

Telegesis		TG-ETRXn-R305-AT-Commands
ETRX2 and ETRX3 series		AT-Command Dictionary 3.05

ETRX2 and ETRX3 Series ZigBee® Modules AT-Command Dictionary



Current Firmware R305



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1 Introduction

This document describes the AT-Command interface firmware of the ETRX2 and ETRX3 series ZigBee PRO wireless meshing modules. It applies to the R305 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
- ETRX2CF
- ETRX2EAP and ETRX2RTR
- ETRX351, ETRX357, ETRX351-LR, ETRX357-LR, ETRX351-LRS, ETRX357-LRS
- ETRX351HR, ETRX357HR, ETRX351HR-LR, ETRX357HR-LR, ETRX351HR-LRS, ETRX357HR-LRS

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 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.

1.1 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.

1.2 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 (32 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.

1.3 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.

1.4 Important notes

1.4.1 Hardware compatibility

R305 firmware will now run on the STRX2 series of modules.

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

1.4.2 Unexpected start-up in bootloader mode

The bootloader on 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.

1.4.3 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 are not implementing 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.

1.4.4 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 no XX was not received
SR:XX,<EUI64>,<NodeID>,...	Route Record Message received
BCAST:[<EUI64>,<NodeID>]XX=<data>	A Broadcast with XX characters has been received
MCAST:[<EUI64>,<NodeID>]XX=<data>	A Multicast with XX characters has been received
UCAST:[<EUI64>,<NodeID>]XX=<data>	A Unicast with XX characters has been received
SDATA:[<EUI64>,<NodeID>,<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
FN0130:[<EUI64>,<NodeID>,<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
COO:<EUI64>,<NodeID>	A coordinator announcing itself
FFD:<EUI64>,<NodeID>	A router announcing itself
SED:<EUI64>,<NodeID>	A sleepy end device announcing itself
MED:<EUI64>,<NodeID>	A mobile sleepy end device announcing itself
ZED:<EUI64>,<NodeID>	An end device announcing itself
NEWNODE: <NodeID>,<EUI64>,<Parent NodeID>	Shown on Coordinator: New node has joined the PAN
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>,<NodeID>	Selected new Sink
ADSK:<EUI64>,<NodeID>	Received Sink Advertisement
SREAD:<NodeID>,<EUI64>,<Register>,<errorcode>[=<Data>]	Reply to a remote S Register Read operation
SWRITE:<NodeID>,<EUI64>,<errorcode>	Reply to a remote S Register Write operation

Prompt Overview	
DataMODE:<NodeID>,<EUI64>	Datamode has been opened remotely
DataMODE:<NodeID>,<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
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>[,<NodeID>,<EUI64>]	Response to an address request (also triggered when finding source routes)
RX:<EUI64>,<NodeID>,<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 R302X 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 32.

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 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 NodeID (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+FNDSTR	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+RDATA	Send Binary Raw Data

Table 5: Command Overview

2.5 Module Control & Configuration Commands

I – Display Product Identification Information

Execute Command ATI	Response Telegesis <DeviceName> R<Firmware Revision> <EUI64> OK
Note On modules manufactured before summer 2007 an invalid <DeviceName> is displayed. This does not affect the functionality of the module.	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 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)	
<p>Execute Command AT+CLONE:<EUI64>,<password></p> <p>Use on: Source: FFD, COO Destination: All device types</p> <p>Notes The default password for R3xx nodes is “password”. A description of the cloning process can be found in the Development Kit Product Manual.</p>	<p>Response Cloning...</p> <p>Remote Response ENTERING BLOAD</p> <p>or ERROR<errorcode></p> <p>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.</p>
SW release	R304 ●

+PASSTHROUGH – Pass new Firmware Image To Remote Node (ETRX3 Series Only)	
<p>Execute Command AT+PASSTHROUGH:<EUI64>,<password></p> <p>Use on: Source: FFD, COO Destination: FFD, COO</p> <p>Notes 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</p>	<p>Response PASSTHROUGH BLOAD... Please start .ebi upload image...</p> <p>Remote Response ENTERING BLOAD</p> <p>or ERROR<errorcode></p> <p>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.</p>
SW release	R304 ●

+RECOVER – Recover From A Failed Clone or Passthrough Attempt	
<p>Execute Command AT+RECOVER</p> <p>Use on: Source: FFD, COO Destination: All device types</p> <p>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.</p>	<p>Response Recovering...</p> <p>or</p> <p>ERROR<errorcode></p> <p>Where <errorcode> represents the error code explained in section 3. Enters clone (ETRX2 Series) or Passthrough (ETRX2 Series) mode to a remote node which is already in the bootloader.</p>
SW release	R300 ●

S – S-Register Access	
<p>Read Command ATSXX[x[x]]?</p> <p>Examples ATS00? ATS0AE? ATS1812?</p> <p>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]</p>	<p>Response <data> OK</p> <p>or ERROR:<errorcode></p> <p>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.</p>
<p>Write Command ATSXX[x[x]]=<data>[,<password>]</p> <p>Examples ATS00=3FFC ATS0AE=1:password</p> <p>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.</p>	<p>Response OK or ERROR:<errorcode></p> <p>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.</p>
SW release	R300 ●

REMS – Remote S-Register Access	
<p>Read Command ATREMS:<address>,XX[X[x]]?</p> <p>Examples ATREMS:000D6F00000AAC93,00? ATREMS:000D6F00000AAC93,0AE? ATREMS:000D6F00000AAC93,1812?</p> <p>Where <address> can be the remote node's EUI64, NodeID 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]</p> <p>The result when reading a single bit will always be 0 or 1.</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p>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.</p> <p>Prompt SREAD:<NodeID>,<EUI64>,<Register>,<errorcode>[=<Data>]</p> <p>Where NodeID is the remote NodeID, 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.</p>
<p>Write Command ATREMS:<address>,XX[x[x]]=<data>[,<password>]</p> <p>Examples ATREMS:000D6F0000012345,00=3FFC ATREMS:000D6F0000012345,0AE=1:password</p> <p>Where <address> can be the remote node's EUI64, NodeID 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]].</p> <p>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.</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p>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.</p> <p>Prompt SWRITE:<NodeID>,<EUI64>,<errorcode ></p> <p>Where <NodeID> is the remote NodeID, <EUI64> is the remote EUI64. Only in case the errorcode is 00 the write operation has been completed successfully.</p>
SW release	R302 ●

SALL – Remote S-Register Access	
<p>Write Command ATSALL:<group ID>,XX[x[x]]=<data> [<password>]</p> <p>Examples ATSALL:FFFF,00=3FFC ATSALL:FFFC,0AE=1:password</p> <p>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</p> <p>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.</p>	<p>Response OK or ERROR:<errorcode></p> <p>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.</p>
SW release	R300 ●

+TOKDUMP – Display All S-Registers	
<p>Execute Command AT+TOKDUMP</p> <p>Notes Only used on the local node. You cannot display all the registers of a remote device.</p>	<p>Response <data> OK</p> <p>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.</p>
SW release	R300 ●

2.6 Network Control & Configuration Commands

+ESCAN – Scan The Energy Of All Channels

Execute Command AT+ESCAN	Response +ESCAN: 11:XX 12:XX ... 26:XX OK
Use on: All nodes	or ERROR:<errorcode>
Notes Scanning all channels can take up to 16 seconds. The results are the background radio power in each channel, not the RSSI of incoming ZigBee packets	<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	Response +PANSCAN:<channel>,<PID>,<EPID>,XX,b OK
Use on: All nodes	or ERROR:<errorcode>
Note Scanning for active PANs can take up to 4 seconds.	<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	Response JPAN:<channel>,<PID>,<EPID> OK
Use on: All nodes which are not part of a PAN	or ERROR:<errorcode> <errorcode> represents the error code explained in section 3.
Note When issuing this command the local device becomes a Coordinator (and Trust Centre). Establishing a PAN can take up to 16 seconds. This command can only be executed if the local node is not part of a PAN already.	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	Response JPAN:<channel>,<PID>,<EPID> OK
Use on: All nodes which are not part of a PAN	or ERROR:<errorcode> <errorcode> represents the error code explained in section 3.
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.	The local node scans all channels selected in register S00 for the existence of a PAN. When finding any PAN which allows joining it will automatically join in via the remote node with the highest RSSI. 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>,<NodeID>,<parent EUI64>
SW release	R300 ●

+JPAN – Join Specific PAN	
<p>Execute Command AT+JPAN:<channel>,<PID or EPID></p> <p>Examples AT+JPAN:20,1234 AT+JPAN:24,0793E14FFB220A38</p> <p>Use on All nodes which are not part of a PAN</p> <p>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.</p>	<p>Response JPAN:<channel>,<PID>,<EPID> OK</p> <p>or ERROR:<errorcode></p> <p><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 remote node with the highest RSSI.</p>
<p>Remote Action On the Trust Centre / Coordinator</p>	<p>Prompt NEWNODE:<node EUI64>,<NodeID>,<parent EUI64></p>
<p>SW release</p>	<p>R300 ●</p>

+SJM – Silent Join	
<p>Execute Command AT+SJM:<channel>,<TC EUI64>,<NM NodeID>,<nwk update ID></p> <p>“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.</p> <p><channel> is a decimal number Other parameters are hexadecimal</p> <p>Use on All joining Devices</p> <p>Example AT+SJM:11,000D6F0000AAAD0,AFFE,00</p>	<p>Response JPAN:<channel>,<PID>,<EPID> OK</p> <p>or ERROR:<errorcode> ></p> <p><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 NodeID of the network manager specified in <NM NodeID>, 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. It is assumed that the key-sequence-number of the network key is 0 when issuing this command.</p>
<p>SW release</p>	<p>R305 ●</p>

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

+N – Display Network Information	
Read Command AT+N?	Response +N=<devicetype>,<channel>,<power>,<PID>,<EPID> or +N=NoPAN
Use on All Devices	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)																				
<p>Read Command AT+NTABLE:XX,<address></p> <p>Where XX is the start index of the remote LQI table and <address> can be the remote node's EUI64, NodeID or address table entry.</p> <p>Note: Also the local node can be the target of this command (e.g. use address table entry FF as the address)</p> <p>Use on FFD, COO as the target device</p>	<p>Response SEQ:XX OK or ERROR<errorcode></p> <p>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.</p>																					
	<p>Prompt (example) NTable:<NodeID>,<errorcode> Length: 03</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">No.</th> <th style="text-align: left;">Type</th> <th style="text-align: left;">EUI</th> <th style="text-align: left;">ID</th> <th style="text-align: left;">LQI</th> </tr> </thead> <tbody> <tr> <td>00.</td> <td>FFD</td> <td>000D6F000015896B</td> <td>BC04</td> <td>FF</td> </tr> <tr> <td>01.</td> <td>FFD</td> <td>000D6F00000B3E77</td> <td>739D</td> <td>FF</td> </tr> <tr> <td>02.</td> <td>FFD</td> <td>000D6F00000AAD11</td> <td>75E3</td> <td>FF</td> </tr> </tbody> </table> <p>In this example the neighbour table of the remote node with the short ID shown in <NodeID> 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.</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode.</p>		No.	Type	EUI	ID	LQI	00.	FFD	000D6F000015896B	BC04	FF	01.	FFD	000D6F00000B3E77	739D	FF	02.	FFD	000D6F00000AAD11	75E3	FF
No.	Type	EUI	ID	LQI																		
00.	FFD	000D6F000015896B	BC04	FF																		
01.	FFD	000D6F00000B3E77	739D	FF																		
02.	FFD	000D6F00000AAD11	75E3	FF																		
SW release	R302 ●																					

+RTABLE – Display Routing Table		(ZDO)																
<p>Read Command AT+RTABLE:XX,<address></p> <p>Where XX is the start index of the remote Routing table and <address> can be the remote node's EUI64, NodeID or address table entry.</p> <p>Note: Also the local node can be the target of this command (e.g. use address table entry FF as the address)</p> <p>Use on FFD, COO as the target device</p>	<p>Response SEQ:XX OK or ERROR<errorcode></p> <p>This command requests the target node to respond by listing its routing table starting from the requested index.</p>																	
	<p>Prompt (example) RTable:<NodeID>,<errorcode> Length:40</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">No.</th> <th style="text-align: left;">Dest</th> <th style="text-align: left;">Next</th> <th style="text-align: left;">Status</th> </tr> </thead> <tbody> <tr> <td>00.</td> <td>1234</td> <td>ABCD</td> <td>00</td> </tr> <tr> <td>01.</td> <td>4321</td> <td>739D</td> <td>00</td> </tr> <tr> <td>02.</td> <td>0000</td> <td>0000</td> <td>03</td> </tr> </tbody> </table> <p>In this example the routing table of the remote node with the short ID shown in <NodeID> 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.</p> <p>The status shown is as described in table 2.128 of the ZigBee Specification.</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode.</p>		No.	Dest	Next	Status	00.	1234	ABCD	00	01.	4321	739D	00	02.	0000	0000	03
No.	Dest	Next	Status															
00.	1234	ABCD	00															
01.	4321	739D	00															
02.	0000	0000	03															
SW release	R303 ●																	

+IDREQ – Request Node’s NodeID		(ZDO)
<p>Execute Command AT+IDREQ:<Address>[,XX]</p> <p>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 NodeID and optionally also elements of its associated devices list.</p> <p>Use on All Devices</p> <p>Note Providing FF as an address table entry addresses the local node</p> <p>SW release</p>	<p>Response OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt AddrResp:<errorcode>[,<NodeID>,<EUI64>] [nn. <NodeID>]</p> <p>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 <NodeID> is its NodeID. In case an extended response has been requested the requested NodeIDs from the associated devices list are listed as well.</p> <p>R302 ●</p>	

+EUIREQ – Request Node’s EUI64		(ZDO)
<p>Execute Command AT+EUIREQ:< Address>,<NodeID>[,XX]</p> <p>Where <Address> is the EUI64, NodeID or address table entry of the node which is to be interrogated about the node with the NodeID specified in <NodeID>. 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).</p> <p>Sends a unicast to obtain the specified device’s EUI64 and optionally also elements of its associated devices list (extended response).</p> <p>Use on All Devices</p> <p>Note Providing FF as an address table entry addresses the local node</p> <p>SW release</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt AddrResp:<errorcode>[,<NodeID>,<EUI64>] [dd. <NodeID>]</p> <p>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 <NodeID> is its NodeID. In case an extended response has been requested the requested NodeIDs from the associated devices list are listed.</p> <p>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.</p> <p>R302 ●</p>	

+NODEDESC – Request Node’s Descriptor		(ZDO)	
<p>Execute Command AT+NODEDESC:<Address>,<NodeID></p> <p>Where <Address> is the EUI64, NodeID or Address table entry of the node which is to be interrogated about the node with the NodeID specified in <NodeID>.</p> <p>Sends a unicast to obtain the specified device’s node descriptor.</p> <p>Use on All Devices</p> <p>Note Providing FF as an address table entry addresses the local node</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt (example)</p> <p>NodeDesc:<NodeID>,<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</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. <NodeID> is the Remote node’s NodeID. 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.</p> <p>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.</p>	<p>SW release</p>	<p>R302</p>

+POWERDESC – Request Node’s Power Descriptor		(ZDO)
<p>Execute Command AT+POWERDESC:<Address>,<NodeID></p> <p>Where <Address> is the EUI64, NodeID or Address table entry of the node which is to be interrogated about the node with the NodeID specified in <NodeID>.</p> <p>Sends a unicast to obtain the specified device’s power descriptor.</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt PowerDesc:<NodeID>,<errorcode> [,<PowerDescriptor>]</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <NodeID> is the Remote node’s NodeID. 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.</p> <p>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.</p>	<p>R302</p> <p style="text-align: right;">●</p>
+ACTEPDESC – Request Node’s Active Endpoint List		(ZDO)
<p>Execute Command AT+ACTEPDESC:<Address>,<NodeID></p> <p>Where <Address> is the EUI64, NodeID or Address table entry of the node which is to be interrogated about the node with the NodeID specified in <NodeID>.</p> <p>Sends a unicast to obtain the specified device’s active endpoint list.</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt ActEpDesc:<NodeID>,<errorcode>[,<XX>,...]</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <NodeID> is the Remote node’s NodeID. In addition all active endpoints are listed as 8-bit hexadecimal numbers separated by commas.</p> <p>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.</p>	<p>R302</p> <p style="text-align: right;">●</p>

+SIMPLEDESC – Request Endpoint’s Simple Descriptor		(ZDO)
<p>Execute Command AT+SIMPLEDESC:<Address>,<NodeID>,<XX></p> <p>Where <Address> is the EUI64, NodeID or Address table entry of the node which is to be interrogated about the node with the NodeID specified in <NodeID> and XX is the number of the endpoint, which simple descriptor is to be read.</p> <p>Sends a unicast to obtain the specified device’s active endpoint list.</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt SimpleDesc:<NodeID>,<errorcode> EP:XX ProfileID:XXXX DeviceID:XXXXvXX InCluster:<Cluster List> OutCluster:<Cluster List></p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode <NodeID> is the Remote node’s NodeID. In addition all active endpoints are listed as 8 bit hexadecimal numbers separated by commas.</p> <p>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.</p>	<p>R302 ●</p>

+MATCHREQ – Find Nodes which Match a Specific Descriptor (ZDO)	
<p>Execute Command AT+MATCHREQ: <ProfileID>, <NumInClusters> [,<InClusterList>], <NumOutClusters> [,OutClusterList]</p> <p>Where <ProfileID> Required profile ID of the device being searched for followed by a specification of required input and output clusters.</p> <p>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).</p> <p><NumInClusters> and <NumOutClusters> must be 2 hexadecimal digits</p> <p>Example at+matchreq:C091,01,0002,02,0004,000B</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt MatchDesc:<NodeID>,<errorcode>,XX,...</p> <p>In case of an error an errorcode other than 00 will be displayed and the prompt will end after the errorcode. Where <NodeID> is the Remote node's NodeID. In addition all endpoints of this node matching the search criterion are listed as 8 bit hexadecimal numbers separated by commas.</p> <p>R302 ●</p>
+ANNCE – Announce Local Device In The Network (ZDO)	
<p>Execute Command AT+ANNCE</p> <p>Send a ZigBee device announce Broadcast announcing the local node on the network.</p> <p>Use on All Devices</p> <p>Remote Action</p> <p>SW release</p>	<p>Response OK or ERROR<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Prompt FFD:<EUI64>,<NodeID> [,syy,zz] MED:<EUI64>,<NodeID> [,syy,zz] SED:<EUI64>,<NodeID> [,syy,zz] ZED:<EUI64>,<NodeID> [,syy,zz]</p> <p>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 <NodeID> the NodeID of the sending device</p> <p>R302 ●</p>

+SR – Set Source Route to Remote Device	
<p>Execute Command AT+SR:<NodeID>,<NodeID>,...</p> <p>Set the source route of a message sent to a remote device, starting with the NodeID of the remote device followed by all NodeIDs on the route from the remote node to the local node</p> <p>Use on All Devices</p> <p>Note: Setting up invalid routes may lead to listed devices becoming unavailable. To confirm a route use AT+FNDSR.</p> <p>SW release</p>	<p>Response OK</p> <p>or ERROR<errorcode></p> <p><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.</p> <p>R300 ●</p>

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

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

+REJOIN – Rejoin the network	
<p>Execute Command AT+REJOIN:b</p> <p>If b is set to 0 join without the known network key (unencrypted) and if b is set to 1 join encrypted.</p> <p>Use on SED, MED</p> <p>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.</p>	<p>Response OK</p> <p>or</p> <p>ERROR<errorcode></p> <p>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.</p> <p><errorcode> represents the error code explained in section 3.</p>
SW release	R300 ●

+SN – Scan Network	
<p>Execute Command AT+SN[:nn]</p> <p>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.</p> <p>Use on COO, SINK</p> <p>Notes</p> <ul style="list-style-type: none"> - 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 <p>SW release</p>	<p>Response OK or ERROR<errorcode></p> <p>Prompts FFD:<EUI64>,<NodeID> [,syy,zz] MED:<EUI64>,<NodeID> [,syy,zz] SED:<EUI64>,<NodeID> [,syy,zz] ZED:<EUI64>,<NodeID> [,syy,zz]</p> <p>Parameters nn ranging from 00 to 30</p> <p><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.</p> <p>R302 ●</p>

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

+BECOMETC – Make Local Device the Trust Centre	
<p>Execute Command AT+BECOMETC</p> <p>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)</p> <p>Use on Router that established the PAN in distributed TC Mode</p> <p>Note Can only be used if Network has been started as non-TC network (bit 9 of S0A set).</p> <p>SW release</p>	<p>Response OK</p> <p>or</p> <p>ERROR<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p>
	R302 ●

+BECOMENM – Make the local device Network Manager	
<p>Execute Command AT+BECOMENM</p> <p>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.</p> <p>Use on Router</p> <p>SW release</p>	<p>Response OK</p> <p>or</p> <p>ERROR<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p>
	R304 ●

+CCHANGE – Change the network’s channel	
<p>Execute Command AT+CCHANGE[:XX]</p> <p>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)</p> <p>Use on Network Manager</p> <p>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.</p> <p>SW release</p>	<p>Response OK</p> <p>or ERROR<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>Parameters Optional XX ranging from 0B to 1A</p> <p>R304 ●</p>

2.7 Messaging

+ATABLE – Display Address Table	
<p>Read Command AT+ATABLE</p> <p>Use on All Devices</p> <p>Notes Entry 05 contains the address of the node’s sink. The user can overwrite it to manually select a different sink.</p> <p>The address table is volatile and its contents are lost if the device is powered down.</p> <p>SW release</p>	<p>Response</p> <pre>No. Active ID EUI 00 N 0000 000D6F0000012345 (...)</pre> <p>OK</p> <p>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.</p> <p>R300 ●</p>

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

+MTABLE – Display Multicast Table																			
<p>Read Command AT+MTABLE</p> <p>Use on All Devices</p> <p><u>Note:</u> For Multicasts to be displayed using the MCAST prompt, endpoint 01 must be selected as the target endpoint.</p> <p>The multicast table is cleared by a reset</p> <p>SW release</p>	<p>Response</p> <table border="1"> <thead> <tr> <th>No.</th> <th>ID</th> <th>EP</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>1234</td> <td>01</td> </tr> <tr> <td>01</td> <td>0000</td> <td>00</td> </tr> <tr> <td>02</td> <td>0000</td> <td>00</td> </tr> <tr> <td>03</td> <td>0000</td> <td>00</td> </tr> <tr> <td>04</td> <td>0000</td> <td>00</td> </tr> </tbody> </table> <p>OK</p> <p>The multicast table contains all multicast IDs which will be received by the local node.</p> <p>R300 ●</p>	No.	ID	EP	00	1234	01	01	0000	00	02	0000	00	03	0000	00	04	0000	00
No.	ID	EP																	
00	1234	01																	
01	0000	00																	
02	0000	00																	
03	0000	00																	
04	0000	00																	

+MSET – Set Multicast Table Entry	
<p>Read Command AT+MSET:XX,<ID>,<endpoint></p> <p>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.</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response</p> <p>OK</p> <p>or ERROR:<errorcode></p> <p><errorcode> represents the error code explained in section 3.</p> <p>R300 ●</p>

+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	
<p>Execute Command AT+BCASTB:XX,nn</p> <p>Where nn is the number of hops the message will travel and XX is the number (in hexadecimal) of data bytes to be sent.</p> <p>Use on All Devices</p> <p>Note This command is particularly useful if the data may contain <CR> and <Backspace> characters.</p>	<p>Response > <data being entered> OK</p> <p>or ERROR:<errorcode></p> <p>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.)</p> <p>Parameters XX ranging from 00 to 52 (hexadecimal) nn ranging from 00 to 30 (decimal)</p> <p>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).</p>
Remote action	<p>Prompt BCAST:<EUI64>,<length>=<data></p> <p>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).</p>
SW release	R300 ●

+UCAST – Transmit A Unicast	
<p>Execute Command AT+UCAST:<address>=<data></p> <p>Example AT+UCAST:000D6F0000012345=Hello</p> <p>Where <address> can be the remote node's EUI64, NodeID or address table index</p> <p>Use on All Devices</p> <p>Notes Unicasts can be addressed either by referencing the recipient's EUI64, NodeID 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.</p> <p>Up to 10 unicasts may be in flight at one time</p>	<p>Response SEQ:XX OK</p> <p>or</p> <p>ERROR:<errorcode></p> <p>Where <errorcode> represents the error code explained in section 4.</p> <p>Prompt ACK:XX</p> <p>or NACK:XX</p> <p>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.</p>
Remote action	<p>Prompt</p> <p>UCAST:[<EUI64>,<length>=<data></p> <p>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).</p>
SW release	R300 ●

+UCASTB – Transmit A Unicast Of Binary Data	
<p>Execute Command AT+UCASTB:XX,<address></p> <p>Where <address> can be the remote node's EUI64, NodeID or address table index and XX is the number (in hexadecimal) of data bytes to be sent.</p> <p>Use on All Devices</p> <p>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, NodeID 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.</p> <p>Up to 10 unicasts may be in flight at one time</p>	<p>Response > <data being entered> SEQ:XX OK</p> <p>or ERROR:<errorcode></p> <p>Prompt ACK:XX</p> <p>or NACK:XX</p> <p>Parameters XX ranging from 00 to 52 (hex)</p> <p>After the ' >' prompt a number of XX characters are expected to be entered. Up to 82 bytes are sent to the node with address <EUI64>. In case 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.</p>
Remote action	<p>Prompt</p> <p>UCAST:[<EUI64>,<length>=<data></p> <p>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).</p>
SW release	R300 ●

+SCAST – Transmit Data To The Sink	
<p>Execute Command AT+SCAST:<data></p> <p>Example AT+SCAST:Hello world</p> <p>Use on All Devices</p> <p>Notes</p> <ul style="list-style-type: none"> - 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. 	<p>Response SEQ:XX OK</p> <p>or ERROR<errorcode></p> <p>Where <errorcode> represents the error code explained in section 3.</p> <p>Prompt ACK:XX</p> <p>or NACK:XX</p> <p>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.</p>
Remote action	<p>Prompt UCAST:[<EUI64>,<length>=<data></p> <p>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).</p>
SW release	R300 ●

+SCASTB – Transmit Binary Data To A Sink	
<p>Execute Command AT+SCASTB:XX</p> <p>Where XX is the number (in hexadecimal) of data bytes to be sent.</p> <p>Use on All Devices</p> <p>Notes</p> <ul style="list-style-type: none"> - 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. 	<p>Response</p> <p>> <data being entered> SEQ:XX OK</p> <p>or ERROR<errorcode></p> <p>Parameters</p> <p>XX ranging from 00 to 52 (hex)</p> <p>After the '>' prompt a number of XX characters are expected to be entered. A maximum of 82 bytes are sent to the network's sink. (In case 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.</p>
Remote action	<p>Prompt</p> <p>UCAST:[<EUI64>],XX=<data></p> <p>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).</p>
SW release	R300 ●

+SSINK – Search For A Sink	
<p>Read Command AT+SSINK</p> <p>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.</p> <p>Use on All Devices</p> <p>SW release</p>	<p>Response OK or ERROR<errorcode></p> <p>Prompt SINK:<EUI64>,<NodeID> or ADSK:<EUI64>,<NodeID></p> <p><errorcode> represents the error code explained in section 3.</p> <p>R300 ●</p>

+MCAST – Transmit A Multicast	
<p>Execute Command AT+MCAST:nn,<ID>,<data></p> <p>Use on: All devices</p> <p>Notes</p> <ul style="list-style-type: none"> - 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. <p>Remote action</p> <p>SW release</p>	<p>Response OK or ERROR<errorcode></p> <p>Where <errorcode> represents the error code explained in section 3.</p> <p>Parameters nn ranging from 00 to 30</p> <p>Up to 82 bytes are sent to the multicast group <ID>. 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).</p> <p>Prompt MCAST:[<EUI64>,<Length>]=<data></p> <p>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).</p> <p>R300 ●</p>

+MCASTB – Transmit A Multicast Of Binary Data	
Execute Command AT+MCASTB:XX,nn,<ID>	Response > <data being entered> OK or ERROR<errorcode>
Where XX is the number (in hexadecimal) of data bytes to be sent and nn is the number of hops the message will travel.	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.
Use on All Devices	Parameters XX ranging from 00 to 52 (hex) nn ranging from 00 to 30
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.	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)	
<p>Execute Command AT+DMODE:<address></p> <p>Where <address> can be the remote node's EUI64, NodeID or address table index</p> <p>Use on All Devices</p> <p>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</p>	<p>Response SEQ:XX OK</p> <p>or ERROR<errorcode></p> <p>Prompt ACK:XX</p> <p>or NACK:XX</p> <p><errorcode> represents the error code explained in section 3 and XX is the sequence number of the unicast.</p>
<p>Remote Prompt DataMODE:<NodeID>,<EUI64></p> <p>OPEN</p> <p>Where <NodeID> is the NodeID of the remote node and <EUI64> is its EUI64.</p>	<p>Prompt DataMODE:<NodeID>,<EUI64>,<errorcode></p> <p>[OPEN]</p> <p>Where <NodeID> is the NodeID of the remote node and <EUI64> is its EUI64. Only if the errorcode equals 0 the data mode will open</p>
SW release	R302 •

+++ – Leave Data Mode	
<p>Execute Command +++</p> <p>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.</p> <p>Use on All Devices</p>	<p>Response CLOSED</p>
SW release	R302 •

+IDENT – Play A Tune On Remote Devboard	
<p>Execute Command AT+IDENT:<address></p> <p>Where <address> can be the remote node's EUI64, NodeID or address table index</p> <p>Use on All Devices</p>	<p>Response SEQ:XX OK</p> <p>or ERROR<errorcode></p> <p>Prompt ACK:XX</p> <p>or NACK:XX</p> <p><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.</p>
SW release	R300 ●

+RDATAB – Send Binary Raw Data	
<p>Execute Command AT+RDATAB:XX</p> <p>Use on All Devices</p> <p>Notes Can be useful to quickly exchange bulk data with neighbouring node. The application needs to handle addressing, error checking, retries and acknowledgements.</p> <p>AT+RDATAB generates broadcasts so any node may only originate up to 8 broadcasts in every 8 second interval. Broadcasts use a lot of bandwidth.</p> <p>End Devices do not receive raw data. Raw data will only travel one hop.</p> <p>Use with great care. Raw data messages are not ZigBee-compliant and may even leak into other PANs.</p>	<p>Response > <data being entered> OK</p> <p>or ERROR:<errorcode></p> <p>Parameters XX ranging from 00 to 67 (hex)</p> <p>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.</p> <p><errorcode> represents the error code explained in section 3.</p>
Remote action	<p>Prompt RAW:snn,<data></p> <p>where snn is the RSSI, or</p> <p><data></p> <p>in case bit 9 of S0E is set. Displaying the data can also be disabled by setting bit D of S0E.</p>
SW release	R300 ●

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
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

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 NodeID	(●/-)	(●/-)
S06	Parent's EUI	(●/-)	(●/-)
S07	Parent's NodeID	(●/-)	(●/-)
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

<p>Description The 802.15.4 channel mask.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective When Joining, Scanning or establishing a PAN</p> <p>Note The channel mask does not affect the AT+JPAN command</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Range 0001 - FFFF</p> <p>Factory Default ETRX3 LRS-Variants: 7FFF Others: FFFF</p> <p>R302 ●</p>
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S01 – Transmit Power Level

<p>Description The device's transmit power level in dBm.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Notes The output power of the "-PA" and "-LR" 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.</p> <p>Becomes effective When Joining or establishing a PAN</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters snn</p> <p>Where snn represents a signed 8-bit decimal number.</p> <p>Range ETRX2: 4 to -43 ETRX3: 8 to -43 ETRX3 LRS Variants: -7 to -43</p> <p>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.</p> <p>Factory Default ETRX3 LRS-Variants: -11 Others: 3</p> <p>R305 ●</p>
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S02 – Preferred PAN ID	
<p>Description The 802.15.4 PAN ID.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective When Joining or establishing a PAN</p> <p>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</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <PID></p> <p>Where <PID> represents a 16-bit hexadecimal number</p> <p>Range 0000 – FFFF</p> <p>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.</p> <p>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.</p> <p>Factory Default 0000</p> <p>R300 ●</p>

S03 – Preferred Extended PAN ID	
<p>Description The extended PAN ID.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective When Joining or establishing a PAN</p> <p>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</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <EPID></p> <p>Where <EPID> represents a 64-bit hexadecimal number</p> <p>Range 0000000000000000 – FFFFFFFFFFFFFFFF</p> <p>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.</p> <p>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.</p> <p>Factory Default 0000000000000000</p> <p>R300 ●</p>

S04 – Local EUI64

<p>Description The local node’s unique EUI64 identifier.</p> <p>Operations R LOCAL R REMOTE</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <EUI64></p> <p>Range 0000000000000000 – FFFFFFFF</p> <p>Factory Default <unique number></p> <p>R300</p>
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S05 – Local 16-Bit NodeID

<p>Description The local node’s 16-bit NodeID.</p> <p>Note Reading this register while not associated with a network will result in an undefined return value.</p> <p>Operations R LOCAL R REMOTE</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <NodeID></p> <p>Range 0000-FFFF</p> <p>Factory Default n/a</p> <p>R300</p>
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S06 – Parent’s EUI64

<p>Description The parent node’s unique EUI64 identifier.</p> <p>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</p> <p>Operations R LOCAL R REMOTE</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <EUI64></p> <p>Range 0000000000000000 – FFFFFFFF</p> <p>Factory Default n/a</p> <p>R300</p>
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S07 – Parent’s 16-Bit NodeID

<p>Description The parent node’s 16-bit NodeID.</p> <p>Operations R LOCAL R REMOTE</p> <p>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</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters <NodeID></p> <p>Range 0000-FFFF</p> <p>Factory Default n/a</p> <p>R300</p>
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S08 – Network Key

<p>Description The network key which can be written using the password. The default password for R3xx is “password”.</p> <p>Operations W LOCAL W REMOTE</p> <p>Write operation ATS08=<key>:<password> ATREMS:<address>,08=<key>:<password></p> <p>Becomes effective Only when establishing a PAN</p> <p>Storage Non Volatile</p> <p>SW release</p>	<p>Range From 0 to 2¹²⁸-1</p> <p>The 128-bit AES network key in hexadecimal representation (32 characters).</p> <p>When set to all 0’s (default) a random network key is generated when establishing a PAN.</p> <p>This key is transmitted to all joining nodes and can be encrypted using the link key.</p> <p>Factory Default 00000000000000000000000000000000</p> <p>R300</p>
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S09 – Trust Centre Link Key	
Description The link key which can be written using the password. The default password for R3xx is “password”.	Range From 0 to 2¹²⁸-1
Operations W LOCAL W REMOTE	The 128-bit trust centre link key in hexadecimal representation (32 characters).
Write operation ATS09=<key>:<password> ATREMS:<address>,09=<key>:<password>	When set to all 0s (default) a random trust centre link key is generated when establishing a PAN.
Becomes effective When Joining or establishing a PAN	
Storage Non Volatile	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-E)
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: Reserved
Bit C: Reserved
Bit B: Set: Enable custom endpoint 2
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

<p>Description Password protected user defined name which can be used to identify the node</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Write operation ATS0B=<name>:<password> ATREMS:<address>,0B=<name>:<password></p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters CCCCCCCCCCCCCCCC</p> <p>Name with up to 16 characters.</p> <p>Factory Default Telegesis</p> <p>R302</p>
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S0C – Password

<p>Description The local node's password.</p> <p>Operations W LOCAL W REMOTE</p> <p>Write operation ATS0C=<NEW>:<OLD> ATREMS:<address>,0C=<NEW>:<OLD></p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters CCCCCCC</p> <p>8 case sensitive characters (8 bytes). Note that the password must have exactly 8 characters.</p> <p>Factory Default password</p> <p>R300</p>
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S0D – Device Information	
Description String containing the module's order code and firmware revision.	Parameters CCC...CCC
Operations R LOCAL R REMOTE	Text string Examples ETRX2 R305X ETRX357 R305C
Storage Non-Volatile	Factory Default N/A
SW release	R300 ●

S0E – Prompt Enable 1	
Description Defines the behaviour of the Device.	Parameters XXXX
Operations R/W LOCAL R/W REMOTE	Where XXXX represents a 16-bit hexadecimal number.
Becomes effective Instantly	Range 0000 to FFFF
Storage Non-Volatile	Bit F: Set: Disable '>' prompt when entering binary data Bit E: Set: Disable UCAST, MCAST, BCAST 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 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
SW release	Factory Default 0000 R300 ●

S0F – Prompt Enable 2	
<p>Description Defines the behaviour of the Device.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Notes Use of bit 8 requires bit 1 to be unset Use of Endpoint 2 requires bit B of S0A to be set</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>Where XXXX represents a 16-bit hexadecimal number.</p> <p>Range 0000 to 01FF</p> <p>Bit 9 – Bit F: 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: <u>Set:</u> Hide all Sink Advertisements Unset: Show all Sink Advertisements, except advertisements by the current sink Bit 1: <u>Set:</u> Disable showing unhandled messages received by Endpoints 0, 2, 3 etc Bit 0: Set: Disable COO, FFD, SED and MED prompts</p> <p>Factory Default 0006</p>
SW release	R301 ●

S10 – Extended Function	
<p>Description Defines the behaviour of the Device.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>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</p> <p>Only set bit 8 if transmissions to the sink are infrequent!</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>Where XXXX represents a 16-bit hexadecimal number.</p> <p>Range 0000 to FFFF</p> <p>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.</p> <p>Factory Default 0000</p>
SW release	R302 ●

S11 – Device Specific	
<p>Description Defines the behaviour of the Device.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>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</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>Where XXXX represents a 16-bit hexadecimal number.</p> <p>Bit F (MSB): Set: I/O3 (ETRX2) or PB7 (ETRX3) is PWM as defined by S1B/S1D. <u>Unset:</u> Standard I/O pin.</p> <p>Bit E: Set: Enable Boost Mode</p> <p>Bit D: Set: Present 1.2V A/D-Reference at I/O0 during measurement (ETRX2 only)</p> <p>Bit C: Set: I/O8 turns into A/D3, which can be read from S21 (ETRX2 only)</p> <p>Bit B: Set: Pad 38 turns into A/D4, which can be read from S22 (ETRX2 only)</p> <p>Bit A: Reserved</p> <p>Bit 9: Set: Enable wakeup on UART activity (1st input character is discarded)</p> <p>Bit 8: Set: Enable 100ms debouncing for all IRQs</p> <p>Bit 7: Set: IRQ3 on rising edge</p> <p>Bit 6: Set: IRQ3 on falling edge</p> <p>Bit 5: Set: IRQ2 on rising edge</p> <p>Bit 4: Set: IRQ2 on falling edge</p> <p>Bit 3: Set: IRQ1 on rising edge</p> <p>Bit 2: <u>Set:</u> IRQ1 on falling edge</p> <p>Bit 1: Set: IRQ0 on rising edge</p> <p>Bit 0: <u>Set:</u> IRQ0 on falling edge</p> <p>Factory Default 0005</p>
SW release	R301 ●

4.4 I/O related S-Registers

S12 – UART Setup																											
<p>Description The device's RS232 Baudrate and mode. The default setting of 0500 results in: 19200bps, no parity, 1 stop bit, 8 data bits.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>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.</p> <p>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 ETRX2 is full data will be dropped.</p> <p>The parity settings do not affect the bytes transmitted over the air.</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>Where XXXX represents a 16-bit hexadecimal number.</p> <p>Range of the most significant byte 00 to 0C</p> <table border="0"> <tr><td>00:</td><td>1200 baud</td></tr> <tr><td>01:</td><td>2400 baud</td></tr> <tr><td>02:</td><td>4800 baud</td></tr> <tr><td>03:</td><td>9600 baud</td></tr> <tr><td>04:</td><td>14400 baud</td></tr> <tr><td><u>05:</u></td><td>19200 baud</td></tr> <tr><td>06:</td><td>28800 baud</td></tr> <tr><td>07:</td><td>38400 baud</td></tr> <tr><td>08:</td><td>50000 baud</td></tr> <tr><td>09:</td><td>57600 baud</td></tr> <tr><td>0A:</td><td>76800 baud</td></tr> <tr><td>0B:</td><td>100000 baud</td></tr> <tr><td>0C:</td><td>115200 baud</td></tr> </table> <p>Range of the least significant byte 00 to FF</p> <ul style="list-style-type: none"> 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 <p>Factory Default 0500</p>	00:	1200 baud	01:	2400 baud	02:	4800 baud	03:	9600 baud	04:	14400 baud	<u>05:</u>	19200 baud	06:	28800 baud	07:	38400 baud	08:	50000 baud	09:	57600 baud	0A:	76800 baud	0B:	100000 baud	0C:	115200 baud
00:	1200 baud																										
01:	2400 baud																										
02:	4800 baud																										
03:	9600 baud																										
04:	14400 baud																										
<u>05:</u>	19200 baud																										
06:	28800 baud																										
07:	38400 baud																										
08:	50000 baud																										
09:	57600 baud																										
0A:	76800 baud																										
0B:	100000 baud																										
0C:	115200 baud																										
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

SW release

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

R300

S14 – ETRX2: Pull-down enable ETRX3: Reserved

<p>Description Enables the built-in pull-downs for each individual I/O pin of the ETRX2.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Reset</p> <p>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.</p> <p>On the ETRX3 series this register is Reserved and currently not in use</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>Where XXXX represents a 16-bit hexadecimal number.</p> <p>Range 0000 to FFFF</p> <p>representing I/O pins xx<TXD><RXD> BA98 7654 3210</p> <p>e.g. setting bit 7 to 1 will enable the pull-down for I/O pin 7</p> <p>Factory Default 0000</p>
	R300 ●

S15 – ETRX3: I/O Configuration ETRX2: Reserved

<p>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.</p> <p>representing the I/O pins xxxxxxxx <PC7...PC0><PB7...PB0><PA7...PA0></p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Reset</p> <p>Note PB0 is used internally on the ETRX357-LRS and ETRX357HR-LRS and is not available to the user.</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXXXXXX</p> <p>Where XXXXXXXX represents a 32-bit hexadecimal number.</p> <p>bit 31 reserved bit 30 reserved bit 29 reserved bit 28 reserved bit 27 reserved bit 26 reserved bit 25 reserved bit 24 reserved</p> <p>bit 23 reserved (PC7) bit 22 reserved (PC6) bit 21 Set: Enable TX_Active (reserved on -LR) bit 20 reserved (PC4) bit 19 reserved (PC3) bit 18 reserved (PC2) bit 17 Set: Enable ADC3 (PC1) bit 16 reserved (PC0)</p> <p>bit 15 Set: Enable ADC2 (PB7) bit 14 Set: Enable ADC1 (PB6) bit 13 Set: Enable ADC0 (PB5) bit 12 Set: reserved bit 11 Set: reserved bit 10 Set: Enable RXD input (PB2) bit 9 Set: Enable TXD output (PB1) bit 8 Set: Enable Vref Output (PB0) during ADC conversions</p> <p>bit 7 reserved (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)</p> <p>Factory Default 00000600</p>
SW release	R300 ●

S16 – Data Direction of I/O Port	
<p>Description The data direction of the module's I/O port</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Note: On the “-LR” variants of the ETRX3 PC5 is reserved and cannot be controlled using this register.</p> <p>Storage Volatile</p>	<p>Parameters XXXX (ETRX2) or XXXXXXXX (ETRX3)</p> <p>Where XXXX represents a 16-bit hexadecimal number and XXXXXXXX represents a 32-bit hexadecimal number.</p> <p>ETRX2: representing I/O pins xxxx BA98 7654 3210</p> <p>e.g. setting bit 7 to 1 will configure I/O7 to be an output.</p> <p>ETRX3: representing the I/O pins xxxxxxxx <PC7...PC0> <PB7...PB0> <PA7...PA0></p> <p>e.g. setting bit 7 to 1 will configure PA7 to be an output</p> <p>Factory Default Defined in S17</p>
SW release	R300 ●

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

S18 – Output Buffer Of I/O Port	
<p>Description The output buffer of the module's I/O port</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Note: On the "-LR" variants of the ETRX3 PC5 is reserved and cannot be controlled using this register.</p> <p>Storage Volatile</p>	<p>Parameters XXXX (ETRX2) or XXXXXXXX (ETRX3)</p> <p>Where XXXX represents a 16-bit hexadecimal number and XXXXXXXX represents a 32-bit hexadecimal number.</p> <p>ETRX2: representing I/O pins xxxx BA98 7654 3210</p> <p>e.g. setting bit 7 to 1 will cause I/O7 to drive high (if defined as an output in S16)</p> <p>ETRX3: representing the I/O pins xxxxxxxx <PC7...PC0> <PB7...PB0> <PA7...PA0></p> <p>e.g. setting bit 7 to 1 will cause PA7 to drive high (depending on settings in S16 and S15)</p> <p>Factory Default Defined in S19</p>
SW release	R300 ●

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

S1A – Input Buffer of I/O Port	
<p>Description The Logical Levels at the I/O Pins</p> <p>Operations R LOCAL R REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Instant Reading of Port Status</p>	<p>Range 0000 to FFFF (ETRX2) 00000000 to FFFFFFFF (ETRX3)</p> <p>ETRX2: representing I/O pins xxxx BA98 7654 3210</p> <p>ETRX3: representing the I/O pins xxxxxxxx <PC7...PC0> <PB7...PB0> <PA7...PA0></p> <p>S1A represents the logic level at each pin of the I/O port.</p> <p>Factory Default n/a</p>
SW release	R300 ●

S1B – PWM Pin Top Value	
<p>Description The mode of operation for the special function pin</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Operations Instantly</p> <p>Storage Volatile</p> <p>Examples</p>	<p>Parameters XXXX</p> <p>Range 0000 to FFFF</p> <p>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 is set, given that the PWM is enabled in S11.</p> <p>Factory Default Defined in S1C</p>
SW release	R300 ●

S1C – Initial value of S1B	
Description The initial setting of S1B stored in non volatile memory	Parameters XXXX
Operations R/W LOCAL R/W REMOTE	Where XXXX represents the initial value of S1B which is loaded after boot-up, soft or hard reset.
Becomes effective After Soft or Hard Reset	
Storage Non-Volatile	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	Parameters XXXX
Operations R/W LOCAL R/W REMOTE	Range 0000 to FFFF
Becomes effective Instantly	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 is cleared.
Storage Volatile	Factory Default Defined in S1E
SW release	R300 ●

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

S1F – A/D1 Reading (ETRX3 series ADC0)	
<p>Description The analogue reading of A/D1 (ETRX3 series ADC0)</p> <p>ETRX3: Only when bit 13 (0x0D) of S15 is set, invalid otherwise</p> <p>Operations R LOCAL R REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Instant Reading of analogue input</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Range ETRX2: 0000 – 04B0 (0 – 1200) ETRX3: 0000 – 2EE0 (0 – 12000)</p> <p>R300 ●</p>

S20 – A/D2 Reading (ETRX3 series ADC1)	
<p>Description The analogue reading of A/D2 (ETRX3 series ADC1)</p> <p>ETRX3: Only when bit 14 (0x0E) of S15 is set, invalid otherwise</p> <p>Operations R LOCAL R REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Instant Reading of analogue input</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Range ETRX2: 0000 – 04B0 (0 – 1200) ETRX3: 0000 – 2EE0 (0 – 12000)</p> <p>R300 ●</p>

S21 – A/D3 Reading (ETRX3 series ADC2)

<p>Description The analogue reading of A/D3 (ETRX3 series ADC2)</p> <p>ETRX2: Only when bit C of S11 is set, invalid otherwise ETRX3: Only when bit 15 (0x0F) of S15 is set, invalid otherwise</p> <p>Operations R LOCAL R REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Instant Reading of analogue input</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Range ETRX2: 0000 – 04B0 (0 – 1200) ETRX3: 0000 – 2EE0 (0 – 12000)</p>
	R300 ●

S22 – A/D4 Reading (ETRX3 series ADC3)

<p>Description The analogue reading of A/D4 (ETRX3 series ADC3)</p> <p>ETRX2: Only when bit B of S11 is set, invalid otherwise ETRX3: Only when bit 17 (0x11) of S15 is set, invalid otherwise</p> <p>Operations R LOCAL R REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Instant Reading of analogue input</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Range ETRX2: 0000 – 04B0 (0 – 1200) ETRX3: 0000 – 2EE0 (0 – 12000)</p>
	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.

Another event is triggering when the unit is reset or power cycled and also joining a network triggers an event.

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.

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

S24 – Immediate Functionality At IRQ1 (ETRX2: I/O1 ETRX3:PA1)

<p>Description Describes the immediate action taken on IRQ1.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities.</p> <p>Factory Default 0000 (none)</p> <p>R300 ●</p>
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S25 – Immediate Functionality At IRQ2 (ETRX2: I/O10 ETRX3:PB0)

<p>Description Describes the immediate action taken on IRQ2.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Note PB0 is used internally on the ETRX357(HR)-LRS and is not available to the user</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities.</p> <p>Factory Default 0000 (none)</p> <p>R300 ●</p>
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S26 – Immediate Functionality At IRQ3 (ETRX2: I/O11 ETRX3:PB6)	
<p>Description Describes the immediate action taken on IRQ3.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities.</p> <p>Factory Default 0000 (none)</p>
SW release	R300 ●

S27 – Functionality at Bootup

<p>Description Describes the immediate action taken after boot-up (and stack initialization).</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>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</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of available functionalities.</p> <p>Factory Default 0000 (none)</p>
SW release	R305 ●

S28 – Functionality at Network Join

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

S29 –Timer/Counter 0

<p>Description A multipurpose Timer/Counter whose functionality is defined by S2A</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 0004 (1s interval)</p>
SW release	R300 ●

S2A – Functionality For Timer/Counter 0

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

S2B –Timer/Counter 1

<p>Description A multipurpose Timer/Counter whose functionality is defined by S2C</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 00F0 (1 min interval)</p>
SW release	R300 ●

S2C – Functionality For Timer/Counter 1

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

S2D –Timer/Counter 2

<p>Description A multipurpose Timer/Counter whose functionality is defined by S2E</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 00F4 (1 min 1s interval)</p>
<p>SW release</p>	<p>R300 ●</p>

S2E – Functionality For Timer/Counter 2

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

S2F –Timer/Counter 3

<p>Description A multipurpose Timer/Counter whose functionality is defined by S30</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 00F2 (1min interval)</p> <p>R300 ●</p>
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S30 – Functionality For Timer/Counter 3

<p>Description Defines the functionality for Timer/Counter 3 events.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities.</p> <p>Factory Default 8015 (if not part of a network do AT+JN)</p> <p>R300 ●</p>
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S31 –Timer/Counter 4

<p>Description A multipurpose Timer/Counter whose functionality is defined by S32</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 0000</p>
<p>SW release</p>	<p>R302 ●</p>

S32 – Functionality For Timer/Counter 4

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

S33 –Timer/Counter 5

<p>Description A multipurpose Timer/Counter whose functionality is defined by S34</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 0000</p> <p>R300 ●</p>
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S34 – Functionality For Timer/Counter 5

<p>Description Defines the functionality for Timer/Counter 5 events.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If set to 0 the functionality is disabled. Please see section 5 for a list of the functionalities.</p> <p>Factory Default 0000</p> <p>R300 ●</p>
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S35 –Timer/Counter 6

<p>Description A multipurpose Timer/Counter whose functionality is defined by S36</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 0000</p>
SW release	R300 ●

S36 – Functionality For Timer/Counter 6

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

S37 –Timer/Counter 7

<p>Description A multipurpose Timer/Counter whose functionality is defined by S38</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters XXXX</p> <p>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.</p> <p>Factory Default 0000</p>
SW release	R300 ●

S38 – Functionality For Timer/Counter 7

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

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

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

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

S3C – Start-up Functionality Plaintext B

<p>Description Contains Text which is used by some of the actions described in section 5.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters Up to 50 characters</p> <p>Factory Default BUTTON4</p>
SW release	R300 ●

S3D – Supply Voltage

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

4.6 Advanced Settings

S3E – Multicast Table Entry 00

<p>Description The ID portion of Multicast Table Entry 00</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Note Same effect as AT+MSET, but can be set at boot-up by built-in functionality</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If S3E is not set to all 0's multicast table entry 1 to endpoint 1 (the AT command layer's endpoint) is set with the setting of this register is created instantly and after a reset.</p> <p>Factory Default 0000</p> <p>R300 ●</p>
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S3F – Multicast Table Entry 01

<p>Description The ID portion of Multicast Table Entry 01</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Note As for S3E</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>If S3F is not set to all 0's multicast table entry 2 to endpoint 1 (the AT command layer's endpoint) is set with the setting of this register is created instantly and after a reset.</p> <p>Factory Default 0000</p> <p>R300 ●</p>
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S40 – Source and Destination Endpoints for xCASTs (volatile)

<p>Description The source and destination endpoints for all messages.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Volatile</p> <p>SW release</p>	<p>Parameters ssdd</p> <p>Where ss is the hexadecimal source endpoint and dd is the hexadecimal destination endpoint.</p> <p>Factory Default Defined in S41</p> <p>R300 ●</p>
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S41 – Initial Setting of S40

<p>Description The initial setting of S40 stored in non volatile memory</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Soft or Hard Reset</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters ssdd</p> <p>Where ss is the hexadecimal source endpoint and dd is the hexadecimal destination endpoint.</p> <p>Factory Default 0101</p> <p>R300 ●</p>
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S42 – Cluster ID for xCASTs (volatile)	
<p>Description The Cluster ID any xCAST message is sent to.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Volatile</p>	<p>Parameters XXXX</p> <p>The cluster ID of any xCAST message</p> <p>Factory Default Defined in S43</p>
SW release	R300 ●

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

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

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

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

S47 – Power Descriptor

<p>Description Register defining the Node’s power descriptor, which can be read by remote nodes using ZigBee compliant ZDO messaging.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>The Power Descriptor as described in section 2.3.2.4 of the ZigBee specification.</p> <p>Factory Default C110</p> <p>R302 ●</p>
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S48 – Endpoint 2 Profile ID

<p>Description Register defining the Profile ID of the Node’s endpoint 2.</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>The 16 bit Profile ID.</p> <p>Factory Default C091</p> <p>R302 ●</p>
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S49 – Endpoint 2 Device ID

<p>Description Register defining the Device ID of the Node’s endpoint 2</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>The 16 bit device ID.</p> <p>Factory Default 0000</p> <p>R302 ●</p>
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S4A – Endpoint 2 Device Version	
<p>Description Register defining the version of the device attached to the Node's endpoint 2</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters 00XX</p> <p>The 8 bit version trailed by two leading 0's..</p> <p>Factory Default 0000</p>
SW release	R302 ●

S4B – Endpoint 2 Input Cluster List	
<p>Description Register defining the input cluster list of the device attached to the Node's endpoint 2</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p>	<p>Parameters [XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX]</p> <p>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</p> <p>Example ATS4B=1101,000D</p> <p>Factory Default 0000</p>
SW release	R302 ●

S4C – Endpoint 2 Output Cluster List	
<p>Description Register defining the output cluster list of the device attached to the Node's endpoint 2</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective Instantly</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters [XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX,XXXX]</p> <p>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</p> <p>Factory Default 0000</p> <p>R302 ●</p>

S4D – Mobile End Device Poll Timeout	
<p>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".</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Soft or Hard Reset</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters 00XX</p> <p>8-bit number led by "00", which represents the timeout in quarter seconds. The default of 0x0014 results in a timeout of 5s.</p> <p>Factory Default 0014</p> <p>R302 ●</p>

S4E – End Device Poll Timeout

<p>Description Register defining the amount of time after which a Sleepy End Device times out of its parent's child table if it hasn't polled</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Soft or Hard Reset</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXYY</p> <p>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.</p> <p>Maximum 0EFF</p> <p>Factory Default 0605</p> <p>R303 ●</p>
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S4F – MAC Timeout

<p>Description Register defining the MAC timeout</p> <p>Operations R/W LOCAL R/W REMOTE</p> <p>Becomes effective After Soft or Hard Reset</p> <p>Storage Non-Volatile</p> <p>SW release</p>	<p>Parameters XXXX</p> <p>The Ember_Indirect_Transmission_Timeout is the amount of time in milliseconds that the MAC will hold a message for indirect transmission to a child. In addition to this is also basis for the timeout after which an acknowledged unicast is nacked in case no ack is received.</p> <p>Factory Default 0BB8</p> <p>R302 ●</p>
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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 triggered by 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).

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. Note: No functionality on COOs.
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)
003x	Toggle I/Ox
004x	Flash I/Ox (pull low) for 250ms
005x	Set I/Ox to 0
006x	Set I/Ox 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 I/O, 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.

Overview of Actions	
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.
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
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. $N \leq 64$.
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). 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.

EM250 SNR vs LQI

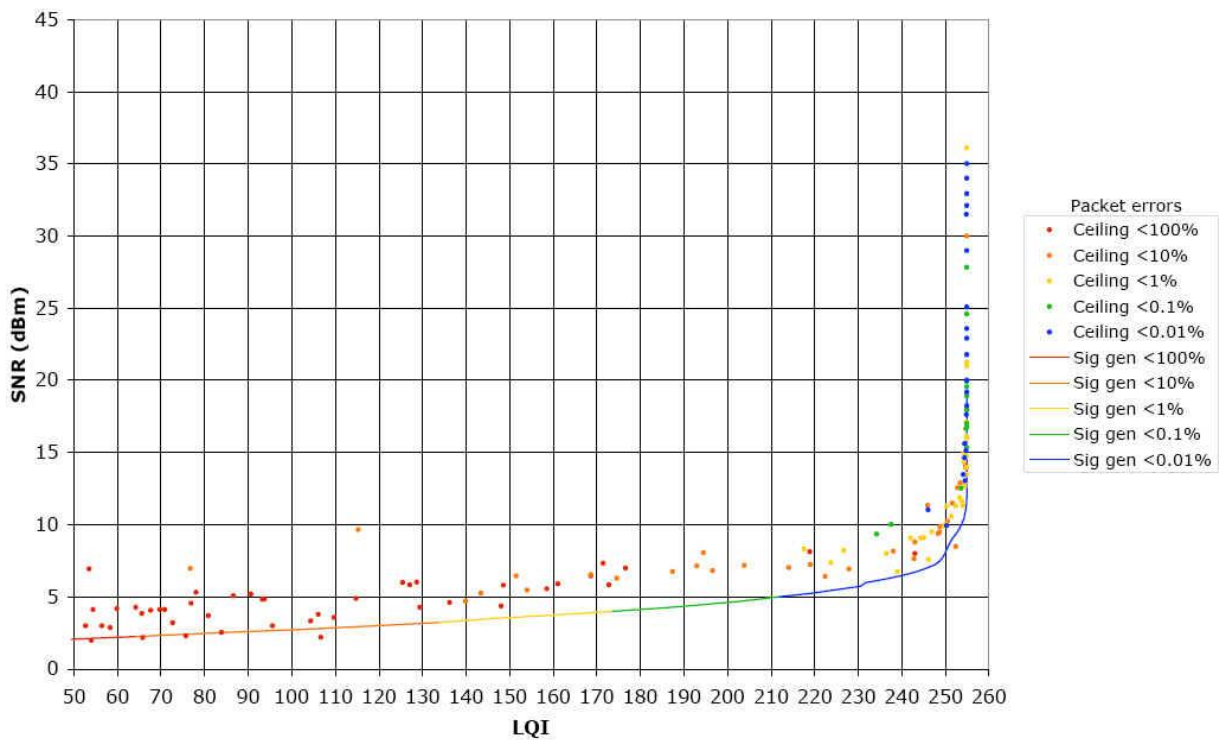


Figure 1: LQI vs. SNR (source: Ember)

From the LQI the stack calculates the cost for a particular link based on the following table:

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 +127 to make it a positive number. 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 60).

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 R305 on the ETRX2 Series

R305 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 R305 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.

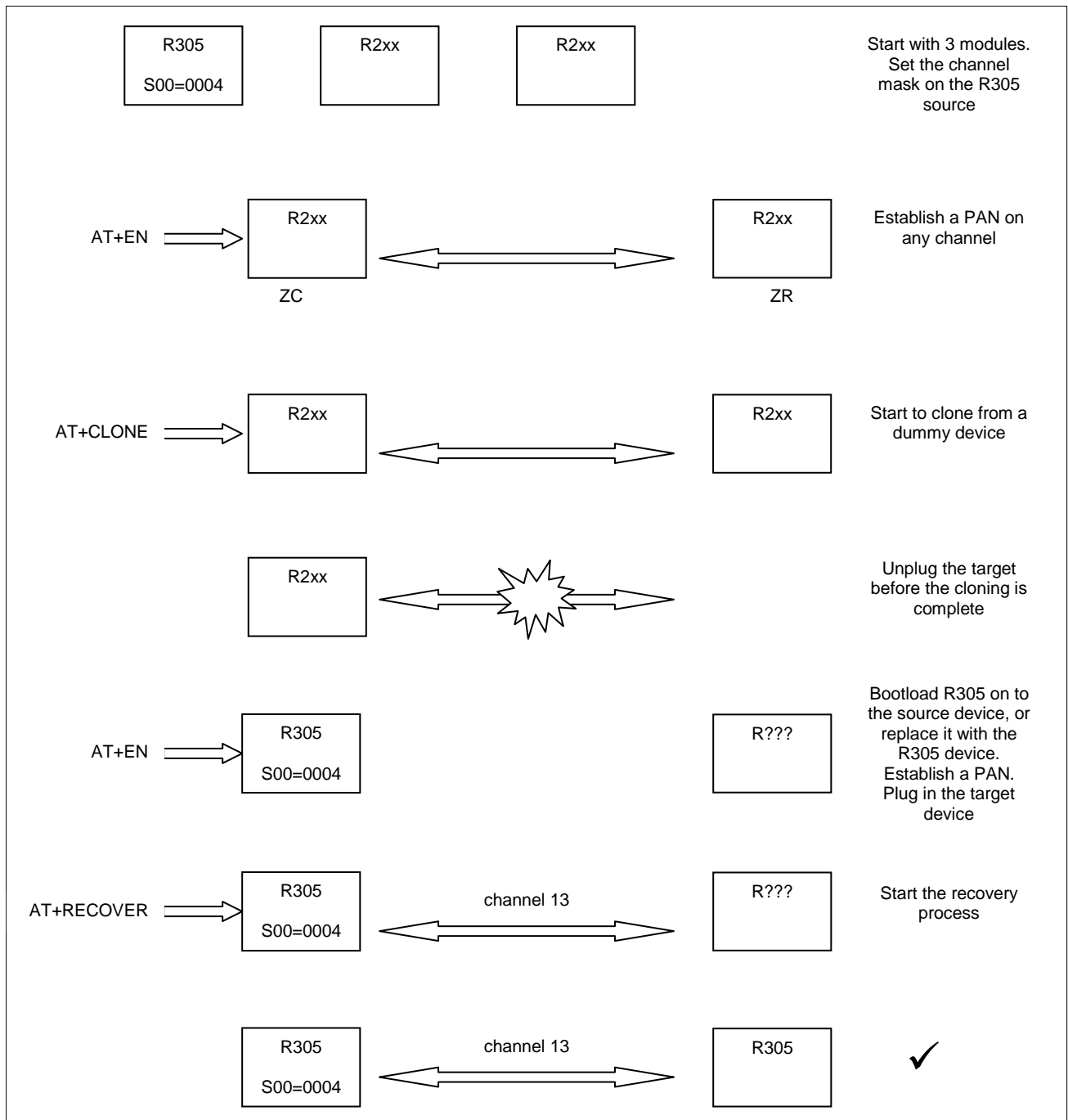


Figure 2. Cloning from an R305 device

10 Trademarks

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13 References

Telegesis – www.telegesis.com

Ember – www.ember.com

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.