Description

Motor Controller SMS 60

Firmware Version 1.1 - 4/25/2002

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Motor Controller SMS 60

List of Contents

1. Introduction

1.1. Technical Data

- Mode of operation:	Stand-alone or via computer interface
- Supply voltage:	230V / 50Hz
- Fusing:	prim. 2AT (mains input), 200mAT (5V power supply unit, internal), sec. 6.3AT for motor supply (on computer printed circuit board), 3.15AT on axis board
- Phase current:	0.18 – 2.74 A, for each of the phases, adjustable via coding switch
- Type of motor:	Two-phase stepper motor, bipolar (four stranded wires)
- Motor supply:	approx. 24V DC at 6A
- Motor driver:	PWM chopper, system clock pulse approx. 200kHz
- Motor connection:	15-pin HD plug (female) with the standard OWIS pin settings
- Mode of operation:	1/25 micro step (permanent)
- Number of axes:	1 to 6 axes
- Computer interfaces:	RS 232 and IEEE 488, selectable via DIP switches on computer p.c. board
- Limit switches:	up to four software definable limit switches per axis (5V, optional 24V), 1 reference switch (definable via jumper)
- Display:	4x20 characters, LCD "super twist", with background illumination
- Travel:	+8,388,607...-8,388,608 micro steps (23 bit plus sign)
- Housing:	19" table housing with integrated rack mounting brackets, 84HP / 3U
- Joystick:	Joystick port supplied as standard, 8 bit A/D converter, speed/position ratio 100:1
- Storage of the system data:	Battery buffered RAM with a life of approx. 10 years, replaceable
- Safety:	Emergency Stop button on front panel for motor shut off within a few 100 milliseconds

1.2. Start-Up

Before connection of the equipment to the mains voltage, the voltage shown on the type plate must be checked to ensure it corresponds to the supply voltage. Connection to the mains supply may only be via an earthed (grounded) socket. The equipment earth and ground conductor are connected internally with the equipment housing.

If the equipment has to be opened, the mains supply line must always be disconnected from the mains supply before opening.

Before connecting a positioning unit, please make sure to check if the phase currents adjusted at the SMS 60 axis modules coincide with the phase currents set at the motors to be connected, because the latter may be damaged in case of an excessive current setting. If you purchased the SMS 60 from OWIS as a package together with the positioning units, we have already made the necessary presetting and the axis modules have been identified by adhesive labels at the support handles of the axis modules. The preset parameters can also be learned from the acceptance protocol included in the delivery.

Furthermore, the positioning units (motors, adjustment components) are to be low impedance- / low inductive-connected with the same ground potential as the motor controller (e.g. using a suitable flat ribbon cable). This is particularly necessary for dispersing the electrostatic charge (ESD) from the positioning units. Please note that optimal reliability and interference resistance can only be assured if shielded cables are used for ***all*** connections to the equipment. The shields should be connected to the equipment housing according to the regulations. When flat ribbon cables are used, the values achievable with shielded cables can naturally not be reached. Conformity to CE is only provided if all connections are designed with shielded cables.

Disconnection or connection of motor cables while the equipment is running is to be avoided. Under no circumstances may plug-in boards be installed or removed while the equipment is switched on. Whenever cables are replaced, the equipment must be re-started.

1.3. Setting the Operating Parameters

Before start-up (connection of the positioning units), the axis parameters stored in the RAM (mode 5) have to be checked absolutely. This data depends - among other things - on the mechanical layout (friction), the load, the motors used as well as the moment of inertia to be moved. Wrong or inappropriate parameter settings can cause damages to the mechanical system and limit switches, step loss and increased running noise levels (resonance).

1.4. Operating Elements

The display and keyboard for manual operation of the controller, the motor connections of the axis boards, the Emergency Stop and Reset buttons and the interface connections of the computer printed circuit board (RS 232, IEEE 488, joystick) are all located on the front of the equipment.

The combined mains on-off switch / input socket is mounted on the rear panel.

Pressing the "Reset" button resets the controller to the initial state.

Pressing the red mushroom-shaped Emergency Stop button ("PUSH") below the display, rapidly disconnects the motors (within approx. 300 ms). **After this button has been pressed, the equipment must be switched off and on again, in order to re-establish the normal mode of operation. As an alternative, the reset command can also be transmitted via this interface ("RST", see resp. section). The Emergency Stop button must be released - before the equipment is started the next time - by turning it briefly clockwise.**

Settings which need to be made very rarely, or just for the setup of the system (such as limit switch level, interface and interface parameters, axis number) are made inside the device. The phase currents of the individual motors are preselected via rotary encoding switch through two bore holes in the corresponding axis front panel.

2. Manual Operation

2.1. Overview of the Operating Modes

The device has 9 modes for manual operation (modes 1-9).

Mode 1 is used for manually setting all the activated axes to the target coordinates, input via the keyboard. These may be absolute or relative positioning values depending on the positioning mode selectable for each axis. The travel speeds of the axes in this mode are preselected in mode 5.

Mode 2 is used for manually positioning an axis using the arrow keys. Pressing the "right arrow" means move in the positive direction; pressing the "left arrow" means a move in the negative direction. There is also a choice of two speeds, "slow" and "fast". The actual speed values can be set exclusively via a submenu in mode 2.

Mode 3 shows the selected interface and the interface parameter settings. Warning ! These values *cannot* be input via the keyboard or software. To change the interface configuration, it is necessary to (carefully) remove the plug-in computer board and reset the relevant DIP switches.

Mode 4 is used to display and preset encoder counter values.

Mode 5 is used to set the number of active axes (1 min., 6 max.) and the parameters for each individual axis.

Mode 6 is the reference travel mode. A reference run regarding the reference limit switch can be performed with or without automatic reset. The speeds of travel to the end stop and free travel are set using the submenu in mode 6.

Mode 7 permits setting or resetting of the actual-value counter. To reset an axis counter, enter the value "0".

Mode 8 permits 2-axis speed control via joystick (optional). The maximum speed is set using the submenu in mode 8.

Mode 9 is the demonstration mode. Input is made as in mode 1. The controller then travels the entered distance alternately in the positive and negative directions, until the mode is terminated.

2.2. General Operating Instructions, Re-initialization

After the controller is switched on, it attempts to initialize all the installed axes and interfaces. If this is successful, main menu "***** SMS 60 ***** ... press <E>" appears on the display.

The computer printed circuit board occupies the first - 8 HP wide - connection port to the left of the 19" rack. It includes among other things the computer interfaces, the Joystick port and the DIP switches for setting the interface parameters. The DIP switches are accessible only after removal of the computer board. We recommend to remove and install the keyboard and computer board always together, or to remove *only* the plug-in computer board partly and pull it out, until you can unplug the keyboard plug. Warning ! When removing and installing the computer board, please pay absolute attention to avoid any damage to the flat ribbon cable which connects it to the keyboard !

By pressing the "Reset" button, on the right of the red "Power" LED on the plug-in computer board, the controller is reset to the initial state.

If the display still remains empty after a delay of several seconds (with the cursor in the upper left corner) after the connection, it is likely that the number of axes was wrongly set in mode 5 or that the address jumper set on one of the axis boards is set incorrectly. If this is not the case, there is a hardware defect.

Re-initialization ("Master Reset"):
If too many parameters have been changed or misadjusted, or the device does no longer react to the inputs, a re-initialization can be performed. The RAM is filled with certain standard values, the number of axes is set to "1". **To re-initialize the system, please press the keys "S" and "E" of the keyboard simultaneously, and switch the unit on while keeping the keys pressed, until the message "Memory Init default..." is displayed.** As an alternative, you can transmit the "MRST" command via the computer interface (see resp. section). All the parameters stored in the RAM have now been replaced by determinate standard values. Re-initialization is *always* possible, even after the keyboard may have been switched off via the computer interface. *After* the re-initialization, the keyboard is generally in *active* mode. **Note: At least one axis board must be installed as an axis No. 1, otherwise no start-up of the equipment is possible.** The addresses of the installed axes must with 1 rise in steps of 1 up to the last installed axis.

Although the values listed below, which are included in the RAM after re-initialization, have been designated above as "standard values" this *does not* mean that *all* our positioning units will function with these values in an optimum way, or that they work at all.

Standard Settings in Mode 5 after re-initialization

Active Axis:	1
F:	237
Acc.:	5
LS	31
LM:	0
PCR:	100
Absol. (1) / Rel. (0):	0

In order to re-establish the original parameters preset by OWIS upon delivery of the device, the corresponding values need to be transferred from the enclosed "acceptance protocol" sheet to the device either manually or via computer interface.

After the "E" button in main menu has been pressed, the controller asks for the "Mode:" and expects the input of a number in the range 1...9, indicating the desired operating mode. The computer interface can only be addressed from main menu (Display: "***** SMS 60 ***** press <E>" or "... MODE:"). In a manual menu, the computer interface is de-activated just like the keyboard is inactive during a command to move, made via interface control. The menus are designed in such a way that by repeatedly pressing the "E" button - without any other action being taken - one returns to the main menu.

The keyboard can be switched off via computer interface ("KOFF" command, refer to corresp. section).

2.3. Mode 1

Positioning of the drives after input of target coordinates via the keyboard.

In the first line the sub-menu ">Dis E:Men C:In S:Go" is displayed. ">" switches over the display indication to the axes 4-6, provided more than three axes are active. Via the "E" key you get back to the main menu, "S" will start the axis travel. "C" calls up the input section: On the left, axis numbers and current positions are displayed; the controller expects the input of the target setting on the right. The separators between the two values are "r" for ***r**elative* and "a" for ***a**bsolute* positioning of this axis (Preselection in Mode 5). With negative values, the negative sign should be entered first. The input of numerical data should be terminated by pressing "E"; corrections can be made by pressing "C" (current value is zeroed). An entered value is confirmed with "E". Once the last value has been input, the above mentioned submenu appears in the first line. You can reenter the input after pressing "C"; "E" takes you back to the main menu, and "S" starts the positioning.

During the positioning procedure, only the counter readings of the first three axes are shown because of the limited capacity of the display. After the end of the positioning procedure, the same menu appears as after selection of mode 1.

When an axis reaches a limit switch during positioning, a deceleration ramp with the programmed acceleration is carried out as fast as possible ("… DEC" limit switch) or the step output is stopped immediately ("...STOP" limit switch). After axis movement has been terminated, the Limit Switch Menu may appear on the display ("Limit Switch Info..."), if at least one limit switch of one connected axis has been activated. Under the list of axis numbers ("123456") the following letters/numbers may be indicated:

- B: both limit switches are actuated (wrong limit switch definition, loss of control or, possibly, positioning unit not connected)
- 1: Limit switch in neg. direction (MINDEC / MINSTOP) has been activated - in the case of linear motion, this limit switch is usually mounted next to the motor
- 2: Limit switch in pos. direction (MAXDEC/MAXSTOP) has been activated - in the case of linear motion, this limit switch is usually on the end of the stage

Now, you have the choice of clearing the display without taking any action (press "E") or of freeing the limit switch (by pressing ">"). Freeing the switch of course is only possible with axes where only ***one*** limit switch was triggered, i.e. where the limit switch status is "1" or "2". When the limit switch status is "B", attempts to free the axis in this way are ignored. The speeds of release for freeing limit switches are set in a submenu to mode 6 or via computer interface.

2.4. Mode 2

Key controlled movement of a selected axis with selectable, programmable speed.

The selected axis, speed ("slow" or "fast") and counter setting of the axis are shown in the display. Pressing "E" causes a return to the main menu. If limit switches are activated, the limit switch menu as in mode 1 is displayed. While an arrow key is pressed, the selected axis continues to move in the given direction. When a limit switch is reached, the deceleration ramp is carried out. One can toggle between the two speeds ("slow" and "fast") by pressing key "S". The actual speeds can be set using the "Speed" submenu in mode 2 which is selected by pressing "-".

"Speed" Submenu:
Pressing "-" calls up the "Speed" Submenu. Next, enter the axis number, whose speed is to be set. The number of any axis is ignored which is not installed. Press "E" to exit the submenu, press ">" to access the speed input mode. Two 12-bit values (range of theoretically possible values: 1 to 8191) may then be entered in the following order: 1. **"fast"** speed **(default: 237)**, 2. **"slow"** speed **(default: 59).** After accepting these values by pressing "E", the main menu of mode 2 is displayed again. **For detailed information about the speed selection, please refer to sections 2.7.1 and 2.7.2.**

2.5. Mode 3

Display of the computer interface parameters, set by means of the DIP switches on the processor printed circuit board. This mode is terminated by pressing the "E" button.

Setting the DIP switches:
Remove the printed circuit board and place it on the table with the chip/component-side face upwards and the front plate to the left. On the left lower edge of the board you can see two eight-fold DIL switch banks, which will be referred to below as SW1 (left) 1 to 8 and SW2 (right) 1 to 8. The switch settings are marked by "ON" = levers facing upward, or "OFF" = levers facing down.

SW1:

1	IEEE address "16"
2	IEEE address "8"
3	IEEE address "4"
4	IEEE address "2"
5	IEEE address "1"
6	free
7	free
8	must always be "ON"

SW2:

1	free
2	EOS character IEEE
3	EOS character IEEE
4	SRQ IEEE on
5	IEEE selected
6	RS 232 baud rate
7	RS 232 baud rate
8	RS 232 baud rate

EOS character settings of the IEEE Interface (SW2):

2	3	EOS character
OFF	OFF	<EOI>
OFF	ON	LF
ON	OFF	CRLF
ON	ON	CR

Setting the baud rate of the RS 232-interface (SW2):

6	7	8	Baud rate
OFF	OFF	OFF	300
OFF	OFF	ON	600
OFF	ON	OFF	1,200
OFF	ON	ON	2,400
ON	OFF	OFF	4,800
ON	OFF	ON	7,200
ON	ON	OFF	9,600
ON	ON	ON	19,200

Limitations:

- RS 232: Do not set baud rates of less than 1,200, because the input/output operations may be discontinued prematurely.
- Interface-Timeout at both interfaces: 300msec. (fixed).

Default settings SW1:

1	OFF
2	ON
3	OFF
4	OFF
5	ON
6	OFF
7	OFF
8	ON

Default settings SW2:

1	OFF
2	OFF
3	ON
4	OFF
5	OFF
6	ON
7	ON
8	OFF

The default setting has the following meaning:

IEEE address:	9
EOS character:	LF (0A hex.)
SRQ:	switched off
IEEE:	switched off (equivalent to: RS 232 switched on)
RS 232 baud rate:	9600 Baud

2.6. Mode 4

Counter readout and setting of *optional* axis encoders (quadrature mode input). The input is similar to the “target” position entry in Mode 1.

2.7. Mode 5

Setting of the number of active axes and selection of the travel parameters.

After selecting mode 5, the current axis number can be changed by pressing the ">" button. The addresses of the installed axes must start by 1 and rise in steps of 1 up to the last axis installed. Please note the advice given in Sec. 2.2. **After changing the number of axes, switch the device off and on again.** Input of the axis number initializes the joystick axis allocation in mode 8 (X = axis No.1, Y = deactivated).

If the number of an installed axis is entered, the parameter set for this axis appears in the display. Press "E" to confirm the display, or press ">" to access the input mode for setting the axis parameters of the axis concerned.

Standard values for the axis parameters after a re-initialization (see also Sec. 2.2.)

Active Axis:	1
F:	237
Acc.:	5
LS	31
LM:	0
PCR:	100
Absol. (1) / Rel. (0):	0

2.7.1. Fundamentals of parameter selection

Every step-motor driven mechanics has its particular **start-stop frequency** which is dependent on the *type of motor, system friction and load (moment of inertia!).* The start-stop frequency designates the maximum moving frequency of the corresponding stepper motor at which this motor can still start from standstill without any acceleration phase. Usually, these and other characteristic frequencies of stepper motors are indicated in ***Hertz full step*** ("Hz FS"), i. e. full steps per second. The shaft of a stepper motor with step angle 1.8°, i.e. 200 full steps per revolution, that runs at 400 Hz FS, e.g., turns at a speed of two revolutions per second or 120 revolutions per minute.

To obtain a speed exceeding the start-stop frequency, the stepper motor must be accelerated beyond this frequency by an appropriate acceleration ramp, or decelerated below this frequency by a suitable deceleration ramp. This acceleration or deceleration is achieved in a ***trapezoidal or S-shaped speed-time curve.*** In certain cases, a damping (viscous damping, mounted to the other end of the shaft of the motor) is required to obtain higher speeds at all.

Almost all the standard stepper motors we employ are able to follow a frequency of 400 Hz FS in start-stop operation. The previously mentioned standard speed value of "237" corresponds almost precisely to 400 Hz FS.

The Motion Controller component used on the SMS 60 axis modules can be operated in three different modes:

1. Automatic ramp generation indicating the target setting / target coordinates by means of the "point-to-point" method. This so-called positioning mode works with an S-shaped speed curve as a principle. Use in modes 1 / 9 and for positioning via computer interface.
2. Trapezoidal speed curve with constant acceleration (constant positive acceleration - constant speed - constant negative acceleration). Use in mode 2 and in the so-called "velocity mode" via computer interface.
3. Constant speed, i.e. start-stop operation of the respective motor. Used for reference run / release for freeing limit switches and in the Joystick mode.

2.7.2. Speed

The ***speed*** "F" is specified by a 12-bit word (or 12 bits plus sign). The "F" values range from 1 to 8191. It must be ensured that no higher speed is entered than the equipment is able to withstand, since otherwise the mechanism may be damaged.

When the speed F is given, the ***motor*** speed (without the influence of any possible gearbox!) is calculated as follows:

$$f_{Step} = \frac{11.0592 * 10^6}{262\,144} * F\ [1..8191]\ \frac{\text{Micro Steps}}{\text{Second}} = 42.1875 * F\,[1..8191]\ \frac{\text{Micro Steps}}{\text{Second}}$$

or

$$f_{Step} = 1.6875 * F\ [1..8191]\ \frac{\text{Full Steps}}{\text{Second}}$$

or

$$n = 0.0084375 * F\ [1..8191]\ \frac{\text{Rev. (Motor with } 1{,}8^{o} \text{ Step Angle in FS)}}{\text{Second}}$$

or

$$n = 0.50625 * F\ [1..8191]\ \frac{\text{Rev. (Motor with } 1{,}8^{o} \text{ Step Angle in FS)}}{\text{Minute}}$$

When converting the number of revolutions of the motor into the positioning speed of the mechanism, mechanical data, such as spindle pitch (unit is usually "mm" per revolution), and, where appropriate, the influence of the gearbox, should also be taken into consideration.

2.7.3. Acceleration

The ***acceleration*** ("Acc.") is specified by a 12-bit word. The values of "Acc." range from 1 to 8191. **For each axis only one acceleration value may be specified. It is valid for all acceleration and braking procedures in modes 1 / 9 and 2, for positioning via computer interface, as well as the so-called "velocity mode" via computer interface. The selected acceleration should be sufficiently high to ensure that the distance traveled after activation of a "DEC" limit switch (deceleration ramp up to standstill) is small enough to avoid mechanical damage.** For more details, please refer to the following section, in the description of a reference run.

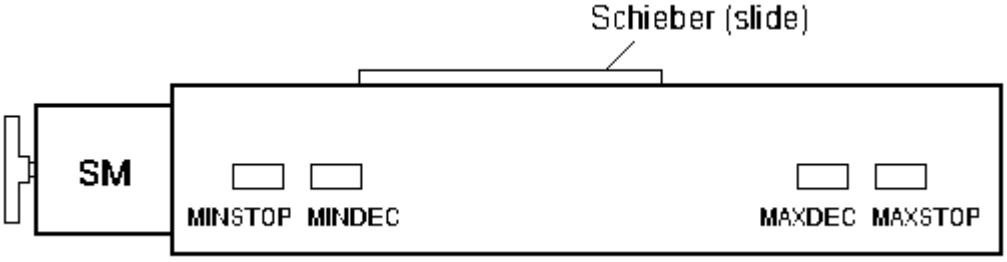
The acceleration value is always a compromise. It must be selected in such a way that the acceleration / deceleration phase is sufficiently short to allow the motor to pass the (inoperable!) resonance without dropping from synchronism, but sufficiently long to allow the moved masses to be well accelerated by the torque available.

As a first approximation we can recommend to select the acceleration ramp in such a way that it is clearly audible, i.e. at a duration of 0.1 to 2 seconds, depending on the final frequency and load. Besides, for smaller motors you should generally use a higher acceleration than for bigger ones. Generally, acceleration values between 1 and 20 are reasonable in this case.

Recommended values for our standard motors:

Motor	typ. frequency (F) up to approx. ...	Acceleration (Acc.)
SM 240	3,600	(5...) 10...20
SM 255	3,600	(5...) 10
SM 260	1,800	5
SM 280	1,800	3
SM 290	1,800	1…2

2.7.4. Limit switch definition LS, configuration of reference switch and axis number



Every SMS 60 axis module has four limit switch inputs and one evaluation possibility for a reference switch. The limit switches in negative direction are designated "MINDEC" and "MINSTOP" , i.e. the slide of a linear stage moves in the direction of the motor (definition!). The limit switches in positive direction are designated "MAXDEC" and "MAXSTOP", i.e. the slide of a linear stage moves in the direction opposite to the motor. The limit switches perform the following functions:

1. MINSTOP. When this limit switch trips during a move in the negative direction, the motor will be stopped immediately and abruptly after a certain reaction time which may take some ten milliseconds. The step output is interrupted. If the current travel frequency at which the motor was stopped, has exceeded the start-stop frequency of the system, the motor will briefly drop from synchronism and perform a short uncontrolled movement. This shows that the indicated position value is wrong and a reference run is required, because the motor has "lost" some steps.
2. MINDEC. When actuated during a motion in negative direction this limit switch starts a deceleration ramp with an acceleration of "Acc." that can also be programmed in mode 5. If the duration of the deceleration ramp is too long, and the positioning unit moves on to the MINSTOP limit switch, the information given under item 1 also applies.

3. MAXDEC. The reaction is equivalent to the "MINDEC" limit switch, but this limit switch works only with moves in positive direction.
4. MAXSTOP. The reaction is also equivalent to the "MINSTOP" limit switch, but this limit switch works only with moves in positive direction.

For "LS" you can indicate a decimal value between 0 and 31. The control system makes a binary conversion and evaluation of this value and defines if certain limit switches and reference switches are present and should be analyzed or not. The individual bits have the following meanings:

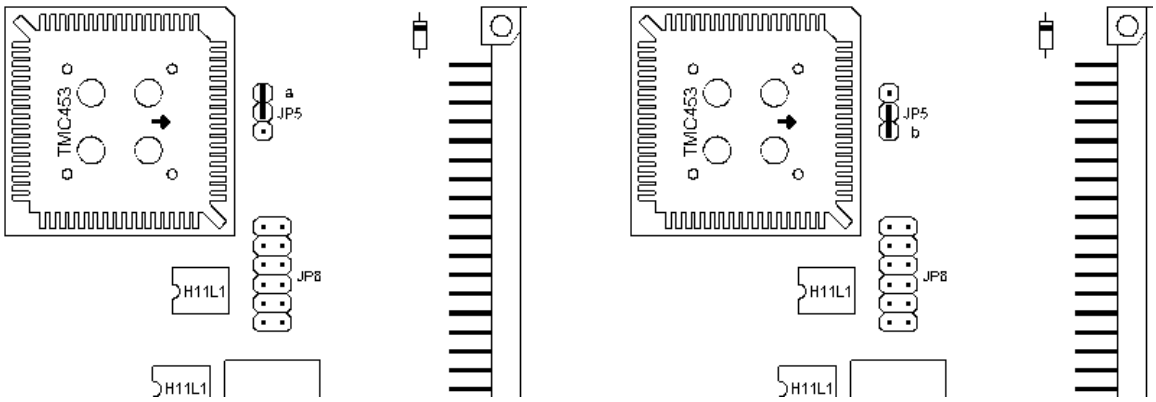
Bit	Significance (decimal)	Function
0	1	MINSTOP
1	2	MAXSTOP
2	4	MINDEC
3	8	MAXDEC
4	16	REF (Reference)

If a bit is set, this means that the corresponding switch is present.

Example:

- "LS = 19" (= 16 + 2 + 1) means that MINSTOP and MAXSTOP are present, a reference switch is to be used, and MINDEC as well as MAXDEC are not present or shall not be evaluated.
- "LS = 31" (default value) means that *all the* above mentioned limit switches are present and / or are analysed.

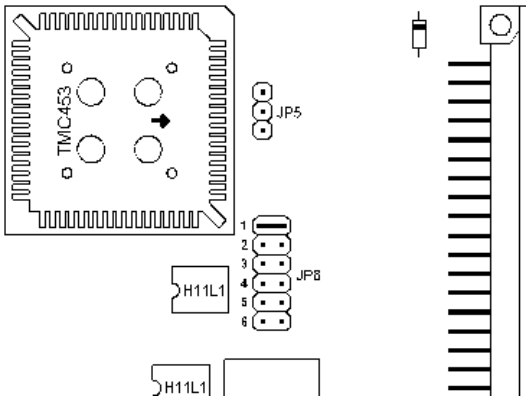
By hardware jumpers on the corresponding axis module (rack) you need to define if MINSTOP or MINDEC is to serve as a reference element (REF).



JP 5 in position "a“ means REF = MINDEC, JP 5 in position "b“ means REF = MINSTOP. If both "MIN..." limit switches are presented and evaluated (e.g. with "LS = 31"), MINDEC *must* be selected as a reference switch (please put JP 5 in position "a"). If either MINDEC or MINSTOP is used, jumper JP 5 must be set correspondingly. Please take into account that the device is not in the position to make a plausibility check of the reference switch configuration. To give you a hint for the correct function, a reversing hysteresis of the reference switch (indication in microsteps of 1/25) is available after the reference run has been terminated. For more details, please refer to mode 6, the reference run mode.

We recommend to make a new reference run as a principle, if any of the limit switches has been approached during a regular positioning procedure.

Setting the axis number (1 to 6) on the axis module:



The axis number at which a determinate axis module is addressed usually needs no modification, because the device has been reasonably adjusted before the delivery, and the axis modules are identified correspondingly.

If you still change the configuration, or want to re-equip the unit with an axis module, you can select axes 1 to 6 via jumper JP 6, in accordance with the illustration above (example: configuration as axis no. 1). When changing the configuration, please consider that the parameters set by software and the speeds may need to be corrected manually or via computer interface, because they are stored in the central RAM of the processor rack *rather than* in the axis modules. If several axes with identical axis numbers (JP 6 on the same position) are configured, severe malfunctions will occur and the device as well as the mechanism may result damaged.

2.7.5. Polarity of limit switches LM, configuration of limit switch level

For "LM" you can indicate a decimal value between 0 and 31. The control system makes a binary conversion and evaluation of this value also, and defines if certain limit switches and reference switches shall be "low" or "high" active. The limit switch inputs work with a 5-V CMOS level as a standard. Both, open-collector-NPN or push-pull outputs can be connected, because high-impedance pullup resistors (10kOhms) to +5V are already provided internally. The individual bits have the following meanings:

Bit	Significance (decimal)	Function
0	1	MINSTOP
1	2	MAXSTOP
2	4	MINDEC
3	8	MAXDEC
4	16	REF (Reference)

If a bit is set, this means that the corresponding switch is active "low" (N/O contact to ground). If a bit is deleted, the corresponding switch is active "high" (standard configuration) (N/C contact to ground).

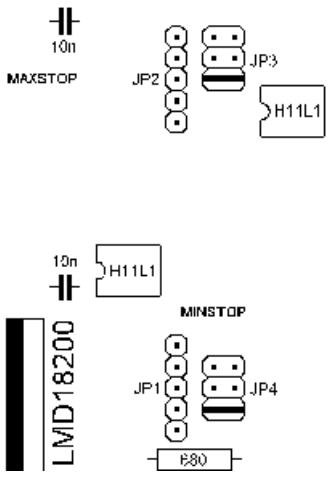
Example:

- "LM = 0" (default value) means that *all the* above mentioned limit switches are configured as NC contacts to ground.

Please make sure that the "REF" bit is set in the same way as the bit defined as the corresponding reference switch (MINDEC or MINSTOP, see Section 2.7.4, Hardware setting via jumper "JP 5“).

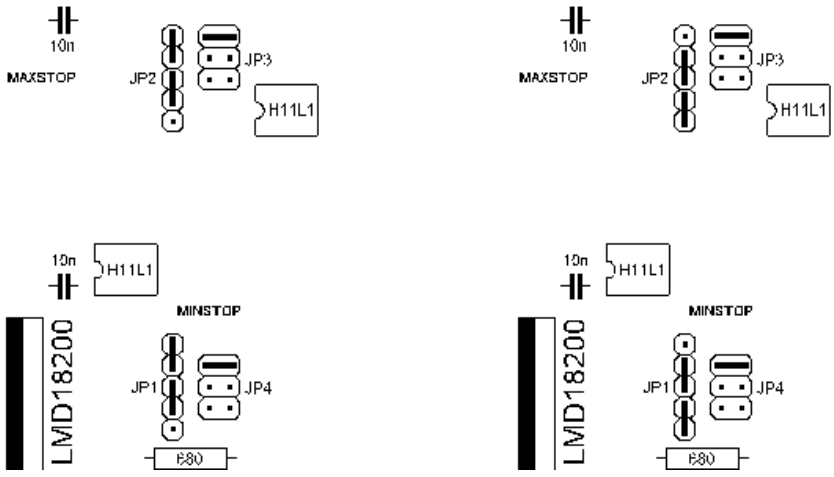
As already mentioned, the standard limit switch level is 5V. The two "...DEC" limit switch inputs work at this level. The levels of the "...STOP" limit switch inputs can be defined via jumper to a level of 5V or 24V. If you want to use 24-V levels, *you need a special hardware option*. *The jumper descripition below is only valid in cases where this option is installed.* Otherwise, the "24-V limit switch level" cannot be used.

Standard configuration for 5-V limit switch level:



JP 1, JP 2 are not plugged in. For JP 3 (MAXSTOP) and JP 4 (MINSTOP), one jumper each is set in the lowest position.

Configuration for 24-V limit switch level:



Configuration for NPN outputs Configuration for PNP outputs

For 24-V limit switch levels, two additional jumpers must be plugged on JP 1 and JP 2 for each limit switch (MINSTOP and MAXSTOP), according to the above illustrations. You can select either NPN or PNP output wiring. In this way, the compatibility with any commercial output variants of inductive proximity switches is ensured. JP 3 and JP 4 must be plugged in the upper or center position. In the center position an additional inverter is looped in the limit switch signal. Basically, this inverter is not required, because the polarity is defined by the software (LM - setting). For special applications where different kinds of limit switches are employed, the use of an inverter may make the software settings more distinct.

2.7.6. Phase-current reduction

In order to keep the obtained position, the stepping motor needs to be supplied with power also when it is at standstill. In the case that the generated heat adversely affects your application, it is possible to define a phase current reduction in the periods of standstill.

For "PCR" you can input a value between 0 and 100. This value designates the holding current / motion current ratio by percentage. Hence, the standard value of "100" means for instance, that the withstand current equals the full phase current (100 percent). For some applications, e.g. if there is no convection cooling in vacuum application, the use of phase-current reduction is absolutely necessary. For vacuum application, we recommend to choose a value between approx. 30…70 (mean: 50).

If the phase-current reduction is set too high the motor may loose steps during start-up, especially if the mechanism is sluggish. Moreover, owing to the snapback effects you generally cannot avoid that the rotor position of the stepper motor changes slightly when the motor is switched back to the reduced withstand current. Besides, with a PCR setting under 100, the command processing time of the SMS 60 is extended, because internally you need to process additional commands for start and end of a positioning process. **In the case that the heat generated with the motor at standstill does not affect your application, we recommend to de-activate the phase current reduction ("PCR = 100"). In this way you reach an optimal instruction processing speed and positioning accuracy.**

2.7.7. Positioning mode

The positioning mode, i.e. the decision, if relative or absolute coordinate data is used for the setting, can be preadjusted separately for each axis. Indicate a "1" for absolute positioning, a "0" for relative positioning. The final counter setting of the device (after positioning is completed) is stored in a battery-buffered RAM and will be retained even when the system is switched off. However, it cannot be ensured that the position of the mechanism will be the same after SMS 60 has been switched on again and initialization is terminated. Therefore, we *absolutely* recommend to make a reference run for all the axes when the device is turned on.

2.8. Mode 6

Reference run of a selectable axis at a programmable speed. The reference run is carried out in the start-stop mode of the stepper motor which means that *no* acceleration or deceleration ramps are executed, but a constant frequency is maintained. For this reason it is coercive for this reference run to select speeds that are *lower* than the start-stop frequency of the corresponding axis (see Section 2.7.1). After re-initialization the standard value for the limit switch approach speed "f(Lock)" is ”118“, the standard value for the limit switch release speed "f(Free)" is "59". The conversion into numbers of revolution or real speeds is handled in Section 2.7.2.

After selecting mode 6, enter the number of the axis for which the reference run is to be carried out. Press "E" to confirm the input. The second input is the ***type*** of the reference run to be performed. The following types are possible:

Type 1: Search and release the reference switch (see Sec. 2.7.)
Type 2: Search the reference switch (see Sec. 2.7.), release it and set the counter to zero

The reference run is performed in the following way:

1. A limit switch is searched in negative direction (MINDEC and / or MINSTOP, depending on definition) at the speed f(Lock).
2. The motor is stopped and this position stored. This position is designated "x1" in this case.
3. The limit switch is released in positive direction at speed f(Free). During this operation:
4. latching of the counter setting, immediately when the corresponding edge can be noticed at the input of the reference switch.
5. The motor is stopped and the position stored. This position is designated "x2" in this case.
6. Move to "x1", without limit switch evaluation.
7. Move to "x2", without limit switch evaluation.

The final move to x1 and x2 is carried out to minimize the backlash of the mechanism. A position approached unidirectional (in this case in positive direction) is generally more precise than a position approached in a bi-directional way. Subsequently, the next command to move will be made in opposite (also positive) direction of the reference switch.

Once the reference run is terminated, the limit switch hysteresis of (x2 - x1) is indicated. This value serves to check the reasonableness, i.e. if the reference switch is configured in the proper way both, as far as the hardware (jumpers) and software ("LS" / "LM" settings) is concerned. Commercial micro switches, Hall sensors, inductive proximity switches or light barriers should show a hysteresis in the range of 1/10 mm. A very small hysteresis indicated in the range of some full steps (approx. 1…50 micro steps or increments) may indicate that the reference switch configuration is not correct.

After selecting the axis and the type, press "S" to start the reference run. Pressing "E" causes the program to return to the main menu while "C" makes it possible to repeat the input. Pressing "-" is used to access a submenu for setting the limit switch approach speed ("lock=L") and the limit switch release speed ("free=F"). The "Speed" submenu is activated with ">" and terminated by "E". Inputs can also be confirmed by pressing "E".

Please note that a change to the limit switch approach / release speed may affect the limit switch reference position. A slow limit switch release (low release speed) generally improves the repeatability of the reference position. As a principle, the reference run of one axis should be performed with the same set of speeds always, to optimize the repeatability.

2.9. Mode 7

Change or reset the actual value counter.

As in mode 1, the axis number, current position and target values are displayed. The input cursor is positioned at the current setting of axis 1, which may then be changed. The "E" button confirms the chosen value, "C" deletes it.

In order to perform a manual reset, select this mode and enter the value "0" for all axes.

2.10. Mode 8

Move up to two axes via joystick.

The display shows the axis numbers and positions of the selected axes. The first value refers to the x-coordinate of the joystick (right - left), the second to the y coordinate (up - down). Speeds and axis allocation can be set by calling up the "Parameter" submenu by pressing "C" ("Change Par.").

"Parameters" submenu:
First, enter the axis numbers to be assigned to the two joystick coordinates ("Axis X=...", "Axis Y=..."). Input of "0" implies a deactivated joystick coordinate. Next "0" or "1" may be specified for each of the two axes as a ***directional*** input ("Dir. X=...", "Dir. Y=..."). Thus, the direction of the axis (positive or negative) is assigned to a joystick movement (e.g., to the right or to the left). "1" inverts the standard assignment. When the directional assignment has been completed, the joystick speeds for the x and y coordinate are shown in the lower half of the display and may be modified. Exit the submenu by pressing "E".

The speed entered in the submenu expresses in each case the maximum speed in the joystick mode. The range extends from factor 100/101 (full excursion) to factor 1/100 (minimal excursion, depending on responsiveness). The speed distribution over the joystick range is tabulated internally, based on an exponential function. The speed proportional to the joystick range is directly output to the motors as a step frequency. Consequently, as in Mode 6, the selected speeds must be lower than the start-stop frequency of the corresponding axis.

When the joystick fire button is pressed, two 8-bit A/D converters are activated and the movement started. The output signals of the converters are shown for checking purposes in the lowest line of the display (0 to 255). The limit switches are monitored during axis travel. On leaving mode 8, the limit switch menu - as described in mode 1 - may be activated, where appropriate (see Sec. 2.3. "Limit switch menu").

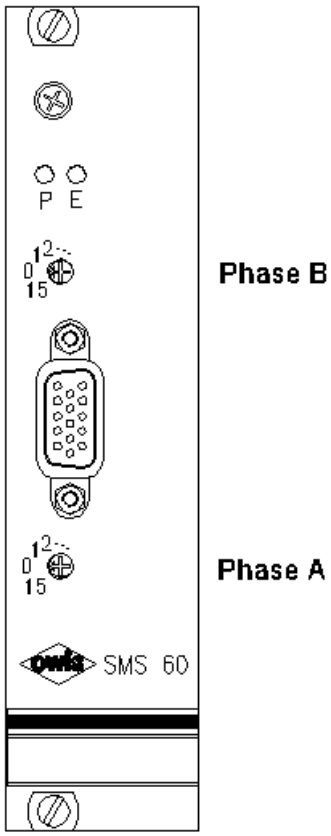
Joystick tuning (adjustment):
With the joystick fire button pressed (for this purpose one of the buttons on the joystick base should to be chosen) and the joystick lever in neutral (when middle centering is activated) a value of approx. 128 should be set for both axes at the converter outputs. If this is not possible (e.g. "0" is shown for both axes), there is a hardware fault.

2.11. Mode 9

Demonstration mode.

The procedure is as in mode 1 (see Sec. 2.3). The controller then travels the entered distance alternately in the positive and negative directions. The mode can be terminated by pressing and holding the "E" button (until the main menu appears). The "E" button is only checked once at a particular point in the "mode 9" program loop.

2.12. Phase current setting



The above illustration shows the front panel of axis module SMS 60. The phase currents for phase A and phase B are separately set via 16-stage rotary encoding switches. The 9 o'clock position (arrow points to "9 o'clock") means "current 0". Clockwise, from catch to catch, the phase current is increased according to the table below. Please make sure that both phase currents have to be set always to the same position, because the drive will otherwise not function properly. To ensure a smooth running (lower resonances) and reduce the loss of heat, we recommend to reduce the rated current indicated on the motor by 20-30 percent. However, this will reduce the available torque output.

Position of switch	Phase current / A	e. g. for motor
0	0	
1	0.18	SM 20 / 24
2	0.34	
3	0.5	SM 440 / 450
4	0.66	
5	0.81	
6	0.98	
7	1.15	SM 240 / 255
8	1.55	SM 240 / 255
9	1.72	
10	1.89	
11	2.06	
12	2.22	
13	2.39	
14	2.57	
15	2.74	

The green-colored "P" LED on the front panel is lit as soon as the +24-V motor supply is available. The red "E" LED indicates, if the phase-to-phase short circuit protection is active. The short circuit protection can only be unlocked by switching the device off for a period of at least 10 seconds.

A certain noise of the motor, owing to the very wide current setting range of the output stage, is quite normal.

3. Operation Using a Control Computer

3.1. Interface Commands

For indications of speed, acceleration or position, the calculations shown in sections 1 and 2 apply analogously. The functioning of the motion commands is comparable to the corresponding manual modes. **In general, the SMS 60 will *never* supply a message *without interrogation.* Messages are only generated after inquiry commands have been sent.**

3.1.1. ACC
"ACC...=..." sets the acceleration of an axis for positioning in modes 2 and 1 / 9, or via computer interface.
Syntax: ACCn=value
n = axis number (1, 2, 3, 4, 5, 6)
value = 1...8191

3.1.2. ?ACC
"?ACC..." reads out the acceleration value of an axis for positioning in modes 2 and 1 / 9 and / or via computer interface.
Syntax: ?ACCn
n = axis number (1, 2, 3, 4, 5, 6)
Contents of the output buffer: acceleration value (1...8191)

3.1.3. AXIS
"AXIS=..." sets the number of the active axes (similar to the corresponding setting option in mode 5). Please observe the notes on this subject in Sec. 2.2. and 2.7.
Syntax: AXIS=n
n = axis number (1, 2, 3, 4, 5, 6)
After the axis number has been changed, the controller must be initialized, e.g. using the "RST" command (see resp. section).

3.1.4. ?AXIS
"?AXIS" reads out the number of axes which are active.
Syntax: ?AXIS
Contents of the output buffer: Number of axes (1…6)

3.1.5. CNT
"CNT...=..." resets the actual value counter of the given axis (equivalent to mode 7).
Syntax: CNTn=value
n = axis number
value = new counter setting (-8,388,608...+8,388,607)

3.1.6. ?CNT
"?CNT..." reads out the counter position (position) of an axis.
Syntax: ?CNTn
n = axis number (1, 2, 3, 4, 5, 6)
Contents of the output buffer: Counter setting (-8,388,608...+8,388,607)

3.1.7. EFREE
"EFREE..." releases the active limit switch for an axis.
Syntax: EFREEn
n=axis number
While this command is carried out, the interface is partially active. The command may be terminated. See also Sec. 3.2.

3.1.8. FVEL
"FVEL...=..." sets the speed of an axis for *releasing* the limit switches
Syntax: FVELn=value
n = axis number (1, 2, 3, 4, 5, 6)
value = 1...8191

3.1.9. ?FVEL

"?FVEL..." reads out the limit switch *release* speed of an axis.

Syntax: ?FVELn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: speed value (1…8191)

3.1.10. GO

"GO..." starts the move of an axis or all axes quasi-simultaneously.

Syntax: GO

or

GOn

n=axis number

"GO" starts the target move defined by preceding "SET..." commands. *Relative* positioning commands (i.e. with the axis in relative positioning mode) are repeated after the next "GO". If this is not required, the travel distance ahead of "GO" must be set to zero by "SET…=0", or the axis must be changed over to the absolute positioning mode.

While the "GO" command is carried out, the interface is *partially active*. In the *partially active* mode, axes which are not - or are no longer - moving may be started. It is also possible to stop one or more moving axes prematurely. See also Sec. 3.2.

3.1.11. ?HYST

"?HYST..." reads out the reference switch hysteresis of an axis (is set again in a reference run).

Syntax: ?HYSTn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: Distance in micro steps / increments (0...+8,388,607)

3.1.12. JOFF

"JOFF" deactivates the remote-controlled joystick mode.

Syntax: JOFF

3.1.13. JON

"JON" activates the remote-controlled joystick mode.

Syntax: JON

While this command is being carried out, the interface is partially active. The command may be aborted. See also Sec. 3.2.

3.1.14. JPLA

"JPLA=..." defines the axis numbers for the joystick "level".

Syntax: JPLA=xy

x= axis number for x-coordinate (joystick right - left)

y= axis number for y-coordinate (joystick down - up)

Input value "0" for a *non-active coordinate.*

3.1.15. ?JPLA

"?JPLA" reads out the axis numbers for the joystick "plane".

Syntax: ?JPLA

Contents of the output buffer: z.B. “10“; i.e. X coordinate = axis 1 and Y-coordinate is deactivated.

3.1.16. JVX

"JVX=…" sets the speed of the joystick X-axis.

Syntax: JVX=value

value = 1...8191

3.1.17. ?JVX

"?JVX" reads out the speed of the joystick X-axis.

Syntax: ?JVX

Contents of the output buffer: speed value (1…8191)

3.1.18. JVY
"JVY=..." sets the speed of the joystick Y-axis.
Syntax: JVY=value
value = 1...8191

3.1.19. ?JVY
"?JVY" reads out the speed of the joystick Y-axis.
Syntax: ?JVY
Contents of the output buffer: speed value (1…8191)

3.1.20. KOFF
"KOFF" locks the keyboard, to prevent any maloperation while the computer interface is active.
Syntax: KOFF
When the keyboard is switched off, the display shows a text which indicates the interface active at this time rather than the message "press <E>".

3.1.21. KON
"KON" switches the keyboard on.
Syntax: KON
After this command, the keyboard can be used again, provided the positioning has been completed, no interface command has to be processed, and the SMS 60 displays the main menu (indication: "press <E>").

3.1.22. LM
"LM...=..." sets the limit switch polarity of an axis.
Syntax: LMn=value
n = axis number
value = limit switch polarity, coded (0...31)
For more information on the coding, please refer to Sections 2.7 or 2.7.5.

3.1.23. ?LM
"?LM..." reads out the limit switch polarity of an axis.
Syntax: ?LMn
n = axis number
Contents of the output buffer: limit switch polarity (0...31)

3.1.24. LS
"LS...=..." sets the limit switch definition of an axis.
Syntax: LSn=value
n = axis number
value = limit switch definition, coded (0...31)
For more information on the coding, please refer to Sections 2.7 or 2.7.4.

3.1.25. ?LS
"?LS..." reads out the limit switch definition of an axis.
Syntax: ?LSn
n = axis number
Contents of the output buffer: limit switch definition (0...31)

3.1.26. LVEL
"LVEL…=" sets the speed of an axis for the *travel* to the end stop.
Syntax: LVELn=value
n = axis number (1, 2, 3, 4, 5, 6)
value = 1...8191

3.1.27. ?LVEL
"?LVEL..." reads out the limit switch *approach* speed of an axis.
Syntax: ?LVELn
n = axis number (1, 2, 3, 4, 5, 6)
Contents of the output buffer: speed value (1…8191)

3.1.28. MOD

"MOD...=..." sets the positioning mode (*relative* or *absolute*) for an axis.

Syntax: MODn=value

n = axis number (1, 2, 3, 4, 5, 6)
value = 0 or 1

“0“ means *relative*, “1“ means *absolute*.

3.1.29. ?MOD

"?MOD..." reads out the positioning mode (*relative* or *absolute*) of an axis.

Syntax: ?MODn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: 0 or 1

“0“ means *relative*, “1“ means *absolute*.

3.1.30. MOFF

"MOFF..." switches off the output stage of the motor of an axis (disable).

Syntax: MOFFn

n=axis number

With the motor switched off, SMS 60 reacts in the very same way as with the motor switched on, but the motor is dead. Positioning procedures are still carried out, because SMS 60 is not able to recognize if the output stage is enabled or not. So, the display may still indicate possible positioning operations without any motor moves.

3.1.31. MON

"MON..." switches on the motor output stage of an axis (enable).

Syntax: MONn

n=axis number

3.1.32. ?MOV

"?MOV" serves to find out the axis travel.

Syntax: ?MOV

Contents of the output buffer: e.g. "101T"

Such a message, e.g., has the following meaning:

- 4 axes are active (since four characters were output)
- Axes 1 and 3 in movement (positioning active), axis 2 inactive, axis 4 locked in velocity mode ("VGO…", see resp. Section).

3.1.33. MRST

"MRST" provokes **a complete re-initialization and clearance of all the data and settings stored in the device.** The device needs approx. 2-3 seconds to be initialized. After that, press the "C" key to confirm, and the usual RESET procedure is started (as after the command "RST" or after switching the device on).

Syntax: MRST

For more information, refer to Section 2.2. **This command has been implemented for the sake of completeness. We recommend, not to use the command. If you use axes with the optional "motor stop brake" the corresponding motors need to be switched off by the "MOFF…" command, *before* the "MRST" command is sent to SMS 60.**

3.1.34. PCR

"PCR...=..." sets the standstill phase current reduction for an axis (to “% of the rated current“).

Syntax: PCRn=value

n = axis number (1, 2, 3, 4, 5, 6)
value = 0...100

3.1.35. ?PCR

"?PCR..." reads out the setting of the standstill phase-current reduction of an axis.

Syntax: ?PCRn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: 0...100

3.1.36. REF

"REF...=..." carries out a reference run, as in manual mode 6.

Syntax: REFn=t

n=axis number

t=type of reference run (1 or 2)

While this command is carried out the interface is partially active. The command may be aborted. See also Sec. 3.2.

3.1.37. ?REF

"?REF" reads out the reference status message temporarily stored in a buffer after the final reference run.

Syntax: ?REF

Depending on the activation of the TERMINAL mode for device message (command "TERM = 1", see below), a message in plain text or a byte in decimal format is output which contains the corresponding information.

"?REF" device message format:

Message "TERM = 1"	Byte hex.	Byte decimal
REF Pos. Axis #...	00	+0
MIN Limit blocked Axis #...	10	+16
REF Motion Axis #… terminated by STP	20	+32
No MIN Limit defined Axis #…	40	+64
No REF SW defined Axis #…	80	+128
REF Motion Axis #… not possible	C0	+192
Internal Error Axis #…	(others)	?

The resp. axis number is added to the above mentioned byte ("TERM = 0") or output behind "Axis #" as a decimal number ("TERM = 1"). Once this command has been processed, the reference status message buffer is cleared. Any further inquiry without previous reference run will provoke a "0".

3.1.38. RST

"RST" resets the controller to the initial state, similar to pressing the "Reset" button. The computer interface needs a max. of approx. 3-4 seconds to be initialized.

Syntax: RST

As a result of reinitializing the interface, it can occur with the RS-232 interface that one or two undefined characters are transmitted to the receiving terminal at the beginning of data transfer. During initialization, avoid to operate the interfaces. **If you use axes with the optional "motor stop brake", the corresponding motors need to be switched off by the "MOFF…" command, *before* the "RST" command is sent to SMS 60.**

3.1.39. SET

"SET...=..." resets the nominal-value counter of the selected axis (similar to the input possibility in mode 1).

Syntax: SETn=value

n = axis number

value = new counter setting (-8,388,608...+8,388,607)

This command and the "GO"- command are the two most important commands for axis positioning.

3.1.40. ?SET

"?SET..." reads out the nominal-value counter of an axis.

Syntax: ?SETn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: Counter setting (-8,388,608...+8,388,607)

3.1.41. ?ST

"?ST" reads out the general controller status (independent from an axis).

Syntax: ?ST

Depending on the activation of the TERMINAL mode for device message (command "TERM = 1", see below), a message in plain text or a byte in decimal format is output which contain the corresponding information.

"?ST" device message format:

Meaning	Name	Bit
0 = no axis in ”GO“ motion state; 1 = min. 1 axis in ”GO“ motion state	MOTION	0
1 = during execution of the latest motion command, at least one limit switch was actuated	LIMIT	1
1 = syntax error in the latest command	CMD_ERR	2
1 = Joystick active	JOY_ON	3
1 = EMERGENCY STOP button has been pressed	E_STOP	4
1 = Reference run currently active	REF	5

Bits no. 1 and 2 are deleted after reading. When the terminal mode is activated, the individual status bits are commented. In this case, the output is as follows:

“MOTION=1, LIMIT=0, CMD_ERR=1, JOY_ON=0, E_STOP=0, REF=0“

The status may *always* be checked by use of the “?ST” command, irrespective of the currently running motion command, i.e. even with a so-called "partially active interface".

Note: Bit 0 is set after “GO...“ exclusively, not after “VGO...“ (see below).

3.1.42. STP

"STP..." stops the movement of one or all of the axes.

Syntax: STP

or

STPn

n=axis number

It is not possible to stop axes which are in a different motion state than the presently active. Example: Axis 1 has been started by "VGO" (velocity mode). At present, a "GO positioning" of axes 2 and 3 is in progress. While at least one of these two axes (2 or 3) is still in motion, axis 1 cannot be stopped.

3.1.43. ?STP

“?STP“ reads out the status message stored temporarily in a buffer after the latest stop command.

Syntax: ?STP

Depending on the activation of the TERMINAL mode for device message (command "TERM = 1", see below), a message in plain text or a 16-bit value (integer) in decimal format is output which contains the corresponding information.

"?STP" device message format:

Message “TERM = 1“	Integer hex.	Integer decimal
Motion Axis ... .. … terminated by STP	0400	1024
GO Axis ... .. … terminated by STP	0800	2048
REF Motion Axis #… terminated by STP	1000	4096
EFREE Axis #… terminated by STP	2000	8192
Joystick Mode terminated by STP	4000	16384
Unable to terminate Axis … by STP	8000	32768

The resp. range of axis numbers is coded in the last-significant byte by one set bit for each axis (bit <axis number> -1) (“TERM = 0“), or output behind “Axis“ as a decimal number (“TERM = 1“). Once this command has been processed, the stop status message buffer is cleared. Any further inquiry without previous stop command will provoke the indication of a "0". Example for axis range coding with "TERM = 0": The range “axes 1 to 6“ is coded by bit “0” set and bit “5” set. Hence, “GO Axis 1..6 terminated by STP” (“TERM = 1”) is equivalent to the message “2081” = 2048 + 32 + 1 (“TERM = 0”).

3.1.44. ?SW

"?SW..." reads out the status of an axis.

Syntax: ?SWn

n=axis number

Depending on the activation of the TERMINAL mode for device message (command "TERM = 1", see below), a message in plain text or a byte in decimal format is output which contains the corresponding information.

"?SW" device message format:

Meaning	Name	Bit
1 = MINSTOP actuated	MINSTOP	0
1 = MAXSTOP actuated	MAXSTOP	1
1 = MINDEC actuated	MINDEC	2
1 = MAXDEC actuated	MAXDEC	3
1 = Axis is in “GO” , “VGO” or “EFREE” motion state	MOV	4
1 = Phase current reduction is enabled and active (motor at standstill)	PCR	5
1 = axis in ”VGO“ motion state	TURN	6

When the terminal mode is activated, the individual status bits are commented. In this case, the output is as follows:

“MINS=1, MAXS=0, MIND=0, MAXD=0, MOV=0, PCR=1, TURN=0“

To send the "?SW" command is permitted *nearly always* except during a reference run.

3.1.45. TERM

"TERM=..." switches the terminal mode for extended plain-text device messages on or off.

Syntax: TERM=value

value = 0 oder 1

“0“ means *“switch terminal mode off“*, “1“ means *“switch terminal mode on“*.

3.1.46. ?TERM

"?TERM" reads out the status of the terminal mode.

Syntax: ?TERM

Contents of the output buffer: 0 or 1

“0“ means *“terminal mode is switched off“*, “1“ means *“terminal mode is switched on“*.

3.1.47. ?VACT

"?VACT..." reads out the current travel speed of an axis.

Syntax: ?VACTn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: speed value (±1... ±8191)

A *positive* speed value indicates a move in the *positive* direction and vice versa.

3.1.48. ?VD

"?VD" is used to find out the current version number of the installed firmware.

Syntax: ?VD

Contents of the output buffer: e.g. “SMS 60 V.1.0 (C) 15.03.2002 OWIS GmbH Staufen“

3.1.49. VEL

"VEL...=..." sets the speed of an axis for positioning in modes 1 / 9 or via computer interface.

Syntax: VELn=value

n = axis number (1, 2, 3, 4, 5, 6)

value = 1...8191

3.1.50. ?VEL

"?VEL..." reads out the positioning speed of an axis for positioning in modes 1 / 9 and / or via computer interface.

Syntax: ?VELn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: speed value (1…8191)

3.1.51. VGO

"VGO...=..." starts the velocity mode for an axis

Syntax: VGOn=value

n=axis number

value = ±1... ±8191

In this case, the axis is accelerated to the selected final speed in a trapezoidal speed curve, until the move is interrupted by the actuation of the limit switch or a stop command.

3.1.52. JDIR

"JDIR=..." assigns the direction for the joystick “plane“.

Syntax: JDIR=xy

x = direction assignment for x-coordinate (joystick right - left)
y = direction assignment for y-coordinate (joystick down - up)

3.1.53. ?JDIR

"?JDIR" reads out the direction assignment for the joystick “plane”.

Syntax: ?JDIR

Contents of the output buffer: e.g. “00“

3.1.54. POS

"POS...=..." sets the encoder counter of the selected axis (similar to the input possibility in mode 4).

Syntax: POSn=value

n = axis number
value = new counter setting (-8,388,608...+8,388,607)

3.1.55. ?POS

"?POS..." reads out the encoder counter of an axis.

Syntax: ?POSn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: Counter setting (-8,388,608...+8,388,607)

3.1.56. ?RDNE

"?RDNE..." indicates, if an axis has done a valid reference motion already (“1“) or not (“0“). This flag will be cleared after actuation of a “...STOP“ limit switch, because the reference position might be lost then.

Syntax: ?RDNEn

n = axis number (1, 2, 3, 4, 5, 6)

Contents of the output buffer: e.g. “0“

3.2. Partially active interface

While a positioning command is being processed that has been sent via computer interface, the interface is *partially active.* This means, during the time in which the interface is partially active, the system does not permit all the implemented commands, but only a certain subset of them. Inadmissible commands will be ignored and rated as "syntactically incorrect" (syntax error).

The respective motion state determines which commands are permissible. There are four different conditions:

1. GO
2. EFREE
3. REF
4. JON

In the table below, a "**+**" marks the commands which are permitted. A "**-**" has the opposite meaning.

Condition to move / Command	”GO“	”EFREE“	”REF“	”JON“
?ST	+	+	+	+
STP	+	+	-	+
STP1	+	+	+	+
?STP	+	+	+	-
?REF	+	+	+	-
?CNT1	+	+	-	+
?SET1	+	-	-	-
SET1	+	-	-	-
?VACT1	+	+	-	+
GO	-	-	-	-
GO1	+	-	-	-
?SW1	+	+	-	+
?MOV	+	+	-	+
?MOD1	+	-	-	-
MOD1	+	-	-	-
?JVX	-	-	-	+
?JVY	-	-	-	+
JVX	-	-	-	-
JVY	-	-	-	-
JOFF	-	-	-	+
POS1	+	+	-	+
?POS1	+	+	-	+
?RDNE1	+	+	-	+
?JPLA	-	-	-	+
?JDIR	-	-	-	+

The reference run is the most restrictive motion state. This state can also be recognized by sending the command "?ST". For all other conditions to move, additional information may be inquired via commands "?SW" and "?MOV". The complete controller status can be inquired during the motion states “GO“, “EFREE“ and “JON“ by a single interrogation of “?ST“ and of “?SW“ for all the axes which are active.

3.3. Interface RS 232

Pin settings of the serial Interface:

1	n.c.
2	RxD (input)
3	TxD (output)
4	n.c.
5	GND (ground)
6	n.c.
7	RTS-Handshake (output)
8	CTS-Handshake (input)
9	n.c.

Hardware handshake via RTS/CTS is implemented. However the use of this function is only recommended when the handshake log of the computer interface (COM...) is known exactly, since the transmission of an incomplete command will be aborted at the end of the internal timeout (300 ms), and an active timeout may affect the positioning routines and limit switch recognition.

If RTS/CTS is not used, a wire jumper should definitely be provided connecting Pin 7 to Pin 8 in the interface connection plug (recommended).

All commands end with <CR> (13 decim. / 0D hex.) to conclude. The device messages are terminated with this character as well (see also Sec. 2.5).

The serial interface has a hardware input buffer. This buffer is able to buffer 31 characters and one <CR> as an end mark. Note that ***commands longer than 31 characters*** are not possible.

3.4. Interface IEEE 488

The built-in interface, conforming to IEEE ***488.1***, is buffered. If a command is received which generates a device message, the message is written into the buffer and remains there until it is fetched. The transmission of another command which generates also an output causes the buffer to be overwritten, even if it has not been read out before. In this case, the previous message which has still not been read, will be lost.

Any attempt to access the output buffer when it is empty (SMS 60 addressed as a talker) will cause the controller to output to the host a "?" with trailing EOS character.

Device address: 1...31 variable (see Sec. 2.5). A secondary device address is not supported.

Interface characteristics: AH1, SH1, L4, T6, SR1, PP0, RL0, DC1, DT1, C0, E2

Log of the device messages: [command][terminator with EOI]

Device message format: [message][terminator, where appropriate with EOI, or only EOI]

*-> **EOI** is a standardized bus message which is transmitted or received simultaneously with the last character of the command or the message.*

IEEE command sequences

Knowledge of the following "low-level" bus sequences is generally no longer necessary today as they are created automatically by the driver software. However, they are listed below for completeness.

- Processing a command from the control computer:
  UNL UNT MTA OLA [command in ASCII] [terminator / EOI]

  UNL=Unlisten
  UNT=Untalk
  MTA=My Talker Address
  OLA=Other Listener Address

- Readout of information from the output buffer by the control computer:
  UNL UNT MLA OTA [message in ASCII of the device] [terminator of the device / EOI] UNT

  MLA=My Listener Address
  OTA=Other Talker Address

Note:
For repeated read-out of the output buffer, it is usually best to address the device as LISTENER, without having to send a command or a particular EOS character, and then immediately afterward to address the device as TALKER again.

Example
Repeated read-out of the buffer is possible e.g. using a NATIONAL INSTRUMENTS GPIB PCIIA computer interface together with the IBIC terminal program and the following command sequence:

ibwrt ""	*(without EOS)*
ibrd 255	*Read out buffer (e.g.)*
ibwrt ""	*etc.*

Service Request (SRQ) Function
The SRQ function is activated by SW2 DIP switch No. 4 (see Sec. 2.5), if required. When certain events occur the SRQ call is generated, and a **status** byte is set, which can be read out by a **"serial poll"**. An analysis of the bits set in the status byte makes it possible to distinguish between particular errors and to interrogate controller status. The following events generate a SRQ:

- End of travel of one or several axes
- End of travel with limit switch triggered at one axis or several axes
- Actuation of EMERGENCY-STOP button

The same status byte is sent which has been generated by the command "?ST" (see above). Bit 6 is set in addition to the information contained in the status byte. Setting of bit 6 causes the host to issue an SRQ call. **Using the status byte for an SRQ call is equivalent to the inquiry by means of the command "?ST", which means that any bits 1 ("LIMIT") and 2 ("CMD_ERR") set will be deleted once the SRQ call has been generated.**

The status byte is only valid if bit 6 has been set, i.e. when after a "serial poll" a status byte ≥ 64 dec. = 40 hex. is returned. A status byte which may not have been read, will be overwritten by the next SRQ message ! In general, the host buffers *all the status bytes* to ensure that no piece of information will be lost.

Multiple Commands
The following multiple commands are supported by the interface:

a) SDC, "Selected Device Clear" -> Re-initialization of the IEEE interface
b) GET, "Group Execute Trigger" -> Start of the positioning (equivalent to the "START" command)

Response Times
The command processing time of the controller, i.e. interpretation of command and possible output of a character string, amounts to approx. 30…70 ms. We recommend you to provide a run-time adjustment by inserting "delay()" or "sleep()" in your application program.

3.5. Pinning of Standard Axis Connector

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Pinning of 15-pole HD plug (female) on the SMS 60 axis module

Pin No.	Function
1	Motor Phase A+
2	Motor Phase A-
3	Motor Phase B+
4	Motor Phase B-
5	(Encoder I)
6	(+12Vout)
7	(-12Vout)
8	+5Vout
9	(Encoder A)
10	(EncoderB)
11	MINSTOP
12	MINDEC
13	GND
14	MAXDEC
15	MAXSTOP

MINSTOP = hardware limit neg. direction, MINDEC = software (reference) limit neg. direction, MAXDEC = software limit pos. direction, MAXSTOP = hardware limit pos. direction. The hardware limits become active *after* the software limits and additional to them. The limits are normally-closed contacts connected to GND.

The pin names enclosed in brackets are reserved for optional equipment. In this case,

- Output +/-12V to supply inductive proximity switches as MINSTOP / MAXSTOP (option)
- TTL encoder input (for future expansions, presently not available)

Under no circumstances may the reserved pins (especially the pins meant for the encoder signals) *accidentally contact the phase connections or the 12-V outputs* ! This will result in severe damages to the hardware, which can also affect other functions !