to the selected channel.
- Check whether a transponder tag is within range. The signal quality readings should exceed 13 dB for pure ID applications and 16 dB for sensing applications.
- Change the polarization direction of the tag to the antenna by rotating one of them by 90 degrees about the connection axis.
- Check the settings for the channel attenuators values and the SignalDifference values (compare Section **Error! Reference source not found.**) and correct them if necessary and possible.
- Contact the manufacturer.

5.2.4 *Temperature readings are incorrect or vary strongly*

- Change the polarization direction of the tag to the antenna by rotating one of them by 90 degrees about the connection axis.
- Check whether a transponder tag is within range. The signal quality readings should exceed 13 dB for pure ID applications and 16 dB for sensing applications.

5.3 Customer Service

CTR Carinthian Tech Research AG
SAW Group

Europastraße 4/1
A-9524 Villach / St. Magdalen
Austria

T: +43 4242 56300 – 0 | F: - 400

WWW: www.ctr.at
E-mail: info@ctr.at

6 Transportation, Storage und Disposal

6.1 Transportation

For transportation purposes, such as mailing, please use a robust box and use adequate padding material to protect the device on all sides.

6.2 Storage

Store the reader and its components in a clean and dry environment in accordance to section 3.2.2 of this user manual. In particular make sure that the electrical contacts are protected and remain clean.

6.3 Disposal

The SAW reader unit and its components, including transponders, antennas and cables, do not constitute environmentally hazardous waste. Proper disposal is as "electronic waste without environmentally relevant amounts of hazardous substances".

Do not dispose of the reader unit and/or its accessories as household rubbish.

If in doubt about proper disposal, please ask you local waste disposal expert about applicable local and national disposal regulations.

7 Appendix - Hardware

7.1 Antennae for use with the SAW Reader Unit

Antenna with circular polarization[Error! Bookmark not defined.]**:**

Art.-Nr.	Description
1324.19.0008	SPA2400/70/9/0/CP, right, 2.4 GHz, 9 dBi

Huber+Suhner
http://www.hubersuhner.com/hs-meta-con.htm

7.2 Antenna Cable

Art.-Nr.	Description
DT58/4F	50 Ohm, SMA (male-male), damping 0.5 dB/m @ 2.4GHz

7.3 Calculation of the Radiated RF Power

When delivered, the SAW reader device is pre-set to a typical output power[8] at the antenna ports (P_{max}) of +3 dBm[9] (attenuator value 4 dB, compare Section **Error! Reference source not found.**). The maximum effectively radiated RF power $P_{radiated}$ depends on this - adjustable - value P_{max}, the damping losses in the connection cables and connectors ($Loss_{Cable\text{-}length}$, $Loss_{Cable\text{-}Connector}$) and the antenna gain ($Gain_{antenna}$). $P_{radiated}$ can be derived according to the following equation (all values in dBm):

$$P_{radiated} = P_{\max} - Attenuator_{value} - Loss_{Cable-length} - Loss_{Cable-Connector} + Gain_{antenna}$$

The damping losses $Loss_{Cable\text{-}length}$ of the specified antenna cable DT58 amount to about 0,5 dBm/m, the connector losses $Loss_{Cable\text{-}Connector}$ to ~ 1 dBm.

The result of the equation given above is in dBm. This value can be converted to mW as follows:

$$P_{radiated}[mW] = 10^{\left(\frac{P_{radiated}[dBm]}{10}\right)}$$

Example:

attenuator setting: 4 dB → P_{max} = +3 dBm (see Section 7.4)

[8] For manufacturing reasons, the effective power output many vary between instruments. The measured effective power outputs (for attenuator settings 0 dB und 15 dB) of your SAW reader unit can be found in the QC protocol enclosed to the respective reader unit.

[9] Pre-setting for Japan: + 1 dBm (attenuator value 6 dB); for more information please refer to the applicable country-specific regulations according to Appendix 9.

cable length (DT58): 2 m → $Loss_{Cable\text{-}length}$ = 2 m · 0,5 dBm/m
antenna gain: +9 dBm

$$P_{radiated}\left[dBm\right] = 3 - 2 \cdot 0.5 - 1 + 9 = 10$$

$$P_{radiated}\left[mW\right] = 10^{\left(\frac{10}{10}\right)} = 10$$

When applied in reversed order, these equations allow to derive the maximally permissible antenna port output for a given antenna configuration and thus the optimal attenuator setting. Typically, to improve the signal quality, it is advisable to select a possibly high output power **without exceeding applicable legal and/or normative limits**[10].

Applicable legal and/or normative limits, regarding in particular the permissible radiation of RF power, have to be strictly observed and must not be exceeded!

7.4 Attenuator Settings

The RadFIT software enables the user to set individual attenuator values for each channel. These attenuator values correspond to specific output levels at the respective antenna port. The correlation between setting parameter and output power is given in the following table:

[10] The possible maximum output power at the antenna port is typically around +7 dBm (attenuator setting 0 dB). For the example arrangement given above this would result in radiating ~ 25 mW of RF power. While improving signal quality and/or possible transmission distances, actually doing so would clearly violate legal limits in most countries and may result in hefty fines.

Attenuator Value [dB] *(see Section **Error! Reference source not found.**)*	**Typical Power Output P_{max}** [dBm] *(output at the antenna port)*	Room for Notes
0 dB	+7 dBm	
1 dB	+6 dBm	
2 dB	+5 dBm	
3 dB	+4 dBm	
4 dB	+3 dBm	
5 dB	+2 dBm	
6 dB	+1 dBm	
7 dB	0 dBm	
8 dB	-1 dBm	
9 dB	-2 dBm	
10 dB	-3 dBm	
11 dB	-4 dBm	
12 dB	-5 dBm	
13 dB	-6 dBm	
14 dB	-7 dBm	
15 dB	-8 dBm	

For manufacturing reasons, the effective power output P_{max} of the single channels may vary over a certain range, both between channels and between instruments.

Enclosed with the reader is a QC protocol. This protocol list the measured effective antenna port output powers for each channel for the attenuator settings 0 dB ("Power (max)") and 15 dB ("Power (min)"). Effective values for all other attenuator settings can be derived from these values by linear interpolation. *Preferably base your calculations to determine the optimal system settings on these real values*.

7.5 Standard Slot-Antenna Transponder Benchmarks

The following table gives typical values for the achievable transmission distances for a correct read out of transponder ID and sensor values under laboratory conditions, i.e. without WLAN or Bluetooth interferences. All measurements were taken using a single antenna configuration.

Radiated Power	Antenna type	Averaging	Temperature of ID Tag	Range T	Range ID
10 mW	linear, 9 dBi	8	25 °C	2.0 m	2.5m
10 mW	linear, 9 dBi	8	300 °C	0.5 m	0.8 m
10 mW	linear, 18 dBi	8	25 °C	4.5 m	6.0 m
10 mW	linear, 18 dBi	8	300 °C	1.2 m	1.8 m

☞ *Please note*: The effectively attainable reading distances in specific (industrial) applications may be highly dependent on the system configuration and the radio conditions at the point of use.

8 Appendix - Software

8.1 Command Protocol of the SAW Reader Unit

The data transfer between the reader unit and the control PC uses either a serial interface or an USB adapter.

8.1.1 Interface Parameters

Baud-Rate:	115.2 kBd (V.24)
Start-Bit:	1
Data-Bits:	8
Parity:	even
Stop-Bit:	1
Protocol:	see below

8.1.2 Command Structure

Command structure and command formats:

STX	Data-Length	Command d_0	Sub-Command d_1	Data $d_2.....d_{N-1}$	CRC8[11]	ETX
1 Byte	4 Bytes	1 Char	1 Char	N Bytes	1 Byte	1 Byte

STX	constant, Start of Text 0x02
Data-Length	number of data bytes between the fields „Data-Length" and „CRC"
Command	'A'-'Z' (please refer to section 8.1.4)
Sub-Command	'A'-'Z', '0'-'9' (please refer to section 8.1.4)
Data	variable
CRC8	check sum over all command and data bytes d_0 – d_{N-1} polynomial: 0x1d, pre-set value: 0xc7
ETX	constant, End of Text 0x03

The commands are processed from the left to the right. In the following sections only the command structure fragments „Command", „Sub-Command" and „Data" are described in detail. The other bytes are either constants or will be calculated as described here.

Example:

Command: **STX 0002V0 CRC8 ETX**

→ Command ‚V0' (read-out hardware version, with a Data-Length of 2 (0x0002))

Response: **STX 0006V000000000000000000000000000000000 CRC8 ETX**

[11] For sample code for deriving the CRC8 value please refer to section 8.1.2.1

8.1.2.1 Calculating the CRC8 value

- *Sample code in programming language "C"*:

Parameters:

p: pointer to data buffer

len: number of bytes in data buffer

Returned Value:

CRC8-value

Programme Code:

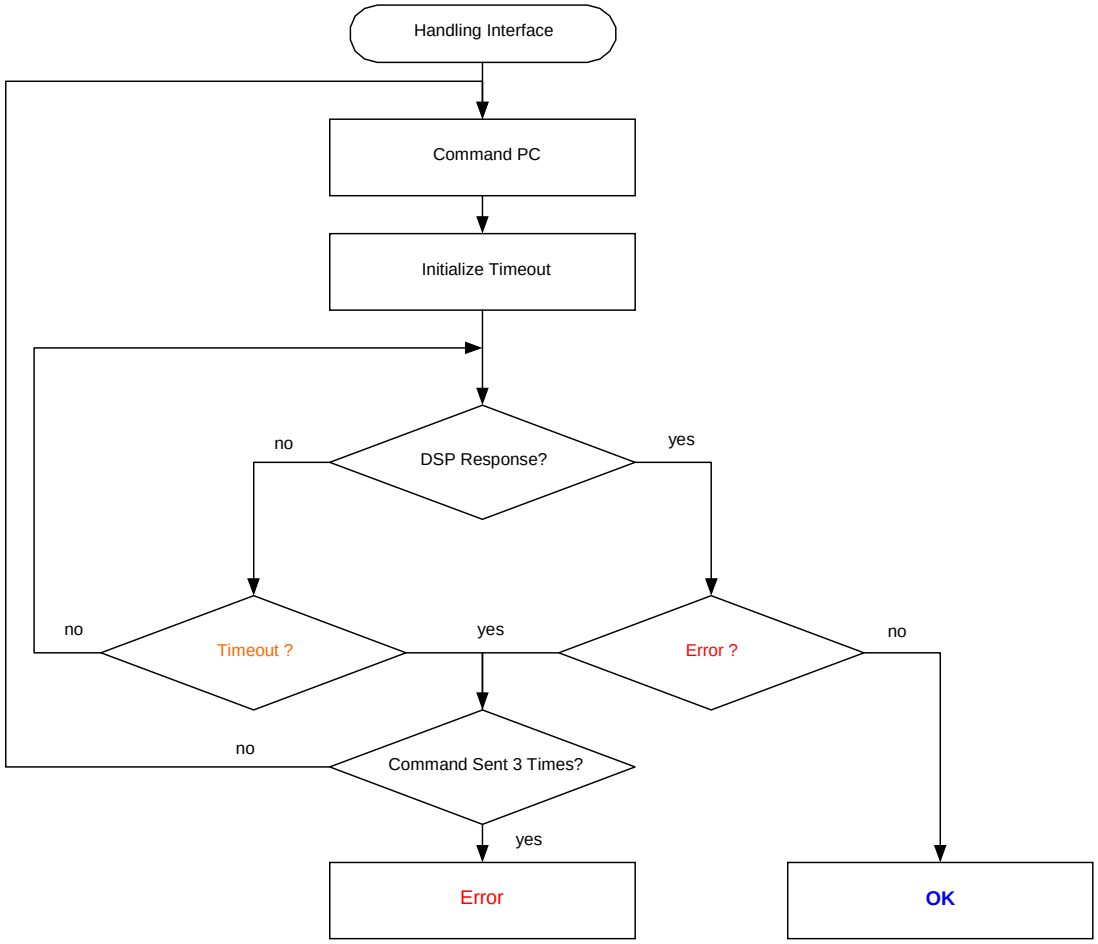
```
unsigned char Crc8(void *p, int len)
{
    #define CRC8_POLYNOM 0x1d // 0001 1101
    #define CRC8_PRESET 0xc7 // 1100 0111

    unsigned char crc = CRC8_PRESET ;
    unsigned char *buff = (unsigned char *)p ;
    int i, j ;

    for (j=0 ; j<len ; j++)
    {
        crc = crc^buff[j] ;
        for (i=0 ; i<8 ; i++)
        {
            if (crc & 0x80)
            {
          crc = (crc << 1)^CRC8_POLYNOM ;
            }
            else
            {
                crc = crc << 1 ;
            }
        }
    }
    return (crc) ;
}
```

8.1.3 Instruction Sequence

The communication follows the Master/Slave principle, with the PC as master. The flow-chart shown below illustrates the sequence of instructions.



8.1.4 Command Overview

Command	Com.	Sub-Com.	Beschreibung
Version	V	0 1	read DSP-HW version read DSP-SW version
GetResults	I	0	read ID, SAWSensorValue and Signal Quality data
Reset	R	0	initiate hardware reset
HWControl	H	0	RF on/off switch
GetConfigUserParameter	C	4	read user parameter
SetConfigUserParameter	C	5	set user parameter

Upon receiving a valid command, the corresponding data will be transmitted. If there is no defined data response to the command (example RESET) the answer will be

S0

In case of an error or upon having received an unknown or invalid command, the response will always be:

SX (X != 0)

8.1.4.1 Read DSP Hardware/Software Version (Command "Version")

PC command:

V	X

Reader response:

V	X	YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY

variable definition:

X: 0: DSP hardware version
1: DSP software version

Y: 32-digit version number

8.1.4.2 Read ID and temperature values (Command "GetResults")

The PC starts the measurement and transmits the read and reception channel(s)

I	0	OI

OI: Channel Out/In Number: 0000-FFFF (2 Bytes)

1: Channel 1
2: Channel 2
3: Channel 3
4: Channel 4

The reader responds by transmitting ID and sensor (e.g. temperature) readings and the signal quality data

I	0	sssstttiiii

ssss: SNR, 4 Bytes as float-value
tttt: temperature, 4 Bytes as float-value
iiii: ID, 4 Bytes as int-value

8.1.4.3 Reader Hardware Reset (Command "Reset")

PC command:

R	0	

Reader response:

R	0	S0

8.1.4.4 Hardware Control Instructions (Command "HWControl")

PC command:

H	X	

- *X=0: PC reads the HWControl register*

H	0	

Reader response:

H	0	BBBB
		B: Bit-field 0000-FFFF (2 Bytes = 16 Bits) Bit 0 [RF] : 0=Power off, 1=Power on Bit 1 [LED] : 0=off, 1=on Bit 2 [ ] : 0=, 1= Bit 3 [ ] : 0=, 1= Bit 4 [ ] : 0=, 1= Bit 5 [ ] : 0=, 1= Bit 6 [ ] : 0=, 1= Bit 7 [ ] : 0=, 1= Bit 8 [ ] : 0=, 1= Bit 9 [ ] : 0=, 1= Bit 10 [ ] : 0=, 1= Bit 11[ ] : 0=, 1= Bit 12 [ ] : 0=, 1= Bit 13[ ] : 0=, 1= Bit 14 [ ] : 0=, 1= Bit 15[ ] : 0=, 1=

- *X=1: PC sets the HWControl register*

H	1	BBBBBBBB

8.1.4.5 User Parameter (Attenuator, SignalDifferences, Averaging)

These commands allow to individually adjust output power levels for each antenna channel by setting attenuation factors.

PC command:

C	X	

valid command parameters are:

Attenuator:	0..15 255	corresponding to 0..15 dB attenuation channel deactivated
SignalDifferences:	0..255	corresponding to 0..255 dB signal difference
Averaging:	1..128	corresponding to averaging 1..128 successive measurement sweeps (raw data)

- *X=4: GetConfigUserParameter: Read attenuator values, signal difference for ID and SAWSensorValue and number of averaging sweeps*

  Reader response:

C	4	**11223344IISSAA**
		11: attenuator channel 1 [dB]: 0..15, 255 (2 Byte) **22**: attenuator channel 2 [dB]: 0..15, 255 (2 Byte) **33**: attenuator channel 3 [dB]: 0..15, 255 (2 Byte) **44**: attenuator channel 4 [dB]: 0..15, 255 (2 Byte) **II**: signal difference ID [dB]: 0..255 (2Byte) **SS**: signal difference SAWSensorValue [dB]: 0..255 (2Byte) **AA**: number of averaging sweeps : 1..128 (2Byte)

- *X=5: SetConfigUserParameter: Set channel attenuator values, signal difference for ID and SAWSensorValue and number of averaging sweeps*

  PC sends:

C	5	**11223344IISSAA**
		11: attenuator channel 1 [dB]: 0..15, 255 (2 Byte) **22**: attenuator channel 2 [dB]: 0..15, 255 (2 Byte) **33**: attenuator channel 3 [dB]: 0..15, 255 (2 Byte) **44**: attenuator channel 4 [dB]: 0..15, 255 (2 Byte) **II**: signal difference ID [dB]: 0..255 (2Byte) **SS**: signal difference SAWSensorValue [dB]: 0..255 (2Byte) **AA**: number of averaging sweeps : 1..128 (2Byte)

Reader response:

C	5	XX
		S0: ACK S1: NACK

8.2 Command Sequence for Multiple Measurements

switch on RF-unit
1st measurement
2nd measurement
…
nth measurement
switch off RF-unit

9 Appendix - Country-Specific Regulations

9.1 European Union[12]

9.1.1 Radiated Power

The maximum power radiated by the antenna must not exceed 10 mW (+10 dBm, EIRP).

The maximal output power at the antenna port is about +7 dBm. When using an antenna with a high gain it is thus possible to exceed the permissible limits.

Please refer to Section 7.3 of this user manual for further details and a calculation example on how to determine the optimal setting for your system.

9.1.2 Declaration of Conformity

DECLARATION OF CONFORMITY

We ..CARINTHIAN TECH RESEARCH AG.....

(supplier's name)

EUROPASTRASSE 4/1, 9524 - VILLACH/ST. MAGDALEN, AUSTRIA

(address)

declare under our sole responsibility that the product

RF-IDT

(name, type or model, lot, batch or serial number, possibly sources and numbers of items)

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 301489-3, EN 300440-2, EN 60950-1, EN 50371

(title and/or number and date of issue of the standard(s) or other normative document(s))

(if applicable) following the provisions of ..... RTTE ..... Directive.

VILLACH, 25.07.2006

(Place and date of issue)

R. Cholewa

(name and signature or equivalent marking of authorized person)

[12] All European Union member countries and those non-EU countries recognising the relevant EU notification. If in doubt, please contact the responsible authorities.

9.1.3 Certificate

TÜV Österreich, vom österreichischen Bundesministerium für wirtschaftliche Angelegenheiten akkreditierte Prüf-, Überwachungs- und Zertifizierungsstelle
TÜV Austria testing, inspection and certification body accredited by the Austrian Ministry for Economic Affairs

Zertifikat - Certificate

Nr.: TÜV-A-MT/EMV-1/06/KR106

Konformitätsbescheinigung
gemäß Anhang IV der EG-Richtlinie 99/5/EG
Certificate of EC-conformity
according to annex IV of the EC-directive 99/5/EC

Produkt: *Product:*	SAW-Reader	**Zubehör:** keines *Accessories:*
Typ: *Type:*	RF-IDT	**Seriennummer:** 1021 *Serial Nbr.:*
Hersteller: *Manufacturer:*	Carinthian Tech Research AG	Europastrasse 4/1 A-9524 Villach
Auftraggeber: *Applicant:*	Carinthian Tech Research AG	Europastrasse 4/1 A-9524 Villach
Prüfgrundlagen: *Tested according to:*	EN 300 440-2 V1.1.1; EN 301489-03 V1.4.1 EN 60950-1:2001+A11:2004 EN 50371:2002	
Prüfbericht: *Testreport:*	M/RTTE-06/108	

Hiermit bescheinigt der TÜV Österreich als benannte Stelle (ID-Nr. 0408), daß das oben angeführte Produkt überprüft wurde und den grundlegenden Anforderungen der Richtlinie 99/5/EG Artikel 3.2 entspricht. Auf Grundlage des Anhangs IV kann das Produkt mit dem CE-Kennzeichen versehen werden.
TUV Austria as notified body (ID-Nr. 0408) certifies that the above mentioned product has been examined and meets the relevant requirements of the directive 99/5/EC article 3.2. According to annex IV the CE-mark can be affixed on the product.

26. 07. 2006	Ing. Andreas Malek	26. 07. 2009
Datum der Ausstellung *Date of issue*	**Zertifizierungsbeauftragter** *Certification representative*	**Ende der Gültigkeit** *End of validity*

TÜV Österreich
Nachrichtentechnik / EMV
A-1015 Wien, Krugerstraße 16

278b_Zertifikat Anh IV
Rev. 00

Tel.: +43 / 1 / 610 91-6502
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e-mail: emv@tuev.or.at
http://www.tuev.or.at

9.2 United States of America

FCC approval pending.

9.3 Japan

9.3.1 Radiated power

The maximum output levels at the antenna port must not exceed 3 mW/MHz (+4.7 dBm/MHz). In addition, the total gain of the antenna system, i.e. antenna and cable(s), must not exceed a maximum of 6 dBi.

The attenuator values for all reader channels are pre-set to 6 dB, which is the optimal value for use with the linearly polarised antenna (Part No. 101816) enclosed to the reader. Please note that the remaining producer-specified antennae may only be used as receiving antennae in Japan, as their antenna gains would exceed the permissible limit.

9.3.2 Certificate

CETECOM ICT Services GmbH
Untertürkheimer Strasse 6-10, D-66117 Saarbrücken, Germany

Conformity Assessment Body
Recognized Certification Body for Japan

認証書 TYPE- BASED CERTIFICATE

特定無線設備の種類 Classification of specified radio equipment:	**Article 2, Clause 1, Item 8** **Specified low-power radio equipment used for identification of moving objects according Ordinance of Technical Regulations Conformity Certification of Specified Radio Equipment**
電波の形式、周波数及び空中線電力 Type of emissions, frequency and antenna power	**NON,** **2400-2483,5 MHz** **0.003 W/MHz**
型式又は名称 Model Name:	**RF-IDT**
製造者名 Manufacturer Name:	**CTR AG**
認証番号 Certified Number:	**202YJ06556111**
認証をした年 月 日 Certified Date:	**2006-11-10**

上記のとおり、電波法第 38 条の 24 第 1 項の規定に基づく認証を行ったものであることを証する。
This is to certify that the above-mentioned certification by type has been granted in accordance with the provisions of Article 38-24, Paragraph 1 of the Radio Law.

Cetecom ICT Services GmbH
Lothar Spitzer
Signature:

Recognized by
The Ministry of Internal Affairs and Communications(MIC)

CAB ID: 202

Deutscher Akkreditierungs Rat
TTI-P-G 081/94-D0

Contact

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SAW Group

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Austria

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