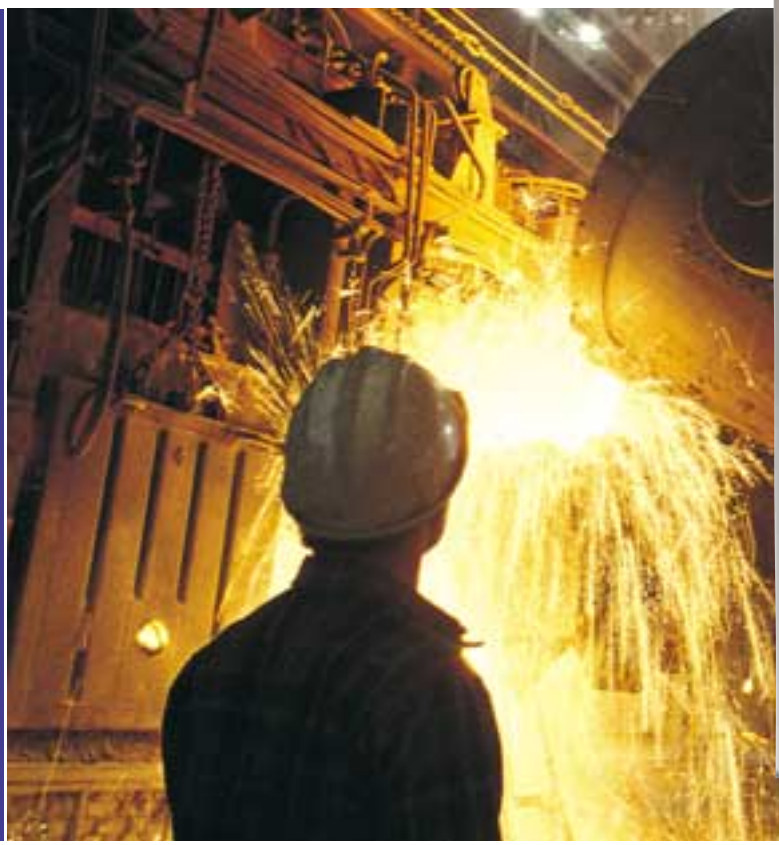
Crane Motion Control

ASTAT®

Crane Motion Controller ASTAT®

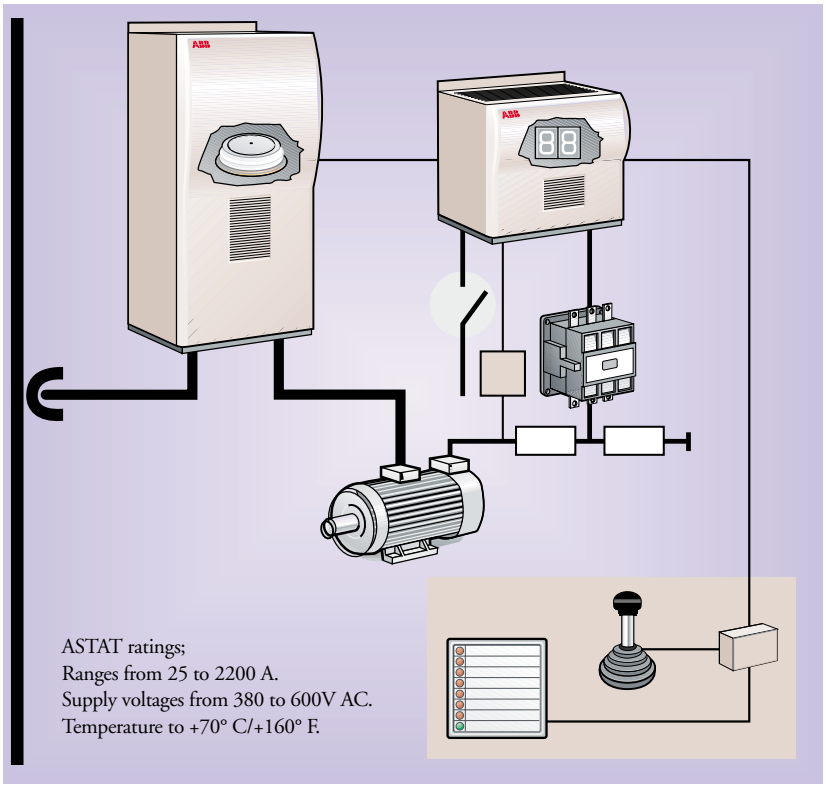


Leading edge control for demanding applications

ABB

ASTAT®

– Leading edge control for demanding applications



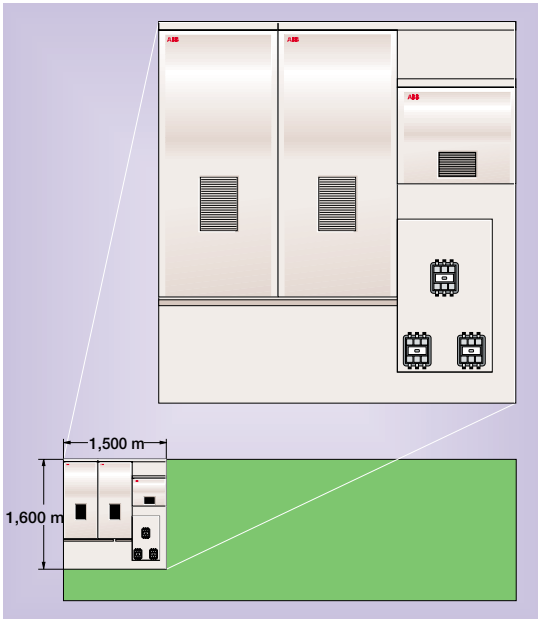
Compact, robust and reliable

ASTAT is designed to meet the demands of space conscious crane designers - a control panel for a 1.5 MW hoist is only 1.6 m high and 1.5 m wide. Component design makes it possible for cranes to operate effectively at high temperatures and in aggressive environments. High quality components, safety features and diagnostic programs make for a long, reliable operating life.

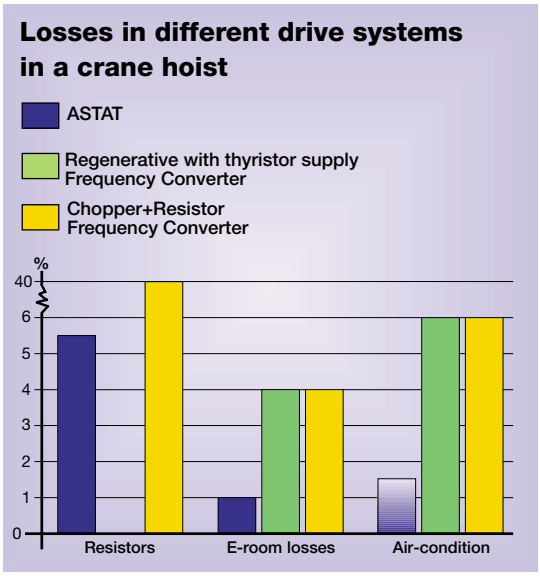
ASTAT® is a highly developed, wellproven system for speed controlled heavy duty motors in industrial cranes. Designed for even the toughest environments ASTAT brings reliable, cost effective crane control into the computer age. Using leading edge computer technology, ASTAT now combines advanced control features with comprehensive information and data distribution to enhance performance at all levels.
ASTAT is made specially for high utilisation, designed with higher grade components and larger margins than normal industrial drives.

- *Robust, well proven thyristor control*
- *Compact, low loss, integrated design*
- *Comprehensive operator information simply displayed*
- *Fully digital system means no drift in parameter settings*
- *PC spread-sheet applications for engineering and equipment management*
- *Data communications link for monitoring, maintenance and high level automation*
- *Rapid installation and commissioning*
- *Option packages for advanced functions*

ASTAT® – the economical and effective approach to crane control



A 2000 A motion control system.



Energy balance – the key to sustained low running costs. Overall power loss in an ASTAT system is low and compares favorably with regenerative frequency converter methods with, in many cases, the added advantage of not needing complicated and expensive climate control.

ASTAT is by far the most economical way to control EOT cranes or other installations due to its high quality design, excellent controllability and optimisation for low total installation costs. ASTAT is:

More efficient and reliable

ASTAT operates reliably even at 70 % of nominal line voltage so it is suitable for locations with a weak power supply.

It is made for many years service in tough environments even at +70° C/160° F. ASTAT is unique as a totally digital motion control system without drift in settings over this extended temperature range - starting with a Scandinavian winter!

Effective to install

ASTAT uses less space for electrical installation and is lighter than other control equipment. It needs less ancillary equipment with basic integrated functions like PTC-relays.

ASTAT imposes less than 0.5 % reduction in voltage for internal power losses and needs less air conditioning. In most cases it needs no air conditioning at all.

It is not sensitive to type or length of motor cables. The control cables can be laid together with power and lighting cables without risk of interference.

Easier and cheaper to run

ASTAT has first class torque response and there is no reduction in torque compared with a motor connected direct on line. The driver gets a very obedient motion controller!

As a closed loop speed controlled drive, ASTAT gives speed control independent of load from zero speed and minimises wear of brakes and contactors.

For hoists and similar applications the lowering energy is recovered and fed to the mains.

Made for automation in tough environments

ASTAT has communication links for integration in overall automation systems. Transducers such as pulse encoders and laser transmitters can be connected to ASTAT as is, without additional interfaces.

In this way your crane is already prepared for total automation when you install a stand-alone ASTAT.

Easier to maintain

The simple system is rapidly and easily understood.

The built-in fault diagnosis is simple and direct and will speed up emergency repairs. It can also be linked to higher level monitoring system with more extended functions to permit maintenance scheduling.

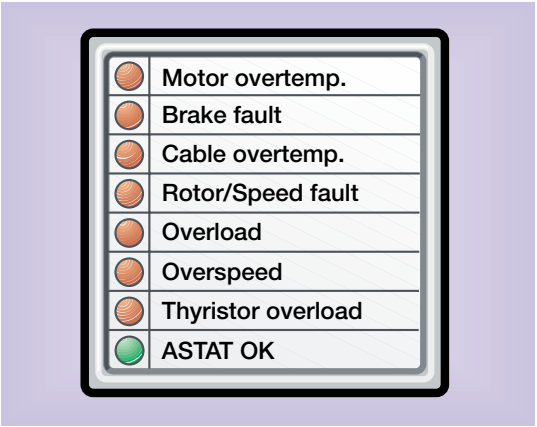
Cost effective control for industrial crane motors

ASTAT is a well established system of crane motor control using phase control thyristors. It includes all the usual functions for crane control such as joystick handling, limit switch logic with slow down and stop, automatic brake application approaching zero speed and closed loop speed control.

Using a newly developed torque and current regulator, supporting the inherently stable voltage control, ASTAT optimises motor control giving improved crane response and longer component life by controlled smooth handling.

Lower energy wastage, longer component life, lower stress on drives and operators mean that ASTAT gives you higher availability and better control.

Set up dialogue from software tool.



Operator's Alert Panel.

Simple to operate

ASTAT provides comprehensive information, simply displayed. There is immediate visual indication via an LED array, of crane status providing the operator with essential information at a glance.

Joystick motion control can be either stepped or stepless. The user determines whether to control the speed or the torque. All other operations are intrinsic parts of ASTAT control system.

Rapidly installed and commissioned

ASTAT is designed for rapid, trouble-free installation. The modular nature of the system makes adaptation to the crane structure a simple task, with less demanding requirements for the electrical room and lower costs for air conditioning of vital components. Electric power and control signals are easily connected with minimal cabling.

Commissioning ASTAT is just as easy. The majority of parameters are preset before delivery, leaving only a few parameters for manual setting on site. A special commissioning mode allows rapid on-site testing of the mechanical shaft train and the main electrical circuits. A standard PC is used for setting local operating parameters and commissioning via dialogue boxes.

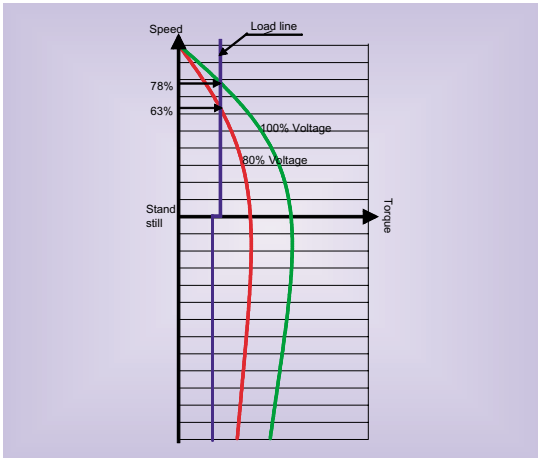
Simple to maintain

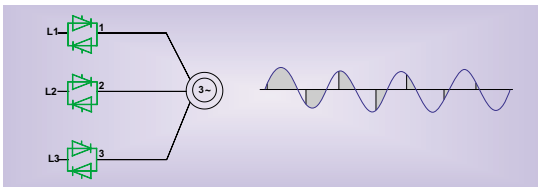
Advanced diagnostics with fewer components, high heat tolerance, plug in components and improved control over motion for reduced stresses on the crane structure all help to make maintenance simpler and less frequent. There is a common spares list for the entire ASTAT range, reducing the number of different parts needed for different cranes. With over 5,000 ASTAT units in use around the world, mainly in steel works, there is a great deal of experience to call upon for support.

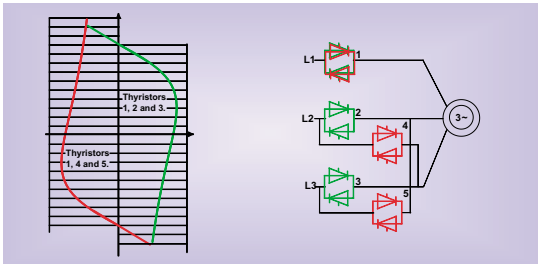
More economical in parts

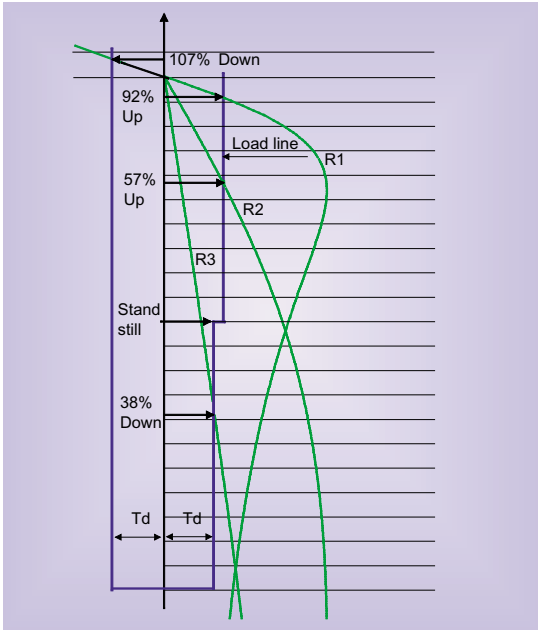
ASTAT systems share common parts throughout the power range, thereby reducing the variety of spare parts needed in stock. The plug in connections facilitate rapid, uncomplicated replacement.

Inherently stable control...









It all works as a car, ASTAT uses two variables for control: Stator control, corresponding to the accelerator of the car, and the Rotor control, corresponding to the gearbox. To continue this analogy, a good driver will use the brake only in emergency situations and as a parking brake.

As in a modern car, the control system includes extra functions like cruise control (speed regulator) and automatic gearbox (optimisation of rotor characteristic).

Stator control by electronic voltage control regulates the torque from the motor...

The aim is to maintain a desired speed. This is achieved by controlling the motor torque. The peak torque is approximately proportional to the square of the voltage. In the example shown here a voltage reduction from 100 % to 80 % reduces the speed from 78 % of synchronous speed to 63 %.

By means of a pair thyristors in each phase, the voltage can be reduced steplessly from full line voltage to zero.

The microprocessor controls the voltage applied to the stator by adjusting the position of the trigger pulses of the phase control thyristors.

... and changes the direction of the torque

No contactors are needed for reversing.

Forward torque direction is achieved by the thyristor-pairs 1, 2 and 3, while the other direction follows by 1, 4 and 5.

Change of direction of torque takes no more than 10 ms.

Rotor control by optimising the resistance gives the motor the right characteristics

Slip-ring motor torque is controllable at any speed by varying the external rotor resistance. In this example speeds 92 % and 57 % up as well as 38 % down are obtained by variation of the resistance only.

When lowering at a speed slightly higher than the motor's synchronous speed, in this example 107 % of the synchronous speed, the motor will generate energy back to the line. When the lowering speed is approaching the synchronous speed, the rotor resistor is minimised to R1 and the direction of torque is changed electronically to act as a motor acting downwards. In the diagram, this is shown by drawing the lowering load line, Td, for both plug braking and for regenerative lowering.

On earlier generations of ASTAT controllers it was necessary to manually balance the motors torque at lowest expected line voltage and the current at normal voltage. The new ASTAT Crane Motion Controller needs no manual adjustment, and reconsiders the best motor characteristic at the momentary voltage. The objective is to minimise the motor current.

The number of rotor characteristics is selected depending on the duty. ASTAT supports 1 – 5 characteristics.

...supported by the latest technology in electronics and control theory

A) The frequency of the rotor voltage is determined by advanced digital filtering. By using the line frequency as a reference, the fundamental component of the rotor frequency gives the slip of the motor, which gives the speed in digital form. ASTAT uses the slip-ring motor as a virtual integrated pulse transmitter. A digital signal processor (DSP) is used for the evaluation.

B) Knowing the slip of the motor, the shaft power component of the total motor power is known. The total power of the motor is calculated based on advanced measurements of current, ASTAT output voltage, active losses in the stator circuit of the motor and vector arithmetic. The slip has already been converted to motor speed, so the shaft power of the motor can be transformed to shaft torque. Another DSP is used for the torque evaluation.

C) The switching of the rotor contactor, if any rotor contactor is used, is very fast. ASTAT uses an algorithm which minimises the stator current of the motor, taking into consideration the momentary line voltage and required torque.

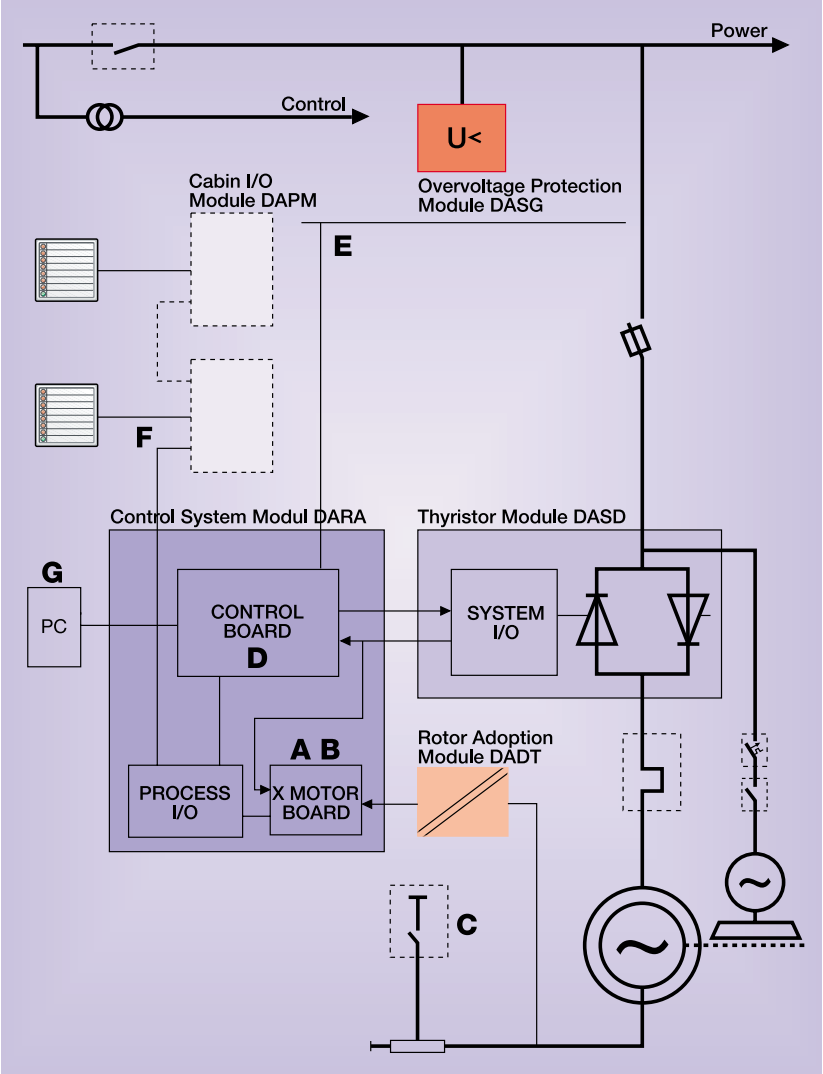
Using this algorithm, the start up adjustment is reduced, the motor can be used with a less stable line supply and it is easier to use existing resistors when revamping.

D) The current and torque regulator has a response time of 3.3 ms similar to a good DC-drive. The torque reversal time is limited to 10 ms which is quite sufficient for cranes and similar motions but on the "safe" side to prevent hazardous control situations.

E) ASTAT is designed to be an intelligent component in automation and information systems. Contact ABB for more information.

F) Remote I/O module for installation in the driver's cabin. A potentiometer or stepped master switch can be used. The Operator's Alert Panel is a part of the Cabin I/O Module. Today, low cost plastic fibre can be used for distances of at least 150 m.

For low budget installations the master switch can be connected directly to the Process I/O of the Control System Module, and no Cabin I/O Module is required.



Costly switching between the radio-controller relay unit and on-board control is minimised as two Cabin I/O Modules can be used and, simply, a DI of the Control System Module is activated to change to on board control.

Shared motion control is possible.

G) A PC is the natural choice for both setting application parameters in the office and start up/trouble shooting on site.

Key data

Electrical data

Control System Modules and Thyristor Modules

- Operational voltage (U_e):
  380 – 600 V AC 50/60 Hz. 3 phase.
  Functional range: 70 % .. 110 % U_e
- Operational current (I_e):
  25 – 1100 (2200) A –
  100 % or 60 % cdf, 60 h^{-1}, 2.5 I_e, 6 s.
- Control Supply (U_s):
  115/230 V AC 50/60 Hz. 1 phase.
  Functional range: 70 % .. 110 % U_s
- Control circuit (U_c):
  110 V DC supplied internally

Cabin I/O Modules

- Control Supply (U_s): 24 V DC Functional range: 70 % .. 110 % U_s
- Control circuit (U_c): 24 V DC Functional range: 70 % .. 110 % U_c; U_c can be same as U_s

Temperature range

Continuous operation rated ambient temperature:

- Control System Modules and Cabin I/O Modules: +70° C/160° F
- Thyristor Modules: +85° C/185° F

Reference Temperature for rated current values

- Thyristor Modules: +40° C/105° F or +50° C/120° F; see the order table

Contamination prevention design

The creep distances required are valid for the micro environment. For practical reasons it has been found less effective to fulfil the requirements by only matching distances with the tracking properties of the isolators; instead the micro environment has been improved by means of moulding or coating.

DASD Thyristor modules: Acc. to EN 60664

- Pollution degree 2: 2 500 V AC
- Pollution degree 3: 1 000 V AC
- Pollution degree 4: 630 V AC

DARA Control System modules:
In accordance with EN 60664

- Pollution degree 2: 1 000 V AC
- Pollution degree 3: 400 V AC
- Pollution degree 4: 250 V AC

Control System I/O:

Control System Module DARA 1001

16 Digital in, 110 V DC
8 Digital out
4 Motor PTC
4 Analogue in,
2 Analogue out
2 RS 232 for intelligent transducers
1 Pulse transmitter
4 Rotor connections for speed feedback/ rotor monitoring
1 Opto Master-Follower
1 Opto Master-Follower cascade
1 RS 232 PC Tool
1 RS 485 Computer communication

Cabin I/O Module DAPM 100

8 Digital in, 24 V DC
8 Digital out for LEDs of Alert Panel
2 Analogue in
2 Analogue out

Requirements on PC for setting parameters and start up:

- Min. 1.44 MB 3 1/2" floppy disk drive. CD recommended.
- Windows 95/98 or NT or 2000
- CPU: the performance of the logger function depends on the CPU.
  Pentium 266 MHz or better recommended.
- Memory: the performance of the logger function depends on the size of memory.
  64 MB or more recommended.
- COM1 port of computer, 9 pin D-sub.

Requirements for Motors

Stresses are similar to motors connected direct on line. Filters are not necessary for existing motors. New motors can be manufactured with traditional insulation.

System design

Technical Manual

Technical Manual 3BSE 017 422 R0002 gives most of the information required for system design. The Manual consists of about 200 pages and includes following sections:

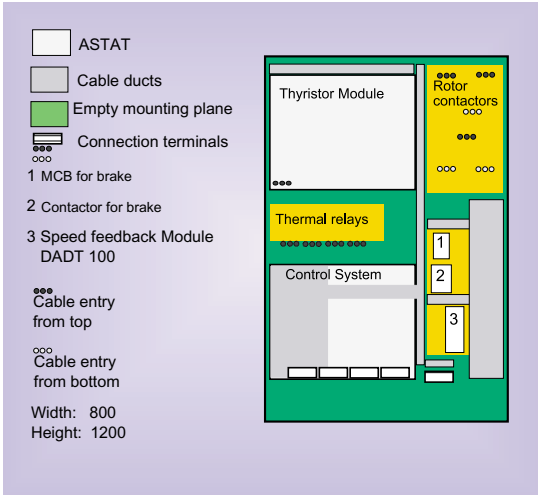
1) ASTAT system basics
2) ASTAT system design
3) Software for design, commissioning and fault tracing
4) Functions
5) EMC considerations
6) Installation
7) Commissioning
8) Maintenance of ASTAT
9) Fault tracing
10) Spare parts list
11) Installation diagram blanks
12) Reference section

Functions – groups of parameters

Group 1: identity
Group 2: run type
Group 3: basic information
Group 4: motor information
Group 5: ASTAT configuration
Group 6: brake information
Group 7: speed feed-back
Group 8: speed reference
Group 9: speed regulator
Group 10: speed supervision
Group 11: current/torque regulator
Group 12: rotor resistor
Group 13: cable reel functions
Group 14: mechanical overload
Group 15: slack rope functions
Group 16: soft limit switch functions
Group 17: rotor monitor system
Group 19: positioning system

Panel layouts

Various suggestions for open panel or closed cubicle design are given in the manual. Rules for selection of auxiliary and ancillary components are also given.



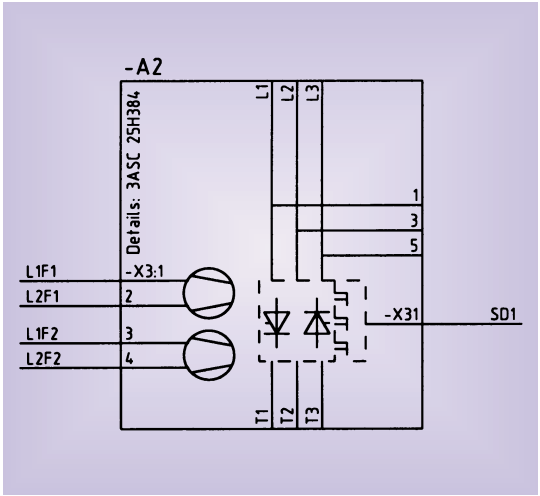
PC Tool

To set up a new installation and to keep an existing installation up to date, a special software and a connection cable from your PC to the ASTAT is needed.

To set up an installation, only parameters have to be set - there is no programming to do.

Guide drawings

The circuit diagram blanks are developed to serve as a tool for the electrical engineer. The blanks are available in printed form in the manual and as dxf-files on the ASTAT Tools CD.



Ordering data

Control System Modules IP41. Rated +70° C. Max +70° C.	**Weight, kg**	**Aux. power V - A**	**Power loss, no load W**	**Power loss, full load W**
3ASC25H231 DARA 1000 Requires tacho/pulse-encoder. Scalar torque control.	17	230 V AC - 0.5 A /	11	28
3ASC25H232 DARA 1001 Can be used without tacho/pulse-encoder. Vector torque control.	17	115 V AC - 1 A	12	29

Thyristor Modules IP20. Rated +40/+50° C. Max +85° C.	**Weight, kg**	**Aux. power V - A**	**P_0, No load losses W**	**Δ_V V**
3ASC25H281 DASD 101 +50° C 500 V - 25 A	20	internal supply	10	0.80
3ASC25H282 DASD 102 +50° C 500 V - 50 A	21	internal supply	30	0.85
3ASC25H283 DASD 103 +50° C 500 V - 100 A	21	internal supply	30	0.95
3ASC25H284 DASD 104 +50° C 500 V - 200 A	34	internal supply	40	0.95
3ASC25H285 DASD 105 +40° C 500 V - 355 A	34	internal supply	40	1.00
3ASC25H286 DASD 106 +50° C 500 V - 630 A	83	internal supply	40	1.45*
3ASC25H287 DASD 107 +40° C 500 V - 1000 A	85	internal supply	40	1.20*
3ASC25H296 DASD 108 +40° C 400 V - 1100 A	85	internal supply	40	1.15*
3ASC25H288 DASD 111 +50° C 600 V - 25 A	20	internal supply	10	1.15
3ASC25H289 DASD 112 +50° C 600 V - 50 A	21	internal supply	30	1.20
3ASC25H290 DASD 113 +50° C 600 V - 100 A	21	internal supply	30	1.25
3ASC25H291 DASD 114 +50° C 600 V - 200 A	34	internal supply	40	1.00
3ASC25H292 DASD 115 +40° C 600 V - 355 A	34	internal supply	40	1.10
3ASC25H293 DASD 116 +50° C 600 V - 630 A	83	internal supply	40	1.45*
3ASC25H294 DASD 117 +40° C 600 V - 1000 A	85	internal supply	40	1.40*

Cabin I/O Modules IP20. Rated +70° C. Max +70° C				
3ASC25H221 DAPM 100 Cabin I/O Module	1	24 V DC 1 A	3	4

Ready made duplex Hard Clad Silica Fibre cable with connectors for use between Control System Module and Cabin I/O Module, and between Cabin I/O Modules where applicable. Not suitable for festoon systems. For lengths other than below or cables for festoon systems: Contact ABB.

3ASC291361J20	HCS cable (L=2 m)
3ASC291361J50	HCS cable (L=5 m)
3ASC291361J100	HCS cable (L=10 m)
3ASC291361J200	HCS cable (L=20 m)
3ASC291361J400	HCS cable (L=40 m)

3ASC25H266 Duplex opto splice unit DATX 140
For joining two Ready made duplex Hard Clad Silica Optical Fibre cables with connectors. Snap on 35 mm rail.

Speed feedback, Rotor circuit monitoring IP20. Rated +70° C. Max +70° C				
3ASC25H211 DADT 100 Feedback Module	0,5	internal supply	3	3

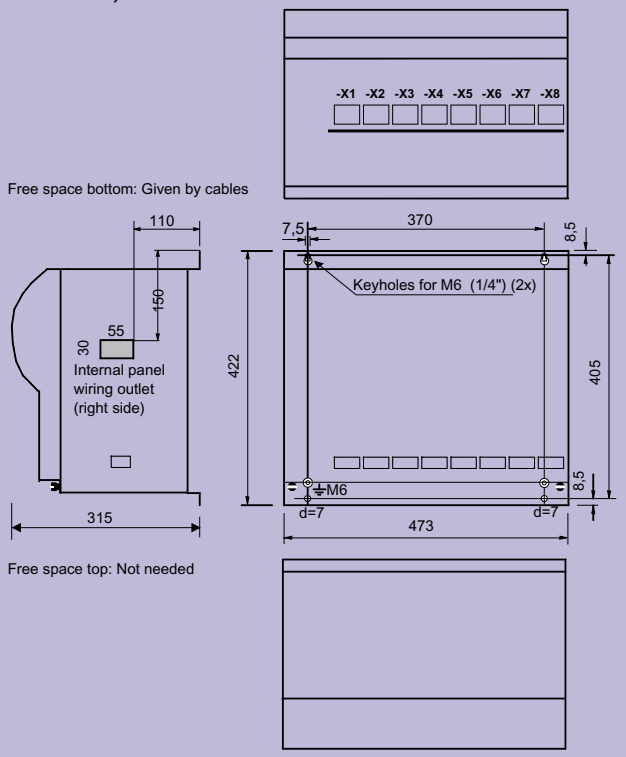
Protection devices IP20. Rated +70° C. Max +70° C				
3ASC25H264 DASG 118 Overvoltage Protection 380-415 V AC	2,5	–	30	30
3ASC25H265 DASG 119 Overvoltage Protection 440-525 V AC	2,7	–	35	35
3ASC25H299 DASG 121 Overvoltage Protection 600 V AC	2,9	–	35	35

3ASD532001C80 Top Heat Exchanger ≤ +85° C.	30	230 V AC - 1.2 A	–	–
3ASC262741H1 Tool Cable RS232, L=3m.	0,1	–	–	–

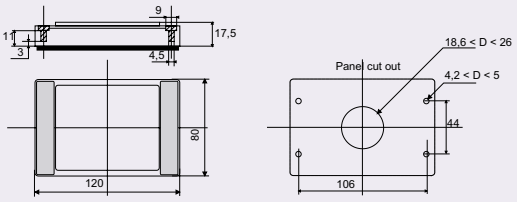
* Including Semiconductor fuses

Dimension drawings

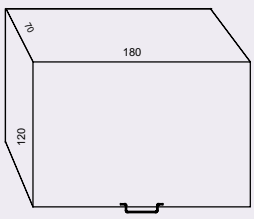
DARA1000, 1001



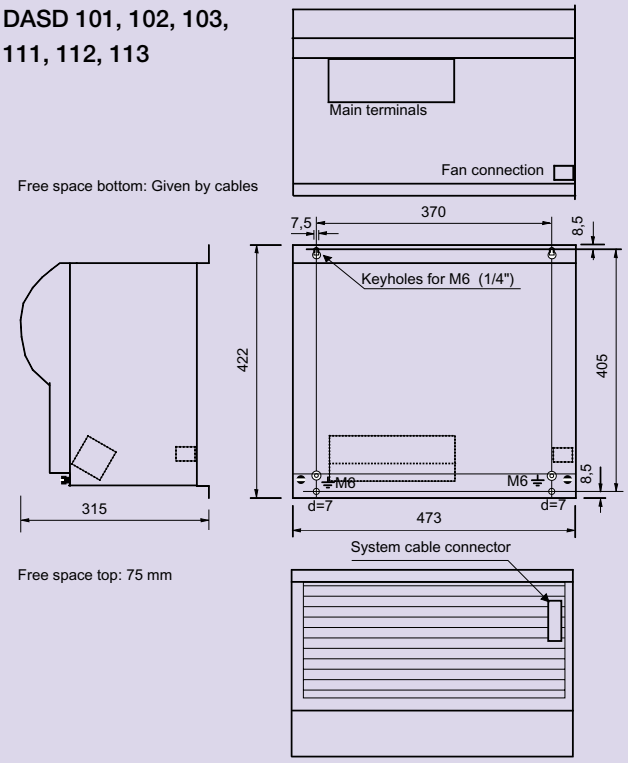
DAPM100: Indication part



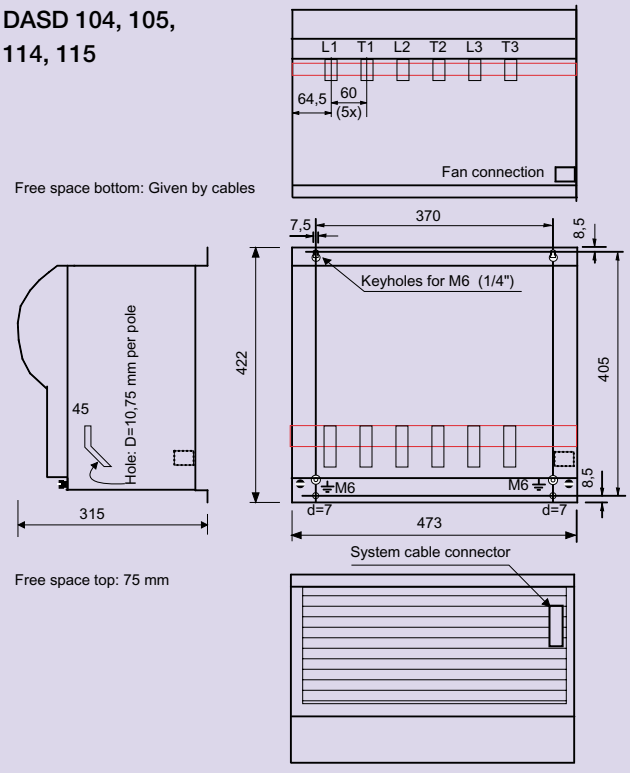
DAPM 100: Connection part



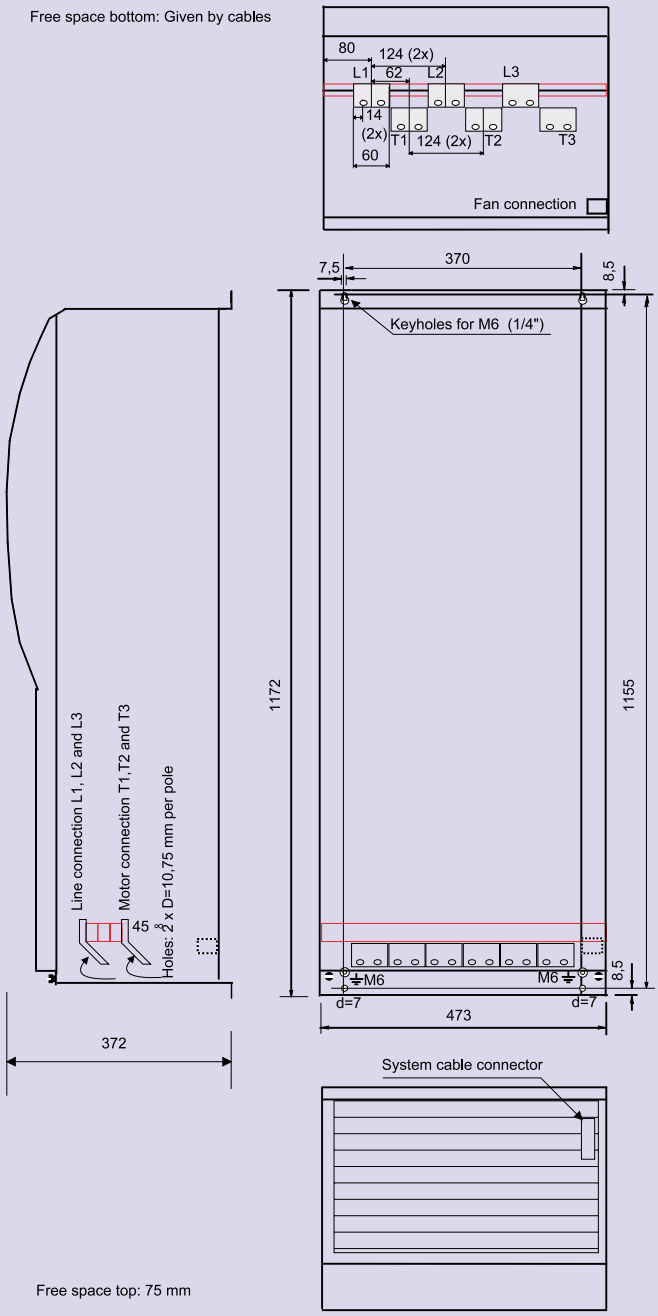
DASD 101, 102, 103, 111, 112, 113



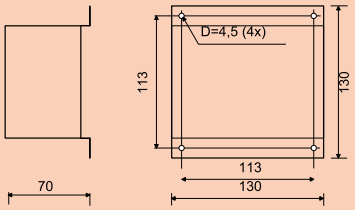
DASD 104, 105, 114, 115



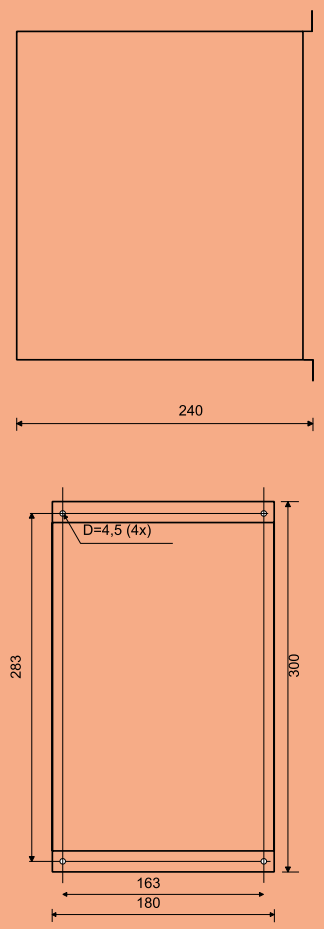
DASD 106, 107, 108, 116, 117



DADT 100, Feedback Module.



DASG 118, 119, 121
Overvoltage protection Module.



Component selection

Control System Modules DARA 1000 and DARA 1001

- Protection: IP 41
- Calculated loss contribution: 20 W
- Temperature range: Max +70° C.
- Select 1 per motion.
- DARA 1001 is selected for rotor frequency based speed feedback or when precise torque control is required.
- DARA 1000 should be selected for tachometer feedback without rotor monitoring. Torque control is still better than traditional solutions.

Thyristor Modules DASD

- Protection: IP 20
- The nominal current capacity is valid for any duty factor, ED [%], for the motor (15, 25, 40, 60 or 100 %).
- Calculated loss contribution:
  $P_{loss} = P_0 + 1.25 * ED[\%] * 3 * I_1 * \Delta_V$ [W], where 1.25 is a start current factor, I_1 is the normal mechanical load current, P_0 and Δ_V are from the table.
- Temperature range: Nominal values are given at +40 or +50° C. Max +85° C. Reduce the allowed current by 1.2 %/K above +40 or +50° C. Highest altitude without derating is 1000 m.a.s.l.
- Normally select 1 per motion, but 2 units can be used in parallel without any current reduction.

Rotor Adoption Module DADT 100

- Protection: IP 41
- Calculated loss contribution: 3 W
- Temperature range: Max +70° C.
- Connect the rotor voltage to the DADT 100 module. It is mounted in the vicinity of the Control System Module. DADT 100 has a 1.0 m long cable attached to connect to the DARA 1001.
- Select 1 DADT 100 per motion for tachometer free feedback.
- Optionally, select 1 DADT 100 per motion for independent monitoring of tachometer speed feedback and rotor condition.
- 2 or 4 DADT 100s are also chosen for rescue service with 1 of 2 or 2 of 4 motors in a motion, and the speed feedback can be selected from different motors in the configurations.

Cabin I/O Module DAPM 100

- Protection: IP 20
- Calculated loss contribution: 3 W
- Temperature range: Max +70° C.
- Select one per operation station for every motion. Maximum two units; one for the onboard operation station of the crane and the second for the relay unit of a radio remote controller.

Overvoltage Protection Modules DASG

- Protection: IP 20
- Calculated loss contribution: 50 W
- Temperature range: Max +70° C.
- Prevents spikes and checks supply voltage level and phase sequence.
- Select one DASG per crane or other machine.

Heat exchanger

- Protection: IP 55
- Temperature range: Max +70 ambient /85° C inside the cubicle.
- Selection guide for Thyristor Module:
  - The ambient temperature is T_{amb} °C.
  - The required (mechanical) current is I_1 A.
  - Required ASTAT controller current

  $$I_e \geq \frac{100 * I_1}{100 - (T_{amb} + 10 - T_{DR}) * 1,2}$$ A, where T_{DR} =

  - 50 for Thyristor Modules rated ≤ 200 A and 630 A,
  - 40 for Thyristor Modules rated 355 A, 1000 A and 1100 A.
- I_e should never be less than I_1.
- Select the right number of heat exchangers 3ASD532001C80 as a function of I_1 and the c d f stated in the table:

Load current I_1 [A]	Duty factor c d f (40 %)	c d f (60 %)
0 - 100	0	0
101 -200	0	1
201 - 350	1	1
351 - 500	1	2
501 - 750	2	2
751 - 1000*	2	3
1001 - 1200	3	3
1201 - 2000*	3	3
Incomer cubicle for the crane.	Select one Heat exchanger less than is selected for the Main hoist of the same crane.	

- Cubicle height with heat exchanger: best selection 1800 mm + 400 mm for the heat exchanger.
- Cubicle height without heat exchanger: best selection 1800 mm.
- Cubicle width with or without one heat exchanger: best selection 800, 1000 or 1200 mm.
- Cubicle width with two heat exchanger: best selection 1200 mm.
- Cubicle width with three heat exchanger: best selection 1800 mm.
- Instructions for mounting: Each cubicle separately enclosed with 200 mm clear between cubicles, or all cubicles mounted together with free air circulation between the cubicles.

** 1100 A and 2200 A when DASD 108 is used.*

ABB supplies a wide range of products for crane control, having a wide experience of all types of crane operation. ABB provides competitive and effective solutions to crane drive and control requirements.

ABB, with 200,000 employees serving customers in more than 100 countries, is a pioneer in the development of technology and solutions for metals producers and processors.

From high-quality power transmission and distribution systems to integrated drives and control systems; from process automation packages with instrumentation equipment to materials handling with cranes; from environmental products and systems, to installation, commissioning and training services. In Metals, you don't have to look far. You'll find the right electrical partner in ABB.

Care Of. Printed in Sweden by Westerås Media Tryck, Västerås 2000.

ABB Automation Systems AB
Crane Systems
SE-721 67 Västerås, Sweden
Telephone +46 21 34 00 00
Fax +46 21 34 02 90
Internet: www.abb.com/automation

3AST000473R0001