4. WIRING PROCEDURE

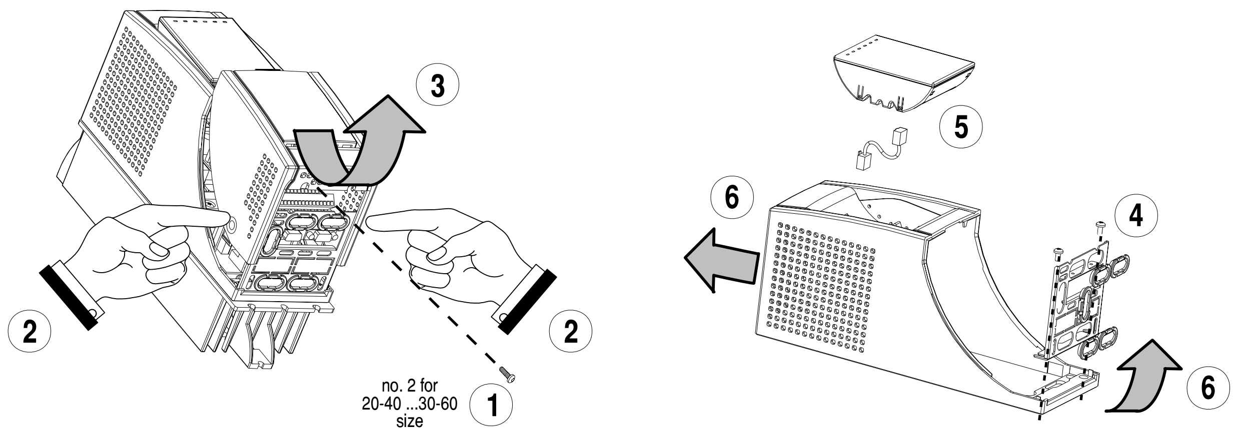
4.1. ACCESSING THE CONNECTORS

4.1.1. Removing the covers

NOTE! Observe the safety instructions and warnings given in this manual. The devices can be opened without the use of force. Only use the tools specified.

See figure 2.2.2 "Drive view & components" to identify the single part.

Figure 4.1.1: Removing the covers (sizes PX-3 to PX-30)



Sizes PX-3 to PX-15:

The terminal cover and cable entry plate of the device must be removed in order to fit the electrical connections:

- unscrew the screw (1), remove the cover of devices (2) by pressing on both sides as shown on the above figure (3).
- unscrew the two screws (4) to remove the cable entry plate.

The top cover must be removed in order to mount option cards and change the internal jumper settings:

- remove the keypad and disconnect the connector (5)
- lift the top cover on the bottom side (over the connector level) and then push it to the top (6).

Sizes PX-20 to PX-30:

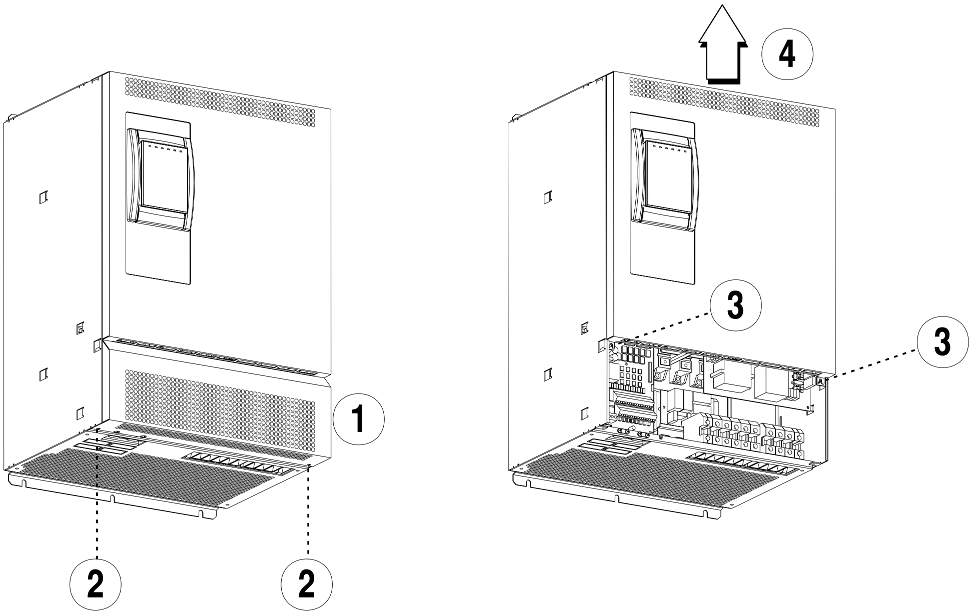
The terminal cover and cable entry plate of the device must be removed in order to fit the electrical connections:

- unscrew the two screws (1) and remove the cover of devices
- unscrew the two screws (4) to remove the cable entry plate.

The top cover must be removed in order to mount the option card and change the internal jumper settings:

- remove the keypad and disconnect the connector (5)
- lift the top cover on the bottom side (over the connector level) and then push it to the top (6).

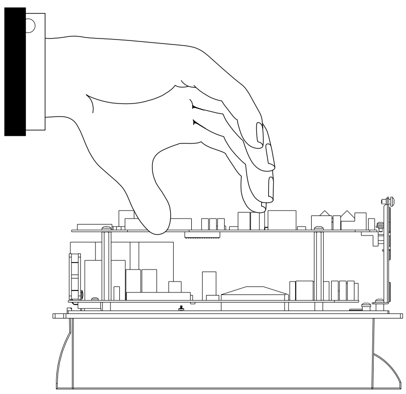
Figure 4.1.2: Removing the covers (sizes PX-40 to PX-300)



Sizes PX-40 to PX-300:

The terminal cover of the device must be removed in order to fit the electrical connections: unscrew the two screw (2) and remove the cover (1)

The top cover must be removed in order to mount the option card and change the internal jumper settings: unscrew the two screw (3) and remove the top cover by moving it as indicated on figure (4)



ATTENTION: In order to avoid damage to the drive it is not allowed to transport it by holding the cards!

4.2. POWER SECTION

4.2.1. PV33-.. Power card

Figure 4.2.1.1: PV33-1-. power card (sizes PX-3 *to* PX-7*)*

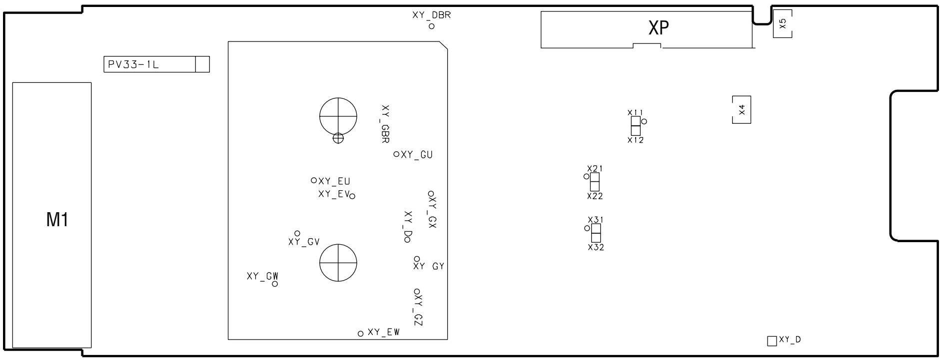


Figure 4.2.1.2: PV33-2-.. power card (sizes PX-10 *to* PX-15*)*

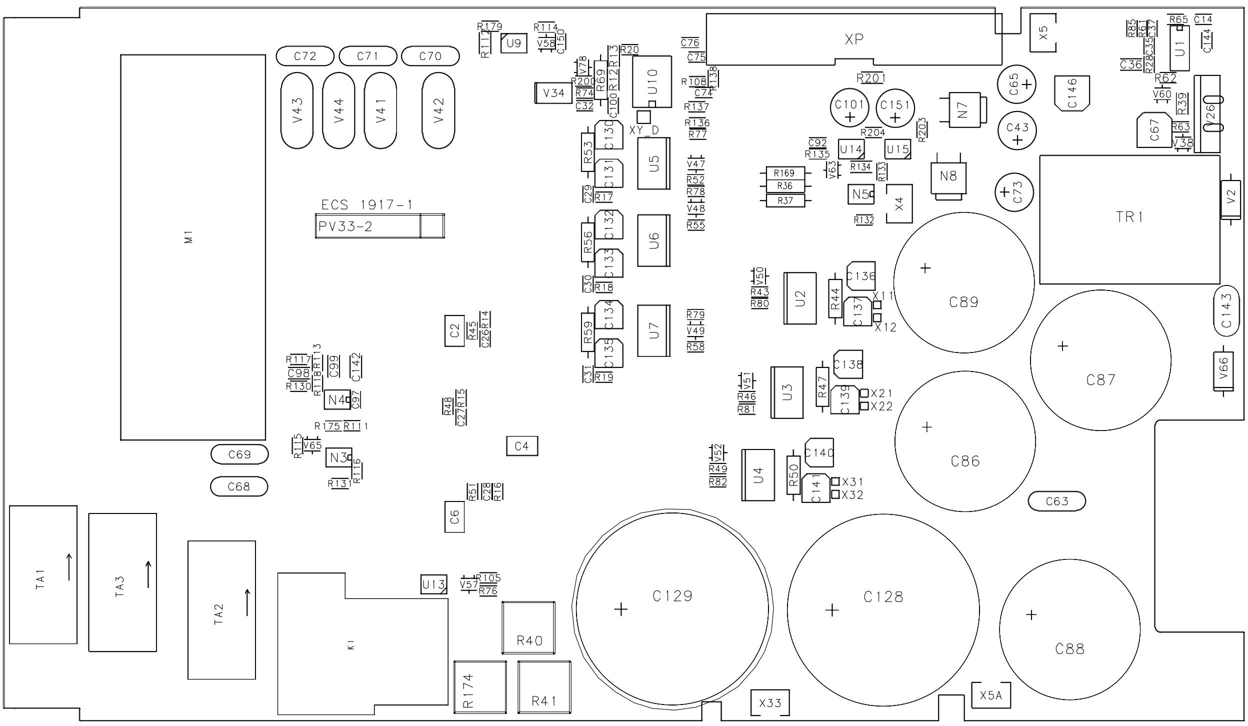


Figure 4.2.1.3: PV33-3-.. power card (sizes PX-20 *and* PX-30*)*

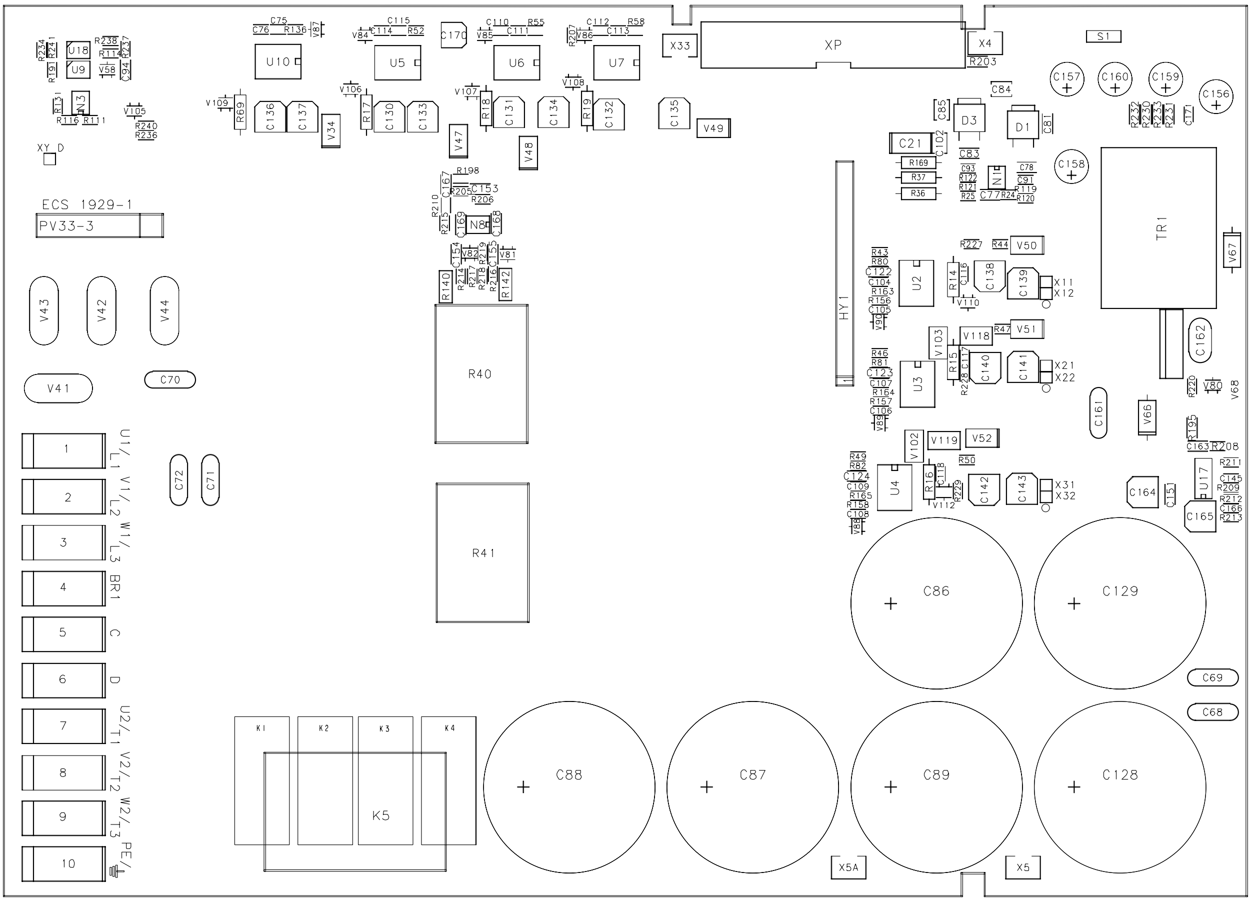


Figure 4.2.1.4: PV33-4-.. power card (sizes PX-40 *to* PX-100*)*

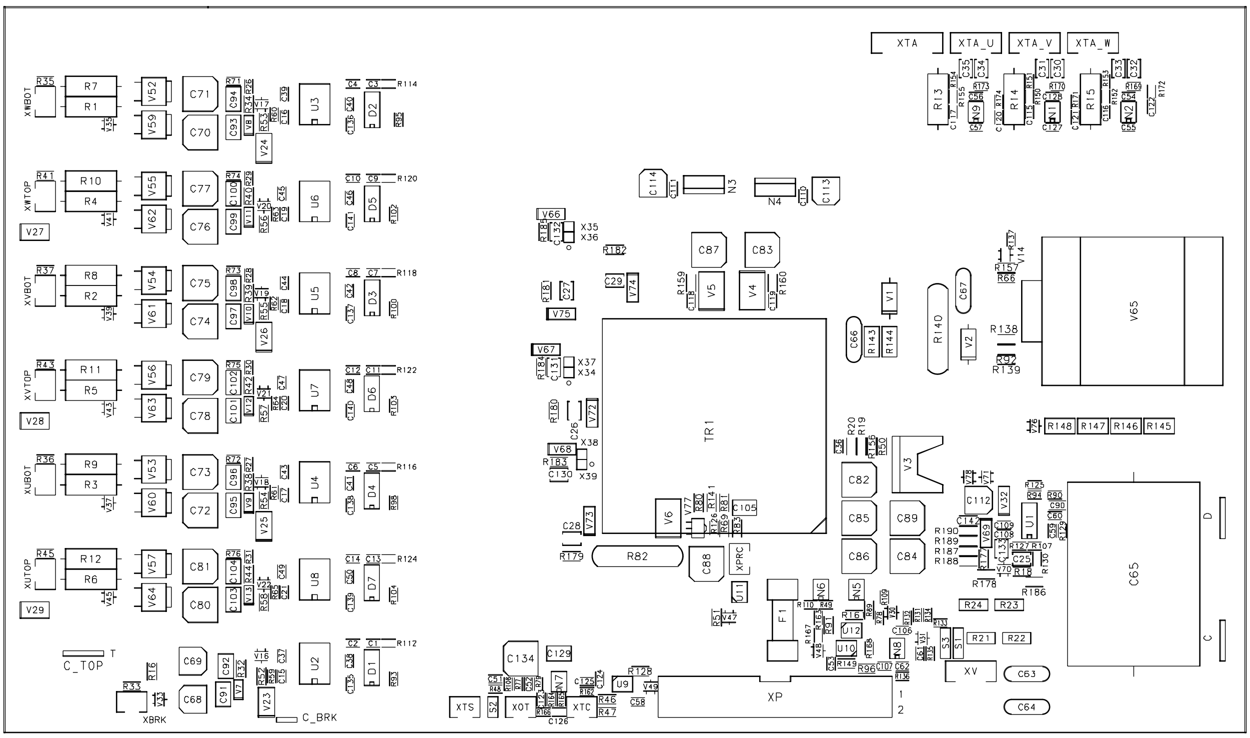
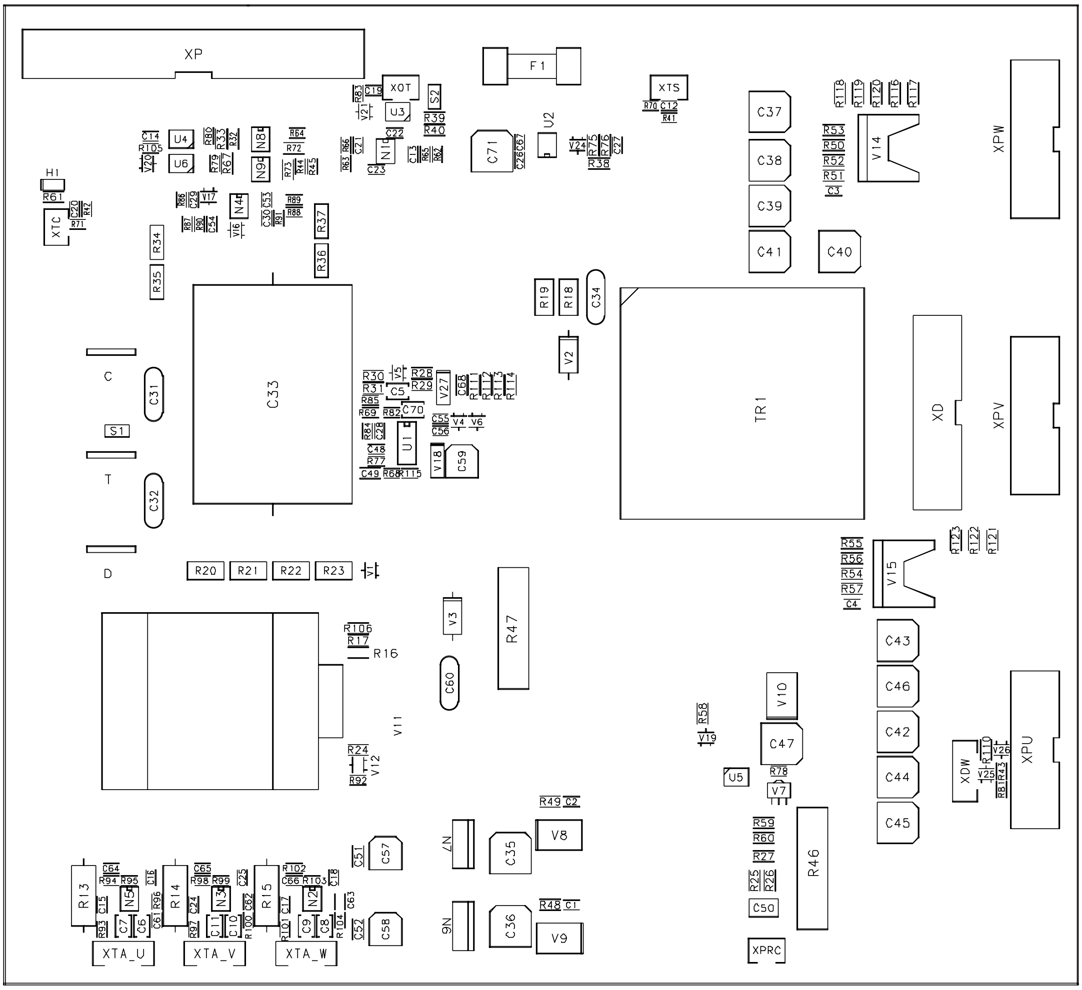
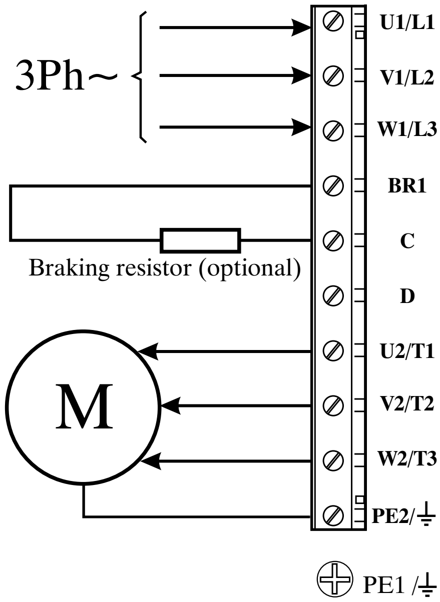


Figure 4.2.1.5: PV33-5-.. power card (sizes PX-125 to PX-300)



4.2.2. Terminal Assignment on Power section / Cable Cross-Section

Table 4.2.2.1: Power Section Terminals



Terminal	Function	max
U1/L1, V1/L2, W1/L3	AC mains voltage	480 V AC +10% 3Ph See table 3.3.2.1
BR1	Braking unit resistor command (braking resistor must be connected between BR1 and C)	
C, D	Intermediate circuit connection	770V DC / 1.65 output current
U2/T1, V2/T2, W2/T3	Motor connection	AC line volt 3Ph 1.36 output current
PE2/⏚	Motor ground connection	
PE1 /⏚	Grounding (protective earth) conductor	

Power terminals lay-out

Sizes PX-3 to PX-30: The terminals of the devices are made accessible by removing the cover and the cable entry plate (see section 4.1, "Accessing the connectors"), on some drive types it is also possible to extract the removable connector .All the power terminals are located on the power card PV33-....shown on previous chapter.

Sizes PX-40 to PX-300: The terminals of the devices are made accessible by removing the cover (see section 4.1, "Accessing the connectors").

Maximum Cable Sizes for power terminals U1, V1, W1, U2, V2, W2, C, D, PE

Table 4.2.2.2: Maximum cable cross section for power terminals

Size		3	5	7	10	15	20	30	40	55
U1,V1,W1,U2,V2,W2,C,D terminals	AWG	14			10		8	6		4
	[mm2]	2			4		8	10	16	25
Tightening torque	[Nm]	0.5 to 0.6					1.2 to 1.5		2	3
PE1, PE2 terminals	AWG	14			10		8	6		
	[mm2]	2			4		8	10	16	
Tightening torque	[Nm]	0.5 to 0.6					1.2 to 1.5		2	3
Size		**70**	**80**	**100**	**125**	**160**	**190**	**230**	**300**	
U1,V1,W1,U2,V2,W2,C,D terminals	AWG	2		1/0	2/0	4/0	300*	350*	4xAWG2	* =kcmils
	[mm2]	35		50	70	95	150	185	4x35	
Tightening torque	[Nm]	4			12		10-30			
PE1, PE2 terminals	AWG	6		2						
	[mm2]	16		50						
Tightening torque	[Nm]	3	4							

txv0060

CAUTION! The grounding conductor of the motor cable may conduct up to twice the value of the rated current if there is a ground fault at the output of the Flexmax Drive.

NOTE: Use 75°C copper conductor only.

4.3. REGULATION SECTION

4.3.1. RV33 Regulation Card

UNDER CONTRUCTION

Table 4.3.1.1: LEDs on Regulation card

Designation	Color	Function
RST	red	LED lit during the Hardware Reset
PWR	green	LED lit when the voltage +5V is present and at correct level
RS485	green	LED is lit when RS485 interface is supplied

ai4050g

Table 4.3.1.2: Test points on Regulation Card RV33

Designation	Function
XY4	Phase current signal (U)
XY5	Reference point

ay4070g

Table 4.3.1.3: Jumpers on Regulation Card RV33

Tab. 4.3.1.3 Jumpers on regulation card RV33

Designation	Function	Factory setting
S0	The setting must not be changed	OFF
S1	The setting must not be changed	OFF
S5-S6	Terminating resistor for the serial interface RS485 ON = Termination resistor IN OFF = No termination resistor	ON
S8	Adaptation to the input signal of analog input 1 (terminals 1 and 2) ON = 0..20 mA / 4..20 mA OFF = 0..10V / -10..+10 V	OFF
S9	Adaptation to the input signal of analog input 2 (terminals 3 and 4) ON = 0..20 mA / 4..20 mA OFF = 0..10V / -10..+10 V	OFF
S10	INTERNAL USE	OFF
S11-S12-S13 S14-S15-S16	Encoder setting (**) (Position does not matter for resolver use) ON = Sinusoidal encoder OFF = Digital Encoder (including Original Powertec Hall Encoder)	OFF
S17	Monitoring of the C-channel of the digital encoder ON = C-channel monitored OFF = C-channel NOT monitored (required to be off for single-ended channels)	OFF
S18-S19 S20-S21	Encoder setting (Postion does not matter for resolver use) A = Sin/Cos encoder B = Hall sensors (including Original Powertec Hall Encoder)	B
S22-S23 S26-S27	Resolver and Sin/Cos Settings A = Sin/Cos standard Input (XE connector on RV33) B = Resolver or Sin/Cos on expansion input (XRF connector on EXP-BRS board)	B
S24-S25	INTERNAL USE - Do not modify factory setting	OFF
S29	Jumper to disconnect 0V (of 24V) from GND ON = OV connected to GND OFF = 0V disconnected from GND	ON
S30	Jumper to disconnect 0V (of regulation section) from GND ON = OV connected to GND OFF = 0V disconnected from GND	ON
S31-S32	INTERNAL USE - Do not modify factory setting	OFF

txv0070

(*) on multidrop connection the jumpers must be ON only for the last drop of a serial line

(**) jumpers on kit EAM_1618 supplied with the drive

Table 4.3.1.4: RV33 Regulation Card Dip Switch S3 Settings

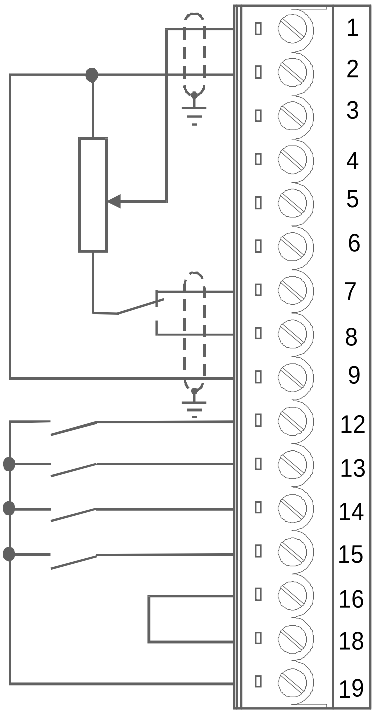
Switch N°	Flexmax Drive model								
	3	5	7	10	15	20	30	40	55
0	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF
1	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF
2	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF
3	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
5	NOT USED								
6	NOT USED								
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	Flexmax Drive model								
	70	80	100	125	160	190	230	300	
0	ON	OFF	ON	OFF	ON	OFF	ON	OFF	
1	OFF	ON	ON	OFF	OFF	ON	ON	OFF	
2	OFF	OFF	OFF	ON	ON	ON	ON	OFF	
3	ON	ON	ON	ON	ON	ON	ON	OFF	
4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	
5	NOT USED								
6	NOT USED								
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	

txv0080

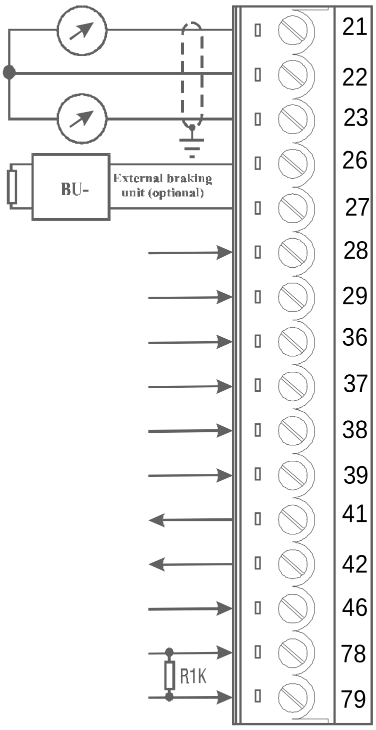
The devices are factory set accordingly .When fitting a regulation card as a spare, remember to set dip-switch S3 accordingly.

4.3.2. Terminal Assignments on regulation section

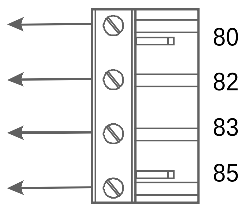
Table 4.3.2.1: Plug-in Terminal Strip Assignments



Strip X1	Function	max
Analog input 1	Programmable/configurable analog differential input. Signal: terminal 1. Reference point: terminal 2. Default setting: Speed Ref 1	±10V
Analog input 2	Programmable/configurable analog differential input. Signal: terminal 3. Reference point: terminal 4. Default setting: none	0.25mA (20mA when current ref input)
Analog input 3	Terminals not used. Analog input 3 is used by resolver. These terminals cannot be used or programmed for some other purpose.	
+10V	Reference voltage +10V; Reference point: terminal 9	+10V/10mA
-10V	Reference voltage -10V; Reference point: terminal 9	-10V/10mA
0V	Internal 0V and reference poInt for±10V	-
Digital Input 0	Defaulted to Drive Enable, 24 vdc to Enable, 0 vdc to disable, Cannot be programmed from Drive Enable	+30V
Digital InpUt 1	Defaulted to Drive Start, 24 vdc to Start, 0 vdc to stop.	3.2mA @ 15V
Digital input 2	Defaulted to Drive Inverse (direction) , 24 vdc to Inverse, 0 vdc to not	5mA @ 24V
Digital input 3	Defaulted to Drive Jog +, 24 vdc to Jog, 0 vdc to stop,	6.4mA @ 30V
Digital Input Common	Reference point for digital inputs and outputs, term.12...15, 36...39, 41...42	-
0 V 24	Reference point for + 24V OUT supply, terminal 19	-
+24V OUT	+24V supply output. Reference point: terminal 18 or 27 or 28	+22…28V 120mA @ 24V



Analog output 1	Program.analog output; def.setting: Motor speed. Ref. point: term.22	±10V/5mA
0V	Internal 0V and reference point for terminals 21 and 23	-
Analog output 2	Program.analog output; def.setting: Motor current. Ref. point: term.22	±10V/5mA
BU comm. output	VeCon controlled BU-... braking units command. Ref. point: term.27.	+28V/15mA
0 V 24	Reference point for BU-... command, terminal 26	-
RESERVED		-
RESERVED		
Digital input 4	Defaulted to Drive Jog -, 24 vdc to Jog, 0 vdc to stop,	+30V
Digital input 5	Programmable digital input; default setting: none	3.2mA @ 15V
Digital input 6		5mA @ 24V
Digital input 7	Defaulted to Drive Reset, 24 vdc to Reset, 0 vdc to allow run,	6.4mA @ 30V
Digital output 0	Programmable digital output; default setting: none	+30V/40mA
Digital output 1		
Supply D O	Supply input for digital outputs on terminals 41/42. Ref. point: term.16.	+30V/80mA
Motor PTC	Motor PTC sensing for overtemperature (cutoff R1k if used). If a Klixon thermal switch is used, remove the 1k resistor and connect the switch to 78, 79 with the resistor in series with the resistor in series, connected to 79.	1.5mA



Strip X2	Function	max curr.
OK relay Contact Digital Out 7	Relay contact OK relay (closed=OK)	250V AC 1 A AC
Relay 2 contact Digital Out 6	Relay contact configurable (relay 2). Default: open 0 drive stopped	250V AC 1 A AC

Maximum Cable Sizes for control terminals

Table 4.3.2.2: Maximum permissible cable cross-section on the plug-in terminals of the regulator section

Terminals	Maximum Permissible Cable Cross-Section			Tightening torque [Nm]
	[mm^2]		AWG	
	flexible	multi-core		
1 ... 79	0.14 ... 1.5	0.14 ... 1.5	28 ... 16	0.4
80 ... 85	0.14 ... 1.5	0.14 ... 1.5	28 ... 16	0.4

Ai4090

The use of a 75 x 2.5 x 0.4 mm (3 x 0.1 x 0.02 inch) flat screwdriver is recommended. Remove 6.5 mm (0.26 inch) of the insulation at the cable ends. Only one unprepared wire (without ferrule) should be connected to each terminal point.

Maximum Cable Length

Table 4.3.2.3: Maximum Control Cable Lengths

Cable section [mm^2]	0.22	0.5	0.75	1	1.5
Max Length m [feet]	27 [88]	62 [203]	93 [305]	125 [410]	150 [492]

avy3130

Potentials of the control section

The potentials of the regulation section are isolated and can be disconnected via jumpers from ground. The connections between each potential are shown in Figure 4.3.2.1.

The analog inputs are designed as differential amplifiers.

The digital inputs are optocoupled with the control circuit. The digital inputs (terminals 12 to 15 and 36 to 39) and digital outputs have terminal 16 as a common reference point.

The analog outputs are not designed as differential amplifiers and have a common reference point (terminal 22).
The analog outputs and the ±10V reference point have same potential (terminal 22 and 9).

The digital outputs are optocoupled with the control circuit. Terminals 41 to 42 have terminal 16 as a common reference point and terminal 46 as common supply.

The brake unit command has reference point (terminal 27) connected to reference point +24V (terminal 18).

Figure 4.3.2.1: Potentials of the control section

UNDER CONSTRUCTION

4.3.3. XE Connector Assignments

The connection with the drive is through a 15 pole high density sub-D connector (VGA type). Please note that it is mandatory to use a shielded cable with at least 80 % coverage. The shield should be connected to ground on both sides of the connector, but not grounded at the motor end.

Table 4.3.3.1: XE Connector Assignments

Assignment		Function	Description
1	ENC B-	Incremental Encoder B-	1V pk-pk / 0…5V
2			
3	ENC I+	Incremental Encoder I+	1V pk-pk / 0…5V
4	ENC I-	Incremental Encoder I-	1V pk-pk / 0…5V
5	ENC A+	Incremental Encoder A+	1V pk-pk / 0…5V
6	ENC A-	Incremental Encoder A-	1V pk-pk / 0…5V
7	GND	Encoder Supply 0V reference	O V
8	ENC B+	Incremental Encoder B+	1V pk-pk / 0…5V
9	AUX+	Encoder Supply + 5V	+5 V /200 mA
10	HALL 1	Hall 1 Positive / Analog Encoder Sin +	1V pk-pk / 0…5V
11	HALL 1-	Hall 1 Negative / Analog Encoder Sin -	1V pk-pk / 0…5V
12	HALL 2	Hall 2 Positive / Analog Encoder Cos +	1V pk-pk / 0…5V
13	HALL 2-	Hall 2 Negative / Analog Encoder Cos -	1V pk-pk / 0…5V
14	HALL 3	Hall 3 Positive	1V pk-pk / 0…5V
15	HALL 3-	Hall 3 Negative	1V pk-pk / 0…5V

txv0090

4.3.4. XFR Connector Assignments (EXP-BRS expansion board)

The connection with the drive is through a 15 pole high density sub-D connector (VGA type). Please note that for resolver feedback it is mandatory to use a twisted pair cable with shields on each pair and an overall shield.

Table 4.3.4.1: XFR Connector Assignments

Assignment		Function	Description
1	ENC B-	Incremental Encoder B-	1V pk-pk / 0…5V
2			
3	ENC I+	Incremental Encoder I+	1V pk-pk / 0…5V
4	ENC I-	Incremental Encoder I-	1V pk-pk / 0…5V
5	ENC A+	Incremental Encoder A+	1V pk-pk / 0…5V
6	ENC A-	Incremental Encoder A-	1V pk-pk / 0…5V
7	GND	Encoder Supply 0V reference	O V
8	ENC B+	Incremental Encoder B+	1V pk-pk / 0…5V
9	AUX+	Encoder Supply + 5V	+5 V /200 mA
10	R_SIN+	Resolver Input Sin+	Analog
11	R_SIN-	Resolver Input Sin-	Analog
12	R_COS+	Resolver Input Cos+	Analog
13	R_COS-	Resolver Input Cos-	Analog
14	RESEX+	Resolver Excitation +	6 V rms / 50 mA rms max
15	RESEX-	Resolver Excitation -	6 V rms / 50 mA rms max

txv0100

4.3.5. Feedback /Drive connections

The Flexmax drive can handle seven different feedback devices (see paragraph 3.4.2), all selectable through the setting of jumpers on the regulation board.

The jumper setting will be as follows :

Table 4.3.5.1: Resolver/Encoder/Drive connections

Encoder/Jumpers settings	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S26	S27
SESC	ON	ON	ON	ON	ON	ON	-	A	A	A	A	A	A	A	A
DEHS	OFF	OFF	OFF	OFF	OFF	OFF	ON	B	B	B	B	-	-	-	-
SEHS	ON	ON	ON	ON	ON	ON	-	B	B	B	B	-	-	-	-
RES	-	-	-	-	-	-	-	-	-	-	-	B	B	B	B
ABSM															

txv0110

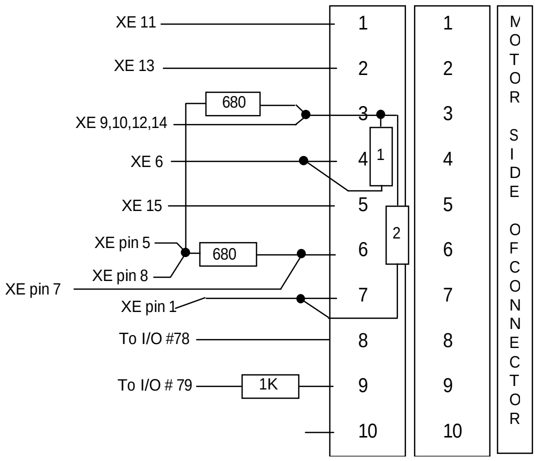
Note: A "-" in the table means that the position of the jumper does not matter. For instance, when setting up for a resolver, it does not matter where any of the jumpers are except S22, S23, S26, and S27. In the following paragraphs are specified the connections between Flexmax drives and the feedback sensors installed on standard Powertec motors.

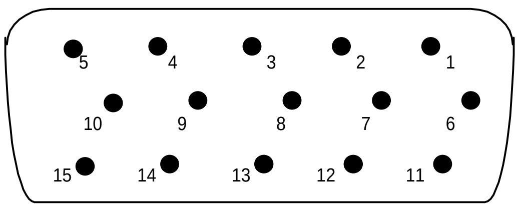
4.3.5.1. Original Powertec Hall Effect Encoder

Table 4.3.5.1.1: Hall encoder 4 pole 30 ppr, 6 pole 45 ppr, 8 pole 60 ppr Connections

Original Hall Effect Encoder	Flexmax XE connector on RV33 regulation board	Powertec Motor Terminal Block
HS-1 (commutation) Brown	Pin 13	2
HS-2 (commutation) Orange	Pin 11	1
HS-3 (commutation) Yellow	Pin 15	5
HS-4 (Speed A) Blue	Pin 6	4
HS-5 (speed B) Green	Pin 1	7
+5V Red	Pin 9,10,12,14	3
Common Black	Pin 7	6
	Pins 5 & 8 together then through 680 ohm resistor to 3 on Motor term blk	3
	Pins 5 & 8 together then through another 680 ohm to 6 on Mtr terminal block, see drawing for detail	6
		Connect 680 ohm ¼w resistor from 3 to 4
		Connect 680 ohm ¼ w resistor from 3 to 7
Klixon Motor Thermal (Violet)	Pin 78, X1 Terminals	8
Klixon Motor Thermal (White)	Pin 79, X1 Terminals	9
Note: Remove 1k resis across 78-79 and wire resistor in Series with wire from thermal to 79, wire other side of thermal to 78. Use shielded wire, ground shield at drive end only.		

txv0120





Back View of VGA D-sub Connector (solder side)

4.3.5.2. TWO POLE RESOLVER (RES)

Table 4.3.5.2.1: Two pole resolver

Powertec Motor Resolver Wires	Flexmax Drive XFR connector on EXP-BRS board	Terminals in Powertec Motor Terminal Box Strip
Yellow	PIN 10 Resolver Sin +	3
Blue	PIN 11 Resolver Sin -	4
Black	PIN 12 Resolver Cos +	2
Red	PIN 13 Resolver Cos -	1
Red/Wht	PIN 14 Resolver Excitation +	6
Black/Wht	PIN 15 Resolver Excitation -	7
		5 (open, NC)
Shield	Solder shield to body of connector.	10 (do not ground)
Klixon Motor Thermal (Violet)	Pin 78, X1 Terminals on Drive	8
Klixon Motor Thermal (White)	Pin 79, X1 Terminals on Drive	9
Note: Remove 1k resis across 78-79 and wire resistor in Series with wire from thermal to 79, wire other side of thermal to 78. Use shielded wire, ground shield at drive end only.		

txv0130

Requirements:

Sinusoidal encoders (XE connector on Regulation card)

max. frequency	80 KHz (select the appropriate number of pulses depending on required max. speed)
Number of pulses per revolution	min 600, max 9999
Channels	two-channel, differential
Power supply	+ 5 V (Internal supply)
Load capacity	> 8.3 mA pp per channel

Digital encoders (XE connector on Regulation card)

max. frequency	150 KHz (select the appropriate number of pulses depending on required max. speed)
Number of pulses per revolution	min 600, max 9999
Channels	- two-channel, differential A / $\overline{A}$, B / $\overline{B}$, C / $\overline{C}$). An encoder loss detection is possible via firmware setting. - two channel, (A,B). Encoder loss detection is not possible.
Power supply	+ 5 V (Internal supply) *

Load capacity	> 4.5 mA / 6.8 ... 10 mA per channel

Resolver interface (XFR connector on EXP-BRS board)

Resolver excitation	sinusoidal
Resolver excitation voltage	6V rms
Resolver excitation current	50mA rms max
Resolver excitation frequency	8KHz
Resolver input	differential
Resolver tranformation ratio	between 0,5 and 1
resolver input impedence	4kΩ
Suggested cable	Belden 9504, 4 twisted pair, for runs of less than 100’. Recommend special shielded twisted pair, low capacitance, for longer runs, contact factory.

Terminals for external encoder connections

Male terminal type:	15 pole high density (VGA type)
Connector cover:	Standard 9 pole type low profile (Example manufacturer code: AMP 0-748676-1, 3M 3357-6509)

Terminals for resolver connections

XFR Connector:	15 pin high density (VGA type), male
XFR Connector cover:	Standard 9 pin low profile (Example manufacturer code: AMP 0-748676-1, 3M 3357-6509)

4.3.6. ENCODER SIMULATION

On the expansion board EXP-BRS there is avaliable an incremental encoder output, with TTL Line Driver levels, that can be used as simulation of the servomotor feedback device.

This function is performed by the microprocessor and it is possible to simulate an encoder output with a programmable number of pulses/rev.

The output interface is optically isolated, so the encoder output must be supplied with an external 15...24 V supply that can be connected to terminals 96 and 97 of the EXP-BRS expansion board.

The encoder output signals are avaliable on the XFO connector with the following connection diagram :

Table 4.3.6.1: Encoder simulation

XFO connector on EXP-BRS	Function	Description
PIN 1	B-	Digital Encoder Simulation. B- channel
PIN 2		
PIN 3	Z+	Digital Encoder Simulation. 0- channel
PIN 4	Z-	Digital Encoder Simulation. O+ channel
PIN 5	A+	Digital Encoder Simulation. A+ channel
PIN 6	A-	Digital Encoder Simulation. A- channel
PIN 7		
PIN 8	B+	Digital Encoder Simulation. B+ channel
PIN 9		
PIN 10		
PIN 11		
PIN 12		
PIN 13		
PIN 14		
PIN 15		

txv0140

Please note that jumper S2 and S3 on the EXP-BRS optional board must be OFF.

Digital encoder simulation

Interface	opto-isolated
Simulation	differential digital incremental
Standard outputs	A+, A-, B+, B-,I+, I-
Outputs levels	Standard TTL
Voltage limits on the TTL high-state outputs (on the pins)	
(U_{high} TTL)	< 2,5V
Voltage limits on the TTL low-state outputs (on the pins)	
(U_{low} TTL)	< 0,5V
TTL load capacity	20mA max. each
Parallel connection of standard Flexmax inputs	
with a TTL outputs	3 inputs
Max. frequency	150KHz
Encoder simulation power supply	5V obtained with an external 15..24V
Max absorption of the encoder simulation power supply	140mA@5V
Mechanics	Male high density 15-pole D-sub connector (type VGA) for standard inputs and extractable terminals to be connected to a 0,14..1,5 mm2 power supply section
Special functions	pulse/rev regulation of the simulated encoder wirh parameter.

Terminals for encoder simulation connections

XFO Connector	15 pin high density (VGA type), female
XFO Connector cover	Standard 9 pin low profile (Example manufacturer code: AMP 0-748676-1, 3M 3357-6509)

4.4. SERIAL INTERFACE

4.4.1. Serial Interface Description

The RS 485 serial interface enables data transfer via a loop made of two symmetrical, twisted conductors with a common shield. The maximum transmission distance is 1200 m (3936 feet) with a transfer rate of up to 38,400 KBaud. The transmission is carried out via a differential signal. RS 485 interfaces are bus-compatible in half-duplex mode, i.e. sending and receiving take place in sequence. Up to 31 Flexmax devices (up to 128 address selectable) can be networked together via the RS 485 interface. Address setting is carried out via the **Device address** parameter. Further information concerning the parameters to be transfered, their type and value range is given in the table contained in section 8, “Parameter lists”.

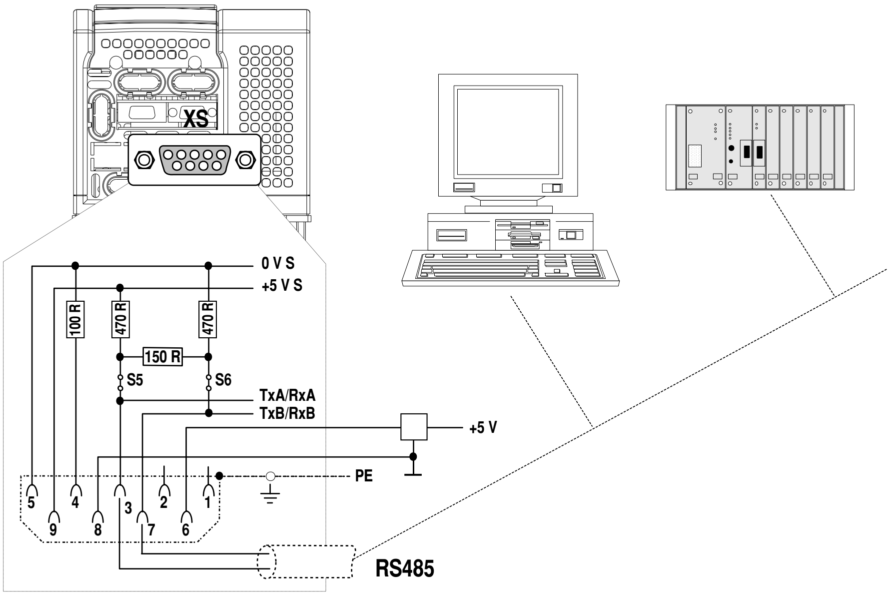


Figure 4.4.1.1: RS485 Serial Interface

The RS 485 on the Flexmax series devices is located on the Regulation card in the form of a 9-pole SUB-D socket connector (XS).The communication may be with or without galvanic isolation: when using galvanic isolation an external power supply is necessary (+5V). Communication without galvanic isolation is suggested only in case of temporary connections for setup with one drive connected. The differential signal is transferred via PIN 3 (TxA/RxA) and PIN 7 (TxB/RxB). Bus terminating resistors must be connected at the physical beginning and end of an RS 485 bus in order to prevent signal reflection. The bus terminating resistors on Flexmax drives are connected via jumpers S5 and S6. This enables a direct point-to-point connection with a PLC or PC.

NOTE! Ensure that only the first and last drop of an RS 485 bus have a bus terminating resistor (S5 and S6 mounted). In all other cases (within the line) jumpers S5 and S6 must not be mounted.

A connection point to point can be done using “PCI-485” option interface, without jumper setting.

For multidrop connection (two or more drive), an external power supply is necessary (pin 5 / 0V and pin 9 / +5V).

Pins 6 and 8 are reserved for use with the “PCI-485” interface card.

When connecting the serial interface ensure that:

- only shielded cables are used
- power cables and control cables for contactors/relays are routed separately

NOTE! See the manual “SLINK3 Communication protocol” for more detail.

4.4.2. RS 485 Serial Interface Connector Description

Table 4.4.2.1: Assignment of the plug XS connector for the RS 485 serial interface

Designation	Function	I/Q	Elec. Interface
PIN 1	Internal use	–	–
PIN 2	Internal use	–	–
PIN 3	RxA/TxA	I/Q	RS485
PIN 4	Internal use	–	–
PIN 5	0V (Ground for 5 V)	–	Power supply
PIN 6	Internal use	–	–
PIN 7	RxB/TxB	I/Q	RS 485
PIN 8	Internal use	–	–
PIN 9	+5 V	–	Power supply

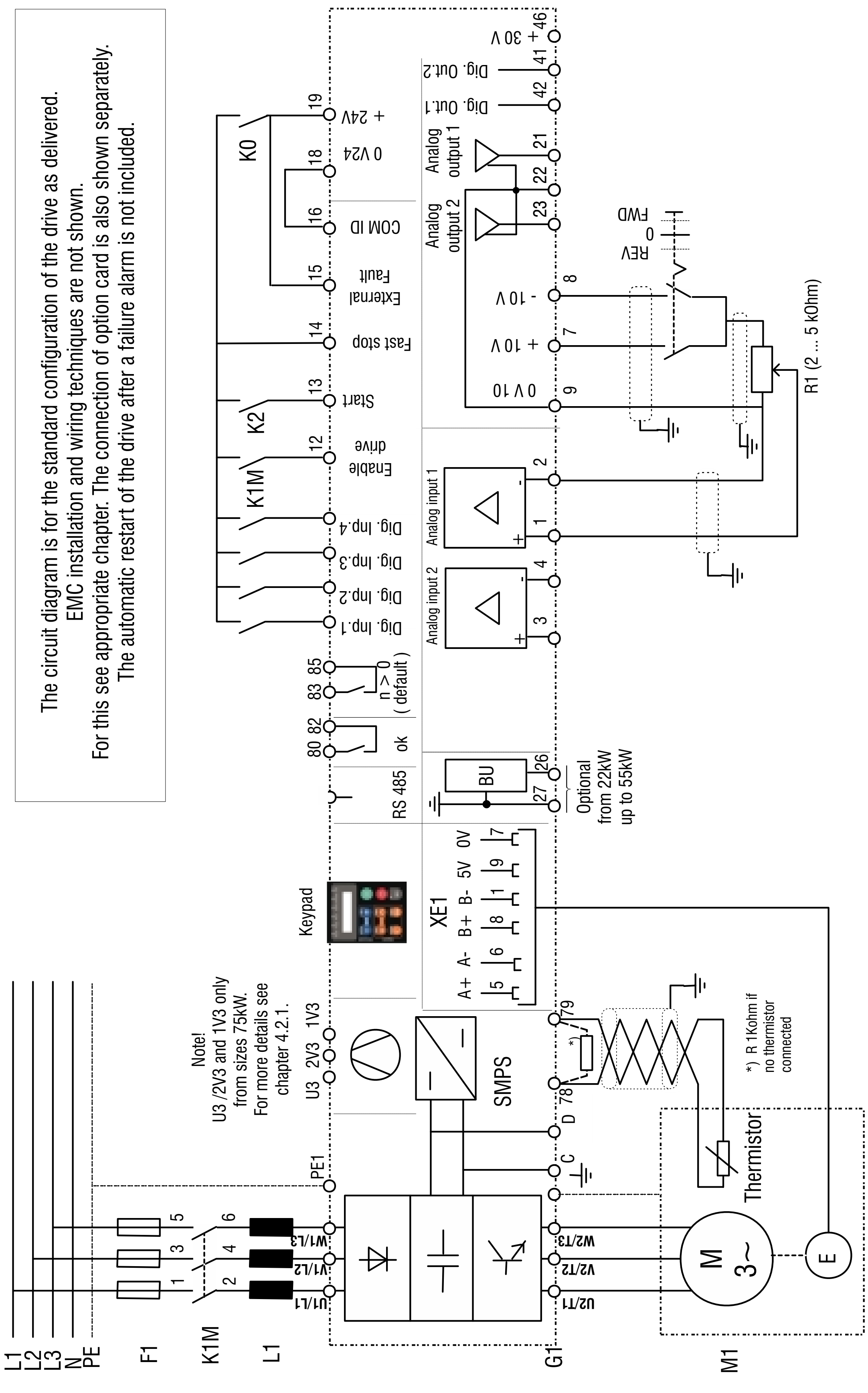
ai4110

I = Input Q = Output

4.5. STANDARD CONNECTION DIAGRAM

4.5.1. Flexmax Connections

Figure 4.5.1.1: Typical connection



4.6. CIRCUIT PROTECTION

4.6.1. External fuses for the power section

The drive must be fused on the AC Input side. Fuses, circuit breakers and slow protective switches can be used. Superfast semiconductor fuses provide a greater degree of protection.

NOTE! If the terminals of the DC Link circuit (C +and D -) are connected with external devices, semiconductor fuses must always be fitted on the AC input side. This, for example, is the case with:

- connected external braking units (BU...)
- coupled DC Link circuits of several inverters
- connected external capacitors

Connections with three-phase inductance on AC input are not essential but will improve the DC link capacitors lifetime and drive reliability in unusual power events.

Table 4.6.1.1: External Fuse Types for AC input

<table>
<tr><th rowspan="2">Drive type</th><th colspan="4">Connections without three-phase reactor on AC input</th><th colspan="4">Connections with three-phase reactor on AC input</th></tr>
<tr><th>DC link capacitors life time [h]</th><th>Europe</th><th colspan="2">USA</th><th>DC link capacitors life time [h]</th><th>Europe</th><th colspan="2">USA</th></tr>
<tr><td>3</td><td rowspan="2">25000</td><td>GRD2/10 or Z14GR10</td><td>A70P10</td><td>FWP10</td><td rowspan="7">50000</td><td>GRD2/10 or Z14GR10</td><td>A70P10</td><td>FWP10</td></tr>
<tr><td>5</td><td rowspan="2">GRD2/16 or Z14GR16</td><td rowspan="2">A70P20</td><td rowspan="2">FWP20</td><td>GRD2/10 or Z14GR10</td><td>A70P10</td><td>FWP10</td></tr>
<tr><td>7</td><td>10000</td><td>GRD2/16 or Z14GR16</td><td>A70P20</td><td>FWP20</td></tr>
<tr><td>10</td><td>25000</td><td>GRD2/25 or Z14GR25</td><td>A70P25</td><td>FWP25</td><td>GRD2/20 or Z14GR20</td><td>A70P20</td><td>FWP20</td></tr>
<tr><td>15</td><td>10000</td><td>GRD3/35 or Z22GR40</td><td>A70P35</td><td>FWP35</td><td>GRD2/25 or Z14GR25</td><td>A70P25</td><td>FWP25</td></tr>
<tr><td>20</td><td>25000</td><td>GRD3/50 or Z22GR40</td><td>A70P40</td><td>FWP40</td><td>GRD3/35 or Z22GR40</td><td>A70P35</td><td>FWP35</td></tr>
<tr><td>30</td><td>10000</td><td>GRD3/50 or Z22GR50</td><td>A70P40</td><td>FWP50</td><td>GRD3/50 or Z22GR50</td><td>A70P40</td><td>FWP40</td></tr>
<tr><td>40</td><td rowspan="11">10000</td><td rowspan="11" colspan="3">For these types an external reactor is mandatory if the AC input impedence is equal or less than 1%</td><td rowspan="11">25000</td><td>GRD3/50 or Z22GR50</td><td>A70P50</td><td>FWP50</td></tr>
<tr><td>55</td><td>S00üf1/80/80A/660V or Z22gR80</td><td>A70P80</td><td>FWP80</td></tr>
<tr><td>70</td><td>S00üf1/80/100A/660V or M00üf01/100A/660V</td><td>A70P100</td><td>FWP100</td></tr>
<tr><td>80</td><td rowspan="2">S00üf1/80/160A/660V or M00üf01/160A/660V</td><td rowspan="2">A70P175</td><td rowspan="2">FWP175</td></tr>
<tr><td>ɨ 100</td></tr>
<tr><td>125</td><td rowspan="2">S1üf1/110/250A/660V or M1üf1/250A/660V</td><td rowspan="2">A70P300</td><td rowspan="2">FWP300</td></tr>
<tr><td>160</td></tr>
<tr><td>190</td><td rowspan="3">S2üf1/110/400A/660V or M2üf1/400A/660V</td><td rowspan="3">A70P400</td><td rowspan="3">FWP400</td></tr>
<tr><td>230</td></tr>
<tr><td>300</td></tr>
</table>

txv0150

Fuse manufacturers:

Type GRD2... (E27), GRD3... (E33), M... (blade fuses), Z14... 14 x 51 mm, Z22... 22 x 58 mm, S....	Jean Müller, Eltville
A70P...	Gould Shawmut
FWP...	Bussmann

NOTE! The technical data of the fuses, e.g. dimensions, weights, heat dissipation, auxiliary contactors, are found in the manufacturers data sheets.

4.6.2. External fuses for the power section DC input side

Use the following fuses when an external bus supply is used. Powertec can provide an external supply if needed.

Table 4.6.2.1: External fuses type for DC input

side

Drive type	Fuses type		
	Europe	USA	
3	Z14GR10	A70P10	FWP10A14F
5			
7	Z14GR16	A70P20-1	FWP20A14F
10	Z14GR20		
15	Z14GR32	A70P30-1	FWP30A14F
20	Z14GR40	A70P40-4	FWP40B
30	Z22GR63	A70P60-4	FWP60B
40	S00üF1/80/80A/660V	A70P80	FWP80
55	S00üF1/80/100A/660V	A70P100	FWP100
70	S00üF1/80/125A/660V	A70P150	FWP150
80	S00üF1/80/160A/660V	A70P175	FWP175
100	S00üF1/80/200A/660V	A70P200	FWP200
125	S1üF1/110/250A/660V	A70P250	FWP250
160	S1üF1/110/315A/660V	A70P350	FWP350
190	S2üF1/110/400A/660V	A70P400	FWP400
230	S1üF1/110/500A/660V	A70P500	FWP500
300			

txv0160

Fuse manufacturers:	Type Z14..., Z22, S00 ..., S1..., S2...	Jean Müller, Eltville
	A70P...	Gould Shawmut
	FWP...	Bussmann

NOTE! The technical data of the fuses, e.g. dimensions, weights, heat dissipation, auxiliary contactors, are found in the manufacturers data sheets.

4.6.3. Internal fuses

Table 4.6.3.1: Internal

Drive type	Designation	Protection of	Fuse (source)	Fitted on:
PX-40 to PX-300	F1	+24V	2A fast 5 x 20 mm (Bussmann: SF523220 or Schurter: FSF0034.1519 or Littlefuse: 217002)	Power card PV33-4-"D" and higher
				Power card PV33-5-"B" and higher
PX-3 to PX-300	F1	+24V	Resettable fuse	Regulation card RV33-1C and higher
PX-125 to PX-230	F3	Fans transformer	2.5A 6.3x32 (Bussmann: MDL 2.5, Gould Shawmut: GDL1-1/2, Siba: 70 059 76.2,5 , Schurter: 0034.5233)	Bottom cover (power terminals side)

txv0170

4.7. CHOKES / FILTERS

NOTE! A three-phase inductance should be connected on the AC Input side in order to limit the input RMS current of Flexmax series Drives. The inductance can be provided by an AC Input choke or an AC Input transformer. While the drive will work without the inductance, capacitor life will be shortened and general reliability will be less.

NOTE! For the use of output sinusoidal filters, please contact the factory..

4.7.1. AC Input Chokes

Table 4.7.1.1: 3-Phase AC Input Chokes

Drive type	Three-phase choke type
3	LR3y-1015
5	LR3y-1022
7	LR3y-1030
10	LR3y-2055
15	LR3y-2075
20	LR3y-3110
30	LR3y-3150
40	LR3-022
55	LR3-030
70	LR3-037
80	LR3-055
100	
125	LR3-090
160	
190	LR3-160
230	
300	

txv0180

For all the sizes an input choke is strongly reccomended in order to:
- prolong the life time of the DC link capacitors and the reliability of the input rectifier.
- reduce the AC mains harmonic distortion
- reduce the problems due to a low impedence AC mains (λεσσ τηαν 1%).

NOTE! The current rating of these inductors (reactors) is based on the nominal current of standard motors, listed in table 2.3.2.1 in section 2.3.2, “AC Input/Output Connection”.

4.7.2. Output Chokes

The Flexmax Drive can be used with general purpose standard motors or with motors specially designed for Drive use. The latter usually have a higher isolation rating to better withstand PWM voltage.

Following is an example of industry “standards” for motors::

Low voltage general purpose standard motors

VDE 0530:	max peak voltage	1kV
	max. dV/dt	500 V/us
NEMA MG1 part 30:	max. peak voltage	1 kV
	min. rise time	2 us

Low voltage motors for use on inverters

NEMA MG1 part 31:	max. peak voltage	1.6 kV
	min. rise time	0.1 us.

Motors purchased new from Powertec do not require any specific filtering of the voltage waveform from the Drive. For old motors (older than 1993 with original winding), especially with long cable runs (typically over 30 m [98.5 feet]) an output choke is recommended to maintain the voltage waveform within the specified limits. Suggested choke ratings and part numbers are listed in table 4.7.2.1. When replacing old drives with the Flexmax, check to be sure the motor insulation system is capable of IGBT operation.

The rated current of the filters should be approx. 20% above the rated current of the frequency Drive in order to take into account additional losses due to PWM waveform.

Table 4.7.2.1: Recommended values for output chokes

Drive type	Three-phase choke type
3	LU3-003
5	
7	
10	LU3-005
15	LU3-011
20	
30	LU3-015
40	LU3-022
55	LU3-030
70	LU3-037
80	LU3-055
100	
125	LU3-090
160	
190	LU3-160
230	
300	

txv0190

NOTE! When the Drive is operated at the rated current and at 50 Hz, the output chokes cause a voltage drop of approx. 2% of the output voltage. Slightly less drop will occur at 60Hz.

4.7.3. Interference Suppression Filters

Flexmax drives must be equipped with an external EMI filter in order to reduce the radiofrequency emissions on the mains line as required for operation in Europe. US rules right now do not dictate miniumum EMI conduction to the line. The filter selection is depending on the drive size and the installation environment. For this purpose see the “EMC Guidelines” instruction book.

In the Guide it is also indicated how to install the drive in an enclosure (connection of filter and mains reactors, cable shield, groundig, etc.) in order to make it EMC compliant according the EMC Directive 89/336/EEC. The document describes the present situation concerning the EMC standards and the compliance tests made on the drives as required by CE.

4.8. FAST LINK CONNECTIONS

On the EXP-BRS board a fast serial connection is available, that is optimized to exchange I/O and regulation parameters between different drives. This synchronous serial interface is named FAST LINK. This interface can have two different connection architectures :

- Multi Point : one drive is configured as master (transmitting) and the others as slaves (receiving).
- Peer-to-Peer: This software is not yet released, but is supported by the existing hardware.

Each EXP-BRS board has two connectors, one is used as input (XT-IN) and the other as signal output (XT-OUT).

Figure 4.8.1: XT-IN Connector (FAST LINK Input)

PIN	Function	Description
1	DT_IN+	Data input Fast Link +
2	DT_IN-	Data input Fast Link -
3	CLK_IN+	Clock input Fast Link +
4	CLK_IN-	Clock input Fast Link -

txv0200

Figure 4.8.2: XT-OUT Connector (FAST LINK Output)

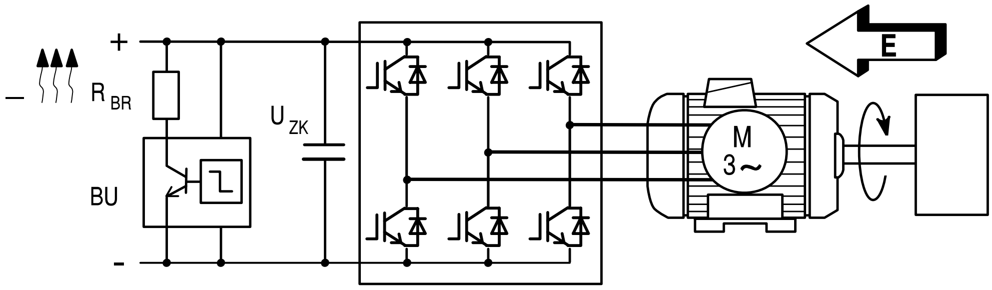
PIN	Function	Description
1	DT_OUT+	Data output Fast Link +
2	DT_OUT-	Data output Fast Link -
3	CLK_OUT+	Clock output Fast Link +
4	CLK_OUT-	Clock output Fast Link -

txv0210

4.9. BRAKING UNITS

In oversynchronous or regenerative operation, the frequency-controlled three-phase motor feeds energy back to the DC link circuit via the Drive. This creates an increase in the intermediate circuit voltage. Braking units (BU) are therefore used in order to prevent the DC voltage rising to a value causing the drive to trip. When used, these activate a braking resistor that is modulated across the capacitors of the intermediate circuit. The feedback energy is converted to heat via the braking resistor (R_{BR}), thus providing very short deceleration times and restricted four-quadrant operation.

Figure 4.9.1: Operation with Braking Unit (Principle)



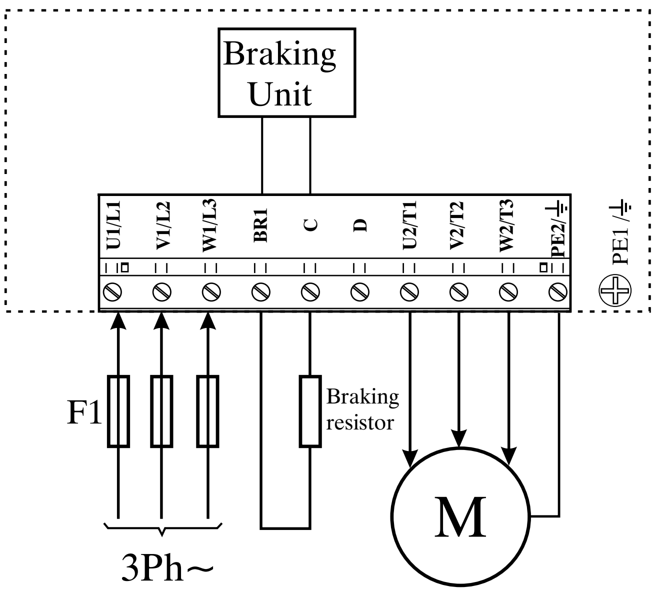
All Flexmax drives can be equipped with an external braking unit (BU-32.xx...) connected to terminals C (+Bus) and D (-Bus).

NOTE! When the internal braking unit is present, or when circuit terminals C and D are connected to external devices, the AC Input must be protected with superfast semiconductor fuses! Observe the mounting instruction concerned.

4.9.1. Internal braking unit

The Internal Braking Unit is included as standard (up to size PX-55). The braking **resistor** is optional and has always to be mounted externally. For parameter settings refer to the section **9.28 "Braking unit".** The figure below shows the configuration for internal brake unit operation.

Figure 4.9.1.1: Connection with internal Braking Unit and external braking resistor



4.9.2. External braking resistor

Recommended resistors for use with internal braking unit:

Table 4.9.2.1: Lists and technical data of the external standard resistors

Drive Type	Resistor Type	P_{NBR} [kW]	R_{BR} [Ohm]	E_{BR} [kJ]
3	MRI/T600 100R	0.6	100	22
5				
7				
10	MRI/T900 68R	0.9	68	33
15				
20	MRI/T1300 49R	1.3	49	48
30	MRI/T2200 28R	2.2	28	82
40	MRI/T4000 15R4	4	15.4	150
55	MRI/T4000 11R6	4	11.6	150
70	MRI/T4000 11R6	4	11.6	150
80	MRI/T8000 7R7	8	7.7	220
100	MRI/T8000 7R7	8	7.7	220

txv0220

Parameters description:

P_{NBR} Nominal power of the braking resistor
R_{BR} Braking resistor value
E_{BR} Max surge energy which can be dissipated by the resistor
P_{PBR} Peak power applied to the braking resistor
T_{BRL} Maximum braking time in condition of limit operating cycle (braking power = P_{PBR} with typical triangular profile)

$$T_{BRL} = 2\,\frac{E_{BR}}{P_{PBR}} = [s]$$

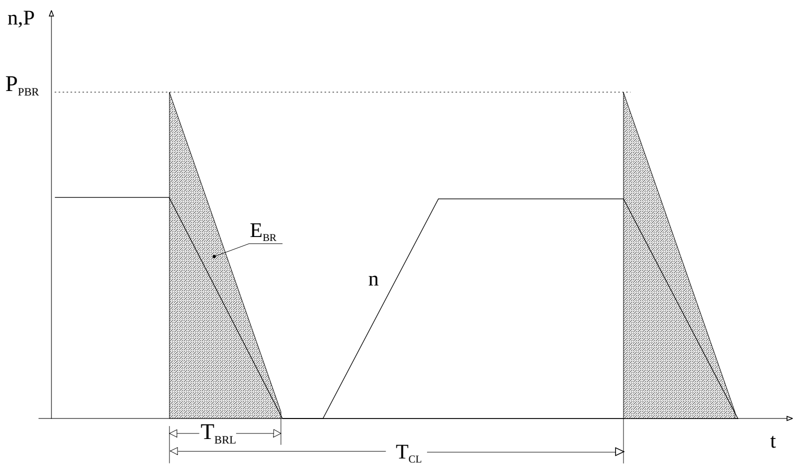


Figure 4.9.2.2: Limit operating braking cycle with typical triangular power profile

T_{CL} Minimum cycle time in condition of limit operating cycle (braking power = P_{PBR} with typical triangular profile)

$$T_{CL} = \frac{1}{2} T_{BRL} \frac{P_{PBR}}{P_{NBR}} = [s]$$

The **BU overload** alarm occurs if the duty cycle exceeds the maximum data allowed in order to prevent possible damage to the resistor.

Resistor model: Standard resistor data

Example code: MRI/T900 68R

MRI = resistor type

900 = nominal power (900 W)

T= with safety thermostat

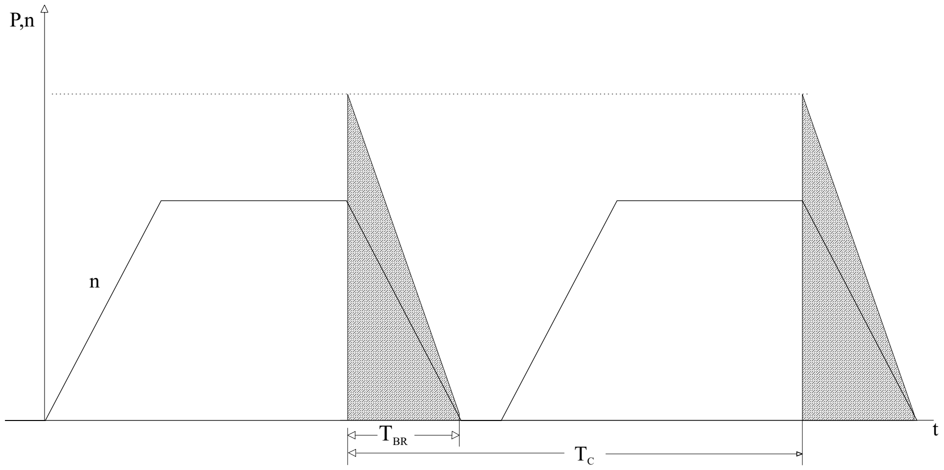
68R = resistor value (68 Ω)

NOTE! The suggested match of resistor-model and inverter-size, allows a braking stop at nominal torque with duty cycle T_{BR} / T_C = 20%

Where: T_{BR} = Braking time

T_C = Cycle time

Figure 4.9.2.3: Braking cycle with T_{BR} / T_C = 20%



These resistors, whose technical data are reported in the table 4.9.2.1, have been sized to tolerate an overload equal to 4 times their nominal power for 10 seconds.

In any event they can tolerate also an overload, whose energy dissipation is the same of the maximum power level defined by:

$$P_{PBR} = \frac{V_{BR}^2\ [V]}{R_{BR}\ [Ohm]} = W$$

Where: V_{BR} = braking unit threshold

With reference to the figure 4.9.2.4, where the power profile is the typical triangular one, the following example can be taken into consideration (see also table 4.9.2.1).

Resistor model: MRI/T600 100R

Nominal power $\mathbf{P_{NBR}}$ = 600 [W]
Maximum energy $\mathbf{E_{BR}}$ = 4 x 600[W] x 10[s] = 24000[J]
Inverter mains supply = 460V
From table 5.8.2.2: $\mathbf{V_{BR}}$=780V

$$P_{PBR} = \frac{V_{BR}^{\,2}}{R_{BR}} = \frac{780^{\,2}}{100} = 6084\ [W] \qquad T_{BRL} = 2\,\frac{E_{BR}}{P_{PBR}} = 2\,\frac{24000}{6084} = 7.8[s]$$

It is necessary to consider the following relation:

A) If $\mathbf{T_{BR} < E_{BR} / P_{NBR}}$ verify:

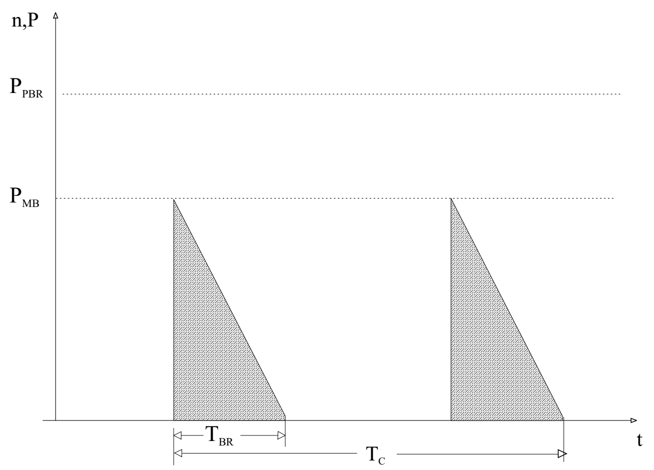
1) $\mathbf{P_{MB} < 2 * E_{BR} / T_{BR}}$ Where: $\mathbf{P_{MB}}$ is the average power of the cycle (see.fig. 4.9.2.4)

2) $$\frac{P_{MB} \times T_{BR}}{2\,T_C} \leq P_{NBR}$$

The average power of the cycle must not be higher than the nominal power of the resistor.

B) If $\mathbf{T_{BR} > E_{BR} / P_{NBR}}$ that is to say, in case of very long braking time, it must be dimensioned $\mathbf{P_{MB} < P_{NBR}}$

Figure 4.9.2.4: Generic braking cycle with triangular profile



If one of the above mentioned rules is not respected, it is necessary to increase the nominal power of the resistor, respecting the limit of the internal braking unit (reported in table 4.9.2.4)

4.9.3. Control of the external braking power

The braking resistance average power is defined by the following formula:

$$P = 0.2 \cdot J_{tot} \cdot \omega^2 \cdot f$$

where: **P** = Dissipated power

J_{tot} = Total inertia (Kgm^2)

ω = Max speed (rad/sec)

f = Cycle frequency in Herz (number of cycles per second).

$$f = 1/T_{BR} \text{ (sec)}$$

4.9.4. External resistance interaction with the system parameters

When the external braking resistance is installed it is always necessary to carry out some modifications in the parameters: “SYSTEM \ BRAKING UNIT”.

Following are the parameters related to the braking resistance: SYSTEM \ BRAKING UNIT

SYS OV_CLM_LIM To set up the internal braking unit operating point.

The factory sets this parameter equal to a voltage value of 860V (DC link continuous voltage).

The overvoltage alarm operating point is fixed at 950V.

In case of alarm due to an overvoltage with external braking resistance, the turn-on point of the braking unit can be reduced by this parameter.

Example: setting the activation value at 830V.

Note ! Be careful not to reduce this parameter too much with main voltage supply of the drive at 460V, else the unit will turn on for normal voltages.

SYS _OV_MAX_LIM Overvoltage alarm threshold cannot be modified

4.9.5. Choice of the thermal relay for brake resistor

Here is a procedure aimed at stating the coordination of a thermal relay for the protection of the resistor bank in case of a sudden component failure (not detected), when the DC bus power supply is continuously connected to the braking resistance.

It is important to remember that the drives are supplied with a I^2t function for the resistor bank protection; such a function is in a position to avoid any possible overload but it cannot protect against component failure that might render impossible the logical control of the braking resistor current.

As stated in the dimensioning procedure for the bus braking system, the resistor bank has, with a given ambient condition, a possible instantaneous overload defined as

$E_{max\ BR}$ in [Joule] or as a product given by

P_{max_BR} x T_{max_BR} [Joule]

supplied by the producer of the resistor.. Such parameters are able to define the resistor overload possibility in case of continuous maximum power peaks.

According to $E_{max\ BR}$ and to the peak power value, which the resistor bank is subject to, $P_{PBR} = V^2_{BR} / R_{BR}$ the maximum time for the peak power application is calculated as

$$T_{max\ BR} = E_{max\ BR} / P_{PBR}$$

Furthermore, the peak current on the resistors is $I_{PK} = V_{BR} / R_{BR}$

Therefore, the time/current curves of the thermal relays are must have an overload ratio requiring a thermal relay intervention time lower than $T_{max\ BR}$.

Given that K, the overload ratio obtained from the curves, the current value to which the thermal relay has to be set is: $I_{term} = I_{PK} / k$

Now it is necessary to check that the product V_{BR} x I_{term} is higher than the average power, which can be dissipated on the resistor bank; such value is stated during the dimensioning procedure of the braking system.

In case the above-mentioned conditions are not satisfied, it is necessary to use a thermal relay with a time/current feature able to obtain a K factor lower than the one stated above.

The thermal relays to be used are those coordinated for the protection of three-phase motors. In this case it is advisable to use all the three contacts which have to be connected in series to be able to break the substantial DC voltage involved.

4.10. BUFFERING THE REGULATOR SUPPLY

The power supply of the control section is provided by a switched mode power supply unit (SMPS) from the DC Link circuit. The Drive is disabled as soon as the voltage of the DC Link circuit is below the threshold value (U_{Buff}). The regulator supply is buffered by the energy of the DC Link circuit until the limit value (U_{min}) is reached. The buffer time is determined by the capacitance of the DC Link capacitors. The minimum values are shown in the table below. The buffer time (t_{Buff}) can be extended (only on 11 kW drive and higher) by connecting external capacitors in parallel (on terminal C (+ bus) and D(- bus)).

Table 4.10.1: DC Link Buffer Time

Inverter type	Internal capacitance C_{std} [µF]	Buffer time t_{Buff} (minimum value) with the internal capacitance at : AC Input voltage =400V [s]	AC Input voltage =460V [s]	Maximum permissible external capacitance C_{ext} [µF]	Maximum power required by switched mode power supply P_{SMPS} [W]
3	220	0.165	0.25	0	65
5	330	0.24	0.37	0	65
7	330	0.24	0.37	0	65
10	830	0.62	0.95	0	65
15	830	0.62	0.95	0	65
20	1500	1:12	1.72	1500	65
30	1500	1:12	1.72	1500	65
40	1800	1.54	2.3	4500	70
55	2200	1.88	2.8	4500	70
70	3300	2.83	4.2	4500	70
80	4950	4.24	6.3	4500	70
100	4950	4.24	6.3	4500	70
125	6600	5.6	8.1	0	70
160	6600	5.6	8.1	0	70
190	9900	8.4	12.1	0	70
230	14100	12.8	17.2	0	70
300	14100	12.8	17.2	0	70

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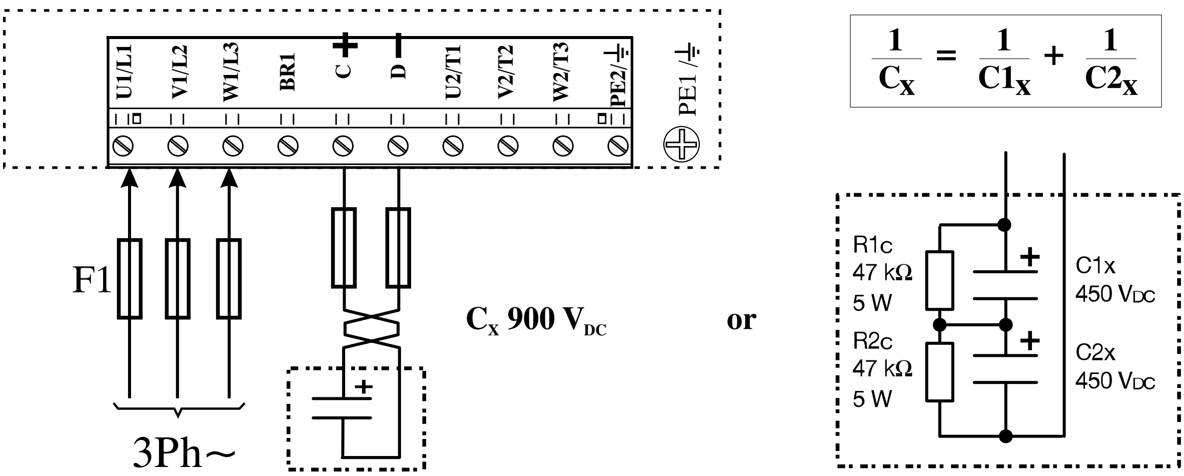

Figure 4.10.1: Buffering the Regulator Supply by Means of Additional Intermediate Circuit Capacitors

NOTE! When connecting the intermediate circuit terminals C and D the AC Input side **must** be protected with superfast semiconductor fuses!

Formula for calculating the size of the external capacitors:

$$C_{ext} = \frac{2 \cdot P_{SMPS} \cdot t_{Buff} \cdot 10^6}{U^2_{Buff} - U^2_{min}} - C_{std}$$

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C_{ext}, C_{std}	[µF]	
P_{SMPS}	[W]	U_{Buff} = 400 V at U_{LN} = 400 V
t_{Buff}	[s]	U_{Buff} = 460 V at U_{LN} = 460 V
U_{Buff}, U_{min}	[V]	U_{min} = 250 V

Calculation example

A PX-40 Drive is operated with an AC Input supply U_{LN} = 400 V. A voltage failure buffer is required for max. 1.5 s.

P_{SMPS}	70 W	t_{Buff}	1.5 s
U_{Buff}	400 V	U_{min}	250 V
C_{std}	1800 µF		

$$C_{ext} = \frac{2 \,.\, 70\,W \,.\, 1.5\,s \,.\, 10^6 \mu F / F}{(400\,V)^2 - (250\,V)^2} - 1800\ F = 2154\ F - 1800\ F = 354\ F$$

4.11. DISCHARGE TIME OF THE DC-LINK

Table 4.11.1: DC Link Discharge Time

Type	I_{2N}	Time (seconds)	Type	I_{2N}	Time (seconds)
3	3.5	90	**70**	76	90
5	4.9	150	**80**	90	120
7	6.5		**100**	110	
10	11	205	**125**	142	
15	15.4		**160**	180	
20	21.6	220	**190**	210	
30	28.7		**230**	250	
40	42	60	**300**	310	
55	58				

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This is the minimum time that must be elapsed when a Flexmax drive is disconnected from the AC Input before an operator may service parts inside the drive to avoid electric shock hazard.

CONDITION The value consider the time to turn-off for a Drive supplied at 480Vac +10%, without any options, (the loads on the switching supply are the regulation card, the keypad and the 24Vdc fans “if mounted”).

The Drive is disconnected from the line.. This represents the worst case condition.