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ESCON 36/3 EC

Hardware Reference

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TABLE OF CONTENTS

READ THIS FIRST

These instructions are intended for qualified technical personnel. Prior commencing with any activities …
- *you must carefully read and understand this manual and*
- *you must follow the instructions given therein.*

The ESCON 36/3 EC is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.

Therefore, you must not put the device into service, …
- *unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!*
- *unless the other machinery fulfills all relevant health and safety aspects!*
- *unless all respective interfaces have been established and fulfill the herein stated requirements!*

1 ABOUT

1.1 About this Document

1.1.1 Intended Purpose

The purpose of the present document is to familiarize you with the ESCON 36/3 EC Servo Controller. It will highlight the tasks for safe and adequate installation and/or commissioning. Follow the described instructions …

- • to avoid dangerous situations,
- • to keep installation and/or commissioning time at a minimum,
- • to increase reliability and service life of the described equipment.

The document contains performance data and specifications, information on fulfilled standards, details on connections and pin assignment, and wiring examples.

1.1.2 Target Audience

The present document is intended for trained and skilled personnel. It conveys information on how to understand and fulfill the respective work and duties.

1.1.3 How to use

Take note of the following notations and codes which will be used throughout the document.

Notation	Meaning
(n)	refers to an item (such as order number, list item, etc.)
➜	denotes "see", "see also", "take note of" or "go to"

Table 1-1 Notation used

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1.1.4 Symbols & Signs

In the course of the present document, the following symbols and signs will be used.

Type	Symbol	Meaning	
Safety Alert	(typical)	DANGER	Indicates an **imminent hazardous situation**. If not avoided, it **will result in death or serious injury**.
		WARNING	Indicates a **potential hazardous situation**. If not avoided, it **can result in death or serious injury**.
		CAUTION	Indicates a **probable hazardous situation** or calls the attention to unsafe practices. If not avoided, it **may result in injury**.
Prohibited Action	(typical)	Indicates a dangerous action. Hence, **you must not**!	
Mandatory Action	(typical)	Indicates a mandatory action. Hence, **you must**!	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior continuing, or gives information on a particular item you need to observe.
		Best Practice	Indicates an advice or recommendation on the easiest and best way to further proceed.
		Material Damage	Indicates information particular to possible damage of the equipment.

Table 1-2   Symbols & Signs

1.1.5 Trademarks and Brand Names

For easier legibility, registered brand names are listed below and will not be further tagged with their respective trademark. It must be understood that the brands (the list below is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted in the later course of this document.

Brand Name	Trademark Owner
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-3   Brand Names and Trademark Owners

1.1.6　Copyright

The present document – including all parts thereof – is protected by copyright. Any use (including reproduction, translation, microfilming, and other means of electronic data processing) beyond the narrow restrictions of the copyright law without the prior approval of maxon, is not permitted and subject to prosecution under the applicable law.

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1.2　About the Device

The ESCON 36/3 EC is a small-sized, powerful 4-quadrant PWM servo controller for the highly efficient control of permanent magnet-activated brushless EC motors up to approximately 97 Watts.

The featured operating modes – speed control (closed loop), speed control (open loop), and current control – meet the highest requirements. The ESCON 36/3 EC is designed being commanded by an analog set value and features extensive analog and digital I/O functionality.

The device is designed to be configured via USB interface using the graphical user interface «ESCON Studio» for Windows PCs.

You can download the latest ESCON software version (as well as the latest edition of the documentation) from the internet under ➔http://escon.maxongroup.com.

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1.3   About the Safety Precautions

- •   Make sure that you have read and understood the note "READ THIS FIRST" on page A-2!

- •   Do not engage with any work unless you possess the stated skills (➜chapter "1.1.2 Target Audience" on page 1-3)!

- •   Refer to ➜chapter "1.1.4 Symbols & Signs" on page 1-4 to understand the subsequently used indicators!

- •   You must observe any regulation applicable in the country and/or at the site of implementation with regard to health and safety/accident prevention and/or environmental protection!

	DANGER

High Voltage and/or Electrical Shock
Touching live wires causes death or serious injuries!
- •   *Consider any power cable as connected to live power, unless having proven the opposite!*
- •   *Make sure that neither end of cable is connected to live power!*
- •   *Make sure that power source cannot be engaged while work is in process!*
- •   *Obey lock-out/tag-out procedures!*
- •   *Make sure to securely lock any power engaging equipment against unintentional engagement and tag it with your name!*

Requirements
- •   *Make sure that all associated devices and components are installed according to local regulations.*
- •   *Be aware that, by principle, an electronic apparatus can not be considered fail-safe. Therefore, you must make sure that any machine/apparatus has been fitted with independent monitoring and safety equipment. If the machine/apparatus should break down, if it is operated incorrectly, if the control unit breaks down or if the cables break or get disconnected, etc., the complete drive system must return – and be kept – in a safe operating mode.*
- •   *Be aware that you are not entitled to perform any repair on components supplied by maxon.*

Electrostatic Sensitive Device (ESD)
- •   *Make sure to wear working cloth in compliance with ESD.*
- •   *Handle device with extra care.*

2 SPECIFICATIONS

2.1 Technical Data

ESCON 36/3 EC (414533)		
Electrical Rating	Nominal operating voltage $+V_{CC}$	10…36 VDC
	Absolute operating voltage $+V_{CC\,min}$ / $+V_{CC\,max}$	8 VDC / 38 VDC
	Output voltage (max.)	0.98 x $+V_{CC}$
	Output current I_{cont} / I_{max} (<4 s)	2.7 A / 9 A
	Pulse Width Modulation frequency	53.6 kHz
	Sampling rate PI current controller	53.6 kHz
	Sampling rate PI speed controller	5.36 kHz
	Max. efficiency	95%
	Max. speed	150'000 rpm (1 pole pair)
	Built-in motor chokes	3 x 47 µH; 2.7 A
Inputs & Outputs	Analog Input 1 Analog Input 2	resolution 12-bit; −10…+10 V; differential
	Analog Output 1 Analog Output 2	resolution 12-bit; −4…+4 V; referenced to GND
	Digital Input 1 Digital Input 2	+2.4…+36 VDC (R_i = 38.5 kΩ)
	Digital Input/Output 3 Digital Input/Output 4	+2.4…+36 VDC (R_i = 38.5 kΩ) / max. 36 VDC (I_L <500 mA)
	Hall sensor signals	H1, H2, H3
Voltage Outputs	Auxiliary output voltage	+5 VDC (I_L ≤80 mA)
	Hall sensor supply voltage	+5 VDC (I_L ≤30 mA)
Potentiometer	Potentiometer P1 (on board)	210°; linear
Motor Connections	EC motor	Motor winding 1, Motor winding 2, Motor winding 3
Interface	USB 2.0 / USB 3.0	full speed
Status Indicators	Operation	green LED
	Error	red LED
Physical	Weight	approx. 36 g
	Dimensions (L x W x H)	55 x 40 x 19.8 mm
	Mounting holes	for M2.5 screws (max. tightening torque 0.16 Nm)

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ESCON 36/3 EC (414533)			
Environmental Conditions	Temperature	Operation	−30…+45 °C
		Extended range *1)	+45…+78 °C Derating ➜Figure 2-1
		Storage	−40…+85 °C
	Altitude *2)	Operation	0…6'000 m MSL
		Extended range *1)	6'000…10'000 m MSL Derating ➜Figure 2-1
	Humidity		5…90% (condensation not permitted)

*1)   Operation within the extended range (temperature and altitude) is permitted. However, a respective derating (declination of output current I_{cont}) as to the stated values will apply.
*2)   Operating altitude in meters above Mean Sea Level, MSL.

Table 2-4   Technical Data
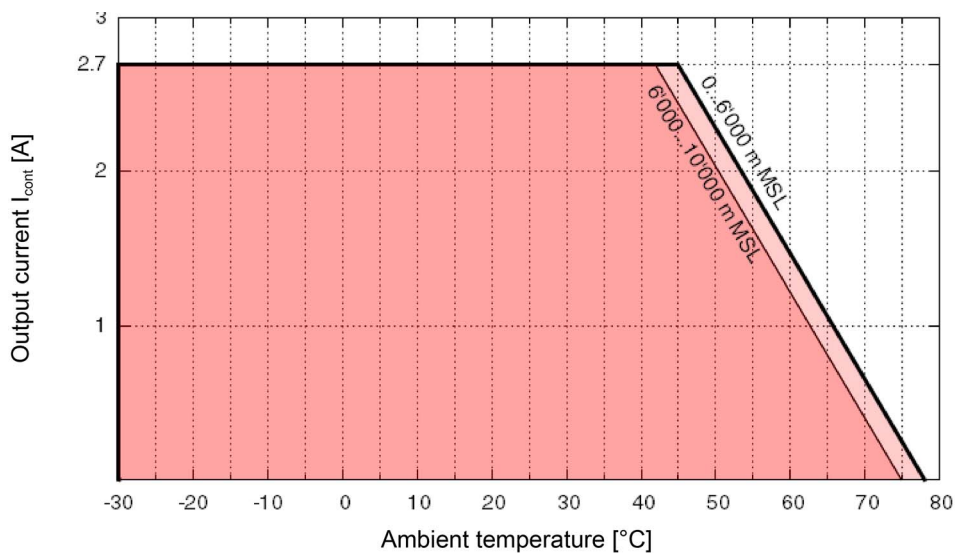
Figure 2-1   Derating Output Current

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	7.2 V	7.4 V
Overvoltage	43 V	41 V
Overcurrent	13.5 A	—
Thermal overload	95 °C	85 °C

Table 2-5   Limitations

Figure 2-2   Dimensional Drawing [mm]
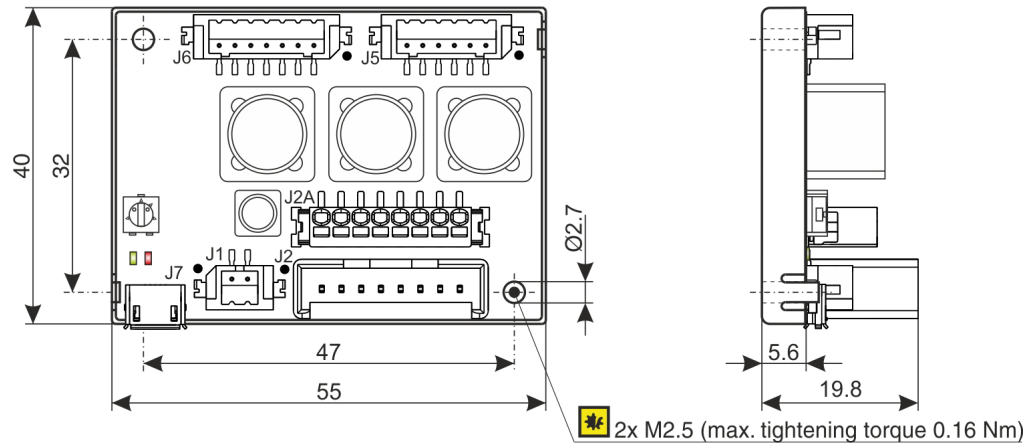
2.2 Standards

The described device has been successfully tested for compliance with the below listed standards. In practical terms, only the complete system (the fully operational equipment comprising all individual components, such as motor, servo controller, power supply unit, EMC filter, cabling etc.) can undergo an EMC test to ensure interference-free operation.

Important Notice
The device's compliance with the mentioned standards does not imply its compliance within the final, ready to operate setup. In order to achieve compliance of your operational system, you must perform EMC testing of the involved equipment as a whole.

Electromagnetic Compatibility		
Generic Standards	IEC/EN 61000-6-2	Immunity for industrial environments
	IEC/EN 61000-6-3	Emission standard for residential, commercial and light-industrial environments
Applied Standards	IEC/EN 61000-6-3 IEC/EN 55022 (CISPR22)	Radio disturbance characteristics / radio interference
	IEC/EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test >10 V/m
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test ±2 kV
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 10 Vrms

Others		
Environmental Standards	IEC/EN 60068-2-6	Environmental testing – Test Fc: Vibration (sinusoidal, 10…500 Hz, 20 m/s^2)
	MIL-STD-810F	Random transport (10…500 Hz up to 2.53 g_{rms})
Safety Standards	UL File Number E207844; unassembled printed circuit board	
Reliability	MIL-HDBK-217F	Reliability prediction of electronic equipment Environment: Ground, benign (GB) Ambient temperature: 298 K (25 °C) Component stress: In accordance with circuit diagram and nominal power Mean Time Between Failures (MTBF): 403'301 hours

Table 2-6   Standards

3 SETUP

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The ESCON 36/3 EC is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment**.

⚠	**WARNING**
	Risk of Injury
	Operating the device without the full compliance of the surrounding system with EU Directive 2006/42/EC may cause serious injuries!
	• *Do not operate the device, unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!*
	• *Do not operate the device, unless the other machinery fulfills all relevant health and safety aspects!*
	• *Do not operate the device, unless all respective interfaces have been established and fulfill the requirements stated in this document!*

3.1 Generally applicable Rules

For each possible motor variant you will find information on the from/to connections and the cables you will require. If you should decide not to use the ready-made maxon cables, you must establish the respective connections as to ➔chapter "3.4.7 ESCON 36/3 EC Connector Set" on page 3-28 and ➔chapter "4 Wiring" on page 4-31.

⚡	***Maximal permitted Supply Voltage***
	• *Make sure that supply power is between 10…36 VDC.*
	• *Supply voltages above 38 VDC, or wrong polarity will destroy the unit.*
	• *Note that the necessary output current is depending on the load torque. Yet, the output current limits of the ESCON 36/3 EC are as follows; continuous max. 2.7 A / short-time (acceleration) max. 9 A.*

⚡	***Hot plugging the USB interface may cause hardware damage***
	If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of controller and PC/Notebook can lead to damaged hardware.
	• *Avoid potential differences between the power supply of controller and PC/Notebook or, if possible, balance them.*
	• *Insert the USB connector first, then switch on the power supply of the controller.*

ⓘ	***How to read the Wiring Details***
	The subsequent description follows this scheme:
	• *Column "**J… & Head A**": Pin number…*
	– of the socket,
	– of the corresponding plug, and
	– of Head A of the matching prefab maxon cable.
	• *Column "**Prefab Cable**": Wire color of the prefab maxon cable.*
	• *Column "**Head B**": Pin number of Head B of the matching prefab maxon cable.*

3.2   Determination of Power Supply

Basically, any power supply may be used, provided it meets the minimal requirements stated below.

Power Supply Requirements	
Output voltage	+V_{CC} 10…36 VDC
Absolute output voltage	min. 8 VDC; max. 38 VDC
Output current	Depending on load • continuous max. 2.7 A • short-time (acceleration, <4 s) max. 9 A

1) Use the formula below to calculate the required voltage under load.

2) Choose a power supply according to the calculated voltage. Thereby consider:

   a) During braking of the load, the power supply must be capable of buffering the recovered kinetic energy (for example, in a capacitor).

   b) If you are using an electronically stabilized power supply, make sure that the overcurrent protection circuit is configured inoperative within the operating range.

Note

The formula already takes the following into account:
• *Maximum PWM duty cycle of 98%*
• *Controller's max. voltage drop of 1 V @ 2.7 A*

KNOWN VALUES:

• Operating torque M [mNm]
• Operating speed n [rpm]
• Nominal motor voltage U_N [Volt]
• Motor no-load speed at U_N, n_0 [rpm]
• Speed/torque gradient of the motor $\Delta n/\Delta M$ [rpm/mNm]

SOUGHT VALUE:

• Supply voltage +V_{CC} [Volt]

SOLUTION:

$$V_{CC} \geq \left[\frac{U_N}{n_O} \cdot \left(n + \frac{\Delta n}{\Delta M} \cdot M \right) \cdot \frac{1}{0.98} \right] + 1 \, [V]$$

3.3   Cabling

Here you can get the connection information required to commission your ESCON 36/3 EC. You will find all details for both approaches, Plug&Play and making your own cables.

PLUG&PLAY

Take advantage of maxon's prefab cable assemblies. They come as ready-to-use parts and will help you to reduce commissioning time to a minimum.

   a) Check the «Cable Selector» (➔Table 3-7) to find the cable assemblies' order number matching the setup you will be using.

   b) Follow the cross-reference to get the cable assemblies' pin assignment.

MAKE&BAKE YOUR OWN

   a) Check the «Cable Selector» (➔Table 3-7) to find the required cables for the setup you will be using.

   b) Follow the cross-reference to get the cable's specification and pin assignment.

   c) Utilize the installation kit (➔page 3-28) containing plugs and terminals that will fit the controller's sockets.

Cable / Adapter			Socket / Header	EC Motor with…	
Designation	**Order number**	**➔ page**		**Cable**	**Flexprint Cable (FPC)**
Power Cable	403957	3-14	J1	X	X
I/O Cable 6core	403965	3-18	J5	X	X
I/O Cable 7core	403964	3-22	J6	O	O
USB Type A - micro B Cable	403968	3-24	J7	X	X
Adapter BLACK FPC11poles	418719	3-26	J2		O
Adapter BLUE FPC8poles	418723	3-27	J2		O
Adapter GREEN FPC8poles	418721	3-27	J2		O
Legend: X = required / O = optional					

Table 3-7   Cable Selector

3.4 Connections

The actual connection will depend on the overall configuration of your drive system and the type of motor you will be using. Some connections must be established in a given way, while for motor/Hall sensor (J2/J2A alternative plug-in locations can be chosen from.

Follow the description in given order and choose the connection scheme that suits the respective components you are using. For corresponding wiring diagrams ➔ chapter "4 Wiring" on page 4-31.

3.4.1 Power (J1)

Figure 3-3   Power Socket J1

J1 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white	−	Power_GND	Ground of supply voltage
2	brown	+	+V_{CC}	Power supply voltage (+10…+36 VDC)

Table 3-8   Power Socket J1 – Pin Assignment & Cabling

Power Cable (403957)		
Cable cross-section	2 x 0.34 mm²	
Length	1.5 m	
Head A	Suitable plugs Suitable contacts	Hirose DF3-2S-2C Hirose DF3-22SC…
Head B	Cable end sleeves 0.34 mm²	

Table 3-9   Power Cable

3.4.2 Motor / Hall Sensor (J2 / J2A)

Potential Destruction
Use only one of the two connectors – either J2 or J2A!

HEADER J2
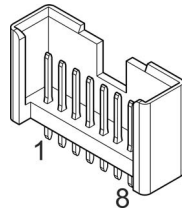
Figure 3-4   Motor / Hall Sensor Header J2

Best Practice
- *For EC motors with built-in FPC (Flexprint cable), you might wish to use one of the ready-made adapters.*
  For details ➜*"Cable Selector" on page 3-13.*

J2 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1			Motor winding 1	EC motor: Winding 1
2			Motor winding 2	EC motor: Winding 2
3			Motor winding 3	EC motor: Winding 3
4			+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq 30$ mA)
5			GND	Ground
6			Hall sensor 1	Hall sensor 1 input
7			Hall sensor 2	Hall sensor 2 input
8			Hall sensor 3	Hall sensor 3 input

Table 3-10   Motor / Hall Sensor Header J2 – Pin Assignment & Cabling

Specification / Accessories	
Type	Mini module pin header, upright, single row, 8 poles, pitch 2.5 mm
Suitable plugs	Lumberg crimping socket, 8 poles (3114 08)
Suitable contacts	Lumberg crimping contact for socket (3111 03)
Suitable tools	Lumberg hand crimper (CZ31)

Table 3-11   Motor / Hall Sensor Header J2 – Specification & Accessories

For circuitry ➜Figure 3-6.

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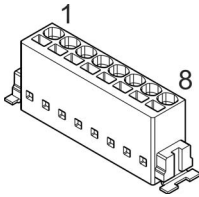
SOCKET J2A

Figure 3-5   Motor / Hall Sensor Socket J2A

J2 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1			Motor winding 1	EC motor: Winding 1
2			Motor winding 2	EC motor: Winding 2
3			Motor winding 3	EC motor: Winding 3
4			+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq$30 mA)
5			GND	Ground
6			Hall sensor 1	Hall sensor 1 input
7			Hall sensor 2	Hall sensor 2 input
8			Hall sensor 3	Hall sensor 3 input

Table 3-12   Motor / Hall Sensor Socket J2A – Pin Assignment & Cabling

Specification / Accessories		
Type	Spring-loaded contacts, 8 poles, pitch 2.5 mm	
Suitable cables	Rigid	0.14…0.5 mm², AWG 26-20 / wire stripping length 6 mm
	Flexible	0.2…0.5 mm², AWG 24-20 / wire stripping length 6 mm 0.25…0.5 mm², AWG 24-20 / wire stripping length 6 mm, cable end sleeves
Suitable tools	Miniature screwdriver, size "00"	

Table 3-13   Motor / Hall Sensor Socket J2A – Specification & Accessories

Hall sensor supply voltage	+5 VDC
Max. Hall sensor supply current	30 mA
Input voltage	0…24 VDC
Max. input voltage	+24 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Internal pull-up resistor	2.7 kΩ (against +5.45 V − 0.6 V)
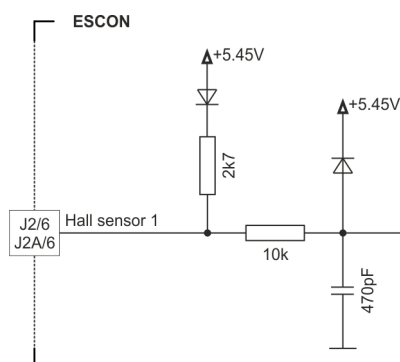
Figure 3-6   Hall Sensor Input Circuit (analogously valid also for Hall Sensors 2 & 3)

3.4.3 Digital I/Os (J5)
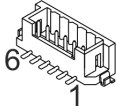
Figure 3-7   Digital I/Os Socket J5

J5 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white		DigIN1	Digital input 1
2	brown		DigIN2	Digital input 2
3	green		DigIN/DigOUT3	Digital input/output 3
4	yellow		DigIN/DigOUT4	Digital input/output 4
5	grey		GND	Signal ground
6	pink		+5 VDC	Auxiliary output voltage (+5 VDC; ≤80 mA)

Table 3-14   Digital I/Os Socket J5 – Pin Assignment & Cabling

I/O Cable 6core (403965)		
Cable cross-section	6 x 0.14 mm²	
Length	1.5 m	
Head A	Suitable plugs Suitable contacts	Hirose DF3-6S-2C Hirose DF3-2428SC…
Head B	Cable end sleeves 0.14 mm2	

Table 3-15   I/O Cable 6core

3.4.3.1 Digital Input 1

Input voltage	0…36 VDC
Max. input voltage	+36 VDC / −36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ 5 VDC
Switching delay	<8 ms

PWM frequency range	10 Hz…5 kHz
PWM duty cycle range (resolution)	10...90% (0.1%)
PWM accuracy	typically 0.1% @ 10 Hz typically 0.5% @ 1 kHz typically 2.5% @ 5 kHz
RC Servo cycle duration	3…30 ms
RC Servo pulse length	1…2 ms
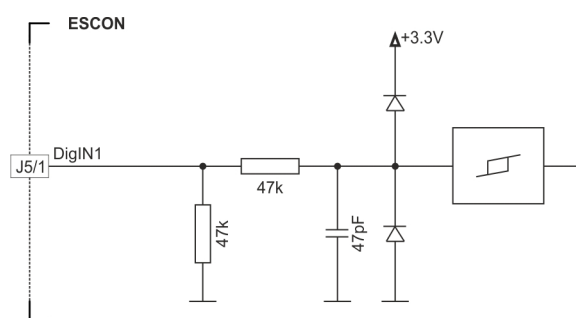
Figure 3-8   DigIN1 Circuit

3.4.3.2 Digital Input 2

Input voltage	0…36 VDC
Max. input voltage	+36 VDC / −36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ 5 VDC
Switching delay	<8 ms

Figure 3-9   DigIN2 Circuit

3.4.3.3 Digital Inputs/Outputs 3 and 4

DigIN	
Input voltage	0…36 VDC
Max. input voltage	+36 VDC
Logic 0	typically <1.0 V
Logic 1	typically >2.4 V
Input resistance	typically 47 kΩ (<3.3 V) typically 38.5 kΩ (@ 5 V) typically 25.5 kΩ (@ 24 V)
Input current at logic 1	typically 130 µA @ 5 VDC
Switching delay	<8 ms
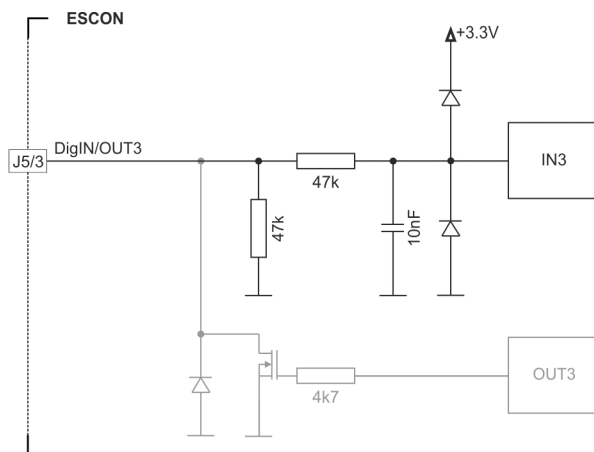
Figure 3-10   DigIN3 Circuit (analogously valid also for DigIN4)

DigOUT	
Max. input voltage	+36 VDC
Max. load current	500 mA
Max. voltage drop	0.5 V @ 500 mA
Max. load inductance	100 mH @ 24 VDC; 500 mA
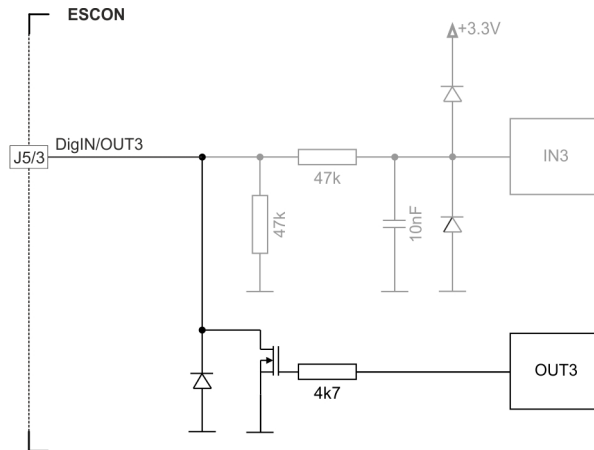
Figure 3-11   DigOUT3 Circuit (analogously valid also for DigOUT4)
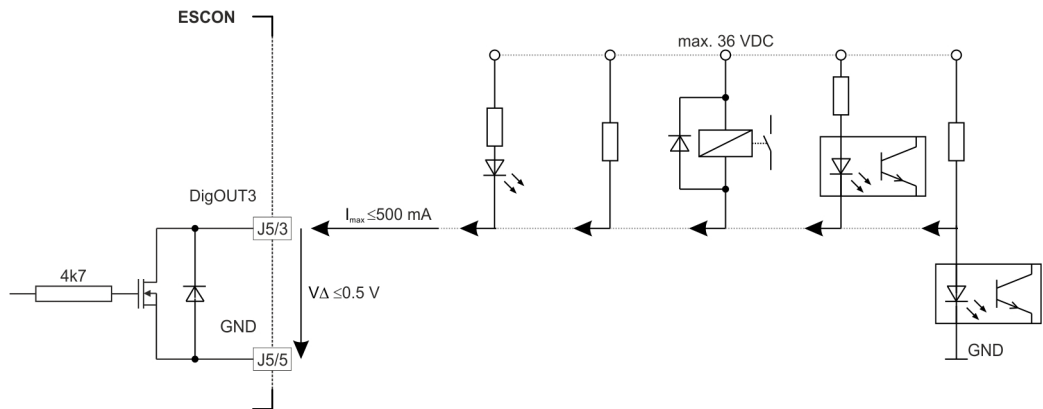
Figure 3-12   DigOUT3 Wiring Examples (analogously valid also for DigOUT4)

3.4.4 Analog I/Os (J6)
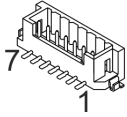
Figure 3-13   Analog I/Os Socket J6

J6 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1	white		AnIN1+	Analog input 1, positive signal
2	brown		AnIN1−	Analog input 1, negative signal
3	green		AnIN2+	Analog input 2, positive signal
4	yellow		AnIN2−	Analog input 2, negative signal
5	grey		AnOUT1	Analog output 1
6	pink		AnOUT2	Analog output 2
7	blue		GND	Signal ground

Table 3-16   Analog I/Os Socket J6 – Pin Assignment & Cabling

I/O Cable 7core (403964)		
A		B
Cable cross-section	7 x 0.14 mm²	
Length	1.5 m	
Head A	Suitable plugs Suitable contacts	Hirose DF3-7S-2C Hirose DF3-2428SC…
Head B	Cable end sleeves 0.14 mm2	

Table 3-17   I/O Cable 7core

3.4.4.1 Analog Inputs 1 and 2

Input voltage	−10…+10 VDC (differential)
Max. input voltage	+24 VDC / −24 VDC
Common mode voltage	−5…+10 VDC (referenced to GND)
Input resistance	100 kΩ (differential) 50 kΩ (referenced to GND)
A/D converter	12-bit
Resolution	5.07 mV
Bandwidth	10 kHz
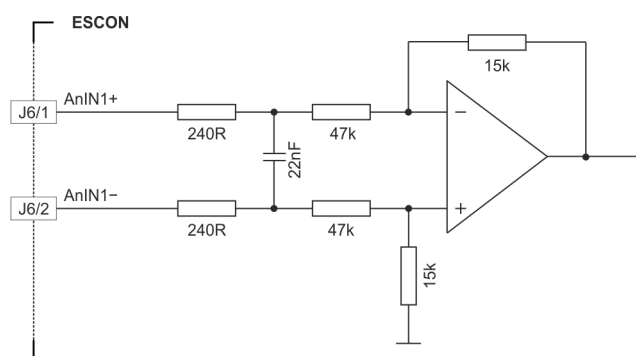
Figure 3-14   AnIN1 Circuit (analogously valid also for AnIN2)

3.4.4.2 Analog Outputs 1 and 2

Output voltage	−4…+4 VDC
D/A converter	12-bit
Resolution	2.30 mV
Refresh rate	AnOUT1: 26.8 kHz AnOUT2: 5.4 kHz
Analog bandwidth of output amplifier	20 kHz
Max. capacitive load	10 nF
Max. output current	1 mA
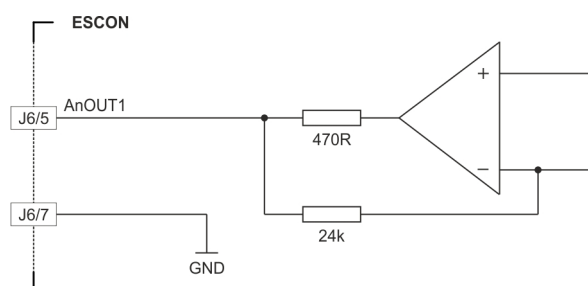
Figure 3-15   AnOUT1 Circuit (analogously valid also for AnOUT2)

3.4.5 USB (J7)

Hot plugging the USB interface may cause hardware damage
If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of controller and PC/Notebook can lead to damaged hardware.
- *Avoid potential differences between the power supply of controller and PC/Notebook or, if possible, balance them.*
- *Insert the USB connector first, then switch on the power supply of the controller.*
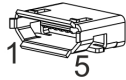
Figure 3-16   USB Socket J7

Note
Column "Head B" (➔Table 3-18) refers to USB terminals of your PC.

J7 & Head A Pin	Prefab Cable Color	Head B Pin	Signal	Description
1		1	V_{BUS}	USB BUS supply voltage input +5 VDC
2		2	D−	USB Data− (twisted pair with Data+)
3		3	D+	USB Data+ (twisted pair with Data−)
4		–	ID	not connected
5		4	GND	USB ground

Table 3-18   USB Socket J7 – Pin Assignment & Cabling
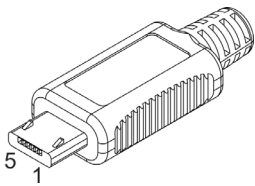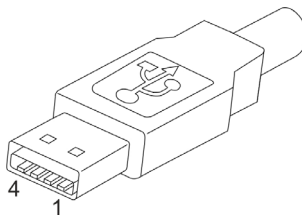
USB Type A - micro B Cable (403968)	
Cable cross-section	According to USB 2.0 / USB 3.0 specification
Length	1.5 m
Head A	USB Type "micro B", male
Head B	USB Type "A", male

Table 3-19   USB Type A - micro B Cable

USB Standard	USB 2.0 / USB 3.0 (full speed)
Max. bus supply voltage	+5.25 VDC
Typical input current	60 mA
Max. DC data input voltage	−0.5…+3.8 VDC

3.4.6 Adapters for maxon EC motors with Flexprint Cable (FPC)

Use the ready-made adapters for easy connection of maxon EC motors with built-in FPC (Flexprint cable). The adapters are color-coded and match the following motors:

Adapter				Suitable motors with Hall sensors (not concluding)	
Order number	Designation	Color	Poles	Type	Rating [W]
418719	Adapter BLACK FPC11poles	black	11	EC 10 EC 13 EC 20 flat EC 32 flat EC 45 flat	8 6 / 12 3 / 5 6 / 15 12 / 30
418723	Adapter BLUE FPC8poles	blue	8	EC 6 EC 8 EC 9.2 flat	1.5 / 2 2 0.5
418721	Adapter GREEN FPC8poles	green	8	EC 6 EC 10 flat	1.2 0.2

Table 3-20   Adapters for Flexprint Cables

ADAPTER BLACK FPC11POLES
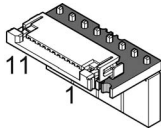
Figure 3-17   Adapter BLACK FPC11poles

Adapter BLACK Pin	Signal	Description
1	+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq 30$ mA)
2	Hall sensor 3	Hall sensor 3 input
3	Hall sensor 1	Hall sensor 1 input
4	Hall sensor 2	Hall sensor 2 input
5	GND	Ground
6	Motor winding 3	EC motor: Winding 3
7	Motor winding 3	EC motor: Winding 3
8	Motor winding 2	EC motor: Winding 2
9	Motor winding 2	EC motor: Winding 2
10	Motor winding 1	EC motor: Winding 1
11	Motor winding 1	EC motor: Winding 1

Table 3-21   Adapter BLACK FPC11poles – Pin Assignment

ADAPTER BLUE FPC8POLES
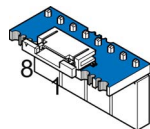
Figure 3-18   Adapter BLUE FPC8poles

Adapter BLUE Pin	Signal	Description
1	Motor winding 1	EC motor: Winding 1
2	Motor winding 2	EC motor: Winding 2
3	Motor winding 3	EC motor: Winding 3
4	+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq 30$ mA)
5	GND	Ground
6	Hall sensor 1	Hall sensor 1 input
7	Hall sensor 2	Hall sensor 2 input
8	Hall sensor 3	Hall sensor 3 input

Table 3-22   Adapter BLUE FPC8poles – Pin Assignment

ADAPTER GREEN FPC8POLES
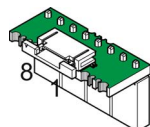
Figure 3-19   Adapter GREEN FPC8poles

Adapter GREEN Pin	Signal	Description
1	Motor winding 3	EC motor: Winding 3
2	Motor winding 2	EC motor: Winding 2
3	Hall sensor 3	Hall sensor 3 input
4	+5 VDC	Hall sensor supply voltage (+5 VDC; $I_L \leq 30$ mA)
5	GND	Ground
6	Hall sensor 1	Hall sensor 1 input
7	Hall sensor 2	Hall sensor 2 input
8	Motor winding 1	EC motor: Winding 1

Table 3-23   Adapter GREEN FPC8poles – Pin Assignment

3.4.7   ESCON 36/3 EC Connector Set

If you decide not to employ maxon's prefab cable assemblies, you might wish to use the prepackaged kit that contains all connectors required to make up your own cabling.

\u00abESCON 36/3 EC Connector Set\u00bb (425255)		
For Socket	**Specification**	**Quantity**
J1	Hirose crimping socket, 2 poles (DF3-2S-2C)	1
J1	Hirose crimping contact for socket (DF3-22SC…)	3
J5	Hirose crimping socket, 6 poles (DF3-6S-2C)	1
J5, J6	Hirose crimping contact for socket (DF3-2428SC…)	14
J6	Hirose crimping socket, 7 poles (DF3-7S-2C)	1

Table 3-24   ESCON 36/3 EC Connector Set – Content

Best Practice
If you should decide not to use the ready-made cable assemblies, we strongly suggest that you use the following hand tools:
- *Hirose hand crimper (DF3-TA22HC) for crimping contacts DF3-22SC…*
- *Hirose hand crimper (DF3-TA2428HC) for crimping contacts DF3-2428SC…*
- *Lumberg hand crimper (CZ31) for crimping contacts 3111 03*

3.5   Potentiometers

POTENTIOMETER P1

Adjustment angle	210°
Type	Linear
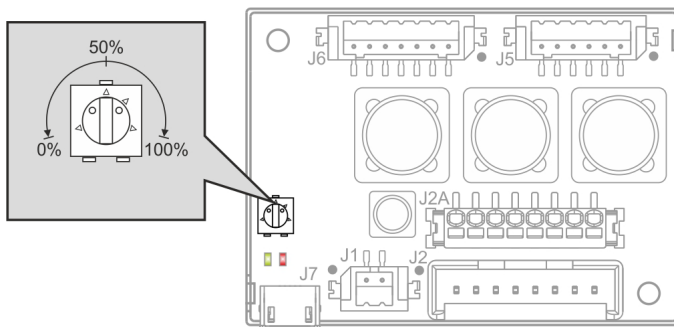
Figure 3-20   Potentiometer P1 – Location & Adjustment Range

3.6 Status Indicators

Light-emitting diodes (LEDs) indicate the actual operating status (green) and possible errors (red).
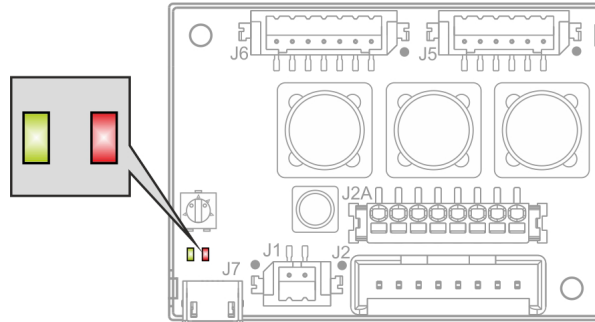
Figure 3-21   LEDs – Location

LED		Status / Error	
Green	**Red**		
off	off	INIT	
slow	off	DISABLE	
on	off	ENABLE	
2x	off	STOPPING; STOP STANDSTILL	
off	1x	ERROR	• +Vcc Overvoltage Error • +Vcc Undervoltage Error • +5 VDC Undervoltage Error
off	2x	ERROR	• Thermal Overload Error • Overcurrent Error • Power Stage Protection Error
off	4x	ERROR	• PWM Set Value Input out of Range Error
off	5x	ERROR	• Hall Sensor Pattern Error • Hall Sensor Sequence Error • Hall Sensor Frequency too high Error
off	on	ERROR	• Auto Tuning Identification Error • Internal Software Error

Table 3-25   LEDs – Interpretation of Condition

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4 WIRING
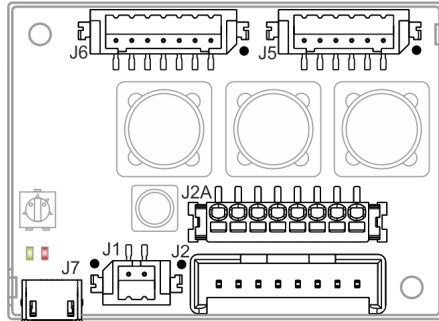
Figure 4-22   Interfaces – Designations and Location

!   ***Remark***

The subsequent diagrams feature these signs:

-    *PCB mounting hole*

-    *Ground safety earth connection (optional)*

4.1 maxon EC motor with Hall Sensors

HEADER J2

Figure 4-23   maxon EC motor with Hall Sensors (J2)

SOCKET J2A

Power Supply
+10...36 VDC

J1

J2

Motor winding 1
Motor winding 2
Motor winding 3
+5 VDC

Hall sensor 1
Hall sensor 2
Hall sensor 3

Digital I/O

DigIN 1
DigIN 2
DigIN/OUT 3
DigIN/OUT 4

+5 VDC

J5

Analog I/O

AnIN 1+
AnIN 1−
AnIN 2+
AnIN 2−
AnOUT 1
AnOUT 2

J6

J2A

Motor winding 1
Motor winding 2
Motor winding 3
+5 VDC

Hall sensor 1
Hall sensor 2
Hall sensor 3

EC Motor

Hall sensor

USB

USB Data−
USB Data+
VBUS

J7

100k
100 nF
100 nF

maxon motor control ESCON 36/3 EC

Figure 4-24   maxon EC motor with Hall Sensors (J2A)

4.2 maxon EC motor with Hall Sensors and Flexprint Cable (FPC)

HEADER J2 / ADAPTER BLACK (J2 TO FPC 11 POLE)
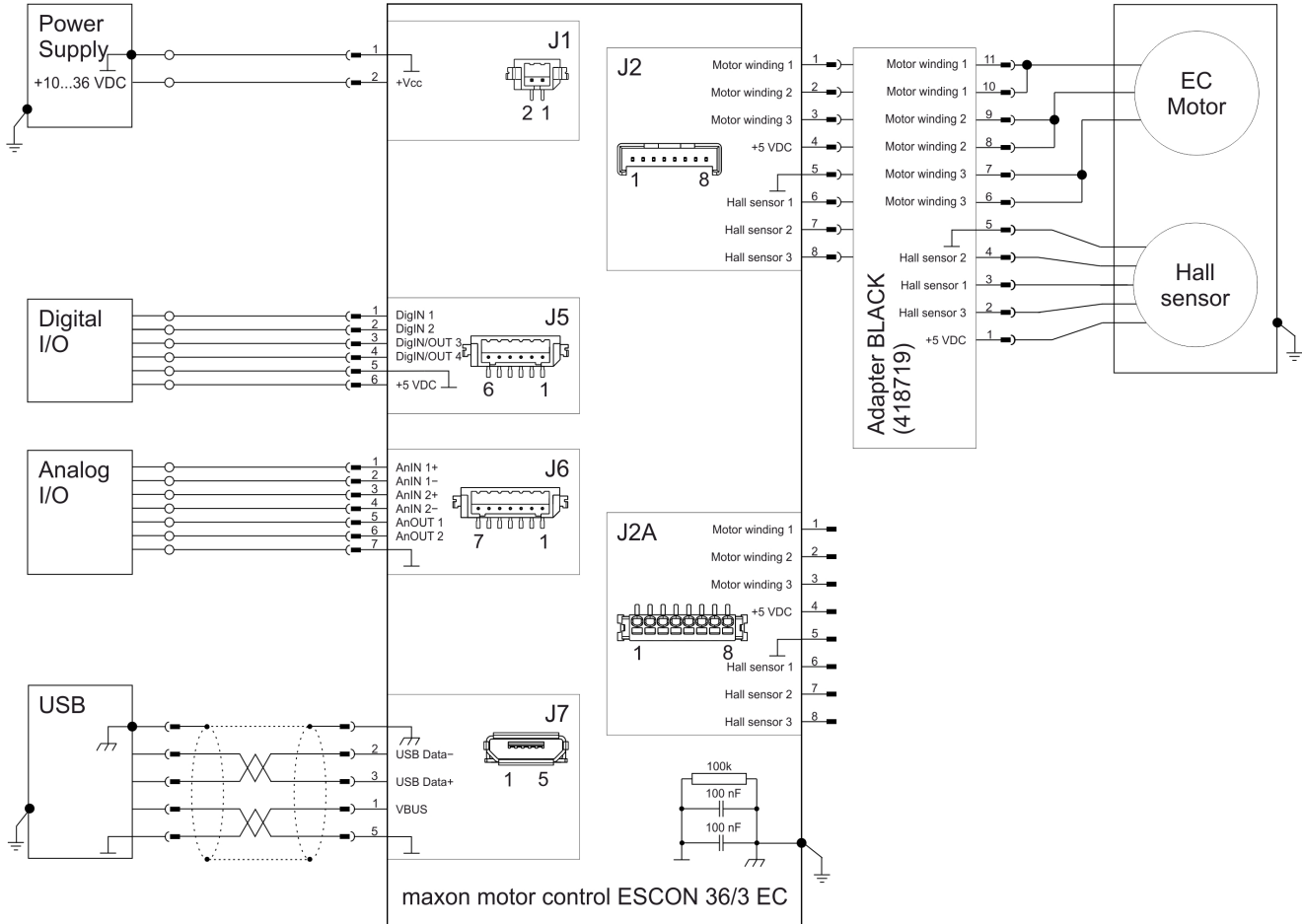
Figure 4-25   maxon EC motor with Hall Sensors (J2 and Adapter BLACK)

HEADER J2 / ADAPTER BLUE (J2 TO FPC 8 POLE)
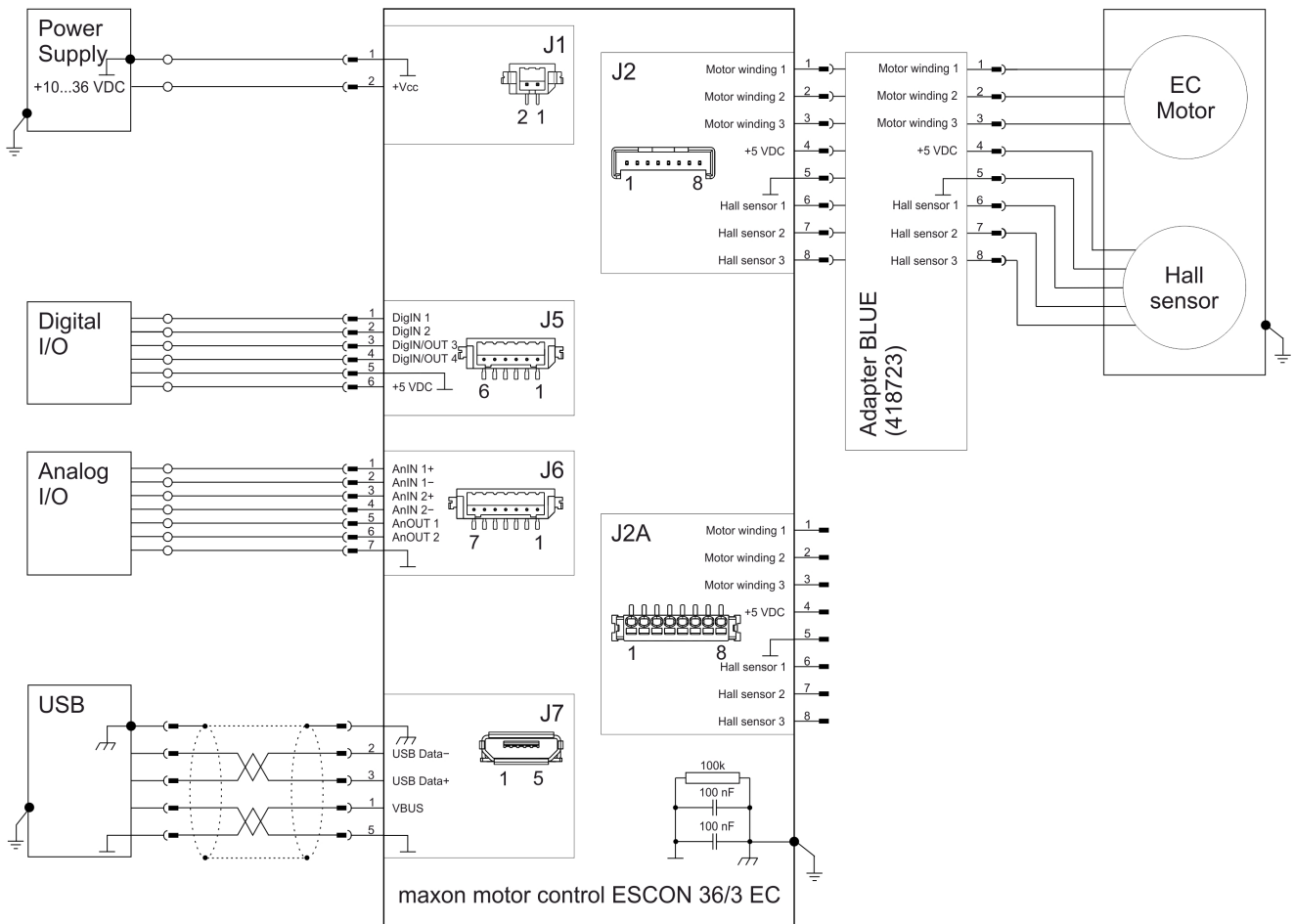
Figure 4-26   maxon EC motor with Hall Sensors (J2 and Adapter BLUE)

HEADER J2 / ADAPTER GREEN (J2 TO FPC 8 POLE)
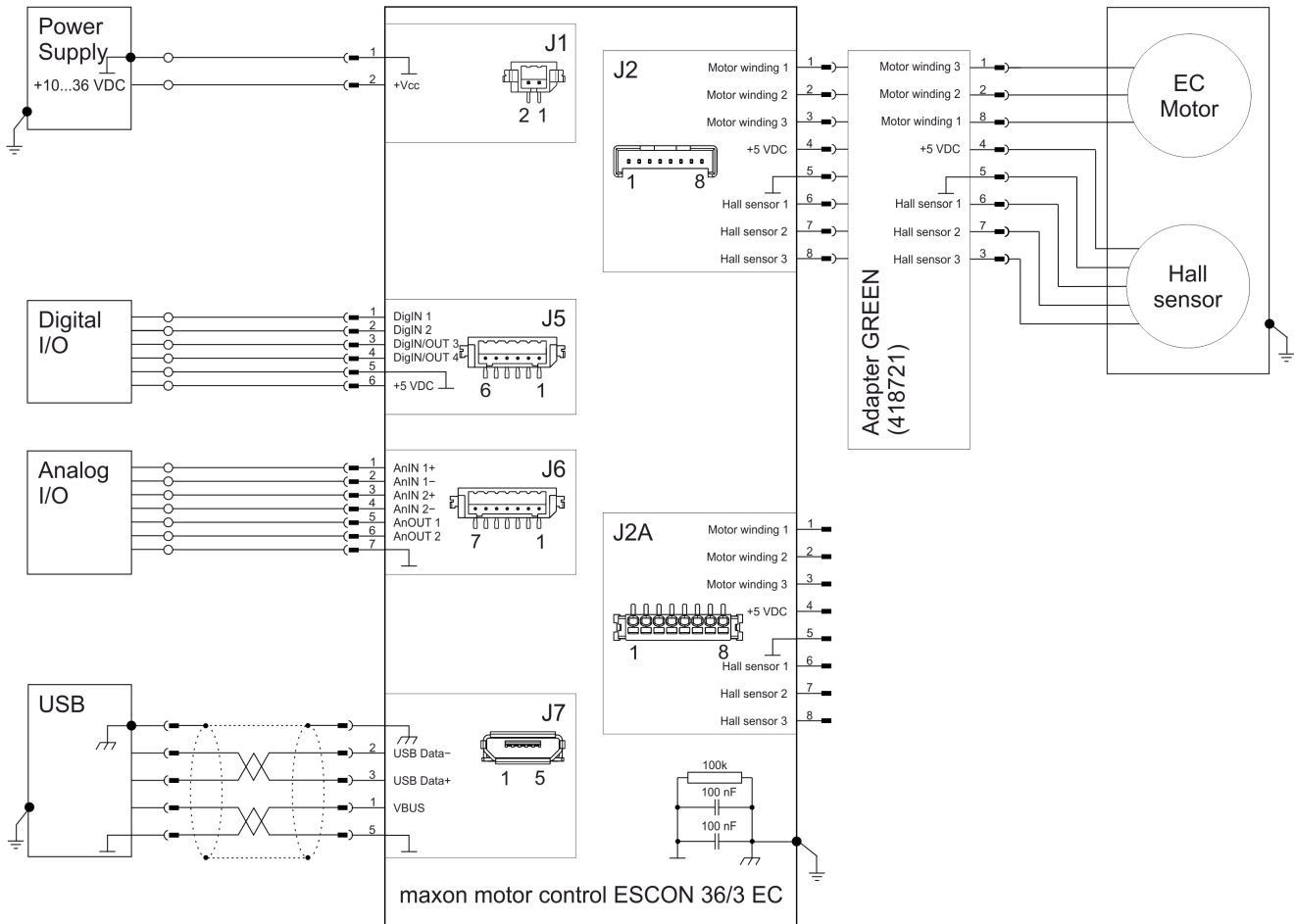
Figure 4-27   maxon EC motor with Hall Sensors (J2 and Adapter GREEN)

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maxon