

**Experience that pays**  
**With the MD2000 range of basic drive modules and cubicle drives, a continuous drive family is available which convinces through functionality, flexibility and easy operation at all power levels.**



visualisation software PCs

- Comprehensive safety and monitoring facilities
- Four-quadrant applications
  - With optional brake chopper
  - Energy regeneration with MD2000 AEM
  - Sinusoidal mains current control
  - High dynamic performance
  - Variable mains power factor  $\cos \phi \pm 1 \dots \pm 0,8$
- Construction of DC system bus with ready-to-connect MD2000 inverters
- Field bus coupler for integration into automation systems
  - CANopen (on board)
  - Profibus DP/FMS
  - Interbus S
  - Modbus Plus
  - Bitbus
  - SNET
  - World FIP (F8000)

**Main characteristics**

- Reduction of capital investment and operating costs thanks to latest IGBT technology.
- Optimum pulse pattern allow high motor utilisation and along with its overload capability MD2000 generates a direct saving in investment

costs

- Modular hardware and software - matches easily with any technical requirement
- Design of decentralised automation systems using field bus connection
- Easy operation through the control panel and easy commissioning with PC

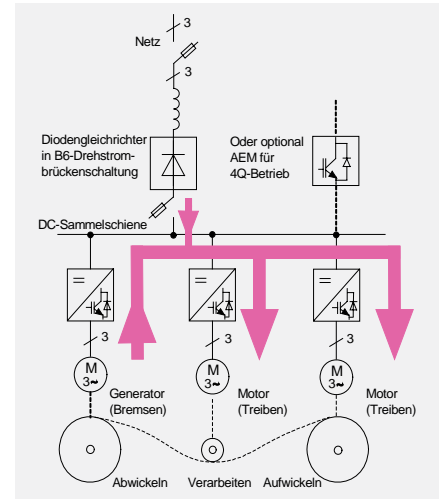
- The link voltage is maintained by the "regenerative ride-through" facility in the event of mains voltage drops. If mains power should fail, the drive decelerates under control and is restarted automatically if required.

## Braking energy optimally exploited

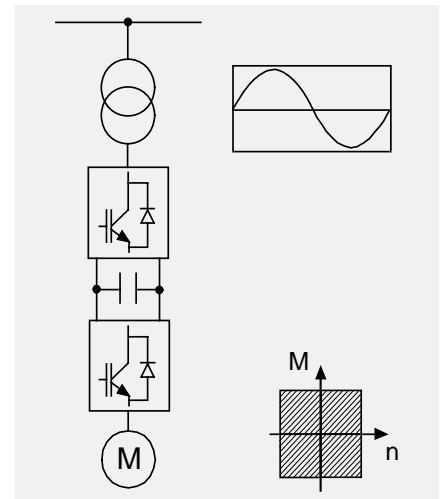
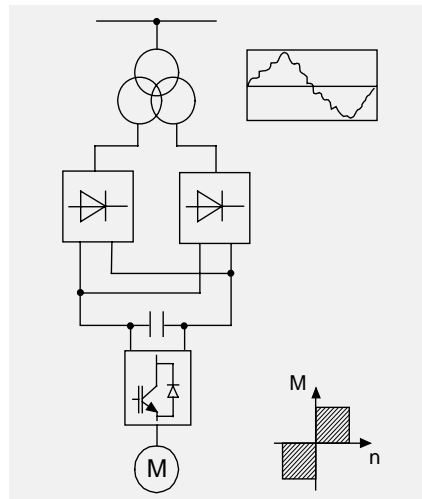
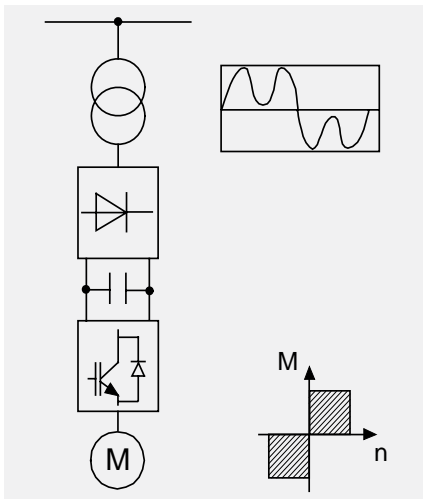
In many drive tasks, several induction motors work together: partly driving motor, partly regenerative braking (e.g. on gearbox test benches, coiler drives in rolling mills or on paper machines etc.).

A common DC busbar for all inverter units allows utilisation of the braking energy – by the shortest distance without passing mains.

Therefore the incoming supply of the DC busbar is to transmit a part of the entire power only.



## Supply concepts



### Standard version:

- mains converter: 6-pulse diode bridge
- harmonic distortion of mains current: typical 40 %
- Two-quadrant operation:
- Driving in both rotational directions (braking with optional braking resistor)

### Option:

- mains converter: 12-pulse diode bridge (transformator with secondary star-/delta winding) auto transformer on request
- harmonic distortion of mains current: typical 12 %
- Two-quadrant operation:
- Driving in both rotational directions (braking with optional braking resistor)

### Option:

- mains converter: Active Energy Management (AEM) with mains friendly inverter
- harmonic distortion of mains current: typical 1 %, depending on existing mains with harmonic distortion
- Four-quadrant operation: driving and braking in both rotational directions.
- power factor selectable: typical: 0.8 ind. ... 1 ... 0.8 cap.

## Built-in units

for 3-phase mains supply

### Type series „400 V“ 3AC 400 V ... 415 V +10 % -20 %

| Type      | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size<br>BG |
|-----------|----------------------------------|--------------------|---------------------------------|------------------|
| 54 - 400  | 37                               | 78                 | 93                              | 1                |
| 61 - 400  | 45                               | 90                 | 108                             | 1E               |
| 102 - 400 | 75                               | 147                | 169                             | 2                |
| 122 - 400 | 90                               | 176                | 221                             | 2                |
| 144 - 400 | 110                              | 208                | 250                             | 2E               |
| 178 - 400 | 132                              | 257                | 324                             | 3                |
| 211 - 400 | 160                              | 304                | 365                             | 3E               |
| 275 - 400 | 200                              | 397                | 488                             | 4                |
| 335 - 400 | 250                              | 483                | 600                             | 4E               |
| 380 - 400 | 280                              | 550                | 660                             | 4F               |

### Type series „460 V“ 3AC 400 V ... 460 V +10 % -20 %

| Type      | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size<br>BG |
|-----------|----------------------------------|--------------------|---------------------------------|------------------|
| 62 - 460  | 45                               | 78                 | 93                              | 1                |
| 71 - 460  | 55                               | 90                 | 100                             | 1E <sup>3)</sup> |
| 117 - 460 | 90                               | 147                | 169                             | 2                |
| 140 - 460 | 110                              | 176                | 221                             | 2                |
| 165 - 460 | 125                              | 208                | 230                             | 2E <sup>3)</sup> |
| 205 - 460 | 150                              | 257                | 324                             | 3                |
| 242 - 460 | 180                              | 304                | 365                             | 3E <sup>3)</sup> |
| 316 - 460 | 250                              | 397                | 488                             | 4                |
| 374 - 460 | 280                              | 470                | 520                             | 4E <sup>3)</sup> |

### Type series „690 V“ 3AC 575 V ... 690 V +10 % -15 %

| Type      | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size<br>BG |
|-----------|----------------------------------|--------------------|---------------------------------|------------------|
| 178 - 690 | 132                              | 149                | 174                             | 3                |
| 213 - 690 | 160                              | 178                | 214                             | 3E <sup>3)</sup> |
| 320 - 690 | 250                              | 268                | 348                             | 4                |
| 365 - 690 | 280                              | 305                | 366                             | 4E <sup>3)</sup> |

| Dimensions<br>mm | Dimensions |      |     | Weight     |
|------------------|------------|------|-----|------------|
|                  | H          | B    | D   | approx. kg |
| BG 1             | 591        | 345  | 384 | 35         |
| BG 1E            | 731        | 345  | 384 | 35         |
| BG 2             | 824        | 495  | 420 | 70         |
| BG 2E            | 999        | 495  | 420 | 70         |
| BG 3             | 1049       | 495  | 420 | 90         |
| BG 3E            | 1224       | 495  | 420 | 90         |
| BG 4             | 1499       | 495  | 420 | 140        |
| BG 4E            | 1674       | 495  | 420 | 140        |
| BG 4F            | 1499       | 495* | 420 | 140        |

- <sup>1)</sup> The motor power values indicated are guideline values for the highest nominal power of the motor that can be reasonably connected. They are based on typical 4-pole standard motors. The decisive value for inverter selection is the motor current resulting from the torque requirement. For motor dimensioning it must additionally be noted that the rated motor voltage should be selected lower than the max. inverter output voltage, depending on the application. Dimensioning depends on the control reserve required and on load-dependent voltage drops. For applications with less dynamic requirements, a rated motor voltage of 0.95 \* nominal mains voltage is recommended for inverters with 3AC supply; for highly dynamic requirements with a higher control reserve 0.85 (... 0.9) \* nominal mains voltage.
- <sup>2)</sup> Maximum current for 60 s overload time at least, depending on heatsink temperature.
- <sup>3)</sup> With power supply voltages > 415 V option E57 has to be ordered in addition to adapt the fan's supply voltage, refer to page 5.

\* Cubicle with top fan. Fan separately on top of cubicle. Overall height with top fan 2500 mm.



## Cubicle-mounted units

for 3-phase mains supply

| Type series „400 V“ 3AC 400 V ... 415 V +10 % -20 % |                                  |                    |                                 |                                |
|---|----------------------------------|--------------------|---------------------------------|--------------------------------|
| Type  | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size <sup>3)</sup><br>BG |
| 550 - 400   | 450                              | 800                | 975                             | 5                              |
| 650 - 400   | 500                              | 940                | 1050                            | 5E                             |
| 1050 - 400  | 850                              | 1520               | 1853                            | 6                              |
| 1230 - 400  | 900                              | 1780               | 1995                            | 6E                             |
| 1500 - 400  | 1150                             | 2160               | 2625                            | 7                              |
| 1750 - 400  | 1400                             | 2540               | 2835                            | 7E                             |
| 1880 - 400  | 1500                             | 2720               | 3320                            | 8                              |
| 2340 - 400  | 1800                             | 3380               | 3780                            | 8E                             |
| Type series „460 V“ 3AC 400 V ... 460 V +10 % -20 % |                                  |                    |                                 |                                |
| Type  | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size <sup>3)</sup><br>BG |
| 630 - 460   | 500                              | 800                | 975                             | 5                              |
| 660 - 460   | 500                              | 830                | 1000                            | 5E <sup>4)</sup>               |
| 1150 - 460  | 950                              | 1520               | 1853                            | 6                              |
| 1250 - 460  | 1000                             | 1570               | 1900                            | 6E <sup>4)</sup>               |
| 1700 - 460  | 1350                             | 2160               | 2625                            | 7                              |
| 1780 - 460  | 1500                             | 2240               | 2700                            | 7E <sup>4)</sup>               |
| 2150 - 460  | 1750                             | 2720               | 3320                            | 8                              |
| 2380 - 460  | 1900                             | 2980               | 3600                            | 8E <sup>4)</sup>               |
| Type series „500 V“ 3AC 480 V ... 525 V +10 % -15 % |                                  |                    |                                 |                                |
| Type  | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size <sup>3)</sup><br>BG |
| 560 - 500   | 400                              | 640                | 890                             | 5                              |
| 660 - 500   | 500                              | 770                | 920                             | 5E                             |
| 780 - 500   | 620                              | 910                | 1010                            | 5F                             |
| 850 - 500   | 670                              | 990                | 1050                            | 5G                             |
| 1050 - 500  | 850                              | 1215               | 1690                            | 6                              |
| 1260 - 500  | 1000                             | 1460               | 1750                            | 6E                             |
| 1490 - 500  | 1200                             | 1725               | 1915                            | 6F                             |
| 1620 - 500  | 1300                             | 1880               | 1995                            | 6G                             |
| 1800 - 500  | 1400                             | 2070               | 2480                            | 7E                             |
| 2120 - 500  | 1700                             | 2455               | 2725                            | 7F                             |
| 2310 - 500  | 1800                             | 2670               | 2835                            | 7G                             |
| 2400 - 500  | 1900                             | 2770               | 3310                            | 8E                             |
| 2830 - 500  | 2200                             | 3275               | 3635                            | 8F                             |
| 3080 - 500  | 2400                             | 3560               | 3780                            | 8G                             |
| Type series „690 V“ 3AC 575 V ... 690 V +10 % -15 % |                                  |                    |                                 |                                |
| Type  | Motor rating <sup>1)</sup><br>kW | Rated current<br>A | Max. current <sup>2)</sup><br>A | Frame size <sup>3)</sup><br>BG |
| 640 - 690   | 500                              | 535                | 690                             | 5                              |
| 840 - 690   | 680                              | 710                | 920                             | 5E                             |
| 990 - 690   | 790                              | 830                | 975                             | 5F                             |
| 1070 - 690  | 850                              | 900                | 1050                            | 5G                             |
| 1200 - 690  | 950                              | 1010               | 1310                            | 6                              |
| 1600 - 690  | 1300                             | 1350               | 1750                            | 6E                             |
| 1900 - 690  | 1500                             | 1575               | 1850                            | 6F                             |
| 2040 - 690  | 1620                             | 1710               | 1995                            | 6G                             |
| 2300 - 690  | 1800                             | 1920               | 2490                            | 7E                             |
| 2680 - 690  | 2100                             | 2240               | 2630                            | 7F                             |
| 2900 - 690  | 2200                             | 2430               | 2835                            | 7G                             |
| 3050 - 690  | 2400                             | 2560               | 3310                            | 8E                             |
| 3570 - 690  | 2800                             | 2985               | 3510                            | 8F                             |
| 3870 - 690  | 3000                             | 3240               | 3780                            | 8G                             |
| 4300 - 690  | 3300                             | 3650               | 4730                            | 9E                             |
| 5520 - 690  | 4300                             | 4620               | 5313                            | 9G                             |
| 5800 - 690  | 4500                             | 4860               | 6290                            | 10E                            |
| 7360 - 690  | 5500                             | 6160               | 7084                            | 10G                            |

| mm     | Dimensions      |      |     | Weight     |
|--------|-----------------|------|-----|------------|
|        | H <sup>*)</sup> | B    | D   | approx. kg |
| BG 5   | 2200            | 1200 | 600 | 725        |
| BG 5E  | 2600            | 1200 | 600 | 725        |
| BG 5F  | 2600            | 1200 | 600 | 750        |
| BG 5G  | 2600            | 1200 | 600 | 760        |
| BG 6   | 2200            | 2400 | 600 | 1400       |
| BG 6E  | 2600            | 2400 | 600 | 1400       |
| BG 6F  | 2600            | 2400 | 600 | 1450       |
| BG 6G  | 2600            | 2400 | 600 | 1470       |
| BG 7   | 2200            | 3600 | 600 | 2070       |
| BG 7E  | 2600            | 3600 | 600 | 2070       |
| BG 7F  | 2600            | 3600 | 600 | 2150       |
| BG 7G  | 2600            | 3600 | 600 | 2200       |
| BG 8   | 2200            | 4800 | 600 | 2800       |
| BG 8E  | 2600            | 4800 | 600 | 2800       |
| BG 8F  | 2600            | 4800 | 600 | 2900       |
| BG 8G  | 2600            | 4800 | 600 | 2950       |
| BG 9E  | 2900            | 5400 | 600 | 3600       |
| BG 9G  | 2900            | 6600 | 600 | 3900       |
| BG 10E | 2900            | 7800 | 600 | 5200       |
| BG 10G | 2900            | 7800 | 600 | 5500       |

<sup>\*)</sup> Ceiling height at least cabinet height plus 100 mm.

- <sup>1)</sup> The motor power values indicated are guideline values for the highest nominal power of the motor that can be reasonably connected. They are based on typical 4-pole standard motors. The decisive value for inverter selection is the motor current resulting from the torque requirement. For motor dimensioning it must additionally be noted that the rated motor voltage should be selected lower than the max. inverter output voltage, depending on the application. Dimensioning depends on the control reserve required and on load-dependent voltage drops. For applications with less dynamic requirements, a rated motor voltage of 0.95 \* nominal mains voltage is recommended for inverters with 3AC supply; for highly dynamic requirements with a higher control reserve 0.85 (... 0.9) \* nominal mains voltage.
- <sup>2)</sup> Maximum current for 60 s overload time at least, depending on heatsink temperature.
- <sup>3)</sup> 6-pulse supply as standard. Frame sizes 6 and 8 can be connected directly to a converter transformer with 2 secondary windings offset through 30° electrical (12-pulse). Frame size 7 can be connected directly to a converter transformer with 3 secondary windings offset through 20° electrical (-20/0/+20) (18-pulse). Frame size 8 can be connected directly to a converter transformer with 4 secondary windings offset through 15° electrical (24-pulse).
- <sup>4)</sup> With power supply voltages > 415 V option E57 has to be ordered in addition to adapt the fan's supply voltage, refer to page 5.

## Options and Accessories

| Option | Description   | Option  | Description  |
|--------|---|---------|--|
| E1     | Digital control unit for control and operation                | E57     | Adaption of fan supply ( $V_{\text{Mains}} > 415 \text{ V AC}$ )             |
| E1-e   | Local/remote changeover                                       | E70     | IT network   |
| E3     | EMERGENCY-OFF (immediate-off/mains-off according to EN60204)  | E71     | Motor dv/dt filter for cables $\geq 20 \text{ m}$ in length                  |
| E4     | Fast stop, safety category 1 according to EN60204             | E72     | Motor dv/dt filter for cables $< 20 \text{ m}$ in length                     |
| E6     | Thermistor interface, shut-down                               | E80     | Optocoupler for binary outputs   |
| E7     | Thermistor interface, warning                                 | E81     | Relay module 230 V   |
| E8     | PT100 interface   | E83     | Encoder interface  |
| E10    | Additional slide-in rack                                      | E85     | Additional power supply units NG3 400 V, 500 V, 690 V                        |
| E11    | Field bus coupler   | E85-E70 | Additional power supply units NG3-E70 400 V, 500 V, 690 V (with IT networks) |
| E13    | Connection set  | E93     | Cubicle/cable base, 100 mm   |
| E23    | Analogue interface  | E94     | Cubicle/cable base, 200 mm   |
| E24    | I/O interface   | E95     | Mains supply from above  |
| E25    | Analogue isolation module, package 1                          | .12     | 12-pulse supply  |
| E26    | Analogue isolation module, package 2                          | .24     | 24-pulse supply  |
| E27    | Analogue isolation module, package 3                          | .IP31   | Protection class IP31  |
| E31    | Brake chopper   | .IP42   | Protection class IP42  |
| E31-TH | Thermal overcurrent relay                                     | .IP54   | Protection class IP54  |
| E33    | Radio interference suppression according to EN 55011, class A | +N2     | Regenerative braking, 4Q with mains pulse inverter                           |
| E41    | Connection of external motor fan                              | +N3     | Mains filter for regenerative braking 4Q with mains pulse inverter           |
| E42    | Hours-run meter   | +SF     | Sea-water proof  |
| E43    | Insulation monitoring   | +Z      | Additional cubicle   |
| E44    | Anti-condensation heater                                      | PCS     | PCS PC drive software  |
| E45    | Socket 230 V  | PCSF    | MD2000 unit-specific files   |
| E46    | Cubicle lighting  | RB...   | Cast grid braking resistor   |
| E49    | Electronics auxiliary supply                                  | RB1     | Steel grid braking resistor $R_1$  |
| E50    | Functional extra-low voltage/according to VIK/Namur guideline | RB2     | Steel grid braking resistor $R_2$  |
| E51    | Coupling relay, package 1                                     | RS232   | RS232 PC interface   |



| Control Unit



| Encoder interface



| Analogue interface



## Technical Data

- Control structures available:
  - Frequency control
  - Speed control with or without encoder
  - Torque control with or without encoder
- Economy mode for power and noise reduction when operating at less than full load
- Fully digital control electronics with all safety and monitoring facilities required
- Comprehensive testing and diagnostics functions:
  - Event log, error log with timing information
  - Oscilloscope facility with 4 analogue and 8 digital measurement channels in conjunction with PC visualisation software
- PC connection through RS 232, RS 485/RS 422 serial interfaces or CANopen

### Control through:

- 2 analogue demand inputs,  $\pm 10$  V; 0(4) ... 20 mA
- 12 digital inputs for control signals, separate potential, 3 of which are parameter-adjustable
- 4 relay outputs for messages, separate potential 60 V/0.8 A, one of which is parameter-adjustable and one configurable
- 2 freely parameter-adjustable analogue outputs -10 V ... +10 V
- CANopen on board
- 6-way parameter set changeover
- 4 fixed speeds
- 3 programmable skip speeds with hysteresis
- Regenerative ride-through on mains failure
- Capture spinning motor without torque surge (synchronous restart)
- Automatic restart after mains failure, adjustable to 15 s

|                            |  |
|----------------------------|--|
| Mains supply voltage:      | „400 V“ 3AC 380 V - 15 % ... 460 V +10 % <sup>1)</sup>   |
| Type series                | „500 V“ 3AC 480 V - 15 % ... 525 V +10 % <sup>1)</sup><br>„690 V“ 3AC 575 V - 15 % ... 690 V +10 % <sup>1)</sup>   |
| Mains frequency::          | 47 ... 63 Hz   |
| Overload capacity:         | 120 % for 60 s (see table type series)   |
| Mains power factor         |  |
| - Fundamental wave:        | $\cos \varphi_p > 0,97$ inductiv   |
| - Total at rated current:  | $\lambda_N \approx 0,88 \dots 0,95$  |
| Output voltage (max.):     | 3AC 0 V to mains voltage <sup>2)</sup>   |
| Rated current and power:   | See type series  |
| Output frequency:          | 0 Hz to 200 Hz with vector closed-loop control   |
| :                          | 0 Hz to 300 Hz with V/f-Frequency control  |
| Speed accuracy:            | Without encoder < 0.5 %<br>with encoder < 0.05 %   |
| Torque rise time:          | 2 ... 8 ms   |
| Min. operating frequency:  | Without encoder to 1 Hz motor<br>with encoder 0 Hz   |
| Efficiency at rated point: | 96 ... 98 %  |
| Frequency control:         | Frequency resolution 6 mHz<br>Frequency stability 0.01 %   |
| Vector frequency:          | 3 kHz as standard, with derating<br>type depending also 6 kHz, 12 kHz, 18 kHz  |
| Protection class:          | Built-in units IP20, optional package up to IP54<br>Cubicle-mounted units IP21, optional up to IP54  |
| Cooling:                   | Forced air cooling   |
| Ambient temperature:       | 0 ... 40 °C at rated current,<br>to +55 °C with power reduction 2 %/K  |
| Altitude:                  | $\leq 1000$ m above MSL, up to max. 2200 m with<br>power reduction 1.2 % per 100 m   |
| Environment class:         | EN 60721 part 3-3 3<br>K3 / 3M2 / 3C2 <sup>3)</sup> /2K2   |
| Insulation coordination:   | Verschmutzungsgrad 2 nach DIN EN 60664-1   |
| EMC:                       | To EMC product standard for variable speed drives EN 61800-3 (IEC 1800-3). For use in second environment („industrial area“). For use in first environment („domestic area“) with options according to operating manual. |
| CE marking:                | EU low voltage directive 73/23 EWG   |

<sup>1)</sup> Standard design for connection to earthed networks (TN/TT networks); Connection to networks with insulated star point (IT networks) optional.

<sup>2)</sup> Depending on the application, the rated motor voltage should be selected lower than the max. inverter output voltage. Dimensioning depends on the control reserve required and on load-dependent voltage drops.

For applications with less dynamic requirements, a rated motor voltage of 0.95 \* nominal mains voltage is recommended for inverters with 3AC supply; for highly dynamic requirements with a higher control reserve 0.85 (... 0.9) \* nominal mains voltage. Project engineering for inverters with DC supply on request.

<sup>3)</sup> But no salt spray mist.