PROCEDURE

REVISION RECORD

REV	DESCRIPTION	DRAWN	CHECK	DATE
C	Add steps to retrieve AWC data from output.html log file after a wafer slip alarm	KP	KP	9/27/21
D	Add section to show where AWC data can be downloaded from Nexus, 2300 software Change SAP Description to remove “dry” which is no longer true. This procedure applies to all VORTEX robots.	KP	KP	8/25/22
E	Update table 4 right-side sensor number	SK	KP	12/01/22

AWC Troubleshooting

WTS, MACH VORTEX Robots

Lam® RESEARCH FREMONT, CA

PROC,AWC TROUBLESHOOTING,VORTEX ROBOT

SEE WATERMARK IN LEFT MARGIN FOR INITIAL AND CURRENT REVISION APPROVALS AND DATES

SEE LAM’S PLM SYSTEM FOR HISTORICAL APPROVAL INFORMATION

DOCUMENT NO. 202-267630-001

REV. E

SIZE **A** | COVER SHEET

DDS-1008 Rev. 8.3

Release_Type Rev
Current_Rev E
Initial_Release A

Drawn_By: TTANNE ---
Checked_By: KPETER ---
EE_By: --- ---
ME_By: --- ---
Other_By: KPETER ---
Date: 11/28/2022

Table of Contents

Release_Type Rev
Current_Rev E
Initial_Release A

Drawn_By: TTANNE --- Checked_By: KPETER --- EE_By: --- --- ME_By: --- --- Other_By: KPETER --- Date: 11/28/2022

Affected Systems –

MACH I
MACH IQ
MACH IV
MACH 1+
WTS
WTS-Max

Categories Related To –

Troubleshooting

Wafer Handling

Release_Type Rev
Current_Rev E
Initial_Release A
Drawn_By: TTANNE --- Checked_By: KPETER --- EE_By: --- --- ME_By: --- --- Other_By: KPETER --- Date: 11/28/2022

202-267630-001, Rev. E

AWC Troubleshooting

Use this procedure to troubleshoot AWC issues on the dry robots at WTS, VECTOR Express, MACH I, MACH I+, MACH IQ, and MACH IV platforms.

Procedure Scheduling and Certification Requirements

Requirement Category	Requirements
Number of persons required	1 person
Certifications	Level 2: Basic Corrective Maintenance, Monthly/Quarterly PMs
Frequency to perform procedure	As needed
Estimated time to complete procedure	2 hours

Reference Documentation

Part Number	Title
202-273624-001	Vortex Log Collection and Robot Log Backup
826-257219-004	VORTEX Robot Utility Version 1.30
74-379603-00	PROC,VORTEX,LIST OF ERROR CODES
74-350842-00	PROC,CALIBRATION,LOADPORT,SSR,ATM ROBOT
73-254136-03	VECTOR Dielectric CVD System (F47)
76-169723-00	SCHEM, INTERCONNECT, F47 VECTOR
76-324887-00	SCHEM, WTS NEXT INTERCONNECT
76-410151-00	SCHEM, C3VEC, AUTOCAL, AWM, AWC, TS DWG
224-226000-410	DIAG,INTERCONNECT, WTS VTM
224-226000-420	DIAG, INTERCONNECT, MACH IV VTM
224-226000-430	DIAG, INTERCONNECT, MACH I VTM
224-226000-431	DIAG, INTERCONNECT, MACH I+ VTM2
224-226000-440	DIAG, INTERCONNECT, MACH IQ VTM
224-263168-001	DIAG,INTERCONNECT, FIBER OPTIC AWC, MACH IQ
224-246200-001	DIAG, INTERCONNECT, MACH IV Legacy
202-273052-002	PROC, F/O Retrofit, MACH IQ Buffer Station

Part Number	Title
202-265357-001	PROC, F/O Retrofit, MACH IQ
202-261912-001	PROC, F/O Retrofit, MACH IV
202-263837-001	PROC, F/O Retrofit, MACH I
202-A16053-001	PROC,FIBER OPTIC AWC Sensor Setup & Calibration
74-447926-00	PROC,AWC Troubleshooting, SABRE
202-208719-001	PROC, AWC DATA ANALYSIS

Tools/Equipment Required

Item	Quantity
Laptop or Chase Computer with Windows 2000 or later operating system	1
Ethernet Cable (when using Windows 2000, a crossover cable is required)	1
03-032159-00, CABLE ASSY, 9PIN, BREAKOUT	1
Digital Voltmeter	1

Materials/Consumables Required

Item	Quantity
71-351052-00, FIXTURE, VIA PT, LOADLOCK, C3WTS, SSR	1

Safety

<table>
<tr><td>Electrical Work Type</td><td>The Safety Guidelines for Semiconductor Manufacturing Equipment (SEMI S2) defines four types of system electrical states.</td></tr>
<tr><td></td><td>Type 2 – Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock.</td></tr>
<tr><td>Hazardous Energy</td><td>Type “X” for the hazardous energies that are present.
<table>
<tr><td></td><td>None</td><td></td><td>RF</td></tr>
<tr><td></td><td>Chemical</td><td></td><td>Thermal</td></tr>
<tr><td></td><td>Electrical</td><td></td><td>Other (type details in box below)</td></tr>
<tr><td>X</td><td>Mechanical</td><td colspan="2"></td></tr>
</table></td></tr>
<tr><td>Personal Protective Equipment</td><td>Wear protective cleanroom-approved clothing, gloves and safety glasses or goggles at all times. Wear steel-toed shoes and a bump cap when required, or at all times as dictated by site protocols.</td></tr>
<tr><td>Lockout/Tagout</td><td>Carefully follow the lockout/tagout procedures described in the appropriate safety documentation before servicing the tool. Only authorized technicians should perform these tasks.</td></tr>
<tr><td>Ergonomics</td><td>Use proper lifting and handling when working on the system. Improper ergonomic handling may result in injury. Some tasks outlined in this procedure may require excess reach by personnel of shorter height. Lam recommends using a suitable footstool, stepladder, or appropriate means when performing these tasks.</td></tr>
<tr><td>Decontamination</td><td>If returning parts or systems to Lam, follow the decontamination procedures described in the appropriate safety documentation.</td></tr>
<tr><td>Waste Material Disposal</td><td>Various maintenance procedures generate waste products such as lint-free wipes soaked in IPA, DI water, excess grease, and cleaning pads. Treat all waste as hazardous. If special disposal is required, observe the proper local, state, and federal government laws and regulations. For additional process generated by-product and exposure information, see the appropriate system safety documentation.</td></tr>
</table>

Release_Type Rev
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Initial_Release A
Drawn_By: TTANNE --- Checked_By: KPETER --- EE_By: --- --- ME_By: --- --- Other_By: KPETER --- Date: 11/28/2022

Discussion

Basic Principle

The Active Wafer Centering (AWC) system is used to correct wafer position offsets on the end effector during a pick/place to typically a transfer or loadlock stations. AWC corrects wafer positioning by comparing a wafer's location during standard cycling to an ideal wafer location identified during setup. The offset is calculated using the sensor transitions captured by the robot when the sensors are triggered as the robot moves the wafer between the sensors dedicated for each station. The captured data is compared to the ideal calibrated position and the wafer offsets are calculated in relation to the ideal location.

The following figure illustrates the basic principle of AWC. The X and Y coordinate frame on the wafer is for illustration only and is not representative of the actual setup.

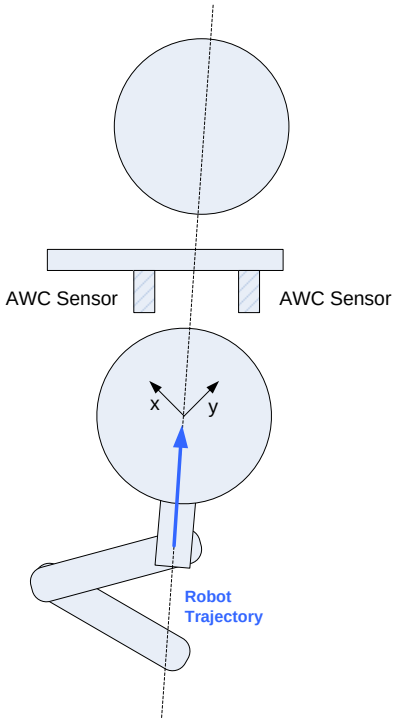

Figure 1 Active Wafer Centering Illustration

AWC requires the use of a pair of through-beam sensors mounted in the path of wafer to the station when the wafer is transferred to/from the station by the robot. The sensors are wired through an IO board on the tool, and eventually to the robot controller.

Each time a sensor triggers, the robot will record the R, T, and Z position of the robot arm. Each sensor triggers twice during the handoff. The first trigger occurs when the leading edge of the wafer blocks the sensor. The second trigger occurs when the trailing edge of the wafer unblocks the sensor.

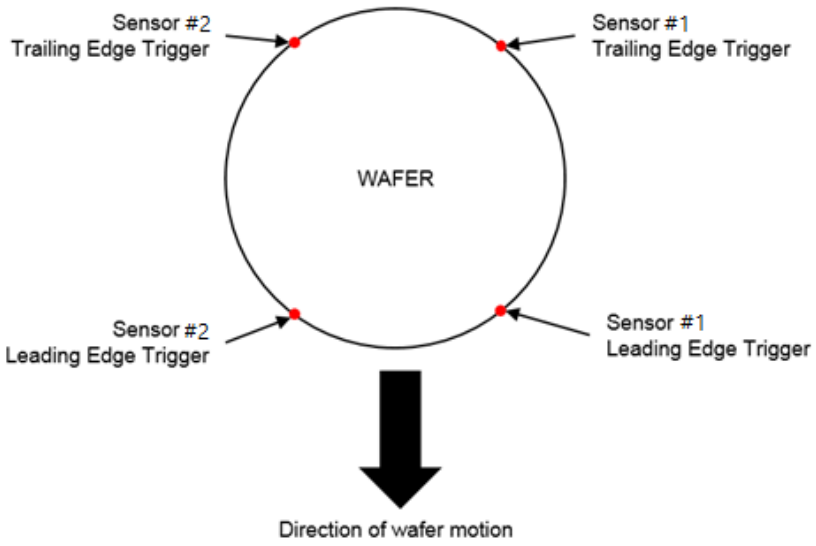

Figure 2 AWC Sensor Triggers (Loadlock Station 1 or 2 Shown)

The R and T values recorded when the sensors triggers are used to calculate the center of the wafer which is compared to the calibration data for that particular station and robot arm. The calculated offset is used to place the wafer at the correct position.

Limitation of AWC

- AWC will only work on stations that have a pair of through-beam sensors installed in front of the station.
- The robot does not perform AWC calculation when the robot is in “virtual wafer” mode even if the station has WAF_CEN enabled. The robot will continue to perform PICK and PLACE to the selected station however it will not be performing AWC on the station even if AWC is enabled for the individual station.
- AWC is limited to a 6mm capture radius for inbound wafer to the transfer station or loadlock. If the center of the wafer is offset from the center of the end effector by more than 6 mm in any direction, AWC will generate an error and not place a wafer. The offset is configurable using the variable MAX_DEVIATION.
- AWC is limited to a 4mm capture radius for outbound wafer coming out of the transfer station or loadlock. If the center of the wafer is offset from the center of the end effector by more than 4 mm during a PICK, AWC will generate an error at the completion of the PICK move. The offset is configurable using the variable ALLOW_DEV.

AWC Offset Corrections

- The robot calculates the wafer offset during the robot extend move (PLACE) or retract move (PICK).
- The wafer offset correction during PLACE is combined with the robot initial extend move to the station, for example, the robot will not stop at the station extend position before correcting for wafer offset. Because the correction is blended into the initial extend move, for a big wafer offset (4-5 mm toward the LL) it is possible to see the robot slightly overshoot first before pulling back and placing the wafer on the station.
- The wafer offset data during PICK is only used to determine a grossly offset wafer or broken wafer. No wafer offset correction is performed when placing the offset wafer after a PICK from a LL station.

AWC System Diagrams

These diagrams can help locate AWC system sub-components on a tool while troubleshooting. Use the interconnect diagrams in the Reference Documents table at the beginning of this procedure for more detailed schematic and reference designator information.

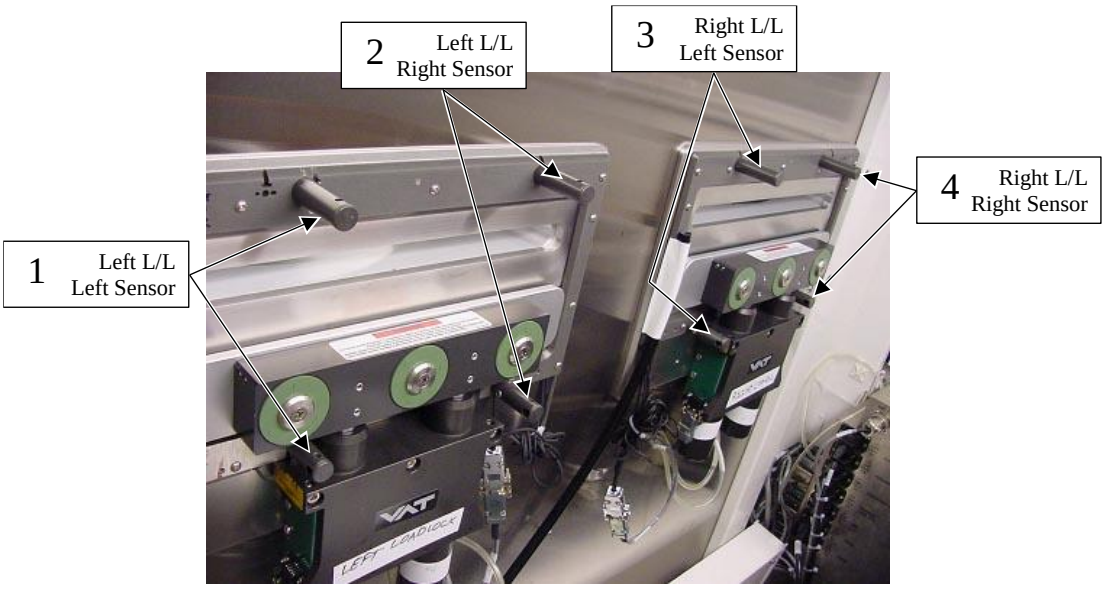

Figure 3 Active Wafer Centering (AWC) Hardware on WTS

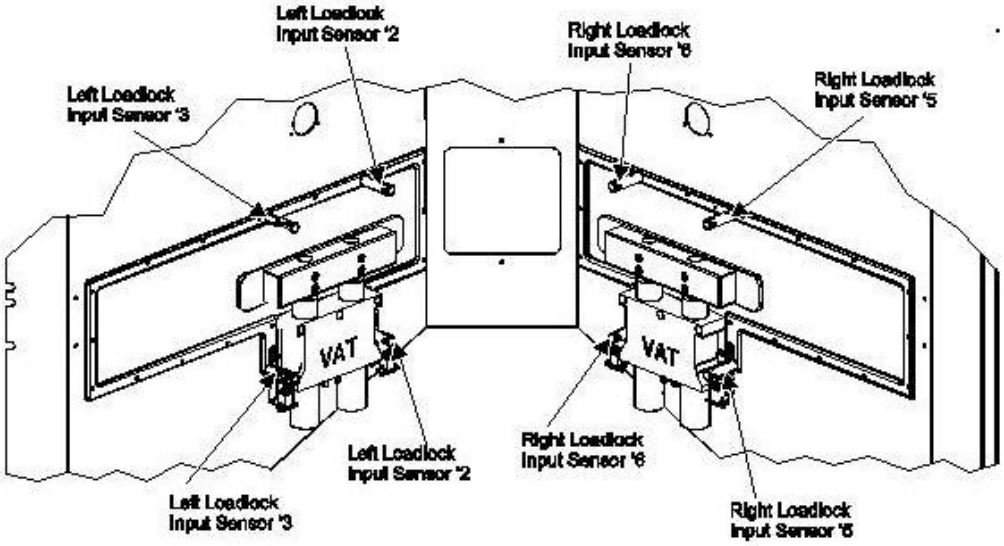

Figure 4 Active Wafer Centering (AWC) Hardware on VECTOR

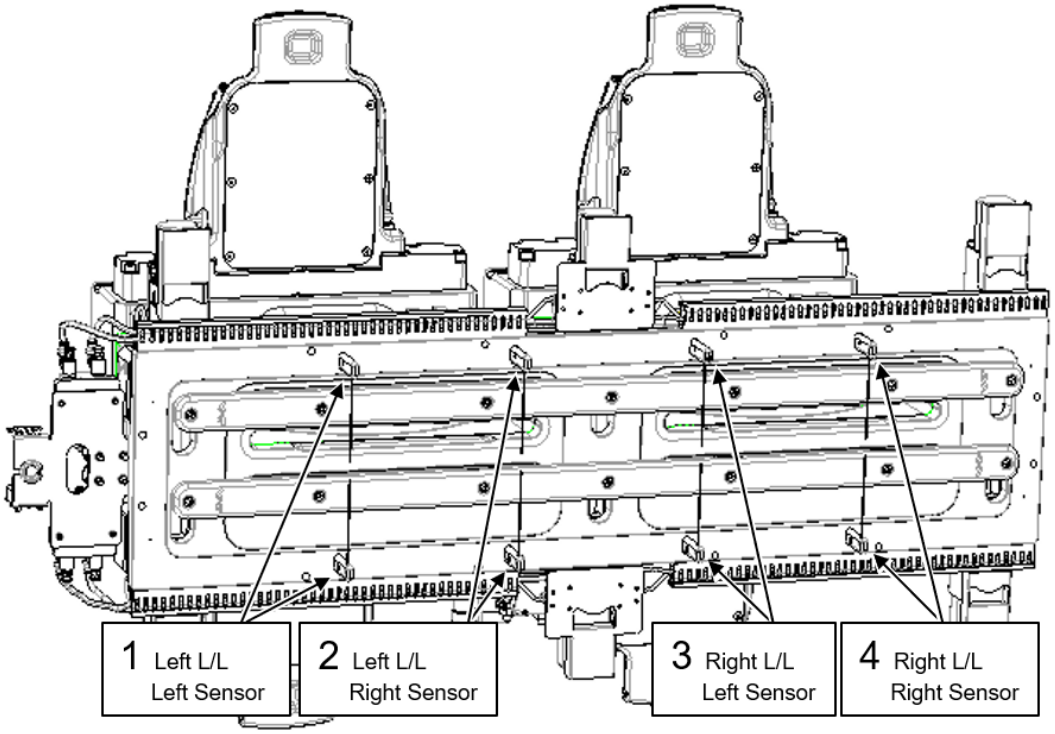

Figure 5 Active Wafer Centering (AWC) Hardware on MACH IV

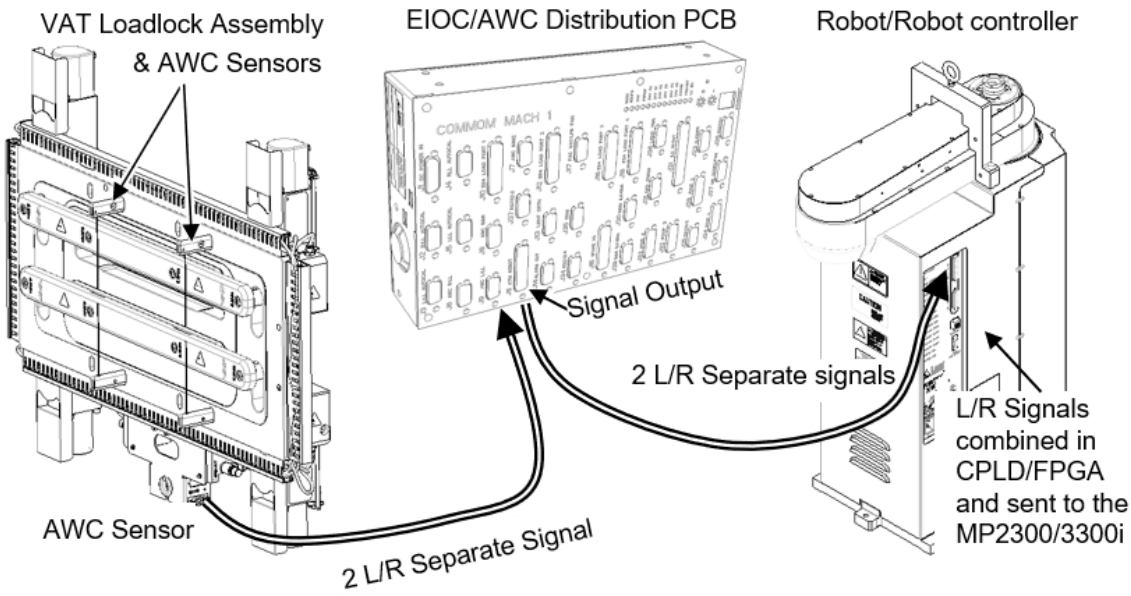

Figure 6 MACH Frontend AWC System Diagram

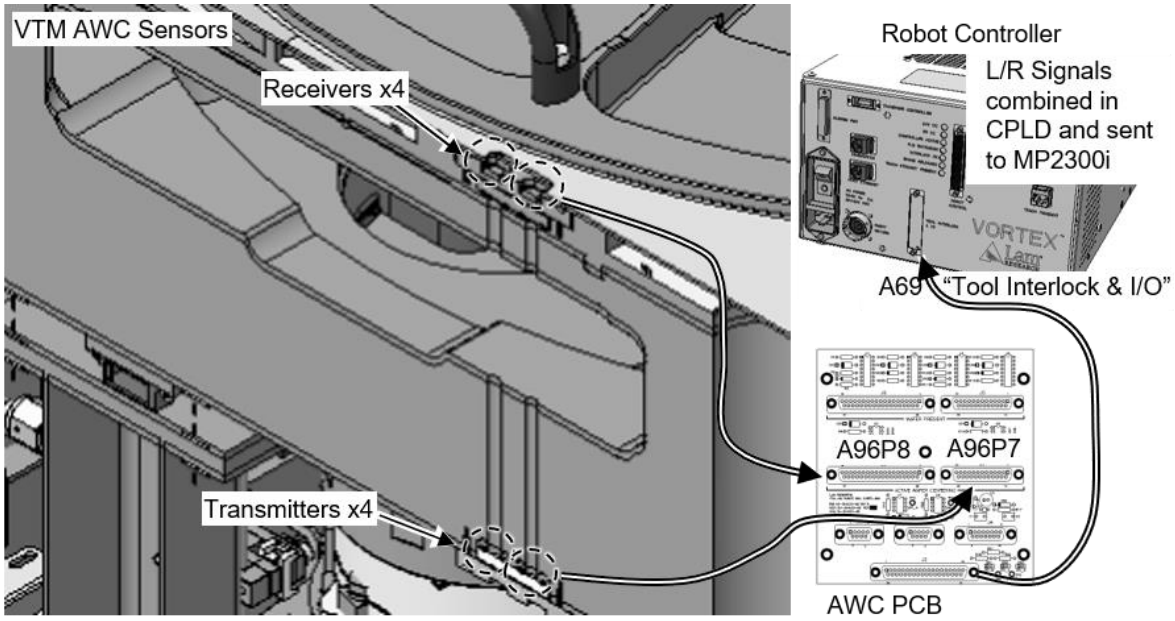

Figure 7 WTS Backend AWC System Diagram

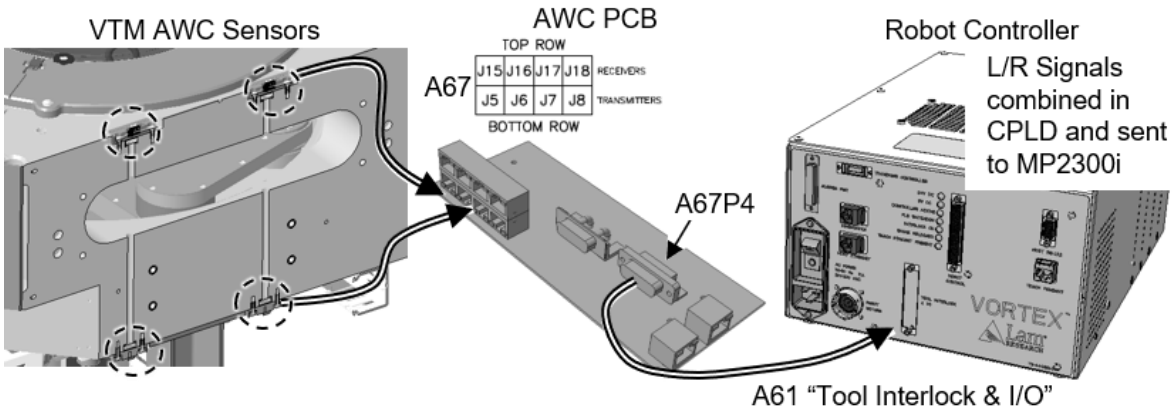

Figure 8 MACH Backend AWC System Diagram with Opto-Electric Sensors

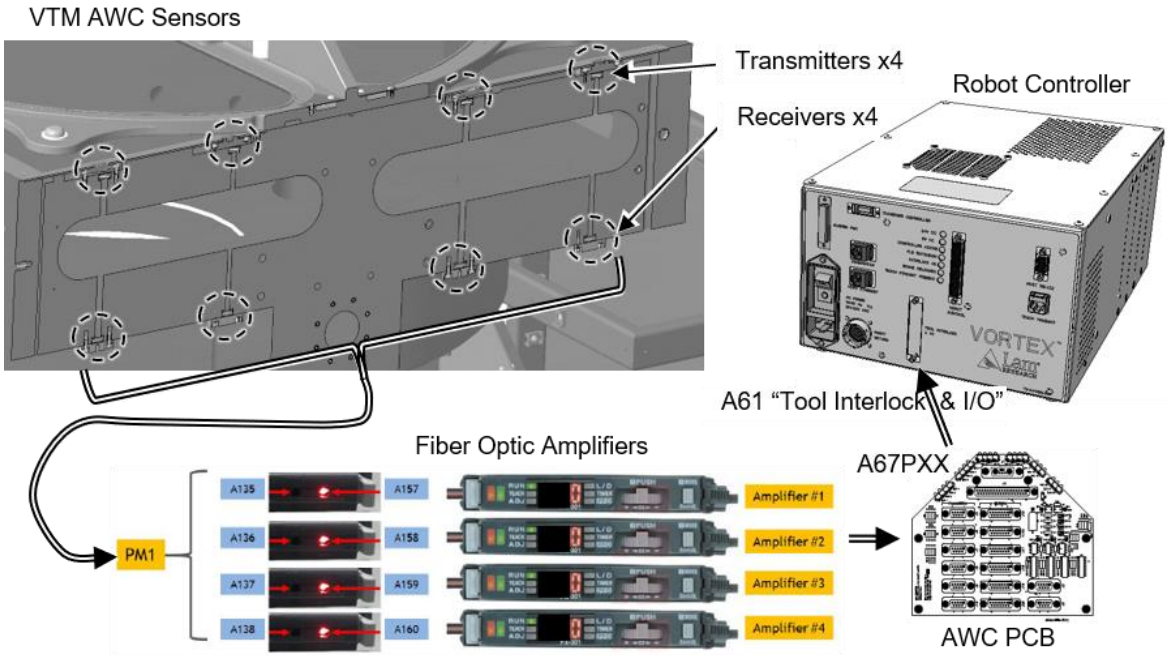

Figure 9 MACH Backend AWC System Diagram with Fiber Optic Sensors

Preparing the System

1 Ensure all wafers have been removed from the system and the system is idle.

	**⚠ Caution** **Pinch Point Hazard:** Robot and other hazardous motions are not tagged out and could cause personnel injury. Only authorized personnel may perform this procedure.

	**⚠ Caution** **Pinch Point Hazard:** During the following procedure, the safety envelope of the robot is entered. It is possible to come into contact with the robot arms or end-effector during this procedure.

2 Open the side front end access door.

3 Override the door interlock by pulling out the plunger on the interlock switch.

4 Connect the robot teach pendant to the robot controller connection marked **Teach Pendant**.

Note The front end robot controller is located on top of EFEM.

Note The teach pendant will automatically turn on when connected.

Figure 10 ATM Robot Controller

5 Using the teach pendant, home the robot by pressing the following keys in sequence:

Home
[Take Pendant control of the robot?] **Yes/CR**
All

AWC Calibration

Calibration Prerequisite

1 Selected LL station handoff position has been taught.

2 Selected LL station atmospheric door opened and all mechanisms inside the LL are homed (pedestal lift, LTM, etc.).

3 Selected LL station has the wafer sensor assignments defined (for example, L/LL LEFT_SENS = "1" and RIGHT_SENS = "2" for WTS MAX. Check your respective tool documentation on the LEFT_SENS and RIGHT_SENS assignment for the stations.)

4 The robot has a wafer centered on the end effector (either from a FOUP or calibration wafer with a center hole).

Calibration Steps

1 Move the robot to the LL station position using the Teach Pendant:

Move
1 (To Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
GOTO (1 or 2) CONFIRM Y/N ? then **Yes/CR**

2 Verify that the station sensor assignments are correct:

Setup
1 (Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC SETUP)
4 (Assign Params)
1 (RIGHT_SENS)
2 (LEFT_SENS)

3 Enable AWC for the station using the Teach Pendant:

Setup
1 (Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC Setup)
1 (Enable / Disable)
1 (Enable)

4 Perform AWC calibration using the Teach Pendant:

Setup
1(Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC Setup)
2 (Calibration), then **Yes/CR**

5 Confirm that the robot has clear path to the station and robot will move at full speed. The AWC calibration routine is outlined in the following diagram.

At the completion of the calibration, the Teach Pendant will issue an audible beep tone indicating that calibration is successful. If an error code is displayed on the Teach Pendant instead, consult the error table in this section for troubleshooting.

List of Basic Parameters

Note Unless directly specified, do not manually change the value for CONFIG and SEQ for the station, as this might cause the AWC not to work properly. Each robot will have the CONFIG value for each AWC station preconfigured. The SEQ value is automatically set during calibration.

Table 1 AWC Parameter Values for WTS Max

Variable Name	Description	Default Setting	WTS MAX STN 1(L/LL)	WTS MAX STN 2(R/LL)
ENABLE	AWC enable / disable	N (Disabled)	Y (Enabled)	Y (Enabled)
First leading edge R	Robot radial value for the first leading edge	Tool dependent	Tool dependent	Tool dependent
First leading edge T	Robot theta value for the first leading edge	Tool dependent	Tool dependent	Tool dependent
WAF_SIZE	Wafer size	300,000	300,000	300,000
LEFT_SENS	Left sensor assignment number	Tool dependent	1	3
RIGHT_SENS	Right sensor assignment number	Tool dependent	2	4
MAX_DEVIATION	Maximum wafer offset in microns allowable during a PLACE with AWC enabled	6,000	6,000	6,000
ALLOW_DEV	Maximum wafer offset in microns allowable during a PICK with AWC enabled	4,000	4,000	4,000

Variable Name	Description	Default Setting	WTS MAX STN 1(L/LL)	WTS MAX STN 2(R/LL)
BREAK_THR	Radial breakthrough threshold value in microns to determine broken wafer detection (BWD) during a pick	6,000	6,000	6,000
CPTR_CONFIG	Station configuration number. Determines the high-speed capture address assignment. Do not change this value.	Tool dependent	28	29
SEQ	Wafer edges capture sequence determined during calibration. SEQ = 0 indicates that wafer edges capture sequence is sequential (CW or CCW). SEQ = 1 indicates that the edges capture sequence is cross pattern.	Tool dependent	1	1
NOTCH_THRESHOLD	Threshold value in microns used to determine notch	2,000	2,000	2,000

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Table 2 AWC Parameter Values for VECTOR Express

Variable Name	Description	Default Setting	VECTOR STN 1 (L/LL)	VECTOR STN 2 (R/LL)
LEFT_SENS	Left sensor assignment number	Tool dependent	3	6
RIGHT_SENS	Right sensor assignment number	Tool dependent	2	5
MAX_DEVIATION	Maximum wafer offset in microns allowable during a PLACE with AWC enabled	6,000	6,000	6,000
ALLOW_DEV	Maximum wafer offset in microns allowable during a PICK with AWC enabled	4,000	4,000	4,000
BREAK_THR	Radial breakthrough threshold value in microns to determine broken wafer detection (BWD) during a pick	2,000	2,000	2,000
CPTR_CONFIG	Station configuration number. Determines the high-speed capture address assignment. Do not change this value.	Tool dependent	24	25
NOTCH_THRESHOLD	Threshold value in microns used to determine notch	2,000	2,000	2,000

Table 3 AWC Parameter Values for Mach I, IV ATM Robot

Variable Name	Description	Default Setting	MACH I / IV STN 1, 3	MACH IV STN 2,4
LEFT_SENS	Left sensor assignment number	Tool dependent	1	3
RIGHT_SENS	Right sensor assignment number	Tool dependent	2	4
MAX_DEVIATION	Maximum wafer offset in microns allowable during a PLACE with AWC enabled	6,000	6,000	6,000
ALLOW_DEV	Maximum wafer offset in microns allowable during a PICK with AWC enabled	4,000	4,000	4,000
BREAK_THR	Radial breakthrough threshold value in microns to determine broken wafer detection (BWD) during a pick	5,000	5,000	5,000
CPTR_CONFIG	Station configuration number. Determines the high-speed capture address assignment. Do not change this value.	Tool dependent	28	29

Table 4 AWC Parameter Values for Mach IV VTM Robot

Variable Name	Default Setting	STN 1	STN 2	STN 3	STN 4	STN 5
Left LEFT_SENS	Tool dependent	1	1	5	9	13
Left RIGHT_SENS	Tool dependent	2	2	6	10	14
Right LEFT_SENS	Tool dependent	3	3	7	11	15
Right RIGHT_SENS	Tool dependent	4	4	8	12	16
MAX_DEVIATION	6,000	6,000	6,000	6,000	6,000	6,000
ALLOW_DEV	4,000	4,000	4,000	4,000	4,000	4,000
BREAK_THR	2,000	2,000	2,000	2,000	2,000	2,000
CPTR_CONFIG	Tool dependent	36	36	37	38	39
NOTCH_THRESHOLD	2,000	2,000	2,000	2,000	2,000	2,000

Table 5 AWC Parameter Values for MACH I, IQ, I+ VTM Front Robot

Variable Name	Default Setting	STN 1	STN 2	STN 3	STN 4	STN 5
LEFT_SENS	Tool dependent	1	1	5	9	13
RIGHT_SENS	Tool dependent	2	2	6	10	14
MAX_DEVIATION	6,000	6,000	6,000	6,000	6,000	6,000
ALLOW_DEV	4,000	4,000	4,000	4,000	4,000	4,000
BREAK_THR	2,000	2,000	2,000	2,000	2,000	2,000
CPTR_CONFIG	Tool dependent	28	28	25	26	32
NOTCH_THRESHOLD	2,000	2,000	2,000	2,000	2,000	2,000

Table 6 AWC Parameter Values for MACH IQ, I+ VTM Rear Robot

Variable Name	Default Setting	STN 6	STN 7	STN 8	STN 9
LEFT_SENS	Tool dependent	1	5	9	13
RIGHT_SENS	Tool dependent	2	6	10	14
MAX_DEVIATION	6,000	6,000	6,000	6,000	6,000
ALLOW_DEV	4,000	4,000	4,000	4,000	4,000
BREAK_THR	2,000	2,000	2,000	2,000	2,000
CPTR_CONFIG	Tool dependent	28	25	26	32
NOTCH_THRESHOLD	2,000	2,000	2,000	2,000	2,000

Table 7 AWC Parameter Values for 2300 e6 MACH Extension

Variable Name	Default Setting	STN 1	STN 3	STN 4	STN 5
LEFT_SENS	Tool dependent	1	5	9	13
RIGHT_SENS	Tool dependent	2	6	10	14
MAX_DEVIATION	6,000	6,000	6,000	6,000	6,000
ALLOW_DEV	4,000	4,000	4,000	4,000	4,000
BREAK_THR	2,000	2,000	2,000	2,000	2,000
CPTR_CONFIG	Tool dependent	28	25	26	32
NOTCH_THRESHOLD	2,000	2,000	2,000	2,000	2,000

AWC Error Codes

Table 8 Error Codes Related to Wafer Centering (AWC)

Error Code	Error Text	Possible Cause	Recommended Action
451	Maximum deviation limit exceeded	Wafer is offset on the end-effector by more than 6 mm prior to placing to the station	Re-verify accuracy of robot handoffs to ensure that wafer center is not offset from the end-effector center by more than 6 mm.
551	AWC: Failed to capture sensor transition during calibration	**FIND WAFER POS N X** command performed but did not finish	Verify hardware and sensor inputs are correct.
770	Station not calibrated yet	AWC has not been taught.	Perform AWC calibration on the station before performing a PICK/PLACE to a station with AWC enabled
771	Invalid amount of sensor data	Four sensor triggers occur during a normal handoff. If the data indicates a greater or lesser number of triggers, it is invalid.	Check that the station wafer sensors are powered and triggering correctly Check that the station AWC configurations are correct (LEFT_SENS, RIGHT_SENS and CPTR_CONFIG) Check that the AWC subsystem hardware is connected properly and no component damage exists.
772	Broken Wafer Detection	The sensor data indicates that the wafer is not round.	If there actually was a broken wafer then AWC is functioning normally. Troubleshoot tool to determine cause of wafer breakage.

Error Code	Error Text	Possible Cause	Recommended Action
773	Not enabled for station	AWC has not been enabled for the station.	Enable AWC on the station and perform AWC calibration
774	Calibration mismatch	This error normally occurs during calibration and indicates a problem with the calibration data or possible movement of the wafer on the end-effector during calibration.	Check the AWC parameters Check the sensor functionality
775	Calculation Not Completed in Time	Wafer offset calculation not completed in the allotted time.	If occurred during a PICK then ignore the error as wafer is already on the end-effector If occurred during a PLACE retry the PLACE Check that the AWC subsystem hardware is connected properly and no component damage exists.
777	Unable to calculate wafer offsets	Invalid wafer offset values calculated	Check wafer position on the end-effector. Check wafer handoff at the station the wafer was picked from. Check the AWC parameters. Check the sensor functionality
780	Sensor number out of range	Specified value for RIGHT_SENS or LEFT_SENS is out of range	Check the sensor assignment number. For example: WTS-xT L/LL left sensor is “1” and right sensor is “2”
781	Gross wafer detection after PICK	Sensor data indicates that wafer offset is excessive.	Check if handoff is taught correctly on the station Check if wafer might have hit the slit valve wall on the way out causing a shift on the end effector Check if wafer is slipping on the end effector Perform AWC calibration on the station and test PICK AWC.
782	Virtual mode is enabled prior to calibration	The robot VIRTUAL mode is currently set to ON. Robot must be running in VIRTUAL mode OFF prior to performing AWC calibration	Use the Teach Pendant to set the robot VIRTUAL mode to OFF and retry AWC calibration

AWC Troubleshooting

Verify the Station AWC Parameters

1 Using the teach pendant, ensure that AWC is turned on by pressing the following keys in sequence:

Setup
1 (Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC Setup)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
1 (Enable / Disable)
1 (Enable)

2 On the teach pendant, enter the AWC Assign Params menu by pressing the following keys in sequence:

Esc
4 (Assign Params)

3 Verify the AWC parameters on the teach pendant match the settings shown in Table 1, Table 2, Table 3, and Table 4.If any of the AWC parameters require updating, press the number of the menu item, type in the correct parameter and press the **Yes/CR** key to store.

4 Turn off the teach pendant by pressing the **On/Off** key.

AWC Sensor Functionality Check

Setup Serial Communication with the Robot – C2/C3 Based Software

1 Ensure the system is idle and offline.

2 Open **Serial Monitor** from the **Tools** menu.

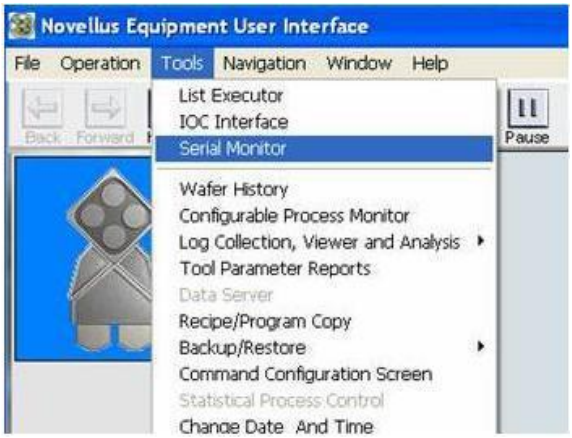


Figure 11 Selecting Serial Monitor from the Tools Menu

3 In the Serial Communications Monitor screen:

a Select **Front End** from the Module drop-down menu.

b Select **Atmospheric Robot** from the Selected Device drop-down menu.

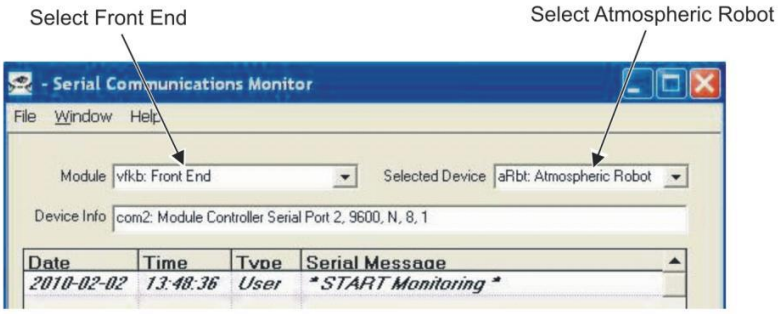


Figure 12 Module and Device Selection

4 Click **START Monitoring** the button to start serial monitoring.

Note The **START Monitoring** button name will change to **STOP Monitoring** when serial monitoring is active.

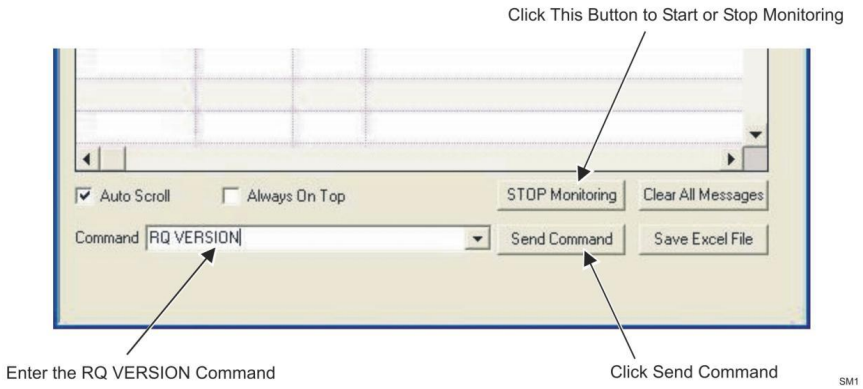
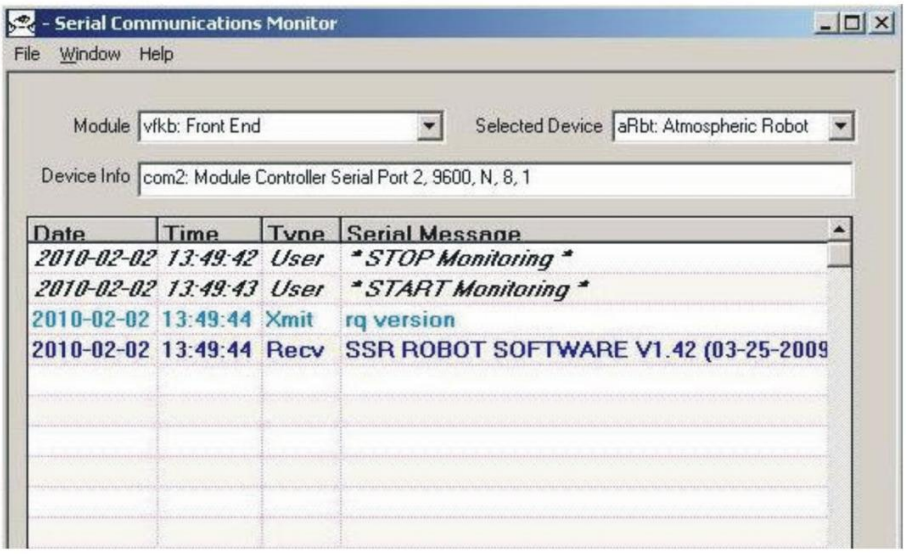


Figure 13 C2/C3 Serial Monitor Communication Verification

5 Clear the buffer by clicking the **Send Command** button before entering anything into the Command field.

6 Type **RQ VERSION** in the Command field and click to verify that the serial monitor and the controller are communicating.



Communication Messages

Figure 14 Communication Messages

Setup Serial Communication with the Robot – Nexus Based Software

1. Ensure the system is idle and offline.
2. Open **Device Monitor** from the **Tools** menu.

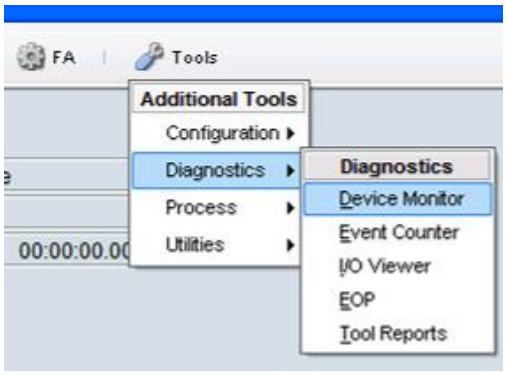


Figure 15 Open Device Monitor

3. Select the **Front End** or **Transfer Chamber Robot** from the **Devices** navigation pane on the left.
4. Type **RQ RVSN** in the Command Window and click **Send**.

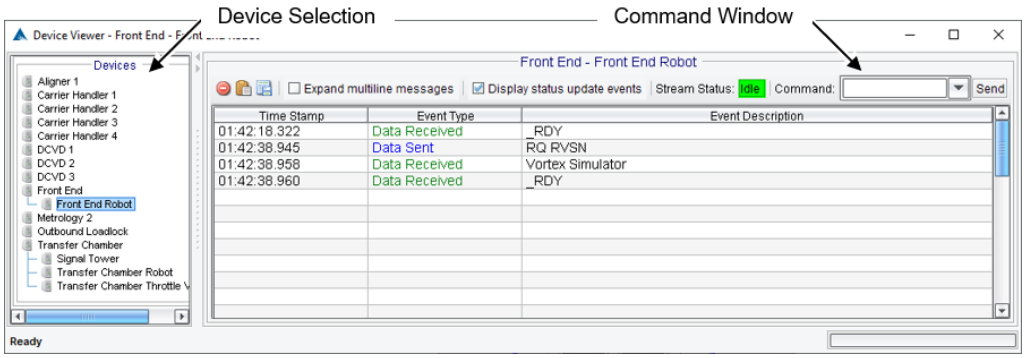


Figure 16 Nexus Device Monitor

Setup Serial Communication with the Robot – 2300 Based Software

1. Ensure the system is idle and offline.
2. For NPM branches: Navigate to **Maintain** -> **Maintenance** on the UI.
3. For Etch branches: Navigate to **Maintain** -> **Command** on the UI and click the **Ext Robot** radio button.
4. Select **Manual Command** in the Command Selection panel (applies to NPM branch only).
5. Type **RQ RVSN** in the Command Window and click the **Execute** button.

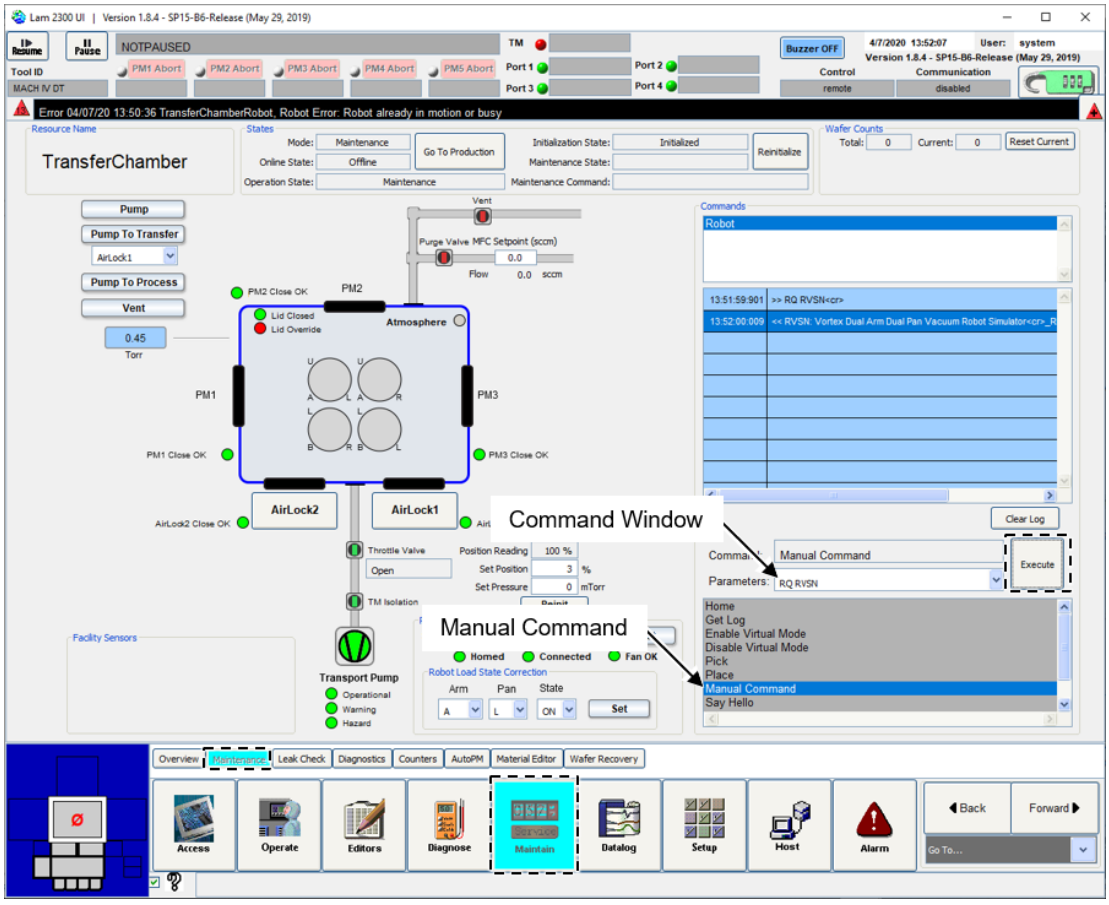


Figure 17 2300 Command Window (NPM Branch)

Release_Type Rev
Current_Rev E
Initial_Release A
Drawn_By: TTANNE --- ---
Checked_By: KPETER --- ---
EE_By: --- ---
ME_By: --- ---
Other_By: KPETER --- ---
Date: 11/28/2022

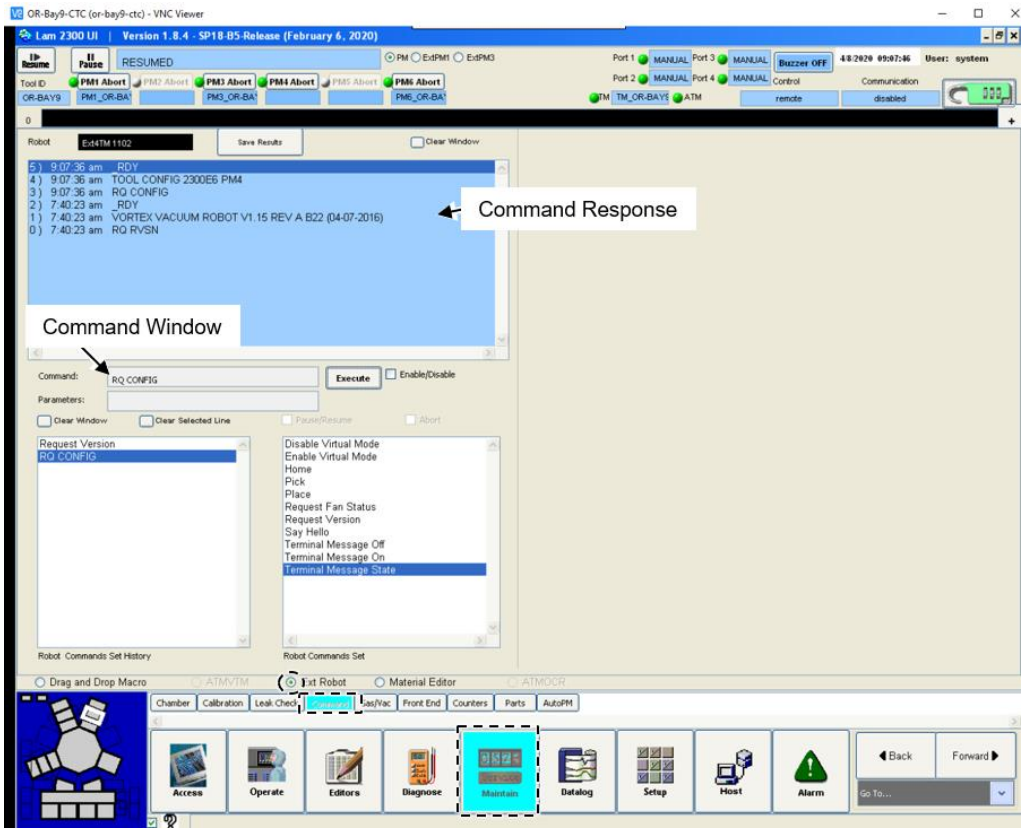


Figure 18 2300 Command Window (Etch Branch)

Testing the AWC Sensor Functionality

1 Set up the robot to capture data from sensor 1 by sending the command **SET CPTR** (*Sensor#*) (*ArmA/B*) **ON** (see the following figure).

Note When capturing data on a single sensor, the command uses the sensor number. For example, for capturing data on the robot for sensor 2 on station 1 the command would be `SET CPTR 2 A ON`. This same formatting is also used in steps 2 and 6.

Note When capturing data for a single-arm robot, omit the **A** or **B** for the arm.

2 Momentarily block sensor 1.

Note It may be necessary to push the front end robot out of the way to gain access to the sensors. This will not affect the results provided the robot is not

actually moving when blocking the sensor. Use the EMO button on the teach pendant to deservo the robot.

3 Request the captured data by sending the command `RQ CPTR` (*Sensor#*) (*ArmA/B*) (see Figure 20).

4 If the robot detects a sensor transition, it reports the robot arm position data as shown below.

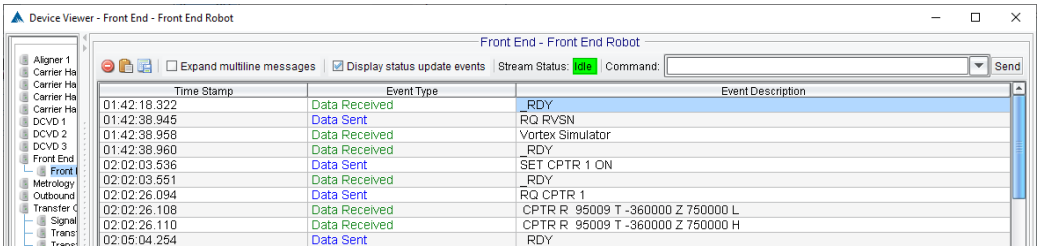


Figure 19 Loadlock AWC Sensor 1 Capture

Each line is a separate sensor transition with the “L” or “H” indicating a low or high transition. The reported coordinates will represent the robot’s stationary position because the arm was not moved.

If no sensor transitions were detected, the robot will respond with `CPTR NOT TRIGGERED`.

5 Using the command line on the TCP Console, turn off data capture by sending the command **SET CPTR** (*Sensor#*) (*ArmA/B*) **OFF**.

6 Repeat steps 1 through 5 for each sensor.

7 Using the command line on the TCP Socket Console, setup the robot to capture data from both sensors by sending the command **SET CPTR** (*Capture Config#*) (*ArmA/B*) **ON** (see the previous figure).

Note When capturing data on a set of sensors, the command uses the capture configuration number.

Table 9 Sensor and CPTR Numbers

	WTS / MACH IV	VECTOR Express	MACH I
Sensor Number	1,2 and 3,4	2,3 and 5,6	sensors 1,2
CPTR #	28 and 29	24 and 25	28

8 Momentarily block both sensors.

Using the command line on the TCP Socket Console, request the captured data by sending the command **RQ CPTR** (*Capture Config#*) (*ArmA/B*) (see the following figure).

9 If the robot detects a sensor transition, it reports the robot arm position data as shown below.

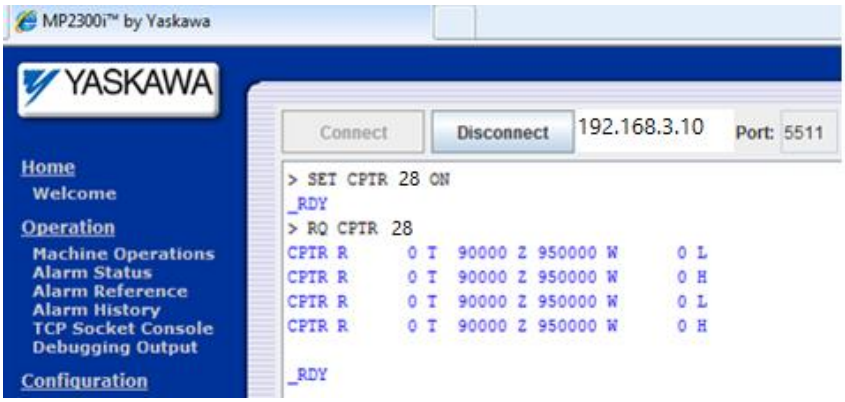


Figure 20 Loadlock AWC Sensor Configuration 29 Capture

Each line is a separate sensor transition with the “L” or “H” indicating a low or high transition. The reported coordinates will represent the robot’s stationary position because the arm was not moved.

If only one sensor triggers, then only two transitions will be shown. If none of the sensors trigger, the robot will respond with `CPTR NOT TRIGGERED`.

10 Using the command line on the TCP Console, turn off data capture by sending the command **SET CPTR** (*Capture Config#*) (*ArmA/B*) **OFF**.

CPTR NOT TRIGGERED Actions

If `CPTR NOT TRIGGERED` is returned by the robot perform the following actions to isolate the problem.

Robot Controller Side Checking

1 Check if the CPLD ACTIVE light on the controller bulkhead is blinking.

2 If the CPLD ACTIVE light is not blinking then verify that the controller part number is correct, and also check connections to the PCB within the controller. If problem persists, replace the controller.

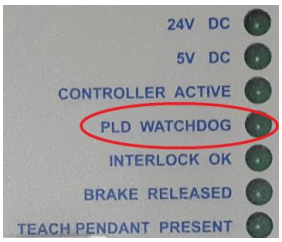


Figure 21 Robot Controller Front Panel Light

3 Double-check to ensure that the correct sensor on the correct station was blocked during the test.

4 Perform the Verify the Station AWC Parameters section to ensure the sensor parameters are correct for the station which was tested.

For VECTOR Express Systems

1 If `CPTR NOT TRIGGERED` is returned for only one of the sensors and all other sensors are operating normally, AWC cable assembly from A216 (03-145147-00, PCA, INTERFACE, AUTOCAL) to L/LL (03-156481-00, CABLE ASSY,AWC,RS LLL/IPCA) or R/LL (03-156481-01, CABLE ASSY,AWC,RS RLL/IPCA) might have failed.

2 Input sensor 3 (L L/LL AWC signal) did not toggle when blocked, disconnect J4 at A216 and connection breakout cable 03-032159-00, CABLE ASSY, 9PIN, BREAKOUT, using a digital voltmeter check the voltage between pin 3 (signal for L L/LL AWC SNS) and 5 (24VRTN), check the voltage change status when blocked, if the sensor changed voltage, until this cable is good (before A216 is good), same as other sensor (J3, J6, J7).

3 Remove the breakout cable and back to J3 connector, disconnect A201_B0PINTLK/IO at robot controller (03-154296-01, CBL ASSY, BCLTR/IPCA, VCTR), this cable for A216 (03-145147-00, PCA, INTERFACE, AUTOCAL) to A201 (dry robot controller), check the voltage between pin 3 (signal for L L/LL AWC SNS) and pin 25 (+24VDC), when blocked the sensor did not change voltage then failure of A216 (03-145147-00, PCA, INTERFACE, AUTOCAL) board.), if changed voltage, A216 board is good.

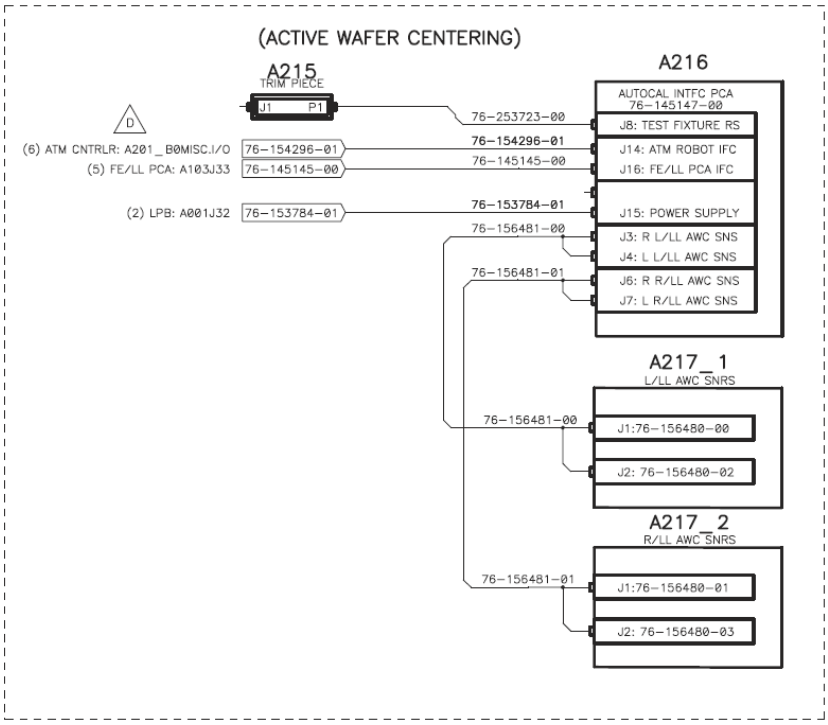


Figure 22 VECTOR Express Interconnection for AWC Sensor Signal

4 If `CPTR NOT TRIGGERED` is returned for two or more sensors, check to ensure the sensor wiring has not been swapped A216 (03-145147-00, PCA, INTERFACE, AUTOCAL). Block different sensors to determine if the wrong sensor triggers. For example, if the controller is set to capture data on Sensor 1 and blocking Sensor 2 results in data from the robot, then Sensor 1 has been swapped with Sensor 2.

For WTS Systems

1 If `CPTR NOT TRIGGERED` is returned for only one of the sensors and all other sensors are operating normally, the AWC cable assay from the EIOC 2 to 03-316865-01 (CBL ASSY, FE AWC, LEFT LOAD LOCK, C3 WTS), 03-316865-02(CBL ASSY, FE AWC, RIGHT LOAD LOCK, C3 WTS) might have failed.

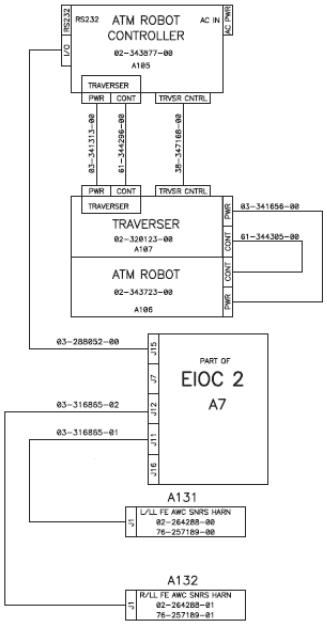


Figure 23 WTS Max Interconnection for AWC Sensor Signal

2 If input sensor 3 (L/LL AWC signal) did not toggle when blocked, disconnect J11 at EIOC 2 and connection breakout cable 03-032159-00, CABLE ASSY, 9PIN, BREAKOUT, using digital voltmeter check the voltage between pin 3 (signal for L L/LL AWC SNS) and 5 (24VRTN), check the voltage and if the sensor changed status when blocked, if the sensor changed voltage, until this cable is good (before EIOC 2 is good)

3 Remove the breakout cable and back to J11 connector, disconnect J15 (03-288052-00, CBL ASSY, E84 SIOC, ATM ROBOT I/O, C3 WTS) at EIOC 2, check the voltage between pin 3 (signal for L L/LL AWC SNS) and pin 25 (+24VDC), when blocked the sensor did not change voltage then failure of EIOC 2 if changed voltage, EIOC 2 is good.

4 If `CPTR NOT TRIGGERED` is returned for two or more sensors, check to ensure the sensor wiring has not been swapped at the EIOC 2. Block different sensors to determine if the wrong sensor triggers. For example, if the controller is set to capture data on Sensor 1 and blocking Sensor 2 results in data from the robot, then Sensor 1 has been swapped with Sensor 2.

For All Systems

1 Check the cabling from AWC Interface PCB to EIOC's.

   a Check EIOC 2 A7P15 at WTS-Max or A216 (03-145147-00, PCA, INTERFACE, AUTOCAL) at VECTOR to **TOOL INTERLOCK** & I/O on the controller bulkhead.

b Reference 224-226000-410 for CEFEM WTS.

c Reference 224-226000-420 for CEFEM MACH IV.

d Reference 224-226000-430 for CEFEM MACH I.

e Reference 224-226000-431 for CEFEM MACH I+ and 2300 e6 MACH Extensions.

f Reference 224-226000-440 for CEFEM MACH IQ.

2 Check if the AWC sensor are powered:

a Verify that the AWC receiver light is green when the sensor is not blocked.

b Verify that the AWC receiver light is green + red when the sensor is blocked.

- If not green + red, verify no debris is blocking the sensor.

3 Check cable 03-341321-00, CBL ASSY,ALL AMPLIFIER CN1 ROBOT CONT PC connection inside robot controller:

a PCA side connection: J8

b Drive side connection :

B4 – T2 drive CN1 port

B5 – T1 drive CN1 port

B6 – Z drive CN1 port

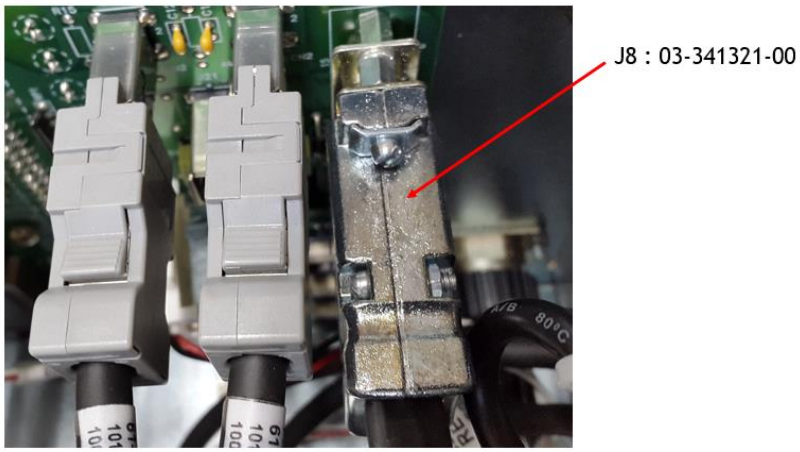


Figure 24 Robot Controller AWC Sensor Cable

4 Check if AWC sensor transitions are received by the controller:

a Connect to the VORTEX Utility, click **Manual Operation** and then click **I/O.**

b Send the command to the robot **SET CPTR 1 A ON** (Omit A for single arm robots) at the Device Monitor, Maintenance, or Serial Server screens.

c Check the I/O status on the screen:

- Input [2] bit [10] and [11] should turn green or ON state

Figure 25 Robot Controller I/O Bit

d Have one person block the AWC sensor connected to channel 1 (left loadlock left sensor – verify with AWC default parameter values, see Table 1.

e Check if Input[2] bit [10] and [11] change state as the sensor is blocked and unblocked.

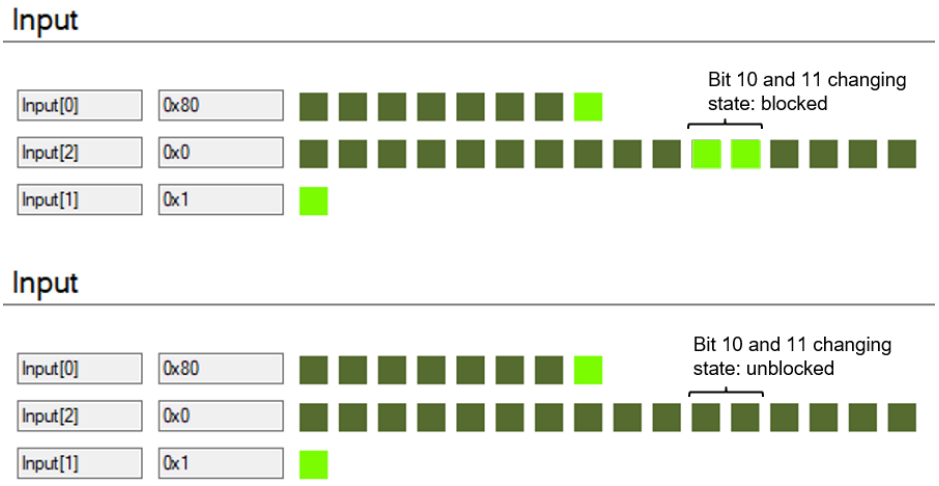


Figure 26 Robot Controller I/O Bit Blocked and Unblocked

This verifies that the controller interface PCA is receiving the AWC sensor signal transitions.

5 Check that the Tx emitters and Rx sensors are installed in proper alignment. There is no extra or missing hardware exists that would cause improper emitter to sensor alignment.

6 Check that no obstructions exist between the Tx emitter and Rx sensors that would interfere with beam sensing.

Troubleshooting Steps

This section covers some of the possible error codes that could be generated during AWC calibration or wafer PICK and PLACE operation. For an expanded list of VORTEX troubleshooting and list of error codes, refer to procedure 74-379603-00.

X and Y Axes Return Wafer Offsets of 0

1 The robot is returning wafer offsets of 0's for both X and Y directions for all wafers.

If AWC is enabled for the station but the robot still returns 0's for X and Y offsets (when queried using the RQ WAF_CEN DATA command) then it is likely that the robot is currently running in virtual mode (i.e. VIRTUAL MODE = ON). The virtual mode determines whether the robot is running with a virtual wafer (VIRTUAL = ON) in which it will not check for wafer presence or calculate AWC or if it is running with a real wafer (VIRTUAL = OFF) in which it will check for wafer presence and offset calculation.

Check the robot virtual mode status from the Teach Pendant:

Setup
1 (Virtual Wfr Mode)

If virtual mode is currently ON then set it to OFF by pressing **2** on the Teach Pendant. The virtual status will be update on the screen to **OFF**.

2 Invalid amount of sensor data captured during calibration (_ERR 771).

During the calibration, PICK and PLACE move with AWC the robot expects to see specific count of transitions as the wafer passes through the sensor, including the two leading edges (sensors blocked) and the two trailing edges (sensors unblocked). There may be additional transitions due to EE/Arms may pass under the sensor. The robot might fail to capture the four wafer edges for the following conditions:

Invalid Amount of Sensor Data (_ERR 771)

Check Parameter Settings

The station sensors have not been configured correctly causing the robot to look at the wrong pair of sensors during the AWC calibration move. Use the Teach Pendant to verify that the station RIGHT_SENS and LEFT_SENS are correctly configured and then repeat AWC calibration on the station:

Setup
1(Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC Setup)
Yes/CR
4 (Assign Params)

Make sure the assigned numbers for RIGHT_SNS and LEFT_SNS match the correct value for the selected station.

If one of the values are incorrect then modify that value by:

1 for RIGHT_SNS or **2** for LEFT_SNS → enter correct value → **Yes/CR**

The station AWC configuration is incorrect causing the robot to look at the wrong pair of sensors during AWC move. Use the Teach Pendant to verify that the station CONFIG is correctly configured:

Setup
1(Station)
[Enter Stn #] (**1**or **2**), then **Yes/CR**
3 (AWC Setup)
Yes/CR
4 (Assign Params)
Yes/CR
Yes/CR
5(CONFIG)

Make sure the assigned number for CONFIG matches the correct value for the selected station. Reference Table 1 through Table 7 parameter values for specific handler types.
If the value is incorrect then modify that value by:

5 enter correct value → **Yes/CR**

Check VIA Teaching for Traverser Robots

For a station with via move option (CURVE_MOVE) enabled, the robot traverser (S-axis) has to be at the correct position when teaching the handoff position. The S

coordinate of the robot is a preset value and should not be changed during teaching (i.e. through hand locate). The default values for some of the common tools are:

Table 10 Default Station S Coordinates

Tool	Left Loadlock / Transfer Stn	Right Loadlock / Transfer Stn
WTS	176,300	328,700
Vector	252,500	252,500

For a station with via (CURVE_MOVE) move option enabled, such as on the WTS-xT, the via-point trajectory must be taught using the appropriate teach fixture to guarantee that the end effector path in and out of the loadlock is using the expected trajectory. If the trajectory is incorrect, the two leading edges might occur at almost the same instance (within 8 ms of each other) causing the robot to miss the second edge as it is still processing the first edge.

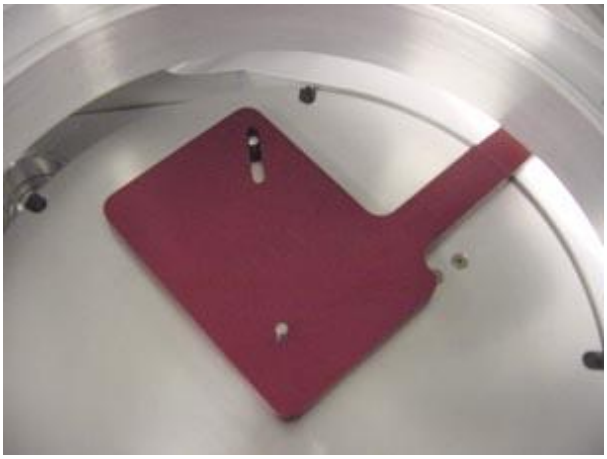


Figure 27 Loadlock via Point Teach Fixture (71-351052-00)

Follow the tool procedure for manually teaching the loadlock via position if re-teaching is required. Use the correct via point fixture (71-351052-00). For example, when manually teaching the WTS-xT 3 FOUP system reference document 74-350842-00 for the teach procedure using the fixture.

Check Capture Mode is OFF

Ensure AWC Sensor Capture Mode has been turned **OFF**. Various robot error conditions or previous troubleshooting could have left the capture mode **ON**, which may interfere with normal operation. Send these commands for each configured sensor channel:

SET CPTR (*Sensor#*) (*ArmA/B*) **OFF**

Check AWC System Hardware

Intermittent errors can be caused by sporadic faults in the AWC system, including but not limited to:

- loose connections
- debris partially blocking sensors
- sensors that are nearing permanent failure.

Refer to section AWC Troubleshooting and its subsections to diagnose faults in specific AWC hardware subsystems.

Calculation Not Completed in Time (_ERR 775)

Check Parameter Settings

See steps in the previous section for this sub-category.

Check VIA Teaching for Traverser Robots

See steps in the previous section for this sub-category.

Check Hardware & Cabling

Check the AWC wiring according to the system interconnect in the Reference Documents section of this procedure.
Check the connections, high speed data cable inside the robot controller.

Unable to Calculate Wafer Offsets (_ERR 777)

Error _ERR 777 might be issued if the calculated wafer offset contains imaginary numbers indicating that some of the four captured edges are not in the right position causing a faulty calculation. Put a centered wafer on the end effector and place the wafer to the station. If the error repeats, the station has not been properly calibrated. Repeat the calibration process using the Teach Pendant.

During the calibration the robot performs a wafer pick with known offsets in the X-Y direction and then compares the known offset with that calculated during the following PLACE move. If the expected and calculated offsets differ by more than 400 microns each then the robot will error out with _ERR 774.

Calibration error mismatch typically indicates that the wafer presence sensors are triggering (i.e. four transitions are detected) but the wafer position during a place offset verification is not where it is expected.

Troubleshooting steps for calibration mismatch error:

- Verify that the AWC sensor assignment for the station is correct.
- Verify that the wafer is initially centered on the end-effector at the start of the calibration.
- Verify that the wafer is not sliding / slipping on the end effector during the robot extend and retract movements. If the wafer is moving during the robot movement, the calculated wafer offsets will not be accurate and cause the calibration to fail.

Gross Wafer Offset Detection During PICK (_ERR 781)

The robot will tolerate up to 4mm in offset magnitude for outbound wafer coming from an AWC enabled station. Visually observe if the wafer is off by more than 4mm on the end effector.

Broken Wafer Detection (BWD) during PICK (_ERR 722)

The robot uses an algorithm to calculate the wafer radius based on the captured wafer edges. If any of the calculated radiuses exceeds the programmed wafer radius (150 mm standard) by the BREAK_THR amount then it will be flagged as broken wafer detection. Visually verify that there is a broken wafer on the end effector. If the wafer is not broken, the BWD error might indicate that one of the captured edges might be faulty due to a glitch during the capture.

Intermittent Maximum Wafer Offset Detected during PLACE (_ERR 451)

The robot will tolerate up to 6 mm in offset magnitude for inbound wafer coming to an AWC enabled station. Visually observe if the wafer is off by more than 6 mm on the end effector. Use the scribe lines on the end effector as a rough guide for a centered wafer position. Ideally the edge of the wafer should be resting on the second scribe line. For a robot with a friction end effector verify that the 3 friction pads on the end-effector are accounted for. If one of the pads is missing the wafer could be slipping on the end effector during the move causing the > 6 mm offset.

The Robot Does Not Sense Broken Wafer or Grossly Offset Wafer

If WAF_CEN is enabled for the station but the robot does not detect broken wafer or grossly offset wafer than it is likely that the robot is currently running in virtual mode (i.e. VIRTUAL MODE = ON).

Gathering AWC Data from Output.html or Output.xml after an Alarm

AWC log data is available in more than one format and is a useful tool for troubleshooting. This section describes how to access the data.

- Raw data stored in the output log of the robot controller
- Aggregate log files stored in Nexus or CTC computer hard drives

Downloading Logs from Nexus

Nexus logs can be downloaded from the following location on the Data Server.

- D:\logs\nexus-devices-robot.log

Downloading Logs from 2300/CTC

2300 logs can be downloaded from the following location on the CTC.

- D:\Lam\data\AtmArm\DataLog*.dat
- D:\Lam\data\TransferChamber\DataLog*.dat

Downloading Logs from a Robot Controller's Output Log

In the event of a robot alarm, the AWC data will not be posted for logging by C2/C3, Nexus, or 2300 system software. It is still possible to collect this data from the Output log stored inside the Robot Controller, but it must be done immediately after the alarm. Recovery actions that involve any robot movement or power cycle of the robot controller will cause the data to be overwritten and lost.

NOTICE

Recovery actions that involve any robot movement or power cycle of the robot controller cause the data to be overwritten and lost.

1. Follow procedure PN 202-273624-001 to collect the output.html or output.xml log file from the robot controller, or from the system software if automatic log downloading is available.
2. Open the log file with a text editor, and search for the text "_ERR" to find all Alarm Events in the log file.

3 Continue searching upwards in the log file to locate the Robot Command, Response, and AWC Data information immediately prior to each Alarm Event.

4 Compile the Robot Commands, Responses, and AWC Data as shown in the examples when sharing with RPS, GPS, Engineering, and Customers for clarity.

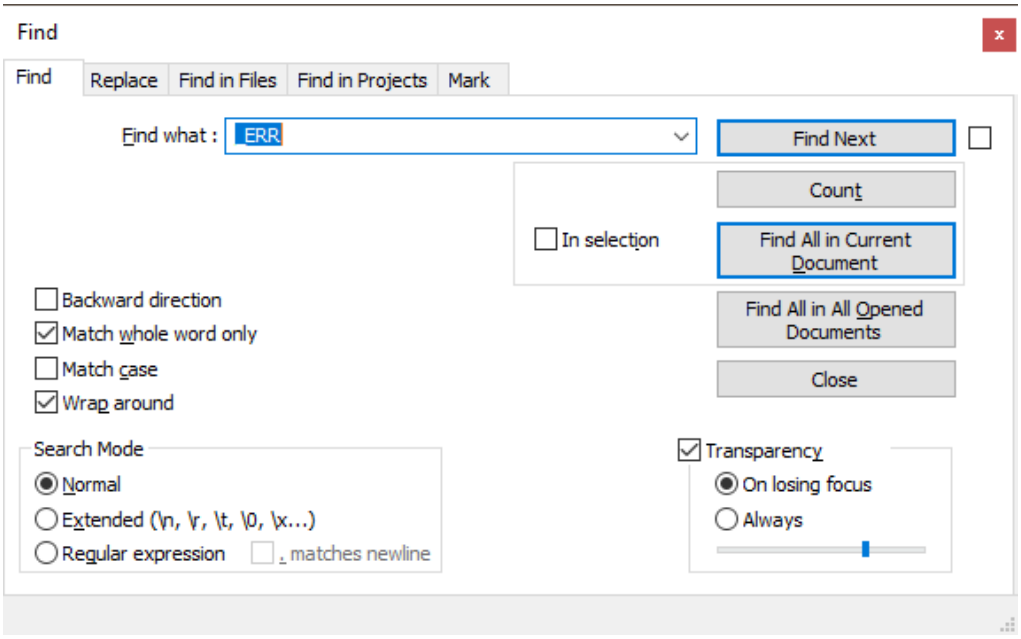


Figure 28 Search for "_ERR" To Find Most Recent Alarm

```
Line 1444: error string _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 1445: 2021-06-29 22:58:32.440 : [Outputting message _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 2020: error string _ERR 90 Invalid EVENT specified
Line 2021: 2021-06-29 23:01:15.890 : [Outputting message _ERR 90 Invalid EVENT specified
Line 2680: error string _ERR 90 Invalid EVENT specified
Line 2681: 2021-06-29 23:11:05.470 : [Outputting message _ERR 90 Invalid EVENT specified
Line 3010: error string _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 3011: 2021-06-29 23:17:21.970 : [Outputting message _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 5835: error string _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 5836: 2021-06-29 22:58:32.440 : [Outputting message _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 6411: error string _ERR 90 Invalid EVENT specified
Line 6412: 2021-06-29 23:01:15.890 : [Outputting message _ERR 90 Invalid EVENT specified
Line 7071: error string _ERR 90 Invalid EVENT specified
Line 7072: 2021-06-29 23:11:05.470 : [Outputting message _ERR 90 Invalid EVENT specified
Line 7401: error string _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
Line 7402: 2021-06-29 23:17:21.970 : [Outputting message _ERR 451 AWC: Maximum wafer offset deviation limit exceeded
```

Figure 29 Example of Search Results

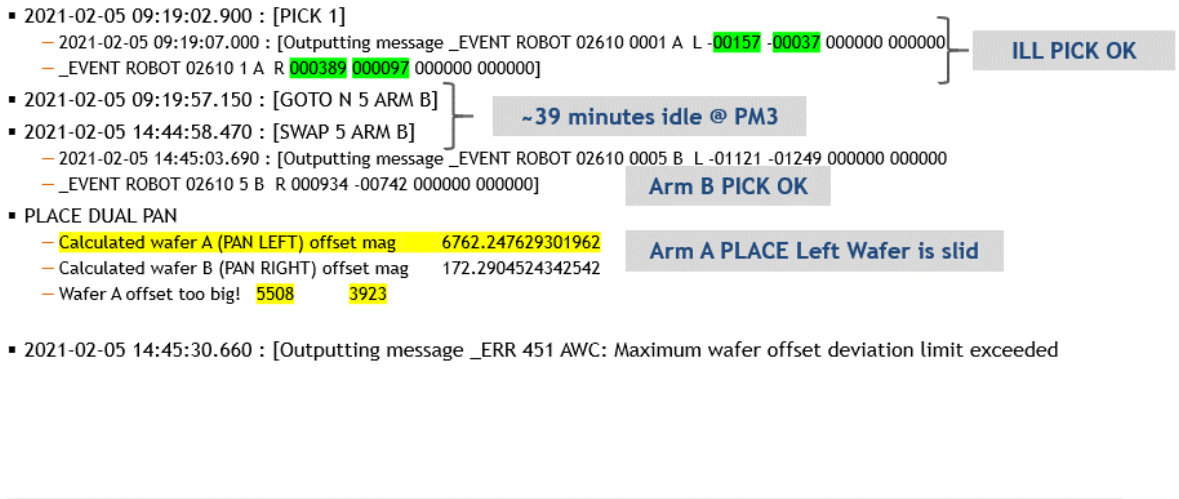


Figure 30 Examples of Robot Commands, Responses, and AWC Data in Log File

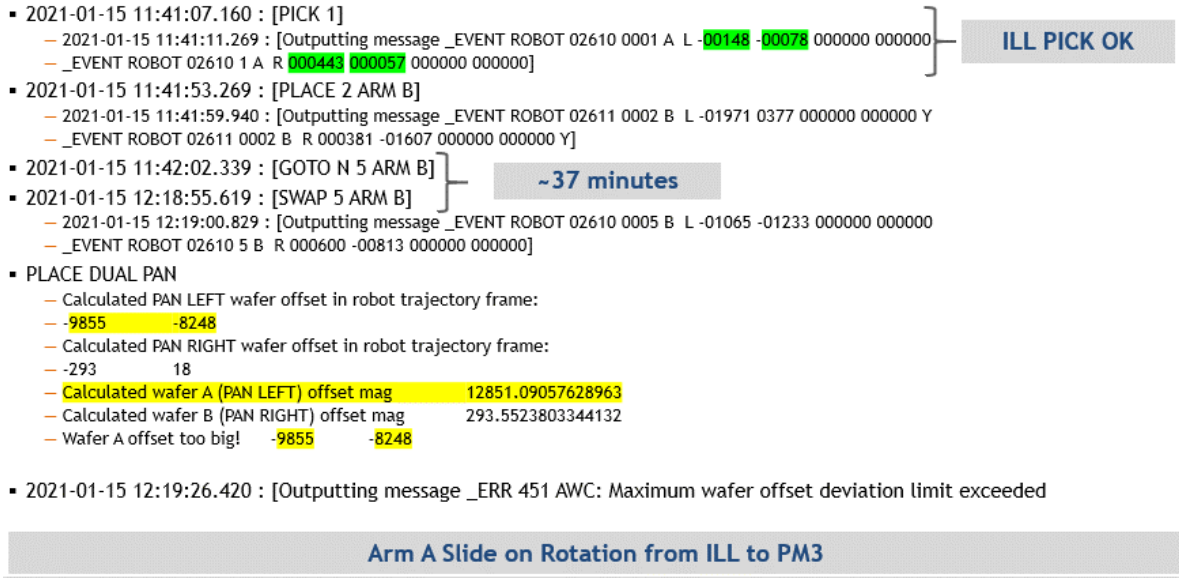


Figure 31 Examples of Robot Commands, Responses, and AWC Data in Log File

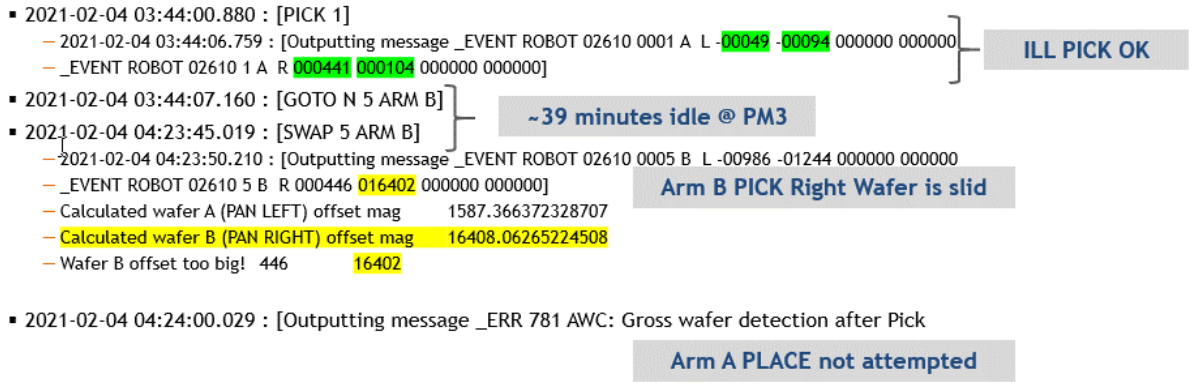


Figure 32 Examples of Robot Commands, Responses, and AWC Data in Log File

Restoring the System

1. On the VORTEX Robot Utility, click **Disconnect.**
2. Refer to procedure 202-273624-001, Vortex Log Collection and Robot Log Backup, to restore the laptop or chase computer to normal operation.
3. Disconnect the Ethernet cable from the diagnostics port on the controller.
4. Dis-engaged the EMO button on the teach pendant.
5. Perform the Verify the Station AWC Parameters section to ensure that AWC is enabled and the parameters are correct.
6. Disconnect the teach pendant from the robot controller and close all access doors.
7. For C2/C3 based tools:
   a. From the UI, go to the appropriate robot interface screen, right-click on the robot **Interlock Reset** switch icon and select **Switch Off** and **Switch On**.
   b. Right-click on the robot state indicator and select **Robot Home.**
8. For Nexus based tools:
   a. From the UI, clear any alarms present and reset interlocks.
   b. Execute the Boot-up and Prepare for Process programs for the front end and transfer chamber.

c End control of both modules after execution completes.

9 For 2300 based tools:

a From the UI, clear any alarms present and reset interlocks.

b Initialize the handler.

10 Cycle 25 wafers from each loadport to verify the system is recovered.

End of Procedure

Release_Type Rev
Current_Rev E
Initial_Release A
Drawn_By: TTANNE --- Checked_By: KPETER --- EE_By: --- --- ME_By: --- --- Other_By: KPETER --- Date: 11/28/2022