Changing Hardware Parameters with Kinetis Motor Suite

Summary

This document describes the procedure of changing of bus voltage and current limits in the Protection and Hardware tab of Kinetis Motor Suite, included the directions used to modify the TWR-MC-LV3PH card.

Make Circuit modifications or build your own circuit:

Make circuit modifications to the TWR-MC-LV3PH board to increase the current and the voltage of the board. A heatsink must be added to dissipate the heat of the extra current and voltage.

Increase Current:

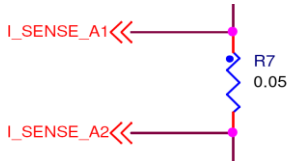
There are two ways to change the maximum current to the motor to the ADC inputs of the MCU. We can either change the sense resistor or change the gain of the amplifier. The inputs must not exceed the MCU's VDDA or VREFA of the MCU of 3.3V.

Current calculated with the sense resistor and op-amp component selection:

$$\boldsymbol{G\ (amplifier\ gain) = \ Rsense * \frac{R40}{R39 + R38}}$$

$$\boldsymbol{I\ (Max\ Current) = \frac{VDD\ V}{2 * Gain\ V/A}}$$

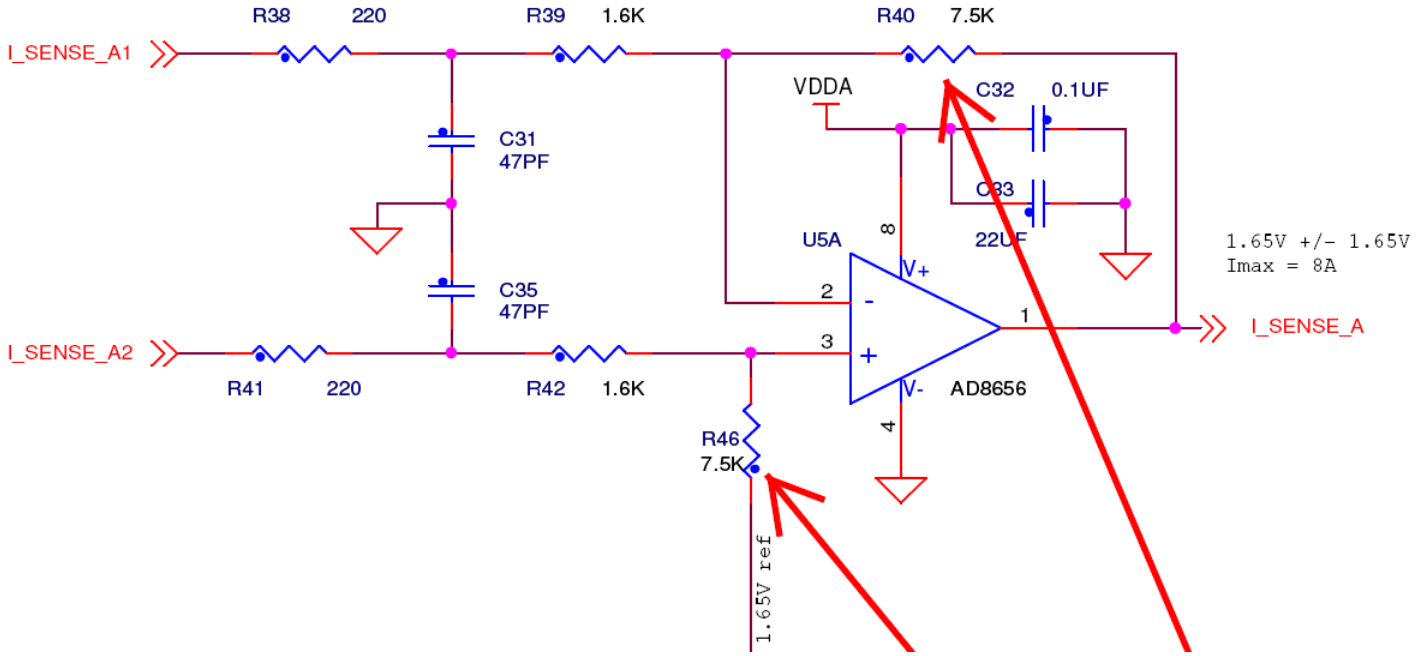
As delivered the sense resistor is 0.05 Ohms.



Plugging in the resistor values of the tower board we get a gain of 0.206 and a max current of +/- 8 Amps.

$$\boldsymbol{Gain = \ 0.05 * \frac{7.5\ K}{220 + 1.6K}} \boldsymbol{= 0.206}$$

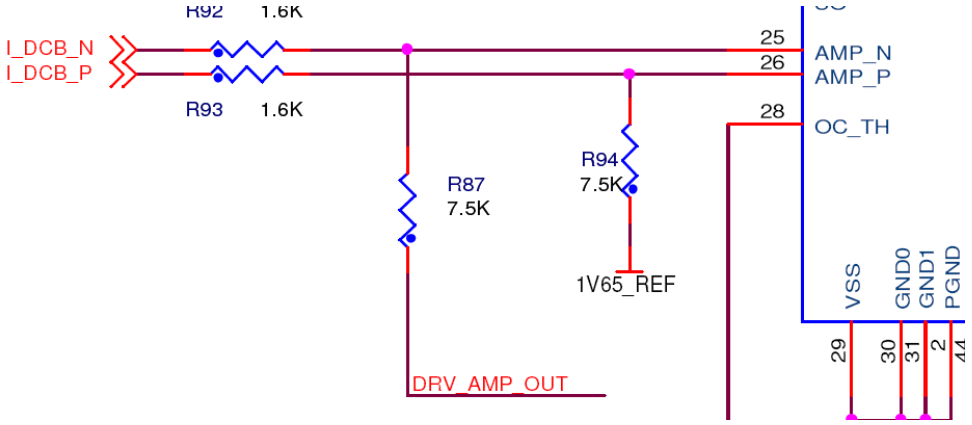
$$\textbf{Maximum Current} = \frac{33.3}{2 * 0.206} = \ 8\ A$$



We need to change several components to adjust the gain of the op-amp. So we are changing:

1. R40 and R46 for I_SENSE_A,
2. R52 and R59 for I_SENSE_B,
3. R65 and R70 for ISENSE_C,
4. R73 and R78 for I_SENSE_DCB if R86 is populated.

Otherwise the voltage input to the AMP in of the MC39937 between I_DCB_N and I_DCB_P must be size to be within spec. by changing R87 and R94.



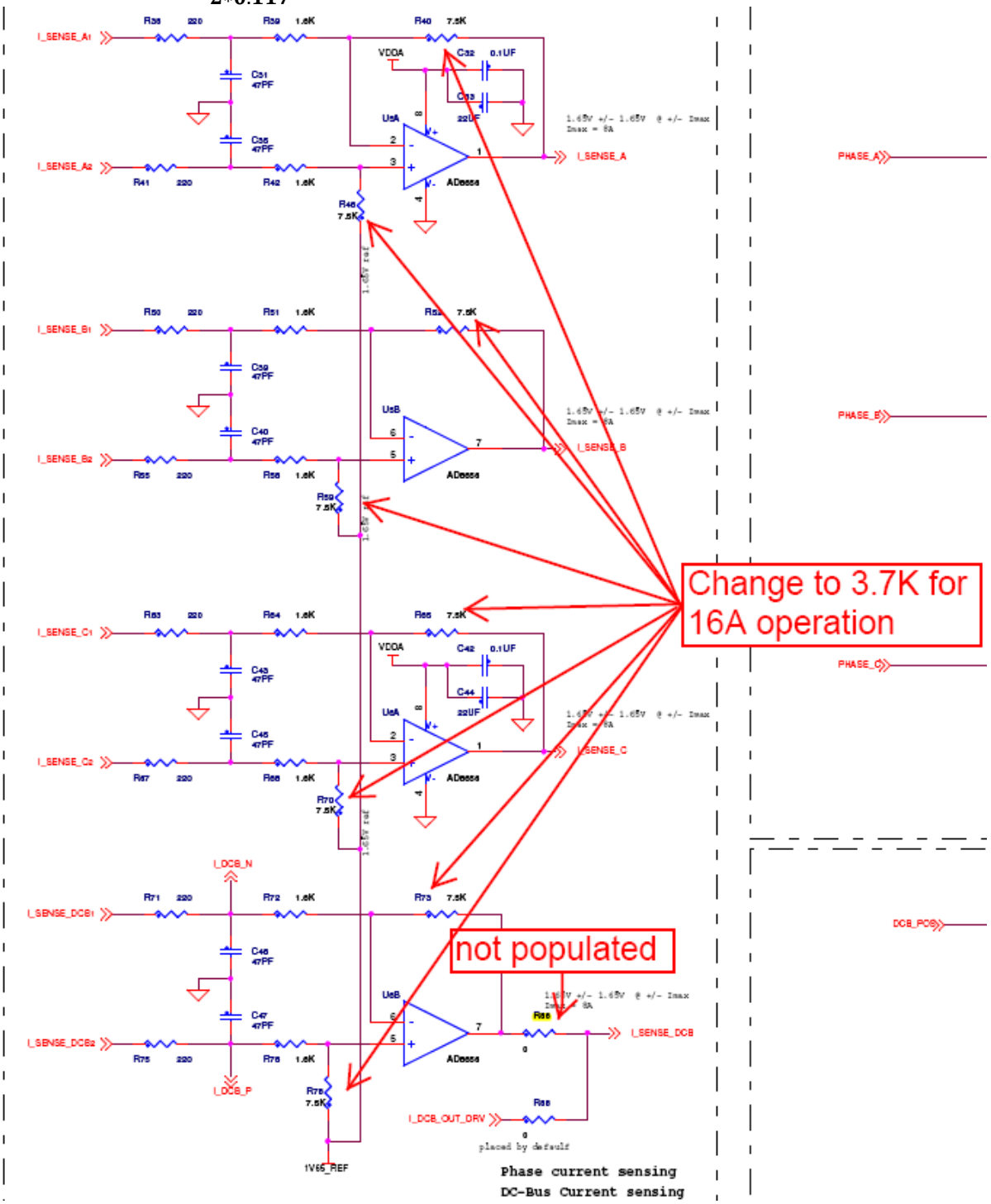
Solving for the R_f feedback resistor in the circuit, where Rin is the input resistance in the gain path and Rs is the current sense resistor.

$$Rf = \frac{VDD * Rin}{2 * I * Rs}$$

If we want a 16 amp circuit change the resistors to 3.75K

$$\mathbf{0.05} * \frac{\mathbf{3.75}\boldsymbol{K}}{\mathbf{1.82}\boldsymbol{K}} = \mathbf{0.117}\ \text{(Gain)}$$

$$\frac{\mathbf{3.3}\ \boldsymbol{V}}{\mathbf{2}*\mathbf{0.117}} = \textbf{16.016 Amps (Max Current)}$$



In case the board maximum current scale is increased to 16Amps and original shunts (current measurement resistors) are not updated as well, then there is a high risk of board damaging / burning.

The original shunts 0.05 ohms have maximum power rating **2Watts**. However for 16Amps and considering harmonic sinusoidal signal maximum power rating can be:

$$P = R \times i^2 = 0.05 \times \left(\frac{16}{\sqrt{2}}\right)^2 = 6.4 \text{ Watts}$$

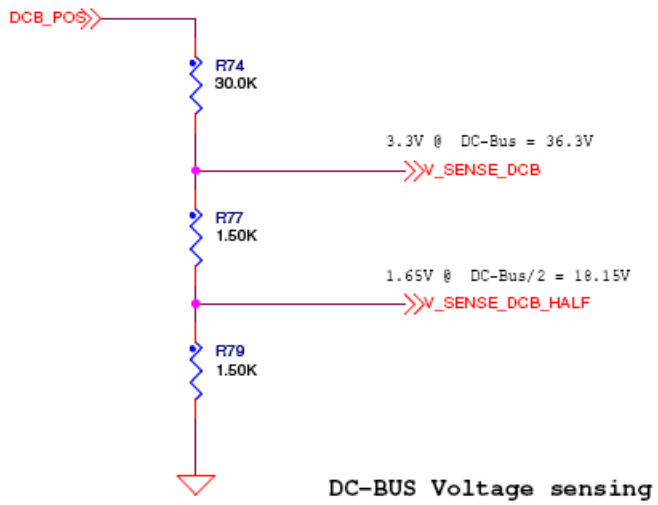
Such high power dissipation will cause shunt burning. Therefore an increase in the maximum power rating of the shunt resistors is required.

If we want a 20 amp circuit reduce the shunt resistor to decrease the gain even more.

Increase Voltage

If the nominal voltage of your motor is 48V you must modify the board to adjust the Maximum DC Bus. You must modify the hardware so that the Maximum DC Bus is greater than 60V (48V * 1.25).

Max voltage of the DCB_POS change requires modification of R74, leaving R77 and R79 alone.



$$Vbusmax = 3.3V = DCB\_VMAX \ * \frac{R77 + R79}{R74 + R77 + R79}$$

Solving for R74

$$R74 = ((DCB\_VMAX/\text{Vinmax}) * (R77+R79)) - R77 - R79$$

$$R74 = \left(\frac{48V * 3000}{3.3\,V}\right) - 3000$$

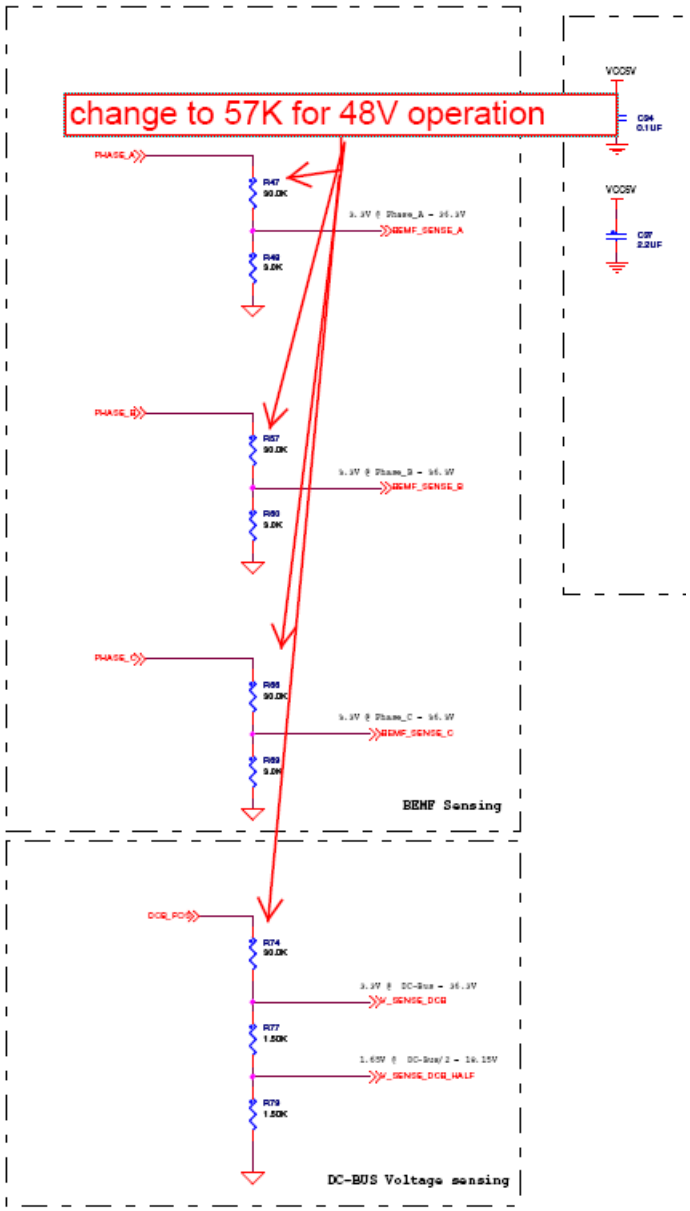
Leaving R77 = R79 = 1.5K

For a nominal bus voltage of 36 V use a voltage greater than 36*1.25 - Use DCB_VMAX = 48V → R74 = 40.6 K ohms

$$R74 = \left(\frac{66.7V * 3000}{3.3\,V}\right) - 3000$$

For a nominal bus voltage of 48V use a voltage greater than 48*1.25 - Use DCB_VMAX = 66.7 V→ R74 = 57 K ohms

For BLDC Motor control methods that use the back EMF voltage instead of Current then, R57, R66, R47 and R74 must be changed together.

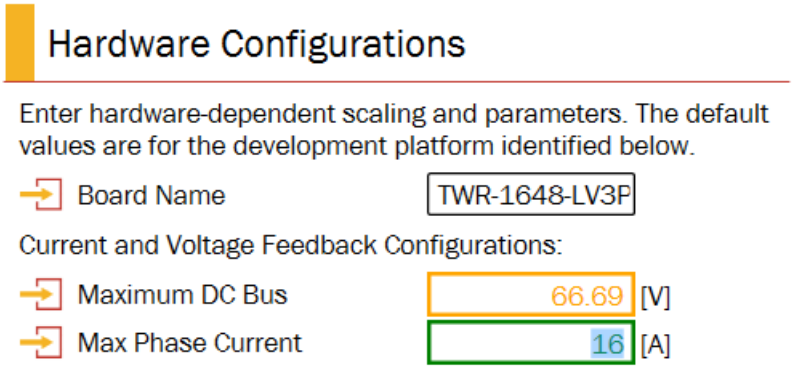


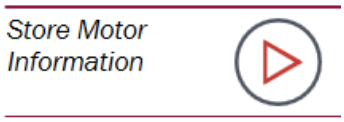
Kinetis Motor Suite GUI changes

1. **Create a new KMS project with the TWR-KV31 and KDS or IAR**
2. **Identify: To update the correct identify values for current, first choose the wizard button in the bottom right of KMS window** 

3. **Select the button (shown here after I selected it)**
4. **Update Board Name, Set the Maximum DC Bus and Max Phase Current**

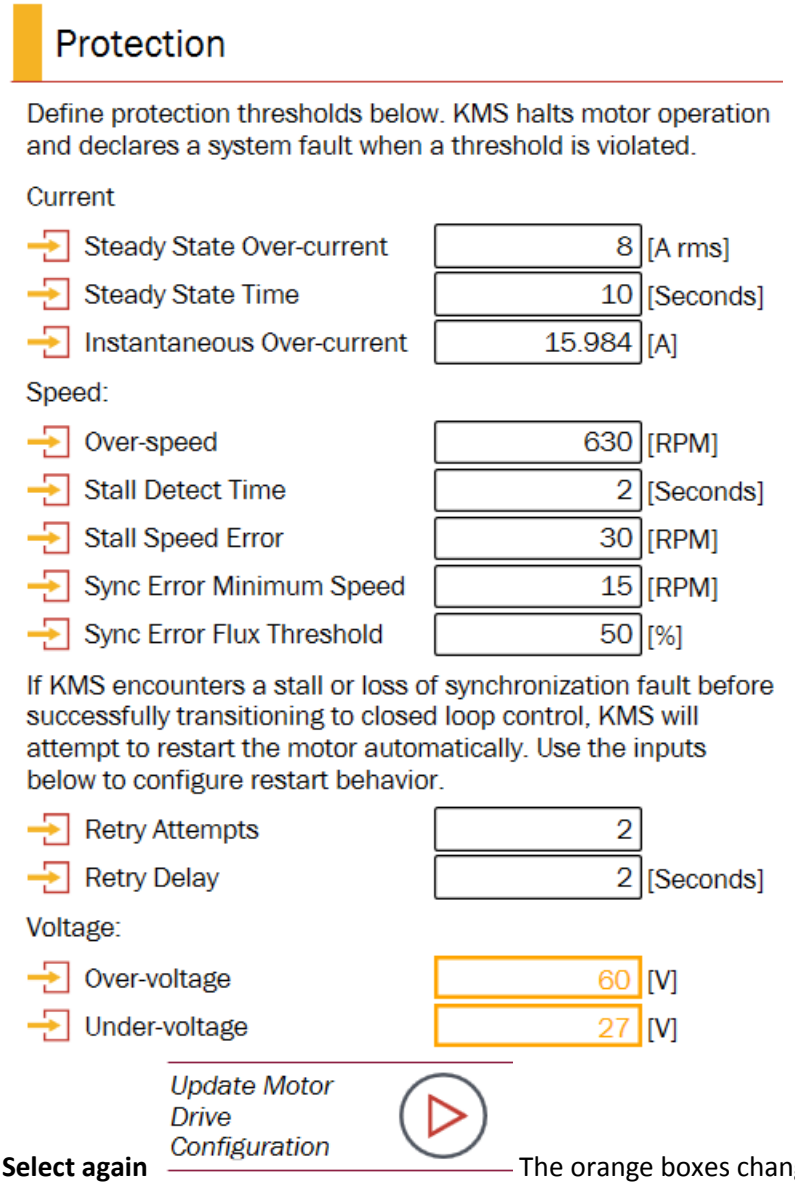
Enter the maximum Phase Current → 16.058A
Enter the maximum DC bus voltage → 62V





Select → Note: you might get a fault notice after this. Not to worry.

5. **In the Protection Parameters set; Set the Steady State Over-Current, Instantaneous Over-current, Select the Overvoltage and Under voltage limits .**

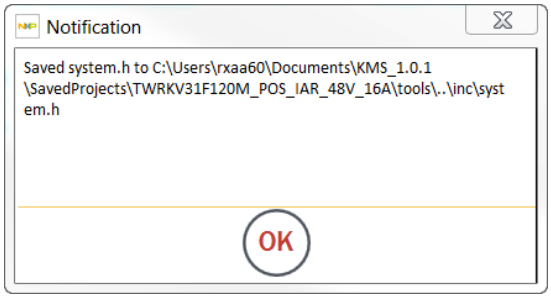


6. **Select again** The orange boxes change to black.

Store Motor Information 

7. **Before leaving this screen select** ——— **to update the system.h file**

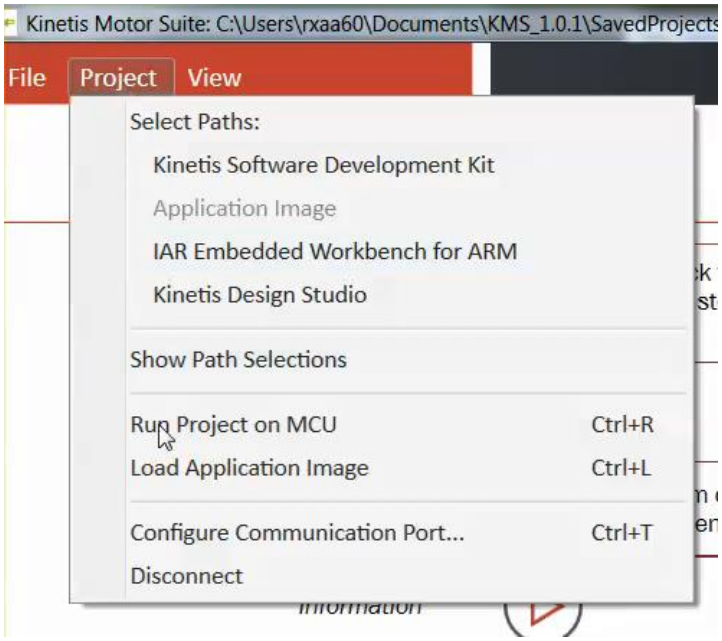
```
{ /* DSM_faultThresholds_t*/
  true,
  _LQ(60.0/FULL_SCALE_VOLTAGE),
  _LQ(27.0/FULL_SCALE_VOLTAGE),
  (uint16_t)(0.4*1000.0),
  _LQ(630.0/FULL_SCALE_SPEED_RPM),
  _LQ(30.0/FULL_SCALE_SPEED_RPM),
  (uint16_t)(2.0*1000.0),
  _SQ8(65.0),
  _SQ8(80.0),
  _SQ(8.0/FULL_SCALE_CURRENT),
  (uint16_t)(10.0*1000.0),
  _SQ(15.98/FULL_SCALE_CURRENT),
  _LQ((0.0187741225407/FULL_SCALE_FLUX)*0.5),
  _LQ(15.0/FULL_SCALE_SPEED_RPM)
},
```



8. **Press Ok to acknowledge Save.**

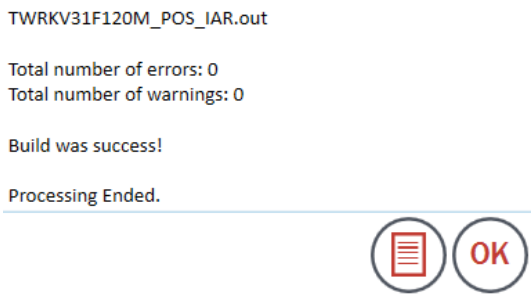
NOTE: This process saves the parameters you have changed in the system.h file, but that file has not been added to the image of the project in the MCU. So that we don't have issues with parameter measurement steps we need to compile the entered parameters into the project and download them to the flash of the MCU. Only then can we proceed with Automatic Electrical and Mechanical measurements.

9. **Select Project → Run Project on MCU**

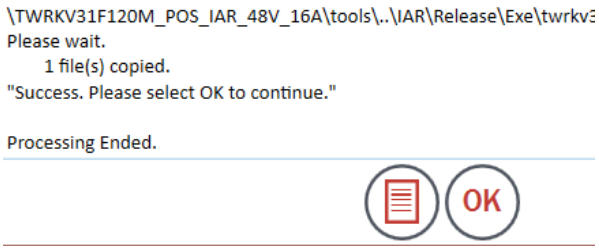


to compile the system.h file into the flash image on the MCU.

10. **You should get no errors or warnings – Select → OK to start the loading of the image to the MCU's Flash….**



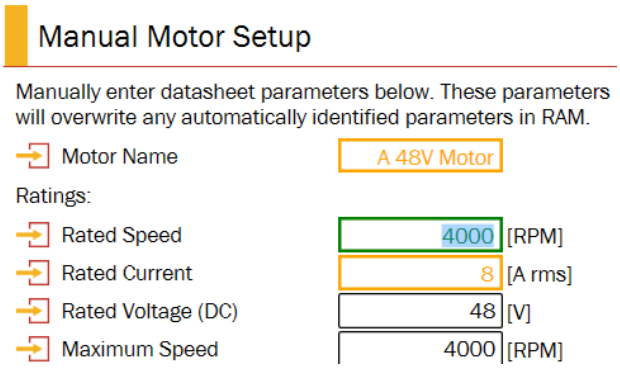
…. To start the loading of the image to the MCU's Flash.

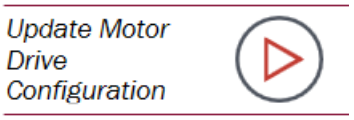


Select → OK.

11. **Go to the Advanced Tuning step by selecting (shown here after I selected it).**

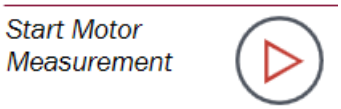
12. Enter the information for the motor



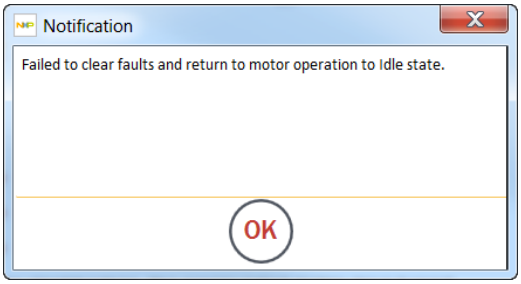
13. Select again 

The orange boxes change to black.

14. Select the Identify Tab 

15. Then choose 

to start the Motor measurements.
Select NO to this prompt to restore the default settings

16. You may get a fault – if you get this 

go back to Protection and Hardware. 

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NOTE: What has happened is that during parameter measurement the bus voltage was measured and and a new value stored in the flash parameters fault maximum voltage. This occurred because you missed a step above or if during the Run project on MCU step you got an error during the compile. Check you software version KMS, KSDK and KDS to make sure you have all the latest compatible software tools.

You can now select → 

and proceed with tuning/ parameter measurement.