# Electromechanical Automation Applications Note

Product: Trilogy coils & Positioners with ACR9000, AriesEPL with ACR9040, or AriesController
Rev: 1.0
Subject: Tuning Trilogy with ACR Controller

This applications note gives step-by-step instructions for tuning with the Trilogy motors and positioners with the ACR9000 controller, the Aries-EPL with ACR9040, or AriesCE drive/controller.

ACR-View's ServoTuner is a powerful 4-channel software oscilloscope allowing performance evaluation of servo systems and adjusting of the PID and feed-forward gains. This procedure shows how to setup and tune a step-response.
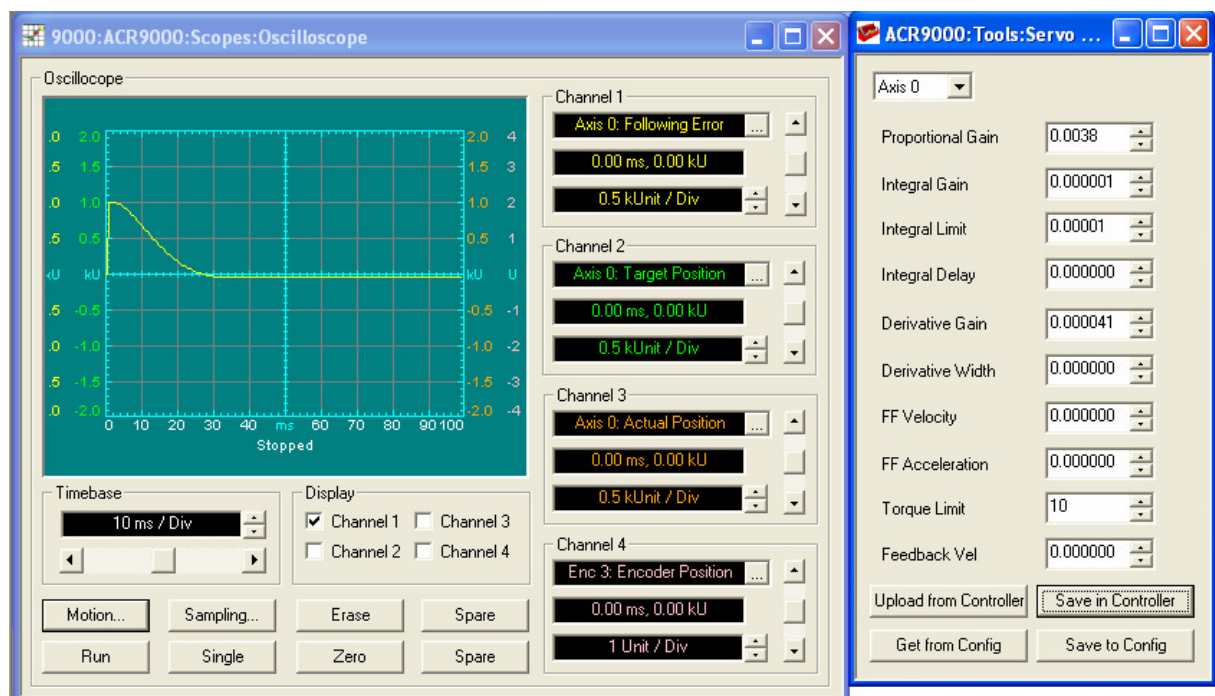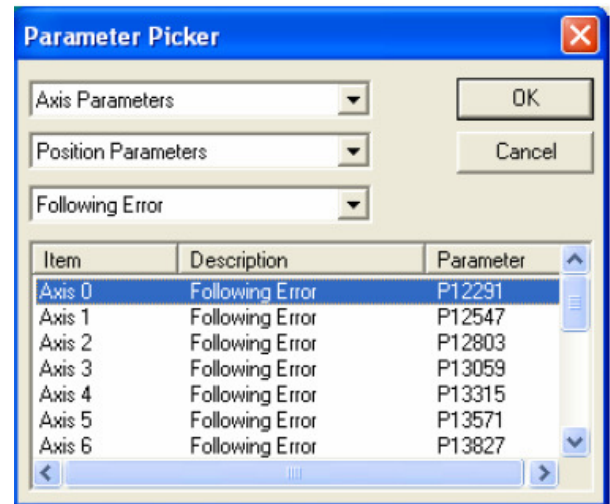

Example of a well-tuned T2D-4P (unloaded), settling within 30ms

1. To display the tracking error on Channel 1:
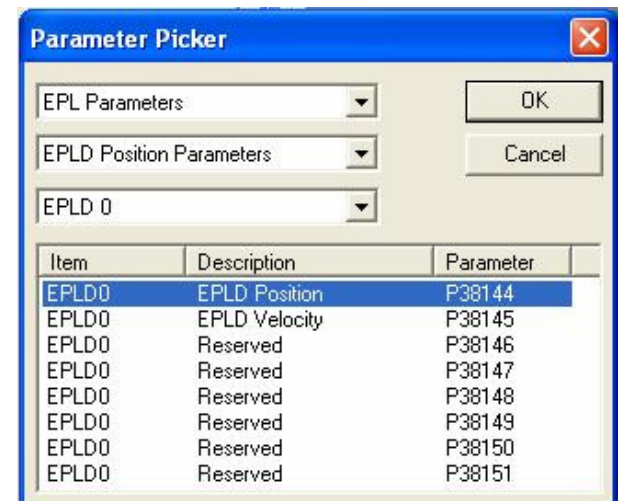Select Parameter for Channel 1:
a. Press "…" to open "Parameter Picker"
b. Select "Axis Parameters" from top drop-down
c. Select "Position Parameters" from middle dropdown
d. Select "Following Error" from bottom drop-down
e. Select the desired axis from list.

2. To display the encoder position on Channel 2:

For an ACR90x0 with AriesEPL:
a. Press "…" to open "Parameter Picker"
b. Select "EPL Parameters" from top drop-down
c. Select "EPLD Position Parameters" from middle dropdown
d. Select "EPLD Position" from bottom drop-down
e. Select the desired axis from list.

For an ACR9000 or AriesCE:

Select Parameter for Channel 2:

a. Press "…" to open "Parameter Picker"
b. Select "Object Parameters" from top drop-down
c. Select "Encoder Parameters" from middle dropdown
d. Select "Encoder Position" from bottom drop-down
e. Select the desired axis from list.
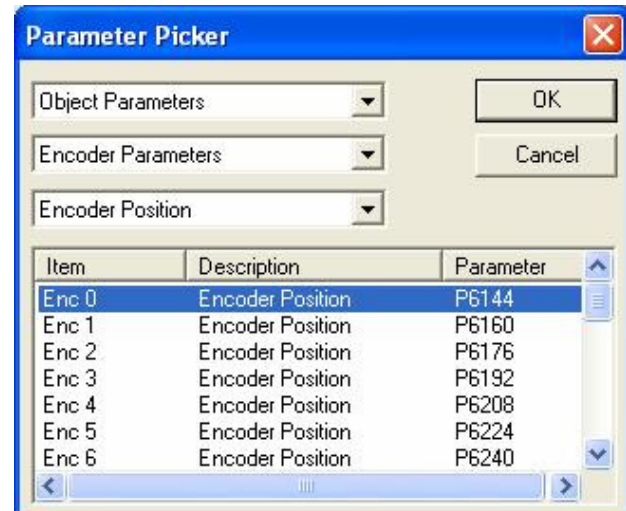
3. To display the commanded position on Channel 3:

a. Press "…" to open "Parameter Picker"
b. Select "Axis Parameters" from top drop-down
c. Select "Position Parameters" from middle dropdown
d. Select "Target Position" from bottom drop-down
e. Select the desired axis from list.
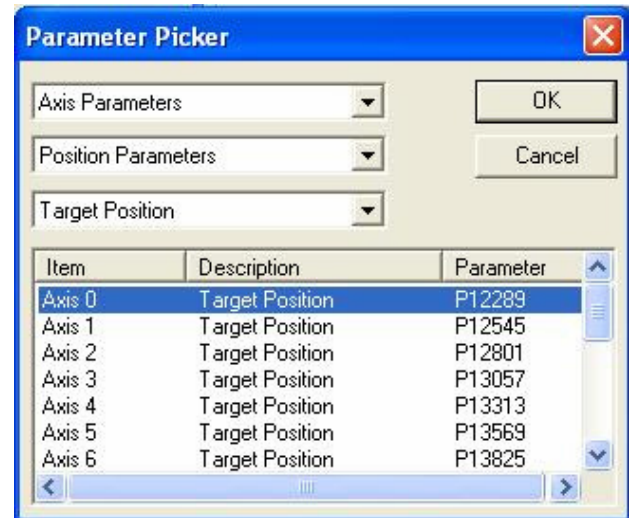
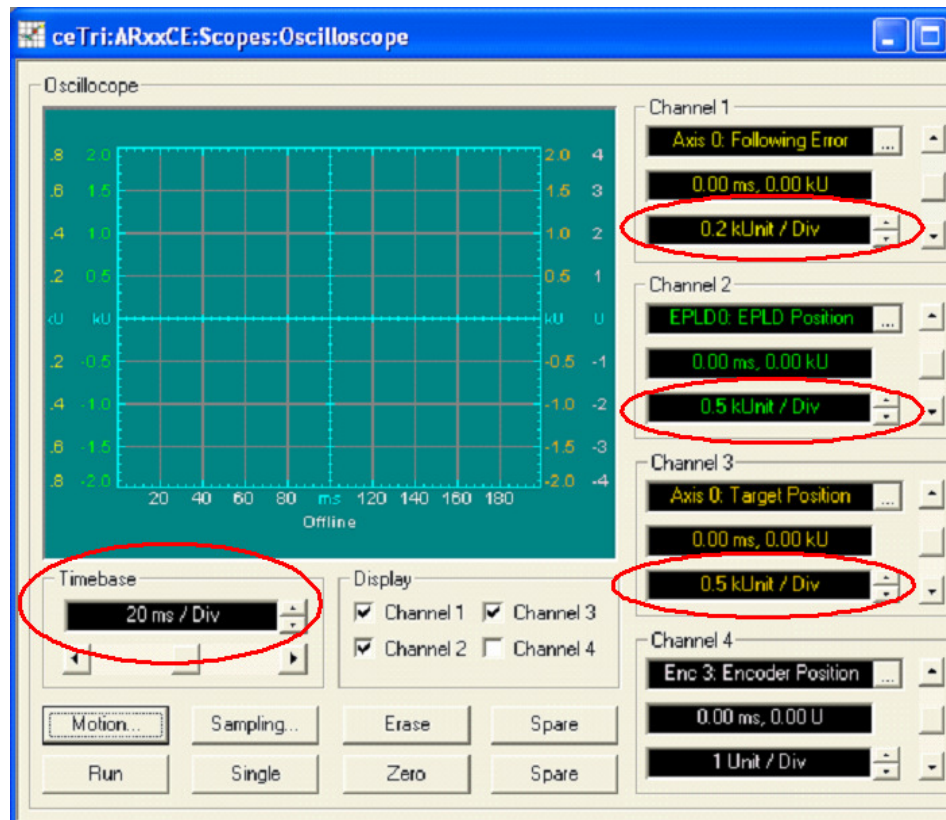**4. Set Channel 1, 2 and 3 Scaling:**

Channel 1: 0.2 k units/division

Channel 2: 0.5 k units/division
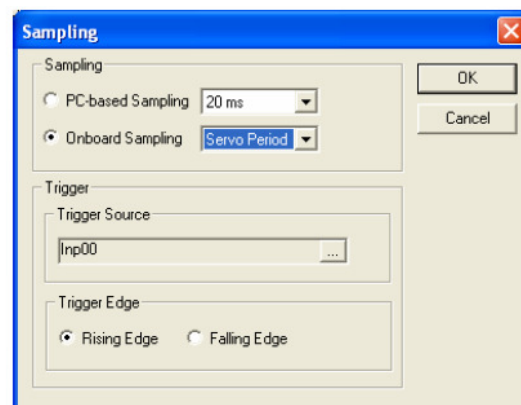
Channel 3: 0.5 k units/division

Disable Channel 4 by unchecking in Display

Set "Timebase" to 20ms/division

5. Select "SAMPLING…" and configure the scope for Controller-based sampling:
a. Select "Onboard Sampling"
b. Select "Servo Period"
c. Click on "…" under "Trigger Source"

Page 3

d. In 'Select A Bit' Window:
Select "Master Flags"
… then "Primary Master Flags"
… followed by "Primary Master0 Flags"
… finally "Bit 516 – In Motion"

Note: Select the In Motion bit for the

Master that the axis is attached to.

i.e., if Axis2 is attached to Master0, use bit516

If Axis3 is attached to Master3, use bit612

To confirm which Master the Axis is attached to see

the Configuration Wizard > Masters
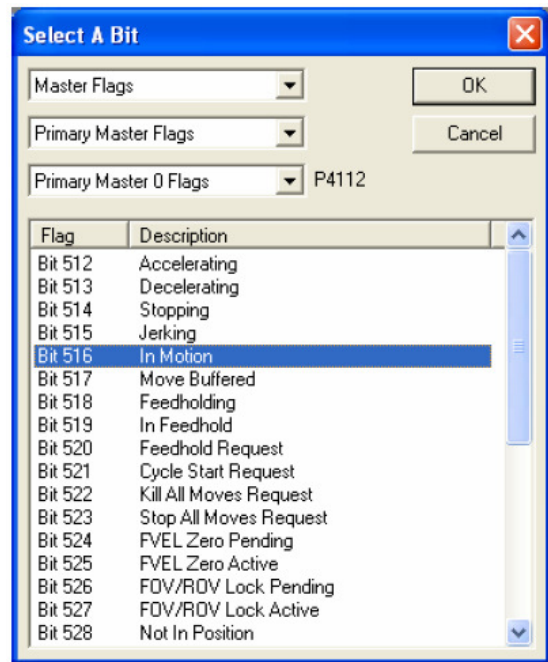
6.   SET TORQUE LIMIT

Set TORQUE LIMIT to a level that ensures that the amplifier current stays within the "continuous current" region of the motor and amplifier. This will prevent overheating of motor and amplifier in case of tuning instability. The Torque Limit setting is based upon the amplifier's command voltage input range and the percentage of that range as it applies to the continuous regions of both motor and amplifier. For our example, we will assume that our drive is matched to our motor with respect to peak current limit.

If our motor's continuous current range is 33% of its peak current range we would want to set our Torque Limit to approximately 3.3. Using the tuning gain window, set the Torque Limit to "3.3", or we could issue the "TLM X3.3" or "AXIS0 TLM 3.3" command in the terminal emulator. If for example the 210-4P motor is being used with an AR-08, this motor is rated at 3.5Arms continuous / 16Arms peak, the drive at 4.5Arms continuous / 13.5Arms peak. Since 3.5 Arms / 13.5Arms = .259, the torque limit should then be set to 2.5. These current ratings can be found in the Aries and Trilogy catalog pages.

7A. Initial Servo Tuner setup - Millimeters
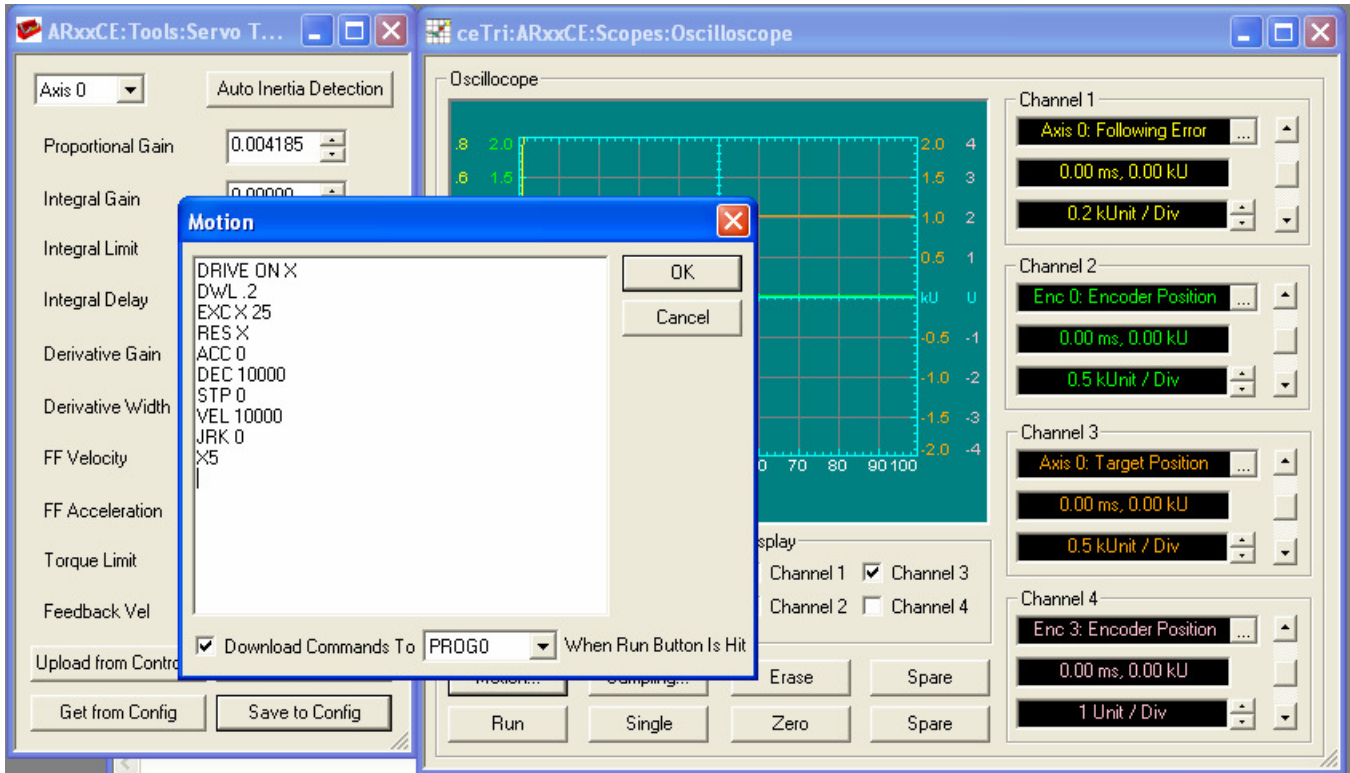
Select Motion… button and set the below commands for motion. Ensure that "Download Commands to PROG0 When Run Button Is Hit" is checked. This will send the code to the controller when the Oscilloscope is set to RUN or SINGLE.

DRIVE ON X

DWL .2

EXC X 25

RES X

ACC 0

DEC 10000

STP 0

VEL 10000

JRK 0

X5

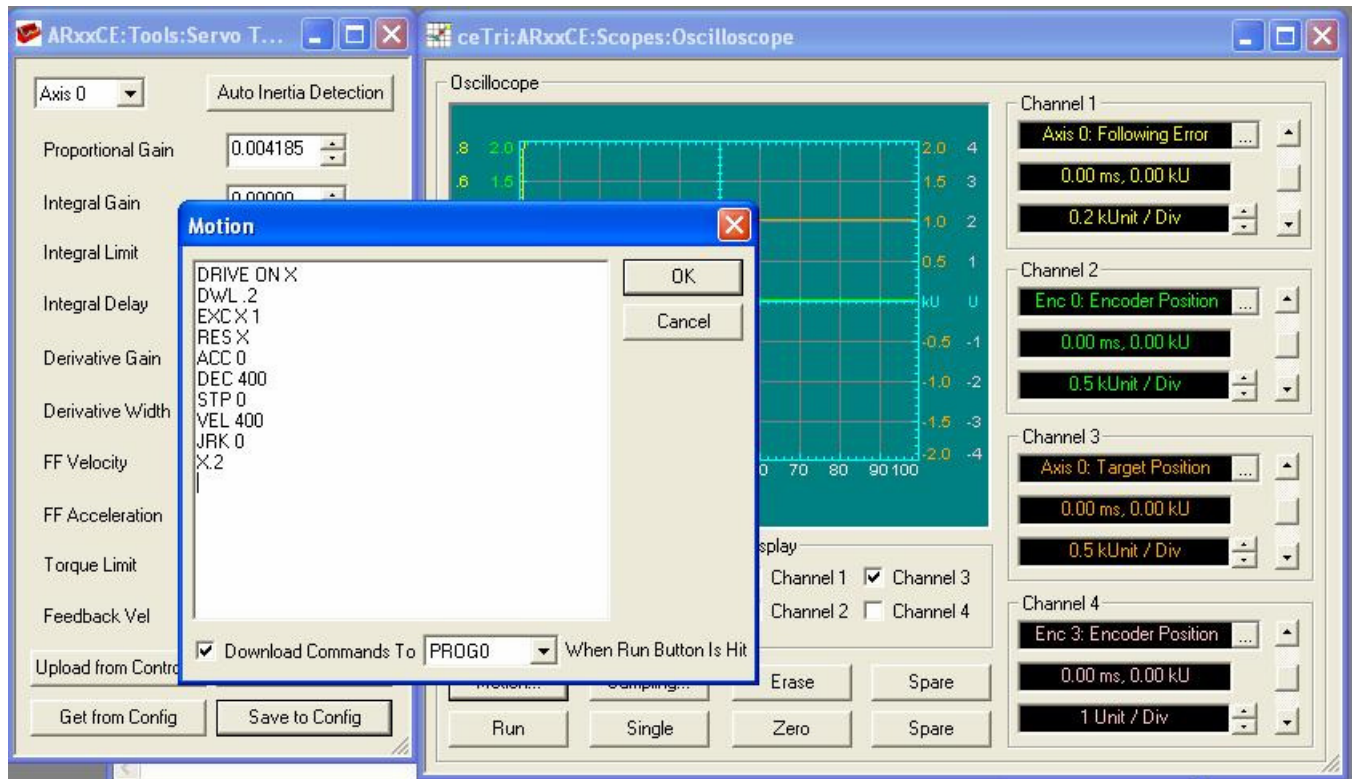**7B. Initial Servo Tuner setup - Inches**

Or for inches, select Motion… button and set the below commands for motion. Ensure that "Download Commands to PROG0 When Run Button Is Hit" is checked. This will send the code to the controller when the Oscilloscope is set to RUN or SINGLE.

DRIVE ON X

DWL .2

EXC X 1

RES X

ACC 0

DEC 400

STP 0

VEL 400

JRK 0

X.2

8A. ACR9000: Set Starting Gains

For the ACR9000, start with basic tuning gains for of proportional gain .0024, derivative gain of .00001 for an unloaded positioner at 5um resolution. For other resolutions, scale proportionally. i.e., if using a 1um resolution encoder, this is 5 times more resolution than the 5um, start with proportional gain of .00048, derivative gain of .000002

8B. ACR9040/9030 or AriesController: Enable EPL Network and Click Auto Inertia Detection

In the terminal window at the system prompt type EPLC ON or in the Configuration Wizard under EPL Network, click Start EPL Network. The ACR9040/9030's EPL led will turn green, showing the EthernetPowerlink network has initiated. Next, start by clicking Auto Inertia Detection. This will move the motor ¼ pitch, i.e. ¼ of 60.96mm for a 110/210/310 motor. Base tuning gains will be set.

9. Use Single shot tuning and graphical display, iterate for best dynamic response.

Now press "SINGLE". This will result in the motor moving 5mm (or .2 inches) in the forward direction and stop.

Note, when the Run or Single buttons the motion commands are downloaded and while this is running, the Run and Single buttons will change to Stop. With Single, this will run once and display the tuning. Run will loop continuously. However, if no waveforms are shown and you only see Stop, the system is still waiting to trigger. Double-check which master the axis is attached to and trigger based on that master's In Motion bit. If you see Run or Single after they're selected and no waveforms are shown, open the terminal emulator and look for error messages such as "Out of memory", "Unknown command", and "Out of range". "Out of memory" and "Out of range" indicate that not enough memory was set aside for PROG0 in the Configuration Wizard. Update the Configuration Wizard, Finish and download configuration again. "Unknown command" indicates the axes were not attached to Master0.

The following steps are based upon the graphical response. An AriesCE was used but the concepts of tuning are consistent with ACR9000 and Aries, ACR9040 and Aries EPL, or Aries Controller.
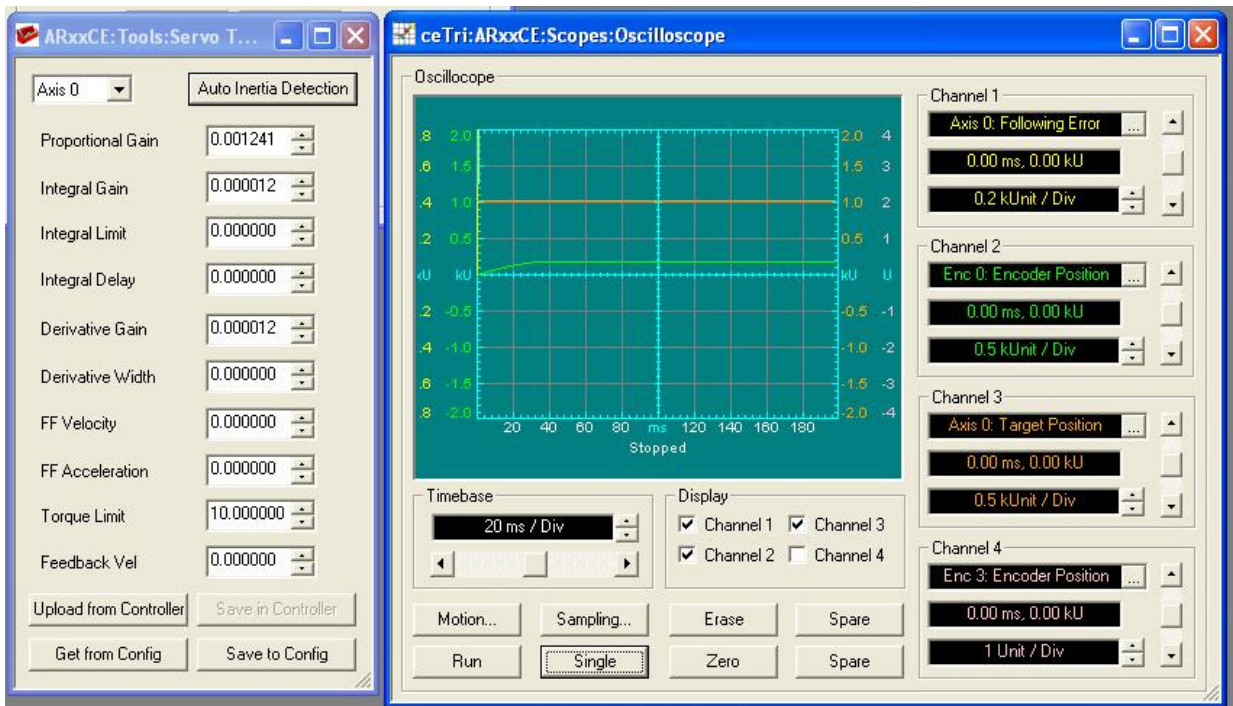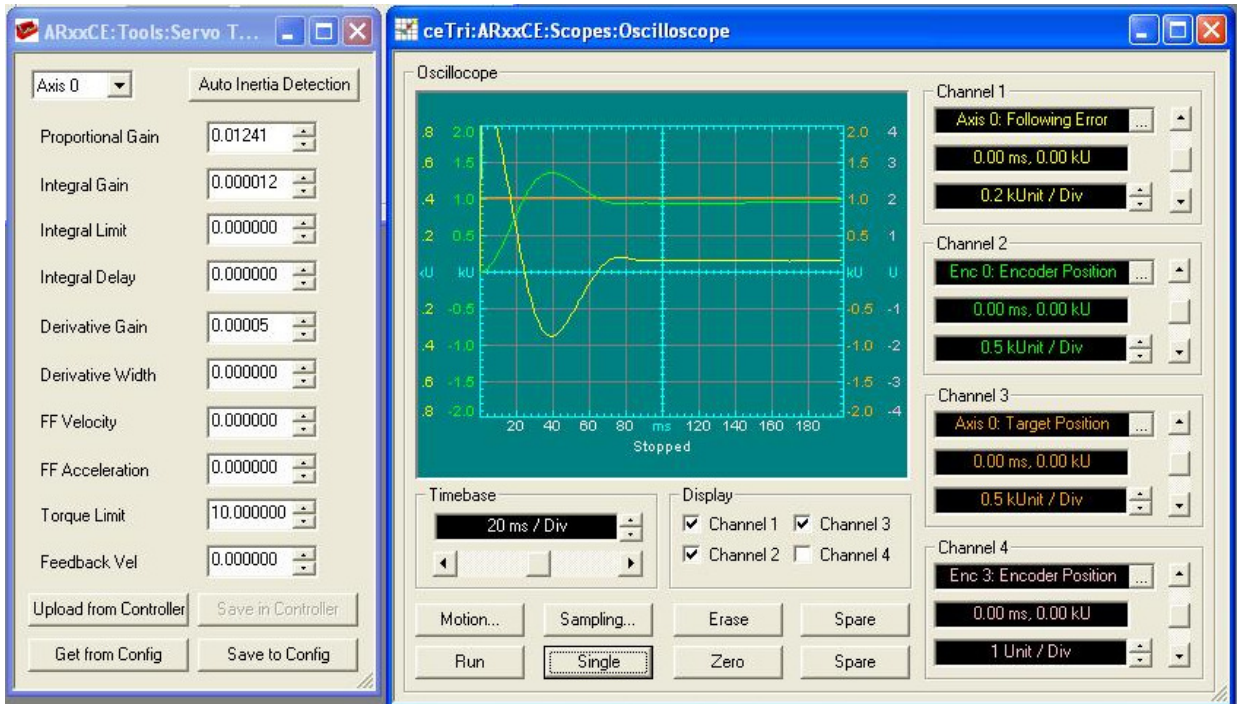
For an ACR9040/9030 system or AriesCE, scale the proportional gain by 10, in this example from .001241 to .01241
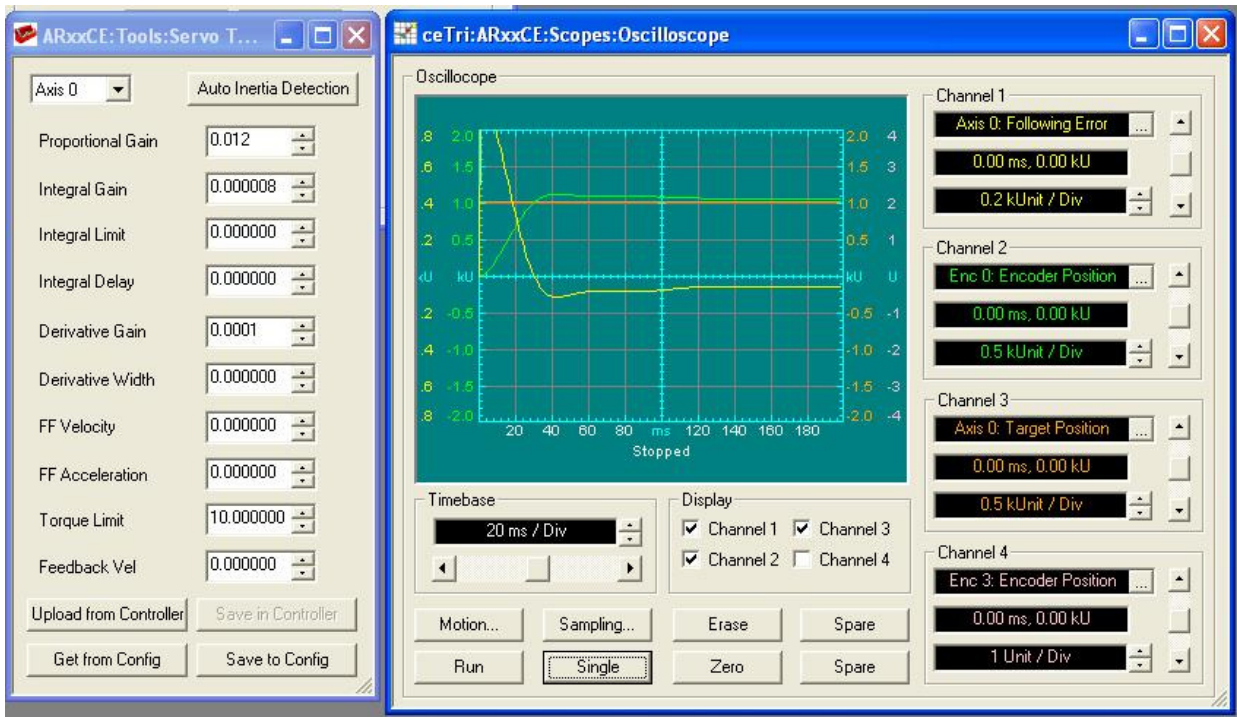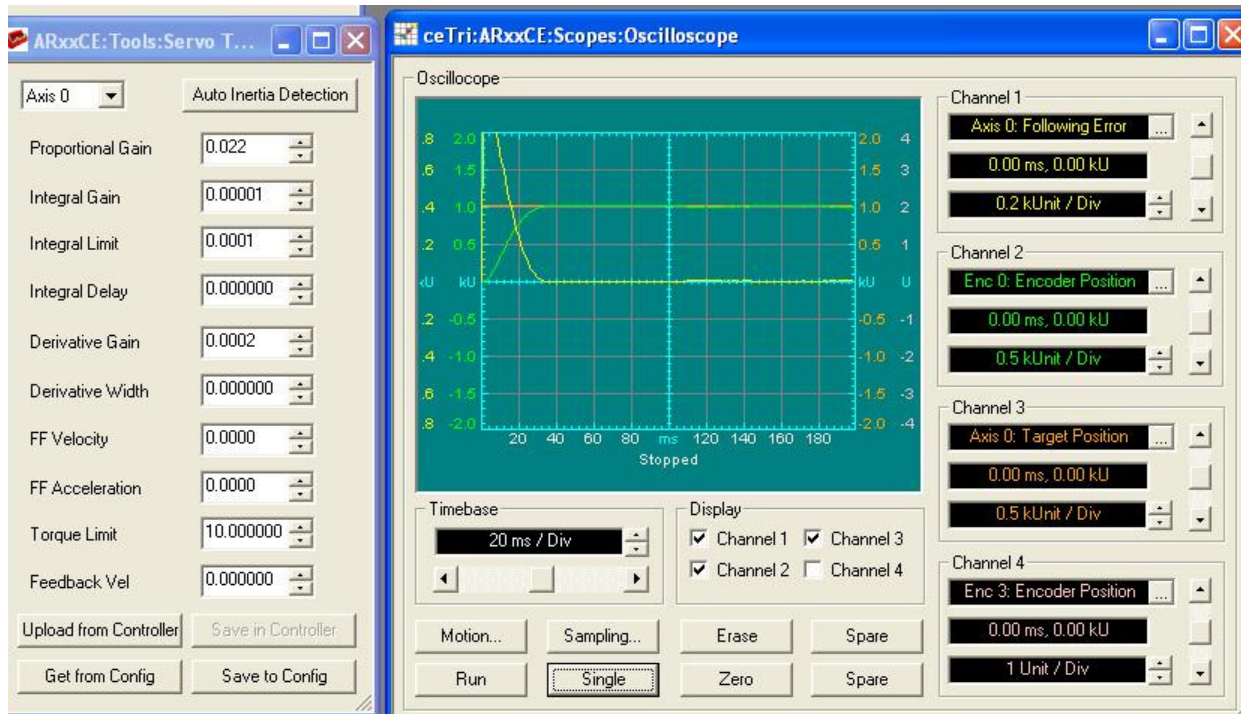

Page 8
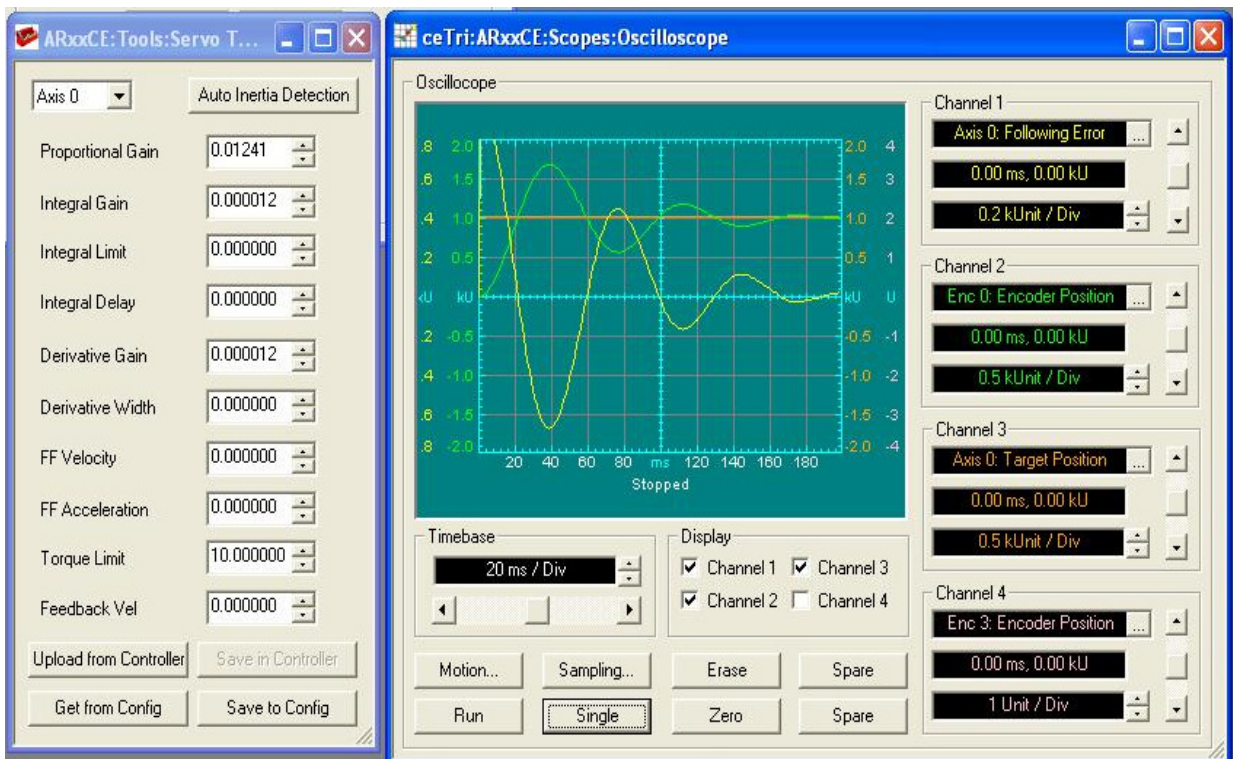
To dampen the overshoot, increase the derivative gain.

Further increasing the derivative gain…

www.comoso.com

Increasing the integral limit, allowing the integrator to correct for steady-state errors:

This shows a well-tuned system, with a step response settling within 30ms.

After the tuning has been completed, click Save in Controller and also Save to Config, which saves the tuning gains to both the controller and project file.

If you have any questions, please contact:

- Technical Assistance, Applications Engineering Department (e-mail: emn_support@parker.com or call 800-358-9070 North America, 707-584-7558 International)