

# ***ESCON 36/3 EC***

***Servo Controller***

***P/N 414533***

***Hardware Reference***



escon.maxonmotor.com

***Document ID: rel5870***

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## 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

### 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      | <br>(typical) | DANGER                                                    | Indicates an <b>imminent hazardous situation</b> . If not avoided, it <b>will result in death or serious injury</b> .                        |
|                   |                                                                                                  | WARNING                                                   | Indicates a <b>potential hazardous situation</b> . If not avoided, it <b>can result in death or serious injury</b> .                         |
|                   |                                                                                                  | CAUTION                                                   | Indicates a <b>probable hazardous situation</b> or calls the attention to unsafe practices. If not avoided, it <b>may result in injury</b> . |
| Prohibited Action | <br>(typical) | Indicates a dangerous action. Hence, <b>you must not!</b> |                                                                                                                                              |
| Mandatory Action  | <br>(typical) | Indicates a mandatory action. Hence, <b>you must!</b>     |                                                                                                                                              |

| Type        | Symbol                                                                            | Meaning                     |                                                                                                                         |
|-------------|-----------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 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

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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 motor ag, 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.maxonmotor.com>.

### 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 1-3 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 motor.



#### Electrostatic Sensitive Device (ESD)

- Make sure to wear working cloth in compliance with ESD.
- Handle device with extra care.

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## 2 Specifications

### 2.1 Technical Data

| ESCON 36/3 EC (414533) |                                                             |                                                                                          |
|------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Electrical Rating      | Nominal operating voltage $+V_{CC}$                         | 10...36 VDC                                                                              |
|                        | Absolute operating voltage<br>$+V_{CC \min} / +V_{CC \max}$ | 8 VDC / 38 VDC                                                                           |
|                        | Output voltage (max.)                                       | $0.98 \times +V_{CC}$                                                                    |
|                        | Output current $I_{cont} / I_{max} (<4 \text{ s})$          | 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 $\mu\text{H}$ ; 2.7 A                                                             |
| Inputs & Outputs       | Analog Input 1<br>Analog Input 2                            | resolution 12-bit; -10...+10 V; differential                                             |
|                        | Analog Output 1<br>Analog Output 2                          | resolution 12-bit; -4...+4 V; referenced to GND                                          |
|                        | Digital Input 1<br>Digital Input 2                          | +2.4...+36 VDC ( $R_i = 38.5 \text{ k}\Omega$ )                                          |
|                        | Digital Input/Output 3<br>Digital Input/Output 4            | +2.4...+36 VDC ( $R_i = 38.5 \text{ k}\Omega$ ) / max. 36 VDC ( $I_L < 500 \text{ mA}$ ) |
|                        | Hall sensor signals                                         | H1, H2, H3                                                                               |
| Voltage Outputs        | Auxiliary output voltage                                    | +5 VDC ( $I_L \leq 80 \text{ mA}$ )                                                      |
|                        | Hall sensor supply voltage                                  | +5 VDC ( $I_L \leq 30 \text{ mA}$ )                                                      |
| 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                                                                          |

| ESCON 36/3 EC (414533)   |                         |                                      |                                               |
|--------------------------|-------------------------|--------------------------------------|-----------------------------------------------|
| Environmental Conditions | Temperature             | Operation                            | -30...+45 °C                                  |
|                          |                         | Extended range <sup>*1)</sup>        | +45...+78 °C<br>Derating → Figure 2-1         |
|                          |                         | Storage                              | -40...+85 °C                                  |
|                          | Altitude <sup>*2)</sup> | Operation                            | 0...6'000 m MSL                               |
|                          |                         | Extended range <sup>*1)</sup>        | 6'000...10'000 m MSL<br>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

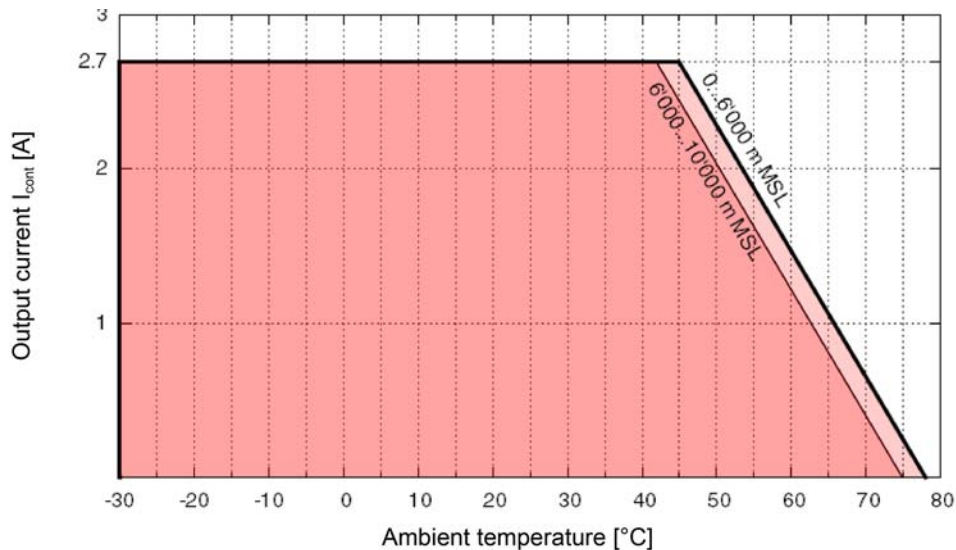


Figure 2-1 Derating Output Current

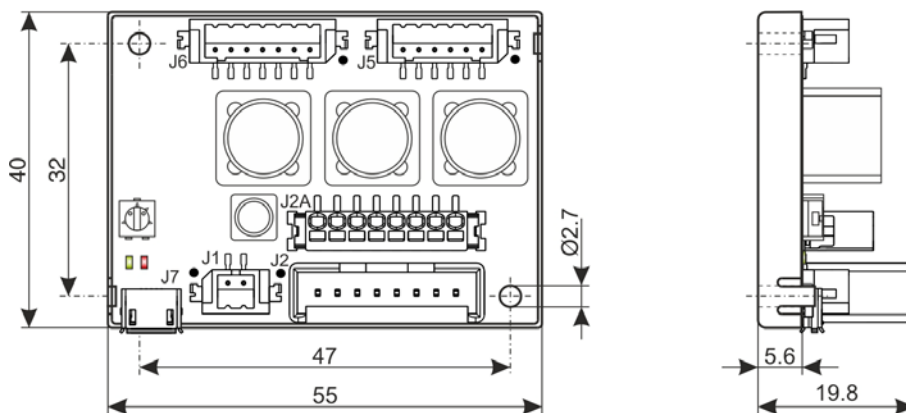


Figure 2-2 Dimensional Drawing [mm]



## 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<br>IEC/EN 55022<br>(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 $\pm 2$ 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 <sup>2</sup> )                                                                                                                                                             |
|                               | MIL-STD-810F                                              | Random transport (10...500 Hz up to 2.53 g <sub>rms</sub> )                                                                                                                                                                                            |
| Safety Standards              | UL File Number E207844; unassembled printed circuit board |                                                                                                                                                                                                                                                        |
| Reliability                   | MIL-HDBK-217F                                             | Reliability prediction of electronic equipment<br>Environment: Ground, benign (GB)<br>Ambient temperature: 298 K (25 °C)<br>Component stress: In accordance with circuit diagram and nominal power<br>Mean Time Between Failures (MTBF): 403'301 hours |

Table 2-5 Standards

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### 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 3-27 and →chapter "4 Wiring" on page 4-29.



##### **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.



##### **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 <sub>CC</sub> 10...36 VDC                                                                                                                   |
| Absolute output voltage   | min. 8 VDC; max. 38 VDC                                                                                                                        |
| Output current            | Depending on load <ul style="list-style-type: none"> <li>continuous max. 2.7 A</li> <li>short-time (acceleration, &lt;4 s) max. 9 A</li> </ul> |

- 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<sub>N</sub> [Volt]
- Motor no-load speed at U<sub>N</sub>, n<sub>0</sub> [rpm]
- Speed/torque gradient of the motor Δn/ΔM [rpm/mNm]

#### SOUGHT VALUE:

- Supply voltage +V<sub>CC</sub> [Volt]

#### SOLUTION:

$$V_{CC} \geq \left[ \frac{U_N}{n_0} \cdot \left( n + \frac{\Delta n}{\Delta M} \cdot M \right) \cdot \frac{1}{0.98} \right] + 1 [V]$$

### 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 3-6) 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 3-6) 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 3-27) 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       | 3-25   | J2              |                  | O                     |
| Adapter BLUE FPC8poles              | 418723       | 3-26   | J2              |                  | O                     |
| Adapter GREEN FPC8poles             | 418721       | 3-26   | J2              |                  | O                     |
| Legend: X = required / O = optional |              |        |                 |                  |                       |

Table 3-6 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 4-29.

#### 3.4.1 Power (J1)



Figure 3-3 Power Socket J1

| J1 & Head A<br>Pin | Prefab Cable<br>Color | Head B<br>Pin | Signal           | Description                          |
|--------------------|-----------------------|---------------|------------------|--------------------------------------|
| 1                  | white                 | –             | Power_GND        | Ground of supply voltage             |
| 2                  | brown                 | +             | +V <sub>CC</sub> | Power supply voltage (+10...+36 VDC) |

Table 3-7 Power Socket J1 – Pin Assignment & Cabling

| Power Cable (403957)                                                                                                                                                                                                                                                                                                                       |  |                                        |                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------|----------------------------------------|
| <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 2px; font-weight: bold;">A</div>  <div style="border: 1px solid black; padding: 2px; font-weight: bold;">B</div> </div> |  |                                        |                                        |
| Cable cross-section                                                                                                                                                                                                                                                                                                                        |  | 2 x 0.34 mm <sup>2</sup>               |                                        |
| Length                                                                                                                                                                                                                                                                                                                                     |  | 1.5 m                                  |                                        |
| Head A                                                                                                                                                                                                                                                                                                                                     |  | Suitable plugs<br>Suitable contacts    | Hirose DF3-2S-2C<br>Hirose DF3-22SC... |
| Head B                                                                                                                                                                                                                                                                                                                                     |  | Cable end sleeves 0.34 mm <sup>2</sup> |                                        |

Table 3-8 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

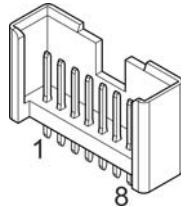


Figure 3-4 Motor / Hall Sensor Header J2



#### 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<br>Pin | Prefab Cable<br>Color | Head B<br>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 3-9 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 3-10 Motor / Hall Sensor Header J2 – Specification & Accessories

For circuitry → Figure 3-6.

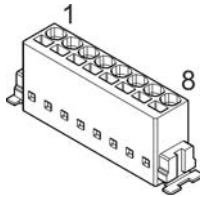
**Socket J2A**


Figure 3-5 Motor / Hall Sensor Socket J2A

| J2 & Head A<br>Pin | Prefab Cable<br>Color | Head B<br>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 3-11 Motor / Hall Sensor Socket J2A – Pin Assignment &amp; Cabling

| Specification / Accessories |                                               |                                                                                                                                                              |
|-----------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type                        | Spring-loaded contacts, 8 poles, pitch 2.5 mm |                                                                                                                                                              |
| Suitable cables             | Rigid                                         | 0.14...0.5 mm <sup>2</sup> , AWG 26-20 / wire stripping length 6 mm                                                                                          |
|                             | Flexible                                      | 0.2...0.5 mm <sup>2</sup> , AWG 24-20 / wire stripping length 6 mm<br>0.25...0.5 mm <sup>2</sup> , AWG 24-20 / wire stripping length 6 mm, cable end sleeves |
| Suitable tools              | Miniature screwdriver, size "00"              |                                                                                                                                                              |

Table 3-12 Motor / Hall Sensor Socket J2A – Specification &amp; 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 k $\Omega$ (against +5.45 V – 0.6 V) |

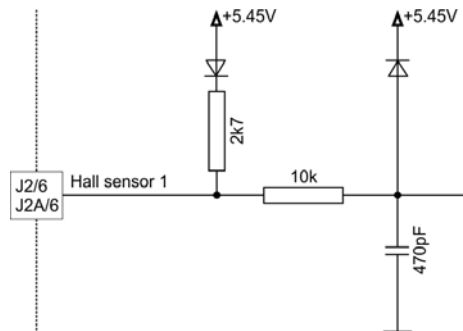


Figure 3-6 Hall Sensor Input Circuit (analogously valid also for Hall Sensors 2 & 3)

### 3.4.3 Digital I/Os (J5)

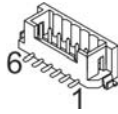


Figure 3-7 Digital I/Os Socket J5

| J5 & Head A<br>Pin | Prefab Cable<br>Color | Head B<br>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 3-13 Digital I/Os Socket J5 – Pin Assignment & Cabling

| I/O Cable 6core (403965)                                                                                                                                                                                                                                                                                                                                        |  |                                        |                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------|------------------------------------------|
| <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 2px; width: 40px; text-align: center;"><b>A</b></div>  <div style="border: 1px solid black; padding: 2px; width: 40px; text-align: center;"><b>B</b></div> </div> |  |                                        |                                          |
| Cable cross-section                                                                                                                                                                                                                                                                                                                                             |  | 6 x 0.14 mm <sup>2</sup>               |                                          |
| Length                                                                                                                                                                                                                                                                                                                                                          |  | 1.5 m                                  |                                          |
| Head A                                                                                                                                                                                                                                                                                                                                                          |  | Suitable plugs<br>Suitable contacts    | Hirose DF3-6S-2C<br>Hirose DF3-2428SC... |
| Head B                                                                                                                                                                                                                                                                                                                                                          |  | Cable end sleeves 0.14 mm <sup>2</sup> |                                          |

Table 3-14 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 k $\Omega$ (<3.3 V)<br>typically 38.5 k $\Omega$ (@ 5 V)<br>typically 25.5 k $\Omega$ (@ 24 V) |
| Input current at logic 1 | typically 130 $\mu$ A @ 5 VDC                                                                               |
| Switching delay          | <8 ms                                                                                                       |

|                                   |                 |
|-----------------------------------|-----------------|
| PWM frequency range               | 10 Hz...5 kHz   |
| PWM duty cycle range (resolution) | 10...90% (0.1%) |
| RC Servo cycle duration           | 3...30 ms       |
| RC Servo pulse length             | 1...2 ms        |

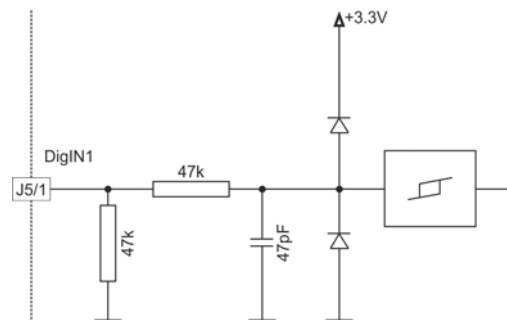


Figure 3-8 DigIN1 Circuit

### 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 k $\Omega$ (<3.3 V)<br>typically 38.5 k $\Omega$ (@ 5 V)<br>typically 25.5 k $\Omega$ (@ 24 V) |
| Input current at logic 1 | typically 130 $\mu$ A @ 5 VDC                                                                               |
| Switching delay          | <8 ms                                                                                                       |

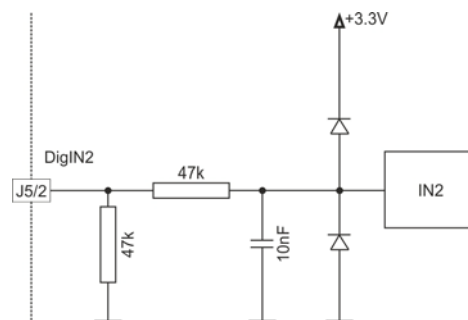


Figure 3-9 DigIN2 Circuit

### 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 k $\Omega$ (<3.3 V)<br>typically 38.5 k $\Omega$ (@ 5 V)<br>typically 25.5 k $\Omega$ (@ 24 V) |
| Input current at logic 1 | typically 130 $\mu$ A @ 5 VDC                                                                               |
| Switching delay          | <8 ms                                                                                                       |

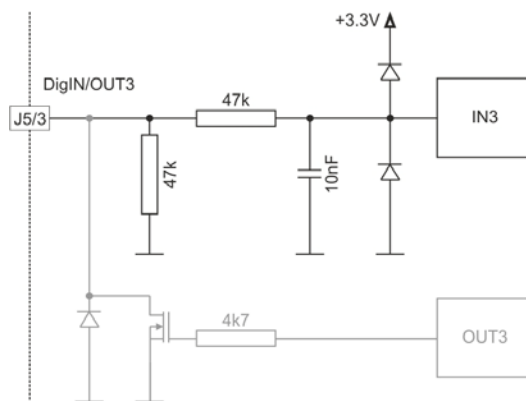


Figure 3-10 DigIN3 Circuit (analogously valid also for DigIN4)

| 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 |

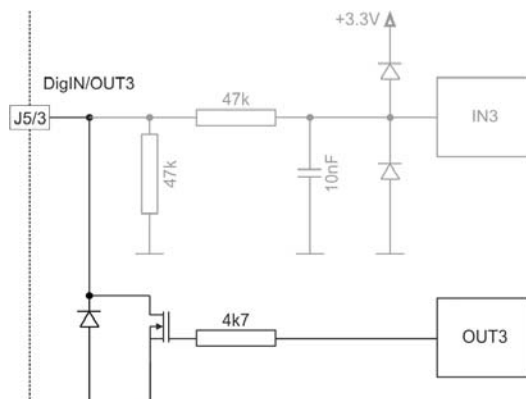


Figure 3-11 DigOUT3 Circuit (analogously valid also for DigOUT4)

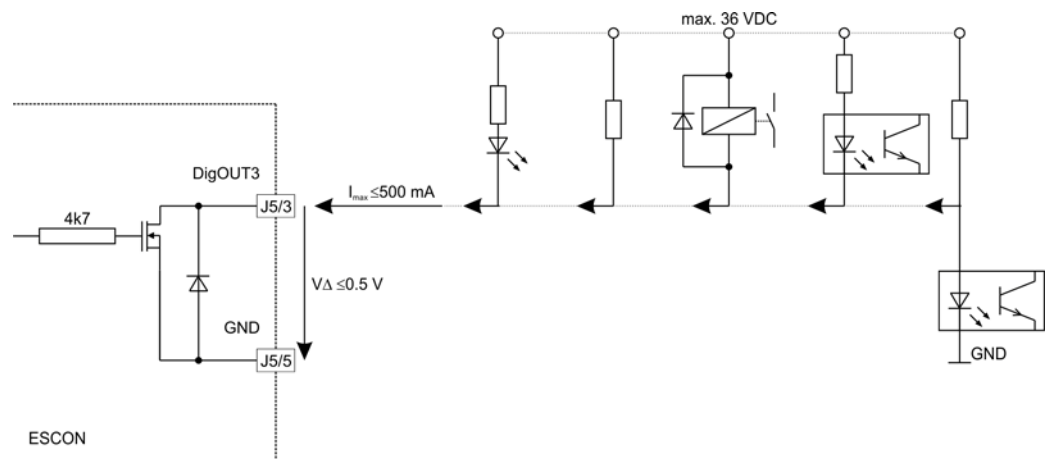


Figure 3-12 DigOUT3 Wiring Examples (analogously valid also for DigOUT4)

### 3.4.4 Analog I/Os (J6)



Figure 3-13 Analog I/Os Socket J6

| J6 & Head A<br>Pin | Prefab Cable<br>Color | Head B<br>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 3-15 Analog I/Os Socket J6 – Pin Assignment & Cabling

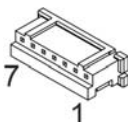
| I/O Cable 7core (403964)                                                                                                          |                                        |                                          |  |
|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|--|
| <div><div><div>A</div></div><div>B</div></div> |                                        |                                          |  |
| Cable cross-section                                                                                                               | 7 x 0.14 mm <sup>2</sup>               |                                          |  |
| Length                                                                                                                            | 1.5 m                                  |                                          |  |
| Head A                                                                                                                            | Suitable plugs<br>Suitable contacts    | Hirose DF3-7S-2C<br>Hirose DF3-2428SC... |  |
| Head B                                                                                                                            | Cable end sleeves 0.14 mm <sup>2</sup> |                                          |  |

Table 3-16 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 k $\Omega$ (differential)<br>50 k $\Omega$ (referenced to GND) |
| A/D converter       | 12-bit                                                             |
| Resolution          | 5.07 mV                                                            |
| Bandwidth           | 10 kHz                                                             |

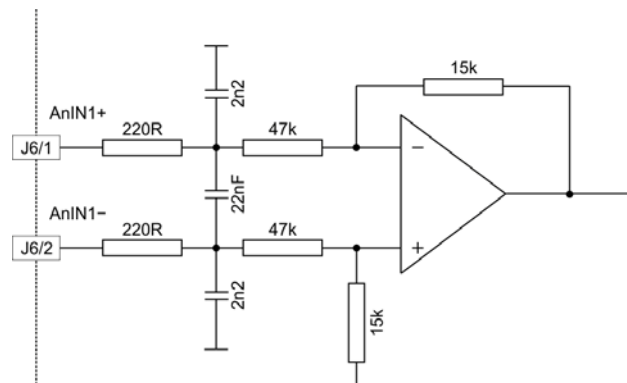


Figure 3-14 AnIN1 Circuit (analogously valid also for AnIN2)

#### 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<br>AnOUT2: 5.4 kHz |
| Analog bandwidth of output amplifier | 20 kHz                              |
| Max. capacitive load                 | 10 nF                               |
| Max. output current                  | 1 mA                                |

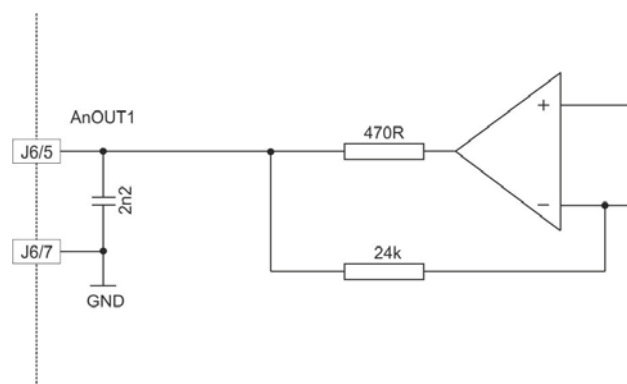


Figure 3-15 AnOUT1 Circuit (analogously valid also for AnOUT2)

### 3.4.5 USB (J7)



Figure 3-16 USB Socket J7


**Note**

Column "Head B" (→Table 3-17) refers to USB terminals of your PC.

| J7 & Head A<br>Pin | Prefab Cable<br>Color | Head B<br>Pin | Signal           | Description                                                  |
|--------------------|-----------------------|---------------|------------------|--------------------------------------------------------------|
| 1                  |                       | 1             | V <sub>BUS</sub> | USB BUS supply voltage input +5 VDC                          |
| 2                  |                       | 2             | D <sup>-</sup>   | USB Data <sup>-</sup> (twisted pair with Data <sup>+</sup> ) |
| 3                  |                       | 3             | D <sup>+</sup>   | USB Data <sup>+</sup> (twisted pair with Data <sup>-</sup> ) |
| 4                  |                       | –             | ID               | not connected                                                |
| 5                  |                       | 4             | GND              | USB ground                                                   |

Table 3-17 USB Socket J7 – Pin Assignment & Cabling

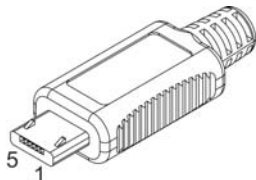
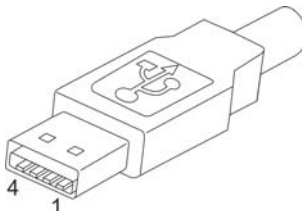
| USB Type A - micro B Cable (403968)                                                                                                                                                                                                |                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;"><b>A</b></div>  </div> | <div style="display: flex; align-items: center;">  <div style="border: 1px solid black; padding: 2px; margin-left: 5px;"><b>B</b></div> </div> |
| 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 3-18 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<br>EC 13<br>EC 20 flat<br>EC 32 flat<br>EC 45 flat | 8<br>6 / 12<br>3 / 5<br>6 / 15<br>12 / 30 |
| 418723       | Adapter BLUE FPC8poles   | blue  | 8     | EC 6<br>EC 8<br>EC 9.2 flat                              | 1.5 / 2<br>2<br>0.5                       |
| 418721       | Adapter GREEN FPC8poles  | green | 8     | EC 6<br>EC 10 flat                                       | 1.2<br>0.2                                |

Table 3-19 Adapters for Flexprint Cables

#### ADAPTER BLACK FPC11POLES

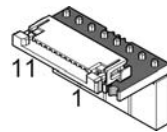


Figure 3-17 Adapter BLACK FPC11poles

| Adapter<br>BLACK<br>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 3-20 Adapter BLACK FPC11poles – Pin Assignment

#### ADAPTER BLUE FPC8POLES

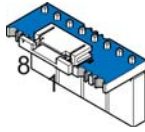


Figure 3-18 Adapter BLUE FPC8poles

| Adapter<br>BLUE<br>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 3-21 Adapter BLUE FPC8poles – Pin Assignment

#### ADAPTER GREEN FPC8POLES

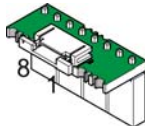


Figure 3-19 Adapter GREEN FPC8poles

| Adapter<br>GREEN<br>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 3-22 Adapter GREEN FPC8poles – Pin Assignment

### 3.4.7 ESCON 36/3 EC Connector Set

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

| «ESCON 36/3 EC Connector Set» (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 3-23 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 |

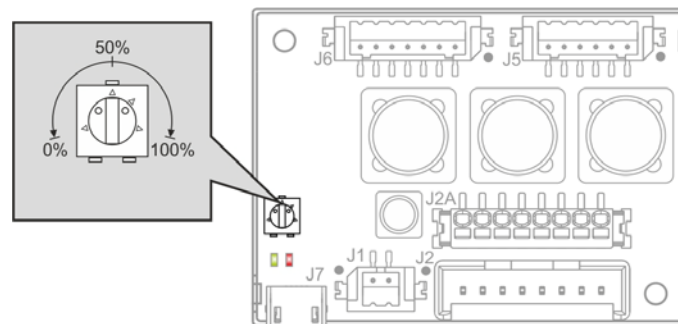


Figure 3-20 Potentiometer P1 – Location & Adjustment Range

### 3.6 Status Indicators

Light-emitting diodes (LEDs) indicate the actual operating status (green) and possible errors (red).

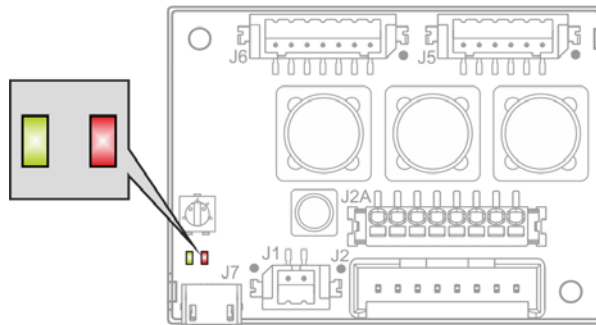


Figure 3-21 LEDs – Location

| LED   |     | Status / Error            |                                                                                                                                                                     |
|-------|-----|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Green | Red |                           |                                                                                                                                                                     |
| off   | off | INIT                      |                                                                                                                                                                     |
| slow  | off | DISABLE                   |                                                                                                                                                                     |
| on    | off | ENABLE                    |                                                                                                                                                                     |
| 2x    | off | STOPPING; STOP STANDSTILL |                                                                                                                                                                     |
| off   | 1x  | ERROR                     | <ul style="list-style-type: none"> <li>• +Vcc Overvoltage Error</li> <li>• +Vcc Undervoltage Error</li> <li>• +5 VDC Undervoltage Error</li> </ul>                  |
| off   | 2x  | ERROR                     | <ul style="list-style-type: none"> <li>• Thermal Overload Error</li> <li>• Overcurrent Error</li> <li>• Power Stage Protection Error</li> </ul>                     |
| off   | 4x  | ERROR                     | <ul style="list-style-type: none"> <li>• PWM Set Value Input out of Range Error</li> </ul>                                                                          |
| off   | 5x  | ERROR                     | <ul style="list-style-type: none"> <li>• Hall Sensor Pattern Error</li> <li>• Hall Sensor Sequence Error</li> <li>• Hall Sensor Frequency too high Error</li> </ul> |
| off   | on  | ERROR                     | <ul style="list-style-type: none"> <li>• Auto Tuning Identification Error</li> <li>• Internal Software Error</li> </ul>                                             |
|       |     |                           |                                                                                                                                                                     |

Table 3-24 LEDs – Interpretation of Condition

## 4 Wiring

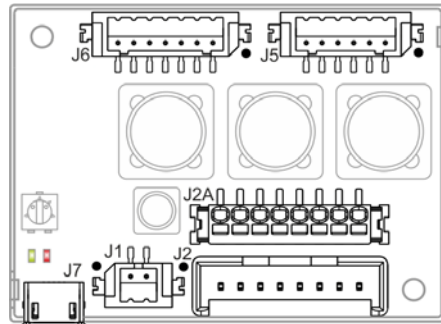


Figure 4-22 Interfaces – Designations and Location



### Remark

The subsequent diagrams feature these signs:

-  PCB mounting hole
-  Ground safety earth connection (optional)

## 4.1 maxon EC motor with Hall Sensors

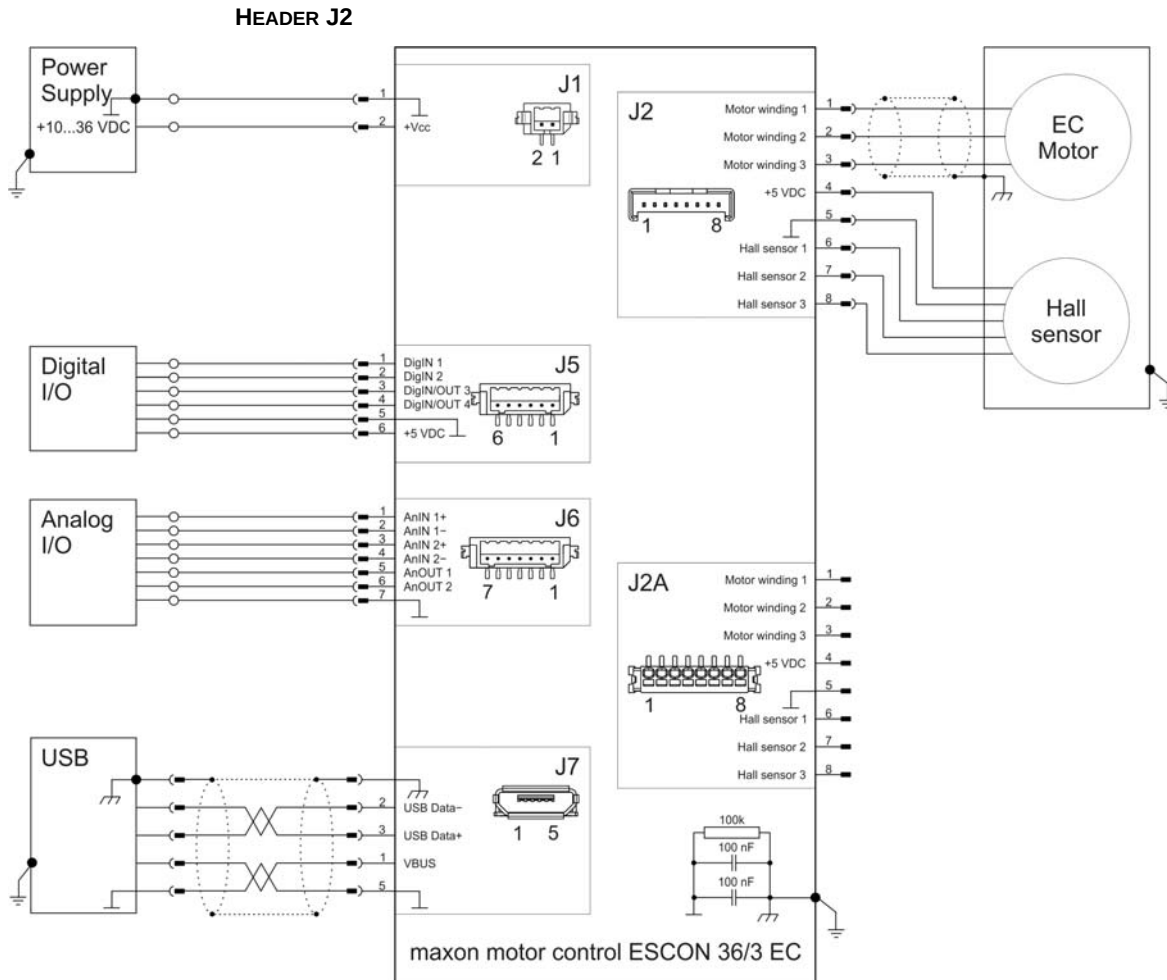


Figure 4-23 maxon EC motor with Hall Sensors (J2)

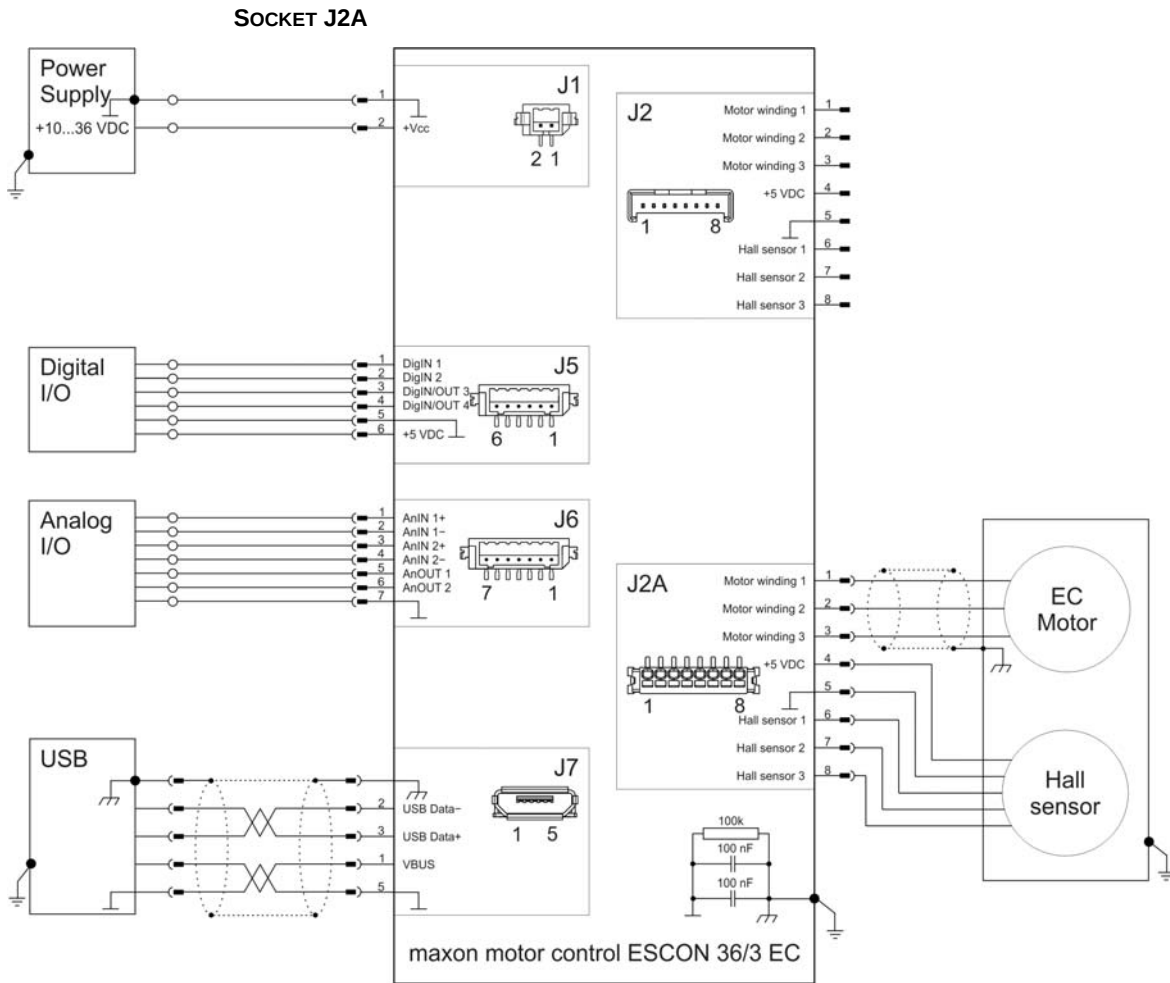


Figure 4-24 maxon EC motor with Hall Sensors (J2A)

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

### HEADER J2 / ADAPTER BLACK (J2 TO FPC 11 POLE)

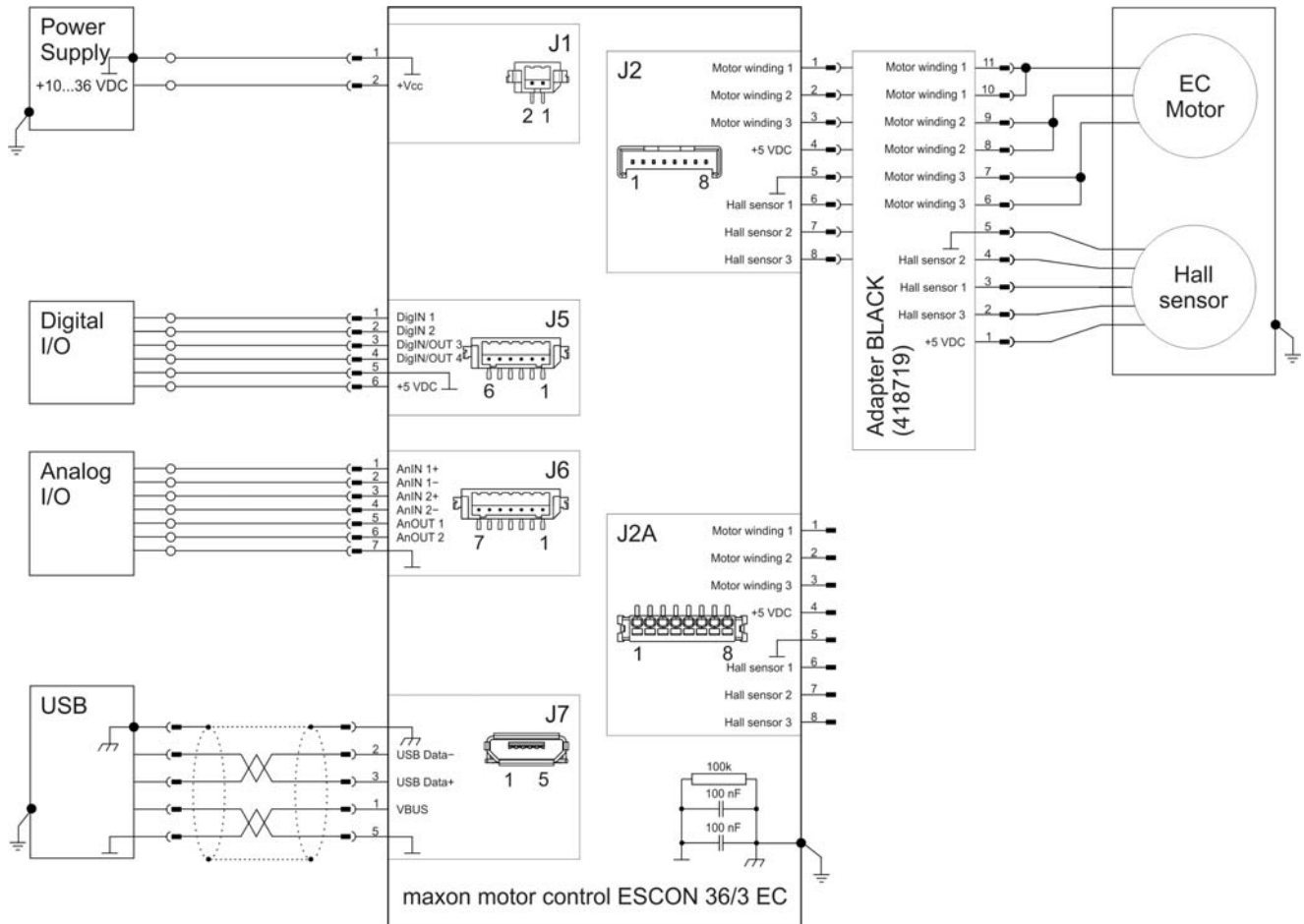


Figure 4-25 maxon EC motor with Hall Sensors (J2 and Adapter BLACK)



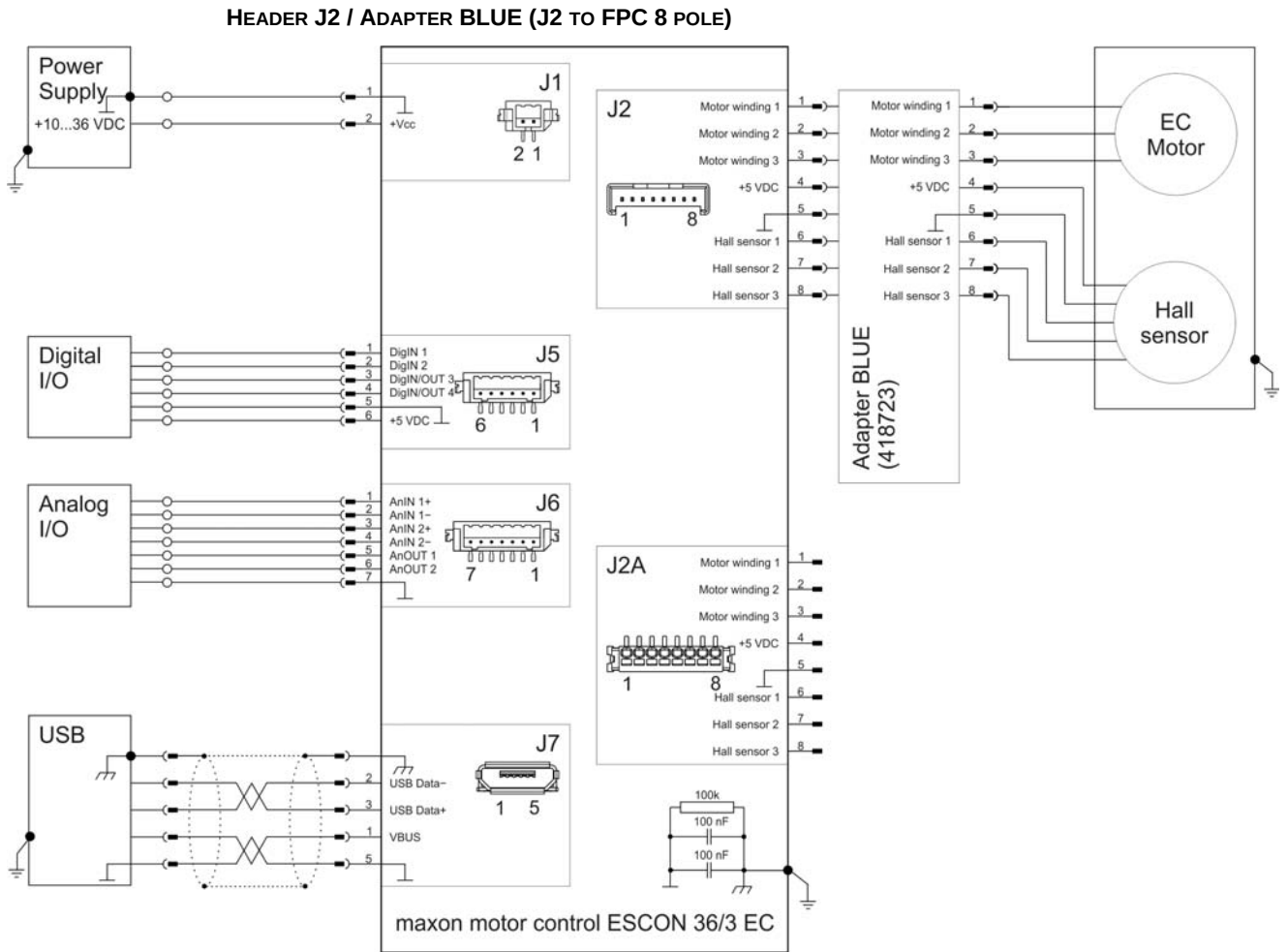


Figure 4-26 maxon EC motor with Hall Sensors (J2 and Adapter BLUE)

### HEADER J2 / ADAPTER GREEN (J2 TO FPC 8 POLE)

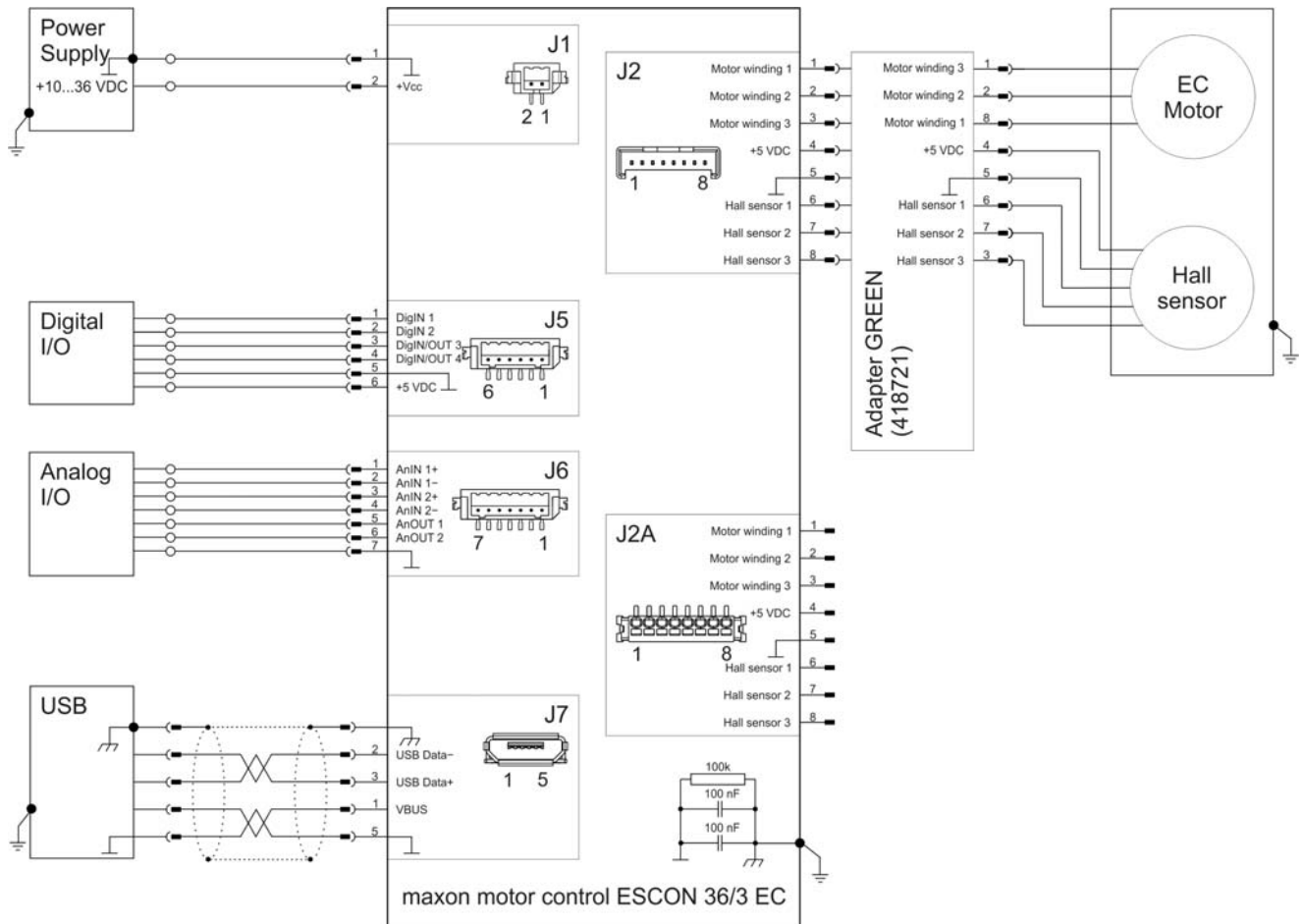


Figure 4-27 maxon EC motor with Hall Sensors (J2 and Adapter GREEN)

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