

# TRIODRIVE A SERVO DRIVE SYSTEMS

Analog AC servo drive systems with sinusoidal commutation  
Servo drives in compact design, 230 V AC mains connection  
Servo motors with high power density up to 5.0 Nm / 1.1 kW



Components of the TrioDrive A servo drive family: BN 6651 servo drive (2 A), MR 4104 and MR 4045 motors

## Products, Consultation, and Service

ESR drive packages consist of servo drives, servo motors, position sensors, gear boxes, and brakes. They are supplemented by power supply units (if not already installed in the drive), connectors and cables (ready-assembled on request). All parts of the packages are matching and have been tested as combinations. This delivery from a single source guarantees trouble-free commissioning, reliable operation, and a definite system responsibility on the part of only one supplier.

Our services include an individual drive system configuration. With many years of experience, we will be pleased to assist you at choosing the appropriate servo drive system for your application.

## Applications

Positioning and feed movements with high dynamics and accuracy in

- Handling and assembly systems
- Optical discs production machinery (CDs, DVDs, ...)
- Electronics production machinery
- Semiconductor production machinery
- Measuring and testing machinery
- Machine tools and metal working machinery
- Packaging machinery
- Textile machinery
- Plastics processing machinery
- Coiling machinery
- and many other applications

## Main Characteristics

### Three power classes

Servo drive		Servo motor	
$I_N$	$U_{Zk}$	$M_N$	$P_N$
2 A	320 V	up to 1.0 Nm	up to 0.5 kW
4 A	320 V	up to 2.6 Nm	up to 0.7 kW
6 A	320 V	up to 5.0 Nm	up to 1.1 kW

### Characteristics of the drive packages

- High-quality drive packages consisting of drive, motor, and accessories
- High dynamics due to motors with low weight-to-power ratio and controllers with highest dynamics
- Smooth running even at low speed because of sinusoidal commutation
- CE identification, layout in compliance with the requirements of the low voltage directive (test according to EN 50178) and the EMC directive (test according to EN 61800-3)
- High safety: position sensor signals monitoring
- Operation monitoring by fault signal in case of motor blocking

### Options

- Encoder emulation with 16 selectable pulse numbers: 50 to 1024 pulses per revolution
- Holding control loop can make a brake superfluous: full torque at standstill without drift
- Options for drive and motor for easy adaption to different applications

### Characteristics of the servo drives

- Compact device for control cabinet installation
- Easy wiring, all connections can be plugged in at the front
- High performance with compact dimensions thanks to use of surface mounting devices (SMD) and state-of-the-art power transistors (IGBT)
- Easy commissioning due to adjustable feedback, speed, offset. Current limit selectable with 16-position rotary switch.
- No re-adjustment necessary when the drive is replaced thanks to plug-in customer module with all setting components

- Simple adjustment to special applications with additional plug-in modules
- Rapid acceleration, deceleration and reversing of the servo motor by momentary current increase to double the rated current
- No noise with switching frequency well above audible range or low power dissipation with reduced switching frequency (selectable)
- 24 V control supply voltage fed externally to retain position information in an emergency stop
- Safe operation due to monitoring and protection circuit with fault memory for short-circuit, earth leakage, drive or motor overheating, motor blocking, encoder fault, and voltage fault
- Drive and motor protected by adjustable current limit
- Drive protected by rapid discharge of the DC-bus voltage in case of mains switch off, frequent switching off and on possible (function can be deactivated)
- Safety with position sensor fault and open circuit monitoring
- Easy error diagnosis with LEDs for fault, ready and overload
- Load and speed monitoring with current and speed monitor outputs
- Also available adapted to motors of other manufacturers

### Characteristics of the MR 74 and MR 4 servo motors

- Maintenance-free, since brushless
- High dynamics
- Wide speed range
- IP 65 protection
- Insulation according to insulation class F, DIN VDE 0530, withstanding tropical conditions
- High power density due to rotor with rare earth permanent magnets
- Ball bearings with grease filling for 20,000 operating hours
- Integrated resolver for sinusoidal commutation
- Thermal protection by integrated PTC resistor
- Connection of motor and position sensor via connectors
- Self-cooling
- Design with flange according to DIN 42 677, any mounting position
- Form according to DIN IEC 34 part 7, IM B 5, IM B 35

- Bearing plates and housings made of high-quality light-metal alloy
- Rotor dynamically balanced according to vibration severity grade R, S on request
- Standard shaft end without groove, special version possible, e. g. with keyway
- Special motors, e. g. motors with brakes, hollow-shaft design available

### Characteristics of the gear boxes

- Helical gears in standard design 1 : 6 to 1 : 129
- Planetary gears, one-, two or three-stage, low backlash on request, gear ratio 1 : 3 to 1 : 175
- Output torque up to 2400 Nm
- Special gears, e. g. worm gears or bevel gears, gears with hollow shafts

## Design of the Servo Drives

### Enclosure and installation

TrioDrive A servo drives are compact devices for installation in control cabinets. Connections are made from the front panel. To avoid radiated emission, the enclosure is made of zinc-plated sheet steel. Since there is no varnish, all metal parts have best electrical contact to each other.

### Power supply unit

The power supply unit is integrated. The power component is fed directly from the 230 V AC mains. For the control unit, a control supply voltage of 24 V has to be supplied. The power supply unit contains a RFI-filter and a shunt regulator whose shunt resistor absorbs the energy fed back when the motor is braked. An externally mounted shunt resistor can be connected, as well.

### Interfaces of the servo drives

All connections can be plugged in at the front of the servo drives. This allows a specially easy, clear, and low cost wiring. The trim potentiometers and the LEDs are also located at the front panel.

The following connectors are located at the front panel:

- motor, mains (230 V AC), and shunt (Combicon connector, 10-pin)

- control supply voltage (24 V DC), "Ready" relay output (Combicon connector, 4-pin)
- control signals (SUB-D female connector, 15-pin)
- position sensor (resolver) (SUB-D female connector, 9-pin)
- encoder signals (encoder emulation, optional) (SUB-D male connector, 9-pin)

Easy controller adjustment with 4 trim potentiometers at the front panel:

- feedback
- speed
- offset
- hold (option)

The operating mode of the servo drive is indicated by lighting up or blinking of 4 LEDs:

- ready
- overload
- fault
- shunt

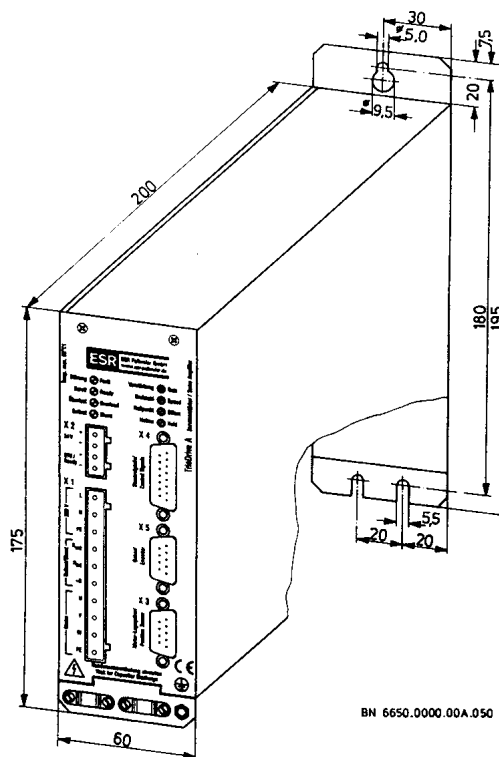


Fig. 1: Mounting dimensions (mm)

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## Functions of the Servo Drives

### Control

TrioDrive A servo drives work with two control loops: the current control loop and the higher-level speed control loop. Since both control loops are realized in analog technology, the controller bandwidth is very high. The TrioDrive A servo drive operates as current controller or as speed controller (with underlying current control loop) depending on the setting on the customer module (see below).

The servo drives are designed for three-phase AC servo motors (permanent magnets in the rotor) with resolvers. The sinusoidal commutation provides smooth motor running even at low speeds and high dynamics.

### Customer module

The set-up elements and the components for the application-specific controller settings are located on the plug-in customer module. In case of a replacement of a drive, the customer module can be removed and installed into the new device. This preserves the controller settings and nothing but the offset has to be readjusted.

### Monitoring and protective circuits

Standard monitoring and protection circuits protect drive and motor even against damages, even in extreme situations, and provide for a drive switch-off in case of a fault. The following is monitored:

- motor output for short circuit and earth fault
- drive overheating
- motor overheating
- position sensor signals for open circuit and short circuit of one or more resolver leads
- motor blocking for more than approx. 5 seconds
- faulty voltages

If one of these faults occurs, the drive is stopped immediately. The fault is stored, displayed, and signaled (via the "Fault" output and by opening the "Ready" relay output). Missing or low operating voltage also leads to a fault. This fault is not stored, the drive will continue operation as soon as the operating voltage has reached a sufficient level.

In case of mains switch off a rapid discharge circuit neutralizes the DC-bus voltage within less than 0.5 s (this function can be deactivated). Due to that, the drive is no longer able to make dangerous active motions.

Speed and current can be traced and monitored using two analog outputs speed monitor and current monitor.

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## Adaptation Using Modules

Using plug-in modules, the TrioDrive A servo drives can be adapted to different applications. In addition to the customer module described in the previous section which is always installed, the following modules are available as options:

- add-on module
- encoder module
- function module

See the servo drive type code on page 8 for an overview of the available modules.

The following sections describe the modules in detail.

### Add-on modules Z1, Z2, Z4

The standard version of the TrioDrive A servo drive (Z0) is not equipped with an add-on module as it is not required for operation. Additional circuits for extra features, e. g.

- two direction-dependent limit switches acting like brakes
- setpoint ramp
- stall monitoring by "Motor standstill" output
- input for current limiting
- input for speed direction reversal

are integrated on a pluggable add-on module (Z1, Z2, Z4 option), see the servo drive type code on page 8 for further details.

### Encoder modules G1 .. G4

The encoder module can be added for generating encoder signals. It digitally analyzes the resolver signals and outputs encoder signals corresponding to the pulses of an incremental encoder (two pulses shifted by 90° and index pulse). Thus, an incremental encoder is not required on the motor. One of the following 16 pulse numbers (incremental encoder pulses per revolution) can be selected using a coding switch:

- 128, 256, 512, 1024,
- 50, 100, 200, 250, 500, 1000,
- 60, 90, 180, 360, 720, 900

Other pulse numbers are also available on request.

The pulses are generated by 5 volts line drivers (RS 422 compatible; G1 and G3 options). A version with 24 volts pulse output is also available (G2 and G4 options). Additionally, with the G3 and G4 options the index pulse can be shifted in 256 steps within one motor revolution.

Since the control circuit of the TrioDrive A servo drive is fed by an external 24 V power supply the position information is saved even when the mains voltage is switched off.

The pulse output can be used for connecting positioning controls as well as digital tachometers for monitoring the motor speed.

### Function modules

Various functions, including customer-specific functions, can be implemented on the function module. The standard function modules "Holding function" and "Field weakening mode" are described in the following.

#### Function module F1 "Holding function"

With the "Holding function" module, the motor can be stopped without drift at full stall torque. When the "Hold" input is switched on, a holding control loop holds the motor digitally in the position it was in at the time of the hold command. The resolution of the holding control loop is 4096 increments per revolution. If the hold command is given while the motor is still turning, the motor will be returned to the position it was in at the time of the command within one revolution. This permits easy positioning solutions. In many cases the holding control loop can render a holding brake unnecessary, which is often used to hold the motor. A brake is only necessary where safety aspects require its use.

#### Function module F2 "Field weakening mode"

With the "Field weakening mode" module the attainable speed of the motor can be increased by some 10% beyond the rated speed at reduced torque. The increase of the speed is achieved by a phase shift of the motor current at higher speed.

## Overview of Functions and Characteristics

### Control

Speed control or current control (selectable on the customer module), sinusoidal commutation (resolver as motor position sensor)

- additional with Z1 option: adjustable ramps 7 ms .. 70 ms per volt setpoint step
- additional F1 option: holding control loop (stop with stall torque without drift)
- additional F2 option: field weakening mode for speed control

### Current limiting

$I^2t$  circuit, peak current approx. double the continuous current. Current limit adjustable in 16 steps with rotary switch

- additional Z2 option: current limit adjustable via analog input

### Monitoring and protection

Safe operation thanks to monitoring and protection circuit with fault memory for short-circuit, earth leakage, drive or motor overheating, motor blocking, encoder fault, and voltage fault; rapid discharge of the DC-bus voltage (can be deactivated)

### Analog inputs

Setpoint  $\pm 10$  V (speed or current) via differential amplifier

- additional Z2 option: current limit 0 .. +10 V

### Analog outputs

Speed monitor  $\pm 7$  V for maximum speed, current monitor  $\pm 10$  V for maximum peak current

### Switching inputs

All inputs PLC compatible, switching to +24 V: Controller enable (with Z1, Z2 options: braking), Reset fault;

- additional Z1 option: 2 limit switches (direction-dependent, acting like brakes)
- additional Z2 option: Reverse direction of rotation
- additional F1 option: Hold (stop with stall torque without drift)

### Switching outputs

Ready (potential-free relay output), all other outputs PLC compatible, switching to +24 V: Fault signal, Overload

- additional Z1, Z2 options: Motor standstill or Power circuit ready

### Encoder emulation with 16 selectable pulse numbers

- G1 option: 5 V push-pull, electrically isolated, fixed index pulse (RS 422)
- G2 option: 24 V signals, fixed index pulse
- G3 option: 5 V push-pull, electrically isolated, adjustable index pulse (RS 422)
- G4 option: 24 V signals, adjustable index pulse

### Accessories

- Motor and resolver/encoder connection cables  
Shielded connection cables for connection of the motor and resolver, also ready-assembled cable sets on request
- Connector sets  
consisting of the matching SUB-D male or female connectors with screwable metallized housings and the Combicon female connectors
- Motor chokes  
for motor cable lengths of more than 15 m

The table on page 7 gives an overview of the accessories.

### Drive packages, major technical specifications, and order numbers

Motor frame size DIN/IEC	Motor order number	Speed (r.p.m.)	Rated torque (Nm)	Stall torque (Nm)	Peak torque (Nm)	Shaft power (kW)	Drive order number
55	MR 4030-U3-N060	6,000	0.3	0.4	1.9	0.2	BN 6651
	MR 4045-U3-N060	6,000	0.5	0.6	2.3	0.3	BN 6651
	MR 4060-U3-N060	6,000	0.7	0.8	2.8	0.4	BN 6651
70	MR 7422-U3-N034	3,400	1.5	1.7	8.0	0.53	BN 6652
	MR 7422-U3-N060	6,000	1.5	1.7	8.0	0.95	BN 6653
	MR 7424-U3-N034	3,400	2.4	2.7	12.7	0.85	BN 6653
	MR 7432-U3-N034	3,400	2.4	2.5	8.8	0.85	BN 6652
	MR 7434-U3-N034	3,400	4.4	4.6	16.0	1.6	BN 6653

In addition to the motors listed above, there are a number of further motors available (see data sheets 6674.260 "MR 74 AC Servo Motors" and 6660.260 "MR 4 AC Servo Motors"). The rated torque refers to the rated speed given above. Higher torque is reached at a lower speed. We would be ready to assist you in choosing the most favorable combination for your particular application. We will be pleased to calculate and configure a drive system for you.

**Servo drives, major technical specifications**

Servo drive order number	BN 6651	BN 6652	BN 6653 *
Rated mains connection voltage	230 V AC $\pm 10\%$ , 50 .. 60 Hz		
Rated DC-bus voltage	320 V DC		
Permissible mains connection voltage	85 .. 253 V AC (with correspondingly reduced/increased DC-bus voltage)		
Maximum permanent current (rms value)	2 A	4 A	6 A
Maximum peak current (crest value)	5.5 A	11 A	17 A
Setting range current limitation	0.5 .. 2 A	1 .. 4 A	1.5 .. 6 A
Integration time of the I <sup>2</sup> t circuit at max. peak current	approx. 3 s		
Maximum continuous braking power	40 W		
Pulse braking power	2.1 kW at 1.5% switch-on duration, 1 s		
Setpoint value	$\pm 10$ V at 20 k $\Omega$		
Operating range of speed trimmer	1 : 7		
Switching frequency / current ripple	8 or 16 kHz / 16 or 32 kHz (selectable)		
Auxiliary voltage outputs	+15 V and -15 V ( $\pm 10\%$ ), max. 10 mA each		
External control circuit supply	24 V DC $\pm 25\%$ , 0.5 A		
Climatic category (DIN EN 50178) operation / storage / transport	3K3 / 1K4 / 2K3		
Permissible ambient temperature	40 °C		
Width	60 mm		
Height (without mounting straps)	175 mm		
Height (with mounting straps)	195 mm		
Depth (without connectors)	200 mm		
Weight	2.0 kg		

\* 16 kHz operation of the BN 6653 drive (6 A device) is permissible without restriction at a loading of 70% only. At higher loading, select 8 kHz switching frequency or provide additional cooling.

**Accessories**

Description	Order number
Motor connection cable, ready-assembled on request	see data sheet 8817.201
Resolver/encoder connection cable, ready-assembled on request	see data sheet 8817.201
Motor choke with terminals and enclosure, for cable length 15 to 25 m	BN 3845.2258
Motor choke with terminals and enclosure, for cable length 25 to 40 m	BN 3857.2311
Connector set for TrioDrive A servo drive without encoder module option	ST 6650
Connector set for TrioDrive A servo drive with encoder module option	ST 6651

## TrioDrive A servo drive type code

Example ⇒ **BN 6651-1234-K2-Z1-G0-F0-S0**



<b>51</b>	<b>Mains connection and DC-bus voltage</b> 5x mains connection 230 V 1-phase, corresponds to 320 V DC-bus voltage	<b>Continuous output current</b> 51 output current 2 A <sub>rms</sub> 52 output current 4 A <sub>rms</sub> 53 output current 6 A <sub>rms</sub>
<b>1234</b>	<b>Assembly code (Bauvorschrift, BV)</b> Assembly code (BV): Company-internal coding is given for various feature combinations. The BV specification need not be given if all other features are given and the customer-specific fittings are described. "BN 6651-K2-Z1" would be sufficient for the above example.	
<b>K2</b>	<b>Controller switching (customer module)</b> K0 none (device not ready for operation) <i>for servo motors MR 2:</i> K1 speed control up to 3,500 r.p.m. K2 speed control up to 7,000 r.p.m. K3 current control <i>for servo motors MR 4, MR 6, MR 74, MR 771x..772x:</i> K4 speed control up to 3,500 r.p.m. K5 speed control up to 7,000 r.p.m. KA speed control up to 10,500 r.p.m. KB speed control up to 14,000 r.p.m. K6 current control <i>for servo motors MR 773x:</i> K7 speed control up to 3,500 r.p.m. K8 speed control up to 7,000 r.p.m. K9 current control	<i>for servo motors MR 774x..777x:</i> KC speed control up to 3,500 r.p.m. KD speed control up to 7,000 r.p.m. KE current control <i>for servo motors MR 72:</i> KF speed control up to 3,500 r.p.m. KG speed control up to 7,000 r.p.m. KH current control <i>for other servo motors</i> KK customer-specific  <i>K... other controller switching on request</i>
<b>Z1</b>	<b>Additional equipment through add-on modules</b> Z0 none (standard) Z1 limit switch, ramp, controller inhibit braking Z2 external current limiting, rotation reversal	Z4 limit switch, P+I/I-lim., controller inhibit braking ZK customer-specific
<b>G0</b>	<b>Additional equipment through encoder modules</b> (incremental encoder emulation) G0 no pulse outputs (standard) G1 pulse outputs, 5 V push-pull signals RS 422 G2 pulse outputs, 24 V push-pull signals	G3 pulse outputs, with index pulse shift, 5 V push-pull signals RS 422 G4 pulse outputs, with index pulse shift, 24 V GK customer-specific
<b>F0</b>	<b>Additional equipment through function modules</b> F0 none (standard) F1 holding control loop	F2 field weakening operation
<b>S0</b>	<b>Special equipment (customization)</b> S0 none (standard) S9 compatible to Promicon	SK customer-specific, explained by text

The statements in this data sheet are for information, only. They do not guarantee properties. We reserve the right to make changes without notice.

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