BK MIKRO 4

Monitoring System for Objects and Tools

Technical Documentation - North American Edition

Issue 02.00
Released: January, 1997

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Contents

1. Description

BK MIKRO 4 is a control system suitable for both tool and free space monitoring applications.

The complete BK MIKRO 4 system comprises

- a control unit,
- a sensor (scanner),
- a connection cable.

BK MIKRO 4 can be used for two different types of monitoring:

- Monitoring of a **scanning position** whose precise location has been previously entered by "teach-in", e.g. to carry out a tool check before each working cycle.
- Monitoring a **scanning range** freely selectable via two adjusting switches, e.g. to carry out tool checks for tools with varying diameters, or for ejection checks (free space monitoring).

Further features enabling customized system configuration include:

- Relay contacts switch-selectable as normally open or normally closed.
- Selection of clockwise or counter-clockwise travel direction for the scanner.
- Two settings of controlled acceleration and deceleration.
- Detection of cable breaks.

Principle of Operation

When given the signal to “scan,” the system will monitor the presence of a particular tool or check a certain area for obstacles.

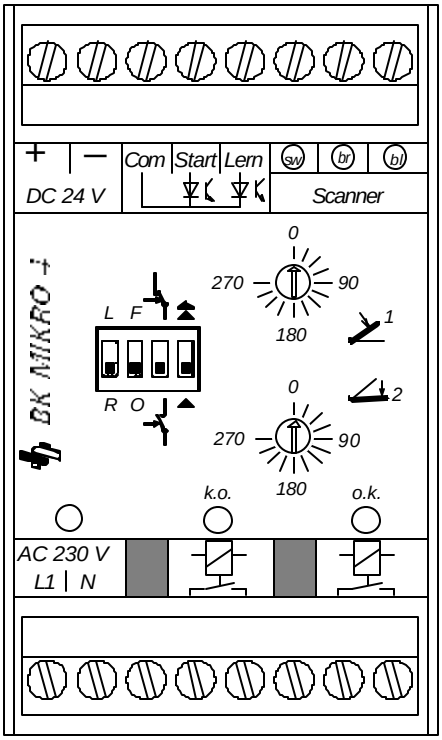
Two different monitoring methods may be selected:

- Monitoring with Learn Cycle
  The monitoring system will first determine the exact position of the tool by a "teach-in" cycle. This cycle is followed by sensor-mode, during which the wand will be moved into the position "just learned", and a comparison takes place.
- Monitoring by Setting a Range
  A scanning range will be set via two rotary switches. Following each start signal, the wand will travel through this angle to determine monitoring results.

All output to the machine will be via two relay contacts, configurable as normally closed or normally open. For evaluation, the "O.K." relay, the "K.O." relay, or both may be used.

2. System Components

2.1. Control Unit



AC 230 V L1 | N	AC 120 V L1 | N

Supply Voltage (optional)

2.1.1. Characteristic Properties

The BK MIKRO 4 system control unit is housed in an insulating material housing. On its front panel, the control unit is fitted with screw terminals to connect all machine inputs and outputs, supply voltage, and the scanner.

Note:
The unit is available in three different models for three different supply voltages:
24 VDC, 120 VAC, 230 VAC.

2.1.2. Technical Data

Housing..... Insulated Material Housing, Protection Class II

Protection Type..... IP 20

Dimensions (W x H x D) ..... 45 mm x 75 mm x 107.5 mm

Case Mountings ..... DIN Rail, 35 mm, to DIN EN 50022

Power Supply Voltage ..... Depending on Model:
24 VDC
120 VAC
230 VAC

Power Consumption ..... 6 VA max.

Control Voltage ..... 24 VDC (internal/external)

Inputs..... Galvanically Isolated

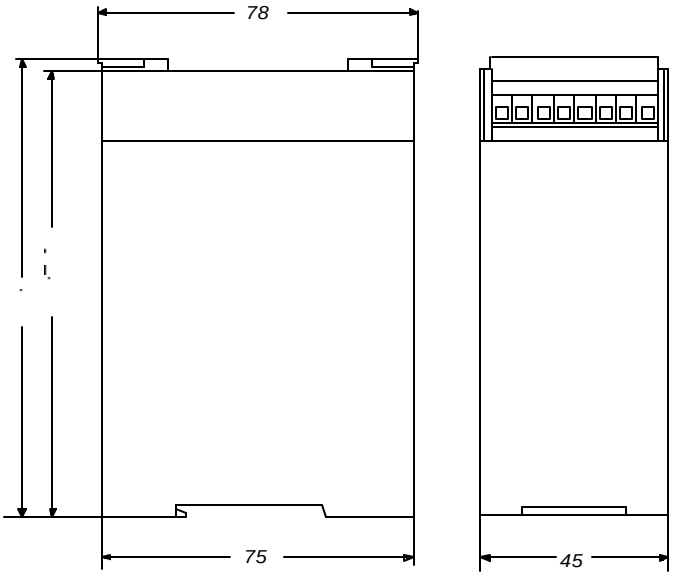
Switched Outputs..... 2 x 250 VAC / 30 VDC

Making/Breaking Capacity ..... 500 VA / 60 W (max.)
10 mA min. at 10 V

Operational Life of Relay ..... 5×10^7 switching cycles

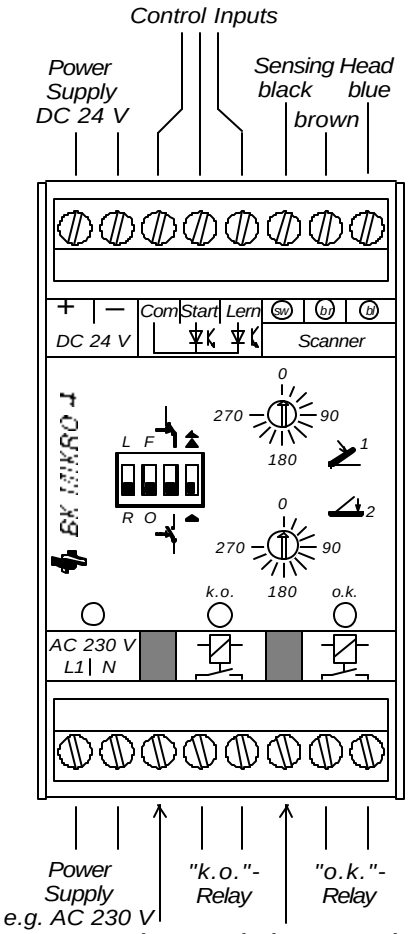
Connections ..... plug-in screw terminals for connecting
- power supply
- control inputs
- relay outputs
- scanner

Temperature Range..... 0°C to +50°C



2.1.3. Screw Terminals

The screw terminals have been arranged on two plug-in terminal blocks. These blocks are keyed so that they cannot be accidentally plugged into the wrong socket. When in operation, plastic caps cover the screws in the front. Wires to be connected are routed from the top or bottom of the unit. Power supply, control inputs, relay outputs, and the scanner are all connected via these screw terminals.



These terminals must not be wired up !

Note:

These plugs may only be inserted or removed when the power supply has been disconnected.

Unmarked terminals must not be connected.

2.1.3.1. Power Supply

"24 VDC" Model

- Terminal "+" 24 VDC

  Supply Voltage Input 24 VDC ± 20%

  Input Current 0.25 A max.

- Terminal "–" 24 VDC

  Reference potential of 24 VDC supply voltage.

"120 VAC" and "230 VAC" Models

Depending on the specific model, the unit will be supplied preconfigured for "120 VAC" or "230 VAC". The relevant version will be marked on the unit type plate next to the supply connections on the front panel.

- Terminals "L1" and “N”

  Supply Voltage Input, depending on model:
  120 VAC (I_{max} = 0.05 A) or
  230 VAC (I_{max} = 0.025 A)

- Terminal "+" 24 VDC

  Control voltage output for controlling inputs "Start" and "Learn,” 24 VDC (16 V ... 32 V) unregulated.

  The control voltage meets the requirements for an extra low function potential with safe disconnection.

  Output Current 0.1 A max.

  If an external control voltage is applied, this terminal is not connected.

- Terminal "–" 24 VDC

  When using the internal control voltage, this terminal must be connected to the control inputs terminal "Com".

  If an external control voltage is applied, this terminal is not connected.

Note:

Alternatively, "120 VAC" and "230 VAC" models may also be supplied with 24 VDC. In this case, terminals "L1" and "N" must not be connected. Terminals "+24 V" and "–24 V" are to be connected as described above for "24 VDC" model.

2.1.3.2. Control Inputs

- "Com" Terminal

  Reference potential for control inputs

- "Start" Terminal

  An input level of +24 VDC will trigger a "sensing" cycle.

  The input current is approximately 5 mA; pulses lasting less than 6 ms will be disregarded.

- "Lern" Terminal

  An input level of +24 VDC will trigger a "learning" cycle (the "teach-in").

  The input current is approximately 5 mA; pulses lasting less than 6 ms will be disregarded.

  The position stored during the learning cycle will remain stored even after the unit has been switched off. Therefore, a new "teach-in" session is required only when your tool geometry changes, or the scanner is changed.

  If a range is set via a switch, any signal to the "Lern" terminal will be ignored.

2.1.3.3. Scanner Connections

Three screw terminals are used to connect scanner TK 4. The connections are marked according to the color-coding of the cable wires.

Note:

Using a different scanner may damage the scanner and control unit.

2.1.3.4. Relay Outputs

The terminals have been designed as dry relay contacts. By switch selection, they may be configured as either normally open or normally closed. (Note that when using the relays as normally closed, the contacts will be open when there is no power to the unit.) The contacts have been designed for 250 V and protected against inductive switch-off peaks of up to 19 W (2 ms).

Maximum switching power is 500 VA.

Maximum switching current may not exceed 2 A.

- "K.O." Relay Terminals

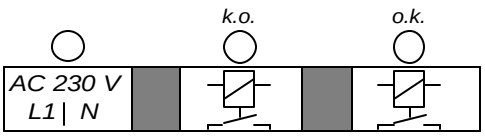
  These two terminals are used to indicate a fault message (K.O.).

- "O.K." Relay Terminals

  These two terminals are used to indicate a good cycle (O.K.).

2.1.4. Light-Emitting Diodes

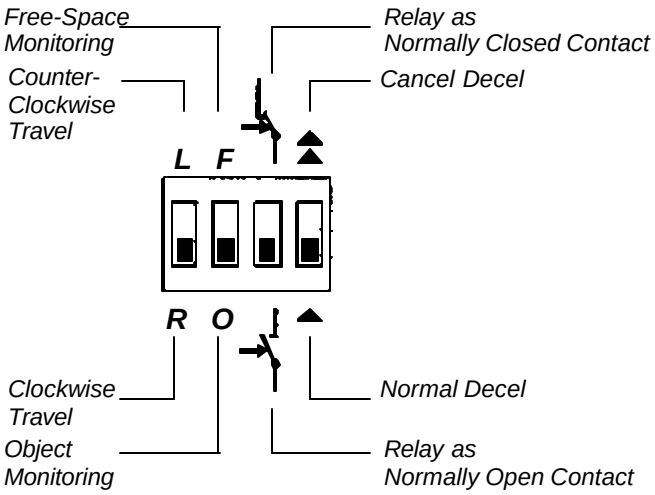
Three light-emitting diodes (LEDs) on the front panel provide information about the current status of the BK MIKRO 4 monitoring system:



- Power Supply / Status
  yellow LED to indicate supply voltage or status
- "K.O." Relay
  red LED to indicate fault message
- "O.K." Relay
  green LED to indicate no fault message

2.1.5. Toggle Switches

Using the four toggle switches arranged next to each other on the control unit front panel, the following functions may be set.



Note - Setup on Delivery:

All switches are toggled downwards !

2.1.5.1. "Clockwise/Counter-Clockwise" Switch

The "Clockwise/Counter-Clockwise" switch determines the direction of rotation for the scanner.

Clockwise rotation is effected when rotating to the right (scanner viewed from behind, looking up length of scanner).

2.1.5.2. "Object/Free Space Monitoring" Switch

This switch selects whether finding an object in the scanning window or not finding an object results in an OK result.

The "Free Space Monitoring" function is permitted only if a scanning range has been set via the rotary switches (it is not possible to “learn” an empty space).

2.1.5.3. "Normally Open Contact/Normally Closed Contact" Switch

The "Normally Open Contact/Normally Closed Contact" switch determines the mode of operation for the two output relays.

2.1.5.4. "Decel" Switch

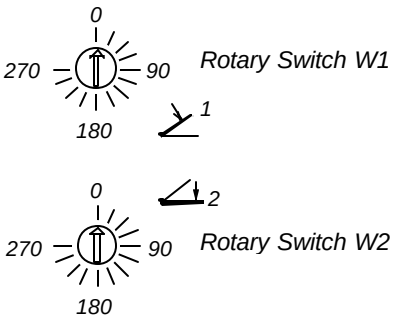
The "Decel" switch determines whether the scanner will slow down while in its scanning range.

Note:

For normal tool detection applications, this switch should be in the “Normal Decel” position, as the normal deceleration of the unit is designed to protect the unit from wear and tear.

2.1.6. Rotary Switches

The two rotary switches are used to set a mode of operation and a scanning range. Switch positions from 0° to 270° (in 22.5° steps) are possible.



Note:

W1 = 0	Return travel monitoring is switched off.
W1 > 0	Return travel monitoring possible depending on start signal length.
W2 = 0	Monitoring a scanning position following "teach-in".
W2 > W1	Monitoring by setting a scanning range:

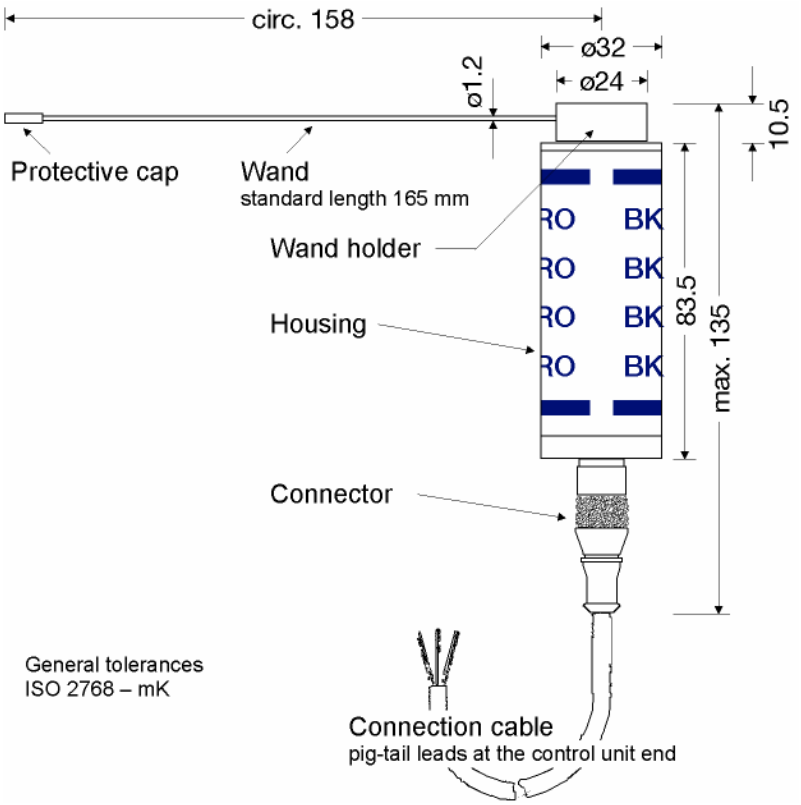
- W1 defines where a scanning range starts, W2 where it ends; rotary direction is set by toggle switch.
- W1 = 0 is possible (return travel monitoring is switched off).
- W2 ≤ 270; positions > 270° are not permitted.
- Monitoring range starts at approximately 10°. Smaller angles will be interpreted as a "sticking scanner" problem.

2.1.7. Notes on Technical Safety

The control unit comprises the following **circuits, all isolated** from each other:

K.O. Output (2 terminals)	safely isolated from all other circuits
O.K. Output (2 terminals)	safely isolated from all other circuits
AC power supply (L1, N)	safely isolated from all other circuits
DC power supply (+24 V, –24 V	safely isolated from K.O. output, O.K. output, and AC power supply
	simply isolated from control inputs
	no isolation from scanner connections
Control Inputs (Com, Start, Lern)	safely isolated from K.O. output, O.K. output, and AC power supply
	simply isolated from DC power supply and scanner connections
Scanner Connections (black, br, blue)	safely isolated from K.O. output, O.K. output, and AC power supply
	simply isolated from control inputs
	no isolation from DC power supply

2.2. Scanner TK 4



2.2.1. Characteristic Properties

The scanner housing is cylindrical and smooth, thus permitting easy installation, e.g. using a collet chuck. The scanner is designed for easy access for servicing and changing the wand.

Aligning the scanner is easy and requires no additional instruments or aids. Initial wand position is defined by an internal mechanical stop of the wand holder.

When a supply voltage is applied, the scanner will always move into its mechanically set initial position. The scanner will be held in this position until a start pulse triggers a scanning cycle.

Note:

Using scanner TK 4 with a different control unit than BK MIKRO 4 may damage the scanner and control unit.

Your wand is a wearing part!

Each contact with a rotating object will cause corresponding wear on the wand. This may even lead to the metal wand breaking. Due to the injury hazard this causes, users should exercise particular caution within any BK MIKRO 4 rotating area.

2.2.2. Technical Data

Housing.....Anodized Aluminum

Protection Type.....IP 67

Wand Length.....165 mm (standard)

Scanning Angle.....0° to 270°

Control Unit Connection.....Connector, M12x1, 3 pins

Temperature Range.....0°C to +80°C

Sensing Cycles.....> 10 million with normal decel

Option: Wand Holder for Small Chips

If BK MIKRO 4 is used to monitor manufacturing processes where materials with small chips are processed (e.g. cast iron, diecast aluminum, brass), we recommend the use of our specially designed wand holder for this purpose.

2.3. Connection Cable

Control unit and scanner are connected by a 3-wire cable:

- pig-tail leads for connecting to the screw terminals on the control unit (note color coding of wires!)
- molded plug at the scanner end
- length 5 m, can be extended to a maximum length of approximately 25 m.

Note:

To avoid unnecessarily reducing the operational life of this cable, it should not be subject to more than a minimum amount of movement during operating cycles. Only the black, brown, and blue conductors in the cable are connected. Any additional wires, such as white, should be left disconnected.

3. Function

The BK MIKRO 4 can be operated in two different ways:

- monitoring with learn function
- monitoring by setting a scanning range

Both modes of operation allow return travel monitoring.

3.1. Mode of Operation

3.1.1. Scanning Process

By applying a low voltage, the scanner will be held at rest in its mechanical stop position. Applying a start pulse will trigger a scanning cycle.

Initially, the scanner will travel at maximum speed to the start of a given monitoring range. However, its motor will slow down to a preselected scanning speed in time before a learned position or a preselected angle set by rotary switch W1 is reached.

The monitoring range will then be traversed at the preset scanning speed and its related force which is to be used to scan an object or range. During the entire operation, all pulses generated by the scanner's internal encoder will be continuously processed. If the system detects that the scanner no longer moves or has exceeded the end of the monitoring range (W2 setting), the direction of rotation immediately changes, and the scanner will return at maximum speed into its stop position.

3.1.2. Return Travel Monitoring

BK MIKRO 4 allows users to select whether or not return travel monitoring is desired.

- If rotary switch W1 = 0, return travel monitoring is off.
- If rotary switch W1 > 0, return travel monitoring is enabled.

  The start signal length then determines whether the return travel will be monitored:

  Before return travel begins, i.e. at the reversing point of the scanner, the system will re-read the current start signal status. If the start signal is still present, return travel monitoring begins. If the start signal has already been removed, an immediate output of results will follow. Return travel monitoring will be not be performed.

3.1.3. Output of Results

- Fault message (K.O.)

  A fault message will be output immediately on detection. The scanner will return to its stop position.

- Good cycle message (O.K.)

  - with return travel monitoring:
    On reaching the stop position, scanning process results will be indicated. This ensures that the scanner will have left the monitoring range at the time the results are output.

  - without return travel monitoring:
    Results will be indicated on reaching the scanner reversing point, as its return travel will not influence scanning results.

  Note:

  "K.O." will not only be indicated when a tool has broken but also when the scanner cannot leave its stop position for any reason (e.g. mechanical "sticking", cable break, etc.).

In the "O.K." state, the "O.K." relay will be active, while the "K.O." relay remains inactive.

In all other cases, "K.O." will be indicated, i.e. the "O.K." relay will be inactive, the "K.O." relay will be active.

The results of a scanning cycle will remain latched until the following cycle starts.

3.2. Monitoring with learn function

Requirement: rotary switch W2 = 0

The scanning range will be determined by a learning cycle (external control signal). This mode of operation is the typical mode for tool detection applications. The system will check for the presence of the tool at the learned position.

3.2.1. Teach-In

The "teach-in" cycle will be started by an active input signal on the "Learn" terminal. Both relay outputs for "O.K." and "K.O." will become inactive. The scanner will travel in its preset direction of rotation.

- If a tool is detected, its position will be stored, and the scanner returns to its initial position. In addition, the "O.K." relay will be activated.
- If the scanner rotates to a maximum of 270° without detecting any tool, the "K.O." relay will be activated.

  In this case, i.e. following a faulty learning action, the previously stored position will remain in force.

The LEDs "O.K." and "K.O." will indicate the result.

Note:

A position learned during "teach-in" will remain stored, even after removal of power to the unit.

Ensure that tool geometry (layout and dimensions) at "teach-in" corresponds to the geometry used during monitoring in the "Start" mode.

3.2.2. Start

A "Start" cycle will be triggered by an active input signal on the "Start" terminal. Both relay outputs for "O.K." and "K.O." will become inactive. The scanner will travel to the previously "learned" position of the object to check for its presence.

- If the tool is in its "correct" position, the "O.K." relay will be activated. Angle tolerance for a good signal (O.K.) is ±10° in relation to the learned position of this tool.
- If the tool is not detected, i.e. either it is missing or there is an obstacle within the scanner rotating area, the "K.O." relay will be activated.

In addition, the LEDs on the control unit will indicate the result.

3.3. Monitoring by Setting a Scanning Range

Requirement: rotary switch W2 ≠ 0

Rotary switch W1 and W2 settings will define the scanning range.

In this mode of operation, BK MIKRO 4 is suitable for **monitoring tools** with differing diameters as well as for **ejection monitoring** (free space monitoring).

Two rotary switches are used to define a scanning range which is to be monitored before each working cycle.

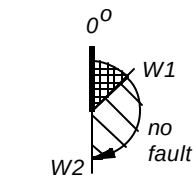
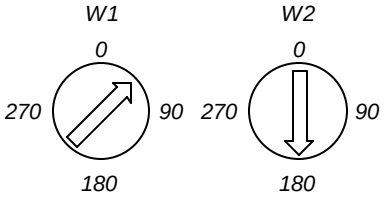
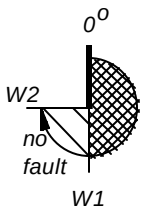
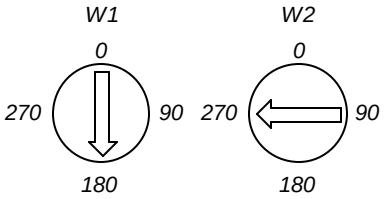
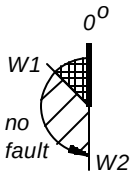
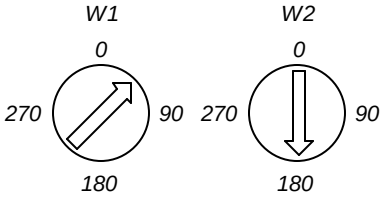
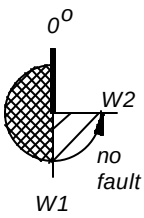
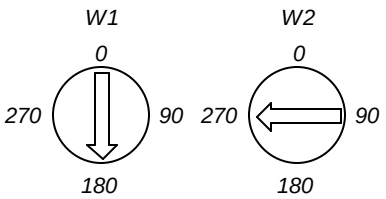
3.3.1. Setting Range

The desired scanning range must be defined using rotary switches W1 and W2. W1 marks where the range starts, W2 where it ends.

Each rotary switch can be adjusted in 12 steps where each step represents an angle of 22.5° respectively. The direction of rotation is set by the toggle switch.

Illegal settings will be indicated to users by both LEDs flashing. The two relays, however, will remain in their rest positions.

Examples for Range Settings

		Rotating Range	*Toggle Switch*	*Rotary Switch*
Direction of Rotation:	*clockwise*			
No fault range starts:	*45°*			
No fault range ends:	*180°*			
No fault range:	*135°*			
Direction of Rotation:	*clockwise*			
No fault range starts:	*180°*			
No fault range ends:	*270°*			
No fault range:	*90°*			
Direction of Rotation:	*CCW*			
No fault range starts:	*45°*			
No fault range ends:	*180°*			
No fault range:	*135°*			
Direction of Rotation:	*CCW*			
No fault range starts:	*180°*			
No fault range ends:	*270°*			
No fault range:	*90°*			

3.3.2. Control Operation "Object Monitoring"

During scanning, both relay outputs will be inactive (LEDs "O.K." and "K.O." not illuminated).

The control unit will change into an "O.K." state, i.e. it will issue a good message, if during a scanning cycle the operation sequence described below is followed:

- The scanner leaves its stop position.
- The angle preset via rotary switch W1 has been exceeded.
- The angle preset via rotary switch W2 has not been reached.

3.3.3. Control Operation "Free Space Monitoring"

The control operation "Free Space Monitoring" differs from the object monitoring mode in that within its monitoring range no object must be detected. Its "O.K." state is characterized by:

- The scanner leaves its rest position.
- The angle preset via rotary switch W2 has been exceeded.

During “Free Space Monitoring” it is typical to set the fourth toggle switch to the “No Deceleration” position. This setting will enable the unit to scan at a higher speed, and, since the unit will rarely contact a part, not reduce the life expectancy of the unit.

Caution:

When performing Free Space Monitoring, a broken wand will always trigger an "O.K." signal.

3.4. Scanning Times

Depending on the length of the path to be traveled, different scanning times will result. Several test series produced the following typical results:

	at Teach-In		at Switch Setting	
Angle	Measuring Time	Scanning Time	Measuring Time	Scanning Time
15°	125 ms	250 ms	125 ms	250 ms
270°	425 ms	850 ms	850 ms	1400 ms

As this shows: Scanning time ≈ double measuring time (advance and return travel).

3.5. Deflection of Wand

Rotation angles will be detected by scanner encoder pulses. These pulses are derived from the rotation of the motor. For scanning, a metal needle (wand) is used which, depending on the scanning force, can be deflected. As the scanner motor is still turning when the end of this wand has already come to a stop, differences between the set and actual rotation ranges will result.

For all speeds, wand deflection is compensated to a range of less than 10°. Deflection will depend, however, on wand length.

3.6. Status Indication

3.6.1. Yellow LED

Fast Flashing = Self-Test

After power-up, the system will carry out a self-test indicated by fast flashing of this yellow LED.

Steady Illumination = Ready to Operate

Following its self-test, the system is ready to operate. The LED stops flashing and remains steady.

Slow Flashing = Motor Fault / Cable Break

The system has detected a motor fault or cable break. Outputs will be switched inactive, the unit will remain in its present state, indicated by slow flashing of this yellow LED.

3.6.2. Red/Green LED

Steady Illumination = Indication following Scanning Cycle

The red LED indicates a fault message.

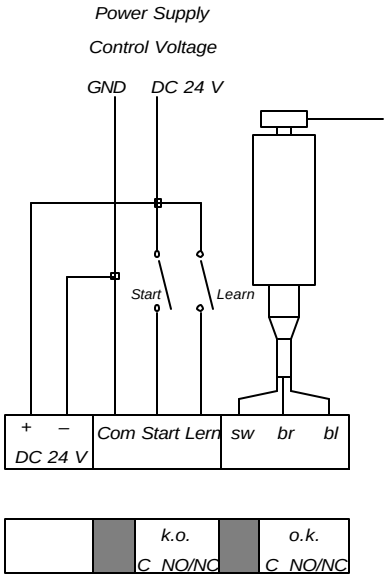
The green LED indicates a no fault message.

Flashing = Illegal Settings

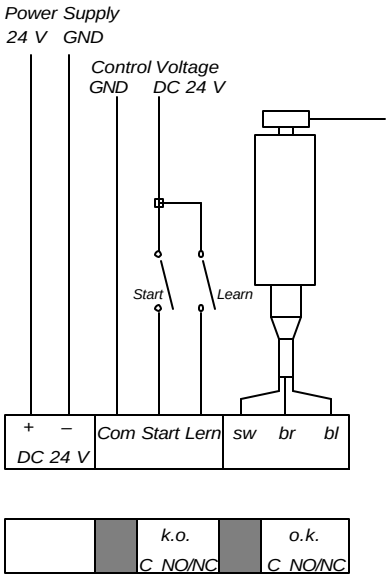
A flashing red and greed LED simultaneously indicates that one or both of the rotary switches is incorrectly set, and/or that the “Freespace” monitoring mode has been selected without setting the rotary switches.

4. Installation Notes

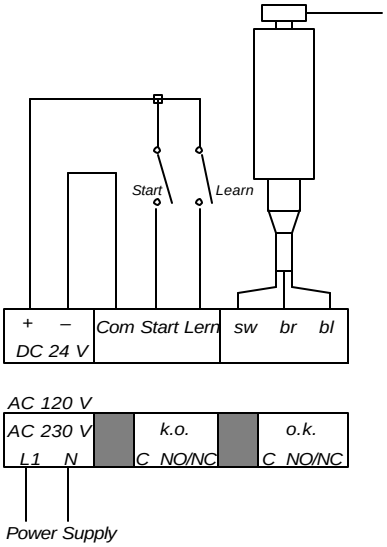
4.1. Control Voltage Connection



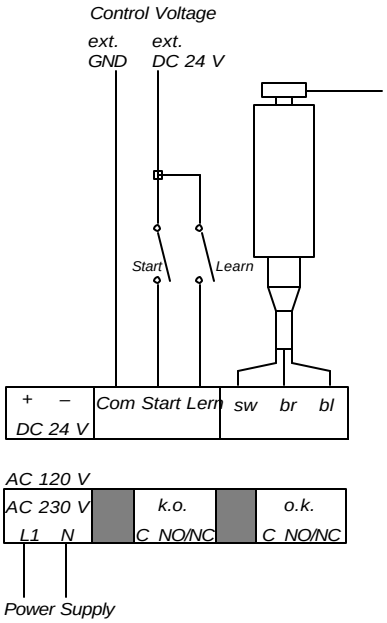
BK MIKRO 4
DC 24 V
common power and control voltage supply



BK MIKRO 4
DC 24 V
separate control voltage



BK MIKRO 4
AC 230 V (AC 120 V)
internal control voltage



BK MIKRO 4
AC 230 V (AC 120 V)
external control voltage

Note:
Any connections to the "Lern" terminal in the mode where ranges are switch-selected will be ignored.

4.2. Interference Prevention

All inputs are opto-decoupled and thus maximally protected against interference voltage peaks, as caused, for example, by inductive sources.

Relay outputs are protected by varistors against inductive interference voltage peaks. Depending on the type of load used, further interference suppression measures may be necessary.

To ensure optimum operational safety, suppression measures, if required, must be taken at the source, i.e. directly where interference is caused.

Possible additional noise filters:

- RC combination (included in the contactor suppliers' product ranges)
- Varistors
- Diodes

Appendix A

Model 4 Manufacturing and Techna-Tool Part Numbers

COMPLETE SYSTEMS:

BK4 110 Volt AC System: **BK4110S**
(Includes BK4SC, BK4110, BK4C5 and BKMB)

BK4 24 Volt DC System **BK424S**
(Includes BK4SC, BK424, BK4C5 and BKMB)

COMPONENTS:

	Model#	Description
Scanner:	BK4SC	Scanner (TK4K.xx)
Controller:		
	BK4110	110 Volt AC (8.0402.xx, 6304200)
	Note:	*BK4110 works with 110 or 24V*
	BK424	24 Volt DC
Cables:		
	BK4C5	5 m length; plug connector at scanner, free wire at controller
Bracket:	BKMB	Mounting Bracket, 50mm.sq. (2" sq.)

ACCESSORIES:

Cables:		
(Plug connector at scanner, free wire at controller)	BK4C10	10 meter length
	BK4C10R	10 meter length w/ right angle con.
	BK4C20	20 meter length
	BK4C20R	20 meter length w/ right angle con.
Extension Cables:	BK4EC01R	1 m length right angle extension cable.