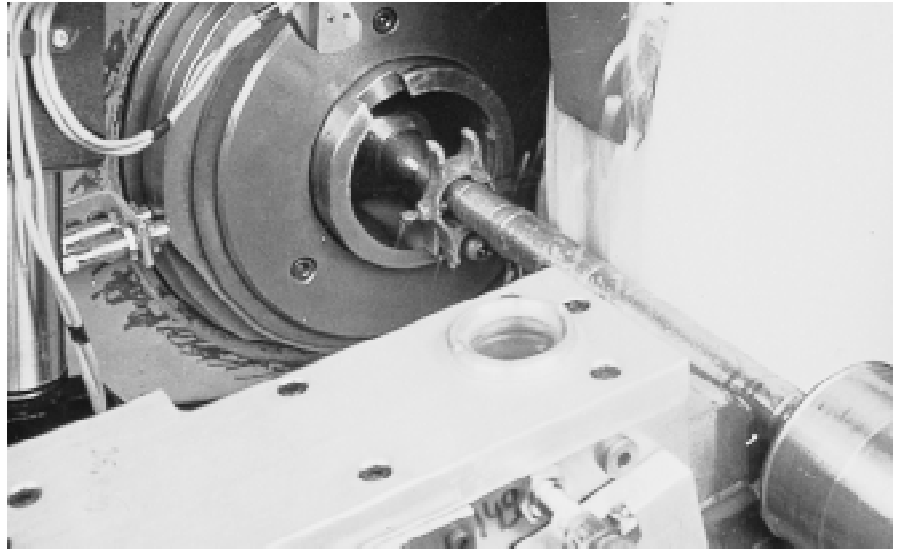
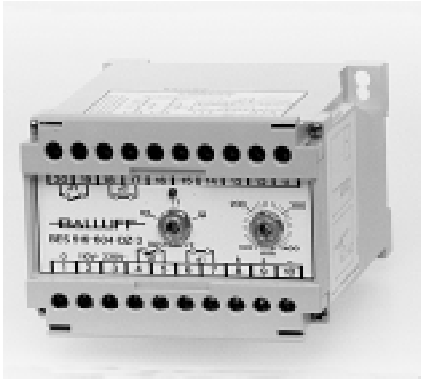


Motion Controller BES-516-604, Typical Applications

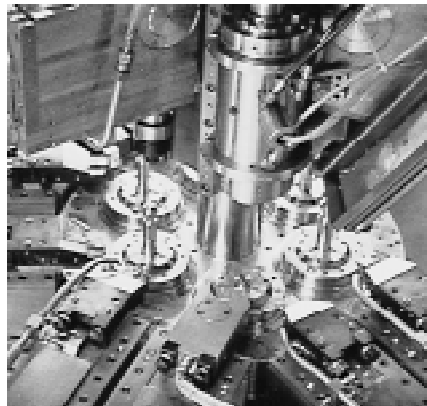
Balluff Zero Speed Controller on a Grinding Machine



Rotary Positioning

The Zero-Speed Controller monitors the rotation of the grinding wheel, and shuts the machine down immediately in case the drive shaft breaks.

Balluff Motion Controller on an Automatic Lathe



Automatic lathes demand a high degree of precision due to their complex and rapid switching sequences.

It is especially important to monitor the speed range of the drive spindle for desired vs. actual rpm, and to store the maximum permitted rotational speed in memory as an error.

Solving such problems is what the BALLUFF family of motion control devices is designed to do, whether the application is generic or customer-specific.

Motion Controller BES-516-604

Design

The motion control housing is made of thermoplastic, and can be mounted with screws or on a DIN rail. The unit provides 24 V DC ($\pm 20\%$ at max. 20 mA load) supply voltage for the inductive proximity sensor.

Function

The pulse sequence from the inductive proximity sensor is compared with a preset nominal value, based on the pulse repetition period. This approach eliminates time delays which could occur if mean value calculations were used. As soon as the nominal pulse number is exceeded, relay d1 is energized and the corresponding LED comes on.

If the actual count falls below the nominal pulse number by a factor greater than the preset hysteresis, relay d1 is blocked (opens), and the LED goes out.

Relay d1 also opens if power is lost or the proximity sensor cable is broken.

Applications

When used in conjunction with an inductive proximity sensor (such as BALLUFF type BES-516-3..), the motion control device digitally monitors the agreement between the actual value and the nominal, preset pulse number.

The device has universal application wherever pulse counts can be made. These applications include machine stop control, monitoring of stroke speeds, conveyor belts, and shaft break monitoring.

If the motion control device is used to monitor safety functions on a machine, the application must conform to the appropriate industrial safety standards.

Using Other Input Devices

Other input devices, such as optoelectronic sensors or magnetic field sensors, may be used as long as the minimum pulse duration is >1 ms. If the sensor has its own external power supply, care must be taken to ensure that the minus potential of the sensor is connected to terminal 10 (minus) and the pulse signals to terminal 8 (A). Terminal 9 (plus) is then not connected.

Start-up Bridge

In order to bridge the difference between the actual and nominal pulse number in the start-up phase of the machine, we also offer units with a start-up bridge.

The start-up bridge can be factory set (per customer requirement) or externally set (using potentiometer P 2) from 0.1 to 2 seconds.

Other ranges up to max. 30 s are also available.

Initiating the start-up bridge must be done with a potential-free external contact.

If the start contact is closed, a separate relay (d 2) is energized and opens again after the preset time has elapsed.

The bridge relay can be checked for function using an external circuit.

Motion Controller BES-516-604

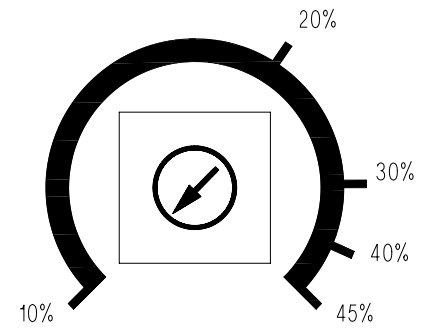
Hysteresis

Hysteresis is defined as the percentage value of the pulse number which must not be exceeded after the nominal pulse number is reached, so that the device can be turned off again.

In this way, any application-induced pulse number variations which occur during running can be picked up. After the nominal pulse number is reached, the actual pulse number must be undershot by the amount of the preset hysteresis before the device can be turned off.

The hysteresis range can be internally set with a trim pot, from 10% to 45%. The usual factory set range is 20% ($\pm 10\%$).

In order to change the hysteresis value, the device must be opened; this makes unauthorized access more difficult.



Installation Hints

Proximity sensor cables should not be routed together with cables from other sources.

If there is a possibility of external noise interference (e.g. high voltage peaks), the minus lead (terminal 10 on the device) should be grounded to the machine.

Under extreme conditions, shielding may be required.

Note:

For machine stop monitoring application, relay d 1 is de-energized (opens) when the nominal pulse number is exceeded and the corresponding LED goes out.

If the actual pulse count falls short of the nominal count by more than the preset hysteresis, relay d 1 is energized again (closes) and the LED comes on.

Function Check When Setting Up

When setting up the motion control device (models CO and CZ as well as DO and DZ), please note the following:

1. Jumper the contact of output relay d 1 (terminals 4/5 or 6/7 if d 1 has positive-opening contact, or 5/6 or 6/7 if d 1 has a changeover contact).
2. Start the machine and run in the desired speed range.
3. Using the scale on potentiometer P 1, adjust the preset nominal pulse number by turning the potentiometer clockwise until the LED goes out. Then turn the potentiometer counter-clockwise until the LED comes on again. To ensure a margin of safety in the case of possible pulse number variations, the potentiometer should be turned slightly further in the counter-clockwise direction by an amount which compensates for individual machine characteristics.
4. Remove jumpers from 4/5 - 6/7 or 5/6 - 6/7.

Now the device is precisely set for the desired pulse number. By bridging the contacts (point 1 above), the function of the device with respect to the machine control is deactivated or bridged.

Motion Controller BES-516-604

Technical Data

Housing

Gray Thermoplastic
Enclosure rating IP 50

Connections

20 screw terminal for 2 x AWG 12
connectors
Enclosure rating IP 10

Housing Mount

1. Snap mount for standard 35 mm DIN rail, or
2. 2 screws M 4 or M 5

Supply Voltage

110/220 V AC $\pm 15\%$ 50-60 Hz
42 V AC $\pm 15\%$ 50-60 Hz
24 V DC $\pm 20\% - 10\%$

Output d 1 (motion control)

1 relay with 1 changeover contact
Contact load 250 V AC/8 A
(2000 V A) or
1 relay with positive opening contacts
1 NO and 1 NC contact load 220 V
AC/5 A
(max. 500 V A)

Output d 2 (start-up bridge)

1 relay with 1 changeover contact
Contact load 250 V AC/8 A (2000 V A)
or
1 relay with positive opening contacts
1 NO and 1 NC Contact load 220 V
AC/5 A
(max. 500 V A)

Positive Opening Contacts

In a positive opening contact group, all contacts are in the operating or on state after a turn-on sequence, and not operating or off state when de-energized. If one or more of the contacts has a fault, all contacts will assume the same condition as the faulty contact, even if another condition existed before the fault.

Response time

$$t = \frac{60}{f \text{ minus preset hysteresis}}$$

Calculating Machine RPM

$$n = \frac{i}{z}$$

n = machine speed in rpm
 i = preset pulse number/min.
(nominal pulse number)
 z = number of teeth or pulse
number per revolution

Calculating Nominal Pulse Number

$$i = n \times z$$

The min. pulse duration which the device can accept is 1 ms with a pulse duty factor of 1:2

Operating Temperature

0°C to +60°C (+32°F to +140°F)

Hysteresis

Adjustable between 10% and 45%, based on preset nominal value of pulse count ($\pm 10\%$ tolerance).

Tolerance

The tolerance of the factory set pulse count for models, AO, AZ, BO, BZ, GO, and GZ is $\pm 10\%$.

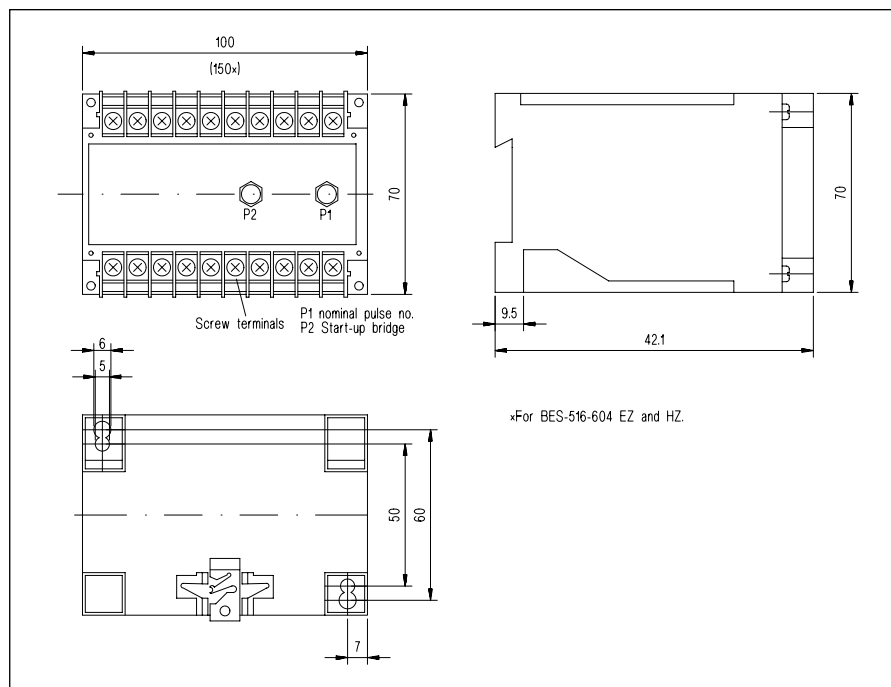
LED

The LED comes on when relay d 1 is energized (nominal pulse number is exceeded), and goes out when relay d 1 is de-energized.

Input Devices

Inductive proximity sensors, preferably PNP logic (e.g. BALLUFF BES-516-3..) with max. 20 mA current draw.

Housing Dimensions



Motion Controller BES-516-604

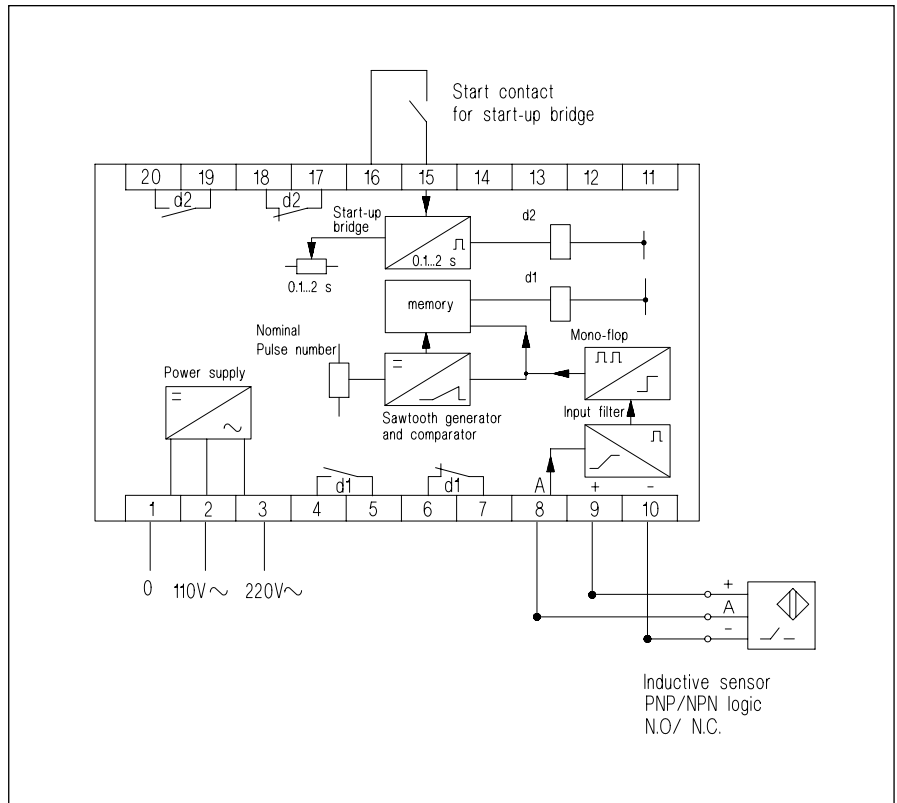
Function Diagram of Motion of Controller

The power supply converts the external supply voltage from 220/110 V AC to 24 V DC. This secondary voltage is rectified and stabilized.

The pulses sent by the inductive proximity sensor pass through an input filter into a mono-flop stage.

The nominal pulse number is given as a DC voltage to a sawtooth generator and comparator circuit, which compares the nominal value with the actual value (input pulses). The result is stored in the memory which switches relay d 1.

The start-up bridge is an adjustable time delay from 0.1 to 2 sec., which switches relay d 2 for the preset time.



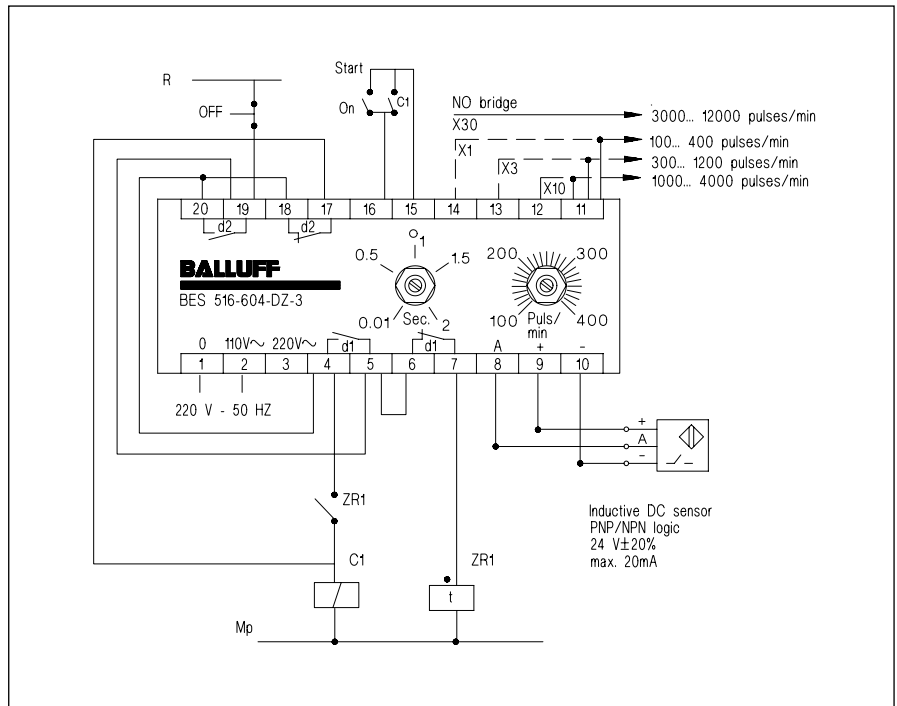
Rotary Positioning

Typical Circuit for BES-604 with Start-Up Bridge Monitored on Machine Control Side and Open-Delayed Time Relay

After pressing the “On” switch, relay d2 of the start-up bridge is energized, contact ZR 1 is closed, and drive protection c 1 is activated.

If the nominal pulse number is reached, relay d 1 pulls up. Relay d 2 is blocked.

Time relay ZR 1 goes to no current, and contact ZR 1 opens after a delay. Drive protection c 1 remains activated by contacts d 1 (NO) and d 2 (NC).



Motion Controller BES-516-604-HZ, Signal Timing Diagram

Start Phase

The start pulse (jumper terminal 15 to terminal 16) energizes relay d 2 after time t_1 during the preset start-up delay. The shaft begins to rotate. At the same time, the rotation pulses commence and the internal measuring cycle begins to run. The length of this cycle depends directly on the preset nominal pulse number (small pulse number = long measuring time).

Run

As soon as the period length T of the rotation pulses reaches the length of the measuring time, if the nominal pulse number is reached the relay d 1 pulls up. The start-up bridge has accomplished its purpose. If properly set, the start-up relay d 2 opens (de-energizes) right after d 1 pulls up (this time is machine-specific).

Stop Phase

The "Off" command from the controller starts to brake the drive. The number of pulses decreases and their period length T increases. As soon as this length reaches the length of the internal measuring time plus the preset hysteresis, the motion relay is de-energized (opens).

Signal Timing Diagram

$t_1 = \text{ca. } 25 \text{ ms}$

Consists of an internal constant time and the pull-up delay of d 2 (ca. 10 ms - 15 ms).

$t_2 = 10 \text{ ms}$

This represents the time until relay d 1 pulls up after the nominal pulse number has been reached (plus pull-up delay of d 1 = ca. 10 ms).

$t_3 = 5 \text{ ms}$

The time until relay d 1 releases if the nominal pulse number plus hysteresis is not reached. Includes the release time of d 1 ($\leq 5 \text{ ms}$).

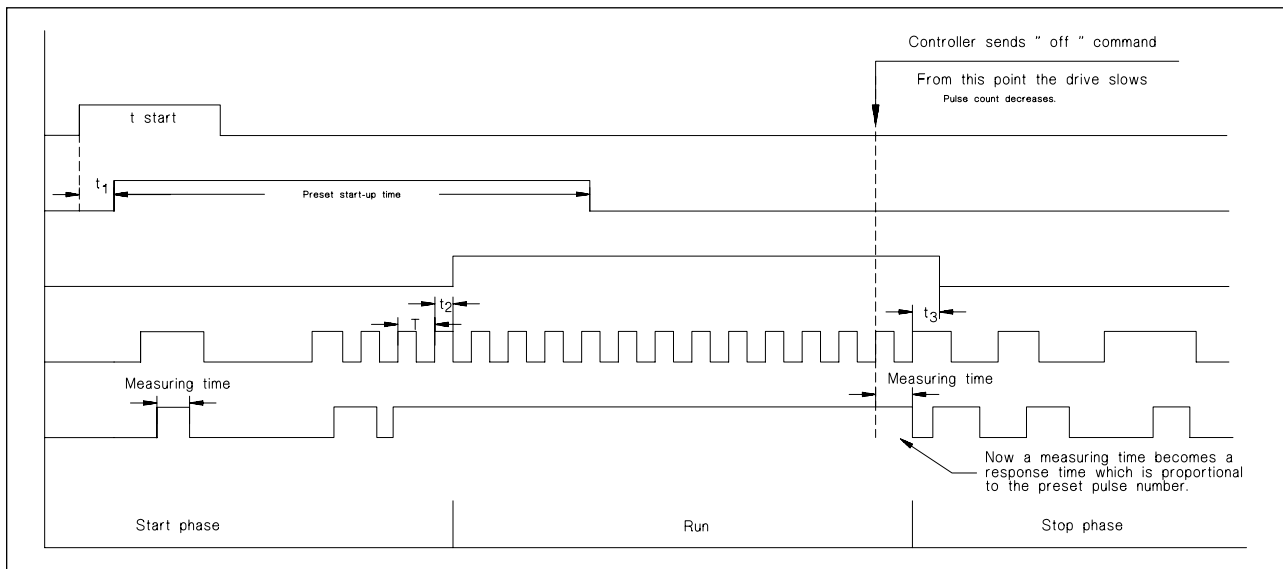
Internal relays d 1 and d 2 have positive opening contacts. The motion controller does not have 2 channels. For 2-channel control, 2 motion controllers are required.

Pulse relay d 1 assumes the home position after time "t".

$$t = \frac{60}{f \text{ minus preset hysteresis}}$$

plus 5 ms relay release time

$f = \text{preset pulse number / min.}$
The time "t" corresponds to the reaction time of the device for shaft break monitoring.



Motion Controller BES-516-604-HZ

Design

Features error memory for speeds above the max. preset, and dynamic function checking of the proximity sensor.

For protection against excessively high rotational speeds on drive motors, a version (type HZ) has been developed which meets specification of the European automobile industry.

As soon as a preset rotational speed is exceeded, the power circuit of the drive unit is contact interrupted. In addition, this version recognizes motor overload and signals this to the output circuit.

The output relays operate on the rest current principle and have a memory function.

The combination of motion controller and sensor function independently of the regulating circuit of the machine.

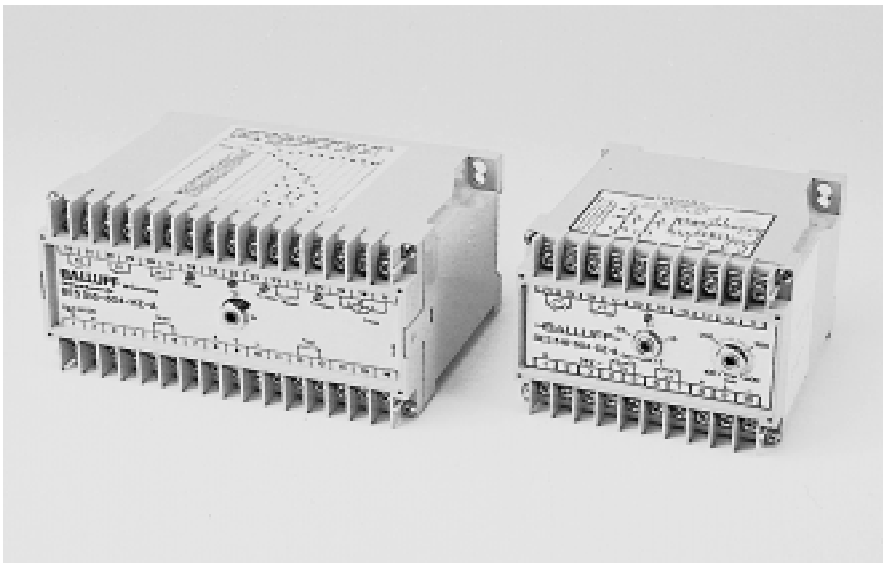
Function

The motion controller is operative immediately after power is applied. The pulses sent by an inductive proximity sensor are compared with a defined pulse number stored in the controller (min./max.) and processed accordingly. If the number is either exceeded or not reached, the output circuit is activated and the output relay releases (opens).

To test for function, the input signals "Test" and "Start" are activated. The "Test" signal serves as a function control for the output relay and allows the relay to release for 100 ms. The peripheral controller checks the necessary change in condition. The "Start" signal activates the start-up bridge, after which rotation pulses must be present, whereby the sensor is dynamically checked for proper function.

Any error recognized by the motion controller is stored and can be cancelled either with the "Reset" button or by interrupting supply voltage.

Housing Styles for Balluff Motion and Zero-Speed Controllers



Motion Controller BES-516-604

Ordering Code for Motion Control and Zero-Speed Controllers

BES - 516 - 604 - A Z - 3

Rotary Positioning

Fixed Designation

Motion Controllers -
Zero-Speed Controllers

604 = Standard Type

Versions

Motion Controller

A = With fixed pulse number
no start-up bridge

Motion Controller

B = with fixed pulse number
with fixed start-up bridge

Motion Controller

C = with adjustable pulse number
no start-up bridge

Motion Controller

D = with adjustable pulse number
with adjustable start-up bridge

Zero-Speed controller

E = with adjustable pulse number
with pre-settable start-up bridge
and fine range set

Zero-Speed Controller

G = with fixed pulse number
without start-up bridge

Motion Controller

H = with error memory for exceeding
max. permitted rpm
with function check of sensor

Output

O = Relay with changeover contact

Z = Relay with positive-opening contacts (1 NO + NC)

Supply Voltage

2 = 42 V AC

3 = 110/220 V AC

A = 24 V DC