Bamocar

Initialisation guide

Short Manual for an initialisation guide for UniTek Bamocar inverters using a resolver as feedback system
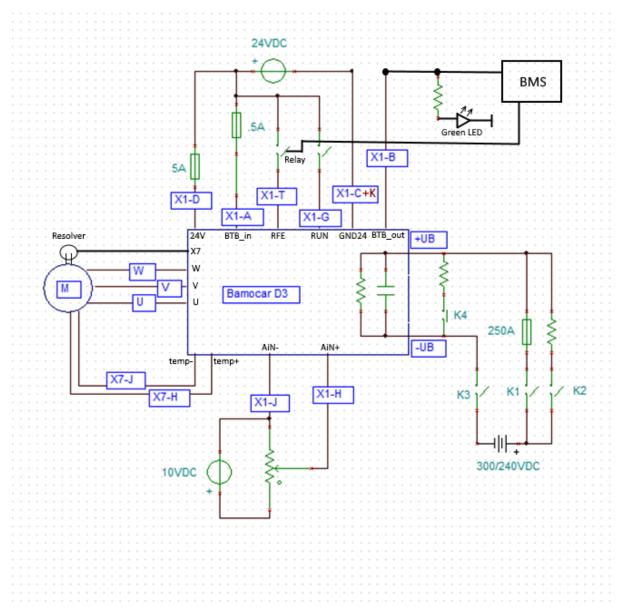
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Hardware setup with additional analogue control

- Important: DO NOT short BTB_in (X1-A) using 24 V with Ground via BTB_out (X1-B)

- The bleeder resistor at K4 and the K3 relay are optional

- The safety circuit for BTB_in and BTB_out are optional. The BTB_out could also be connected to e.g. the main controller instead.

- The "Relay" at the X1-T circuit controlled by the BMS is a recommended safety logic. If it is required to disconnect the HV-DC (+UB, -UB) line during operation in an emergency situation, then it is important to disable the inverter beforehand. This is best done by disabling (cut) the RFE (enable) input using a relay.

- The Green LED is of course just an example of using the BTB output to indicate the ready state of the inverter.

Power on Motor Controller

- Make sure that the switches of branches X1-T, and X1-G are all open.
- Turn on the power supply or power supplies that are being used to connect 24V to the motor controller through X1-D and X1-C

Connect Motor Controller to NDrive

- Once the 24V signal is identified as working correctly load a version of NDrive on a computer and set the baud rate to the 115k value.
- Attach the serial port connector to the controller. Attach the serial port cable to the serial port to USB converter and connect the USB to the designated computer.
- Determine what COM port the USB is connected to and select that COM port on the NDrive software. (Check the Windows device manager to determine the COM port)
- Once the COM port is selected inside NDrive, identify that the NDrive software sees the controller.
  Successful connection will be indicated by the Firmware-Number at the bottom of NDrive (e.g. FW473)

Applying High Voltage to Controller

- Check that the switches in branches K1, K2, K3 are open
- Check that the switch in branch K4 is closed and has been closed for at least 15 seconds
  - If the switch is open, close the switch in branch K4 for at least 15 seconds
- Once the switch in branch K4 has been closed for at least 15 seconds, open the switch
- Close the switch in branch K3 (K3 is the main HV-DC supply switch)
- To initial Pre-Charge, close the switch in branch K2
- Using the N-Drive Software determine when the DC-BUS is at least 90% of the total applied voltage (Check NDrive->Extra->Vdc-Bus (0xeb).
  For the initial phasing process, only a low HV-DC voltage (e.g. 40V) is required.
- Once the DC-BUS voltage is at least 90%, close the switch in branch K1
- Once the switch in branch K1 has been closed, open the switch in branch K2
- High voltage is now being supplied to the motor controller and the system is considered live and should be handled carefully and cautiously

Turn on enables

- Enabling motor controller and phasing process
  - With the 24V power supply already on, from section Power on Motor Controller the motor controller will already be on. This power supply will also supply power to X1-A, X1-G, and X1-T; these connections are initially off until they are switched on (steps below).
  - Once K1 has been enabled, switch on X1-T (RFE: Rotating field enable). Rotating field enable allows the motor to rotate
  - Now we need to determine if the U,V,W connection are correct and we need to determine the feedback offset angle (Depending on your feedback system e.g. resolver) by using the Phasing process:
    1. Go to the connected NDrive.
    2. Set I max pk to 5% (Important)
    3. Set Speed 2 at Pos-Reference to 100
    4. Auto ~> Special functions ~> select [fn4] Phasing-Rotating
    5. Press START (The next step must be done before 10 s are over)
    6. Switch on X1-G (RUN: Run enable)

    (The drive Status-Map (0x40) inside N-Drive will activate Ena (Bit 0) to high and the output safety-circuit X1-B (BTB) will go high.

    7. The motor must then rotate 360° once in CW direction.
        - If the motor is not spinning or is rotating in CCW direction, then the motor phases (U, V, W) are not connected correctly
        - If the motor rotates less or more than 360°, then the motor pole configuration is wrong.
    8. Disable drive by switching X1-G (RUN) to off (NDrive will tell you)
    9. At FB-offset you will see the new offset angle. Write this new value into FB-Offset at the page settings and save to Eprom by pressing the Eprom-STORE 0 button.
  - The motor controller is now ready to accept command signals.

Use and Configure Analogue Input and Test Motor

(If you intend to use digital commands from the start, just skip this section)

- After the phasing process the motor shouldn't be spinning (Because Ena = Off)
- Please leave the current settings at max. 10% for initial testing
    - Please set the motor currents only once to their nominal values and always use the current settings of the Bamocar device (below Parameter) for configurations
- Set inside NDrive the Command mode to Analog Torque (or Analog Speed), set the Format to Cmd+, set the Offset to -1000 and set Mode to 0..+10V
- Turn the potentiometer until the resistance between the between X1-H and the positive side of the 10V supply is at its maximum
- Turn on the 10V power supply that is connected to the potentiometer. The negative terminal of the potentiometer is connected to X1-J (AIN1-: Analog 1-) and the wiper is connected to X1-H (AIN1+: Analog 1+). This will supply Analog input 1 with a 0-10V signal that will act as the throttle for testing purposes.
- Inside NDrive go to the page Speed and on the top left you can see the Analog input
- Check if Ain scaled is below 0 if resistance is at its maximum.
  Now check if by changing the potentiometer the variable Ain scaled will change according to the potentiometer value. If a supply of 10V is used, the range should be between (0..32767)+Offset. (The calculation is Ain x scaled = (Ain in + Offset) * Scale)

- If all this is okay we can try to turn the motor.

- Set the potentiometer to 0. And check if Ain scaled is below 0
- Enable the motor controller by Switch on X1-G (RUN: Run enable)
- After all the status signals are okay, slowly turn the potentiometer and motor should be spinning in CW direction
- If the motor is not turning, crank the potentiometer back to its original position, Switch off X1-G (RUN: Run enable) and turn off the 10V supply. Then diagnose the problem.

Tip.: Please read the manual "Information for Traction Applications.pdf" for proper analogue configuration and the use of recuperative breaking.

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
    - Please set the motor currents only once to their nominal values and always use the current settings of the Bamocar device (below Parameter) for configurations
- Set inside NDrive the Command mode to Dig. Commands
- For initial Testing we recommend to
    - set the speed ramps to a slow value of 10000 ms (N R-Acc = N R-Dec = 10000 ms)
        - Make sure that the speed controller has the following default values:
            - ➔ Kp = 10; Ti = 400 ms; TiM = 60 %
    - To activate Coast stop = ON   (Freier Auslauf).

- If all this is okay we can try to turn the motor.

Speed control:
- Enable the motor controller by Switch on X1-G (RUN: Run enable)
- At the bottom left of NDrive, Send a Speed N value of 1000 Num by pressing on (+). The motor should then spin.
    - 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 Nmax100% value.
        - Rpm = (Nmax100% * 1000) / 32767
- Press on (-) to send a negative speed request of 1000 and check again.
- Press on (0) to stop.

Torque control:
- Limit the maximum motor speed to 10 % (N lim = 10 %)
- Enable the motor controller by Switch on X1-G (RUN: Run enable)
- At the bottom left of NDrive, Send a Torque (Iq) value of 1000 Num by pressing on (+). The motor should then spin.
    - 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 Nmax100%)
    - The rotation speed is calculated depending on the Nmax100% value.
        - Rpm = (Nmax100% * 1000) / 32767
- Press on (-) to send a negative torque request of 1000 and check again.
- Press on (0) to stop and the motor will run free until the inertia will stop the motor.

Read the manual BAMOCAR_FAQ.pdf for detailed explanation of proper torque control.

Important:

- Always make sure that you disable the drive (open RFE) before you disconnect the HV-DC (+UB, -UB) power connection at least 100ms before. This is extremely important, because the Bamocar will work as a step-up converter and will be destroyed 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 connection.

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