STIM202

3-axis
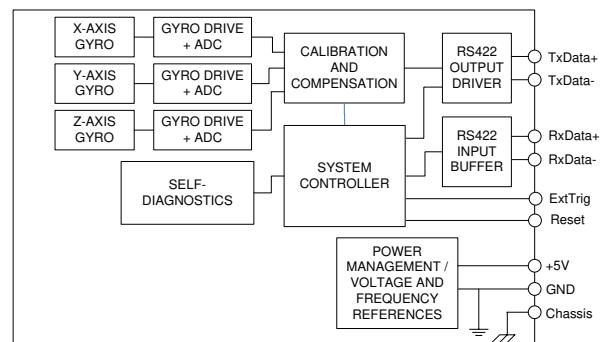## Gyro
Module

FEATURES:

o Excellent performance in vibration and shock environments
o 3 axes offered in same package
   o Electronically calibrated axis alignment
o Single-crystal silicon technology
   o No intrinsic wear-out effects
o Low bias instability
o Low noise
o Digital interface, RS422
o Fully configurable
o Excellent environmental robustness
o Miniature package
o Continuous self-diagnostics

BLOCK DIAGRAM:

1 GENERAL DESCRIPTION

STIM202 is a cluster of 3 high accuracy MEMS-based gyros in a miniature package. Each axis is factory-calibrated for bias, sensitivity and compensated for temperature effects to provide high-accuracy measurements in the temperature range -40°C to +85°C. The unit runs off a single +5V supply.

STIM202 communicates via a standard high-level RS422 interface. The use of a 32 bit RISC ARM microcontroller provides flexibility in the configuration, like choice of output unit, sample rate, LP filter -3dB frequency and RS422 bit-rate and protocol parameters. All configurable parameters can be defined when ordering or set by customer.

When STIM202 is powered up, it will perform an internal system check and synchronize the gyros. As an acknowledgement of the complete power-up sequence, it will provide special datagrams containing data, like part number, serial number and configuration parameters as mentioned above. STIM202 will then automatically proceed to provide measurement data. Hence the simplicity of use is high: just connect power and STIM202 will provide accurate gyro measurements over the RS422 interface.

The measurement data is transmitted as packages of data on a fixed format (datagram) at intervals given by the sample rate. The datagram is in binary coded format in order to have an efficient transfer of data. In addition to the measurement data itself, the datagram contains an identifier, a status byte and a CRC (Cyclic Redundancy Check) byte to provide high degree of fault detection in the transmissions. The status byte will flag any detected errors in the system.

For more advanced users, the gyro may be put in Service Mode. In this mode all the configuration parameters can be intermediately or permanently changed by overwriting the current settings in the flash memory. In Service Mode the commands and responses are in a human readable format; to enable the use of terminal-type software during typical product integration. Service Mode also provides the ability to perform single measurements, perform diagnostics and obtain a higher detail level of detected errors reported in the status byte.

2   TABLE OF CONTENTS

3   ABBREVIATIONS USED IN DOCUMENT

ABBREVIATION	FULL NAME
LP filter	Low-Pass filter
CIC-filter	Cascaded Integrator Comb filter

4   ABSOLUTE MAXIMUM RATINGS

Stresses beyond those listed in Table 4-1 may cause permanent damage to the device.
Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Table 4-1: Absolute maximum ratings

Parameter	Rating	Comment
Dynamic overload	5000°/s	Any direction
Mechanical shock	1500g/0.5ms half-sine	Any direction
ESD human body model	±2kV	
ESD charge device model	±500V	
Storage temperature	-50°C to +90°C	
VSUP to GND	-0.5 to +7V	
RxD+ or RxD- to GND	-0.3V to +7V	
RxD+ to RxD-	±6V	with 120Ω Line Termination = ON
TxD+ or TxD- to GND	VCC-15V to +15V	
NRST to GND	-0.3V to +7V	
EXTTRIG to GND	-0.3V to +3.6V	
Chassis to GND	500VDC	
Helium sensitivity		Not to be exposed to helium concentrations other than those normally found in the atmosphere

5   SPECIFICATIONS

Table 5-1: Operating conditions

Parameter	Conditions	Min	Nom	Max	Unit	Note
INPUT RANGE			±400		°/s	
POWER SUPPLY		4.5	5.0	5.5	V	
OPERATING TEMPERATURE		-40		+85	°C	

Table 5-2: Functional specifications

| Parameter	Conditions	Min	Nom	Max	Unit	Note
GYRO						
Full Scale (FS)			±400		°/s	1
Resolution			24		bits	
			0.22		°/h	
Scale Factor Accuracy			±0.2		%	
Non-Linearity	±250°/s		25		ppm	2
	±400°/s		50		ppm	2
Bandwidth (-3dB)			262		Hz	3
Group Delay			2.2		ms	4
Compensation time, t_{comp}	Ref: Figure 7-4	0.78	0.83	0.91	ms	5
Bias Accuracy		-250	0	+250	°/h	
Bias error over temperature	$\Delta T \leq \pm 1°C/min$		30		°/h rms	6
Bias Instability	Root Allan Variance @25°C		0.4		°/h	
Angular Random Walk	Root Allan Variance @25°C		0.17		°/√h	
Linear Acceleration Effect			14		°/h /g	7
Vibration Rectification Coefficient	f<1000Hz		0.1		°/h /g_{rms}^2	
Misalignment			1		mrad	8
TEMPERATURE MEASUREMENT						
Bias Accuracy	@25°C		±5		°C	9
Scale factor accuracy			±5		%	
POWER CONSUMPTION						
Power consumption				1.5	W	
TIMING						
Time to transmit after Power-On				0.8	s	10
Time to transmit after Reset				0.8	s	11
Time to valid data			3.0	6	s	12
	@+25°C			5	s	12
RS422 Bit-Rate			ref. Table 5-3			
RS422 Bit-Rate Accuracy				±1	%	
Sample Rate				1000	samples/s	3
RS422 PROTOCOL						
Start Bit			1		bit	
Data Length			8		bits	
Parity			ref. Table 5-3			3
Stop Bits			ref. Table 5-3			3
RS422 LINE TERMINATION						
Input resistance	Line termination = ON		120		Ω	
Input resistance	Line termination = OFF	48	125		kΩ	
RESET (NRST PIN)						
Logic levels			5V CMOS and TTL compatible			
Minimum hold time for reset		5			ms	
Pull-Up Resistor		80	100		kΩ	
EXTERNAL TRIGGER						
Logic levels			3.3V CMOS and TTL compatible			
Trigger			Negative transition			
Pull-Up Resistor		35	50		kΩ	
Minimum active low, t_{ext_min}	Ref: Figure 7-4	50			ns	
Maximum time to transmit, t_{ext_tx}	Ref: Figure 7-4			250	µs	
Time between triggers	Output unit:					
	angular rate	1		255	ms	13, 14
	incremental angle	1		255	ms	13, 15
	average rate	1		127	ms	13, 16
	integrated angle	1		8	ms	13, 17
Latency				2000	µs	
CHASSIS						
Resistance pin 6 → chassis				0.1	Ω	
Isolation chassis → GND (pin1)	500VDC	100			MΩ	

Note 1: Output is monotonous and will saturate at ±480°/s
Note 2: Largest deviation from BSL (Best fit Straight Line) over the range specified

Note 3: Low-pass filter -3dB frequency can be configured, ref. Table 5-3 and section 5.1.4
Note 4: Specified group delay is valid for a filter setting = 262Hz. See Table 5-3 to find group delay for other filter-settings
Note 5: Time to transfer data from gyro-channels to µC, perform compensation and prepare for datagram transmission. Total delay to start of datagram transmission = group delay + compensation time
Note 6: rms-value calculated on the residual over two temperature-cycles, ref. Figure 5-3
Note 7: Section 6.2 gives advice on sensitive directions
Note 8: Ref. Figure 6-5 for definition of reference points used in axis alignment
Note 9: Temperature calibrated to reflect ambient temperature and not internal temperature
Temperature error during first 5 minutes: -20°C to +5°C
Note 10: Time from Power-On to start of datagram transmissions (starting with part number datagram)
Note 11: Time from Reset release to start of datagram transmissions (starting with part number datagram)
Note 12: Time from Power-On or Reset to the reset of the Start-Up bit (Bit 6 in the STATUS byte ref. Table 5-10)
During this period the output data should be regarded as non-valid
Note 13: If time between triggers is longer than 255ms, the sample counter will over-run, ref. 7.2.2.3.6
Note 14: Time between triggers should be carefully evaluated as long time between triggers in combination with high bandwidths could lead to issues related to folding
Note 15: If time between triggers is longer than 8ms, an overload may occur in the incremental angle, ref. 7.2.2.3.2. An overload will be flagged in the STATUS byte ref. Table 5-10
Note 16: If time between triggers is longer than specified, the accuracy of average rate may be reduced
Note 17: If time between triggers is longer than specified, the integrated angle may have wrapped several times and hence the change in angle from last sample will not be possible to calculate

5.1 TYPICAL PERFORMANCE CHARACTERISTICS

5.1.1 Root Allan Variance
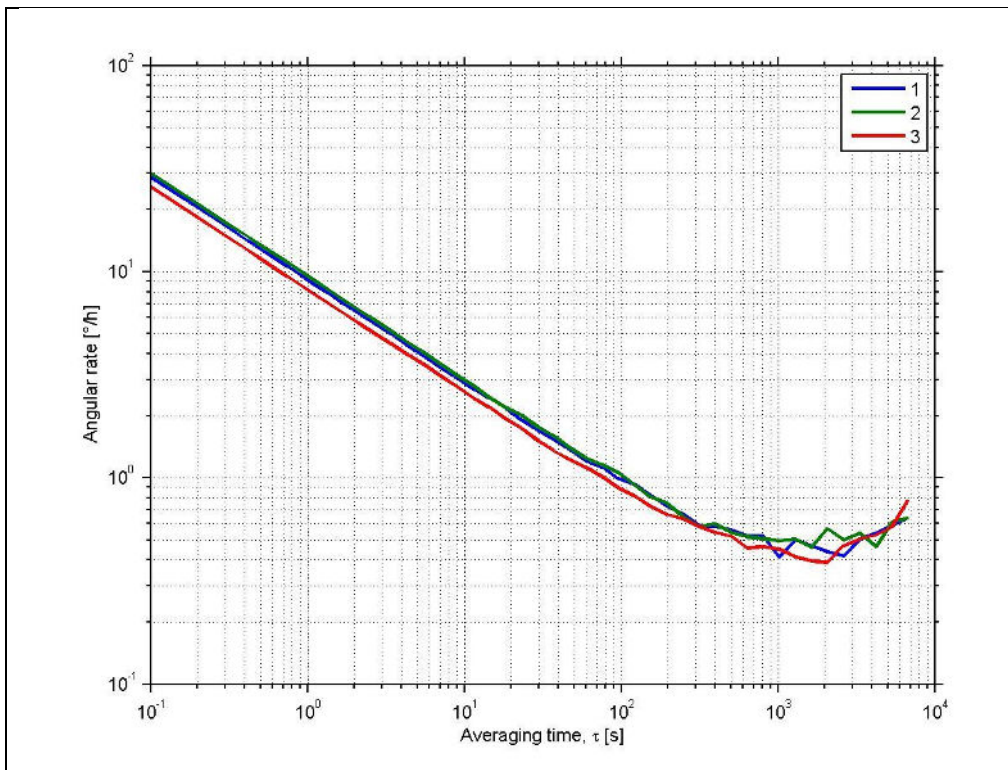
Figure 5-1: Typical Root Allan Variance

5.1.2   Initial bias drift
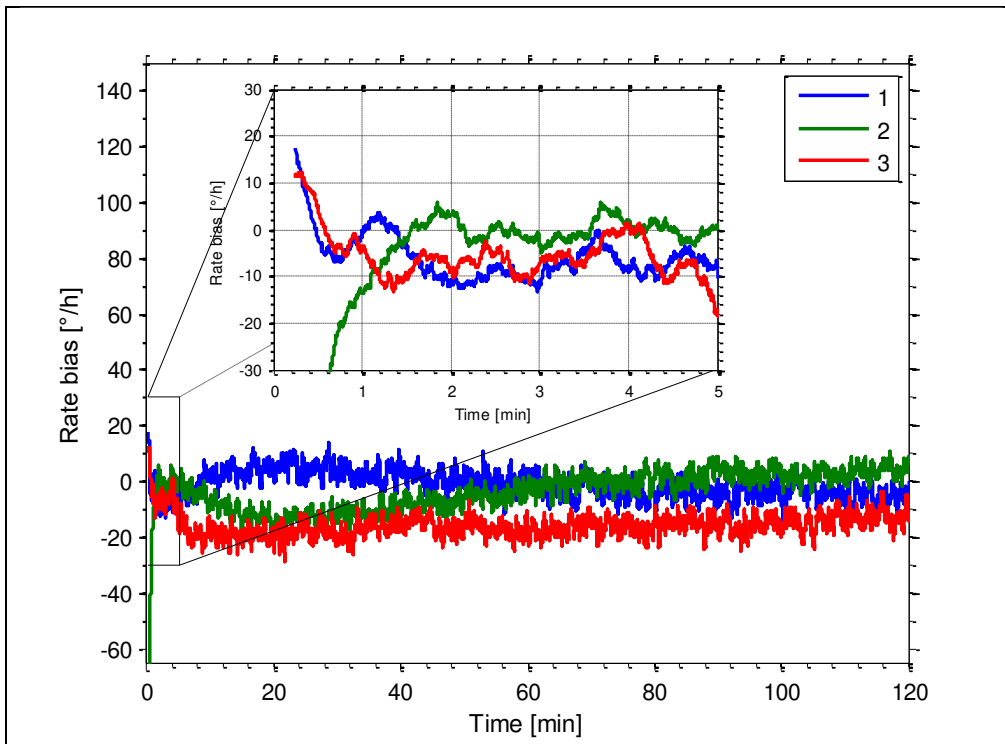
Figure 5-2: Typical initial bias drift

5.1.3   Bias drift over temperature
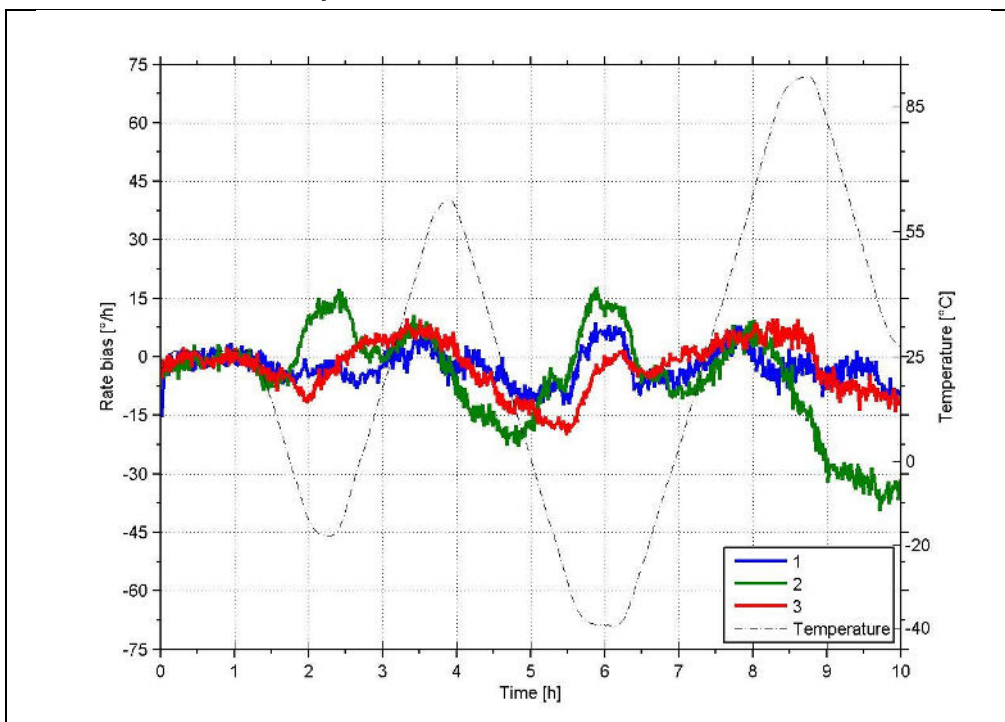
Figure 5-3: Typical bias drift over temperature

5.1.4 Frequency characteristics
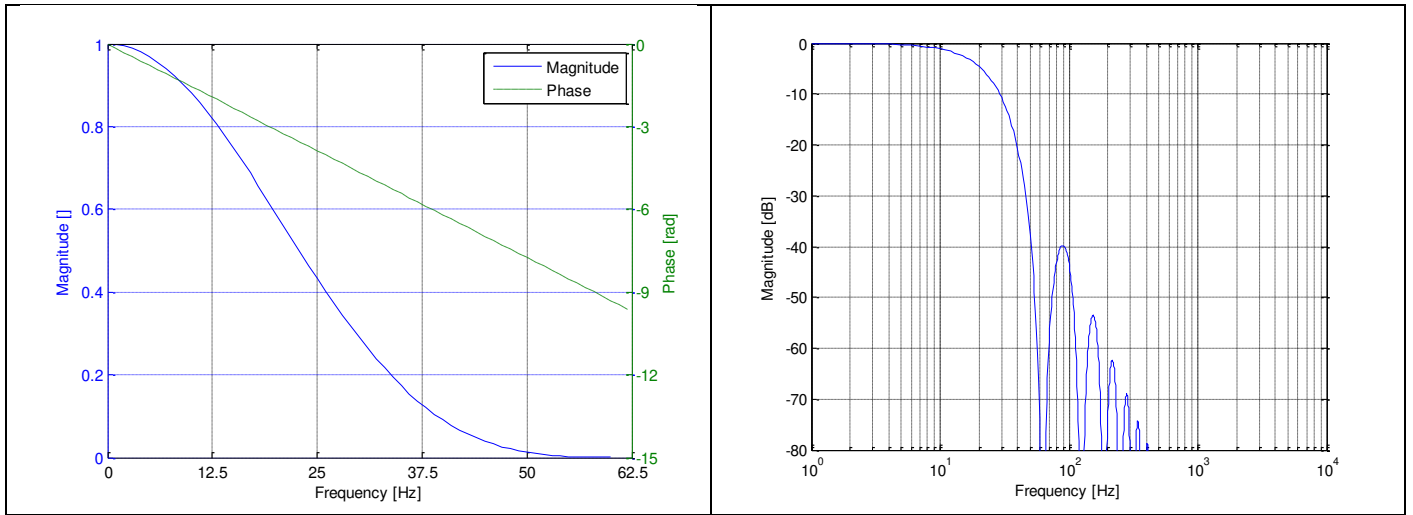
Figure 5-4: Frequency characteristics with low-pass filter -3dB frequency set to 16Hz
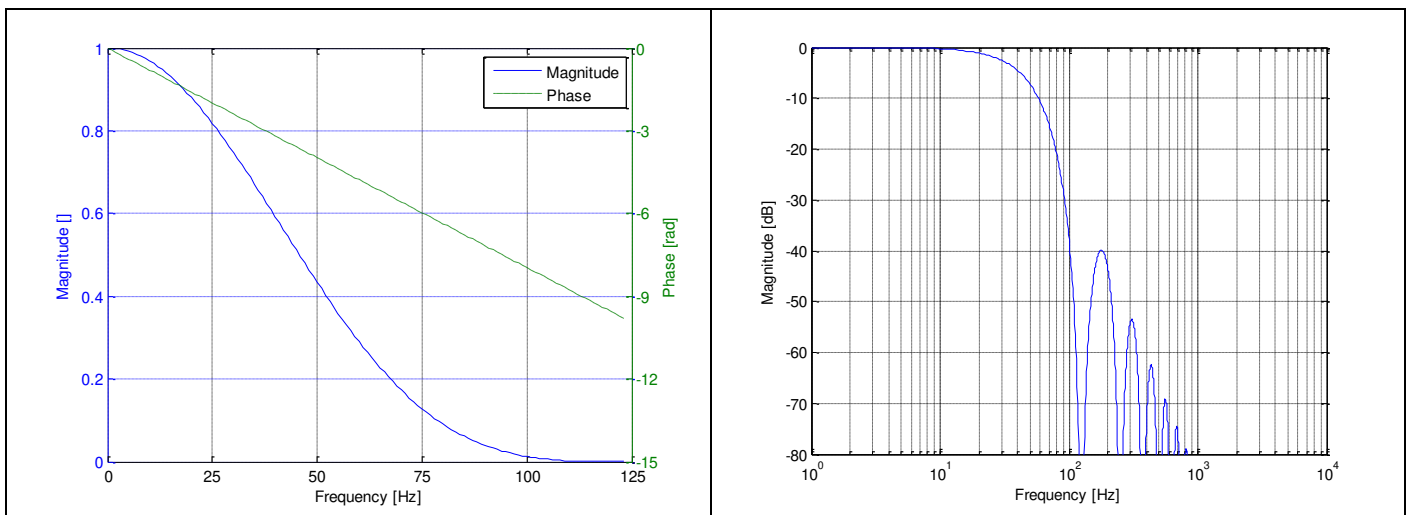
Figure 5-5: Frequency characteristics with low-pass filter -3dB frequency set to 33Hz

Figure 5-6: Frequency characteristics with low-pass filter -3dB frequency set to 66Hz
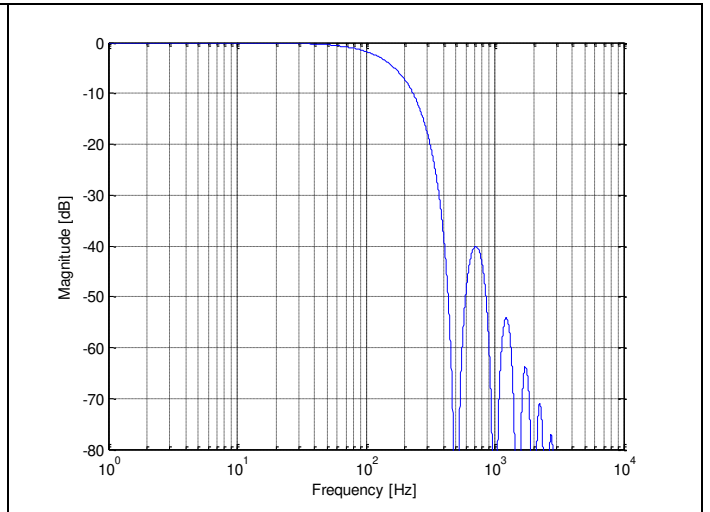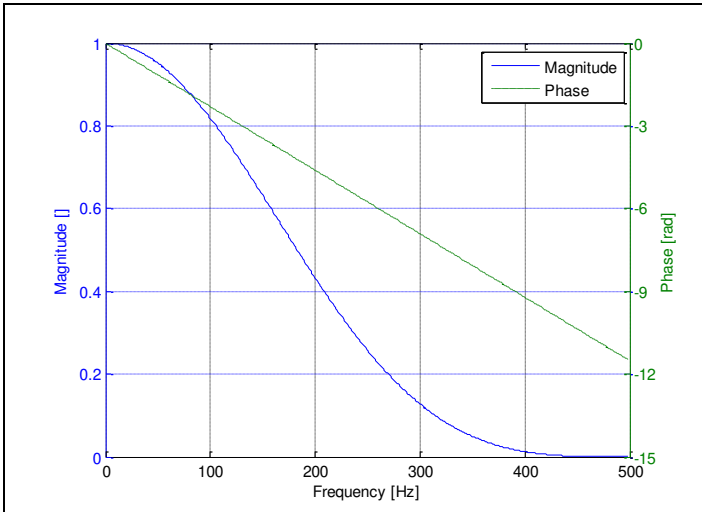
Figure 5-7: Frequency characteristics with low-pass filter -3dB frequency set to 131Hz
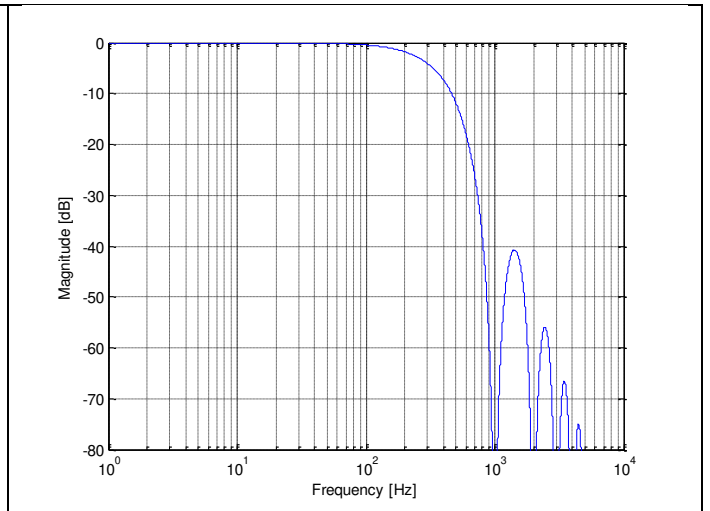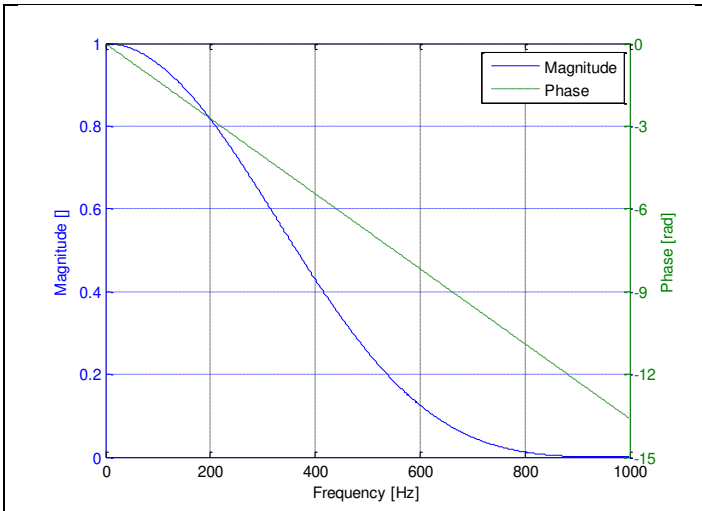
Figure 5-8: Frequency characteristics with low-pass filter -3dB frequency set to 262Hz

5.2 Configurable parameters

Table 5-3: Configurable parameters

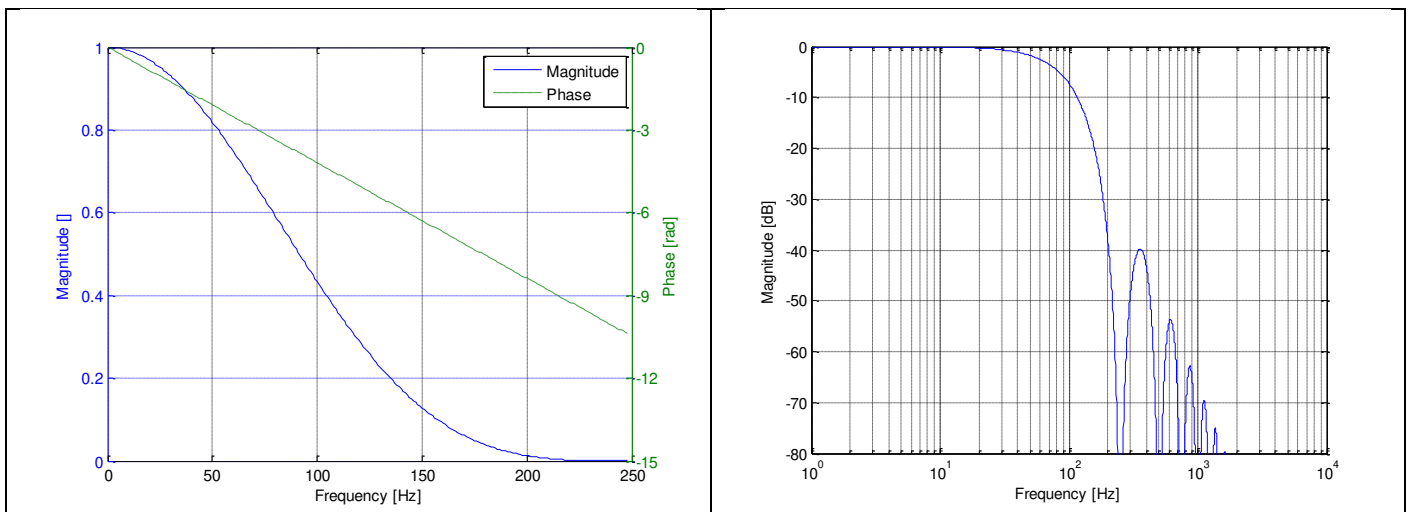| Parameter	Configurations		Comments
DATAGRAM FORMAT	Standard Extended Standard with CR+LF Rate and temperature Rate and counter Rate and latency Rate, temperature and counter Rate, temperature and latency		Contains measurements and status byte For future use Has <CR><LF> added to standard datagram
OUTPUT UNIT	Angular rate [°/s] Incremental angle [°/sample] Average angular rate [°/s] Integrated angle [°]		
SAMPLE RATE	125 samples/s 250 samples/s 500 samples/s 1000 samples/s External trigger		
LOW-PASS FILTER -3dB FREQUENCY	**-3db freq.:** 16Hz 33Hz 66Hz 131Hz 262Hz	**Group delay:** 24.7ms 12.7ms 6.7ms 3.7ms 2.2ms	Filter settings are independent of sample rate. Low-pass filters are CIC type filters with linear phase response. Filter settings can be set individually for each axis in Service Mode. Total delay to start of datagram transmission = group delay + compensation time, t_{comp}
RS422 BIT RATE	374400 bits/s 460800 bits/s 921600 bits/s		
RS422 PARITY	None Odd Even		
RS422 STOP BITS	1 stop bit 2 stop bits		
RS422 120Ω LINE TERMINATION	OFF ON		

Refer to chapter 11 for information on how to configure STIM202 when ordering.

5.3 Datagram specifications

Table 5-4: Specification of the Part Number datagram

Byte#	7	6	5	4	3	2	1	0	Specification
0	0 0	1 1	0 0	1 1	0 0	1 1	0 1	0 0	**Part Number datagram identifier:** 0x54 for datagrams without CR+LF termination 0x56 for standard datagrams w.CR+LF
1	0	0	0	0	$P1_3$	$P1_2$	$P1_1$	$P1_0$	Low nibble: 1.digit (BCD) of part number
2	$P2_3$	$P2_2$	$P2_1$	$P2_0$	$P3_3$	$P3_2$	$P3_1$	$P3_0$	High nibble: 2.digit (BCD) of part number Low nibble: 3.digit (BCD) of part number
3	$P4_3$	$P4_2$	$P4_1$	$P4_0$	$P5_3$	$P5_2$	$P5_1$	$P5_0$	High nibble: 4.digit (BCD) of part number Low nibble: 5.digit (BCD) of part number
4	0	0	1	0	1	1	0	1	ASCII character "-" (0x2D)
5	$P6_3$	$P6_2$	$P6_1$	$P6_0$	$P7_3$	$P7_2$	$P7_1$	$P7_0$	High nibble: 6.digit (BCD) of part number Low nibble: 7.digit (BCD) of part number
6	$P8_3$	$P8_2$	$P8_1$	$P8_0$	$P9_3$	$P9_2$	$P9_1$	$P9_0$	High nibble: 8.digit (BCD) of part number Low nibble: 9.digit (BCD) of part number
7	0	0	1	0	1	1	0	1	ASCII character "-"(0x2D)
8	$P10_3$	$P10_2$	$P10_1$	$P10_0$	$P11_3$	$P11_2$	$P11_1$	$P11_0$	High nibble: 10.digit (BCD) of part number Low nibble: 11.digit (BCD) of part number
9	$P11_3$	$P11_2$	$P11_1$	$P11_0$	$P13_3$	$P13_2$	$P13_1$	$P13_0$	High nibble: 12.digit (BCD) of part number Low nibble: 13.digit (BCD) of part number
10	r_7	r_6	r_5	r_4	r_3	r_2	r_1	r_0	Part number revision. Content of byte represents the ASCII character of the revision. Numbering sequence: "-", "A", "B", …., "Z"
11	c_7	c_6	c_5	c_4	c_3	c_2	c_1	c_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
(12)	0	0	0	0	1	1	0	1	<CR> only when standard datagrams w.CR+LF have been chosen
(13)	0	0	0	0	1	0	1	0	<LF> only when standard datagrams w.CR+LF have been chosen

Table 5-5: Specification of the Serial Number datagram

Byte#	7	6	5	4	3	2	1	0	Specification
0	0 0	1 1	0 0	1 1	1 1	0 0	1 0	0 0	**Serial Number datagram identifier:** 0x5A for datagrams without CR+LF termination 0x5C for standard datagrams w.CR+LF
1	0	1	0	0	1	1	1	0	ASCII character for letter "N"
2	$S1_3$	$S1_2$	$S1_1$	$S1_0$	$S2_3$	$S2_2$	$S2_1$	$S2_0$	High nibble: 1.digit (BCD) of serial number Low nibble: 2.digit (BCD) of serial number
3	$S3_3$	$S3_2$	$S3_1$	$S3_0$	$S4_3$	$S4_2$	$S4_1$	$S4_0$	High nibble: 3.digit (BCD) of serial number Low nibble: 4.digit (BCD) of serial number
4	$S5_3$	$S5_2$	$S5_1$	$S5_0$	$S6_3$	$S6_2$	$S6_1$	$S6_0$	High nibble: 5.digit (BCD) of serial number Low nibble: 6.digit (BCD) of serial number
5	$S7_3$	$S7_2$	$S7_1$	$S7_0$	$S8_3$	$S8_2$	$S8_1$	$S8_0$	High nibble: 7.digit (BCD) of serial number Low nibble: 8.digit (BCD) of serial number
6	$S9_3$	$S9_2$	$S9_1$	$S9_0$	$S10_3$	$S10_2$	$S10_1$	$S10_0$	High nibble: 9.digit (BCD) of serial number Low nibble: 10.digit (BCD) of serial number
7	$S11_3$	$S11_2$	$S11_1$	$S11_0$	$S11_3$	$S11_2$	$S11_1$	$S11_0$	High nibble: 11.digit (BCD) of serial number Low nibble: 12.digit (BCD) of serial number
8	$S13_3$	$S13_2$	$S13_1$	$S13_0$	$S14_3$	$S14_2$	$S14_1$	$S14_0$	High nibble: 13.digit (BCD) of serial number Low nibble: 14.digit (BCD) of serial number
9	x	x	x	x	x	x	x	x	For future use.
10	x	x	x	x	x	x	x	x	For future use.
11	c_7	c_6	c_5	c_4	c_3	c_2	c_1	c_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
(12)	0	0	0	0	1	1	0	1	<CR> only when standard datagrams w.CR+LF have been chosen
(13)	0	0	0	0	1	0	1	0	<LF> only when standard datagrams w.CR+LF have been chosen

Table 5-6: Specification of the Configuration datagram

Byte#	Bit# 7	6	5	4	3	2	1	0	Specification
0	0	0	1	0	1	0	0	0	**Configuration datagram identifier:** 0x28 for datagrams without CR+LF termination
	0	0	1	0	1	0	1	1	0x2B for standard datagrams w.CR+LF
1	r_7	r_6	r_5	r_4	r_3	r_2	r_1	r_0	Part number revision. Content of byte represents the ASCII character of the revision. Numbering sequence: "-", "A", "B", …., "Z"
2	f_7	f_6	f_5	f_4	f_3	f_2	f_1	f_0	Firmware revision. Numbering sequence: 0, 1, …, 255
3	h_7	h_6	h_5	h_4	h_3	h_2	h_1	h_0	Hardware revision. Numbering sequence: 0, 1, …, 255
4									**System configuration, Byte 1:**
	0	x	x	x	x	x	x	x	Z axis is inactive
	1	x	x	x	x	x	x	x	Z axis is active
	x	1	0	0	x	x	x	x	LP filter -3dB frequency for Z axis = 262Hz
	x	0	1	1	x	x	x	x	LP filter -3dB frequency for Z axis = 121Hz
	x	0	1	0	x	x	x	x	LP filter -3dB frequency for Z axis = 66Hz
	x	0	0	1	x	x	x	x	LP filter -3dB frequency for Z axis = 33Hz
	x	0	0	0	x	x	x	x	LP filter -3dB frequency for Z axis = 16Hz
	x	x	x	x	0	x	x	x	Y-axis is inactive
	x	x	x	x	1	x	x	x	Y-axis is active
	x	x	x	x	x	1	0	0	LP filter -3dB frequency for Y axis = 262Hz
	x	x	x	x	x	0	1	1	LP filter -3dB frequency for Y axis = 121Hz
	x	x	x	x	x	0	1	0	LP filter -3dB frequency for Y axis = 66Hz
	x	x	x	x	x	0	0	1	LP filter -3dB frequency for Y axis = 33Hz
	x	x	x	x	x	0	0	0	LP filter -3dB frequency for Y axis = 16Hz
5									**System configuration, Byte 2:**
	0	x	x	x	x	x	x	x	X-axis is inactive
	1	x	x	x	x	x	x	x	X-axis is active
	x	1	0	0	x	x	x	x	LP filter -3dB frequency for X axis = 262Hz
	x	0	1	1	x	x	x	x	LP filter -3dB frequency for X axis = 121Hz
	x	0	1	0	x	x	x	x	LP filter -3dB frequency for X axis = 66Hz
	x	0	0	1	x	x	x	x	LP filter -3dB frequency for X axis = 33Hz
	x	0	0	0	x	x	x	x	LP filter -3dB frequency for X axis = 16Hz
	x	x	x	x	1	0	1	x	Sample rate = External trigger
	x	x	x	x	0	1	1	x	Sample rate = 1000 samples/s
	x	x	x	x	0	1	0	x	Sample rate = 500 samples/s
	x	x	x	x	0	0	1	x	Sample rate = 250 samples/s
	x	x	x	x	0	0	0	x	Sample rate = 125 samples/s
	x	x	x	x	x	x	x	0	Output unit = ANGULAR RATE
	x	x	x	x	x	x	x	1	Output unit = other than ANGULAR RATE (ref. byte#8)
6									**System configuration, Byte 3:**
	0	x	x	x	x	x	x	x	Datagram format = STANDARD+STANDARD w.CR+LF
	1	x	x	x	x	x	x	x	Datagram format = other than STANDARD (ref. byte#8)
	x	0	0	0	x	x	x	x	Bit rate = 374400 bits/s
	x	0	0	1	x	x	x	x	Bit rate = 460800 bits/s
	x	0	1	0	x	x	x	x	Bit rate = 921600 bits/s
	x	x	x	x	0	x	x	x	Stop bit = 1
	x	x	x	x	1	x	x	x	Stop bits = 2
	x	x	x	x	x	0	0	x	Parity = none
	x	x	x	x	x	0	1	x	Parity = even
	x	x	x	x	x	1	0	x	Parity = odd
	x	x	x	x	x	x	x	0	Line termination = OFF
	x	x	x	x	x	x	x	1	Line termination = ON
7	s_7	s_6	s_5	s_4	s_3	s_2	s_1	s_0	STATUS byte. Ref.Table 5-10 for specification of the STATUS byte.
8									**System configuration, Byte 4:**
	0	0	0	0	x	x	x	x	Output unit = ANGULAR RATE
	0	0	0	1	x	x	x	x	Output unit = INCREMENTAL ANGLE
	0	0	1	0	x	x	x	x	Output unit = AVERAGE ANGULAR RATE
	0	0	1	1	x	x	x	x	Output unit = INTEGRATED ANGLE
	x	x	x	x	0	0	0	0	Datagram format = Standard
	x	x	x	x	0	0	0	1	Datagram format = Extended
	x	x	x	x	0	0	1	0	Datagram format = Standard w.CR+FL
	x	x	x	x	0	0	1	1	Datagram format = Rate and temperature,
	x	x	x	x	0	1	0	0	Datagram format = Rate and counter,
	x	x	x	x	0	1	0	1	Datagram format = Rate and latency
	x	x	x	x	0	1	1	1	Datagram format = Rate, temperature and counter
	x	x	x	x	1	0	0	0	Datagram format = Rate, temperature and latency
9	x	x	x	X	x	x	X	X	For future use.
10	x	x	x	X	x	x	x	x	For future use.
11	c_7	c_6	c_5	c_4	c_3	c_2	c_1	c_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
(12)	0	0	0	0	1	1	0	1	<CR> only when standard datagrams w.CR+LF have been chosen
(13)	0	0	0	0	1	0	1	0	<LF> only when standard datagrams w.CR+LF have been chosen

Table 5-7: Specification of the Extended Error Information datagram

Byte#	Bit# 7	6	5	4	3	2	1	0	Specification
0	0	0	1	0	1	1	1	0	**Extended Error Information datagram identifier:** 0x2E for datagrams without CR+LF termination
	0	0	1	0	1	1	1	1	0x2F for datagrams with CR+LF termination
1	E_{79}	E_{78}	E_{77}	E_{76}	E_{75}	E_{74}	E_{73}	E_{72}	Ref. Table 5-8
2	E_{71}	E_{70}	E_{69}	E_{68}	E_{67}	E_{66}	E_{65}	E_{64}	Ref. Table 5-8
3	E_{63}	E_{62}	E_{61}	E_{60}	E_{59}	E_{58}	E_{57}	E_{56}	Ref. Table 5-8
4	E_{55}	E_{54}	E_{53}	E_{52}	E_{51}	E_{50}	E_{49}	E_{48}	Ref. Table 5-8
5	E_{47}	E_{46}	E_{45}	E_{44}	E_{43}	E_{42}	E_{41}	E_{40}	Ref. Table 5-8
6	E_{39}	E_{38}	E_{37}	E_{36}	E_{35}	E_{34}	E_{33}	E_{32}	Ref. Table 5-8
7	E_{31}	E_{30}	E_{29}	E_{28}	E_{27}	E_{26}	E_{25}	E_{24}	Ref. Table 5-8
8	E_{23}	E_{22}	E_{21}	E_{20}	E_{19}	E_{18}	E_{17}	E_{16}	Ref. Table 5-8
9	E_{15}	E_{14}	E_{13}	E_{12}	E_{11}	E_{10}	E_9	E_8	Ref. Table 5-8
10	E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0	Ref. Table 5-8
11	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
(12)	0	0	0	0	1	1	0	1	<CR> If datagram termination has been selected
(13)	0	0	0	0	1	0	1	0	<LF> If datagram termination has been selected

Table 5-8: Specification of the Extended Error Information

Bit#	Specification	Bit#	Specification	Bit#	Specification	Bit#	Specification
E_{79}	For future use (=0)	E_{78}	For future use (=0)	E_{77}	For future use (=0)	E_{76}	For future use (=0)
E_{75}	For future use (=0)	E_{74}	For future use (=0)	E_{73}	For future use (=0)	E_{72}	For future use (=0)
E_{71}	For future use (=0)	E_{70}	For future use (=0)	E_{69}	For future use (=0)	E_{68}	For future use (=0)
E_{67}	For future use (=0)	E_{66}	For future use (=0)	E_{65}	For future use (=0)	E_{64}	For future use (=0)
E_{63}	For future use (=0)	E_{62}	For future use (=0)	E_{61}	For future use (=0)	E_{60}	For future use (=0)
E_{59}	GYRO Z: Config.error	E_{58}	GYRO Y: Config.error	E_{57}	GYRO X: Config.error	E_{56}	Self-test not running
E_{55}	UART unable to transmit	E_{54}	GYRO Z: data missing	E_{53}	GYRO Y: Data missing	E_{52}	GYRO X: Data missing
E_{51}	Transmit stack warning	E_{50}	Flash stack warning	E_{49}	Sample stack warning	E_{48}	Command stack warning
E_{47}	Monitor stack warning	E_{46}	Flash check error	E_{45}	RAM check error	E_{44}	GYRO Z: Data lost
E_{43}	GYRO Z: Exc.ampl.error	E_{42}	GYRO Z: Int.comm.error	E_{41}	For future use (=0)	E_{40}	For future use (=0)
E_{39}	GYRO Z: ASIC overflow, I	E_{38}	GYRO Z: ASIC overflow, Q	E_{37}	GYRO Y: Data lost	E_{36}	GYRO Y: Exc.ampl.error
E_{35}	GYRO Y: Int.comm.error	E_{34}	For future use (=0)	E_{33}	For future use (=0)	E_{32}	GYRO Y: ASIC overflow, I
E_{31}	GYRO Y: ASIC overflow, Q	E_{30}	GYRO X: Data lost	E_{29}	GYRO X: Exc.ampl.error	E_{28}	GYRO X: Int.comm.error
E_{27}	For future use (=0)	E_{26}	For future use (=0)	E_{25}	GYRO X: ASIC overflow, I	E_{24}	GYRO X: ASIC overflow, Q
E_{23}	Regulated voltage#3 error	E_{22}	Regulated voltage#2 error	E_{21}	Regulated voltage#1 error	E_{20}	Supply voltage error
E_{19}	Reference voltage#3 error	E_{18}	Reference voltage#2 error	E_{17}	Reference voltage#1 error	E_{16}	Start-up phase active
E_{15}	GYRO Z: Int.comm.error	E_{14}	GYRO Y: Int.comm.error	E_{13}	GYRO X: Int.comm.error	E_{12}	GYRO Z: Clipped
E_{11}	GYRO Y: Clipped	E_{10}	GYRO X: Clipped	E_9	TEMP GYRO Z: Error	E_8	TEMP GYRO Y: Error
E_7	TEMP GYRO X: Error	E_6	GYRO Z: ASIC temp.error	E_5	GYRO Y: ASIC temp.error	E_4	GYRO X: ASIC temp.error
E_3	µC temperature error	E_2	GYRO Z: Exc.freq.error	E_1	GYRO Y: Exc.freq.error	E_0	GYRO X: Exc.freq.error

Table 5-9: Specification of the Normal Mode datagram

Standard datagram	Extended datagram	Standard datagram w.CR+LF	Rate and temperature	Rate and counter	Rate and latency	Rate, temperature and counter	Rate, temperature and latency	7	6	5	4	3	2	1	0	Specification
0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	**Normal Mode datagram identifier:** 0x90 standard datagram
								1	0	0	1	0	0	1	0	0x92 extended datagram
								1	0	0	1	0	0	1	1	0x93 standard datagram w. CR+LF
								1	0	1	0	0	0	0	0	0xA0 datagram with rate and temperature
								1	0	1	0	0	0	1	0	0xA2 datagram with rate and counter
								1	0	1	0	0	1	0	0	0xA4 datagram with rate and latency
								1	0	0	1	1	0	0	1	0x99 datagram with rate, temperature and counter
								1	0	1	0	0	1	1	0	0xA6 datagram with rate, temperature and latency
1	1	1	1	1	1	1	1	x_{23}	x_{22}	x_{21}	x_{20}	x_{19}	x_{18}	x_{17}	x_{16}	X axis gyro output. Ref. chapter 7.2.2.3 for conversion to units
2	2	2	2	2	2	2	2	x_{15}	x_{14}	x_{13}	x_{12}	x_{11}	x_{10}	x_9	x_8	
3	3	3	3	3	3	3	3	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	
4	4	4	4	4	4	4	4	y_{23}	y_{22}	y_{21}	y_{20}	y_{19}	y_{18}	y_{17}	y_{16}	Y axis gyro output. Ref. chapter 7.2.2.3 for conversion to units
5	5	5	5	5	5	5	5	y_{15}	y_{14}	y_{13}	y_{12}	y_{11}	y_{10}	y_9	y_8	
6	6	6	6	6	6	6	6	y_7	y_6	y_5	y_4	y_3	y_2	y_1	y_0	
7	7	7	7	7	7	7	7	z_{23}	z_{22}	z_{21}	z_{20}	z_{19}	z_{18}	z_{17}	z_{16}	Z axis gyro output. Ref. chapter 7.2.2.3 for conversion to units
8	8	8	8	8	8	8	8	z_{15}	z_{14}	z_{13}	z_{12}	z_{11}	z_{10}	z_9	z_8	
9	9	9	9	9	9	9	9	z_7	z_6	z_5	z_4	z_3	z_2	z_1	z_0	
10	10	10	10	10	10	10	10	s_7	s_6	s_5	s_4	s_3	s_2	s_1	s_0	STATUS byte. Ref.Table 5-10 for specification of this byte.
N/A	11	N/A	N/A	N/A	N/A	N/A	N/A	x	x	x	x	x	x	x	x	For future use.
N/A	12	N/A	N/A	N/A	N/A	N/A	N/A	x	x	x	x	x	x	x	x	For future use.
N/A	13	N/A	N/A	N/A	N/A	N/A	N/A	x	x	x	x	x	x	x	x	For future use.
N/A	N/A	N/A	11	N/A	N/A	11	11	Tx_{15}	Tx_{14}	Tx_{13}	Tx_{12}	Tx_{11}	Tx_{10}	Tx_9	Tx_8	X axis temperature data. Ref. chapter 7.2.2.3.5 for conversion to units
N/A	N/A	N/A	12	N/A	N/A	12	12	Tx_7	Tx_6	Tx_5	Tx_4	Tx_3	Tx_2	Tx_1	Tx_0	
N/A	N/A	N/A	13	N/A	N/A	13	13	Ty_{15}	Ty_{14}	Ty_{13}	Ty_{12}	Ty_{11}	Ty_{10}	Ty_9	Ty_8	Y axis temperature data. Ref. chapter 7.2.2.3.5 for conversion to units
N/A	N/A	N/A	14	N/A	N/A	14	14	Ty_7	Ty_6	Ty_5	Ty_4	Ty_3	Ty_2	Ty_1	Ty_0	
N/A	N/A	N/A	15	N/A	N/A	15	15	Tz_{15}	Tz_{14}	Tz_{13}	Tz_{12}	Tz_{11}	Tz_{10}	Tz_9	Tz_8	Z axis temperature data. Ref. chapter 7.2.2.3.5 for conversion to units
N/A	N/A	N/A	16	N/A	N/A	16	16	Tz_7	Tz_6	Tz_5	Tz_4	Tz_3	Tz_2	Tz_1	Tz_0	
N/A	N/A	N/A	N/A	11	N/A	17	N/A	n_7	n_6	n_5	n_4	n_3	n_2	n_1	n_0	Counter. Ref. chapter 7.2.2.3.6
N/A	N/A	N/A	N/A	N/A	11	N/A	17	l_{15}	l_{14}	l_{13}	l_{12}	l_{11}	l_{10}	l_9	l_8	Latency. Ref. chapter 7.2.2.3.7 for conversion to units.
N/A	N/A	N/A	N/A	N/A	12	N/A	18	l_7	l_6	l_5	l_4	l_3	l_2	l_1	l_0	
11	14	11	17	12	13	18	19	c_7	c_6	c_5	c_4	c_3	c_2	c_1	c_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
N/A	N/A	12	N/A	N/A	N/A	N/A	N/A	0	0	0	0	1	1	0	1	<CR>
N/A	N/A	13	N/A	N/A	N/A	N/A	N/A	0	0	0	0	1	0	1	0	<LF>

5.4 Status byte

Table 5-10: Interpretation of bits in STATUS byte

| Bit	STATUS bit information	Comment
7	0=OK, 1=System integrity error	
6	0=OK, 1=Start-Up	
5	0=OK, 1=Outside operating conditions	
4	0=OK, 1=Overload	Bits 0-2 will flag the overload channel(s)
3	0=OK, 1=Error in gyro channel	Bits 0-2 will flag the error channel(s)
2	0=OK, 1=Z channel	
1	0=OK, 1=Y channel	
0	0=OK, 1=X channel	

6 MECHANICAL

Table 6-1: Mechanical specifications

Parameter	Conditions	Min	Nom	Max	Unit	Note
WEIGHT			55		grams	
DUST AND HUMIDITY CLASSIFICATION			IP56			
CONNECTOR Type Number of pins Contact type			Nicomatic CMM220 series male 10 LF			
PLUG Proposed plug to fit connector Proposed cover to fit plug			Nicomatic CMM-222-S-10-A32 Nicomatic CMM-C2-15			
FIXATION BOLTS	2.5mm tool 3mm tool		M4 DIN 7991-A2 M4 DIN 912-A2			

6.1 Mechanical dimensions

All dimensions are in mm.

Figure 6-1: Mechanical dimensions

Figure 6-2: Drilling pattern
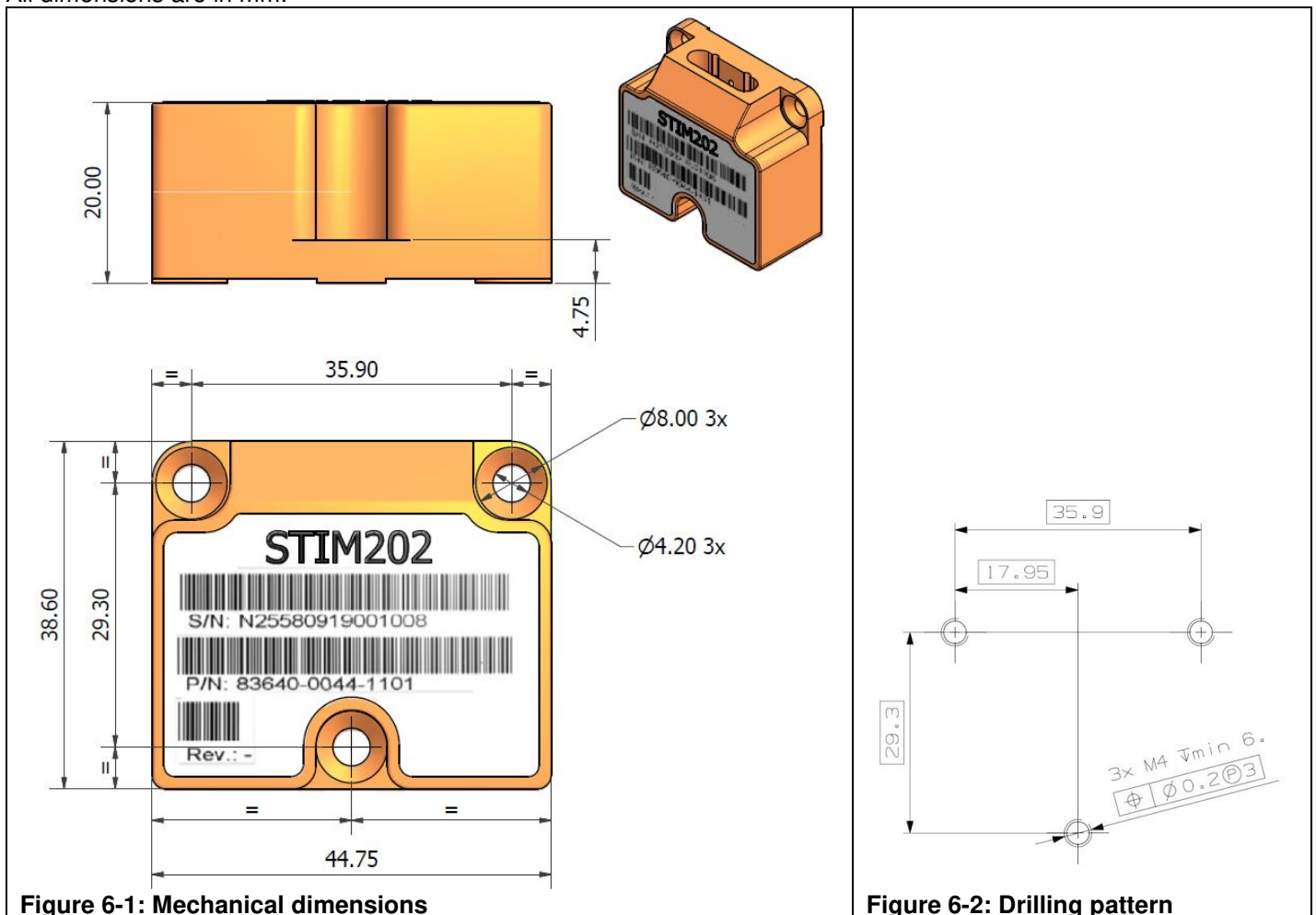
6.2 Advice on mounting orientation
The gyros are sensitive to acceleration-forces in certain directions:
- X- and Y-gyros have their highest sensitivity to acceleration-forces in Z-direction
- Z-gyro has its highest sensitivity to acceleration-forces in Y-direction
- X-gyro has its lowest sensitivity to acceleration-forces in X-direction
- Y-gyro has its lowest sensitivity to acceleration-forces in Y-direction
- Z-gyro has its lowest sensitivity to acceleration-forces in Z-direction

6.3   Pin configuration
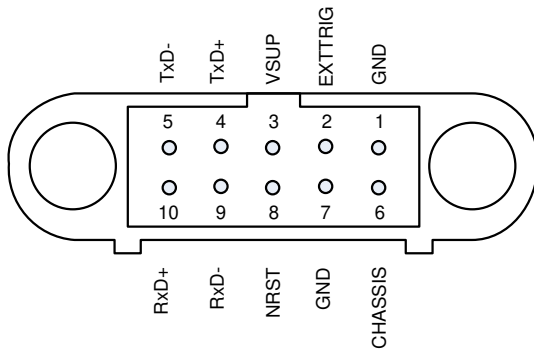
Figure 6-3: Pin configuration as seen from front of STIM202

Table 6-2: Pin descriptions

Pin#	Label	Type	Description
1	GND	SUPPLY	Power ground (0V)
2	EXTTRIG	INPUT	External trigger input (if not in use, connect to GND)
3	VSUP	SUPPLY	Power supply (+5V)
4	TxD+	OUTPUT	RS422 positive output
5	TxD-	OUTPUT	RS422 negative output
6	CHASSIS	CHASSIS	Chassis connection (galvanic isolation from power ground)
7	GND	INPUT	Test pin: Connect to ground (0V)
8	NRST	INPUT	Reset (if not in use, connect to VSUP or leave floating)
9	RxD-	INPUT	RS422 negative input
10	RxD+	INPUT	RS422 positive input

6.4   Definition of axes
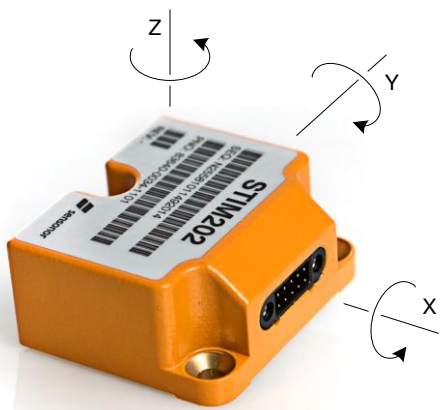
Figure 6-4: Definition of axes
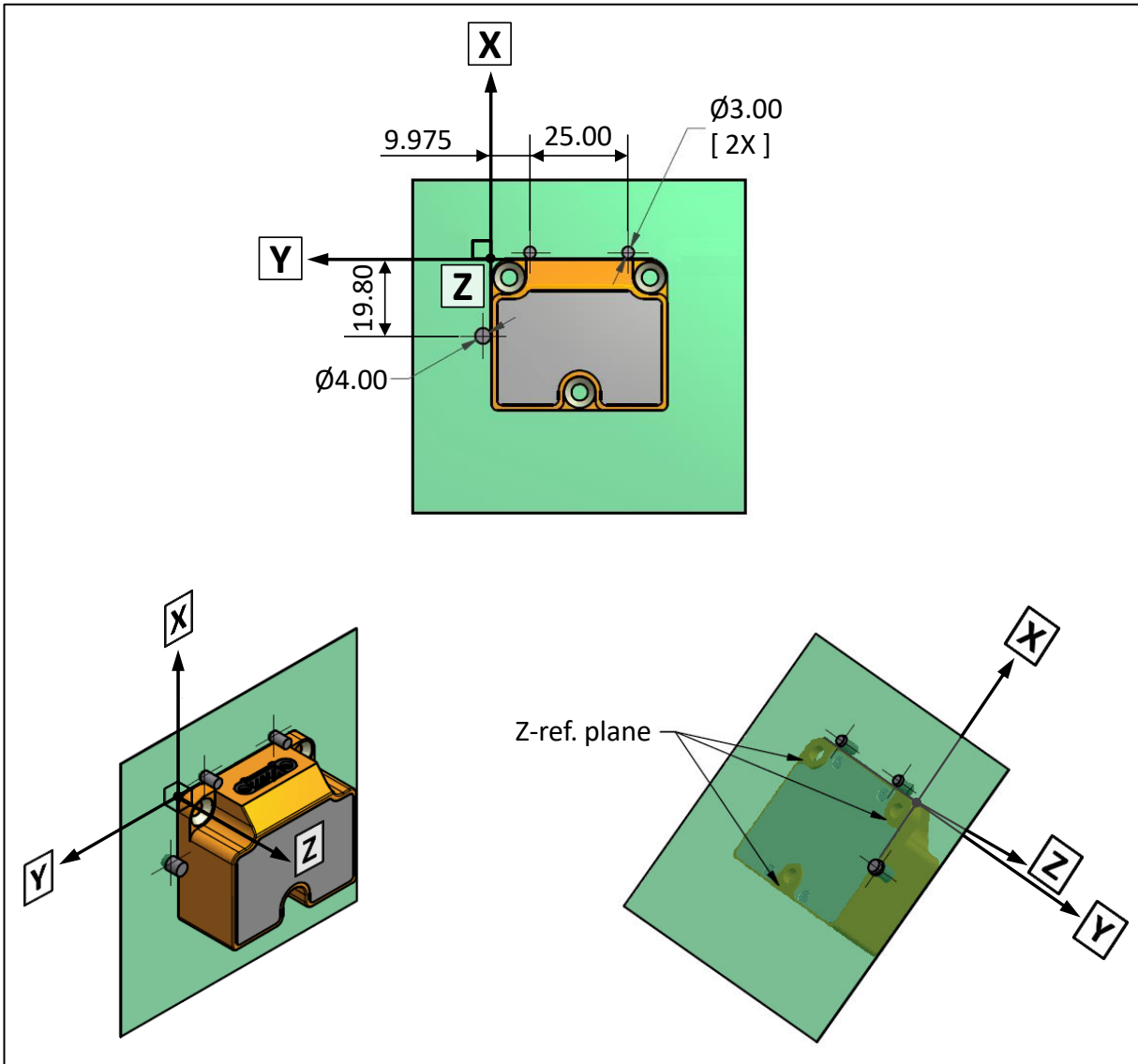
Figure 6-5: Reference points for alignment of axes

7 BASIC OPERATION

STIM202 is very simple to use. After having connected power, the unit will start performing measurements and transmit the results over the RS422 interface without any need for additional signalling or set-up. Figure 7-1 shows the simplest connection set-up for STIM202.
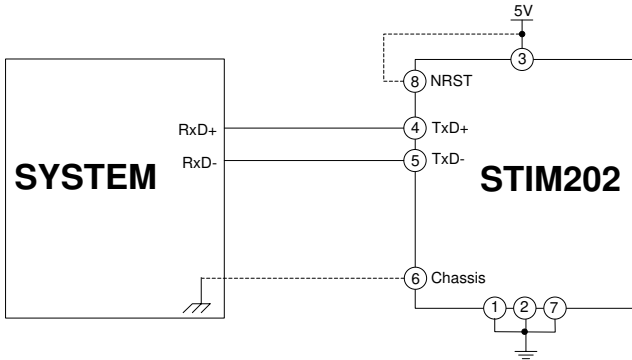
Figure 7-1: Transmit-Only Electrical Connection Diagram

In order to take full advantage of all features of STIM202 the unit needs to be connected as shown in Figure 7-2. In this set-up the system can reset the unit without having to toggle power, external trigger functionality can be utilized, configuration parameters can be changed and extended information like diagnostic information can be read from the device.
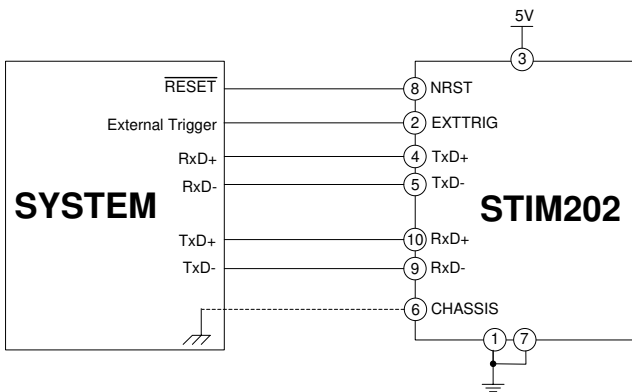
Figure 7-2: Full Function Electrical Connection Diagram

7.1 Reset

STIM202 has a separate reset pin (NRST) in order for the application to reset the unit without having to toggle power.

The reset is active low and has an internal pull-up. Hence the input could be left floating if not in use.

The reset signal is routed to the reset of the microcontroller and effectively forces STIM202 into Init Mode (ref. Figure 7-3 and chapter 7.2.1).

7.2   Operating modes
The operating modes of STIM202 are shown in Figure 7-3:
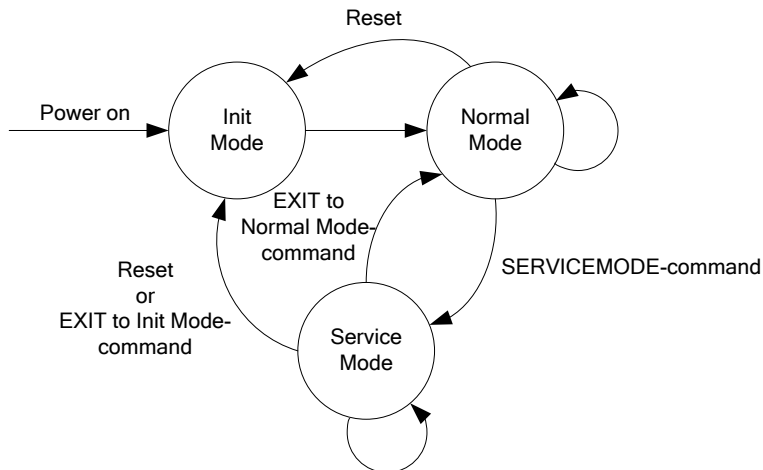
Figure 7-3: Operating modes

7.2.1   Init Mode
Init Mode is entered after power on, after an external reset, when receiving a reset command in Normal Mode or when exiting to Init Mode from Service Mode. In Init Mode the system waits for internal references to settle, resets and synchronizes the gyro measurements channels and transmits three special datagrams containing part number, serial number and configuration data.

Table 5-4 specifies the sequence and contents of the Part Number datagram.
Table 5-5 specifies the sequence and contents of the Serial Number datagram.
Table 5-6 specifies the sequence and contents of the Configuration datagram.

After having transmitted the special Part Number, Serial Number and Configuration datagrams, STIM202 enters Normal Mode. All these special datagrams can also be requested by commands in Normal Mode, ref. chapter 8.

7.2.2   Normal Mode
In Normal Mode STIM202 will constantly measure the gyro channels at an internal sample rate of 1000 samples/s and transmit at the chosen sample rate, alternatively when receiving an external trigger, dependent on the selected datagram. STIM202 will transmit data regardless of any errors reported in the STATUS byte (ref. Table 5-10). Hence the content of the STATUS byte should continuously be examined.

Table 5-7: Specification of the Extended Error Information datagram

Byte#	Bit#								Specification
	7	6	5	4	3	2	1	0	
0	0	0	1	0	1	1	1	0	**Extended Error Information datagram identifier:** 0x2E for datagrams without CR+LF termination
	0	0	1	0	1	1	1	1	0x2F for datagrams with CR+LF termination
1	E_{79}	E_{78}	E_{77}	E_{76}	E_{75}	E_{74}	E_{73}	E_{72}	Ref. Table 5-8
2	E_{71}	E_{70}	E_{69}	E_{68}	E_{67}	E_{66}	E_{65}	E_{64}	Ref. Table 5-8
3	E_{63}	E_{62}	E_{61}	E_{60}	E_{59}	E_{58}	E_{57}	E_{56}	Ref. Table 5-8
4	E_{55}	E_{54}	E_{53}	E_{52}	E_{51}	E_{50}	E_{49}	E_{48}	Ref. Table 5-8
5	E_{47}	E_{46}	E_{45}	E_{44}	E_{43}	E_{42}	E_{41}	E_{40}	Ref. Table 5-8
6	E_{39}	E_{38}	E_{37}	E_{36}	E_{35}	E_{34}	E_{33}	E_{32}	Ref. Table 5-8
7	E_{31}	E_{30}	E_{29}	E_{28}	E_{27}	E_{26}	E_{25}	E_{24}	Ref. Table 5-8
8	E_{23}	E_{22}	E_{21}	E_{20}	E_{19}	E_{18}	E_{17}	E_{16}	Ref. Table 5-8
9	E_{15}	E_{14}	E_{13}	E_{12}	E_{11}	E_{10}	E_9	E_8	Ref. Table 5-8
10	E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0	Ref. Table 5-8
11	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0	Cyclic Redundancy Check is performed on all preceding bytes and is generated from the polynomial: $x^8 + x^2 + x + 1$, seed = 0xFF
(12)	0	0	0	0	1	1	0	1	<CR> If datagram termination has been selected
(13)	0	0	0	0	1	0	1	0	<LF> If datagram termination has been selected

Table 5-8: Specification of the Extended Error Information

Bit#	Specification	Bit#	Specification	Bit#	Specification	Bit#	Specification
E_{79}	For future use (=0)	E_{78}	For future use (=0)	E_{77}	For future use (=0)	E_{76}	For future use (=0)
E_{75}	For future use (=0)	E_{74}	For future use (=0)	E_{73}	For future use (=0)	E_{72}	For future use (=0)

E_{71}	For future use (=0)	E_{70}	For future use (=0)	E_{69}	For future use (=0)	E_{68}	For future use (=0)
E_{67}	For future use (=0)	E_{66}	For future use (=0)	E_{65}	For future use (=0)	E_{64}	For future use (=0)
E_{63}	For future use (=0)	E_{62}	For future use (=0)	E_{61}	For future use (=0)	E_{60}	For future use (=0)
E_{59}	GYRO Z: Config,error	E_{58}	GYRO Y: Config,error	E_{57}	GYRO X: Config.error	E_{56}	Self-test not running
E_{55}	UART unable to transmit	E_{54}	GYRO Z: data missing	E_{53}	GYRO Y: Data missing	E_{52}	GYRO X: Data missing
E_{51}	Transmit stack warning	E_{50}	Flash stack warning	E_{49}	Sample stack warning	E_{48}	Command stack warning
E_{47}	Monitor stack warning	E_{46}	Flash check error	E_{45}	RAM check error	E_{44}	GYRO Z: Data lost
E_{43}	GYRO Z: Exc.ampl.error	E_{42}	GYRO Z: Int.comm.error	E_{41}	For future use (=0)	E_{40}	For future use (=0)
E_{39}	GYRO Z: ASIC overflow, I	E_{38}	GYRO Z: ASIC overflow, Q	E_{37}	GYRO Y: Data lost	E_{36}	GYRO Y: Exc.ampl.error
E_{35}	GYRO Y: Int.comm.error	E_{34}	For future use (=0)	E_{33}	For future use (=0)	E_{32}	GYRO Y: ASIC overflow, I
E_{31}	GYRO Y: ASIC overflow, Q	E_{30}	GYRO X: Data lost	E_{29}	GYRO X: Exc.ampl.error	E_{28}	GYRO X: Int.comm.error
E_{27}	For future use (=0)	E_{26}	For future use (=0)	E_{25}	GYRO X: ASIC overflow, I	E_{24}	GYRO X: ASIC overflow, Q
E_{23}	Regulated voltage#3 error	E_{22}	Regulated voltage#2 error	E_{21}	Regulated voltage#1 error	E_{20}	Supply voltage error
E_{19}	Reference voltage#3 error	E_{18}	Reference voltage#2 error	E_{17}	Reference voltage#1 error	E_{16}	Start-up phase active
E_{15}	GYRO Z: Int.comm.error	E_{14}	GYRO Y: Int.comm.error	E_{13}	GYRO X: Int.comm.error	E_{12}	GYRO Z: Clipped
E_{11}	GYRO Y: Clipped	E_{10}	GYRO X: Clipped	E_9	TEMP GYRO Z: Error	E_8	TEMP GYRO Y: Error
E_7	TEMP GYRO X: Error	E_6	GYRO Z: ASIC temp.error	E_5	GYRO Y: ASIC temp.error	E_4	GYRO X: ASIC temp.error
E_3	µC temperature error	E_2	GYRO Z: Exc.freq.error	E_1	GYRO Y: Exc.freq.error	E_0	GYRO X: Exc.freq.error

Table 5-9 specifies the sequence and contents of the datagrams transmitted in Normal Mode.

7.2.2.1   Start-Up

When STIM202 enters Normal Mode from Init Mode, there will be a start-up period where STIM202 is stabilizing the gyros. This is a fixed period as specified in Table 5-2 and bit 6 is set in the STATUS byte (ref. Table 5-10) to communicate this condition. During the start-up period STIM202 will continuously sample, compensate and output data.

There will not be any start-up period when STIM202 is exiting from Service Mode directly to Normal Mode.

7.2.2.2   External trigger

STIM202 can be configured to transmit data only when being externally triggered (ref. chapter 11). Trigger will be on negative going edge. Once having received a trigger signal the STIM202 will transmit one datagram containing the currently available data.

NB: external trigger input is 3.3V logic. The input pin has an internal pull-up, hence the pin can be driven by open-collector logic to avoid the need for external 3.3V logic.
Note that STIM202 will always transmit the 3 special datagrams when leaving Init Mode even if datagram with external trigger has been chosen and that it will respond in Service Mode as described in chapter 9 regardless of external trigger input.

The timing diagram is shown in Figure 7-4. Latency is the time from the sample has been digitized and low-pass filtered to the external trigger occurs.
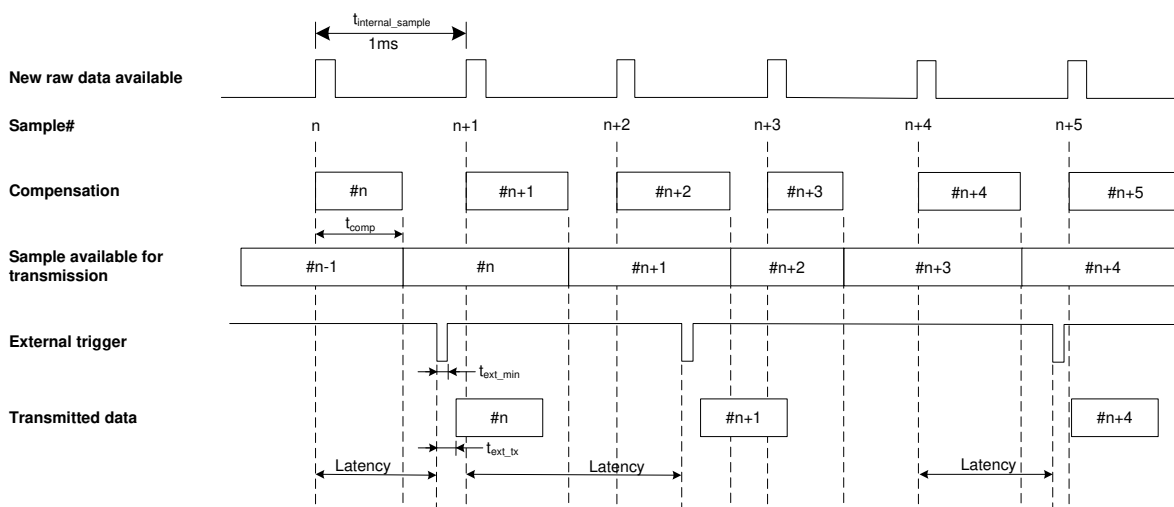

Figure 7-4: Timing of external trigger

7.2.2.3 Data output options and interpretation

The gyros in STIM202 measure angular rate [°/s]. However, in order to make the STIM202 more versatile, a few simple functions are offered, ref. Table 7-1:

Table 7-1: Implemented functions for gyro output units

Function	Description of function	Equation	Output unit
Incremental	Adds all internal samples between two transmissions multiplied by the time between internal samples	$$Incremental = \sum_{i=1}^{n} AngularRate_i \cdot \frac{1}{1000}s$$ n = 1000 / sample rate	[°]
Average	Calculates the average of the internal samples between two transmissions	$$Average = \frac{1}{n} \cdot \sum_{i=1}^{n} AngularRate_i$$ n = 1000 / sample rate	[°/s]
Integrated	Adds all internal samples multiplied by the time between internal samples since start-up / last reset. Note that the result takes values in the interval [-4°, 4°> and will naturally wrap-around with no error-message indication in the Status-byte	$$Integrated = \sum_{i=1}^{n} AngularRate_i \cdot \frac{1}{1000}s$$ n = internal samples (at a rate of 1000 samples/s) since start-up or last reset)	[°]

7.2.2.3.1 Angular Rate

Angular Rate is available in all datagrams when STIM202 has been configured to output angular rate. The transmitted data will be the last internal sample. E.g. in the case of continuous transmission of datagrams and a sample rate of 250 samples/s, every fourth internally sample will be transmitted.

Equation 1 and Figure 7-5 show how to convert to [°/s]. Note that the output data is represented as two's complement.

Equation 1: Converting output to [°/s]:

$$Output[°/s] = \frac{(AR_1) \cdot 2^{16} + (AR_2) \cdot 2^{8} + (AR_3) - (AR_{b23}) \cdot 2^{24}}{2^{14}}$$

where AR_1 is the most significant byte of the 24bit output
AR_2 is the middle byte of the 24bit output
AR_3 is the least significant byte of the 24bit output
AR_{b23} is the most significant bit of AR_1

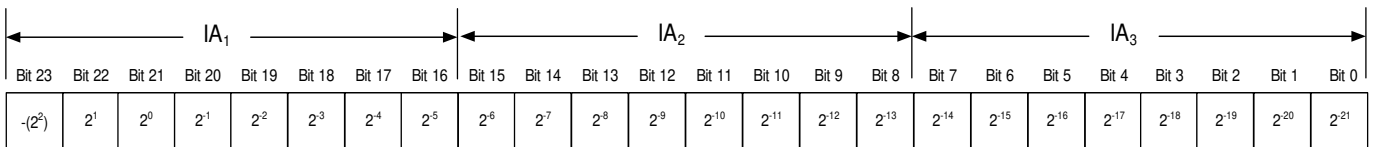|			AR$_1$								AR$_2$								AR$_3$				
Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 17	Bit 16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
$-(2^9)$	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}
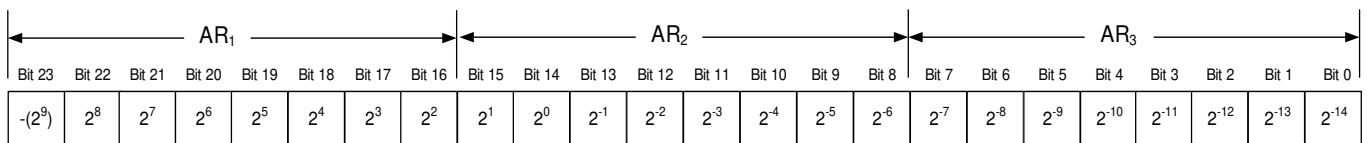
Figure 7-5: Converting output bytes to [°/s]

7.2.2.3.2 Incremental angle

In the case of STIM202 being configured to output incremental angle per sample, the equations for conversion to [°/sample] can be found in Equation 2 and Figure 7-6. Note that the output data is represented as two's complement.

Equation 2: Converting output to [°/sample]

$$Output[°/sample] = \frac{(IA_1) \cdot 2^{16} + (IA_2) \cdot 2^8 + (IA_3) - (IA_{b23}) \cdot 2^{24}}{2^{21}}$$

where IA_1 is the most significant byte of the 24bit output
            IA_2 is the middle byte of the 24bit output
            IA_3 is the least significant byte of the 24bit output
            IA_{b23} is the most significant bit of IA_1

IA₁								IA₂								IA₃							
Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 17	Bit 16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
$-(2^2)$	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}

Figure 7-6: Converting output bytes to [°/samples]

7.2.2.3.3 Average angular rate

In the case of STIM202 being configured to output average angular rate, the transmitted data will be the average of the samples since last transmission. E.g. in the case of continuous transmission of datagrams and a sample rate of 250Hz, each transmission will contain the average of the four previous internal samples.

Note that the configured low-pass filtering is performed prior to calculating the average.

Conversion to [°/s] is the same as for angular rate and is described in Equation 1.

7.2.2.3.4 Integrated angle

In the case of STIM202 being configured to output integrated angle, the transmitted data will be the continuously integrated angle since power-on or reset. The integrated angle takes values in the interval [-4°, 4°> and will naturally wrap-around with no error-message indication in the Status-byte.

Conversion to [°] is the same as for incremental angle and is described in Equation 2.

7.2.2.3.5 Temperature

Temperature data for each axis is available in certain datagrams (ref. chapter 11).

Equation 3 and Figure 7-7 show how to convert to [°C]. Note that the output data is represented as two's complement (most significant bit is the sign bit):

Equation 3: Converting temperature data to [°C]

$$Output[°C] = \frac{(T_1) \cdot 2^8 + (T_2) - (T_{b15}) \cdot 2^{16}}{2^8}$$

where T_1 is the most significant byte of the 16bit output
 T_2 is the least significant byte of the 16bit output
            T_{b15} is the most significant bit of T_1

T₁								T₂							
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
$-(2^7)$	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}
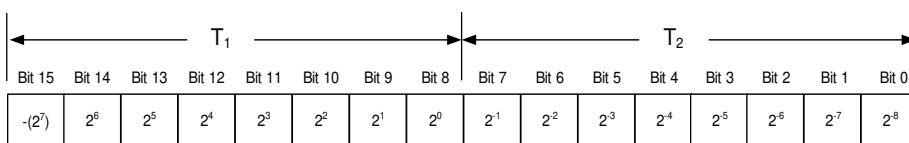
Figure 7-7: Converting temperature data to [°C]

7.2.2.3.6 Counter

A counter is available in certain datagrams (ref. chapter 11). The counter is continuously counting the internal samples (1000 samples/s). It is an un-signed single byte taking values in the interval [0 , 255]. The counter will naturally wrap-around with no error-message indication in the Status-byte.

7.2.2.3.7 Latency

Latency is available in certain datagrams (ref. chapter 11). Latency is an unsigned word taking values in the interval [0 , 65535] µs.

Equation 4 and Figure 7-8 show how to convert to [seconds]:

Equation 4: Converting latency data to [seconds]

$$Output[seconds] = \left((t_1) \cdot 2^8 + (t_2)\right) \cdot 10^{-6}$$

where t_1 is the most significant byte of the 16bit output
         t_2 is the least significant byte of the 16bit output
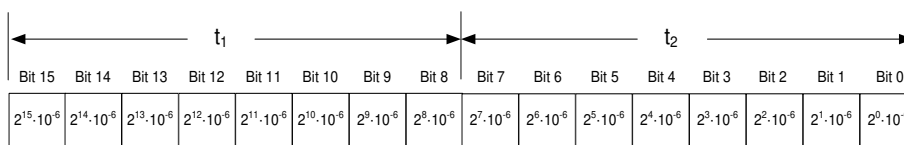
Figure 7-8: Converting latency data to [seconds]

7.2.3 Service Mode

In Service Mode the communication interface is human readable and hence the communication format supports well the use of terminal based software during the development phase, when the configuration of a device needs to be changed or during investigations into an observed problem.

When Service Mode is entered, STIM202 will respond with its configuration information (same as the response to the i (INFORMATION) command, ref: Figure 9-1).

A set of commands are available, ref. Chapter 9, enabling the user to change intermediately or permanently the configuration parameters, display latest measurement results, display higher details on error information and perform a full diagnostic of the unit.

In Service Mode the gyro measurements will still be running in the background, enabling to switch directly back to Normal Mode without the need for any stabilisation time of filters, etc. However the measurement data itself, when STIM202 is in Service Mode are not transmitted and therefore lost. By using the a (SINGLE-SHOT MEASUREMENT) command (ref. Chapter 9.2) it is possible to display single measurement results.

Exiting Service Mode can be done in several ways:
1. Using the external reset. This will force STIM202 into Init Mode. Be advised that during Init Mode, all the configuration parameters are loaded from flash. If any of the configuration parameters have been changed during the Service Mode session but not saved to flash, these changes will be overwritten by the content already stored in flash.
2. Using the x (EXIT) command. When using this command a parameter is required to decide whether the device should go to Init Mode or to Normal Mode. When exiting to Normal Mode, any of the changes made to the configuration parameters will still be valid. However, if not saved, the configuration parameters will be overwritten by the content already stored in flash at the next power-up or reset.

7.3 Self diagnostics
STIM202 is constantly checking its internal status. The checks include:
- Check of internal references
- Check of gyros (error and overload)
- Check of internal temperatures
- Check of RAM and flash
- Check of supply voltage

When an error situation is detected, the corresponding bit in the STATUS byte (ref. Table 5-10) will be set.

The bits in the STATUS are valid for the data in a single transmission. Hence any error condition is not latched.

In Service Mode it is possible to see the last detected error by using the i e (INFORMATION on LAST ERROR IN NORMAL MODE) command, ref. Chapter 9.1 or run a full diagnostic and see the result of the individual checks by using the c (DIAGNOSTIC) command, ref. Chapter 9.3.

8 COMMANDS IN NORMAL MODE

Several commands are available in Normal Mode, as listed in Table 8-1. Note that all commands in Normal Mode must be transmitted in upper case letters.

Table 8-1 Available commands in Normal Mode

Command	Short description
N	Transmits one Part Number datagram
I	Transmits one Serial Number datagram
C	Transmits one Configuration datagram
E	Transmits one Extended Error Information datagram
R	Resets the unit
SERVICEMODE	Enters Service Mode

Table 8-2 List of special ASCII characters used in Normal Mode

Char	Hex	Dec	Short description
<CR>	0x0D	13	"Carriage Return": used as execution character for commands

No echo of received command characters nor error messages will appear for these commands. Only at the receipt of the complete correct command, STIM202 executes accordingly.

NB: if OUTPUT UNIT is set to INCREMENTAL ANGLE (ref. Chapter 9.7), the transmitted incremented angle in the datagram following any of the requested special datagrams will NOT contain the incremental angle since the last transmitted measurement. Hence the incremented angle occurring during the transmission of a special requested datagram will be lost.

8.1 N (PART NUMBER DATAGRAM) command
General description: Requests transmission of a Part Number datagram (ref. Table 5-4).

Table 8-3 : Available I (PART NUMBER DATAGRAM) command

Syntax	Response
N<CR>	Transmits one Part Number datagram

The Part Number datagram will replace the next transmitted Normal Mode datagram.

8.2 I (SERIAL NUMBER DATAGRAM) command
General description: Requests transmission of a Serial number datagram (ref. Table 5-5).

Table 8-4 : Available I (SERIAL NUMBER DATAGRAM) command

Syntax	Response
I<CR>	Transmits one Serial Number datagram

The Serial Number datagram will replace the next transmitted Normal Mode datagram.

8.3 C (CONFIGURATION DATAGRAM) command
General description: Requests transmission of a configuration datagram (ref. Table 5-6).

Table 8-5: Available C (CONFIGURATION DATAGRAM) command

Syntax	Response
C<CR>	Transmits one Configuration datagram

The Configuration datagram will replace the next transmitted Normal Mode datagram.

8.4 E (EXTENDED ERROR INFORMATION DATAGRAM) command

General description: Requests transmission of an Extended Error Information datagram (ref.
Table 5-7). This datagram contains the accumulated detected errors (ref. section 7.3).

Once the Extended Error Information datagram has been transmitted, the error-registers are cleared.

Table 8-6: Available E (EXTENDED ERROR INFORMATION) command

Syntax	Response
E<CR>	Transmits one Extended Error Information datagram

The Extended Error Information datagram will replace the next transmitted Normal Mode datagram. If the Extended Error Information datagram is longer than the chosen Normal Mode datagram, the Extended Error Information datagram may replace more than one Normal Mode datagram transmission (dependent on sampling-rate and bit-rate).

8.5 R (RESET) command
General description: Force a Reset (ref. Figure 7-3).

Table 8-7: Available R (RESET) command

Syntax	Response
R<CR>	Resets the unit

8.6 SERVICEMODE command
General description : Enters Service Mode (ref. chapter 7.2.3).

Table 8-8: Available SERVICEMODE command

Syntax	Response
SERVICEMODE<CR>	Enters Service Mode

If the command is received during the transmission of a datagram, it will complete the transmission before entering Service Mode.

When entering Service Mode, the configuration and identification data of the device will be listed, as shown in Figure 8-1:

```
SERIAL NUMBER = N25581915623782
PRODUCT = STIM202
PART NUMBER = 84556-1034-0121 REV B
HW CONFIG = M5432 REV 13
FW CONFIG = SWD11768 REV 12
OUTPUT UNIT = [°/sample] – INCREMENTAL ANGLE
SAMPLE RATE [samples/s] = 1000
LP FILTER -3dB FREQUENCY, X-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Y-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Z-AXIS [Hz] = 262
DATAGRAM FORMAT = STANDARD
BIT RATE [bps] = 374400
DATA LENGTH = 8
STOP BITS = 1
PARITY = EVEN
LINE TERMINATION = ON


>
```
Figure 8-1: Example of response from SERVICEMODE command

9 COMMANDS IN SERVICE MODE

Several commands are available in Service Mode, as listed in Table 9-1. Note that all commands in Service Mode must be transmitted in lower case letters.

Note that backward compatibility in Service Mode responses is not guaranteed.

Table 9-1 Available commands in Service Mode

Command	Short description
i	Lists specific information (e.g. serial number, configuration, error information)
a	Performs a single-shot measurement
c	Performs a diagnostic of the unit
d	Changes datagram format (standard, extended or standard with CR+LF-termination)
t	Changes transmission parameters (e.g. bit rate, data length, stop bits)
r	Turns line termination ON or OFF
u	Changes measurement output unit
f	Changes LP filter -3dB frequency
m	Changes sample rate
s	Saves configuration data
x	Exits Service Mode and returns to Normal Mode or Init Mode
z	Restore to factory settings
?	Help function on the available commands in Service Mode

Table 9-2 List of special ASCII characters used in Service Mode

Char	Hex	Dec	Short description
<BS>	0x08	8	"Back Space": deletes last received character (received since last <CR>)
<CR>	0x0D	13	"Carriage Return": typically used as execution character for commands
<SP>	0x20	32	"Space": used to separate command and first parameter
','	0x2C	44	"Comma": used to separate parameters in a command
'>'	0x3E	62	Used together with <CR> as: "Ready to receive new command" prompt

When STIM202 is in Service Mode and ready to receive a new command, it will issue the special ASCII character <CR> followed by '>'. As some commands (e.g. SINGLE-SHOT MEASUREMENT command) may respond with a varying number of lines, automated set-ups should look for the special prompt sequence (<CR>+'>') before issuing a new command.

Received characters will be echoed. A command is decoded and executed when receiving the special ASCII character <CR>. <BS> is also recognised and will delete the last received character in the input buffer. The size of the input buffer is 80 characters. <BS> is valid for the characters received since last <CR>.

The command character and first parameter (when applicable) are separated by a space (character 0x20). When there are more than one parameter to a command (e.g. TRANSMISSION PARAMETER command), these must be separated by a comma (character 0x2C).

In the event of an unknown command, inconsistent syntax or incorrect value of parameter(s), STIM202 will respond with an error message. Error messages are on the format:

E<nnn><SP><Error description><CR>

where; nnn is an error number

9.1 i (INFORMATION) command

General description: Lists various requested information about the device

Table 9-3 : Available i (INFORMATION) commands

Syntax	Response
i<CR>	Lists the product configuration and identification data
i<SP><cmd><CR>	Gives information about the specific parameter

Table 9-4 : Allowed values for <cmd> parameter for i (INFORMATION) commands

<cmd>	Result
s	Returns the serial number of the device
n	Returns the product name of the device
x	Returns the part number of the device
h	Returns the HW configuration and revision of the device
p	Returns the FW configuration and revision of the device
m	Returns the sample rate of the device
f	Returns the LP filter -3dB frequency for each axis
d	Returns the datagram format
t	Returns the transmission parameters of the device
r	Returns the line termination (ON or OFF)
u	Returns the output unit of the device
e	Prints the extended error information from the last detected error in Normal Mode

Table 9-5: Error messages for i (INFORMATION) commands

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command or parameter is not recognised
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter

```
>i
SERIAL NUMBER = N25581915623782
PRODUCT = STIM202
PART NUMBER = 84556-1034-0121 REV B
HW CONFIG = M5432 REV 13
FW CONFIG = SWD11768 REV 12
OUTPUT UNIT = [°/sample] – INCREMENTAL ANGLE
SAMPLE RATE [samples/s] = 1000
LP FILTER -3dB FREQUENCY, X-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Y-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Z-AXIS [Hz] = 262
DATAGRAM FORMAT = STANDARD
BIT RATE [bps] = 374400
DATA LENGTH = 8
STOP BITS = 1
PARITY = EVEN
LINE TERMINATION = ON


>
```
Figure 9-1: Example of response from i (INFORMATION) command

```
>i s
SERIAL NUMBER = N25581915623782


>
```
Figure 9-2: Example of response from i s (INFORMATION on SERIAL NUMBER) command

```
>i n
PRODUCT = STIM202


>
```
Figure 9-3: Example of response from i n (INFORMATION on PRODUCT NAME) command

```
>i x
PART NUMBER = 84556-1034-0121 REV B

>
```

Figure 9-4: Example of response from i x (INFORMATION on PART NUMBER) command

```
>i h
HW CONFIG = M5432 REV 13

>
```

Figure 9-5: Example of response from i h (INFORMATION on HW CONFIGURATION) command

```
>i p
FW CONFIG = SWD11768 REV 12

>
```

Figure 9-6: Example of response from i p (INFORMATION on FW CONFIGURATION) command

```
>i m
SAMPLE RATE [samples/s] = 1000

>
```

Figure 9-7: Example of response from i m (INFORMATION on SAMPLE RATE) command

```
>i f
LP FILTER -3dB FREQUENCY, X-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Y-AXIS [Hz] = 262
LP FILTER -3dB FREQUENCY, Z-AXIS [Hz] = 262

>
```

Figure 9-8: Example of response from i f (INFORMATION on LP FILTER -3dB FREQUENCY) command

```
>i d
DATAGRAM FORMAT = STANDARD

>
```

Figure 9-9: Example of response from i d (INFORMATION on DATAGRAM CONTENT) command

```
>i t
BIT RATE [bps] = 374400
DATA LENGTH = 8
STOP BITS = 1
PARITY = EVEN

>
```

Figure 9-10: Example of response from i t (INFORMATION on TRANSMISSION PARAMETERS) command

```
>i r
LINE TERMINATION = ON

>
```

Figure 9-11: Example of response from i r (INFORMATION) command

```
>i u
OUTPUT UNIT = [°/sample] – INCREMENTAL ANGLE

>
```

Figure 9-12: Example of response from i u (INFORMATION on OUTPUT UNIT) command

```
>i e
GYRO Z-AXIS NO CLIPPING DETECTED = FAIL

LAST ERROR HISTORY IS NOW CLEARED

>
```

Figure 9-13: Example of response from i e (INFORMATION on LAST ERROR IN NORMAL MODE) command

9.2 a (SINGLE-SHOT MEASUREMENT) command

General description: Displays the result of latest measurement (measurement process running constantly in the background).

If sample rate has been set to external trigger, the SINGLE-SHOT MEASUREMENT will respond to the measurement result at the latest trigger. Hence if no trigger is received, the command will respond with the same data if sent multiple times.

Table 9-6: Available a (SINGLE-SHOT MEASUREMENT) command

Syntax	Response
a<CR>	Displays the result of the latest measurement sample

Table 9-7: Error messages for a (SINGLE-SHOT MEASUREMENT) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Any characters between command and <CR>

```
>a
X-AXIS = 1.43255°/s
Y-AXIS = 3.42847°/s
Z-AXIS = 243.33667°/s
STATUS = 00000000 = OK

>
```
Figure 9-14: Example of response from a (SINGLE-SHOT MEASUREMENT) command

```
>a
X-AXIS = 0.000716275°
Y-AXIS = 0.043718269°
Z-AXIS = 0.121668335°
STATUS = 00100101 = NOT OK
BIT 5: OUTSIDE OPERATING CONDITIONS
BIT 2: ERROR IN Z-CHANNEL
BIT 0: ERROR IN X-CHANNEL

>
```
Figure 9-15: Example of response from a (SINGLE-SHOT MEASUREMENT) command with error flagging

9.3   c (DIAGNOSTIC) command

General description: Performs a diagnostic of the unit.

Table 9-8: Available c (DIAGNOSTIC) command

Syntax	Response
c<CR>	Performs a diagnostic check

Table 9-9: Error messages for c (DIAGNOSTIC) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Any characters between command and <CR>

```
>c
SERIAL NUMBER = N25581915623782
PRODUCT = STIM202
PART NUMBER = 84556-1034-0121 REV B
HW CONFIG = M5432 REV 13
FW CONFIG = SWD11768 REV 12
SYSTEM STATUS:
  RAM CHECK = OK
  FLASH CHECK = OK
  STACK STATUS MONITOR  = OK
  STACK COMMAND HANDLER  = OK
  STACK SAMPLE  = OK
  STACK FLASH  = OK
  STACK TRANSMIT  = OK
  MICRO CONTROLLER TEMPERATURE  = OK
  START-UP PHASE = NOT ACTIVE
  SELF-TEST RUNNING = OK
  UART = OK
VOLTAGES AND REFERENCES:
  REFERENCE VOLTAGE_1 = OK
  REFERENCE VOLTAGE_2 = OK
  REFERENCE VOLTAGE_3 = OK
  REGULATED VOLTAGE_1 = OK
  REGULATED VOLTAGE_2  = OK
  REGULATED VOLTAGE_3  = OK
  SUPPLY VOLTAGE 5.0V = OK
GYRO X-AXIS:
  GYRO X-AXIS DATA RECEIVED = OK
  GYRO X-AXIS EXCITATION FREQUENCY = OK
  GYRO X-AXIS ASIC TEMPERATURE = OK
  GYRO X-AXIS TEMPERATURE = OK
  GYRO X-AXIS NO CLIPPING DETECTED = OK
  GYRO X-AXIS INTERNAL COMMUNICATION = OK
  GYRO X-AXIS NO ASIC OVERFLOW DETECTED = OK
  GYRO X-AXIS EXCITATION AMPLITUDE = OK
  GYRO X-AXIS CONFIGURATION  = OK
GYRO Y-AXIS:
  GYRO Y-AXIS DATA RECEIVED = OK
  GYRO Y-AXIS EXCITATION FREQUENCY = OK
  GYRO Y-AXIS ASIC TEMPERATURE = OK
  GYRO Y-AXIS TEMPERATURE = OK
  GYRO Y-AXIS NO CLIPPING DETECTED = OK
  GYRO Y-AXIS INTERNAL COMMUNICATION = OK
  GYRO Y-AXIS NO ASIC OVERFLOW DETECTED = OK
  GYRO Y-AXIS EXCITATION AMPLITUDE = OK
  GYRO Y-AXIS CONFIGURATION  = OK
GYRO Z-AXIS:
  GYRO Z-AXIS DATA RECEIVED = OK
  GYRO Z-AXIS EXCITATION FREQUENCY = OK
   GYRO Z-AXIS ASIC TEMPERATURE = NOK
  GYRO Z-AXIS TEMPERATURE = OK
  GYRO Z-AXIS NO CLIPPING DETECTED = OK
  GYRO Z-AXIS INTERNAL COMMUNICATION = OK
  GYRO Z-AXIS NO ASIC OVERFLOW DETECTED = OK
  GYRO Z-AXIS EXCITATION AMPLITUDE = OK
  GYRO Z-AXIS CONFIGURATION  = OK


>
```

Figure 9-16: Example of response from c (DIAGNOSTIC) command

9.4   d (DATAGRAM FORMAT) command

General description: Changes the datagram format in Normal Mode (ref. Table 5-9).

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-10 : Available d (DATAGRAM FORMAT) command

Syntax	Response
d<SP><d_format><CR>	Changes the datagram format in Normal Mode

Table 9-11 : Allowed values for d (DATAGRAM FORMAT) command

<d_format>	Result
s	Changes the datagram format in Normal Mode to standard format
e	Changes the datagram format in Normal Mode to extended format
r	Changes the datagram format in Normal Mode to standard format with CR+LF termination
j	Changes the datagram format in Normal Mode to rate and temperature
k	Changes the datagram format in Normal Mode to rate and counter
l	Changes the datagram format in Normal Mode to rate and latency
n	Changes the datagram format in Normal Mode to rate, temperature and counter
o	Changes the datagram format in Normal Mode to rate, temperature and latency

Table 9-12: Error messages for d (DATAGRAM FORMAT) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>d s
DATAGRAM FORMAT = STANDARD

>
```
Figure 9-17: Example of response from d s (DATAGRAM FORMAT) command

```
>d e
DATAGRAM FORMAT = EXTENDED

>
```
Figure 9-18: Example of response from d e (DATATGRAM FORMAT) command

```
>d r
DATAGRAM FORMAT = STANDARD WITH <CR><LF> TERMINATION

>
```
Figure 9-19: Example of response from d r (DATATGRAM FORMAT) command

9.5   t (TRANSMISSION PARAMETERS) command

General description: Changes the transmission parameters for the RS422 interface.

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-13 : Available t (TRANSMISSION PARAMETERS) commands

Syntax	Response
t<SP><bit rate><CR>	Changes the transmission bit rate and leaves number of stop bits and parity unchanged
t<SP><bit rate>','<stop bits>','<parity><CR>	Changes the transmission bit rate, number of stop bits and parity

Table 9-14: Allowed values for <bit rate> parameter for t (TRANSMISSION PARAMETERS) commands

<bit rate>	Result
374400	Will set the bit rate to 374400 bits/s
460800	Will set the bit rate to 460800 bits/s
921600	Will set the bit rate to 921600 bits/s

Table 9-15: Allowed values for <stop bits> parameter for t (TRANSMISSION PARAMETERS) commands

<stop bits>	Result
1	Will set number of stop bits to 1
2	Will set number of stop bits to 2

Table 9-16: Allowed values for <parity> parameter for t (TRANSMISSION PARAMETERS) commands

<stop bits>	Result
n	Will set no parity
e	Will set even parity
o	Will set odd parity

Table 9-17: Error messages for t (TRANSMISSION PARAMETERS) commands

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>t 460800,2,e
TRANSMISSION PROTOCOL = 460800 bits/s, 2 STOP BIT(S), EVEN PARITY

>
```

Figure 9-20: Example of response from t (TRANSMISSION PARAMETERS) command

Transmission parameters will change after the response as shown in Figure 9-20 has been given.

9.6 r (LINE TERMINATION) command

General description: Turns the line termination ON or OFF. Line termination should be ON when communicating point-to-point (single master – single slave).

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-18: Available r (LINE TERMINATION) command

Syntax	Response
r<SP><lineterm><CR>	Changes the line termination

Table 9-19: Allowed values for r (LINE TERMINATION) command

<lineterm>	Result
0	Turns line termination OFF
1	Turns line termination ON

Table 9-20: Error messages for r (LINE TERMINATION) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>r 0
LINE TERMINATION = OFF

>
```

Figure 9-21: Example of response from r 0 (LINE TERMINATION) command

```
>r 1
LINE TERMINATION = ON

>
```

Figure 9-22: Example of response from r 1 (LINE TERMINATION) command

9.7 u (OUTPUT UNIT) command

General description: Sets the unit of the transmission in Normal Mode to angular rate or incremental angle.

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-21: Available u (OUTPUT UNIT) command

Syntax	Response
u<SP><outunit><CR>	Changes the unit of the transmission in Normal Mode

Table 9-22: Allowed values for <outunit> for u (OUTPUT UNIT) command

<outunit>	Result
a	Changes the unit of the transmission in Normal Mode to angular rate [°/s]
i	Changes the unit of the transmission in Normal Mode to incremental angle [°/sample]
m	Changes the unit of the transmission in Normal Mode to average angular rate [°/s]
s	Changes the unit of the transmission in Normal Mode to integrated angle [°]

Table 9-23: Error messages for u (OUTPUT UNIT) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>u a
OUTPUT UNIT = [°/s] – ANGULAR RATE

>
```
Figure 9-23: Example of response from u a (OUTPUT UNIT) command

```
>u i
OUTPUT UNIT = [°/sample] – INCREMENTAL ANGLE

>
```
Figure 9-24: Example of response from u i (OUTPUT UNIT) command

```
>u m
OUTPUT UNIT = [°/s] – AVERAGE ANGULAR RATE

>
```
Figure 9-25: Example of response from u m (OUTPUT UNIT) command

```
>u s
OUTPUT UNIT = [°] – INTEGRATED ANGLE

>
```
Figure 9-26: Example of response from u s (OUTPUT UNIT) command

9.8 f (LP FILTER -3dB FREQUENCY) command

General description: Changes the low-pass filter -3dB frequency for one or all axes.

Note that filter settings should be considered together with the sample rate in order to avoid issues with folding due to undersampling. No warnings will be issued by STIM202 if e.g. a high filter bandwidth and a low sample rate have been chosen. Also note that change in filter setting will change the group delay, ref. Table 5-3.

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-24: Available f (LP FILTER -3dB FREQUENCY) commands

Syntax	Response
f<SP><-3dBfreq><CR>	Changes the LP filter -3dB frequency for all axes
f<SP><-3dBfreq>','<axis><CR>	Changes the LP filter -3dB frequency for a specified axis

Table 9-25: Allowed values for <-3dBfreq> parameter for f (LP FILTER -3dB FREQUENCY) commands

<-3dBfreq>	Result
16	Will change LP filter -3dB frequency to 16Hz
33	Will change LP filter -3dB frequency to 33Hz
66	Will change LP filter -3dB frequency to 66Hz
131	Will change LP filter -3dB frequency to 131Hz
262	Will change LP filter -3dB frequency to 262Hz

Table 9-26: Allowed values for <axis> parameter for f (LP FILTER -3dB FREQUENCY) commands

<axis>	Result
x	Will change LP filter -3dB frequency for X-axis only
y	Will change LP filter -3dB frequency for Y-axis only
z	Will change LP filter -3dB frequency for Z-axis only

Table 9-27: Error messages for f (LP FILTER -3dB FREQUENCY) commands

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>f 66,x
LP FILTER -3dB FREQUENCY = 66 Hz FOR X-AXIS


>
```
Figure 9-27: Example of response from f (LP FILTER -3dB FREQUENCY) command

```
>f 131
LP FILTER -3dB FREQUENCY = 131 Hz FOR ALL AXES


>
```
Figure 9-28: Example of response from f (LP FILTER -3dB FREQUENCY) command

9.9 m (SAMPLE RATE) command

General description: Changes the sample rate in Normal Mode. The sample rate is the same for all gyro channels.

Note that sample rate should be considered together with filter settings in order to avoid issues with folding due to undersampling. No warnings will be issued by STIM202 if e.g. a high filter bandwidth and a low sample rate have been chosen.

Note that this change will only be effective until STIM202 is initialized, reset or powered off, unless the new setting has been stored in flash using the SAVE-command (ref. chapter 9.10). In order to use or test a new setting in Normal Mode without permanently storing it, this can be achieved by skipping the SAVE-command and using the EXIT n-command (ref. chapter 9.11).

Table 9-28: Available m (SAMPLE RATE) command

Syntax	Response
m<SP><sampl.freq><CR>	Changes the sample rate in Normal Mode

Table 9-29: Allowed values for <sampl.freq> parameter for m (SAMPLE RATE) command

<sampl.freq>	Result
125	Will set sample rate to 125 samples /second
250	Will set sample rate to 250 samples /second
500	Will set sample rate to 500 samples /second
1000	Will set sample rate to 1000 samples /second
0	Enables External Trigger

Table 9-30: Error messages for m (SAMPLE RATE) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>m 500
SAMPLE RATE = 500 samples/s

>
```
Figure 9-29: Example of response from m (SAMPLE RATE) command

```
>m 0
SAMPLE RATE = EXTERNAL TRIGGER

>
```
Figure 9-30: Example of response from m (SAMPLE RATE) command

9.10   s (SAVE) command

General description: Saves configuration parameters to flash. This will permanently change the configuration parameters and hence be valid after an initialisation or power-off.

The flash used in STIM202 is specified to be capable of minimum 1000 saves. A save-counter has been implemented and when the number of saves exceeds 1000, there will be issued a warning. STIM202 will always attempt to save the configuration when receiving the s (SAVE) command regardless of the content of the save-counter.

Table 9-31: Available s (SAVE) command

Syntax	Response
s\<CR\>	Saves system parameters to flash. This command will require an additional confirmation prior to execution. The confirmation ("Y") is to be responded in upper case letter.
	If transmission parameters have been changed (ref. TRANSMISSION PARAMETERS command, section 9.5) AND confirmation to the save-command is not "Y", then the transmission parameters, including bit-rate, will be reset to the previously saved settings.
	NB: Do not turn off power until the ready-prompt (">") has been received

Table 9-32: Error messages for s (SAVE) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Any characters between command and \<CR\>
E003	INVALID PARAMETER	Value of parameter outside valid range
E004	EXCEEDED MAXIMUM NUMBER OF SAVES	Warning appears when maximum number of saves has been exceeded (1000 saves). STIM202 will always attempt to save the configuration when receiving the s (SAVE) command.
E005	ERROR DURING SAVE	System parameters not successfully transferred to flash

```
>s
SYSTEM PARAMETERS WILL BE PERMANENTLY CHANGED. CONFIRM SAVE(Y/N): Y
SYSTEM PARAMETERS SUCCESSFULLY STORED IN FLASH.
NUMBER OF SAVES = 26


>
```
Figure 9-31: Example of response from s (SAVE) command when confirming save

```
>s
SYSTEM PARAMETERS WILL BE PERMANENTLY CHANGED. CONFIRM SAVE(Y/N): N
SAVE COMMAND ABORTED.


>
```
Figure 9-32: Example of response from s (SAVE) command when not confirming save

```
>s
SYSTEM PARAMETERS WILL BE PERMANENTLY CHANGED. CONFIRM SAVE(Y/N): y
SAVE COMMAND ABORTED.

E003 INVALID PARAMETER


>
```
Figure 9-33: Example of response from s (SAVE) command when not correctly responding to confirmation

9.11 x (EXIT) command

General description: Terminates Service Mode and returns to Normal Mode directly or via Init Mode (ref. Figure 7-3).

Table 9-33 : Available x (EXIT) command

Syntax	Response
x<SP><exit_to><CR>	Terminates Service Mode

Table 9-34 : Allowed values for <exit_to> for x (EXIT) command

<exit_to>	Result
n	Terminates Service Mode and return to Normal Mode. If system parameters have been changed compared to flash content, a confirmation is requested before exiting to Normal Mode ("Y" in upper case letter). There will be a 3 seconds hold time between the transmitted command response and execution of the EXIT command.
i	Terminates Service Mode and return to Init Mode. If system parameters have been changed compared to flash content, a confirmation is requested before exiting to Normal Mode ("Y" in upper case letter). There will be a 3 seconds hold time between the transmitted command response and execution of the EXIT command. **NB: Changes made to system parameters, but not saved, will be overwritten by the data already stored in flash when entering Init Mode.**
N	Terminates Service Mode and return immediately to Normal Mode (without confirmation if system parameters have been changed compared to flash and without any hold time)
I	Terminates Service Mode and return immediately to Init Mode (without confirmation if system parameters have been changed compared to flash and without any hold time). **NB: Changes made to system parameters, but not saved, will be overwritten by the data already stored in flash when entering Init Mode.**

Table 9-35: Error messages for x (EXIT) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>x n
SYSTEM RETURNING TO NORMAL MODE.
```

Figure 9-34: Example of response from x n (EXIT) command when system parameters match contents of flash

```
>x i
SYSTEM RETURNING TO INIT MODE.
```

Figure 9-35: Example of response from x i (EXIT) command when system parameters match contents of flash

```
>x n
CURRENT SYSTEM PARAMETERS DO NOT MATCH FLASH CONTENT. CONFIRM EXIT(Y/N): Y
SYSTEM RETURNING TO NORMAL MODE.
```

Figure 9-36: Example of response from x n (EXIT) command after system parameters have been changed but not saved with confirmed EXIT.

```
>x i
CURRENT SYSTEM PARAMETERS DO NOT MATCH FLASH CONTENT. CONFIRM EXIT(Y/N): N

>
```

Figure 9-37: Example of response from x i (EXIT) command after system parameters have been changed but not saved with confirmed not to EXIT.

```
>x n
CURRENT SYSTEM PARAMETERS DOES NOT MATCH FLASH CONTENT. CONFIRM EXIT(Y/N): n

E003 INVALID PARAMETER

>
```

Figure 9-38: Example of response from x n (EXIT) command after system parameters have been changed but not saved with incorrect response to confirmation.

9.12   z (RESTORE TO FACTORY SETTINGS) command

General description: Restores the configuration of the unit to its factory settings.

Table 9-36: Available z (RESTORE TO FACTORY SETTINGS) commands

Syntax	Response
z<CR>	Restores the configuration of the unit to its factory settings. **NB: The restored configuration will not be permanent unless it is SAVEd to flash before EXITing Service Mode, resetting the unit or turning off power.**
z<SP>,'s',<CR>	Restores the configuration of the unit to its factory settings and saves the configuration to flash.

Table 9-37: Error messages for z (RESTOR TO FACTORY SETTINGS) command

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Any characters between command and <CR>
E003	INVALID PARAMETER	Value of parameter outside valid range
E004	EXCEEDED MAXIMUM NUMBER OF SAVES	Warning appears when maximum number of saves has been exceeded (1000 saves). STIM202 will always attempt to save the configuration when receiving the s (SAVE)-command.
E005	ERROR DURING SAVE	System parameters not successfully transferred to flash


```
>z
RESTORE TO FACTORY SETTINGS.
CONFIRM CHANGE TO FACTORY SETTINGS (Y/N): Y

APPLYING FACTORY SETTINGS
FACTORY SETTINGS APPLIED. TO PERMANENTLY STORE THE SETTINGS, USE THE SAVE COMMAND.

>
```

Figure 9-39: Example of response from z (RESTORE TO FACTORY SETTINGS) command with no change in transmission parameters.


```
>z
RESTORE TO FACTORY SETTINGS.
CONFIRM CHANGE TO FACTORY SETTINGS(Y/N): Y

TRANSMISSION PARAMETERS WILL BE CHANGED. PLEASE CONFIRM (Y/N): Y
THE TRANSMISSION CONFIGURATION WILL BE CHANGED TO:
TRANSMISSION PROTOCOL = 460800 bits/s, 2 STOP BIT(S), EVEN PARITY

APPLYING FACTORY SETTINGS
FACTORY SETTINGS APPLIED. TO PERMANENTLY STORE THE SETTINGS, USE THE SAVE COMMAND.

>
```

Figure 9-40: Example of response from z (RESTORE TO FACTORY SETTINGS) command with change in transmission parameters.

```
>z s
RESTORE TO FACTORY SETTINGS.
CONFIRM CHANGE TO FACTORY SETTINGS(Y/N): Y

TRANSMISSION PARAMETERS WILL BE CHANGED. PLEASE CONFIRM (Y/N): Y
THE TRANSMISSION CONFIGURATION WILL BE CHANGED TO:
TRANSMISSION PROTOCOL = 460800 bits/s, 2 STOP-BIT(S), EVEN PARITY

APPLYING FACTORY SETTINGS
FACTORY SETTINGS APPLIED AND SAVED.
NUMBER OF SAVES = 26


>
```

Figure 9-41: Example of response from z s (RESTORE TO FACTORY SETTINGS with save of configuration) command with change in transmission parameters.

9.13 ? (HELP) command

General description: Help function on the available commands in Service Mode.

Table 9-38: Available ? (HELP) commands

Syntax	Response
?<CR>	Lists the available parameters for this command
?<SP><hlp><CR>	Responds with information on the specified command

Table 9-39: Allowed values for <hlp> for ? (HELP) command

<hlp>	Result
i	Responds with information on the INFORMATION command
a	Responds with information on the SINGLE-SHOT MEASUREMENT command
c	Responds with information on the DIAGNOSTIC command
d	Responds with information on the DATAGRAM FORMAT command
t	Responds with information on the TRANSMISSION PARAMETERS command
r	Responds with information on the LINE TERMINATION command
u	Responds with information on the OUTPUT UNIT command
f	Responds with information on the LP FILTER -3dB FREQUENCY command
m	Responds with information on the SAMPLE RATE command
s	Responds with information on the SAVE command
x	Responds with information on the EXIT command
z	Responds with information on the RESTORE TO FACTORY SETTINGS command

Table 9-40: Error messages for ? (HELP) commands

Error	Message	Possible reason
E001	UNKNOWN COMMAND	Command is incorrectly entered
E002	INCORRECT NUMBER OF PARAMETERS	Too many or too few parameters, use of comma between command and first parameter
E003	INVALID PARAMETER	Value of parameter outside valid range

```
>?
AVAILABLE PARAMETERS:
i:  LISTS SPECIFIC INFORMATION
a: PERFORMS A SINGLE-SHOT MEASUREMENT
c: PERFORMS A DIAGNOSTIC OF THE UNIT
d: CHANGES DATAGRAM FORMAT
t : CHANGES TRANSMISSION PARAMETERS
r: CHANGES THE LINE TERMINATION
u : CHANGES OUTPUT UNIT
f: CHANGES LP FILTER -3dB FREQUENCY
m: CHANGES SAMPLE RATE
s: SAVES CONFIGURATION DATA
z: RESTORES FACTORY SETTINGS
x: EXITS SERVICE MODE


>
```

Figure 9-42: Example of response from ? (HELP) command

```
>? i
i:  LISTS THE PRODUCT CONFIGURATION DATA
i s: RETURNS THE SERIAL NUMBER
i n: RETURNS THE PRODUCT NAME
i x: RETURNS THE PART NUMBER
i h: RETURNS THE HW CONFIGURATION AND REVISION
i p: RETURNS THE FW CONFIGURATION AND REVISION
i m: RETURNS THE SAMPLE RATE
i f: RETURNS THE LP FILTER -3dB FREQUENCY
i d: RETURNS THE DATAGRAM FORMAT
i t: RETURNS THE TRANSMISSION PARAMETERS
i r: RETURNS THE LINE TERMINATION SETTING
i u: RETURNS THE OUTPUT UNIT
i e: PRINTS THE EXTENDED ERROR INFORMATION FROM THE LAST DETECTED ERROR IN NORMAL MODE


>
```

Figure 9-43: Example of response from ? i (HELP on INFORMATION) command

```
>? a
a: PERFORMS A SINGLE-SHOT MEASUREMENT

>
```

Figure 9-44: Example of response from ? a (HELP ON SINGLE-SHOT MEASUREMENT) command

```
>? c
c: PERFORMS A DIAGNOSTIC OF THE UNIT

>
```

Figure 9-45: Example of response from ? c (HELP on DIAGNOSTIC) command

```
>? d
d s: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO STANDARD CONTENT
d e: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO EXTENDED CONTENT
d r: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO STANDARD CONTENT W.CR+LF TERMINATION
d j: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO RATE AND TEMPERATURE
d k: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO RATE AND COUNTER
d l: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO RATE AND LATENCY
d n: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO RATE, TEMPERATURE AND COUNTER
d o: CHANGES THE CONTENT OF THE DATAGRAMS IN NORMAL MODE TO RATE, TEMPERATURE AND LATENCY

>
```

Figure 9-46: Example of response from ? d (HELP on DATAGRAM FORMAT) command

```
>? t
t <bit rate>: CHANGES THE BIT RATE [bits/s]
t <bit rate>,<stop bits>,<parity>: CHANGES THE BIT RATE [bits/s], NUMBER OF STOP BITS AND PARITY
   ALLOWED VALUES FOR <bit rate> = 374400, 460800 AND 921600
   ALLOWED VALUES FOR <stop bits> = 1 AND 2
   ALLOWED VALUES FOR <parity> = n (=NONE), e (=EVEN) AND o (=ODD)

>
```

Figure 9-47: Example of response from ? t (HELP on TRANSMISSION PARAMETERS) command

```
>? r
r 0: TURNS LINE TERMINATION OFF
r 1: TURNS LINE TERMINATION ON

>
```

Figure 9-48: Example of response from ? r (HELP on LINE TERMINATION) command

```
>? u
u a: CHANGES OUTPUT UNIT TO ANGULAR RATE [°/s]
u i: CHANGES OUTPUT UNIT TO INCREMENTAL ANGLE [°/sample]
u m: CHANGES OUTPUT UNIT TO AVERAGE ANGULAR RATE [°/s]
u s: CHANGES OUTPUT UNIT TO INTEGRATED ANGLE [°]
>
```

Figure 9-49: Example of response from ? u (HELP on OUTPUT UNIT) command

```
>? f
f <-3dBfreq>: CHANGES THE LP FILTER -3dB FREQUENCY [Hz] FOR ALL AXES
f <-3dBfreq>,<axis>: CHANGES THE LP FILTER -3dB FREQUENCY [Hz] FOR A SPECIFIC AXIS
    ALLOWED VALUES FOR <-3dBfreq> = 16, 33, 66, 131 AND 262
    ALLOWED VALUES FOR <axis> = x, y AND z


>
```

Figure 9-50: Example of response from ? f (HELP on LP FILTER -3dB FREQUENCY) command

```
>? m
m <sampl.freq>: CHANGES THE SAMPLE RATE [samples/s]
    ALLOWED VALUES FOR <sampl.freq> = 125, 250, 500, 1000 AND 0 (EXTERNAL TRIGGER)


>
```

Figure 9-51: Example of response from ? m (HELP on SAMPLE RATE) command

```
>? s
s: SAVES SYSTEM PARAMETERS TO FLASH

>
```

Figure 9-52: Example of response from ? s (HELP on SAVE) command

```
>? z
z: RESTORES FACTORY SETTINGS

>
```

Figure 9-53: Example of response from ? z (HELP on RESTORES TO FACTORY SETTINGS) command

```
>? x
x n: EXITS SERVICE MODE AND RETURNS TO NORMAL MODE
x i: EXITS SERVICE MODE AND RETURNS TO INIT MODE
x N: EXITS SERVICE MODE AND RETURNS IMMEDIATELY TO NORMAL MODE
x I: EXITS SERVICE MODE AND RETURNS IMMEDIATELY TO INIT MODE
NB: NON-SAVED SYSTEM PARAMETERS WILL BE OVERWRITTEN BY STORED CONTENT IN FLASH WHEN EXITING TO INIT MODE

>
```

Figure 9-54: Example of response from ? x (HELP on EXIT) command

10 MARKING

Figure 10-1: Example of marking of STIM202

11 PART NUMBER / ORDERING INFORMATION

Configuration options in **bold** letters are the standard option.

84556	-	Output unit	Data-gram	Sample rate	Band-width	-	Bit rate	Stop bits	Parity	Line termination

Line termination:
0 = Termination OFF
1 = Termination ON

Parity:
0 = no parity
1 = odd parity
2 = even parity

Output unit:
0 = Angular Rate
1 = Incremental Angle
2 = Average Angular Rate
3 = Integrated Angle

Stop bits:
1 = 1 stop bit
2 = 2 stop bits

Bandwidth:
0 = 16Hz
1 = 33Hz
2 = 66Hz
3 = 131Hz
4 = 262Hz

Bit rate:
0 = 374400 bits/s
1 = 460800 bits/s
2 = 921600 bits/s

Datagram content:
0 = Standard
1 = Extended
2 = Standard w.CR+LF
3 = Rate and temperature
4 = Rate and counter
5 = Rate and latency
7 = Rate, temperature and counter
8 = Rate, temperature and latency

Sample rate:
0 = 125 samples/s
1 = 250 samples/s
2 = 500 samples/s
3 = 1000 samples/s
5 = External trigger

Example: part number 84556-0032-1211 has the following configuration:
- o   Angular Rate Output [°/s]
- o   Standard Datagram
- o   1000 samples/s
- o   -3dB bandwidth = 66Hz
- o   Bit rate = 460800 bits/s
- o   2 stop bits
- o   Odd parity
- o   Line termination ON

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