Positioning and servo drive functions in a single package

The Compax M servo drive integrates the functions of position, speed and current control within a fully digital system.   By combining these functional elements into a single user-friendly package, Compax offers a cost-effective solution in a wide range of servo control applications having continuous power requirements up to 35kVA.

The drive is designed to operate in conjunction with three-phase brushless servo motors using sinusoidal commutation and resolver feedback. A range of compatible motors is available offering continuous torques up to 90Nm and speeds up to 5000 rpm. The IGBT power stage is fully protected against overheating, short circuits, earth faults and power supply failure.

Powerful control functions

Compax may be controlled using direct commands in real time from a host controller, or can operate from an internally-stored control program with up to 250 command lines. In addition to the basic position control version, application-specific variants cater for a wide variety of tasks from processing material in motion to electronic gearing and cam control.

An RS232 serial interface provides complete configuration and diagnostic facilities using an external computer or terminal. Parameter editing and storage software is provided with the controller. Additional communication and encoder interfaces are available as an option. For diagnostic purposes, the front panel incorporates a 7-segment LED display combined with a simple three-button selection system to monitor system status.

A choice of power ratings

There is a selection of four power ratings covering the range 3.3 - 35kVA. Two central power supply modules are available, both of which operate from three-phase AC inputs at voltages up to 460V. The power supplies have a built-in dynamic braking circuit to dissipate regenerated power during deceleration. The Compax 3500M has a built in power supply

All configuration data required for standard motors is pre-loaded at the factory and may be recalled using a 3-digit code, minimising the setup time for standard motors.   By simply entering the maximum and minimum values for the external load inertia, the drive will automatically calculate optimum tuning values to ensure stable operation from power-up.

Compax drives are housed in a rugged, fully-enclosed metal casing providing a high degree of protection as well as effective electromagnetic shielding. The rear-mounted heat sink allows the higher-power units to be mounted through a cutout in the panel, minimising the heat dissipation within the equipment cabinet.

Compax M features

- ■ Position, velocity & torque controller for three phase sinusoidal brushless motors

- ■ Four power ratings up to 35kVA continuous

- ■ Fully protected IGBT power stage

- ■ Three-phase power input, direct on line (no transformer required)

- ■ Separate power module allows shared supply in multi-axis systems

- ■ Non-volatile memory for stored-program operation

- ■ Completely enclosed metal casing for total protection and electromagnetic shielding

- ■ Fully-digital current loop based on high-speed signal processor (100µs cycle time)

- ■ Range of customised variants tailored to meet the demands of specific applications

- ■ Automatic tuning adjustment from given load data

- ■ Simplified servo loop optimisation using only two parameters

- ■ Open communications structure with a choice of serial, binary and PLC interfaces as well as Profibus, CANbus and Interbus-S

- ■ PLC-compatible input and output circuits using 24V signal levels

- ■ High-speed data interface allows precise multi-axis synchronisation with de-centralised control

The technology

In most conventional servo systems, the control of the machine or overall process is separated both electrically and physically from the control of velocity, torque and position.　Since these functions are closely inter-related, there are significant benefits in integrating them into a single device.

The control system in the Compax drive is based on two microprocessors - a host controller and a high-speed digital signal processor. The host processor handles I/O and low-speed communications, whilst the DSP controls the digital current loop, processes encoder & resolver data and communicates with other axes using a high-speed data channel. The DSP has access to all relevant data, including motion profiles, external moments of inertia and instantaneous motor currents. This permits the application of advanced control concepts such as adaptive and observer control, and allows all main controller parameters to be set fully automatically.

Benefits of the integrated solution

■ High-accuracy tracking in contouring applications, achieved with the use of velocity, acceleration and current feedforward terms.

■ Outstanding smoothness at low speeds resulting from the use of observer control.

■ Automatic parameter setting from external load data (load inertia, motor type, gear ratio etc.)

■ Simplified optimisation for specific applications using only two independent adjustments - stiffness and damping.

■ Precise multi-axis synchronisation achieved using a high-speed data link between drives.

■ Closer co-ordination of process and motion control resulting in improved dynamic performance, better stability, higher stiffness and lower peak currents.

■ The high-level process controller becomes less complex, costs less & requires fewer connections.

Open communications

Compax offers a variety of communication interfaces to suit all types of applications and host controllers.

■ RS232C interface for parameter setting and motion control

■ Card slots for fast bus systems (Profibus, CAN-Bus, Interbus-S or RS485)

■ 16 binary inputs & outputs for program control & status checks

■ Universal PLC data interface using binary I/O

■ 7-segment display for status & error messages

Where there is a requirement for fast bus communication with the rest of the system, Compax can accommodate most of the popular options. However, where very rapid data transmission is not necessary, the universal data interface is particularly convenient as a means of simple data exchange with the host controller. Using only 5 binary I/O lines, it can be implemented inexpensively with all types of PLC and avoids the need to become conversant with serial bus systems.

The control section

The basic Compax M controller is designed to meet the requirements of a standard positioning axis. Its standard features accommodate applications such as point-to-point positioning in either absolute or incremental modes. In addition, there is a range of application-specific variants designed to handle tasks such as electronic gearing and cam control. These variants are described on the next page and are identified by a code within the part number. For example, the Compax 0210M incorporates the roller feed control function (code 10).

Up to 250 sequentially-numbered command lines can be stored by the user in the program memory. Execution of the program can be controlled either by a data interface or the binary I/O lines. Specific addresses within the control program can also be selected.

The structure of the control program has been kept as simple as possible and closely resembles BASIC. As well as motion-related commands such as speed, position and acceleration rate, there are also comparison operators, I/O control commands and program flow commands.

Here is a sample program:

N001	**ACCEL 250**	Acceleration time 250ms
N002	**SPEED 80**	Speed 80% of rated
N003	**REPEAT 10**	Conditional wait loop lasting a maximum of 1 sec.
N004	**IF I7=1 GOTO 9**	If input 7 is at logic 1 jump to line 9, otherwise continue
N005	**WAIT 100**	Wait for 100ms
N006	**END**	End of the wait loop
N007	**OUTPUT O7=1**	Turn on output 7
N008	**GOTO 13**	Jump to end
N009	**POSA 1250**	Move to absolute position 1250
N010	**OUTPUT O8=1**	Turn on output 8
N011	**WAIT 500**	Wait for 500ms
N012	**OUTPUT O8=0**	Turn off output 8
N013	**END**	End of program

The commands are always executed sequentially, and the program can be interrupted by a break signal which will bring the axis to a halt. The program can then be restarted at a different program line. The ability to nominate the line at which execution will start allows the program to contain several individually-selectable motion sequences.

Completely digital control including the power stage

The fully-digital COMPAX M relies wholly on software algorithms to calculate all the manipulated variables. As a result, all settings are entirely reproducible and may be saved to disk. Since all main control parameters are set automatically, stable operation is guaranteed right from power-up. End users have no need of extensive experience with control technology since the required expertise is incorporated in software form. The optimised control structure based on powerful control algorithms results in very high performance combined with extreme flexibility in meeting the requirements of specific applications.

Compax XX10M: Roller feed

Precision feeding of material in a manufacturing process. Requires E2 or E4 encoder option

- Die cutting
- Pressing
- Pressure rolling
- Feed to length
- Label dispensing

Special features:

- Mechanical start up
- Direction override
- Wheel diameter adjustment
- Slip filter and slippage monitoring
- Monitoring of materials
- Registration positioning
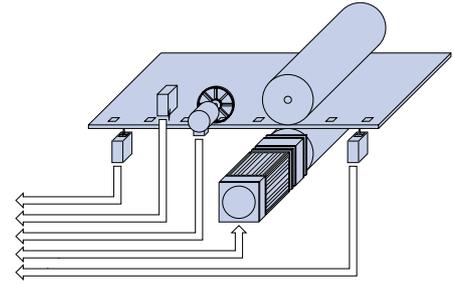
Compax XX30M: Indexing table control

High precision control and positioning of indexing tables and endless assembly chains

Special features:

- External position sensing possible with E2 encoder option
- Indexing calculator up to 1000 increments per revolution
- Control of mechanical clamping
- Manual fine adjustment of table position
- No cumulative error
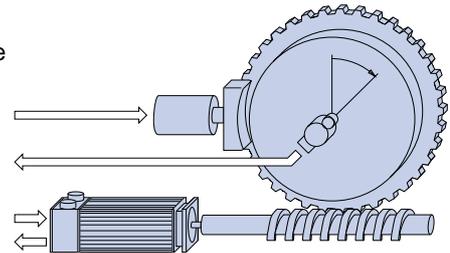
Compax XX50M: Cutting on the fly

Processing of material or work-piece in motion - a well known example is cutting on the fly. Requires E2 or E4 encoder option.
Further examples of in-motion processing operations:

- Die cutting
- Filling
- Tapping/screwing
- Sawing
- Casting
- Drilling

Special features:

- Encoder input for predefining speed
- Registration-based positioning
- Compensation for fluctuations in material feed
- Pilot frequency simulator as a start-up aid
- Diagonal-beam version for wide media
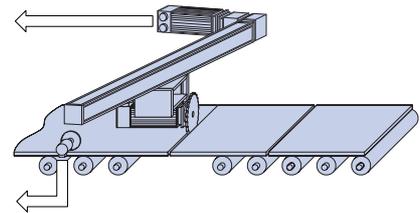
Compax XX60M: Electronic gearing

Synchronous control of angle, synchronous control of speed, processing in motion. Requires E2 or E4 encoder option.

- Electronic gearing
- Processing of moving parts

Special features:

- Any desired gear ratio, including negative values
- Synchronous control of angle or rotational speed
- Enable/disable external master reference value
- Internal motion program superimposed on master motion
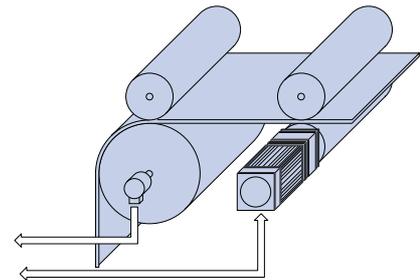
Compax XX70M: Cam control

Replacement of mechanical elements of machines, for example cam plates and discontinuous shaft, camshaft or gear elements. Requires E2 or E4 encoder option.

Special features:

- Several curves storable
- 8 digital outputs as a function of cam position
- Up to 2500 base points per curve
- Powerful software tool for design and implementation of curves
- Flying synchronisation into predefined positions

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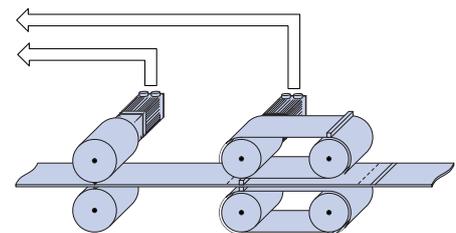
Compax block diagram
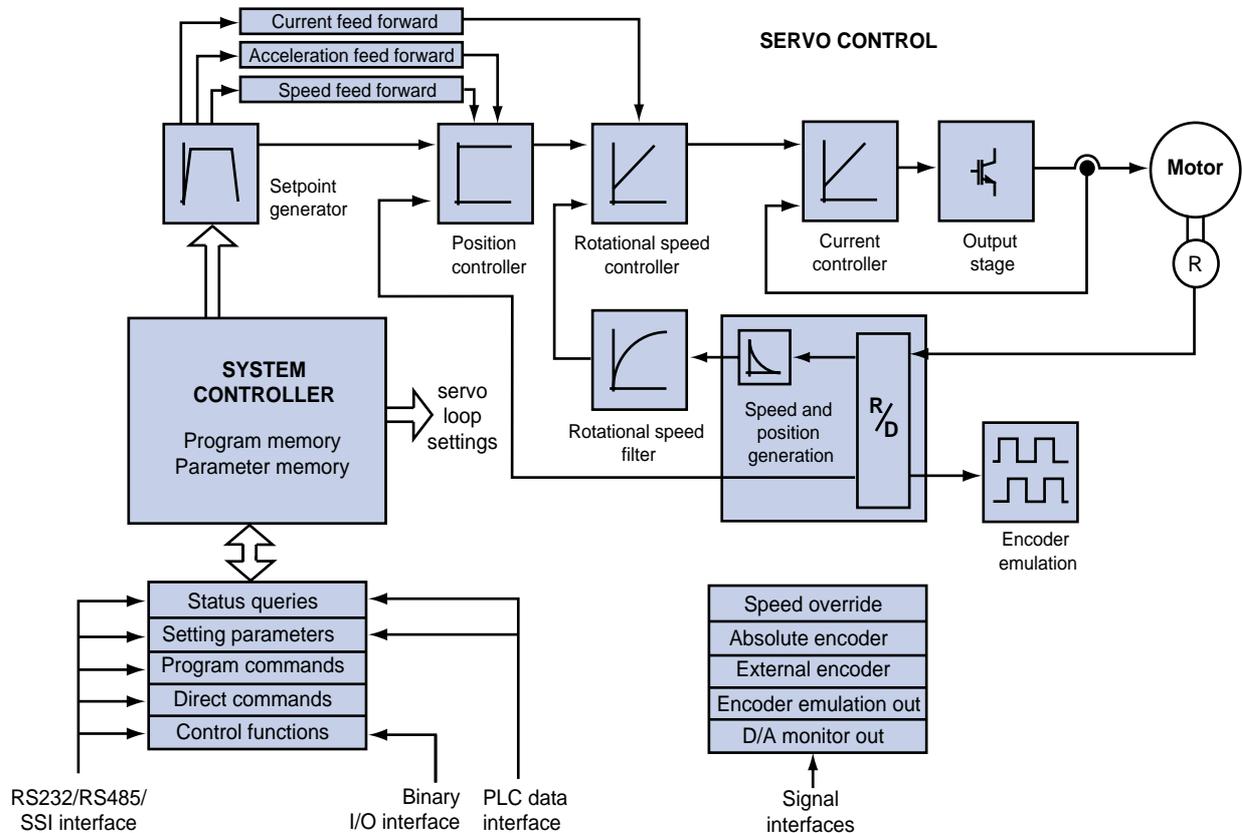
Control Section

Control via digital inputs and outputs

16 inputs and 16 outputs are available for controlling program execution. These have the following functions in the basic controller (XX00M):

Output	Function
O1	No errors
O2	No warnings
O3	At home position
O4	Ready to start
O5	Target position reached
O6	Standstill after Stop
O7 - O16	User programmable in standard version (XX00M)

Input	Function
I1	SHIFT
I2	Manual run +
I3	Manual run -
I4	Quit
I5	Start
I6	Stop (interrupt line)
I7 - I16	User definable
SHIFT I2	Search for home
SHIFT I3	Travel to position zero
SHIFT I4	Teach position zero
SHIFT I5	Reserved
SHIFT I6	Break (abort line)

System controller

The processor-based system controller monitors and co-ordinates all input and output functions, determines the characteristics of the servo control loop and supervises the overall functioning of the drive.

Parameter and program memories

The parameter memory holds all application-specific data. The parameter editor software can be used to copy the settings to disk and transfer them to other Compax M devices.

The integrated program memory has the capacity for storage of up to 250 command lines. This allows the Compax to be pre-loaded with a complete motion program.

Setpoint generator

The setpoint generator produces a velocity-time profile from the programmed move parameters. Linear, jerk-free and square profiles are available.

Position controller

The target position determined by the setpoint generator is compared with the actual position of the motor. The output of the position controller becomes the setpoint value for the velocity controller.

Velocity and torque controllers

The velocity setpoint value delivered by the position controller is compared with the actual speed of the motor. The result becomes the torque setpoint value for the following digital current controller.

Power output stage

The isolated power output stage is implemented in IGBT technology. It is self-monitoring to detect any short circuits or ground faults, and incorporates over-temperature protection.

Feed forward control

In the setpoint generator, the course of a positioning event is calculated and passed to the position controller as a setpoint. As a consequence, the setpoint generator has access to preliminary information about the velocity, acceleration and torque demands needed for the positioning task at hand. By routing this information through the controller, contouring errors can be minimized, the controller achieves an improved transient response and the drive dynamics are enhanced.

Motor speed & position generation

This module converts rotor position data from the resolver into digital speed and position information. The resolver is an integral component of the motor - no additional feedback signal generators are required.

Speed Override input

Using an analogue input, the velocity can be reduced from the set value down to zero. This is a convenient way of operating at reduced speed during startup and troubleshooting.

Encoder interface

With the encoder interface E2 option, it is possible to connect an external incremental encoder (Litton G7 1SSLDBI-2500-151-050BX or equivalent type). This can then be used to synchronise the Compax M to an external speed with the aid of the "SPEED SYNC" command. The resolution can take any value between 120 and 5000 increments per revolution.

Encoder modules and accessories:

E2: ERM5/01	Encoder input module with line termination for individual connections
E3: ERM4/01	Encoder emulation output module, resolution 512 or 1024
E4: ERM5/02	Encoder input module without line termination for setting up an encoder bus
EAM4/01	Encoder distributor for setting up an encoder bus
BUS1/01	Bus terminator

Absolute positioning sensing option (A1)

When an absolute positioning sensor is used, it is unnecessary for the axis to return to a reference position following a power failure.
The Stegmann type AG100MS/GRAY 4096/4096 absolute encoder is recommended.

D/A monitor (D1)

The D1 option offers the possibility of representing two of 16 internal measurement values as analogue output voltages ($\pm$10V) and viewing them on an oscilloscope. Especially during initial parameter setting and startup, this provides a powerful tool for monitoring system operation.

Automation

## Dimensions and mounting details
for direct panel mounting

35XXM

02XXM, 05XXM,
15XXM, NMD10
& NMD20

P1XXM

Typical side view
(all modules)
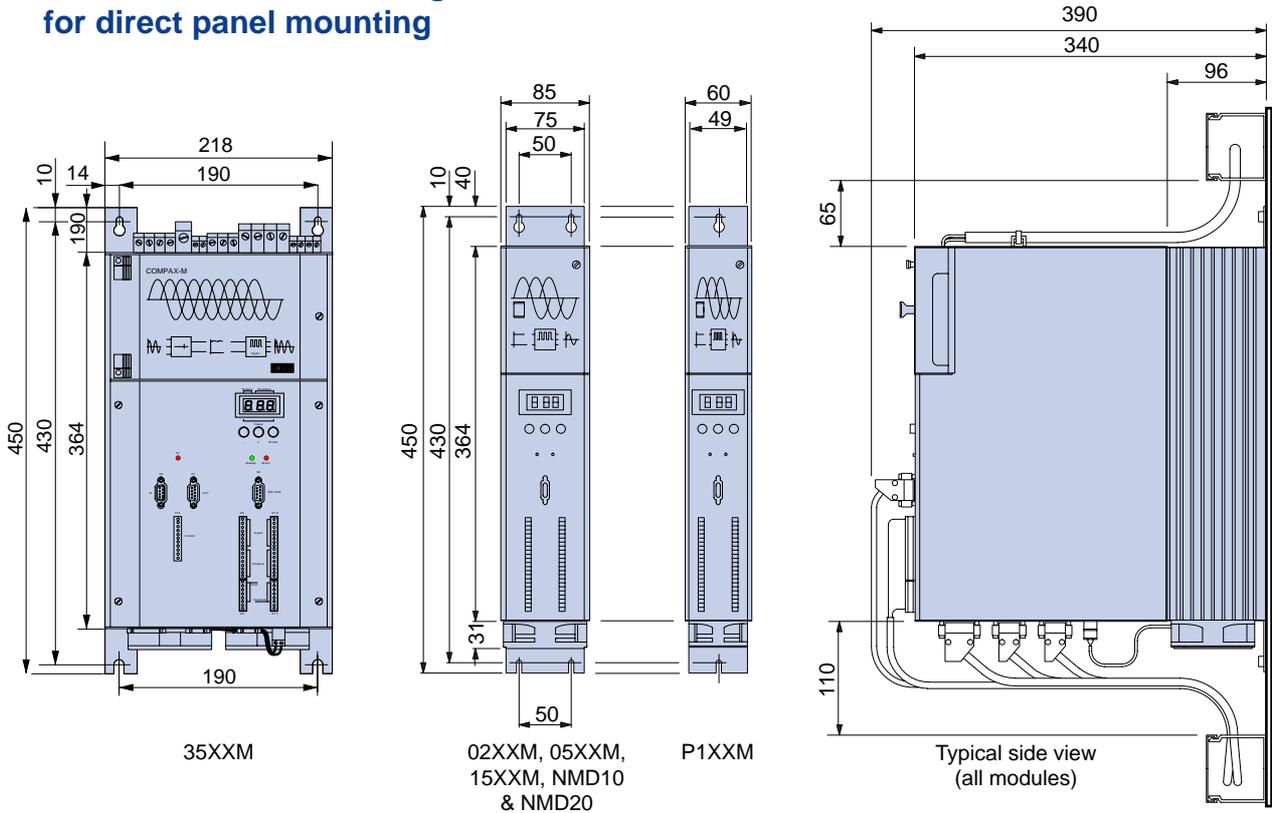
Mounting details for through-panel mounting
(not applicable to P1XX or 3500M)

Panel cut-out
dimensions

Mounting
plate
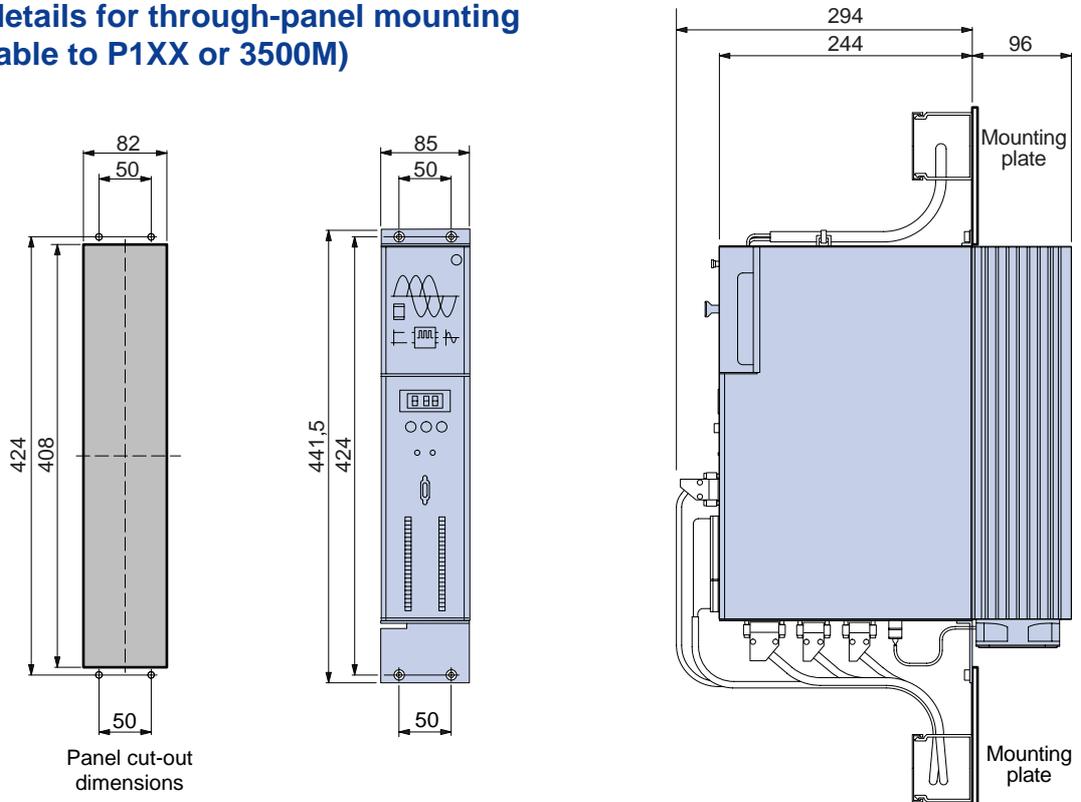
Mounting
plate

All backplate & bracket fixings accept M6 screws. For through-panel mounting, use brackets type MTS2/01

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Output current & power ratings

Model no.	Cont. current	Peak (<5s) current	DC bus voltage	Cont. power	Power dissipation
P1XXM	5.5A	8.5A	650V	3.3kVA	140W
02XXM	6.5A	8.5A	650V	3.8kVA	120W
05XXM	11.5A	17A	650V	6.8kVA	250W
15XXM	25A	50A	650V	15kVA	250W
35XXM	50A	100A	650V	35kVA	610W

General characteristics

Motor type	Sinusoidal synchronous, up to 9000 rpm
Supported resolvers	Litton JSSBH-15-E5, JSSBH-21-P4, RE-21-1-A05 & RE-15-1-B04 Siemens 23401-T2509-C202 Tamagawa 2018N321 E64 Support for SinCos feedback (Stegmann)
DC bus voltage range	100-560V DC from NMD power supply module (integral supply on Compax 35XXM)
AC supply (35XXM)	3 x 80V - 3 x 500V AC, 45 - 65 H_z
Power dump (35XXM)	1100µF/173Ws storable energy; 10Ω 2kW external dump resistor
Control voltage	+24V DC ±10%, ripple <1V p-p
Control current	Each controller module 0.8A (1.3A on Compax 35XXM), with fan installed add 0.1A, absolute encoder option add 0.3A, motor brake option add 0.35-1.6A, each digital output allow 0.1A
Positioning resolution	P1XXM - 15XXM: 14 bits (≡ 1 arc minute); 35XXM 16 bits (≡ 0.3 arc minute)
Positioning accuracy	±15 arc-minutes
Internally-monitored functions	DC bus voltage, control voltage, short-circuit/overcurrent, output stage temperature, motor temperature, jammed motor, excess tracking error

Program functions

Program memory	250 data blocks, non-volatile
Program commands	ACCEL, SPEED, POSA, POSR, WAIT, GOTO, GOSUB, IF, OUTPUT, REPEAT, RETURN, END, WAIT START, GOTO EXT, GOSUB EXT, SPEED SYNC, O/P A0, POSR SPEED, POSR OUTPUT
Ref. generator ramps	Linear, quadratic, smooth
Ramp time range	10ms to 60s
Distance indication	mm, inch or variable using scaling factor
Parameter input	RS232/485/PLC interface or hand terminal
Status indication	RS232/485/PLC interface, hand terminal or 3-digit display on front panel

Housing

Enclosure rating	IP20	
Isolation	VDE0160	
Ambient temp. range	0° - 45°C	
Screw terminal connections	Motor, power input, control inputs and outputs	
D-type plug connections	Resolver & encoder inputs, data bus cables	
Mounting	Direct or through-panel (P1XXM direct only)	
Weights:	P1XXM	5.1kg
	02XXM	7.1kg
	05XXM, 15XXM	7.8kg
	35XXM	21 kg
	NMD10	7.6kg
	NMD20	8.1kg
Humidity	0-95% non-condensing	

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Signal & data interfaces

Compax M is equipped with an RS232C interface as standard. Other communication and encoder interfaces are optional.

RS232 interface

Baudrate	4800 or 9600
Format	8-bits, 1 start bit, 1 stop bit
Handshaking	Hardware & software (XON/XOFF supported)

RS485 interface option

Max. Baudrate	115kBaud
Format	2 or 4 wire
Addresses	1 - 31

Interbus-S option

Type	2-wire
Transmission rate	500kBaud
Subscribers/ring	64 maximum

Control inputs

Number of inputs	16
Logic low level	0 - 7.5V
Logic high level	14 - 32V
Input impedance	10kΩ

Connector layout
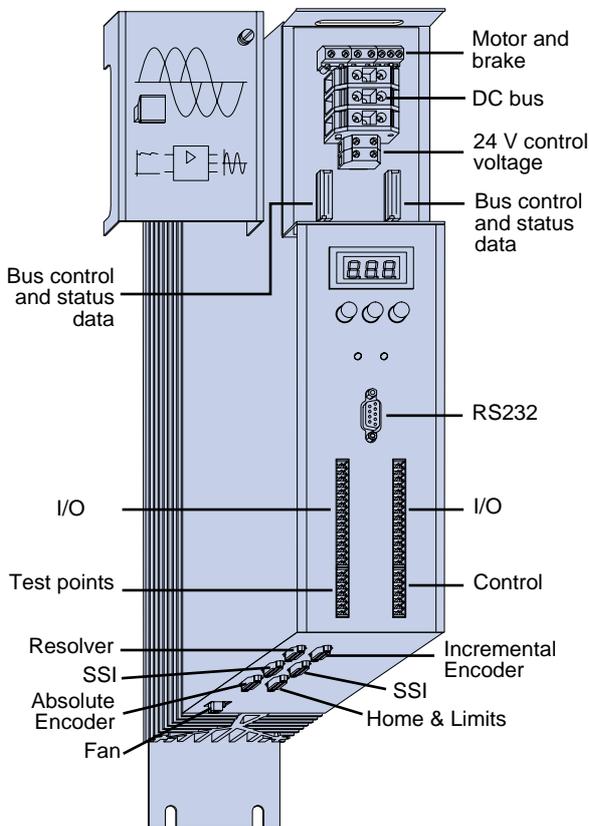
Control outputs

No. of outputs	16
Output type	PNP transistor
Voltage rating	24V (from external supply)
Current rating	100mA
Active state	High (transistor on)
Protection	Short-circuit protected

Encoder interface option

Functions	encoder input or emulation
Channels	A, B, Z with complement
Output resolution	512 or 1024 pulses/rev
Output levels	5V (RS422)
Input resolution	120-5000 increments/rev

Absolute encoder interface option

|	
Input voltage	24V ±10%
Scan code	Gray code, unit step
Data interface	RS422
Data format	24-bit, MSB first
Clock frequency	100kHz
Count direction	Increasing for clockwise rotation looking at the flange end of the motor

Delivery contents

Standard shipment	Controller, mating screw-terminal connectors, one copy parameter editor software per order

Handheld terminal

The BDF2/01 Handheld Terminal is a convenient menu-driven aid for operating & configuring the Compax M. It is connected and powered via the RS-232C port. The handheld terminal is particularly suitable for rapid troubleshooting and startup support, and has the following functions:

- Display of any desired status value
- Menu-driven configuration
- Viewing and editing of programs
- Viewing and editing of parameters
- Direct input of commands

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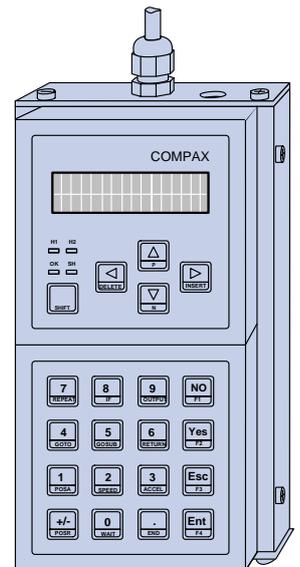
Three-phase direct on line power supplies

Two central power modules are available to power SV-M or Compax-M drives, with continuous ratings of 10kW (NMD10) and 20kW (NMD20). These supplies operate from a 3-phase AC input up to 460V. The DC output is connected to one or more servo drives by jumper cables fitted behind a removable front plate. A separate 24V DC supply is required to power the control circuits, permitting communication and diagnostic facilities to be retained should the main power supply fail.

Energy regenerated during deceleration will be stored in the power supply capacitors unless the DC bus voltage exceeds a preset level, in which case a ballast resistor is automatically switched in to dissipate the surplus energy. The high-power NMD20 module may be used in conjunction with an external ballast resistor to handle high regenerated energy levels. The separate power supply module is not required with the Compax 3500M

Power supply characteristics

AC supply voltage	460V +10% -15%
Supply frequency	50-60Hz
Safety specification	VDE0160
Control voltage	+24V DC ±10%, ripple <1V p-p
Control current	See ratings
Standby contact rating	0.5A, 60V, 30W
Overheating protection	Heatsink temperature >85°C
Overvoltage protection	Braking resistor switched in at preset level
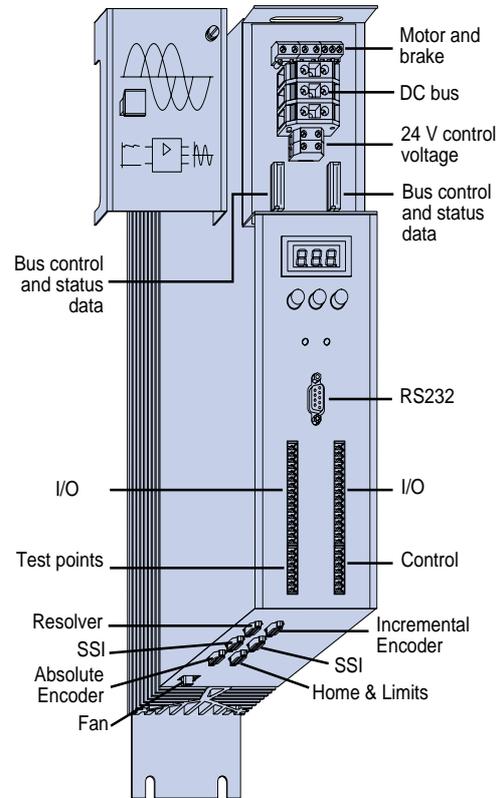
Power supply ratings

Model no.	Cont. power	Peak (<3s) power	AC supply voltage†	DC output voltage	AC supply protection*
NMD10	10kW	20kW	460V 3ø	650V	16A (20A with current)
NMD20	20kW	40kW	460V 3ø	650V	35A

*External cutout or equivalent cartridge fuse, supplied by customer   † Maximum voltage for CE compliance 400V

Power supply braking & ballast ratings

Model no.	Cont. power dissipation	Intermittent ratings: power	duration	cooling time	DC bus capacity	Storable energy
NMD10	120W*	4.0kW	<1s	>50s	1100µF	173 Ws
		17kW	<50ms	>10s		
NMD20	120W*	2.5kW	<1s	>50s	1100µF	173 Ws
		9.5kW	<50ms	>10s		
BMR4/1†	570W	37kW	<0.4s	>120s	-	-
BMR4/2†	740W	37kW	<0.6s	>120s	-	-
BMR4/3†	1.5kW	37kW	<1.2s	>120s	-	-

*Increased to 250W with fan option   †External ballast used with NMD20