CENTROID

ATC2
Swing Arm Tool Changer

Operator's Manual

Rev. 71513

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ARM2 Operating Instructions for Arm ATC Systems
(29-APR-2008)

Overview

This document is the instruction manual for "Swing Arm" type tool changers equipped with Centroid ATC controls and that have the ARM2 version of plc programs. The ARM2 programs were first used after the release of v1.15 software and can be identified in the Utilities|Options menu as having the plc names arm2cp3/arm2pc3. This document assumes that the tool changer machine has been properly set up and initialized by an authorized Centroid technician. The mechanical operating nature of the "Swing Arm" type tool changer is very different from the conventional "Umbrella" type tool changer. Because of the differences the "Swing Arm" tool changer requires a different PLC structure and different Parameter settings. The "9046 M13 TIMEOUT" check was implemented at the end of April, 2008.

ATC Machine Related Software Parameters

The following parameters and software settings **must** be set before any use of the ATC Tool Changer is attempted:

- Control Parameter 0. This parameter specifies the PLC bit to which the physical E-stop is connected. It should be set to 11.

- Control Parameter 6. This parameter signifies if an Automatic Tool changer system is installed. It should be set to 1, to signify an ATC type machine, for proper operation.

- Control Parameter 160. This parameter is used to signify an enhanced ATC application. It should be set to 2 (Random) for "Swing Arm" tool changers. If this value is changed, it does not become fully effective until the system is rebooted.

- Control Parameter 161. This parameter is used to signify the maximum number of bin locations of the tool carousel. If this value is changed, it does not become effective until the system is rebooted.

- Machine Parameter 162. This parameter affects how Intercon programs post M&G codes for a tool change operation. When set to a non-zero value, Intercon will post out an M-code at the start of a tool change and an M5 command after the Txx M6 command. This parameter should be set to 17 so that Intercon will post an M17 code at the start of a tool change. The M17 command turns off spindle and coolant and starts the spindle orientation process

- Control Parameter 175. The parameter specifies the time in minutes that the spindle chiller and/or cooling fan will remain on after the spindle is stopped. For example, a setting of 10 will keep the spindle chiller/cooling fan on for 10 minutes after the spindle has stopped.

- Control Parameter 176. This parameter is used to specify the delay time after an unclamp is performed. This parameter is measured in 0.01 second units. For example, to specify a delay of 1.00 second, set this parameter to 100.

- In the Work Coordinate System Configuration menu, Return #2 (G30) Z value is set to the position of the Z-axis at the tool change height. Failure to have the Return #2 (G30) Z value set correctly will result in a crash when attempting a tool change. If the Z-axis motor is removed or replaced, or the Z-axis machine home position is changed, (i.e. the Z+ limit switch were moved or replaced), this value must be checked and changed if needed.

Other ATC Specifics

The M19 command is used to orient the spindle. The spindle inverter controls the orient position, and all settings related to it. For details on spindle inverter settings, see Tech. Bulletin 112.

The air pressure gauge, which detects low air pressure normally, has two adjustments, which affect a set point and range for normal operation. These settings should not be changed to compensate for lack of air capacity. The carousel motor is a 3-phase motor. Because of this the phase order must be correct in order for the carousel to rotate in the correct direction. When the Tool Index + key is pressed the carousel bin's should count up when observed.

Startup

When the CNC software is powered up, **the following steps must be completed before any tool change is attempted**:

1.) Machine Home must be set.
2.) Tool number displayed in the CNC software status window must be correct – "T---" signifies no tool is present in the spindle.
3.) Press <ALT> + <K> on the control to confirm correct ATC Bin, "ATC BIN xx" will be displayed, where xx is the current carousel position. The carousel bin numbers can be seen from the left hand side of the machine, located on a numbered cover plate on the carousel.

If any of the above operations are not completed after powering up the machine, **a crash could happen**. If the tool number or ATC Bin numbers do not match, refer to the section *Handling Errors*.

General Operation

Once the tool changer system has been homed successfully and the operator has made the initial checks, the system is ready for general operation.

On the "Swing Arm" tool change system, all tool changer operations must be performed through the control software interface or G-Code program with the exception of the following features:

- Drawbar Unclamp - There is a push-button switch mounted on the head that can be used to activate the drawbar unclamp and air blow, provided that the spindle is not running and the control is not running a program (or in MDI mode).
- Carousel Index - The jog panel has two keys that can be used to index the tool carousel, provided that a program is not running (or in MDI mode).

If a tool change is attempted for a tool number which does not have a valid bin number specified in the tool library, the message "Tool library invalid for Txx" message will be displayed in the CNC software message window.

When using the tool changer system, the tool change (or tool indexing) process should not be stopped unless necessary. If a tool change process must be stopped, the procedures in the *Handling Errors* section should be followed to ensure that the tool changer is initialized correctly. If a tool change does not fully complete, then the following prompt will be displayed when entering MDI mode or otherwise trying to run a job.

```
┌─────────────────────────────────────────────┐
│ ***** WARNING: Possible ATC Fault *****       │
│    The PLC system reports carousel bin 2.     │
│       The tool in the spindle is T1.          │
│       The tool library should be checked.     │
│   To clear the fault and continue press Y.    │
└─────────────────────────────────────────────┘
```

```
                         Tool Library
  Tool  Bin  Ht.   Dia.  Coolant Spindle Speed      Description
  T001  000  H001  D001   FLOOD    CW     1000   1/4 " flat end
  T002  002  H002  D002   FLOOD    CW     1500   1/8 " ball
  T003  003  H003  D003   FLOOD    CCW    2000
  T004  004  H004  D004   MIST     CCW    2200
  T005  005  H005  D005   FLOOD    CW      700
  T006  006  H006  D006   MIST     CW     5000
  T007  007  H007  D007   FLOOD    CCW       0
  T008  008  H008  D008   MIST     CCW       0
  T009  009  H009  D009   MIST     OFF       0
  T010  010  H010  D010    OFF     OFF       0

  Tool in spindle: 1

 ┌───────┐┌───────┐┌───────┐                              ┌───────┐
 │ Clear ││ Clear ││       │                              │       │
 │ Bin   ││ All   ││ Init  │                              │ Save  │
 │  F1   ││  F2   ││  F3   │                              │  F10  │
 └───────┘└───────┘└───────┘                              └───────┘
```

At this point, the operator should check the tool library to make sure it agrees with the tools in the spindle and in the tool carousel. The ATC BIN number should also be checked.

Tool Library Interface

The Tool Library screen is shown below. This screen is where the normal tool settings and descriptions are stored. On an ATC system this is also where ATC Bin number information is stored. Each Bin location will have one of 3 values:

- **000** – Signifies the tool currently in the spindle
- **001** through max no. of bin locations – Bin number for each tool.
- **-1 (Displayed as ---)** – Tool not in use, or not in carousel or spindle

The functions keys only work when the cursor is in the Bin column.

- <F1> - Clear Bin - Clears a bin number. This is the same as entering a -1 for the bin number.

- <F2> - Clear All - Clears all the bin fields. An additional prompt is displayed to confirm this action.

- <F3> - Init - Initializes the Bin fields such that T1 has a bin number of 1, T2 has a bin number of 2, T3 has a bin number of 3, and so on, all the way up to the maximum number of bins specified in machine parameter 161. All the remaining tool numbers are cleared. An additional prompt is displayed to confirm this action.

- <F10> - Save - Saves the tool library information and exits the menu.

- <ESC> - Can be used to discard all changes and exit the tool library menu.

Note: only one tool can be specified as 0, or in the spindle. If the tool in the spindle is being changed, the current one must be cleared first. Otherwise, an error message is displayed. Error messages are also displayed for trying to enter an invalid tool number.

When a tool change is completed, the tool library is updated and saved to reflect the changes. The changes that are made are to set the bin number of the tool currently in the spindle to 0 and to set the bin number for the tool that was in the spindle to the current carousel position (the same bin the tool now in the spindle was picked up from). For example, consider changing to T7 given an initial setup as in the figure above. After the tool change for T7 completes, the tool library would show T1 in bin 7 and T7 in bin 0 (in the spindle).

Loading Tools

The Centroid recommended method for loading tools into the carousel:

1. Ensure carousel is empty
2. Initialize the ATC Tool Library.
3. From the main menu of the CNC software, press **<F1> Setup**.
4. From the Setup menu press **<F7> ATC**.
5. Enter 1 when prompted for **Tool #**.
6. Press **Cycle Start**.
7. Insert Tool 1 into the spindle, using the **Clamp/Unclamp** button.
8. Repeat steps 3 through 7 for every tool, entering the tool number that you wish to load.
9. Once all tools have been loaded, verify tool information stored in the Tool Library.

Note: for CAT40 tooling **it is important which way the tool is placed into the spindle**. **The correct orientation for the tool is for the key slot with the counterbore to face the operator when the spindle is oriented.** Issuing an M19 command from MDI will manually orient the spindle. Remember that the *drawbar unclamp switch mounted on the head will not function in MDI mode*.

M & G code programming

On the Swing Arm tool changers, the next tool needed in a program can be pre-fetched, that is the carousel can be rotated to the location of the tool that will be needed next. This can cut down tool change time. Tool changes (Tnn M6) should be followed by a Tnn M107 command to pre-fetch the next tool used in the program. When programming in Intercon, the pre-fetch commands are generated automatically.
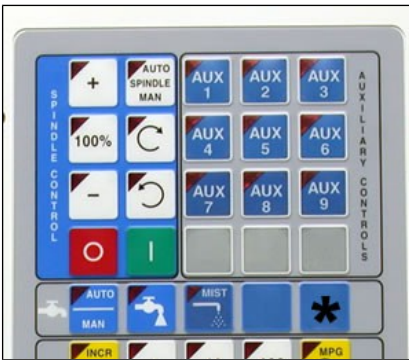
Swing Arm M-codes

The tool changer system has a set of custom M functions which, when combined in the proper

sequence (by an M6), accomplish a tool change.   The custom M functions are:

M5   Turn off spindle and cancel orientation (M19)
M13*   Cycle the ATC arm. Must be in safety lockout mode (pressing the AUX_12 key).
            The M13 cycle does the following
            (1) Turns on the arm motor, and waits for the ARM_STOP signal to go off.
            (2) Waits for the ARM_STOP signal to come on and then turns off the arm motor.
M14*   Retracts the tool pot.
M17   Turn off spindle and coolant and start to orient the spindle.
M18   ATC Homing, sets the carousel position in the PLC to bin #1.
M19   Spindle Orient
M22   Move Z axis to carousel height
M6   A complete tool change sequence.

It is recommended that these M-codes are not casually used. Their main purpose is to simplify the ATC integration and for troubleshooting a faulty system by qualified technicians. It is possible to cause damage to the ATC system by blindly executing these M functions.

*The M13/M14 commands require that the AUX12 jog panel key be pressed. The AUX12 key must be held down continually until the carousel and clamp switches are in the default state or a stop condition will result. The AUX12 key is the unlabeled blue key located in the rightmost column of the coolant section (right of the mist key and below the tool index + key). AUX12 is indicated by the * in the picture to the left.

Jog Panel showing location of Aux 12.

Arm Tool Change Sequence

The general tool change sequence performed on a "Swing Arm" type machine is listed below:

1. Move Z axis to tool change height (M22)
2. Orient spindle (M19)
3. Extend tool pot.
4. Move arm to clamp1 position
5. Unclamp tool and turn on air blow. Delay by time specified by P176.
6. Move arm to clamp2 position (exchange the tool in spindle and tool in pot)
7. Clamp tool
8. Move arm to home
9. Retract tool pot

Handling Errors

There are several ATC related errors that can be detected and displayed. For these types of errors, a numbered error message will be displayed in the CNC software message window. These numbered error messages can be used to pinpoint the exact problem or cause of a problem. The meanings of all numbered error messages can be found in the ATC Messages section at the end of this manual. There are some fault conditions that the system cannot detect, and what to do depends upon the particular fault and when it occurs.

For all errors or problems that may be encountered, verify the information in the tool library to ensure that the tool bin numbers are in agreement with the actual bin positions. Make changes as necessary and remember to save the changes.

If the ATC BIN number (displayed when the <ALT>+<K> key combination is pressed) does not agree with

the actual tool carousel position, follow this procedure:

1. Use the tool index keys to index the carousel to the #1 position.
2. Execute an M18 command in MDI mode. This will signal to the system that the carousel position is at the #1 position.
3. Verify the ATC BIN by pressing <ALT>+<K>. The message "ATC BIN 1" should be displayed briefly.

If the ATC arm is out of position:

If the arm is not clamped onto any tools, use a wrench to turn the nut at the top of the arm motor so the arm moves back to the home position. If the tool pot is down, or use the M14 command or manually reset it using the button located on the solenoid.

For cases in which the arm is clamped onto tools:

1. If the arm is at the clamp position (one end of the arm is clamped onto a tool which is fully inserted into the spindle and the other end of the arm is clamped onto a tool from an extended tool pot), use a wrench to turn the nut at the top of the arm motor such that the arm moves away from the tools and back into the home position. If the nut is turned the wrong way, the arm may try to move downward and the drawbar clamp will be resisting the movement.

2. If the arm is not at the clamp position (it was stopped somewhere in the cycle that moves downward, rotates 180 degrees, and then moves upward), manually activate the unclamp solenoid (so the tool can be inserted fully into the spindle) and then wrench the nut at the top of the arm motor until the arm is in the clamp position. Deactivate the unclamp solenoid (so the tool won't fall out of the spindle) and then continue wrenching the arm motor in the same direction to return the arm to the home position.

Note: Tools cannot be removed from the arm when the arm is the cycle that moves downward, rotates 180 degrees, and then moves upward.

ATC Messages

The following messages are displayed in the CNC software message window during the tool changing process (M6) or during execution of one of the basic customized M functions. The numbered messages, "90xx …", cause a running program to be stopped unless otherwise noted. Faults can be cleared with Emergency Stop.

`"WAITING FOR SPINDLE ORIENT..."`
This message is displayed as part of an M19 command. It indicates that a signal has been communicated to the spindle drive requesting an orient operation and that an orient complete signal from the spindle drive is being waited for.

`"WAITING FOR PLC (MOVE Z AXIS)"`
This message is displayed at the start of a tool change while the M6 macro is waiting for the plc system to send a signal to move the Z axis to the proper height for a tool change. The plc system sends the message after the tool bin carousel is positioned at the correct tool.

`"WAITING FOR PLC (END)"`
This message is displayed after the Z axis has been moved and the M6 macro is waiting for the plc system to complete the tool change.

`"9001 ATC NOT READY: ARM_HOME INP"`
This message is displayed if the ARM_HOME input (INP61) is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the ARM_HOME input to be electrically open (RED as shown in live plc debugger).

`"9002 ATC NOT READY: ARM_CLAMP INP"`
This message is displayed if the ARM_CLAMP input is not in the correct state and a tool change (M6) is not being executed. The

correct state after a tool change is for the ARM_CLAMP input (INP59) to be electrically closed (GREEN as shown in live plc debugger).

"9003 ATC NOT READY: ARM_STOP INP"
This message is displayed if the ARM_STOP input is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the ARM_STOP input (INP60) to be electrically open (RED as shown in live plc debugger).
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"9004 ATC NOT READY: TOOL_UNCLAMP INP"
This message is displayed if the TOOL_UNCLAMP input is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the TOOL_UNCLAMP input (INP23) to be electrically open. (RED as shown in live plc debugger).

"9005 ATC NOT READY: TOOL_CLAMP INP"
This message is displayed if the TOOL_CLAMP input is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the TOOL_CLAMP input (INP22) to be electrically closed (GREEN as shown in live plc debugger).

"9006 ATC NOT READY: POT_DOWN INP"
This message is displayed if the POT_DOWN input is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the POT_DOWN input (INP28) to be electrically open (RED as shown in live plc debugger).

"9007 ATC NOT READY: POT_UP INP"
This message is displayed if the POT_UP input is not in the correct state and a tool change (M6) is not being executed. The correct state after a tool change is for the POT_UP input (INP27) to be electrically closed (GREEN as shown in live plc debugger).
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"9008 ATC NOT READY: TOOL_COUNTER INP"
This message is displayed if the TOOL_COUNTER input is not in the correct state and a tool indexing operation is not being executed. The correct state after a tool change is for the TOOL_COUNTER input (INP26) to be electrically open (RED as shown in live plc debugger). If control parameter 178 (bit 3 – value 8) is set such that the tool counter input logic is reversed then the default correct state is closed (GREEN as shown in live plc debugger).

."9010 ATC NOT READY: MZ_ACK INP"
This message is displayed if the MZ_ACK software input is not in the correct state at the start of a tool change (M6). The correct state at the start of a tool change is for the MZ_ACK software input to be off.

"9011 ATC_MOVE_Z_AXIS TIMEOUT"
This message is displayed if the Z axis move to the tool change height is not completed within a certain amount of time. The cause could be any one of the ATC inputs in the wrong state or the FEED HOLD has been activated.

"9012 ATC_ORIENT TIMEOUT"
This message is displayed if the spindle orient is not completed within a certain amount of time. The cause could be inverter settings, wiring of the ORIENT_START from the plc to the spindle drive (inverter), bad spindle motor, faulty encoder wiring or inverter orient option card, etc. It could also be caused by any one of the ATC inputs in the wrong state.

"9013 ATC_POT_DOWN TIMEOUT"
This message is displayed if the tool pot extend operation is not completed within a certain amount of time. The cause is most likely a faulty or mechanically misaligned tool pot down sensor. It could also be caused by any one of the ATC inputs in the wrong state.

"9014 ATC_POT_DOWN ORIENT LOST"
This message is displayed if the ORIENT_COMPLETE input from the spindle drive goes off while in the process of extending the tool pot down.

"9015 ATC_AHTC CLAMP WITHOUT STOP"
"9016 ATC_ARM_TO_CLAMP TIMEOUT"
"9017 ATC_ATHC_WAIT_STOP TIMEOUT"
"9018 ARM HOME/CLAMP NO STOP"
Messages displayed if the arm cannot be positioned correctly moving from the home to the clamp position.

"9019 ATC_UNCLAMP TIMEOUT"
Message displayed if the tool unclamp cannot be completed. Probably a failure of the CLAMP/UNCLAMP INPUT.

"9020 ATC_ARM_D180U TIMEOUT"
"9021 ATC_ARM_D1UWS TIMEOUT"
"9022 ARM HOME/CLAMP NO STOP"
"9031 ATC_ARM_D180U CLAMP FAULT"
"9032 ATC_ARM_D1UWS CLAMP FAULT"
Message displayed if arm cycle to exchange the tool in the spindle with the one in the extended tool pot cannot be performed correctly.

"9023 ATC_CLAMP TIMEOUT"
Message displayed if the ATC cannot execute the tool clamping procedure.

"9024 ATC_ARM_CTH TIMEOUT"
"9025 ATC_ACTH HOME NO STOP"
"9026 ATC_ARM_HTCWS TIMEOUT"
"9027 ARM HOME/CLAMP NO STOP"
Displayed if the cycle to move the arm from the clamp position back to the home position cannot be executed correctly.

"9028 ATC_POT_UP TIMEOUT"
Message displayed if the tool pot retraction process cannot be completed.

"9029 ATC_END TIMEOUT"
Message displayed if the final handshaking procedures cannot be accomplished.

"9030 ATC M6 PROCESS CANCELLED"
Message displayed if an M6 is started and then cancelled using the <ESC> key or the CYCLE CANCEL jog panel key.

"9033 ATC TOOL COUNTER NOISE"
Message displayed if the TOOL_COUNTER input closes too quickly. This message will appear if the carousel is indexed and the TOOL_COUNTER input is not in the correct state, such as would happen if there is a power loss or the E-stop is pressed while the tool carousel is turning.

"9034 ATC TOOL COUNTER TIMEOUT"
Message displayed if the tool carousel motor is on but the TOOL_COUNTER input does not close.

"9035 ATC_ROTATE POT FAULT"
"9038 ATC_COUNT POT FAULT"
Message occurs if the POT_UP or POT_DOWN signals are not in the correct state while the tool carousel is rotating.

"9036 ATC TOOL COUNTER NOISE"
Message is the same as 9033 but occurs when the TOOL_COUNTER input opens too quickly.

"9037 ATC TOOL COUNTER TIMEOUT"
Message is the same as 9034 but occurs while waiting for the TOOL_COUNTER input to open.

"9039 --- ATC Initialized ---"
Message to acknowledge an M18 command to reset the tool carousel position to bin#1.

"9040 TOOL NOISE FAULT CLEARED"
Message displayed after using the tool index keys to clear a tool counter noise error.
This message does not require an Emergency Stop to continue.

"9041 INTERNAL PLC FAULT"
This message is displayed when there is an internal fault with the plc system. It is not likely to ever occur, but could be caused by a corrupt pc.plc file or using the wrong version of the plc executor software.

"9042 LOW AIR FAULT"
This message indicates that the system has received a low air signal from the air pressure switch for more than 0.5 seconds. If a tool change is in process when this occurs, an Emergency Stop condition is generated. The E-stop switch must be engaged after air pressure has returned to normal to clear this fault.

"9043 M19 FAULT TOOL CLAMPED"

This message is displayed whenever an M19 (spindle orient) command has been executed and the TOOL_UNCLAMP input is closed.

"9044 M19 STOPPED"
This message is displayed whenever an M19 (spindle orient) command has been executed and then stopped via the CYCLE CANCEL key on the operator panel or the <ESC> key was pressed on the keyboard before the ORIENT_COMPLETE signal was detected indicating the spindle was oriented.

"9045 M19 ORIENT LOST"
This message is displayed if the M19 command to orient the spindle has completed but then afterwards the ORIENT_COMPLETE input indicates that the spindle is no longer oriented.

"9046 M13 TIMEOUT"
This message is displayed whenever an M13 (arm sequence) command has been executed and the arm stop input is not seen. The arm has a one second timeout to move out of the stop position (assuming tit started at a stop position) and then a two second timeout to move (back) into a stop position.

"9099 FAULT CLEARED"
Message acknowledges that the Emergency Stop has been pressed to clear a fault condition.