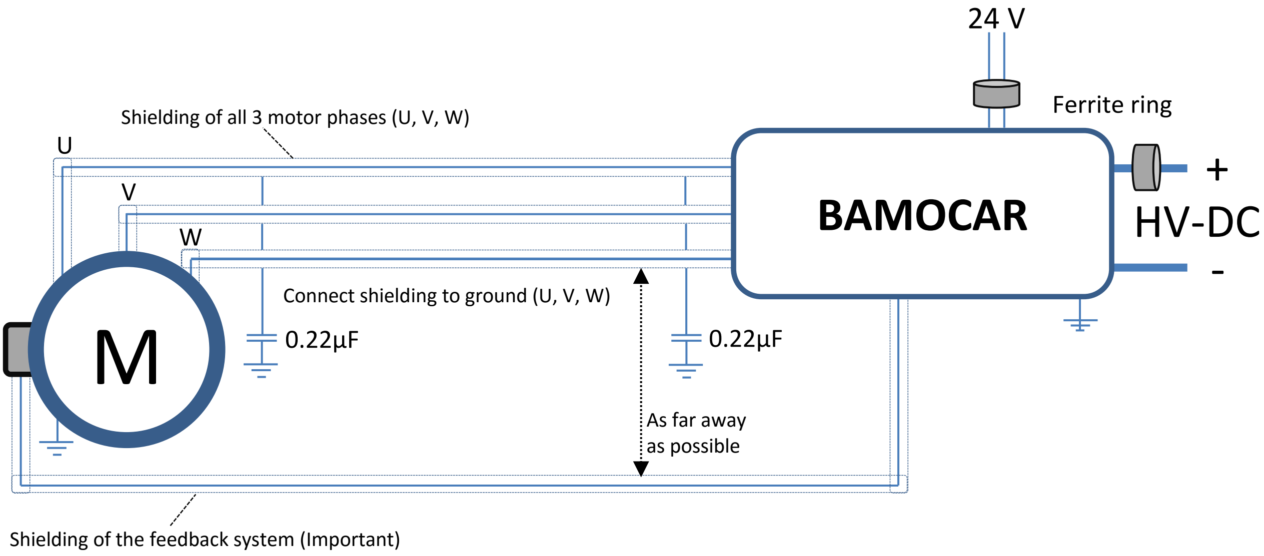
Contents

1. What are the Shielding Recommendations for EMI reduction?



- Ensure proper shielding of all 3 motor phase cables
- Connect the shielding of the motor phase cables (U, V, W) to ground (best would be at both ends)
- Ensure proper shielding to the feedback cables (very important)
- Make sure that motor cables and feedback cables are as far away to each other as possible (best would be a 90° angle to each other)
- Connect the casing of the Bamocar device to ground
- A ferrite ring at the 24 V auxiliary voltage can also help

=> Please also check BAMOCAR-PG-D3 manual chapter 4.3 “Connection diagram”

2. What M_set(dig) value do I need to send to reach my desired motor torque?

The maximum torque of ±32767 is always bound to the 100% of the ±I_max_pk value.
Also, I_max_pk is not the continuous current your drive can operate with but the max. peak current.

Short example for calculating the torque for a desired current I_des [Arms]:

Given: Bamocar device with I_con = 200 Arms;
I_max_pk = 424.2 A; I_con = 200 Arms; I_des = 100 A

Desired: CountValue_torque M_set(dig) (0x90) (Range: ±32767) for I_des value.

Solution 1:	CountValue_torque = (32767 * I_des * sqrt(2)) / I_max_pk
Solution 2: (Easier)	CountValue_torque = (32767 * I_des) / (I_con * 1.5)

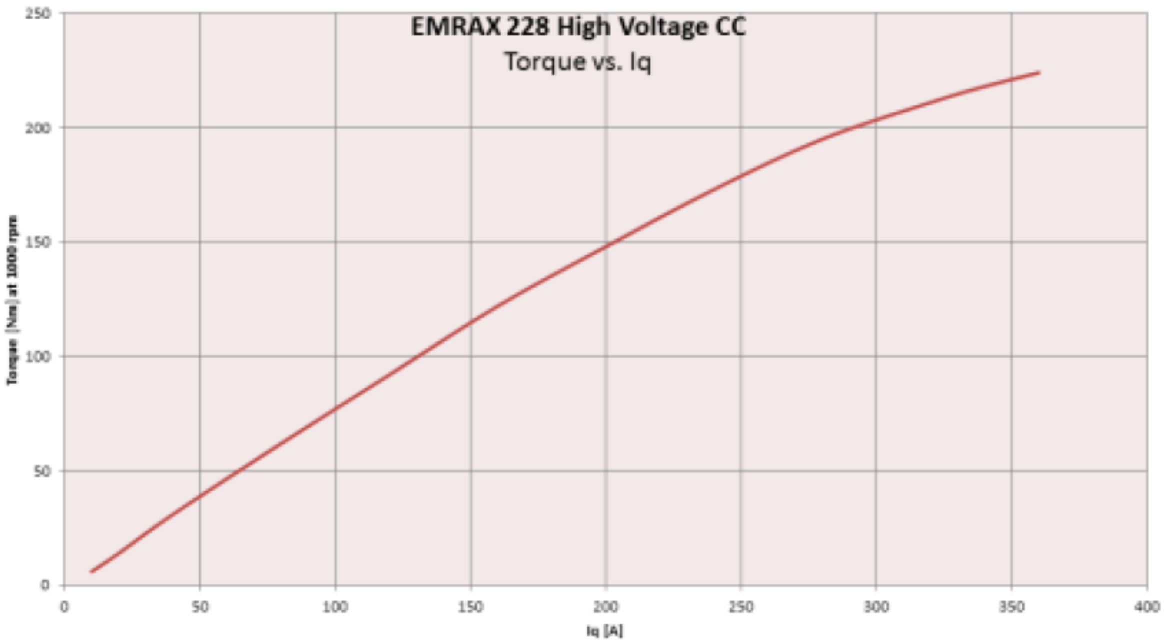
SUMMARY:

- I_des as Arms current:
  CountValue_torque = (32767 * I_des * sqrt(2)) / I_max_pk

- I_des as peak current:
  CountValue_torque = (32767 * I_des) / I_max_pk

EXAMPLE: (This graph from Emrax is for current in peak (not rms)).

First, the motor should generate 40 Nm.
Second, find out the current value corresponds to 40 Nm in the Torque-Current Map.
In this example the current should be 50 A which means that I_des = 50 A



Advice: Please do not use RegID 0xF6 (power).

Third step, calculate the number that should be send to BAMOCAR via CAN
In this example: (In this formula, I_des = 50 A, I_max_pk = 424.2 A)

CountValue_torque = (32767 * I_des) / I_max_pk
= (32767 * 50 A) / 424.2 A
= 3862

Finally, send 3862 to BAMOCAR via CAN and the motor will generate 40 Nm on the car/plane.
We know the actual torque is about 8 - 10 % lower than the calculated value. This depends on the motor.

EXAMPLE: (From Emrax Datasheet of the 228HV)

Torque / motor current [Nm/1Aph rms]	1,1

The motor should generate 200 Nm.

⇨ I_des(rms) = 200 Nm / 1.1 Nm/1Aph rms = 181.81 Aph rms

CountValue_torque = (32767*I_des(rms) * sqrt(2)) / I_max_pk
= (32767*181.81 Arms * sqrt(2)) / 424.2 A
= 19861

According to the measurements of the University of Darmstadt the actual Torque to motor current ratio of the 228HV motor with a Bamocar device is about 0.93 Nm/1Aph rms (as motor) and 0.97 Nm/1Aph rms (as generator).

Torque Output Mout RegID: 0xA0
The variable Mout will show the used torque output (Iq-current) using the same scaling (conversion) factor as the parameter M_set(dig.) RegID: 0x90 (±32767 ≙ 100% of ±I_max_pk)

3. How to implement a Hill Hold Logic for operating a vehicle?

Hill Hold is a logic where a vehicle is hold in a stationary position, independent from the terrains rate of slope, until the driving torque is high enough to accelerate the vehicle smoothly from this position in a forward motion without rolling backwards.

It is possible to accomplish a Hill Hold by implementing this logic in your master controller:

- The vehicle has stopped and you activate the Hill Hold by sending not a torque request but a speed command of 0 rpm (→ n_set(dig.) (0x31) = 0).
  (The trigger for activation can be e.g. pressing the brake pedal for 3 s)
    - The inverter is now operating in speed control mode and will show the used holding torque (Iq-current) with the variable I_actual (0x5F) or with the more useful variable Mout (0xA0).
- Monitor the variable Mout (0xA0). Since the variable Mout (0xA0) has got the same scaling as the torque command parameter M_set(dig) (0x90), both can be compared without any required conversions.
- As soon as the desired driving torque M_set(dig) (0x90) is higher than the holding torque Mout (0xA0), the master controller can then send the new M_set(dig) value, switching the inverter back to torque operating mode, and the vehicle will accelerate smoothly from its holding position.
    - If (M_set(dig) > Mout) → send M_set(dig) value

- For a proper operation of this logic, we recommend an inverter Firmware ≥ 476.

4. How to calculate the internal current and torque conversion values?

(e.g.: Bamocar D3-PG-700-400)
0xD9 = 1070; 0xEE = 700; 0xC6 = 2000   (These values are default write protected values)

- Conversion of Torque command (M_set(dig) (0x90)) into current command (I_cmd (rms) 0x26): (All "0x" numbers represent RegID Addresses)

- I_cmd = (0x90 * (0xd9 / 2) * 1.5) / 32767 (internal unit, but as rms)
  - ➢ I_cmd = (0x90 * (1070 / 2) * 1.5) / 32767 Arms

- I_cmd (0x26) in Ampère [Arms]:
  I_cmd[Arms] = 0x26 * ((0xC6 * 2) / (0xD9 * 10))
  - ➢ I_cmd = 0x26 * ((2000 * 2) / (1070 * 10)) = 0x26 * (400 / 1070) Arms

- NDrive Display current: (Filtered I actual)
  Display current (Arms) = 0x5F * ((0xC6 * 2) / (0xD9 * 10))
  - ➢ I_{AC} = 0x5F * ((2000 * 2) / (1070 * 10)) = 0x5F * (400 / 1070) Arms

  NDrive oscilloscope values:
  All the physical values of the measured currents are 'peak' and not 'rms' values.

5. How to command the desired physical speed and set a defined limit?

- Goal Speed command of N_cmd (0x31) = 2000 rpm:
  With N_max100% = 6000 rpm (≙ 32767)
  - ➢ N_cmd = (32767 * 2000 rpm) / 6000 rpm = 10922

- Limit your speed with N-Lim < 100%:
  e.g.:
  N-Lim = 10% (10% of N_max100%)
  N_cmd = 10922 (≙ 2000 rpm)
  final command is N-Lim of 3276 (≙ 600 rpm)

6. What is the theoretical peak and continuous performance output of the BAMOCAR using a PMSM motor?

Bamocar PG-D3-400-400:

P_peak = 133 kW (for max 30 s. Nominal for 5..10 s.)

U_eff = [U_Bat / sqrt(2)] - loss = [400 V / sqrt(2)] - 10 V = 273 V

I_peak = 400 A / sqrt(2) = 283 Arms

P_peak = U_eff * I_peak * sqrt(3) = 133 817 W (= 133 kW)

P_con = 94 kW (continuous)

U_eff = 273 V

I_con = 200 Arms

P_con = U_eff * I_con * sqrt(3) = 94 570 W (= 94 KW)

Bamocar PG-D3-700-400:

P_peak = 237 kW (for max 30 s. Nominal for 5..10 s.)

U_eff = [U_Bat / sqrt(2)] - loss = [700 V / sqrt(2)] - 10 V = 484 V

I_peak = 400 A / sqrt(2) = 283 Arms

P_peak = U_eff * I_peak * sqrt(3) = 237 242 W (= 237 kW)

P_con = 167 kW (continuous)

U_eff = 484 V

I_con = 200 Arms

P_con = U_eff * I_con * sqrt(3) = 167 662 W (= 167 KW)

7. What PWM-Frequency depending on the maximum motor speed and motor poles should be selected?

For a proper motor control, a general condition is the number of measuring points during every electrical angle. 16 measuring points are recommended. In this example we use the Emrax 228HV motor with 10 pole pairs.

For PWM freq = 16 kHz:

16000 Hz / 16 = 1000 Hz (= fnom_max)

n_max = (60 * 1000 Hz) / 10 = 6000 rpm (→ 10 are the pole pairs)

But: Using PWM freq. of 16 kHz will reduce I max pk and I con eff to 70 %.

For PWM freq. = 12 kHz:

12000 Hz / 16 = 750 Hz (= fnom_max)

n_max = (60 * 750 Hz) / 10 = 4500 rpm

But: Using PWM freq of 12 kHz will reduce I max pk and I con eff to 85 %.

For PWM freq. = 8 kHz:

8000 Hz / 16 = 500 Hz (= fnom_max)

n_max = (60 * 500 Hz) / 10 = 3000 rpm

8. How to calculate the output phase voltage (rms) to the motor?

The output voltage to the motor is not "Vout" (RegID: 0x8a), but depends on Vout.
The "PWM ratio in %" is Vout. The range of Vout is 0-4096 (≙ 0-100 %).

The output voltage U_{phase} can be calculated (in theory):
Input DC-Voltage / sqrt(2) multiplied with the percentage value of the PWMs multiplied with the efficiency conversion ρ of about 92 % (switching losses)

- U_{ph} = (VdcBus / sqrt(2)) * PWM ratio in % * ρ
- $U_{ph} = \left(\frac{V_{dcBus}}{\sqrt{2}}\right) * \frac{V_{out}}{4096} * \rho$

E.g.: VdcBus = 400 V; Vout = 1400 Num:

$$U_{ph} = \left(\frac{V_{dcBus}}{\sqrt{2}}\right) * \frac{V_{out}}{4096} * \rho = \left(\frac{400\ V}{\sqrt{2}}\right) * \frac{1400}{4096} * 0.92 = 88.5\ V$$

A different way is to use the motor specific data (if provided) depending on the motor speed (with field weakening not in use)

Example from Emrax 228 motor:

AC voltage between two phases [Vrms/1RPM]	0,0730	0,0478	0,0176

Test for confirmation:

- Kn = 0,073 Vrms/1 rpm (Emrax 228 HV)
- n_{actual} = 1500 rpm

  - $U_{ph\_measured}$ = 105,7 Vrms
  - U_{ph_Kn} = 109,5 Vrms

9. How to Enable and Disable the Drive using CAN while having a fixed wired RFE und RUN Input?

If you have the digital Enable Pins RFE and Run always on high (hard wired without a switch), the drive will generally not go to Status “Enable”.

But you can send a series of messages which will simulate a external switch (e.g. via CAN):
1. Lock: (CAN-ID: 0x201, Length: 3, Value: 0x510400)
2. Enable drive: (CAN-ID: 0x201, Length: 3, Value: 0x510000)

→ It will only work in this order.
→ This will also automatically cancel any saved errors.

Cancel/Clear Error via CAN by sending a command to ID-Address 0x8E
- ⇨ CAN-ID: 0x201, Length: 3, Value: 0x8E0000

10. How to configure CAN-Time-Out with combination of Coast-Stop?

Conditions:
- Make sure you have coast stop activated.
- Make sure you have some sort of Keep Alive Msg..

We recommend asking for the Error status (0x8F) or the Status Map (0x40):
RegID 0x40 every 255ms → Addr.: 0x201 DLC: 3 Msg.: 3D 40 00

1. Activate the digital input for FRG => Set FRG to high.
2. Set the CAN timeout (using CAN message) to 500 ms
   → Addr.: 0x201 DLC: 3 Msg.: D0 F4 01
3. Start sending your torque Set points.

If the CAN Com breaks down, e.g. pull the cable, and the timeout time has reached its limit, a time out error will be set, the drive will be disabled and the motor will coast to a stop.

Sadly, the only way to get rid of the timeout error is to:
4. Set the FRG/RUN input to low or lock the inverter via CAN (question 8).
   (An error can never be erased if FRG/RUN is active or the inverter is not locked.)
5. Start sending the keep alive CAN msg. or plug the cable back in.
6. Set FRG/RUN input to high or unlock the inverter via CAN.
   (This will also erase any saved errors.)

To deactivate CAN Time Out → Addr.: 0x201 DLC: 3 Msg.: D0 FF FF

11. How can the motor rotation direction CW and CCW be switched using a CAN command?

Just send a negative CAN command!! A workaround would be to set a digital input on the Logic page (Din1 → RegID: 0xC0) to "N cmd Reverse". By switching the condition of Lo/Hi when it will be activated, you can trigger a reverse command using CAN. Din1 settings can be saved inside the Eeprom.

The CAN command for Din1 would be:
Normal: msg[] = {0xC0, 0x0C, 0x80}   => 0x0C will set Din1 to "N cmd Reverse"
(msg[] = {0xC0, 0x00, 0x80} is also possible)
Reverse: msg[] = {0xC0, 0x0C, 0x00}

12. How to activate the Phasing Rotating process using a CAN command?

The Phasing Rotating process in order to determine the FB-offset angle of a resolver feedback system is usually not designed via CAN but it is possible.

1. Make sure that all important parameters (M-Pole, FB-Pole, Speed 2, I max pk, …) are configured correctly. Read the general initialisation process manual if you have never done a phasing process before (Important)!
2. Lock the inverter via CAN (question 8).
3. Set the FRG/RUN input to high.
4. Apply the HV power supply.
5. Send CAN command to enable phasing process (RegID: 0x85; Value: 0x04 (Phasing Rotating)).
   → CAN-ID: 0x201, Length: 3, Value: 0x850400   (Best to send this command 2 times)
6. Unlock the inverter via CAN (question 8) within 10 s of step 5.
   The phasing process will start now.
7. Read the RegID 0x85 to receive status information about the phasing process.
   → RegID_0x85_value = (CAN-ID: 0x201, Length: 3, Value: 0x3D8500)
8. Lock the inverter after the phasing process is finished: (Send Lock command 2 times)
   The upper 16 Bit equal 0   → if ((RegID_0x85_value & 0xFF00) == 0x00) { // Phasing finished }
   The lower 16 Bit equal 10   → if ((RegID_0x85_value) == 0x000A)
   { // Phasing finished, please Disable / Lock the inverter }
9. Send CAN command to save/write to Eeprom sector 0 (question 12).

13. How to load or save all parameters to the different Eeprom sectors using a CAN command?

In order to save your current settings to one of the 2 Eeprom sectors (0 and 1) or if you wish to load your settings from one of the 3 Eeprom sectors (0, 1 and 2) **the drive must be disabled**.

Write / Read parameter to / from Eeprom sectors:

- Read:
  - RegID: 0x83 ;   Byte[1] = 0,1 or 2 (≙ sector inside Eeprom)
    - Msg = {0x83; 0x00; 0x00} "Read from sector 0"
    - Msg = {0x83; 0x01; 0x00} "Read from sector 1"
    - Msg = {0x83; 0x02; 0x00} "Read from sector 2"
- Write:
  - RegID: 0x84 ;   Byte[1] = 0 or 1 (≙ sector inside Eeprom)
    - Msg = {0x84; 0x00; 0x00} "Write to sector 0"
    - Msg = {0x84; 0x01; 0x00} "Write to sector 1"

14. How can I achieve recuperative braking using a CAN command?

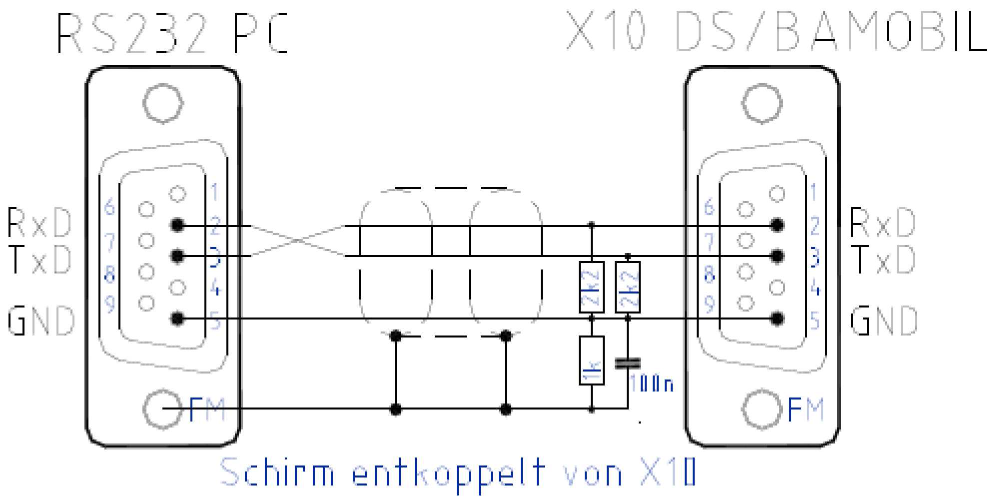
The theory of recuperative braking is actually very simple. As soon as the motor phase current (I_actual) and the motor phase voltage (SpeedActual) are of opposite sign, then recuperative energy will go back to the battery.
This means that all you have to do is to send a negative torque command for braking torque and you will be recuperating current back to the battery ($P_{DC} \leftrightarrow P_{AC}$).

Using digital torque command, the user itself has got complete control whether the demanded torque will be a driving or a generator torque (recuperative braking) just by sending the desired torque value (M set (dig.)) using one of the digital communication interfaces (CAN, RS232).

We recommend that you use the Actual rotation speed to adjust the torque command on the fly. The goal is of course that the system will end at a standstill (n = 0 rpm) and not turn backwards at one point.

15. How can I improve my RS232 signal connection because of EMI distortions while activating (ENA) the drive operation?

1. Adapter with RC-Filter



It is important to:
- have isolated motor cables
- ground the isolation of the motor cables
- have same ground potential

2. A ferrite bead or a ferrite choke

This is a quick and easy solution to suppress any high frequency noise and improve the signal stability.

16. What are the key factors on configuring the liquid cooling system?

- The internal Volume is 0,000167 m^3 (≙ 0,167 l)
- The maximum pressure of the cooling plate is 1,3 bar (→ 18,8549 Psi)
- The maximum flow rate is 12 l/min
- Connect the system in Series:

```
--------> BAMOCAR (first) -------> MOTOR (second) -----
|                                                     |
---------------- water pump <----- radiator <---------------
```

- Calculating the power loss for cooling is about:
  - About 10 V * MotorCurrent [Arms] (For all 3 IGBT modules combined)
  - Maximum: Q = 731 * 6 = 4386 W (≙ P_{v_max})

- Pressure drop loss coefficient (12 l/min):
  (Special thanks for these measurements to the university of Ulm)

Pressure drop in bar	V_p in l/min
0,0625	3,46
0,1188	4,82
0,1875	6,06
0,2563	7,32
0,3563	8,64
0,45	9,9
0,5813	11,2
0,5938	11,5

- The maximum operation temperature for the igbts is 83 °C (25200). Then an emergency software shutdown will be triggered. It is recommended that the inlet water temperature should not be above 45 °C.

UniTek Industrie Elektronik GmbH

17. How can I calculate the motor power (e.g. EMRAX motor)?

The theory of course states that you will get maximum power at maximum torque at maximum rotation speed. Because the input voltage is proportional to the rotation speed, the best and easiest way would be if the "Kn" value of the motor is used ($\rightarrow U_{ph\_Kn} = Kn * n_{actual}$).

I recommend you check the new EMRAX manual starting at page 52!
EMRAX have written some interesting notes on calculating the used power.

Then you can use your calculated torque from the current and then calculate your current power.

For calculating the torque, the easiest way is to use the motor torque to 1 A_{ph} rms ratio value [Nm/1 A rms]. With the Bamocar controller the efficiency is about 0.87 compared to the theoretical value (→ 1.1 Nm/1 A rms * 0.87 = 0.95 Nm/1 A rms).

Example:
Given:

- Bamocar 700 V - 400 A (→ I_{con} = 200 Arms)
- U_{Bat} = 360 V (= 254 Vrms)
- Emrax 268 MV
- K_n = 0.0825 [Vrms/1 rpm]
- Nm to 1 A ratio = 1.4 [Nm/1 A_{ph} rms] → 1.2 [Nm / 1 A_{ph}rms]
- Specific load speed = 7 [rpm/1 V_{dc}]
- Efficiency conversion DC to AC → ρ = 92 %.

Bamocar electrical peak power:

- $U_{eff} = \frac{U_{Bat}}{\sqrt{2}} * \rho = \frac{360\,V}{\sqrt{2}} * 0.92 = 234.2\,V$
- $P_{el\_peak} = U_{eff} * I_{peak} * \sqrt{3} = 234.2\,V * 300\,A\,rms * \sqrt{3} = 121.7\,kW$
- $P_{el_{con}} = 81.1\,kW$

During constant drive we measure:

- n = 2400 rpm

⇨ U_{ph_kn} = 198 Vrms

- I_{actual} = 200 Arms

⇨ $P_{el} = U_{ph} * I_{actual} * \sqrt{3} = 198\,V * 200\,Arms * \sqrt{3} = 68\,kW$

Emrax mechanical peak power (Info from Emrax manual):

- M_t = I_{con}*1.2 Nm/1 A_{ph}rms = 200 Arms * 1.2 Nm/1A_{ph} rms = 240 Nm
- n_{max} = 360 V * 7 rpm/1 V_{dc} = 2520 rpm

⇨ $P_{mech\_max} = n_{max} * \frac{Mt}{9550} = 2520\,rpm * 240\,Nm/9550 = 63\,kW$

18. How to calculate the theoretical DC current value?

(Bamocar D3-PG-700-400)
0xD9 = 1070
0xEE = 700
0xC6 = 2000
ρ = 0.92 (efficiency conversion of about 92 %)
DC Voltage gain factor $U_{DC\_gain:}$ 31.5848 count / 1 V

- AC Current: I_{AC} (RegID: 0x20/0x5F)
  - I_{AC} = 0x5F * ((2000 * 2) / (1070 * 10)) = 0x5F * (400 / 1070) Arms

- DC Voltage: U_{DC} (RegID: 0xEB) (Note: Small Variations possible because of calibration)
  - U_{DC} = 0XEB / U_{DC_gain} = 0xEB / 31.5848 / V

- AC Voltage: U_{AC}
  - $U_{ph} = \left(\frac{U_{dc}}{\sqrt{2}}\right) * \frac{V_{out}}{4096} * \rho$

- AC Power: P_{AC}
  - $P_{AC} = I_{AC} * U_{ph} * \sqrt{3}$

- DC Power: P_{DC}
  - $P_{DC} = \frac{P_{AC}}{\rho} = \frac{P_{AC}}{0.92}$

- DC Current: I_{DC}
  - $I_{DC} = \frac{P_{DC}}{\mathrm{U_{DC}}}$

Note: Calculations of I_{DC} are only about +/- 2 % exact.

19. What to do in case of a hardware power error (POWERFAULT)?

This error is a hardware monitoring #FAULT error.

It is a combined error of:

1. IGBT Temperature error
2. Under-Voltage error of the auxiliary voltage (< 10 V)
3. Voltage error detected on the power board for the reference voltages (15 V, 5 V)
4. Over-Voltage error at the dc voltage link

⇨ These 3 errors are also indicated by the red LED on the power board and the signal I_FAULT

5. High currents in the motor phases detected
   For this there can be several reasons:
   - Damaged hardware (IGBT modules or power board).
   - Oscillating current controller due to bad configurations.
   - Oscillating current controller due to missing or bad resolver shielding (very important).

If the POWERFAULT error is always set right after you set RUN input to high?
→ Broken IGBT module (usually the power board will also be damaged as a result)
If it is set during operation at high torques (high rpm)?
→ Bad settings or bad resolver shielding

Solutions / preventions:

- A measurement with the NDrive oscilloscope and a parameter file (.urf) with your settings always helps to analyse any oscillating currents or bad controller settings.
- Check the quality of your feedback system: “UniTek - Quality check of the feedback angle measurement.pdf” for bad shielding.
- Check the hardware of the IGBT modules using the guide: “Infineon IGBT diodes and resistor check guide.pdf” if you believe that one of the IGBT modules is broken.

20. What does the error (POWERFAULT – Illegal Status Contact Supplier) mean?

This error is usually triggered if the control board detects / receives an IGBT - #FAULT error by the hardware current monitoring system. This means that a very high current was detected.

- Make sure to check your currents using NDrive oscilloscope for any high current over shots or oscillating currents.
- Adjust your current controller, if any unwanted currents (over shots, oscillations) are detected.

The other reason for this fault is that it can triggered by EMI problem on the electronic circuit board / cables. This problem usually appears if the Bamocar has been modified!

Solutions / preventions:

- Improve your shielding of the motor and feedback cables.
- Make sure that there are no HV-cables other LV parts.
- Make sure that the currents are not oscillating and adjust the controller settings.
- A redesign of the current hardware setup might be in order.

21. How to fine tune the resolver FB-offset angle operating a PMS-Motor after the phasing process?

The Goal is to have a centred operating angle (90°) adjusted to the electrical angle of the motor poles. The NDrive phasing process will determine this angle to a precision of about 3 %. Sometimes it is necessary to fine tune this FB-offset angle or generally try to determine this angle manually.

The goal is to have,
Vd with the same value in positive and negative rotation direction,
Vq with the same absolute value in positive and negative rotation direction.

This guide is written for the use of firmware ≥ 746.
In case your firmware is lower, you have to use the variables Vq and Vd and you can skip step 2 and 3.

1. The condition to do a fine tuning of the FB-offset angle is to have a constant load at the motor in both positive and negative rotation direction.

2. Open NDrive → Diagnostic → Manual Read/Write
3. Write at ID Register = 0xdc   and   value = 0x28

4. Open NDrive → Oscilloscop and set:
   - one channel to (dbg)*ptr1 with U/Div = 1000 (≙ Vq_filt)
   - one channel to (dbg)*ptr2 with U/Div = 1000 (≙ Vd_filt)
   - Trigger: On = Chan 1;   Edge = != Lev;   Level = 0
   - Capture: Buf = 2000;   Run = Single;   Timescale = 100ms;   Pre trig = 0 %

5. Send a positive motor speed command e.g. +5000 (with a constant load (and no field weakening))
   -> Press "Run" to do a measurement.
   -> Remember ptr1 (Vq_filt) and ptr2 (Vd_filt) values.

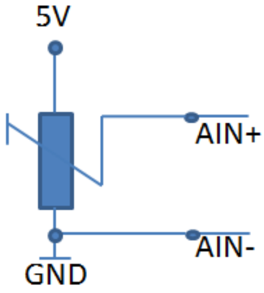
6. Send a negative a motor speed command e.g. -5000 (with a constant load (and no field weakening))
   -> Press "Run" to do a measurement.
   -> Compare ptr1 (Vq_filt) and ptr2 (Vd_filt) values with the measurement beforehand.

*You can also just Open NDrive → Diagnostic → Track   and add (dbg)*ptr1 (≙ Vq_filt) and (dbg)*ptr2 (≙ Vd_filt) comparing the results from there.*

The goal is to have,
Vd with the same value in positive and negative rotation direction,
Vq with the same absolute value in positive and negative rotation direction.

Repeat steps 5 and 6 until while adjusting the FB-offset angle until you have the best result possible.
It is best to check your result using 1..3 different motor rotation speeds.

22. How to test the correct analogue connections and the range of command control?



For testing the correct analogue input and calculations you do not need to enable the drive.
Just apply your 5V dc supply to your throttle, switch on the drive and you can see in NDrive on the page speed on the top left your input and calculations (Offset, Cutoff, Scale). The range will then be between 0 and 32767 (Scale = 2.2).

The calculation is Ain x scaled = (Ain in + Offset) * Scale

23. How to load or save all parameters to the different Eeprom sectors using a CAN command?

In order to save your current settings to one of the 2 Eeprom sectors (0 and 1) or if you wish to load your settings from one of the 3 Eeprom sectors (0, 1 and 2) **the drive must be disabled**.

Write / Read parameter to / from Eeprom sectors:

- Read:
  - RegID: 0x83 ; Byte[1] = 0,1 or 2 (≙ sector inside Eeprom)
    - Msg = {0x83; 0x00; 0x00} "Read from sector 0"
    - Msg = {0x83; 0x01; 0x00} "Read from sector 1"
    - Msg = {0x83; 0x02; 0x00} "Read from sector 2"

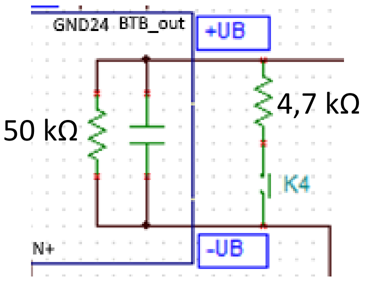
- Write:
  - RegID: 0x84 ; Byte[1] = 0 or 1 (≙ sector inside Eeprom)
    - Msg = {0x84; 0x00; 0x00} "Write to sector 0"
    - Msg = {0x84; 0x01; 0x00} "Write to sector 1"

24. What is the discharge time of the DC Bus after disconnecting the HV supply?

Inside the Bamocar there are 2 parallel connected 100 kΩ (15 W) passive bleeder resistors (= 50 kΩ) in order to discharge the capacitors with a capacity of 320 µF after disconnecting the HV supply at the DC Bus.

Time for discharge: (R-ZW = 50 kΩ; C-ZW = 320 µF)
T = R-ZW * C-ZW = 16 s (discharge time for 63 %)
→ Total discharge time = 5 * T = 80 s

The discharge time can be shortened by switching an extra external resistor between U+ and U- via a relay (K4) after disconnecting the HV power supply (e.g. 4.7 kΩ). Of course it is important not to close the relay while the HV supply is still connected.



Total discharge resistance: (2 * 100 kΩ (internal) + 4.7 kΩ (external))
→ 1/R = 1/100 kΩ + 1/100 kΩ * 1/4.7 kΩ
→ R-ZW-new = 4.296 kΩ

The capacitors in the DC Bus are in total 320 µF.
Whether with a 100 V or with 700 V for the HV supply the discharge time for the capacitors will always be the same.

Time for discharge: (R-ZW-new = 4.296 kΩ; C-ZW = 320 µF)
T = R-ZW-new * C-ZW = 1.37472 s (discharge time for 63 %)
→ Total discharge time = 5 * T = 6.8736 s