# SWM/LWM7 Installation and Setup Guide

SWM7S standard version

SWM7-300 / 600 high voltage

**WARNING !**

**• If possible the motor should be disconnected from the load. No loose parts should be attached to the motor shaft, which might be ejected by centrifugal force. Make sure that the motor is safely anchored to avoid being displaced by high acceleration reactions.**

**WARNING !**

**• Ensure that no person or material damage can occur, when the drive or axis responds unexpectedly.**

**Check that any limit switches, mechanical stops, emergency switches etc. are functioning normally.**

**Impressum**

# 1 General Information

## 1.1 SWM7(S)

The ***SWM7*** (Sine-Wave commutated servo Module family) represents the culmination of 20 years of development and application experience in industrial, military and vehicle servo systems. The SWM7 motor controller offers all the benefits of modern digital and power electronics technology. Special features of this advanced motor controller are:

- power stage for DC-brush, 2, 3-phase brushless DC and AC-induction motors
- wide voltage supply ranges (12 to 60V, 24 to 350V, 24 to 650V), 24V aux. supply
- commercial (-CT), extended (-ET) temperature and MIL-types (-MT) available
- field-oriented motor control with field weakening capability
- fully adjustable PID-control with feed-forward
- high-efficiency PWM (adjustable 15, 20, 25, 40, 50kHz) with parallel modulation
- extremely fast control loop update rate, synchronous to PWM
  (e.g. 40 kHz PWM: current loop 80 kHz, velocity loop 40 kHz, position loop 10 kHz)

- current/voltage/feedback sensor resolution 16bit, velocity 32bit float, position 48bit
- +/-10V analog interface (2x) for U/V-current, torque or speed control, logic interlocks
- Ethernet and CANbus-interface, also for positioning purposes (optional)
- 2xRS232, CAN, USB communication ports
- CANaerospace and private CAN communication profiles available
- sine-ware or block commutation using Hall-effect, resolver or encoder f/b, sensorless
- velocity feedback via DC-tachometer, resolver, encoder or Hall-effect devices
- simultaneous usage of up to 3 feedback devices
- 100% digital set-up of drive parameters including current loops
- multiple digital and analog I/O's
- connector panel adaptable to special connectivity requirements - SWM7 version
- shorter housing version available (only 65mm high) – SWM7S
- contact cooling through base plate; high power versions air (-AC) or water (-WC) cooled
- parameter monitoring and configuration via the USB/RS232-interface
- PC set-up software under MS-Windows
- accordant to CE, MIL-STD-810, -461/462, -1275B (48V versions) etc.
- high reliability, 20,000hrs to MIL-HDBK- 217F (NS-naval sheltered)

## 1.2 LWM7S

A drive version with a linear (non-switching) power stage is available in the same housing and with the same motor and control interface configurations as the SWM7. The ***LWM7S*** has excellent linearity around zero current, unsurpassed EMC-characteristics and no PWM-jitter.

It is ideal for critical applications in science and medicine as well as in semiconductor and magnetically sensitive environments, e.g. for positioning with sub-nanometer resolutions.

## 1.3 Versions and options of the SWM7 Controller Family

| | | | |
|---|---|---|---|
| SWM7(S)/048-12.5-CT | 12-60V/12.5 Arms | 0 to 45°C | |
| SWM7(S)/048-25-CT | 12-60V/25 Arms | 0 to 45°C | |
| SWM7(S)/048-50-CT | 12-60V/50 Arms | 0 to 45°C | |
| SWM7(S)/048-100-CT | 12-60V/100 Arms | 0 to 45°C | |
| SWM7(S)/048-150-CT | 12-60V/150 Arms | 0 to 45°C | *under development* |
| SWM7(S)/150-05-CT | 24-330V/5 Arms | 0 to 45°C | |
| SWM7(S)/150-12.5-CT | 24-330V/12.5 Arms | 0 to 45°C | |
| SWM7(S)/150-25-CT | 24-330V/25 Arms | 0 to 45°C ‘ | |
| SWM7(S)/300-05-CT | 24-475V/5 Arms | 0 to 45°C | |
| SWM7(S)/300-12.5-CT | 24-475V/12.5 Arms | 0 to 45°C | |
| SWM7(S)/300-25-CT | 24-475V/25 Arms | 0 to 45°C | |
| SWM(7S)/600-05-CT | 24-660V/5 Arms | 0 to 45°C | |
| SWM(7S)/600-12.5-CT | 24-660V/12.5 Arms | 0 to 45°C | |
| SWM(7S)/600-25-CT | 24-660V/25 Arms | 0 to 45°C | |
| SWM(7S)/600-50-CT | 24-660V/50 Arms | 0 to 45°C | *75Arms peak, under development* |
| LWM7S/048-05 | 12-60V/5 Arms | 0 to 45°C | *no LWM7, no –ET version* |
| SWM7/ versions | with additional I/O connections; | | *height +25 mm* |

*The current values given are continuous or RMS phase current ratings. A peak current of two-times continuous is available for 2 seconds.*

| | | |
|---|---|---|
| Option -ET | extended temperature range | -40 to +65°C |
| Option -MT | as –ET, with conformal coating etc. | -40 to +65°C |
| Option –AC / -WC | Forced air cooling (water cooling option for 300/600V controllers) | |

| | | |
|---|---|---|
| SWM7/TB | SWM7 Test box with cable | *under development* |
| SWM7/FBM | Front base mounting plate (width +30mm, height +6mm) | |
| SWM/PSU-xxx- ET | Power supply unit (xxx= nominal bus voltage) | -40 to +65°C |
| PSU-600-45-R-ET | Power supply unit (with regeneration protection) | -40 to +65°C |
| SWM7G/MB,SWM7/MB | Mounting brackets, large and small | (for –AC option only) |

## 1.4 Mechanical Data

The SWM/LWM modules are mounted on a base plate and are completely sealed. Main connections are made via military-style Sub-D or screw connectors.

Dimensions are:

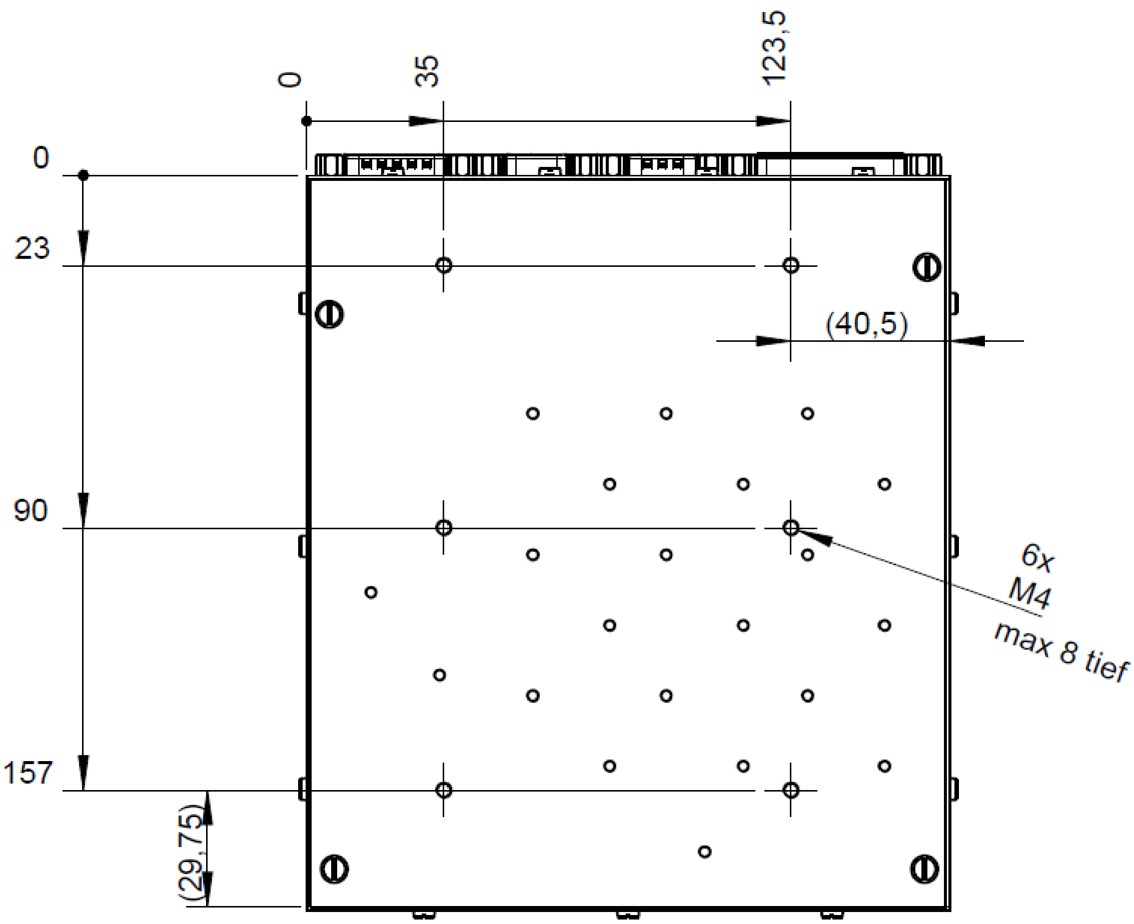
| | LWM7S | SWM7S/048-xx<br>SWM7S/150-xx | SWM7S/048-100 & 150 | SWM7S/x00-12.5, 25 & 50 |
|---|---|---|---|---|
| Length | 188mm | 188mm | 188mm | 217mm |
| Width | 164mm | 164mm | 189mm | 216mm |
| Height /-AC | 65mm/105mm | 65mm/105mm | 91mm/131mm | 118mm/152mm |
| Weight /-AC | 1.5kg/3.2kg | 1.65kg/3.35kg | 2.3kg/4.25kg | 3.25kg/5.40kg |

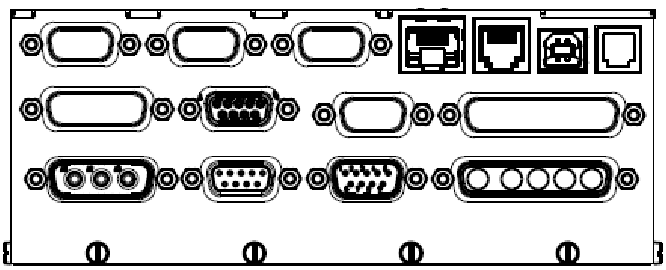
*The controller is physically mounted by screwing the base plate to a bulkhead, from the rear. This ensures mechanical stability and optimum conduction cooling, without an additional heatsink.*

## 1.5 Mounting

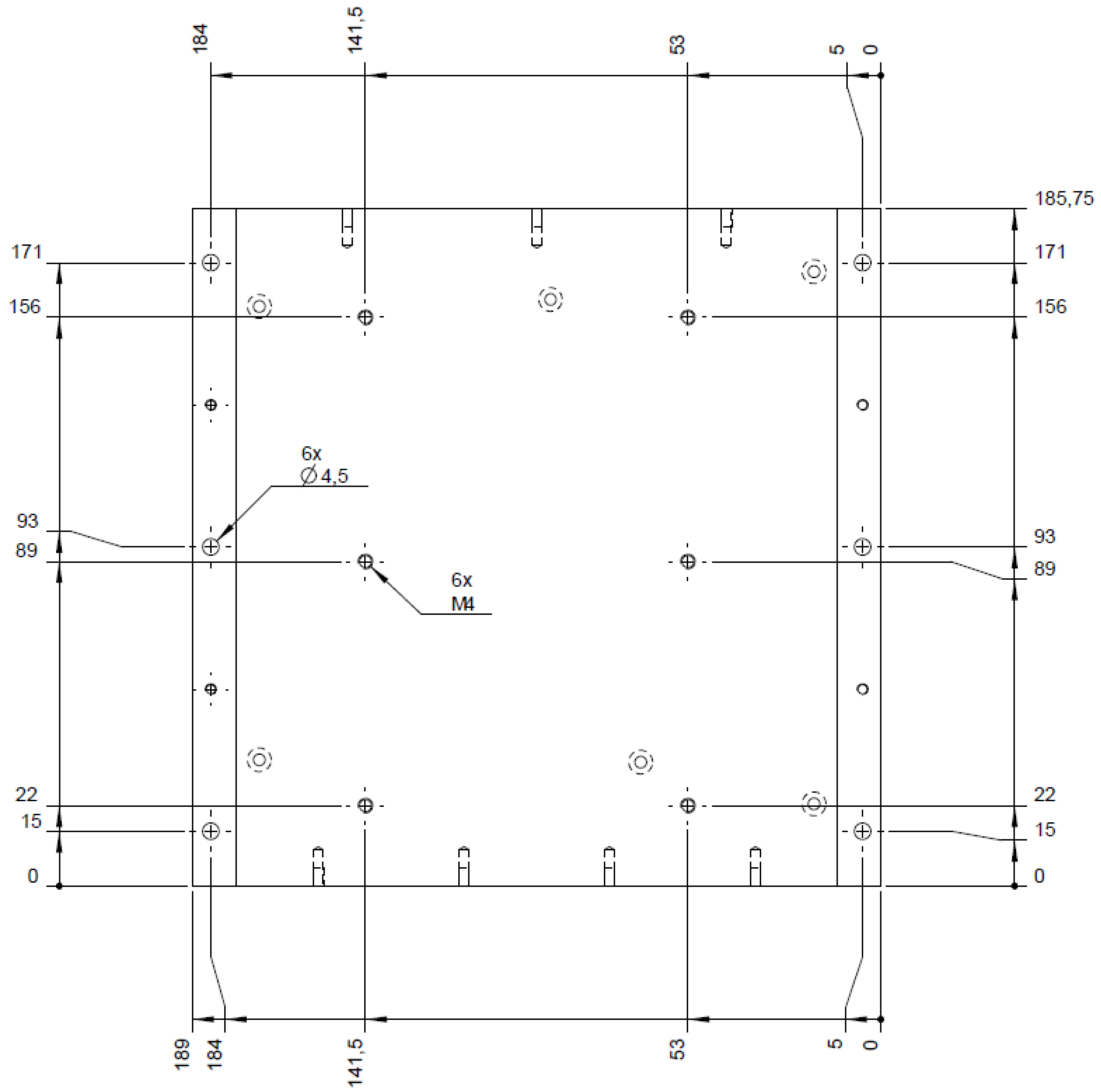
The device is mounted from below by six M4 screws according to the drawing.

### 1.5.1 188 x 164 mm base plate

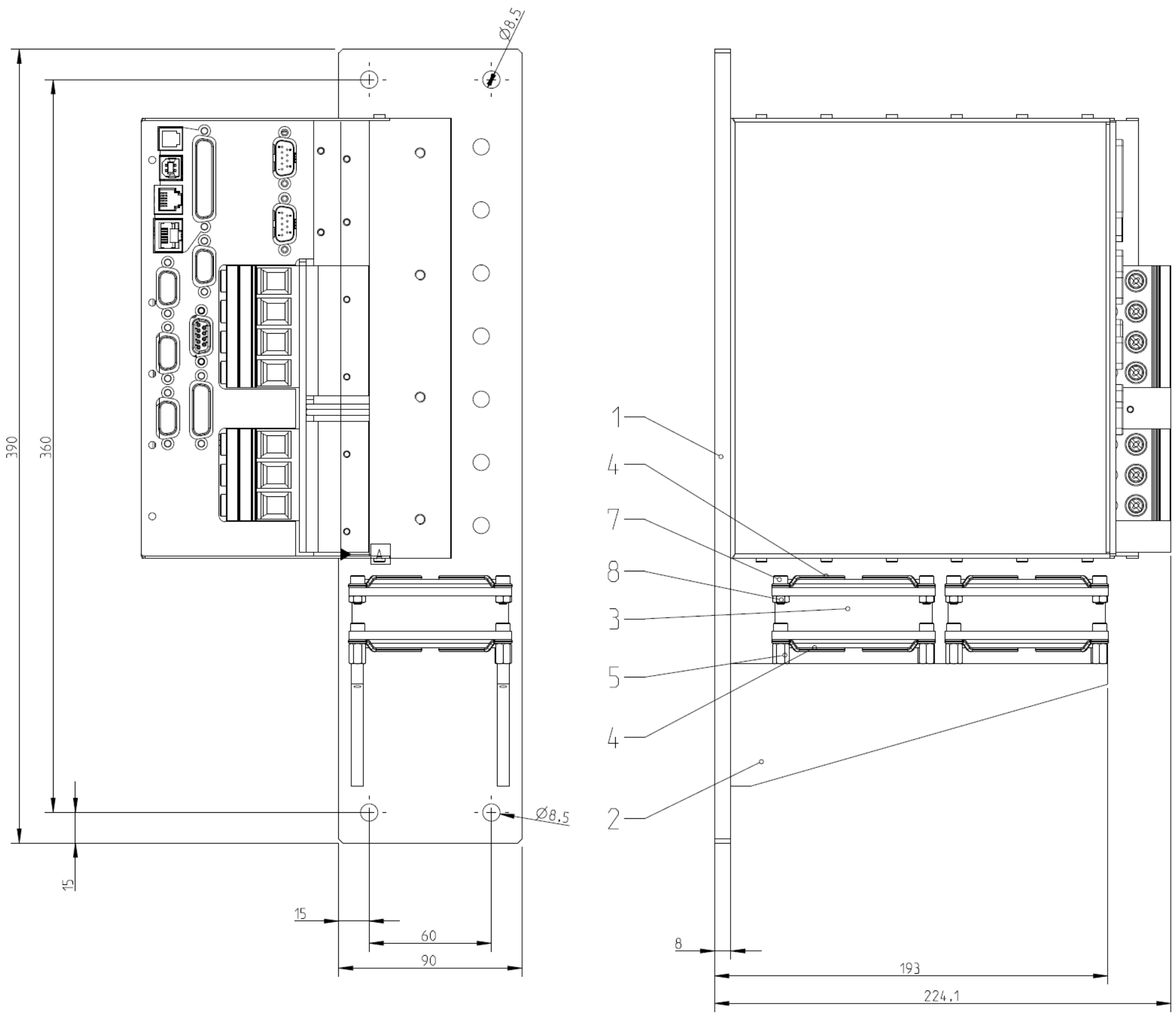


### 1.5.2 188 x 189 mm base plate



### 1.5.3 SWM7-300 / -600 high voltage, wall mount version

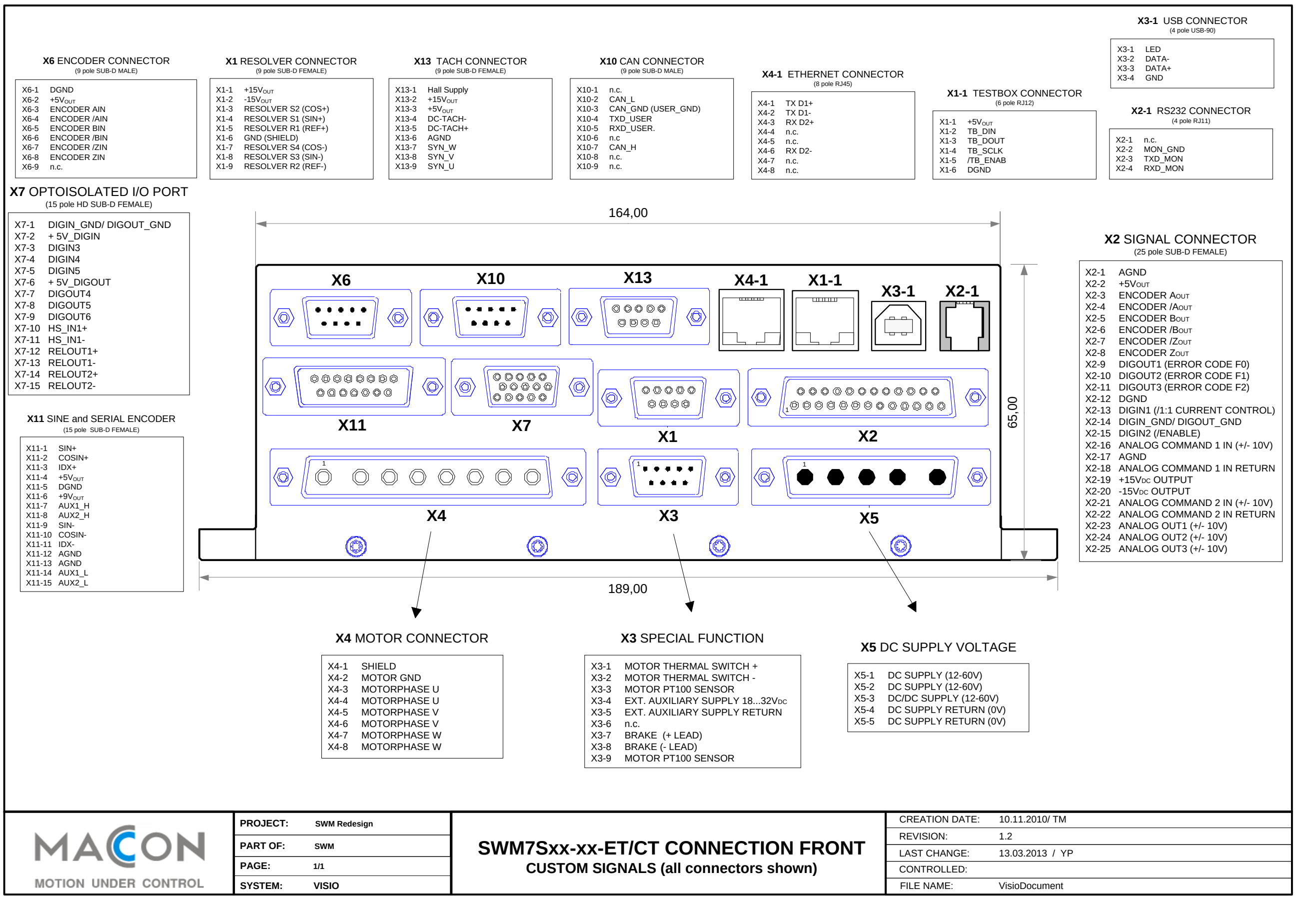


# 2 Electrical installation

## 2.1 Overview

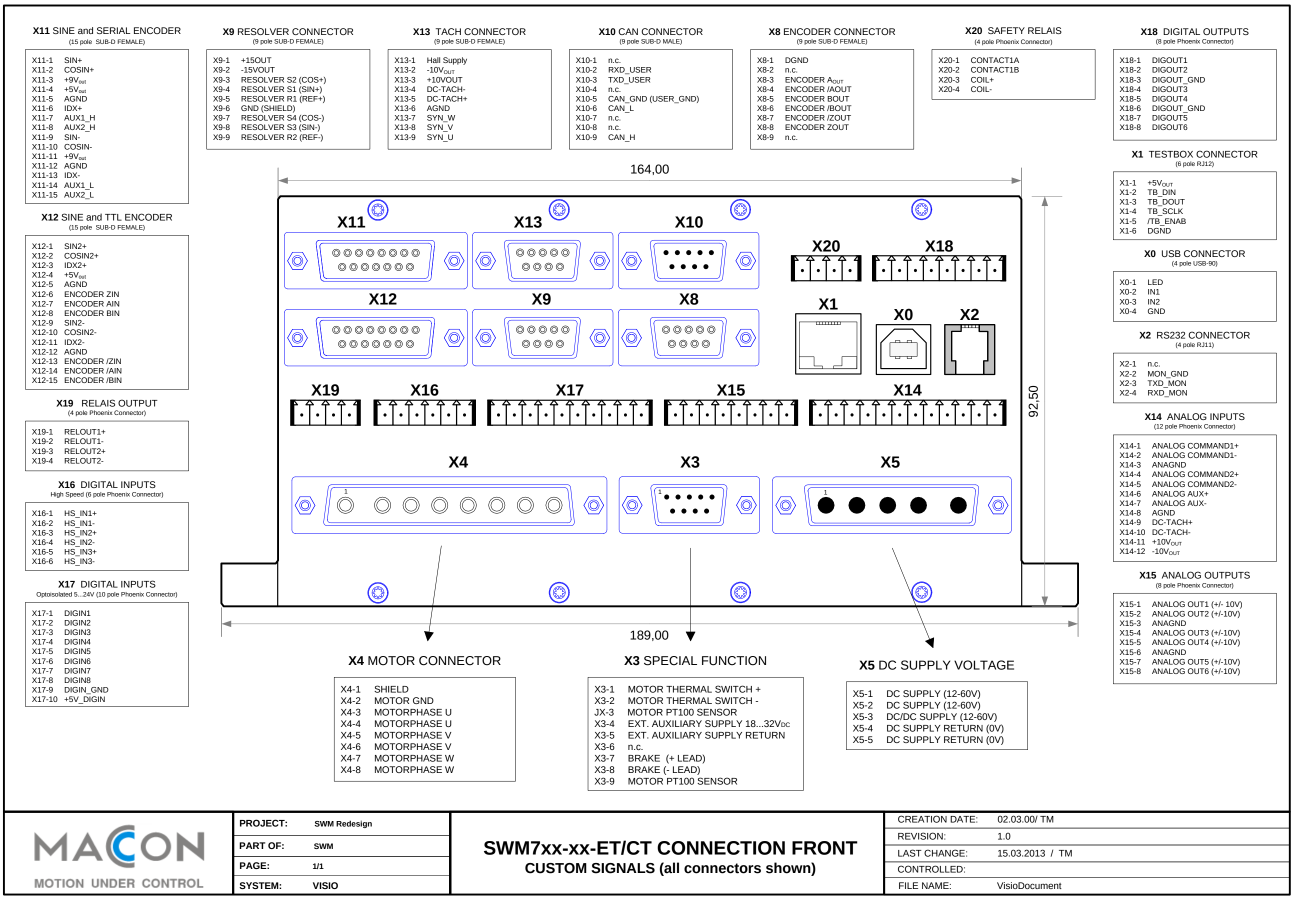
### 2.1.1 SWM7S

This overview shows all connections of a standard SWM7S module.



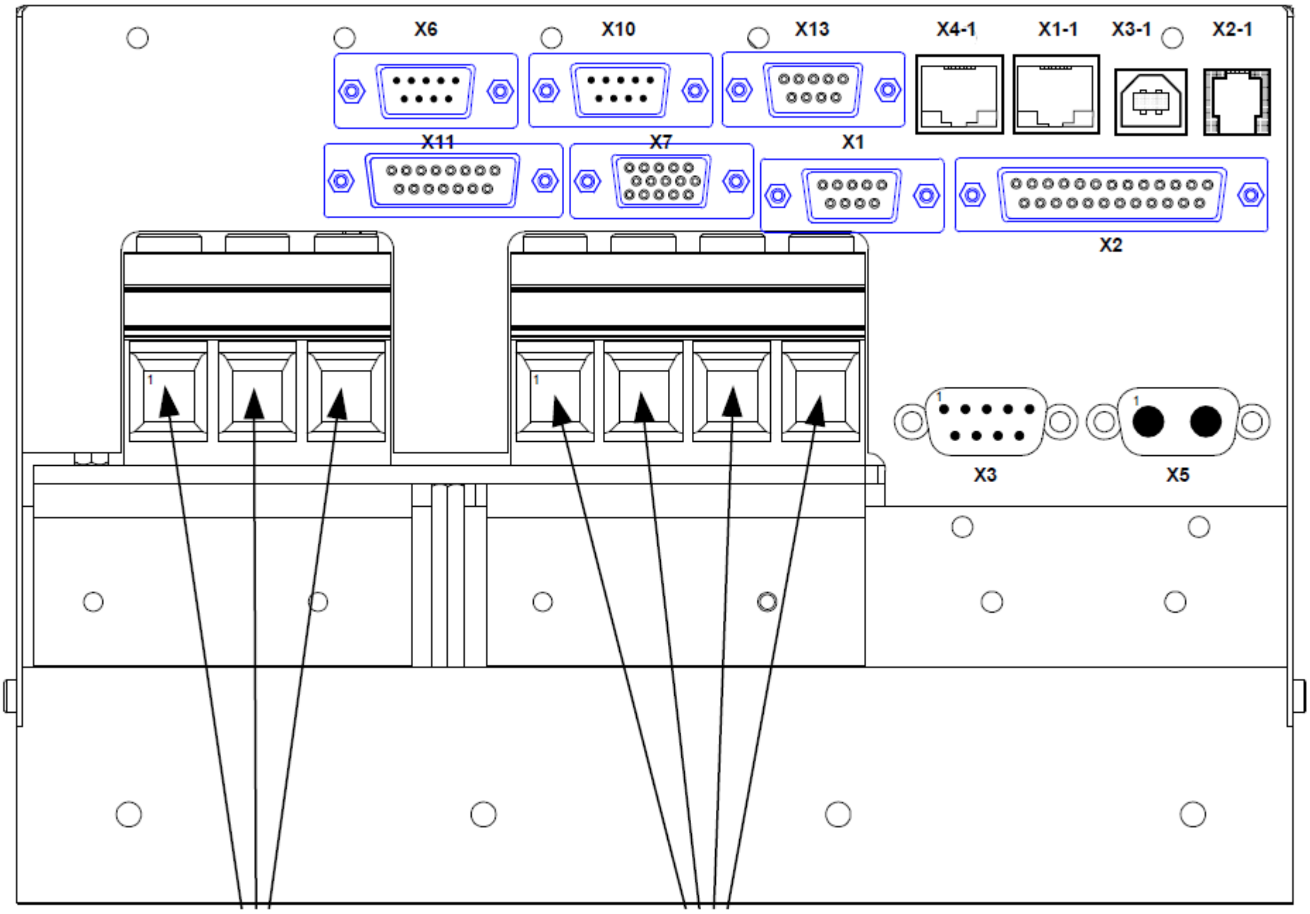
### 2.1.2 SWM7 with extended I/O

For customer specific features, additional project documentation can be applicable.



### 2.1.3 SWM7S-300 / 600

This drawing shows the high power connectors of the SWM7S-300 and SWM7S-600 Versions.
For data connector assignment, refer to chapter 2.1.1




**POWER CONNECTIONS**
(3 CONNECTIONS)

| | |
|---|---|
| 1 | DC Supply Return |
| 2 | DC Supply |
| 3 | PE |

**MOTOR CONNECTIONS**
(4 CONNECTIONS)

| | |
|---|---|
| 1 | Motor Ground |
| 2 | Motor Phase U |
| 3 | Motor Phase V |
| 4 | Motor Phase W |

**X5** DC SUPPLY VOLTAGE
(2pol SUB-D H MALE)

| | |
|---|---|
| X5-1 | DC/DC SUPPLY (24V) |
| X5-2 | DC/DC SUPPLY RETURN (0V) |

## 2.1.5 LWM7S

**X6** ENCODER CONNECTOR
(9 pole SUB-D MALE)

| | |
|---|---|
| X6-1 | DGND |
| X6-2 | $+5V_{OUT}$ |
| X6-3 | ENCODER AIN |
| X6-4 | ENCODER /AIN |
| X6-5 | ENCODER BIN |
| X6-6 | ENCODER /BIN |
| X6-7 | ENCODER /ZIN |
| X6-8 | ENCODER ZIN |
| X6-9 | n.c. |

**X1** RESOLVER CONNECTOR
(9 pole SUB-D FEMALE)

| | |
|---|---|
| X1-1 | $+15V_{OUT}$ |
| X1-2 | $-15V_{OUT}$ |
| X1-3 | RESOLVER S2 (COS+) |
| X1-4 | RESOLVER S1 (SIN+) |
| X1-5 | RESOLVER R1 (REF+) |
| X1-6 | GND (SHIELD) |
| X1-7 | RESOLVER S4 (COS-) |
| X1-8 | RESOLVER S3 (SIN-) |
| X1-9 | RESOLVER R2 (REF-) |

**X13** TACH CONNECTOR
(9 pole SUB-D FEMALE)

| | |
|---|---|
| X13-1 | Hall Supply |
| X13-2 | $+15V_{OUT}$ |
| X13-3 | $+5V_{OUT}$ |
| X13-4 | DC-TACH- |
| X13-5 | DC-TACH+ |
| X13-6 | AGND |
| X13-7 | SYN_W |
| X13-8 | SYN_V |
| X13-9 | SYN_U |

**X10** CAN CONNECTOR
(9 pole SUB-D MALE)

| | |
|---|---|
| X10-1 | n.c. |
| X10-2 | CAN_L |
| X10-3 | CAN_GND (USER_GND) |
| X10-4 | TXD_USER |
| X10-5 | RXD_USER. |
| X10-6 | n.c |
| X10-7 | CAN_H |
| X10-8 | n.c. |
| X10-9 | n.c. |

**X4-1** ETHERNET CONNECTOR
(8 pole RJ45)

| | |
|---|---|
| X4-1 | TX D1+ |
| X4-2 | TX D1- |
| X4-3 | RX D2+ |
| X4-4 | n.c. |
| X4-5 | n.c. |
| X4-6 | RX D2- |
| X4-7 | n.c. |
| X4-8 | n.c. |

**X1-1** TESTBOX CONNECTOR
(6 pole RJ12)

| | |
|---|---|
| X1-1 | $+5V_{OUT}$ |
| X1-2 | TB_DIN |
| X1-3 | TB_DOUT |
| X1-4 | TB_SCLK |
| X1-5 | /TB_ENAB |
| X1-6 | DGND |

**X3-1** USB CONNECTOR
(4 pole USB-90)

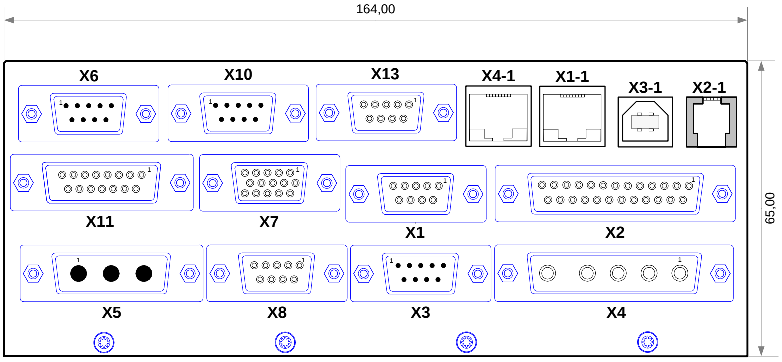
| | |
|---|---|
| X3-1 | LED |
| X3-2 | DATA- |
| X3-3 | DATA+ |
| X3-4 | GND |

**X2-1** RS232 CONNECTOR
(4 pole RJ11)

| | |
|---|---|
| X2-1 | n.c. |
| X2-2 | MON_GND |
| X2-3 | TXD_MON |
| X2-4 | RXD_MON |

**X7** OPTOISOLATED I/O PORT
(15 pole HD SUB-D FEMALE)

| | |
|---|---|
| X7-1 | DIGIN_GND/ DIGOUT_GND |
| X7-2 | + 5V_DIGIN |
| X7-3 | DIGIN3 |
| X7-4 | DIGIN4 |
| X7-5 | DIGIN5 |
| X7-6 | + 5V_DIGOUT |
| X7-7 | DIGOUT4 |
| X7-8 | DIGOUT5 |
| X7-9 | DIGOUT6 |
| X7-10 | HS_IN1+ |
| X7-11 | HS_IN1- |
| X7-12 | RELOUT1+ |
| X7-13 | RELOUT1- |
| X7-14 | RELOUT2+ |
| X7-15 | RELOUT2- |




**X11** SINE and SERIAL ENCODER
(15 pole SUB-D FEMALE)

| | |
|---|---|
| X11-1 | SIN+ |
| X11-2 | COSIN+ |
| X11-3 | IDX+ |
| X11-4 | $+5V_{OUT}$ |
| X11-5 | DGND |
| X11-6 | $+9V_{OUT}$ |
| X11-7 | AUX1_H |
| X11-8 | AUX2_H |
| X11-9 | SIN- |
| X11-10 | COSIN- |
| X11-11 | IDX- |
| X11-12 | AGND |
| X11-13 | AGND |
| X11-14 | AUX1_L |
| X11-15 | AUX2_L |

**X2** SIGNAL CONNECTOR
(25 pole SUB-D FEMALE)

| | |
|---|---|
| X2-1 | AGND |
| X2-2 | $+5V_{OUT}$ |
| X2-3 | ENCODER $A_{OUT}$ |
| X2-4 | ENCODER $/A_{OUT}$ |
| X2-5 | ENCODER $B_{OUT}$ |
| X2-6 | ENCODER $/B_{OUT}$ |
| X2-7 | ENCODER $/Z_{OUT}$ |
| X2-8 | ENCODER $Z_{OUT}$ |
| X2-9 | DIGOUT1 (ERROR CODE F0) |
| X2-10 | DIGOUT2 (ERROR CODE F1) |
| X2-11 | DIGOUT3 (ERROR CODE F2) |
| X2-12 | DGND |
| X2-13 | DIGIN1 (/1:1 CURRENT CONTROL) |
| X2-14 | DIGIN_GND/ DIGOUT_GND |
| X2-15 | DIGIN2 (/ENABLE) |
| X2-16 | ANALOG COMMAND 1 IN (+/- 10V) |
| X2-17 | AGND |
| X2-18 | ANALOG COMMAND 1 IN RETURN |
| X2-19 | $+15V_{DC}$ OUTPUT |
| X2-20 | $-15V_{DC}$ OUTPUT |
| X2-21 | ANALOG COMMAND 2 IN (+/- 10V) |
| X2-22 | ANALOG COMMAND 2 IN RETURN |
| X2-23 | ANALOG OUT1 (+/- 10V) |
| X2-24 | ANALOG OUT2 (+/- 10V) |
| X2-25 | ANALOG OUT3 (+/- 10V) |

**X5** DC SUPPLY VOLTAGE
(3 pole HS MALE)

| | |
|---|---|
| X5-1 | DC SUPPLY (10-60V) |
| X5-2 | DC/DC SUPPLY (12-60V) |
| X5-3 | SUPPLY RETURN |

**X8** AUXILIARY SUPPLY
(9 pole SUB-D FEMALE)
(not used if internal DC/DC converter is activated)

| | |
|---|---|
| X8-1 | $+ 5V_{DC}$ AUXILIARY SUPPLY |
| X8-2 | $+ 5V_{DC}$ AUXILIARY SUPPLY |
| X8-3 | $+15V_{DC}$ AUXILIARY SUPPLY |
| X8-4 | $+15V_{DC}$ AUXILIARY SUPPLY |
| X8-5 | GND |
| X8-6 | $-15V_{DC}$ AUXILIARY SUPPLY |
| X8-7 | $-15V_{DC}$ AUXILIARY SUPPLY |
| X8-8 | GND |
| X8-9 | GND |

**X3** SPECIAL FUNCTION
(9 pole SUB-D MALE)

| | |
|---|---|
| X3-1 | MOTOR THERMAL SWITCH + |
| X3-2 | MOTOR THERMAL SWITCH - |
| X3-3 | n.c. |
| X3-4 | EXT. AUXILIARY SUPPLY 18...$32V_{DC}$ |
| X3-5 | EXT. AUXILIARY SUPPLY RETURN |
| X3-6 | n.c. |
| X3-7 | BRAKE (+ LEAD) |
| X3-8 | BRAKE (- LEAD) |
| X3-9 | n.c. |

**X4** MOTOR CONNECTOR
(5 pole HS FEMALE)

| | |
|---|---|
| X4-1 | SHIELD |
| X4-2 | MOTOR GND |
| X4-3 | MOTORPHASE U |
| X4-4 | MOTORPHASE V |
| X4-5 | MOTORPHASE W |

MACCON
MOTION UNDER CONTROL

| | |
|---|---|
| PROJECT: | LWM Redesign |
| PART OF: | LWM |
| PAGE: | 1/1 |
| SYSTEM: | VISIO |

**LWM7S-48-xx-CT CONNECTION FRONT**
**CUSTOM SIGNALS (all connectors shown)**

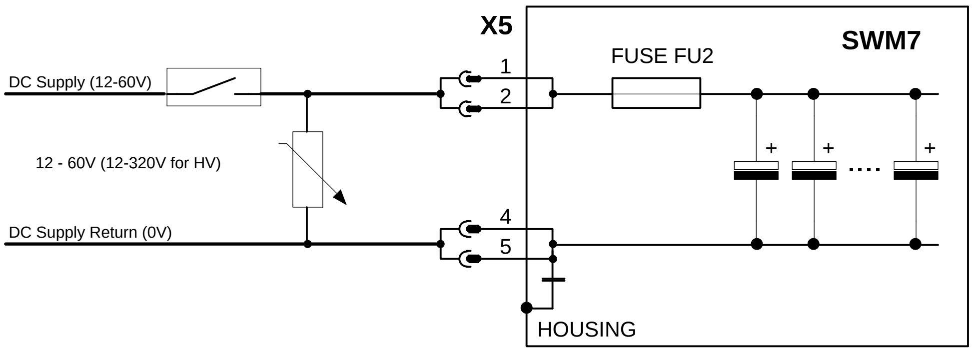
| | |
|---|---|
| CREATION DATE: | 09.02.2012 / KM |
| REVISION: | 1.0 |
| LAST CHANGE: | / |
| CONTROLLED: | |
| FILE NAME: | VisioDocument |

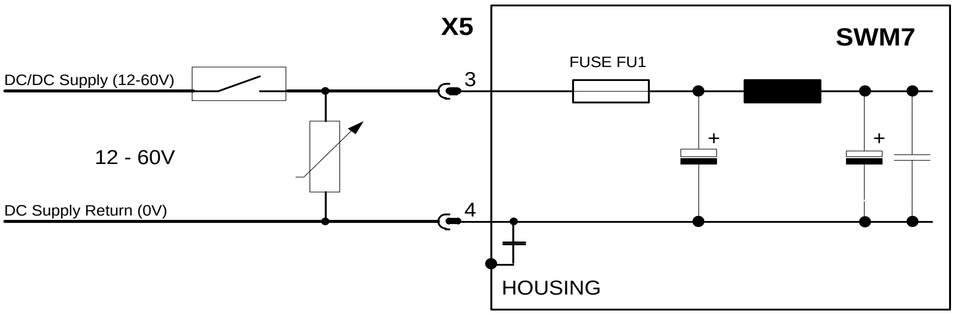
## 2.2 Power and motor connectors

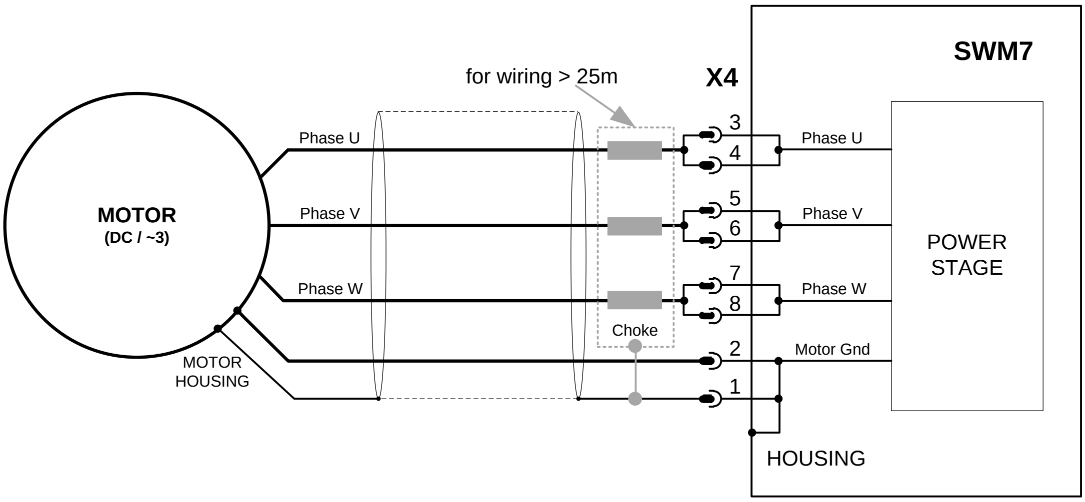
The device uses two DC power supplies:
- DC/DC control supply for all functions of the control board
- DC power input for motor power supply

Make sure your type of power supply offers sufficient capabilities to deal with regenerative voltage, depending on deceleration profile, inertia and friction conditions. Contact Maccon to clarify if a PSU power supply unit is needed for your installation.

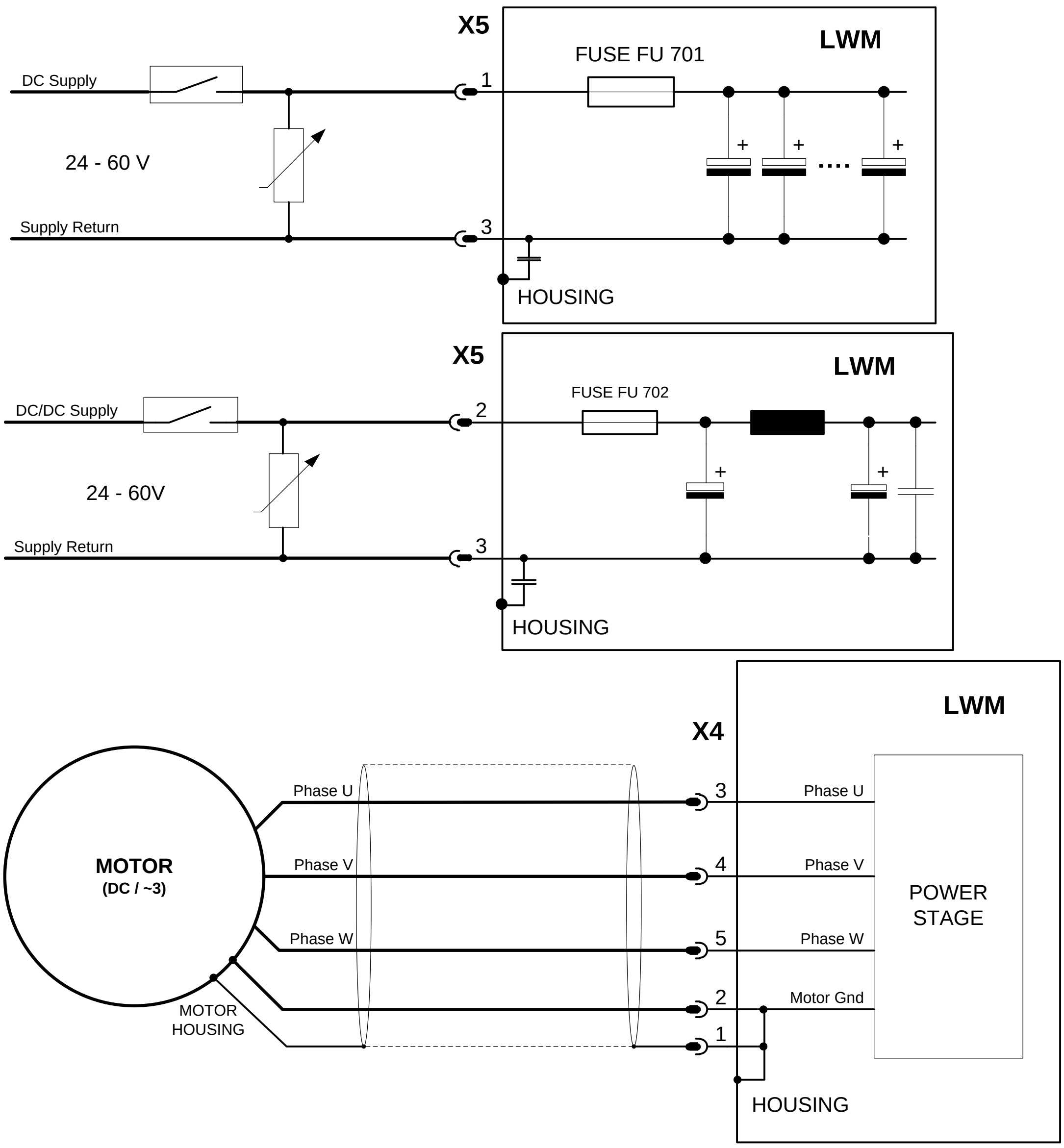
### 2.2.1 DC supply and motor connection for SWM7(S) -048 / -150



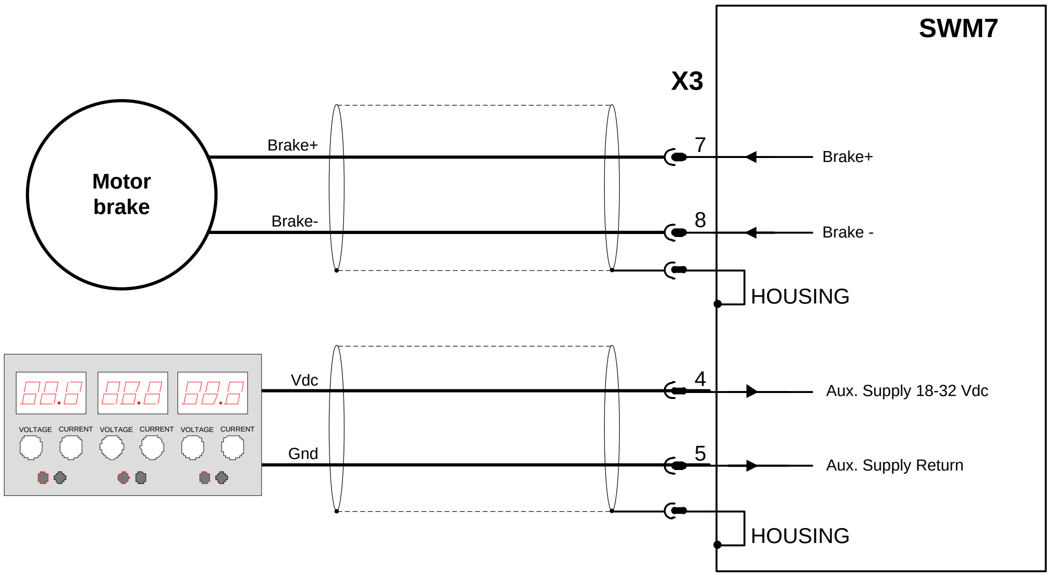
### 2.2.2 DC supply and motor connection for LWM7



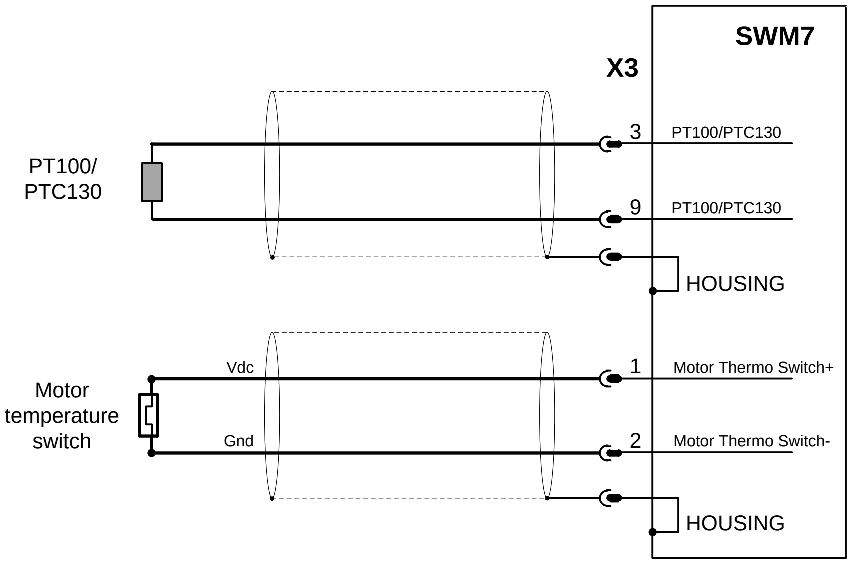
## 2.3 Brake and temperature sensors

### 2.3.1 Brake connection

For the use of a holding brake, an external auxiliary supply according to the brake voltage has to be provided.

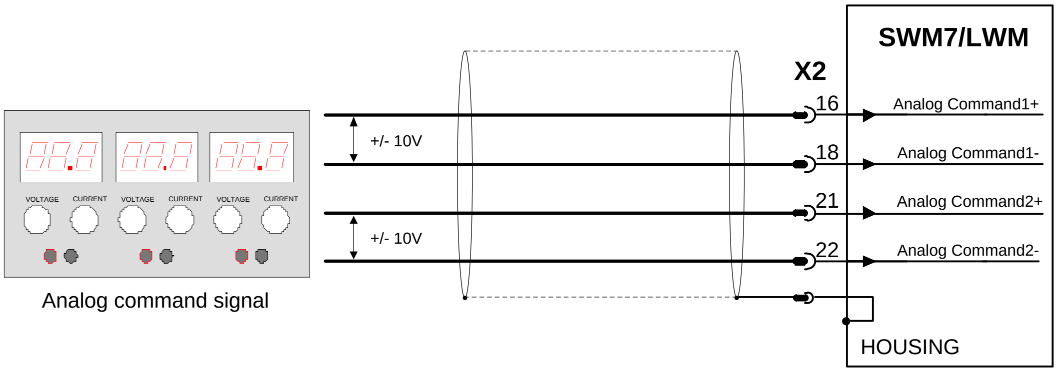



### 2.3.2 Temperature sensors



## 2.4 Analog command interface

Analog signals of +/- 10 Volts can be used to control current or speed setpoints.



## 2.5 Feedback systems

Every closed loop servo system will normally require at least one feedback device for sending actual values from the motor to the servo drive. Depending on the type of feedback device used, information will be fed back to the servo amplifier using digital or analog means.

The servo amplifier of the SWM/LWM7 family provides interfaces for all common sensors on the market.

The amplifiers are equipped with a highly dynamic current loop with a superposed speed and position controller by default.

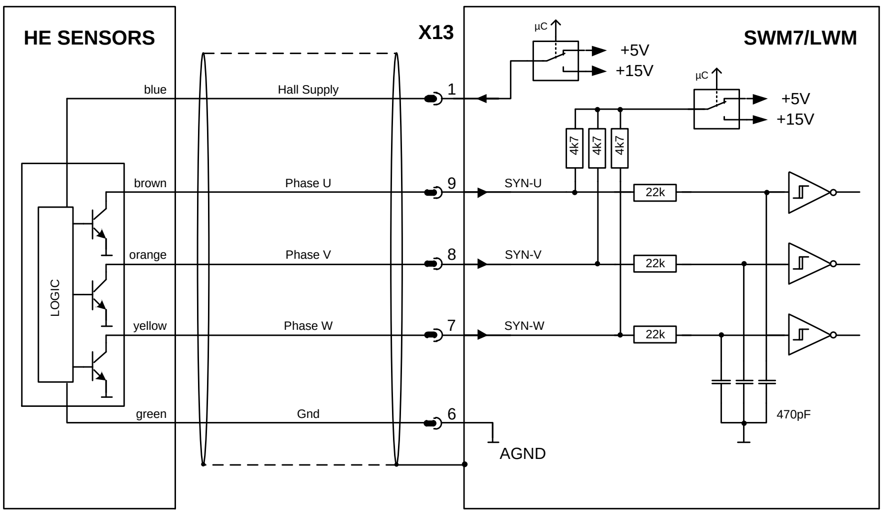
To close the current loop for electrical commutated servo motors (DC3) a commutation sensor is necessary. In addition, a speed sensor to close the speed control loop for all servo motors must be employed.

With the usage of a brush-type DC motor there is no need for a commutation sensor.

### 2.5.1 Hall sensors

The most simple feedback to support the commutation of a DC-brushless (DC3) are three Hall-effect sensors (HE). The phase current generated with help of this sensor is block current.

A special feature of the SWM/LWM-servo controller is the capability of activating a special prediction algorithm, which enables sine-wave current commutation with the sole support of digital HE-sensors. Above a fixed minimum speed of 1 Hz (commutation frequency) the servo controller can automatically generate sine-wave currents (with „Sine with Hall Sensor“ activated, instead of block). The motor controller "follows" the rotation of the motor shaft between HE-switching edges with the help of an internal observer in the firmware of the controller. For a 12-pole motor the switch-over threshold to "quasi-sine" operation is 10rpm.



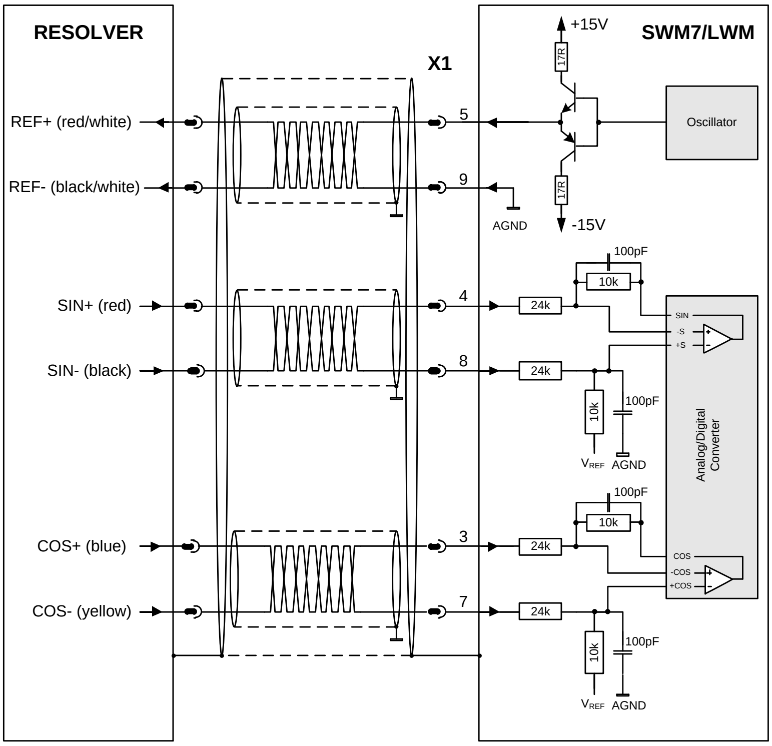
### 2.5.2 Resolver

The resolver is now accepted as the most robust commutation and position feedback device to support DC-brushless motors. The SWM/LWM servo controller allows for the use of a 2 or multi-pole resolver. The maximum achievable resolution with a resolver is 16 Bit. A 2-pole resolver (1 electrical cycle per revolution) can deliver a position resolution of:

360° / 65.536 = 0,0055° (≅0,33` arc minutes)

Due to the limited „Tracking Rate“ of the Resolver/Digital converter used, the maximum achievable position resolution depends on the maximum speed. The limits are (valid for a 2-pole resolver):

- *16 Bit for < 1.000rpm*
- *14 Bit for < 4.000rpm*
- *12 Bit for <16.000rpm*
- *10 Bit for <64.000rpm*



### 2.5.3 TTL Encoder (general)

Many motor manufacturers supply servo motors with optical encoders with TTL-in puts. Depending on the application encoders with low (500...1000 lines) or higher (up to 18,000 lines) resolution may be used.

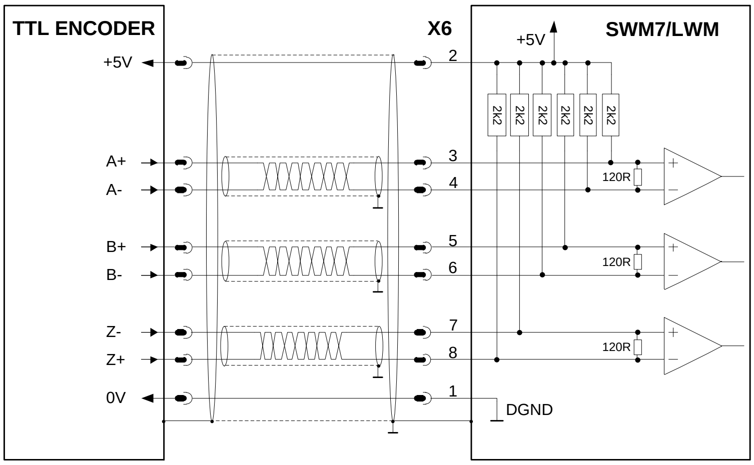
Depending of the type of TTL incremental encoder the SWM/LWM servo controller allows connection of either differential or unipolar encoder signals.

The maximum permissible input frequency is 1MHz (4MHz edge frequency). The maximum permissible velocity is thus

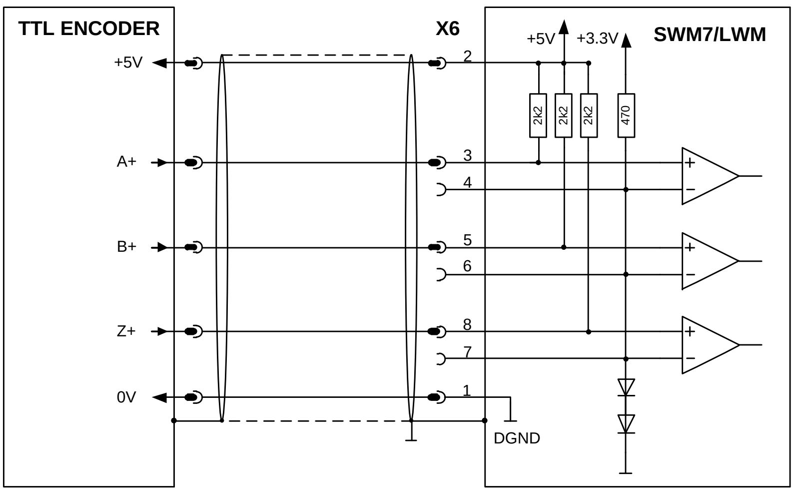
10^6 * 60 / Resolution

For an encoder with 5,000 lines per revolution the motor can be operated up to a speed of 12.000 rpm.

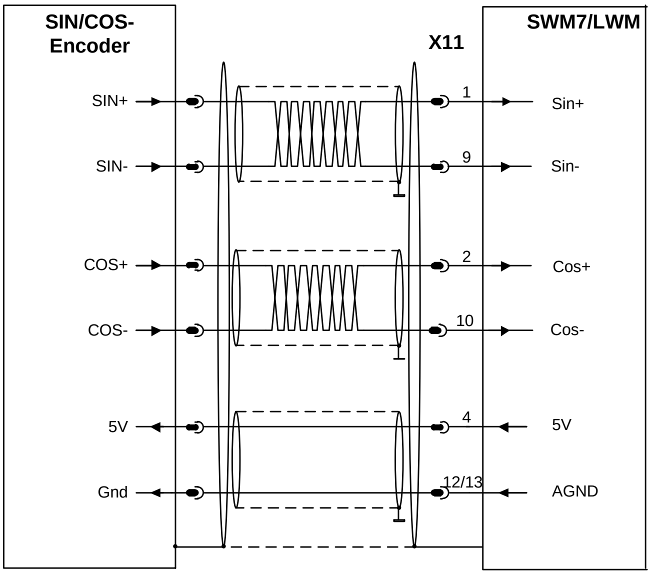
### 2.5.4 TTL Encoder (bipolar wiring)



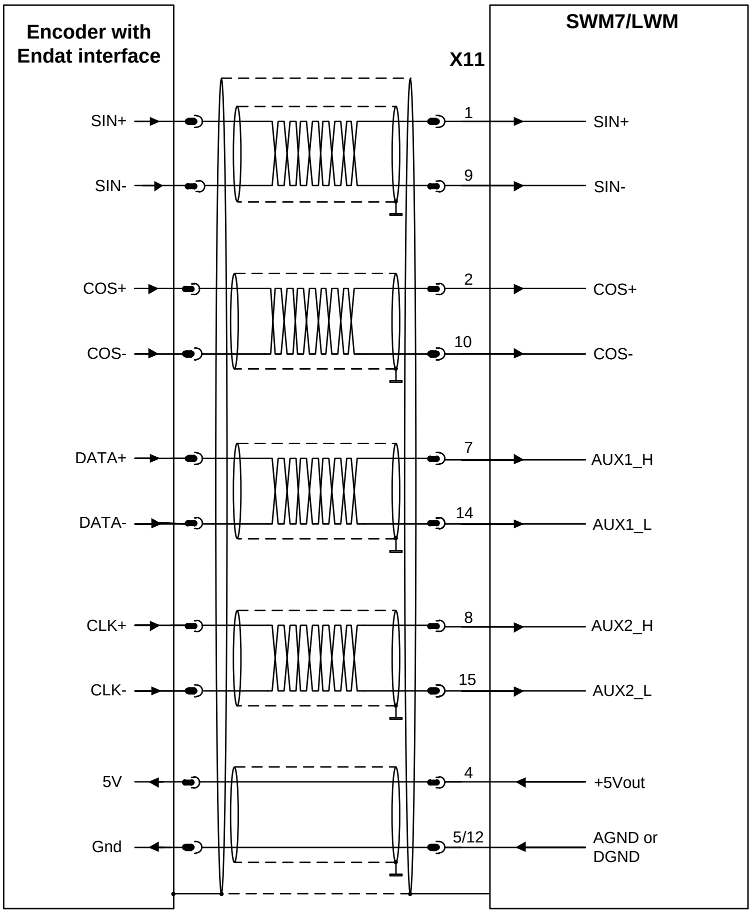

### 2.5.5 TTL Encoder (unipolar wiring)



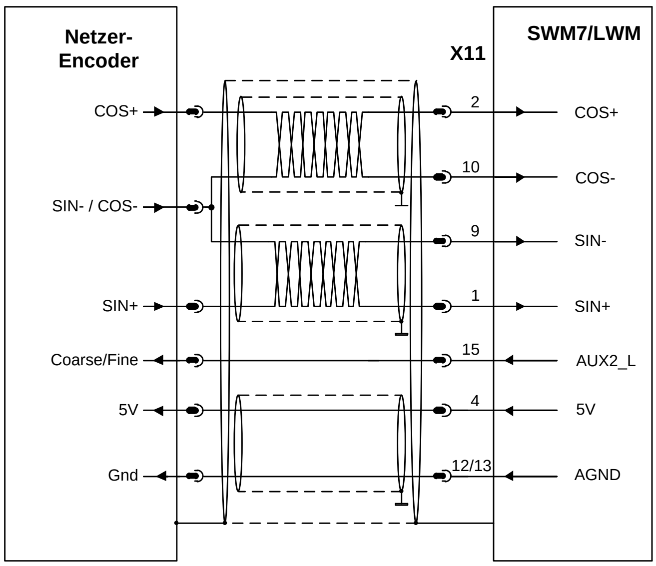
### 2.5.6 Sin/Cos Encoder




### 2.5.7 Sine Encoder with EnDat 2.2



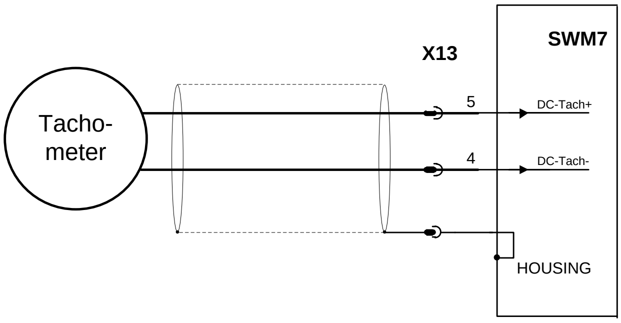
### 2.5.8 Netzer Encoder



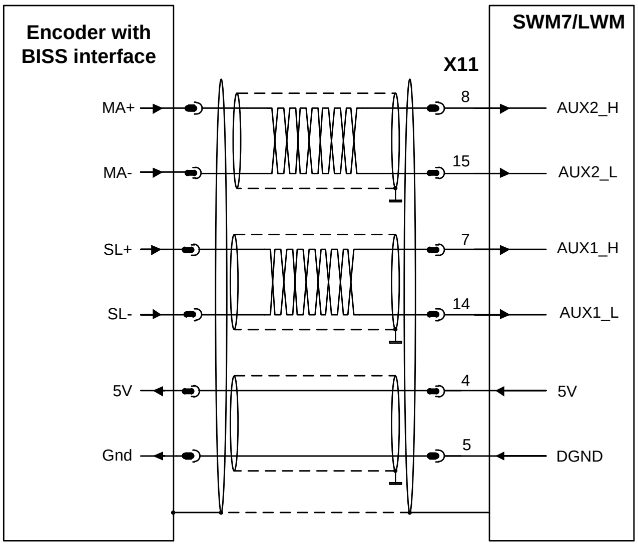

### 2.5.9 DC Tacho

The DC-Tachometer input is normalised for +/-10V max. voltage input. The controller may be adapted to the signal level of the DC tacho by changing internal resistor values.

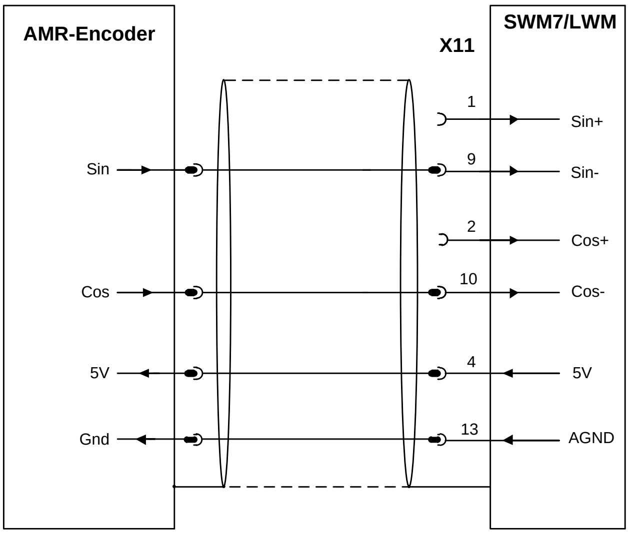
Details can be provided on request.



## 2.5.10 BiSS Encoder




## 2.5.11 AMR Encoder

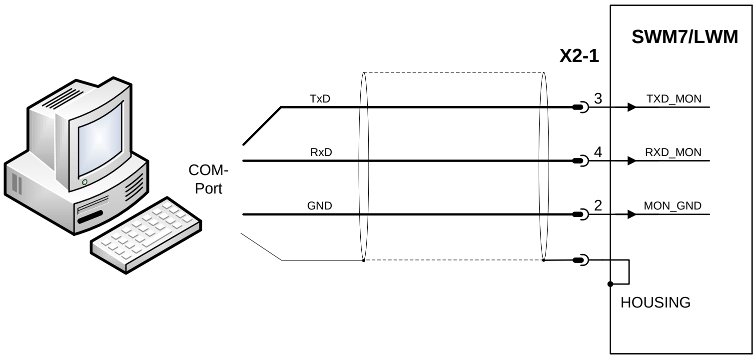


# 2.6 Communication

## 2.6.1 RS-232

Operating, position control, and motion-block parameters can be set up by using the setup software on an ordinary commercial PC. Connect the PC interface (X2) of the servo amplifier to a serial interface on the PC, while the supply to the equipment is switched off. This interface is galvanically isolated. The serial cable is included in the shipping of the drive system.

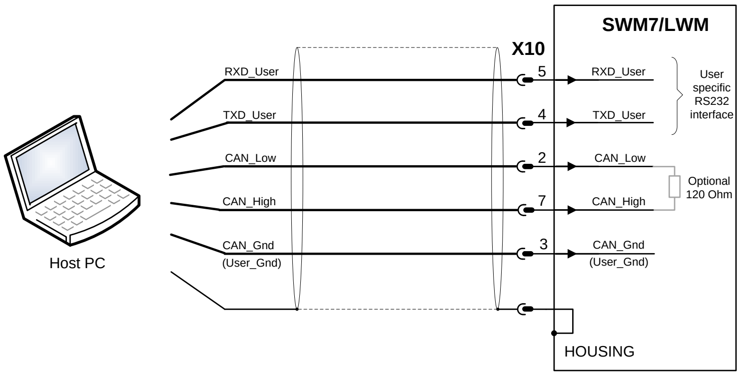
For installation and use of PC Setup Tool, see chapter 3




## 2.6.2 CAN

The baud rate of the interface for connection to the CAN bus is configurable. The integrated CAN communication profiles are customer specific or Maccon standard. If applicable, refer to your specific ducomentation.

The CAN-GND is isolated from other grounds and is the same for the second serial interface (UserTXD/RXD). The analog setpoint inputs can still be used.




## 2.6.3 Ethernet / USB ports

Reserved for customer specific use, depending on firmware
Refer to separate documentation if applicable.

# 3 Setup tool and serial link to PC

Your actual version of SWM7 Setup Tool (SWM7.exe) will work as a single file without installation procedure. The software can be operated directly out of your working directory.

There are two file types related with SWM7 software:
**MAC files: list of parameters and corresponding setup window sections**

A .MAC file provides SWM7 software with information about valid drive parameters. It also contains the setup window assembly which can be adapted by the user.

On software startup, the last used MAC file is loaded.

“File” → “Open” and “Save” are related to MAC files.

**MACP files: customer parameter values**

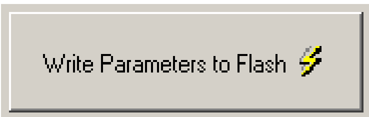
The .MACP parameter files contain the parameter set for a certain drive setup.
“File” → “Load Parameters” and “Save Parameters” are related to MACP files.

The connection between PC and SWM7 device is established via RS232 link to X2 connector.

The matching cable is delivered with your device.
The COM port to be used can be defined in the “Settings” menu.

## 3.1 Loading / Saving a Parameter Set

An existing parameter set can be opened using “File” → “Load Parameters”. Parameters are downloaded automatically to the SWM and have immediate effect.

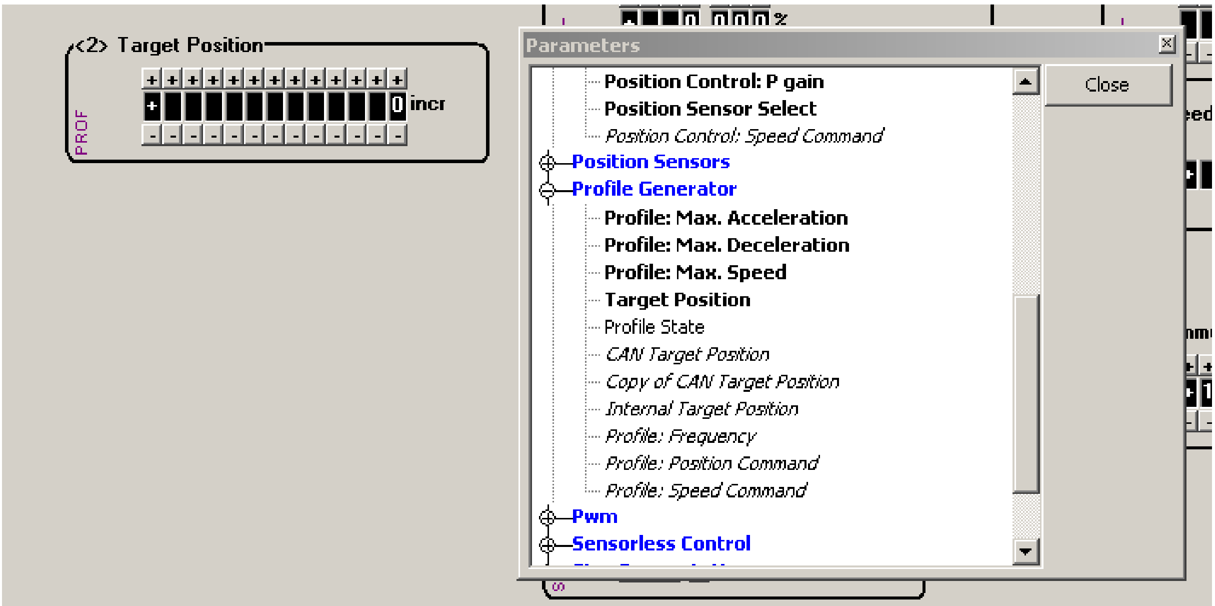



All parameter changes are discarded at power-off unless saved to flash using the “write-to-flash” button. (bottom right)

As the parameters in the setup tool are always up-to-date when connected to a device, no upload is necessary before saving to disk. (“File” → “Save Parameters as”).

## 3.2 Adding parameters to a section

The menu item “Parameters” opens a window which allows selecting additional parameters for display. Simply move the desired parameter to the certain setup page by drag-and-drop.
Parameters can be used simultaneously in several sections of the setup software.

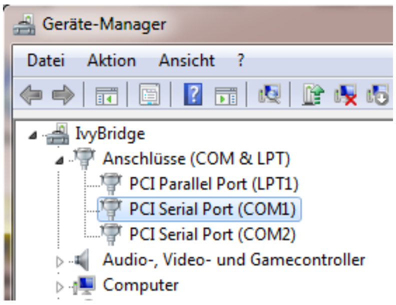



## 3.3 Handling of RS-232 communication errors

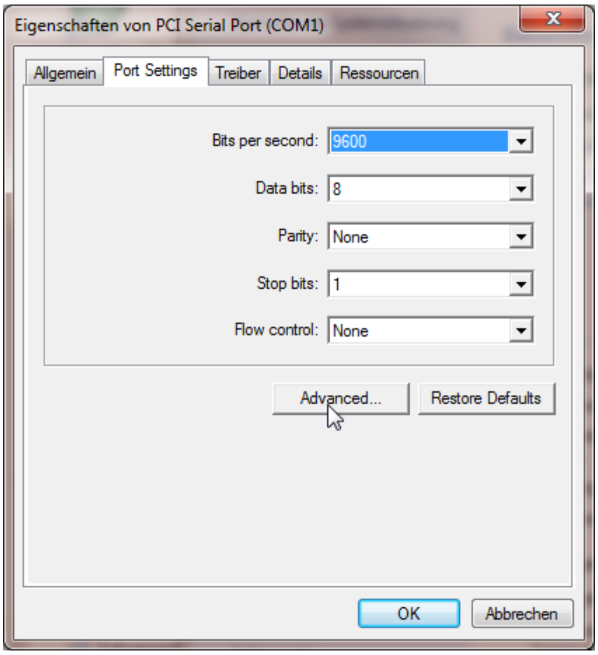
If you experience warning messages of type “COM Error 0x02” in the status line of SWM7.exe, it is necessary to change the serial port setting.

(This applies to communication chips of type 16C550)

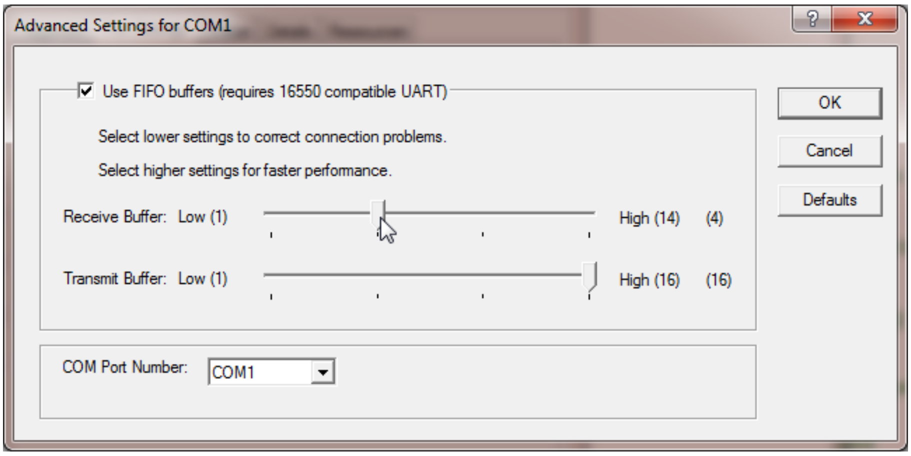
1. Open the Windows device manager




2. Display the properties of the COM port used




3. Click „Advanced“




4. Reduce settings for **receive buffer** to **(4)**
5. Click “OK” 3 times to close all device manager windows
6. <u>Restart Windows</u> to make these changes become effective

Now the warnings should not show up anymore.

# 4 Parameter Sections

All shown examples are based on a certain device and firmware version. Differences may occur depending on your specific drive system.

## 4.1 System Setup

This part specifies the basic description for the used motor type.

### 4.1.1 Phase Count

2-phase: for brushed motors
3-phase: for brushless motors

### 4.1.2 Motor Type

Select rotary or linear motor

### 4.1.3 Motor temp sensor type

A fault message and controller turn-off result at 130°C when either of these sensors is present.

### 4.1.4 Motor Inductance

Enter the value according to your motor data sheet.
The inductance measured between two motor phases has to be divided by 2.

### 4.1.5 Back EMF Const

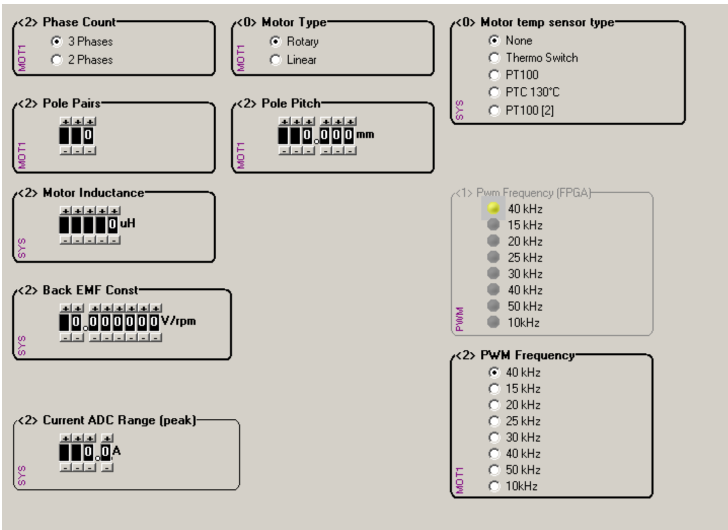
Enter the value according to your motor data sheet.
The EMF value measured between two motor phases (RMS) has to be divided by SQRT(3)

### 4.1.6 Pole Pairs

Enter the value according to your motor data sheet (rotary motors only).

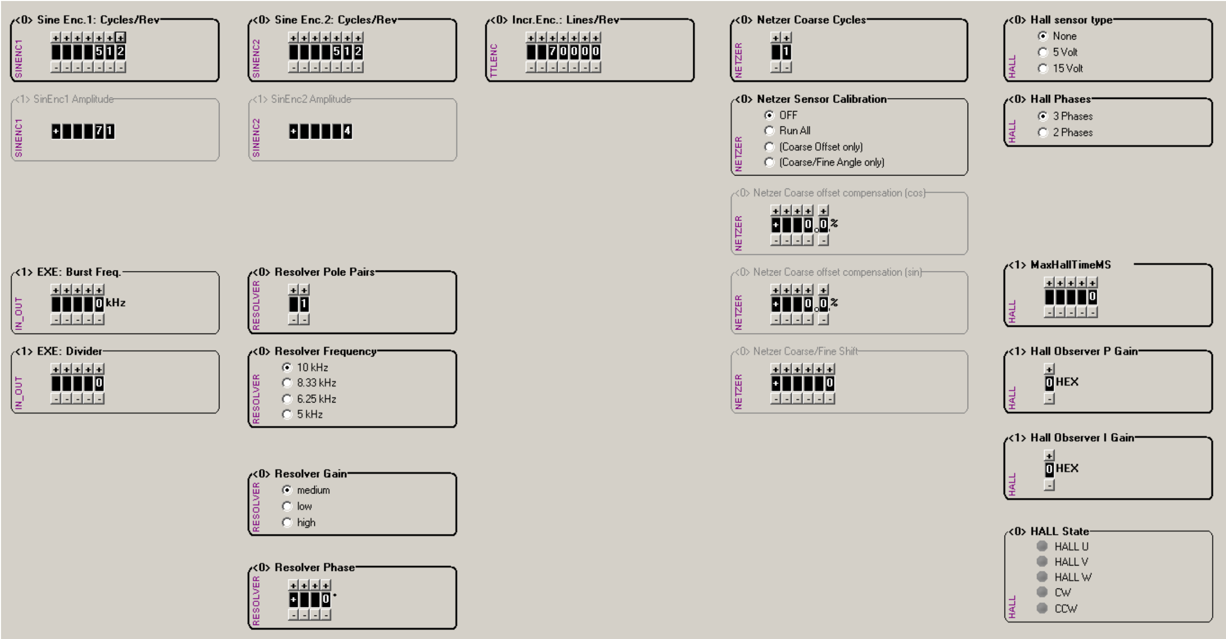
### 4.1.7 Pole Pitch

Enter the value according to your motor data sheet (linear motors only).



## 4.2 Motion Sensors

Enter all relevant data for your applicable feedback sensors.




### 4.2.1 Sine encoder(s) 1/2

Set up the Resolution in full sinusoidal cycles per revolution

### 4.2.2 Resolver

Set up the pole pair count, excitation frequency, gain and resolver phase according to motor/resolver data sheet

### 4.2.3 Incremental Encoder

Set up the encoder lines per revolution

### 4.2.4 Hall sensor

Set up the supply voltage and the number of phases

#### *4.2.4.1 Netzer capacitive sensor*

After setting coarse cycles, a calibration run can be performed. Please refer to additional documentation concerning this sensor type.

#### *4.2.4.2 EnDat sensor*

Refer to next chapter

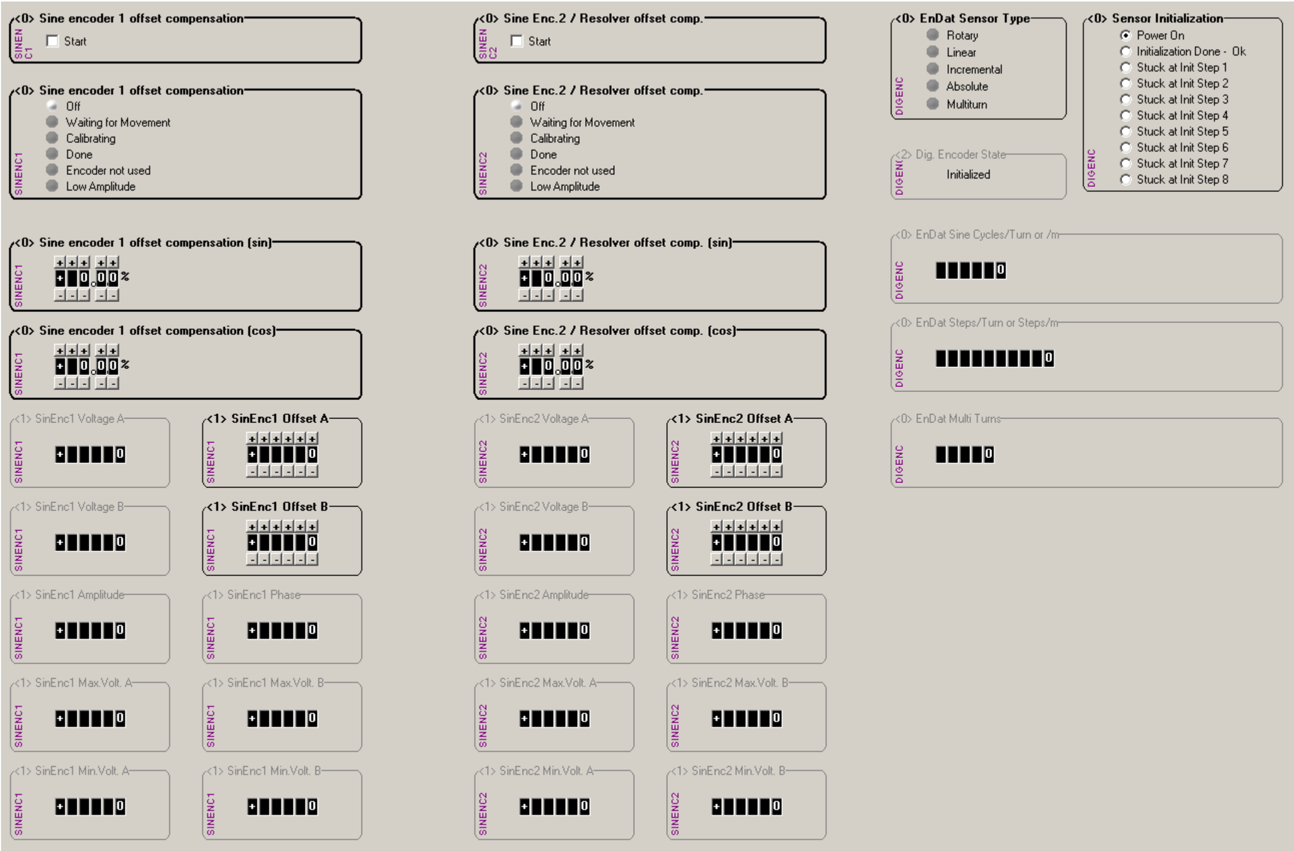
Additional settings and calibration methods can be found in the “Motion Sensor Monitoring” section.

## 4.3 Motion Sensor Monitoring

Different internal signals of certain feedback systems can be watched here.

For sinusoidal encoders, an automatic offset compensation routine is available. The compensation values can be adjusted manually.

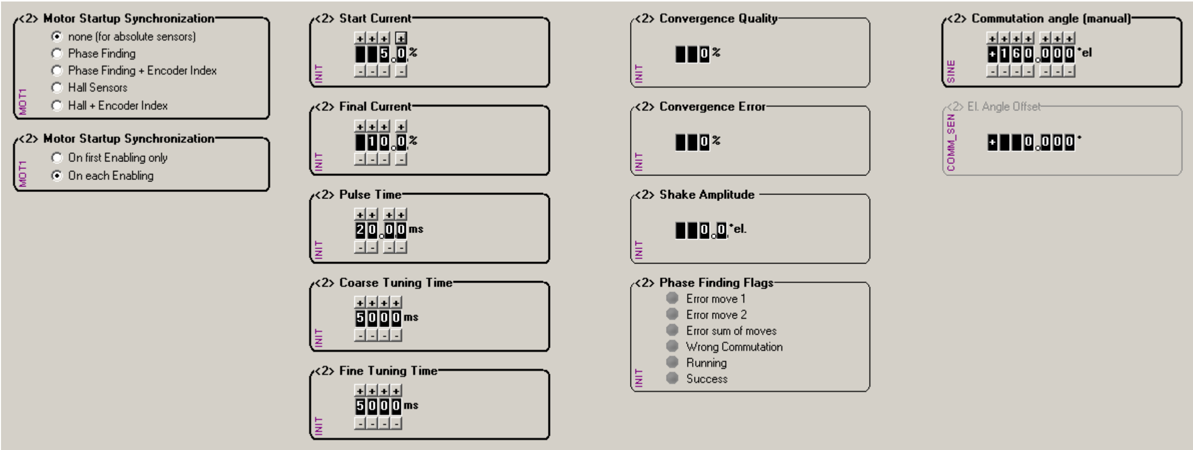
EnDat sensors can be initialized automatically.



## 4.4 Phase Finding

A phase finding cycle is necessary to determine the relation between the motor phases and the feedback signals.

For non-absolute feedback systems, phase finding is required after each power-up.




### 4.4.1 Motor Startup Synchronization

Choose “Phase Finding” when no hall sensors and no analog encoder are present.
After first enabling, the phase finding result can be used until power-off. The phase finding can anyway be performed on each enabling.
The parameters may be optimized to achieve a smoother or shorter phase finding cycle. If current values are too low or selected times are too short the convergence quality will get lower.
Phase finding should result in a quality level of more than 90%.

### 4.4.2 Start Current

Suggested start value: 5%

### 4.4.3 Final Current

Suggested start value: 10%

### 4.4.4 Pulse Time

Suggested start value: 10ms

### 4.4.5 Coarse Tuning Time

Suggested start value: 1000ms

### 4.4.6 Fine Tuning Time

Suggested start value: 1000ms

### 4.4.7 Phase Finding Flags

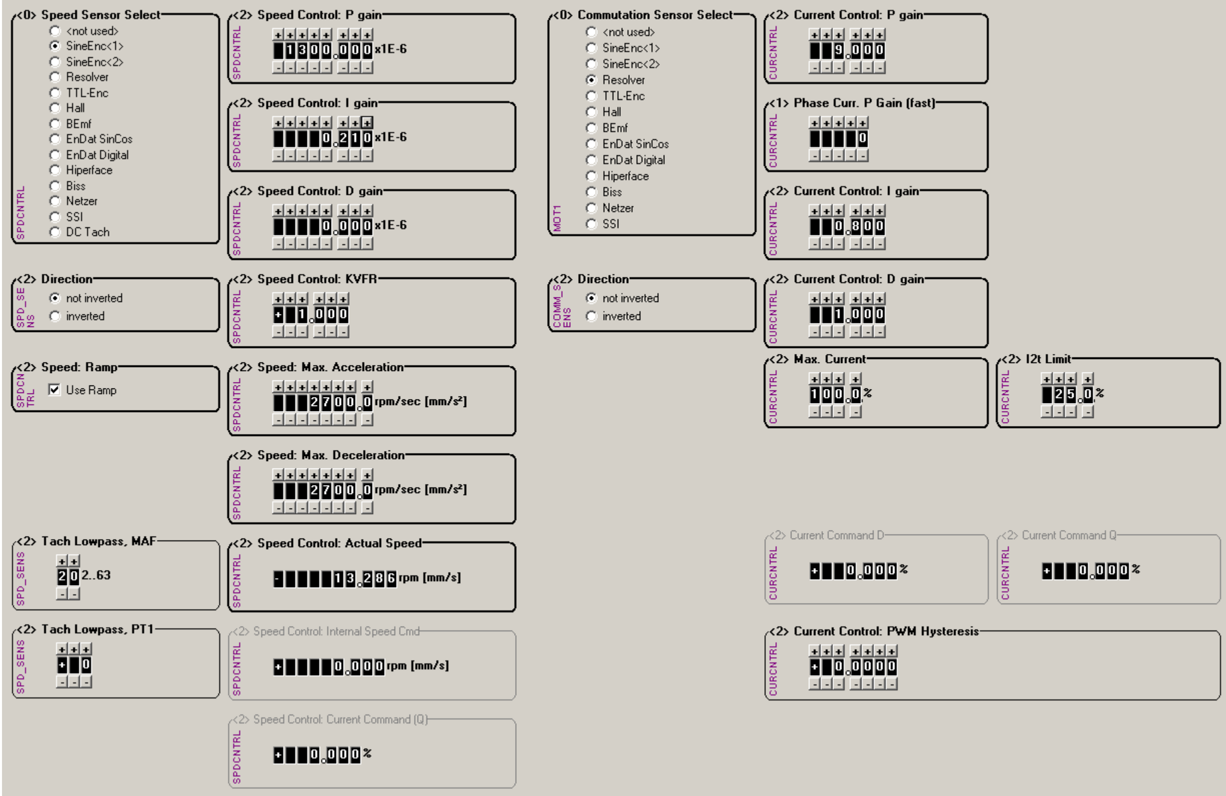
Shows the progress and result of the phase finding algorithm

### 4.4.8 Commutation angle

Is set by the phase finding algorithm and can be adjusted manually for special requirements.

## 4.5 Speed / Current Control

In this section the control parameters for current and speed loop are adjusted.




The current and speed loops can be optimized by monitoring the step response of the actual value to a rectangular setpoint function. The SWM7 Test Box can operate as a function generator.

### 4.5.1 Current loop

An optimum matching of the current controllers to the motor ensures good torque control and a good servo response. This also reduces losses in the motor.

The current loop is optimized by adjusting mainly the Current Control P and I gains.

#### *4.5.1.1 Current control P gain / I gain*

**Parameter identification by optimisation of current step response:**

This practical method of establishing current controller parameters by step-response optimisation of motor current involves the following steps:

- *Operate the motor in current control.*
- *Connect a signal generator to the command input (possibly using the Test box).*
- *Set frequency to around 100...500Hz, amplitude corresponding to 50...100% of mo tor current.*
- *Measure the current in a motor phase with a current probe or by using an analog output.*
- *View the commanded and the actual motor current on a 2-channel oscilloscope.*
- *Adjust the response of the actual motor current by changing the current controller parameters.*

Care should be taken that the motor shaft does not move. If necessary, increase signal frequency or reduce amplitude.

A good setup sequence to optimise the current control response is:

- *Set I-component of current controller to 0dB (nearly zero integral gain)*
- *Increase P-component of current controller gain until the current starts to oscillate*
- *Halve the value of the P-gain*
- *Again increase the I-component until the current begins to oscillate*
- *Halve this value of I-gain*
- *Store the optimum current controller values established in Flash memory.*

#### 4.5.1.2 Max. Current

provides a current limit for all operating modes based on the maximum current of the drive. Reduce this value to a level according to your motor.

#### 4.5.1.3 Commutation Sensor Select

defines the feedback system which is used for phase and current control. It may be the same as speed and position Sensor.

#### 4.5.1.4 I2t Limit

I2t monitoring limit for creating a warning / error

### 4.5.2 Speed loop

It is necessary to match the servo controller to the mechanics of the drive system in order to optimise performance in the velocity control mode.

#### 4.5.2.1 Speed control P gain / I gain

**Parameter identification by optimisation of velocity step response:**

This practical method of establishing controller parameters by step-response optimisation of mo tor velocity involves the following steps:

- *Motor is operated in the velocity control mode*
- *Connect a frequency generator to the control input (possibly using test box)*
- *Adjust frequency to around 0,5...10Hz*
- *Adjust the amplitude initially to around 10% of nominal velocity*
- *View the command and the actual motor velocities on a 2-channel oscilloscope (test box or analog output)*
- *Adjust motor velocity response by changing the velocity controller parameters*
- *Increase the amplitude of the command signal in stages to nominal*
- *Check and correct velocity control parameters, if necessary*
- *Store the established parameters in Flash*

#### 4.5.2.2 Speed Sensor Select

This setting defines the feedback system which is used for speed control loop.

#### 4.5.2.3 Speed: Max. Acceleration / Deceleration

specify the limits for speed profile operating mode.

#### 4.5.2.4 Speed: Ramp

If ramps are provided by the user setpoint signal, the internal ramps can be bypassed by this flag.

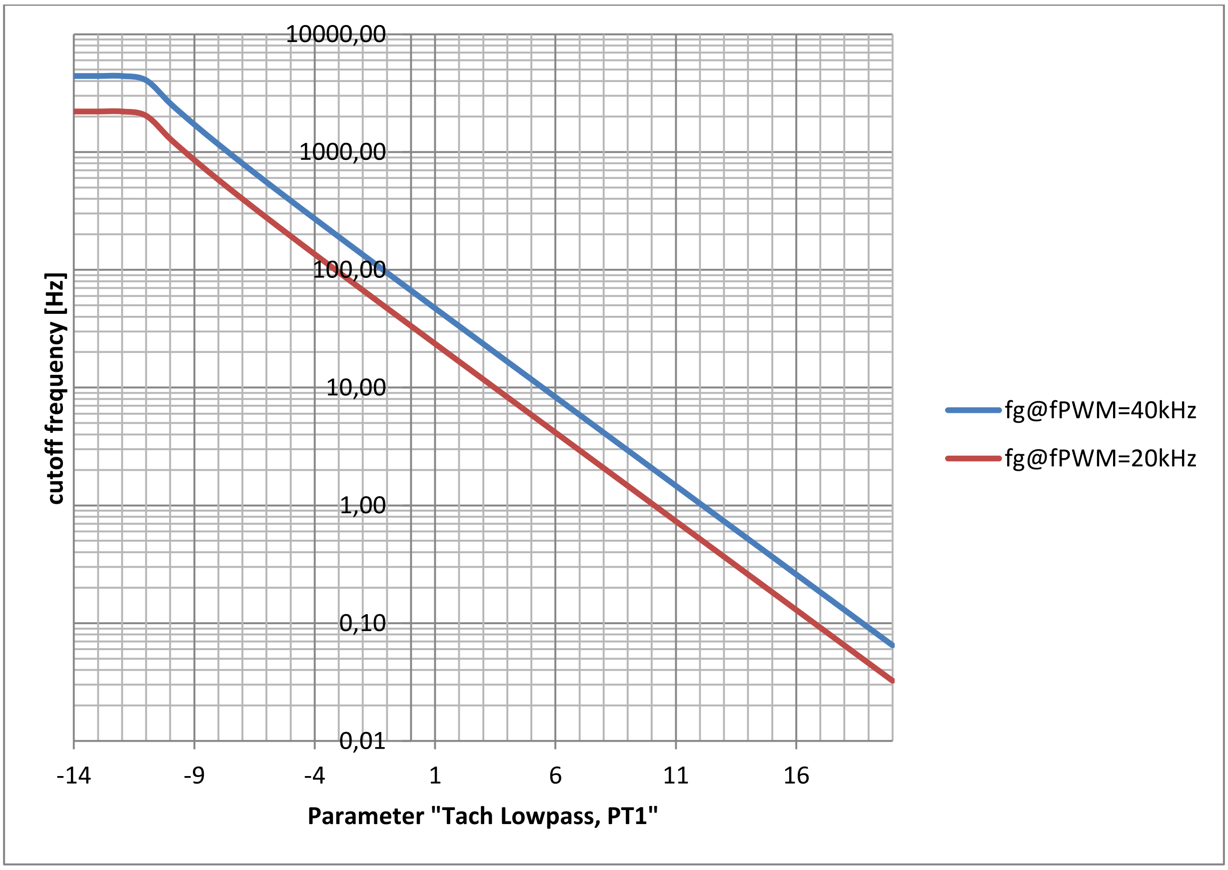
#### 4.5.2.5 Tach Lowpass, MAF

For resolver operation the lowpass has to be configured according to the following table:

| PWM frequency (kHz) → | | 15 | 20 | 25 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|---|
| | | **Lowest filter value, or a multiple** | | | | | |
| **Resolver frequency (kHz)** | **10** | 6 | 8 | 10 | 6 | 8 | 10 |
| | **8** | 15 | 10 | 25 | 15 | 10 | 25 |
| | **6,6666** | 18 | 24 | 30 | 18 | 24 | 30 |
| | **5** | 12 | 16 | 20 | 12 | 16 | 20 |

### *4.5.2.6 Tach Lowpass, PT1*

PT1 filter for smoothing the speed loop reaction



## 4.6 Position Control

This section contains all settings for position profile operating mode.

### 4.6.1 Position Control P Gain

The position control loop is mainly adjusted via this proportional gain

### 4.6.2 Position Control Feed Fwd

Additional control parameter for optimized response and low following error

### 4.6.3 Position Sensor Select

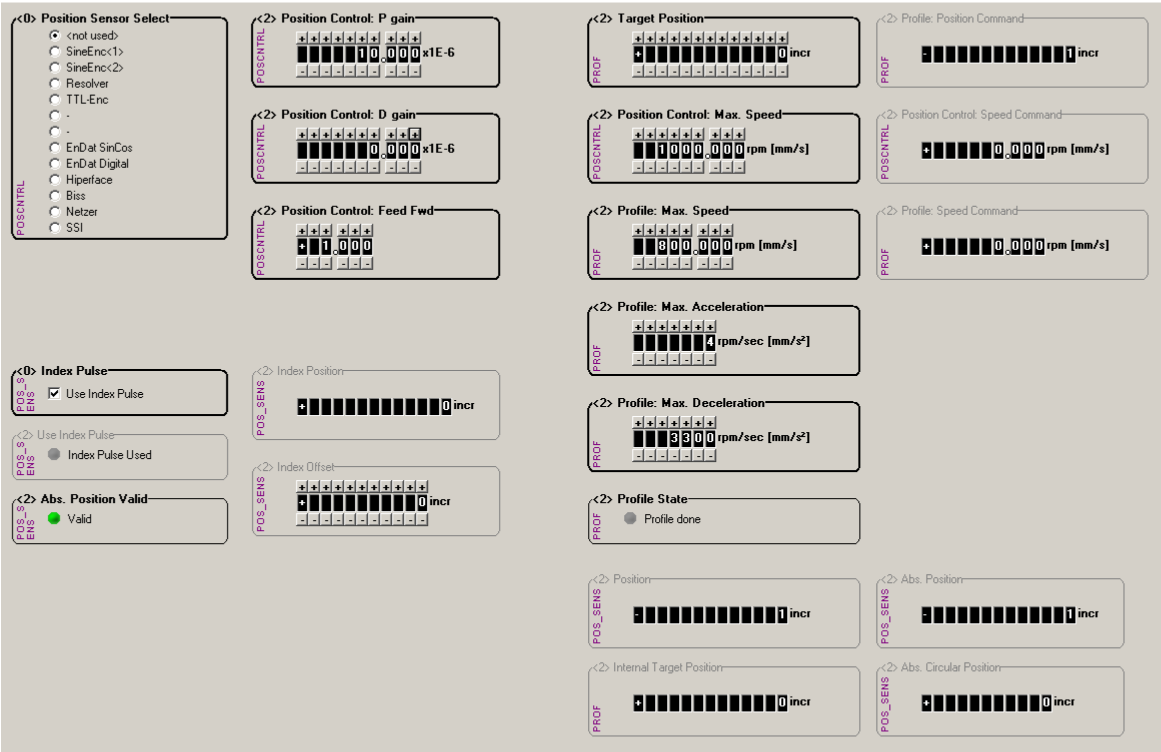
defines the feedback system which is used for position control loop.

### 4.6.4 Position Control: Max. Speed

General speed limit for position profile mode

### 4.6.5 Profile: Max. Speed / Acceleration / Deceleration

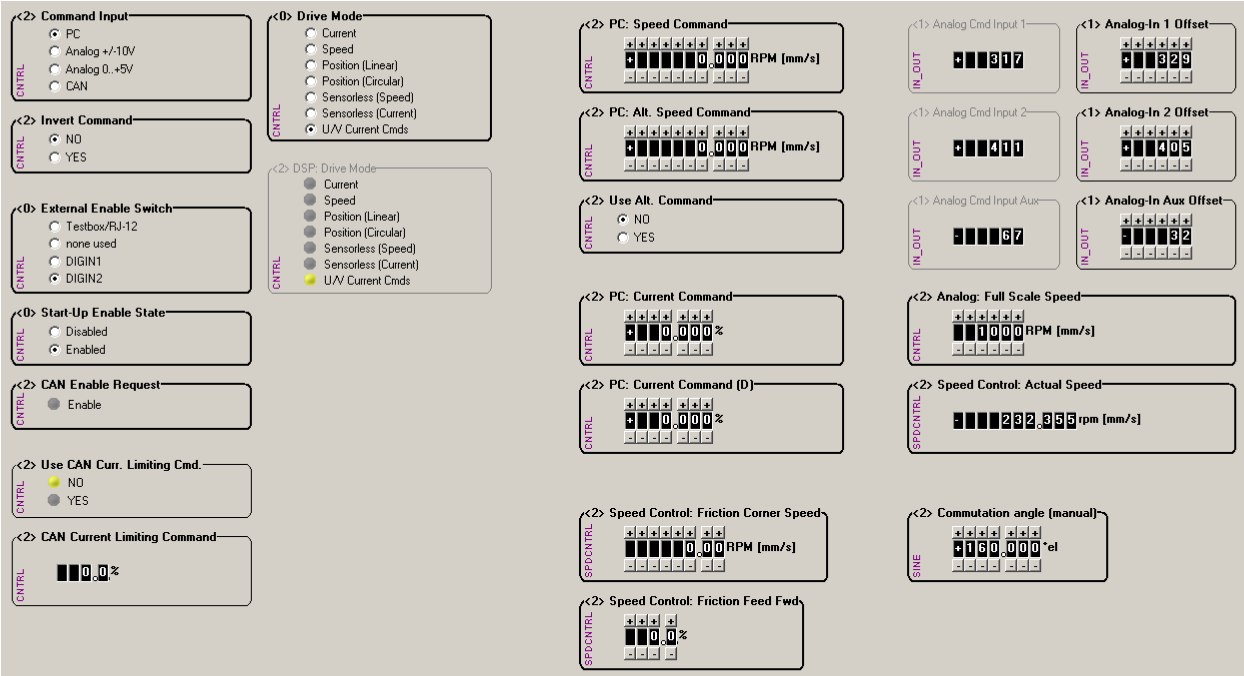
specifies the limits for position profile operating mode



## 4.7 Command Input

This section offers motor control in all supported operating modes.
The Enable and Disable buttons at the bottom are necessary for any motor operation controlled by the software. Additional hardware enable by I/O signals can be required.

If you need additional parameters for your testing, refer to chapter 1 "Software Setup".




### 4.7.1 Command Input

Select the desired command channel for operation. Use "analog" when connecting an external function generator.

### 4.7.2 Start-Up Enable State

This allows the drive to auto-enable on power-up. This refers to software enabling. Additional hardware signals may be required.

### 4.7.3 Drive Mode

Select the required operating mode

### 4.7.4 DSP Drive Mode

Confirmation of the actually selected mode as set in the DSP

### 4.7.5 PC Speed Command

Speed setpoint for operation by software

### 4.7.6 PC Alt. Speed Command

Second speed setpoint can be used for fast switching and generating a step behavior

### 4.7.7 Use Alt. Command

Switches between the two setpoints

### 4.7.8 PC Current Command

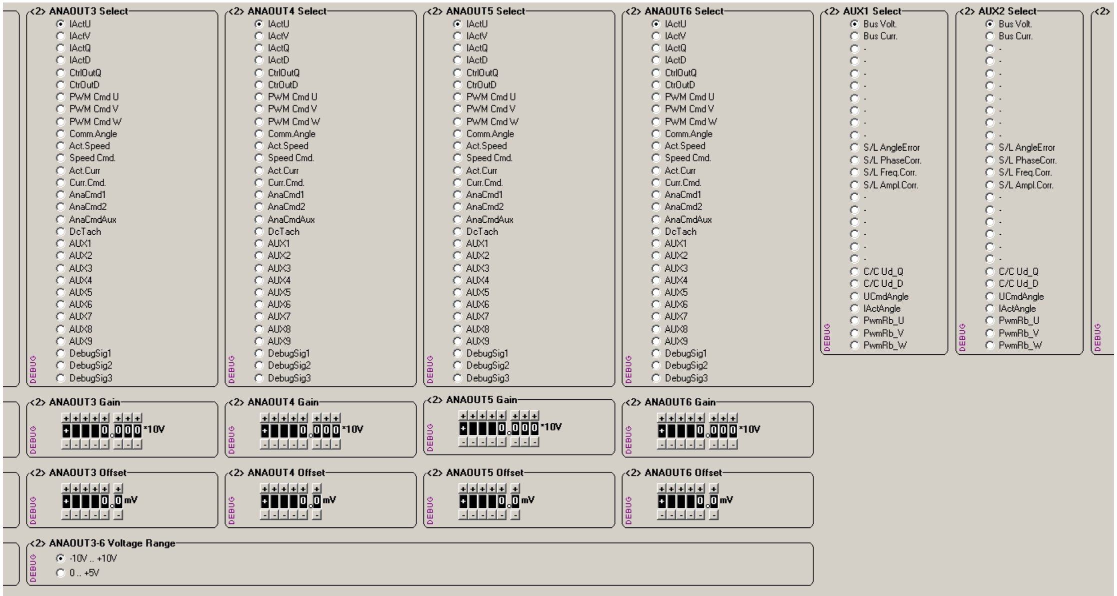
Current setpoint (Q vector) for operation by software

#### 4.7.9 PC Current Command(D)

Current setpoint (D vector) for operation by software

## 4.8 Analogue Measurement

In this section you can select the assignment of signals to analog outputs.
SWM7 offers 6 analogue outputs which can be widely configured to the specific application needs.




### 4.8.1 ANAOUT 1…6 Select

Select the signal for assignment to the certain output

### 4.8.2 ANAOUT 1…6 Gain

Use the gain setting for scaling the linked signal to the output range

### 4.8.3 ANAOUT 1...6 Offset

Is used for calibrating the zero level of the output

### 4.8.4 ANAOUT … Voltage Range

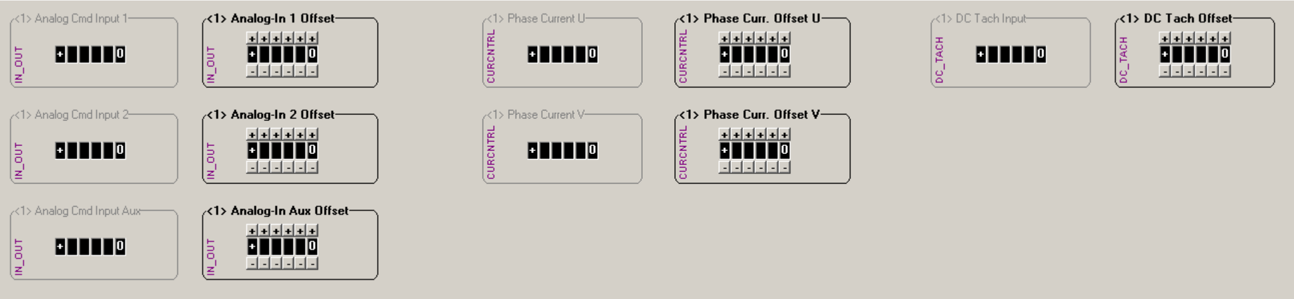
Select 5V or +/-10V Range for each group of outputs

### 4.8.5 AUX x Select

Additional signals can be selected by defining AUX allocations

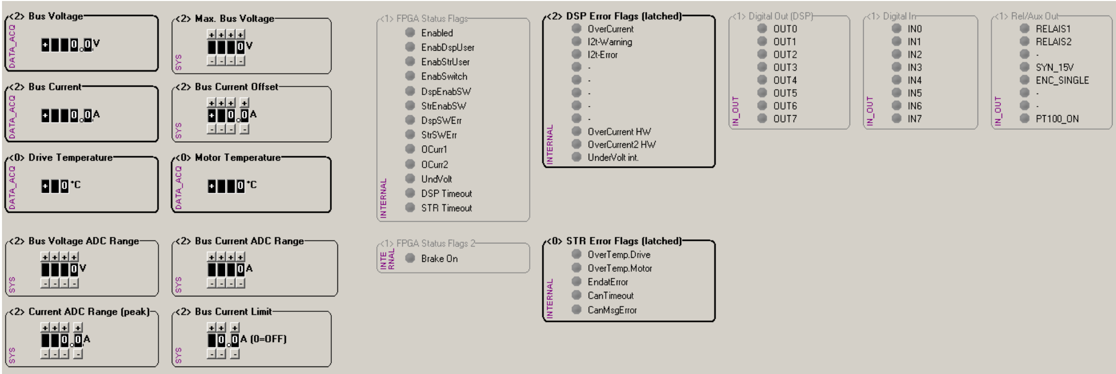
## 4.9 Offset

The values of analogue inputs, phase current and DC tach signal can be calibrated by adding an offset.



## 4.10 Data Acquisition

Different internal data, mainly concerning the power stage and processor status, is summarized in this section.

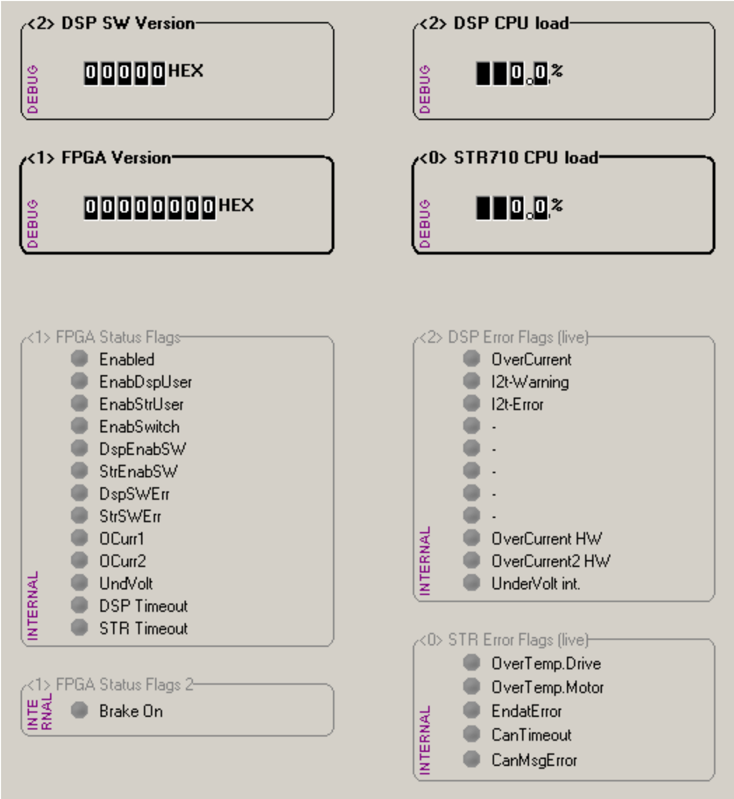



Limitations for power stage bus voltage and current can be set.

The state of digital I/O as well as processor status flags can be monitored.

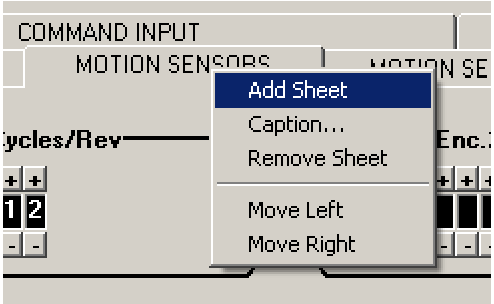
## 4.11 SWM Status

Firmware versions and internal status flags are displayed here. This information may be needed if queried by Maccon tech support.



## 4.12 Creating user-defined sections

You have the ability to create your own parameter page(s) for controlling and monitoring your drive system. Right-click on a section title to open the context menu.



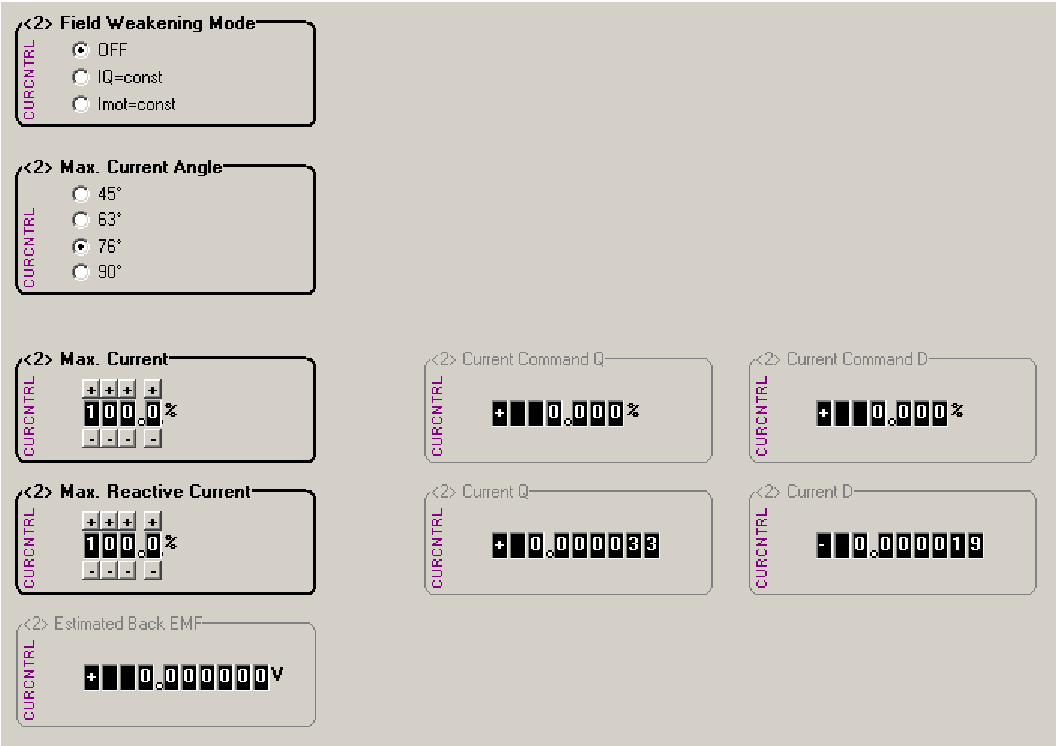

Select "Add Sheet" to create a new section.
A new sheet with be created. Use "Caption" to assign a name.

Add your desired parameters from the parameter list as described in chapter 1.

# 5 Special Operating Modes

## 5.1 Field Weakening

The necessary parameters for field weakening operation can be controlled in this section.
This feature can be used to drive a motor at a higher speed than nominal while reducing torque to keep power consumption within the motor rating. The field weakening effect is achieved by influencing the $I_d$ and $I_q$ current vectors.

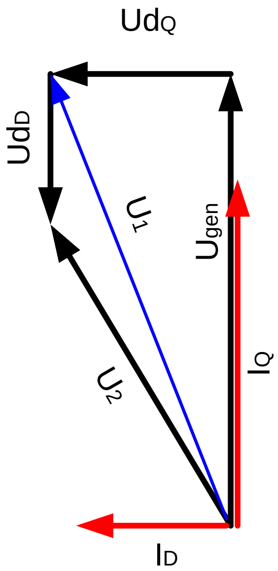



For controlling and monitoring field weakening mode by setup software it is useful to add the following parameters:

Active Speed Sensor → Rotatory speed
Command Inputs → PC Current Command
Command Inputs → PC Current Command D

### 5.1.1 Operating principle

Shown by a 1-phase diagram with rotor vectors.




Setting only an effective current vector $I_Q$, the reaction is an output voltage of $U_1$. Should this voltage get higher than the bus voltage, no further current can be supplied and the motor speed reaches its limit.

Adding a reactive current $I_D$, the inductive loss of voltage $Ud_D$ leads to the output voltage $U_2$ which is lower. With this effect the motor speed can be further increased.

### 5.1.2 Field Weakening Mode

For automized control of additional reactive current two algorithms are implemented.

$I_Q$=const: $I_Q$ is defined by the current setpoint, $I_D$ is zero at the beginning. When the bus voltage (back EMF limit) is reached additional reactive current $I_D$ is applied; the absolute value of the effective current stays unchanged. This results in nearly constant torque, the motor current gets higher than commanded.

$I_{mot}$=const: $I_Q$ is defined by the current setpoint, $I_D$ is zero at the beginning. When the bus voltage (back EMF limit) is reached additional reactive current $I_D$ is applied; the absolute value of the effective current is reduced. Hereby, the torque is reduced, the motor current stays at the commanded value.

Manual control of field weakening operation can be achieved by the following procedure:

Increase Q Current until maximum speed is reached

Start increasing D Current and watch increasing speed.

Generally, Iq component can be reduced proportionally to the speed increase as this is equal to the reduced torque which is available.

### 5.1.3 Max. Current Angle

Start field weakening test with a setting of 76°. Reduce occasionally depending on reached speed.

### 5.1.4 Max. Current

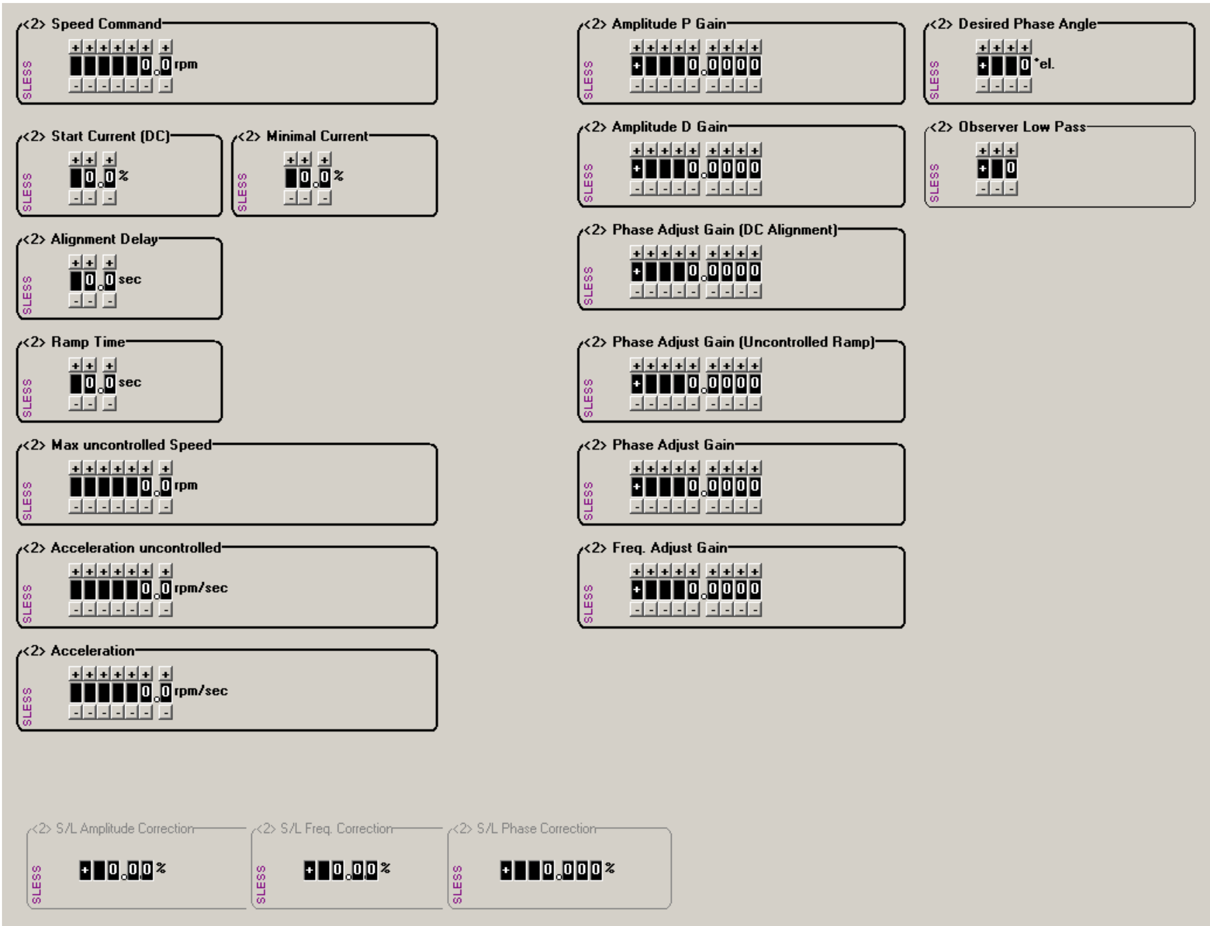
provides a current limit for all operating modes based on the maximum current of the drive.
Same parameter as listed in the “Current / Speed Control” section.

### 5.1.5 Max. Reactive Current

Limitation of Reactive current vector based on the “Current ADC range” of the motor.

## 5.2 Sensorless control

For sensorless (open loop) motor control, the relevant settings can be made here.
Usually you receive a customized and validated parameter set for your sensorless application.



# Contents