

MSA, communication with the MSA-INF.

**Description updated 000918 valid for INF program, version 01.03.
Updated 060403 with the new format for the .ini-file.**

The MSA thermal stimulator is controlled by a computer interface (INF), which communicates with a host computer through commands and responses sent on a standard serial link (RS 232). At system start-up, the INF initiates the hardware to generate a default temperature slope of 1 degree/second, going to a default temperature around 35 degree, which temperature the thermode shall maintain until further commands are received from the host computer.

Programming conventions:

To communicate with the INF, the serial link of the host shall be set to 9600 Baud, 8 bits of data, no parity, 1 stop-bit and X-on/X-off flow control.

As power is connected to the MSA, the INF will go into the start-up mode. This means that a watchdog timer in the INF will reset the thermode to the default temperature and at 2 seconds intervals transmit an ID signal announcing the resident software version, **INF01.03**. The reception at the host of this ID signal indicates that the MSA is present (including the version of the software) and that the communication can start.

The communication consists of commands sent to the MSA and responses returned to the host. This bidirectional stream of information blocks the watchdog from further actions as long as there is a minimum of 1 command per 2 seconds. In case the communication between the MSA and the host is broken for more than 2 seconds, the INF will revert to the start-up mode and shall start to transmit the **INF01.03** message. This is done to protect the MSA from possible errors. As the INF has made a complete reset when the **INF01.03** message is transmitted, the command sequences to the MSA has to start from the beginning as in the case of a normal system start-up.

The communication consists of commands to the MSA, and responses transmitted from the MSA, all sent as 4 character combinations. The first character is a letter, indicating the command or response type. The following 3 characters are hexadecimal numbers forming a 12 bit signed offset binary number, with the parameter for the command or response (example, 69 => 045, -12 => ff3). The hexadecimal notation used are as standard, with the letters a to f given in lowercase. There shall be no space in-between the characters and no terminating character (like CR or LF). The command shall thus consist of 4 characters in total.

All commands sent to the INF, and accepted by the INF software, are echoed back to the host. The reception by the host of this echo verifies the proper reception of the command by the MSA. In case no echo is received within 100 ms, the command shall be repeated until, a predetermined number of repetitions (say 3) have passed, when the host program shall stop and give an error message. This forms a basic handshaking method for the command sequence of the MSA and shall be performed for each and every command sent to the MSA. No similar handshaking (by the host) is needed for the responses from the MSA.

The following commands are in use:

To identify the interface and the software version:

INFxx.yy is transmitted from the INF at start-up and at every watchdog interrupt (at the same time as all variables are set to their start-up values. The xx and yy are version numbers for the interface and the software. Presently, they send 01 and 03, giving the message the form INF01.03

The calibration constants has to be set to their correct values, before stimulation. Calibration constants (offset and scale factor) for the relationship between the internal representations of temperature and offset in the INF and the corresponding values for the user (in degree Celsius) are kept in a calibration file, called SENSE.INI, stored in the directory C:\Program files\MSA\Sensexx\Inifiles\ (xx stands for the version of the program SenseLab, like Sense52). These calibration values have to be transferred to the INF before stimulation can start, if not, default values will be used and the accuracy of the stimulation will be reduced. To transfer the calibration file, the following commands are used:

Gxxx : Offset for temperature to D/A 0 conversion
Hxxx : Gain for temperature to D/A 0 conversion (gain *10)
Oxxx : Offset for slope to D/A 1 conversion
Nxxx : Gain for slope to D/A 1 conversion
Kxxx : Offset for A/D to temperature conversion
Lxxx : Gain for A/D to temperature conversion (gain *10)

An example of the SENSE.INI file, as well as the commands to send to the INF module is found in Appendix 1.

To control the INF, the following commands are used. Please note that all commands are transferred according to the conventions described above. The commands will rely on the calibration values for their interpretation, why it is necessary that the calibration constants has been transferred to the INF prior to any stimuli generation. Note also that temperature values should reside within the range of 0 to 55 °C and slope values within 0 to 10 °C/s, in both cases with one decimal allowed. All values shall be multiplied with 10, before conversion to binary, to allow for the decimal. The xxx refer to the argument, converted to a binary word.

Bxxx : Begin (start) temperature. Used at start and after return from stimulation.
Rxxx : Reset slope. Used together with Bxxx.

Txxx : Temperature. Used to define the endpoint of temperature stimulation.
Sxxx : Slope. Shall be given before Txxx and will then define the slope to reach Txxx.

Cxxx : xxx defines the type of stimulation.
000 initiates a change of temperature to B, using the slope of R. When B is reached, the temperature will stay there until further commands.
001 does the same as 000
002 initiate a change of temperature to T, using the slope of S. When T is reached, the temperature will stay there until further commands.
003 initiate a change of temperature to T, using the slope of S. When T is reached, the command C000 will be generated within the INF, the command Fxxx, where xxx corresponds to actual temperature is sent and the temperature return to B, using the slope of R.

The A/D converter of the INF has 9 channels and can be set to a specific channel and perform a measurement, by the following command:

Mxxx : where xxx states the channel number for the channel to be measured. The response is given as Myyy. The channel number is set in the lowest bits of xxx and represents:

000:	TEMPCF1	(actual temperature TH1)
001:	TEMPCB	(rear side temperature TH1)
002:	VPELTIER	(drive voltage TH1)
003:	THDRIVE	(drive current TH1)
004:	TEMPCF1	(actual temperature TH2)
005:	TEMPCB	(rear side temperature TH2)
006:	VAS1	(vas-scale nr 1)
007:	VAS2	(vas-scale nr 2)
008:	ProcTemp	(processor temperature)

For the command M000, the response would be the calibrated (according to the calibration data), for all other commands (001 to 008), yyy is the value measured by the A/D converter, expressed as three hexadecimal digits, representing a 12 digit binary code.

From the INF, the following messages are also transmitted:

P xxx : The Patient has pushed the patient push-button at xxx degree.

F xxx : After that the command C003 has been given, the temperature T has been reached and the temperature stimulation was interrupted . At this point, the actual temperature is reported with the message Fxxx, at the same time as the temperature return to B, using R.

Q001 The chosen temperature can not be created, default temp generated.

Q002 The chosen slope can not be generated, default slope generated.

Q003 Argument for command C outside of the permitted range (0 to 3).

Recommendations for the communication and use of the MSA-INF:

- 1/ Check the version number of the INF and it's software before program start.
- 2/ Take advantage of the fact that INF01.03 is transmitted and use this to start the command sequence.
- 3/ Send commands as 4 character strings and check that the received echo corresponds to the sent command before the next command is sent. In case an echo is not received, or incorrect, the command may be resent or an error message given.
- 4/ Always send the calibration data as the first part of any program.
- 5/ If INF01.03 is detected during normal communication, this indicates that too long time has passed since the previous command. Then the watchdog has gone into action. As the INF now has done a reset, the controlling software has also to do a reset.
- 6/ To prevent the MSA from repeated start-up, use a polling scheme that checks the thermode temperature, at frequent (at least 1 per second) intervals.
- 7/ After communication has been established, but before stimulation starts, check that the thermode temperature has reached its initial values. Or if B and R has been generated, in level with these values.
- 8/ If in C003-mode the patient interrupts the stimulation (P-reply sent from INF), or if the temperature endpoint has been reached (F-reply sent from INF), check that the temperature has returned to the baseline before a new stimulation is started. (Here the value for the tolerance limit, in the SENSE.INI file, may be used to set the window for acceptance of a baseline return.)

APPENDIX 1: Example of SENSE.INI file and calibration commands transferred to INF.

The SENSE.INI file consists of a table of numbers, with headings and short keywords. The numbers are below listed like in the .ini-file, with a short indication of their use.

Heading/Keyword	Value	Use
[Thermode name]		
Thermode name=	25 x 50	Identifies the size of the thermode
Thermode identification=	1	Couples this thermode to normal data for size 1
Thermode number=	210	Individual serial number of thermode
[Configuration info]		
Serial number=	209	Ini-file valid for operation with this MSA
Version=	1	Valid for this version of the interface
[Calibration info]		
Tolerance=	1	Maximum deviation from setpoint value
OffSetTemp_DA=	315	Offset for stimulus temperature level calibration
ScaleFactorTemp_DA=	45.4	Gain for stimulus temperature level calibration
OffSetSlope_DA=	23	Offset for stimulus temperature level calibration
ScaleFactorSlope_DA=	411	Gain for stimulus temperature slope calibration
OffSetTemp_AD=	-11	Offset for temperature readout calibration
ScaleFactorTemp_AD=	69.5	Gain for temperature readout calibration
[Temperatures]		
Max temp=	50	Init_MaxTemp (°C)
Min temp=	5	Init_MinTemp (°C)
Max slope=	5	Init_MaxSlope (°C/s)
[Thermode properties]		
S=0.3		Not presently used
G=1		
N=1		
P=1		

Of these values, the following could be of interest to a user, or programmer. Please do not modify the other positions.

[Thermode name] and [Configuration info]
Check if the supplied INI-file match the supplied MSA

[Calibration info]
Tolerance=1 – set to higher values if the system do not start due to error in calibration.
Other parameters set by calibration routine. Used by both SENSELab and other programs.

[Temperatures]
Max temp= 50 - may be set to 52 degree in cases of severe insensitive subjects.

If a user writes their own programs, the calibration part of the SENSE.INI file has to be transmitted to the INF module, before any calibrated use can take place. As part of the user program, the following values has to be sent as part of the program initialisation, from the SENSE.INI file, as commands to the MSA-INF in accordance with the conventions of the programming for the INF. Note that the calibration values from the SENSE.INI file are multiplied with 10, before transmission to the INF (to allow for one decimal to be used). Please also note that the program, sending the command, shall wait until the command has been echoed back, and checked, before the next command is sent.

SENSE.INI pos	Typical value	Sent as
OffsetTemp_DA	423	G1A7
ScaleFactorTemp_DA	46.2	H1D3
OffsetSlope_DA	-13	OFF2
ScaleFactorSlope_DA	519	N207
OffsetTemp_AD	-8	KFF6
ScaleFactorTemp_AD	71.7	L2CD