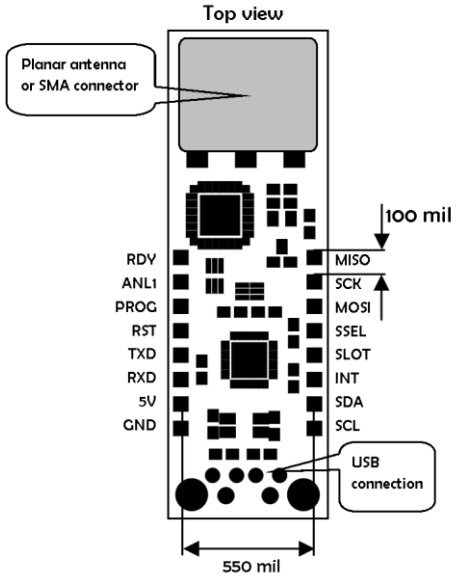
APPLICATION NOTE 1

PROGRAMMING THE NTM

Programming the Ninthway Transceiver Module (NTM)



Command set

Serial Protocol
Programming codes
n= number
CR = carriage return
LF = line feed
B= bit number 0 – 7
X = 0 or 1
_ = mandatory space

SENT_destination address_string *CRLF* (no sensor address is sent)
SENF_string *CRLF* (sensor address is sent, no destination address)
RMOT_destination address_command_command_...command *CRLF*
CRGP_grnr_destination_data*CRLF*
TSTW *CRLF* Test watchdog, activates a wait loop that will trigger the watchdog reset

HSCD=n *CRLF*	or HSCD *CRLF* program/ask house code
SNSR=n *CRLF*	or SNSR?*CRLF* program/ask sensor number
GTNR=n *CRLF*	or GTNR*?CRLF* program/ask gateway number
MTMR=n *CRLF*	or MTMR?*CRLF* program/ask status timing in 10 s steps
ASNR=n *CRLF*	or ASNR?*CRLF* program/ask alarm element address
FUNC=n *CRLF*	or FUNC?*CRLF* program/ask transceiver function
	0: basic; 1: alarm; 2: Repeater; 3: Gateway etc.
POWR=n *CRLF*	or POWR?*CRLF* program/ask transmission power index
VERS? *CRLF*	ask version

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	FLG1 B=X *CRLF* or FLG1?*CRLF* see I²C register 0 FLG2 B=X *CRLF* or FLG2?*CR*LF see I²C register 14 VOLT? *CRLF* ask supply voltage level in dV I2CD=n *CRLF* or I2CD?*CRLF* Program/ask I2C extender address I2CW=*n* *CRLF* or I2CW?*CRLF* Program/ask I2C extender register width BTLM=n *CRLF* or BTLM?*CRLF* program/ask low bat limit in dV STTL=N *CRLF* or STTL?CRLF set or ask maximum number of repetitions. MEAS=n *CRLF* n =1 starts n= 0 stops reporting RSSI level every 2.5 s TEST=n *CRLF* n =1 start test; n = 0 stop continuous broadcasting test

I2C registers

Register range	Description
0 - 15	NTM-command registers
16 - 31	API-command registers including result registers
128 - 230	Transmission frame registers

NTM basic parameters

Register	description	default
0	Flags1 (FLG1)	0x00
0:0	Wake flag	0 (awake)
0:1	I2C or UART	0 (UART)
0:2	Synchronised operation	0 (no sync)
0:3	Use sensor or destination address	0 (sensor address)
0:4	Beacon	0 (no beacon)
0:5	Receive/Transmit mode	0 (transmit)
0:6	Remote	0 (local)
0:7	Restart transceiver	0 (1 = restart, will default to 0 after restart)
1	Network ID high byte	255
2	Network ID low byte	255
3	Device id upper byte	16
4	Device id lower byte	255
5	Alarm group	0

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6	Gateway number	255
7	Destination address upper byte	255
8	Destination address lower byte	0
9	Supply voltage low level	40 dV
10	Transmission power	3 dBm
11	Status report period	5 min
12	Extension I2C address	0
13	I2C address width 0 = 8 bit, 1 = 16 bit	0
14	Flags2 (FLG2)	0x01
14:0	Reserved for future use	0
14:1	Transfer Acknowledgement	0 (no)
14:2	PAN coordinator	1 (yes)
14:3	DIG1 control 1 = input, 0 = output	1 (input)
14:4	DIG2 control 1= input, 0 = output	1 (input)
14.5	Gateway	0
14.6	Transceiver handles Data/Audio	1 (Data)
14.7	Repeater	0 (no)
15	API service number	0 (basic mode)

NTM API parameters

Register	Description	Remarks
16	API par1	255
17	API par2	255
18	API par3	255
19	API par4	255
20	API par5	255
21	API par6	255
22	API par7	255
23	API par1	255
24	API par9	255
25	API par10	255

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26	API par11	255
27	API par12	255
28	API par13	255
29	API par14	255
30	API par15	255
31	API par16	255

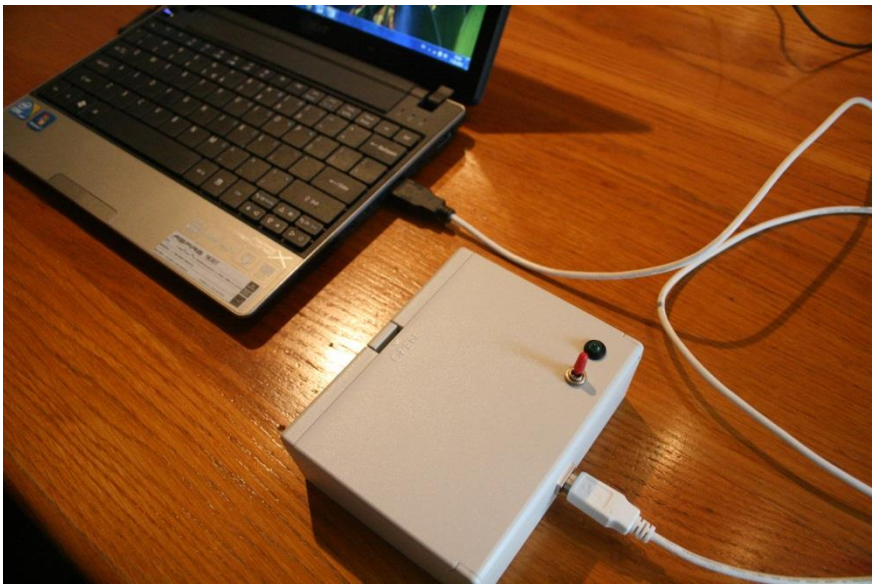
Description of the programmers

The function mode of the NTM is determined by a set of parameters.

The mode is either set via the IIC register by the application controller or via a UART connection. Most of the time this is done after production of the application.

However, in the field every transceiver is expected to have a sensor and an actor address as well as a network id as specified in the datasheet of the NTM.

For setting these parameters the NTMComm program is available to download from www.ninthway.eu site or a program like HyperTerminal can be used.



Ninthway NTM programming station for wireless programming of NTMs in application connected to a PC via USB.

These parameters can either be set via a wired link to the NTM or wireless link, using a second NTM wired to the programming device, like a gateway, Ninthway programmer or a self-prepared device like i.e. an adapted Keil MCB900 test board.

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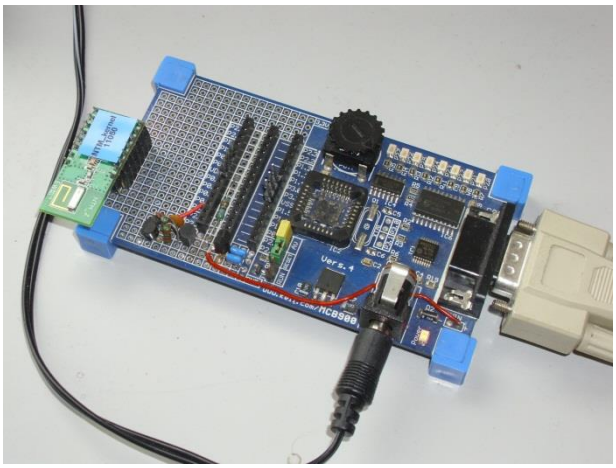


Or one of the sockets on a gateway with serial conversion module

Programming parameters into the NTM

Be sure the INT/PROG pin on the NTM is grounded.

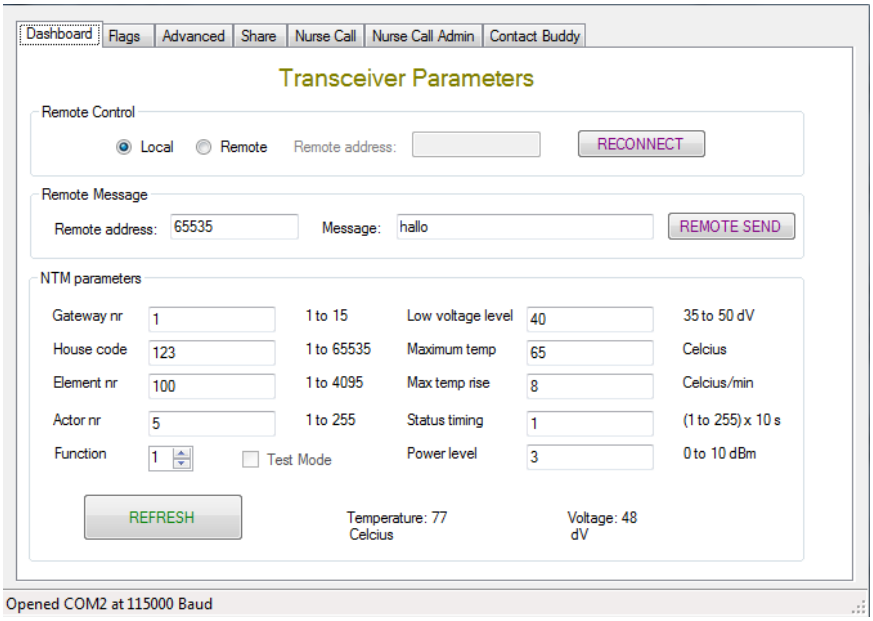
At start-up NTMComm searches for the right com port. Pressing the REFRESH button will load the existing parameter values from the connected NTM.

A message to a receiver can be send by filling in the remote address and message fields and press SEND.

Fill in the parameters and confirm with enter or tab.

The filled in data is immediately transferred to the NTM.

Parameters can be obtained from NTM by pressing REFRESH.



NTMComm parameter window

Select flags window

Awake keeps the NTM active at cost of battery life

Select output channel for received data. Either UART or I^2C.

If I^2C is chosen, the I^2C destination address should be filled in and width of the I^2C register addressing.

The address is specified as an 8 bit byte using the 7 upper bits. The LSB is use as R/W flag. So *I^2C addresses are always even.*

Gateway is chosen if the NTM is a repeater function with gateway facility.

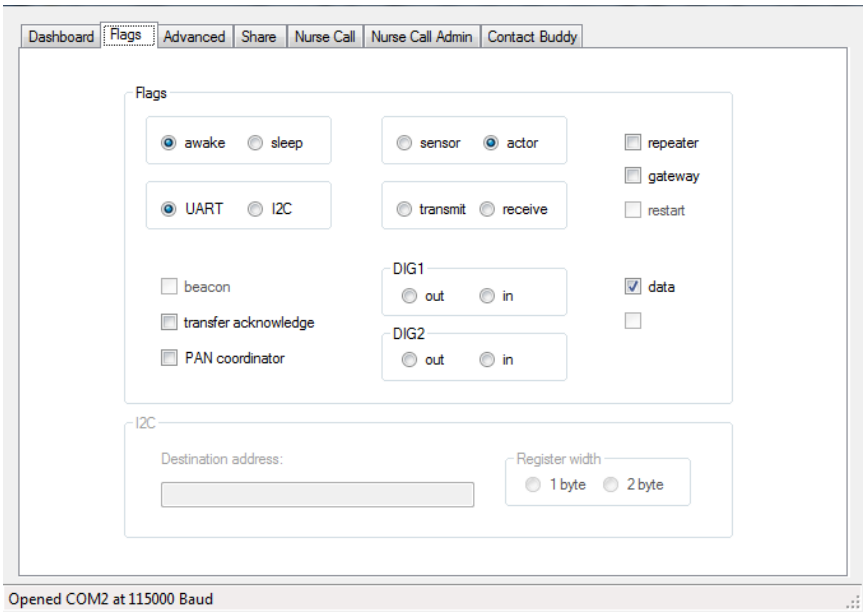
Is the device used in a sensor of actor application?

Actor application requires a synchronized operation with a beacon transmitter like a repeater station.

Address match should be chosen.

Choose PAN coordinator if the device is used as a repeater or receiver in a control unit.

Programming complete!



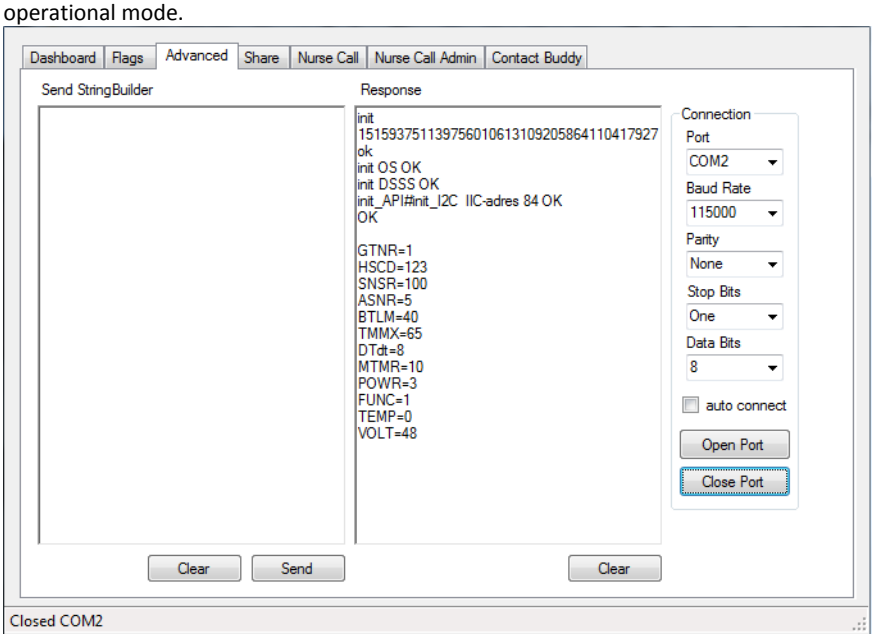
NTMComm flags window

At start up flags are already set in accordance with the requirement for the chosen operational mode.

Remote programming of a device

Selecting the remote radio button lets happen everything exactly the same but on a wirelessly connected NTM indicated by the Remote address window.

It is not necessary to have the program jumper placed on the remote device.

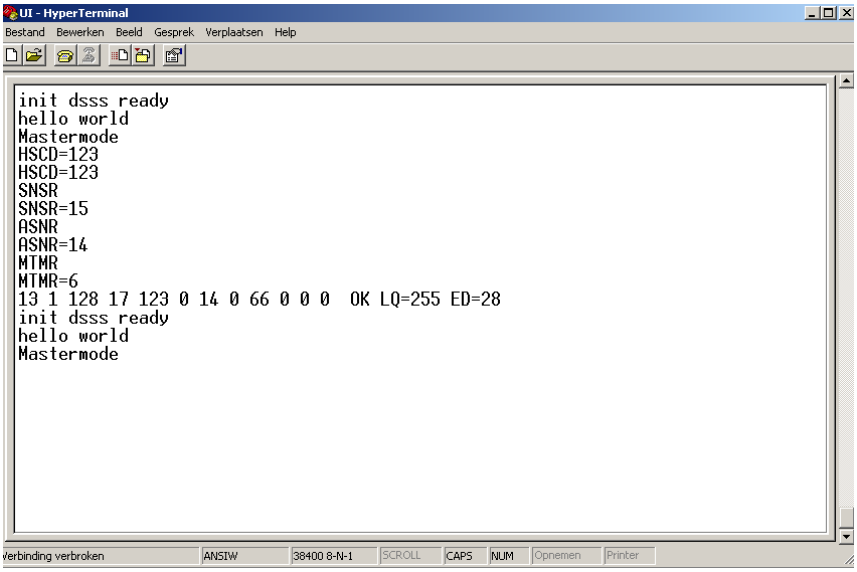


NTMComm Advanced window

Advanced control is available at the Advanced tab.

The com port can be chosen, as protocol parameters. NTM

After establishing contact by choosing the right com port and baud rate, commands (in

communication will only work with default values. The auto connect can be switched off to control the serial link with the NTM by hand by using Open and Close buttons. The StringBuilder window can be used to prepare command strings as specified in this application note and send them to the NTM by tapping the Send button. **Using a program like HyperTerminal**	CAPITALS!) can be given. Wrong command strings are ignored. Commands can be typed on separate lines or consecutively on one line. HSCD(enter) MTMR(enter) Or HSCD?MTMR?SNSR=456 ASNR=456 VERS?(enter) *Notice the space behind a number character string.* 
Start-up strings	After power up, the NTM sends strings to the UART like: *init 151647277 1397560106 1310922864 4110417926 ok* primary initiation of device with its unique device number *Clock calibrated* *init OS OK :* operating system started *init DSSS OK :* transceiver successfully initiated *init_SAPI OK:* mode 0 initiation routine executed *C1 :* first status message broadcasted with CSMA protocol *DN :* program pin grounded (program mode) *C2 :* second status message If the device starts up in another mode, the init SAPI is replaced by a similar string indicating the used mode. This might include status reports on the initiation of I2C or VORN/SPI peripherals. Every time a frame is transmitted, this is reported via de UART bus by its frame number preceded by an indicator for the used protocol. L for LTB, C for CSMA.

Single pin I/O	**Using SCL and SDA for I^2C.** Flags1:1 or register 0:1 should be set to 1. "FLG1=1 1". SCL and SDA should be tied to V+ in accordance with I^2C specifications. Registers 12 and 13 must contain the I^2C address and register width. The address is specified as an 8 bit byte using the 7 upper bits. The LSB is use as R/W flag. So *I^2C addresses are always even.* **Using SCL and SDA as DIG1 and DIG2.** FLG1:1 or register 0:1 should be set to 0. "FLG1=1 0". Set input/output function of both pins via UART command "FLG2=3 X" and "FLG2=4 X". X= 1 pin is input, X= 0 pin is output. Pins used as output are in open collector mode (max sink current 20 mA per pin). To be able to activate the output(s) the NTM needs to be either in Awake mode (FLG1=0 1) or Sleep with Sync mode ("FLG1=0 0" & "FLG1=3 1"). Synchronisation needs to be set up in combination with a beacon transmitter (repeater station). **Using ANL as analogue input**. Voltage input signal 0 – 3 V. (Internal programmable gain amplifier can be configured on request).
	Remote programming the NTM
Remote programming	Remote programming is a basic functionality of the NTM and can be performed in any NTM mode. Remote programming is either done via a Ninthway programming station ()in mode 0 state, a gateway (in mode 3 state) or an NTM application hardwired to a PC. There are two ways to set parameters in a remote NTM: • Use remote option on the dashboard of NTMComm • Use the RMOT command  Place the active NTM application near the programmer

Remote programming via dashboard

Remote via the NTMComm dashboard

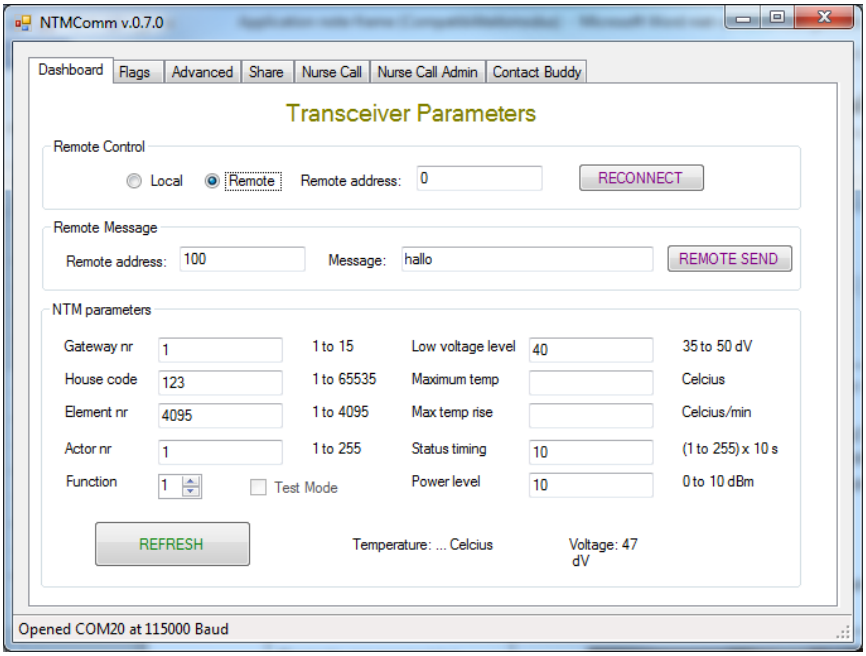
By pushing the radiobutton 'Remote' and filling in the proper device address of the remote NTM, all data on the dashboard will be exchanged with the remote NTM.

This is only true when the remote NTM has the same:

- Gateway number (default 1)
- House code (default 65535)

To program a new NTM remotely, the local NTM needs to be programmed with the default gateway and house code.

After changing either parameters, the local parameters need to be adapted to the same value one by one before sending a new command to the remote NTM.



Example of remote programming

The dashboard allows setting of the most common parameters. Other parameters and application dependent parameters can we controlled with the RMOT and CGRP command.

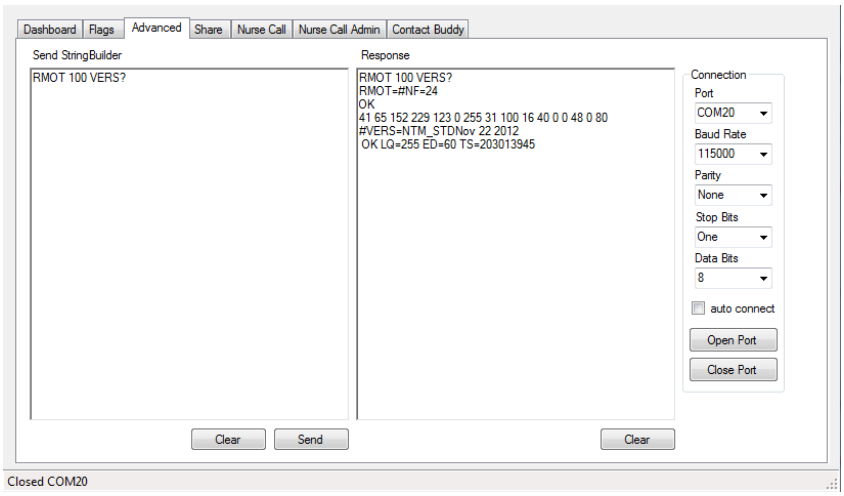
Syntax:

RMOT_Element-nr_ Command_ Command … *LF*

This will send one or more command strings to Element nr.

The example here under asks for the software version from device 100

The local NTM is a gateway station linked to the PC



On the left the string builder with the remote command

On the right the response from the local and remote NTM

The local NTM echoes the command RMOT followed by some information from the gateway about the length of the stored frame. The parser in de gateway NTM confirms the execution of the command with OK.

A gateway stores commands in a buffer and transmits them right after the broadcast of the beacon signal. (The beacon signal will tell the targetted device that it will need to stay awake to be able to receive the command frame).

The remote NTM echoes a frame with the requested information in its payload: #VERS= NTM_STD….

Keep in mind that the RMOT command intrinsically applies gateway number and house code of the local device. If they do not match those in the remote NTM, you will get no response from the remote NTM.

The remote command is a so called mac command and is intended to control transceiver and application parameters.

Data intended to be handed over to a remote application is send with the

SENT(o) or SENF(rom) command. The first requires a device number of the remote NTM. The second one is a broadcast to any device in the network.

N.B. SENT commands are not relayed by a repeater.

Example of group command control

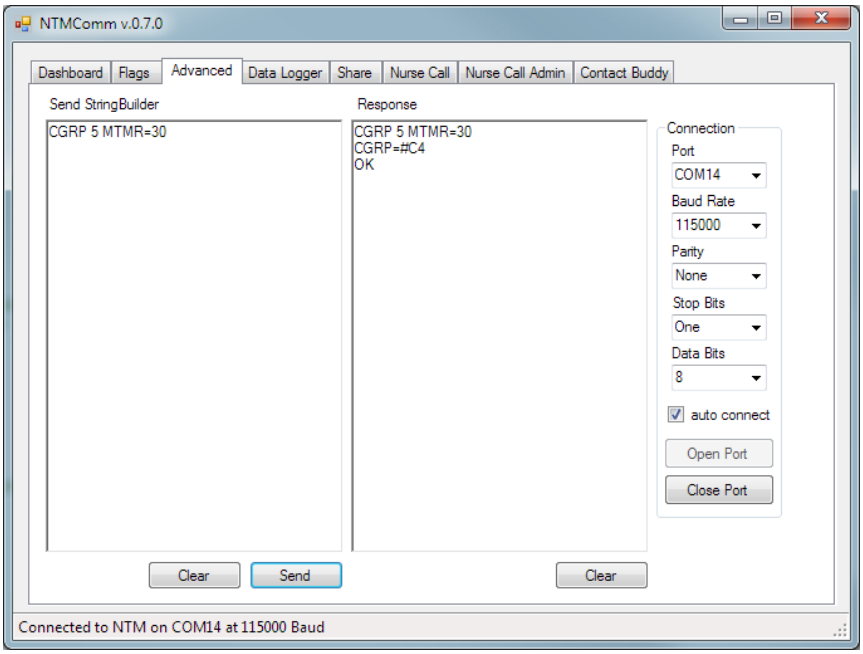
To overcome this problem the command CGRP is provided. This is also a mac command. Mac commands are transmitted by both NTMs on the gateway or repeater.

Syntax:

CRGP_Actor-nr_data…LF

_data may be any command or string understood by the addressed group.

Example:

	 In this case alle devices with actor or group number 5 will receive the command MTMR=30 and will set their status timing to 5 minutes. The local NTM echoes the command in the usual way. There might be a response from the addressed NTM. Whether that is displayed depends on the function setting of the receiving NTM.
Range calculations	The maximum distance between a transmitter and a receiver is determined by: - Transmission power PT - Signal losses in the transceiver TL - Signal attenuation and losses between transmitter and receiver LS - Signal fluctuation margin FM - Signal losses in the receiver RL - Minimum signal detectable by the receiver. S/N The minimum detectable signal is a signal that can be clearly distinguished from receiving noise and can be reliably decoded. For O_QPSK this level is at least 10 dB over the noise level to achieve a bit error rate of less than 1 $\%_o$. The minimum S/N ratio should be at least 10 dB. The noise level or noise floor is given by the formula Pnoise = - kTB. With k = Planck constant, T = absolute temperature and B =bandwidth of the system. For the planar antenna, the bandwidth is 25 MHz and the noise floor at the antenna becomes about -104 dBm. We have to take into account the losses in the antenna and the noise added to the signal by the frontend and the receiver itself. The frontend amplifier amplifies all

incoming signals, noise included, with 16 dB.

TL = antenna loss + system noise factor + insertion loss = 5 + 2 + 1.5 dB = 8.5 dB.

The noise floor at the demodulator becomes -104 + 16 + 8.5 dBm = -79.5 dBm.

With a minimum S/N of 10 dBm, the received signal must have a minimum of -69.5 dBm to be detectable (PM).

The radiated power of the transmitter equals the transmitter power less the transmission losses TL, in this case antenna losses = 6dB and insertion loss = 3 dB.

PL = 30 - 6 – 3 = 21 dBm. (125 mW e.r.p., using about 800 mA).

In free field high above ground, the attenuation due to distance is given by Friis law:

LS = 32.4 + 20 log F(MHz) + 20 logR(km) dB

For a 868 MHz signal it becomes:

LS = 31 + 20 log(R) dB, R in meters.

Remember: the received signal is amplified with G = 16 dB.

PL – LS + G = PM. This will give us a value for R.

21 – 31 – 20log R + 16 = -69.5 dB => R = 6000 meter.

Using better antennas with 0dB loss on both sides and same bandwidth, will enlarge the distance to 24 km!

In buildings, walls and ceilings can have a devastating effect on the link budget.

1. Because walls and ceilings reflect part of the signal, attenuating the signal, with 3 to 12 dB per surface.
2. Multiple reflections arrive at the receiver antenna from different directions and different phases causing constructive and destructive interference at the receiver antenna making the signal strength fluctuate in time. This is called fading. To dimension a single radio link for reliable operation, a fading margin of about 30 dB has to be taken into account. This reduces the 6 Km to 190 meters!

Every wall in-between can reduce range with a factor of 4.

For short distances, short in comparison with the wavelength of the radio signal, Friis law is not valid. Attenuation due to distance will be larger than predicted by Friis law.

Regulations.

FCC (USA) regulations allow the use of a DSSS signal with PL of 30 dBm.

ETSI (EU) regulations allow for DSSS in the 863 - 870 MHz band an effective radiation power PL of 25 mW = 14 dBm.

Without fading margin the range becomes then: 2600 meters.

With FM = 30 the range becomes: 80 meters.

EN54-25 states that if one makes provisions to improve the link reliability between transmitter and receiver, an FM = 10 dB may be applied.

	By using repeater stations, one creates multiple paths in space and time between transmitter and receiver that enhance the reliability of the link considerably. With PL = 14 dBm and FM = 10 dB the range becomes about 900 meters. For further information about range calculations see: *Atmel Doc9144* *Range Calculation for 300 MHz to 1000 MHz Communication Systems.*
Additional documentation	Datasheet NTM_3 Datasheet NTM Repeater/gateway Datasheet NCA Application note_2 Ninthway high secure radio network Application note_3 Third party software for the NTM. Application note_7 Application note 6 lay-out of a gateway module