Problem: For new users of an intelligent drive, starting to implement a motion control application can be a quite complex task. You need to know how to hook-up the components of the motion system, to configure them (motor, sensors and drive), test their functionality, identify parameters and tune controllers. Finally, execute a simple movement to validate the basic system functionality and focus on your real motion application.

Solution: ♦ **Drive**   :   Technosoft Intelligent Servo Drive **IPM240 – 5E**
                  ♦ **S/W environment** :   Technosoft **IPM MotionStudio – V2.0.1.1** or above

Description: This Application Note explains:
- how to perform the basic hardware connections for IPM240 – 5E and brushless motor with encoder/hall sensors;
- how to create under the 'IPM Motion Studio' a new project/application for motion control with a brushless motor;
- how to configure the components of the motion system: motor, sensors, drive;
- how to test the functionality of the system components;
- how to identify the motor parameters and tune the controllers;
- how to run and use data analysis tools;
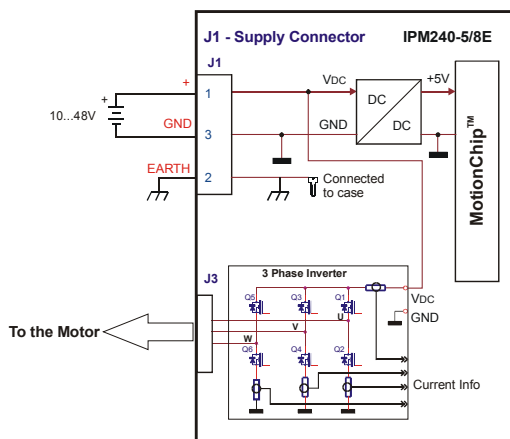- how to save your project/application;

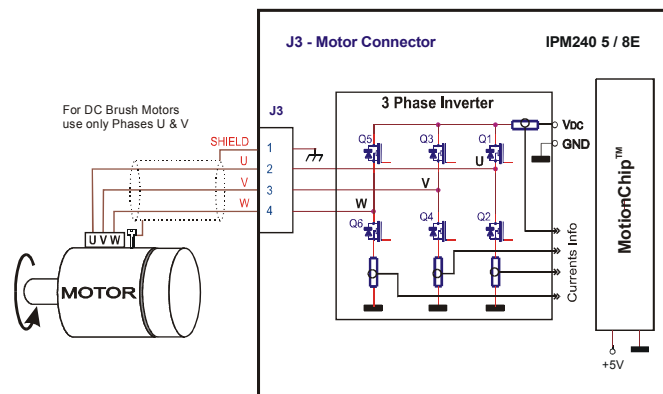**Connections:**

***Figure 1.** Power Supply – J1 connector*   ***Figure 2.** Motor – J3 connector*
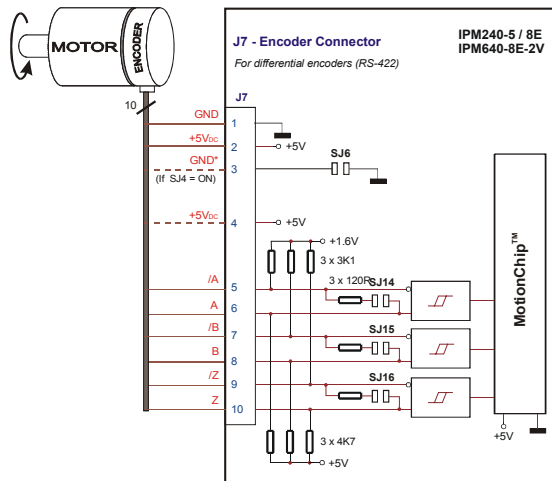
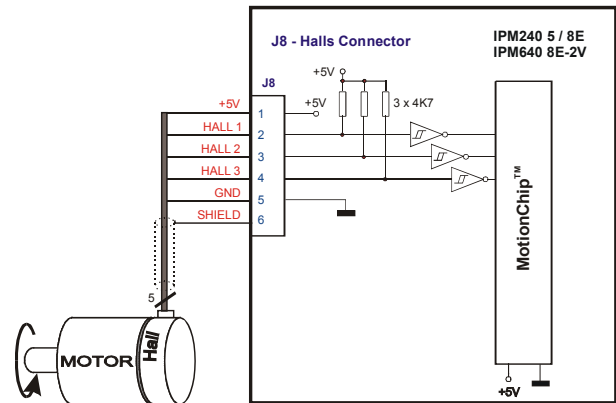**Figure 3. .** *Encoder - J7 connector (differential encoders)*
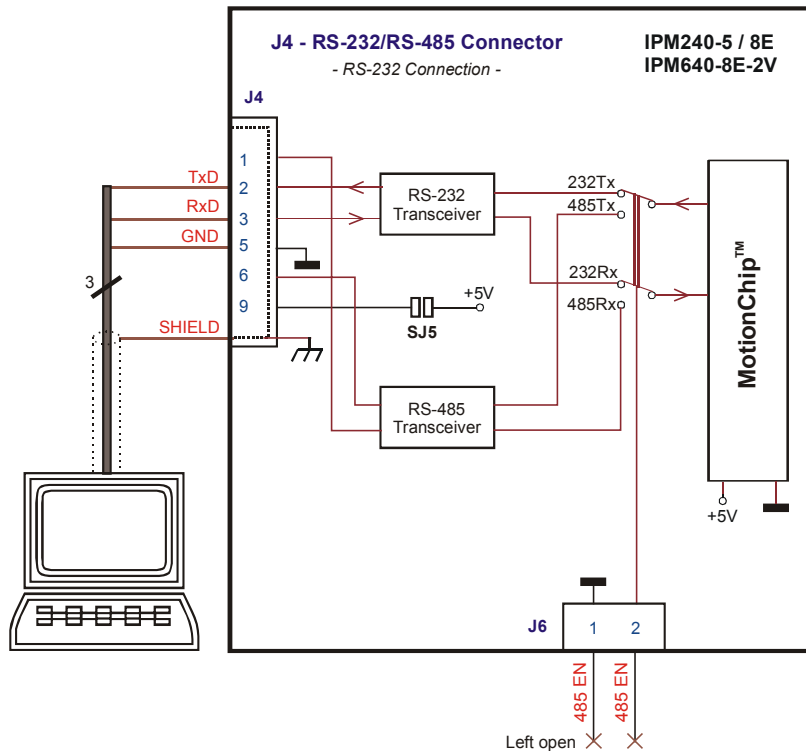

Figure 4. *J8 – Halls connector*

Figure 5. *RS-232 connection diagram*

Please follow the next steps for a hardware connection of the system components:
1. Connect the power supply, the motor, encoder and halls to the IPM240 – 5E drive as you can see in the Figure1, Figure 2, Figure 3 and Figure 4 respectively.
2. Connect the IPM240 – 5E drive to the PC computer as you can see in the Figure 5
3. If you have also an IO240 board then please connect it to the IPM240 – 5E drive as you can see in the Figure 6
4. First power up the PC
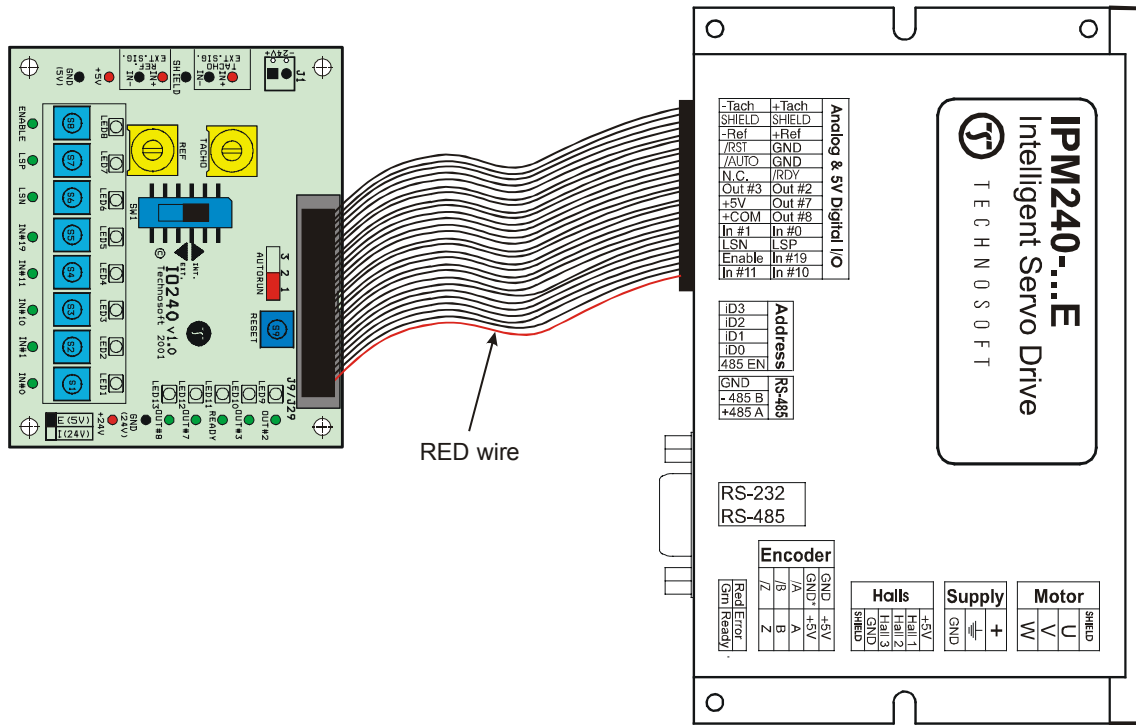5. Secondly power up the drive

*Figure 6. Connecting **IO240** with IPM240 board*

Project set-up:

1. **Start the execution of IPM Motion Studio**; use the Windows "**Start | Programs | IPM Motion Studio | IPM Motion Studio**" menu command. A dialog as in Figure 7 should be displayed if the communication with the board is established and operates properly.
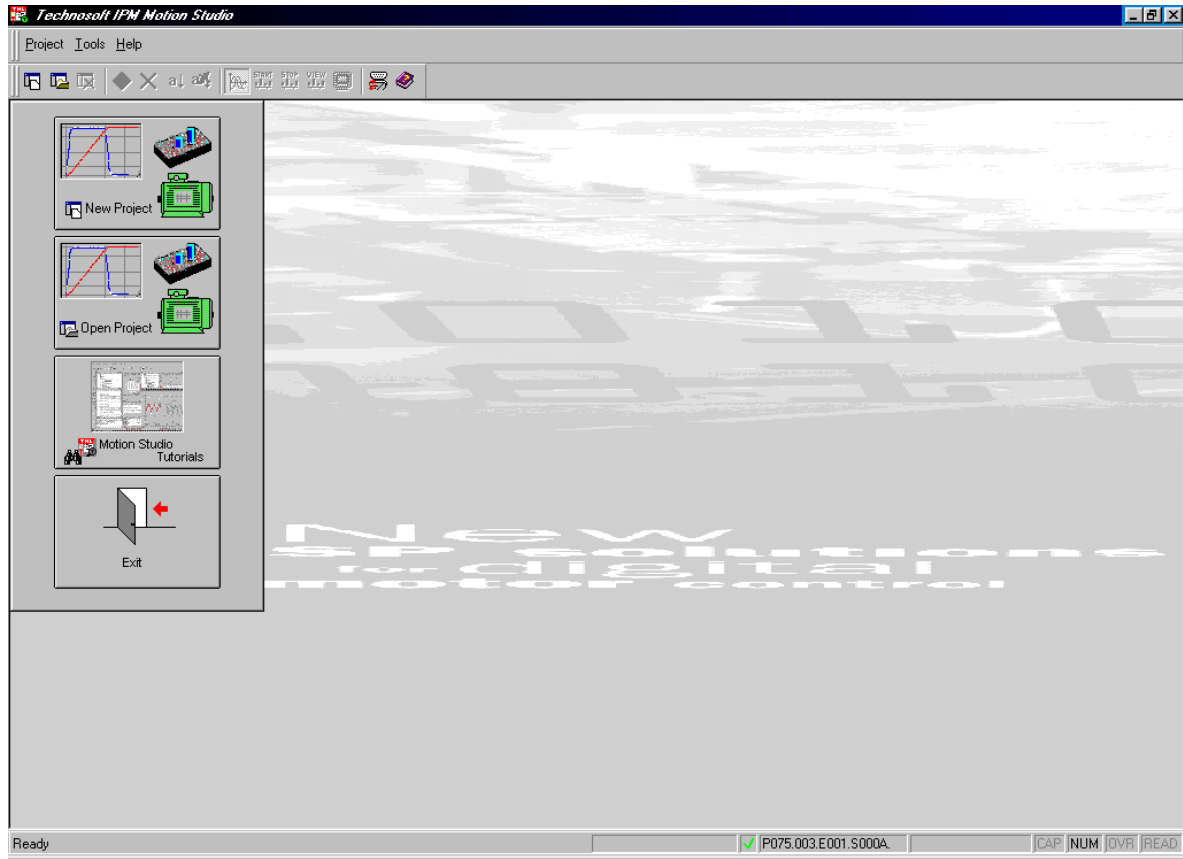

Figure 7. IPM Motion Studio opening screen

Remarks: If the board is not detected, the "**Board NOT found**" message is displayed in the bottom of the program window. In this case check first the serial cable and the power supply connections on the IPM240 and PC, exit the program and launch it again. Alternatively, use the "**Tools | Refresh Serial Settings**" menu command, to retry to communicate with the drive. If the board was detected, the text "**Board present**" or the board type and version (e.g. "**P075.003.E001.S000A**") is displayed in the bottom of program window. In this case, the communication between the IPM drive and the PC works fine, so you can start to use the program.

Otherwise, if the problem persists, follow the next steps:
   a. From the **Tools** menu, choose **Options**. This command opens the **Options** dialog box.
   b. Select the **Serial port** tab from the **Options** dialog box. Select the "**Serial type**" (RS-232 for a single axis structure). Try to start using a smaller **Baud rate** value (as 9600). For single axis structures (only one IPM exists in the system and is connected directly to the PC), set the "**Host Address**" as 255 (default). Select the correct "**COM Port Number**" of the PC, where the serial cable was connected. Press the **OK** button. If the communication with the IPM drive does not operate properly, an error message is displayed "**Cannot open the serial port**". Check if the selected COM port is correct, and not used by another resource of the PC (as mouse, modem, etc). Try again.
   c. If the communication works properly, pressing the **OK** button will exit the **Options | Serial port** dialog, without an error message, and the "**Board present**" or the board type and version (e.g. "**P075.003.E001.S000A**") is displayed in the bottom of program window.
   d. You can in this case try to increase the baud rate, up to the maximal 115 kbaud allowed by the PC.
   e. If the communication operates usually but gives communication errors from time to time, try to increase the "**Read interval timeout**", "**Timeout multiplier**" and "**Timeout constant**" parameters, from the same **Options | Serial port** settings dialog. Note that this is related to some PCs hardware operation, and that usually the default values for these parameters need not to be modified.
   f. Note that the IPM Motion Studio program can be used offline, with no IPM connected to the PC, or powered-up. All the modeling, project and applications definition, and program wizards can be used to configure and parameterize the system and define the motion. Obviously, no IPM information, motion system parameter identification and measurement data can be performed or displayed.

2. Start a new project

All the applications in IPM Motion Studio are organized as projects. A project is specific for a selected type of IPM drive (IPM100, IPM240 or IPS150) and a specific motor type (DC brushed, brushless or step motor). Press the "**New Project**" button, and select the type of the drive and motor you installed in your system:
  "**IPM240 ->IPM240 – 5E -> Brushless Motor**", in order to create such a new project.
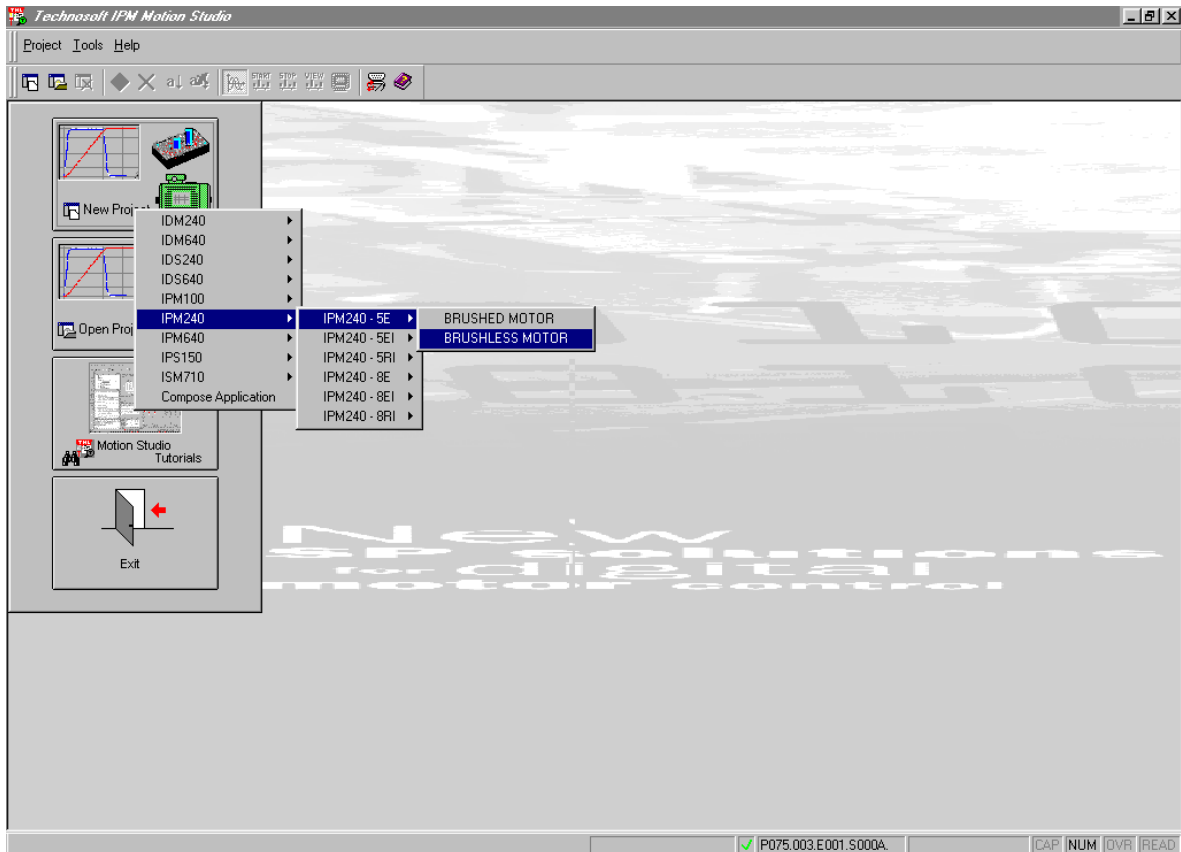
Figure 8. *Create a new project in IPM Motion Studio*

3. Project diagram structure

A schematic diagram of the motion system will be displayed on the screen. It contains the three basic elements of the system, i.e. the motor and sensors, the drive and, as a separate component, the motion reference generator module. Each of these elements can be selected and will allow you to define the parameters and specific settings associated to that element. Note that the new project is opened with some elements already pre-loaded. You need to change / test / validate these elements, in order to fit to your configuration, as described in the next steps. A small arrow pointing to the left upper corner of the element shows you which element to define/check next.
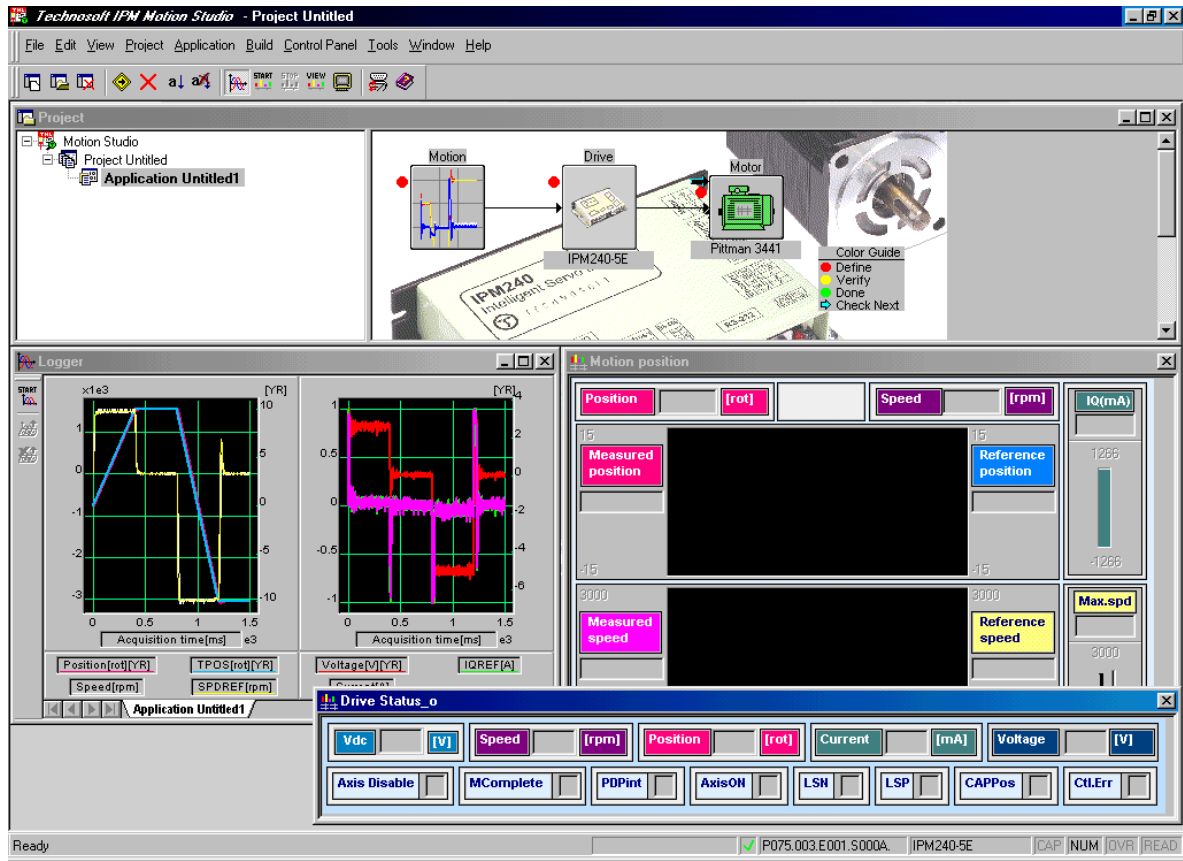
Figure 9. Motion system diagram in IPM Motion Studio

4.   Choose and test the motor and load

Click on the **Motor** icon. The motor and load dialog will be opened, as in Figure 10.

The dialog allows you to choose and / or parameterize your motor and sensors. You can select the motor from a predefined database ("**Default Brushless Motors**" or "**User**"). You can also, starting from a given motor, change its parameters, in order to fit your motor characteristics.

Several specific tests can be performed, allowing you to check the correctness of some motor parameters, the correct operation of existing sensors as encoder and/or Hall, and connection of motor to the drive.

WARNING! Note that most of these tests apply power to the motor. Please check carefully the motor parameters, mainly the nominal and maximum current values. Each test applying a voltage to the motor will be performed with a protection limit on the current. If this limit exceeds the motor maximum current, severe damage of the motor can occur!

In order to perform the tests in the proper order, use the "**Guideline Assistant**" textbox, and follow the steps as described there (the following example is given for a brushless motor used with an IPM240 drive; note that for step motors configurations, different dialogs and tests can be performed):

Step 1. Select your motor from the corresponding database. If your motor does not exist in the database, proceed through all the steps in order to define your motor and sensors data. In either case, use these steps to verify the new functionality.
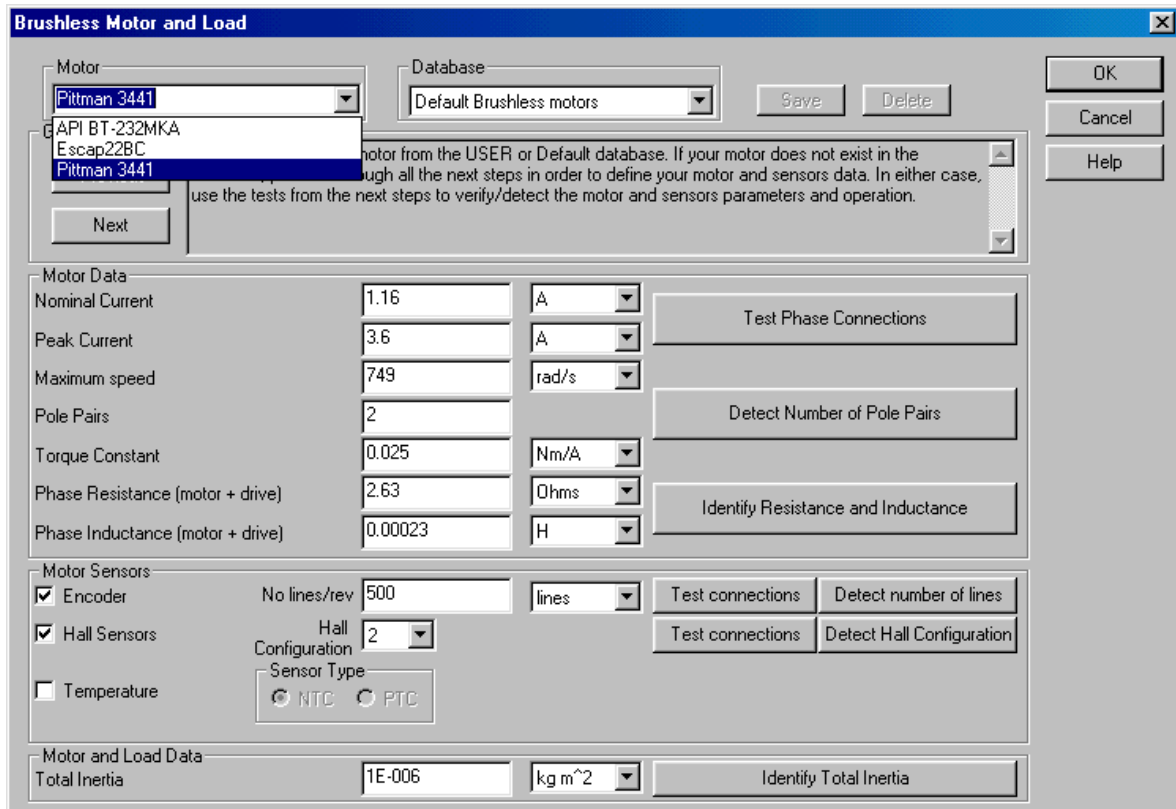

Figure 10. *The Motor Dialogue*

Step 2. Check the values for ***nominal*** and ***peak currents*** (given by the motor catalogue data). Modify these values if needed. Press the **"Test Phase Connections"** button to verify that your motor phases are well connected to the drive. The "**Motor Phases Connection Test**" dialog will open. Check the value of the current to be used during the test, and follow the "**Test Procedure**" steps. The test applies a positive voltage on one motor phase (A) and the negative half of it on the other two phases (B and C). Consequently, the measured currents on two motor phases must be in relation $I_A = -2*I_B$. If the test is passed, it validates the physical connection of

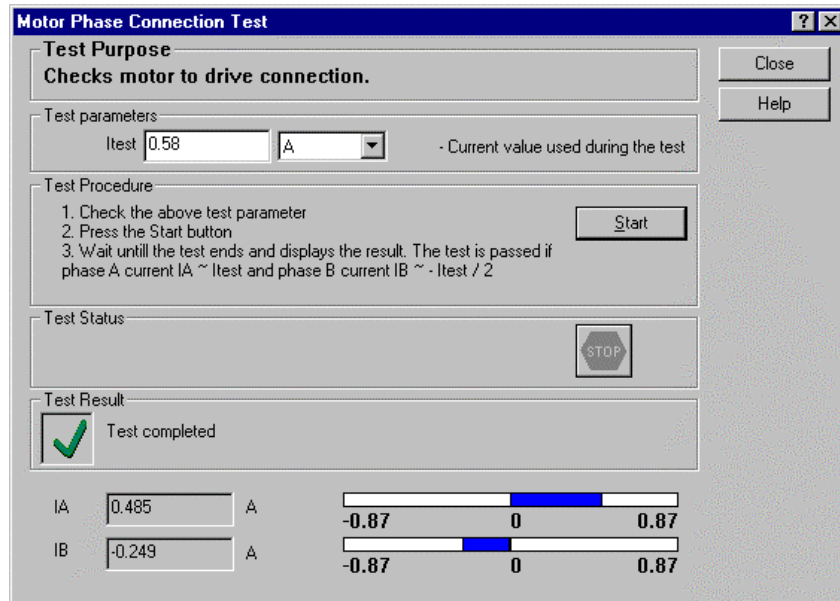motor phases to the IPM drive, and the correct operation of the current measurement interface on the drive.

Figure 11. Motor Phases Connection Test

Step 3. Check the *maximum motor speed* value, as a motor catalog data. Modify this value if needed.

Step 4. Check the *number of motor pole pairs*. Modify this value according to motor catalog. In order to check or automatically detect this value, press the "**Detect Number of Pole Pairs**" button. The "**Motor Pole Pairs Detection Test**" dialog will open. Check the value of the current to be used during the test, and follow the "**Test Procedure**" steps. The test successively rotates the motor by one electrical period, and requires you to visually detect one complete mechanical rotation of the motor. Once finished, the test will display the number of pole pairs of the motor.
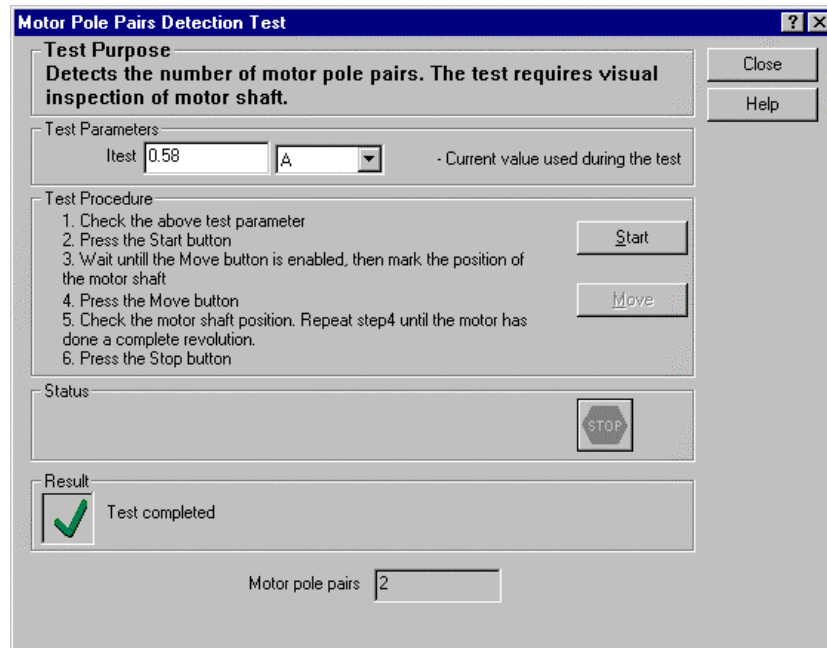
Figure 12. *Motor Pole Pairs Detection Test*

Step 5. Check the *torque constant* value, as a motor catalog data. Modify this value if needed.

Step 6. Check the *phase resistance* and *inductance* values (these are the motor catalogue data). Modify these values if needed. Press the "**Identify Resistance and Inductance**" button to automatically detect these parameters. The "**Motor Resistance and Inductance Identification Test**" dialog will open. Check the value of the current to be used during the test, and follow the "**Test Procedure**" steps. The test will finally identify the motor phase resistance and inductance. Note that when exiting this dialog, if the identified values differ from the catalogue ones, you'll be asked to confirm the replacement of the old parameter values with the newly identified ones.
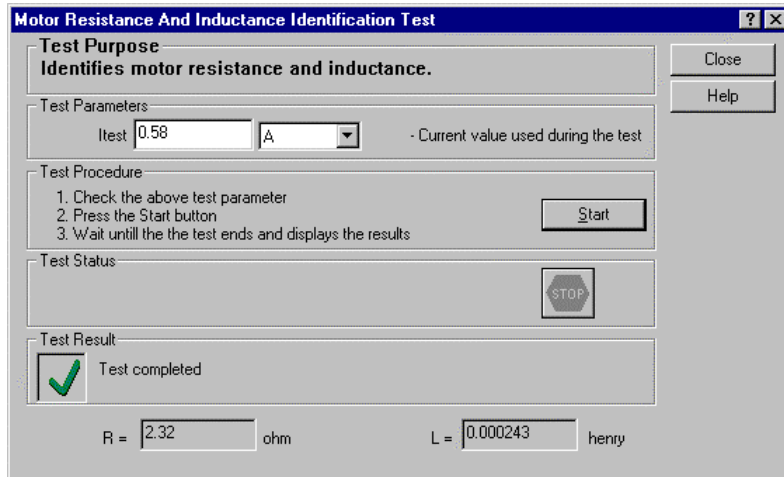
Figure 13. *Motor Resistance and Inductance Identification Test*

Step 7. Check-in the "**Encoder**" checkbox if a quadrature incremental encoder is mounted on your motor shaft. Use the "**Test connections**" button in order to verify the operation of A and B encoder signals. The "**Encoder Connection Test**" dialog will open. Follow the "**Test Procedure**" steps. The test will visually show the motor shaft movement, as measured from the encoder signals. You need to manually move the motor shaft. No voltage is applied to the motor for this test. If either A or B signals are defective, the motor position indicator will not move on the dialog while you move the motor shaft.
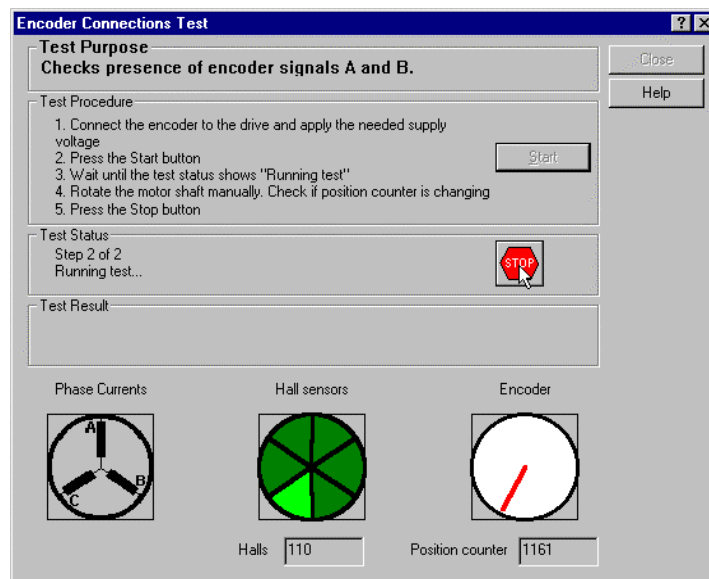

Figure 14. *Encoder Connection Test*

Check the value of the *encoder number-of-lines/revolution* parameter. Press the "**Detect number of lines**" button in order to auto-detect this value. The "**Encoder Counting Direction And Resolution Test**" dialog will open. Check the value of the current to be used during the test, the number of motor pole pairs, and follow the "**Test Procedure**" steps. The test will rotate the motor shaft with one mechanical rotation. The measured number of counts from the encoder will be used to detect the estimated number of encoder lines per revolution. Note that the "**Measured position counter over one revolution**" value is the exact number of encoder pulses measured during this movement. It is 4 times bigger than the number of lines of the encoder over the same movement. The "**Estimated encoder lines / revolution**" value is computed as the closest standard value corresponding to the measured number of encoder pulses.
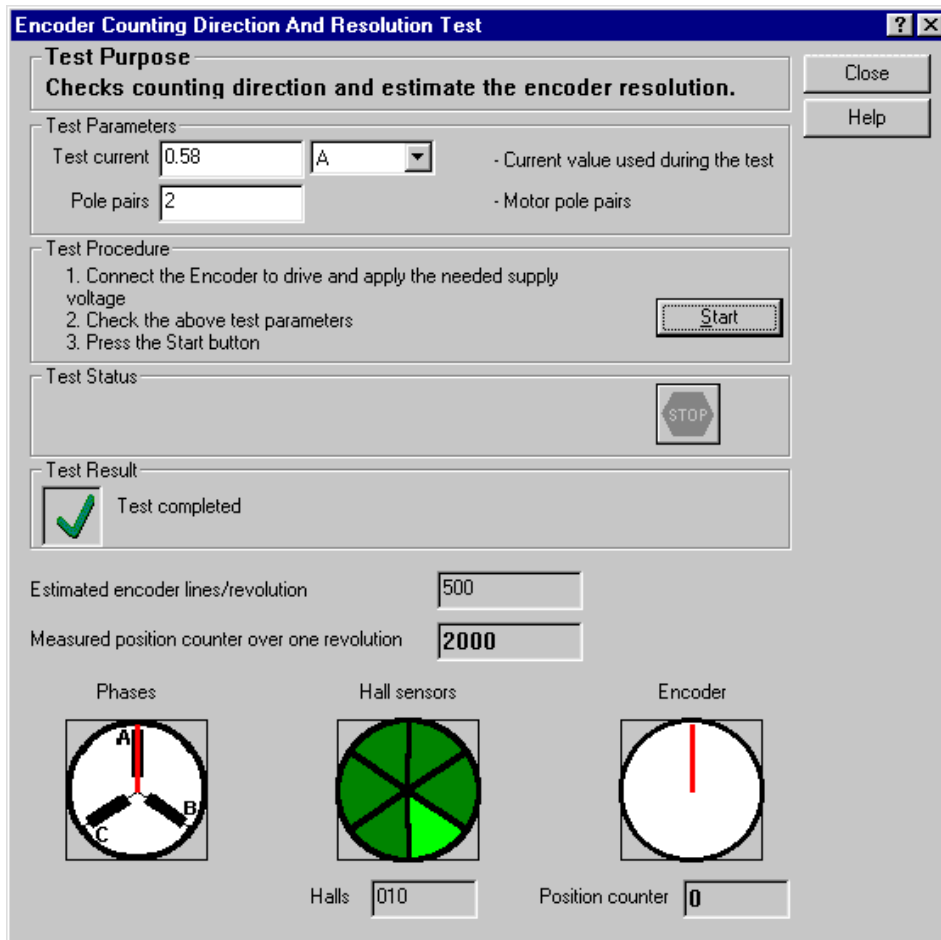

Figure 15. *Encoder Counting Direction and Resolution Test*

Step 8. Check in the "**Hall Sensors**" checkbox if Hall sensors are mounted on your motor. Use the "**Test connections**" button in order to verify the operation of the 3 Hall sensor inputs. The "**Hall Signals Connection Test**" dialog will open. Follow the "**Test Procedure**" steps. You need to manually move the motor shaft. The test will visually show the motor shaft movement, and the commutation of different sectors, as defined by the status of the three Hall sensors of the motor. The test is passed if during the motion, all the six possible combinations of the Hall signals are covered. If any of the signals is not changed during the test, it will be reported as defective.
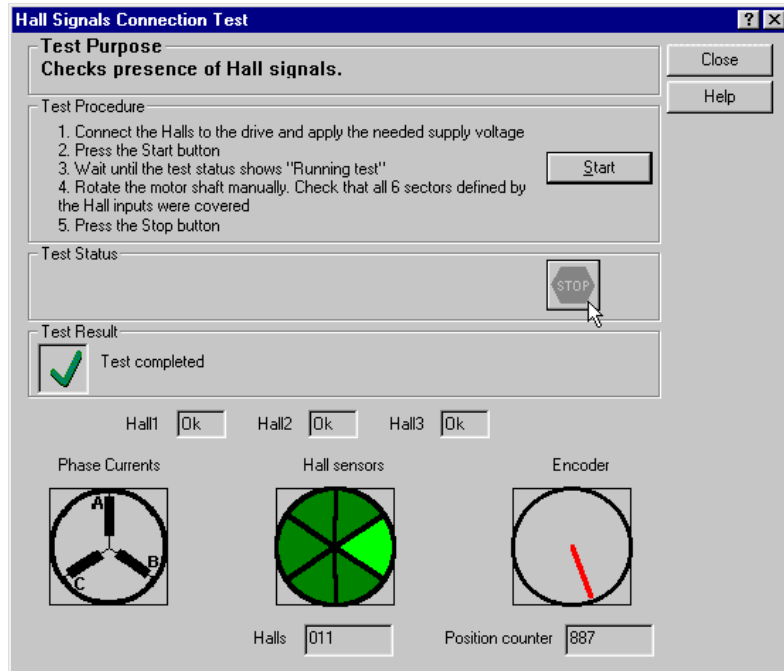

Figure 16. Hall Signals Connection Test

Check the ***Hall configuration*** parameter value. Press the "**Detect Hall Configuration**" button to auto-detect the sequence of Hall sensor connection to the drive (Hall Configuration parameter). The "**Hall Configuration Detection Test**" dialog will open. Check the value of the current to be used during the test, and follow the "**Test Procedure**" steps. The test will rotate the motor shaft and detect, from two successive Hall sensors combinations, the Hall configuration parameter (there are 12 different possible configurations) needed to drive the motor.
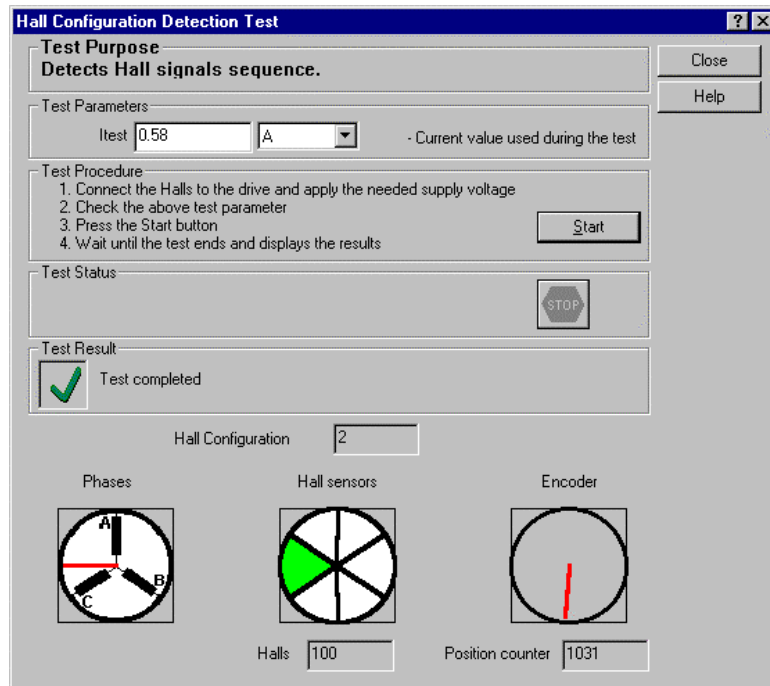
Figure 17. *Hall Configuration Detection Test*

Step 9. Check in the "**Temperature**" checkbox if you have connected an output of the motor temperature sensor to the corresponding connector pin of the IPM. Check the values of the temperature sensor parameters.

Step 10. Check the value of the ***Motor and Load - Total Inertia***. Press the "**Identify Total Inertia**" button to auto-detect this parameter. The "**Total Inertia Identification Test**" dialog will open. Check the value of the test current and that of the current protection to be used during the test and follow the "**Test Procedure**" steps. The test will rotate the motor and estimate the total inertia (motor + load), as reported at motor shaft.
Please note that this test will try to impose a constant torque in the motor. In case that you have a new motor that was not chosen from the motor database, you need to perform the tuning of the current controller before running this test. The current controller tuning can be validated in the Drive dialogue.
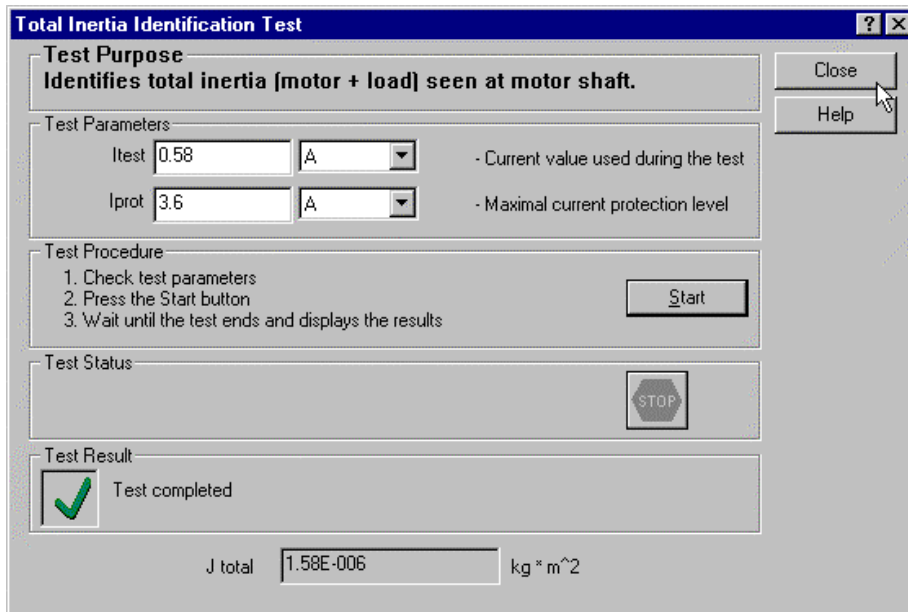
Figure 18. *Total Inertia Identification Test*

Step 11. Exit the **Motor and Load** dialog, by pressing the **OK** button.

5. Define the control scheme, tune and test controllers

Click on the **Drive** icon. The drive dialog will be opened, as in Figure 19.

The dialog allows you to choose and parameterize the control scheme to be implemented in your application. You can select which control loops to be activated in the scheme, tune and test the activated controllers, and also select and setup the protections of the drive.

Several specific tests can be performed, allowing you to check the behavior of the control loops.

WARNING! Note that most of these tests apply power to the motor. Please check carefully the motor parameters, mainly the nominal and maximum current values. Each test applying a voltage to the motor will be performed with a protection limit on the current. If this limit are exceeds the motor maximum current, severe damage of the motor can occur!

In order to perform the tests in the proper order, use the "**Guideline Assistant**" textbox, and follow the steps as described there.
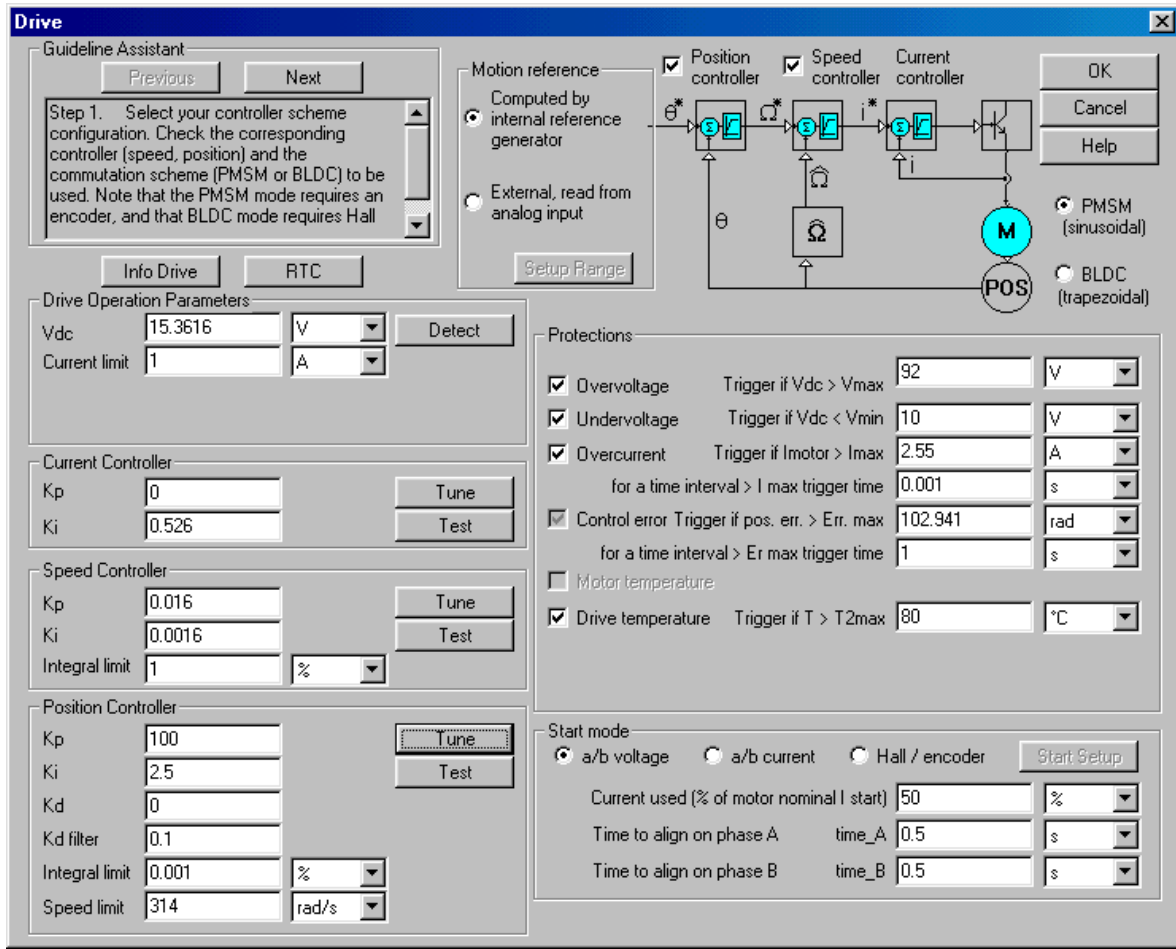
Figure 19. The Drive dialog

Step 1. Select your controller scheme configuration. Check the corresponding controllers (speed, position) and commutation scheme (**PMSM** or **BLDC**) to be used. Note that the PMSM mode requires an encoder, and that BLDC mode requires Hall sensors mounted on the motor shaft. Thus, if these sensors were not defined in the motor dialog, the associated control scheme is not selectable.

Step 2. In the "**Motion reference**" group-box, select the motion reference type to be used when the motion will be executed. Use the "**Internal Reference Generator**" selection for motions generated through TML motion commands. In this case, the reference will be defined at a latter stage, in the "**Motion**" block of the motion system diagram. If an external analog reference is used during the motion, use the "**Setup Range**" button to set up its parameters.

Step 3. In the "**Drive Operation Parameters**" group-box set the value of the DC voltage power supply (**Vdc**). Use the "**Detect**" button to measure its actual value as applied to the drive. The "**V$_{DC}$ Detection Test**" dialog will open. The test will measure the actual value of the power supply voltage applied to the IPM drive.
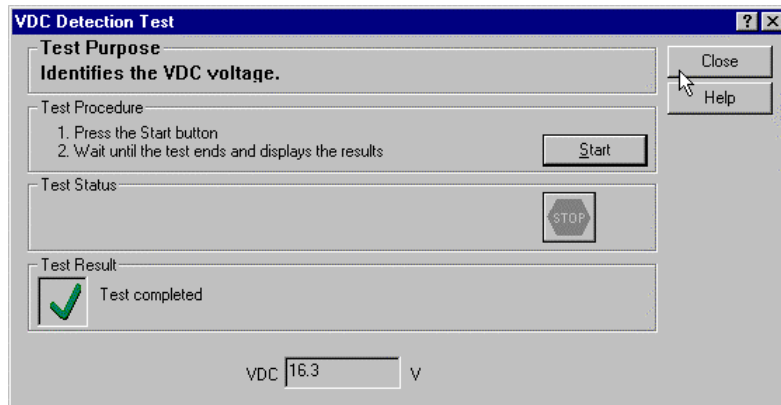

Figure 20. V$_{DC}$ Detection Test

Also set the "**Current Limit**" parameter, e.g. the maximum current value, controlled by the drive during motion.

Step 4. In the "**Current Controller**" group-box you can set the current controller parameters **Kp** (proportional) and **Ki** (integral).

Use the "**Tune**" button to compute these parameters based on the imposed dynamical performances of the closed loop, and on the system parameters. The "**Current Controller - Tuning**" dialog will open in this case. If you set the ***dump factor*** and the ***passband*** of the closed control loop, the program will automatically compute the controller coefficients, based also on motion system parameter values. Expected system response to a step reference input in the controller is graphically displayed, as well as the frequency characteristic of the closed loop structure. Once you exit this dialog by pressing the **OK** button, the newly computed controller parameters replace the previous values.

If you are not comfortable with the damp factor and passband parameters, you may cancel the Current Controller – Tuning dialogue and type directly the **Kp**, **Ki** coefficient values in the Current Controller group-box:
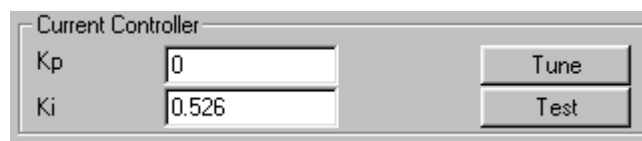

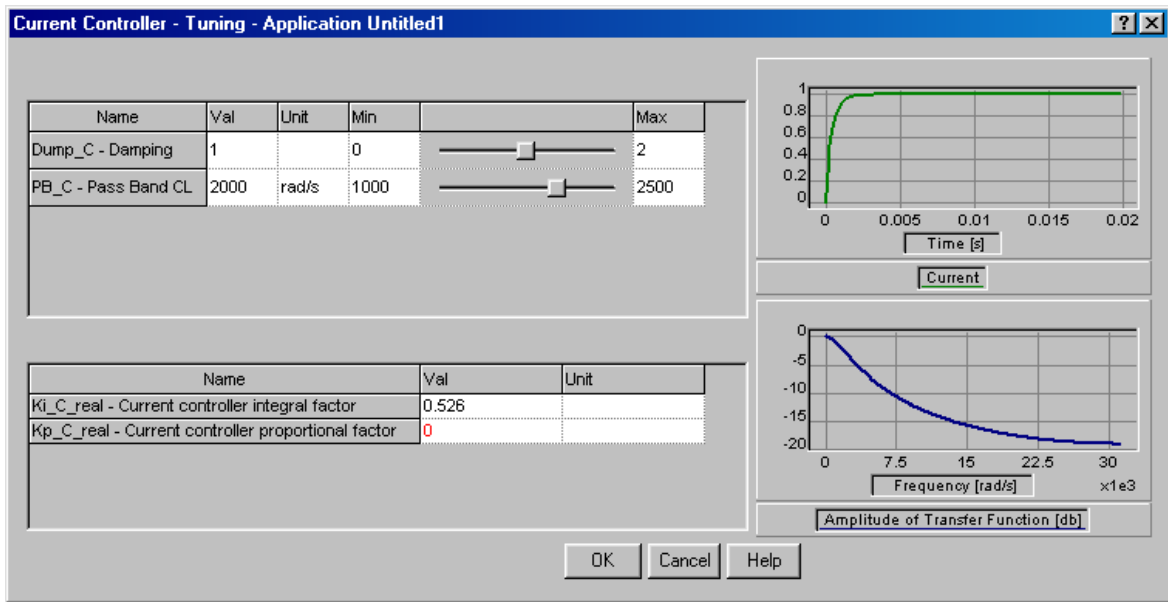*Figure 21. Current Controller group-box*

Figure 22. *Current Controller Tuning*

Use the "**Test**" button in order to test the step response of the closed current loop, for the actual values of the controller parameters. The "**Current Controller Tuning Test**" dialog will open.

The test has two phases:

- Set-up test parameters ('**Test parameters**' tab)

- Run the test. ('**Test**' tab)

In the '**Test Parameters**' tab you ca define the test parameters: check the value of the current reference to be used during the test, as well as the protection current value.

The test applies power to the motor. It applies a step current of "Test current" value, to the motor. The reference (IQREF) and measured (IQ) currents, as well as the reference voltage (UQREF) applied to the motor during the test are then displayed at the end of the test.

The test controls the current applied to the motor as imposed by the user, as the "Test current" parameter from the "Test Parameters" group box. When entering the dialog, the program suggests a value for this current, computed as the half of the nominal motor current. You may change this value, within a specific range, limited by motor and drive maximum accepted currents. The "Iprotection" parameter is used to set the value of the current for which the over current protection will be activated during the test. If this value is reached during the test, then the test execution is stopped. See the time diagram included in the dialog in order to have a better understanding of the meaning of these parameters.

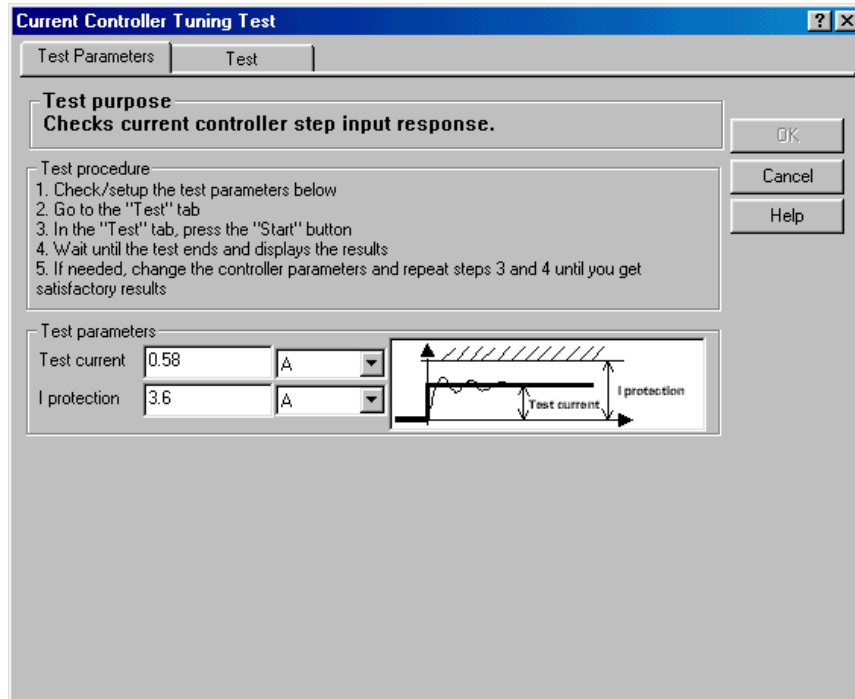In order to perform the test, follow the "Test Procedure" indications.

Figure 23.a. Current Controller Tuning Test – 'Test Parameters' settings

The '**Test**' tab is used to run the test. In this "**Test**" tab press the Start button and wait until the test ends and displays the results.

If needed, change controller parameters and repeat the procedure (press the Start button etc.) until you get satisfactory results.

You can change the controller parameters by modifying the value of the parameter in the corresponding edit box or by dragging the associated slider. To modify the range of values for the slider you can use the spin buttons (for minimum and for maximum limit values).

Note that the current min/max range is a sub-range of the absolute range. The absolute limits are computed and depend on specific scaling factors and parameters of the system. Note that a sub-range of the maximum absolute range will allow fine adjustments of the parameters and eventually will reduce the risk of unstable control loop behavior at sudden changes of parameter value.
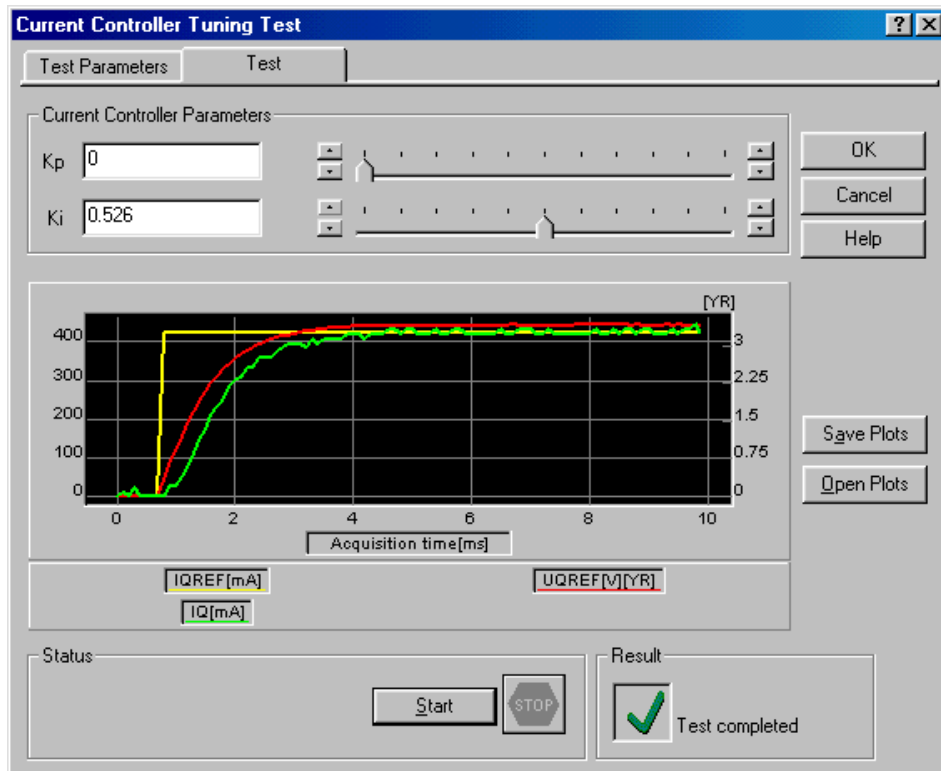
Figure 23.b. *Current Controller Tuning Test – 'Test' running*

If the test fails, check the following:

- Check if the Technosoft drive is powered correctly (use for example, the "VDC Detection Test" from the Drive dialog, to measure the DC-link voltage applied to the power transistors of the Technosoft drive)
- Check if motor phases are connected to the drive
- Check if motor phases are not interrupted by measuring its phase-to-phase resistance (use an ohmmeter; disconnect the motor from the Technosoft drive before performing this measurement)

The test will be validated through visual inspection of the graphical test results. If the controlled current reaches the reference current with acceptable performances (response time, overshoot, final error), you can validate the controller coefficients. Otherwise, change their parameters and execute the test until the results are satisfactory.

Pressing the OK button will save the actual values of controller parameters and return into the Drive dialogue. Pressing Cancel button will leave controller parameters unchanged.

Note. You can save the results of a test, using the "Save Plots" button. You can also re-load results of previously saved tests, using the "Load Plots" button.

Step 5. In the "**Speed Controller**" group-box set the speed controller parameters **Kp** (proportional), **Ki** (integral) and **Integral limit** (saturation limit for the integral term of the controller).

Use the "**Tune**" button to compute these parameters based on the imposed dynamical performances of the closed loop, and on the system parameters. The "**Speed Controller - Tuning**" dialog will open in this case. If you set the *dump factor* and the *passband* of the closed control loop, the program will automatically compute the controller coefficients, based also on motion system parameter values. Expected system response to a step reference input in the controller is graphically displayed, as well as the frequency characteristic of the closed loop structure. Once you exit this dialog by pressing the **OK** button, the newly computed controller parameters replace the previous values.

If you are not comfortable with the damp factor and passband parameters, you may cancel the Speed Controller – Tuning dialogue and type directly the **Kp**, **Ki** coefficient values in the Speed Controller group-box:
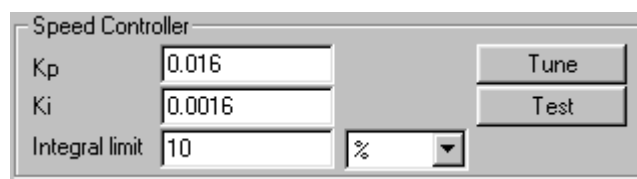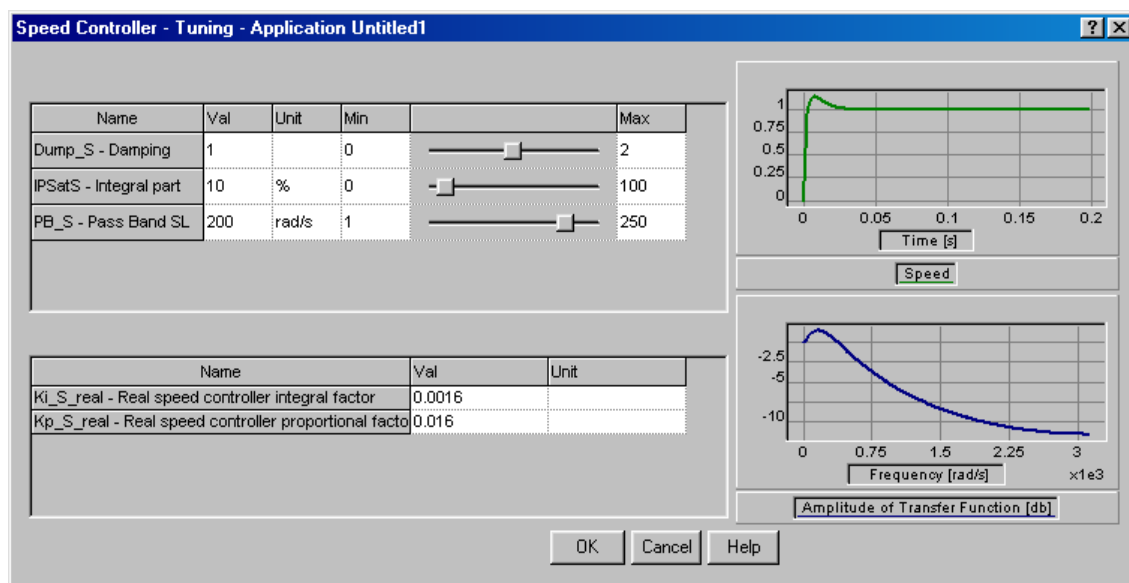

Figure 24. Speed Controller group-box

Figure 25. Speed Controller Tuning

Use the "**Test**" button in order to test a ramp response of the closed speed loop, for the actual values of the controller parameters. The "**Speed Controller Tuning Test**" dialog will open.

The test has two phases:

- Set-up test parameters ('**Test parameters**' tab)

- Run the test. ('**Test**' tab)

In the '**Test Parameters**' tab you ca define the test parameters: check the value of the speed reference to be used during the test, as well as the protection and limit current values.
The test applies power to the motor. It applies a speed profile (see graphical diagram), to the motor.
The "Ilimit" parameter is the value at which is limited the current value during the test, by the current controller. The "Iprotection" parameter is used to set the value of the current for which the over current protection will be activated during the test. If this value is attained during the test, the test execution is stopped. The "Istart "parameter is the value of the current used during the initial positioning of the motor (note that this parameter is needed only for a brushless motor, operating in the PMSM mode). See the time diagram included in the dialog in order to have a better understanding of the meaning of these parameters.

The test controls the speed applied to the motor as imposed by the user, as the speed profile from the "Test Parameters" group box. When entering the dialog, the program suggests a value for the Upper and Lower speed. You may change these values, in a specific range, limited by motor maximum accepted speed.

Trapezoidal or ramp profiles can also be generated, setting the acceleration and deceleration time intervals, tap and/or tan. Single or repetitive cycle movements can be selected using the Multiple Cycle Movement checkbox.
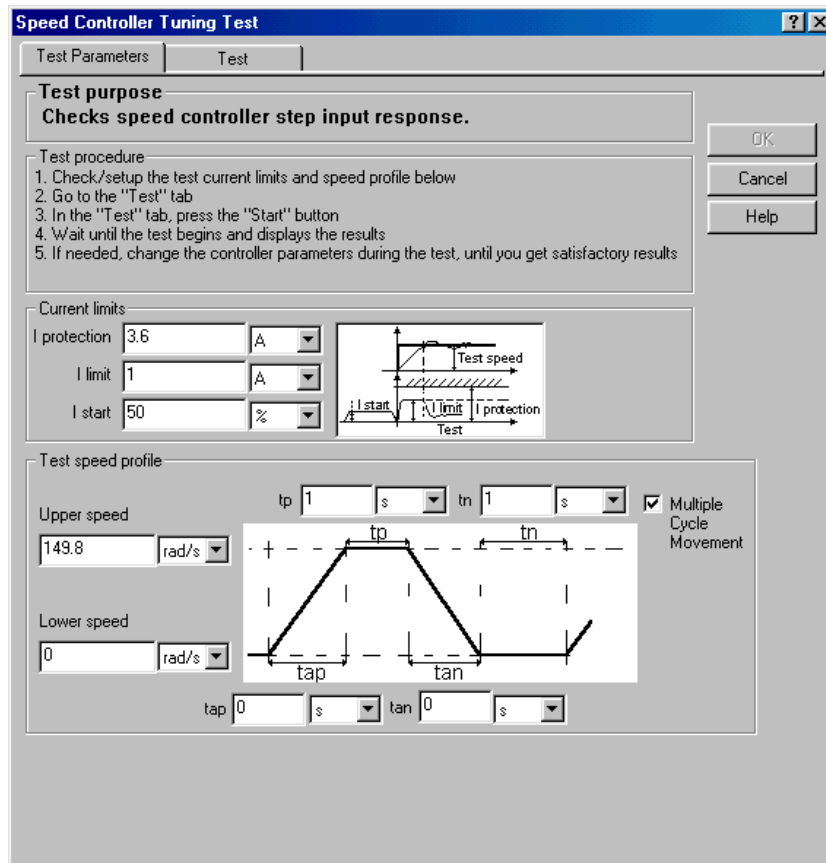In order to perform the test, follow the "Test Procedure" indications.

Figure 26.a. Speed Controller Tuning Test – 'Test Parameters' settings

The '**Test**' tab is used to run the test. In this '**Test**' tab press the Start button and wait until the test ends and displays the results. If needed, change controller until you get satisfactory results.

If On-line plot option is selected, the reference (SPDREF) and measured (ASPD) speed values will be continuously displayed during the test (oscilloscope function). If Data logger option is selected, the reference (SPDREF) and measured (ASPD) speed values, (as well as the reference (IQREF) and measured (IQ) current values), are displayed at the end of the test.

You can change the controller parameters during test execution by modifying the value of the parameter in the corresponding edit box or by dragging the associated slider. To modify the range of values for the slider you can use the spin buttons (for minimum and for maximum limit values).

Note that the current min/max range is a sub-range of the absolute range. The absolute limits are computed and depend on specific scaling factors and parameters of the system. Note that a sub-range of the maximum absolute range will allow fine adjustments of the parameters and eventually will reduce the risk of unstable control loop behavior at sudden changes of parameter value.
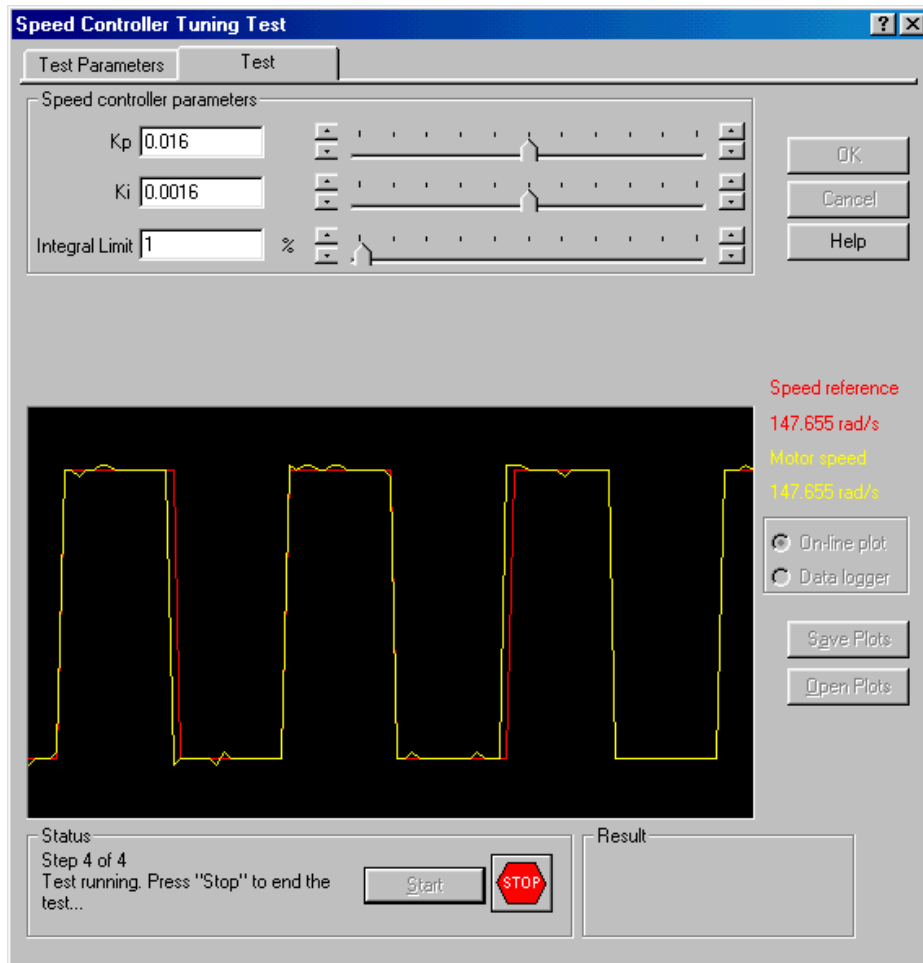
Figure 26.b. Speed Controller Tuning Test – 'Test' running

If the test fails, check the following:

- Check if the Technosoft drive is powered correctly (use for example, the "VDC Detection Test" from the Drive dialog, to measure the DC-link voltage applied to the power transistors of the Technosoft drive)
- Check motor phases connections (use for example, the "Test Phases Connections" from the Motor dialog)
- Check if the position sensor operates properly (use the tests associated to the position sensors from, the Motor dialog)
- Check motor parameters (eventually using the motor parameters identification tests from the Motor dialog)
- Check current controller parameters (use the "Current Controller Tuning Test")

Test validation. The test will be validated through visual inspection of the graphical test results. If the controlled speed reaches the reference speed with acceptable performances (response time, overshoot, final error), you can validate the controller coefficients. Otherwise, change their parameters and execute the test until the results are satisfactory.

Pressing the OK button will save the actual values of controller parameters and return into the Drive dialogue. Pressing Cancel button will leave controller parameters unchanged.

Note. You can save the results of a test, using the "Save Plots" button. You can also re-load results of previously saved tests, using the "Load Plots" button.

Step 6. In the "**Position Controller**" group-box set the position controller parameters **Kp** (proportional), **Ki** (integral), **Kd** (derivative), **Kd filter** (filtering coefficient for the derivative term). Set also the **Integral limit** (saturation limit for the integral term of the controller) and **Speed limit** (saturation limit for the position controller output, seen as a speed reference value).

Use the "**Tune**" button to compute these parameters based on the imposed dynamical performances of the closed loop, and on the system parameters. The "**Position Controller - Tuning**" dialog will open in this case. If you set the *dump factor* and the *passband* of the closed control loop, the program will automatically compute the controller coefficients, based also on motion system parameter values. Expected system response to a step reference input

in the controller is graphically displayed, as well as the frequency characteristic of the closed loop structure. Once you exit this dialog by pressing the **OK** button, the newly computed controller parameters replace the previous values.
If you are not comfortable with the damp factor and passband parameters, you may cancel the Position Controller – Tuning dialogue and type directly the **Kp**, **Ki**, **Kd**, **Kd filter** coefficient values in the Position Controller group-box:
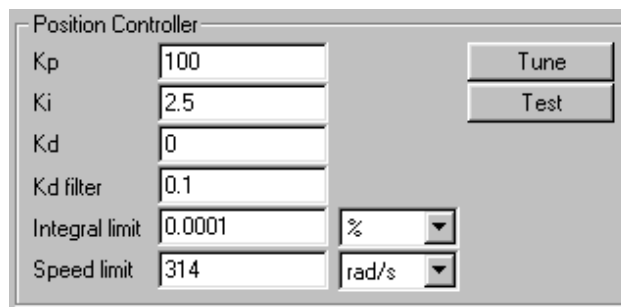

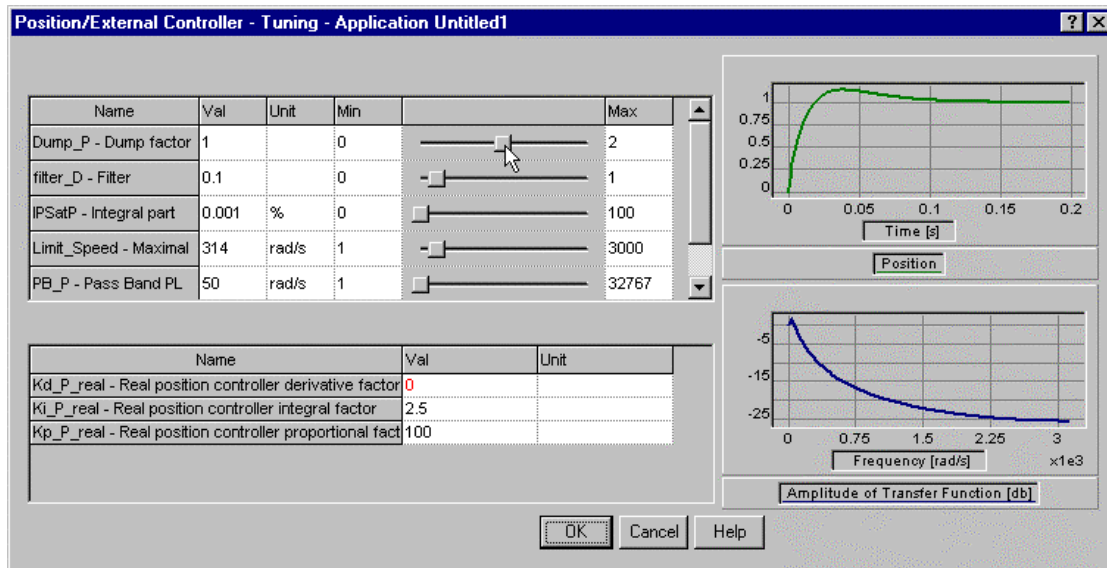*Figure 27.* Position Controller group-box

Figure 28. *Position Controller Tuning*

Use the "**Test**" button in order to test the step response of the closed position loop, for the actual values of the controller parameters. The "**Position Controller Tuning Test**" dialog will open.

The test has two phases:

- Set-up test parameters ('**Test parameters**' tab)

- Run the test. ('**Test**' tab)

In the '**Test Parameters**' tab you ca define the test parameters: check the value of the position reference to be used during the test, as well as the protection and limit current values.

The test applies power to the motor. It applies a position profile to the motor.

The "Ilimit" parameter is the value at which is limited the current value during the test, by the current controller. The "Iprotection" parameter is used to set the value of the current for which the over current protection will be activated during the test. If this value is attained during the test, the test execution is stopped. The "Istart "parameter is the value of the current used during the initial positioning of the motor (note that this parameter is needed only for a brushless motor, operating in the PMSM mode). See the time diagram included in the dialog in order to have a better understanding of the meaning of these parameters.
The test controls the position applied to the motor as imposed by the user, as the position profile from the "Test Parameters" group box. When entering the dialog, the program suggests a value for Upper and Lower position. You may change these values.

Trapezoidal or ramp profiles can also be generated, setting the acceleration and deceleration time intervals, tap and/or tan. Single or repetitive cycle movements can be selected using the Multiple Cycle Movement checkbox.

In order to perform the test, follow the "Test Procedure" indications.
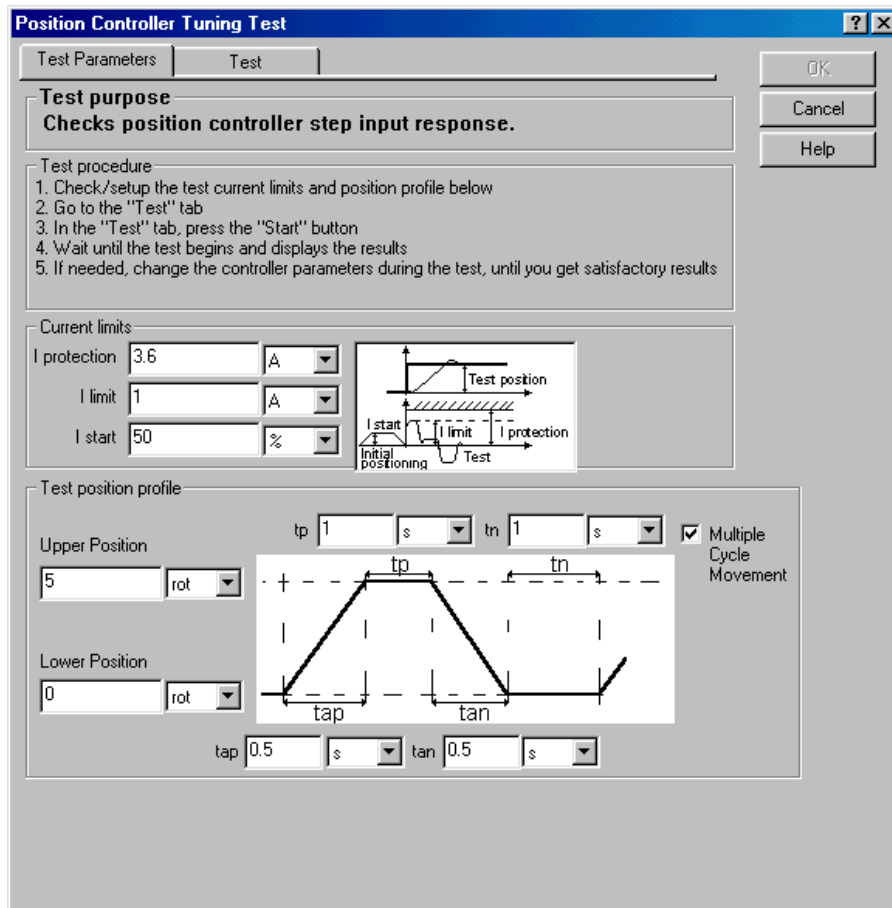

Figure 29.a. Position Controller Tuning Test – 'Test Parameters' settings

The '**Test**' tab is used to run the test. In this '**Test**' tab press the Start button and wait until the test ends and displays the results. If needed, change controller parameters and repeat the procedure (press the Start button etc.) until you get satisfactory results.

If On-line plot option is selected, the reference (TPOS) and measured (APOS) position values will be continuously displayed during the test (oscilloscope function). If Data logger option is selected, the reference (TPOS) and measured (APOS) position values, (as well as the reference (SPDREF) and measured (ASPD) speed values), are then displayed at the end of the test.

You can change the controller parameters during test execution by modifying the value of the parameter in the corresponding edit box or by dragging the associated slider. To modify the range of values for the slider you can use the spin buttons (for minimum and for maximum limit values).

Note that the current min/max range is a sub-range of the absolute range. The absolute limits are computed and depend on specific scaling factors and parameters of the system. Note that a sub-range of the maximum absolute range will allow fine adjustments of the parameters and eventually will reduce the risk of unstable control loop behavior at sudden changes of parameter value.
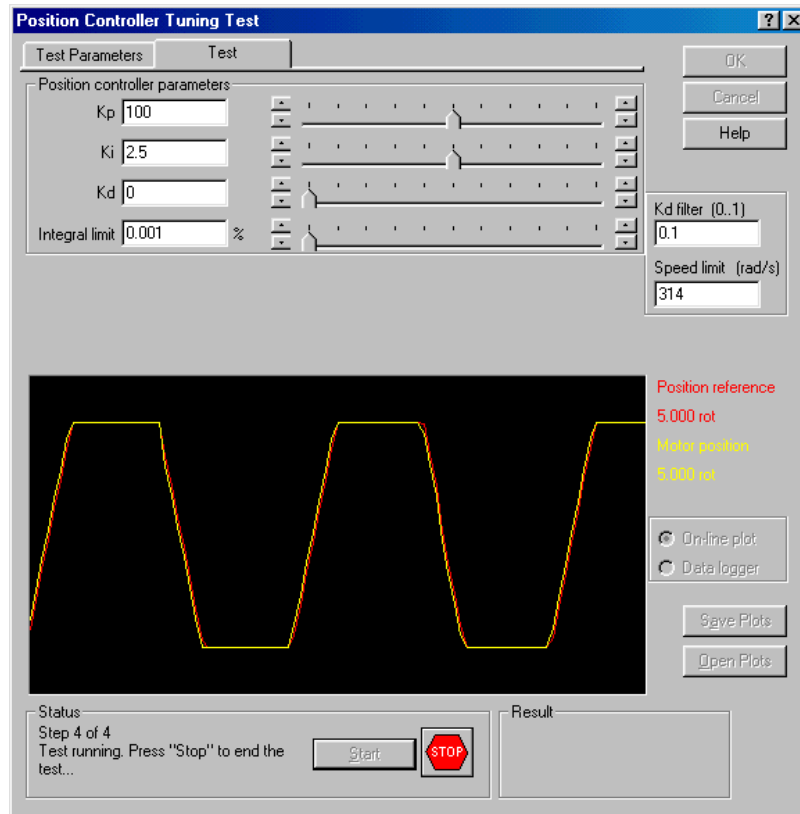

Figure 29.b. *Position Controller Tuning Test – 'Test' running*

If the test fails, check the following:

- Check if the Technosoft drive is powered correctly (use for example, the "VDC Detection Test" from the Drive dialog, to measure the DC-link voltage applied to the power transistors of the Technosoft drive)
- Check motor phases connections (use for example, the "Test Phases Connections" from the Motor dialog)

- Check if the position sensor operates properly (use the tests associated to the position sensors from, the Motor dialog)
- Check motor parameters (eventually using the motor parameters identification tests from the Motor dialog)
- Check current controller parameters (use the "Current Controller Tuning Test")

Test validation. The test will be validated through visual inspection of the graphical test results. If the controlled position reaches the reference position with acceptable performances (response time, overshoot, final error), you can validate the controller coefficients. Otherwise, change their parameters and execute the test until the results are satisfactory.

Pressing the OK button will save the actual values of controller parameters and return into the Drive dialogue. Pressing Cancel button will leave controller parameters unchanged.

Note. You can save the results of a test, using the "Save Plots" button. You can also re-load results of previously saved tests, using the "Load Plots" button.

Step 7. In the "**Protections Controller**" group-box, select and parameterize those protections that you want to be activated during the motion. For a first evaluation, use the default settings and selections.

Step 8. For PMSM operating mode, the "**Start mode**" group-box is active. Set up the current value used during the motor start (**Istart**), select the start method to be used, and set up de corresponding parameters. Note that if you select a current mode start, you need the values of current offsets. Use the "**Detect**" button in order to measure these values on your IPM drive.

Step 9. Press the **OK** button of the **Drive** dialog, in order to validate the defined control structure and its associated parameters.

6.   Define and test the motion

Click on the **Motion** icon. The motion wizard dialog will be opened, as in Figure 30.
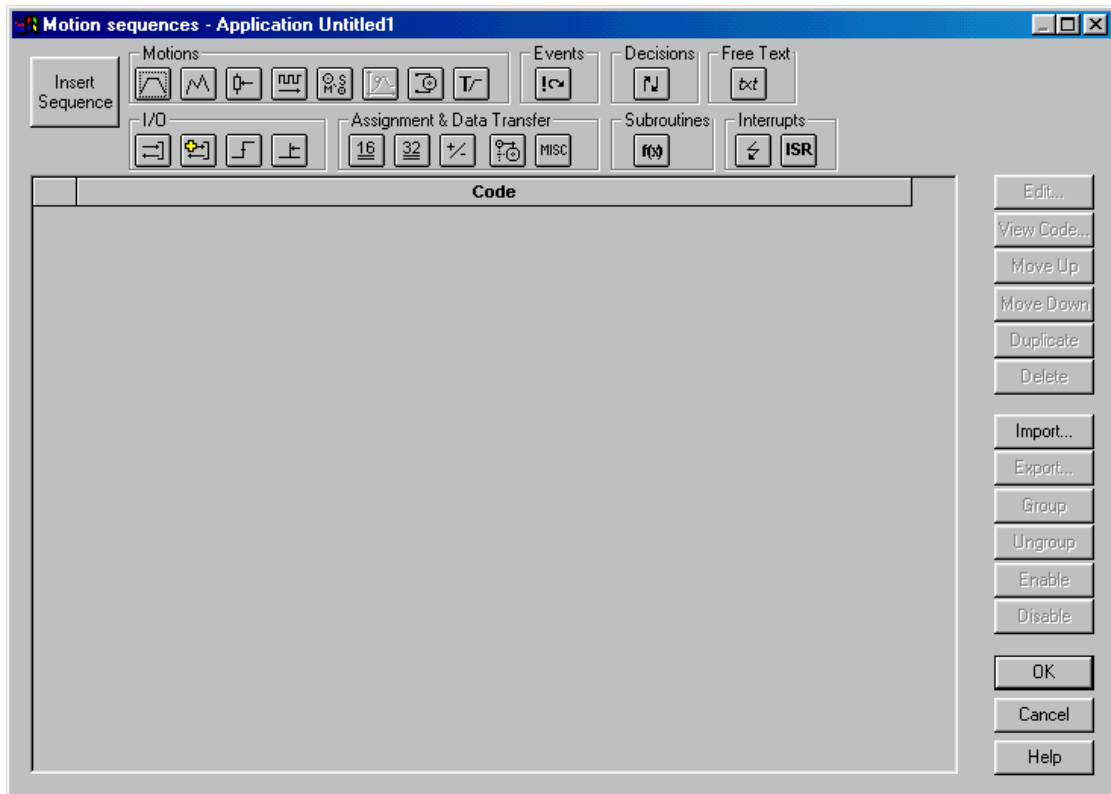

Figure 30. The Motion Wizard dialog

The dialog allows you to insert specific motion sequences and other TML commands, as arithmetic, I/O operations, events, etc. Details about the functionality and features of the Motion Wizard are given in Chapter 5 of "IPM Motion Studio User Manual".

In order to perform a simple motion, only to validate the complete overview of this paragraph, use the predefined motion sequence already defined in the motion profile by clicking the button

In the associated Motion Profiles dialog window you can define a position profile as you can see in the figure below:
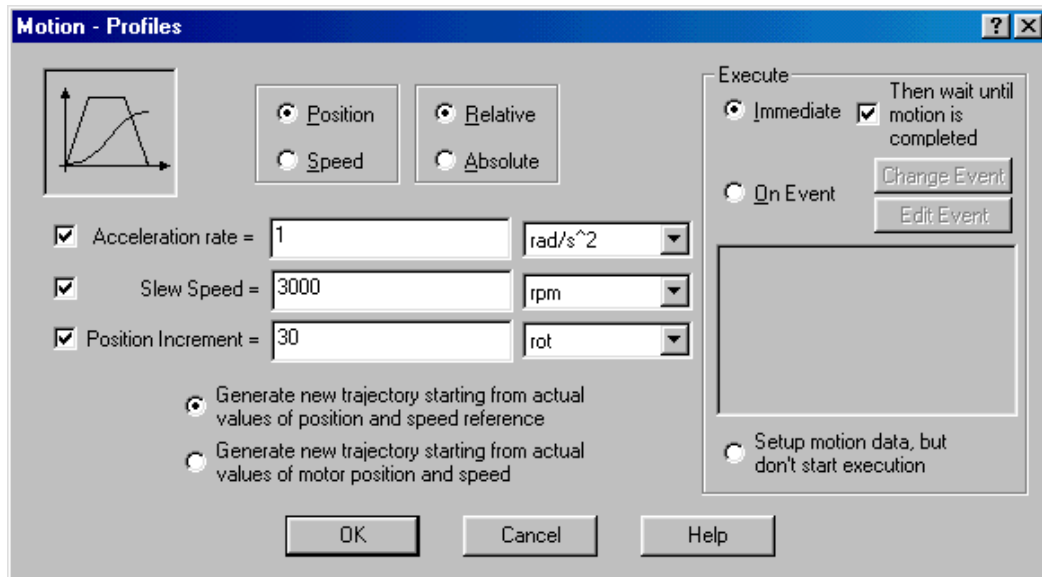
Figure 31. *The Motion Profiles dialog*

You can define the profile parameters, i.e. the acceleration/deceleration, the slew speed, and the reference position value.

Once the motion is defined, exit the Motion Wizard by pressing the **OK** button.

You can now generate the complete TML code associated to the chosen configuration, download it to the IPM drive, and execute it. You simply press the "**Run**" button, and all the operations associated to this command will be executed: reset the IPM, generate the TML code based on the configuration and imposed parameters, as well as on the motion, download the code to the IPM, and start its execution. The motor should execute the imposed motion.

You can upload the data logged during the motion by selecting the data logger window, click the right button of the mouse, and activate the "**Upload Data**" menu command. The variables stored during the execution of the motion will be displayed on the screen.

You can Stop the motor by disabling the PWM outputs (Stop the motion by Axisoff)
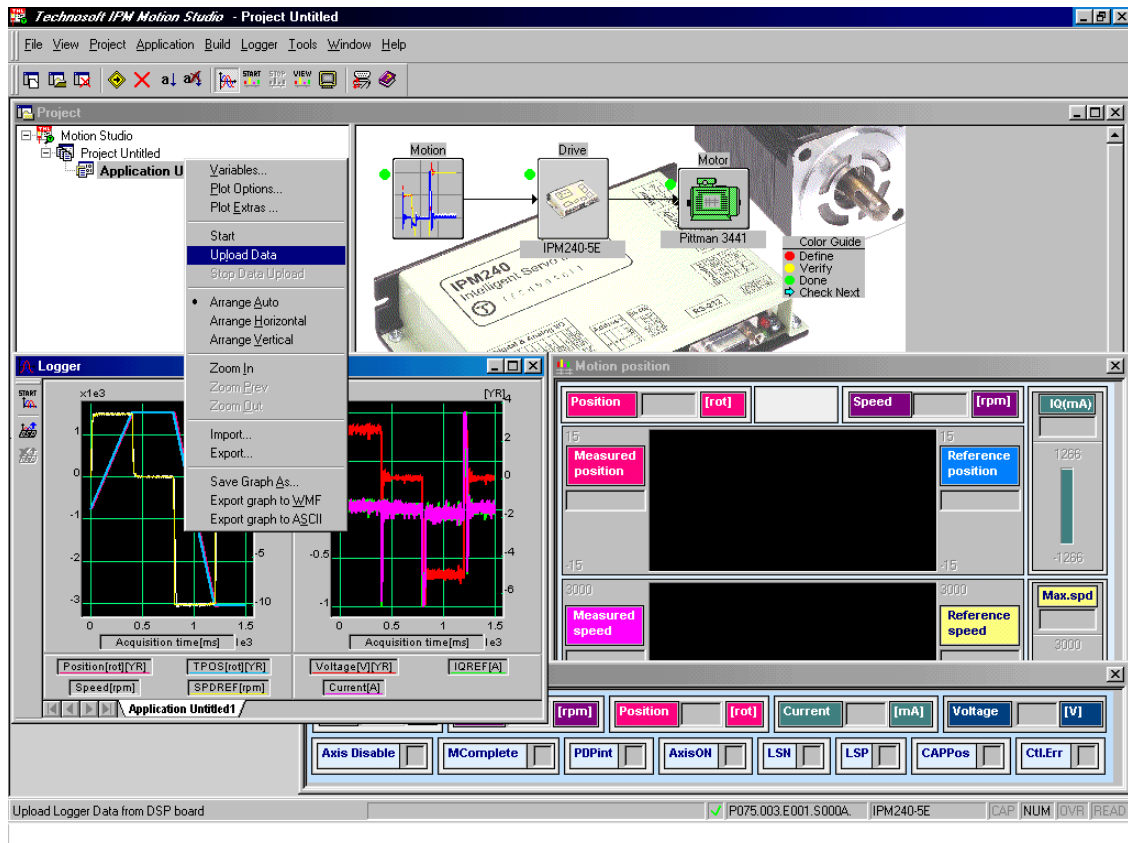
Reset the drive

Figure 32. *The Data Logger dialog*

More details about the data analysis tools (Logger and Control Panel) are presented in the IPM Motion Studio User Manual.

7.   Save and close the project

The precedent paragraphs guided you through the process of starting a motion project, configuring and parameterizing it, defining the motion and finally executing it on the IPM drive. As one can see from the described procedure, the steps to follow are straightforward, and allow you to validate the operation of your complete drive configuration.

When arrived at this point, you can start and really go into details related to all the features of the program, mainly focusing on the motion description and implementation using TML instructions.

The just defined project, completed with the correct structure definition and parameters of the elements (motor, sensors, controllers, etc.), can be saved for further use. Select the "**Project | Close**" menu command. You'll be asked to give a name for the project and the application to be saved. Latter on, you'll be able to open the project, in the same status as when saved the last time.
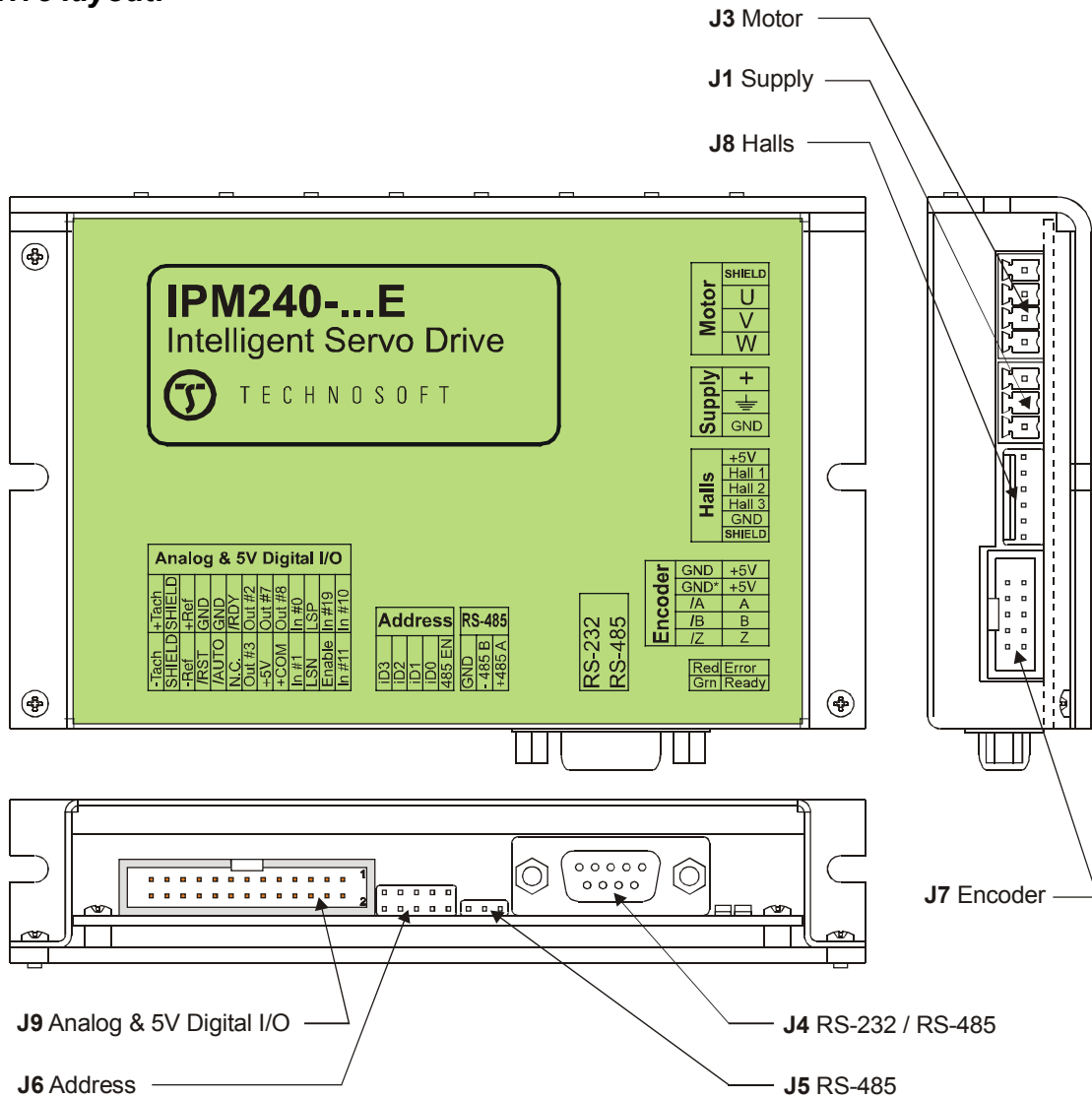
Drive layout:

Figure 33. *IPM240-5E drive layout*

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