

# DEPRAG

## **OPERATING INSTRUCTIONS**

### **Sequence Controller**

**AST2 823036 A**

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**Quality Unites**

Certified according to ISO 9001

# **CONTENT:**

<b>Safety Tips</b>	<b>1 - 2</b>
<b>General Information</b>	<b>3</b>
<b>1. Error Description</b>	<b>4 - 5</b>
<b>2. Equipment Views</b>	
<b>Dimensions</b>	<b>6</b>
<b>Front View</b>	<b>7</b>
<b>Electric Connections</b>	<b>8</b>
<b>3. Lay-Out</b>	
<b>x1 Mains Supply</b>	<b>9</b>
<b>x2 Equipment Controller</b>	<b>9 - 10</b>
<b>x3 Torque / Angle</b>	<b>10</b>
<b>x4 I-Bus</b>	<b>10</b>
<b>x5 Power Supply</b>	<b>11</b>
<b>x6 PC</b>	<b>11</b>
<b>x7 Printer</b>	<b>11</b>
<b>Motor Cable for Spindle 300E40-XXX</b>	<b>12</b>
<b>Motor Cable for Spindle 300E57-XXX</b>	<b>13</b>
<b>Motor Cable for Spindle 300E80-XXX</b>	<b>14</b>
<b>Automatic Start (Option) Sensor Pin Lay-Out</b>	<b>15</b>

## **4. Terminal Program**

<b>Input Controller Factors</b>	<b>16 - 23</b>
<b>Parameter-Sets / General Information</b>	<b>24 - 27</b>
<b>Description of a Parameter</b>	<b>28 - 31</b>
<b>Input Parameter Set of Screwdriving Diagram 2 (DIA2)</b>	<b>32 - 33</b>
<b>Input Parameter Set of Screwdriving Diagram 3 (DIA3)</b>	<b>34 - 35</b>
<b>Input Parameter Set of Screwdriving Diagram 4 (DIA4)</b>	<b>36 - 37</b>
<b>Input Parameter Set of Screwdriving Diagram 5 (DIA5)</b>	<b>38 - 39</b>
<b>Input Parameter Set of Screwdriving Diagram 1 (DIA1)</b>	<b>40 - 41</b>
<b>Input Parameter Set of Screwdriving Diagram 6 (DIA6)</b>	<b>42 - 43</b>
<b>Programs - General Information</b>	<b>44 - 46</b>
<b>Input Program</b>	<b>47 - 50</b>
<b>Listing of Programming Commands</b>	<b>51 - 58</b>
<b>Programming Examples</b>	<b>59 - 65</b>
<b>Statistics Menu</b>	<b>66 - 69</b>
<b>Print Menu</b>	<b>70</b>
<b>Software Change</b>	<b>71 - 72</b>
<b>Data Transfer</b>	<b>73 - 76</b>
<b>Test Menu</b>	<b>77 - 82</b>
<b>Other Functions</b>	<b>83</b>

# **SAFETY TIPS**

**Attention:** When using electrical equipment, the following basic safety rules have to be observed, to avoid electrical shocks, injury and fire hazards.

Please read and observe all safety rules, prior to the use of the tool.  
Keep this Booklet (Safety Rules) nearby and easy to access!

- 1. Keep your work area organized**
  - Untidy work areas result into injuries!
  
- 2. Consider Work-Environment**
  - Do not use electrical equipment in damp or wet environments. Make sure sufficient lighting is available. Do not use electrical equipment close to flammable liquids or gases.
  
- 3. Protect yourself from electrical shocks**
  - Eliminate direct body contact with grounded parts, such as pipes, radiators, or other connected electrical equipment.
  
- 4. Do not overload device**
  - You work more efficient and safer within the rated power-range. Make sure that the calibration value of the driver is input into the controller.
  
- 5. Use the correct Screwdriving-Tool**
  - Do not use power insufficient drivers or additional parts (i.e. offsets) for non-applicable assemblies. Do not use tools for purposes or assemblies other than what they are designed for.
  
- 6. Wear suitable Work-Clothes**
  - Do not wear loose clothing or jewelry, since they could be caught by moving parts. For long hair, use a hair net.
  
- 7. Do not miss-use cable**
  - **Do not carry the tool by its cable. Do not pull on cable to disconnect plug! Protect the cable from heat, oil and sharp edges.**

## **8. Maintain your Tools**

- check regularly the cable and if damaged, have it replaced. Check also the extension cable on a regular basis and replace it, if damaged. Keep the handles clean, dry and free of oil or grease.

## **9. Eliminate unintentional Start**

- Make sure that the on/off switch is in the "off" position, when connecting the equipment to an electrical outlet.

## **10. Concentrate on your Work**

- Remain alert. Work sensibly and do not use the tool, if you are not focused.

## **11. Check Device for Damages**

- Prior to the use of the equipment, pay attention to the safety features and all other parts, in regards to their correct and designated function. Damaged safety guards and parts should be repaired by a DEPRAG service technician or exchanged, unless otherwise specified in the Operating Instruction. Damaged switches or plugs have to be replaced by DEPRAG. Do not use a device with defective switches or plugs.

## **12. Attention**

- For your own safety use only accessories and equipment, which are listed in the Operating Instructions or which are shown in the associated catalog. The use of any other driver, not shown in the OP-instructions or in our catalog, is not permissible.

## **13. Repair by DEPRAG only**

- This electrical device complies with all relevant safety regulations. Repairs can therefore only be done by a DEPRAG electrician; otherwise injury could be possible, for which DEPRAG is not liable.

## **14. Vibration-Free Installation**

- The electronic equipment (controller and power supply) has to be installed on a compact- and vibration-free surface.

## **15. Temperature**

- The room temperature should not exceed 40° Celsius (104 ° F). If temperature exceeds this point, provide sufficient cooling.

## **General Information**

**ALL RIGHTS RESERVED**

**THIS PUBLICATION CANNOT BE REPRODUCED, COPIED OR OTHERWISE USED,  
WITHOUT THE EXPLICIT AND WRITTEN APPROVAL OF DEPRAG.**

**TECHNICAL MODIFICATION SUBJECT TO CHANGE WITHOUT NOTICE.**

**THIS MANUAL HAS BEEN WRITTEN WITH THE MOST DETAILED CARE. HOWEVER, SHOULD  
THERE BE AN ERROR, WE WOULD APPRECIATE YOUR NOTIFICATION.**

**DEPRAG IS NOT BE LIABLE FOR ANY ERRORS OR THEIR SUBSEQUENT RESULTS!**

# 1. ERROR DESCRIPTION

## Possible Error Indications on the AST-Display

<b>OFFSET-ERROR</b>	<b>Error:</b> OFFSET	<b>Error:</b> <ul style="list-style-type: none"><li>- defective cable</li><li>- no transducer</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- check cable</li><li>- connect transducer</li></ul>
<b>TTL-VOLTAGE &lt;4.75V</b>	<b>Error:</b> TTL<	<b>Error Source:</b> <ul style="list-style-type: none"><li>- Supply Voltage of internal parts defective</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- Not-Repairable by customer; send equipment to DEPRAG</li></ul>
<b>TTL-VOLTAGE &gt;5.25V</b>	<b>Error:</b> TTL>	<b>Error Source:</b> <ul style="list-style-type: none"><li>- Supply Voltage of internal parts defective</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- Not-Repairable by customer; send equipment to DEPRAG</li></ul>
<b>TRANSDUCER VOLTAGE &lt;11.5V</b>	<b>Error:</b> GEB+<	<b>Error Source:</b> <ul style="list-style-type: none"><li>- Supply Voltage of Transducer defective</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- Not-Repairable by customer; send equipment to DEPRAG</li></ul>
<b>TRANSDUCER VOLTAGE &gt;12.5V</b>	<b>Error:</b> GEB+>	<b>Error Source:</b> <ul style="list-style-type: none"><li>- Supply Voltage of Transducer defective</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- Not-Repairable by customer; send equipment to DEPRAG</li></ul>
<b>TRANSDUCER VOLTAGE &lt;11.0V</b>	<b>Error:</b> GEB-<	<b>Error Source:</b> <ul style="list-style-type: none"><li>- Supply Voltage of Transducer defective</li></ul>	<b>Solution:</b> <ul style="list-style-type: none"><li>- Not-Repairable by customer; send equipment to DEPRAG</li></ul>

# 1. ERROR DESCRIPTION

## Possible Error Indications on the AST-Display

### TRANSDUCER VOLTAGE >-13.0V

Error:

**GEB->**

#### **Error Source:**

- Supply Voltage of internal parts defective

#### **Solution:**

- Not-Repairable by customer; send equipment to DEPRAG

### MD CAL TOO SMALL

Error:

**MDKAL<**

#### **Error Source:**

- Transducer locked
- Transducer damaged (overloaded)

#### **Solution:**

- Turn Driver by Hand
- Not-Repairable by customer; send equipment to DEPRAG

### MD CAL TOO LARGE

Error:

**MDKAL>**

#### **Error Source:**

- Transducer locked
- Transducer damaged (overloaded)

#### **Solution:**

- Turn Driver by Hand
- Not-Repairable by customer; send equipment to DEPRAG

### NO DLE FROM V24

Error:

**MDKAL>**

#### **Error Source:**

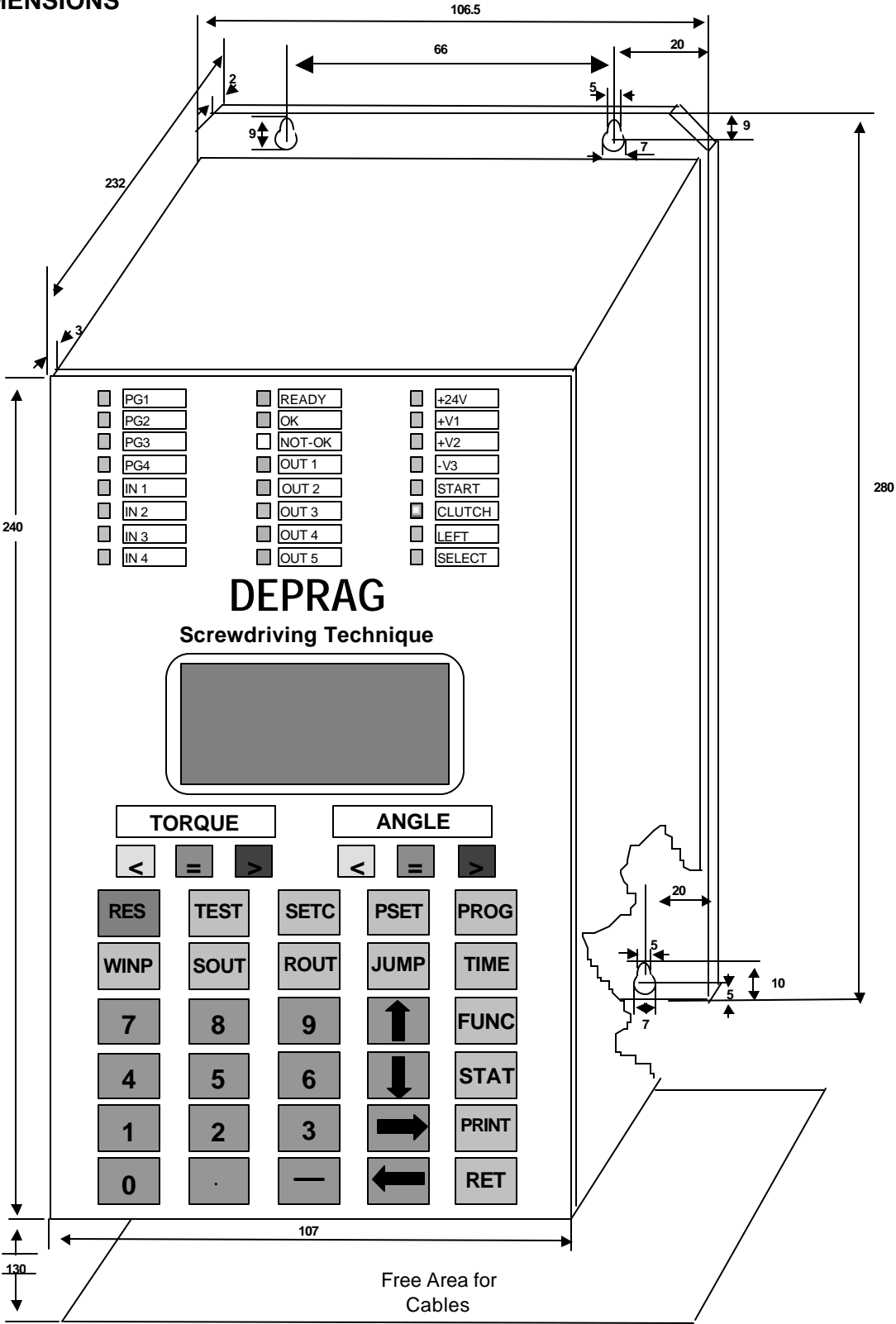
- No cable connected
- Cable damaged
- Cable incorrectly soldered

#### **Solution:**

- Check Cable
- Use original cable

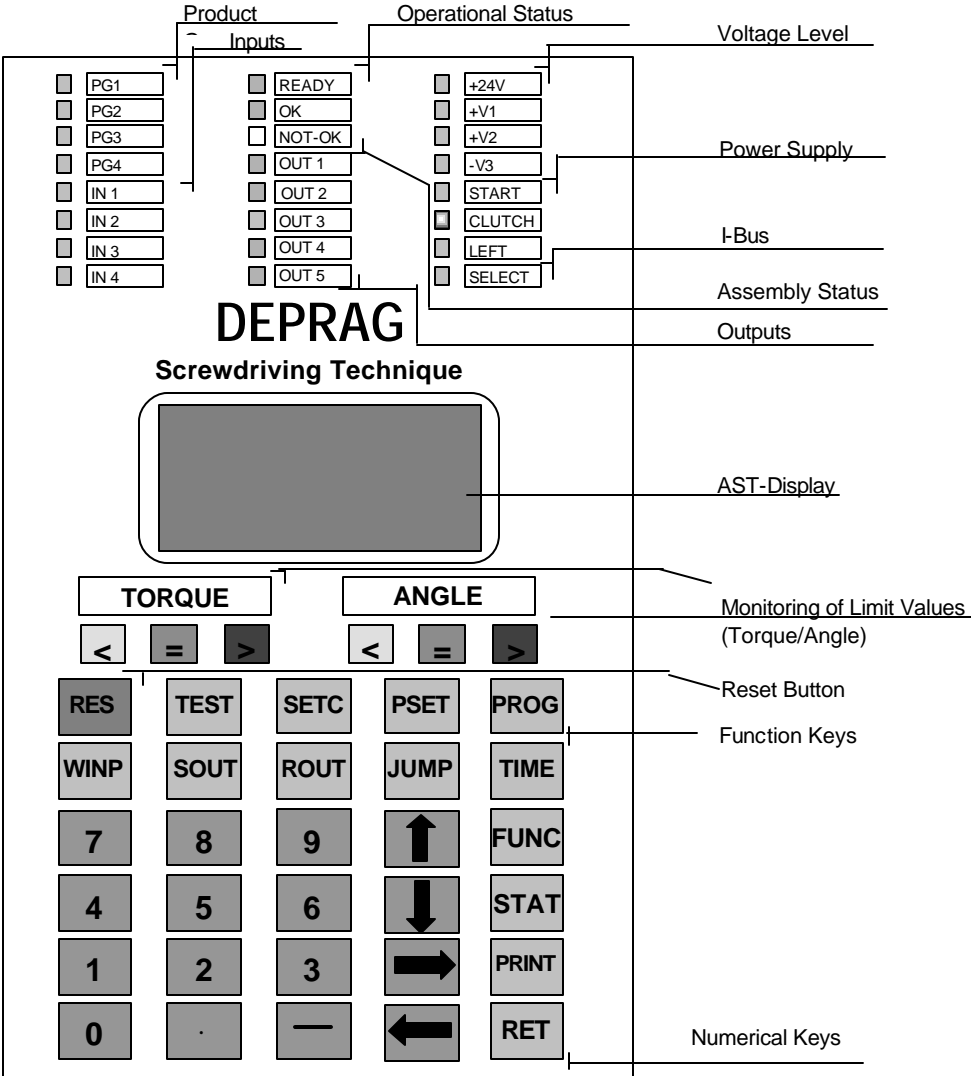
# 2. EQUIPMENT VIEW

## DIMENSIONS



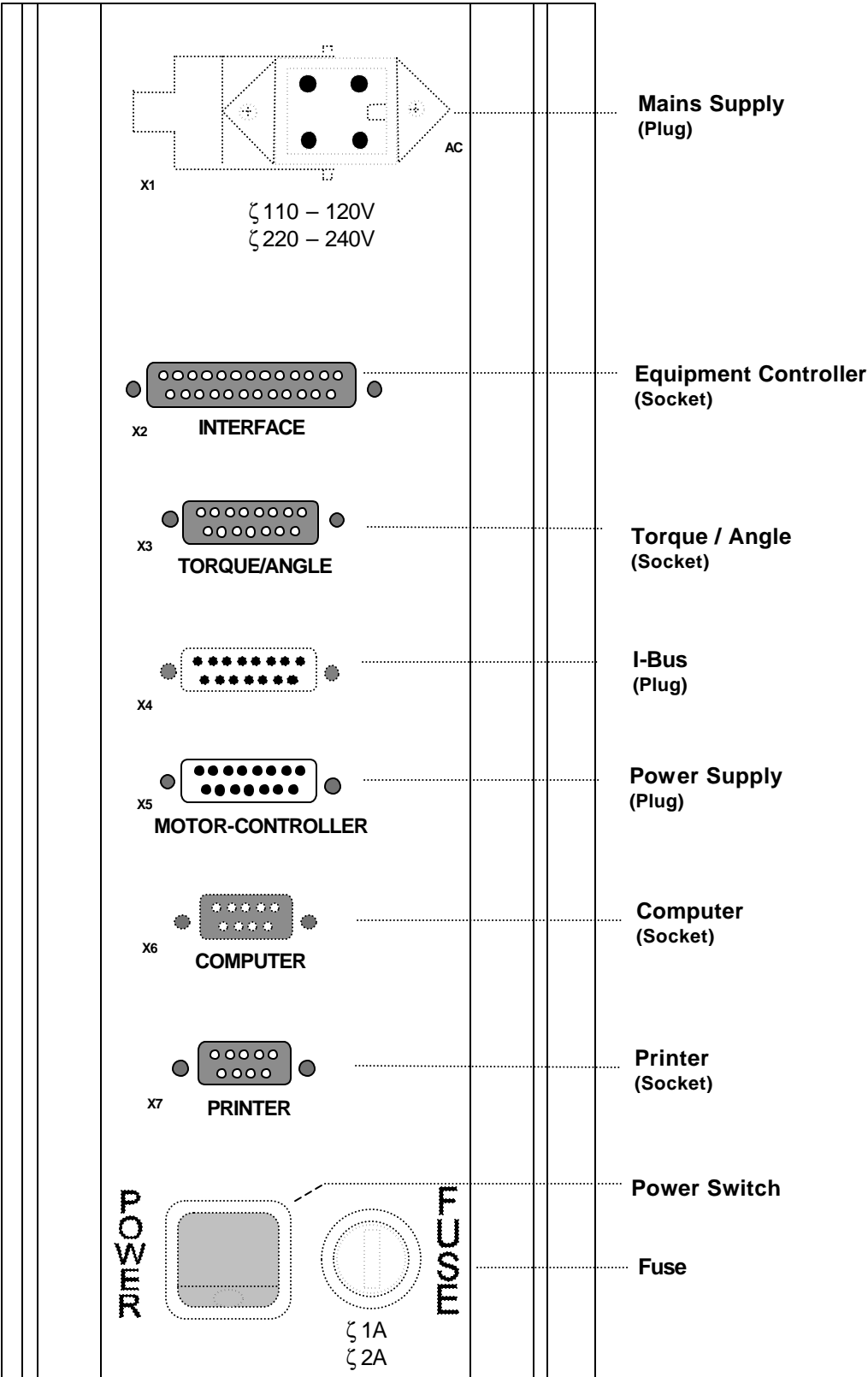
# 2. EQUIPMENT VIEW

## FRONT VIEW



# 2. EQUIPMENT VIEW

## ELECTRICAL CONNECTIONS



### 3. LAY-OUT

#### X1 MAINS SUPPLY

4-pole Hartig-Plug with Lock  
220 – 240V / 50 Hz or  
110 – 120V / 60 Hz

<u>PIN</u>	<u>DESTINATION</u>
1	Phase L1
2	not used
3	Neutral MP
4	Ground SL

#### X2 EQUIPMENT CONTROLLER

25-pole MIN-D Socket

<u>PIN</u>	<u>DESTINATION</u>	
1	0V-Programming	Input
2	Program 1	Input
3	Program 3	Input
4	Input 1	Input
5	Input 3	Input
6	+24V-Programming	Input
7	Ready (Operational)	Output
8	Fault (NIO - Not O.K.)	Output
9	Output 2	Output
10	Output 4	Output
11	+24V-Supply Voltage	Output
12	0V-Supply Voltage	Output
13	not used	
14	0V-Programming	Input
15	Program 2	Input
16	Program 4	Input
17	Input 2	Input
18	Input 4	Input
19	+24V-Programming	Input
20	OK (IO / O.K.)	Output
21	Output 1	Output
22	Output 3	Output
23	Output 5	Output
24	+24V-Supply Voltage	Output
25	0V-Supply Voltage	Output

All In- and Outputs carry a 0V/24V level and are controlled with the same.

### 3. LAY-OUT

#### X2 EQUIPMENT CONTROLLER – continued:

The BMS-Interface requires +24V Voltage. If no external +24V is available, the following bridges can be can be soldered on the 25-pole plug:

<b>PIN</b>		<b>PIN</b>
1	with	12
6	with	11
14	with	25
19	with	24

#### Output Load:

- with internal supply (bridged plug) 500 mA per output / 1A total load
- with external supply 500 mA per output

#### X3 TORQUE/ANGLE

15-pole MIN-D Socket

<b>PIN</b>	<b>DESTINATION</b>
1	Calibrate
2	+MD
3	+12V
4	SC
5	+5V
6	Angle 1
7	Angle 3
8	GND
9	Depth Analog
10	-MD
11	-12V
12	GND
13	+5V
14	Angle 2
15	DI

#### X4 I-BUS

15-pole MIN-D Socket

<b>PIN</b>	<b>DESTINATION</b>
1	Card Address 0
2	Card Address 1
3	Card Address 2
4	Card Address 3
5	Card Address 4
6	Card Address 5
7	Card Address 6
8	Card Address 7
9	RxD
10	TxD
11	RTS
12	CTS
13	GND
14	GND
15	+5V

### 3. LAY-OUT

#### X5 POWER SUPPLY

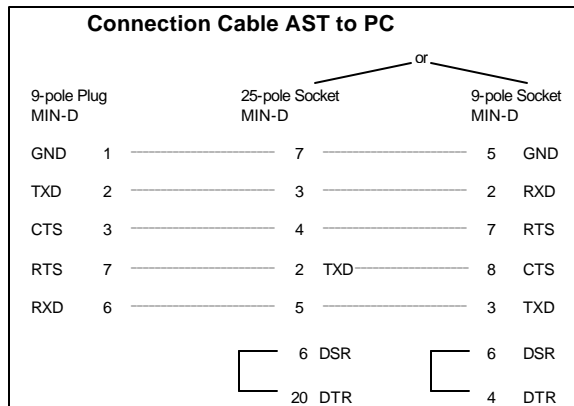
9-pole MIN-D Plug

<u>PIN</u>	<u>DESTINATION</u>
1	OV
2	Left Rotation
3	N Set-Value
4	N Actual-Value
5	Error
6	Start
7	Clutch
8	I Set-Value
9	Ip Error

#### X6 P/C - COMPUTER

9-pole MIN-D Socket

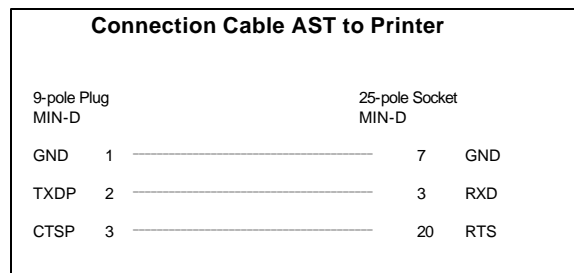
<u>PIN</u>	<u>DESTINATION</u>
1	GND
2	TxD
3	CTS
4	not used
5	not used
6	RxD
7	RTS
8	GND
9	not used



#### X7 PRINTER

9-pole MIN-D Socket

<u>PIN</u>	<u>DESTINATION</u>
1	GND
2	TxD
3	CTS
4	not used
5	not used
6	RxD
7	RTS
8	GND
9	not used



**Adjustment on Printer**

**1. EPSON Modus**

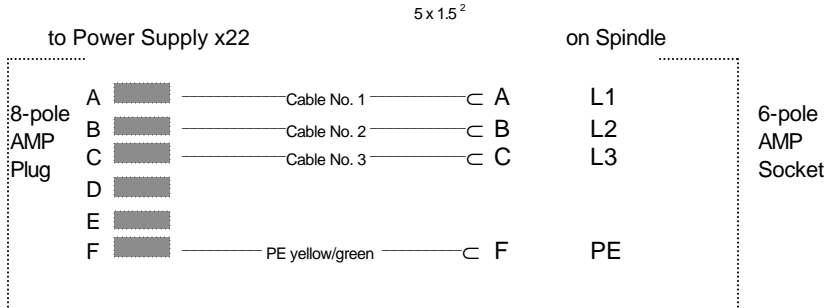
<b>Baud Rate</b>	<b>9600</b>
<b>Data</b>	<b>8</b>
<b>Parity</b>	<b>N</b>
<b>Stop</b>	<b>1</b>

### 3. LAY-OUT

#### MOTOR CABLE FOR SPINDLE 300E40-XXX

9-pole Amphenol Plug

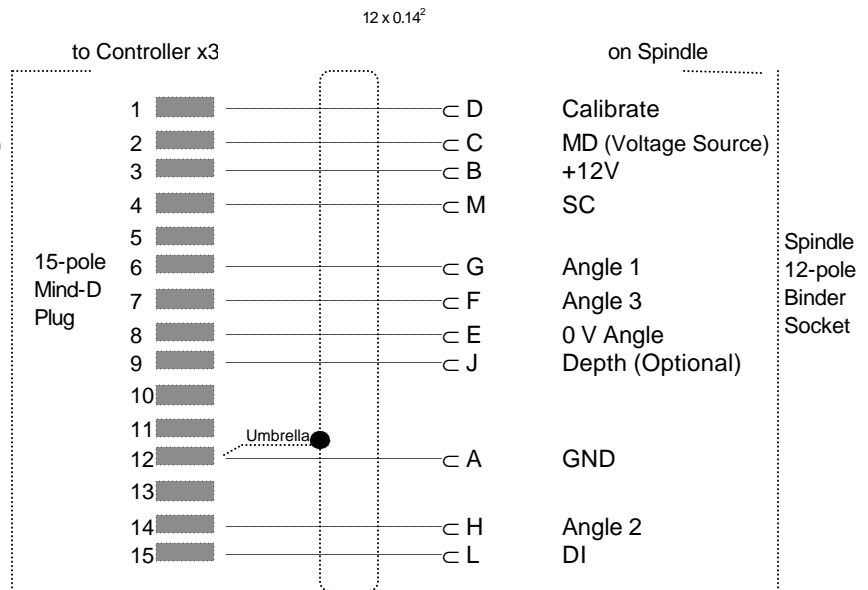
PIN	DESTINATION
A	L1
B	L2
C	L3
D	
E	
F	PE



#### MD / WI FOR SPINDLE

12-pole Binder Socket

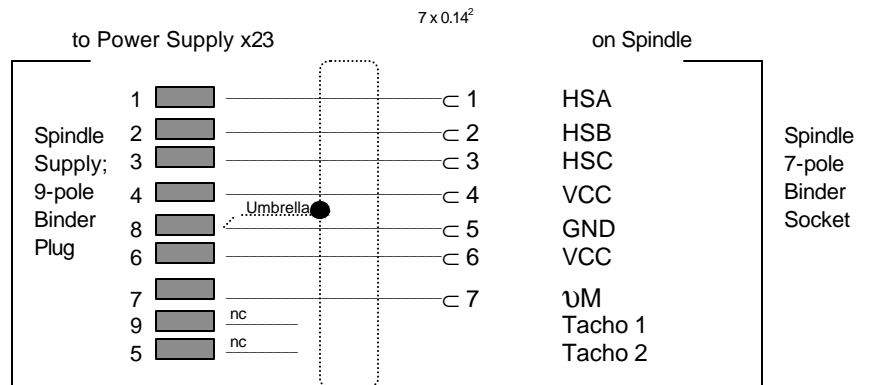
PIN	DESTINATION
D	Calibrate
C	MD (Voltage Source)
B	+12V
M	SC
G	Angle 1
F	Angle 3
E	0 V Angle
J	Depth (Optional)
A	GND
H	Angle 2
L	DI



#### CONTROL CABLE FOR SPINDLE

7-pole Binder Socket

PIN	DESTINATION
1	HSA
2	HSB
3	HSC
4	VCC
5	GND
6	VCC
7	UM



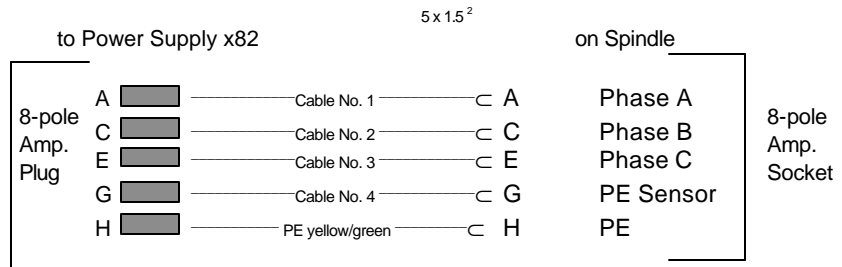
### 3. LAY-OUT

#### MOTOR CABLE FOR SPINDLE 300E57-XXX

8-pole Amphenol Plug

<u>PIN</u>	<u>DESTINATION</u>
------------	--------------------

A	Phase A
C	Phase B
E	Phase C
G	PE-Sensor
H	PE

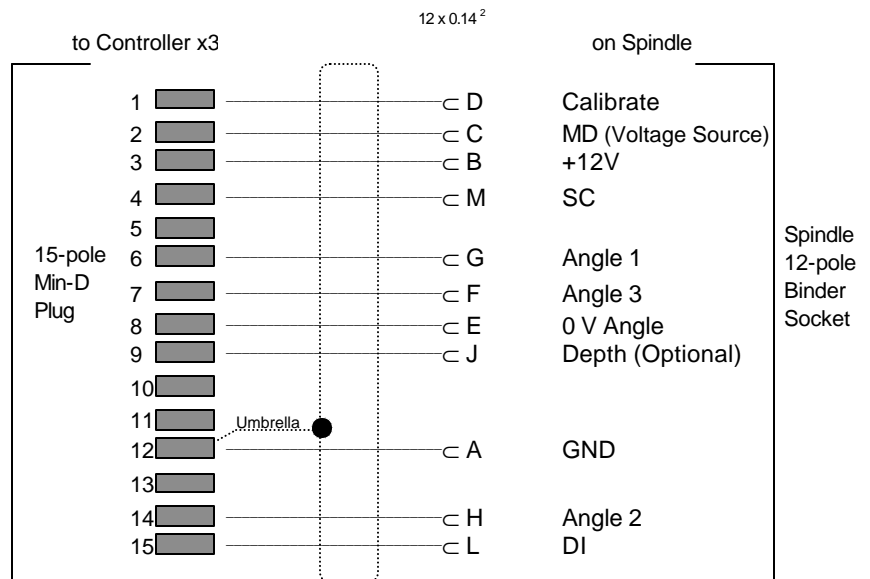


#### MD / WI FOR SPINDLE

12-pole Binder Socket

<u>PIN</u>	<u>DESTINATION</u>
------------	--------------------

D	Calibrate
C	MD (Voltage Source)
B	+12V
M	SC
G	Angle 1
F	Angle 3
E	0 V Angle
J	Depth (Option)
A	GND
H	Angle 2
L	DI

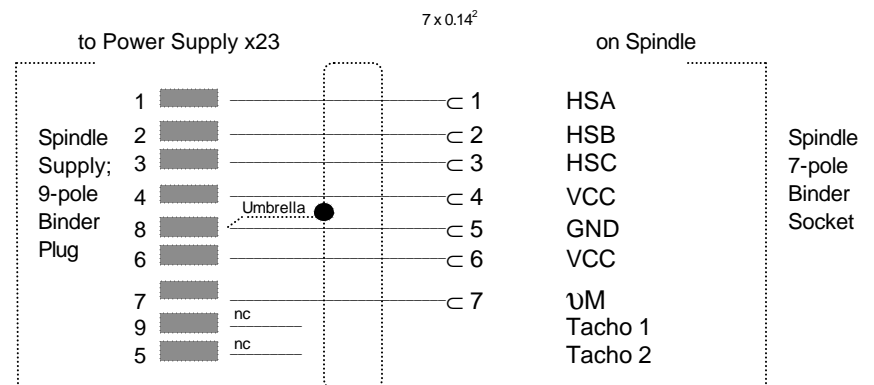


#### CONTROL CABLE FOR SPINDLE

7-pole Binder Socket

<u>PIN</u>	<u>DESTINATION</u>
------------	--------------------

1	HSA
2	HSB
3	HSC
4	VCC
5	GND
6	VCC
7	UM



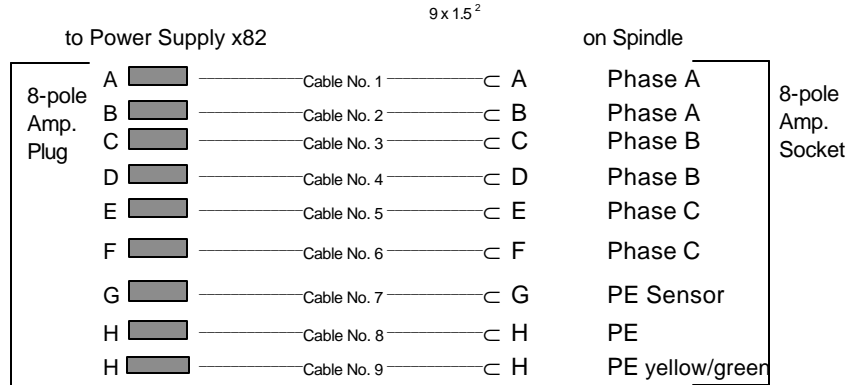
### 3. LAY-OUT

#### MOTOR CABLE FOR SPINDLE 300E80-XXX

8-pole Amphenol Plug

**PIN      DESTINATION**

A	Phase A
B	Phase A
C	Phase B
D	Phase B
E	Phase C
F	Phase C
G	PE Sensor
H	PE
H	PE yellow/green

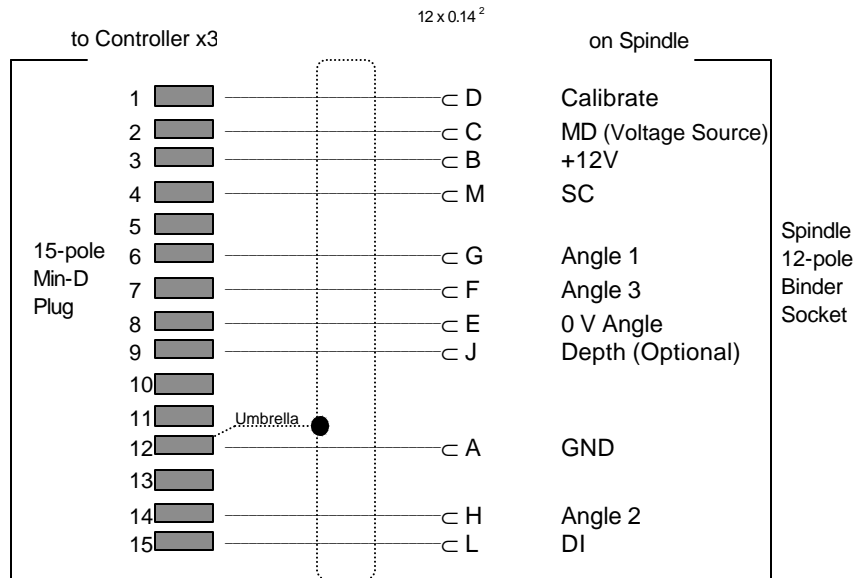


#### MD / WI FOR SPINDLE

12-pole Binder Socket

**PIN      DESTINATION**

D	Calibrate
C	MD (Voltage Source)
B	+12V
M	SC
G	Angle 1
F	Angle 3
E	0 V Angle
J	Depth (Option)
A	GND
H	Angle 2
L	DI

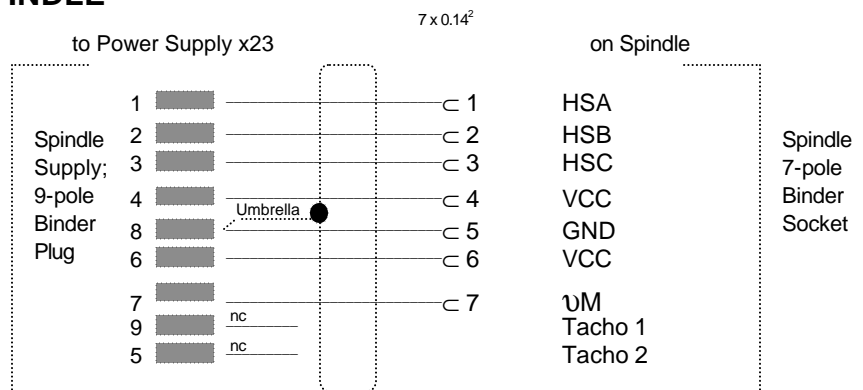


#### CONTROL CABLE FOR SPINDLE

7-pole Binder Socket

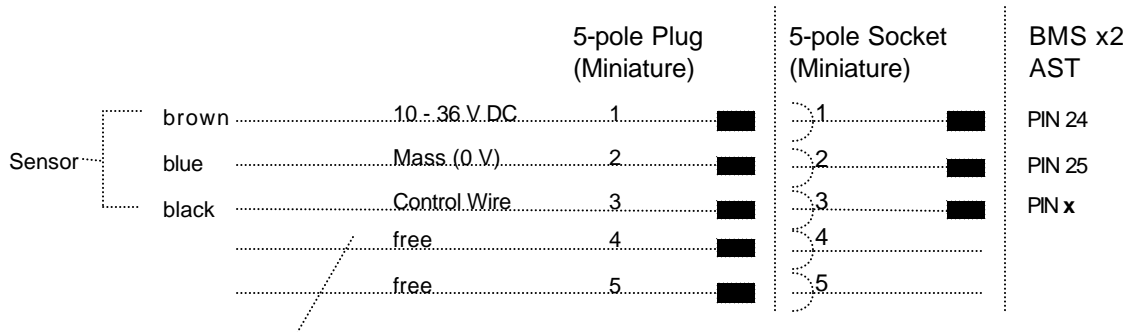
**PIN      DESTINATION**

1	HSA
2	HSB
3	HSC
4	VCC
5	GND
6	VCC
7	UM



### 3. LAY-OUT

#### AUTOMATIC START (OPTION) SENSOR PIN LAY-OUT



Sensor Cable (0.8 m) with 5-pole Miniature Plug

Standard Equipment:  
Sensor with 0.8 m cable mounted to drive and soldered to 5-pole miniature plug, as well as a 5-pole miniature socket for connection by customer.

#### Control of each corresponding Program Group

	PG 1	PG 2	PG 3	PG 4
PIN x	2	15	3	16

The BMS-Connection requires +24V Voltage. If no external +24V is available, the following bridges can be can be soldered on the 25-pole plug:

PIN		PIN
1	with	12
6	with	11
14	with	25
19	with	24

Output Load:

- with internal supply (bridged plug) 500 mA per output / 1A total load
- with external supply 500 mA per output






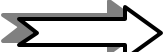


## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS















- Controller Factors are values that allow the Sequence Controller to adapt to hardware (spindle, printer, PC, etc.) and the operational requirements (access control, LCD-contrast, etc.) All factors are input by the user and subsequently stored. The Sequence Controller will be automatically configured with those factors, every time the system is turned ON. A change of those Factors is possible at any time.

#### Controller Factor Menu Choices

The Controller Factor menu can only be selected, if the controller is operational, which means the START-Message has been displayed or a system error occurred.

-  Press the orange function key 
-  If the access control is activated, the sequence controller asks for the access number. Input the access number and confirm with the blue Key. 
-  The factor MD-KAL is displayed.
-  Use the Arrow Keys   to scroll to other factors.

#### Input/Change of factors

-  Use the Arrow Keys   to scroll to the required factor.
-  Input the required value.
-  The previous value will be overwritten.
-  If the input value has to be changed, delete the value with the  Key and input a new value.
-  confirm with the blue  Key.
- Or  Adjust the factors Baud1, Baud2 and LCD-Contrast with the Arrow Keys   to the required values.
-  confirm with the blue  Key.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### Exit the Controller Factor Menu

The Controller Factor menu can only be selected, if the controller is operational, which means the START-Message has been displayed or a system error occurred.



Check and confirm that all values are correct.



Press the orange function key **SETC**



The factors are being saved.



The factor menu is exited and the AST-display shows the START-Message. The sequence controller AST2 is ready.

If you do not wish to save the input factors, press the **RES** Key.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### MD-KAL (Calibration Factor)

MD-KAL is the calibration value of the transducer in the Spindle. This value indicates for what maximum torque the transducer is designed. The calibration value is imprinted on the serial number tag of the spindles and has to be input in Nm.

#### MD-FAK (Torque Factor)

The Torque-Factor **MD-FAK** has two functions:

- Equalizes the torque-loss on its way from the Transducer to the Assembly (i.e. use of reduction gearing).
- Adapts the reduction factor to the measuring electronic when using reduction gears.

Example: An Angle-Head has an efficiency of  $h = 0.93$ , which means a torque-loss of 7%.  
Furthermore it has a reduction factor of  $i = 1.40$ .

The MD-FAK is calculated as follows:

$$\text{MD-FAK} = \frac{1}{h \cdot i} = \frac{1}{0.93 \times 1.40} = 0.768$$

#### WI-FAK (Angle Factor)

Spindles mounted with Angle-Transducers produce per angle degree a certain number of voltage impulses, which are counted by the Sequence Controller.

The amount of impulses by degree has to be input as the Angle-Factor.

<u>SPINDLE TYPE</u>	<u>ANGLE-FACTOR</u>
300E40-XXX	1.00
300E57-XXX	1.00
300E80-XXX	2.00

The required Angle-Factors for spindle not shown here, can be found in the individual spindle specification sheets.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### KUP-ZEIT (Clutch Time)

Spindles with a mechanical clutch require for the reverse a certain time period. During this clutch-time, the spindle is at a standstill.

Afterwards, the program sequence continues.

The input is done in ms (Standard Value > 500 ms)

#### NIO-DRUCK (PRINTOUT)

If NIO-DRUCK is activated (NIO-DRUCK = 1), only the measuring values for assemblies NIO (NOT O.K.) will be printed.

If NIO-DRUCK is not activated (NIO-DRUCK = 0), all measuring values will be printed (NIO and IO) NOT O.K. and O.K.

To have any value printed at all, a CHKM- and PRIM-Command has to be programmed into the screwdriving program.

#### BAUD 1

BAUD1 is the baud rate for the printer serial port

This Baud rate is adjustable to 300 / 600 / 1200 / 2400 / 4800 / 9600 / 19200 by using the



Cursor Keys

#### BAUD 2

BAUD1 is the baud rate for the computer serial port

This Baud rate is adjustable to 300 / 600 / 1200 / 2400 / 4800 / 9600 / 19200 by using the



Cursor Keys

#### KONTRAST (Contrast)

The Contrast of the AST-Displays can be adjusted to the required values, by using the Cursor



Keys.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### **STATION**

When using more than one AST-controllers, it is possible to assign to each system a Station Number to simplify recognition.  
The Station Number is being displayed when the System is turned ON and also indicated on each printout.  
The station number has no purpose at cross-linked AST-controllers.

#### **ZUTRITT 1/2 (ACCESS)**

If control factors, parameters and programs should only be accessed or changed by certain personnel, it is possible to assign access numbers.

Two access numbers in a range from 1 - 32000 can be input. If at Access 1 and Access 2 a zero (0) is input, this function is not active and no access control is possible.

#### **ROT-DRUCK (RED-PRINT)**

When using special printers, it is possible to print the NIO (Not O.K.) assemblies and error messages in Red. This function is activated when a 1 is input and deactivated with a 0.  
For Printers any other than the AST-printer, a 0 has to be input.

#### **I-BUS**

If the controller is cross-linked over the I-Bus, input a 1 at this position.  
If the controller is used as an individual station, input a 0.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### **FARB-ZEIT (ms) - (COLOR-TIMING)**

There is a possibility to integrate a spray-paint system to Output5 (OUT1) of the BMS-port. The paint-spray system is activated (Set Output5), if the assembly is evaluated as IO (O.K.)

- If a paint-spray system is used, the color-timing has to be input in ms (milli-seconds). Output 5 is then reserved for this paint-spray system (OUT5 is no longer free programmable).
- If no paint-spray system is used, input a zero (0). OUT5 is free programmable.

#### **RAMPEN-ZEIT (RAMP-TIMING)**

The period from the time the driver is at standstill, till the moment when the driver starts at the default speed, is known as Ramp-Time. This Ramp-Timer can be adjusted in a range from 0 - 3000 ms.

#### **WINKELx4 (0/1) = (ANGLE x4)**

Spindles mounted with Angle-Transducers produce per angle degree a certain number of voltage impulses. Depending on the type of Spindle, it may be necessary to multiply the number of impulses by a factor 4, to achieve correct results.

Spindle Type	Anglex4
-300E40-XXX	1
-300E57-XXX	1
-300E80-XXX	1

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### SA-MODE

The parameter "SA-Mode" influences the behavior of the controller, when removing the Start Signal, "SA" (Abort through Start key)

SA-Mode = 0      The program is exited by use of Start key and the NIO (Not O.K.) output is set (i.e. at Automatic Stations)

SA-Mode = 1-4    The program will not be exited when using the Start key, but continues by renewed Start. (i.e. at Hand-Screwdriver Stations) - see also NEXT-STEP!

At a renewed Start, the program will continue (independent of the adjustment NEXT-STEP).

This is important for Hand-Drivers, which run through a sequenced loop and program should not be interrupted by start removal. However, if the assembly has to be completely finished, the Input (1-4) which was set to "SA-Mode 1-4", has to be dampened.

**Attention!** The selected input cannot be used anymore with the Function WINP!

#### NEXT-STEP

Here it is possible to select how to continue the operation after Start was removed.

NEXT-STEP = 0    Assembly will be continued at the precise STEP, where it was interrupted.

NEXT-STEP = 1    Assembly will be continued at the following STEP, from where it was interrupted.

## 4. TERMINAL PROGRAM

### INPUT CONTROLLER FACTORS

#### **INVERS (Invert)**

When Spindles with reverse option (i.e. spindles with integrated off-set drive) are used, the turn-direction of the Motors can be inverted with the INVERS Option.

INVERS = 0 Turn-Direction is followed as specified in the screwdriving diagram.

INVERS = 1 Turn-Direction will be inverted.

#### **GRAFIK-ZT = (Graphic-Timer) – only with Software Option “DFUE”**

This option allows a choice of what type of graphic will be transmitted to the PC (PC-Software MULTICOM IM)

GRAFIK-ZT = 0 Graphic “Torque over Angle” will be indicated and transmitted to the PC.

GRAFIK-ZT = 1 Graphic “Torque over Time” (input from 1 to 255 ms is possible) will be indicated and transmitted to the PC.

## 4. TERMINAL PROGRAM

### PARAMETER-SET / GENERAL INFORMATION

#### What is a Parameter?

During actual assembly it is often necessary to tighten or loosen assemblies in more than one step. The AST-controller requires for **each** tightening- respectively loosening-step detailed information:

- Does the fastener need tightening or loosening
  - Does the Spindle have to shut-off when reaching torque or angle
  - Information about the required shut-off values
  - Information about the limit values
  - Information about the determined speed
  - Information about the determined voltage
- etc.

This information is called parameters.

Parameters, which contain **one** tightening- or loosening-step, are input by the user into the AST-controller in form of **one** parameter-set.

Since the AST-controller has over 80 parameter sets available, it is possible to input and store 80 different tightening- or loosening steps.

### CONSTRUCTION OF A PARAMETER SET

The most important parameter is the screwdriving diagram (short: DIA).

The AST-controller has four standard Screwdriving Diagrams available as a standard, specifically DIA2 to DIA5.

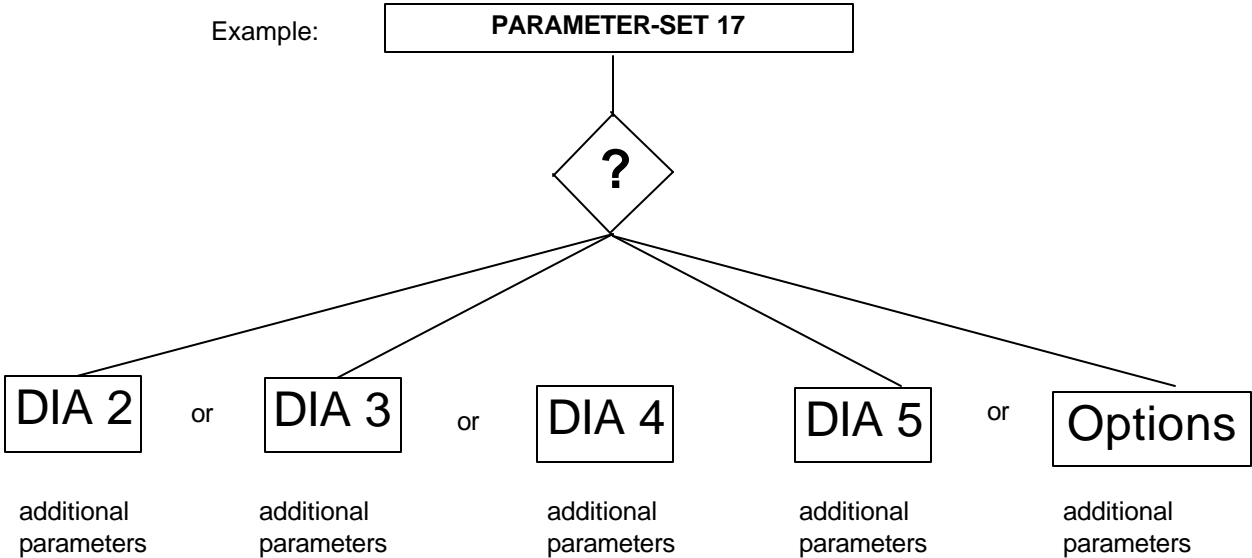
Each diagram is an independent tightening process, respectively loosening process.

	DIA 2	DIA 3	DIA 4	DIA5
Loosening			●	
Tightening	●	●		●
Shut-Off at Torque	●	●		
Shut-Off at Angle			●	●
Check Torque			○	○
Check Angle		○		

# 4. TERMINAL PROGRAM

## PARAMETER-SET / GENERAL INFORMATION

For each Parameter-Set only **one** Screwdriving Diagram can be selected. All subsequent parameters depend on the selected screwdriving diagram.



Besides DIA2 through DIA5, there are additional screwdriving diagrams possible as an option, i.e. tightening to yield point, depth shut-off/depth control.





**Please find on the next pages a description of how to input a parameter and the individual screwdriving diagrams.**



# 4. TERMINAL PROGRAM


## PARAMETER-SET / GENERAL INFORMATION

### Selection of a Parameter Set

The Controller Factor menu can only be selected, if the controller is operational, which means the START-Message has been displayed or a system error occurred.

 Press the orange function key   
 If the access control is activated, the sequence controller asks for the access number. Input the access number and confirm with the blue Key. 


 Input the number of the required parameter set (1 to 80) and confirm with the  Key.




 The screwdriving diagram (DIA) of the selected parameter set is displayed.



 Use the Arrow Keys   to scroll to other parameter sets.

### Input/Change of parameter

 Use the Arrow Keys   to scroll to the required parameter.

 Input the required value.

 The previous value will be overwritten.  
 If the input value has to be changed, delete the value with the  Key and input a new value.

 confirm the input value with the blue  Key.

If a different screwdriving diagram is selected, check all values of the parameter set!

## 4. TERMINAL PROGRAM

### PARAMETER-SET / GENERAL INFORMATION

#### Exit the Parameter Set



Check and confirm that all parameters are correct.



Press the orange function key **PSET**



The parameter set is exited.



An additional parameter set can be selected.

Or



Input **0** and press the **RET** key.



All 80 parameter sets are saved.



The parameter set is exited and the AST-display shows the START-Message. The sequence controller AST2 is ready.

If you do not wish to save the input parameters, press the **RES** Key.

## 4. TERMINAL PROGRAM

### DESCRIPTION OF THE PARAMETERS

#### **MP (Nm)**

MP is the torque value, at which the spindle shuts-off.  
Input Range: 0 Nm up to Calibration Value (MD-KAL) of the Spindle (Factor)

#### **WP (Grd) / Degree**

WP is the angle degree, at which the spindle shuts-off.  
Input Range: 0 Degree up to 32000 Degree

#### **MS (Nm)**

When the spindle reaches the threshold torque MS, the angle measurement starts.  
Input Range: 0 Nm up to shut-off torque (MP)

#### **MD-MIN (Nm)**

MD-MIN is the minimum torque value, at which the screwdriving step is assessed as IO (O.K.).  
(lower limit of the IO-window = O.K.-window)  
Input Range: 0 Nm up to shut-off torque (MP)

#### **MD-MAX (Nm)**

MD-MAX is the maximum torque value, at which the screwdriving step is assessed as IO (O.K.).  
(upper limit of the IO-window = O.K.-window)  
Input Range: shut-off torque (MP) up to 110% of calibration value (MD-KAL) of the Spindle (Factor)

#### **WI-MIN (Grd) / Degree**

MD-MIN is the minimum angle degree, at which the screwdriving step is assessed as IO (O.K.).  
(lower limit of the IO-window = O.K.-window)  
Input Range: 0 (Grd) Degree up to 32000 (Grd) Degree

#### **WI-MAX (Grd) / Degree**

MD-MAX is the maximum angle degree, at which the screwdriving step is assessed as IO (O.K.).  
(upper limit of the IO-window = O.K.-window)  
Input Range: minimum angle (WI-MIN) (MP) up to 32000 (Grd) Degree

## 4. TERMINAL PROGRAM

### DESCRIPTION OF PARAMETER

#### **DREHZAHL (%) = SPEED**

With the parameter DREHZAHL (SPEED), the spindle speed for the tightening step can be input. Since the speed depends on the spindle type, this input is not done in absolute-values, but rather as a percentage.

Input-Range: 0% (no speed) **up to** 100% (maximum speed) in 1% increments

Determination of Value:

**For the determination of the best speed, the following 2 items have to be considered:**

- The harder a screw joint, the lower a speed should be selected.
- The softer a screw joint, the higher a speed can be selected.

#### **STROM (%) = VOLTAGE**

With the parameter STROM (Voltage), the maximum motor voltage for the spindle can be programmed.

If the motor requires during the assembly more voltage than predetermined by STROM (Voltage), the power supply of the spindle will shut-off. This will eliminate damage to the spindle.

Since the motor voltage depends on the spindle type, this input is not done in absolute-values, but rather as a percentage.

Input-Range: 0% (no voltage) up to 100% (maximum voltage) in 1% increments

Determination of Value:

Input at STROM (Voltage) a low value (i.e. 10%) and proceed with the assembly. If the spindle halts the assembly because of too high motor voltage (Control Indicator I-MAX on the power supply lights up), increase the voltage step-by-step, until the assembly is shown as IO (O.K.).

## 4. TERMINAL PROGRAM

### DESCRIPTION OF PARAMETER

#### **T-SCHRAUB (ms) = Screwdriving Time**

With the parameter T-SCHRAUB, the maximum allowable assembly time can be programmed. If the AST-controller does not reach the required torque within the screwdriving-time, (i.e. missing screw) the tightening step will be stopped after expiration of screwdriving time, and a NIO (Not O.K.) assembly will be indicated.

Input-Range: 1 ms up to 32000 ms in 1 ms increments

Determination of Value: Input a relative long Screwdriving-Time (i.e. 20000 ms) and proceed with the assembly. Use the actual assembly time, add a buffer of about 2000 ms and input the resulting value as the T-SCHRAUB value.

#### **T-NACHLAUF (ms) = Lag Time**

Because of the spindle's mass inertia, the spindle does not come to an absolute standstill at shut-off, but rather has some lag.

With the Lag-Time (T-NACHLAUF) it is possible to input a time interval, for how much longer the torque and angle will be measured, after the spindle shuts-off.

Input-Range: 1 ms up to 32000 ms in 1 ms increments

Determination of Value: To determine the actual assembly values, the lag-time has to be fully considered. Basic Rule: the larger the spindle, the larger the lag-time needs to be selected. (approx. 100 ms - 500 ms).

## 4. TERMINAL PROGRAM

### DESCRIPTION OF PARAMETER

#### **AF (Scan-Factor)**

Chord Length for the gradient calculation:

This value indicates, for how many angle-degrees the gradient of the torque sequence will be calculated. The value to be input has to be determined for each individual screw joint.

#### **DF = Damping Factor**

This value indicates, how many torque values will be used to obtain the average torque for the upper and lower limit point of the chord.

The value to be input has to be determined for each individual screw joint.

#### **GU = Shut-Off Gradient**

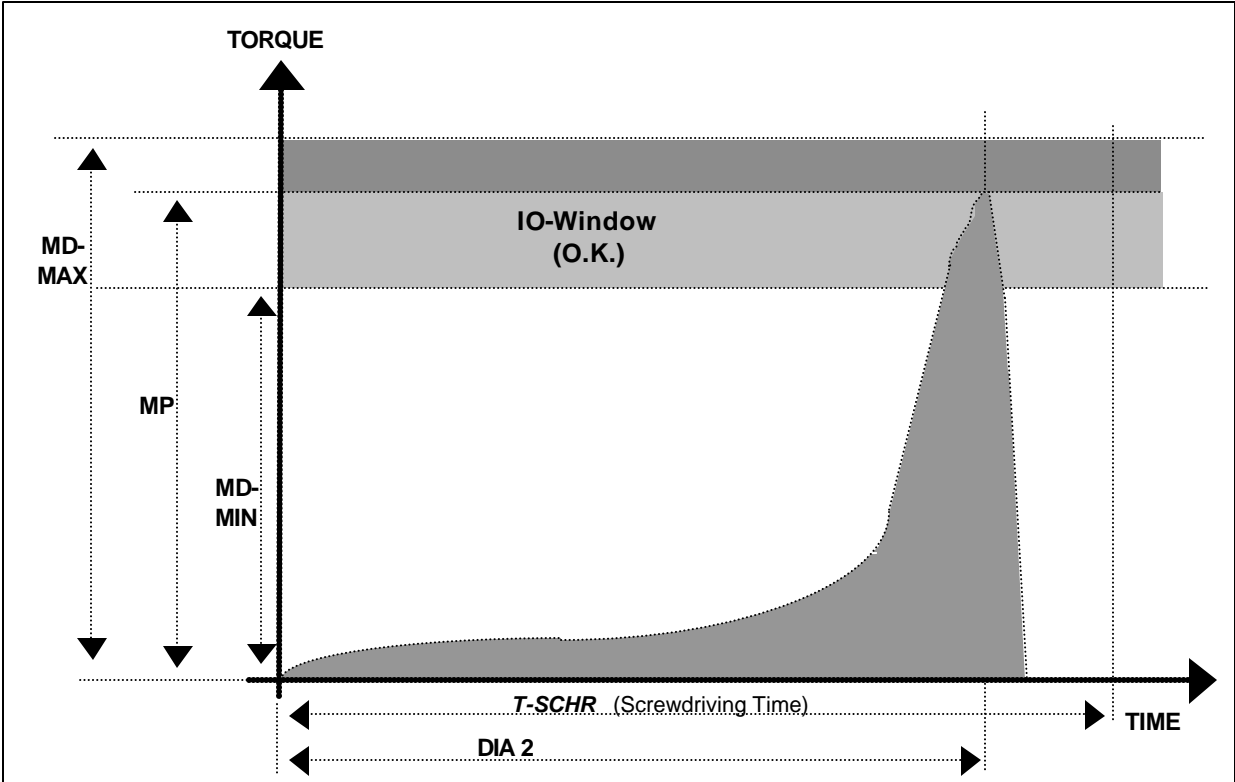
If the gradient of the torque curve is below the determined shut-off gradient (GU), the spindle will be shut-off.

The value to be input has to be determined for each individual screw joint, screw quality, tensile length, etc.

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 2 (DIA2)

Tightening Process with: ● Shut-Off at Torque



This illustration shows a one-step tightening of a EC-Servo-Spindle

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 2 (DIA2)

#### SEQUENCE:

- At the beginning of the tightening process, the Screwdriving Time T-SCHR starts. During the assembly, the AST-controller carries out cyclical torque measurements
- The Spindle shuts-off when:
  - The shut-off torque **MP** is reached or
  - The screwdriving time T-SCHR expires

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off torque is within the IO (O.K.)-Window, which means:
  - torque is in-between MD-MIN and MD-MAX and
  - within the screwdriving time T-SCHR

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off torque is outside the IO (O.K.)-Window, which means:
  - outside the MD-MIN and MD-MAX or
  - outside the screwdriving time T-SCHR

#### Parameters used in Screwdriving Diagram 2 (DIA2):

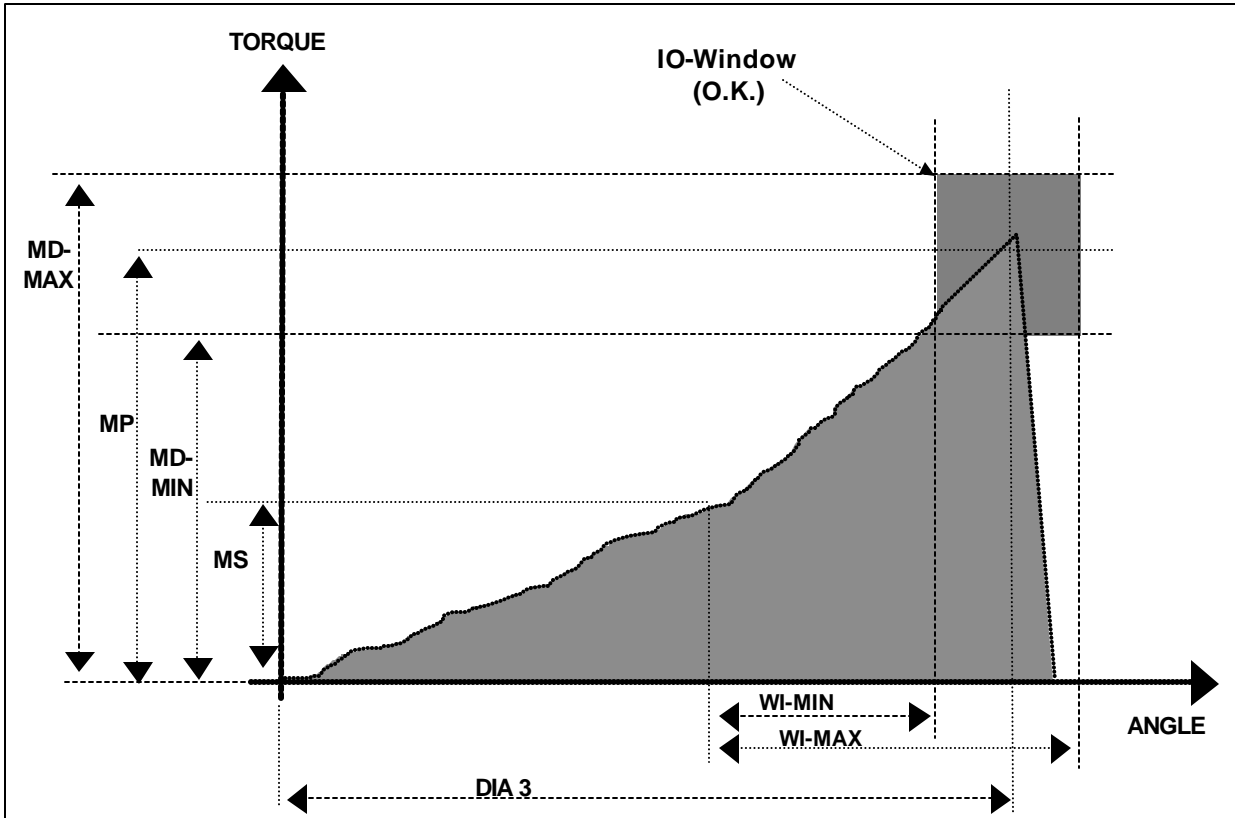
MP, MD-MIN, MD-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time)

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 3 (DIA3)

Screwdriving Diagram 3 (DIA3) Tightening in Right-Rotation  
Screwdriving Diagram 31 (DIA31) same as DIA3, however the tightening is done in left-rotation.

Tightening Process with: ● Shut-Off at Torque  
● Check Angle



This illustration shows a two-step tightening.

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 3 (DIA3)

Screwdriving Diagram 3 (DIA3) Tightening in Right-Rotation  
Screwdriving Diagram 31 (DIA31) same as DIA3, however the tightening is done in left-rotation.

Tightening Process with:  Shut-Off at Torque  
 Check Angle

#### SEQUENCE:

- At the beginning of the tightening process, the screwdriving time T-SCHR starts.
- During the assembly, the AST-controller carries out cyclical torque measurements.
- Starting at the threshold torque MS, the system carries out angle measurements.
- The Spindle shuts-off when:
  - The shut-off torque MP is reached or
  - The maximum angle WI-MAX is reached or
  - The screwdriving time T-SCHR expires

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off torque is within the IO (O.K.)-Window, which means:
  - torque is in-between MD-MIN and MD-MAX and
  - angle is in-between WI-MIN and WI-MAX and
  - the screwdriving time T-SCHR has not expired

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off torque is outside the IO (O.K.)-Window, which means:
  - outside the MD-MIN and MD-MAX or
  - outside the WI-MIN and WI-MAX or
  - the screwdriving time T-SCHR has expired

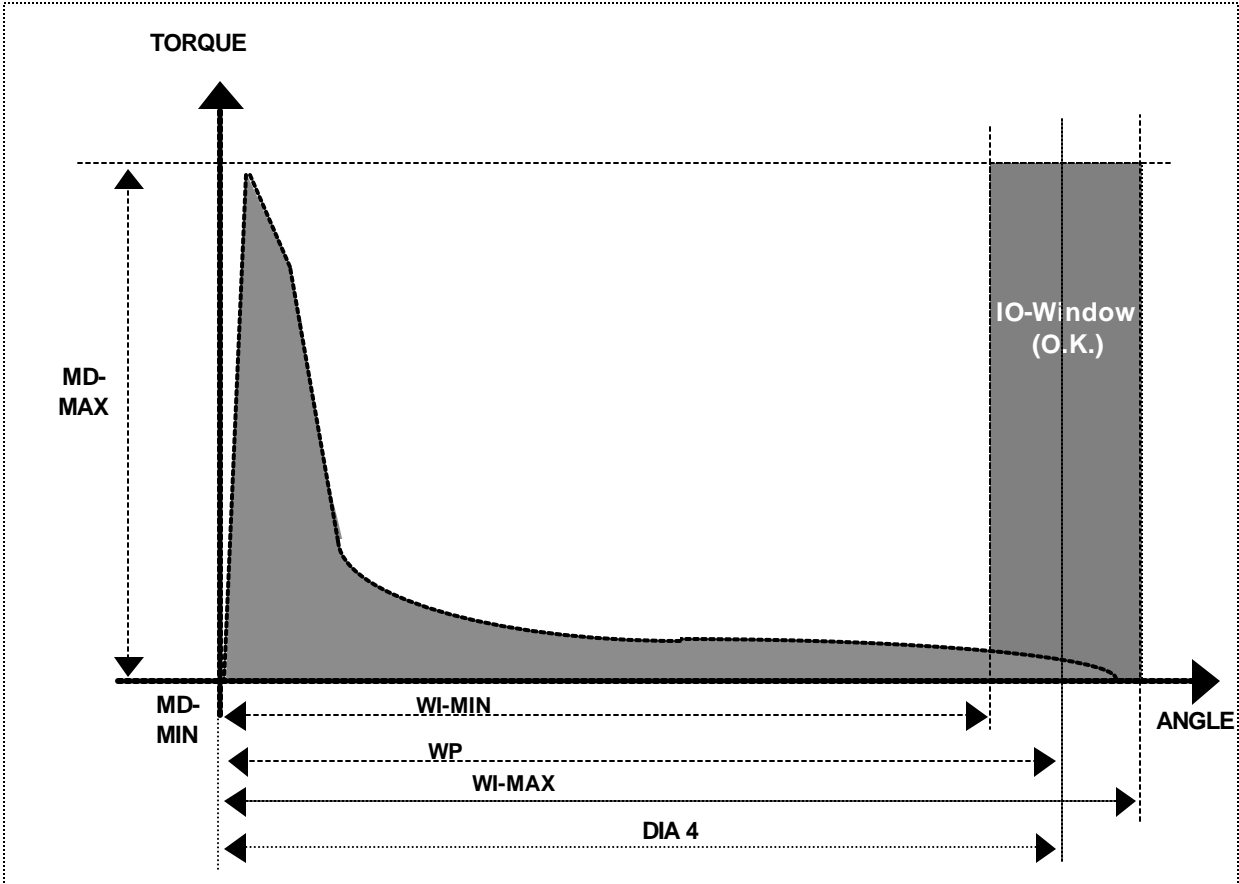
#### Parameters used in Screwdriving Diagram 3 (DIA3):

MS, MP, MD-MIN, MD-MAX, WI-MIN, WI-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time)

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 4 (DIA4)

Loosening Process with: ● Shut-Off at Angle  
● Check Torque



This illustration shows the loosening of an assembly.

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 4 (DIA4)

Loosening Process with:  Shut-Off at Angle  
 Check Torque

#### SEQUENCE:

- At the beginning of the loosening process, the screwdriving time T-SCHR starts.
- During the loosening process, the AST-controller carries out cyclical torque and angle measurements.
- The Spindle shuts-off when:
  - The shut-off angle WP is reached or
  - The maximum torque MD-MAX is reached or
  - The screwdriving time T-SCHR expires

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off angle is within the IO (O.K.)-Window, which means:
  - between WI-MIN and WI-MAX and
  - below the MD-MAX and
  - within the screwdriving time T-SCHR

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off angle is outside the IO (O.K.)-Window, which means:
  - outside WI-MIN and WI-MAX or
  - over the MD-MAX or
  - outside the screwdriving time T-SCHR

#### Parameters used in Screwdriving Diagram 4 (DIA4):

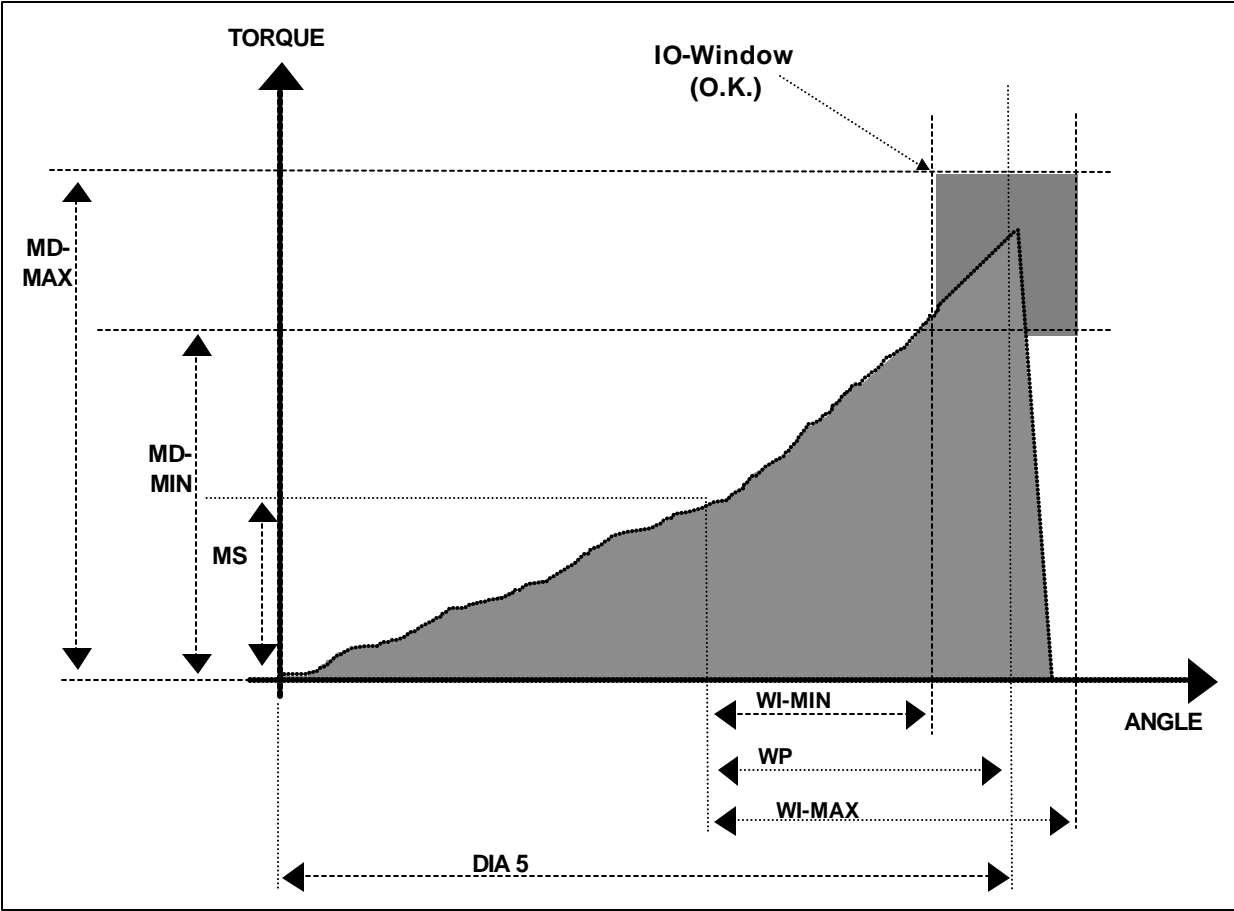
MD-MIN, MD-MAX, WP, WI-MIN, WI-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time)

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 5 (DIA5)

Screwdriving Diagram 5 (DIA5) Tightening in Right-Rotation  
Screwdriving Diagram 51 (DIA51) same as DIA5, however the tightening is done in left-rotation.

Tightening Process with: ● Shut-Off at Angle  
● Check Torque



This illustration shows the a one-step tightening process.

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 5 (DIA5)

Screwdriving Diagram 5 (DIA5) Tightening in Right-Rotation  
Screwdriving Diagram 51 (DIA51) same as DIA5, however the tightening is done in left-rotation.

Tightening Process with:  Shut-Off at Angle  
 Check Torque

#### SEQUENCE:

- At the beginning of the tightening step, the screwdriving time T-SCHR starts.
- During the assembly, the AST-controller carries out cyclical torque measurements
- Starting at the threshold torque MS, the AST-controller carries out angle measurements
- The Spindle shuts-off when:
  - The shut-off angle WP is reached or
  - The maximum torque MD-MAX is reached or
  - The Screwdriving Time T-SCHR expires.

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off angle is within the IO (O.K.)-Window, which means:
  - between WI-MIN and WI-MAX and
  - between MD-MIN and MD-MAX andthe screwdriving time T-SCHR has not expired.

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off angle is outside the IO (O.K.)-Window, which means:
  - outside WI-MIN and WI-MAX or
  - over the MD-MIN and MD-MAX orthe screwdriving time T-SCHR has expired.

#### Parameters used in Screwdriving Diagram 5 (DIA5):

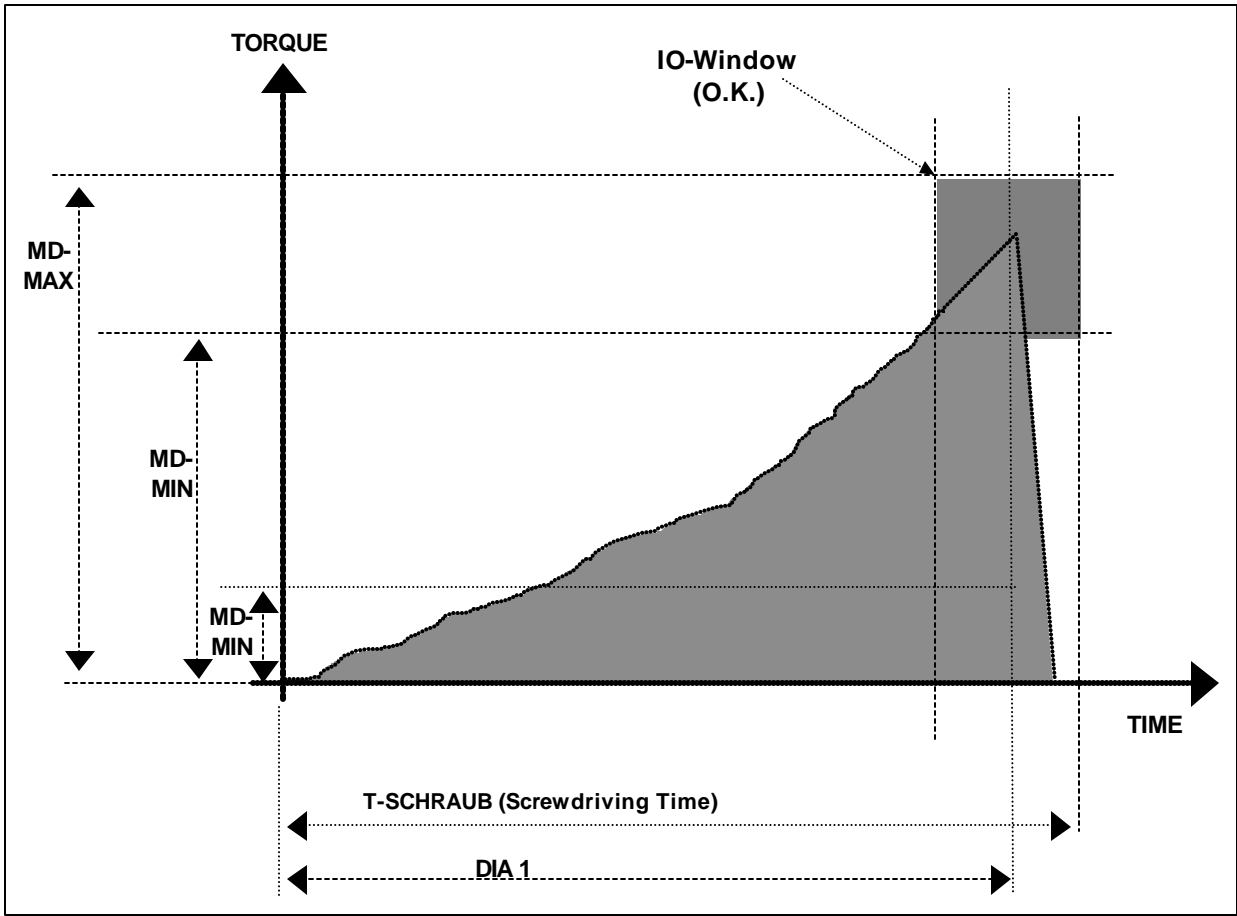
MS, MD-MIN, MD-MAX, WP, WI-MIN, WI-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time)

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 1 (DIA1) (OPTIONAL)

Screwdriving Diagram 1 (DIA1) Tightening in Right-Rotation

- Tightening Process with:
- Shut-Off over Input 4
  - Check Torque
  - Emergency Shut-Off at MD-MAX



This illustration shows the a one-step tightening process.

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 1 (DIA1) (OPTIONAL)

#### SEQUENCE:

- At the beginning of the tightening step, the screwdriving time T-SCHR starts.
- During the assembly, the AST-controller carries out cyclical torque measurements
- The Spindle shuts-off when:
  - A signal is set at input 4
  - The screwdriving time T-SCHR expires.

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off torque is within the IO (O.K.)-Window, which means:
  - between MD-MIN and MD-MAX and
  - within the screwdriving time T-SCHR.

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off torque is outside the IO (O.K.)-Window, which means:
  - outside MD-MIN and MD-MAX or
  - outside screwdriving time T-SCHR.

#### Parameters used in Screwdriving Diagram 1 (DIA1):

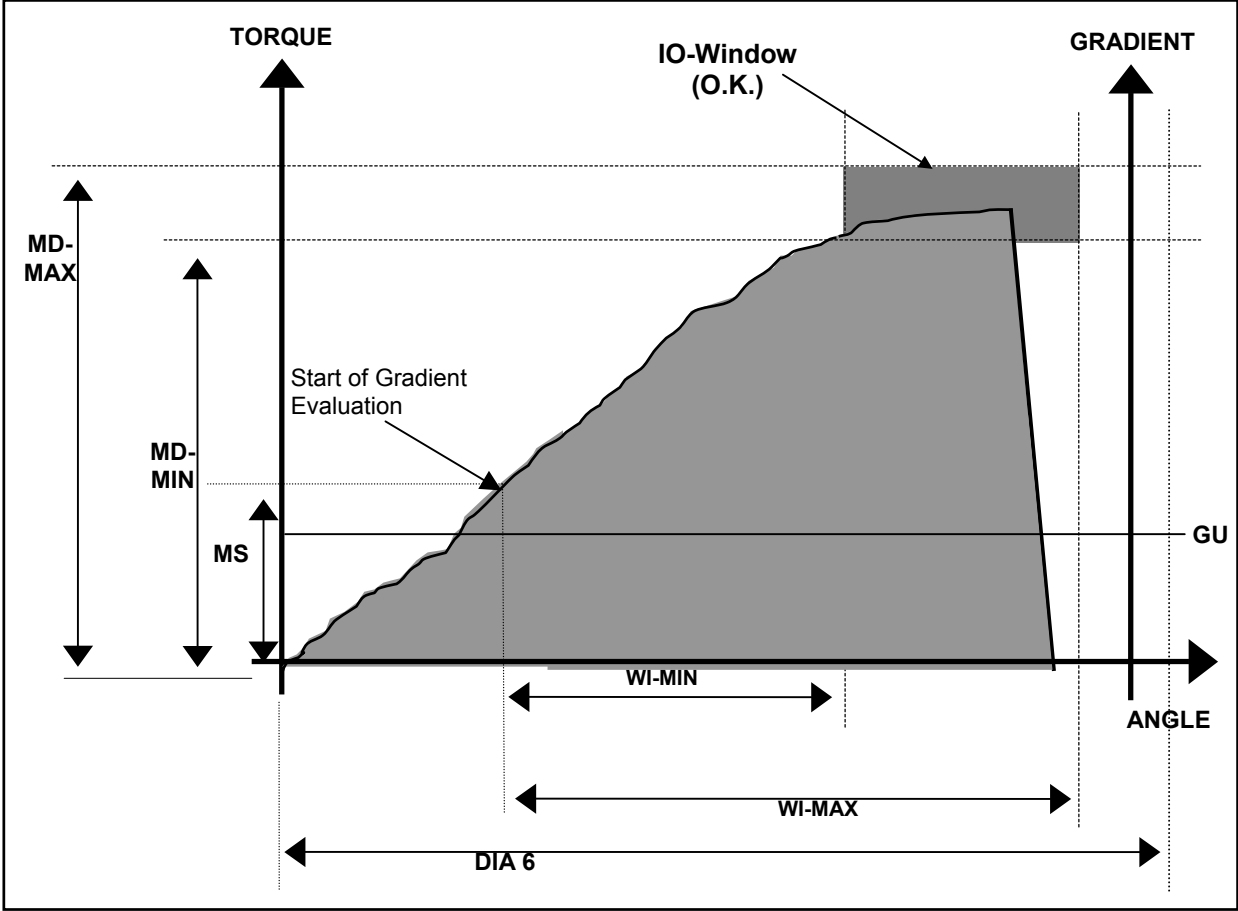
MD-MIN, MD-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time)

# 4. TERMINAL PROGRAM

## INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 5 (DIA5)

Screwdriving Diagram 6 (DIA6) Tightening in Right-Rotation

- Tightening Process with:
- Shut-Off at Gradient
  - Check Torque
  - Check Angle



This illustration shows the a one-step tightening process.

## 4. TERMINAL PROGRAM

### INPUT PARAMETER-SET OF SCREWDRIVING DIAGRAM 6 (DIA6) (OPTIONAL)

#### SEQUENCE:

- At the beginning of the tightening step, the screwdriving time T-SCHR starts.
- During the assembly, the AST-controller carries out cyclical torque measurements
- Starting at the threshold torque MS, the AST-controller carries out angle measurements
- Starting at the threshold torque MS, the AST-controller starts with the gradient evaluation
- The Spindle shuts-off when:
  - The shut-off gradient GU is not reached
  - The maximum angle WI-MAX is reached
  - The maximum torque MD-MAX is reached or
  - The screwdriving time T-SCHR expires.

The assembly process is considered **IO (O.K.)** if:

- The actual shut-off torque/angle is within the IO (O.K.)-Window, which means:
  - between MD-MIN and MD-MAX and
  - between WI-MIN and WI-MAX andthe screwdriving time T-SCHR has not expired.

The assembly process is considered **NIO (Not O.K.)** if:

- The actual shut-off torque/angle is outside the IO (O.K.)-Window, which means:
  - outside the MD-MIN and MD-MAX or
  - outside WI-MIN and WI-MAX
  - the screwdriving time T-SCHR has expired.

#### Parameters used in Screwdriving Diagram 6 (DIA6):

MS, MD-MIN, MD-MAX, WI-MIN, WI-MAX, Drehzahl (Speed), Strom (Voltage), T-Schraub (Screwdriving Time), T-Nachlauf (Lag Time), AF, DF, GU

# 4. TERMINAL PROGRAM

## PROGRAMS - GENERAL INFORMATION

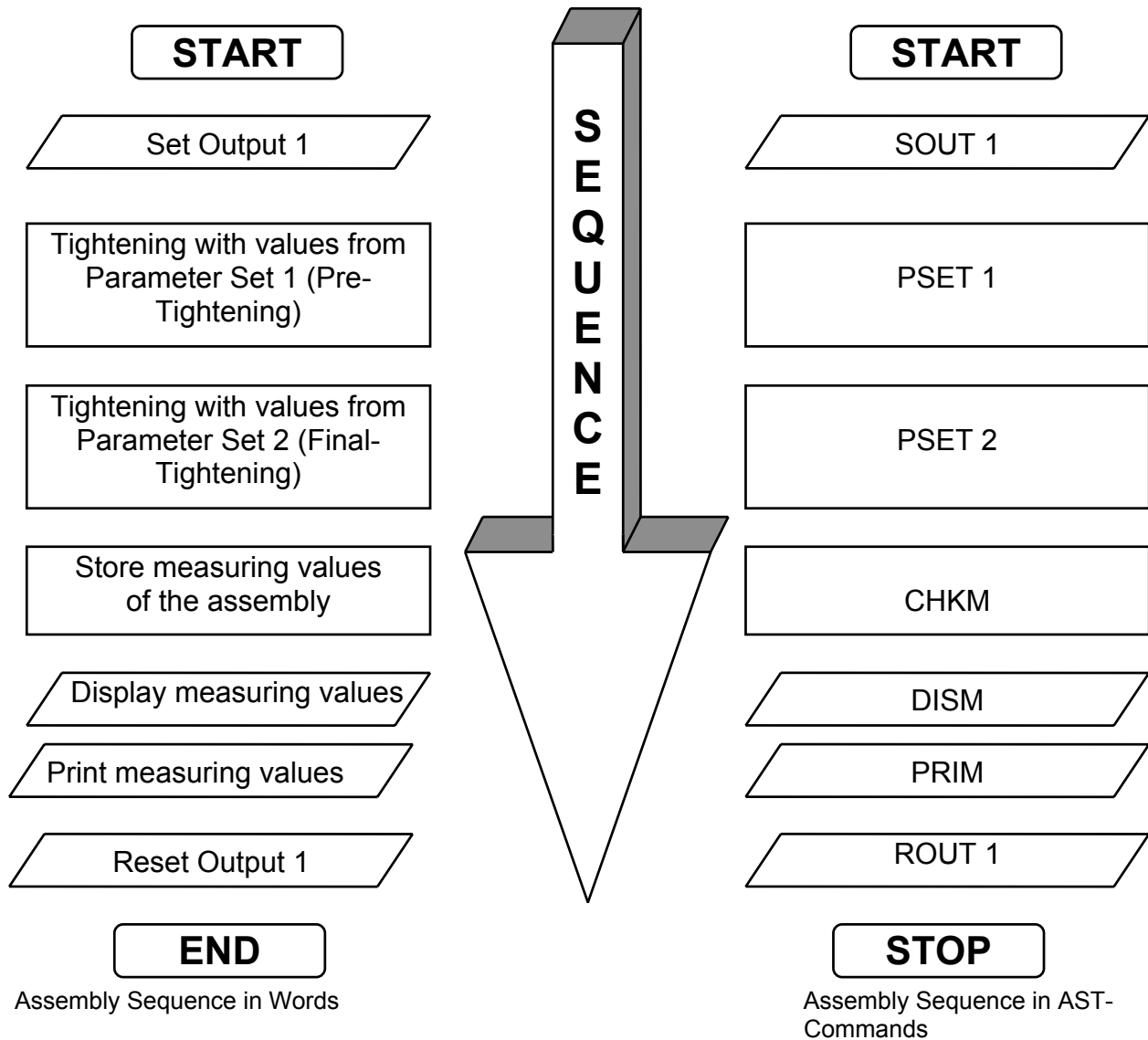
### What is a Program?

A program is a list of instructions to determine how the assembly process should run.

If a program is started, the instructions are being followed in sequence.

If a tightening- or loosening process is necessary, input the number of the parameter-set, with which the spindle should run.

Because of this, multiple screwdriving-steps are possible, with up to 10 different tightening- or loosening steps, as shown below:



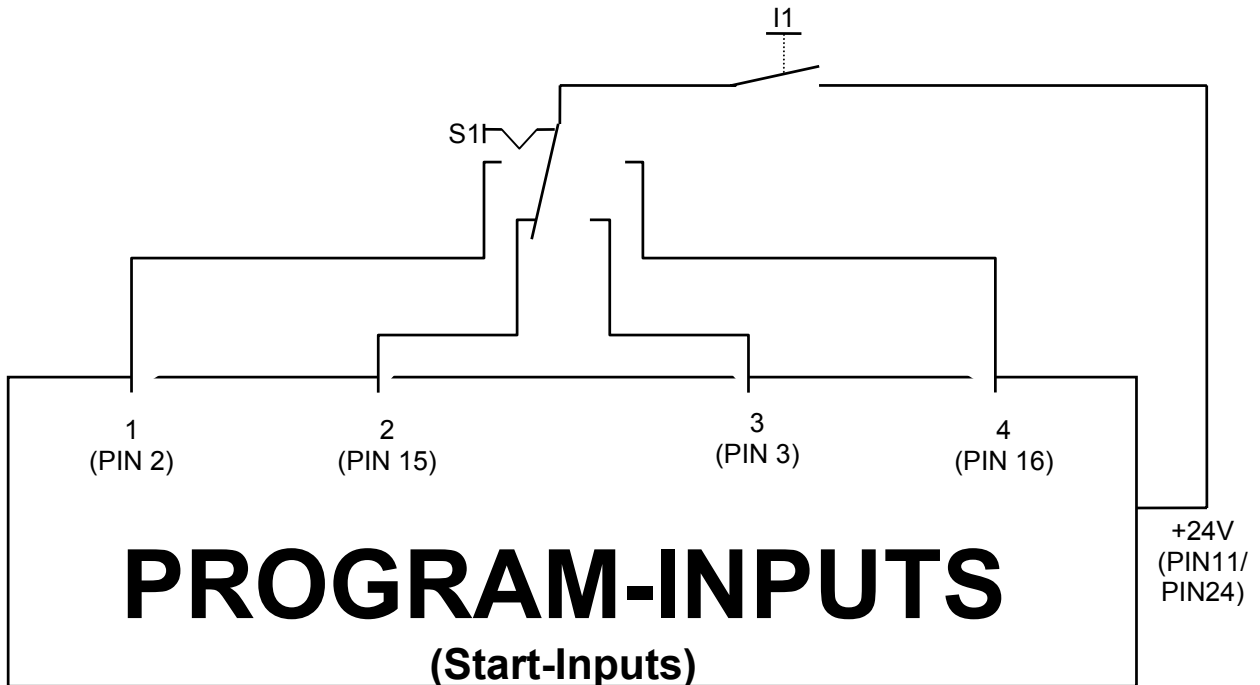
## 4. TERMINAL PROGRAM

### PROGRAMS - GENERAL INFORMATION

#### Program-Inputs

The 4 programs are started, by means of program-inputs PG 1 to PG 4.

If program 2 has to be started, a +24V signal has to be given to program-input 2. This signal can be provided by the internal voltage source or from an external voltage source, such as an output of a PLC.



If the internal +24V voltage is used (as shown in above diagram), for the controlling of the program inputs, the 0V of the supply voltage (PIN12/PIN25) has to be bridged with the 0V of the program inputs (PIN1/PIN14)

**Note:** The complete pin-layout of the BMS-port can be found under paragraph "Lay-Out".

The above illustration shows a simple circuit of the program-inputs.

With the selector switch S1, one of the 4 programs can be selected. If solely the button T1 is activated, the AST-controller starts with the process of the selected program.

T1 has to remain activated, until the program is completed. If T1 is released prior to program completion, the AST-controller stops and indicates an error.

On the next Pages we explain the program structure and the individual program commands.

## 4. TERMINAL PROGRAM

### INPUT PROGRAM

#### CREATE A PROGRAM

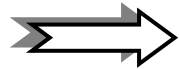
Prior to creating a program, the exact screwdriving sequence has to be clarified.  
The next step is the inputting of the controller factors and the needed parameter-sets.  
Then input the program.

#### PROGRAM SELECTION

- Programs can only be selected, when the AST-controller is operational, i.e. the START-Message is being displayed, or a system error occurs.



Press the orange function key **PROG**



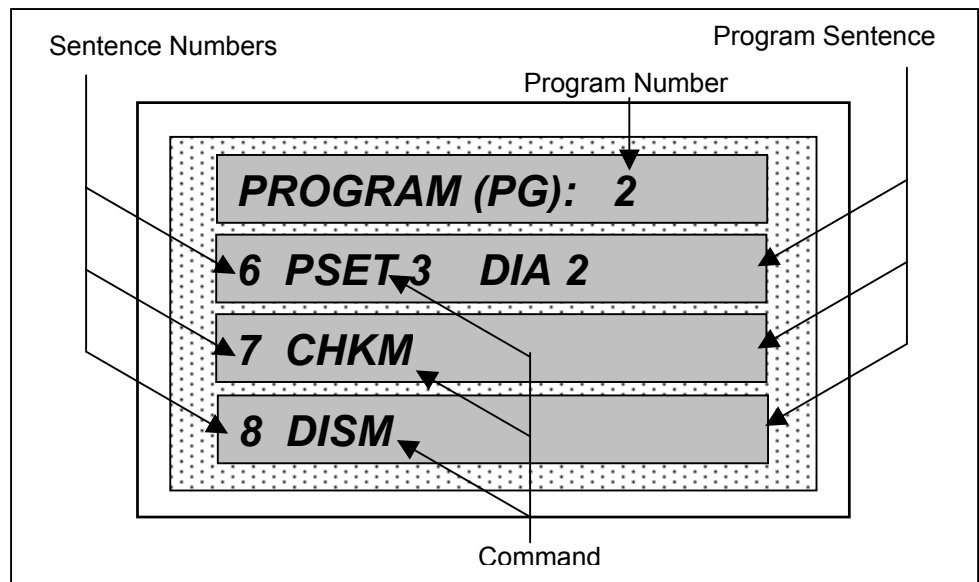
If the access control is activated, the sequence controller asks for the access number. Input the access number and confirm with the blue Key. **RET**



Input the required program number (1 through 4) and press **RET** key.



The program is displayed.




Use the Arrow Keys   to scroll to other program sentences.


## 4. TERMINAL PROGRAM



### INPUT PROGRAM


#### Input/Change a Programming Command

 Use the Arrow Keys   to scroll to required program sentence.


 There are three different possibilities, to input or change a command:


 Each programming command has its own command number. On the pages 51/52 is a complete listing of all commands and their corresponding command-numbers. Proceed as follows to input a command:


 Press the orange function key 


 The message FUNC? appears.


 Input the required command-number and press  key.

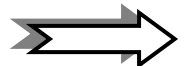

 The command is displayed.


Or  Some commands can be input directly, by using the orange function keys (hot-keys). Proceed as follows:


 Press orange function key (hot-key) of the required command.

 The command is displayed.

Or  Some commands consist of the command itself and a number value, such as a waiting time TIME 500. If only the number value has to be changed, and the command remains the same, proceed as follows:

 Input new number value and press  key.






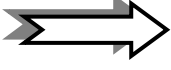



 The old number value is being overwritten by the new one.

 The input command will be moved up one sentence. Now, additional commands may be input or changed.






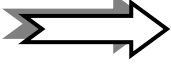


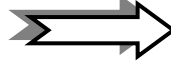
## 4. TERMINAL PROGRAM

### INPUT PROGRAM



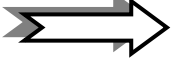


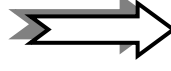



#### Delete a Program-Sentence

-  Scroll to the program sentence to be deleted, using the   Keys
  -  Press orange function  key
  -  The screen displays the message FUNC?.
  -  Use the Arrow-Key 
  -  The program sentence was deleted, all other program sentences move forward one spot.
- Please refer to the “NOTE” shown below!

#### Insert a Program-Sentence

-  Scroll to the program sentence to be inserted, using the   Keys.
  -  Press orange function  key
  -  The screen displays the message FUNC?.
  -  Use the Arrow-Key 
  -  The program sentence was inserted, all other program sentences move back one spot.
- Please refer to the “NOTE” shown below!

#### Search for a Program-Sentence x


-  Press orange function  key
-  The screen displays the message FUNC?.
-  Use the Arrow-Key 
-  The screen displays the message ZEILE? (sentence).
-  Input the required sentence number and press  key.
-  The screen displays the required program sentence.


**“NOTE”** When inserting or deleting a program sentence, any Jump-Command with sentence number indicated, will not be accepted. Such Jump-Commands have to be implemented later “manually”.



## 4. TERMINAL PROGRAM


### INPUT PROGRAM

#### Delete an actual Program


 Press orange function **FUNC** key

 The screen displays the message FUNC?.


 Use the Arrow-Key 

 The screen displays the message PROG.LOESCHEN?  
(DELETE?).  
1 = JA (YES)

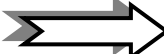
 **NOTE:** If a 1 is input, the program is deleted and cannot be restored.


 If the Program should not be deleted, press **RET** key.


#### Exit the Program

 Check all commands if they are correct.


 Press **PROG** Key

 You will exit the program.

 Another program can be selected.

Or  Insert 0 and confirm by pressing the **RET** Key.

 All 4 Programs will be stored.

Or  If the inserted Program should not be stored, press the **RES** Key.

 The screen displays the **START-Message**. You can now continue with the Operation of the **AST-Controller**.

## 4. TERMINAL PROGRAM

### LISTING OF PROGRAMMING COMMANDS

COMMAND	COMMAND-NUMBER	EXPLANATION
STOP	0	End Program
PSET x	1	Assemble with Parameter-Set x
WINP x	2	Wait until Input x is set (x = 1 to 4)
SOUT x	3	Set Output x (x = 1 to 5)
ROUT x	4	Reset Output x (x = 1 to 5)
TIME x	5	Wait x Milli-Seconds (x = 1 to 30000)
Jump x	6	Jump to Sentence x
JNOK x	7	If Not O.K. (NIO), jump to Sentence x
JOK x	8	If O.K. (IO), jump to Sentence x
CHKM	9	Store the Measuring Values of the last assembly stage
STAT	10	Record the Measuring Values of the last assembly stage and process them statistically
REPT x	11	Repeat this part of the program x-times (after REPT a JUMP-command is necessary!)
NOP	12	Reserve space for a command
HALT	13	Pause until the input of the active program is reset and then once more set
DISM	14	Display the Measuring Values, which were stored with the CHKM command
JINP x	15	Jump into a different program part, when Input x is set (after JINP a JUMP-command is necessary!)
PRIM	16	Print the Measuring Values, which were stored with the CHKM command
CLON	17	Activate the Clutch
CLOF	18	De-activate the Clutch
OFFT	20	Offset-Test and equalization

## 4. TERMINAL PROGRAM

### LISTING OF PROGRAMMING COMMANDS

#### OPTIONAL PROGRAMMING COMMANDS

COMMAND	COMMAND-NUMBER	EXPLANATION
CHKS x	17	Stores per angle degree or time-interval a torque value into storage (only with Option "Software with DFUE)
DFUE x	18	Data transfer of the measuring values to PC for graphic display and statistics (only with Option "Software with DFUE)
CONT x	19	The cycle counter will be reduced by 1 for each assembly (Optional).
OFFT	20	Offset-Test and equalization

## 4. TERMINAL PROGRAM

### LISTING OF PROGRAMMING COMMANDS

#### **STOP** Program-End

COMMAND-Number: 0

The STOP-command determines the program end.

The following functions are processed:

- The AST-controller evaluates the measuring values of the assembly process, which has been stored with the last CHKM command.  
If the Assembly is evaluated as IO (O.K.), the IO-Output of the BMS-Port will be set and the OK-LED on the AST-controller lights up. Accordingly, if the Assembly is NIO (Not O.K.), the BMS-port will be set and the NOK (Not O.K.) LED lights up.
- If a spray paint-timer is input, the Output 5 is set for this time
- The free programmable Outputs 1 to 5 (not the status outputs IO (O.K.) NIO (Not O.K.) READY) will be reset

Each Program has to be ended with the STOP-Command.

#### **PSET x** Assemble with Parameter-Set x

COMMAND-Number: 1

The PSET-Command initiates one Assembly-Step.

The Spindle is controlled by the values of the indicated parameter-sentence x.

If the PSET-Command and a Parameter-Set-Number is input, the actual screwdriving diagram will be displayed automatically.

Prior to inputting a PSET-Command, confirm that the selected parameter-set has the correct data.

#### **WINP x** Wait until Input x is set

COMMAND-Number: 2

If the controller recognizes a WINP command in the program, the operation will only continue, if a +24V signal is given to Input x.

Input choices are 1 through 4.











## 4. TERMINAL PROGRAM

### PROGRAMMING EXAMPLES

The following program examples should help to learn the programming of the AST-System in an simple and fast way. They also show solutions for complex programs.

#### 1. **Example:** One-Step Tightening with IO/NIO (O.K./Not O.K.) Evaluation

A fastener has to be tightened to a certain torque and then evaluated whether this assembly was IO (O.K.) or NIO (Not O.K.).

Note: It is assumed that the AST-controller, Power Supply, Spindle and Printer is connected and operational. More details to this subject can be found in the paragraph (Equipment View)

Procedure: First, determine how many parameter sets and what screwdriving diagrams are required for the assembly. Since this example shows a one-step assembly, only one parameter set is required. The Screwdriving diagram DIA2 is best, since the shut-off has to be when torque is reached. Now, select a parameter set which is "free", which means the set is not needed by another program. Input into this parameter set the screwdriving diagram number and all other values, i.e. shut-off torque-, voltage- and speed, etc. As soon as this is done, store the parameter set.

Now, the actual programming can start. Select out of the 4 programs an "empty" one, respectively one that is no longer needed and input the following commands:

1	PSET*x DIA2
2	CHKM
3	STOP

\* x is the number of the inserted parameter set

## **4. TERMINAL PROGRAM**

### **PROGRAMMING EXAMPLES**

#### **Explanation to Program:**

- Sentence 1:           The Spindle starts and is controlled by the values of parameter set x. When the shut-off torque is reached, the spindle will shut-off.
- Sentence 2:           The Measuring Value of the Assembly is stored into a buffer.
- Sentence 3:           The stored measuring values are compared to the limit values of the parameter set. If the measuring value is within both limit values, the assembly is deemed IO (O.K.), otherwise as NIO (Not O.K.) The corresponding status-outputs and -displays are set. The program finishes and the AST-controller is again ready.

To start a program, give a +24V Signal to the corresponding program input on the BMS-port. This signal needs to stay on, until the program has completely finished and the AST-controller is again ready.

## 4. TERMINAL PROGRAM

### PROGRAMMING EXAMPLES

**2. Example:** Two-Step Tightening with IO/NIO (O.K./Not O.K.) evaluation and display of measuring values to AST-Display and Printer

During the first assembly stage, a fastener is tightened with high speed to a certain torque, without checking angle.

During the 2nd assembly stage, the fastener is tightened with slow speed to the final torque with simultaneously checking angle. Afterwards, the measuring results are displayed on the AST-display and printed. An IO (O.K.) and NIO (Not O.K.) evaluation will be done.

1	PSET x DIA2
2	TIME 500
3	PSET y DIA3
4	CHKM
5	DISM
6	PRIM
7	STOP

**Explanation to Program:**

This example requires 2 parameter sets, namely PSET x with screwdriving diagram 2 for the first assembly stage and PSET y with screwdriving diagram 3 for the 2nd assembly stage.

- Sentence 1: The Spindle starts and is controlled with the values from parameter set x. (1st Assembly Stage)
- Sentence 2: Wait for 500 ms. (This waiting period is only needed if a mechanical clutch in the spindle has to be reversed, in-between the two assembly steps.)
- Sentence 3: The Spindle starts and is controlled with the values from parameter set y. (2nd Assembly Stage)
- Sentence 4: The Measuring Values of the 2nd Assembly are stored.
- Sentence 5: The Measuring Values of the 2nd Assembly are shown on the AST-Display.
- Sentence 6: The Measuring Values of the 2nd Assembly are printed
- Sentence 7: IO (O.K.) and NIO (Not O.K.) evaluation of the 2nd assembly step; setting of status-outputs and status-displays; end of program.

## 4. TERMINAL PROGRAM

### PROGRAMMING EXAMPLES

#### 3. Example: One-Step Tightening with screw-feeding and loosening at NIO (Not O.K.) Assembly

After program start, the screw-feeding needs to be activated by output 1. Then wait, until screw is fully fed (Input 1 will be set by a initiator). Reset Output 1, and tighten the screw to torque (no angle checking). The measuring result is being shown on the AST-display.

If the assembly is NIO (Not O.K.), screw will be loosened and additionally an alarm is given by Output 2 for 3000 ms. If assembly is IO (O.K.), the program ends.

```
1   SOUT 1
2   WINP 1
3   ROUT 1
4   PSET x DIA2
5   CHKM
6   DISM
7   JOK 11
8   PSET y DIA4
9   SOUT 2
10  TIME 3000
11  STOP
```

#### Explanation to Program:

This example requires 2 parameter sets, namely PSET x with screwdriving diagram 2 for the tightening stage and PSET y with screwdriving diagram 4 for the loosening stage.

- |             |   |
|-------------|---|
| Sentence 1: | Activate Output 1   |
| Sentence 2: | Wait until Input 1 is activated   |
| Sentence 3: | Re-Set Output 1   |
| Sentence 4: | The Spindle starts and is controlled with the values from parameter set x. (Tightening Stage) |
| Sentence 5: | The Measuring Values of the tightening stage are stored.                                      |
| Sentence 6: | The Measuring Values of the tightening stage are shown on the AST-Display.                    |

## 4. TERMINAL PROGRAM

### PROGRAMMING EXAMPLES

- Sentence 7: Jump to sentence 11 (program end), if the assembly was IO (O.K.). If assembly was NIO (Not O.K.), then continue with sentence 8.
- Sentence 8: The Spindle starts and is controlled with the values from parameter set y. (Loosening Stage).
- Sentence 9: Activate Output 2.
- Sentence 10: Wait 3000 ms.
- Sentence 11: IO (O.K.) and NIO (Not O.K.) evaluation of the tightening stage; setting of status-outputs and status-displays; re-set output 2, end of program.

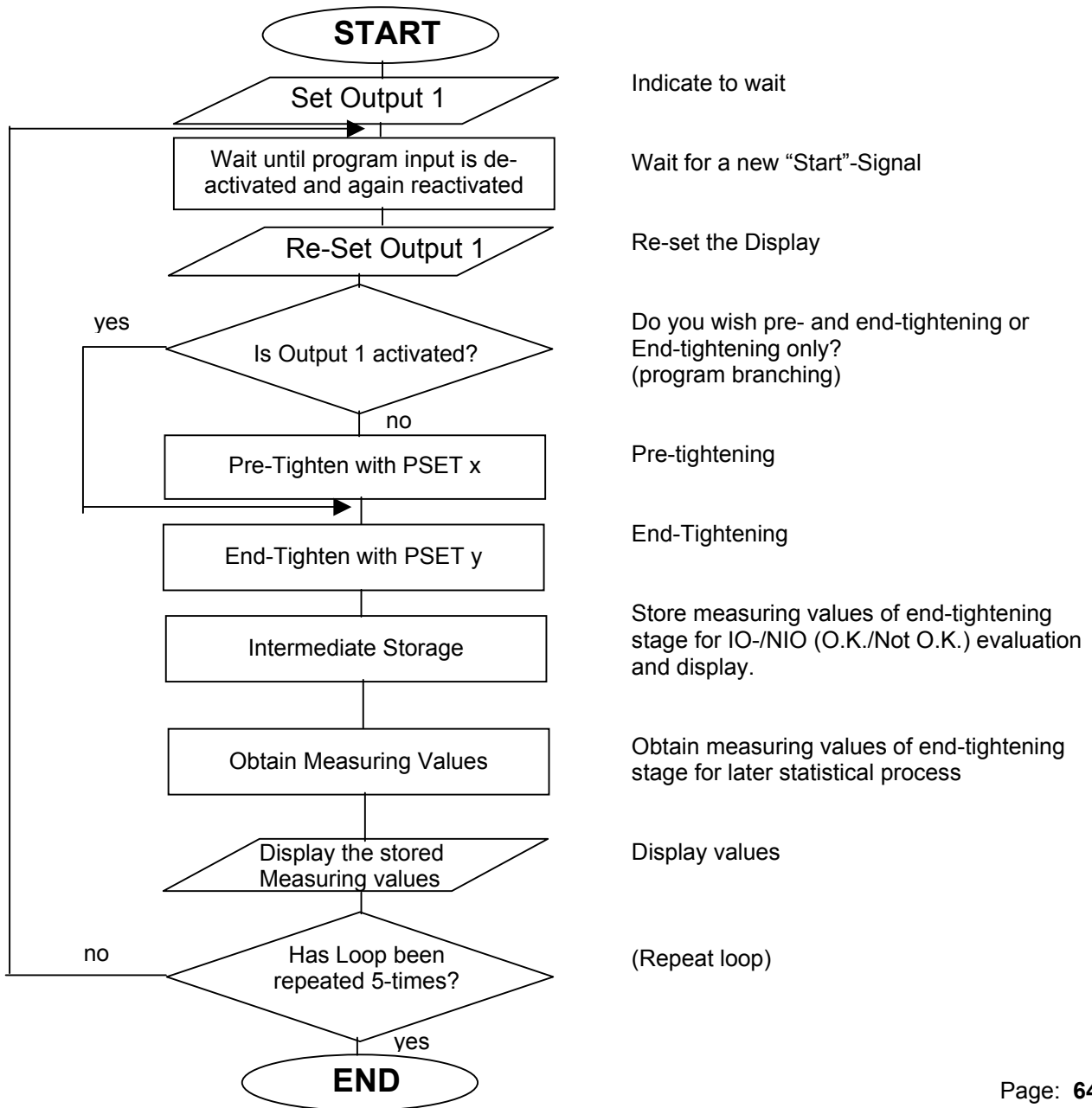
# 4. TERMINAL PROGRAM

## PROGRAMMING EXAMPLES

### 4. Example: One- or Two-Step Tightening with repeating loop, branching and statistics

With this example, either a pre- or end tightening or one end-tightening process will be done, depending on Input 1. The measuring values will be stored in a buffer and statistically processed. The whole program will be repeated 5-times. At the beginning of each loop, the start-signal of the program has to be deactivated and again reactivated.

NOTE: When writing large and complicated programs, it is recommended to sketch the sequence on a piece of paper and then convert the sketch into commands.



## 4. TERMINAL PROGRAM

### PROGRAMMING EXAMPLES

Listing of commands for example 4:

1	SOUT 1
2	HALT
3	ROUT 1
4	JINP 1
5	JUMP 7
6	PSET x DIA x
7	PSET y DIA y
8	CHKM
9	STAT
10	DISM
11	REPT 5
12	JUMP 1
13	STOP

#### Explanation to Program:

- Sentence 4 + 5: Branching  
Jump to sentence 7 (end-tightening), if Input 1 is set.  
If Input 1 is not set, continue with sentence 6 (pre-tightening).
- Sentence 11 + 12: Repeating Loop  
If loop has not been repeated 5-times, jump to sentence 1.  
If loop has been repeated 5-times, continue with sentence 13  
(program end)

## 4. TERMINAL PROGRAM

### STATISTICS MENU

```
1 Print
2 Delete
0 End
```

Press Key **1**

Print Program? (1-n)

Input for example 1 + **RET** = Statistics will be printed

Press Key **2**

Delete Program? (1-n)

Input for example 1 + **RET** = Statistics will be deleted (cannot be recovered)

Press Key **0**

Menu will be exited.

## 4. TERMINAL PROGRAM

### STATISTICS MENU

The AST-controller offers the possibility to statistically process an assembly-stage.

For example, the controller calculates an arithmetic average value plus a standard deviation, and stores the largest and smallest measuring values.

For each of the 4 programs, a statistics storage area is reserved. This storage area is permanent, which means the storage content does not get lost when the AST-controller is turned off.

A screwdriving stage can be processed statistically up to 32000-times.

The following Example shows, how a statistical process of a screwdriving stage is obtained:

In Program 4, the following two-step tightening process is input:

1	PSET 17 DIA 2
2	PSET 29 DIA 3
3	CHKM
4	DISM
5	STOP

A statistics for the measuring values of the 2nd tightening step has to be obtained.

1. After sentence 4, the STAT-command has to be input:

1	PSET 17 DIA 2
2	PSET 29 DIA 3
3	CHKM
4	DISM
5	STAT
6	STOP

2. By using the orange **STAT** key, change into the Statistics-Menu and delete the statistics storage of program 4.

3. After repeated assemblies with program 4, the statistics can be printed in the statistics-menu.

# 4. TERMINAL PROGRAM

## STATISTICS MENU

Example Printout of the Statistical Evaluation

STATISTICAL DATA			
D E P R A G			
15.01.92 13:09:45			Date + Time
PROGRAM 4			Number of Measurements
MEASUREMENTS: 7. IO: 6.			Number of IO (O.K.) Measurements
			Torque Value in Nm
OK-EVALUATIONS: MD (Nm) WI (Degree)			Angle-Values in Degree
ARITH.AVERAGE: 250.42 39.50			ARITHMETIC AVERAGE
STANDARD DEV.: 0.20 0.84			STANDARD DEVIATION IN SIGMA
AVERAGE +4SIG: 251.23 42.85			ARITHMETIC AVERAGE VALUE +4 SIGMA
AVERAGE-4SIG: 249.60 36.15			ARITHMETIC AVERAGE VALUE -4 SIGMA
MIN.VALUE: 250.00 39.00			MINIMUM VALUE
MAX.VALUE: 250.50 41.00			MAXIMUM VALUE
DISPERSION: 0.50 2.00			DISPERSION
MEASUREMENT<MIN.: 0 0			NUMBER OF MEASUREMENTS < MIN.VALUE
MEASUREMENT>MAX: 1 0			NUMBER OF MEASUREMENTS > MAX.VALUE
SET VALUES			
MINIMUM: 248.00 35			MD-MINIMUM + WI-MINIMUM
MAXIMUM: 252.00 90			MD-MAXIMUM + WI- MAXIMUM
<u>HISTOGRAM</u>			
TORQUE			TORQUE HISTORY
ABSOLUTE: 0.... 20.... 40.... 60.... 80.... 100%			
+++++ +++++ +++++ +++++ +++++			
0< MIN.			
0< 248.4			
0< 248.8			
0< 249.2			
0< 249.6			
0< 250.0			
1< 250.4  ****			
5< 250.8  *****			
0< 251.2			
0< 251.6			
0<= 250.0			
1> MAX.  ****			
ANGLE			ANGLE HISTORY
ABSOLUTE: 0.... 20.... 40.... 60.... 80.... 100%			
+++++ +++++ +++++ +++++ +++++			
0< MIN.			
6< 40.5  *****			
1< 46.0  ****			
0< 51.5			
0< 467.0			
0< 462.5			
0< 68.0			
0< 73.5			
0< 79.0  *****			
0< 484.5			
0<= 90.0			
0> MAX.			

relates only to IO (O.K.) Measurements

# 4. TERMINAL PROGRAM

## STATISTICS MENU

Example Printout of the Statistical Evaluation (with CMK-Value):

STATISTICAL DATA			
D E P R A G			
26.06.95 08:49:15			Date + Time
PROGRAM 1			Number of Measurements
MEASUREMENTS: 9.	IO: 9.		Number of IO (O.K.) Measurements
			Torque Value in Nm
OK-EVALUATIONS:	MD (Nm)	WI (Degree)	Angle-Values in Degree
ARITH.AVERAGE:	0.14	734.00	ARITHMETIC AVERAGE
STANDARD DEV.:	0.01	0.00	STANDARD DEVIATION IN SIGMA
AVERAGE +4SIG:	0.16	734.00	ARITHMETIC AVERAGE VALUE +4 SIGMA
AVERAGE-4SIG:	0.11	734.00	ARITHMETIC AVERAGE VALUE -4 SIGMA
MIN.VALUE:	0.13	734.00	MINIMUM VALUE
MAX.VALUE:	0.14	734.00	MAXIMUM VALUE
DISPERSION:	0.01	0.00	DISPERSION
<b>CMK</b>	0.44	0.00	<b>CMK-Value</b>
MEASUREMENT<MIN.:	0	0	NUMBER OF MEASUREMENTS < MIN.VALUE
MEASUREMENT>MAX:	0	0	NUMBER OF MEASUREMENTS > MAX.VALUE
SET VALUES			
MINIMUM:	0.00	0	MD-MINIMUM + WI-MINIMUM
MAXIMUM:	5.00	1000	MD-MAXIMUM + WI- MAXIMUM
<u>HISTOGRAM</u>			
TORQUE			TORQUE HISTORY
ABSOLUTE: 0.... 20.... 40.... 60.... 80.... 100%			
+++++ +++++ +++++ +++++ +++++			
0< MIN.			
9< 0.5	*****		
0< 1.0			
0< 1.5			
0< 2.0			
0< 2.5			
0< 3.0			
0< 3.5			
0< 4.0			
0< 4.5			
0<= 5.0			
0> MAX.			
ANGLE			ANGLE HISTORY
ABSOLUTE: 0.... 20.... 40.... 60.... 80.... 100%			
+++++ +++++ +++++ +++++ +++++			
0< MIN.			
9> 100.0			
0< 200.0			
0< 300.0			
0< 400.0			
0< 500.0			
0< 600.0			
0< 700.0			
0< 800.0	*****		
0< 900.0			
0<= 1000.0			
0> MAX.			

Machine Capability (CMK)  
Process Capability (CPK)

$$CMK, CPK = \frac{OSG - Total\ Average}{3 \times Standard\ Deviation}$$


OSG: upper specification limit

relates only to IO (O.K.) Measurements

## 4. TERMINAL PROGRAM

### PRINT MENU

With the PRINT-menu of the sequence controller AST, factors, parameter, programs or commands can be printed.

To change into the PRINT-menu, press the orange  key.

The display shows:

1	FACTORS
2	PARAMETER
3	PROGRAMS
4	COMMANDS
5	ALL VALUES
6	END

To choose a menu point, input the corresponding menu number and, press the  key.

To 1: All controller factors will be printed.

To 2: Select the parameter set to be printed. Printing is only possible, if the parameter set contains a valid screwdriving diagram (DIA2, DIA3, DIA4, DIA5 or Options).

To 3: Select the program to be printed. Printing is only possible, if the first program sentence does **not** contain a STOP-command.

To 4: All commands with corresponding command-numbers and a short description will be printed.

To 5: In sequence, all factors, parameter-sets, programs and commands will be printed.

To 6: Exit the PRINT-menu. The Controller is again ready.

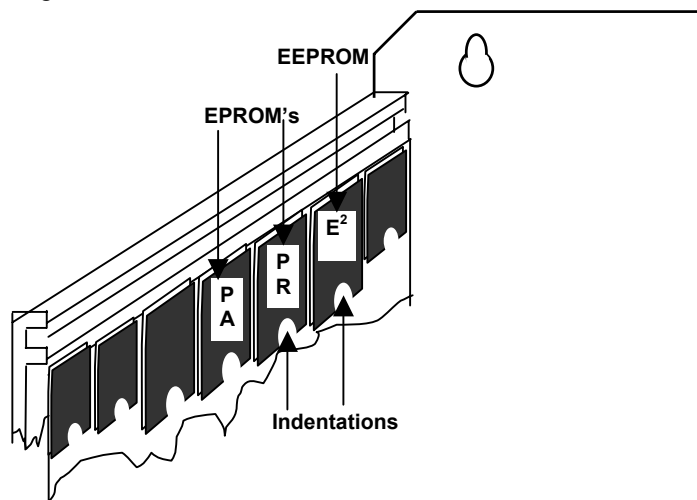
## 4. TERMINAL PROGRAM

### SOFTWARE CHANGE

To change the software of the sequence controllers, open the unit and exchange two EPROM's.

Process:

- Turn-Off sequence controller AST2
- Pull power supply cable.
- Unscrew the 4 screws on the front plate
- Lift front plate, and pull-out the cover-sheet on the upper housing side.
- The following view is shown:



- Remove the two EPROM's from their base, using a screwdriver.
- Insert the two new EPROM's in the empty bases. Make sure, that the EPROM's marked with PA and PR are inserted as shown on the sketch. The indentations have to be down!
- Check to make sure that the EPROM-legs are inserted into the bases.
- Close housing
- Connect power plug and turn unit on. On the AST-display the new software number is shown.

## **4. TERMINAL PROGRAM**

### **SOFTWARE CHANGE**

If the software of one sequence controller should be exchanged with the software on another sequence controller, the EEPROM can be changed.

The EEPROM contains the factors, parameters and programs, which were input by the user.

This eliminates the need to again input those values.

## 4. TERMINAL PROGRAM

### DATA TRANSFER

With the help of the data transfer of the PC-software (Optional), it is possible to remote-program the AST2. This remote-programming allows the loading and management of product groups. The screwdriving results will be saved with date and time. Graphics evaluation with curve display allow a screw joint analysis.

The DFUE = 1 command for the data transfer is done over the V24 port.

Cable length should not exceed 20 meters.

The following example shows, how to input the data transfer of an assembly.  
In Program 1, a two-step screwdriving process is input:

1.	PSET 1 DIA 2
2.	PSET 2 DIA 3
3.	CHKM
4.	DISM
5.	STAT
6.	STOP

Now, a data transfer of the measuring values has to be done.

1	CHKS 1	→	Start down-loading the torque values
2	PSET 1 DIA 2		
3	PSET 2 DIA 3		
4	CHKM		
5	DISM		
6	STAT		
7	CHKS 0	→	Stop down-loading the torque values
8	DFUE 1	→	Transfer to PC
9	STOP		

After several assemblies, a statistics can be done with the data sent to the PC, as shown here with the example program 1. The data will be evaluated with a special designed software. A graphics evaluation of the transferred values is possible.

## 4. TERMINAL PROGRAM

### DATA TRANSFER



PC – Software for

**PROGRAMMING**

and

**ARCHIVING**

of Controller AST2

#### Programming:

- Create product groups
- For each product group 80 parameter sets, 4 programs and controller factors can be managed.
- Bi-directional data transfer PC – AST2
- Serial Port can be configured over PS-software
- Password protection
- Pull-down menu's with online-help
- Mouse- or keyboard operation

#### Archiving:

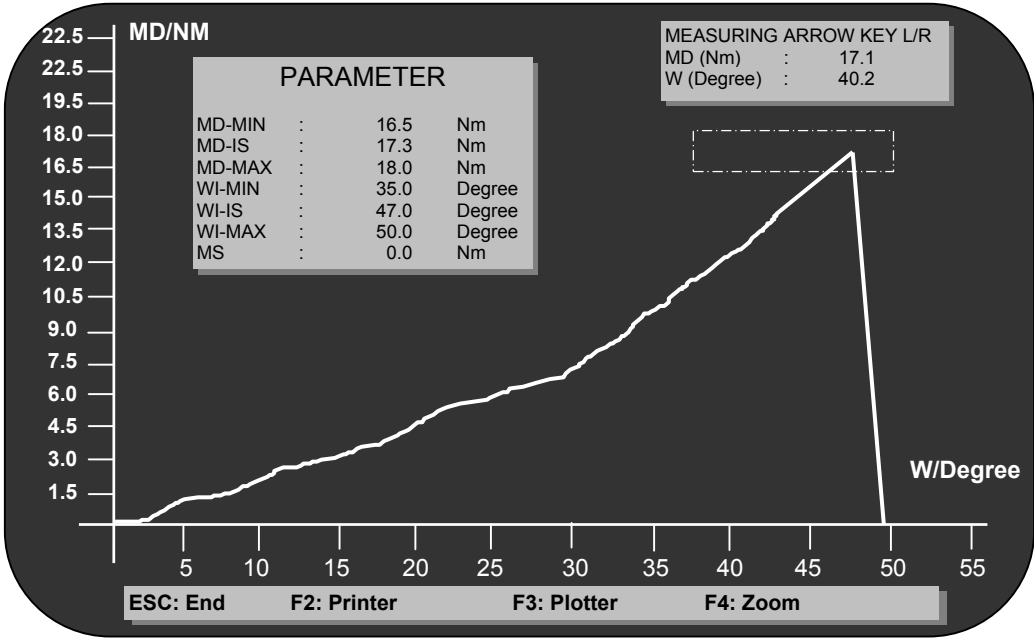
- Receive any and all measuring values with Date, Time and Status (O.K./Not O.K.)
- Storage to hard drive.
- Listing of measurements sorted by status (O.K./Not O.K.)

# 4. TERMINAL PROGRAM

## DATA TRANSFER



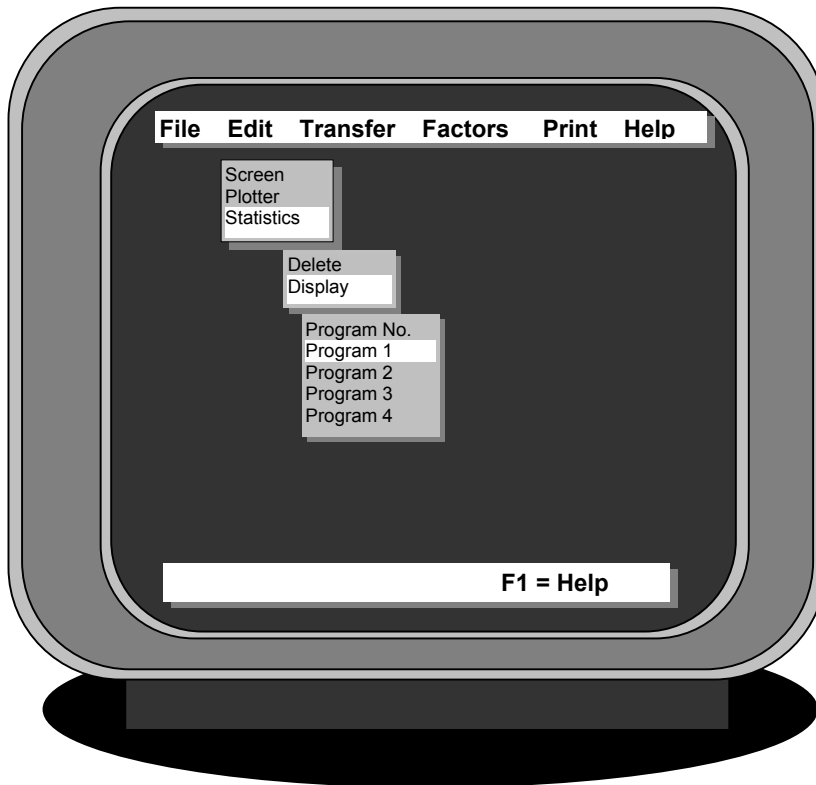
## GRAPHICS



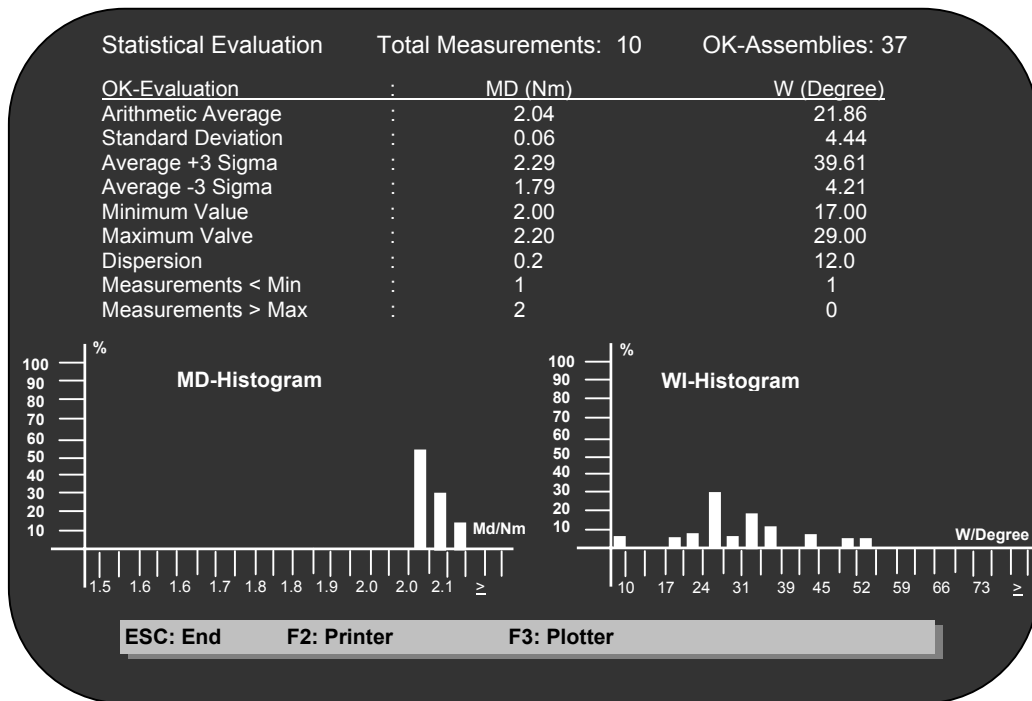
- Curve Display with variable axis design allows an insertion analysis
- Zoom
- Display of OK-window and the parameters
- Printer or plotter
- Scanning of measuring curve by a measuring arrow

# 4. TERMINAL PROGRAM

## DATA TRANSFER



## STATISTICS



- Display of statistical distribution (histogram)
- Statistical calculation with arithmetic average, standard deviation and dispersion
- Printer or plotter

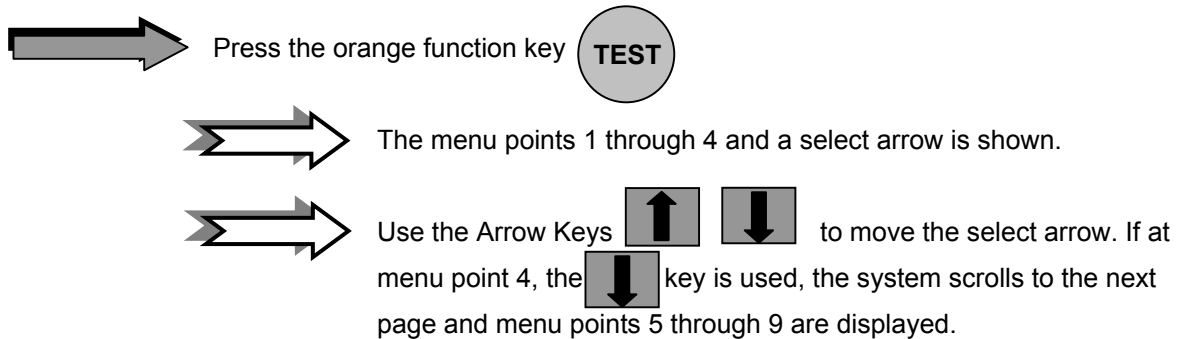
## 4. TERMINAL PROGRAM

### TEST MENU

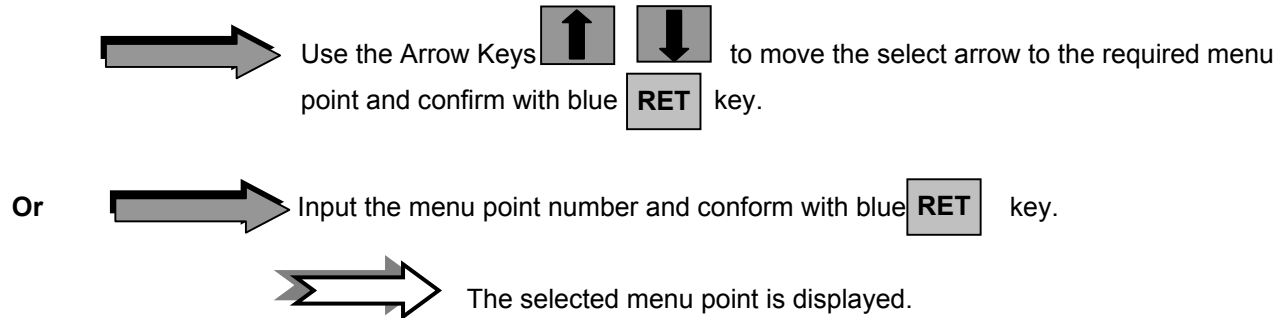
The Test-Menu offers the possibility to check the AST-controller and the hardware (spindle, power supply, printer...), in regards to their function and accuracy. Operational errors can be analyzed or at least recognized by the user.

#### Selection of Test Menu

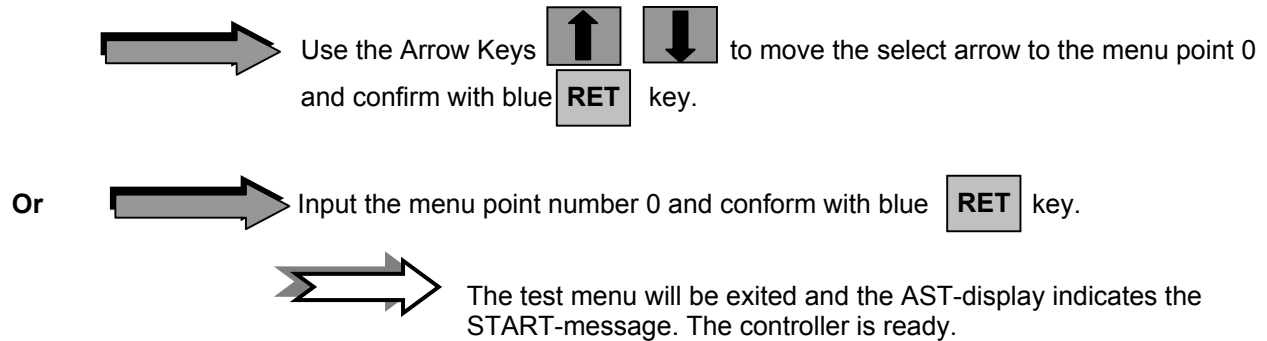
The Test-Menu can only be selected, if the AST-system is operational, i.e. the Start-Message has been displayed or a system-error occurs.



#### Selection of Menu Point



#### Exit Text-Menu



## 4. TERMINAL PROGRAM

### TEST MENU

With the following two Menu-Points, the function of the Spindle transducer can be checked. To receive correct results, spindle should not be under load.

#### Calibration

The calibration value of the Transducer will be detected by the AST-controller and displayed on the screen.

This value should not differentiate by more than +/- 5% from the loaded calibration factor. If it is necessary to newly balance the calibration value, this is possible. For this, loosen the front plate of the sequence controller to access the trimmer at the height of the in-line keys and balance the trimmer with a insulated screwdriver. Afterwards, the offset of the transducer should be newly obtained. This can be done by pushing the "RESET" key. If the message "START?" is displayed, recheck the calibration value in the test menu. If the required value has not been reach, readjust the trimmer and repeat the above sequence.

#### Off-Set Test

The right and the left Off-Set value will be received by the AST-controller and displayed on the screen. Those values should be within the range of 100 and 120. A small difference within this range is allowable.

With the following test only the Spindle Angle-Transducer can be tested.

#### Angle-Test

The degree counter will be reset to 0, when this option is selected.

When the drive shaft of the spindle is turned, the degree counter has to count the received angle impulses. After a full rotation of the shaft, the screen has to show a value of 360 Degree.

The degree counter has to display the degree value with a " - ", for left-rotation. The Spindle starts when LEFT/RIGHT cursor keys are pressed.

With the following Option, the internal TTL=Supply voltage as well as the voltage for the transducer can be checked.

#### Voltage

The actual voltage values, as well as the corresponding tolerance ranges, are shown on the AST-display:

TTL-Supply Voltage	(+ 4.75 V -- + 5.25V)
Positive Transducer Voltage	(+11.50 V -- +12.50V)
Negative Transducer Voltage	(-11.00 V -- -13.00V)

## 4. TERMINAL PROGRAM

### TEST MENU

#### Display Time

The actual Date and Time is displayed

#### Set Time

To input Date (i.e. 23.01.1992 = January 23rd) and Time (i.e. 16:43), continue as follows:  
(always input two-digits)



- Day (23)
- Month (01)
- Year (92)
- Hour (16)
- Minute (43)

When an error occurs during inputting data, re-start the whole entry!  
Please refer to Page 83 to change from summer- to winter-time.

**The Current Test and the Speed Test allow a partial testing of the Power Supply and Spindle.**

#### Current Test



Provide Current I for the Spindle Motor in 1%-increments.

The adjustment is done with the   keys, whereby 0% corresponds with no current and 100% with the maximum current.

When using the CW- or CCW-Button on the Power Supply and the motor does not start due to low current, the LED "I-MAX" has to light up on the power supply.

#### Speed Test

Provide Speed N for the Spindle Motor in 1%- increments.

The adjustment is done with the   keys, whereby 0% corresponds with no speed and 100% with maximum speed.

When using the CW- or CCW-Button on the Power Supply, the spindle can be tested in its entire speed range.




The default values of the current test apply also for the speed test. Furthermore, the default values of the speed test are valid for the current test.

# 4. TERMINAL PROGRAM

## TEST MENU

With this Menu Option, the output-ports, as well as the LED's of the AST-System, can be checked.

### Set Port

In sequence the following outputs can be set or re-set. To set the output, use  key, to reset output, use the  key. To continue to the next output, use the  key

The corresponding BMS-port will be set/reset and the corresponding LED lights up/does not light up

- READY (Operational)
- IO (O.K.)
- NIO (Not O.K. / Error)
- OUT1 (Output 1)
- OUT2 (Output 2)
- OUT3 (Output 3)
- OUT4 (Output 4)
- OUT5 (Output 5)

the corresponding LED lights up/does not light up

- MD< (Torque too small)
- MD= (Torque O.K.)
- MD> (Torque too large)
- WI< (Angle too small)
- WI= (Angle O.K.)
- WI> (Angle too large)

On the screen the corresponding output and its status (ON/OFF) is indicated.

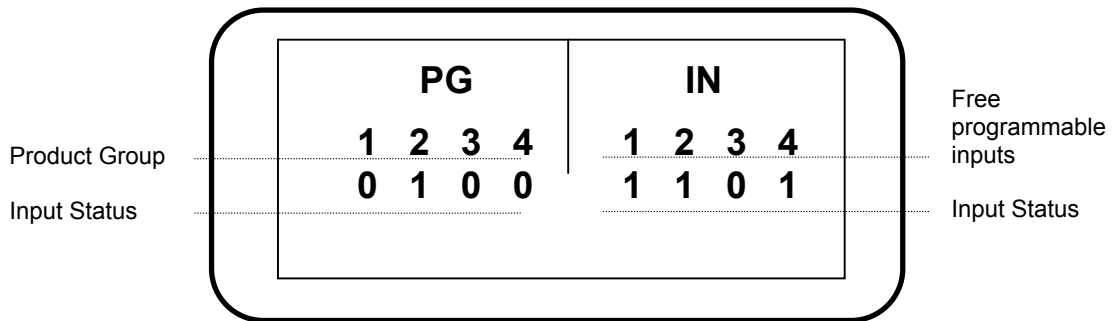
## 4. TERMINAL PROGRAM

### TEST MENU

With this Menu Option, the INPUT-modules, as well as the LED's of the AST-System, can be checked.

#### Read Port

The Input-Ports (Product Group PG 1 - 4) of the AST-Controller are displayed on the screen.



If a +24V Signal is given to an input, then

- the corresponding Input-LED should light up on the AST-controller
- a "1" should be indicated on the screen for this input

If a 0V Signal is given to an input, or if the input is open, then

- the corresponding Input-LED should not light up on the AST-controller
- a "0" should be indicated on the screen for this input

#### Printer Test

A test print-out will be done by the connected printer.

If the printer is OFFLINE, which means not ready to receive, a jump back into the test menu occurs.

#### V24 Test

This V24-Test is only used for service purposes.

## 4. TERMINAL PROGRAM

### TEST MENU

#### Torque-Test

The AST-controller takes cyclical torque-measurements. The actual value is displayed. By pressing the RIGHT cursor-key or LEFT cursor key, the spindle starts.



#### Peak Value - Test

The AST-controller takes cyclical torque-measurements. The highest torque value (peak value) is displayed.

#### Cycle Time On/Off

The cycle time is the time period required by the AST-controller to complete one screwdriving program.


This is done with the  key

- ON  Cycle Time:  
The cycle time will be printed after program end.
- OFF  The cycle time will not be printed.

This adjustment will be stored.

#### Speed

The actual Speed (100%) is displayed in rotations per minute.

Input = 1: Spindle Starts (End with  Key)

Input = 0: End (Return to Test-Menu)

#### End

Exit the TEST-menu; the screen displays the START-message and the AST-controller is again ready.

## 4. TERMINAL PROGRAM

### OTHER FUNCTIONS

#### Change from Summer- to Winter-Time

This change can be done only, when the system is in the base position (START?).

This is done with the following key combination **FUNC** + **9** + **7** + 

The following current Date appears:



Winter-Time	
Date:	03.03.94
Time	07:43:59
Change = 1	End = 0

With the key 1 you can select between winter- and summer-time. With the key 0, the system Returns to the START-mode.

#### Test-Operation for Spindles

The spindle turns with the speed and voltage as indicated by the system. This Test can be done, when the system is in the base position (START?).

This is done with the following key combination **FUNC** + **9** + **8** + **RET**

The spindle turns in the required direction when using the   keys. The spindle turns only for the duration as a key is pressed.

Arrow left indicates left-rotation; arrow right indicates right-rotation.

To exit this test, use the **RET** key.