MACHMOTION

Setting Up Your Tool Changer

Using Automation Direct PLCs

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Everything you need to know to setup a tool changer with your Automation Direct PLC.

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Getting the Software

The following files and software are needed for this tool changer to function properly:

- DirectSOFT 5
- Generic Tool Changer Program
- M6Start and M250

DirectSOFT5

Begin by downloading DirectSOFT 5 from <u>http://ftp.automationdirect.com/pub/DSP_53_SP.exe</u>. You can also go to <u>www.automationdirect.com</u> and find the software yourself.

This is a free demo which limits your program to 100 rungs. Currently only 37 rungs are used in the PLC in the example tool changer program. If your tool changer is quite extensive, you may need to consider purchasing the software directly from Automation Direct.

When you open up the software, you will see the following window:





Double click on **DirectSOFT 5 Programming** as shown above. It will ask you if you want to purchase it. If you will need more than 100 rungs, select the option to run the demo.

Generic Tool Changer Program, M6Start, and M250

You can find all of these files on our website at <u>www.machmotion.com/support-2/downloads.html</u>. Copy M6Start and M250 into the following location: **C:\Mach3\macros\YourProfileName** where "YourProfileName" is the profile you are using on your control.

Setting up Mach3

To setup your tool changer, begin by configuring Mach3.

- 1. Start the Mach3 software.
- 2. Open up the the serial modbus control. Select **Function Cfg's** from the menu bar and then click on **Setup Serial Modbus Control** as shown below.



Figure 2 Setup Serial ModBus

You will see the **ModBus Configuration** window (Figure 3).

 The following configuration in the modbus window must be used (Figure 3). Notice that at least 7 inputs and 6 outputs must be transferred between Mach3 and the PLC. For more information on addressing in a PLC, see our manual *Programmable Logic Controls: Using ModBus to Interface PLCs with Mach3*.

V ModBus Run No error								
	Enabled	Comment or	Port/Address	Slave #	Refresh	Address	# of	Direction
	On/Off	Device		0-10	25ms Incr.	ModBus(¥ar)	Registers	Input Output
Cfg #0	×	PLC - Inputs	1	5	25	640	7	Input-Holding
Cfg #1	×	PLC - Output	1	5	25	768	6	Output-Holding
Cfg #2			1	1	50	0	1	Input Reg
Cfg #3			1	1	50	0	1	Input Reg
Cfg #4			1	1	50	0	1	Input Reg
Cfg #5			1	1	50	0	1	Input Reg
Cfg #6			1	1	50	0	1	Input Reg
Cfg #7			1	1	50	0	1	Input Reg
Cfg #8			1	1	50	0	1	Input Reg
Cfg #9			1	1	50	0	1	Input Reg
:fg #10			1	1	50	0	1	Input Reg
:fg #11			1	1	50	0	1	Input Reg
fg #12			1	1	50	0	1	Input Reg
fg #13			1	1	50	0	1	Input Reg
fg #14			1	1	50	0	1	Input Reg
fg #15.			1	1	50	0	1	Input Reg
fg #16			1	1	50	0	1	Input Reg
					50	0	1	Input Reg

Figure 3 ModBus Configuration

4. From the menu bar select **Config**, then press **General Config...**



Figure 4 General Config

The following window will appear:

General Logic Configuration			
General Logic Configuration G20,G21 Control □ Lock DR0's to setup units Tool Change ○ Ignore Tool Change ○ Stop Spindle. Wait for Cycle Start. ○ Auto Tool Changer Angular Properties Unchecked for Linear ♥ Axis is Angular ♥ B-Axis is Angular ♥ C-Axis is Angular ♥ C-Axis is Angular ♥ G-Axis is Angular ♥ G-Axis is Angular ♥ G-Axis is Angular ♥ G-Axis is Angular ♥ B-Axis is Angular ♥ B-Axis is Angular ♥ B-Axis is Angular ♥ G-Axis is Angular ♥ B-Axis is Angular ♥ G-Axis	Editor GCode Editor Browse \\Windows\Notepad.exe Startup Modals G80, M251 Motion Mode Constant Velocity C Exact Stop Distance Mode Active Plane of Movement Active Plane of Movement C XZ Jog Increments in Cycle Mode Position 1 Use 939 to 0.0001 Use 939 to 0.0001 Use 939 to 0.0001 Use 939 to 0.0001	Shuttle Wheel Setting Shuttle Accel. 0 004 Seconds General Configuration Z is 2.5D on Output #5 Home Sw. Safety LookAhead 20 Lines Ignore M calls while loading M9-Execute after Block UDP Pendent Control Run Macro Pump ChargePump On in EStop Persistent Jog Mode. Persistent Jog Mode. Persistent Jog Mode. Second VerRide Persist No System Menu in Mach3 Use Key Cicks Home Slave with Master Axis Include TLO in 2 from G31 V Lock Rapid FR0 to Feed FR0 Rotational Rot 360 rollover Ang Short Rot on G0 V Rotational Soft Limits	Inputs Signal Debouncing/Noise rejection Debounce Interval Index Debounce 0 x 40us Index Debounce 0 Debug This Run Enhanced Pulsing Allow Vave Files Allow Vave Files Allow Vave Files Allow Speech Set Charge Pump to 5Khz - Laser Stndby Use OUTPUT20 as Dwell Trigger No FRO on Queue 100 Turn Manual Spindle Incr. 10 Spindle OV increment CV Control Plasma Mode V C Visit Tolerance 180 Units G 100 Adaptive NurbsCV Stop CV on angles > 0 Degrees Axis DRD Properties Totel Set one
8-Bit 1 Stop 7 Bit 2-Stop Program Safety Program Safety Lockout This disables program translation while the External Activation #1 input is activated.		Screen Control Hi-Res Screens Ø Boxed DR0's and Graphics Ø Auto Screen Enlarge Ø Flash Errors and comments.	 ☐ Tool Selections Persistent. ☑ Optional Offset Save ☑ Persistent Offsets ☑ Persistent DROs ☑ Copy G54 from G59.253 on startup
			ОК

Figure 5 General Logic Configuration

5. Select Auto Tool Changer on the far left of the window.



Figure 6 Auto Tool Changer

6. In the **Initialization String** box, add ",M250" to the current text. This will run the initialization macro when the control turns on.

ieneral Logic Configuration	
G20,G21 Control	Editor GCode Editor Browse
C Ignore Tool Change C Stop Spindle. Wait for Cycle Start. AutoTool Changer	Startup Modals Use Init String on ALL "Resets"
Angular Properties Unchecked for Linear A-Axis is Angular B-Axis is Angular	G80, M250 Motion Mode © Constant Velocity © Exact Stop

FT	-	1	1	Charles -
Figure	1	Initia	lization	String

7. Then press OK and the General Logic Configuration window will close.

Mach3 is now configured to interface with your PLC.

Timeout Error

If the control tells the PLC to change tools and B1200.15 stays on for longer than 20 seconds, the control will give you the following timeout error: "Tool Change is not Complete."

To change this timeout value, select **Operator** and then **VB Script Editor**. Open **M6Start** which will be found in *C*:*Mach3**Macros**YourProfileName*.

M6Start - Mach3 VB Scipt Editor File Edit Run Debug BreakPoints - 🗆 🗵 🗁 📥 🕨 🔰 🕨 = 🛛 🐱 E+ E-Tool Cha Description Tells the PIC which tool to go to and when to do it. Notifies Mach3 if it worked [correctly or not] '12/17/10 'Carl Eldredge Dim Num As Integer Dim Number As Integer Sub Main TimeOut = 20 '20 Seconds Finished = 1600 CurTool = 1605 MaxTool = 1606 StartVal = 1500 ComTool = 1505 CurrentTool = GetUserDRO(CurTool) MaxToolNum = GetUserDRO(MaxTool) ''From PLC Ln 9, Col 19 NUM

Change the variable TimeOut to whatever you want.

Figure 8 Change the TimeOut Value

Setting up Your PLC

With Mach3 setup, it is time to configure your PLC.

1. Open the **Generic Tool Changer** project in DirectSOFT 5. Click **File** on the menu bar and then select **Open Project**.

🗮 Di	irectSOFT 5 Programmir	ıg - Gener	ic Tool Char	nger - [Ladd	er Vie
Eile	Edit Search View	<u>T</u> ools <u>P</u> L	C Debug	Window H	lelp
	New Project	•	86 9		â
2	Open Project	Ctrl+O	Accept CT	E CORD P	aste
Citizes	⊆lose Project		1 🗐	1	
	Save Project	•	Info Syr	ntas: ▼ ₽	
<u>ta</u>	Save Project <u>A</u> s				
<u>.</u>	Backup Project				_
	Read Program	,	Address	Instruct	▲
	Write Program	,	U		
	Import	,	3	HE STR	
	Export	,	7	HE STR	
100	Print Preview		11	EE STR	
	Print	Ctrl+P	19	III STR	-1
PORG	Print All		23	EE STR	-1
Hereita 2000 a	Print Setup		27	III STR	
			31	EE STR	-
22 	Properties		_	4	
	1 GENERIC TOOL CHANGE	R.PRJ		<u>+</u>	–
	2 GENERIC PLC.PRJ				
	3 DUMMY TOOL CHANGER	PRJ	Status		•
	4 STANDARD_IO.PRJ			_	
.	E≚it			-	
3				1	

Figure 9 Open Project

You should see the following:

E DirectSOFT 5 Programming - Generic Tool Changer - [Ladder	/iew]		
<u>Eile Edit Search View Tools PLC Debug Window Help</u>			
Read Write New Open Back HOIL See Law Copy Part	Find	Next Brows The Soom will the second s	
Status Data Value Mode Info Smaar -			
XRef View 문 포	Stage Vie	Ladder View	
Image: Constraint of the second se	1	FirstScan SP0 K OUT Maximum To	8 Number of
4 11 12 37R 5 15 15 12 37R 6 19 32 37R 7 23 372 377 378 378 8 27 379 378 378 9 31 327 378 378	2	Tool 1 Arrived	
Data1 🛱 🗴		out	ant Tool
El I			1205
2 V1400	3	Tool 2 Arrived	K2 +≠+ ! -+≥+
1 V1200 2 V1400 3			K2 entTool 1205
8			1205
		Tool 3 Arrived LD	
Output			AX Box
			Browz
			• *
For Help, press F1		OK Online:06 KSeq Run 00180/0766	30 06

Figure 10 Generic Tool Changer

2. Enter in your maximum number of tools. Press the red button called **EDIT MODE** to be able to change the program.



Figure 11 Max Number of Tools

The above example only uses 8 tools.

3. Add more initialization rungs for however many tools are needed. The tool changer initialization that tells your control what tool is currently loaded. Rungs 2-9 load the current tool position into register V1205. This value is used to reference your control with your tool changer when the control first turns on.



Figure 12 Find Current Tool

As shown above, depending on what input is active, the PLC knows what position the tool changer is in. Just copy the existing rungs to add another one. Notice that is routine is only run during the first scan. From then on, the only way to change the tool position is to receive an actual command from your control. 4. Depending on how many tools are needed, copy the existing example of the of the tool changer start rungs.



Figure 13 Start Rungs

The V memory location V1405 is the commanded tool from your control. When the M6Start macro is run in Mach3, it turns on B1400.15 for 500ms. That turns on B1200.15 which tells your control that the tool changer is currently changing the part. As long as the commanded tool and the current tool are different and the start command is received (B1400.15), the coil corresponding to the commanded tool will turn on for one cycle (PD). B1200.15 also starts the tool changer routine.

To add another tool, copy the rung for tool 8. Change the constant that V1405 is compared with and the coil that it turns on.

5. Program your specific tool changer. Each tool has a specific coil that is turned on for one PLC scan. This coil starts your tool changer.



Figure 14 Tool Changer Routine

In the code above, C4 is only energized for one scan. In that time it turns on the output Y3 and C14. The PLC continues to scan the program until the input X3 is activated (Tool 4 Arrived). When that happens, C14, B1200.15, and Y3 are reset. When B1200.15 goes low, it tells the control that the tool change is complete. The new tool number is also loaded into the current tool memory (V1205). See the Appendix at the end of this document for a layout of all the V Memory used in the generic tool changer program.

In the example above, rungs 27 and 28 are where you will do most of your programming. Here you can add a stepper motor system which will rotate until the desired tool is reached. There is no limit to the number of ways you can program this tool changer. However, whatever you do, make sure not to forget these 4 vital steps:

- Tool Coil (C14 in the example above) must be reset.
- B1200.15 must be reset.
- Current tool must be loaded into V1205.

If the tool change is complete (B1200.15 is low) but the current tool does not equal the commanded tool, then Mach3 will give a pop up error stating, "Tool Change Failure." If the control tells the PLC to change tools and B1200.15 stays on for longer than 20 seconds, the control will give you the following timeout error: "Tool Change is not Complete." For more information see the section called Timeout Error above.

TIP: Study the manual for your specific PLC to learn how to program it. Automation Direct offers many very helpful examples in all of their manuals.

6. Add more tool change routine rungs if more tools are needed. After you have one rung programmed for your machine, it might be easiest just to copy it multiple times and then make the changes for each specific tool.



Figure 15 Adding More Routines

Underneath the 8th tool routine, you can add as many tools as you need.

WARNING

Your program will not run without an END statement.

Appendix

PL	C Inputs	PLC Outputs		
V Memory	Function	V Memory	Function	
V1400	Status Register	V1200	Status Register	
V1401	Reserved for I/O	V1201	Reserved for I/O	
V1402	Reserved for I/O	V1202	Reserved for I/O	
V1403	Reserved for I/O	V1203	Reserved for I/O	
V1404	Reserved for I/O	V1204	Reserved for I/O	
V1405	Commanded Tool	V1205	Current Position	
V1406	Unused	V1206	Max Number of Tools	

These tables show the allocation of V memory V1400-1406 and V1200-V1206.

Below is the layout of each bit in the output status register V1200.

V1200 Status		
Register	Function	Active Low
Bit 0	Communication Check	
Bit 1	N.C.	
Bit 2	N.C.	
Bit 3	N.C.	
Bit 4	N.C.	
Bit 5	N.C.	
Bit 6	N.C.	
Bit 7	N.C.	
Bit 8	N.C.	
Bit 9	N.C.	
Bit 10	N.C.	
Bit 11	N.C.	
Bit 12	N.C.	
Bit 13	N.C.	
Bit 14	N.C.	
Bit 15	Finished Moving	Low

Below is the layout of each bit in the input status register V1400.

V1400 Status		
Register	Function	Active Low
Bit 0	Communication Check	
Bit 1	Emergency Stop	Low
Bit 2	N.C.	
Bit 3	N.C.	
Bit 4	N.C.	
Bit 5	N.C.	
Bit 6	N.C.	
Bit 7	N.C.	
Bit 8	N.C.	
Bit 9	N.C.	
Bit 10	N.C.	
Bit 11	N.C.	
Bit 12	N.C.	
Bit 13	N.C.	
Bit 14	N.C.	
Bit 15	Start Moving	High