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# AUTOMATION UNIVERSITY

Continuous Process -Advanced Process Control Instructions with Logix www.infoPLC.net

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# **Continuous Process - Advanced Process Control Instructions with Logix**

# **About Advanced Process Control Functionality**

A traditional control system controls processes to fixed setpoints determined by operators. Generic control algorithms and instructions such as a PID controller are used.

Advanced Process Control (APC) is designed to automatically account for an expected (modeled, predicted, etc.) process response and calculates "optimal" control actions to minimize process variations. APC system utilizes technologies such as:

- Model Predictive control
- Multivariable control
- Fuzzy logic and control
- Adaptive control
- Inferential control
- Process modeling and simulation

#### What You Will Accomplish In This Lab

In this lab you will explore two different versions of APC: Internal Model Control (IMC) and Coordinated Control (CC).

#### Who Should Complete This Lab

This hands-on lab is intended for individuals who:

- Want to become more familiar with the Advance Process Control features of RSLogix 5000.
- Already have familiarity with RSLogix 5000 organizational layout and programming techniques.

## **Before You Begin**

Before you begin this Hands-On Lab, please be sure to close any applications that are currently running.

To complete this lab, a general familiarity of computers, programmable controllers, I/O and automation software is recommended but not essential.

You will be using a V17 controller for this lab. Locate it on your station in the upper controller rack. The IP address of the Ethernet/IP card in the rack should be 172.16.XX.3, where XX is the number of your station

## Lab Materials

For this Hands-On lab, we have provided you with the following materials that will allow you to complete the labs in this workbook.

#### Hardware

L63 Logix Controller.

#### Software

This hands-on lab uses the following software:

- RSLogix<sup>™</sup> 5000 V17
- RSLinx Classic

#### Lab Files

This hands-on lab uses the following files:

- V17 Advanced Process Control AU09.doc
  - IMC\_Simulation.L5X
  - SquareWave.L5X

# **Document Conventions**

Throughout this workbook, we have used the following conventions to help guide you through the lab materials.

This style or symbol:	Indicates:
Words shown in bold italics (e.g., <b>RSLogix 5000</b> or <b>OK</b> )	Any item or button that you must click on, or a menu name from which you must choose an option or command. This will be an actual name of an item that you see on your screen or in an example.
Words shown in bold italics, enclosed in single quotes (e.g., <b>'Controller1'</b> )	<ul> <li>An item that you must type in the specified field. This is information that you must supply based on your application (e.g., a variable).</li> <li>Note: When you type the text in the field, remember that you do not need to type the quotes; simply type the words that are contained within them (e.g., Controller1).</li> </ul>
	The text that appears inside of this gray box is supplemental information regarding the lab materials, but not information that is required reading in order for you to complete the lab exercises. The text that follows this symbol may provide you with helpful hints that can make it easier for you to use this product. Most often, authors use this "Tip Text" style for important information they want their students to see.

**Note:** If the mouse button is not specified in the text, you should click on the left mouse button.

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# Lab 1: Using the IMC Instruction (40 minutes)

### About This Lab

In this lab you will explore the functionality of the Internal Model Control (IMC) instruction. This instruction controls a single process variable by manipulating a single output. The instruction compares the actual process signal to an internal model. The internal model can be manually entered, or the built-in autotuner can be used. This instruction is most suitable for processes with long deadtimes which are difficult to control with standard PID instructions. The setup and configuration parameters, as well as the autotune function, are very similar to the PIDE instruction.

Note: The PIDE instruction uses an autotune to generate a process model which is then used to generate P, I and D gain values. Once the gains are calculated the model is not utilized in the control loop. The IMC instruction uses the process model directly and continuously compares the process response (PV) to the modeled response. This results in tighter control to the setpoint for processes with long deadtimes, when compared with PIDE performance.

## **Comparing PIDE Loop Control to IMC Loop Control**



- 1. Open **RSLogix 5000**
- 2. Select File > New



3. Configure your controller as shown below adding Name: CLX and then click OK.

New Controller		×	
Vendor:	Allen-Bradley		
<u>T</u> ype:	1756-L63 ControlLogix5563 Controller	ОК	
Re <u>v</u> ision:	17 💌	Cancel	
	<u>R</u> edundancy Enabled	Help	Use Name CLX
Na <u>m</u> e:			
Descri <u>p</u> tion:	A		
	-		
<u>C</u> hassis Type:	1756-A10 10-Slot ControlLogix Chassis		
Sl <u>o</u> t:	2 Safety Partner Slot:		
Cr <u>e</u> ate In:	C:\RSLogix 5000\Projects	<u>B</u> rowse	

4. Expand the MainProgram by clicking on the '+'. Right click on *MainProgram* and select *New Routine.* 

ė€	∃ Tasks ∃- 🤕 MainTask			
		New Routine	N	
		Import Routine	43	

5. Configure the new routine as shown below and click OK.



6. Right click on *MainTask* and select *Properties*.



7. Go to the **Configuration** tab and change the **Type** to **Periodic** and set the **Period** to **'500'**.

👪 Task Propert	ies - MainTask	
General Configur	ation <sup>*</sup> Program / Phase Schedule Monitor	
Type: Period: Priority: Watchdog:	Periodic 500.000 ms 10  (Lower Number Yields Higher Priority) 500.000 ms	
Disable Auton	natic Output Processing To Reduce Task Overhead	
	OK Cancel Apply	Help

- 8. Click **OK** when done.
- 9. Right click on *MainProgram* and select *Properties*. In the *Configuration* tab, change *Assigned Routines Main* to *'PIDE\_vs\_IMC'* and click *OK*.

💕 Program Pro	perties - MainPr	ogram	
General Configu	ration <sup>*</sup> Monitor		,
Assigned Routin	es:		
Main: 🔝	'IDE_vs_IMC		•
Fault: <nor< td=""><th>e&gt;</th><th></th><th>•</th></nor<>	e>		•
🔲 Inhibit Progra	m		
🔽 Synchronize	Redundancy Data a	fter Execution	
ОК	Cancel	Apply	Help

10. Right click on *MainRoutine* and select *Delete*.

Tasks     AinTask     AinProgram     AinProgram     AinProgram     Det_vs_IM     MainProgram     MainProgram     MainProgram	js C		
Unscheduled Pr	Open		
E Motion Groups	Cut	Ctrl+X	
🛁 Add-On Instruction 🗎	Сору	Ctrl+C	
Conta Types	Paste	Ctrl+V	
	Delete	Del	

11. Click **Yes** to confirm the deletion.



Why did we delete this? We could have just used a JSR to call the PIDE\_vs\_IMC routine. It was deleted to totally eliminate any ladder logic from the project. Some "Process" people would see ladder logic and say "this is a PLC – and PLCs aren't good for process control. It really just shows that ControlLogix controller is in no way dependent on Ladder logic.

12. Right click on the Add-On Instructions folder and select Import Add-On Instruction.



13. Go to the Advanced Process Control folder and select IMC\_Simulation.L5K.



#### 14. Click Import.

The following window opens:

Import Configuration						
Find: Find Within: Final Name	<u>_</u>	Find/Replace				
Import Content:	Configure Add-O Import Name: Operation: Final Name: Description:	n Instruction Properties IMC_Sim Create IMC_Sim	•	Properties		
	Revision: Revision Note: Vendor:	v1.0				
Ready				OK	Cancel	Help

15. Click **OK** to complete the import.

The Add-On Instruction should now appear in your project.



16. Import the **SquareWave.L5K** Add-On Instruction.

Import Instruct	ion			
Look in:	C Advanced Pro	ocess Control	+ 🗈 💣 💷	]-
My Recent Documents Desktop My Documents My Computer	' IMC_Simulation ' SquareWave.L	n.L5X 5X		
<b>S</b>	File name:	SquareWave.L5X	•	Import
My Network Places	Files of type:	RSLogix 5000 XML Files (*.L5X)	<u> </u>	
	Files containing:	Instruction	-	Help
	Into:	Add-On Instructions	Ψ.	

17. Double click on the PIDE\_vs\_IMC routine and configure the logic shown below.

Note: If you are unfamiliar with configuring logic using function blocks just ask your instructor for assistance.



18. Add the PIDE and IMC blocks as shown below.



Note: In order to reduce the size of the function blocks several parameters (which are by default visible) have been hidden. You may leave them visible, or go into the function block parameters and uncheck the box in the first column (do this on the PIDE block only). If you are unfamiliar with this ask your instructor for assistance.

Note: You may have to increase the sheet size. Just right click on the page, select Properties and then Sheet Layout and select whatever size sheet you want.

FW3EN.doc



19. Next we need to add process simulation. Add the Add-On Instruction IMC\_Simulation as shown below.

Note: Be sure to add 'Assume Data Available' to the feedback from the simulation to the PIDE and IMC blocks. Again, if you are not familiar with this concept or process ask your instructor.

20. Add a 'PID\_Tune' tag to the PIDE block and right click to define the New 'PID\_Tune' tag.



Properties - IMC_01		×
General Configuration EU Scaling Limits Cascade/Ratio Mo	odel Parameters Tag Autotune	$\square$
Autotune Input:	Perform Autotune:	
Process Type: Non-integrating	CV Step Size:	10.0 + %
PV Change Limit: 0.0 ϵ	Start Abort	
Autotune Timeout Limit: 60.0	Autotune State:	Ready
Noise Level: Medium	Current Model Values	
,	Gain:	0.0
	Time Constant:	0.0 s
	Deadtime:	0.0 s
	Response Time Constant:	0.0 s
	Autotuned Model Values	
	Gain:	0.0
	Time Constant:	0.0 s
	Deadtime:	0.0 s
	Response Time Constant:	
	C Slow	0.0 s
	🖸 Medium	0.0 s
	C Fast	0.0 s
	Set Tuned Values 🗲	
	Status: Ready	
Status: OK		
Execution Order Number: < routine not verified>		
	OK Canad	Annala I Unio I
I Inever display description in a routine		миру нер

22. Click **OK** to accept your change.

23. Verify your controller. There should be no errors.



#### 24. Create a new trend by right clicking on the *Trend* folder and selecting *New Trend*.



25. Configure the new trend as shown below. Name Process\_Simulation, Sample Period 100ms.

New Trend - Ge	eneral 🛛 🔀
Name:	Process_Simulation
Description:	
Sample Period:	100 Hillisecond(s)
Cancel	< Back Next > Finish Help

26. Click *Next* and add the tags listed below.

New Trend - Add/Configure Tags	×
Scode:	
MainProgram	
Available1 ags.	1
Name A	
HIMC_U1 III III Sim 01	
H-Inic_sin_01	
III.SquareWave 01	
Add	
Tags To Trend:	
MainProgram\PIDE_01.PV	
MainProgram\PIDE_01.SPProg MainProgram\IMC_01_PV	
Remove	
Cancel < Back Next> Finish Help	

#### 27. Click *Finish*.

#### The chart will appear.

Bun Stop Errors Log -	Logging Stopped Periodic 100 ms Capture: 0 of 0
MainProgramVPIDE_01.PV 1	Process_Simulation Tuesday, February 12, 2008
MainProgramVPIDE_01.SPProg 1	
MainProgramWMC_01.PV 1	
<u> </u>	
0	
0	
0	
0	
0	
8:01:56 AM	8:01:57 8:01:57 8:01:58 8:01:58 AM

28. Right click on the chart and select *Chart Properties*.



RSTrendX Properties			
Name General Display F	ens   X-Axis   Y-Axis   Template   Sam	npling   Start Trigger   Stop Trig	ger
Name: Process_Simul	ation		
Description:			
	OK	Cancel Apply	Help

29. Click on the *Pens* tab and adjust the pen colors as you wish. The first pen is usually dark purple which doesn't show-up very well.



30. Click on the *X-Axis* tab and adjust the X-axis time span as shown below.

RSTrendX Properties
Name     General     Display     Pens     X-Axis     Y-Axis     Template     Sampling     Start Trigger     Stop Trigger       Chart time range     Start date       Start date
2/12/2008     are not available when scrolling is allowed. To clear Allow Scrolling, use the Display tab       Time span       20
Display options Display scale Display date on scale Display grid lines 4  Minor grid lines Grid color
OK Cancel Apply Help

RSTrendX Properties	×
Name       General       Display       Pens       X-Axis       Y-Axis       Te         Minimum / maximum value options <ul> <li>Automatic (best fit based on actual data)</li> <li>Preset</li> <li>(use min/max setting from Pens tab)</li> <li>Custom</li> <li>Minimum value</li> <li>Actual minimum value</li> <li>Maximum value</li> <li>Maximum value</li> <li>Actual minimum value</li> <li>100</li> </ul>	mplate   Sampling   Start Trigger   Stop Trigger
Display options Isolated graphing Display scale Display scale Display grid lines Grid color Display grid lines Minor grid lines	Scale options C All pens on same scale Each pen on independent scale Scale using pen Scale as percentage
	OK Cancel Apply Help

31. Click on the **Y-Axis** tab and adjust the Y-axis as shown below.

- 32. Click OK to finish the trend.
- 33. Verify and Save sour project.
- 34. Download the project to your controller and put the controller into *Run* mode.
- 35. Double click on the *PID\_vs\_IMC routine* to view the logic.
- 36. Open the PIDE parameters by clicking on the .... button.

#### 37. Select the *Autotune* tab.

Properties - PIDE_C	01				
General Configuration	EUs/Limits C	ascade/Ratio	Alarms Parameters	Teg Autotune	
Tag					
Name:	PID_Tune				
Acquire Tag Release Tag	Tag Status:	Available			
Autotune Inputs			Current Gains		
Process Type:	Temperature	-	Proportional: Integral:	0.0 0.0	
PV Change Limit:		0.0	Derivative:	0.0	
CV Step Size:		0.0 %			
Autotune			Execution State: ?		
Status: OK					
Execution Order Number	: 2	Г	0K		Halp
Never display descrip	otion in a routine			Apply Apply	

38. Click on the Acquire Tag button Acquire Tag and adjust the CV Step Size to '20'.

Properties - PIDE_01
General Configuration EUs/Limits Cascade/Ratio Alarms Parameters Tag Autotune <sup>®</sup>
Tag         Name:       PID_Tune         Acquire Tag       Tag Status:         Acquire Tag       Tag Status:         Acquire Tag       Tag Status:         Acquire Tag       Current Gains         Autotune Inputs       Current Gains         Process Type:       Temperature         Proportional:       0.0
PV Change Limit: 0.0 Derivative: 0.0
CV Step Size: 20 %
Autotune Execution State: Ready
Status: OK
Execution Order Number: 2
Never display description in a routine     OK     Cancel     Apply     Help

39. Click on the *Autotune* button and click **Yes** to accept the changes before starting the autotune.



40. Click on the *Start* button to begin the autotune.

PIDE Autotune - PIDE	_01			X
Start Abort	Execution State: Autotune Status:	Ready OK		
- Autotune Gains	Proportion	al	Integral (1/min)	Derivative (min)
Slow Response	0.0		0.0	0.0
C Medium Response	0.0		0.0	0.0
C Fast Response	0.0		0.0	0.0
C Current	0.0		0.0	0.0
Set Gains in PIDE				
Time Constant: Deadtime: Gain:	0.0 s 0.0 s 1.0			
	Close	]	Help	

41. The Execution State will change from Ready to In Progress.

PIDE Autotune - PIDE	_01		×
Start Abort	Execution State: Autotune Status:	rogress	<
- Autotune Gains	Proportional	Integral (1/min)	Derivative (min)
Slow Response	0.0	0.0	0.0
C Medium Response	0.0	0.0	0.0
C Fast Response	0.0	0.0	0.0
C Current	0.0	0.0	0.0
Set Gains in PIDE			
Time Constant: Deadtime: Gain: Based on Non-integrating	0.0 s 0.0 s 0.0 model		
	Close	Help	

42. When the autotune is complete (this will take several minutes) the Execution State will change to Complete and Autotune Gains will be displayed.

PIDE Autotune - PIDE_	01		×	
Start Abort	Execution State: Cor Autotune Status: OK		<	
Autoturie dains	Presentional	Integral (1/min)	Derivative (min)	
C Slow Response	0.48953214	0.51081616	0.044235263	
C Medium Response	0.9790643	1.0216323	0.088470526	
G Fast Response	1.4685965	1.5324485	0.1327058	
Current	0.0	0.0	0.0	
Set Gains in PIDE				ſ
Time Constant: Deadtime: Gain: 1.0800 Based on Non-integrating m	43.0 s 43.5 s 1836 nodel			
	Close	Help		

43. Select Mediu	E Set Gains in PIDE			
PIDE Autotune - PIDE_	01			
Start Abort	Execution State: Comp Autotune Status: OK	olete		
Autotune Gams	Proportional 0.48953214 0.9790643 1.4685965 0.9790643	Integral (1/min) 0.51081616 1.0216323 1.5324485 1.0216323	Derivative (min) 0.044235263 0.088470526 0.1327058 0.088470526	
Time Constant: Deadtime: Gain: 1.080 Based on Non-integrating n	43.0 s 43.5 s D836 nodel Close	Help		

Note that gains have now been loaded into the 'Current' line.

44. Click *Close*. The Autotune tab shows the results of the autotune and the current loaded gains.

Properties - PIDE_01				X
General Configuration El	Us/Limits Cascade/Ratio	Alarms Parameter	rs Tag Autotune	
Tag				
Name: F	PID_Tune			
Acquire Tag T Release Tag	Fag Status: Acquired			
Autotune Inputs Process Type: PV Change Limit: CV Step Size:	Temperature  0.0 20.0	Current Gains Proportional: Integral: Derivative: %	0.9790643 1.0216323 0.088470526	
Autotune		Execution State: 0	Complete	
Status: OK				
Execution Order Number: 2	2		1	
🔲 Never display descriptio	on in a routine	OK	Cancel Apply	Help

#### 45. Click **OK**.

46. Click on the Properties button . for the IMC block and then select the **Autotune** tab.

Properties - IMC_01				X
General Configuration EU Se	caling Limits Cascade/Ratio Mo	odel Parameters Tag Autotun	• )	
Autotune Input:		Perform Autotune:		
Process Type:	Non-integrating 🔍 🗲	CV Step Size:	10.0 + %	
PV Change Limit:	0.0 ←	Start Abort		
Autotune Timeout Limit:	60.0   mtext{minutes}	Autotune State:	Ready	
Noise Level:	Medium 🔻 🗲	Current Model Values		
		Gain:	0.0	
		Time Constant:	0.0 s	
		Deadtime:	0.0 s	
		Response Time Constant:	0.0 s	
		Autotuned Model Values		
		Gain:	0.0	
		Time Constant:	0.0 s	
		Deadtime:	0.0 s	
		Response Time Constant:		
		C Slow	0.0 s	
		Medium	0.0 s	
		C Fast	0.0 \$	
		Set Tuned Values 🗲		
		Status: Ready	in the second se	1
Status: OK				
Execution Order Number: 3				
Never display description in	a routine	OK Cancel	Apply Help	<u> </u>

47. Change the CV Step size to '20' and then click Apply

Properties - IMC_01							
General Configuration EU Scaling Limits Cascade/Ratio Model Parameters Tag Autotune							
Autotune Input:		Perform Autotune:					
Process Type:	Non-integrating 💌 🗲	CV Step Size:	20.0				
PV Change Limit:	0.0 ←	Start Abort					
Autotune Timeout Limit:	60,0 e minutes	Autotune State:	Ready				
Noise Level:	Medium 🔻 🗲	Current Model Values					
	,	Gain:	0.0				
		Time Constant:	0.0 s				
		Deadtime:	0.0 s				
		Response Time Constant:	0.0 s				
		Autotuned Model Values					
		Gain:	0.0				
		Time Constant:	0.0 s				
		Deadtime:	0.0 s				
		Response Time Constant:					
		C Slow	0.0 s				
		Medium	0.0 s				
		C Fast	0.0 s				
		Set Tuned Values 🔦					
		Status: Ready					
Status: OK							
Execution Order Number 3							
Never display description in	a routine	OK Cancel	Apply Help				

48. Click on the *Start* button ( \_\_\_\_\_\_) to perform the autotune.

Properties - IMC_01			×
General Configuration EU S	caling Limits Cascade/Ratio Mo	del Parameters Tag Autotu	ne
Autotune Input:		Perform Autotune:	
Process Type:	Non-integrating 🖉 🗲	CV Step Size:	20.0 +%
PV Change Limit:	0.0	Start Abort	
Autotune Timeout Limit:	60.0 ፍ minutes	Autotune State:	In Progress
Noise Level:	Medium 💌 🗲	Current Model Values	
	,	Gain:	0.0
		Time Constant:	0.0 s
		Deadtime:	0.0 s
		Response Time Constant:	0.0 s
		Autotuned Model Values –	
		Gain:	0.0
		Time Constant:	0.0 s
		Deadtime:	0.0 s
		Response Time Constant:	
		C Slow	0.0 s
		Medium	0.0 s
		C Fast	0.0 s
		Set Tuned Values 🔸	
		Status:	
Status: OK			
Execution Order Number: 3			
Never display description in	a routine	OK Cancel	Apply Help

Properties - IMC_01	
General Configuration EU Scaling Limits Cascade/Ratio Mo	del Parameters Tag Autotune
Autotune Input:	Perform Autotune:
Process Type: Non-integrating 💌 🗲	CV Step Size: 20.0 ← %
PV Change Limit: 0.0 ←	Start Abort
Autotune Timeout Limit: 60.0	Autotune State: Complete
Noise Level: Medium 💌 ፍ	Current Model Values
,	Gain: 0.0
	Time Constant: 0.0 s
	Deadtime: 0.0 s
	Response Time Constant: 0.0 s
	Autotuned Model Values
	Gain: 1.0818344
	Time Constant: 43.0 s
	Deadtime: 42.5 s
	Response Time Constant:
	C Slow 57.0 s
	Medium 28.5 s
	C Fast 14.25 s
	Set Tuned Values 🗧
	Status: OK
Status: OK	
Execution Order Number: 3	
Never display description in a routine	OK Cancel Apply Help

49. After completion the Autotuned Model Values will be populated.

50. *Medium* is the default Response Time Constant selected, click on the *Set Tuned Values* button Set Tuned Values.

Properties - IMC_01				
General Configuration EU S	caling Limits Cascade/Ratio Mo	del Parameters Tag Autotu	ine	
Autotune Input:		Perform Autotune:		
Process Type:	Non-integrating 🗨 🗲	CV Step Size:	20.0 +%	
PV Change Limit:	0.0 🔶	Start Abort		
Autotune Timeout Limit:	60.0 ፍ minutes	Autotune State:	Complete	
Noise Level:	Medium 🔻 🗲	Current Model Values		
	,	Gain:	1.0818344	
		Time Constant:	43.0 s	
		Deadtime:	42.5 s	
		Response Time Constant:	28.5 s	
		Autotuned Model Values –		
		Gain:	1.0818344	
		Time Constant:	43.0 s	
		Deadtime:	42.5 s	
		Response Time Constant:		
		C Slow	57.0 s	
		Medium	28.5 s	
		C Fast	14.25 s	
		Set Tuned Values 🔦		
		Status: OK		
		,		2
Status: OK				
Execution Order Number: 3				
Never display description in	a routine	OK Cancel	Apply	əlp

51. Click on the *Model* tab. This displays the internal model which will be used by the instruction.

Properties - IMC_01	×
General Configuration EU Sc	aling Limits Cascade/Ratio Model Parameters Tag Autotune
Calculate Error As:	l% of Span
Process Type:	Non-integrating
Model Factor:	100.0
Process Gain Sign:	Positive
Model Gain:	1.0818344
Model Time Constant:	43.0 s
Model Deadtime:	42.5 s
Response Time Constant:	28.5 s
Status: UK Execution Order Number: 3	
🔲 Never display description in	routine OK Cancel Apply Help

52. Click **OK** to close the IMC Parameters window.

53. Double click on the **Process\_Simulation** trend and then click on the **Run** button (top left corner) to start the chart. Depending on the moment that you start trending, the next screen may look different. The setpoint is cycled from 5 to 70 by the simulation every 10 min.



Note that the SPProg values changes (square wave) but that the PIDE.PV and IMC.PV values are steady state, that is because both the PIDE and IMC blocks are in Operator Manual mode and their CE outputs to the process simulation are at zero.

54. Change both the PIDE and IMC blocks to Program Auto mode by setting the *ProgProgReq* and *ProgAutoReq* parameters to '1'. If you are not familiar with this process ask your instructor.



Observe the trend for at least one cycle.

Notice that the PID loop overshoots when the setpoint jumps up and undershoots when it drops low. The PID loop eventually gets to the setpoint, but the IMC loop does a much better job for this particular process.

If you want to see more details, add the CVEU pens to watch the control actions of the PIDE and IMC instructions.

This concludes lab 1.

# Lab 2: Coordinated Control (20 Minutes)

## About This Lab

In this lab you will explore the functionality of the Coordinated Control (CC) instruction. This instruction controls a single process variable by manipulating as many as three different outputs. Target values and priorities for each of the outputs are used to optimize your process control. The instruction compares the actual process signal to an internal model for each output. Each output may be in manual control or automatically controlled. The internal models can be manually entered, or the built-in autotuners for each control variable can be used. The setup and configuration parameters, as well as the autotune function, are very similar to the PIDE instruction.

# **Exploring the Coordinated Control Instruction**

- 1. Go Offline with your RSLogix 5000 project Advanced Process Control
- 2. Right click on the *MainTask* and select *New Program*.



3. Name the new program 'Coordinated\_Control' and click OK.





4. Right click on *Coordinated\_Control* and select *New Routine*.



5. Name the new routine '*CC\_Simulation*', select *Function Block Diagram* as the Type and click *OK*.

New Routine	9		$\mathbf{\times}$
Name:	CC_Simulation	ОК	
Description:		Cancel	
Туре:	Function Block Diagram	✓ Help	
In Program or Phase:	Coordinated_Control	•	
🔲 Open Rou	tine		
Tasks	Task MainProgram Program Tags Top PIDE_vs_IMC Toordinated_Control Program Tags CC_Simulation		

6. Double click on *CC\_Simulation* and create the following logic:





S	Scope: Show Show All						
	Name 🗠	Alias For	Base Tag	Data Type	Style		
	⊞-CC_01			CC			
	MPC_AgitatorSpeed			REAL	Float		
	MPC_AirFlow			REAL	Float		
	MPC_DissolvedOxygen_PV			REAL	Float		
	MPC_DissolvedOxygen_SP			REAL	Float		
	MPC_Pressure			REAL	Float		





Details: Input and Output reference tags used on sheet 2 were created on sheet 1 Create the following blocks and arrange as shown above:

- LDLG01 15 sec Lag
- LDLG02 30 sec Lag
- LDLG03 45 sec Lag
- DEDT01 5 sec Deadtime
- DEDT02 10 sec Deadtime
- DEDT03 15 sec Deadtime

In the storage array tab in the properties of the deadtime blocks, create the following new tags with Data type: REAL (and change Dim0 value to 1000), Scope: Coordinated\_Control and Style: Float

DEDT\_01\_Array REAL[1000] DEDT\_02\_Array REAL[1000] DEDT\_03\_Array REAL[1000] 7. Set the CC block parameters on the various tabs as shown

Properties - CC_01		
General Configuration EU Scaling	J Limits Model Parameters Tag Au	itotune
Timing		
Mode:	Periodic 🗨	
Oversample ∆t:	0.0 s	
RTS Period:	1 ms	
Control Variables		
🔲 Use CV Track Values	CV1 CV2	CV3
CV Track Value:	0.0 %	0.0 % 0.0 %
Override Value:	00%	0.0 % 0.0 %
Target Value:	5.0 %	15.0 %
	First Second	Third
Deviation Action Priority:	CV1 CV2	▼ CV3 ▼
Drive to Target Priority:	CV1 CV2	▼ CV3 ▼
Target Response Time Constant:	30.0 s	
🔲 Program Control Value Reset		
🔲 Manual Mode after Initializatio	n	
PV Tracking		
Status: OK		
Execution Order Number: 1		
Never display description in a rot	itine O	JK Cancel Apply Help

The target values are the desired values for CV1, CV2 and CV3.

Click **APPLY** 

Properties - CC_01						X
General Configuration El	J Scaling	Parameters   Tag	Autotune			
Process Variables					_	
Max at 100% Span:	100.0					
Min at 0% Span:	0.0					
Control Variables —					_	
Control Yunabics	CV1	CV2	CV3			
Max at 100% Output:	100.0	100	0	100.0		
Min at 0% Output:	0.0	0	0	0.0		
Status: OK						
Execution Order Number: 1						
🔲 Never display descriptio	n in a routine		ОК	Cancel	Apply	Help

Note: These are to be left at the default settings.

Properties - CC_01			
General Configuration EU Sca	ng Limits Model Parameters	Tag Autotune	
Set Point			
High Limit:	100.0		
Low Limit:	0.0		
Control Variables			
	CV1 CV2	CV3	
High Limit:	100.0 %	100.0 %   100.0 %	
Low Limit:	0.0 %	0.0 % 0.0 %	
Positive Rate of Change:	1.0 %/s	1.0 %/s 1.0 %/s	、
Negative Rate of Change:	1.0 %/s	1.0 %/s	)
🔲 Limit Control Variable in I	Manual Mode		
Statue: OK			
Execution Order Number: 1			
Never display description in a	routine	OK Cancel Apply	Help

Note: This tab allows you to set limits on Set point and the control variables.

Click APPLY

Properties - CC_01							
General Configuration EU Sc	aling (imits Mod	del Para	aneters   Tag   A	utotune			
Calculate Error As:	% of Span	J					
Process Type:	Non-integrating	•					
Model Factor:		100.0					
	CV1		CV2		CV3		
Process Gain Sign:	Positive	-	Positive	•	Positive	<b>-</b>	
Model Gain:		0.0		0.0		0.0	
Model Time Constant:		0.0 s		0.0 s		0.0 s	
Model Deadtime:		0.0 s		0.0 s		0.0 s	
Response Time Constant:		0.0 s		0.0 s		0.0 s	
Status: OK							
Execution Order Number: <rout< td=""><td>tine not verified&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td></rout<>	tine not verified>						
Never display description in a	a routine			OK	Cancel	Apply	Help

Note: These are to be left at the default settings. They will be automatically populated after we run the autotune feature. If models were developed using some other method they could be manually entered here.

Properties - CC_01		X
General Configuration EU Scaling Limits Model Parameters	(ag Autotune	
Autotune Input:	Perform Autotune on:      CV1	C CV2 C CV3
Process Type: Non-integrating 💌 🗧	CV1 Step Size:	10.0 + %
PV Change Limit: 0.0 ←	Start Abort	
Autotune Timeout Limit: 60.0 ፍ minutes	Autotune State:	Ready
Noise Level: Medium 🗨 ሩ	Current Model Values	
·	Gain:	0.0
	Time Constant:	0.0 s
	Deadtime:	0.0 s
	Response Time Constant:	0.0 s
	Autotuned Model Values	
	Gain:	0.0
	Time Constant:	0.0 s
	Deadtime:	0.0 s
	Response Time Constant:	
	C Slow	0.0 s
	🖸 Medium	0.0 s
	C Fast	0.0 <b>s</b>
	Set Tuned Values 🗲	
	Status: CV1 Ready	
Status: OK		
Execution Order Number: <routine not="" verified=""></routine>		
Never display description in a routine	OK Cancel	Apply Help

These are the default settings for this tab.

8. Click **OK** and then **Verify** controller

You should get the following Error:

Warning: Coordinated\_Control: Program doesn't have associated main routine.

9. Right click on the Coordinated\_Control program, select *Properties, Configuration* and then set the Main routine to *CC\_Simulation*.

👪 Program	Properties - Coordinated_Control 🔲 🗖 🔀
General C	onfiguration* Monitor
Assigned F	loutines:
Main:	CC_Simulation
Fault:	<none></none>
🗐 Inhibit f	Program
🔽 Synchr	onize Redundancy Data after Execution
	DK Cancel Apply Help

#### 10. Create another trend as follows:

	New Trend	N	
🗄 📇 I/O 🖉 👘	Import Trend	45	

## 11. Add Name and Sample Period and click Next.

New Trend - Ge	eneral	×
Name:	Dissolved_Oxygen	
Description		
Description:		
Sample Period:	100 Millisecond(s)	
		_
Cancel	< Back Next > Finish Help	1

12. Select Tags as shown and click Finish.

New Trend - Add	/Configure T	lags 🛛		X
Scope:				
Coordinated_	Control	•		
AvailableTags:				
Name				~
MPC_Agit:	atorSpeed			
MPC_AirFl	low			
MPC_Diss	olvedOxygen_P	∾V		
MPC_Diss	olvedOxygen_S	SP		
MPC_Pres	sure			<b>~</b>
Tags To Trend:	[	Add		
Coordinated_Con Coordinated_Con Coordinated_Con Coordinated_Con <u>Coordinated_Con</u>	trol\MPC_Disso trol\MPC_Disso trol\MPC_Agitat trol\MPC_AirFlo trol\MPC_Press	lved0xygen_PV lved0xygen_SP torSpeed w ure		
J		Remove		
Cancel	< Back	Next >	Finish	Help

Coordinated_ControlWPC_DissolvedOxygen_	1		
	0	1	
Coordinated_ControlWPC_DissolvedOxygen_	1		
	0		
Coordinated_ControlWPC_AgitatorSpeed	1		
	0		
Coordinated_ControlWPC_AirFlow	1		
	0	0	
Coordinated_ControlWPC_Pressure	1		
	0		

13. Right click on chart to select Properties.



#### 14. Adjust pen colors to your preference

RSTrendX Properties								
Name General Display Pens X-Axis Y-Axis Template Sampling Start Trigger Stop Trigger								
	1					1.122	1	
Pen Attributes	Pen Attributes							
1 Conditioned Con	Tag\Expr. Color Visible Width Type							
2 Coordinated_Cor	trol/MPC_Dissolv	redOxygen_FV redOxygen_SP		l0n l0n	1	Analog Analog		
3 Coordinated Cor	ntrol\MPC_Agitato	rSpeed		On	1	Analog		
4 Coordinated_Con	htrol\MPC_AirFlow	) 		On	1	Analog		
5 Coordinated_Cor	htrol\MPC_Pressu	re		On	1	Analog		
1							•	
			Add/Configu	ure Tags	Dele	ete Pen(s)		
Multiple Pen Edits								
Visible Width	Type Style	Marker	Min	Max	Eng. Uni	ts		
Charl Calculation Apple to Calculated Barr(c)								
OK Cancel Apply Help								

15. Adjust *Time span* on the *X-Axis.* 

16. Adjust Y-Axis to Custom and Display Decimal Places to 1 and click OK.

RSTrendX Properties	
Name General Display Pens X-Axis Y-Axis T	emplate Sampling Start Trigger Stop Trigger
Minimum / maximum value options Automatic (best fit based on actual data) Preset (use min/max setting from Pens tab) Custom Minimum value Actual minimum value	
Maximum value C Actual maximum value	
Display options	Scale options
Isolated graphing	C All pens on same scale
Display scale     Decimal places	Each pen on independent scale C Scale using pen
✓ Display grid lines	
Grid color 0 📩 Minor grid lines	Scale as percentage
	OK Cancel Apply Help

- 17. Download to the controller and place in *Run* mode.
- 18. Open the CC\_01 properties, go to the Autotune tab and click *Start* to run the Autotune for CV1

Properties - CC_01		$\mathbf{\Sigma}$
General Configuration   EU Scaling   Limits   Model   Parameters	Tag Autotune	
Autotune Input:	Perform Autotune on:  CV1 CV2 CV3	
Process Type: Non-integrating 💌 🗲	CV1 Step Size: 10.0 + %	
PV Change Limit: 0.0 🗲	Start Abort	
Autotune Timeout Limit: 60.0 ፍ minutes	Antotune State Ready	
Noise Level: Medium 💌 ፍ	Current Model Values	
·	Gain: 0.0	
	Time Constant: 0.0 s	
	Deadtime: 0.0 s	
	Response Time Constant: 0.0 s	
	Autotuned Model Values	
	Gain: 0.0	
	Time Constant: 0.0 s	
	Deadtime: 0.0 s	
	Response Time Constant:	
	C Slow 0.0 s	
	Medium 0.0 s	
	C Fast 0.0 s	
	Set Tuned Values	
	Status: CV1 Ready	
Status: OK		_
Execution Order Number: 1		
☐ Never display description in a routine	OK Cancel Apply Help	

#### CV1 should be highlighted in green and the Autotune Status should show In Progress



Start

19. When the Autotune is completed the Autotune Status will change to **Completed** and the **Autotuned Model Values** will update

Tag Autotune	
Perform Autotune on: 💿 CV1	C CV2 C CV3
CV1 Step Size:	10.0 + %
Start Abort	$\frown$
Autotune State:	( Complete )
Current Model Values	
Gain:	0.0
Time Constant:	0.0 s
Deadtime:	0.0 s
Response Time Constant:	0.0 s
Autotuned Model Values –	
Gain:	1.0757825
Time Constant:	/ 15.5 s
Deadtime:	6.5 s
Response Time Constant:	
C Slow	14.666667 s
Medium	7.3333335 s
C Fast	3,9666667
Set Tuned Values 🗲	<b>C</b>
Status: CV1 OK	

20. The *Medium* Response Time Constant is preselected, click *Set Tuned Values* (Set Tuned Values).

Tag Autotune		
Perform Autotune on: 💿 CV1	C CV2	O CV3
CV1 Step Size:	10.0 + %	
Start Abort		
Autotune State:	Complete	
Current Model Values	$\frown$	
Gain:	1.0757825	
Time Constant:	15.5 s	
Deadtime:	6.5 s	
Response Time Constant:	7.3333335 s	
Autotuned Model Values	/	
Gain:	1.0757825	
Time Constant:	15.5 s	
Deadtime:	6.5 s	
Response Time Constant:		
C Slow	14.666667 s	
Medium	7.3333335 s	
C Fast	3.6666667 s	
Set Tuned Values 🔸		
Status: CV1 OK		* *

21. Run the autotune for CV2 by selecting Perform Autotune on CV2 and clicking Start.

	Tag Autotune		
	Perform Autotune on: 🕜 CV1	( CV2	C CV3
	CV2 Step Size:	10.0 + %	
(	Start Abort		
	Autotune State.	Ready	
	Current Model Values		
	Gain:	0.0	
	Time Constant:	0.0 s	
	Deadtime:	0.0 s	
	Response Time Constant:	0.0 s	
	Autotuned Model Values –		
	Gain:	0.0	
	Time Constant:	0.0 s	
	Deadtime:	0.0 s	
	Response Time Constant:		
	C Slow	0.0 s	
	Medium	0.0 s	
	C Fast	0,0 s	
	Set Tuned Values 🗲		
	Status: CV2 Ready		

#### CV2 will turn green and the status will show In Progress.



22. When the Autotune is completed the Autotune Status will change to *Completed* and the *Autotuned Model Values* will update

Tag Autotune	
Perform Autotune on: C CV1	C CV3
CV2 Step Size: 10.0 € %	6
Start Abort	
Autohumo State:	<b>`</b>
Autorume state.	)
Current Model Values	-
Gain: 0.0	
Time Constant: 0.0 s	
Deadtime: 0.0 s	
Response Time Constant: 0.0 s	
Autotuned Model Values	
Gain: 1.0121793	<b>`</b>
Time Constant: / 30.0 s	$\mathbf{A}$
Deadtime: 13.5 s	1
Response Time Constant:	
C Slow 29.0 s	
Medium 14.5 s	
C Fast 7.25 s	/
Set Tuned Values	/
Status: CV2 OK	

23. The *Medium* Response Time Constant is preselected, click *Set Tuned Values* (Set Tuned Values)

Tag Autotune	
Perform Autotune on: 🕜 CV1	€ CV2
CV2 Step Size:	10.0 <%
Start Abort	
Autotune State:	Complete
Current Model Values	$\frown$
Gain:	1.0121793
Time Constant:	30.0 s
Deadtime:	13.5 s
Response Time Constant:	14.5 s
Autotuned Model Values $-$	/
Gain:	1.0121793
Time Constant:	30.0 s
Deadtime:	13.5 s
Response Time Constant:	
C Slow	29.0 s
Medium	14.5 s
C Fast	7.25 s
Set Tuned Values 🗲	
Status: CV2 OK	

24. Run the autotune for CV3 by selecting Perform Autotune on CV3 and clicking Start.

Tag Autotune	$\frown$
Perform Autotune on: C CV1	○ cv2 ○ cv3
CV3 Step Size:	10.0
Start Abort	
Autotune State:	Ready
Current Model Values	
Gain:	0.0
Time Constant:	0.0 s
Deadtime:	0.0 s
Response Time Constant:	0.0 s
Autotuned Model Values —	
Gain:	0.0
Time Constant:	0.0 s
Deadtime:	0.0 s
Response Time Constant:	
C Slow	0.0 s
Medium	0.0 s
C Fast	0.0 s
Set Tuned Values 🗲	
Status: CV3 Ready	

#### CV3 will turn green and the status will show In Progress.



25. When the Autotune is completed the Autotune Status will change to *Completed* and the *Autotuned Model Values* will update.

Tag Autotune
Perform Autotune on: C CV1 C CV2 C CV3
CV3 Step Size: 10.0 ◆ %
Start Abort
Autotune State: (Complete )
Current Model Values
Gain: 0.0
Time Constant: 0.0 s
Deadtime: 0.0 s
Response Time Constant: 0.0 s
Autotuned Model Values
Gain: 0.9911041
Time Constant: / 45.5 s
Deadtime: 19.5 s
Response Time Constant:
C Slow 43.333332 s
Medium 21.666666 s
C Fast 10.833333 s
Set Tuned Values
Status: CV3 OK

26. The *Medium* Response Time Constant is preselected, click *Set Tuned Values* (Set Tuned Values).

Tag Autotune		
Perform Autotune on: 🔘 CV1	C CV2	€ CV3
CV3 Step Size:	10.0 + %	
Start Abort		
Autotune State:	Complete	
Current Model Values	$\frown$	
Gain:	1.0181004	
Time Constant:	45.0 s	
Deadtime:	17.0 s	
Response Time Constant:	20.666666 s	
Autotuned Model Values	$\checkmark$	
Gain:	1.0181004	
Time Constant:	45.0 s	
Deadtime:	17.0 s	
Response Time Constant:		
C Slow	41.333332 s	
Medium	20.666666 s	
Fast	10.333333 s	
Set Tuned Values 🔦		
Status: CV3 OK		

#### 27. Click on the *Model* tab

Properties - CC_01				
General Configuration EU Sc	caling Limits Model Para	ameters   Tag   Autotune		
Calculate Error As:	🖇 of Span 📃 💌			
Process Type:	Non-integrating			
Model Factor:	100.0			
	CV1	CV2	CV3	
Process Gain Sign:	Positive 💌	Positive 💌	Positive 💌	
Model Gain:	1.0757825	1.0121793	1.0181004	
Model Time Constant:	15.5 s	30.0 s	45.0	s
Model Deadtime:	6.5 s	13.5 s	17.0	s
Response Time Constant:	7.3333335 s	14.5 s	20.666666	s
Status: UK Execution Order Number: 1				
Never display description in	a routine	ОК	Cancel App	ly Help

The internal models being used for each of the outputs is shown here.

28. Open the CC\_Simulation trend and click *Run* to begin trending.

29. The state of the CC control is Operator – Manual. Change SPOper to **'40'** and CV1Oper to **'10'**, click **OK** and observe the trend.

Prope	Properties - CC_01							
Gene	ral Co	onfiguration EU Scali	ng Limits Model	Parameters	Tag Autotune	1		
	l&U	&Check In	Value	&Add to	&Check Out			
		SPOper	40.0	REAL	SP Operator value, scaled in PV units, SP set to this value whe			
Τ	iri	SPHLimit	100.0	REAL	SP high limit value, scaled in PV units.			
	iri	SPLLimit	0.0	REAL	SP low limit value, scaled in PV units.			
	iri	CV1Fault	0	BOOL	Control variable 1 bad health indicator. If CV1EU controls an an			
	İΓ	CV2Fault	0	BOOL	Control variable 2 bad health indicator. If CV2EU controls an an			
	IГ	CV3Fault	0	BOOL	Control variable 3 bad health indicator. If CV3EU controls an an			
		CV1InitReg	0	BOOL	CV1 initialization request. This signal will normally be controlled b			
	Г	CV2InitReg	0	BOOL	CV2 initialization request. This signal will normally be controlled b			
	Г	CV3InitReg	0	BOOL	CV3 initialization request. This signal will normally be controlled b			
	Г	CV1InitValue	0.0	REAL	CV1EU initialization value, scaled in CV1EU units. When CV1Ini			
	Г	CV2InitValue	0.0	REAL	CV2EU initialization value, scaled in CV2EU units. When CV2Ini			
		CV3InitValue	0.0	REAL	CV3EU initialization value, scaled in CV3EU units. When CV3Ini			
		CV1Prog	0.0	REAL	CV1 Program-Manual value. CV1 is set to this value when in Pro			
		CV2Prog	0.0	REAL	CV2 Program-Manual value. CV2 is set to this value when in Pro			
		CV3Prog	0.0	REAL	CV3 Program-Manual value. CV3 is set to this value when in Pro			
1		CV10per	10.0	REAL	CV1 Operator-Manual value. CV1 is set to this value when in Op			
		CV20per	0.0	REAL	CV2 Operator-Manual value. CV2 is set to this value when in Op			
	Г	CV30per	0.0	REAL	CV3 Operator-Manual value. CV3 is set to this value when in Op			
	Г	CV10verrideValue	0.0	REAL	CV1 Override value. CV1 set to this value when in Override mod 😒			
	Insert Instruction Defaults Insert Factory Defaults Save Instruction Defaults							
Status	Statue: OK							
Status:								
Execu	ion O	rder Number: 1						
🗌 Ne	ver di	isplay description in a r	outine		OK Cancel Apply Help			

Always click **Apply** after each change.

Note: The trend will show a response to the CV1Oper change since the CC control is in manual. The SPOper change will not affect anything at this time since we are not in Auto control.

30. Put CV1Oper back to zero, let the PV settle back to zero and then make CV2Oper 10. Repeat for CV3Oper. Observe the trends.



Note that the dissolved oxygen levels respond to each of the outputs being moved from 0 to 10. The response is slightly different for each of the CV actions.

Put CV3Oper value back to zero and click *Apply* 

31. Now put CV1 into auto by entering a '1' into OperCV1AutoReq and then clicking Apply.

# IMPORTANT: the OperCV1AutoReq is a front edge request, meaning as soon as you Apply it triggers back to 0

Pr	Properties - CC_01						
G	iener	al Co	onfiguration EU Scalir	ng Limits Model	Parameters*	Tag Autotune	
		&U	&Check In	Value	&Add to	&Check Out	
		Г	OperOperReq	0	BOOL	Operator Operator Request. !	
	×	Г	OperCV1AutoReg	1)	BOOL	Operator-Auto mode request	
	Τ	Г	OperCV2AutoReg	0	BOOL	Operator-Auto mode request	
		Г	OperCV3AutoReg	0	BOOL	Operator-Auto mode request	
	1	Г	OperCV1ManualReq	0	BOOL	Operator-Manual mode reque	
	Ι	Г	OperCV2ManualReg	0	BOOL	Operator-Manual mode reque	
	Ι	Г	OperCV3ManualReg	0	BOOL	Operator-Manual mode reque	

Note: The '1' is a one-shot entry and will return to a '0'.



Note that AgitatorSpeed (CV1EU) has been adjusted to control the DissolvedOxygen to the setpoint of 40. The Target value for CV1 is 5, but since the only control available is CV1 (CV2 and CV3 are still in manual), CV1 is adjusted as needed to reach the setpoint.

Properties - CC_01							
General Configuration EU Scaling	Limits Model Par	amel	ters Tag	Autotune			
Timing							
Mode:	Periodic	·					
Oversample $\Delta t$ :	0.	0 \$					
RTS Period:		1 ms	;				
Control Variables							
🔲 Use CV Track Values	CV1		CV2		CV3		
CV Track Value:	0.	0 %		0.0 %	:	0.0 %	
Override Value:	0.	0 %		0.0 %	<u>،</u>	0.0 %	
Target Value:	5.	0 %		15.0 9	:	10.0 %	
	First		Second		Third		
Deviation Action Priority:	CV1	·	CV2	•	CV3	•	
Drive to Target Priority:	CV1	·	CV2	•	CV3	•	
Target Response Time Constant:	30.	0 s					
Frogram Control Value Reset							
Manual Mode after Initialization	ı						
FV Tracking							
Status: OK							
Execution Order Number: 1							
Never display description in a rou	tine			OK	Cancel	Apply	Help

#### 32. Put *CV2* into auto too.

Pr	ope	rtie	s - CC_01			
0	ìene	ral Co	nfiguration EU Scalin	ng Limits Model	Parameters*	Tag Autotune
		&U	&Check In	Value	&Add to	&Check Out
	1		OperProgReq	0	BOOL	Operator Program Request. Set T
	1		OperOperReq	0	BOOL	Operator Operator Request. Set
	1	Г	OperCV1AutoReg	0	BOOL	Operator-Auto mode request for C
	×	Г	OperCV2AutoReg	1	BOOL	Operator-Auto mode request for C
		Г	OperCV3AutoReg	0	BOOL	Operator-Auto mode request for C
		_			0001	O 1 11 1 1 1 1 1



Note that AgitatorSpeed (CV1EU) has been reduced to its target value (5) and AirFlow (CV2EU) adjusted to control the DissolvedOxygen to the setpoint of 40. The Target value for CV2 is 15, but since the only control available is CV1 and CV2 (CV3 are still in manual), and CV1 is the first priority to stay at target value, CV2 is adjusted as needed to reach the setpoint.

Control Variables							
🔲 Use CV Track Values	CV1	CV2	CV3				
CV Track Value:		0.0 %	0.0 %	0.0 %			
Override Value:		0.0 %	0.0 %	0.0 %			
Target Value:		5.0 %	15.0 %	10.0 %			

#### 33. Put CV3 into Auto.

Pr	op	ertie	s - CC_01			
G	iene	eral Co	onfiguration EU Scali	ng Limits Model	Parameters*	Tag Autotune
		1&U.	&Check In	Value	&Add to	&Check Out
	T	Г	OperProgReg	0	BOOL	Operator Program Request. Set TRUE
	T	iri	OperOperReq	0	BOOL	Operator Operator Request. Set TRUI
	Τ	Г	OperCV1AutoReq	0	BOOL	Operator-Auto mode request for CV1.
		Г	OperCV2AutoReq	0	BOOL	Operator-Auto mode request for CV2.
	1		OperCV3AutoReg	1	BOOL	Operator-Auto mode request for CV3.



Note that AgitatorSpeed (CV1EU) has been reduced to its target value (5), AirFlow (CV2EU) has been reduced to its target value (15) and Pressure has been adjusted to control the DissolvedOxygen to the setpoint of 40. The Target value for CV3 is 10, but since CV3 is the lowest priority it is adjusted as needed to reach the setpoint.

34. In the General Tab change the *Drive to Target Priorities* and observe the changes in the three outputs.



Notice that CV2 and CV3 (now having the highest priorities) are being brought at their target values and CV1 is being adjusted to meet the setpoint.

35. Leaving our priority setting as they were, change the Operator SP to 60.

Properties - CC_01						
G	General Configuration EU Scaling Limits Model Parameters* Tag Autotune					
		&U	&Check In	Value	&Add to	&Check Out
	Τ	Г	EnableIn	1	BOOL	Enable Input. If Fal
	Τ		PV	39.99798	REAL	Scaled process var
	Τ	Г	PVFault	0	BOOL	PV bad health indic
	Τ	Г	PVEUMax	100.0	REAL	Maximum scaled va
	Τ	Г	PVEUMin	0.0	REAL	Minimum scaled va
	Τ		SPProg	0.0	REAL	SP Program value,
	*	Г	SPOper	60	REAL	SP Operator value,



CV1 is adjusted to meet the setpoint. CV2 or CV3 did initially move from their target values, but eventually went back to their target values.

36. Changes the setpoint to 85 and priorities as shown. Observe the reaction of the control.





End of lab 2

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# CONGRATULATIONS! YOU HAVE COMPLETED THE ADVANCED PROCESS CONTROL HANDS-ON LAB!

You can find this workbook on www.rockwellautomation.com/events/au