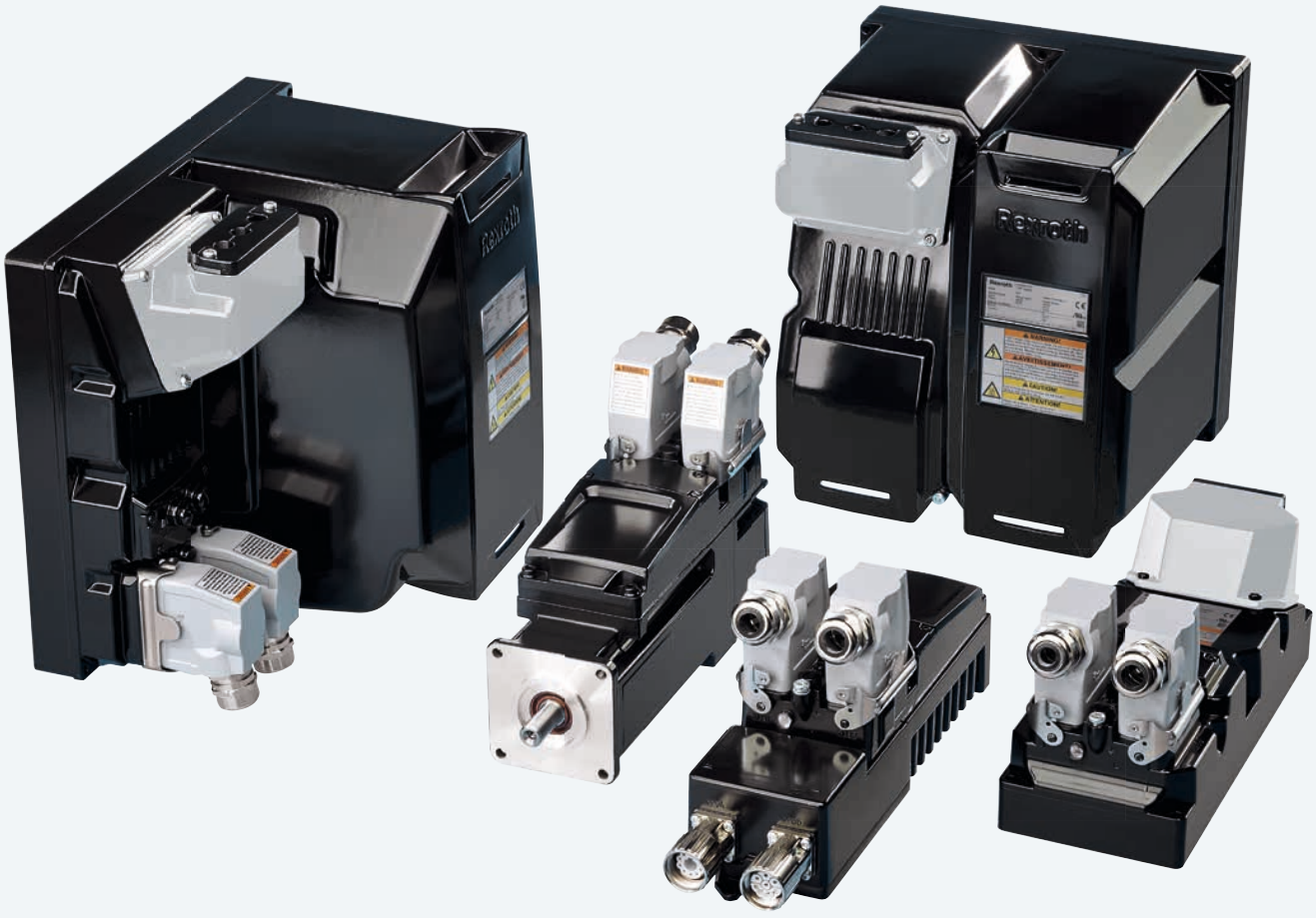
DBR AUTOMATION

The Drive & Control Company

Rexroth
Bosch Group

IndraDrive Mi
cabinet-free drive technology for maximum flexibility and efficiency

DBR AUTOMATION SL, Malaga Spain, Telf: +34 951709474 E-mail: comercial@dbrautomation.com



IndraDrive Mi:
Maximum flexibility in minimum space with the intelligent IndraDrive Mi

Consumer habits are changing faster than ever. New or modified products must be brought to market at an increasing rate. This poses a challenge to manufacturers and to plant engineering as a whole. Today's machines must be modular and scalable. Intelligent drive systems are in demand: compact, highly efficient, easy to integrate and, to save the most space, ideally cabinet-free. And this is exactly why Rexroth has developed the most flexible drive system in the world: IndraDrive Mi. The ideal gateway to Industry 4.0.

With the release of IndraDrive Mi in 2007, Rexroth revolutionized mechanical engineering. Since then, this cabinet-free drive technology has seen use across the globe. IndraDrive Mi has proven itself on the market countless times over with its flexibility when integrating into decentralized machine concepts and how easy it is to install and set up. And all this along with continuously adding new functions and models that place the expertise of Rexroth, the leading Motion Control provider, at the customer's fingertips.

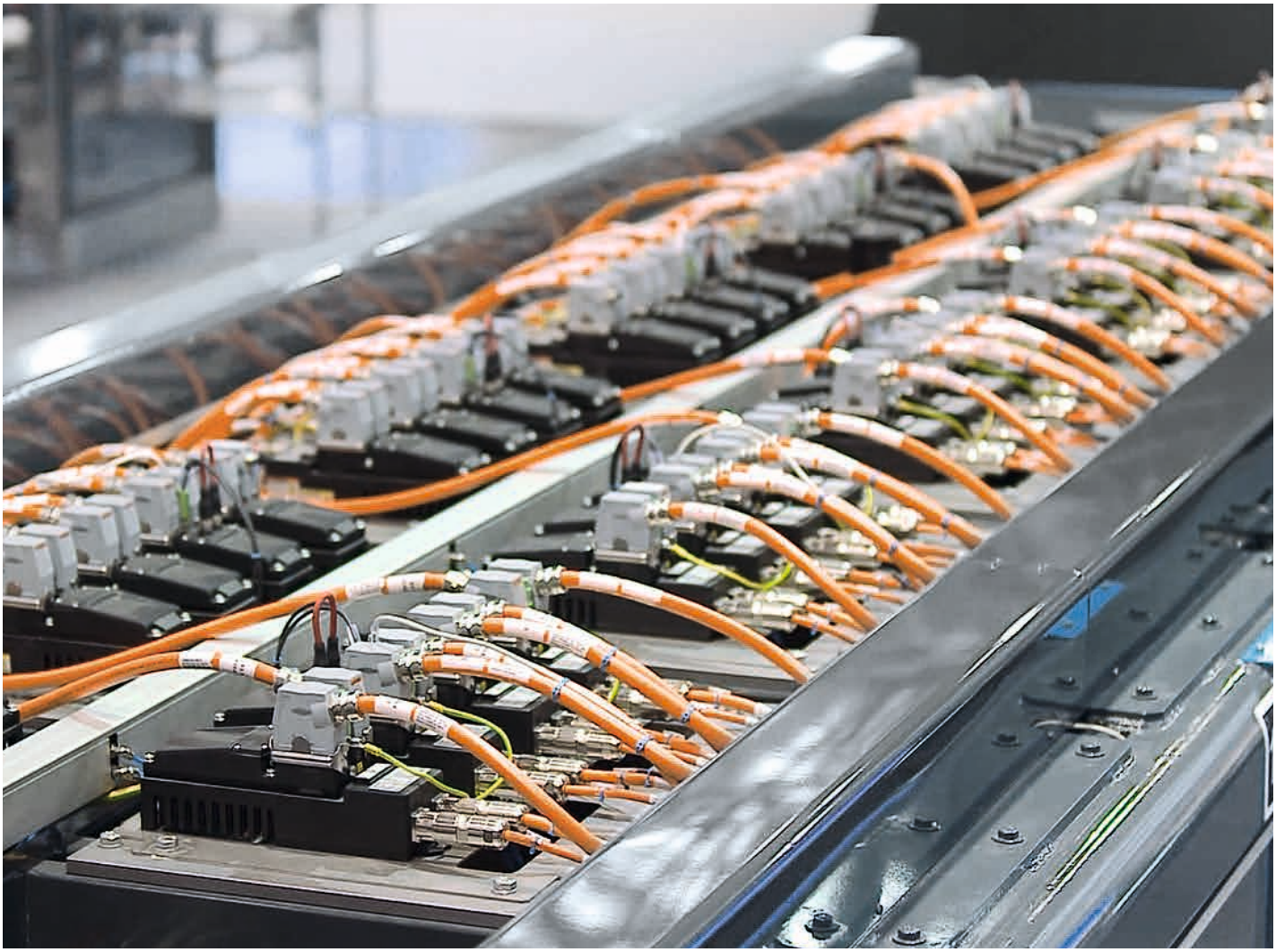
Reduce wiring around 90% and optimize power balance
With the intelligent IndraDrive Mi drive system, machine manufacturers today can transfer all of their drive technology, including mains connection and power supply, from the control cabinet directly into their machines. This saves space, reduced wiring effort by up to 90%, and optimizes power balance for the machine user.

Forget up to 100% of the control cabinet
With Ethernet-based communication and integrated Motion Logic, machine manufacturers have a complete automation system with the most certified safety functions. Rexroth is the first to consistently utilize all avenues of decentralized drive technology to even go as far as eliminate the control cabinet altogether.

Save 100% of external cooling
The cost effectiveness and sustainability of the IndraDrive Mi system lies not just in its flexibility and intelligence, but also in that it does not require any external cooling.

IndraDrive Mi:
All advantages at a glance

IndraDrive Mi enables machine manufacturers to integrate all electrical drive components directly into the machine. The result are entirely cabinet free, modular machines with a minimized required space.



Energy-efficient power supply
- Compatible and freely combinable with the IndraDrive drive system
- Energy saving by using the common DC bus, power recovery, energy buffering, power for other drives
- Supply multiple drive strings with a single unit

Intelligent communication
- Supports all relevant Ethernet-based communication protocols (Sercos, PROFINET IO, EtherNet/IP, EtherCAT, POWERLINK)
- Uniform hardware, protocol selection via software
- Communication ports for integrating sensors and actuators (I/O, pneumatics, hydraulics, third party)

Time-saving installation
- Cabinet-free
- Up to 90% less wiring with hybrid cable technology for supply and communication
- No external cooling needed
- Simple drive string expansion with hybrid cable technology

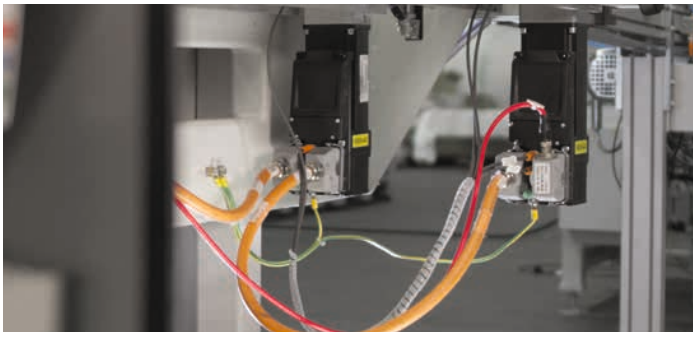
Flexible control functions
- Drive-integrated Motion Logic for axis-based tasks in the drive string
- Ready-made, industry-specific technology functions for fast parameterization
- Programming in accordance with IEC 61131-3

Drive-integrated safety technology to effectively protect man, machine, and work piece
- Safe Torque Off
  - Simple mapping of safety zones
  - Certified Cat 4, PL e under EN ISO 13849-1 and SIL 3 under EN 62061
- Safe motion functions with safety controller
  - Functions without encoder certified Cat 4, PL e under EN ISO 13849-1 and SIL 3 under EN 62061
  - Functions with encoder certified Cat 3, PL d under EN ISO 13849-1 and SIL 2 under EN 62061

Optimal design
- Easy to clean
- IP65 protection type
- Various hybrid cables for minimized cabling effort or for tight spaces
- Option for rotating applications with slip-ring systems
- Option for potentially explosive atmospheres (ATEX)

Application-optimized concept for energy efficient production
- DC bus capacities (KLC) for dynamic energy storage at Smart Energy Mode

▼ **Real example from the packaging industry: The difference between conventional wiring (top) and hybrid cabling (bottom) is obvious. Several hundred meters less cable, several hours less work**



System design:
As simple as it is cost-effective

The unique system design of the IndraDrive Mi drive solution is the key to high cost effectiveness and flexibility. Make your drive technology completely self-sufficient and cabinet-free with IP65 system components. Or use existing converters and supply modules in a control cabinet and power up to 30 drives in one cable harness with control electronics. Whichever you choose, installation and cooling will be minimal. Control cabinet volume is reduced substantially. Or even eliminated altogether.

Control cabinet volume reduced ...
IndraDrive Mi adapts easily to all modular frameworks like no other system. The cabinet-reducing variant uses an existing converter (HCS) or modular supply unit (HMV) to provide power. All variants feature a DC bus for optimal energy exchange between regenerative and motorized axes. The power stays in the system.

IndraDrive Mi only requires drive connection box (KCU) placed in the control cabinet next to a supply unit for operation. It provides voltage and communication supply for a drive string with up to 30 nodes and protects them against short circuit. Additional IndraDrive Mi strings, each up to 200 meters in length, can be connected using more KCUs.

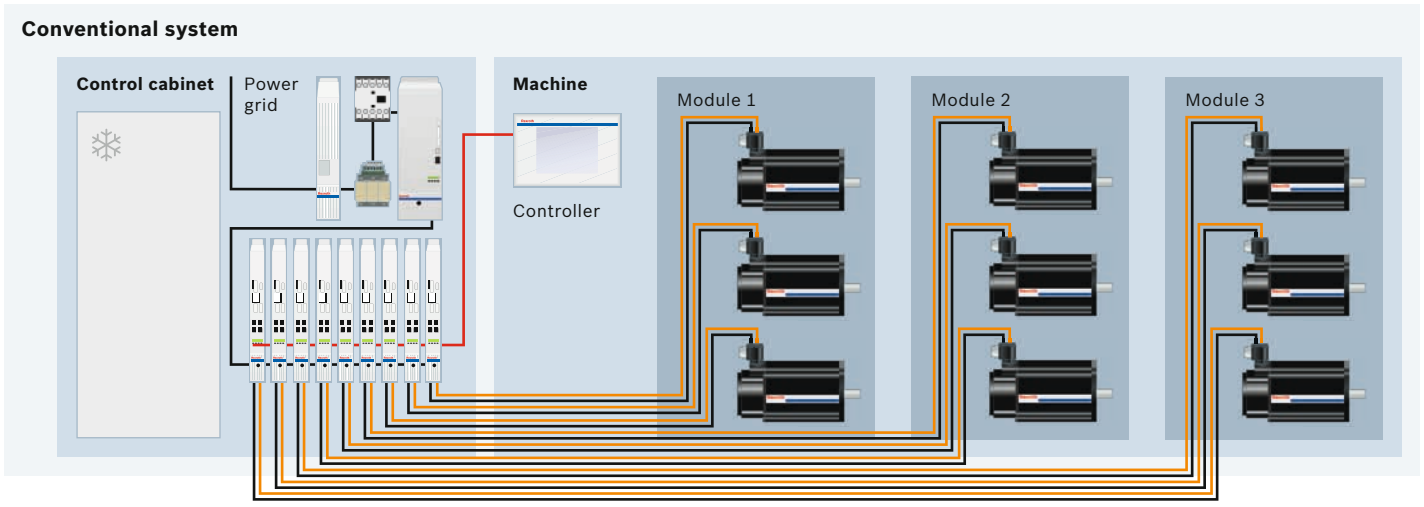
... or eliminated altogether
However, the IndraDrive Mi system can also be completely self-sufficient and cabinet-free with the IP65 supply module. The mains module (KNK) is connected directly to the power grid. The supply module (KMV) replaces the regenerative power supply and control electronics in the control cabinet. This means the entire drive system can be integrated directly into the machine. Any power supply components still in the control cabinet (mains filter, mains contactor, mains throttle, supply unit) are eliminated.

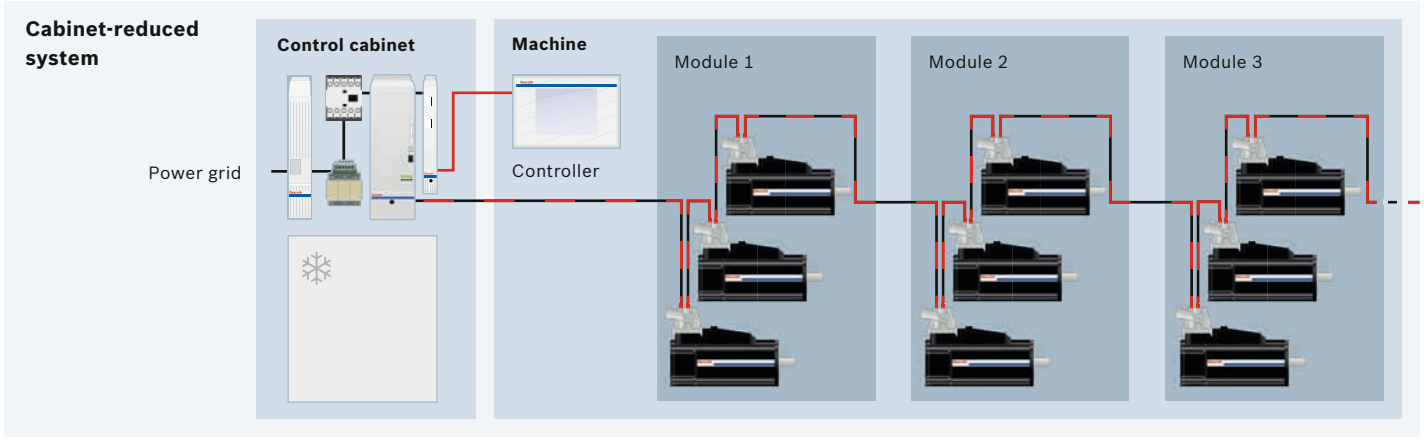
The result:
- **100% cabinet-free**
- **100% flexible**

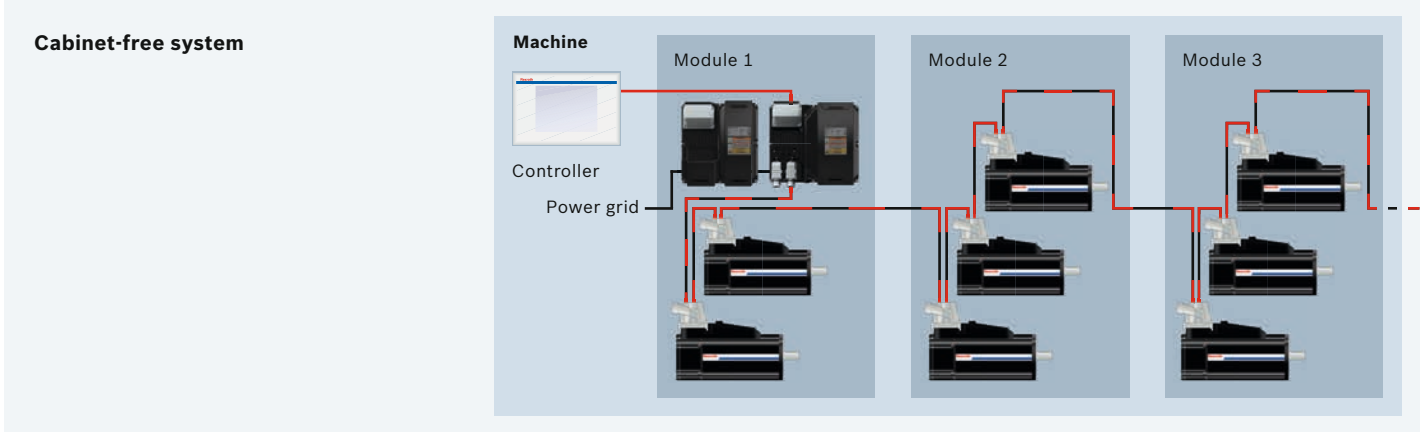
A hybrid cable directly daisy-chains the serial drives. Up to 30 in one string. No distributor boxes needed. The motor-integrated servo drives (KSM) consist of a Rexroth servo motor with an integrated inverter. The motor casing surface cools the system.

Near-motor servo drives (KMS) can be used where space is tight or motors without integrated inverter electronics are required. The inverter electronics are installed elsewhere in the system and connected to the motor.

- **Compared to conventional variants, the IndraDrive Mi can not only reduce control cabinet volume, it can eliminate the control cabinet altogether. This saves up to 90% of the wiring and no control cabinet cooling system is necessary**


Conventional system
Control cabinet
Power grid
Machine
Controller
Module 1
Module 2
Module 3


Cabinet-reduced system
Control cabinet
Power grid
Machine
Controller
Module 1
Module 2
Module 3


Cabinet-free system
Machine
Controller
Power grid
Module 1
Module 2
Module 3

Installation: Unrivaled simplicity and trouble-free expansion

With the simple system design of the IndraDrive Mi, you not only save on components, but above all on installation. Up to 90 % less wiring, minimal control cabinet volume, and drastically reduced cooling load. This is what Rexroth offers – and in the area of expandability, Rexroth offers even more.

Only one cable is needed to connect drives in series. This saves big compared to conventional installations: For example, a system with 60 servo drives no longer requires 120 cables to be routed several meters through the machine, it only requires two hybrid cable – this immediately saves you several thousand meters of cable in addition to the costs, labor, and restricted flexibility.

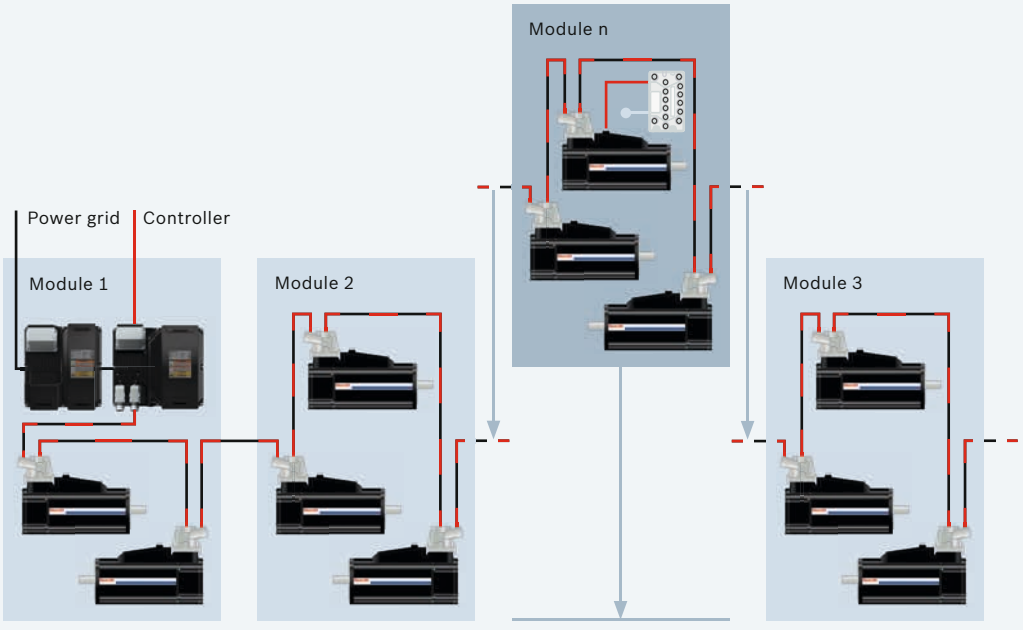
If the system needs drives later on, e.g., in the form of an additional machine module, they are simply integrated at the end or wherever they are needed. Done. And all without affecting existing installations or the rest of the system.

At the same time, you can also connect sensors, I/Os, and fieldbus components directly to the IndraDrive Mi drives. This even saves on wiring costs beyond just the drive system itself. It does not get any easier.

For special circumstances, e.g., extremely tight spaces or peripherals that need to be connected individually, Rexroth also offers another wiring alternative in the form of a thin cable for power and internal signals and another one for communication. This allows the cables to be bent very tightly.

All in all, installation with numerous advantages:

- Control cabinet volume reduced by up to 100%
- Up to 90% less wiring
- Control cabinet cooling output reduced by up to 100%
- Easier integration of additional machine modules, sensors, I/Os and fieldbus components



Communication: Built-in intelligence

Automation needs communication. That is why it is our job to advance communication in systems and design a wide variety of applications to be user-friendly through multi-protocol-capable hardware and software that greatly increase the flexibility and modularity of machines, as well as through seemingly small details, such as a single hybrid cable that intelligently consolidates power and communication.

The multiprotocol-capable communication hardware in IndraDrive Mi meets the growing demand for openness and integration. It can be operated with all standard industrial controllers. The protocol for the Ethernet-based interfaces is selected in the software.

The following protocols are available:

- Sercos
- PROFINET IO
- EtherNet/IP
- EtherCAT
- POWERLINK

- CIP Safety on Sercos (CSoS)
- Safety over EtherCAT (FSoE)
- PROFIsafe on PROFINET

Control communication can be optionally extracted to inexpensively integrate I/O units or pneumatic and hydraulic actuators into an IndraDrive Mi cable harness.

IndraDrive Mi – the most communicative drive in the world
The result of so much intelligence in a system speaks for itself: You are getting the most communicative decentralized drive solution on the market today.

sercos the automation bus

The automation bus Sercos fulfills all requests of interlaced machines with its openness, flexibility and standardization. It connects all devices of a production system in a horizontal network by hard real time functions and opens by the integration of open Ethernet-protocols new possibilities for vertical networking.

PROFINET

EtherNet/IP

EtherCAT

ETHERNET POWERLINK

CIP Safety

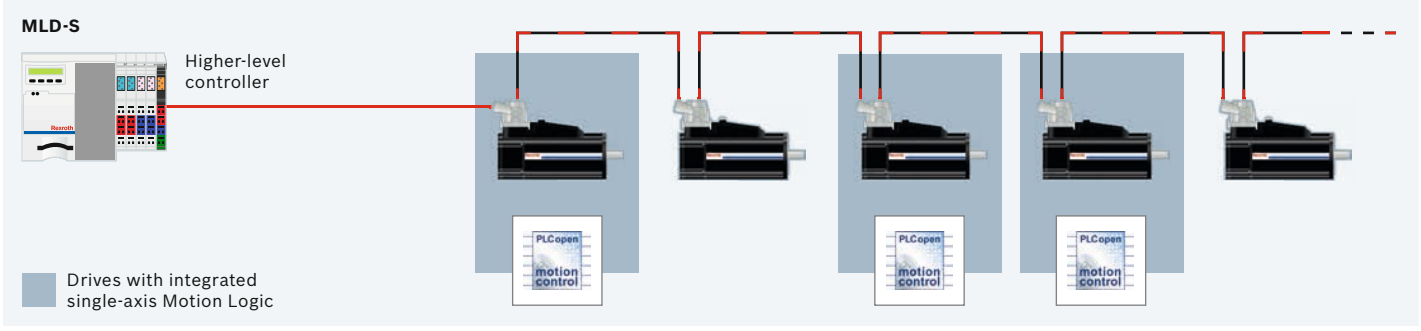
Safety over EtherCAT

PROFIsafe PROFINET

Control functions: More options for each application

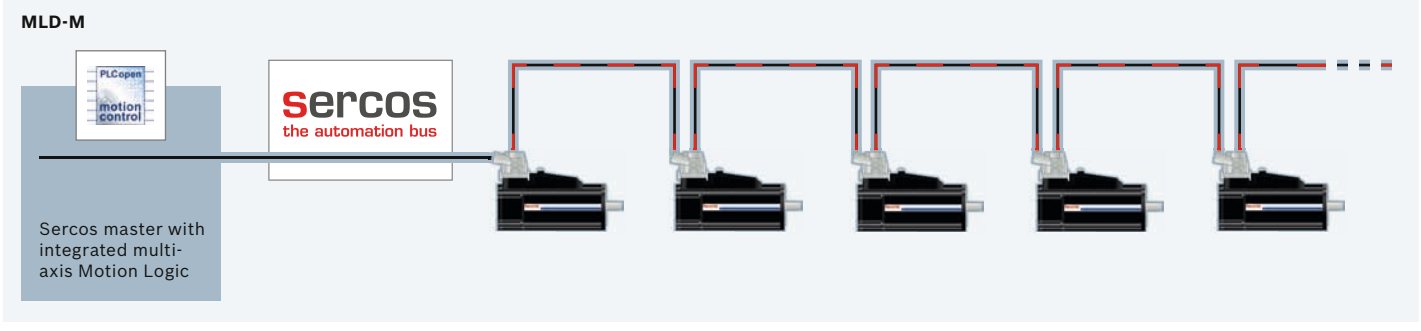
i 4.0
CONNECTED INDUSTRY

IndraDrive Mi also sets the course for controllers for advancing to Industry 4.0: With IndraMotion MLD, Rexroth's drive-integrated controller, the drive functions, motion control and PLC logic merge into an open automation platform for modular machine concepts. This allows for applications to be easily implemented regardless of the controller.



IndraMotion MLD-S single-axis Motion Logic
In order to execute axis-based drive tasks and thereby relieve the higher-level controller, the system comes with the option of transferring individual functions to individual drives. Extensive, predefined technology functions can also be used, or a separate application flexibly created.

IndraMotion MLD-M multi-axis Motion Logic
For applications with a limited number of axes, a Sercos master drive can coordinate up to nine additional Mi drives. Even more complex motion tasks can simply be executed at the drive level without a higher-level controller.



Energy efficiency: Optimized and adapted to each application

4EE ENERGY EFFICIENCY

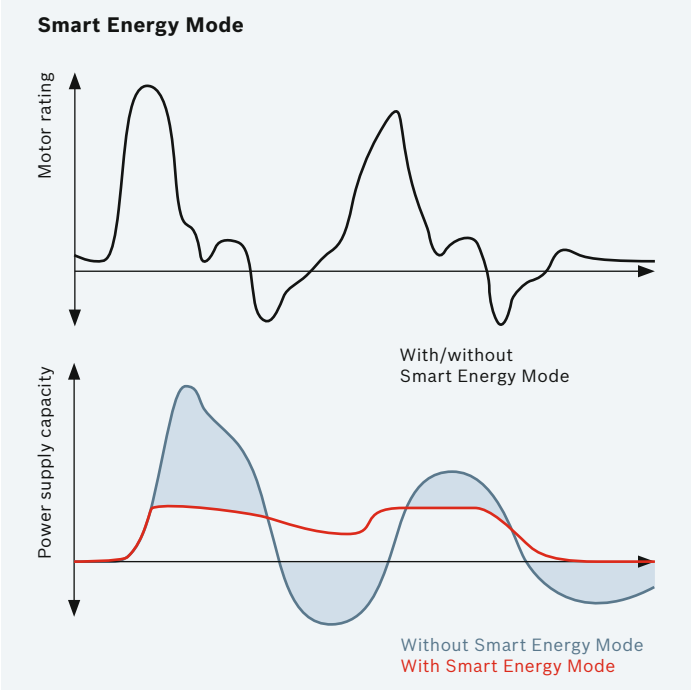
With IndraDrive Mi, you benefit from a consistently application-optimized concept for thoroughly energy-efficient production. A variety of static and rotative energy accumulator options, Smart Energy Mode options, and numerous other options are at your disposal to save energy and reduce peak loads in the power grid.

Power recovery
The recovery of excess energy to the power grid drastically reduces energy consumption, especially in regenerative mode over longer periods, while maintaining top power quality.

Smart Energy Mode
In Smart Energy Mode, the supply module is regulated to provide a DC bus voltage regardless of line voltage. This prevents peak loads and greatly reduces average energy consumption. The result: better grid compatibility, and the same machine performance with smaller components.

Electric and kinetic buffering
Large amounts of energy can also be stored in a buffer: With electric buffering, DC capacity is simply stored; with kinetic buffering, excess energy is converted into kinetic energy, buffered, process-optimized and provided to the system.

DC bus coupling
It is possible to exchange energy between all axes and utilize the central energy accumulators since the drives are inherently connected through the DC bus.



Reactive current control
Regulating the reactive current eliminates losses in the power supply string caused by reactive current. Other inductive and capacitive consumers can also be offset.

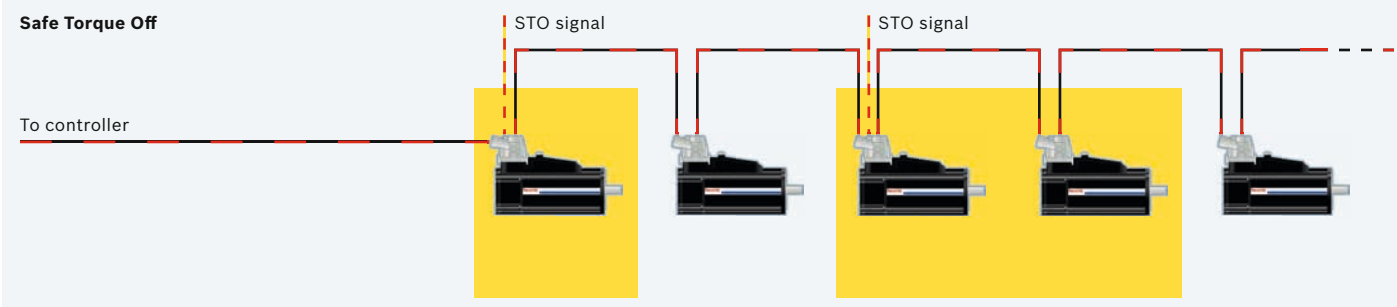
Safety functions: Dynamics always under control

SAFETY ON BOARD

It is paramount in any kind of application for persons to be protected from uncontrollable machine movements. IndraDrive Mi offers flexible solutions for integrating safety technology into the overall system: While the Safe Torque Off safety function cuts of the torque on the drives within a few milliseconds, the Option Safe Motion safety technology provides a broad range of safety functions. They range from safe stops to safe movements.

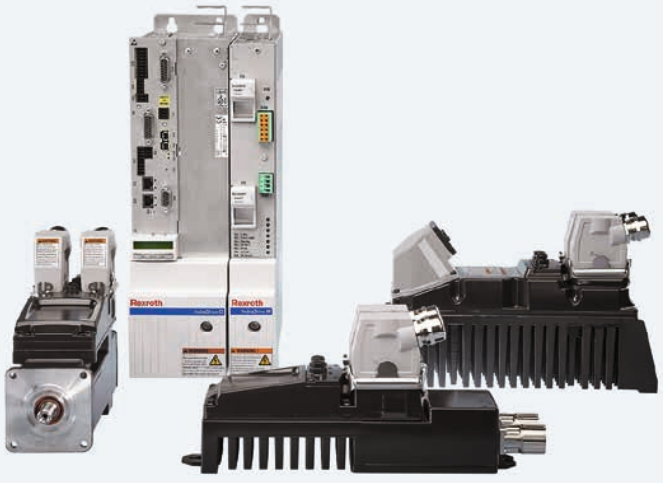
The drive-integrated Safe Torque Off saves on hardware and reduces wiring costs, since no higher-level controller is required. In addition to simultaneously disabling the torque in all drives, any number of various safety zones can be mapped by IndraDrive Mi. The IndraDrive Mi STO function is certified Cat 4, PL e under EN ISO 13849-1 and SIL 3 under EN 62061. The Safe Motion safety function is controlled by a safety controller.

The functions that do not require an encoder are certified CAT 4, PL e under EN ISO 13849-1 and SIL 3 under EN 62061. Functions that inherently require encoder feedback comply with Cat 3, PL d under EN ISO 13849-1 and SIL 2 under EN 62061. For these, IndraDrive Mi uses the CIP Safety on Sercos, Safety over EtherCat and PROFIsafe on PROFINET safety standards for protocol backup.

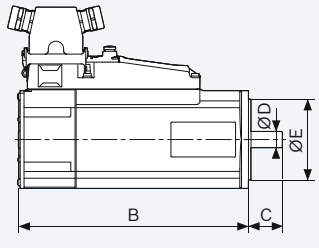


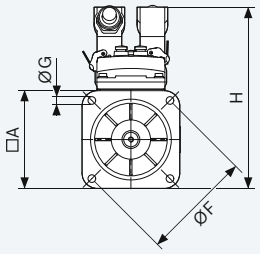
Servo drives: Motor-integrated servo drive KSM and near-motor servo drive KMS

The compact power and control electronics of the KSM motor-integrated servo drive uses the casing surface of an MSK servo motor as the cooling element. This reduces the overall volume by more than 50 % compared to classic servo drive solutions and up to 30 % compared to other integrated solutions.



KSM motor-integrated servo drive

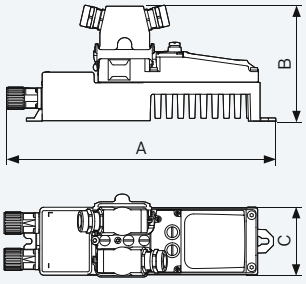




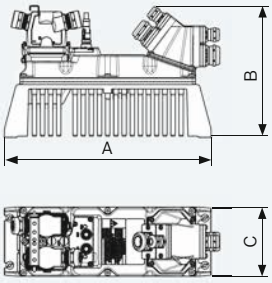
Motor-integrated servo drive			Maximum speed	Permanent torque	Maximum torque	Continuous stall current	Maximum current	Moment of inertia	Dimensions								Mass
			n_{Max}	$M_{0\,60\,K}$	M_{Max}	I_0	I_{Max}	J_R	A	B	C	ØD	ØE	ØF	ØG	H	m
			[rpm]	[Nm]	[Nm]	[A]	[A]	[kgm²]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[kg]
KSM02.1B	-041	C-42	5500	2.2	9.4	1.5	6.8	0.00017	82	252	30	14	50	95	6.6	194	5.6/5.9
KSM02.1B	-061	C-35	4300	6	25	3.3	14.9	0.00087	115	271	40	19	95	130	9	219	9.6/10.1
KSM02.1B	-061	C-61	6000	5.5	18	5.2	17.7	0.00087	115	271	40	19	95	130	9	219	9.6/10.1
KSM02.1B	-071	C-24	3400	10.5	35	4.6	17.7	0.00173	140	307	58	32	130	165	11	247	14.1/15.2
KSM02.1B	-071	C-35	4700	10	28	6.0	17.7	0.00173	140	307	58	32	130	165	11	247	14.1/15.2
KSM02.1B	-076	C-35	4700	8.7	29	5.2	17.7	0.0043	140	290	50	24	130	165	11	247	14.6/15.7

The KMS near-motor servo drive allows a wide range of motors to be integrated into an IndraDrive Mi drive string. It is designed to be used when integrating other Rexroth servo motors or 3rd-party motors.

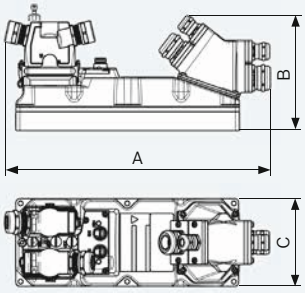
KMS02.1B-A018
near-motor servo drive
(natural convection)



KMS03.1B-A036
near-motor servo drive
(natural convection)



KMS03.1B-B036
near-motor servo drive
(thermal interface for coldplate mounting)



	KSM02	KMS02	KMS03
Single-turn optical encoder	●	–	–
Multi-turn absolute optical encoder	●	–	–
Single-turn capacitive encoder	●	–	–
Multi-turn absolute capacitive encoder	●	–	–
Smooth shaft	●	–	–
Keyway	o	–	–
Safe Torque Off (STO)	o	o	o
Safe Motion (SS1, SS1-ES, STO, SS2, SOS, SLS, SMS, SMD, SLI, SDI, SBC)	o	o	o
Multi-Ethernet communication (Sercos, PROFINET IO, EtherNet/IP, EtherCat, POWERLINK)	●	●	●
Multi-Ethernet extraction	●	●	●
Separate Multi-Ethernet	●	●	●
4 digital inputs/outputs (2 can be used as quick probes)	●	●	●
Motion Logic in acc. with IEC 61131	o	o	o
Encoder interface	–	o	–
Multi-encoder interface	–	–	●
Natural convection	●	●	●
Thermal interface	–	–	●

● Included ● Alternative o Optional – Not available

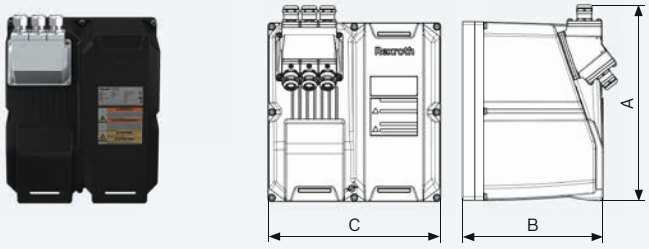
Near-motor servo drive	Continuous stall current	Maximum current	Dimensions			Mass
	I_0	I_{Max}	A	B	C	m
	[A]	[A]	[mm]	[mm]	[mm]	[kg]
KMS02.1B-A018	6	18	341	147	86	2.5
KMS03.1B-A036	12	36	344	209	110	
KMS03.1B-B036	22	36	320	144	110	

(For further details and technical specifications, see the catalog or visit: www.boschrexroth.de/indradrive-mi)

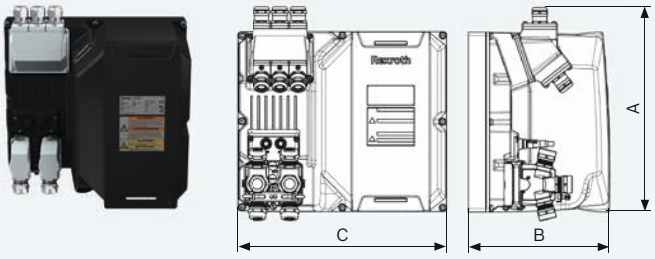
Mains and DC bus components

The main target for the power supply and control components is the same: as cabinet-free as possible, as little wiring as possible. For technically optimized and cost-effective engineering – and individual applications. The complete package becomes still much more flexible with the new cooling options. In addition to the thermal interface for cold plate (B) or insulated mounting (I), models that utilizes convection through a ribbed cooler (A) and forced air cooling (W) are now available.

KNK03 mains module
Thermal interface for coldplate mounting



KMV03 supply module
Thermal interface for coldplate mounting



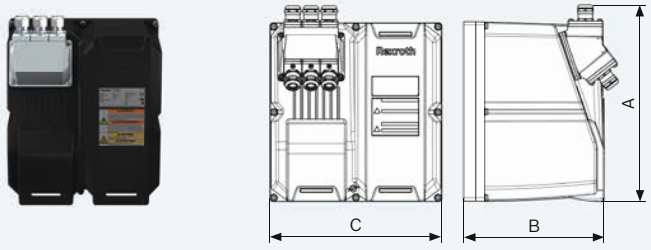
KNK mains module
For direct power from the grid. With integrated mains filter, mains choke and mains contactor. Available in IP65 protection type and connectable to the KMV supply module.

KMV supply module
The feeding and regenerating KMV module is also IP65-compliant and has an integrated brake chopper, braking resistors for 13.5 kW maximum power and a 24/42 V DC converter.

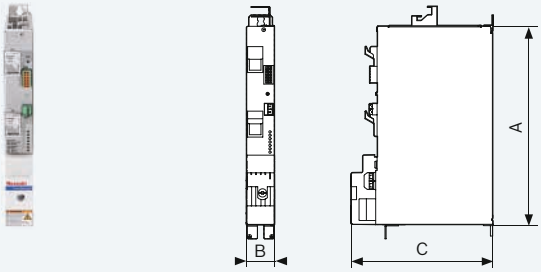
	Mains connection voltage	Mains frequency	Continuous mains input current	Dimensions		
	V_{mains}	f_{mains}	I	A	B	C
	[V]	[Hz]	[A]	[mm]	[mm]	[mm]
KNK03.1A-NR-**B**	3 AC 380–500	50/60	12	306	243	270
KNK03.1A-NR-**I**	3 AC 380–500	50/60	2.3	306	243	270
KNK03.1A-NR-**A**	3 AC 380–500	50/60	8.1	360	283	274
KNK03.1A-NR-**W**	3 AC 380–500	50/60	9.5	360	283	274

	DC bus voltage (regulated)	Continuous DC bus power	Maximum power	Dimensions		
	V_{DC}	P_{cont}	P_{max}	A	B	C
	[V]	[kW]	[kW]	[mm]	[mm]	[mm]
KMV03.1R-**B**	750	7.5	15	318	220.5	325
KMV03.1R-**I**	750	1.5	15	318	220.5	325
KMV03.1R-**A**	750	5	15	360	280	330
KMV03.1R-**W**	750	6	15	360	280	330

KLC03 capacity module



KCU drive connection box



KLC03 capacity module

The capacy module KLC03 is used to avoide power peaks on the mains. Further it enables the storage of energy for backwards movement in case of mains failure or allows to increase the peak power within the DC bus.

KCU drive connection box

The compact KCU drive connection box provides all the necessary connections from the IndraDrive Mi drive string to a common connection point and protects them against short circuit. It also transmits status and diagnostic messages between the drives and the supply unit. A KCU is only necessary when the control cabinet already has a power supply.

	Cycle time	DC bus voltage	DC bus capacity	Dimensions		
	t_{cyc}	U_{DC}	C_{DC}	A	B	C
	[s]	[V]	[mF]	[mm]	[mm]	[mm]
KLC03.1-**B**	i.p.	540–750	4.7	306	243	270
KLC03.1-**A**	i.p.	540–750	4.7	360	283	274
KLC03.1-**W**	i.p.	540–750	4.7	360	283	274

	Rated voltage	Rated current	Dimensions			Mass
	V_{LN_rated}	I_{LN}	A	B	C	m
	[VDC]	[A]	[mm]	[mm]	[mm]	[kg]
KCU02.2N	540–750	25	352	50	252	3.8

Accessories

Hybrid cable with communication
For minimized cabling effort in the IndraDrive Mi drive chain.

Hybrid cable without communication
For tight spaces and minimized bending radius. A separate communication-cable between the servo drives is needed.

Hybrid cable with round connector
Very compact design useful for small cable tubes or cable feedthrough in machines.
Compatible for the connection with RIE-TECH slip-rings to transmit energy and communication to rotating machines.

Hybrid connector
To connect motor-integrated servo drives KSM and near-motor servo drives KMS when mounted directly side by side.

End plug
For terminating each drive string.

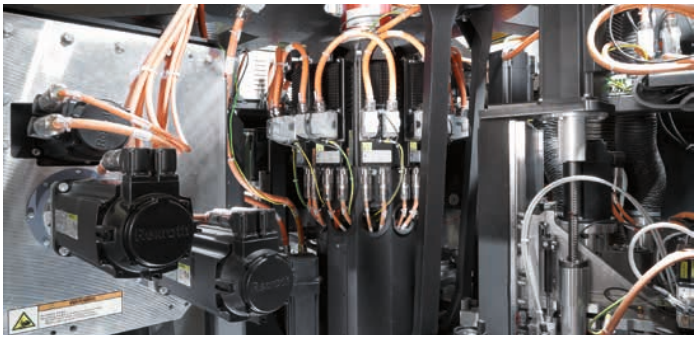
Interface cable
Pre-assembled, for connecting sensors to the IndraDrive Mi digital I/Os and for the input of the safe torque off signal.

Plug for safety zone subscriber
For easy creation of security zones when using the safety function Safe Torque Off.

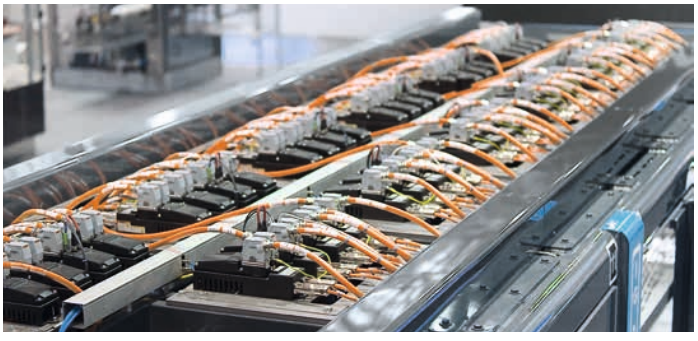
Best practice: Numerous drives in tight spaces

IndraDrive Mi systems are in use in factory automation across the world by machine manufacturers in all sectors who want or need to transfer all of their drive technology, including controller intelligence and power, from the control cabinet to the machine to save space and wiring, especially in the packaging and printing industries and when it comes to installation and handling. The plant construction and engineering sectors benefit in particular. See three real examples to learn how.

KBA Kammann: Changing over in under 60 minutes
Changing over a screen printing press normally takes up to four hours. Kammann uses Rexroth automation systems to implement a new, modular machine concept with up to 155 drives, reducing changeover times by a factor of four. A slip-ring system for rotating applications which can be integrated in the drive chain, allows a compact machine design.



CAMA Group: Controlling robots without collision
The latest high-end loading unit at CAMA uses 12 robots in the smallest of areas. The near-motor drives are directly installed on the machine and outside of the clean area. Supported by patented CAMA anti-collision software, they provide for extremely dynamic movements. The result: an extremely clever co-flow loading unit.



Wave generator: Precisely and flexibly simulating
For the precise simulation of sea conditions, Hamburger Schiffbau-Versuchsanstalt (HSVA), a shipbuilding laboratory, relies on cabinet-free IndraDrive Mi drives. The individual sections of the wave generator can be modularly expanded at any time, and can be flexibly installed and removed with unrivaled ease and without the usual wiring chaos. For precise, reproducible, high-dynamic and high-accuracy waves every time.

In order to determine savings potential for your application, use our savings calculator at www.boschrexroth.de/indradrive-mi

You can also find other interesting application examples

The Drive & Control Company

Rexroth
Bosch Group

Bosch Rexroth AG
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr, Germany
www.boschrexroth.com

Find your local contact person here:
www.boschrexroth.com/contact

Further information:
www.boschrexroth.com/indradrive-mi

R999000023 (2016-11)