General Initialisation guide for Resolver or SSI Abs Encoder

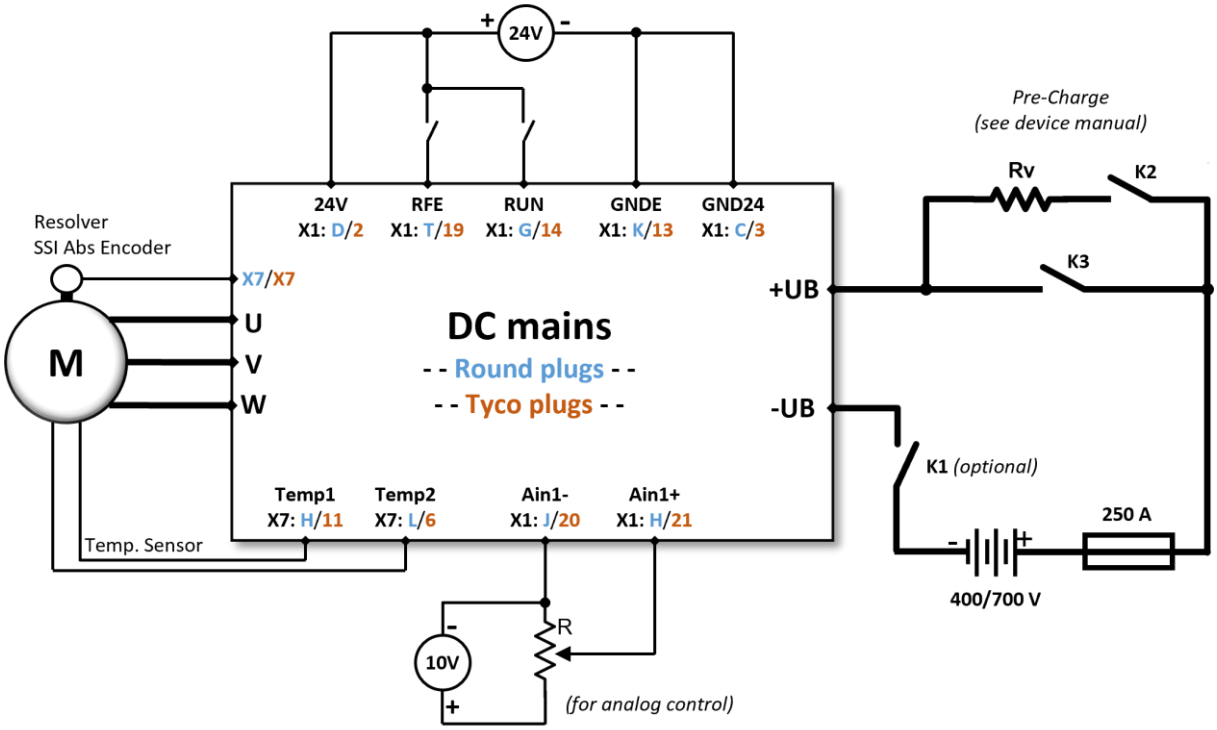
Short initialisation guide manual
for UniTek digital motor controllers operating a
PMS-Motor and a resolver or SSI Abs encoder
as feedback system

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Date: 22.05.2025

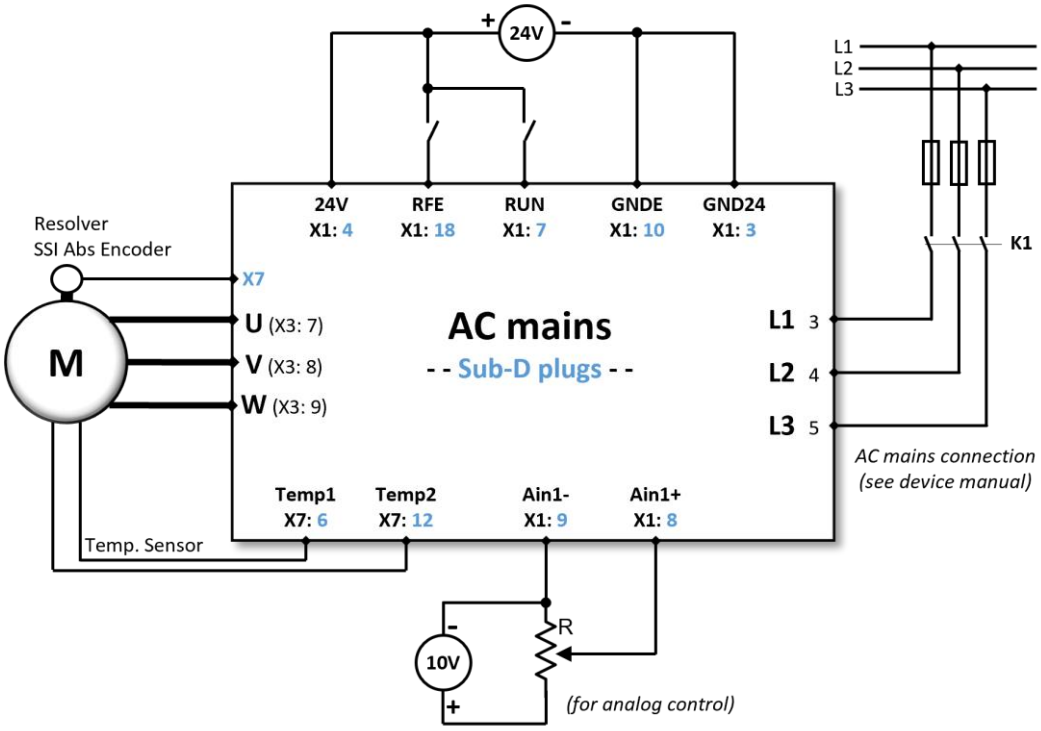
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Configuration circuit diagram for DC mains powered digital motor controllers:

(Motor controllers with Sub-D plugs → please check AC mains connection diagram)



Configuration circuit diagram for AC mains powered digital motor controllers:



Power on the digital motor controller

- Make sure that the switches of RFE and RUN are all open.
- Make sure that the DC or AC power supply of the power stage is switched off.
- Turn on the 24 V auxiliary power supply to power the digital motor controller.
    - The 7 segment display at the digital motor will start its initialization process.

Connect the digital motor controller to NDrive

- Start the current version of NDrive.
- Make sure your serial port cable is connected to the digital motor controller and your serial port to USB converter at your USB port of the designated computer.
- Determine what COM port the USB is connected to and select that COM port inside the NDrive software. You can check your COM port using the Windows device manager.
- Once the COM port is selected inside NDrive, NDrive will try to establish a communication connection.
- A successful connection will be indicated at the status bar with “Drive is online” information and the Firmware-Number at the bottom of NDrive (e.g. FW480).

A detailed configuration information, or on how to connect via CAN bus, is explained inside the NDrive manual.

Check if the Feedback signal is received and no Feedback Error is triggered (Recommended)

- Rotate the motor by hand in clockwise direction.
  In NDrive you must see a positive rotation speed rpm signal, and a negative signal if you rotate in counter clockwise direction.
    - If this is not the case or you receive a Feedback Error signal. Check your wiring.

Applying the AC power supply to the AC digital motor controller

- Follow the AC mains connection setup guide from the device manual.
- Apply the AC power voltage (3 or 1 phases) to the power stage connectors via the K1 switch.

Applying the DC power supply to the DC digital motor controller (using pre-charge circuit)

- Make sure that the switches K1, K2, K3 are open.
- Close the main HV-DC switch K1.
- To initialize the pre-charge circuit, close the pre-charge switch K2.
  Now the power stage DC-Bus of the motor controller will be loaded.
- Once the voltage is at least 90 % loaded, close the switch K3 to finish the pre-charge logic.
    - This will take about 60…200 ms depending on the battery motor controller type and the used pre-charge resistor.
    - Using the N-Drive Software, the DC-Bus voltage can be checked on the page Device → Vdc-Bus or by reading the ID-Address 0xEB.
- Once the switch in branch K3 has been closed, you can open the pre-charge switch K2.

! High voltage is now being supplied to the motor controller and the system is considered live and should be handled carefully and cautiously!

With the HV battery digital motor controllers, for the initial phasing process and basic rotation tests, only a low HV-DC voltage (e.g., 12…40 V) is required.

Phasing process

First setup test and measuring the FB-offset angle.

Goals:

- Check the correct connection of the motor cables (U, V, W).
- Check the entry number of motor poles (M-Pole).
- Identification of the phase angle (FB-Offset) of the resolver or SSI Abs encoder.

Hardware preparation:

- The motor must be freewheeling or connected on a light load.
- The motor must not present a hazard in the event of uncontrolled acceleration.
- The power voltage (AC or DC mains) should be present.
  (For units with HV DC voltage, it is recommended to apply a low DC voltage (12…40 V)).
- Switch on the RFE input, but not the RUN input.

Parameters preparation:

- In NDrive go to the page “Settings”
  - Set the general Motor parameters (I max eff; I nom eff; N-100%)
  - Set the Motor pole number (M-Pole (0x4F))
    - the resolver pole number (FB-Pole (0xA7)).
    - SSI Abs enc pole number is always FB-Pole = 2.
  - Set the maximum allowed current (I max pk (0xC4)) to 10 % (Important).
  - If unknown, set default current controller parameters to
    Kp = 10; Ti = 2000 ms; TiM = 100 %
- In NDrive go the page “Auto”
  - Set the phasing rotating speed (Speed 2 (0x77 L)) to 100.

Start and procedure description:

1. In NDrive go to the page “Auto”.
2. At the Special Functions drop-down bar, select [Fn4] Phasing – Rotating.
3. Activating the function → Press START (or message on the ID address 0x85 = 4).
4. After pressing START, 10 s remain to activate the enable RUN input “Wait for RUN = 1” and the phasing process will start.
5. The set current is induced to the motor, and the motor moves with a jerk between 2 of its electrical poles.
6. The motor then rotates clockwise for exactly 360° from pole to pole depending on the motor pole number (may jump jerkily from pole to pole).
7. After a short time, the current ramp degrades down to 0.
8. As soon as NDrive will show the message “Wait for RUN = 0”, deactivate the RUN input.
9. The phase angle is identified and is displayed at FB-Offset in the right-hand field (grey). Enter the new value in the left field (yellow) and confirm by pressing ENTER.
10. Go to the page “Settings” and save to the Eprom level 0.

Findings:

- The slow clockwise rotation confirms the correct arrangement of the U, V, W connections.
- The 360° rotation confirms the correct specification of the motor pole number.
- The FB-Offset angle of the resolver or SSI Abs encoder is identified.

Note:

- The FB-Offset of the resolver or SSI Abs encoder only needs to be identified once and not after every restart.
- The accuracy of this method is physically limited to ±2 %.

Error situation:

- The motor does not turn or just jerks
  - U, V, W connection is not correct → change unknown.
  - Current limit possibly too small or the connected load is too large.
  - The value of Speed 2 is far too small or too large.

- The motor rotates anticlockwise (counterclockwise)
  - U, V, W connection is not correct → Switch connection U and W

- The motor rotates more or less than 360°
  - Incorrect specification of the number of motor poles (M-Pole (0x4F)) → correction.

- Your FB-offset value is always very different (+/- 20°) every time you repeat the phasing process
  - The resolver or SSI Abs encoder signal has got a fault
    → 99 % it is usually a wiring problem.
  - Your U, V, W connection is incorrect

- A feedback Error message stops the process
  - The resolver signal or SSI Abs encoder signal has got a fault
    → 99 % it is usually a wiring problem.

- The phasing process was successful but trying to rotate the motor, the motor just jerks or just a high current flow is present
  - This could have many reasons…
  - Incorrect specification of the resolver poles (FB-Pole (0xA7))
    → correct the resolver pole number and repeat the phasing process, because a new FB-Offset value will be identified.

<u>Important for DC digital motor controllers:</u>

- Always make sure that during general operation and an emergency disconnection of high voltage DC-Bus voltage (e.g., by the BMS, emergency switch), that the drive is disabled (disconnect RFE) before you disconnect the HV-DC (+UB, -UB) power connection beforehand or at the same time.

  This is extremely important, because the battery digital motor controllers will work as a step-up converter and will be damaged if the energy during breaking cannot be consumed by the battery.
  - We recommend to link a relay at the RFE connection. If the BMS controller needs to separate the HV-DC (+UB, -UB) supply due to safety, it must open this relay beforehand.

- Always ensure proper shielding to the motor phases and especially to the resolver or SSI Abs encoder connection.

Use digital command input and test motor

- After the phasing process the motor shouldn't be spinning (Because Ena = Off).
- Please leave the current settings at max. 10 % for initial testing.
- Set the Command mode to Dig. Commands.
- For initial testing we recommend to
    - set the speed ramps to a slow value of 5000 ms (N R-Acc = N R-Dec = 5000 ms)
    - make sure that the speed controller has the following default values:
      Kp = 5; Ti = 400 ms; TiM = 60 %
      Coast stop = ON (Freier Auslauf)

Digital Speed control:

- Enable the motor controller by activating the RUN input.
- At the bottom left of NDrive at the "Test" control area,
  set the command option to "Speed (N)".
- Enter a small value of 1000 Num.
- Press on (+) and the motor should then spin in clockwise direction.
- Check the rotation speed at the top left of NDrive. The NUM 0xa8 value should match your desired speed of 1000 Num.
  (The rotation speed is calculated depending on the N-100% value
  Rpm = (N-100% * 1000) / 32767).
- Press on (-) to send a negative speed request of 1000 and check for the negative rotation speed.
- Press on (0) to send a speed command of 0 to stop the motor.
- After testing, disable the motor controller by deactivating the RUN input.

Digital Torque control:

- Limit the maximum motor speed to 10 % (N-Lim = 10 %).
- Enable the motor controller by activating the RUN input.
- At the bottom left of NDrive at the "Test" control area,
  set the command option to "Torque (Iq)".
- Enter a small value of 1000 Num.
- Press on (+) and the motor should then spin in clockwise direction.
- Check the rotation speed at the top left of NDrive. The NUM 0xa8 value should match the configured speed limit of 10 % (→ 3276 Num = 10 % of N-100%).
  (The rotation speed is calculated depending on the N-100% value
  Rpm = (N-100% * 1000) / 32767).
- Press on (-) to send a negative torque request of 1000 and check for the negative rotation speed.
- Press on (0) to send a torque command of 0 and the motor will run free until the inertia will stop the motor.
- After testing, disable the motor controller by deactivating the RUN input.

Advice:
Read the NDrive manual or "BAMOCAR_FAQ.pdf" for detailed explanation of proper torque control.