# *ESCON 36/2 DC*

*Servo Controller*
*P/N 403112*

# *Hardware Reference*
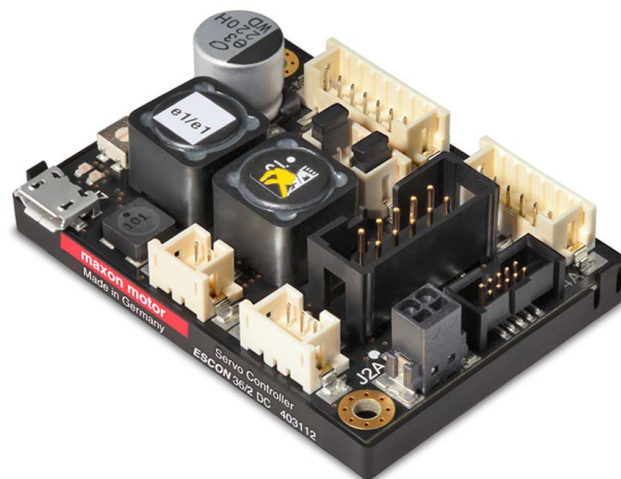
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## TABLE OF CONTENTS

## 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 36/2 DC** 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!*

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# 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 36/2 DC 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** | (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**! | |

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| 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

**maxon motor ag**
Brünigstrasse 220          Phone   +41 41 666 15 00
P.O.Box 263                Fax   +41 41 666 16 50
CH-6072 Sachseln           Web   www.maxonmotor.com

## 1.2 About the Device

The ESCON 36/2 DC is a small-sized, powerful 4-quadrant PWM servo controller for the highly efficient control of permanent magnet-activated DC motors up to approximately 72 Watts.

The featured operating modes – speed control (closed loop), speed control (open loop), and current control – meet the highest requirements. The ESCON 36/2 DC 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.

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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 1-3 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 36/2 DC (403112) | | |
|---|---|---|
| **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.) | $0.98 \times +V_{CC}$ |
| | Output current $I_{cont}$ / $I_{max}$ (<60 s) | 2 A / 4 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 | limited by max. permissible speed (motor) and max. output voltage (controller) |
| | Built-in motor choke | 300 µH; 2 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) |
| | Encoder signals | A, A\, B, B\, (max. 1 MHz) |
| **Voltage Outputs** | Auxiliary output voltage | +5 VDC ($I_L$ ≤40 mA) |
| | Encoder supply voltage | +5 VDC ($I_L$ ≤70 mA) |
| **Potentiometer** | Potentiometer P1 (on board) | 210°; linear |
| **Motor Connections** | + Motor | |
| | − Motor | |
| **Interface** | USB 2.0 / USB 3.0 | full speed |
| **Status Indicators** | Operation | green LED |
| | Error | red LED |
| **Physical** | Weight | approx. 30 g |
| | Dimensions (L x W x H) | 55 x 40 x 16.1 mm |
| | Mounting holes | for M2.5 screws (max. tightening torque 0.16 Nm) |

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| ESCON 36/2 DC (403112) | | | |
|---|---|---|---|
| **Environmental Conditions** | Temperature | Operation | −30…+45 °C |
| | | Extended range *1) | +45…+81 °C<br>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<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.

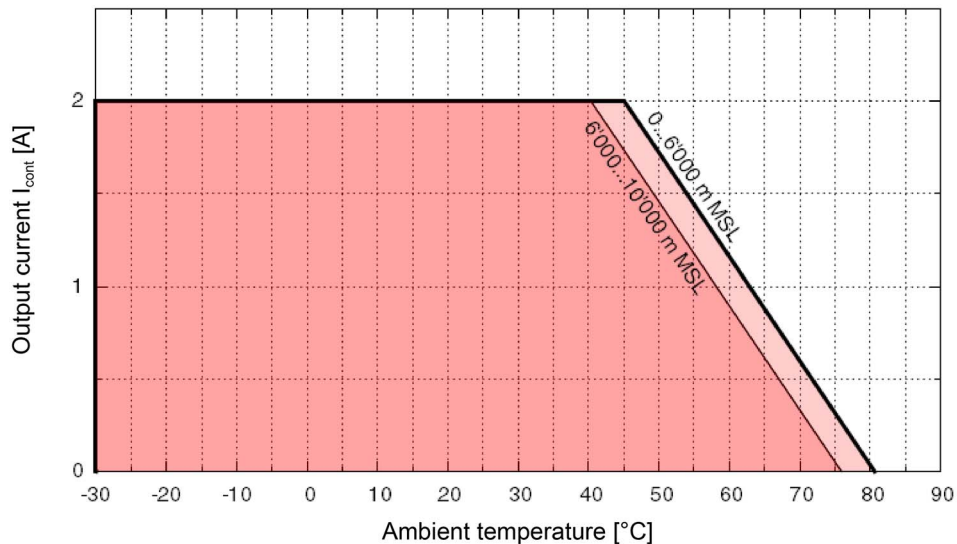*2)	Operating altitude in meters above Mean Sea Level, MSL.

Table 2-4	Technical Data



Figure 2-1	Derating Output Current

| Protection functionality | Switch-off threshold | Recovery threshold |
|---|---|---|
| Undervoltage | 7.2 V | 7.4 V |
| Overvoltage | 43.1 V | 41 V |
| Overcurrent | 6.75 A | — |
| Thermal overload | 95 °C | 85 °C |

Table 2-5	Limitations

Figure 2-2    Dimensional Drawing [mm]

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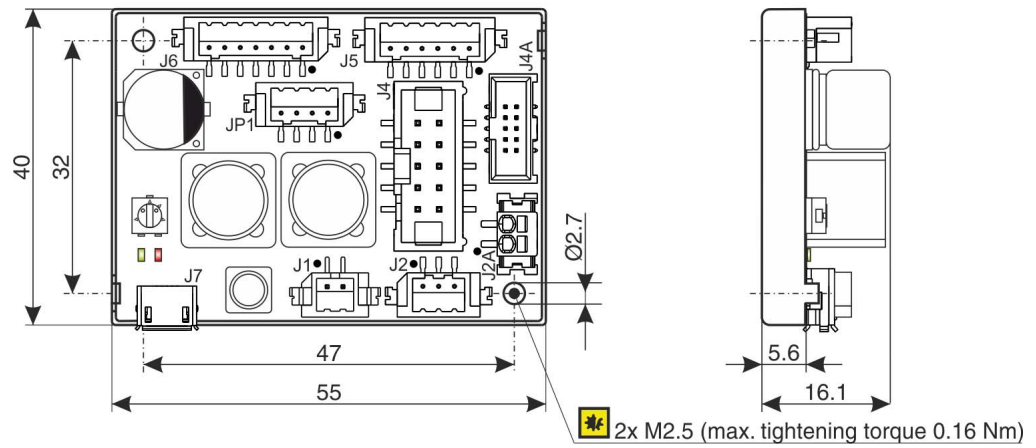*Edition: November 2018*

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## 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): 511'401 hours |

Table 2-6        Standards

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# 3 Setup

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

**The ESCON 36/2 DC** 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 36/2 DC Connector Set" on page 3-29 and ➔chapter "4 Wiring" on page 4-33.

> *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 36/2 DC are as follows; continuous max. 2 A / short-time (acceleration) max. 4 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.*

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## 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<br>• continuous max. 2 A<br>• short-time (acceleration, <60 s) max. 4 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 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 Δn/ΔM [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 36/2 DC. 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 3-29) containing plugs and terminals that will fit the controller's sockets.

| Cable | | | | Socket | DC Motor with… | |
|---|---|---|---|---|---|---|
| **Designation** | **Order number** | **➔ page** | | **Socket** | **Separated Motor/Encoder Cable** | **Integrated Motor/Encoder Ribbon Cable** |
| Power Cable | 403957 | 3-14 | | J1 | X | X |
| DC Motor Cable | 403962 | 3-15 | | J2 | X | |
| Encoder Cable | 275934 | 3-18 | | J4 | O | O |
| I/O Cable 6core | 403965 | 3-22 | | J5 | X | X |
| I/O Cable 7core | 403964 | 3-26 | | J6 | O | O |
| USB Type A - micro B Cable | 403968 | 3-28 | | J7 | X | X |
| Legend: X = required / O = optional | | | | | | |

Table 3-7    Cable Selector

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## 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 (J2/J2A and encoder (J4/J4A) 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 4-33.

### 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<br>Suitable contacts | Hirose DF3-2S-2C<br>Hirose DF3-22SC… |
| Head B | Cable end sleeves 0.34 mm² | |

Table 3-9      Power Cable

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# maxon motor

### 3.4.2    Motor (J2 / J2A)



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

**SOCKET J2**



Figure 3-4        Motor Socket J2

| J2 & Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---|---|---|---|---|
| 1 | white | | Motor (+M) | Motor + |
| 2 | brown | | Motor (−M) | Motor − |
| 3 | black | | Motor shield | Cable shield |

Table 3-10        Motor Socket J2 – Pin Assignment & Cabling

| DC Motor Cable (403962) | | |
|---|---|---|
| A  3 1 | | B |
| Cable cross-section | 2 x 0.34 mm$^2$ shielded | |
| Length | 1.5 m | |
| Head A | Suitable plugs<br>Suitable contacts | Hirose DF3-3S-2C<br>Hirose DF3-22SC… |
| Head B | Cable end sleeves 0.34 mm$^2$ | |

Table 3-11        DC Motor Cable

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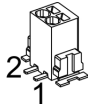
### SOCKET J2A



Figure 3-5        Motor Socket J2A

| J2A & Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---|---|---|---|---|
| 1 | | | Motor (+M) | Motor + |
| 2 | | | Motor (−M) | Motor − |

Table 3-12        Motor Socket J2A – Pin Assignment

| Specification / Accessories | | |
|---|---|---|
| Type | 2 poles, spring-loaded contacts, 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<br>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 Socket J2A – Specification & Accessories

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### 3.4.3 Encoder (J4 / J4A)

***Potential Destruction***
*Use only one of the two sockets – either J4 or J4A!*

**SOCKET J4**
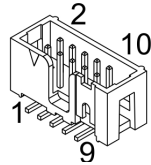


Figure 3-6        Encoder Socket J4

| J4 & Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---|---|---|---|---|
| 1 | | | Motor (+M) | Motor +M (➔note below) |
| 2 | | | +5 VDC | Encoder supply voltage (+5 VDC; ≤70 mA) |
| 3 | | | GND | Ground |
| 4 | | | Motor (−M) | Motor −M (➔note below) |
| 5 | | | Channel A\ | Channel A complement |
| 6 | | | Channel A | Channel A |
| 7 | | | Channel B\ | Channel B complement |
| 8 | | | Channel B | Channel B |
| 9 | | | not connected | – |
| 10 | | | not connected | – |

Table 3-14        Encoder Socket J4 – Pin Assignment & Cabling

***Note***
*If you are using a* ***maxon DC motor with integrated Motor/Encoder Ribbon Cable****, make sure to close both JP1 jumpers (➔chapter "3.5 Jumpers" on page 3-30).*

| Accessories | | |
|---|---|---|
| Suitable strain relief | Lock | 2 levers, Harting (09 18 000 9905) |
| | Retainer | For sockets with strain relief:<br>1 retainer clip, height 13.5 mm, 3M (3505-8110) |
| | | For sockets without strain relief:<br>1 retainer clip, height 7.9 mm, 3M (3505-8010) |
| | Latch | For sockets with strain relief: 2 pieces, 3M (3505-33B) |

Table 3-15        Encoder Socket J4 – Accessories
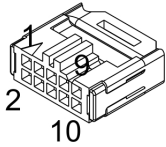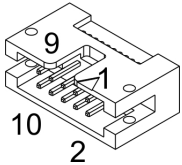
| Encoder Cable (275934) | |
|---|---|
|  |  |
| Cable cross-section | 10 x AWG28, round-jacket, twisted pair flat cable, pitch 1.27 mm |
| Length | 3.20 m |
| Head A | DIN 41651 female, pitch 2.54 mm, 10 poles, with strain relief |
| Head B | DIN 41651 Plug, pitch 2.54 mm, 10 poles, with strain relief |

Table 3-16      Encoder Cable

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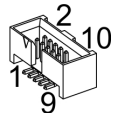
**SOCKET J4A**



Figure 3-7      Encoder Socket J4A

| J4A & Head A Pin | Prefab Cable Color | Head B Pin | Signal | Description |
|---|---|---|---|---|
| 1 | | | not connected | – |
| 2 | | | +5 VDC | Encoder supply voltage (+5 VDC; ≤70 mA) |
| 3 | | | GND | Ground |
| 4 | | | not connected | – |
| 5 | | | Channel A\ | Channel A complement |
| 6 | | | Channel A | Channel A |
| 7 | | | Channel B\ | Channel B complement |
| 8 | | | Channel B | Channel B |
| 9 | | | not connected | – |
| 10 | | | not connected | – |

Table 3-17      Encoder Socket J4A – Pin Assignment

| Specification / Accessories | |
|---|---|
| Type | 2 x 5 poles, half pitch box header, pitch 1.27/1.27 mm |
| Suitable plugs | Samtec: FFSD series<br>W+P Products: 376 series<br>Elcotron: IDC32 series |
| Suitable cables | Flat ribbon cable AWG 30 |

Table 3-18      Encoder Socket J4A – Specification & Accessories

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***Best Practice***
- *Because of its resistance against electrical interferences, **we recommend using differential scheme**. Nevertheless, the controller supports both schemes – differential and single-ended.*
- *The controller does not require an index impulse (Ch I, Ch I\).*
- *For best performance, **we strongly recommend using encoders with line driver**. Otherwise, speed limitations may apply due to slow switching edges.*

| Differential | |
|---|---|
| Min. differential input voltage | ±200 mV |
| Max. input voltage | +12 VDC / −12 VDC |
| Line receiver (internal) | EIA RS422 Standard |
| Max. input frequency | 1 MHz |
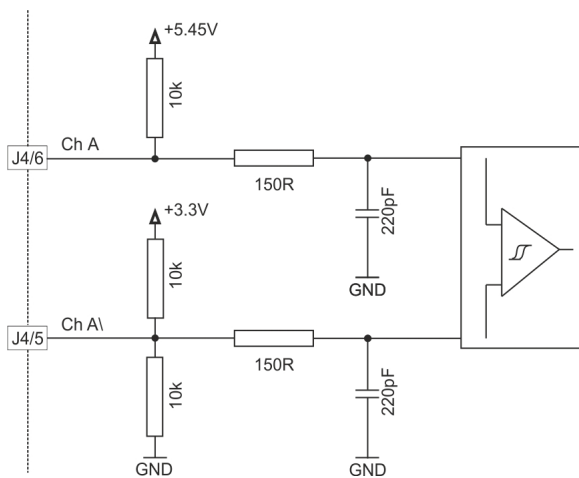


Figure 3-8    Encoder Input Circuit Ch A "Differential" (analogously valid also for Ch B)

| Single-ended | | 3-21 |
|---|---|---|
| Input voltage | 0…5 VDC | |
| Max. input voltage | +12 VDC / −12 VDC | |
| Logic 0 | <1.0 V | |
| Logic 1 | >2.4 V | |
| Input high current | $I_{IH}$ = typically −50 µA @ 5 V | |
| Input low current | $I_{IL}$ = typically −550 µA @ 0 V | |
| Max. input frequency | 100 kHz | |
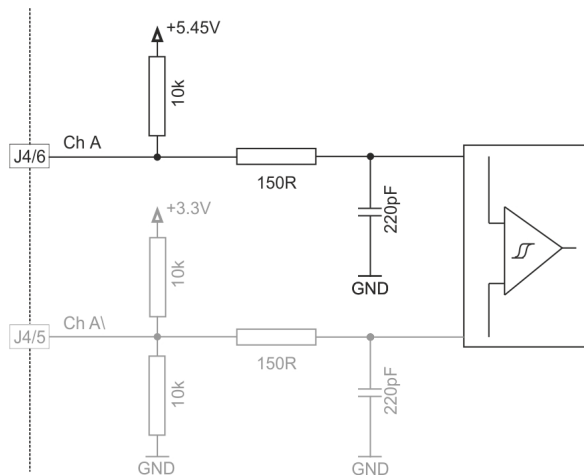


Figure 3-9      Encoder Input Circuit Ch A "Single-ended" (analogously valid also for Ch B)

### 3.4.4    Digital I/Os (J5)
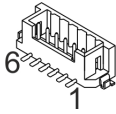


Figure 3-10        Digital I/Os Socket J5

| 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; ≤40 mA) |

Table 3-19        Digital I/Os Socket J5 – Pin Assignment & Cabling

| I/O Cable 6core (403965) | | |
|---|---|---|
| A  | | B |
| Cable cross-section | 6 x 0.14 mm$^2$ | |
| 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$^2$ | |

Table 3-20        I/O Cable 6core

### 3.4.4.1 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)<br>typically 38.5 kΩ (@ 5 V)<br>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%) |
| RC Servo cycle duration | 3…30 ms |
| RC Servo pulse length | 1…2 ms |
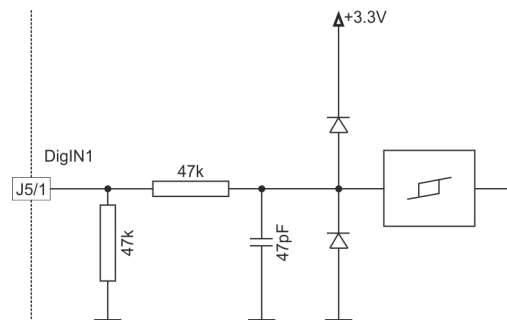


Figure 3-11    DigIN1 Circuit

### 3.4.4.2 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)<br>typically 38.5 kΩ (@ 5 V)<br>typically 25.5 kΩ (@ 24 V) |
| Input current at logic 1 | typically 130 µA @ 5 VDC |
| Switching delay | <8 ms |



Figure 3-12    DigIN2 Circuit

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### 3.4.4.3    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)<br>typically 38.5 kΩ (@ 5 V)<br>typically 25.5 kΩ (@ 24 V) |
| Input current at logic 1 | typically 130 µA @ 5 VDC |
| Switching delay | <8 ms |
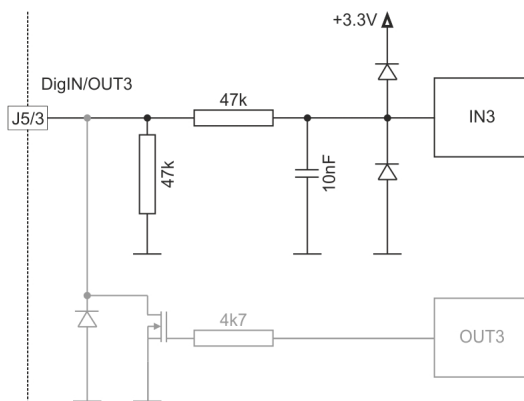
Figure 3-13    DigIN3 Circuit (analogously valid also for DigIN4)

| 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 |
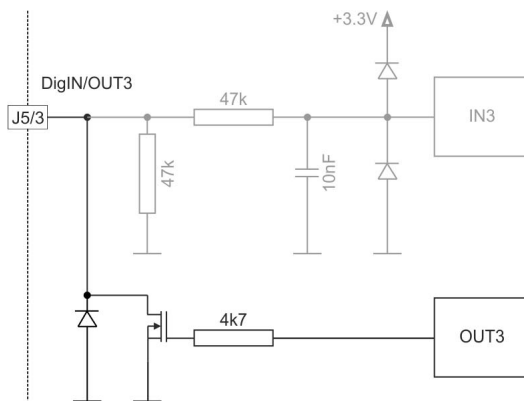
Figure 3-14    DigOUT3 Circuit (analogously valid also for DigOUT4)

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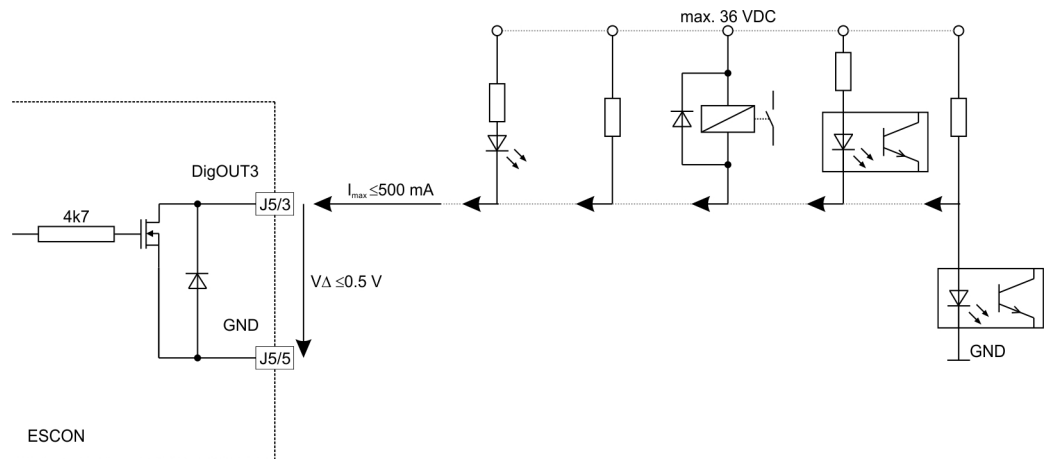
Figure 3-15        DigOUT3 Wiring Examples (analogously valid also for DigOUT4)

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### 3.4.5 Analog I/Os (J6)
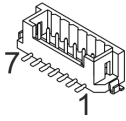


Figure 3-16        Analog I/Os Socket J6

| 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 3-21        Analog I/Os Socket J6 – Pin Assignment & Cabling

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

Table 3-22        I/O Cable 7core

### 3.4.5.1    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)<br>50 kΩ (referenced to GND) |
| A/D converter | 12-bit |
| Resolution | 5.07 mV |
| Bandwidth | 10 kHz |
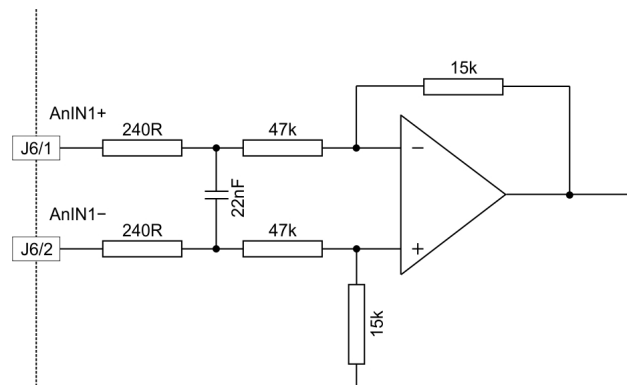


Figure 3-17    AnIN1 Circuit (analogously valid also for AnIN2)

### 3.4.5.2    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 |
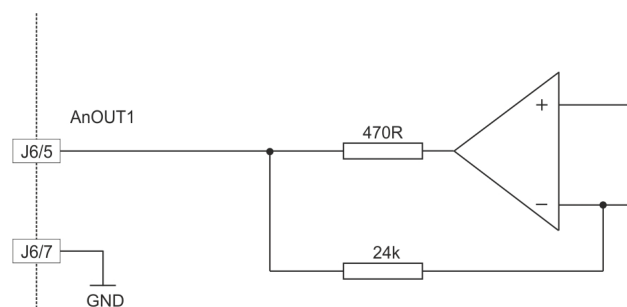


Figure 3-18    AnOUT1 Circuit (analogously valid also for AnOUT2)

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### 3.4.6 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.*
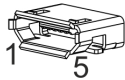
Figure 3-19    USB Socket J7

**Note**

*Column "Head B" (➜Table 3-23) 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 3-23    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 3-24    USB Type A - micro B Cable

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| 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 |

### 3.4.7 ESCON 36/2 DC 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 36/2 DC Connector Set» (404404) | | |
|---|---|---|
| **For Socket** | **Specification** | **Quantity** |
| J1 | Hirose crimping socket, 2 poles (DF3-2S-2C) | 1 |
| J1, J2 | Hirose crimping contact for Socket (DF3-22SC…) | 6 |
| J2 | Hirose crimping socket, 3 poles (DF3-3S-2C) | 1 |
| J4 | 3M Retainer Clip with Strain Relief, H=13.5 mm (3505-8110) | 1 |
| 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 3-25    ESCON 36/2 DC 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…*

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## 3.5 Jumpers

⚠️ **STOP**
*Check on safety precautions before continuing (➔page 1-6).*

**JUMPER JP1**

For maxon DC motor with integrated Motor/Encoder Ribbon Cable, activate the motor terminal by setting both jumpers to CLOSED (➔Figure 3-22, right).
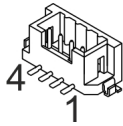
Figure 3-20      Jumper JP1
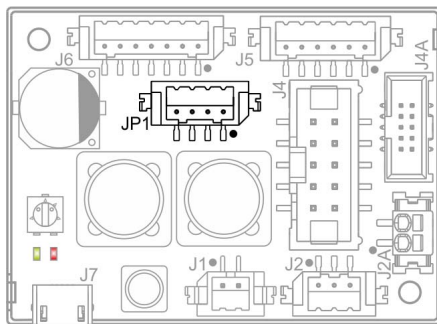
Figure 3-21      Jumper JP1 – Location

Figure 3-22      Jumper JP1 – OPEN, Default Setting (left) / CLOSED (right)

## 3.6 Potentiometers

**POTENTIOMETER P1**

| Adjustment angle | 210° |
|---|---|
| Type | Linear |
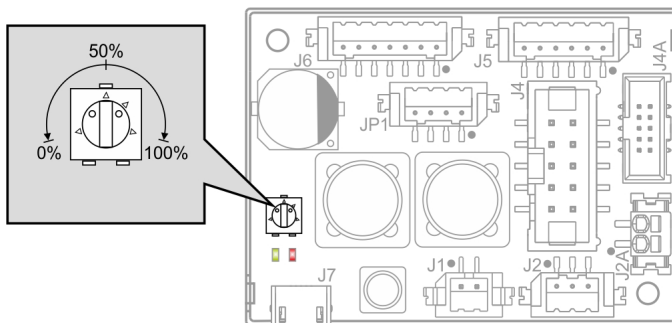
Figure 3-23      Potentiometer P1 – Location & Adjustment Range

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## 3.7        Status Indicators

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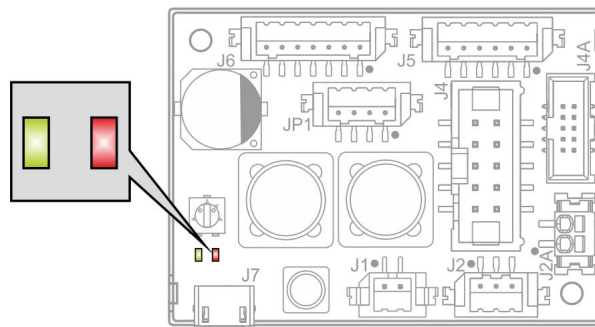


Figure 3-24          LEDs – Location

| 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<br>• +Vcc Undervoltage Error<br>• +5 VDC Undervoltage Error |
| off | 2x | ERROR | • Thermal Overload Error<br>• Overcurrent Error<br>• Power Stage Protection Error |
| off | 3x | ERROR | • Encoder Cable Break Error<br>• Encoder Polarity Error<br>• DC Tacho Cable Break Error<br>• DC Tacho Polarity Error |
| off | 4x | ERROR | • PWM Set Value Input out of Range Error |
| off | on | ERROR | • Auto Tuning Identification Error<br>• Internal Software Error |



Table 3-26          LEDs – Interpretation of Condition

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# 4 Wiring
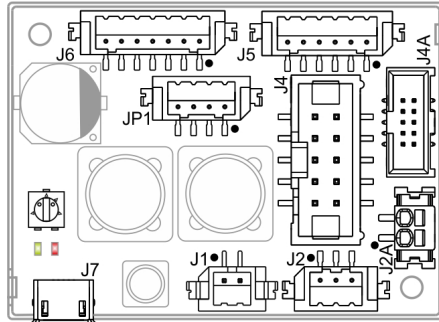


Figure 4-25        Interfaces – Designations and Location

---

> ### Remark
>
> The subsequent diagrams feature these signs:
>
> -     *PCB mounting hole*
>
> -     *Ground safety earth connection (optional)*

---

## 4.1 maxon DC motor
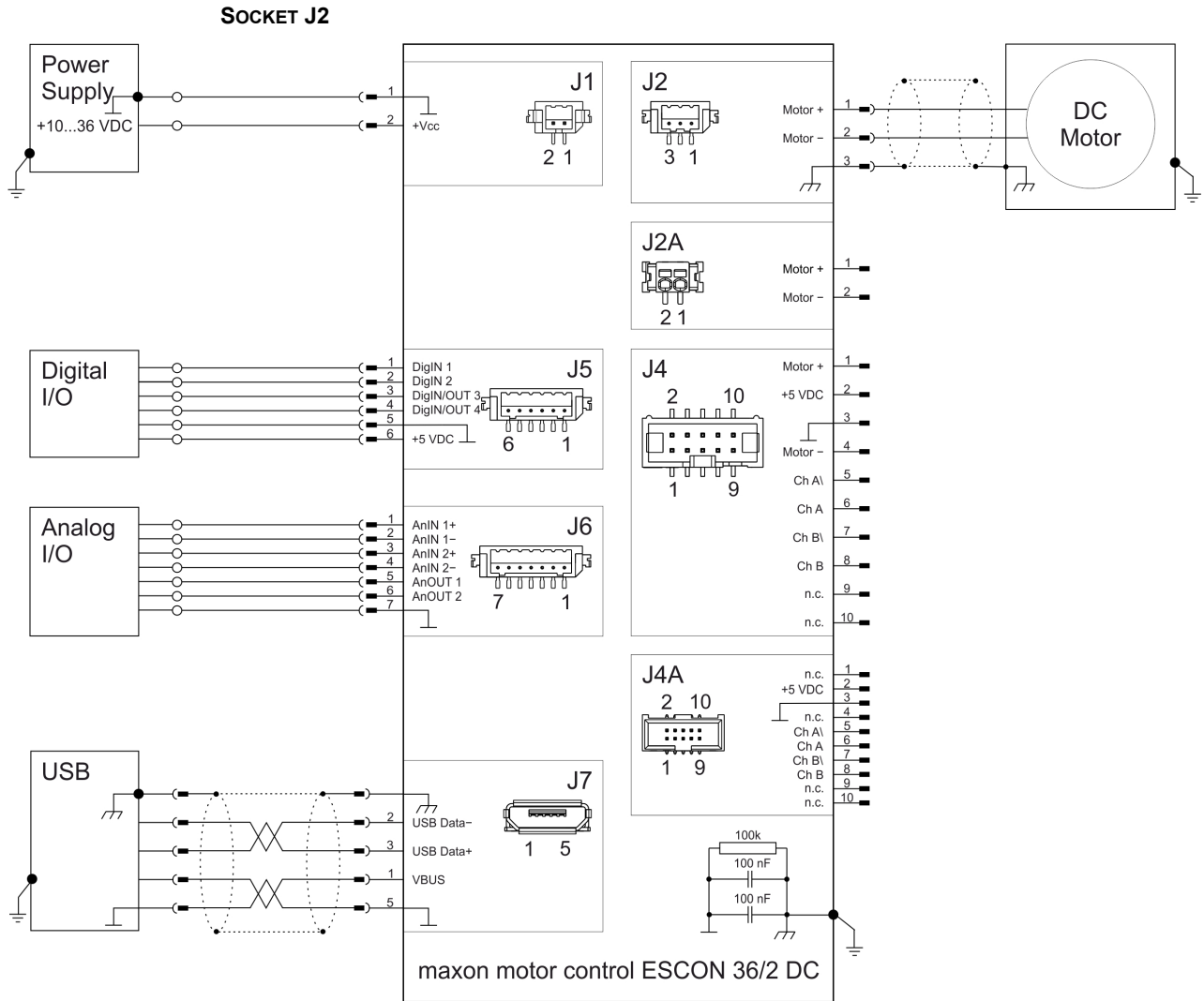


Figure 4-26    maxon DC motor (J2)

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## 4.2    maxon DC motor with DC Tacho
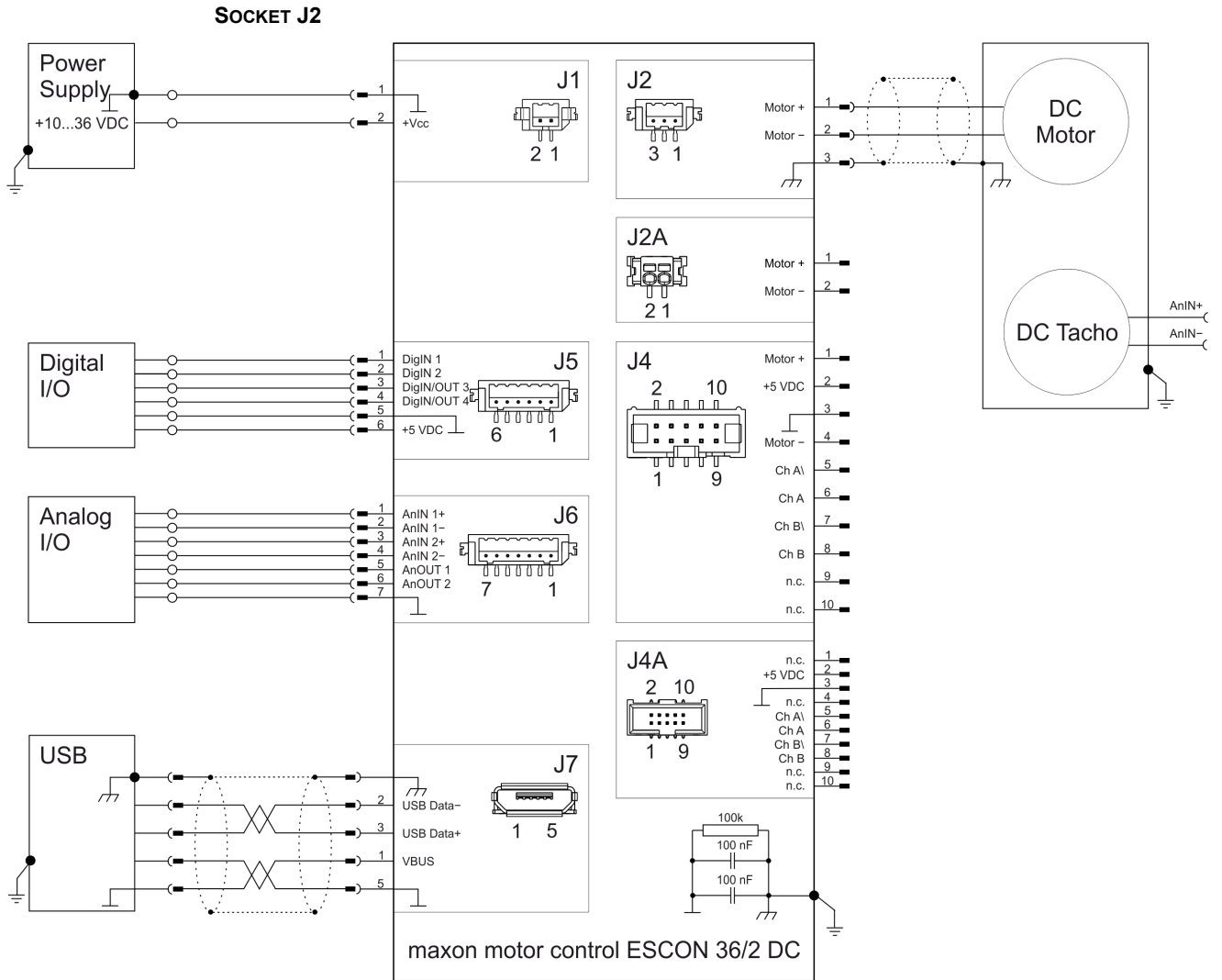
SOCKET J2



Figure 4-27        maxon DC motor with DC Tacho (J2)

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## 4.3    maxon DC motor with separated Motor/Encoder Cable

SOCKETS J2 / J4
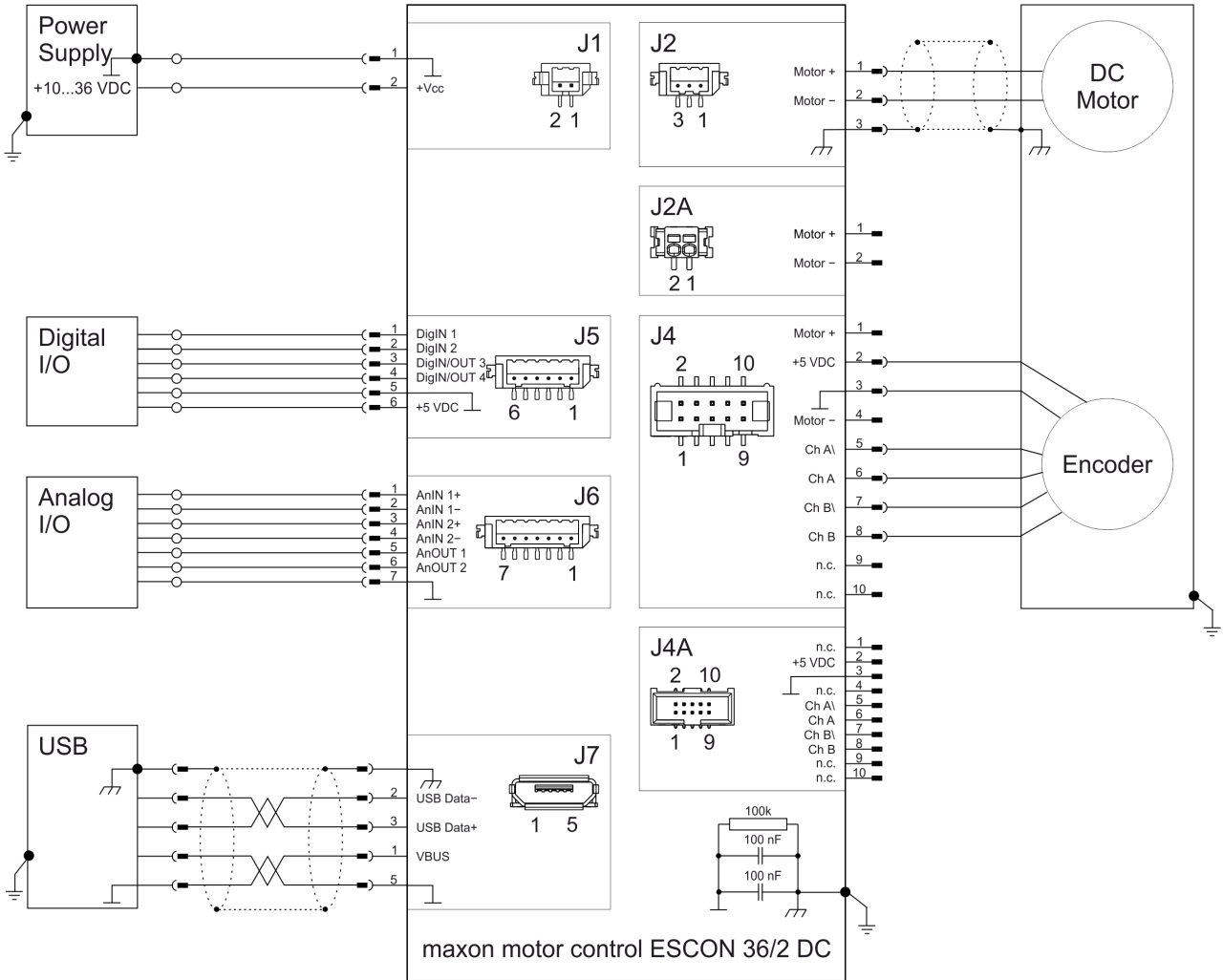


Figure 4-28    maxon DC motor with Encoder – separate Cables (J2 / J4)

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**SOCKETS J2 / J4A**
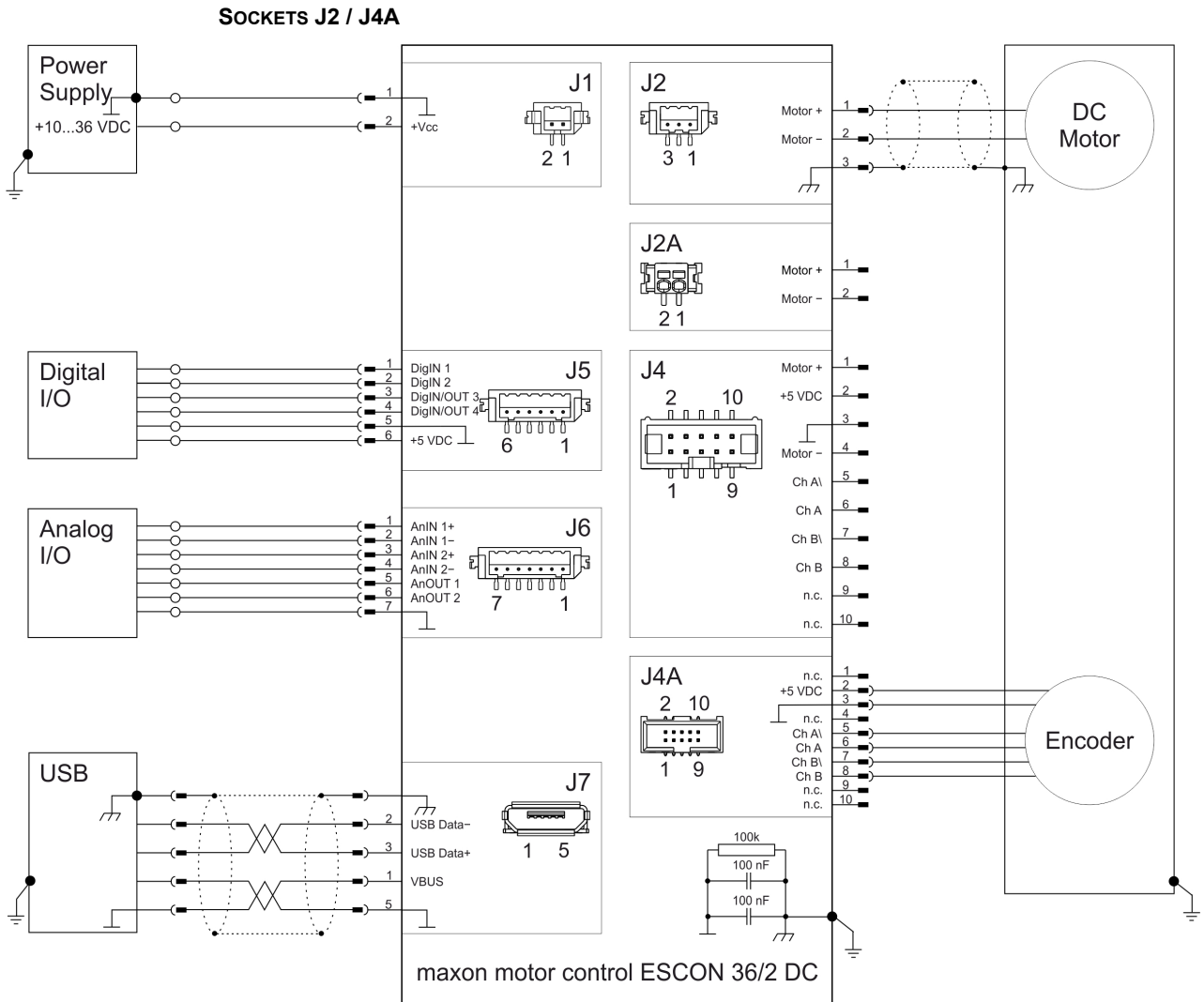


Figure 4-29      maxon DC motor with Encoder – separate Cables (J2 / J4A)

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SOCKETS J2A / J4
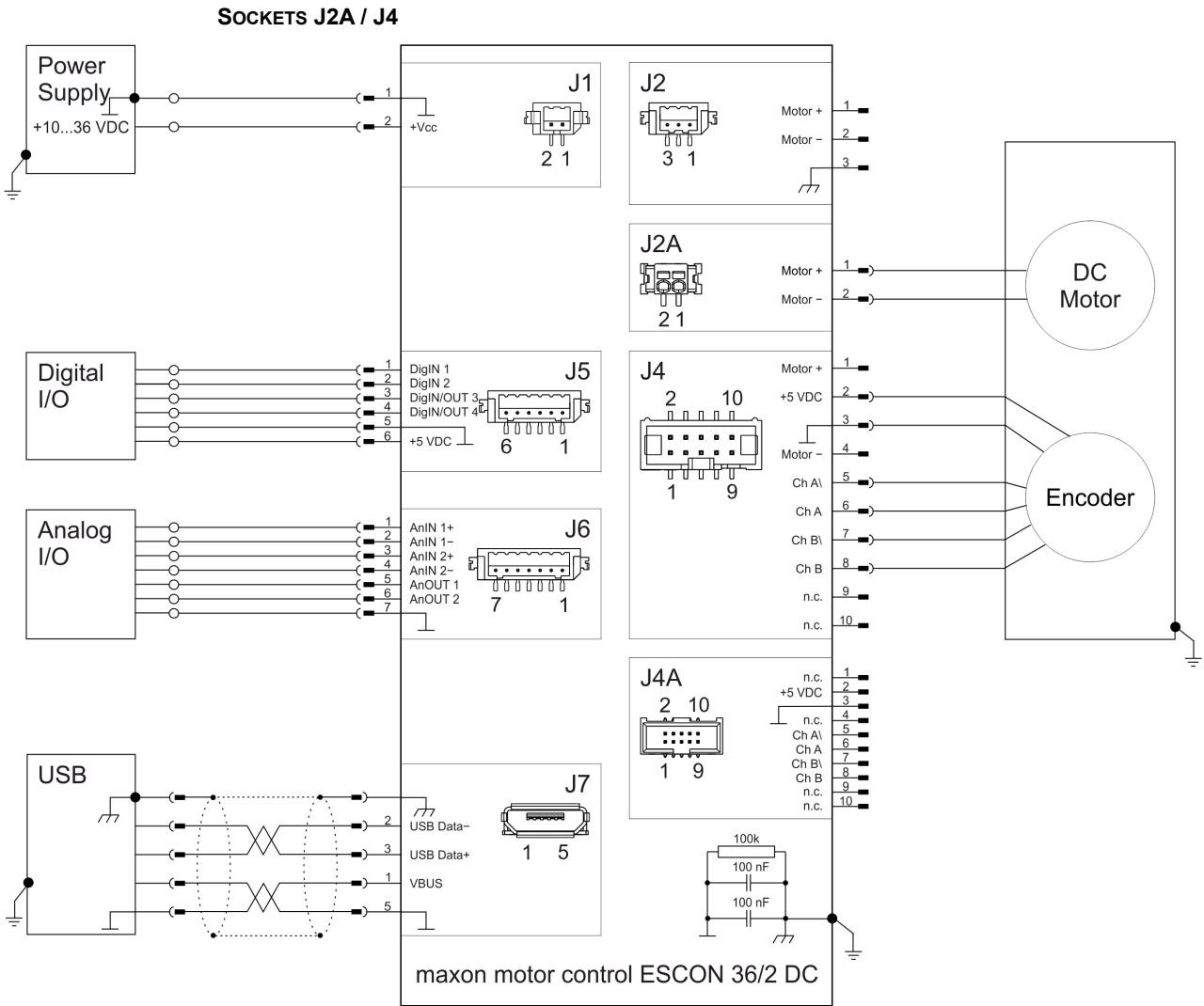


Figure 4-30      maxon DC motor with Encoder – separate Cables (J2A / J4)

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## SOCKETS J2A / J4A
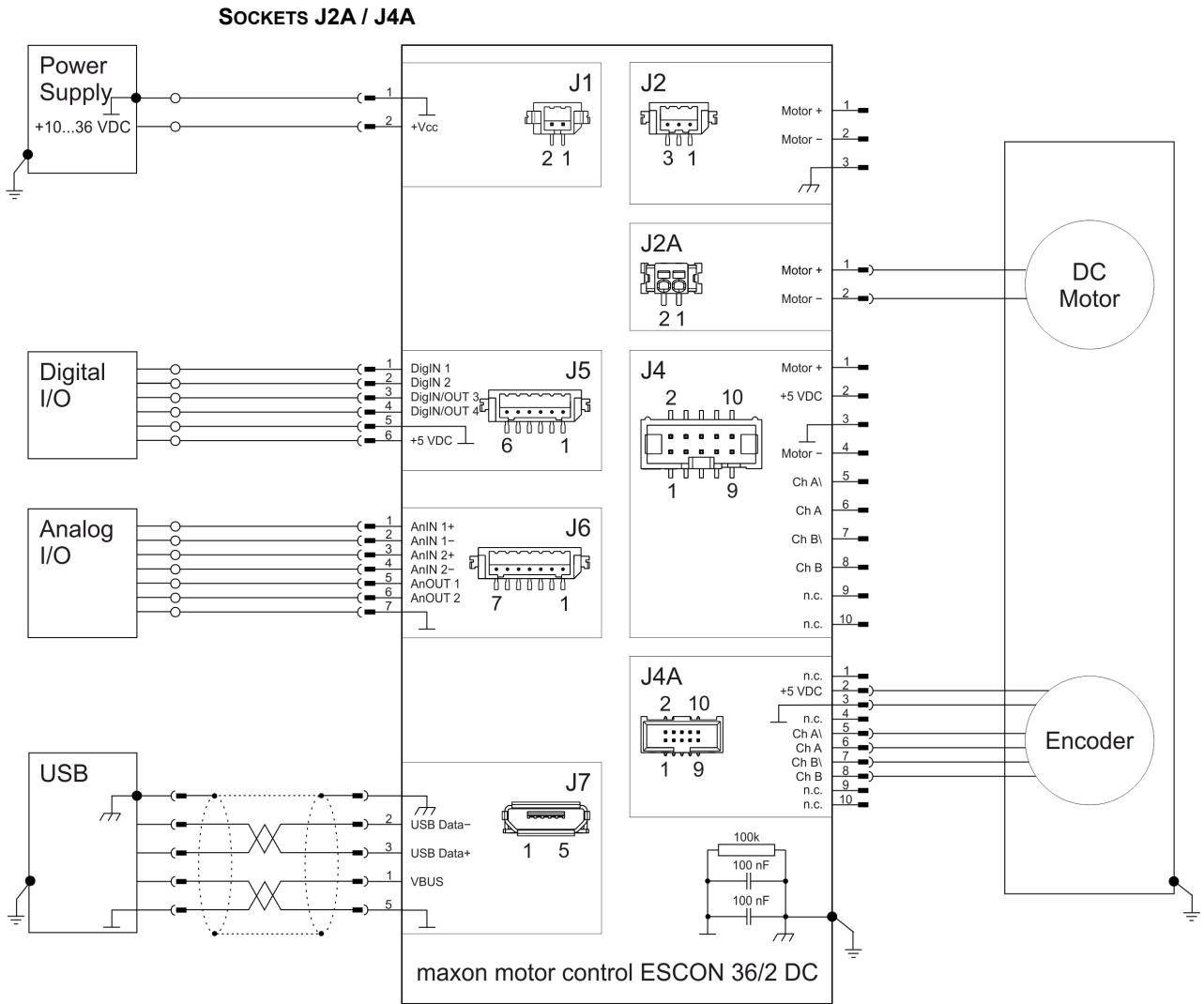


Figure 4-31    maxon DC motor with Encoder – separate Cables (J2A / J4A)

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## 4.4 maxon DC motor with integrated Motor/Encoder Ribbon Cable
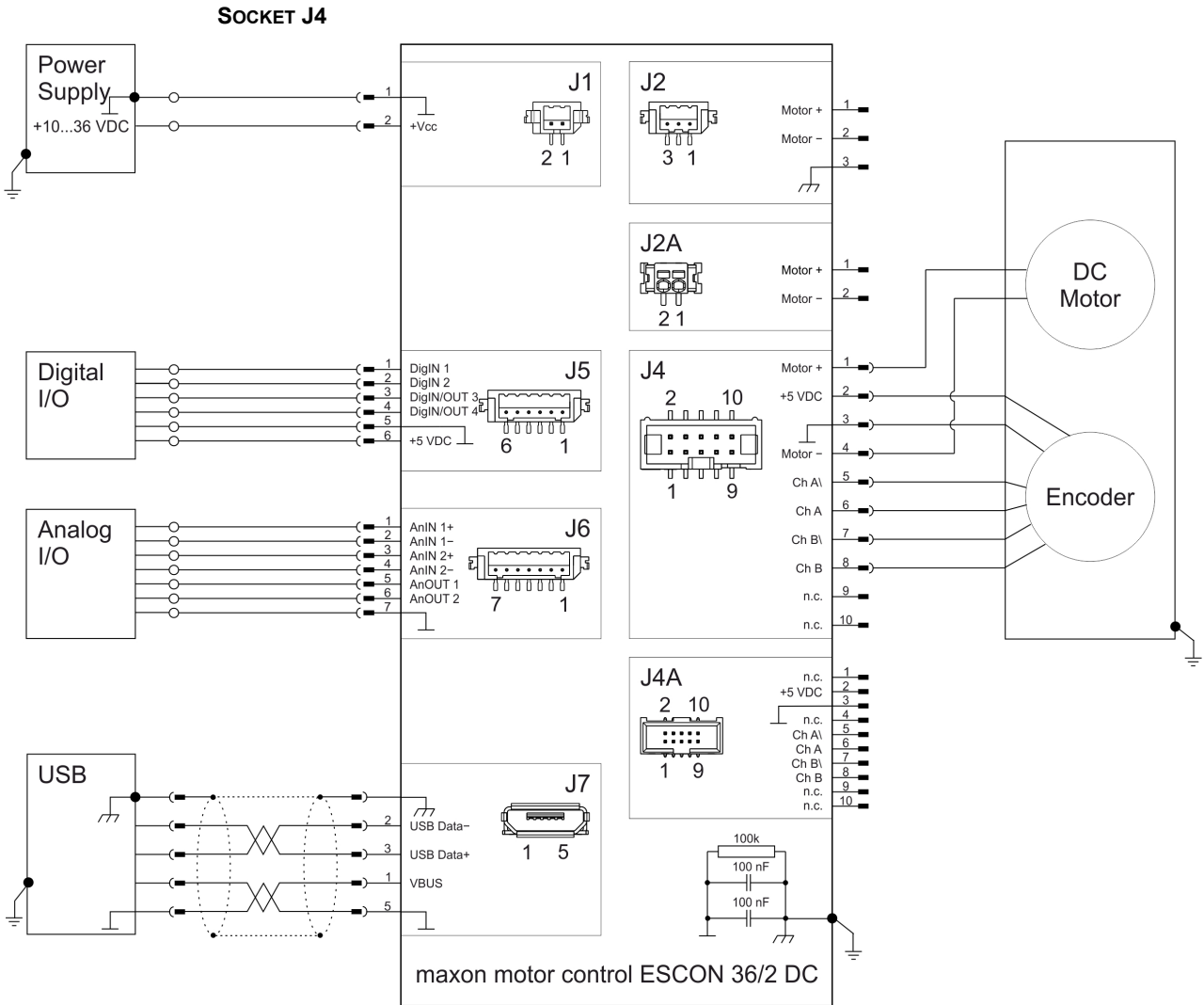
SOCKET J4



Figure 4-32      maxon DC motor with Encoder – integrated Ribbon Cable (J4)

**Note**
*For jumper settings* ➔*chapter " Jumper JP1" on page 3-30.*

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## LIST OF FIGURES

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