Motion Control Products

Application note
Configuring ACSM1 for use with servo motors

AN00236

Rev C (EN)

The ABB ACSM1 AC servo drive can provide basic speed or torque control modes as well as versatile motion control features. It also supports a wide variety of servo motors due to the flexible nature of the modular feedback interface modules

Introduction

The aim of this application note is to outline how to configure an ACSM1 drive to run with an ABB BSM series AC servo motor.

ACSM1 drives can control induction, synchronous and asynchronous servo and high torque motors with various feedback devices. The compact hardware, different variants and programming flexibility ensure the optimum system solution. The innovative memory unit concept enables flexible drive configuration. The ACSM1 is available in different sizes from 0.75 to 355 kW / (1 to 450 HP) and is designed for three-phase operation with a 230 to 480 V AC supply. All units have an IP20 enclosure for cabinet installation (UL open) and are suitable for single drive and multi-drive (common dc) configurations with integrated Safe Torque-Off (STO) as standard.

The ACSM1 has both a hardware manual and a firmware manual. These manuals can be downloaded from the ACSM1 home page; https://library.e.abb.com/public/6eb2fea8f1da46609c57a06a71007e61/ACSM1-FW_motion_revH_screen_A4.pdf
There are different firmware variants available such as ‘speed and torque’ or ‘position control’ in addition to specific application/control types such as ‘Winder’ and ‘Cam’ so when downloading the manuals, you must make sure you download the correct documentation.

The ACSM1 also has different option cards that can be added at the point of order or can be added at a later date, these include F series fieldbus option modules and FEN series motor feedback modules.

To get hold of the configuration software (Drive Studio v1.6) please speak to your local ABB sales office. More information can be found on the ABB home page (www.abb.com > Search for Drive Studio).

The ABB BSM series of AC servo motors provides a wide range of inertias and torques and are designed for excellent performance response. This series has a rugged, durable, industrial design. Many of the BSM motors are capable of peak torques equal to four times their continuous rating, which can be used to provide high acceleration torques in applications. BSM motors are available with a wide variety of feedback devices to suit application needs. IEC and NEMA configurations are available as well as stainless steel variants.

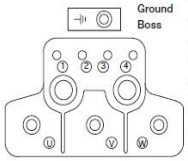
The ACSM1 (firmware version 1880 or later) with FEN-x1 (Hardware revision J or later with firmware VIE1 2200 or later) will support the following BSM feedback types; Incremental encoder (E or F), Resolver (A), EnDat v2.1 (D or D2) and Hiperface (D3 or D4). EnDat v2.2?
revision
More information can be found on the BSM homepage; http://www.abbmotion.com/products/servomotors/servomotors.asp and in the BSM brochure; https://library.e.abb.com/public/d7e5741298fe4760a818106caec8a45a/9AKK106417%20E%20Servo%20Motors_1215_WEB.pdf

Connecting drive and motor power cables

Please refer to the ACSM1 hardware manual for installation details for the drive power connections (3 phase AC supply) and to the motor technical documentation for information on how to connect the motor power connections. Excerpts shown below;

AC servo motors
Motor connection diagrams

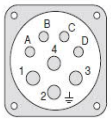
Terminal block



Power connections
BSM 90/100

Post	Function
1	Thermal Switch
2	Thermal Switch
3	Brake (optional)
4	Brake (optional)
U1	Motor Lead U
V2	Motor Lead V
W3	Motor Lead W
Screw	Ground

Standard motor connector

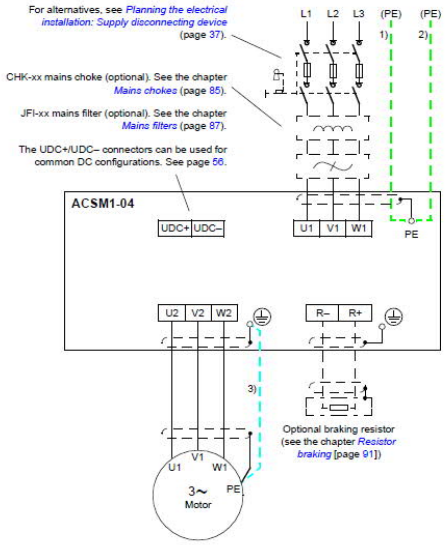


Power connections
BSM 50/63/80 and SSBSM

Post	Function
A	Thermal Switch
B	Thermal Switch
C	Brake (optional)
D	Brake (optional)
1	Motor Lead U
2	Ground
3	Motor Lead W
4	Motor Lead V

Power cable connection

Power cable connection diagram



Pre-made motor power cables to connect a BSM motor to an ACSM1 drive are available from ABB in a variety of pre-defined lengths. Use the part number CBLxxxSP-12 for 12A motor power cable and CBLxxxSP-20 for 20A motor power cable, where xxx is replaced with a length code. E.g. CBL075SP-12 is a 7.5m cable

Connecting up the feedback device in the system

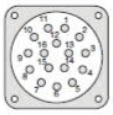
Please refer to the relevant FEN-xx option manual for installation details of the motor feedback device at the drive end and to the motor technical documentation for information on how to connect the motor feedback device at the motor end (if using ABB pre-made cables this is simply a matter of attaching the ready-made connector/cable). Excerpts shown below;

Standard resolver connector
12 Pin

Resolver connections
BSM and SSBSM

Post	Function
1	REF HI R1
2	REF LO R2
3	COS+ S1
4	COS- S3
5	SINE- S4
6	SINE+ S2
7-12	No connection

Standard encoder connector
16 pin

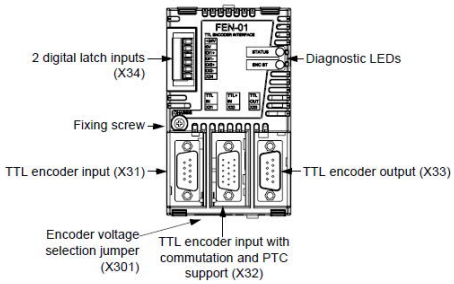


Encoder connections
BSM and SSBSM

Post	Function
1	DC + 5V
2	Ground
3	Channel A
4	Channel Ā
5	Channel B
6	Channel B̄
7	Channel Z
8	Channel Z̄
9	Open
10	Channel U
11	Channel Ū
12	Channel V
13	Channel V̄
14	Channel W
15	Channel W̄
16	No connection

The FEN-01 TTL Encoder Interface

The FEN-01 offers an interface for two TTL encoder connections, one with commutation signals and PTC support. It also offers a TTL encoder output for emulation purposes and two digital latch inputs for position latching.



FEN-01 layout

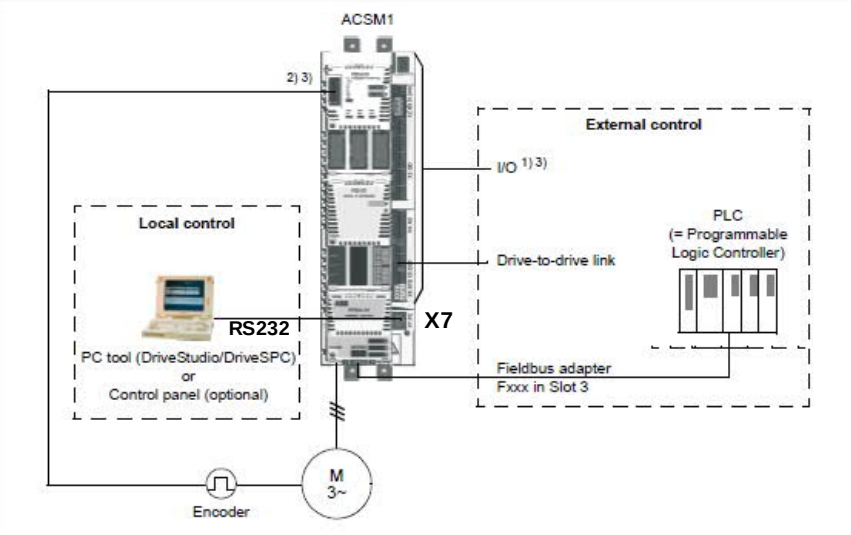
Pre-made feedback cables to connect a BSM motor to an ACSM1 drive are available from ABB in a variety of pre-defined lengths. Replace the xxx with a length code. E.g. CBL150SF-R5 is a 15m Resolver feedback cable for ACSM1.

Incremental encoder and halls feedback cable for ACSM1, connectors both ends	CBLxxxSF-E5
Resolver feedback cable for ACSM1, connectors both ends	CBLxxxSF-R5
EnDat 2.1 and Hiperface feedback cable for ACSM1, connectors both ends	CBLxxxSF-D5

How to setup the connection and programming software for the ACSM1

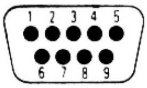
As we mentioned earlier, the ACSM1 uses software called Drive Studio for configuration. Like other ABB standard drives products the parameters are split into numbered groups, each with a numbered sub-index. The combination of these two numbers becomes the parameter reference e.g. Group 99 Parameter 4; Motor Type is referred to as P9904.

The Drive Studio software talks to the ACSM1 via a RS232 connection using an OPCA-02 cable connected to the X7 connector on the ACSM1;



The OPCA-02 is available from ABB (part no 68239745). The pinouts for this cable are as shown below;

RJ45 Skt pin No.	Wire colour	D type connection to be made
1	black	2
2	yellow	5 optional
3	orange	3
4	red	not connected
5	green	not connected
6	brown	5
7	grey	not connected
8	blue	not connected



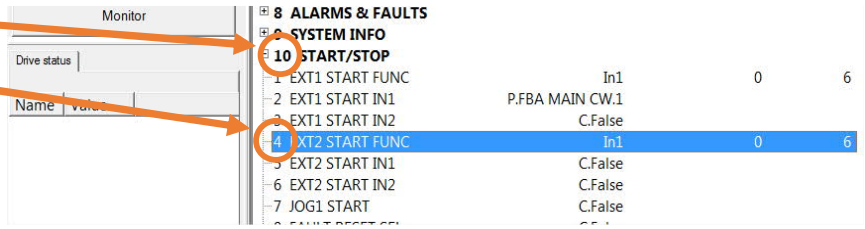
Once the connection to the ACSM1 has been made you can open Drive Studio. Drive Studio will automatically establish a connection to the ACSM1 when opened if the COM port settings are correct. If a connection is not established there is a problem. Ensure any USB to serial converters that are used are set up correctly. The baud rate is auto detected by the drive and can be from 9600 to 57600 with a parity of 0/none. If any settings need to be changed go to Drive Studio > Edit > Configure OPC page, then and re-open Drive Studio to test.

You can tell that you are online by checking that the tool bar appears as below showing a connection over COMx and all the local controls should be highlighted;

If you now go to the Parameter browser section in the left hand navigation window you will be able to see all the parameters that are available on the drive in numerical order;

Group Number: 10

Sub Index number: 04



All these settings will now be live so any changes made should be immediately reflected in the drive.
Once you're in online the setup of the drive can begin. More information on Drive Studio can be found inside the help menu.

How to get the information required to set up the drive

To make the correct motor feedback and power connections we must first get the connection details. This information is in the BSM motor brochure (https://library.e.abb.com/public/d7e5741298fe4760a818106caec8a45a/9AKK106417%20E%20Servo%20Motors_1215_WEB.pdf).

First it's a good idea to look at the **Identification matrix** (page 59 in the latest BSM brochure) to find out what motor options such as feedback type and mechanical brake are fitted to the motor being used.

Next the **Motor Performance curves** for your relevant part number can be used to find all the information required for Group 99 start-up data (Note, some values will need to be calculated as they aren't present). Start by locating your **Speed @ 300Vdc value** from the table of data for your motor in the motor brochure (this is listed as Rated Speed @ 300V) and then enter the values in the parameters as shown below;

Group 99

99.04	Motor Type	PMSM (Permanent Magnet Servo Motor)
99.05	Motor Ctrl. Mode	DTC
99.06	Rated Current	Obtain value by reading off the current from the Speed-Torque graph using the **'Speed @ 300V value'.** See below for details on how to do this
99.07	Voltage	can be calculated by **Voltage constant (V_{RMS}/k_{RPM}) x ('Speed @ 300V value'/1000)**
99.08	Frequency	can be calculated by **(Poles/2) x 'Speed @ 300V value' / 60**
99.09	Motor rpm	use **'Speed @ 300V value'**
99.10	Power	can be calculated by (**P9906 x P9907 x P99.11 x √3)/1000 x Power factor**
99.11	CosFi	as this is a PMSM enter a value of **1**
99.12	Torque	P (kW) x (60∗1000)/2π)/ ω (rpm) **= (P9910 x 9549) / 'Speed @ 300V value'** Note, if any problems persist with this value it can be left blank and the drive will calculate it.
99.13	ID Run Mode	**Normal** (This defines how the motor will be auto tuned)

At this point you can now do a motor ID run by putting the drive in local control and running it (this will carry out a Normal ID-Run (which will tune the drive to the motor).

Local control mode Run to start ID-Run

If the motor data is correct then this will pass and you can move onto the next step. If not you will need to review/check the settings above and try again.

Next you will need to enter information for the relevant motor feedback device, this can be found in the '**Correct settings for motor feedback device'** of this document, below. This information can be used to set up parameter groups 90 – 93;

Group 90 will always be set up first to select the encoder module that has been fitted
Group 91 will be used if an absolute encoder (FEN-11) interface is used
Group 92 will be used if a resolver interface (FEN-21) is used

Group 93 will be used if an incremental encoder (FEN-01) interface is used

Correct settings for each motor feedback device

The following table details the relevant settings for each feedback option type. When the settings have been made you must change the value of P90.10 ENC PAR **to** REFRESH **to transfer these settings into the drive's actual parameter list.**

Motor feedback option code	Relevant parameters							
Resolver Feedback	**P90.01** ENCODER 1 SEL	**P92.01** RESOLV POLEPAIRS	**P92.02** EXC SIGNAL AMPL	**P92.03** EXC SIGNAL FREQ				
A = Resolver	FEN-21	1	6V	7kHz				
Absolute EnDat 2.1 (SinCos+Serial) Feedback	**P90.01** ENCODER 1 SEL	**P91.01** SINE COSINE NR	**P91.02** ABS ENC INTERF	**P91.03** REV COUNT BITS	**P91.04** POS DATA BITS	**P91.05** REFMARK ENA	**P91.30** ENDAT MODE	**P91.31** ENDAT MAX CALC
D = Absolute encoder multi-turn (EnDat 2.1)	FEN-11	2048	EnDat	12 (4096 turns)	13 (8192 cts/rev)	False	Initial Position	50ms
D2 = Absolute encoder single-turn (EnDat 2.1)		2048	EnDat	1	13 (8192 cts/rev)	False	Initial Position	50ms
Absolute EnDat 2.2 (purely Serial) Feedback	**P90.01** ENCODER 1 SEL	**P91.01** SINE COSINE NR	**P91.02** ABS ENC INTERF	**P91.03** REV COUNT BITS	**P91.04** POS DATA BITS	**P91.05** REFMARK ENA	**P91.30** ENDAT MODE	**P91.31** ENDAT MAX CALC
D = Absolute encoder multi-turn (EnDat 2.2)	FEN-11		EnDat	12 (4096 turns)	13 (8192 cts/rev)	False	Cont.spd+ position.	50ms
D2 = Absolute encoder single-turn (EnDat 2.2)			EnDat	1	13 (8192 cts/rev)	False	Cont.spd+ position.	50ms
Absolute Hiperface Feedback	**P90.01** ENCODER 1 SEL	**P91.01** SINE COSINE NR	**P91.02** ABS ENC INTERF	**P91.03** REV COUNT BITS	**P91.04** POS DATA BITS	**P91.05** REFMARK ENA	**91.10** HIPERFACE PARITY	**91.11** HIPERF BAUDRATE
D3 = Absolute encoder Single-turn (Hiperface)	FEN-11 Absolute Encoder Jumper +8 V	128	Hiperface	1	12 (4096 turns)	False	Odd	9600
D4 = Absolute encoder Multi-turn (Hiperface)		128	Hiperface	12 (4096 turns)	12 (4096 turns)	False	Odd	9600
Incremental Encoder Feedback	**P90.01** ENCODER 1 SEL	**93.01** ENC1 PULSE NR	**93.02** ENC1 TYPE	**93.03** ENC1 SP CALCMODE	**93.04** ENC1 POS EST ENA	**93.05** ENC1 SP EST ENA	**93.06** ENC1 OSC LIM	
E = Encoder + Halls (1000ppr)	FEN-01 Absolute Encoder Jumper +5 V	1000	Quadrature	(4) Auto rising	False	False	(0) 4880Hz	
F = Encoder + Halls (2500ppr)		2500	Quadrature	(4) Auto rising	False	False	(0) 4880Hz	

Note that the following BSM motor feedback types are not supported by ACSM1;

B = Absolute encoder Single-turn (BiSS)
B2 = Absolute encoder Multi-turn (BiSS)
S1 = Absolute encoder Single-turn (SSi)
S2 = Absolute encoder Multi-turn (SSi)
H = Halls only
T = Absolute encoder single turn (SmartAbs)
T2 = Absolute encoder multi-turn (SmartAbs)

It is also worth noting that if using EnDat 2.2 only Drive FW 1.88 (or newer) in the ACSM1 and FW 1.210 (or newer) in the FEN-11 are needed. So for EnDat 2.1 the SinCos signals of the encoder must be wired to the ACSM1, these are not needed for EnDat 2.2.

Once this information is entered we will need to carry out the steps below to complete the drive tuning process;

Set Group 99 Parameter 13 ID Run Mode (This defines how the motor will be tuned) to **Autophasing**

Then do a motor ID run by putting the drive in local control and running it (this will now carry out an Autophasing ID-Run which will tune the motor to the feedback device).

If the motor and feedback data entered is correct then this will pass and you can now start putting your application specific settings into the drive. If not you will need to review the settings above and try again.

Final Tests and settings

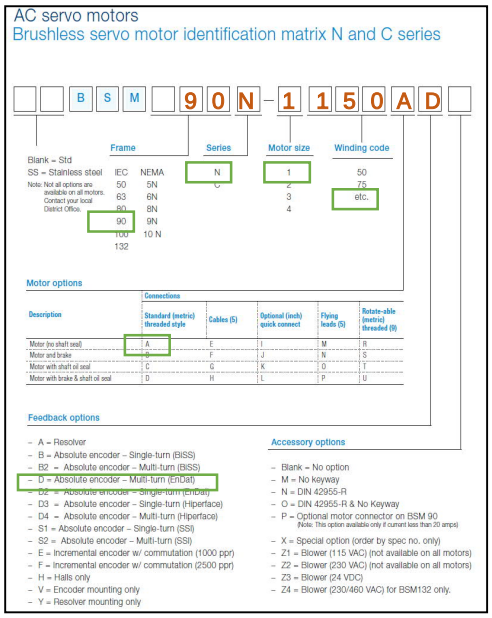
Before telling the drive to close the speed loop you can test your values by running the motor in local mode at a set speed (e.g. 1000rpm) and monitor 01.01 Speed Act (which will be set to "estimated" by the setting of 22.01 SPEED FB SEL) and 01.08 Encoder Speed 1 (which is always the actual speed measured from the encoder feedback). If all the settings are correct then these should match! If not re-evaluate your settings.

To finish off you must set the drive to close the speed and position loops (if you are using position control) so that the drive uses the feedback device's information and does not just estimate them. To do this set 22.01 to ENC1 to close the speed loop and 60.01 to ENC1 to close the position loop. If all is well the drive should run without errors

Now that all of the steps have been covered we can run through an example of using them;

Example - How to set up ACSM1 for BSM90N-1150AD

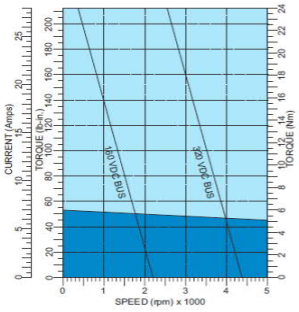
First it's a good idea to look at the Identification matrix to find out which Motor options (such as a mechanical brake) and feedback options are fitted;



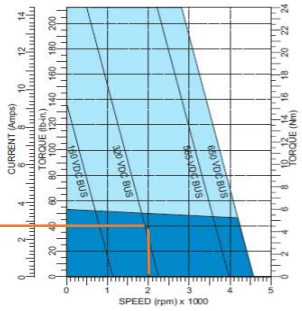
- Not Stainless Steal
- 90 Frame
- N series low inertia motor
- 1 Motor size (stack length)
- 150 winding code
- Standard metric threaded connectors
- No brake or shaft oil seal
- Absolute multi turn EnDat encoder

Next the **Motor Performance curves** for part number: BSM90N-1150xx

BSM90N-175



BSM90N-1150



2.9A

Model number		BSM90N-175	BSM90N-1150	BSM90N-1250
General				
Continuous stall torque	lb-in	53	53	53
	Nm	6	6	6
Continuous current	amps	7.8	4.03	2.6
Peak torque	lb-in	212.41	212.41	212.41
	Nm	24	24	24
Peak current	amps	28.1	14.5	9.37
Thermal resistance	°C/watt	1.16	1.16	1.16
Thermal time constant	Min	38	38	38
Mechanical time constant	msec	0.58	0.54	0.55
Electrical time constant	msec	3.3	4	4.1
Rated speed @ 300 volts	rpm	4000	2000	1200
Rated speed @ 600 volts	rpm		4000	2400
Electrical				
Torque constant	lb-in/amp	7.31	14.16	21.93
	Nm/amp	0.853	1.65	2.56
Voltage constant	Vpk/krpm	72.8	141.3	218.9
	Vrms/krpm	51.5	99.9	154.8
Resistance	ohms	1.24	4.33	10.66
Inductance	mH	4.15	17.6	43.5
Mechanical				
Inertia	lb-in-s ²	0.003	0.003	0.003
	Kg-cm ²	3.389	3.389	3.389
Maximum speed	rpm	7,000	7,000	7,000
Number of motor poles	—	8	8	8
Weight lbs/Kg	—	18/8.2	18/8.2	18/8.2

Speed @ 300V value = 2000rpm

Group 99

99.06	Current	@ 2000rpm @ 300Vdc bus the current = **2.9A**
99.07	Voltage	= Voltage constant x ('Speed @ 300V value'/1000) = 99.9 x (2000/1000) = **199.8V**
99.08	Frequency	= (Poles/2) x 'Speed @ 300V value' / 60 = 8/2 x 2000/60 = **133.3Hz**
99.09	Motor rpm	= 'Speed @ 300V value' **= 2000rpm**
99.10	Power	= (*P99.06* x *P99.07* x *P99.11* √3)/1000 **=** (2.9 x 199.8 x 1 x √3)/1000 = 1.0024kW so = **1 kW**
99.11	CosFi	= **1** (because it's a permanent magnet servo motor)
99.12	Torque	= (*P99.10* x 9549) / 'Speed @ 300V value' = 1 x 9549 / 2000 = **4.774Nm**
99.13	ID Run Mode	**Normal** (This defines how the motor will be tuned)

At this point you can now do a motor ID run by putting the drive in local control and running it (this will now carry out a Normal ID-Run (which will tune the drive to the motor).

Local control mode Run to start ID-Run

Next you will need to enter information for the relevant motor feedback device, for this part number this is an **Absolute Multi turn Endat Encoder** as identified earlier. Refer to the earlier table detailing feedback settings for the relevant encoder type. An excerpt from this is as shown below;

Absolute EnDat 2.1 Feedback	**P90.01** ENCODER 1 SEL	**P91.01** SINE COSINE NR	**P91.02** ABS ENC INTERF	**P91.03** REV COUNT BITS	**P91.04** POS DATA BITS	**P91.05** REFMARK ENA	**P91.30** ENDAT MODE	**P91.31** ENDAT MAX CALC
D = Absolute encoder multi-turn (EnDat 2.1)	FEN-11	2048	EnDat	12 (4096 turns)	13 (8192 cts/rev)	False	Initial Position	50ms

Next you must change the value of **P90.10 ENC PAR** to **REFRESH** to update the settings into the drives used parameter list.

Once this information is entered we will need to do carry out the steps below to complete the drive tuning process

99.13 ID Run Mode **Autophasing** (This defines how the motor will be tuned)

At this point you can now do a motor ID run by putting the drive in local control and running it (this will now carry out an Autophasing ID-Run (which will tune the motor to the feedback device).

If the motor data is correct then this will pass and you can now start putting your application specific settings into the drive. If not you will need to review the settings above and try again.

Test your values by running the motor in local control mode at a set speed of 1000rpm and monitor 01.01 Speed Act and 01.08 Encoder Speed 1, if all the settings are correct then these should match! If not re-evaluate your settings.

To finish off you must close the speed loop and the position loop (if you're using position control) so that the drive uses the feedback device information and does not just estimate the speed and position. To do this set 22.01 to ENC1 to close the speed loop and 60.01 to ENC1 to close the position loop. If all is well the drive should run without errors.

Contact us

For more information please contact your
local ABB representative or one of the following:
new.abb.com/motion
new.abb.com/drives
new.abb.com/drives/drivespartners
new.abb.com/PLC