



**Operating and  
Programming Manual**  
**RFID Wand MICROSCAN**  
**TIRIS™ Version**  
Software Version W1.3

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## 2 FCC Note

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and,
2. This device must accept any interference received including interference that may cause undesired operation.

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## 4 Notation

[ESC]	keys are printed in square brackets
READ_TIME	keywords are printed in capitals
<u>attention</u>	important notes are marked by two lines

## 5 Warnings

Under no circumstances try to open the MICROSCAN. Electrical safety cannot be guaranteed if the device is opened by a non-expert. Your health and life are endangered due to high voltage in the electronics.

In case of damage do not continue to use the devices. Send back the device to your local distributor or - along with a copy of the invoice - to DTE Automation GmbH in Herford, Germany for service support.

Do not dip the device into water. Since it is only protected against water splash and rain, serious damages may occur when using or storing this device under water.

Only use original cables and spare parts with this device.

## 6 Introduction

MICROSCAN is an easy to use transponder read/write device. The TIRIS version reads all TIRIS transponders and writes data into all r/w TIRIS transponders. Since MICROSCAN is driven by a simple ASCII protocol it is easy to integrate the device into any existing or new application.

Please refer to our Internet Web Site at <http://www.dte.de> for latest information on our products.

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Before using the MICROSCAN,  
read this manual carefully from the beginning.  
It contains important information!

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## **7 Getting Started**

In order to prepare the MICROSCAN for the first use carry out all of the following steps:

1. unpack all components
2. switch off your personal computer (PC), connect the MICROSCAN to the serial interface of the PC using the RS-232 interface cable and switch on the PC
3. plug in the mains adapter and connect it to the MICROSCAN. Observe mains voltage!
4. start working with your MICROSCAN

### **7.1 Quick Start**

Start a terminal program on your PC (Telix, Procomm, Hyperterm, or similar).

Choose the serial interface to which you connected the MICROSCAN. Set the parameters as follows:

9600 baud  
1 start bit  
8 data bits  
no parity  
1 stop bit

Start a reading cycle on the MICROSCAN using the [START] key. MICROSCAN tries to read a transponder within a certain time frame. If a transponder has been read successfully, its data will be sent to the PC and the reading cycle will stop.

## **8 When MICROSCAN “hangs”**

In certain situation, e.g. when there is a configuration error, the pocket MICROSCAN may stop its work. There are two ways of resetting the system:

### **8.1 Disconnect supply voltage**

Simply disconnect the system from the supply voltage and wait for 30 seconds. Connect the MICROSCAN to the supply voltage again.

The system will reset itself and will be operational immediately. Parameters previously set through serial commands will not get lost.

### **8.2 Send RESET command**

If the MICROSCAN produces abnormal results this may have been caused by wrong parameter combinations. You may reset the default parameters anytime with the RESET command (see 10.2.9) through the serial interface.

**9 Technical Data**

Dimensions:	140 mm x 62 mm x 35 mm (5.5" x 2.4" x 1.4")
Cable:	app. 2 meter with DB9 female connector
Weight:	app. 150 g (5.3 oz.)
Protection Class:	IP43
RFID Frequency:	134.2 kHz
CPU:	Powerful RISC Processor
Memory:	8 Kbytes FLASH for User program, 512 Byte RAM, 512 Byte EEPROM, 16 KB optional EEPROM
Feedback:	3 LED's, internal beeper
Software	DTE or customer specific
Operating Temp.	-10°C to +60°C (14°F to 140°F)
Storage Temp.	-20°C to +60°C (-4°F to 140°F)
Drop test	1.2 m (3'10") on concrete
Interface	serial RS 232 short-cut circuit resistant, 9.600 Baud
Power Supply	9V to 16V AC or DC

## 10 Software

### 10.1 Introduction

MICROSCAN is equipped with a powerful interpreter that is controlled by serial ASCII commands.

All commands have to be sent with trailing CR LF (0x0D, 0x0A) characters. MICROSCAN answers with trailing CR LF as well.

If a command contains values between 0 and 255, these parameters have to be sent in hexadecimal format with a leading \ and a trailing \ character. For example, if you want to transfer a horizontal TAB (0x09), you should send \09\ to the MICROSCAN.

MICROSCAN will answer in one of these ways:

[ACK] (0x06)	Acknowledge; the command was successful
I	Ignore; the command was invalid
E	Error; there was an error in the command

### 10.2 Configuration Commands

These commands are available to configure the MICROSCAN.

Command	Description	Page
<b>CF</b> Clock Format	Configures date and time format	7
<b>CR</b> Clock Read	Reads the clock	7
<b>CW</b> Clock Write	Sets the clock	7
<b>D</b> Data Length	Sets the length of a data record	8
<b>F</b> Transponder Format	Sets the format of the data record	8
<b>K</b> Data Preamble	Defines the characters that lead a data record	8
<b>L</b> Data Postamble	Defines the trailing character behind a data record	9
<b>M</b> Data Midamble	Defines the middle character when data is sent in TIRIS format, e.g. <b>K1111M1111111111111111L</b>	9
<b>S</b> Sysdata	Sets a variety of system values	9

### 10.2.1 CF Clock Format

PC: CF[aaaaaaaaaaaaaaaaaaaaaa]

MICROSCAN: [ACK]

Description:

This command sets the format of the clock values. Any characters are valid. Certain characters have special functions.

Y	2-digit year	or
YY	4-digit year	
M	2-digit month	
D	2-digit day	
h	2-digit hour	
m	2-digit minute	
s	2-digit second	
w	day of the week (1..7)	

Example: "CFTime\09\h:m:s D-M"

Result: Time[TAB]hh:mm:ss DD-MM

Default: "CFD.M.YY h:m:s w"

### 10.2.2 CR Clock Read

PC: "CR"

MICROSCAN: date and/or time string

Description:

MICROSCAN sends date/time string according to the format previously set with the CF command.

### 10.2.3 CW Clock Write

PC: "CWDD.MM.YYYY hh:mm:ss w"

MICROSCAN: [ACK]

Description:

Sets the internal clock.

Example: "CW10.09.1999 15:48:00 5"

Result: Sets the clock to 10<sup>th</sup> September 1999, 3:48:00 PM, Friday

default: 01.01.2000 00:00:00 1

### 10.2.4 D Data Length

PC: "D[\hh]"

MICROSCAN: [ACK]

Description:

Sets the length of the transponder data string for decimal and hexadecimal format. If it is set to 0, the entire transponder data will be returned. A value greater than the actual length will be ignored.

If the value is less than the actual length, only the least significant digits will be returned.

Example: "D\06"

If the transponder data is "126A8F64E30AC5E4" MICROSCAN will return "0AC5E4".

Default: \0\

### 10.2.5 F Transponder Format

PC: "F[I][D | H | T][C]"

MICROSCAN: [ACK]

Description:

This command sets the transponder format for the string that MICROSCAN send to the PC whenever it reads a transponder.

I	Type Information (R = read/only, W = read/write)
DIHIT	decimal   hexadecimal   TIRIS Format
C	Clock; adds date/time Information

If you choose the TIRIS format, the transponder data is split into a 4 digit application code and a 16 digit identification code.

Example: "FH"

Default: Hexadecimal format

### 10.2.6 K Data Preamble

PC: "K[aaaaaaaaaaaaaaaaaaaa]"

MICROSCAN: [ACK]

Description:

Sets the fixed leading characters that will be send before the transponder data. Up to 20 characters can be defined.

Example: "KTransponder Data:"

MICROSCAN will send "Transponder Data:1111111111111111" whenever a transponder is read.

Default: no preamble



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### 10.2.7 L Data Postamble

PC: "L[aaaaaaaaaaaaaaaaaaaaaa]"

MICROSCAN: [ACK]

Description:

Sets the fixed trailing characters that will be send behind the transponder data. Up to 20 characters can be defined.

Example: "L\0D0A\"

MICROSCAN will send Carriage Return/ Line Feed behind the transponder data.

Default: Carriage Return/ Line Feed

### 10.2.8 M Data Midamble

PC: "M[aaaaaaaaaaaaaaaaaaaaaa]"

MICROSCAN: [ACK]

Description:

Sets the fixed middle characters that will be send between the applications code and the identification code in TIRIS format. Up to 20 characters can be defined.

Example: "M\202020\"

Three blanks will be send between the two codes.

Default: no midamble

## 10.2.9 S Sysdata

PC: "S[n\hh]"

MICROSCAN: [ACK]

Description:

This command sets a variety of system values.

Command	Function	Valid values	Default values	Description
S	Get Values	-	-	Returns current system settings
S0	Reset	\00\		All values will be reset to their defaults.
S1	Read Mode	\00\ .. \0F\	\05\ 0 000 0 1 0 1	Used bit-wise: B7,B6,B5,B4,B3,B2,B1,B0 B7 = 0 Sleep-Mode off B7 = 1 Sleep Mode active (will be ignored when 'line mode' is active or START button is locked) B6 .. B4 reserved B3 = 1: Line Mode = fast permanent reading (B2 and B1 will be ignored) B3 = 0: Line Mode off B2 = 1: Activate START button B2 = 0: Deactivate START button B1 = 1: Automatically start a new reading cycle after a successful reading B1 = 0: Stop after successful reading B0 = 1: Only changed transponders will be read B0 = 0: The same transponder will be accepted again and again
S2	Read Time	\0000\ .. \FFFF\	\00C8\= 200	One reading is set to \hh\ * 0.1 seconds
S3	Read Speed	\00\ .. \FF\	\03\	A reading cycle is \hh\ * 0.1 seconds. The "ON" LED flashes.
S4	Beep Time	\00\ .. \FF\	\02\	The beeper sounds for \hh\ * 0.1 seconds when transponder data is send to the PC
S5	"READ" LED Time	\00\ .. \FF\	\02\	The "READ" LED turns on for \hh\ * 0.1 seconds after a successful reading
S6	"OK" LED Time	\00\ .. \FF\	\00\	The "OK" LED turns on for \hh\ * 0.1 seconds when transponder data is send to the PC
S7	Wait Time	\00\ .. \FF\	\05\	The button repeat time is set to \hh\ * 0.1 seconds
S8	Reserved	\00\ .. \FF\	\00\	reserved

Please be careful when changing system values. The parameters will not be checked.  
Wrong system values may cause strange results or even lock the reader.

In Sleep Mode MICROSCAN does not accept an commands through the serial interface.  
Use the START button to wake it up.

### 10.3 Operation Commands

The commands are used during normal operation.

Command	Description	Page
<b>V</b> <b>Get Version</b>	Returns the software version	11
<b>R</b> <b>Read Transponder</b>	Starts a reading cycle	11
<b>Rpp</b> <b>Read Transponder Page</b>	Reads a certain transponder page	12
<b>W</b> <b>Write Transponder</b>	Writes into a transponder	12
<b>Wpp</b> <b>Write Transponder Page</b>	Writes into a certain transponder page	13
<b>Ppp</b> <b>Page Locking</b>	Locking of a transponder page	13

#### 10.3.1 V Get Version

PC: "V"  
MICROSCAN: "ccctnn"

Description:

The command returns the version of the internal software program.

ccc customer code  
t type  
nn version number

Example: "V"

MICROSCAN returns "DTEW13". This is a DTE software, type read/write, version 1.3.

#### 10.3.2 R Read Transponder

PC: "R"  
MICROSCAN: "thhhhhhhhhhhhhhhhh"

Description:

This command starts a reading cycle for a certain time. You may configure the cycle using the S2 command (see 10.2.9).

Variable	Function	Description
t	Transponder Type	R = Read Only (R/O) W = Read/ Write (R/W)
hhhhhhhh hhhhhhhh	Transponder Data	Data will be return in hexadecimal format (16 digits)

If no successful reading took place in the give time interval, MICROSCAN will return "E".

Example:

PC "R"

MICROSCAN "W112D33EE55A67788"

### 10.3.3 Rpp Read Multi Page Transponder

PC: "R\pp\"

MICROSCAN: "Mpshhhhhhhhhhhhhhhhh"

Description:

This command starts a reading cycle for a certain time. It tries to read a certain page of an M/P transponder. You may configure the cycle using the S2 command (see 10.2.9).

Variable	Function	Description
M	Transponder Type	M = Multi Page (M/P)
ps	Page and Status Information	this value is used bit wise: pppppp ss Page 1 000001 00 Page read Page 2 000010 01 Page programmed Page 3 000011 10 locked page read ..... Page 16 010000 Page 17 010001
hhhhhhhh hhhhhhhh	Transponder Data	Data will be return in hexadecimal format (16 digits)

If no successful reading took place in the give time interval, MICROSCAN will return "E".

Example:

PC "R\0C\"

MICROSCAN "M302222222222222222"

MICROSCAN read page 12 with the data '2222222222222222'.

### 10.3.4 W Write Transponder

PC: "W\hhhhhhhhhhhhhhhhhh\"

MICROSCAN: "Whhhhhhhhhhhhhhhhh"

Description:

This command tries to write data into a read/Write transponder for a certain time. The time may be configured with the S2 command. If the attempt was successful, MICROSCAN returns as shown above. Otherwise it returns "E".

Variable	Function	Description
W	Transponder Type	W = Read/ Write (R/W)
hhhhhhhh hhhhhhhh	Transponder Data	Data will be send in hexadecimal format (16 digits)

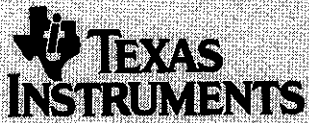
Example:

PC "W\1234567890ABCDEF"

MICROSCAN "W1234567890ABCDEF"







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**Series 2000 Reader System**  
*Micro-reader*                      **RI-STU-MRD1**

**Reference Guide**

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**TIRIS** Technology by  
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## Edition Three - May 2000

This is the third edition of this manual, it describes the following equipment:

TIRIS Micro-reader Module      **RI-STU-MRD1**

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# Read This First

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## About This Guide

This manual describes the TIRIS Micro-reader, its goal is to describe the reader, how it works, how to integrate it and how to use it.

## Conventions



**WARNING:**

A WARNING IS USED WHERE CARE MUST BE TAKEN, OR A CERTAIN PROCEDURE MUST BE FOLLOWED IN ORDER TO PREVENT INJURY OR HARM TO YOUR HEALTH.

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**CAUTION:**

This indicates information on conditions which must be met, or a procedure which must be followed, which if not heeded could cause permanent damage to the equipment or software.

---



**Note:**

Indicates conditions which must be met, or procedures which must be followed, to ensure proper functioning of the equipment or software.

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**Information:**

Indicates information which makes usage of the equipment or software easier.

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## If You Need Assistance

Application Centers are located in Europe, North and South America, the Far East and Australia to provide direct support. For more information, please contact your nearest TIRIS Sales and Application Center. The contact addresses can be found on our home page:

<http://www.tiris.com>

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# Product Description

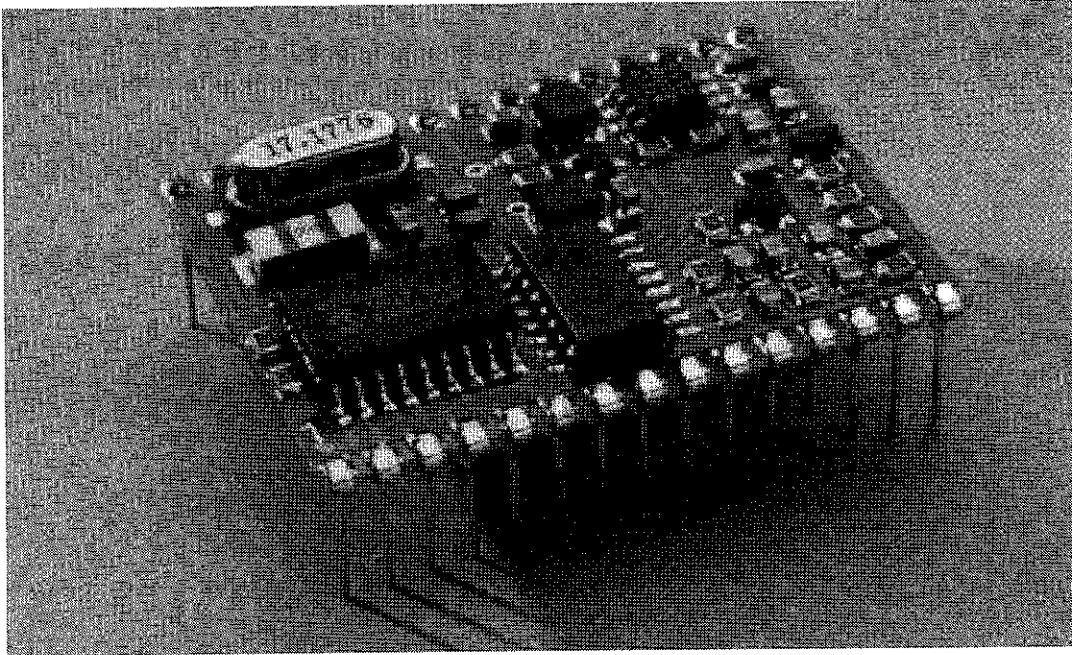
This chapter describes the hardware of the Micro-reader. It tells you about the module and how to integrate it.

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## 1.1 General

The Micro-reader is an intelligent module providing RF and Control functions to read and program TIRIS transponders. It is equipped with a Serial Communications Interface (SCI) which may be directly connected to commonly used system controllers. The Micro-reader works together with a 47  $\mu$ Henry, low-Q antenna, and therefore the system does not need tuning.

**Figure 1: Micro-reader Module**



## 1.2 Product Description

The Micro-reader module is a plug-in module which can be plugged into or soldered onto an application specific adapter board. It supports serial data communications between a PC and TIRIS transponders. With its Serial Communications Interface (SCI) the Micro-reader supports TTL data communications, which with the addition of a communications driver (for example: RS232 or RS422) allows communication to a standard interface.

The Micro-reader can be controlled remotely by either providing certain inputs with the corresponding voltage level or sending commands to the SCI. It can be driven either with or without synchronization - the synchronization can be either wireless or wired to enable reliable operation in multi-reader environments. Two outputs show the reader status and inform the user about a successful command execution. The Micro-reader supports all available TIRIS LF transponders.

### 1.2.1 Power Supply

There are two separate 5V supplies to the Micro-reader, one for the output stage (VSP) and the other for the logic (VSL). On power up VSL should rise faster than 0.1 V/ms to ensure a reliable operation. The Micro-reader has an on-board reset circuit which will reset it should the supply fall below 4 V ( $\pm 0.2$  V).

In order to avoid problems with noise conducted via the supply lines, we recommend that if a single supply is used, separate connections from a common de-coupling capacitor are used to feed the Micro-reader.

**Note:**

The RF Module must not be supplied by Switched Mode Power Supplies (SMPS). This is because most SMPS operate at frequencies around 50 kHz. The harmonics of the generated field can interfere with the TIRIS receiver. Therefore only use linear regulated power supplies, or SMPS with a fundamental operating frequency of 200 kHz or higher.

---

### 1.2.2 Antenna

The Micro-reader has been designed for use with a 47  $\mu$ H antenna with a Q of 10 to 20 to generate the exciter frequency of 134.2 kHz. Because of the low Q the system does not need to be tuned.

**WARNING:**

CARE MUST BE TAKEN WHEN HANDLING THE MICRO-READER AS HIGH VOLTAGES ACROSS THE ANTENNA PINS COULD BE HARMFUL TO YOUR HEALTH.

---

### 1.2.3 Synchronization

There are two possible methods of wired synchronization:

1. Connect a pulse waveform to all RDEN- input pins of the Micro-readers to be synchronized. The pulse would normally be at VSL, dropping to GND for 100  $\mu$ s every 200 ms.
2. Connect all SYNC outputs to an 'Or' and then connect this as an input to RDEN- of each Micro-reader to be synchronized.

Wireless synchronization of the Micro-reader is very effective at synchronizing to adjacent readers, however problems may occur if the antennas are positioned such that a transponder can be within range of two readers at the same time. In this situation one reader could synchronize with the transponder instead of the other reader.

When the WLSC input is active the Micro-reader is in wireless synchronization mode. Wireless synchronization can also be switched on/off by a corresponding command via the serial interface. During execution of this command it has priority over the WLSC input. After the command execution the status of the WLSC input will be considered again.

**Note:**

It is not recommended to have both wired and wireless synchronization switched on as synchronization could be unreliable.

We recommend the use of bus drivers for wired synchronization with other Micro-readers and to prevent ESD damage.

Wired or wireless synchronization prolongs the cycle time by typically 20 ms.

### 1.2.4 Trigger Mode

When the Micro-reader is in idle mode it is possible to trigger a single charge-only read with a power burst duration of 50 ms by taking the RDEN- pin to logic high for 100  $\mu$ s. The single read will start on the falling edge of the 100  $\mu$ s pulse.

If a transponder command is sent to the Micro-reader via the SCI while RDEN- is in a logic high state (waiting position), a falling edge would trigger execution of the command. In waiting position the Micro-reader can only store one command. This means that if two commands were to be sent to the Micro-reader while it is in the waiting position the second command will overwrite the first one.

### 1.2.5 Continuous Mode

When the CRDM input is active the Micro-reader goes into continuous charge-only read mode using a power burst duration of 50 ms. The serial data input takes priority over the CRDM input such that if a serial command is received it will be executed regardless of the state of the CRDM input. After the execution of the serial data command the Micro-reader continues with the previous read mode.

In the default continuous read mode, only those valid RO, R/W or MPT IDs that differ from the previously read ID; or valid IDs read after a "NO READ", are transferred via the SCI (Normal Mode). The Micro-reader can be set to transfer all valid IDs that are read (Line Mode) by means of a corresponding serial data command.

Without synchronization the Micro-reader has a reading frequency of approximately 10 readouts per second using a power burst duration of 50 ms. Timing is given in more detail in section 3.2.

### 1.2.6 Serial Communication

The two serial I/O pins are configured for 9600 Baud, 1 start bit, 8 data bits, no parity and 1 stop bit; they can be connected directly to a communications driver to allow a half duplex communication with a PC via its serial communications interface (for example: RS232 or RS422).

The communications protocol is specified in Chapter 2.

#### Handshake

The Micro-reader accepts handshake commands  $X_{on}/X_{off}$ . When it receives an  $X_{off}$  ( $13_{hex}$ ) the Micro-reader stops its current operation and stops transmitting data via the serial port. It stays in idle mode until  $X_{on}$  ( $11_{hex}$ ) is received when it continues with the previous mode/command. During this idle period the Micro-reader accepts commands via the serial port, however, it waits for its execution until  $X_{on}$  is received. In this idle period the Micro-reader can store only one command.



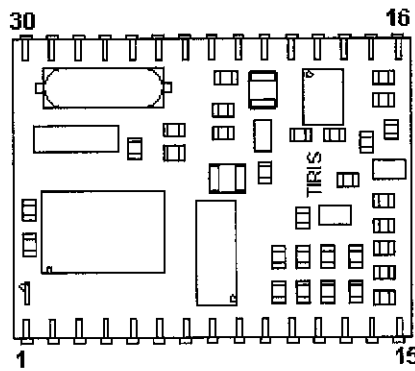
**Note:**

While receiving a command protocol from the serial port X<sub>on</sub>/X<sub>off</sub> is interpreted as normal data without affecting the serial communication.

**1.3 Connector Pins**

The Micro-reader module has 30 pin connections which are shown in Figure 2 and listed in Table 1.

**Figure 2: Micro-reader Pin Connections**



**Table 1: Pin Connections**

Pin	Signal Name	Function
1	SYNC	Output for wired synchronization
2	RDEN-	Input for wired synchronization and single read trigger
3	--	Reserved, do not connect
4	RESET-	Reset of the Micro-reader
5	RXD	Receive Data signal input of serial interface
6	TXD	Transmit Data signal output of serial interface
7	--	Reserved, do not connect
8	--	Reserved, do not connect
9	--	Reserved, do not connect
10	--	Reserved, do not connect
11	--	Reserved, do not connect
12	--	Reserved, do not connect
13	--	Reserved, do not connect

**Table 1: Pin Connections**

Pin	Signal Name	Function
14	--	Reserved, do not connect
15	GND	Ground for logic
16	ANT1	Antenna terminal 1
17	ANTCAP	Antenna capacitor terminal
18	--	Reserved, do not connect
19	ANT2	Antenna terminal 2
20	--	Reserved, do not connect
21	GNDP	Ground for output stage
22	VSP	Supply voltage output stage
23	--	Reserved, do not connect
24	VSL	Supply voltage logic
25	GND	Ground for logic
26	CRD	Input for continuous read mode
27	WLS	Input to switch wireless synchronization on
28	--	Reserved, do not connect
29	OKT	Output to show if a valid ID was read
30	STAT	Output to show status of RF-transmitter control signal

### 1.3.1 Pin Connection Description

- SYNC (1)** Output for wired synchronization. This output is at GND level until the Micro-reader starts its read cycle, at which time it goes to VSL until the complete reading, programming or locking cycle is finished.
- RDEN- (2)** Input for wired synchronization. Taking this pin to VSL acts as a hold-off for the Micro-reader's output stage preventing it from transmitting until the input returns to GND. The Micro-reader only samples this input at the start of its own reading, programming or locking cycle, this means that if the input goes to VSL after a cycle is started, the cycle is not interrupted. RDEN is a high impedance input and must be tied to GND via a suitable resistor (27 kOhm) when it is not being used.
- When the Micro-reader is idle it is possible to trigger a single read by taking the RDEN-pin logic high for 100 ms. The single read will start on the falling edge of the 100 ms pulse.
- RESET- (4)** Taking this pin to GND holds the Micro-reader in reset. If the reset pin is not used it can be left disconnected as it is internally pulled up. Minimum pulse duration to perform a reset is 1 ms. After a reset the



---

	processor takes between 28 ms and 132 ms (typically 72 ms) before it can receive new instructions via the serial communications interface.
RXD (5)	Input configured to receive serial data commands at 9600 Baud, 1 start bit, 8 data bits, no parity and 1 stop bit.
TXD (6)	Output configured to transmit serial data at 9600 Baud, 1 start bit, 8 data bits, no parity and 1 stop bit.
GND (15, 25)	Pins 15 and 25 are ground for the logic part.
ANT1 (16)	Antenna pin for the connection of 47 $\mu$ H, low Q antennas.
ANTCAP (17)	It is possible to use antennas of lower inductance by connecting a suitable capacitor between ANT1 and ANTCAP. This additional capacitor (ceramic, 100 VDC) will be in parallel with the 30 nf resonance capacitor on board the Micro-reader (see Figure 4 and Appendix C).
ANT2 (19)	Antenna pin (GND) for the connection of 47 $\mu$ H, low Q antennas.
GNDP (21)	Pin 21 is ground for the output stage.
VSP (22)	Pin 22 is for connecting the positive supply voltage (5 V) for the output stage.
VSL (24)	Pin 24 is for connecting the positive supply voltage (5 V) for the logic part.
CRDM (26)	Supplying pin 26 with a logic high signal causes the Micro-reader to run in a continuous charge-only read mode (see section 1.2.5 for more information).  When the CRDM pin is tied to logic low, the Micro-reader is in an idle state waiting for commands via the serial interface or for a trigger signal (RDEN-) to start a single read out cycle. CRDM is a high impedance input and must be tied to either VSL or GND via a suitable resistor (27 kOhm).
WLSC (27)	Pin 27 enables or disables wireless synchronization. To enable the wireless synchronization, pin 27 must be taken to VSL. When wireless synchronization is enabled, the Micro-reader will try to synchronize its transmit signals with any other readers in range. To disable wireless synchronization pin 27 must be taken to GND. Pin 27 is a high impedance input and must be tied to either VSL or GND via a suitable resistor (27 kOhm).  Wireless synchronization can also be switched on/off by a corresponding command via the serial interface. During execution of this command it has priority over the WLSC input.
OKT (29)	This output is set to logic high for approx. 60 ms if a valid transponder was read. It can be connected to an LED externally to indicate the result of the read cycle.
STAT(30)	Pin 30 is set to logic low when the RF-transmitter is activated. Supplying an external LED with this signal makes the status of the Micro-reader visible.

---

### 1.3.2 Module and Antenna Block Diagrams

Figure 3: Block Diagram of the Micro-reader

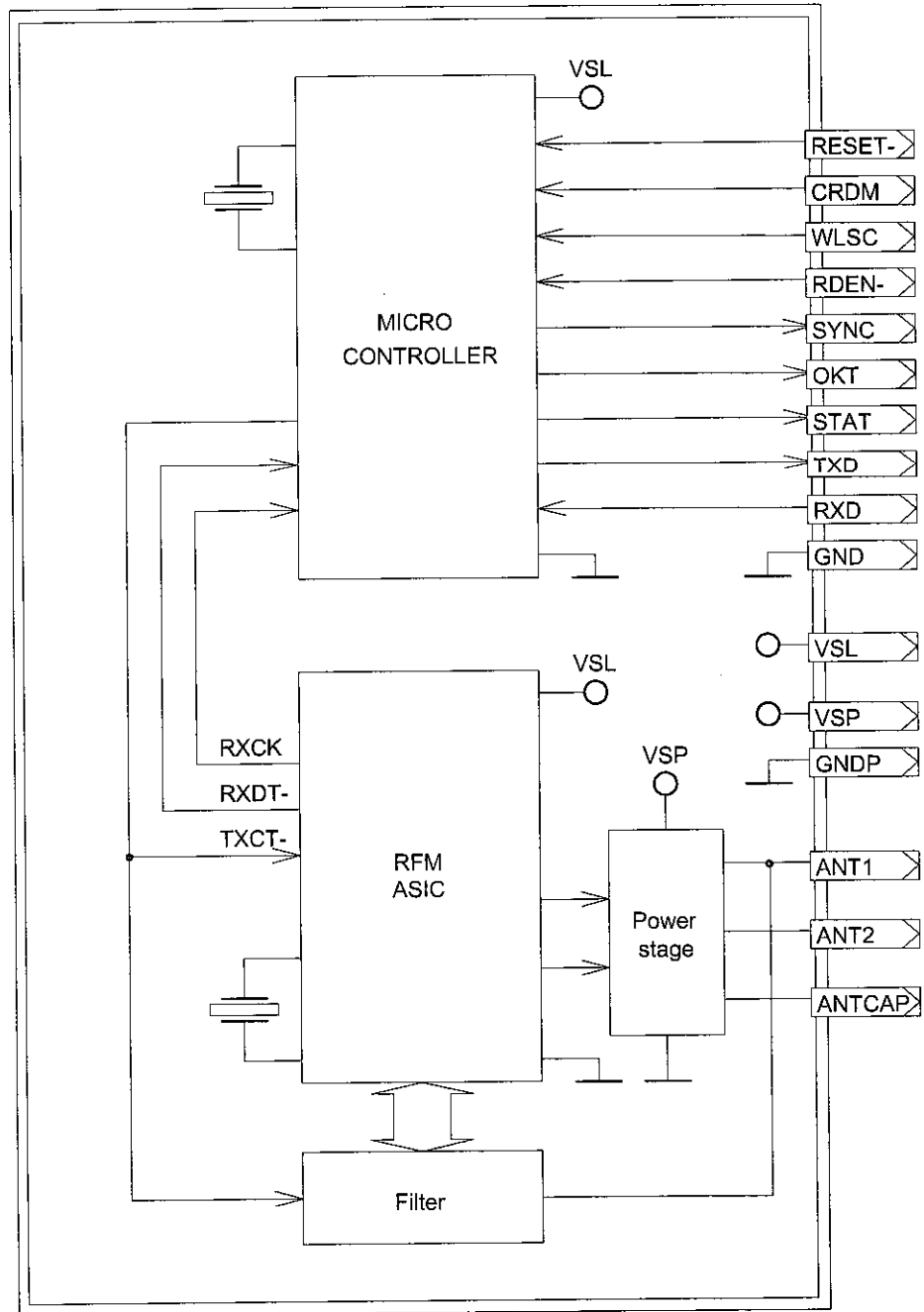
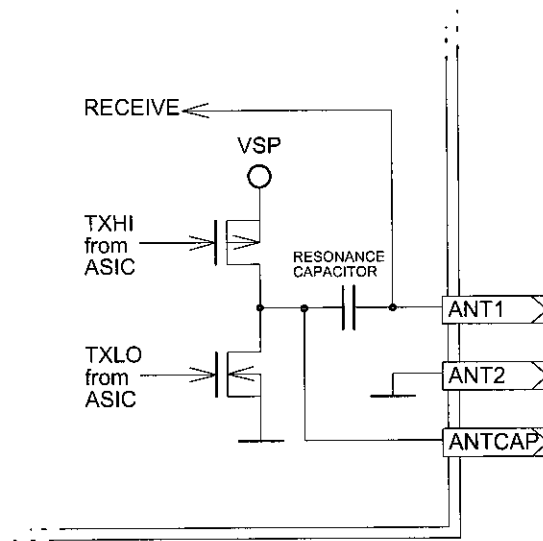


Figure 4: Antenna Circuit Block Diagram



# Communications Protocol

This chapter describes the protocol that you need to use to send instructions from your PC to the micro-reader. It also describes the protocol that the micro-reader uses to respond to the PC.

Topic	Page
<b>2.1 Protocol PC to Micro-reader</b> .....	<b>15</b>
2.1.1 Start Mark .....	15
2.1.2 Length .....	15
2.1.3 Command Field .....	16
2.1.4 Data Field .....	17
2.1.5 BCC .....	18
<b>2.2 Protocol Micro-reader to PC</b> .....	<b>18</b>
2.2.1 Start Mark .....	18
2.2.2 Length .....	18
2.2.3 Status .....	19
2.2.4 Data Field .....	19
2.2.5 BCC .....	19

## 2.1 Protocol PC to Micro-reader

Start	Length	Cmd 1	Cmd 2	Data	BCC
-------	--------	-------	-------	------	-----

Byte	Contents (hexadecimal value)
0	Start Mark (SOH, 01 <sub>hex</sub> )
1	Length
2	Command Field (1)
3	Command Field (2) (optional)
4(3)	Data Field (1)
.	.
.	.
N+3(2)	Data Field (N)
N+4(3)	BCC



**Note:**

The total number of bytes sent within a protocol frame (including Start Mark and BCC) is limited to 41 bytes.

Examples are given in section 5.1.

### 2.1.1 Start Mark

The 'Start-Mark' signifies the beginning of a message. It is represented by the ASCII character SOH (Start Of Header, 01<sub>hex</sub>).

### 2.1.2 Length

The 'Length' byte indicates the length, in bytes, of the following Command and Data Fields.

**2.1.3 Command Field**

The 'Command Field(s)' defines the mode in which the Micro-reader operates and determines the operation that is to be carried out in the transponder. Depending on the setting of the relevant bits, the corresponding information specified in the Data Fields will be sent to the transponder or not. Thus all functions of each particular transponder type can be executed (see 2.1.4 for further information).

**Command Field (1)**

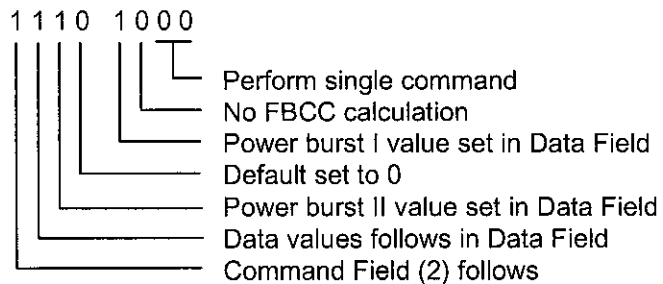
Bit	Use	Setting	Comment
0/1	Mode/Cmd	00 (MSB,LSB)	Perform single command (for example: single read, program, lock)
		01	Read in continuous Normal Mode
		10	Read in continuous Line Mode
		11	Send Micro-reader S/W version
2	FBCC calculation	1/0	If set, Micro-reader calculates FBCC of the MPT protocol
3	Power Burst I	1/0	If set, needs to be determined in Data Field (see 2.1.4)
4	Power Pause Duration	1/0	If set, needs to be determined in Data Field
5	Power Burst II	1/0	If set, needs to be determined in Data Field
6	Data	1/0	If set, needs to be determined in Data Field
7	Cmd expansion Field	1/0	If set, Command Field (2) follows

If bit 5 (Power Burst II, for example: for programming and locking) is set, the Micro-reader automatically operates in single mode. Thus the user is enabled to validate the programming or lock response before a further cycle is started.

If bit 2 (FBCC calculation) and bit 6 (Data) are set, the Micro-reader automatically calculates a two byte BCC over the data to be sent to the transponder and adds it to the protocol. When bits 2 and 6 are set the PC must not send the 2 byte FBCC to the Micro-reader.

Bit 4 (Power Pause Duration) is for future use and must not be set when addressing standard TIRIS transponders.

**Example:**  $E8_{Hex} = 1110\ 1000_{BIN}$



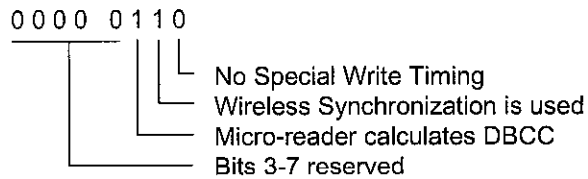
**Command Field (2)**

Command Field (2) is only present if bit 7 of Command Byte 1 is set.

Bit	Use	Setting	Comment
0	Special Write Timing	1/0	If set, needs to be determined in Data Field (see 2.1.4)
1	Wireless Synchronization	1/0	If set, wireless synchronization is used
2	DBCC calculation	1/0	If set, Micro-reader calculates DBCC of the R/W and MPT write data

3-7 Reserved

**Example:** 06<sub>Hex</sub> = 0000 0110<sub>Bin</sub>



If Command Field (2) is not present, standard TIRIS write timings are used and wireless synchronization is switched on/off according to the status of input line WLSC.



**Note:**

The settings specified in Command Field (1) and (2) are only valid during the execution of the current command.

**2.1.4 Data Field**

The presence of the relevant data field depends on the setting of the bits in the Command Field.

If the relevant bit (for example: Command bit 3 "Power Burst I") is set to "1", then Data Field 1 is present defining the Power Burst length. If the relevant bit in the Command Field is set to "0" the consequent Data Field is omitted, this results in the following data field being moved forward (decremented) by one.

Data Field	Use	Range (dec)	Comment
1	Power Burst I	1..255 ms	If bit 3 of Command Field(1) is set
2	Power Pause Duration	1..255 ms	If bit 4 of Command Field(1) is set
3	Power Burst II	1..255 ms	If bit 5 of Command Field(1) is set
4/5	toffLow (LSByte/MSByte)	28..2044 ms	If bit 0 of Command Field(2) is set
6/7	tonLow (LSByte/MSByte)	28..2044 ms	If bit 0 of Command Field(2) is set
8/9	toffHigh (LSByte/MSByte)	28..2044 ms	If bit 0 of Command Field(2) is set
10/11	tonHigh (LSByte/MSByte)	28..2044 ms	If bit 0 of Command Field(2) is set
12	# of Data Fields that follow	see *	If bit 6 of Command Field(1) is set
13..	Data Fields	LSByte first	

\* The number of Data Fields must not cause an infringement of the total number of bytes allowed within a protocol frame.

Transponder command protocols are described in detail in section 4.1.

**2.1.5 BCC**

The 'BCC' field is a one-byte value of the Longitudinal Redundancy Check calculation (Xor'ed bytes) for the preceding message. The calculation is performed on the whole message excluding the Start-Mark.

**Example:** 02 08 32

```

02  0000 0010
08  0000 1000
-----
XOR 0000 1010
32  0011 0010
-----
XOR 0011 1000 = 38 (hex)
    
```

**2.2 Protocol Micro-reader to PC**

Start	Length	Status	Data	BCC
-------	--------	--------	------	-----

Byte	Contents (hexadecimal value)
0	Start Mark (SOH, 01 <sub>hex</sub> )
1	Length
2	Status
3	Data Field (1) (LSByte)
.	.
.	.
N+2	Data Field (N) (MSByte)
N+3	BCC

Refer to section 5.2 for examples.

**2.2.1 Start Mark**

The 'Start-Mark' signifies the beginning of a message. It is represented by the ASCII character SOH (Start Of Header: 01<sub>hex</sub>)

**2.2.2 Length**

The 'Length' byte indicates the length, in bytes, of the following Status and Data Fields.



### 2.2.3 Status

The 'Status' byte provides feedback from the preceding read or program operation.

<i>Status Bits</i>	<i>Setting</i>	<i>Comment</i>
0,1	00	Transponder type: RO
	(MSB,LSB)	
	01	Transponder type: R/W
	10	Transponder type: MPT/SAMPT
	11	Other
2	1/0	If set, Startbyte detected
3	1/0	If set, DBCC O.K.
4	1/0	If set, FBCC O.K.
5	1/0	If set, Micro-reader S/W version follows
6 - 7	Reserved	

### 2.2.4 Data Field

<i>Response Type</i>	<i># of Bytes in Data Field</i>	<i>Comment</i>
RO	8	Identification Data (LSByte first), 4.2.1
R/W	8	Identification Data (LSByte first), 4.2.2
MPT/SAMPT	9	Identification Data (LSByte first), plus Read Address, see 4.2.3
Other	14	Complete transponder protocol without pre-bits provided that a valid RO or R/W start byte was detected
No read	0	No Data Fields, not even transponder start byte was detected, status 03 <sub>hex</sub>
S/W version	1	For example: 15 <sub>hex</sub> means S/W version 1.5

Section 4.2 provides an overview of the response telegrams of the current TIRIS transponder types.

### 2.2.5 BCC

The 'BCC' field is a one-byte value of the Longitudinal Redundancy Check calculation (Xor'ed bytes) for the preceding message. The calculation is performed on the whole message excluding the Start-Mark. An example is shown in section 2.1.5.

# Specifications

This chapter provides the specifications for the micro-reader, its inputs and outputs, and its timing.

<b>Topic</b>	<b>Page</b>
<b>3.1 Recommended Operating Conditions</b> .....	<b>21</b>
<b>3.2 Timings</b> .....	<b>22</b>
<b>3.3 Mechanical Data</b> .....	<b>22</b>

### 3.1 Recommended Operating Conditions

Operating free-air temperature range	T_oper	-25 to +70 °C
Storage temperature range	T_store	-40 to +85 °C



**Note:**

Free-air temperature: air temperature immediately surrounding the Module. If the module is incorporated into a housing, it must be guaranteed by proper design or cooling that the internal temperature does not exceed the absolute maximum ratings.

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_VSP	Supply voltage for power stage	4.5	5.0	5.5	V
V_VSL	Supply voltage for logic	4.5	5.0	5.5	V
I_VSP	Supply current for power stage	-	10 <sup>*1</sup>	-	mA
I_VSL	Supply current for logic	-	30 <sup>*2</sup>	-	mA
I_su	Output current sunk by an output pin	-	5.0	15.0	mA
I_so	Output current sourced by an output pin	-	5.0	15.0	mA
I_sutot	Output current sunk by all output pins	-	20.0	60.0	mA
I_sotot	I_sotot Output current sourced by all output pins	-	20.0	60.0	mA
V_ret	VSP start voltage to guarantee power on reset	-	-	GND	-
Vrise_ret	VSP rise rate to guarantee power on reset	0.1	-	-	V/ms
I_idle	Supply current with Micro-reader idle	-	5.0	-	mA
I_act	Supply current with Micro-reader active	-	100 <sup>*3</sup>	-	mA
ViH	Input high voltage	0.8 VSL	-	VSL	-
ViL	Input low voltage	GND	-	0.2 VSL	-
VoH	Output high voltage	VSL - 0.7		VSL	
VoL	Output low voltage	GND		0.6	V
Q_Ant	Antenna quality factor	10	15	20	
L_Ant	Antenna inductance value	46.1	47.0	47.9	μH

\*1 Typical supply current (peak value) for the power stage when the RF transmitter is switched on (L = 47 μH, Q = 12).

\*2 Typical supply current for logic when the RF transmitter is switched on.

\*3 Typical supply current (average value) of the Micro-reader when the RF transmitter is switched on (L = 47 μH, Q = 12).

### 3.2 Timings

Parameter	Typical	Maxim	Unit
Read Cycle time without synch (no read)	100	105	ms
Read Cycle time with synch (no read)	120	175	ms
Read Cycle time without synch (valid read)	170	175	ms
Read Cycle time with synch (valid read)	190	245	ms
Interbyte time-out for serial communication	10 <sup>*1</sup>		ms

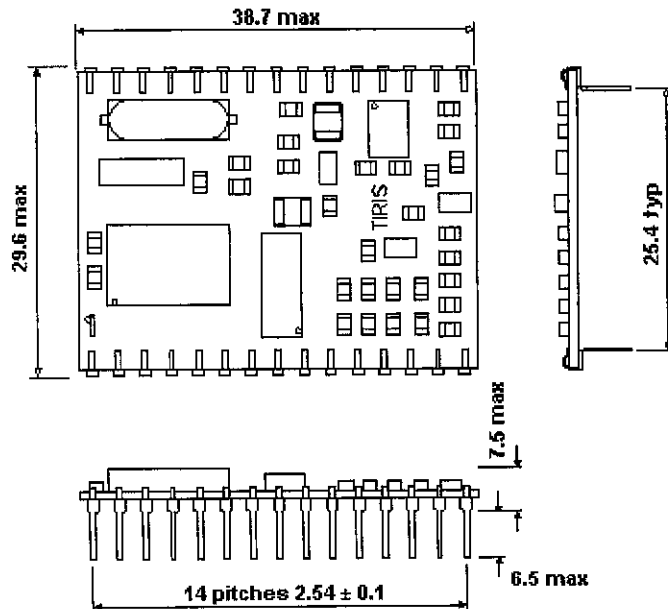
\*1 If an Interbyte time-out occurs the Micro-reader performs a reset.

### 3.3 Mechanical Data

Parameter	Minimum	Typical	Maximum	Unit
Length	37.9	38.3	38.7	mm
Width	28.8	29.3	29.6	mm
Height including pins	12.5	13.5	14.0	mm
Weight		5.0		Grams

Recommended finished pin hole size is 1 mm diameter.

Figure 5: Top, Front and Side View (measurements in mm)



# Transponder Protocols

This chapter describes the protocols used when sending commands to the transponder and the protocols used by the transponder when responding.

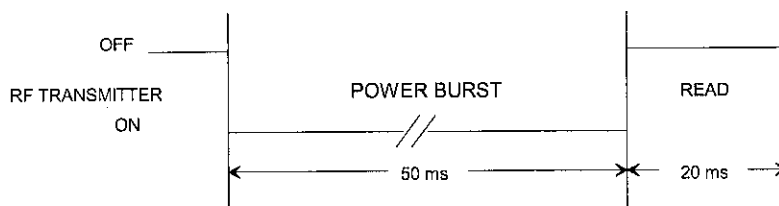
Topic	Page
<b>4.1 Transponder commands</b> .....	<b>24</b>
4.1.1 Read RO, R/W .....	24
4.1.2 Program R/W .....	24
4.1.3 Addressing MPTs/SAMPTs .....	24
4.1.3.1 General Read Page of MPT/SAMPT .....	25
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4.1.3.4 Selective Read Page of SAMPT .....	26
4.1.3.5 Selective Program Page of SAMPT .....	26
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<b>4.2 Transponder Responses</b> .....	<b>27</b>
4.2.1 Read Only Transponder .....	27
4.2.2 Read/Write Transponder .....	27
4.2.3 MPT/SAMPT .....	27

### 4.1 Transponder commands

This section describes the protocols that need to be sent by the PC to the transponder via the Micro-reader in order to execute the required function.

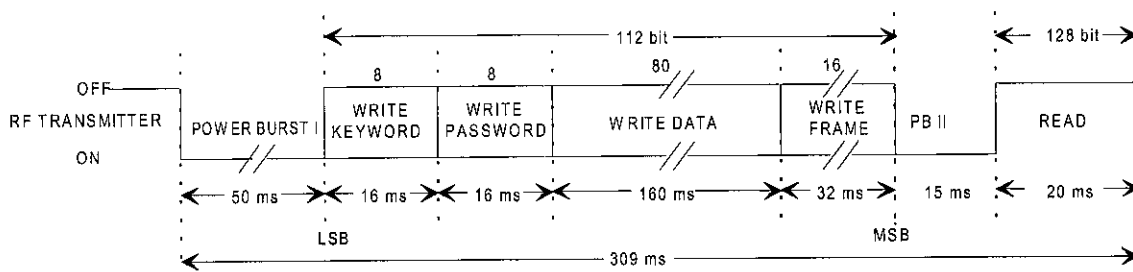
#### 4.1.1 Read RO, R/W

Figure 6: Read Function



#### 4.1.2 Program R/W

Figure 7: Programming Data Format of the 64-bit Read/Write Transponder



Write Keyword : BB<sub>hex</sub>  
 Write Password : EB<sub>hex</sub>  
 Write Frame : 0300<sub>hex</sub>

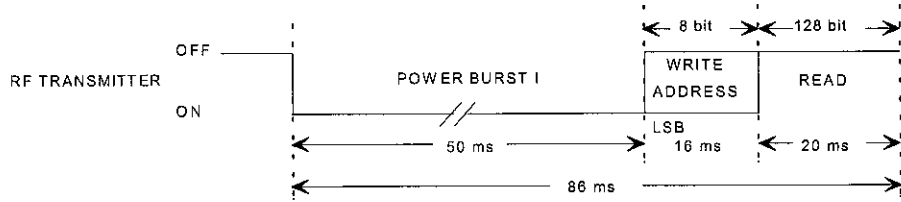
#### 4.1.3 Addressing MPTs/SAMPTs

Since MPT/SAMPTs allow the execution of the different commands applicable to multiple pages the 'Write Address' needs to be sent within the protocol in order to determine the function to be executed with a specific MPT/SAMPT page.

WRITE ADDRESS			
MSB		LSB	
P	P	P	C
P	P	P	C
PAGE		COMMAND	
MSB	LSB	MSB	LSB
Page 1	000001	00	General read page
Page 2	000010	01	Program page
...	.	10	Lock page
Page 16	010000	11	Selective read
Page 17	010001		

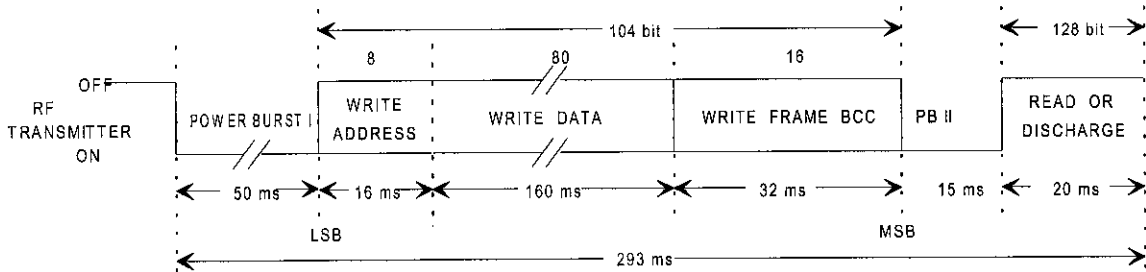
4.1.3.1 General Read Page of MPT/SAMPT

Figure 8: Data Format of the General Read Page Function



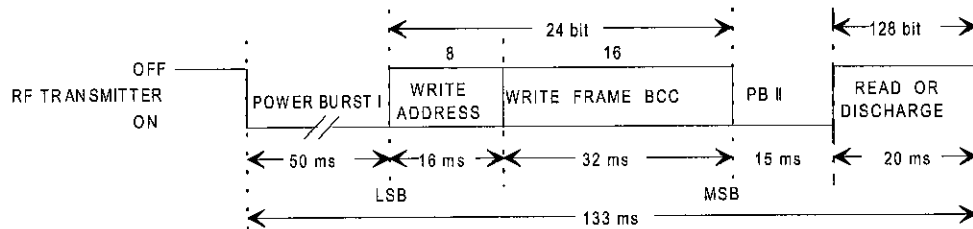
4.1.3.2 Program Page of MPT/SAMPT

Figure 9: Programming Data Format of the MPT



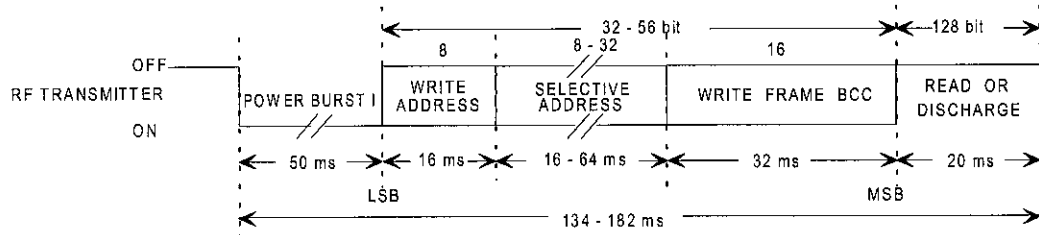
4.1.3.3 Lock Page of MPT/SAMPT

Figure 10: Lock Page of MPT/SAMPT



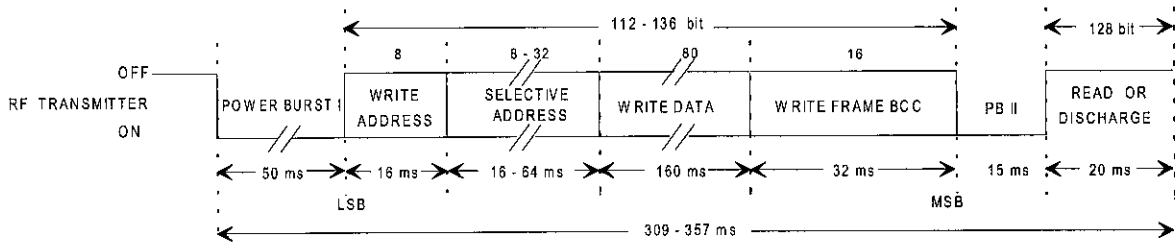
4.1.3.4 Selective Read Page of SAMPT

Figure 11: Data Format of the Selective Read Page Function



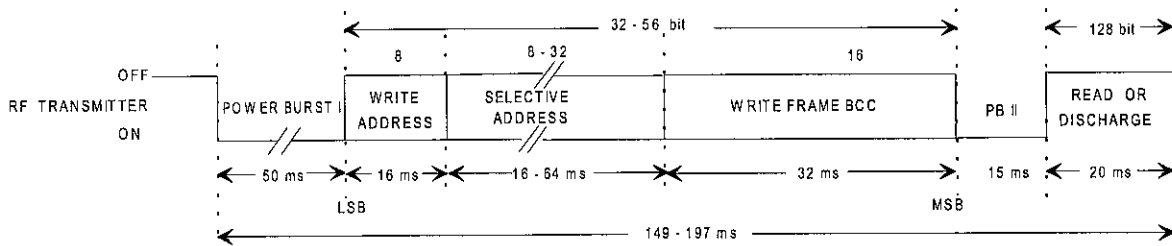
4.1.3.5 Selective Program Page of SAMPT

Figure 12: Data Format of the Selective Program Page Function



4.1.3.6 Selective Lock Page of SAMPT

Figure 13: Data format of the Selective Lock Page function



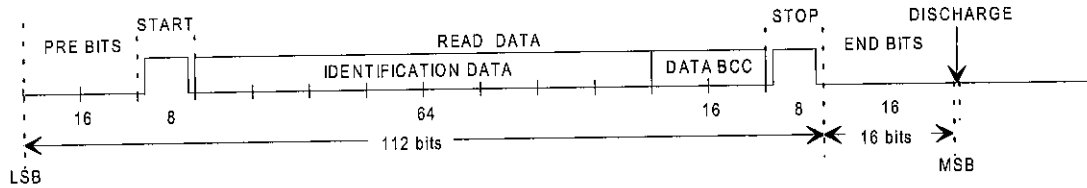


## 4.2 Transponder Responses

This section shows the response telegrams of the current TIRIS transponder types.

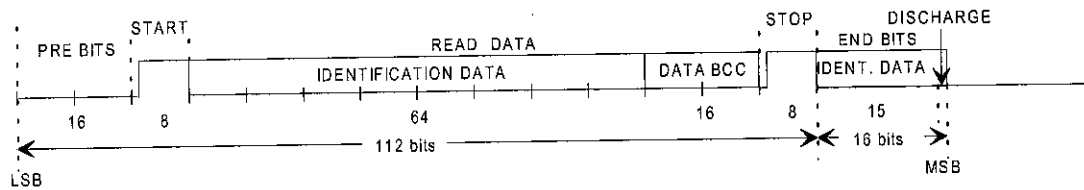
### 4.2.1 Read Only Transponder

Figure 14: RO Read Data Format



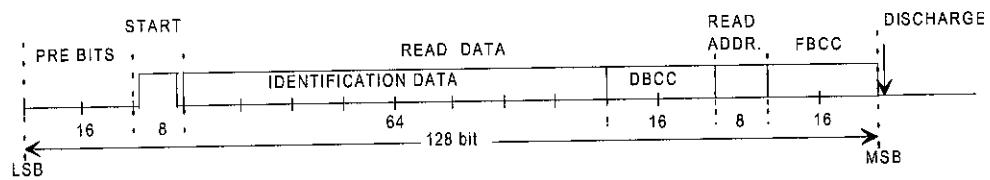
### 4.2.2 Read/Write Transponder

Figure 15: RIW Read Data Format



### 4.2.3 MPT/SAMPT

Figure 16: MPT/SAMPT Read Data Format



The Read Address consists of a 2-bit status field and a 6-bit page field. The status field provides information about the function the multipage transponder has executed and the page field shows which page was affected.

READ ADDRESS		PAGE COMMAND		
MSB	LSB	MSB	LSB	
P	P	P	P	
P	P	P	P	
P	P	P	P	
P	P	P	P	
P	P	P	P	
C	C			
Page 1	000001	00		Read unlocked page
Page 2	000010	01		Programming done
...		10		Read locked page
Page 16	010000	11		Reserved *
Page 17	010001			
	000000	00		Read unlocked page, locking not correctly executed
	000000	01		Programming done, but possibly not reliable
	000000	10		Read locked page, but locking possibly not reliable

- \*) If the status indicates 'Reserved', the read data cannot be interpreted as identification data.



**Note:**

It is strongly recommended to verify whether the requested function has actually been carried out in the transponder by checking the Read Address. If a 'not reliable' response message is received, the command must be sent again to guarantee transponder data retention.

---

# Communication Protocol Examples

This chapter provides some examples of some actual commands sent to a transponder and some possible responses.

Topic	Page
<b>5.1 PC to Micro-reader</b> .....	<b>30</b>
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5.1.2 Program R/W Transponder .....	30
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5.1.8 Selective Lock Page of SAMPT .....	33
<b>5.2 Micro-reader to PC</b> .....	<b>33</b>
5.2.1 Successful Read of RO .....	33
5.2.2 Successful Program Page 2 of MPT .....	34
5.2.3 No Read .....	34



### 5.1.3 General Read Page of MPT

The following sequence of bytes reads page 2 of an MPT.

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	04	Length	Four bytes follow excluding BCC
2	48	Command Field (1)	Perform Single command, send Power Burst I with data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	01	Data Field (2)	One Data Field follows
5	08	Data Field (3)	Write Address specifying General Read Page 2
6	77	BCC	BCC over previous bytes excluding Start Mark

### 5.1.4 Program Page of MPT

The following sequence of bytes programs page 2 of an MPT with:

```

00 00 00 00 00 2D C6 47
MSByte                               LSByte

```

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	0F	Length	15 bytes follow excluding BCC
2	6C	Command Field (1)	Perform Single command, calculate FBCC, send Power Burst I & II with Data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	0F	Data Field (2)	Power Burst II with 15 ms duration (Progr. burst)
5	0B	Data Field (3)	11 Data Fields follow
6	09	Data Field (4)	Write Address specifying Program Page 2
7	47	Data Field (5)	Programming data (LSByte)
8	C6	Data Field (6)	Programming data
9	2D	- :-	- :-
10	00	- :-	- :-
11	00	- :-	- :-
12	00	- :-	- :-
13	00	Data Field (11)	Programming data
14	00	Data Field (12)	Programming data (MSByte)
15	96	Data Field (13)	DBCC (LSByte)
16	50	Data Field (14)	DBCC (MSByte)
17	36	BCC	BCC over previous bytes excluding Start Mark

### 5.1.5 Lock Page of MPT

The following sequence of bytes locks page 2 of an MPT.

Byte	Content	Comment	Description
------	---------	---------	-------------

	(hex)		
0	01	Start Mark	
1	05	Length	Five bytes follow excluding BCC
2	6C	Command Field (1)	Perform Single command, calculate FBCC, send Power Burst I & II with data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	07	Data Field (2)	Power Burst II with 15 ms duration (Progr. burst)
5	01	Data Field (3)	One Data Field follows
6	0A	Data Field (4)	Write Address specifying Lock Page 2
7	5F	BCC	BCC over previous bytes excluding Start Mark

### 5.1.6 Selective Read Page of SAMPT

The following sequence of bytes reads page 2 of an SAMPT.

The 24 bit selective address = 12 34 56  
 MSByte LSByte

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	07	Length	7 bytes follow excluding BCC
2	4C	Command Field (1)	Perform Single command, calculate FBCC, send Power Burst I with Data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	04	Data Field (2)	4 Data Fields follow
5	0B	Data Field (3)	Write Address specifying selective Read Page 2
6	56	Data Field (4)	Selective Address LSB
7	34	Data Field (5)	Selective Address
8	12	Data Field (6)	Selective Address MSB
9	06	BCC	BCC over previous bytes excluding Start Mark

### 5.1.7 Selective Program Page of SAMPT

The following sequence of bytes selective programs page 2 of an SAMPT with:

00 00 00 00 00 00 00 11  
 MSByte LSByte

The 24 bit selective address = 12 34 56  
 MSByte LSByte

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	12	Length	18 bytes follow excluding BCC
2	6C	Command Field (1)	Perform Single command, calculate FBCC, send Power Burst I & II with Data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	0F	Data Field (2)	Power Burst II with 15 ms duration (Progr. burst)
5	0E	Data Field (3)	14 Data Fields follow

6	09	Data Field (4)	Write Address specifying Program Page 2
7	56	Data Field (5)	Selective Address LSB
8	34	Data Field (6)	Selective Address
9	12	Data Field (7)	Selective Address MSB
10	11	Data Field (8)	Programming data (LSByte)
11	00	Data Field (9)	Programming data
12	00	--	--
13	00	--	--
14	00	--	--
15	00	--	--
16	00	--	--
17	00	Data Field (15)	Programming data (MSByte)
18	9F	Data Field (16)	DBCC (LSByte)
19	BD	Data Field (17)	DBCC (MSByte)
20	34	BCC	BCC over previous bytes excluding Start Mark

### 5.1.8 Selective Lock Page of SAMPT

The following sequence of bytes locks page 2 of an SAMPT.

The 24 bit selective address = 12 34 56  
 MSByte LSByte

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	08	Length	8 bytes follow excluding BCC
2	6C	Command Field (1)	Perform Single command, calculate FBCC, send Power Burst I & II with Data
3	32	Data Field (1)	Power Burst I with 50 ms duration (charge-up)
4	0F	Data Field (2)	Power Burst II with 15 ms duration (Progr. burst)
5	04	Data Field (3)	4 Data Fields follow
6	0A	Data Field (4)	Write Address specifying selective Lock Page 2
7	56	Data Field (5)	Selective Address LSB
8	34	Data Field (6)	Selective Address
9	12	Data Field (7)	Selective Address MSB
10	27	BCC	BCC over previous bytes excluding Start Mark

## 5.2 Micro-reader to PC

### 5.2.1 Successful Read of RO

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	09	Length	9 bytes follow excluding BCC
2	0C	Status	Valid RO, Startbyte detected, DBCC O.K.
3	6A	Data Field (1)	Identification Data (LSByte)

4	58	Data Field (2)	Identification Data
5	4C	- :-	- :-
6	00	- :-	- :-
7	00	- :-	- :-
8	00	- :-	- :-
9	00	Data Field (7)	Identification Data
10	00	Data Field (8)	Identification Data (MSByte)
11	7B	BCC	BCC over previous bytes excluding Start Mark

### 5.2.2 Successful Program Page 2 of MPT

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	0A	Length	10 bytes follow excluding BCC
2	1E	Status	Valid MPT, Startbyte detected, DBCC O.K., FBCC O.K.
3	47	Data Field (1)	New Identification Data (LSByte)
4	C6	Data Field (2)	New Identification Data
5	2D	- :-	- :-
6	00	- :-	- :-
7	00	- :-	- :-
8	00	- :-	- :-
9	00	Data Field (7)	New Identification Data
10	00	Data Field (8)	New Identification Data (MSByte)
11	09	Data Field (9)	Read Address specifying successful progr. of page 2
12	B1	BCC	BCC over previous bytes excluding Start Mark

### 5.2.3 No Read

Byte	Content (hex)	Comment	Description
0	01	Start Mark	
1	01	Length	One byte follows excluding BCC
2	03	Status	Other, no Startbyte, DBCC not O.K., FBCC not O.K.
3	02	BCC	BCC over previous bytes excluding Start Mark



## **CE Declaration**

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The Micro-reader module complies with the European CE requirements specified in the EMC Directive 89/336/EEC. The relevant documentation numbers are:

Declaration of Conformity 11-06-02-005

Type Examination Certificate 11-06-05-001

If the Micro-reader is operated from a mains power supply, all power connections and additional components of the final device must comply with the European EMC directive.

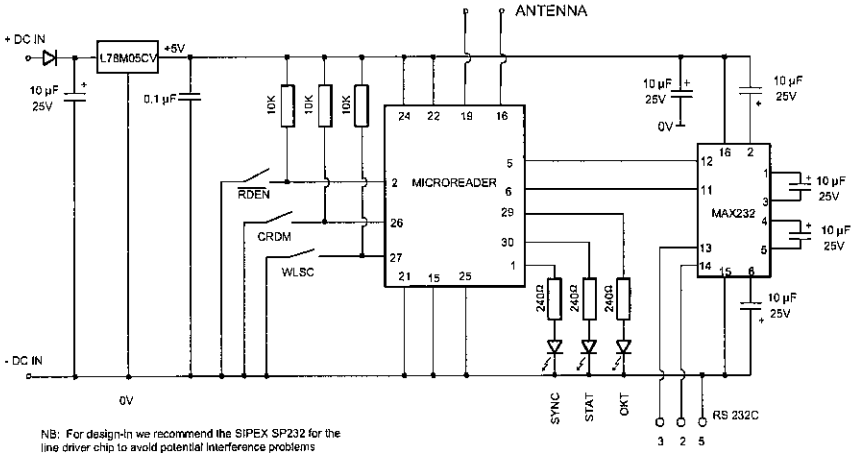
Additional connections may have a length of up to 2 m maximum, or in fixed installations up to 1 m maximum.

European customers must themselves make sure that the final device conforms to the European EMC Directive.

# Demonstration Circuit

The Micro-reader module can be demonstrated using the circuit shown in Figure 17.

**Figure 17: Micro-reader Demonstration Circuit**



# Antenna Design

## C.1 Introduction

This appendix gives an example of how you could construct an antenna to work with the micro-reader. It also provides information about calculating the Q factor and adapting the inductance range.

The antenna properties should be:

Q factor less than 20

Inductance between 46 and 48  $\mu\text{H}$

Recommended maximum size 200 mm x 200 mm

## C.2 Antenna Construction

Item List:

Item	Description	Quantity
1	Enamelled solid copper wire, 0.2 mm	2.1 g
2	Tape, 10 mm wide	20 mm
3	Block cloth tape, 12 mm wide	0.12 m
4	Spiroband, 3 mm diameter	0.24 m
5	Screened antenna lead	1 m

Method:

- Wind 15 turns of item 1 with a diameter of 75 mm.
- Leave about 50 mm free at the ends, cross the wires (at the +/- 50 mm point) and secure them together using the tape (item 2).
- twist the spiroband (item 4) onto the coil that you have just made, leaving the start and finish ends free.
- Strip the insulating braid back at the end of the antenna lead (item 5). Wrap the start and finish ends at least three times around the bared ends and solder the joints (the polarity is not important).
- Tightly bind the soldered joints to the spiroband using the cloth tape (item 3).

This method should result in a 47  $\mu\text{H}$  antenna with a quality factor of approximately 17 - 18.

### C.3 Q Factor

If the antenna's Q factor exceeds 20:

1. The output capacitors will be overloaded and long term damage could result.
2. The antenna may still be resonating when the response from the transponder is received. Without built-in damping the data will not be correctly received.
3. The antenna may be detuned if there is any metal in the area.

The following formula provides an approximate method of calculating the Q factor of the antenna:

$$Q = \frac{2\pi fL}{R}$$

Where: f = 134200 Hz (Frequency = 134.2 kHz)

L = Inductance (henry)

R = Series resistance (ohm)

Example:

The inductance (L) = 47µH.

The resistance (R) = 2.2 Ohm.

$$\begin{aligned} Q &= \frac{2 \times \pi \times 134200 \times 0.000047}{2.2} \\ &= \frac{39.636}{2.2} \\ &= 18 \end{aligned}$$

### C.4 Adapting the Inductance Range

If your antenna is outside of the required inductance range of 46 to 48 µH, you can adapt it to work with the micro-reader by adding an external capacitor to it, either in series or in parallel. You can use this external capacitor to change the inductance range by ± 5 µH.

You can work out the total resonance capacity using the following formula:

$$C_{tot} = 1 / (4\pi^2 L_{Ant} f^2)$$

If the antenna inductance is less than 46.1 µH you can add an extra capacitor (externally) to the antenna between pin 16 (ANT1) and pin 17 (ANTCAP). The formula to work out the value of this capacitor is:

$$C_{ext} = C_{tot} - 30\eta F$$

If the antenna inductance is more than 47.9 µH you can add an extra capacitor in series with the antenna between pin 19 (ANT2) and the antenna. The formula to work out the value of this capacitor is:

$$\frac{1}{C_{ext}} = \frac{1}{C_{tot}} - \frac{1}{30\eta F}$$