ETRX2 and ETRX3 Series ZigBee Modules
AT-Command Dictionary

Current Firmware R308
EmberZNet 4.6.4 stack

Table of Contents

1 Introduction

1.1 The first step

Send the command “ATI” to a module to find its firmware version. If it is not R308 then you should refer to the correct version of the AT command manual, or send an e-mail to zigbeesupport@telegesis.com requesting a copy of the R308 firmware file and stating whether it is for the ETRX2 or ETRX357 (or both). All four variants of the ETRX357 module share the same file, likewise there is just one file for all the variants of the ETRX357.

Alternatively if your module has R308 and you prefer a different version, this can be provided on request.

All the standard AT command set firmware files are free of charge to users who already have the ETRXn devices, but they must only be used on Telegesis modules.

1.2 Module overview

This document describes the AT-Command interface firmware of the ETRX2 and ETRX3 series ZigBee PRO wireless meshing modules. It applies to the R308 firmware, which can be loaded on to all products of the ETRX2 and ETRX3 module series, for example:

-ETRX2, ETRX2-PA, ETRX2HR, ETRX2HR-PA

-ETRX2USB

- ETRX2EAP and Router-E

- ETRX351, ETRX357, ETRX351-LR, ETRX357-LR, ETRX351-LRS, ETRX357-LRS

- ETRX351HR, ETRX357HR, ETRX351HR-LR, ETRX357HR-LR, ETRX351HR-LRS,

ETRX357HR-LRS

- ETRX3USB

- ZigBee Communications Gateway

The Telegesis ZigBee modules have been designed to be built into any device and provide a low cost, low power ZigBee solution based on the industry leading EmberZNet ZigBee stack. Integration into a wide range of applications is made easy using a simple AT-style software interface and advanced hardware design.

No RF experience or expertise is required to add this powerful wireless networking capability to your products. Telegesis ZigBee modules offer fast integration opportunities and the shortest possible time to market for your product.

Important note

Using the AT-Command interface described in this document can shorten the time to market significantly, however customers using the range of Telegesis modules also have the option of using Ember’s EZSP interface firmware or of developing custom firmware using the Ember Development tools.

1.3 Document Overview

This document is meant as an AT-Command and S-Register reference for R3xx revisions of the firmware based on EmberZNet3.x and EmberZNet4.x. In order to learn how your products can benefit from wireless mesh networking please also refer to the following documents:

ETRX2/3 Product Manuals

R3xx Firmware User Guide

Migration guide for existing R2xx firmware customers

ETRX2/3 Development Kit User Guides

Application notes from www.telegesis.com

The ETRX2/3 Product Manuals concentrate on the hardware specification of the modules. The Development Kit Product Manuals contain all of the information required to set up your development kit and run firmware upgrades where necessary.

1.4 Network topology

A network consists of a ZigBee Coordinator (ZC) which started the network, ZigBee Routers (ZR) and ZigBee End Devices (ZED). There do not have to be any routers (other than the coordinator, which functions as a router) or end devices in any given network. Each router can support up to 16 end devices (30 on the ETRX3 series) in any combination of non-sleepy, sleepy and mobile End Devices. The network is always formed as a mesh according to the ZigBee PRO featureset of the ZigBee standard; the tree structure is not available.

By default the module joins a PAN as a router, but modifying register S0A allows you to define it as an end device. The coordinator is simply the device that first establishes the PAN, and it should not be allowed to leave the PAN as it is not possible for a node that is already joined to the PAN to take over the role of a coordinator or Trust Centre.

1.5 The ADCs

The ETRX357 can operate up to 4 ADCs, which are individually enabled by settng the appropriate bits in register S15. A reading is taken each time one of the registers S1F-22 is read, or when a built-in function is executed which reads an ADC. If bit 8 of S15 is set the 1.2V Vref level is presented at pin PB0 for the brief interval while the reading is taken.

Mode:	single-ended
Range:	0-1200mV
Resolution:	14 bits
Units:	1 LSB = 0.1mV
Max load on PB0:	1mA

1.6 A Note on ZigBee® Compliance

The Telegesis R300 firmware has been tested and certified for MSP (manufacturer specific profile) compliance by a test house appointed by the ZigBee Alliance.

This certification includes tests guaranteeing that:

- Modules running the Telegesis AT-Command set will not interfere with existing ZigBee Networks in a malicious way
- Modules running the Telegesis AT-Command set can join a 3rd party ZigBee PRO network and use its routing capabilities
- Modules running the Telegesis AT-Command set can allow 3rd party nodes to join into a network consisting of Telegesis nodes and use its routing capabilities

In addition to implementing a manufacturer specific application profile the AT-Command set allows for transparency allowing communication with 3rd party nodes running any public application profile. In addition to this a transparent endpoint has been added allowing a host processor to implement any public application profile in fully transparent mode.

If you want to use the term ZigBee or the ZigBee Logo in your product documentation the current regulations state that you have to

(i) Be at least an adopting member of the ZigBee Alliance in the year you release your product

(ii) Implement a public application profile

If you intend to get your product certified feel free to contact Telegesis for additional information. Also if you intend to build a product compliant to a public application profile (e.g. Home Automation, Smart Energy) feel free to contact us to discuss your options.

1.7 Important notes

1.7.1 Hardware compatibility

R2xx firmware will not run on the ETRX3 series of modules.

1.7.2 Unexpected start-up in bootloader mode

The bootloader in the ETRX2 can be triggered using the command AT+BLOAD as described in section 2, but it can also be triggered in hardware. If the A/D2 pin is pulled low during the boot-up of the module, the module will also enter the bootloader, so exercise caution when doing hardware design and ensure that this pin is not grounded during start-up and reset. If unused the pad can be left floating and a pull-up is not required.

In analogy to this pulling down PA5 during a reset will cause an ETRX3 series module to enter the bootloader.

1.7.3 Compatibility with other devices

Most features of the R3xx Telegesis AT-Command line Interpreter are part of a Manufacturer Specific Profile using the ZigBee PRO feature set of ZigBee 2007. Interoperability with other devices that use the ZigBee PRO featureset is limited to a number of transparent commands.

R3xx is not compatible with earlier versions of ZigBee which do not implement the ZigBee PRO featureset, including Telegesis R2xx firmware. Also, it is not compatible with the ZigBee Smart Energy profile as it lacks the required security key.

1.7.4 Persistence of network parameters

Once a device has joined a network as a coordinator, router or end device, it will retain its network parameters if it is powered off and on again. It will still be a member of its original PAN, assuming that PAN still exists, though an end device may need to find a new parent and it may have missed an update of the network key. Certain S-registers will have been reset to default values, though, which may change an end device's power mode for example.

2 AT Style Command Conventions

To simplify the communication with the modules, an AT-style command set, similar to the industry standard Hayes modem control language, is used.

Each command must be preceded by the "AT" or "at" prefix. To terminate a command enter <CR>. Any data not following this pattern is either not accepted by the module or will cause an error message in response. Every command must be terminated with a <CR>, they cannot be concatenated.

Commands are followed by an optional response that includes <CR><LF><Response><CR><LF> and/or a prompt <CR><LF><Prompt><CR><LF> where the prompt could also be an error message.

Example:

ATS00?<CR>
<CR><LF>FFFF<CR><LF>
<CR><LF>OK<CR><LF>

It is recommended to wait for an “OK” or “ERROR:XX” prompt before issuing the next command.

Any data which is prompted to the user is delivered in the format <CR><LF><prompt><CR><LF>. Unless disabled in S0E or S0F prompts may appear whenever the corresponding event occurs.

Example:

<CR><LF><BCAST:000D6F000005A666,04=test><CR><LF>

A prompt intersecting a command being entered will not affect the command itself.

Throughout this document, only the responses and prompts are presented, <CR><LF> are omitted intentionally. Sequences of AT commands in a single line are not supported.

The ETRX2 and ETRX357 feature a 128-byte FIFO to buffer incoming characters from the host processor, which is sufficient to hold even the longest possible command. The ETRX357 features a 256-byte FIFO buffer for incoming radio messages, which allows rapid reception of multiple messages without loss of characters. To prevent a buffer overflow XON/XOFF handshaking is used. Optional hardware handshaking can be enabled as described in the register description of S12 in section 4.

Read Command **ATXXX?**	Commands ending with a ‘?’ return the currently set value of the parameter or parameters
Write Command **ATXXX=<…>**	This command sets user-definable parameters as indicated by the ‘=’ sign.
Execute Command **ATXXX**	This command executes routines of the module and returns parameters

Table 1: Types of AT commands

When bit 7 of S12 is set each individual reply or prompt is additionally started with the STX and ended with the ETX character to aid the interpretation of the incoming strings on a host processor.

2.1 Parameters

Each parameter must be entered in the correct format for any of the AT commands to execute correctly. Optional parameters are marked with square brackets […].

XX	8-bit hexadecimal number. Valid characters are 0-9, a-f and A-F
XXXX	16-bit hexadecimal number. Valid characters are 0-9, a-f and A-F
n	Number from 0-9
s	Sign
b	Bit (0 or 1)
c	character
<PID>	16-bit hexadecimal PAN ID (0000 to FFFF)
<EPID>	64-bit hexadecimal extended PAN ID

<channel>	decimal channel (802.15.4 channel 11-26)
<password>	8 character password
<EUI64>	64-bit IEEE 802.15.4 address in hexadecimal
<ioread>	32-bit hexadecimal number representing the reading of S1A
<data>	Custom Data
<ClusterList>	A list of 16 bit cluster identifiers in hexadecimal representation
<FirmwareRevision>	The Firmware Revision Number

Table 2: Different formats of parameters

2.2 Prompt Overview

The following prompts can show up during the operation of the ETRXn modules. Most of the prompts can be disabled using register S0E and S0F.

Prompt Overview	
OK	OK terminator
ERROR:XX	Error number XX occurred
ACK:XX	Acknowledgement for message XX was received
NACK:XX	Acknowledgement for message XX was not received
SR:XX,<EUI64>,<NWK addr>,…	Route Record Message received
BCAST:[<EUI64>,]XX=<data>	A Broadcast with XX characters has been received
MCAST:[<EUI64>,]XX=<data>	A Multicast with XX characters has been received
UCAST:[<EUI64>,]XX=<data>	A Unicast with XX characters has been received
RAW:snn,<data>	A raw message has been received with strength snn dBm
SDATA:[<EUI64>,],<ioread>,<A/D1>,<A/D2>, <sequenceNo>,<Vcc>	A data message has been received at the sink. ADC data is A/D1 & A/D2 or ADC0 & ADC1
FN130:[<EUI64>],<NWK addr>,<ioread>, <sequence no>,<S46>,[<A/D1>],[<A/D2>], [<A/D3>],[<A/D4>]	A data message has been received at the sink. The number of ADC data fields depends on how many ADCs are activated at the sender
FFD:<EUI64>,<NWK addr>	A router announcing itself
SED:<EUI64>,<NWK addr>	A sleepy end device announcing itself
MED:<EUI64>,<NWK addr>	A mobile sleepy end device announcing itself
ZED:<EUI64>,<NWK addr>	An end device announcing itself
NEWNODE: <NWK addr>,<EUI64>, <Parent NWK addr>	Shown on Coordinator: New node has been given permission to join the PAN. NB joining is not complete until an “FFD” prompt or similar is received
LeftPAN	Local Node has left the PAN
LostPAN	End Device has lost contact with Parent
JPAN:<channel>,<PID>,<EPID>	Local Node has joined PAN with given parameters
SINK:<EUI64>,<NWK addr>	Selected new Sink
ADSK:<EUI64>,<NWK addr>	Received Sink Advertisement
SREAD:<NWK addr>,<EUI64>,<Register>, <errorcode>[=<Data>]	Reply to a remote S Register Read operation
SWRITE:<NWK addr>,<EUI64>,<errorcode>	Reply to a remote S Register Write operation
Bind:<NWK addr>,<status>	Create Binding Status (ETRX3 only)
Unbind:<NWK addr>,<status>	Delete Binding Status (ETRX3 only)

Prompt Overview	
DataMODE:<NWK addr>,<EUI64>	Datamode has been opened remotely
DataMODE:<NWK addr>,<EUI64>, <errorcode>	Response to an attempt to open data mode
OPEN	Data mode is open
CLOSED	Data mode is closed
TRACK:<EUI64 R>,<EUI64 S>,<RSSI>, <i/o read>,<AD1>,<AD2>,<Vcc>,<S46>	Tracking message: EUIs of receiver and sender, RSSI, input data, Vcc & S46 counter of sender (only the low-order 16 bits of S46 are shown)
TRACK2:<EUI64 R>,<EUI64 S>,<RSSI>, <I/O read>,<S46>	Tracking message: EUIs of receiver and sender, RSSI, I/O data, and S46 counter of sender
PWRCHANGE:XXXX	Local node has changed Power Mode to XXXX
AddrResp:<errorcode> [,<NWK addr>,<EUI64>]	Response to an address request (also triggered when finding source routes)
RX:<EUI64>,<NWK addr>,<profileID>, <destinationEndpoint>,<SourceEndpoint>, <clusterID>,<length>:<payload>	An incoming message not addressed to the AT command endpoint. EUI64 is only shown if included in network frame header
NM:ES REPORT WARNING	More than 16 energy scan reports have been recently received by the network manager indicating high packet loss
ENTERING BLOAD	Passthrough bootloading has been initiated from another node

Table 3: Prompt Overview

2.3 Device Overview

2.3.1 ZigBee types

Table 4 gives an overview of the ZigBee device types mentioned in this document.

Device Types		ZigBee Naming Convention
COO	Coordinator	ZigBee Coordinator (ZC)
FFD	Router	ZigBee Router (ZR)
ZED	End Device (non sleepy)	ZigBee End Device (ZED)
SED	Sleepy End Device	
MED	Mobile Sleepy end Device	

Table 4: Device Overview

The terms Full Function device (FFD) and Reduced Function Device (RFD) are obsolete, but the abbreviations are retained in the R308X firmware to avoid problems with users' legacy application software.

Each ETRX2 coordinator or router can support up to 16 End Devices, in any combination of Sleepy End Devices and Mobile End Devices, and an ETRX357 can support 30.

Only end devices should be put into a low-power state because routers and the coordinator must always be powered up to maintain the network connectivity. ZigBee End Devices do not poll for data, instead their incoming messages are relayed immediately by their parent without being buffered. This means that ZEDs must not be put into a sleep mode.

2.3.2 Non-ZigBee types

Sink. The sink is a Telegesis feature. When a node is defined as a sink by setting S10 bit 4, it can broadcast its address to the rest of the network. Other nodes can then send messages to the sink node using AT+SCAST or various built-in functions. This simplifies the application software since it is not necessary to know the EUI64 of the sink in advance. Devices discover the sink when (1) they receive a regular advertisement broadcast from the sink (2) they are commanded to send a message without knowing the sink address and bit 8 of S10 is set (the first sink-cast message is therefore lost (3) the AT+SSINK command is used. To reduce traffic to end devices they do not receive the advertisement broadcasts, but will be informed of the sink address when they join the PAN. Otherwise, you should set bit 8 of S10 on end devices.

2.4 Addressing modes

Many of the AT commands take a device address as a parameter, which can usually be expressed in several different formats.

EUI64. 16 hexadecimal characters. This is flashed on to the chip at manufacture and cannot be changed by the user. This can be compared to the permanent MAC address of an IP-based device.

Network address. 4 hexadecimal characters. This is allocated to the device when it joins the PAN and cannot be changed or preset, except that 0x0000 is always the coordinator. It is analogous to a temporary IP address. Otherwise known as the Node ID.

Address table entry. Range 00-06. Entry 05 is a sink address, entry 06 is the source address of the last received UCAST, SCAST or MCAST.

Binding table entry. Range 10-24 (hexadecimal). Entry FE causes a search of the table for the first entry whose source endpoint and cluster ID matches registers S40 and S42.

FF. In many commands address FF represents the local device.

2.5 AT Command Overview

The following table gives a quick reference of all commands available.

Command Overview		
Module control and configuration		
ATI	**Display Product Identification Information**	
ATZ	**Software Reset**	
AT&F	**Restore Factory Defaults**	
AT+BLOAD	**Enter The Bootloader Menu**	
AT+CLONE	**Clone Local Node To Remote Node (ETRX2 Series Only)**	
AT+PASSTHROUGH	**Pass new Firmware Image To Remote Node (ETRX3 Series Only)**	
AT+RECOVER	**Recover From A Failed Clone Attempt**	
ATS	**S-Register Access**	
ATREMS	**Remote S-Register Access**	
ATSALL	**Remote S-Register Access**	
AT+TOKDUMP	**Display All S-Registers**	
Network control and configuration		
AT+ESCAN	**Scan The Energy Of All Channels**	
AT+PANSCAN	**Scan For Active PANs**	
AT+EN	**Establish Personal Area Network**	
AT+JN	**Join Network**	
AT+JPAN	**Join Specific PAN**	
AT+SJN	**Silent Join**	
AT+DASSL	**Disassociate Local Device From PAN**	
AT+DASSR	**Disassociate Remote Node From PAN**	**(ZDO)**
AT+N	**Display Network Information**	
AT+NTABLE	**Display Neighbour Table**	**(ZDO)**
AT+RTABLE	**Display Routing Table**	**(ZDO)**
AT+IDREQ	**Request Node's Network address**	**(ZDO)**
AT+EUIREQ	**Request Node's EUI**	**(ZDO)**
AT+NODEDESC	**Request Node's Descriptor**	**(ZDO)**
AT+POWERDESC	**Request Node's Power Descriptor**	**(ZDO)**
AT+ACTEPDESC	**Request Node's Active Endpoint List**	**(ZDO)**
AT+SIMPLEDESC	**Request Endpoint's Simple Descriptor**	**(ZDO)**
AT+MATCHREQ	**Find Nodes which Match a Specific Descriptor**	**(ZDO)**
AT+ANNCE	**Announce Local Device in the Network**	**(ZDO)**
AT+SR	**Set Source Route To Remote Device**	
AT+FNDSR	**Find The Source Route To A Remote Device**	
AT+POLL	**Poll For Data From Parent**	
AT+REJOIN	**Rejoin The Network**	
AT+SN	**Scan Network**	
AT+KEYUPD	**Update the Network Key**	**(ZDO)**
AT+BECOMETC	**Make Local Device the Trust Centre**	
AT+BECOMENM	**Make the local device Network Manager**	
AT+CCHANGE	**Change the network's channel**	

Command Overview (continued)		
Messaging		
AT+ATABLE	**Display Address Table**	
AT+ASET	**Set Address Table Entry**	
AT+MTABLE	**Display Multicast Table**	
AT+MSET	**Set Multicast Table Entry**	
AT+BCAST	**Transmit A Broadcast**	
AT+BCASTB	**Transmit A Broadcast Of Binary Data**	
AT+UCAST	**Transmit A Unicast**	
AT+UCASTB	**Transmit A Unicast Of Binary Data**	
AT+SCAST	**Transmit Data To The Sink**	
AT+SCASTB	**Transmit Binary Data To The Sink**	
AT+SSINK	**Search For A Sink**	
AT+MCAST	**Transmit A Multicast**	
AT+MCASTB	**Transmit A Multicast Of Binary Data**	
AT+DMODE	**Enter Data Mode (Serial Link Mode)**	
+++	**Leave Data Mode**	
AT+IDENT	**Play A Tune On Remote Devboard**	
AT+RDATAB	**Send Binary Raw Data**	
Binding Management (ETRX3 only)		
AT+LBTABLE	**Display Local Binding Table**	
AT+BSET	**Set Local Binding Table Entry**	
AT+BCLR	**Clear Local Binding Table Entry**	
AT+BTABLE	**Display Binding Table**	**(ZDO)**
AT+BIND	**Create Binding on Remote Device**	**(ZDO)**
AT+UNBIND	**Delete Binding on Remote Device**	**(ZDO)**

Table 5: Command Overview

2.6 Module Control & Configuration Commands

I – Display Product Identification Information	
Execute Command **ATI** Note On modules manufactured before summer 2007 an invalid <DeviceName> is displayed. This does not affect the functionality of the module.	Response **Telegesis <DeviceName>** **R<Firmware Revision>** **<EUI64>** **OK** Where <DeviceName> is the order code of the device, <Firmware Revision> is the firmware revision and <EUI64> is the Device's IEEE 802.15.4 identifier
SW release	R300 ●

Z – Software Reset	
Execute Command **ATZ**	Response **JPAN:<channel>,<PID>,<EPID>** **OK** or **OK** Module Performs a software reset All non-volatile S Registers keep the user defined values, if the module was part of a PAN it will remain part of it.
SW release	R300 ●

&F – Restore Factory Defaults	
Execute Command **AT&F**	Response Module Performs a factory reset All non-volatile S Registers are updated with their factory defaults and the node leaves the network it is currently joined to.
SW release	R300 ●

+BLOAD – Enter The Bootloader Menu	
Execute Command **AT+BLOAD**	Response **<entering bootloader>** The device leaves the AT command line and enters the bootloader menu for downloading new firmware. A description of the bootloading process can be found in the Development Kit Product Manual. Please note that the bootloader will run at a baudrate of 115k2, no parity, 8 data bits regardless of the current serial port settings.
SW release	R300 ●

+CLONE – Clone Local Node To Remote Node (ETRX2 Series only)	
Execute Command **AT+CLONE:<EUI64>,<password>** Use on: Source: FFD, COO Destination: All device types Notes The default password for R3xx nodes is “password”. A description of the cloning process can be found in the Development Kit Product Manual.	Response **Cloning…** Remote Response **ENTERING BLOAD** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. This command clones the firmware of the local node to a remote node within the same PAN, whose address is given by <EUI64>. <password> represents the remote node’s 8-character password. After completion a soft reset is caused on the remote end.
SW release	R304 ●

+PASSTHROUGH – Pass new Firmware Image To Remote Node (ETRX3 Series Only)	
Execute Command **AT+PASSTHROUGH:<EUI64>,<password>** Use on: Source: FFD, COO Destination: FFD, COO, ZED Notes Passthrough is not possible to SEDs or MEDs or over multiple hops. The default password for R3xx nodes is "password". A description of the passthrough process can be found in the Development Kit Product Manual; it is the same procedure as cloning. The ETRX357(HR)-LRS module cannot be reliably upgraded by the passthrough process	Response **PASSTHROUGH BLOAD...** **Please start .ebl upload image...** Remote Response **ENTERING BLOAD** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. <password> represents the remote node's 8-character password. After completion a soft reset is caused on the remote end.
SW release	R304 ●

+RECOVER – Recover From A Failed Clone or Passthrough Attempt	
Execute Command **AT+RECOVER** Use on: Source: FFD, COO Destination: All device types Note Use this command in cases where the cloning (ETRX2 Series) or Passthrough Bootloading (ETRX3 Series) operation was interrupted and the target device therefore remains in the bootloader. In case the target device has been reset channel 13 must be used for recovering. For more information on over-the-air firmware upgrading please refer to the Development Kit Manual.	Response **Recovering…** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. Enters clone (ETRX2 Series) or Passthrough (ETRX3 Series) mode to a remote node which is already in the bootloader.
SW release	R300 ●

S – S-Register Access	
Read Command **ATSXX[x[x]]?** Examples **ATS00?** **ATS0AE?** **ATS1812?** XX is the S-Register which is to be read. As an option for all 16 bit registers it is also possible to address an individual bit only by specifying the bit number [x]. For all 32 bit registers it is possible to address an individual bit by specifying the bit number in hexadecimal [xx]	Response **<data>** **OK** or **ERROR:<errorcode>** The module displays the contents of S-register xx or an error message, where <errorcode> represents the error code explained in section 3. All 16- and 32-bit registers can also be accessed bit by bit. In order to do this [x[x]] may specify the bit which is to be read. The result when reading a single bit will always be 0 or 1.
Write Command **ATSXX[x[x]]=<data>[,<password>]** Examples **ATS00=3FFC** **ATS0AE=1:password** Notes Some S-Registers require a password for write access. See S-Register description for details. **The default password for R3xx is "password".** Some S-Registers are read-only and will return an error if you are trying to write to them. When writing an individual bit by specifying [x[x]], <data> can only be either 0 or 1.	Response **OK** or **ERROR:<errorcode>** The data is written to S-register number XX and if applicable stored in non-volatile memory. The data format for each individual S-Register is given in the S-Register description. <errorcode> represents the error code explained in section 3. For all 16- and 32-bit registers individual bits can also be set or cleared by specifying the bit using hexadecimal [x[x]] and setting it to either 0 or 1.
SW release	R300 ●

REMS – Remote S-Register Access

Read Command
ATREMS:<address>,XX[X[x]]?

Examples
ATREMS:000D6F00000AAC93,00?
ATREMS:000D6F00000AAC93,0AE?
ATREMS:000D6F00000AAC93,1812?

Where <address> can be the remote node's EUI64, Network address or address table index and XX is the S-Register which is to be read. As an option for all 16 bit registers it is also possible to address an individual bit only by specifying the bit number [X]. For all 32 bit registers it is possible to address an individual bit by specifying the bit number in hexadecimal [xx]
The result when reading a single bit will always be 0 or 1.

Note
Also the local node can be the target of this command (e.g. use address table entry FF as the address)

Response
SEQ:XX
OK

or **ERROR:<errorcode>**

The module asks for the contents of the remote S-register using a unicast. The sequence number of the unicast is displayed (an **ACK** or **NACK** prompt will follow). <errorcode> represents the error code explained in section 3.

Prompt

SREAD:<Network address>,<EUI64>,<Register>, <errorcode>[=<Data>]

Where Network address is the remote Network address, EUI64 is the remote EUI64, Register is the S-Register which was read and <errorcode> is indicating the success (00) or failure of the read operation. The contents of the remote S-Register are following in case of a successful read only.

Write Command
ATREMS:<address>,XX[x[x]]=<data> [,<password>]

Examples
ATREMS:000D6F0000012345,00=3FFC
ATREMS:000D6F0000012345,0AE=1:password

Where <address> can be the remote node's EUI64, Network address or address table index and XX is the S-Register which is to be written. As an option for all 16- and 32-bit registers it is also possible to address an individual bit only by specifying the bit number [x[x]].

Notes
Some S-Registers require a password for write access. See S-Register description for details. **The default password for R3xx is "password".**
Some S-Registers are read-only and will return an error if you are trying to write to them.
When writing an individual bit by specifying [x[x]], <data> can only be either 0 or 1.

Response
SEQ:XX
OK

or **ERROR:<errorcode>**

The data is written to the remote S-register number XX and if applicable stored in non-volatile memory. The data format for each individual S Register is given in the S-Register description.
The sequence number of the unicast is displayed (an ACK or NACK prompt will follow). <errorcode> represents the error code explained in section 3.

Prompt
SWRITE:<Network address>,<EUI64>,<errorcode >

Where <Network address> is the remote Network address, <EUI64> is the remote EUI64. Only in case the errorcode is 00 the write operation has been completed successfully.

SW release	R302	●

SALL – Remote S-Register Access	
Write Command **ATSALL:<group ID>,XX[x[x]]=<data> [,<password>]** Examples **ATSALL:FFFF,00=3FFC** **ATSALL:FFFC,0AE=1:password** Where group IDs are remote node's multicast IDs or FFFF - Broadcast to all devices FFFD - Broadcast to all non-sleepy devices FFFC – Broadcast to all Routers Notes Some S-Registers require a password for write access. See S-Register description for details. **The default password for R3xx is "password".** Some S-Registers are read-only and cannot be written to.	Response **OK** or **ERROR:<errorcode>** The data is written to the remote S-register number XX on all nodes addressed by the multicast group ID. The data format for each individual S-Register is given in the S-Register description. <errorcode> represents the error code explained in section 3. For all 16- and 32-bit registers individual bits can also be set or cleared by specifying the bit using hexadecimal [x[x]] and setting it to either 0 or 1.
SW release	R300 ●

+TOKDUMP – Display All S-Registers	
Execute Command **AT+TOKDUMP** Notes Only used on the local node. You cannot display all the registers of a remote device.	Response **<data>** **OK** The module displays the contents of all local S-Registers. The data format for each individual S-Register is given in the S-Register description in section 4.
SW release	R300 ●

2.7 Network Control & Configuration Commands

+ESCAN – Scan The Energy Of All Channels	
Execute Command **AT+ESCAN** Use on: All nodes Notes Scanning all channels can take up to 4 seconds. The results are the background radio power in each channel, not the RSSI of incoming ZigBee packets	Response **+ESCAN:** **11:XX** **12:XX** **…** **26:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. XX represents the average energy on the respective channel (see description in Section 8). Channels masked out in S00 are not scanned.
SW release	R300 ●

+PANSCAN – Scan For Active PANs	
Execute Command **AT+PANSCAN** Use on: All nodes Note Scanning for active PANs can take up to 4 seconds.	Response **+PANSCAN:<channel>,<PID>,<EPID>,XX,b** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. The node gives a list of all PANs found. <channel> represents the channel, <PID> the PAN ID, <EPID> the extended PAN ID, XX the ZigBee stack profile (00 = Custom, 01 = ZigBee, 02 = ZigBee PRO) and b indicates whether the network is allowing additional nodes to join (1 = joining permitted). The node does not join any of the PANs found.
SW release	R300 ●

+EN – Establish Personal Area Network	
Execute Command **AT+EN** Use on: All nodes which are not part of a PAN Note When issuing this command the local device becomes a Coordinator (and Trust Centre). Establishing a PAN can take up to 4 seconds. This command can only be executed if the local node is not part of a PAN already.	Response **JPAN:<channel>,<PID>,<EPID>** **OK** **or ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. The local node becomes a coordinator and performs an energy scan on all channels selected in S00. It then starts a PAN with a random unused PAN ID and extended PAN ID on the quietest channel. If a PAN ID and/or extended PAN ID is specified in S02 or S03 the provided IDs are used instead of random ones, given the selected IDs are not already in use by other networks within range
SW release	R300 ●

+JN – Join Network	
Execute Command **AT+JN** Use on: All nodes which are not part of a PAN Note Joining a PAN can take up to 4 seconds, depending on the number of channels which need scanning. This command can only be executed if the local node is not part of a PAN already.	Response **JPAN:<channel>,<PID>,<EPID>** OK **or** ERROR:<errorcode> <errorcode> represents the error code explained in section 3. The local node scans all channels selected in register S00 for the existence of a PAN. When finding a PAN which allows joining it will automatically join via the router with an adequate signal quality and the fewest hops to the COO. In case registers S02 and S03 differ from the default value of all zeros the node will only join a PAN with the specified PAN ID and/or extended PAN ID.
Remote Action On the Trust Centre / Coordinator	Prompt **NEWNODE:<node EUI64>,** **<Network address>,<parent EUI64>**
SW release	R300 ●

+JPAN – Join Specific PAN	
Execute Command **AT+JPAN:<channel>,<PID or EPID>** Examples **AT+JPAN:20,1234** **AT+JPAN:24,0793E14FFB220A38** Use on All nodes which are not part of a PAN Notes This command can only be executed if the local node is not part of a PAN already. The JPAN command ignores the channel mask in register S00 and the PID and EPID settings in S02 and S03.	Response **JPAN:<channel>,<PID>,<EPID>** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. The local node joins a particular PAN on <channel> with the specified <PID> or <EPID> via the router with an adequate signal quality and the fewest hops to the COO.
Remote Action On the Trust Centre / Coordinator	Prompt **NEWNODE:<node EUI64>,** **<Network address>,<parent EUI64>**
SW release	R300 ●

+SJN – Silent Join	
Execute Command **AT+SJN:<channel>,<TC EUI64>,** **<NM Network address>,<nwk update ID>** "Silent" joining is joining via the commissioning method. All data required to enter the network is provided to the node, so that no joining procedure itself is required. The node will appear in the target network without any joining procedure given the supplied data is correct. The node can only join as a router, not an end device <channel> is a decimal number Other parameters are hexadecimal Use on All joining Devices Example **AT+SJN:11,000D6F00000AAAD0,AFFE,00**	Response **JPAN:<channel>,<PID>,<EPID>** **OK** or **ERROR:<errorcode>** **>** <errorcode> represents the error code explained in section 3. The local node will become part of the network with the channel specified in <channel>, the trust centre EUI64 specified in <TC EUI64>, the Network address of the network manager specified in <NM Network address>, the 8 bit network update ID specified in <nwk update ID>, the network key provided in S08, the trust centre link key provided in S09, the PAN ID provided in S02 and the extended PAN ID provided in S03. Joining is still possible if the network update ID is incorrect. It is assumed that the key-sequence-number of the network key is 0 when issuing this command.
SW release	R305 ●

+DASSL – Disassociate Local Device From PAN	
Execute Command **AT+DASSL** Use on All Devices Note Use with care on a Coordinator. It will not be able to rejoin the PAN	Response **OK** or **ERROR<errorcode>** Prompt **LeftPAN** <errorcode> represents the error code explained in section 3. Instruct local device to leave the PAN.
SW release	R300 ●

+DASSR – Disassociate Remote Node from PAN	**(ZDO)**
Execute Command **AT+DASSR:<address>** Where <address> can be a node's EUI64, Network address or address table index Use on All Devices Note Use with care when targeting a Coordinator. It will not be able to rejoin the PAN	Response SEQ:XX OK **or** ERROR:<errorcode> <errorcode> represents the error code explained in section 3. Instruct device to leave the PAN.
Remote Action Node leaves PAN	Prompt **LeftPAN**
SW release	R300 ●

+N – Display Network Information	
Read Command **AT+N?** Use on All Devices	Response **+N=<devicetype>,<channel>,<power>, <PID>,<EPID>** or **+N=NoPAN** followed by **OK** <devicetype> represents the node's functionality in the PAN (FFD,COO,ZED,SED,MED), <power> the node's output power in dBm, <channel> the IEEE 802.15.4 radio channel (11-26), <PID> the node's PAN ID and <EPID> the node's extended PAN ID.
SW release	R302 ●

+NTABLE – Display Neighbour Table	**(ZDO)**

Read Command
AT+NTABLE:XX,<address>
 	
Where XX is the start index of the remote LQI table and <address> can be the remote node's EUI64, Network address or address table entry.
 	
Note
Also the local node can be the target of this command (e.g. use address table entry FF as the address)
 	
Use on
FFD, COO as the target device
	Response
	SEQ:XX
	OK or ERROR<errorcode>
	
	This command requests the target node to respond by listing its neighbour table starting from the requested index. Can be used to find the identity of all ZigBee devices in the network including non-Telegesis devices.
	
	Prompt (example)
	`NTable:<Network address>,<errorcode>`
	`Length:03`
	`No.| Type | EUI | ID | LQI`
	`00.| FFD | 000D6F000015896B | BC04 | FF`
	`01.| FFD | 000D6F00000B3E77 | 739D | FF`
	`02.| FFD | 000D6F00000AAD11 | 75E3 | FF`
	
	In this example the neighbour table of the remote node with the short ID shown in <Network address> contains three entries (hexadecimal), which are displayed. In case the table contains more than three entries it may be required to repeat this command and increase the index count until the full table is derived.
	In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode.

SW release	R302 ●

+RTABLE – Display Routing Table	**(ZDO)**
Read Command **AT+RTABLE:XX,<address>** Where XX is the start index of the remote Routing table and <address> can be the remote node's EUI64, Network address or address table entry.	Response **SEQ:XX** **OK or ERROR<errorcode>** This command requests the target node to respond by listing its routing table starting from the requested index.

Note
Also the local node can be the target of this command (e.g. use address table entry FF as the address)
 	
Use on
FFD, COO as the target device
	Prompt (example)
	`RTable:<Network address>,<errorcode>`
	`Length:40`
	`No.| Dest | Next | Status`
	`00.| 1234 | ABCD | 00`
	`01.| 4321 | 739D | 00`
	`02.| 0000 | 0000 | 03`
	
	In this example the routing table of the remote node with the short ID shown in <Network address> contains 64 entries (hexadecimal 0x40), of which the first three are displayed. When the table contains more than the displayed entries it may be required to repeat this command and increase the index count until the full table is derived.
	The status shown is as described in table 2.128 of the ZigBee Specification.
	In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode.

SW release	R303 ●

+IDREQ – Request Node's Network address	**(ZDO)**
Execute Command **AT+IDREQ:<Address>[,XX]** Where <Address> can be a node's EUI64, or address table entry and XX is an optional index number. In case an index number is provided, an extended response is requested asking the remote device to list its associated devices (ie children). Sends a broadcast to obtain the specified Device's Network address and optionally also elements of its associated devices list. Use on All Devices Note Providing FF as an address table entry addresses the local node	Response **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **AddrResp:<errorcode>** **[,<Network address>,<EUI64>]** **[nn. <Network address>]** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. <EUI64> is the Remote node's EUI64 and <Network address> is its Network address. In case an extended response has been requested the requested Network addresses from the associated devices list are listed as well.
SW release	R302 ●

+EUIREQ – Request Node's EUI64	**(ZDO)**
Execute Command **AT+EUIREQ:< Address>,** **<Network address>[,XX]** Where <Address> is the EUI64, Network address or address table entry of the node which is to be interrogated about the node with the Network address specified in <Network address>. XX is an optional index number. In case an index number is provided, an extended response is requested asking the remote device to list its associated devices (ie children). Sends a unicast to obtain the specified device's EUI64 and optionally also elements of its associated devices list (extended response). Use on All Devices Notes Providing FF as an address table entry addresses the local node. To find the EUI64 of an end device use its parent's address as the <Address> parameter.	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **AddrResp:<errorcode>** **[,<Network address>,<EUI64>]** **[dd. <Network address>]** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. <EUI64> is the Remote node's EUI64 and <Network address> is its Network address. In case an extended response has been requested the requested Network addresses from the associated devices list are listed. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed.
SW release	R302 ●

+NODEDESC – Request Node's Descriptor	**(ZDO)**
Execute Command **AT+NODEDESC:<Address>,** **<Network address>** Where <Address> is the EUI64, Network address or Address table entry of the node which is to be interrogated about the node with the Network address specified in <Network address>. Sends a unicast to obtain the specified device's node descriptor. Use on All Devices Note Providing FF as an address table entry addresses the local node	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt (example) NodeDesc:<Network address>,<errorcode> Type:FFD ComplexDesc:No UserDesc:No APSFlags:00 FreqBand:40 MacCap:8E ManufCode:1010 MaxBufSize:52 MaxInSize:0080 SrvMask:0000 MaxOutSize:0080 DescCap:00 In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. <Network address> is the Remote node's Network address. In addition the node descriptor is displayed. The individual fields of the Node Descriptor are described in section 2.3.2.3 of the ZigBee specification. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed.
SW release	R302 ●

+POWERDESC – Request Node's Power Descriptor	**(ZDO)**
Execute Command **AT+POWERDESC:<Address>,** **<Network address>** Where <Address> is the EUI64, Network address or Address table entry of the node which is to be interrogated about the node with the Network address specified in <Network address>. Sends a unicast to obtain the specified device's power descriptor. Use on All Devices	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **PowerDesc:** **<Network address>,<errorcode>** **[,<PowerDescriptor>]** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <Network address> is the Remote node's Network address. In addition the power descriptor is displayed as a 16 bit hexadecimal number as described in section 2.3.2.4. of the ZigBee specification. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed.
SW release	R302 ●

+ACTEPDESC – Request Node's Active Endpoint List	**(ZDO)**
Execute Command **AT+ACTEPDESC:<Address>,** **<Network address>** Where <Address> is the EUI64, Network address or Address table entry of the node which is to be interrogated about the node with the Network address specified in <Network address>. Sends a unicast to obtain the specified device's active endpoint list. Use on All Devices	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **ActEpDesc:<Network address>,<errorcode>[,XX,…]** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <Network address> is the Remote node's Network address. In addition all active endpoints are listed as 8-bit hexadecimal numbers separated by commas. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed.
SW release	R302 ●

+SIMPLEDESC – Request Endpoint's Simple Descriptor	**(ZDO)**
Execute Command **AT+SIMPLEDESC:<Address>,** **<Network address>,** **<XX>** Where <Address> is the EUI64, Network address or Address table entry of the node which is to be interrogated about the node with the Network address specified in <Network address> and XX is the number of the endpoint, which simple descriptor is to be read. Sends a unicast to obtain the specified device's active endpoint list. Use on All Devices	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **SimpleDesc:<Network address>,<errorcode>** **EP:XX** **ProfileID:XXXX** **DeviceID:XXXXvXX** **InCluster:<Cluster List>** **OutCluster:<Cluster List>** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <Network address> is the Remote node's Network address. In addition all active endpoints are listed as 8 bit hexadecimal numbers separated by commas. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed.
SW release	R302 ●

+MATCHREQ – Find Nodes which Match a Specific Descriptor	**(ZDO)**
Execute Command **AT+MATCHREQ: <ProfileID>, <NumInClusters> [,<InClusterList>], <NumOutClusters> [,OutClusterList]** Where <ProfileID> Required profile ID of the device being searched for followed by a specification of required input and output clusters. If a remote node has a matching ProfileID and matches at least one of the specified clusters it will respond to this broadcast listing the matching endpoint(s). <NumInClusters> and <NumOutClusters> must be 2 hexadecimal digits Examples **AT+MATCHREQ:C091,01,0002,02,0004,000B** **AT+MATCHREQ:C091,00,01,0004** **AT+MATCHREQ:C091,01,0002,00** Use on All Devices	Response **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3. Prompt **MatchDesc:<Network address>, <errorcode>,XX,…** In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. <Network address> is the Remote node's Network address. In addition all endpoints of this node matching the search criterion are listed as 8 bit hexadecimal numbers separated by commas.
SW release	R302

+ANNCE – Announce Local Device In The Network	**(ZDO)**
Execute Command **AT+ANNCE** Send a ZigBee device announce Broadcast announcing the local node on the network. Use on All Devices	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3.
Remote Action	Prompt **FFD:<EUI64>,<Network address>[,syy,zz]** **MED:<EUI64>,<Network address>[,syy,zz]** **SED:<EUI64>,<Network address>[,syy,zz]** **ZED:<EUI64>,<Network address>[,syy,zz]** The prompt above will be displayed on all nodes which can hear the announcement. In case bit C of register S10 is set the RSSI level (syy dBm) and LQI (zz in hexadecimal) of the last hop are displayed. For a description of the LQI reading please see section 7. <EUI64> is the identifier and <Network address> the Network address of the sending device
SW release	R302 ●

+SR – Set Source Route to Remote Device	
Execute Command **AT+SR:<Network address>, <Network address>,…** Set the source route of a message sent to a remote device, starting with the Network address of the remote device, followed by all Network addresses on the route from the remote node to the local node starting at the remote end Use on All Devices Note Setting up invalid routes may lead to listed devices becoming unavailable. To confirm a route use AT+FNDSR.	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3. Stores route information for up to 30 hops which will be used when sending any message to a remote node, which is part of the listed devices.
SW release	R300 ●

+FNDSR – Find the Source Route to a remote device	
Execute Command **AT+FNDSR:<address>** Where <address> can be the remote node's EUI64 or address table index Tries to find source route information to the specified device by sending a ZDO request to the remote device and thus triggering a reply. Use on Sink, COO	Response **OK** or **ERROR<errorcode>** Prompt **SR:XX,<EUI64>,<Network address>,<Network address>…** Where XX represents the number of hops to the remote node, EUI64 its EUI64 number followed by a list of Network addresses starting with the remote node listing all nodes along the path to the local node <errorcode> represents the error code explained in section 3.
SW release	R302 ●

+POLL – Poll The Parent Device	
Execute Command **AT+POLL** Poll the parent device for new data. Note Action 0010/8010 is recommended for periodic polling using the built-in timers. Use on SED, MED	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R300 ●

+REJOIN – Rejoin the network	
Execute Command **AT+REJOIN:b** If b is set to 0 join without the known network key (unencrypted) and if b is set to 1 join encrypted. Use on All devices except COO Notes Polling a parent on an end device that has lost its parent will automatically call AT+REJOIN:1. Furthermore functionality 0012 and 0013 make use of this command.	Response **OK** or **ERROR<errorcode>** If the contact with the network has been lost because an end device has lost its parent, the network has changed channel, or updated its encryption key the command AT+REJOIN can be used to rejoin the network. <errorcode> represents the error code explained in section 3.
SW release	R300 ●

+SN – Scan Network	
Execute Command **AT+SN[:nn]** All Telegesis devices which are up to nn hops away are listed. If nn = 01 only direct neighbours will reply and nn = 00 will search the entire network. Use on **COO, SINK** Notes - In case no parameter is specified for nn, 30 is used by default. - If used on nodes other than the COO and a sink the command may be unreliable	Response **OK** or **ERROR<errorcode>** Prompts **FFD:<EUI64>,<Network address>[,syy,zz]** **MED:<EUI64>,<Network address>[,syy,zz]** **SED:<EUI64>,<Network address>[,syy,zz]** **ZED:<EUI64>,<Network address>[,syy,zz]** Parameters nn ranging from 00 to 30 <errorcode> represents the error code explained in section 3. In case bit C of register S10 is set the RSSI level (syy in dBm) and LQI (zz in hexadecimal) of the last hop are displayed. For a description of the LQI reading please see section 7. Source route messages may also be displayed.
SW release	R302 ●

+KEYUPD – Update the Network Key	
Execute Command **AT+KEYUPD** Updates the Network Key with a new random key. Use on Trust Centre Note Can only be used on the Trust Centre	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R302 ●

+BECOMETC – Make Local Device the Trust Centre	
Execute Command **AT+BECOMETC** Local Device takes over the Trust Centre. Can only be used if no other device in the network is Trust Centre (i.e. the network has been started in distributed Trust Centre mode) Use on **Router that established the PAN in distributed TC Mode** Note Can only be used if Network has been started in distributed Trust Centre mode (bit 9 of S0A set). AT+BECOMETC causes the network key to be updated.	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R302 ●

+BECOMENM – Make the local device Network Manager	
Execute Command **AT+BECOMENM** Local Device takes over role of Network Manager. By default the COO is the Network Manager, but any other router in the network can take over this responsibility. The Network Manager can change the radio channel and the PAN ID. Use on **Router**	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R304 ●

+CCHANGE – Change the network's channel	
Execute Command **AT+CCHANGE[:XX]** Ask all nodes in the network to change their channel. If no channel is specified a random channel out of the channels masked in S00 is picked which wasn't previously blacklisted because of excessive packet loss (**NM:ES REPORT WARNING** prompt**)** Use on **Network Manager** Note The New channel needs to be masked in in S00 for all nodes on the network. Ideally S00 should be identical for all nodes on a network.	Response **OK** or **ERROR<errorcode>** <errorcode> represents the error code explained in section 3. Parameters Optional XX ranging from 0B to 1A
SW release	R304 ●

2.8 Messaging

+ATABLE – Display Address Table	

Read Command
AT+ATABLE
 	
Use on
All Devices
 	
Notes
Entry 05 contains the address of the node's sink. The user can overwrite it to manually select a different sink.
Entry 06 contains the address of the node sending the most recently received UCAST, SCAST or MCAST.
 	
The address table is volatile and its contents are lost if the device is powered down.
	Response
	
	`No. | Active | ID | EUI`
	`00 | N | 0000 |000D6F0000012345`
	`(…)`
	`OK`
	
	The Address Table contains nodes which can be addressed by referring to the corresponding address table entry. The "Active" column shows nodes to which a message is currently in flight.

SW release	R300 ●

+ASET – Set Address Table Entry	
Write Command **AT+ASET:XX,<Network address>,<EUI64>** Where XX is the entry number of the address table entry which is to be written. If the Network address is unknown, the Network address must be substituted with "FFFF". Use on All Devices	Response **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R300 ●

+MTABLE – Display Multicast Table	
Read Command **AT+MTABLE** Use on All Devices Note For Multicasts to be displayed using the MCAST prompt, endpoint 01 must be selected as the target endpoint. The multicast table is cleared by a reset	Response `No.	ID	EP` `00	1234	01` `01	0000	00` `02	0000	00` `03	0000	00` `04	0000	00` `OK` The multicast table contains all multicast IDs which will be received by the local node.
SW release	R300 ●

+MSET – Set Multicast Table Entry	
Write Command **AT+MSET:XX,<ID>,<endpoint>** Where XX is the index number of the multicast-table entry which is to be written. For the AT-Command interface operation the endpoint should always be set to 01. Note SEDs and MEDs cannot receive multicast messages Use on All Devices	Response **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R300 ●

+BCAST – Transmit A Broadcast	
Execute Command **AT+BCAST:nn,<data>** Example **AT+BCAST:00,Hello world** Use on: All devices Note Use broadcasts sparingly! The ZigBee specification only allows any node to repeat or originate up to 8 broadcasts in every 8 second interval. Broadcasts use a lot of bandwidth.	Response **OK** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. Parameters **nn ranging from 00 to 30** A maximum of 82 bytes are sent (with attached EUI only 74 bytes). The response OK shows successful transmission. Successful transmission does not guarantee successful reception. To make sure data has been received by a specific node use a unicast message. Only neighbours which are up to nn hops away will receive the broadcast. If nn = 01 only direct neighbours will receive the broadcast and if n = 00 the entire network will (max. 30 hops).
Remote action	Prompt **BCAST:[<EUI64>,]<length>=<data>** Every node in the PAN which has received the broadcast message will prompt the above message where <EUI64> is the address of the sender, <length> is the length of the payload and <data> is the data which was attached to the broadcast. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+BCASTB – Transmit A Broadcast Of Binary Data	
Execute Command **AT+BCASTB:XX,nn** Where nn is the number of hops the message will travel and XX is the number (in hexadecimal) of data bytes to be sent. Use on All Devices Note This command is particularly useful if the data may contain <CR> and <Backspace> characters.	Response **> <data being entered>** **OK** or **ERROR:<errorcode>** After the '>' prompt a number of XX characters are expected to be entered. <errorcode> represents the error code explained in section 3. (In case bit 9 of S10 is set a timeout error is generated if no character is received for 1 second.) Parameters **XX ranging from 00 to 52 (hexadecimal)** **nn ranging from 00 to 30 (decimal)** A maximum of 82 bytes are sent (with attached EUI only 74 bytes). The response OK shows successful transmission. Successful transmission does not guarantee successful reception. To make sure data has been received by a specific node use a unicast message. Only neighbours which are up to nn hops away will receive the broadcast. If nn=01 only direct neighbours will receive the broadcast and if n = 00 the entire network will (max 30 hops).
Remote action	Prompt **BCAST:<EUI64>,<length>=<data>** Every node in the PAN which has received the broadcast message will prompt the above message where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+UCAST – Transmit A Unicast	
Execute Command **AT+UCAST:<address>=<data>** Example **AT+UCAST:000D6F0000012345=Hello** Where <address> can be the remote node's EUI64, Network address or address table index Use on All Devices Note Unicasts can be addressed either by referencing the recipient's EUI64, Network address or an entry in the address table. The maximum payload is 82 bytes. It is reduced by 8 bytes when appending the EUI to the network header (default) and also it is reduced by 2 bytes per hop in case a source route is known. The latter event can neither be suppressed nor foreseen. Up to 10 unicasts may be in flight at one time Unicasts can travel up to 30 hops	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** Where <errorcode> represents the error code explained in section 3. Prompt **ACK:XX** **or NACK:XX** Up to 82 bytes are sent to the node up to 30 hops away. On successful transmission the user is given the transmission's sequence number followed by "OK". The user is then prompted "ACK" on receipt of an acknowledgement or "NACK" in case the message was not acknowledged. A NACK does not guarantee that the message has not reached its destination. If bit B of S10 is set, "SEQ", "ACK" and "NACK" are not reported. "OK" means that the message has been acknowledged by the destination.
Remote action	Prompt **UCAST:[<EUI64>,]<length>=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+UCASTB – Transmit A Unicast Of Binary Data	
Execute Command **AT+UCASTB:XX,<address>** Where <address> can be the remote node's EUI64, Network address or address table index and XX is the number (in hexadecimal) of data bytes to be sent. Use on All Devices Notes This command is particularly useful if the data may contain <CR> and <Backspace> characters. The ACK and/or NACK prompt can be disabled in S0E Unicasts can be addressed either by referencing the recipient's EUI64, Network address or an entry in the address table. The maximum payload is 82 bytes. It is reduced by 8 bytes when appending the EUI to the network header (default) and also it is reduced by 2 bytes per hop in case a source route is known. The latter event can neither be suppressed nor foreseen. Up to 10 unicasts may be in flight at one time Unicasts can travel up to 30 hops	Response **> <data being entered>** **SEQ:XX** **OK** or **ERROR:<errorcode>** Prompt **ACK:XX** **or NACK:XX** Parameters **XX ranging from 00 to 52 (hex)** After the '>' prompt a number of characters are expected to be entered as defined by XX. Up to 82 bytes are sent to the node with address <EUI64>. When bit 9 of S10 is set a timeout error is generated if no character is received for 1 second. On successful transmission the user is given a transmission number followed by "OK". After that the user is prompted "ACK" on receipt of an acknowledgement or "NACK" in case the message was not acknowledged. A NACK does not guarantee that the message has not reached its destination. If bit B of S10 is set, "SEQ", "ACK" and "NACK" are not reported. "OK" means that the message has been acknowledged by the destination.
Remote action	Prompt **UCAST:[<EUI64>,]<length>=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+SCAST – Transmit Data To The Sink	
Execute Command **AT+SCAST:<data>** Example **AT+SCAST:Hello world** Use on All Devices Notes - When bit 8 of S10 is set, if a sink cannot be reached for three consecutive transmissions the sink is assumed unavailable and a new one is sought - The ACK and/or NACK prompt can be disabled in S0E - When attaching the node's EUI64 to the network frame the maximum payload reduces to 74 bytes - The maximum payload is 82 bytes. It is reduced by 8 bytes when appending the EUI to the network header (default) and also it is reduced by 2 bytes per hop in case a source route is known. The latter event can neither be suppressed nor foreseen. - S-casts can travel up to 30 hops	Response **SEQ:XX** **OK** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. Prompt **ACK:XX** or **NACK:XX** Parameters Up to 82 bytes are sent to the node's sink. On successful transmission the user is given the sequence number followed by "OK". After that the user is prompted "ACK" on receipt of an acknowledgement or "NACK" in case the message was not acknowledged. A NACK does not guarantee that the message has not reached its destination. If bit B of S10 is set, "SEQ", "ACK" and "NACK" are not reported. "OK" means that the message has been acknowledged by the destination.
Remote action	Prompt **UCAST:[<EUI64>,]<length>=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+SCASTB – Transmit Binary Data To A Sink	
Execute Command **AT+SCASTB:XX** Where XX is the number (in hexadecimal) of data bytes to be sent. Use on All Devices Notes - When bit 8 of S10 is set, if a sink cannot be reached for three consecutive transmissions the sink is assumed unavailable and a new one is sought. - The ACK and/or NACK prompt can be disabled in S0E - When attaching the node's EUI64 to the network frame the maximum payload reduces to 74 bytes - The maximum payload is 82 bytes. It is reduced by 8 bytes when appending the EUI to the network header (default) and also it is reduced by 2 bytes per hop in case a source route is known. The latter event can neither be suppressed nor foreseen. - S-casts can travel up to 30 hops	Response **> <data being entered>** **SEQ:XX** **OK** or **ERROR<errorcode>** Parameters **XX ranging from 00 to 52 (hex)** After the '>' prompt a number of characters are expected to be entered as defined by XX. A maximum of 82 bytes are sent to the network's sink. When bit 9 of S10 is set a timeout error is generated if no character is received for 1 second. On successful transmission the user is given a transmission number followed by "OK". After that the user is prompted "ACK" on receipt of an acknowledgement or "NACK" in case the message was not acknowledged. A NACK does not guarantee that the message has not reached its destination. If bit B of S10 is set, "SEQ", "ACK" and "NACK" are not reported. "OK" means that the message has been acknowledged by the destination.
Remote action	Prompt **UCAST:[<EUI64>,]XX=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+SSINK – Search For A Sink	
Execute Command **AT+SSINK** Search for a sink on the network by sending a broadcast causing all sinks to reply. By default, if a sink is already known and no better sink is found, no prompt will be displayed. A sink which is already known can be found at index 05 of the address table. Use on All Devices	Response **OK** or **ERROR<errorcode>** Prompt **SINK:<EUI64>,<Network address>** or **ADSK:<EUI64>,<Network address>** <errorcode> represents the error code explained in section 3.
SW release	R300 ●

+MCAST – Transmit A Multicast	
Execute Command **AT+MCAST:nn,<ID>,<data>** Use on: All devices Notes When attaching the node's EUI64 to the network frame the maximum payload reduces to 74 bytes Entries in the multicast table must be set to endpoint 01 to trigger the desired prompt Use multicasts sparingly! They are a form of broadcast so any node may only repeat or originate up to 8 multicasts in every 8 second interval. SEDs and MEDs cannot receive multicast messages	Response **OK** or **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 3. Parameters **nn ranging from 00 to 30** Up to 82 bytes are sent to the multicast group <ID>. Instead of a 16-bit multicast ID an 8 bit binding table entry can be specified. The response OK shows successful transmission. Successful transmission does not guarantee successful reception. To make sure data has been received by a specific node use a unicast message. Only neighbours which are up to nn hops away will receive the broadcast. If nn = 01 only direct neighbours will receive the broadcast and if nn = 00 the entire network will (max. 30 hops).
Remote action	Prompt **MCAST:[<EUI64>,]<Length>=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+MCASTB – Transmit A Multicast Of Binary Data	
Execute Command **AT+MCASTB:XX,nn,<ID>** Where XX is the number (in hexadecimal) of data bytes to be sent and nn is the number of hops the message will travel. Use on All Devices Notes When attaching the node's EUI64 to the network frame the maximum payload reduces to 74 bytes This command is particularly useful if the data may contain <CR> and <Backspace> characters. Use multicasts sparingly! They are a form of broadcast so any node may only repeat or originate up to 8 multicasts in every 8 second interval. SEDs and MEDs cannot receive multicast messages	Response **> <data being entered>** **OK** or **ERROR<errorcode>** After the '>' prompt a number of characters are expected to be entered as defined by XX. <errorcode> represents the error code explained in section 3. When bit 9 of S10 is set a timeout error is generated if no character is received for 1 second. Parameters **XX ranging from 00 to 52 (hex)** **nn ranging from 00 to 30** Up to 82 bytes are sent to devices up to nn hops away. The response OK shows successful transmission. Successful transmission does not guarantee successful reception. To make sure data has been received by a specific node use a unicast message. Only neighbours which are up to nn hops away will receive the broadcast. If nn=01 only direct neighbours will receive the broadcast and if n = 00 the entire network will.
Remote action	Prompt **MCAST:[<EUI64>,]<length>=<data>** Where <EUI64> is the address of the sender and <length> is the length of the message in hexadecimal. The EUI64 is only displayed if it is part of the network header (set bit 0 of S10 to disable attaching the EUI64 to outgoing messages).
SW release	R300 ●

+DMODE – Enter Data Mode (Serial Link Mode)	
Execute Command **AT+DMODE:<address>** Where <address> can be the remote node's EUI64, Network address or address table index Use on All Devices Note Opening a serial link to end devices will result in a limited data rate which depends on the polling interval of the child. In Data mode all prompts are disabled	Response **SEQ:XX** **OK** or **ERROR<errorcode>** Prompt **ACK:XX** or **NACK:XX** <errorcode> represents the error code explained in section 3 and XX is the sequence number of the unicast.
Remote Prompt **DataMODE:<Network address>,<EUI64>** **OPEN** Where <Network address> is the Network address of the remote node and <EUI64> is its EUI64.	Prompt **DataMODE:<Network address>,<EUI64>,<errorcode>** **[OPEN]** Where <Network address> is the Network address of the remote node and <EUI64> is its EUI64. Only if the errorcode equals 0 the data mode will open .
SW release	R302 ●

+++ – Leave Data Mode	
Execute Command **+++** To leave data mode +++ must be entered at a minimum of 500ms after the last character which is to be transmitted to the remote node. In case the data payload contains +++ it can be transmitted safely as long as it is made sure no more than 250ms pass between sending +++ and the previous character. Use on All Devices	Response **CLOSED**
SW release	R302 ●

+IDENT – Play A Tune On Remote Devboard	
Execute Command **AT+IDENT:<address>** Where <address> can be the remote node's EUI64, Network address or address table index Use on All Devices	Response **SEQ:XX** **OK** or **ERROR<errorcode>** Prompt **ACK:XX** or **NACK:XX** <errorcode> represents the error code explained in section 3. Plays a tune on a remote devboard if the Beeper is connected. Useful to identify remote nodes. See devkit manual for details about connecting a buzzer to the ETRXn.
SW release	R300 ●

+RDATAB – Send Binary Raw Data	
Execute Command **AT+RDATAB:XX** Use on All Devices Notes Can be useful to quickly exchange bulk data with neighbouring node. The application needs to handle addressing, error checking, retries and acknowledgements. End Devices do not receive raw data. Raw data will only travel one hop. Use with great care. Raw data messages are not ZigBee-compliant and may even leak into other PANs.	Response **> <data being entered>** **OK** or **ERROR:<errorcode>** Parameters **XX ranging from 00 to 67 (hex)** After the '>' prompt a number of XX characters are expected to be entered. Up to 103 bytes of data can be send to all nodes within reach (direct neighbours) The data is neither encrypted nor error checked. No retries are made and no acknowledgement is received. <errorcode> represents the error code explained in section 3.
Remote action	Prompt **RAW:snn,<data>** where snn is the RSSI, or **<data>** in case bit 9 of S0E is set. Displaying the data can also be disabled by setting bit D of S0E.
SW release	R300 ●

2.9 Binding Management (ETRX3 Series only)

+LBTABLE – Display Local Binding Table	
Read Command **AT+LBTABLE** Use on All Devices	Response No. | Type | Active | LocalEP | ClusterID | Addr | RemEP 10. | Ucast | No | 01 | DEAD | 1234567887654321 | 01 11. | MTO | No | 01 | DEAD | E012345678876543 | 88 12. | Mcast | No | 01 | DEAD | CDAB 13. | Unused 14. | Unused 15. | Unused 16. | Unused 17. | Unused 18. | Unused 19. | Unused Entries in the local Binding Table.
SW release	R307 ●

+BSET – Set local Binding Table Entry	
Write Command **AT+BSET:<type>,<LocalEP>,<ClusterID>, <DstAddress>[,<DstEP>]** Where **<Type>** is the type of binding as shown below, **<LocalEP>** is the local endpoint **<ClusterID>** is the cluster ID **<DstAddress>** is either the EUI64 of the target device, or a multicast ID **<DstEP>** the destination endpoint which is not specified in case of a multicast binding. The new binding is created in the next available free binding table entry. Types: *1= Unicast Binding with EUI64 and destination EP specified* *2= Many to one Binding with EUI64 and destination EP Specified* *3= Multicast Binding with Multicast ID Specified* Example **AT+BSET:1,01,0002,000D6F000059474E,01** Note All parameters must have exactly the correct number of characters Use mode 2 when the source or destination is a coordinator or sink Use on All Devices	Response **OK**
SW release	R307 ●

+BCLR – Clear local Binding Table Entry	
Write Command **AT+BCLR:XX** Where **XX** is the entry number of the binding table entry which is to be cleared. To keep the numbering of the local binding table in-line with the numbering of the remote binding table all remaining entries are moved to the beginning of the table. AT+BCLR:FF clears the whole table. Use on All Devices	Response **OK** or **ERROR:<errorcode>** <errorcode> represents the error code explained in section 3.
SW release	R307 ●

+BTABLE – Display Binding Table	**(ZDO)**

Read Command
AT+BTABLE:XX,<address>
 	
Where XX is the start index of the remote Binding table and <address> can be the remote node's EUI64, Network address or address/binding table entry.
 	
Note
Also the local node can be the target of this command (e.g. use address table entry FF as the address)
 	
Example
AT+BTABLE:00,0000
SEQ:01
 	
OK
 	
Use on
All devices
	Response
	SEQ:XX
	OK or ERROR<errorcode>
	
	This command requests the target node to respond by listing its binding table starting from the requested index.
	The response indicates success or failure in sending this message. The acknowledgement as well as the actual response to this request will follow as asynchronous prompts.
	
	Example
	`BTable:0000,00`
	`Length:03`
	`No. | SrcAddr | SrcEP | ClusterID | DstAddr | DstEP`
	`00. | 000D6F000059474E | 01 | DEAD | 1234567887654321 | 12`
	`01. | 000D6F000059474E | 01 | DEAD | E012345678876543 | E0`
	`02. | 000D6F000059474E | 01 | DEAD | ABCD`
	
	`ACK:01`
	
	In this example the neighbour table of the remote node with the short ID shown in <Network address> contains three entries (hexadecimal), which are displayed. In case the table contains more than three entries it may be required to repeat this command and increase the index count until the full table is derived.
	In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode.

SW release	R307 ●

+BIND – Create Binding on Remote Device	**(ZDO)**
Write Command **AT+BIND:<address>,<type>, <SrcAddress>,<SrcEP>,<ClusterID>, <DstAddress>[,<DstEP>]** Create Binding on a remote device with **<address>** the target Node's EUI64, Network address, or Address/Binding Table entry **<type>** the Addressing mode as shown below **<SrcAddress>** The EUI64 of the Source **<SrcEP>** The source Endpoint **<ClusterID>** The Cluster ID on the source Device **<DstAddress>** The EUI64 or 16-bit multicast ID, depending on <type> **<DstEP>** Only in Mode 3: The destination endpoint Types: *1= Multicast Binding with Multicast ID Specified in <DstAddress>* *3= Unicast Binding with destination EUI64 in <DstAddress> and destination EP in <DstEP>* Example **AT+BIND:0000,3,000D6F000059474E,01, ABCD,000D6F0000123456,01** Notes "Source" and "destination" are defined from the viewpoint of the remote device The local node can also be the target of this command (e.g. use address table entry FF as the address) All parameters must have exactly the correct number of characters Use on All devices	Response **SEQ:XX** **OK or ERROR:<errorcode>** The response indicates success or failure in sending this message. The acknowledgement as well as the actual response to this request will follow as asynchronous prompts. Prompt **Bind:<network address>,<status>** In case of an error an status other than 00 will be displayed **<Network address>** is the Remote node's Network address. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed. Example **SEQ:01** **OK** **Bind:0000,00 ACK:01** .
SW release	R307 ●

+UNBIND – Delete Binding on Remote Device	**(ZDO)**
Write Command **AT+UNBIND:<address>,<type>, <SrcAddress>,<SrcEP>,<ClusterID>, <DstAddress>[,<DstEP>]** Delete Binding on a remote device with **<address>** the target Node's EUI64, Network address, or Address/Binding Table entry **<type>** the Addressing mode as shown below **<SrcAddress>** The EUI64 of the Source **<SrcEP>** The source Endpoint **<ClusterID>** The Cluster ID on the source Device **<DstAddress>** The EUI64 or 16-bit multicast ID, depending on <type> **<DstEP>** Only in Mode 3: The destination endpoint Types: *1= Multicast Binding with Multicast ID Specified in <DstAddress>* *3= Unicast Binding with destination EUI64 in <DstAddress> and destination EP in <DstEP>* Note Also the local node can be the target of this command (e.g. use address table entry FF as the address) Example **AT+UNBIND:0000,3,000D6F000059474E, 01,ABCD,000D6F0000123456,01** Note All parameters must have exactly the correct number of characters Use on All devices	Response **SEQ:XX** **OK** or **ERROR:<errorcode>** The response indicates success or failure in sending this message. The acknowledgement as well as the actual response to this request will follow as asynchronous prompts. Prompt **Unbind:<network address>,<status>** In case of an error an status other than 00 will be displayed **<Network address>** is the Remote node's Network address. As with all unicasts after successful transmission the sequence number of the unicast is stated using the "SEQ:XX" prompt. When acknowledged (or not) the accompanying "ACK:XX" (or "NACK:XX") prompt is displayed. Example **SEQ:01** **OK** **Unbind:0000,00** **ACK:01**
SW release	R307 ●

3 List of Error codes

00	Everything OK - Success
01	Couldn't poll Parent because of Timeout
02	Unknown command
04	Invalid S-Register
05	Invalid parameter
06	Recipient could not be reached
07	Message was not acknowledged
08	No sink known
09	Address Table entry is in use and cannot be modified
0A	Message could not be sent
0B	Local node is not sink
0C	Too many characters
0E	Background Scan in Progress (Please wait and try again)
0F	Fatal error initialising the network
10	Error bootloading
12	Fatal error initialising the stack
18	Node has run out of Buffers
19	Trying to write read-only register
1A	Data Mode Refused by Remote Node
1B	Connection Lost in Data Mode
1C	Remote node is already in Data Mode
20	Invalid password
25	Cannot form network
27	No network found
28	Operation cannot be completed if node is part of a PAN
2C	Error leaving the PAN
2D	Error scanning for PANs
33	No response from the remote bootloader
34	Target did not respond during cloning
35	Timeout occurred during xCASTB
39	MAC Transmit Queue is Full
6C	Invalid Binding Index
70	Invalid Operation
72	More than 10 unicast messages were in flight at the same time
74	Message too long
80	ZDP Invalid Request Type
81	ZDP Device not Found
82	ZDP Invalid Endpoint
83	ZDP Not Active
84	ZDP Not Supported
85	ZDP Timeout
86	ZDP No Match
87	ZDP Table Full
88	ZDP No Entry
89	ZDP No Descriptor

91 Operation only possible if connected to a PAN
93 Node is not part of a Network
94 Cannot join network
96 Mobile End Device Move to new Parent Failed
98 Cannot join ZigBee 2006 Network as Router
A1 More than 8 broadcasts were sent within 8 seconds
AB Trying to join, but no beacons could be heard
AC Network key was sent in the clear when trying to join secured
AD Did not receive Network Key
AE No Link Key received
AF Preconfigured Key Required
C5 NWK Already Present
C7 NWK Table Full
C8 NWK Unknown Device

Bootloader error codes

18 Transfer aborted prematurely
1B Start of data transfer timed out
1C Data transfer timed out
44 Unknown tag detected in .EBL image (wrong file format?)
45 Invalid .EBL header signature (wrong file type for chip?)
4E An invalid length was detected in the .EBL image (corrupt file?)

4 S-Registers

Most S-Registers of the ETRX2 and ETRX357 can be read and written locally as well as remotely. The S-Registers are summarised in the table below.

S-Register Overview		Local R/W	Remote R/W
S00	Channel Mask	(•/•)	(•/•)
S01	Transmit Power Level	(•/•)	(•/•)
S02	Preferred PAN ID	(•/•)	(•/•)
S03	Preferred Extended PAN ID	(•/•)	(•/•)
S04	Local EUI	(•/-)	(•/-)
S05	Local Network address	(•/-)	(•/-)
S06	Parent's EUI	(•/-)	(•/-)
S07	Parent's Network address	(•/-)	(•/-)
S08	Network Key[1]	(-/•)	(-/•)
S09	Link Key[1]	(-/•)	(-/•)
S0A	Main Function[1]	(•/•)	(•/•)
S0B	User Readable Name[1]	(•/•)	(•/•)
S0C	Password[1]	(•/•)	(•/•)
S0D	Device Information	(•/-)	(•/-)
S0E	Prompt Enable 1	(•/•)	(•/•)
S0F	Prompt Enable 2	(•/•)	(•/•)
S10	Extended Function	(•/•)	(•/•)
S11	Device Specific	(•/•)	(•/•)
S12	UART Setup	(•/•)	(•/•)
S13	Pull-up enable	(•/•)	(•/•)
S14	Pull-down enable	(•/•)	(•/•)
S15	I/O Configuration	(•/•)	(•/•)
S16	Data Direction of I/O Port **(volatile)**	(•/•)	(•/•)
S17	Initial Value of S16	(•/•)	(•/•)
S18	Output Buffer of I/O Port **(volatile)**	(•/•)	(•/•)
S19	Initial Value of S18	(•/•)	(•/•)
S1A	Input Buffer of I/O Port **(volatile)**	(•/-)	(•/-)
S1B	Special Function pin 1 **(volatile)**	(•/•)	(•/•)
S1C	Initial Value of S1B	(•/•)	(•/•)
S1D	Special Function Pin 2 **(volatile)**	(•/•)	(•/•)
S1E	Initial Value of S1D	(•/•)	(•/•)
S1F	A/D1 (ETRX3: ADC0)	(•/-)	(•/-)
S20	A/D2 (ETRX3: ADC1)	(•/-)	(•/-)
S21	A/D3 (ETRX3: ADC2)	(•/-)	(•/-)
S22	A/D4 (ETRX3: ADC3)	(•/-)	(•/-)
S23	Immediate functionality at IRQ0	(•/•)	(•/•)
S24	Immediate functionality at IRQ1	(•/•)	(•/•)
S25	Immediate functionality at IRQ2	(•/•)	(•/•)
S26	Immediate functionality at IRQ3	(•/•)	(•/•)

[1] Password Protected Registers

S-Register Overview (continued)		Local R/W	Remote R/W
S27	Functionality 1 at Boot-up	(•/•)	(•/•)
S28	Functionality at Network Join	(•/•)	(•/•)
S29	Timer/Counter 0	(•/•)	(•/•)
S2A	Functionality for Timer/Counter 0	(•/•)	(•/•)
S2B	Timer/Counter 1	(•/•)	(•/•)
S2C	Functionality for Timer/Counter 1	(•/•)	(•/•)
S2D	Timer/Counter 2	(•/•)	(•/•)
S2E	Functionality for Timer/Counter 2	(•/•)	(•/•)
S2F	Timer/Counter 3	(•/•)	(•/•)
S30	Functionality for Timer/Counter 3	(•/•)	(•/•)
S31	Timer/Counter 4	(•/•)	(•/•)
S32	Functionality for Timer/Counter 4	(•/•)	(•/•)
S33	Timer/Counter 5	(•/•)	(•/•)
S34	Functionality for Timer/Counter 5	(•/•)	(•/•)
S35	Timer/Counter 6	(•/•)	(•/•)
S36	Functionality for Timer/Counter 6	(•/•)	(•/•)
S37	Timer/Counter 7	(•/•)	(•/•)
S38	Functionality for Timer/Counter 7	(•/•)	(•/•)
S39	Power mode (volatile)	(•/•)	(•/•)
S3A	Initial Power Mode	(•/•)	(•/•)
S3B	Start-up Functionality Plaintext A	(•/•)	(•/•)
S3C	Start-up Functionality Plaintext B	(•/•)	(•/•)
S3D	Supply Voltage	(•/-)	(•/-)
S3E	Multicast Table Entry 00	(•/•)	(•/•)
S3F	Multicast Table Entry 01	(•/•)	(•/•)
S40	Source and Destination Endpoints for xCASTs (volatile)	(•/•)	(•/•)
S41	Initial Value of S40	(•/•)	(•/•)
S42	Cluster ID for xCASTs (volatile)	(•/•)	(•/•)
S43	Initial Value of S42	(•/•)	(•/•)
S44	Profile ID for xCASTs (volatile)	(•/•)	(•/•)
S45	Initial Value of S44	(•/•)	(•/•)
S46	Start-up Functionality 32 bit number (volatile)	(•/•)	(•/•)
S47	Power Descriptor	(•/•)	(•/•)
S48	Endpoint 2 Profile ID	(•/•)	(•/•)
S49	Endpoint 2 Device ID	(•/•)	(•/•)
S4A	Endpoint 2 Device Version	(•/•)	(•/•)
S4B	Endpoint 2 Input Cluster List	(•/•)	(•/•)
S4C	Endpoint 2 Output Cluster List	(•/•)	(•/•)
S4D	Mobile End Device Poll Timeout	(•/•)	(•/•)
S4E	End Device Poll Timeout	(•/•)	(•/•)
S4F	MAC Timeout	(•/•)	(•/•)

Table 6: S-Register Overview

With a few exceptions the S-registers are stored in non-volatile memory and will keep their user defined settings unless reset to the factory defaults using the “AT&F” command. S16, S18, S1A, S1B, S1D, S39, S40 and S42 are directly accessing volatile I/O registers to prevent memory corruption due to constant I/O access. Registers S17, S19, S1C, S1E, S3A, S41 and S43 represent the non-volatile registers which define the contents of S16, S18, S1B, S1D, S39, S40 and S42 respectively after booting up or reset.

4.1 Recovery of the Factory Default Settings

If the unit seems to be unresponsive to commands on the serial port this is most often due to the unit having been set into a power-down mode or the set-up for the serial connection having been altered. To overcome this a feature has been added which performs a factory reset on any module which seems unresponsive. To factory reset a module, connect it to the PC’s serial port and execute the Factory Reset Tool (downloadable from www.telegesis.com). When pressing the Reset button on the Reset Tool you are prompted to cause a hardware reset to the module by pulling the module’s reset line low for more than 100ms (done by pressing the reset button on the Development Board). Once completed, the factory default settings of the ETRXn module are restored.

4.2 S-Registers for Network Setup

S00 – Channel Mask	
Description The 802.15.4 channel mask. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **When Joining, Scanning or establishing a PAN** Note The channel mask does not affect the AT+JPAN command Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit decimal number enabling IEEE 802.15.4 channel numbers 11 to 26. Writing a bit to 1 enables a channel and subsequently writing a bit to 0 disables a channel for scanning, joining and establishing networks. e.g. when setting S00 to 0001, only channel 11 will be used for all following operations. Range **0001 - FFFF** Factory Default **ETRX3 LRS-Variants: 7FFF** **Others: FFFF**
SW release	R302 ●

S01 – Transmit Power Level	
Description The device's transmit power level in dBm. Operations **R/W LOCAL** **R/W REMOTE** Notes The output power of the "-PA" and "-LRS" variants is higher than the value in S01. Please refer to the respective hardware manuals. The ETRX357-LRS power is reduced for EC regulatory compliance. See the hardware manual. Becomes effective **When Joining or establishing a PAN** Storage **Non-Volatile**	Parameters **snn** Where snn represents a signed 8-bit decimal number. Range ETRX2: 4 to -43 ETRX3: 8 to -43 ETRX3 LRS Variants: -7 to -43 Actual values are {8, 7, 6, 5, 4, 3, 2, 1, -1, -2, -3, -4, -5, -6, -7, -8, -9, -11, -12, -14, -17, -20, -26, -43} Entering a value not on this list (such as -19) will result in the next lowest output power. Entering a value higher than 3 will automatically enable boost mode regardless of the setting of bit E of S11. Factory Default **ETRX3 LRS-Variants: -11** **Others: 3**
SW release	R305 ●

S02 – Preferred PAN ID	
Description The 802.15.4 PAN ID. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **When Joining or establishing a PAN** Notes Two networks operating on the same channel with the same PAN ID, but a different EPID are detected to be in conflict with each other. PAN ID conflicts are detected by the stack and resolved by one of the networks dynamically changing its PAN ID. The preferred PID does not affect the AT+JPAN command Storage **Non-Volatile**	Parameters **<PID>** Where <PID> represents a 16-bit hexadecimal number Range **0000 – FFFF** When establishing a PAN the coordinator will pick a random PAN ID if S02 is set to 0000. If set to any value between 0001 and FFFF this number will be used as PAN ID instead, unless trying to use a PAN ID which already exists on the same channel. In this case a random PAN ID will be used instead. When joining only a PAN with the ID stored in S02 will be joined unless S02 is set to 0000. In this case the next best PAN which allows joining is joined. Factory Default **0000**
SW release	R300 ●

S03 – Preferred Extended PAN ID	
Description The extended PAN ID. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **When Joining or establishing a PAN** Note The EPID is used for PAN ID conflict detection. It is therefore recommended to use a random EPID at all times. The preferred EPID does not affect the AT+JPAN command Storage **Non-Volatile**	Parameters **<EPID>** Where <EPID> represents a 64-bit hexadecimal number Range **0000000000000000 – FFFFFFFFFFFFFFFF** When establishing a PAN the coordinator will pick a random EPID if S03 is set to all 0's. If set to any other value this number will be used as EPID instead. When joining only a PAN with the EPID stored in S03 will be joined unless S03 is set to all 0's. In this case the next best PAN which allows joining is joined. Factory Default **0000000000000000**
SW release	R300 ●

S04 – Local EUI64		
Description The local node's unique EUI64 identifier. Operations **R LOCAL** **R REMOTE** Storage **Non-Volatile**	Parameters **<EUI64>** Range **0000000000000000 – FFFFFFFFFFFFFFFF** Factory Default **<unique number>**	
SW release	R300	●

S05 – Local 16-Bit Network address		
Description The local node's 16-bit Network address. Note Reading this register while not associated with a network will result in an undefined return value. Operations **R LOCAL** **R REMOTE** Storage **Non-Volatile**	Parameters **<Network address>** Range **0000-FFF7** Factory Default **n/a**	
SW release	R300	●

S06 – Parent's EUI64		
Description The parent node's unique EUI64 identifier. Note The return value is undefined for nodes without parents (coordinators and nodes that are not joined to a network). For an FFD, S06 is the ID of the node via which the local node joined the PAN Operations **R LOCAL** **R REMOTE** Storage **Non-Volatile**	Parameters **<EUI64>** Range **0000000000000000 – FFFFFFFFFFFFFFFF** Factory Default **n/a**	
SW release	R300	●

S07 – Parent's 16-Bit Network address		
Description The parent node's 16-bit Network address. Operations **R LOCAL** **R REMOTE** Note The return value is undefined for nodes without parents (coordinators and nodes that are not joined to a network). For an FFD, S07 is the ID of the node via which the local node joined the PAN Storage **Non-Volatile**	Parameters **<Network address>** Range **0000-FFF7** Factory Default **n/a**	
SW release	R300	●

S08 – Network Key		
Description The network key which can be written using the password. The default password for R3xx is "password". Operations **W LOCAL** **W REMOTE** Write operation **ATS08=<key>:<password>** **ATREMS:<address>,08=<key>:<password>** Becomes effective **Only when establishing a PAN** Storage **Non Volatile**	Range **From 0 to 2^{128}-1** The 128-bit AES network key in hexadecimal representation (32 characters). When set to all 0's (default) a random network key is generated when establishing a PAN. This key is transmitted to all joining nodes and can be encrypted using the link key. Factory Default **00000000000000000000000000000000**	
SW release	R300	●

S09 – Trust Centre Link Key	
Description The link key which can be written using the password. The default password for R3xx is "password". Operations **W LOCAL** **W REMOTE** Write operation **ATS09=<key>:<password>** **ATREMS:<address>,09=<key>:<password>** Becomes effective **When Joining or establishing a PAN** Storage **Non Volatile**	Range **From 0 to 2^{128}-1** The 128-bit trust centre link key in hexadecimal representation (32 characters). When set to all 0s (default) a random trust centre link key is generated when establishing a PAN. Factory Default **00000000000000000000000000000000**
SW release	R300 ●

4.3 S-Registers for Module Setup

S0A – Main Function

Description
Defines the behaviour of the Device.

Operations
R/W LOCAL
R/W REMOTE

Becomes effective
When joining or establishing a PAN (bits F-D)

When PWM is next enabled (bit C)

Instantly (bits B-0)

Write operation
ATS0A=XXXX:<Password>
ATREMS:<address>,0A=XXXX:<Password>

Notes
For security reasons this register is password protected. The default password for R3xx is "password".

See section 14 regarding secure networks

To block joining, set either bit 5 on the trust centre or bit 0 on every node. Built-in function 0017 only overrides bit 0

An End Device (not Sleepy or Mobile) is primarily to let a ZigBee PRO device join a ZigBee 2006 PAN. An SED or MED is the more usual choice

Storage
Non-Volatile

Parameters
XXXX

Where XXXX represents a 16-bit hexadecimal number.

Range
0000 to FFFF

Bit E-F: Device Selection

Bit F	Bit E	Device Type
0	0	Router (FFD)
1	0	End Device
0	1	Sleepy End Device
1	1	Mobile End Device

Bit D: Set: If a router, do not route any messages
Bit C: Prescale PWM clock to reduce frequency by 256

Bit B: Set: Allows Endpoint 2 to reply to ZDO endpoint queries
Bit A: Set: When joining don't ask for Trust Centre link key
Bit 9: Set: Don't use central Trust Centre (distributed TC Mode)
Bit 8: Set: Use Pre-Configured Trust Centre Link Key when joining

Bit 7: Set: Trust centre uses hashed link key
Bit 6: Reserved
Bit 5: Set: Don't allow nodes to join (TC setting)
Bit 4: Set: Send Network key encrypted with the link key to nodes joining

Bit 3: Set: Don't allow nodes to re-join unsecured
Bit 2: Set: Send Network key encrypted with the link key to nodes re-joining unsecured
Bit 1: Reserved
Bit 0: Set: Don't allow other nodes to join the network via this node

Factory Default
0000

SW release: R301 ●

S0B – User Readable Name	
Description Password protected user defined name which can be used to identify the node Operations **R/W LOCAL** **R/W REMOTE** Write operation **ATS0B=<name>:<password>** **ATREMS:<address>,0B=<name>:<password>** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **ccccccccccccccc** Name with up to 16 characters. Factory Default **Telegesis**
SW release	R302 ●

S0C – Password	
Description The local node's password. Operations **W LOCAL** **W REMOTE** Write operation **ATS0C=<NEW>:<OLD>** **ATREMS:<address>,0C=<NEW>:<OLD>** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **cccccccc** 8 case sensitive characters (8 bytes). Note that the password **must** have exactly 8 characters. Factory Default **password**
SW release	R300 ●

S0D – Device Information	
Description String containing the module's order code and firmware revision. Operations **R LOCAL** **R REMOTE** Storage **Non-Volatile**	Parameters **ccc…ccc** Text string Examples **ETRX2 R308X** **ETRX357 R308C** Factory Default **N/A**
SW release	R300 ●

S0E – Prompt Enable 1	
Description Defines the behaviour of the Device. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. Range **0000 to FFFF** **Bit F:** Set: Disable '>' prompt when entering binary data **Bit E:** Set: Disable UCAST, MCAST, BCAST, SCAST data **Bit D:** Set: Disable RAW data **Bit C:** Set: Disable SEQ prompt **Bit B:** Set: Disable SINK prompt **Bit A:** Set: Disable SR: prompt **Bit 9:** Set: Disable RAW wrapper **Bit 8:** Set: Disable NEWNODE prompt **Bit 7:** Set: Disable NACK:XX prompt **Bit 6:** Set: Disable ACK:XX **Bit 5:** Set: Disable UCAST, MCAST, BCAST, SCAST wrapper **Bit 4:** Set: Disable LeftPAN prompt **Bit 3:** Set: Disable JPAN prompt **Bit 2:** Set: Disable PWRCHANGE:nn prompt **Bit 1:** Set: Disable OK prompt **Bit 0:** Set: Disable ERROR:XX prompt Factory Default **0000**
SW release	R300 ●

S0F – Prompt Enable 2	
Description Defines the behaviour of the Device. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Notes Use of bit 8 requires bit 1 to be unset Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. Range **0000 to FFFF** **Bit F:** Add prefix to local S-register reads (ETRX35n only) **Bit E:** Show RSSI and LQI for all received unicasts and broadcasts (ETRX35n only) **Bit 9 – Bit D:** Reserved **Bit 8:** Set: Show unhandled messages received by Endpoints 3 and above **Bit 7:** Set: Hide “AddrResp” prompt **Bit 6:** Set: Hide Network Manager Warning **Bit 5:** Set: Hide “DataMODE” prompt **Bit 4:** Set: Hide “CLOSED” prompt **Bit 3:** Set: Hide “OPEN” prompt **Bit 2:** Set: Hide all Sink Advertisements Unset: Show all Sink Advertisements, except advertisements by the current sink **Bit 1:** Set: Disable showing unhandled messages received by Endpoints 0, 2, 3 etc **Bit 0:** Set: Disable COO, FFD, SED and MED prompts Factory Default **0006**
SW release	R301 ●

S10 – Extended Function	
Description Defines the behaviour of the Device. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Notes Bit C: the ETRX357-LRS and ETRX357HR-LRS have an RF preamplifier, so the reported RSSI is 12dB higher than the power at the antenna Do not set bit 8 if the sink is likely to be missing and transmissions to the sink are frequent (about once a second)! Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. Range **0000 to FFFF** **Bit F:** Set: Don't exit data mode in case of data loss **Bit E:** Set: Don't accept Data Mode **Bit D:** Set: High RAM concentrator instead of Low RAM concentrator **Bit C:** Set: Display RSSI and LQI of the last hop when devices report to AT+SN or AT+ANNCE **Bit B:** Set: UCASTs and SCASTs wait for ACK **Bit A:** Set: Disable playing Tune when receiving AT+IDENT **Bit 9:** Set: Enable one second character timeout when entering data for xCASTB **Bit 8:** Set: Actively search for a sink if none is known **Bit 7:** Set: Node doesn't replace existing sink with better one (lower cost) **Bit 6:** Set: Node doesn't lose sink if it couldn't be reached for three times **Bit 5:** Set: Sink won't reply to nodes searching for a sink **Bit 4:** Set: Node is Sink **Bit 3:** Set: Changes to S01 take effect instantly **Bit 2:** Set: Send BCAST[B] messages to routers only **Bit 1:** Set: Send unicast messages unacknowledged **Bit 0:** Set: Don't attach EUI64 to NWK frame when sending a message. Factory Default **0000**
SW release	R302 ●

S11 – Device Specific	
Description Defines the behaviour of the Device. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note On the ETRX2 series IRQ0,1,2,3 are generated by logic transitions on inputs I/O0,1,10,11 respectively, on the ETRX3 series they are generated by logic level transitions on PA0, PA1, PB0 and PB6 respectively. If bit 8 is not set, the shortest interrupt pulse is 450ns. Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. **Bit F (MSB):** Set: I/O3 (ETRX2) or PB7 (ETRX3) is PWM as defined by S1B/S1D. Unset: Standard I/O pin. **Bit E:** Set: Enable Boost Mode **Bit D:** Set: Present 1.2V A/D-Reference at I/O0 during measurement (ETRX2 only) **Bit C:** Set: I/O8 turns into A/D3, which can be read from S21 (ETRX2 only) **Bit B:** Set: Pad 38 turns into A/D4, which can be read from S22 (ETRX2 only) **Bit A:** Reserved **Bit 9:** Set: Enable wakeup on UART activity (1st input character is discarded) **Bit 8:** Set: Enable 100ms debouncing for all IRQs **Bit 7:** Set: IRQ3 on rising edge **Bit 6:** Set: IRQ3 on falling edge **Bit 5:** Set: IRQ2 on rising edge **Bit 4:** Set: IRQ2 on falling edge **Bit 3:** Set: IRQ1 on rising edge **Bit 2:** Set: IRQ1 on falling edge **Bit 1:** Set: IRQ0 on rising edge **Bit 0:** Set: IRQ0 on falling edge Factory Default **0005**
SW release	R301 ●

4.4 I/O related S-Registers

S12 – UART Setup	
Description The device's RS232 Baudrate and mode. The default setting of 0500 results in: 19200bps, no parity, 1 stop bit, 8 data bits. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note If bit 5 is set, bi-directional Hardware Flow Control is used instead of XON/XOFF flow control. If using Hardware flow control I/O4 or PB4 becomes the RTS output and the CTS input is assigned to I/O2 or PB3. Access to these I/Os via S16, S18 is blocked whilst Hardware Flow control is active. Note that in case the 128-byte output buffer of the ETRXn is full data will be dropped. The parity settings do not affect the bytes transmitted over the air. Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. Range of the most significant byte **00 to 0C** 00: 1200 baud 01: 2400 baud 02: 4800 baud 03: 9600 baud 04: 14400 baud 05: 19200 baud 06: 28800 baud 07: 38400 baud 08: 50000 baud 09: 57600 baud 0A: 76800 baud 0B: 100000 baud 0C: 115200 baud Range of the least significant byte **00 to FF** bit 7 set: Enable STX ETX wrapper bit 6 Reserved bit 5 set: H/W flow control enable bit 4 set: no command echo bit 3 set: 7 data bits instead of 8 bit 2 set: 2 stop bits instead of one bit 1 set: odd parity enabled bit 0 set: even parity enabled Factory Default **0500**
SW release	R300 ●

S13 – ETRX2: Pull-up enable ETRX3: I/O Configuration

Description

Configures the I/O pins.

Setting a bit on the ETRX2 enables the built-in pull-up on the corresponding pin.
Setting a bit on the ETRX3 will have the following effect:

S13	S16	S18	
0	0	0	Floating Input
0	0	1	floating input
0	1	0	Output driving 0
0	1	1	Output driving 1
1	0	0	Input with pull-down
1	0	1	Input with pull-up
1	1	0	Open Drain Output (0)
1	1	1	Open Drain Output (open)

Operations

R/W LOCAL
R/W REMOTE

Becomes effective

After Reset

Note

To achieve ultra low current consumption on the ETRX2 it is recommended not to use the built-in pull-ups and leave this register in its default state.
The ETRX357's current consumption may benefit from the use of pull-ups or pull-downs where inputs are otherwise unconnected.

Storage

Non-Volatile

Parameters

XXXX (ETRX2) or XXXXXXXX (ETRX3)

Where XXXX represents a 16-bit hexadecimal number and XXXXXXXX represents a 32-bit hexadecimal number.

ETRX2: representing I/O pins

```
xx <TXD><RXD> BA98 7654 3210
```

e.g. setting bit 7 to 1 will enable the pull-up for I/O pin 7

ETRX3: representing the I/O pins

```
xxxxxxxx      <PC7…PC0>      <PB7…PB0>
<PA7…PA0>
```

e.g. setting bit 7 to 1 will configure PA7 to either be an input with pull-up or pull-down, or an open-drain output.

Factory Default

ETRX2: 0000
ETRX3: 00000000

SW release	R300	●

S14 – ETRX2: Pull-down enable ETRX3: Reserved		
Description Enables the built-in pull-downs for each individual I/O pin of the ETRX2. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Reset** Note To achieve ultra low current consumption it is recommended not to use the built-in pull-downs and leave this register in its default state. On the ETRX3 series this register is Reserved and currently not in use Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents a 16-bit hexadecimal number. Range **0000 to FFFF** representing I/O pins `xx<TXD><RXD> BA98 7654 3210` e.g. setting bit 7 to 1 will enable the pull-down for I/O pin 7 Factory Default **0000**	
SW release	R300	●

S15 – ETRX3: I/O Configuration ETRX2: Reserved

Description

This Register is not used on the ETRX2. On the ETRX3 it is used to enable alternate functionalities for each I/O pin. When set to zero the corresponding I/O pin is a standard I/O pin, when set to 1 any other setting for this I/O are overwritten by the peripheral functionality.

representing the I/O pins
xxxxxxxx
<PC7…PC0><PB7…PB0><PA7…PA0>

Operations
R/W LOCAL
R/W REMOTE

Becomes effective
After Reset

Notes

PA7 indicates that the UART has data to send.

PB0 is used internally on the ETRX357-LRS and ETRX357HR-LRS and is not available to the user.

Storage
Non-Volatile

Parameters
XXXXXXXX

Where XXXXXXXX represents a 32-bit hexadecimal number.

bits 31-24 reserved

bit 23 Set: PC7 indicates status of DMODE. Set High = Active, set low = Inactive. PC7 needs to be defined as output in S16 and can be overridden using S18
bit 22: Set: Enable nTX_Active (reserved on -ERS Variants)

bit 21 Set: Enable TX_Active (reserved on –LRS and –ERS Variants)
bit 20 reserved (PC4)
bit 19 reserved (PC3)
bit 18 reserved (PC2)
bit 17 Set: Enable ADC3 (PC1)
bit 16 reserved (PC0)

bit 15 Set: Enable ADC2, can be used as PWM out when enabled in S11 (PB7)
bit 14 Set: Enable ADC1 (PB6)
bit 13 Set: Enable ADC0, not available on –ERS variants (PB5)
bit 12 Set: reserved, CTS when enabled in S12 (PB4)
bit 11 Set: reserved, RTS when enabled in S12 (PB3)
bit 10 Set: Enable RXD input (PB2)
bit 9 Set: Enable TXD output (PB1)
bit 8 Set: Enable 1.2V Vref Output during ADC conversions (PB0), reserved on -LRS and -ERS variants

bit 7 Set: UART TX_ACTIVE (PA7)
bit 6 reserved (PA6)
bit 5 reserved (PA5)
bit 4 reserved (PA4)
bit 3 reserved (PA3)
bit 2 reserved (PA2)
bit 1 reserved (PA1)
bit 0 reserved (PA0)

Factory Default
00000600

SW release	R300	●

S16 – Data Direction of I/O Port	

Description
The data direction of the module's I/O port
 	
Operations
R/W LOCAL
R/W REMOTE
 	
Becomes effective
Instantly
 	
Note
On the "-LRS" variants of the ETRX3 PC5 and PB0 are reserved and cannot be controlled using this register. On the "-ERS" variant PC6 and PB5 are also not freely configurable.
 	
Storage
Volatile
	Parameters
	XXXX (ETRX2) or XXXXXXXX (ETRX3)
	
	Where XXXX represents a 16-bit hexadecimal number and XXXXXXXX represents a 32-bit hexadecimal number.
	
	ETRX2: representing I/O pins
	`xxxx BA98 7654 3210`
	
	e.g. setting bit 7 to 1 will configure I/O7 to be an output.
	
	ETRX3: representing the I/O pins
	`xxxxxxxx <PC7…PC0> <PB7…PB0> <PA7…PA0>`
	
	e.g. setting bit 7 to 1 will configure PA7 to be an output
	
	Factory Default
	Defined in S17

SW release	R300 ●

S17 – Initial Setting of S16	
Description The initial setting of S16 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX (ETRX2) or XXXXXXXX (ETRX3)** Where XXXX or XXXXXXXX represent the initial value of S16 which is loaded after boot-up, soft or hard reset. Factory Default **ETRX2: 00F8** **ETRX3: 000142CC**
SW release	R300 ●

S18 – Output Buffer Of I/O Port	

Description
The output buffer of the module's I/O port
 	
Operations
R/W LOCAL
R/W REMOTE
 	
Becomes effective
Instantly
 	
Note
On the "-LRS" variants of the ETRX3 PC5 and PB0 is reserved and cannot be controlled using this register. On the "-ERS" variants PC6 is also not freely configurable and PB5 is used to control the PA and LNA bypass mode.
 	
Storage
Volatile
	Parameters
	XXXX (ETRX2) or XXXXXXXX (ETRX3)
	
	Where XXXX represents a 16-bit hexadecimal number and XXXXXXXX represents a 32-bit hexadecimal number.
	
	ETRX2: representing I/O pins
	`xxxx BA98 7654 3210`
	
	e.g. setting bit 7 to 1 will cause I/O7 to drive high (if defined as an output in S16)
	
	ETRX3: representing the I/O pins
	`xxxxxxxx <PC7…PC0> <PB7…PB0> <PA7…PA0>`
	
	e.g. setting bit 7 to 1 will cause PA7 to drive high (depending on settings in S16 and S15)
	
	Factory Default
	Defined in S19

SW release	R300 ●

S19 – Initial Setting of S18	
Description The initial setting of S18 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX (ETRX2) or XXXXXXXX (ETRX3)** Where XXXX or XXXXXXXX represent the initial value of S18 which is loaded after boot-up, soft or hard reset. Factory Default **ETRX2: 00F0** **ETRX3: 00000000**
SW release	R300 ●

S1A – Input Buffer of I/O Port		

Description
The Logical Levels at the I/O Pins
 	
Operations
R LOCAL
R REMOTE
 	
Becomes effective
Instantly
 	
Storage
Instant Reading of Port Status
	Range
	0000 to FFFF (ETRX2)
	00000000 to FFFFFFFF (ETRX3)
	
	ETRX2: representing I/O pins
	`xxxx BA98 7654 3210`
	
	ETRX3: representing the I/O pins
	`xxxxxxxx <PC7…PC0> <PB7…PB0> <PA7…PA0>`
	
	S1A represents the logic level at each pin of the I/O port.
	
	Factory Default
	n/a	

SW release	R300	●

S1B – PWM Pin Top Value		
Description The mode of operation for the special function pin. S1B controls the PWM frequency. Frequency = 12MHz/({S1B}+1) Operations **R/W LOCAL** **R/W REMOTE** Operations **Instantly** Storage **Volatile**	Parameters **XXXX** Range **0000 to FFFF** This register represents the top value of the 16-bit counter counting from 0 to top repeatedly incrementing at 12MHz. When reaching top I/O3 (ETRX2) or PB7 (ETRX357) is set, given that the PWM is enabled in S11. Factory Default **Defined in S1C**	
SW release	R300	●

S1C – Initial value of S1B	
Description The initial setting of S1B stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents the initial value of S1B which is loaded after boot-up, soft or hard reset. Factory Default **3A98 (800Hz 50% m/s ratio)**
SW release	R300 ●

S1D – PWM Pin Compare Value	
Description The mode of operation for the special function pin. S1D controls the PWM duty cycle Duty cycle = {S1D}/({S1B}+1) Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **XXXX** Range **0000 to FFFF** If the special function pin is enabled by setting bit F of S11, this register represents the compare value of the 16-bit counter counting from 0 to top repeatedly incrementing at 12MHz. When reaching compare I/O3 (ETRX2) or PB7 (ETRX357) is cleared. Factory Default **Defined in S1E**
SW release	R300 ●

S1E – Initial Value S1D	
Description The initial setting of S1D stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX** Where XXXX represents the initial value of S1D which is loaded after boot-up, soft or hard reset. Factory Default **1D4C (800Hz 50% m/s ratio)**
SW release	R300 ●

S1F – A/D1 Reading (ETRX3 series ADC0)	
Description The analogue reading of A/D1 (ETRX3 series ADC0) ETRX3: Only when bit 13 (0x0D) of S15 is set, invalid otherwise Operations **R LOCAL** **R REMOTE** Becomes effective **Instantly** Storage **Instant Reading of analogue input**	Parameters **XXXX** Representation The hexadecimal reading of the analogue input in mV (mV * 10 on the ETRX3) with respect to ground. The return value will be undefined in case the corresponding A/D converter has not been enabled. Range **ETRX2: 0000 – 04B0 (0 – 1200)** **ETRX3: 0000 – 2EE0 (0 – 12000)**
SW release	R300 ●

S20 – A/D2 Reading (ETRX3 series ADC1)	
Description The analogue reading of A/D2 (ETRX3 series ADC1) ETRX3: Only when bit 14 (0x0E) of S15 is set, invalid otherwise Operations **R LOCAL** **R REMOTE** Becomes effective **Instantly** Storage **Instant Reading of analogue input**	Parameters **XXXX** Representation The hexadecimal reading of the analogue input in mV (mV * 10 on the ETRX3) with respect to ground. The return value will be undefined in case the corresponding A/D converter has not been enabled. Range **ETRX2: 0000 – 04B0 (0 – 1200)** **ETRX3: 0000 – 2EE0 (0 – 12000)**
SW release	R300 ●

S21 – A/D3 Reading (ETRX3 series ADC2)	
Description The analogue reading of A/D3 (ETRX3 series ADC2) ETRX2: Only when bit C of S11 is set, invalid otherwise ETRX3: Only when bit 15 (0x0F) of S15 is set, invalid otherwise Operations **R LOCAL** **R REMOTE** Becomes effective **Instantly** Storage **Instant Reading of analogue input**	Parameters **XXXX** Representation The hexadecimal reading of the analogue input in mV (mV * 10 on the ETRX3) with respect to ground. The return value will be undefined in case the corresponding A/D converter has not been enabled. Range **ETRX2: 0000 – 04B0 (0 – 1200)** **ETRX3: 0000 – 2EE0 (0 – 12000)**
SW release	R300 ●

S22 – A/D4 Reading (ETRX3 series ADC3)	
Description The analogue reading of A/D4 (ETRX3 series ADC3) ETRX2: Only when bit B of S11 is set, invalid otherwise ETRX3: Only when bit 17 (0x11) of S15 is set, invalid otherwise Operations **R LOCAL** **R REMOTE** Becomes effective **Instantly** Storage **Instant Reading of analogue input**	Parameters **XXXX** Representation The hexadecimal reading of the analogue input in mV (mV * 10 on the ETRX3) with respect to ground. The return value will be undefined in case the corresponding A/D converter has not been enabled. Range **ETRX2: 0000 – 04B0 (0 – 1200)** **ETRX3: 0000 – 2EE0 (0 – 12000)**
SW release	R300 ●

4.5 S-Registers Defining the Functionality of the Module

There are 14 events which can trigger a user-selectable action to prevent the need for a host microcontroller for simple applications. Four out of those 14 events are the external interrupts which can be enabled in register S11. The actions to be performed on those four interrupt events are defined in S23 to S26. The user can pick any of the actions from the list in section 5 of this document and assign them to any event.

Two further events occur when the unit is reset or power cycled, or joins a network.

The remaining 8 events are timed events. Registers S29 to S38 control those 8 timers and their corresponding events. Please note that the first 4 timers are used by default for network management tasks, which can be modified by the user when changing the corresponding registers. A timer will increment every 250ms (4 times a second) and when the timer reaches the value stored in the timer/counter register the corresponding action will be executed.

For examples, see the descriptions of register S23 and register pair S29/S2A.

S23 – Immediate Functionality At IRQ0 (ETRX2: I/O0 ETRX3:PA0)	
Description Describes the immediate action taken on IRQ0. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0001 (Wakeup to power mode 0)**
SW release	R300 ●

S24 – Immediate Functionality At IRQ1 (ETRX2: I/O1 ETRX3:PA1)		
Description Describes the immediate action taken on IRQ1. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0000 (none)**	
SW release	R300	●

S25 – Immediate Functionality At IRQ2 ((ETRX2: I/O10 ETRX3:PB0)		
Description Describes the immediate action taken on IRQ2. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note PB0 is used internally on the ETRX357(HR)-LRS and is not available to the user Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0000 (none)**	
SW release	R300	●

S26 – Immediate Functionality At IRQ3 (ETRX2: I/O11 ETRX3:PB6)	
Description Describes the immediate action taken on IRQ3. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0000 (none)**
SW release	R300 ●

S27 – Functionality at Bootup		
Description Describes the immediate action taken after boot-up (and stack initialization). Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note On versions before R305 this was executed before the protocol stack was running so it could not be used for network or message functions Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0000 (none)**	
SW release	R305	●

S28 – Functionality at Network Join		
Description Describes the immediate action taken after joining a network. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities. Factory Default **0000 (none)**	
SW release	R302	●

S29 –Timer/Counter 0	
Description A multipurpose Timer/Counter whose functionality is defined by S2A Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **0004 (1s interval)**
SW release	R300 ●

S2A – Functionality For Timer/Counter 0	
Description Defines the functionality for Timer/Counter 0 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **8010 (end devices poll parent)**
SW release	R300 ●

S2B –Timer/Counter 1	
Description A multipurpose Timer/Counter whose functionality is defined by S2C Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **00F0 (1 min interval)**
SW release	R300 ●

S2C – Functionality For Timer/Counter 1	
Description Defines the functionality for Timer/Counter 1 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **821E (advertise sink for 30 hops and create aggregation routes to COO and sinks)**
SW release	R300 ●

S2D –Timer/Counter 2	
Description A multipurpose Timer/Counter whose functionality is defined by S2E Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **00F4 (1 min 1s interval)**
SW release	R300 ●

S2E – Functionality For Timer/Counter 2	
Description Defines the functionality for Timer/Counter 2 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **8014 (leave network if I am alone)**
SW release	R300 ●

S2F –Timer/Counter 3	
Description A multipurpose Timer/Counter whose functionality is defined by S30 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **00F2 (1min interval)**
SW release	R300 ●

S30 – Functionality For Timer/Counter 3	
Description Defines the functionality for Timer/Counter 3 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **8015 (if not part of a network do AT+JN)**
SW release	R300 ●

S31 –Timer/Counter 4	
Description A multipurpose Timer/Counter whose functionality is defined by S32 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **0000**
SW release	R302 ●

S32 – Functionality For Timer/Counter 4	
Description Defines the functionality for Timer/Counter 4 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **0000**
SW release	R302 ●

S33 –Timer/Counter 5	
Description A multipurpose Timer/Counter whose functionality is defined by S34 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **0000**
SW release	R300 ●

S34 – Functionality For Timer/Counter 5	
Description Defines the functionality for Timer/Counter 5 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters XXXX If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **0000**
SW release	R300 ●

S35 –Timer/Counter 6	
Description A multipurpose Timer/Counter whose functionality is defined by S36 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **0000**
SW release	R300 ●

S36 – Functionality For Timer/Counter 6	
Description Defines the functionality for Timer/Counter 6 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **0000**
SW release	R300 ●

S37 –Timer/Counter 7	
Description A multipurpose Timer/Counter whose functionality is defined by S38 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** A 16-bit hexadecimal number representing a threshold for either a timer or counter event to be triggered. When reading this register the threshold rather than the actual timer/counter value is displayed. If set to 0 the corresponding functionality is disabled. Factory Default **0000**
SW release	R300 ●

S38 – Functionality For Timer/Counter 7	
Description Defines the functionality for Timer/Counter 7 events. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities. Factory Default **0000**
SW release	R300 ●

S39 – Power Mode	
Description The current power mode of the module Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **XXXX** Range 0000 – 0003 The module's power mode as described in section 6. Factory Default **Defined in S3A**
SW release	R300 ●

S3A – Initial Power Mode	
Description The module's power mode after start-up and reset. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After hard or soft reset** Storage **Non-Volatile**	Parameters **XXXX** Range 0000 – 0003 The module's power mode as described in section 6. Factory Default **0000**
SW release	R300 ●

S3B – Start-up Functionality Plaintext A	
Description Contains Text which is used by some of the actions described in section 5. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **Up to 50 characters** Factory Default **BUTTON3**
SW release	R300 ●

S3C – Start-up Functionality Plaintext B		
Description Contains Text which is used by some of the actions described in section 5. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **Up to 50 characters** Factory Default **BUTTON4**	
SW release	R300	●

S3D – Supply Voltage		
Description The Supply voltage of the device in mV. Operations **R LOCAL** **R REMOTE** Becomes effective **N/A** Storage **Volatile**	Parameters **nnnn** Where nnnn represents the supply voltage in mV. Factory Default **N/A**	
SW release	R300	●

4.6 Advanced Settings

S3E – Multicast Table Entry 00	
Description The ID portion of Multicast Table Entry 00 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note Same effect as AT+MSET, but can be set at boot-up by built-in functionality Storage **Non-Volatile**	Parameters **XXXX** If S3E is not set to all 0's multicast table entry 00 to endpoint 1 (the AT command layer's endpoint) is set with the setting of this register is created instantly and after a reset. Factory Default **0000**
SW release	R300 ●

S3F – Multicast Table Entry 01	
Description The ID portion of Multicast Table Entry 01 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Note As for S3E Storage **Non-Volatile**	Parameters **XXXX** If S3F is not set to all 0's multicast table entry 01 to endpoint 1 (the AT command layer's endpoint) is set with the setting of this register is created instantly and after a reset. Factory Default **0000**
SW release	R300 ●

S40 – Source and Destination Endpoints for xCASTs (volatile)	
Description The source and destination endpoints for all messages. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **ssdd** Where ss is the hexadecimal source endpoint and dd is the hexadecimal destination endpoint. Factory Default **Defined in S41**
SW release	R300 ●

S41 – Initial Setting of S40	
Description The initial setting of S40 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **ssdd** Where ss is the hexadecimal source endpoint and dd is the hexadecimal destination endpoint. Factory Default **0101**
SW release	R300 ●

S42 – Cluster ID for xCASTs (volatile)		
Description The Cluster ID attached to any xCAST message. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **XXXX** The cluster ID of any xCAST message Factory Default **Defined in S43**	
SW release	R300	●

S43 – Initial Setting of S42		
Description The initial setting of S42 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX** The cluster ID of any xCAST message Factory Default **0002**	
SW release	R300	●

S44 – Profile ID for xCASTs (volatile)	
Description The profile ID for all messages. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **XXXX** The profile ID of any xCAST message Factory Default **Defined in S45**
SW release	R300 ●

S45 – Initial Setting of S44	
Description The initial setting of S44 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX** The profile ID of any xCAST message Factory Default **C091**
SW release	R300 ●

S46 – Start-up Functionality 32-bit number	
Description Volatile 32-bit register which can be used by some of the build in functionality Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Volatile**	Parameters **XXXXXXXX** Factory Default **00000000**
SW release	R303 – upgraded to 32-bit ●

S47 – Power Descriptor	
Description Register defining the Node's power descriptor, which can be read by remote nodes using ZigBee compliant ZDO messaging. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** The Power Descriptor as described in section 2.3.2.4 of the ZigBee specification. Factory Default **C110**
SW release	R302 ●

S48 – Endpoint 2 Profile ID	
Description Register defining the Profile ID of the Node's endpoint 2. Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** The 16 bit Profile ID. Factory Default **C091**
SW release	R302 ●

S49 – Endpoint 2 Device ID	
Description Register defining the Device ID of the Node's endpoint 2 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **XXXX** The 16 bit device ID. Factory Default **0000**
SW release	R302 ●

S4A – Endpoint 2 Device Version	
Description Register defining the version of the device attached to the Node's endpoint 2 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **00XX** The 8 bit version preceded by two leading 0's. Factory Default **0000**
SW release	R302 ●

S4B – Endpoint 2 Input Cluster List	
Description Register defining the input cluster list of the device attached to the Node's endpoint 2 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **[XXXX,XXXX,XXXX,XXXX,XXXX,XXXX, XXXX,XXXX,XXXX,XXXX,XXXX,XXXX]** A list of a maximum of 12 x 16 bit cluster IDs separated by commas. The list may have any length from 0 to 12 clusters Example ATS4B=1101,000D Factory Default **0000**
SW release	R302 ●

S4C – Endpoint 2 Output Cluster List		
Description Register defining the output cluster list of the device attached to the Node's endpoint 2 Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **Instantly** Storage **Non-Volatile**	Parameters **[XXXX,XXXX,XXXX,XXXX,XXXX,XXXX, XXXX,XXXX,XXXX,XXXX,XXXX,XXXX]** A list of a maximum of 12 x 16 bit cluster IDs separated by commas. The list may have any length from 0 to 12 clusters Factory Default **0000**	
SW release	R302	●

S4D – Mobile End Device Poll Timeout		
Description In an FFD, the register defining the amount of time after which a mobile end device times out of its parent's child table if it has not polled. In an MED, defines the delay between an MED losing contact with its parent and reporting "LostPAN". Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Note The timer tested according to S4D continues to run in Power Mode 3 Storage **Non-Volatile**	Parameters **00XX** 8-bit number led by "00", which represents the timeout in quarter seconds. The default of 0x0014 results in a timeout of 5s. Factory Default **0014**	
SW release	R302	●

S4E – End Device Poll Timeout	
Description Register in a parent defining the amount of time after which an SED or ZED times out of its parent's child table if it has not polled Register in an SED or ZED defining the amount of time after which it reports LostPAN when it loses the parent Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Note The timer tested according to S4E continues to run in Power Mode 3 Storage **Non-Volatile**	Parameters **XXYY** Where YY is the timeout in seconds left-shifted by XX (YY * 2^XX). The default number results in a timeout of 5 Minutes, whereas the maximum number results in a timeout of approximately 48 days. Maximum **0EFF** Factory Default **0605**
SW release	R303 ●

S4F – MAC Timeout	
Description Register defining the MAC timeout Operations **R/W LOCAL** **R/W REMOTE** Becomes effective **After Soft or Hard Reset** Storage **Non-Volatile**	Parameters **XXXX** The Ember_Indirect_Transmission_Timeout is the amount of time in milliseconds that the MAC in a parent node will hold a message for indirect transmission to a child. In addition to this is also the basis for the timeout after which an acknowledged unicast to an end device is nacked when no ack is received. The default value is 3000ms. The maximum is 30s Maximum **7530** Factory Default **0BB8**
SW release	R302 ●

5 Build in Functionality

The following table gives an overview of the built-in functionality which can be triggered either by the four external interrupts, boot-up, joining a network, or by 8 individually programmable timers/counters. If the node is in a low power mode and the action requires the node to wake up, the node will do so and go back to its original power mode after completion of the action. When a function is used in conjunction with a timer, the timer will restart only in case the most significant bit of the action is set to 1 (e.g. instead of 0001 set 8001). The timers count 250ms intervals.

The timers run in power modes 0, 1 and 2, but in power mode 3 their count values are frozen and their associated functions are therefore not executed.

The timers are firmware functions, not hardware circuits, so negligible power is saved by deleting unused timers.

Overview of Actions	
0000	No operation of the corresponding interrupt/timer/counter
0001	Change to power mode 0.
0002	Change to power mode 1.
0003	Change to power mode 2.
0004	Change to power mode 3.
…	Reserved
0010	If I am an end device Poll Parent for data.
0011	Update the Network key with new random key.
0012	Check for other devices on the network. If no other devices could be found for three consecutive tries, attempt a rejoin using the current network key each time this functionality is triggered. Note: No functionality on COOs.
0013	Check for other devices on the network. If no other devices could be found for three consecutive tries, attempt a rejoin using the known network key. If this is unsuccessful try an unsecured rejoin each time this functionality is triggered from there on. Note: No functionality on COOs.
0014	Check for other devices on the network. If no other devices could be found for three consecutive tries, attempt a rejoin using the known network key. If this is unsuccessful try a rejoin using the current link key the next time this functionality is triggered. If this is unsuccessful leave the current network the next time this action is triggered. Notes: No functionality on COOs. This function may be inhibited if other devices try to join the PAN
0015	In case I am not joined to a network scan for and join the next best
0016	Reserved
0017	Allow joining via the local node for 60 Seconds (when it is disabled using bit 0 of S0A)
0018	Copy local Inputs to Remote outputs: Read Local S1A and if changed since the previous time, write the reading into the remote S18 whose address is given in S3B.
001D	End Data Mode (if active)
001E	Disassociate from the PAN if no coordinator or sink has been heard from since the function was last executed. Note 1: this has no effect on an End Device. Note 2: only execute this function every few minutes or devices may leave the PAN unexpectedly. Note 3: The actual code in the register needs to be 801E
0020	Check for other devices on the network. If no other devices could be found for three consecutive tries, set S11F to 1 to enable PWM, then attempt a rejoin using the current network key each time this functionality is triggered. Note: No functionality on COOs

Overview of Actions	
0021	Check for other devices on the network. If no other devices could be found for three consecutive tries, set S11F to 0 to disable PWM, then attempt a rejoin using the current network key each time this functionality is triggered. Note: No functionality on COOs
003x	ETRX2: Toggle I/Ox. ETRX357: Toggle PA0-7 (x=0-7) or PB0-7 (x=8-F)
004x	Flash I/Ox (pull low) for 250ms. Note: can only be triggered by a timer, not an IRQ
005x	ETRX2: Set I/Ox to 0. ETRX357: Set PA0-7 (x=0-7) or PB0-7 (x=8-F) to 0
006x	ETRX2: Set I/Ox to 1. ETRX357: Set PA0-7 (x=0-7) or PB0-7 (x=8-F) to 1
0108	The unit sends the contents of S3B to the networks sink.
0109	The unit sends the contents of S3C to the networks sink.
0110	Sends the reading of the lower 16 I/O pins, A/D1 & A/D2 or ADC0 & ADC1 and V_{cc} as well as an 8-bit transmission counter which increments with every transmission to the network's sink, and if no sink is known the unit will search for a sink immediately when bit 8 of S10 is set.
0111	Same as 0110, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
0112	Send a Tracking Message to all nearby routers which will forward this message and the RSSI reading to their nearest sink.
0113	Same as 0112, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
0114	Same as 0112, but tracking message doesn't contain ADC readings to save power on tracked device (TRACK2 Prompt)
0115	Same as 0114, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
0116	Send a Tracking Message to all nearby routers which will forward this message and the RSSI reading to their nearest sink if the local RSSI reading is higher than the *first* three digits of S3B (S3B is interpreted as snnsnn). S3B must be set in all routers
0117	Same as 0116, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
0118	Send a Tracking Message to all nearby routers which will forward this message and the RSSI reading to their nearest sink if the local RSSI reading is higher than the *second* three digits of S3B (S3B is interpreted as snnsnn). Tracking message does not contain ADC readings to save power on tracked device (TRACK2 Prompt)
0119	Same as 0118, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
0120	Sends the contents of S3B as a RAW transmission.
0121	Sends the contents of S3C as a RAW transmission.
0130	Sends to the network's sink the reading of the I/O, an 8-bit transmission counter which increments with every transmission, the contents of S46 and the reading of any A/D [1..4] enabled in S15 (ETRX3) or S11 (ETRX2). If no sink is known the unit will search for a sink immediately when bit 8 of S10 is set
0131	Same as 0130, but to charge an external RC timer ETRX2:I/O7 or ETRX3:PA3 is pulled high whilst sending the data and left high impedance the rest of the time.
02XX	If I am a Sink advertise me for x hops (max. no. of hops: 30). If I am a COO create aggregation routes needed for Trust Centre. NB message does not reach end devices when parent already knows a sink address
0300	Increment S46
0301	Decrement S46
0302	Clear S46

Overview of Actions	
0400	Show status on ETRX2:I/O3, ETRX3:PA7. LED on (pin driven low) = no connection. Blinking fast = Auto-searching for PAN. Blinking slow = connected to PAN. The accompanying counter register defines the update interval. Note: I/O3/PA7 must be defined to be an output.
0401	Show status on ETRX2:I/O10, ETRX3:PB7. LED on (pin driven low) = no connection. Blinking fast = Auto-searching for PAN. Blinking slow = connected to PAN. The accompanying counter register defines the update interval. Note: I/O10/PB7 must be defined to be an output.
2000	When triggered the number of times listed in the accompanying counter a message is sent to the sink containing a transmission counter and the reading of the analogue and digital inputs. Note: Can only be triggered by setting S23, S24, S25 or S26 to 24XX.
2001	When enabling this action the command line is disabled and as soon as a number of bytes in excess of the number N specified in the accompanying timer/counter register is received on the serial port, a SCAST containing these characters is sent to the network's sink. Notes: This event is triggered by receiving a character on the serial port. N ≤ 64. N must be written as a 4-character hexadecimal number. This function can only be stopped by overwriting the register that contains code 2001 from another node.
2100	The contents of S3B is sent to the local command line followed by carriage return. Note: No AT-Prefix required!
2101	The contents of S3C is sent to the local command line followed by carriage return. Note: No AT-Prefix required!
24XX	Start timers masked in XX.
25XX	Toggle timers masked in XX.
26XX	Stop timers masked in XX.
3XXX	Change I/O port to the LSBs.
4XXX	Change data direction of the I/O port to the LSBs.

Table 7. Built-in functions

6 ETRX2 Power Consumption

As the module's power consumption is firmware dependent, the values in the following tables supersede any of the numbers given in previous revisions of the AT command dictionary. Table 8 gives the hardware dependent theoretical figures for the ETRX2 as stated in the current hardware manual, whereas Table 9 shows the firmware dependent average power consumption of an ETRX2 measured with light to medium network traffic. For more details please refer to the separate application note regarding power consumption, which can be found on www.telegesis.com.

Typical values at 3.3V 25°C.

Parameter	Min.	Typ.	Max.	Units	Condition
Supply Current		36		mA	TX 4dBm
		32		mA	TX –1dBm
		29		mA	TX –10dBm
		28		mA	TX –20dBm
		37		mA	RX
		1.5		µA	Asleep, Timers on
		0.7		µA	Asleep, Timers off

Table 8: Power Consumption

Mode	Router, COO				MED, SED			
	MCU	Radio	Timers	I	MCU	Radio	Timers	I
0	Awake	Awake	User defined	36mA	Awake	Asleep	User defined	9mA
1	Idle	Awake	User defined	32mA	Idle	Asleep	User defined	4.5mA
2	Asleep	Asleep	User defined	0.7mA[1]	Asleep	Asleep	User defined	0.7mA[1]
3	Asleep	Asleep	Off	0.7µA	Asleep	Asleep	Off	0.7µA

Table 9: Averaged power consumption during operation

Notes:

- Sleep modes 1-3 should not be used on a router or coordinator, however it was found that mode 1 may work on a router with light to medium network traffic. Successful operation of a router in mode 1 cannot be guaranteed and needs to be evaluated carefully for each target application in case the additional energy saving is vital.
- Wakeup from mode 3 is only possible by external interrupt or reset. Make sure never to set the initial power mode (S3A) to mode 03 unless you want the device to always wake up into this mode.
- Modules in power mode 2 and 3 will not respond to commands at the serial port, so always make sure you have defined means to wake it up from these modes.
- If no means of waking up from any of the power down modes has been defined and the module appears unresponsive the Telegesis factory default resetter can be used to reset the modules factory defaults via the serial port.
- In order to achieve ultra low power consumption of sub 1µA it is required to either define all I/Os to be outputs, or to pull all inputs to a defined level as floating input pins will increase the current consumption. Furthermore as described in the hardware manual a pull-down of 10kΩ must be attached to the SIF_MOSI pin for lowest possible power consumption.

[1] Assuming the unit polls every second. If no polling and other timed actions are performed the power consumption can be as little as 1.5µA in this mode.

7 ETRX357 Power Consumption (Provisional data)

Typical values at 3.3V 25°C.

Parameter	Min.	Typ.	Max.	Units	Condition
Supply Current		30		mA	TX 8dBm
		28		mA	TX 3dBm
		28		mA	TX –1dBm
		28		mA	TX –43dBm

Table 10: Power Consumption

Mode	Router, COO				MED, SED			
	MCU	Radio	Timers	I	MCU	Radio	Timers	I
0	Awake	Awake	User defined	28mA	Awake	Asleep	User defined	9.5mA
1	Idle	Awake	User defined	22mA	Idle	Asleep	User defined	3.5mA
2	Asleep	Asleep	User defined		Asleep	Asleep	User defined	
3	Asleep	Asleep	Off		Asleep	Asleep	Off	

Table 11: Averaged power consumption during operation

Notes:

- Sleep modes 1-3 should not be used on a router or coordinator, however it was found that mode 1 may work on a router with light to medium network traffic. Successful operation of a router in mode 1 cannot be guaranteed and needs to be evaluated carefully for each target application in case the additional energy saving is vital.
- Wakeup from mode 3 is only possible by external interrupt or reset. Make sure never to set the initial power mode (S3A) to mode 03 unless you want the device to always wake up into this mode.
- Modules in power mode 2 and 3 will not respond to commands at the serial port, so always make sure you have defined means to wake it up from these modes.
- If no means of waking up from any of the power down modes has been defined and the module appears unresponsive the Telegesis factory default resetter can be used to reset the modules factory defaults via the serial port.
- In order to achieve ultra low power consumption of sub 1µA it is required to either define all I/Os to be outputs, or to pull all inputs to a defined level as floating input pins will increase the current consumption.

8 Notes on Energy Levels and LQI

8.1 Interpreting LQI

On the EM250 as well as the EM35x, the LQI is closely related to the SNR (signal noise ratio) but is calculated from the chip error rate. The graph below shows the relation between the SNR and the LQI reading on the EM250, which is the basis of the ETRX2 series of modules.

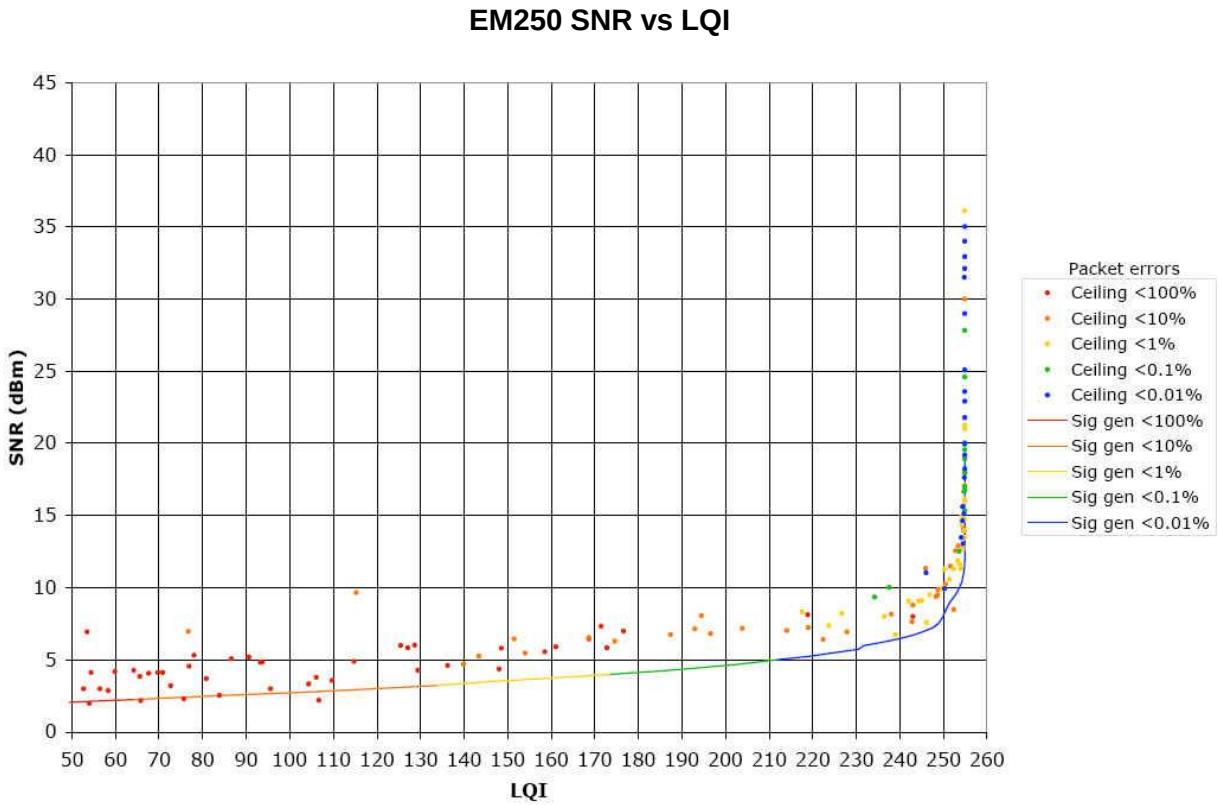

Figure 1: LQI vs. SNR (source: Ember)

From the LQI the stack calculates the cost for a particular link based on the following table. The cost is used by the stack to compare routes between nodes.

Cost	LQI
1	254 - 255
3	247 - 253
5	200 - 246
7	0 - 199

Table 12: LQI/Cost relationship

8.2 Interpreting RSSI Energy Levels

On the ETRX2 and ETRX3 series modules the readings from AT+ESCAN represent the hexadecimal readings from the RSSI register of the EM250 or EM35x, offset by +256 to make it a positive number; alternatively read it as a signed 8-bit integer. AT+ESCAN returns the background radio power so that the quietest channel can be selected for a new network; if you want to measure the RSSI of incoming messages you must set bit C of register S10 (see page 71).

The EM250 and EM35x SoCs calculate the RSSI over an 8-symbol period as well as at the end of a received packet. They utilize the RX gain settings and the output level of the ADC within its algorithm. The linear range of RSSI is specified to be 40dB over all temperatures. At room temperature, the linear range is approximately 60dB (-90 dBm to -30dBm).

9 Upgrading from R2xx to R308 on the ETRX2 Series

R308 firmware can be loaded on to an ETRX2 by bootloading through the serial port or by re-flashing with an Ember Insight Adaptor. Cloning over the air is tricky because the new R308 node and the old R2xx node will not join the same PAN. It is possible to clone by using an extra R2xx device, as shown in the step-by-step guide below.

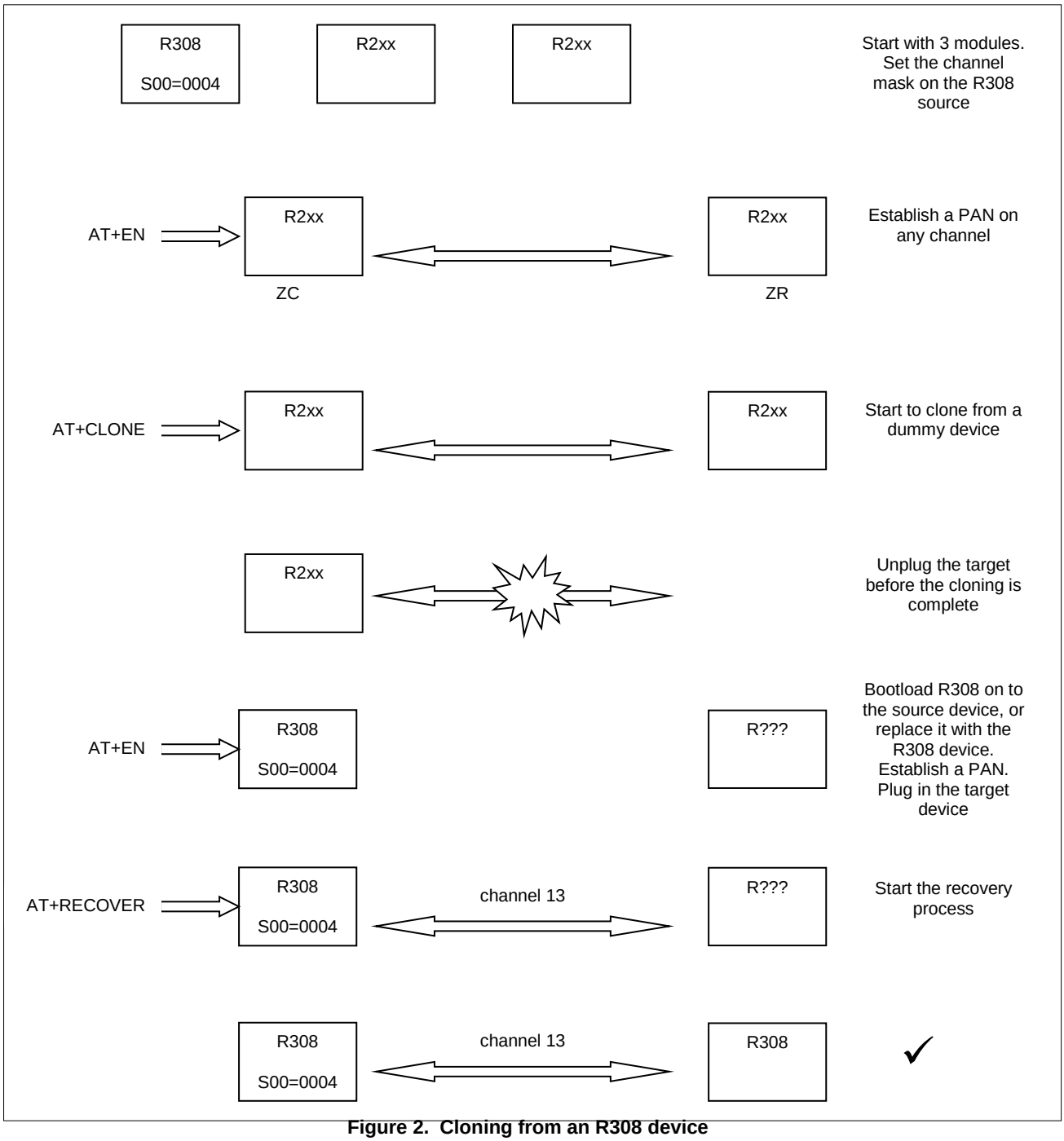

Figure 2. Cloning from an R308 device

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13 References

Telegesis – www.telegesis.com

Silicon Labs - www.silabs.com/products/wireless/zigbee/Pages/default.aspx

14 Appendix A. Forming a secure network

The default S-register settings lead to a network that is easy to set up and to which extra devices can easily be added, but it is not very secure. Not only can malicious devices intrude themselves, but there is also no safeguard against your devices joining a nearby network established by another user with similar Telegesis devices and register settings, and vice-versa. The use of a pre-defined Trust Centre Link Key can avoid all these problems. ZigBee PRO normally uses a Network Key common to all devices for general network traffic, and a Trust Centre Link Key common to all devices for key distribution. More specific applications such as Smart Energy systems can use a higher level of security such as a different link key for each point-to-point link.

The default register settings produce the following behaviour when a device establishes a PAN and another node joins:

1. ZC selects a random Link Key and Network Key
2. ZC sends Network Key to new node, unencrypted
3. ZC sends Link Key to new node, encrypted with Network Key

To create a secure network, use the following settings:

- Write your own Link Key into S09 on every device. If you do this off-line it can never be hacked
- Set bit 8 of register S0A on all devices that will join the PAN (Use Pre-Configured Trust Centre Link Key when joining)
- Set bits 4 and 2 of register S0A on the coordinator (Send Network key encrypted with the link key to nodes joining; Send Network key encrypted with the link key to nodes re-joining unsecured)
- (For simplicity, you can set bits 8, 4 and 2 of S0A on every device)

The joining procedure now becomes:

1. ZC selects a random Network Key
2. ZC sends the Network Key to new node, encrypted with Link Key

A sniffer can now no longer read the Network Key and use it to decrypt your messages, because the Link Key is never sent over the air.

You can choose a Network Key and write it into S08 in the coordinator, but there is not much point in doing this. The other devices ignore S08 as they receive the key from the coordinator, and if the key is ever updated over the air S08 no longer contains the current value. A pre-defined Network Key will be needed, however, if your device has to join a secure ZigBee 2006 network.

Bit A of S0A (When joining don't ask for Trust Centre link key) is intended for use when your ZigBee PRO device needs to join a ZigBee 2006 network, since ZigBee 2006 does not use Link Keys. In normal use bit A is not set.

15 Appendix B. Bootloading new firmware

15.1 Bootloading through the serial port

The process of bootloading an application file through the serial port or over the air is described more fully in the ETRX357 Development Kit Product Manual. For convenience the main points are described here also, as they relate to Telegesis Terminal. Other terminal applications can be used provided they support the XMODEM protocol.

In order to upgrade the firmware of the ETRX35x module using the serial bootloader, issue the "**AT+BLOAD**" command either by typing it in, or by pressing the respective button in the "**Module Control**" group of the Telegesis Terminal Application.

Alternatively the button labelled "Bload" can be pressed on the development board whilst the reset button is pressed and released. The same effect is achieved by holding pin PA5 low while resetting or turning on the device.

After entering the bootloader, the connection parameters need to be changed to 115200bps, 8 data bits, 1 stop bit, no parity, no flow control (providing that it is not already set to these values).

After pressing '**Enter**' (sometimes twice), the bootloader menu will be shown in the terminal window as shown in Figure 3.

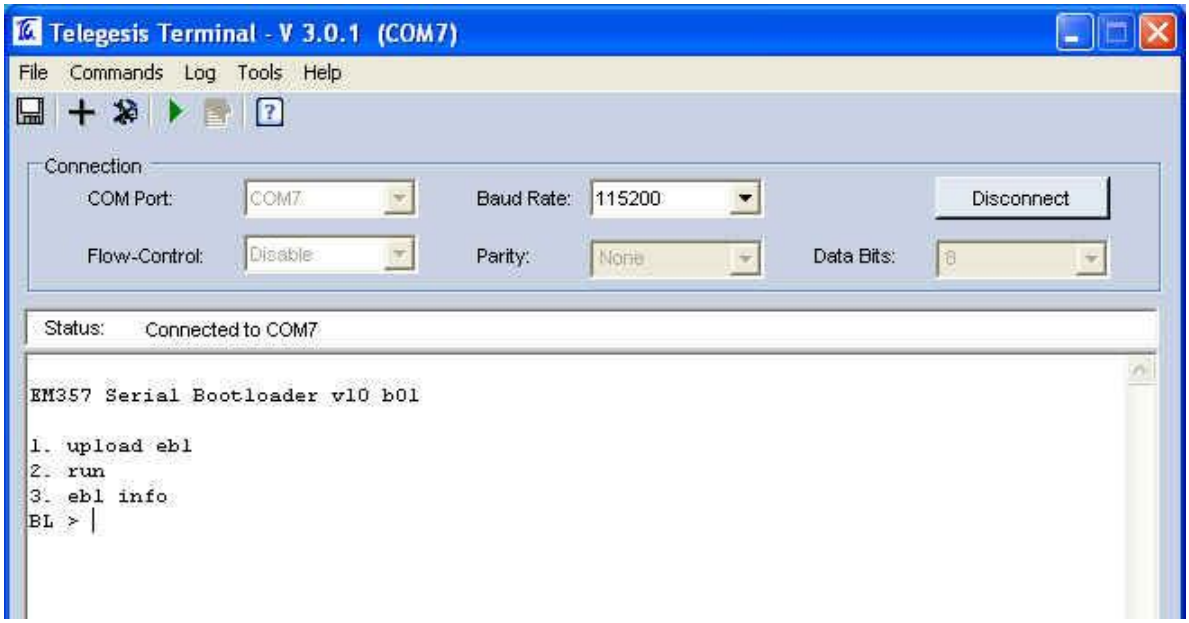

Figure 3. Bootloader Menu

Pressing '**1**' initiates the upload of the new firmware and a number of '**C**' characters will indicate that the ETRX35x is ready to receive data. Within 60 seconds, select **Tools** / **Transfer File**… and browse for the new firmware file.

Firmware files for the ETRX35x will be in the format ETRX35x_R3xxC.ebl. After checking that the protocol is set to XMODEM (128 Bytes), press the **Send** button and the new firmware will be downloaded as shown in Figure 4.

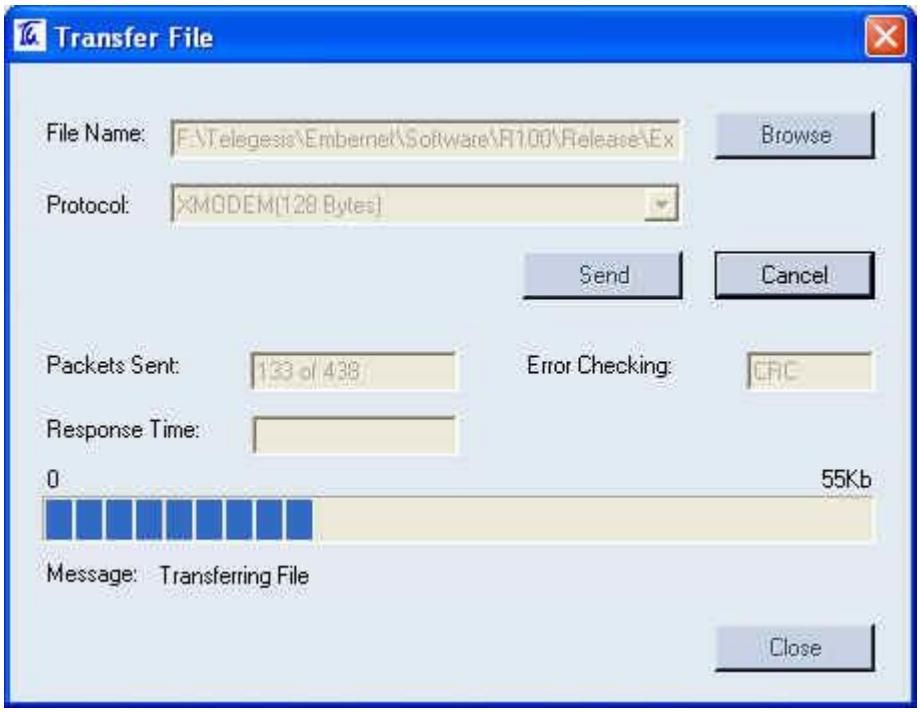

Figure 4. File Transfer Window

When the transfer has been completed successfully, press **Enter** again in order to return to the bootloader menu and type '**2**' to run the downloaded application software. If the application software has a baudrate other than 115200bps, this will need to be changed to the application baudrate as described above – 19200 baud in the case of R3xx firmware.

Selecting option 2 instead of option 1 just runs the existing firmware without any changes. It is therefore safe to start the bootloader at any time, to check its version for example.

15.2 Bootloading over the air

The AT+PASSTHROUGH command enables you to send a bootload file to a remote router, provided it is only one hop away. If the bootload process fails, the remote device will have no valid firmware so it will listen for a new file on channel 13. Move the local device to channel 13 with the AT+CCHANGE command or by starting a new network with the S00 channel mask set to 0004, then use the AT+RECOVER command.

It is possible to bootload to an end device that is a child of the local device by starting the bootloader on the end device then using the recover process. The bootloader can be started by power-cycling or resetting the module with pin PA5 held low. However, after resetting the module it is necessary to send a <cr> character to the serial port which implies that the latter is available for use, so it may be easier to just use the AT+BLOAD command.