Servo Drive Commissioning Instruction

Version 02

Important Notice:

This document is object to the following conditions and restrictions:

- This Document contains proprietary information belonging to Servo Dynamics. This information is provided for the purpose of assisting users of the servo drive in its installation.
- The text and graphics in this document are for the purpose of illustration and reference only.
- The information in this document is object to change without notice.

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Table of Figures:

1 Inserting parameters

Follow each step inserting correct parameter for your application.

Note: Servo drive must be connected to the PC and “24” Volt power on.

1.1 Drive Parameter Page

Go to the Drive Parameter page under Device Manager tab:

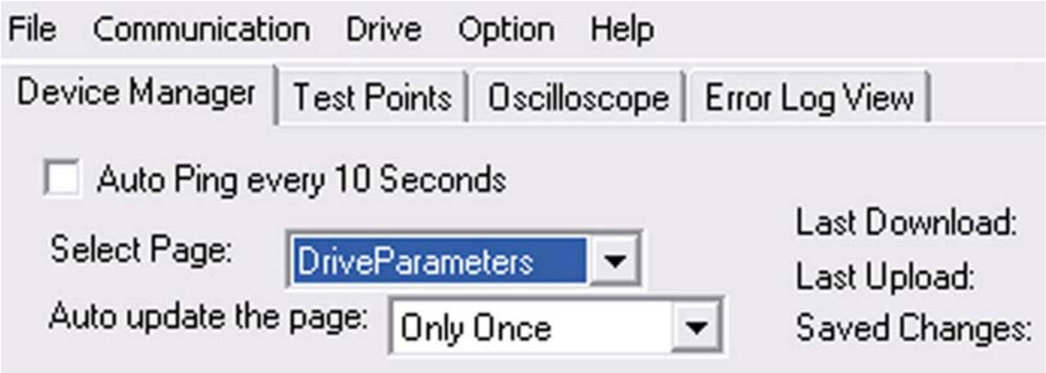

Figure 1 - Drive Parameters

Pick “500 milliseconds” at Auto Update the Page.

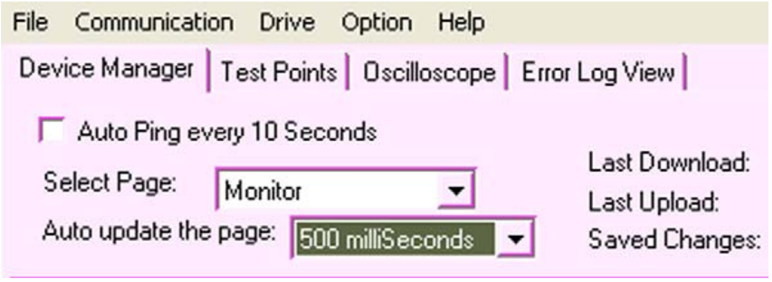

Figure 2 – 500 Milliseconds

Insert correct parameters for your application:

1.1.1 14 – Drive Mode

Figure 3 - Drive Mode

Input Data:

- **“0”** for Velocity Mode
- **“1”** for Current Mode
- **“2”** for Position Pulse and direction mode
- **“3”** for Position Encoder follower mode (Master/Slave mode)

1.1.2 15 – DC/1Ph/3Ph

Figure 4 - DC/1Ph/3Ph

Input data:

- **“0”** for DC Voltage Input
- **“1”** for Single Phase AC Power Input
- **“2”** for 3 Phase AC Power Input

1.1.3 17 – Enc Out Div

Figure 5 - Enc Out Div

This is for setting the emulated encoder output. The input number must be a binary number and the 2X , like 1, 2, 4, …, 128. i.e. the primary encoder is 2000 ppr and set the driver at 4, the emulated encoder output is 500ppr.

1.1.4 20 – Max Peak Current

Figure 6 - Max Peak Current

Input data can be any value no bigger than the drive’s rated peak current. This value corresponds to the max current command input (±10V) if the servo drive is in the current mode.

1.1.5 21 – RMS Current Limit

Figure 7 - RMS Current Limit

Input data can be any value no bigger than the drive's rated continuous current.

1.1.6 24 – Max RPM

Figure 8 - Max RPM

Input data defines the max velocity (RPM) of the motor. This value corresponds to the maximum velocity command ($\pm$10V) if the servo drive is in velocity mode.
And click update changes.

1.2 Motor Parameter Page

Go to the Motor Parameter select page:

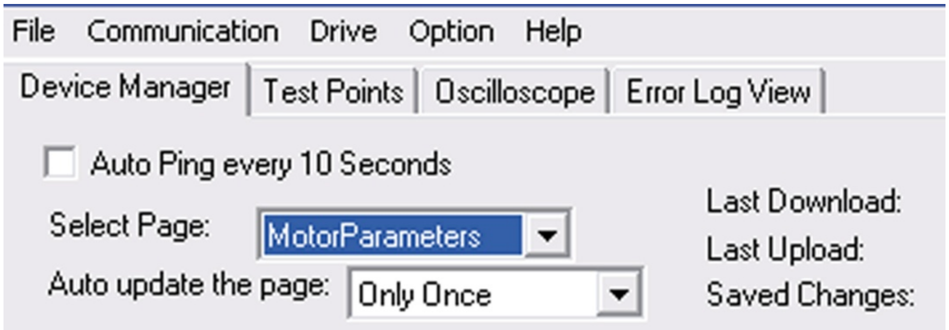

Figure 9 - Motor Parameter Page

Insert correct parameters for your application:

1.2.1 30 – Velocity Sensor Page

For all types of motors

Figure 10 - velocity Sensor Page

Input data defines the velocity feedback sensor type:

- **"0"** for Incremental encoder
- **"1"** for Tachometer
- **"2"** for Sensorless (Brushed motors only)

1.2.2 31 – Motor Type

For all types of motors.

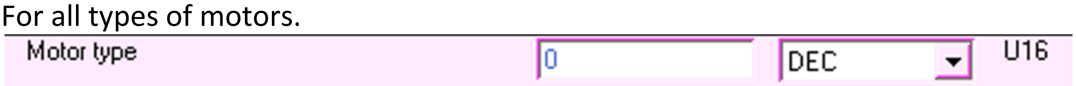

Figure 11 - Motor Type

Input data defines the motor type:

- **"0"** for Brushless DC Motor
- **"1"** for Brushed Motor

1.2.3 32 – Encoder Resolution

For encoder feedback motors

Figure 12 - Encoder Resolution

Input data defines the quadratic incremental encoder resolution in ppr (Pre-quad). The maximum resolution is 16384.

1.2.4 33 – Num of Poles

For Brushless Motors only.

Figure 13 - Num of Poles

Input data defines the number of brushless motor poles. (Not pole pairs)

1.2.5 34 – Stall Current

For all types of motors.

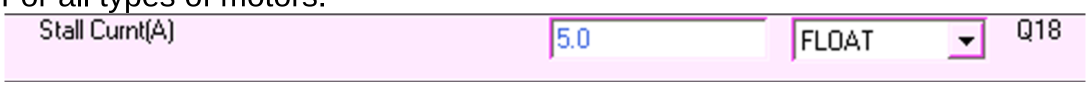

Figure 14 - Stall Current

Input data defines the continuous stall current of the motor. This data is necessary for the auto-phasing.

1.2.6 39 – Brushed R (ohm)

For sensorless mode only.

Figure 15 - Brushed R

Input data defines the winding resistance of the brushed motor.

1.2.7 40 – Brushed Ke (V/Krpm)

For sensorless mode only.

Figure 16 - Brushed Ke

Input data defines the voltage constant Ke (V/kRPM) of the brushed motor. The value is only used in the sensorless mode.

1.2.8 41 – Tacho

For tachometer feedback.

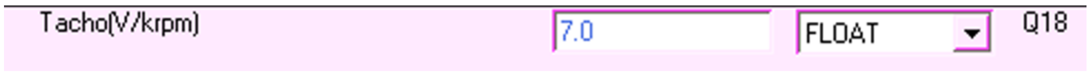

Figure 17 – Tacho

Input data defines the tachometer voltage constant (V/kRPM). It can be a positive or a negative number to determine the correct rotation.

And click “update changes” button.

2 Tuning the Servo System

Once the drive and motor parameters have been entered you are ready to begin to tune the system. Connect all wiring per installation instructions for your application requirements. Before tuning make sure the servomotor is not connected to the load. This is to prevent any possible damage due to initial tuning parameters or wiring problems. Begin tuning the drive.

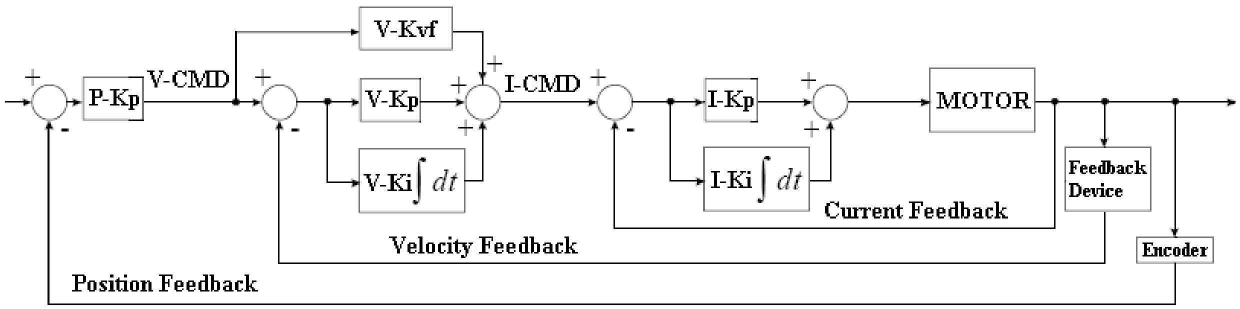

Figure 18 - Control Diagram

Brushless Servomotor:

1. Tune the current loop by following the **Current Loop Tuning Instructions**.
2. Phase the servomotor by following the **Servomotor Phasing Instructions**.

   The servo drive is now ready to run in **Current Mode**. For **Velocity or Position Mode** additional configuration and tuning is required. Follow specific instructions for **Velocity or Position Mode** as shown in this document.

Brushed Servomotors:

1. Tune the current loop by following the **Current Loop Tuning Instructions**.

   The servo drive is now ready to run in **Current Mode**. For **Velocity or Position Mode** additional configuration and tuning is required. Follow specific instructions for **Velocity or Position Mode** as shown in this document.

2.1 Current Loop Tuning:

Go to Controllers Page in software as shown below:

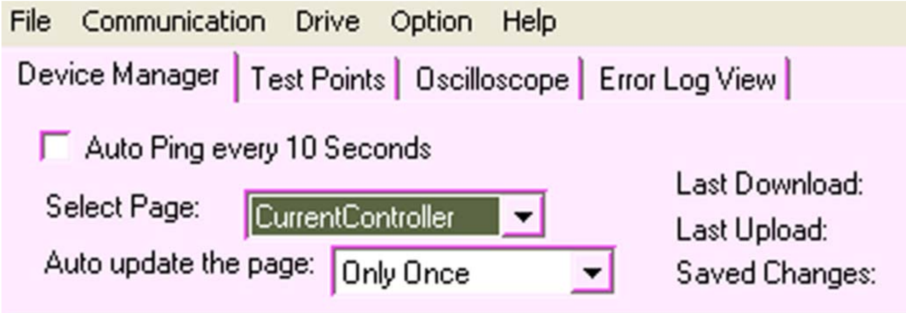

Figure 19 – Controllers

Insert “1” in the Value column of Current PI Man/Auto row and click “update changes” button:

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Figure 20 - Current PI Man-0/Auto-1

The current loop auto-tuning process begins running when updated. The process will last for 10 seconds. The tuning results in Figure 20 will be:

- If “0” is shown, it means the auto-tuning is successful; there should be a positive number in “I-Kp” row.

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Figure 21 – I-Kp

- If “99” is shown, it means the auto-tuning has failed:

Reduce the value of “Current Loop Bandwidth” row and repeat the auto-tuning process,

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Figure 22 – Current Loop

2.2 Servomotor Phasing for Brushless Servomotors only

Note: In order to successfully auto-phase the motor, the bus voltage should be sufficient for the motor to run above 2000 RPM, also the drive should be disabled (orange light)

Go to Motor Parameters Page in software as shown below:

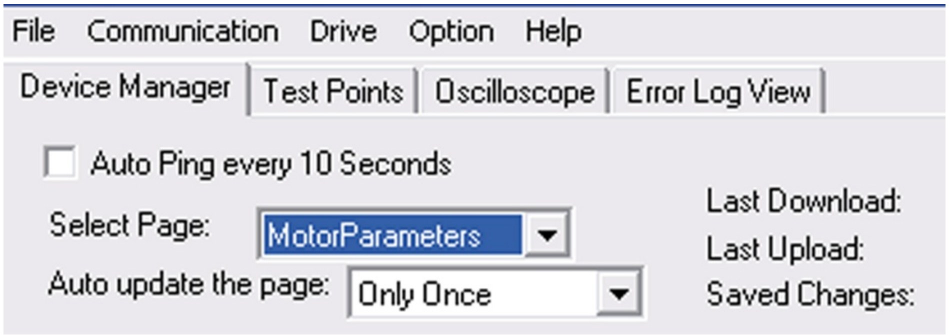


Figure 23 - Motor Parameter Page

Insert “1” in the Value column of “Autophase” row and click update:

Figure 24 - AutoPhase

The brushless motor auto-phasing process begins running when updated. The phasing result will be:

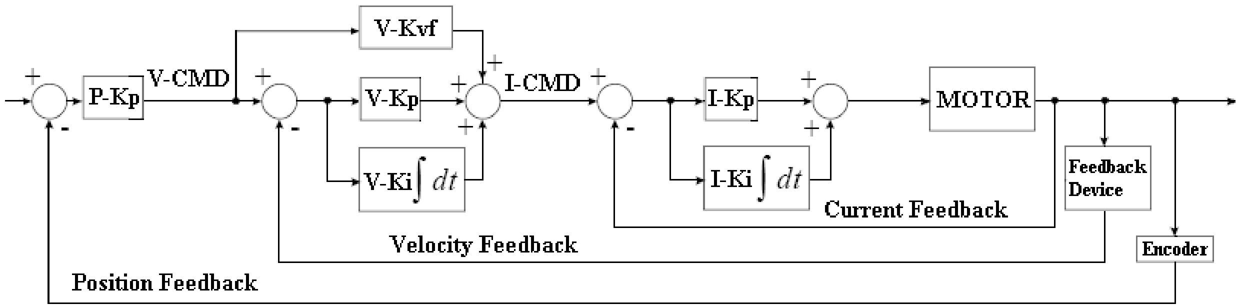
a. There is a number of 1~6 shown in the row “36”—*HALL Code*. It means the auto-phasing process is successful. The number is the right hall code for this motor.
b. There is a “0” shown in the row 36. It means the auto-phasing process is failed. The user has to manually put the hall code in row “36”. The motor can be tested under the current or velocity mode to verify the code. The right code should let the motor run with the current and the velocity in the same direction (The current and velocity feedback value should have the same sign. The signals can be found in the signal monitoring page)

Click the “Update Changes” button.
Click the “Save Changes” button to save the changes into the drive’s EEPROM.

2.3 *Velocity Loop Tuning*

2.3.1 Guidelines for Tuning Velocity

Before tuning velocity loop, according to figure below there are three close loops: Current Loop, Velocity Loop and Position Loop.



Tuning the Velocity Loop means adjusting the parameters of “Vel-Kvf”, “Vel-Kp” and “Vel-Ki”. Keep it in mind, the current loop is the most inner loop, and must have been completed successfully first.

By changing the above parameters, some system characteristics may be improved, but the others may be worsened. For example, increasing “Vel-Kp” improves the responsiveness, but the system may start oscillating. Before you can optimize the system, inertia of the load, the stiffness of acceleration and deceleration, overshoot and undershoot, steady state’s position error effect the system responsiveness. Since some of these characteristics are conflicting with each other, you may need to determine what characteristic is critical in your application, and what can be tolerated. So trade-off may be necessary to get the best result. Knowing how to compromise these parameters is the key in tuning the velocity loop.

2.3.2 Tuning Velocity

Go to drive parameters page and set drive mode to “0” for velocity mode. (Device Manager → Drive Parameters → Drive Mode)

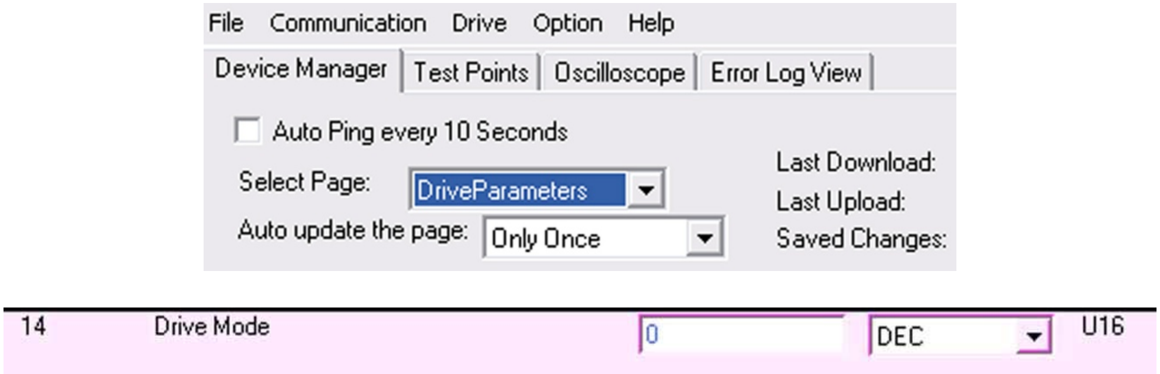
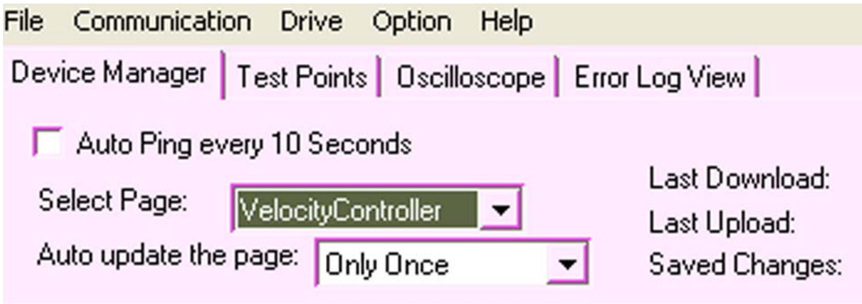


Figure 25 - Drive Mode

- “0” for Velocity Mode , “Update Changes” , “Save Changes”
- Got to Device Manager → Velocity Controller



For high performance tuning the step velocity command must be generated outside of the servo drive, contact application support at Servo Dynamics if you have questions or concerns.

Apply a step velocity command and compare the velocity command and feedback on the oscilloscope.

- Start with small numbers in “Vel-Kvf”, “Vel-Kp” and “Vel-Ki”, and then increase and monitor them individually (in the oscilloscope function) to optimize the velocity loop. “Vel-Kvf” and “Vel-Kp” adjust how fast the system will respond to the command, but if they are too high, system may be unstable, so set these numbers as high as possible before the system appears oscillating. “Vel-Ki” improves the overshoot or undershoot. If some overshoot or undershoot is acceptable in your system, you may want to keep some overshoot or undershoot without scarifying the fast response of the system.
- Monitor the changes under Oscilloscope Tab, “Select Signal”

2.4 Position Loop Tuning

2.4.1 Tuning Position Loop

The position loop is the most outer loop, so it should be tuned at last. Go to Drive Parameter Page and set drive mode to “2” for position pulse and direction mode or “3” for encoder following mode, (Device Manager → Drive Parameters → Drive Mode)

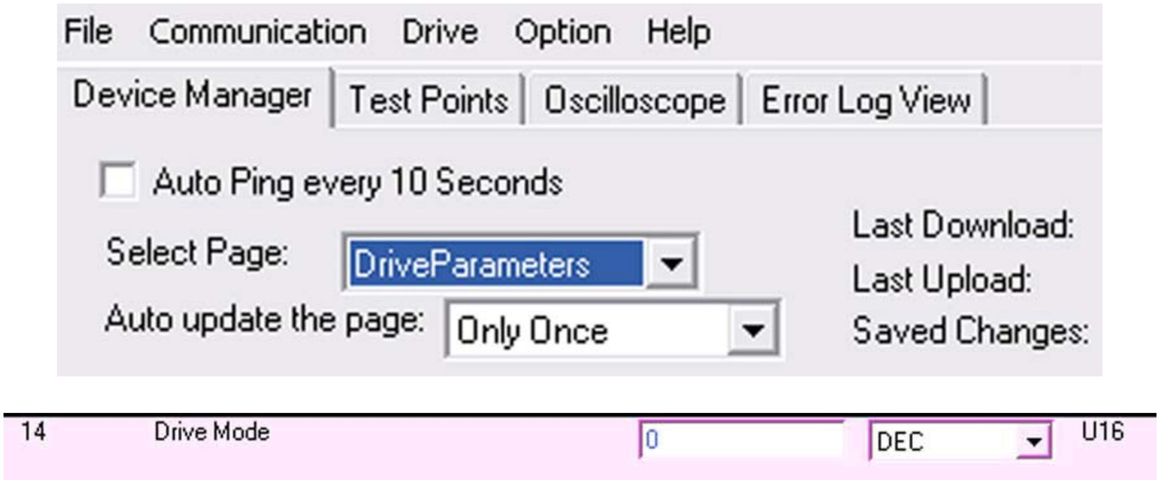


Figure 26 - Device Mode

- “2” for Position Pulse and Direction Mode
- “3” for Encoder Following Mode

Go to “Velocity Controllers” page (Device Manager → Velocity Controller) and apply a step command and compare the command and the position feedback.

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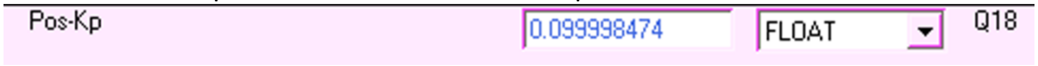

Figure 27 – Pos-Kp

The Ruby drive doesn’t provide the Oscilloscope for the position monitoring, a 2nd source of the position scope is necessary. You want to start with a small number in “Pos-Kp” first, and then increase the number gradually.

If the “Pos-Kp” gain is too high, system will appear unstable, and start oscillating. If that is the case, you need to lower “Pos-Kp” till the desired performance can be achieved.