

The TiNo Data Protocol

V2.0.1



Preamble, mandatory for all Packets

AA	AA	AA	2D	XX	LEN	LEN Bytes of Data
0	1	2	3	4	5	6 7...

Preamble is required by RFM69 mode of operation

Byte	Remarks
0,1,2	Preamble for frequency Sync
3	Syncword 1. fixed to 2D for compatibility with RFM12B
4	Syncword 2. Network ID, defined by user, set to D2 for compatibility with RFM12B
5	LEN = length of Data block
6...6+LEN	Data Block

Data Block (TiNo Sensor Protocol)

D	S	F	V	C	T	H
---	---	---	---	---	---	---

LEN = 8

Param.	#Bits	Remarks
D	8	Destination, the Target ID
S	8	Sender Node ID
F	8	Flags:

x	0	0	x	x	x	x	x
7	6	5	4	3	2	1	0

x=undefined

- 0 Heartbeat (system is healthy)
 - 1 PCI 0
 - 2 PCI 1
 - 3 PCI 2
 - 4 PCI3
- } Pin Change Events, mapped to Ports in EEPROM of Sender
- 5 0 = TiNo Sensor Protocol, 1= Alternate Protocol
 - 6 ACK Must be set to 0.
 - 7 Request ACK from receiver, when set to 1

V	12	unsigned int	Voltage measurement. resolution 1 mV, offset 0 mV possible values range from 0 to 4096 (0 to 4.096V)
C	8	unsigned char	counter, incremented for each packet sent, runs over from 255 to 0
T	12	unsigned int	Temperature Measurement Resolution 0.04 degC, offset +40 degC encode: $T = (t[\text{degC}] + 40) * 25$ decode: $t[\text{degC}] = T/25.0 - 40$
H	8	unsigned char	Humidity Measurement Resolution 0.5 %RH, offset 0%RH encode: $H = h[\%RH] * 2$ decode: $h[\%RH] = H/2.0$

Data Block - Alternate Protocol



D	S	F	C	Any other data
0	1	2	3	4...LEN

LEN = user defined , must be modulo 8
if encryption is used

LEN=4 indicates empty data block

Param.	#Bits	Remarks
D	8	Destination, the Target ID
S	8	Sender Node ID
F	8	Flags:

x	0	1	x	x	x	x	x
7	6	5	4	3	2	1	0

x=undefined

0	}	user defined Flags.
1		
2		
3		
4		
5		Must be set to 1 (indicates an alternate Protocol)
6		ACK Must be set to 0.
7		when set to 1, request ACK from receiver

C	8	unsigned char	incremented for each packet sent, runs over from 255 to 0
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Data Block - ACK Packet

D	S	F	FEI	C	RSSI	T
---	---	---	-----	---	------	---

LEN = 8

Param.	#Bits	Remarks
0 D	8	Destination, the Target ID
1 S	8	Sender Node ID
2 F	8	Flags:

0	1	0	x	x	x	x	x
7	6	5	4	3	2	1	0

x=undefined

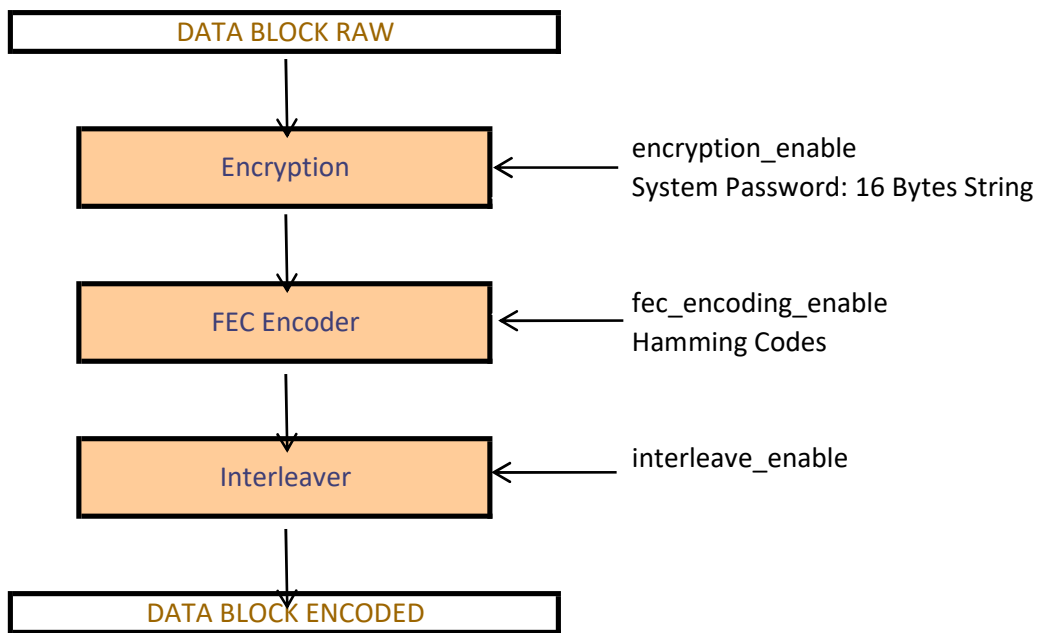
Bit 7: must be 0 to avoid acknowledge of an ack packet

Bit 6: must be one to indicate an ACK

Bit 5: must be 0, indicates the response to a TiNo Sensor Packet

3	FEI	16	signed int	Frequency Error Indicator [frequency Steps] 1 Step = 61.03515625 Hz, see Data Sheet of RFM69
5	C	8	unsigned char	must be identical to the count of the packet that is acknoledged
6	RSSI	8	unsigned char	Received Signal Strength Indicator $rssi[dB] = - RSSI / 2.0$ Tells the Sender about the channel quality
7	T	8	Temperature Measurement of the receiver's RFM69 resolution: 1 degC/LSB rough temperature indicator, currently not calibrated, can be wrong by several degrees.	

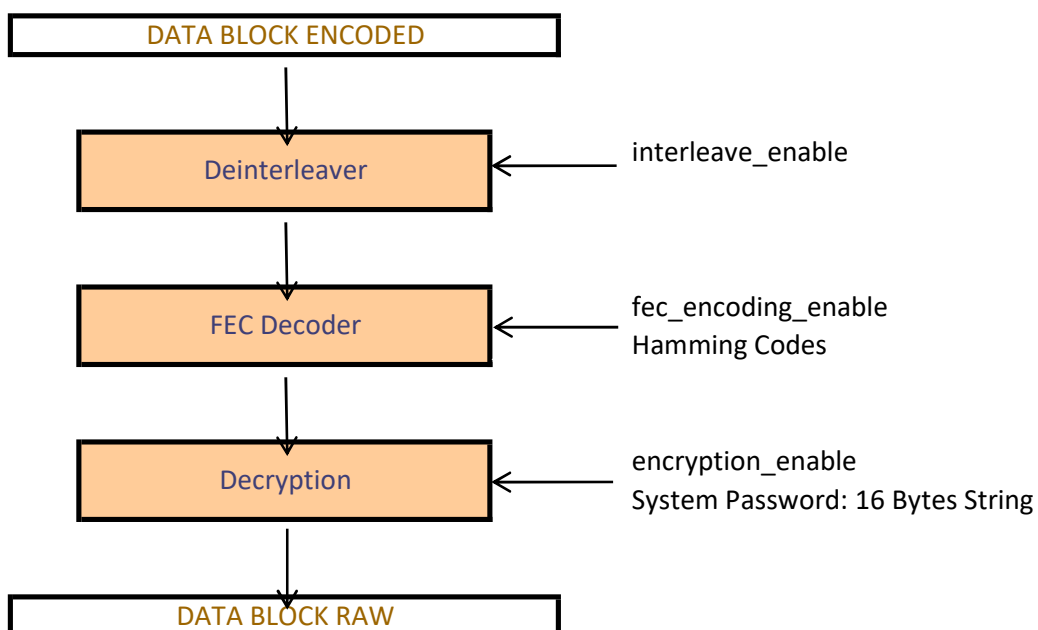
TiNo Data Block Encoding/Decoding



Notes:

1. Coding is configured in EEPROM. Configuration must be same in Sensor (Sender) and gateway(receiver)
2. FEC Encoding doubles the number of Bytes in DATA BLOCK, hence
3. Interleaver is only useful together with FEC, otherwise its useless. $LEN_{enc} = 2 * LEN_{raw}$
4. FEC Encoder is using 8/4 Hamming Codes (for simplicity of implementation)
5. Preamble, including LEN byte is NOT encoded

TiNo Data Block Decoding



TiNo Actions Definition



EEPROM Mapping:

Address		Parameter	
from	to		
318	318	NUM_ACTIONS	0 ≤ NUM_ACTIONS ≤ 40
319	478	Action Blocks	40 X 4 Bytes = 160 Bytes
479	480	CRC16 Checksum	

Action Structure: 4 Bytes

Node	The Node to Listen to	N ₇	N ₆	N ₅	N ₄	N ₃	N ₂	N ₁	N ₀	0...255
Port	The Port to activate	R	R	R	P ₄	P ₃	P ₂	P ₁	P ₀	0...31
Mask	Bit in the Flag Byte that triggers	x	x	x	T	T	T	T	x	
OnOff	Action to take	D	Pd ₄	Pd ₃	Pd ₂	Pd ₁	Pd ₀	A ₁	A ₀	

- N Node
- R Reserved
- P Port , 5 bit Number representing Arduino Port Numbering. A0=14, A1=15, ...
- x don't care
- T Trigger bit. Flag byte is compared with Flag Byte from Sender
- D Port state at power up. 0= LOW, 1= HIGH
- Pd Pulse duration. $t_{ime} = 2^{Pd-1}$ seconds. Pd=0 is 0.5 seconds (minimum)
only valid when A = 0b11

A1	A0	
0	0	turn port off
0	1	turn port on
1	0	toggle port
1	1	Pulse



Port Parameters:

Gateway	38400 Bd	8N1	8 Data bits, no parity bit, 1 Stop bit
Sensor	4800 Bd	8N1	8 Data bits, no parity bit, 1 Stop bit

Receiver Message Protocol:

human readable byte sequence, coded with Ascii characters (0-127):

```
<nodeID><Leerzeichen><msg-variable1>=<Wert>&<msg-variable2>=<Wert>...\n
```

N	LZ	V ₁	=	W ₁	&	V ₂	=	W ₂	&	...	&	V _n	=	W _n	\n
---	----	----------------	---	----------------	---	----------------	---	----------------	---	-----	---	----------------	---	----------------	----

N Node ID of Sender
LZ Separation sign (space sign)
V_x Variable name x
W_x Value of Variable x – Values must be Integer numbers
& separation sign (Ampersand)
\n new line sign (Ascii sign 10)

Available Variables

VariableName	Parameter (ger.)	paramter(engl.)	Unit	Min	Max	scale factor
d	Entfernung	distance	cm	-1	300	10
h	Luftfeuchte	humidity	%rH	0	120	100
he	Höhe	height	m	-450	9999	100
p	Luftdruck	Air pressure	hPa	300	1100	1
r	Reed-Kontakt	contact	---	0	1	1
t	Temperatur	temperature	degC	-40	90	100
v	Batteriespannung	battery voltage	V	0	5	1000
int	Interrupt	interrupt	---	0	0xff	1
rsi	Signalstärke	RSSI	dBm	-130	0	10
lqi	Kanalgüte	link quality indicator	---	0	127	1
fo	Frequenzversatz	Frequency offset	Hz	-30000	30000	1
c	Zähler	count	---	0	65535	1
be	Bitfehler	bit errors	---	0	127	1

Example

```
23 v=3002&c=243&t=3400&h=5650&int=0&rsi=-835&fo=2014&be=0\n
```

Variables Details



VariableName	Resolution	Description
d	1 cm/10 = 1 mm	distance as measured by a ultrasonic ensor
h	0.01%	relative humidity in percent, can be higher than 100% in rare cases
he	1m/100=1cm	height over sea level
p	1hPa/100	Air pressure
r		digital bit value, 1 or 0
t	degC/100	
int		16 bits, 2 bits per interrupt

int8	int7	int6	int5	int4	int3	int2	int1
------	------	------	------	------	------	------	------

int x:

b1	b0
----	----

b1	b0	
0	0	no interrupt
0	1	CHANGE
1	0	FALLING
1	1	RISING

In some cases the gateway does not know the exact nature of the interrupt trigger. In this case a CHANGE is signalled.

rss	dBm/10	signal strength as measured by the Gateway
lqi		a number indicating if the channel is free of noise or interference. 0 is best, 127 is worst. Not applicable to some radios
fo	1Hz	Frequency offset measured by the receiver. TiNo Modulation is FM. Tight Frequency tuning control (AFC) is crucial. 0 ist best, values above 5000 are somewhat critical
c		Packet counter, rolling over at some point. Can be a 8-bit value or a 16 bit, value depending on implementation
be	1bit	Bit errors in Packet. Only useful when forward Error correction is used. The amount of bit errors the algorithm detected and corrected.
sy	1 bit	the gateway is keeping track with the senders rolling code (count value). If track ist lost this signal is set to 0