Job Execution State Machines

Software Functional Specification

State Machines' description

PURPOSE:

This document will present the different job’s execution state machines.

SCOPE:

**Author**

Date :

Company : Agileo Automation

Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Release** | **Modified parts** | **Comments** | **Date** | **Author** |
| 1.0 | All | Documents creation | 06/13/2022 | Agileo |
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# Definitions and References

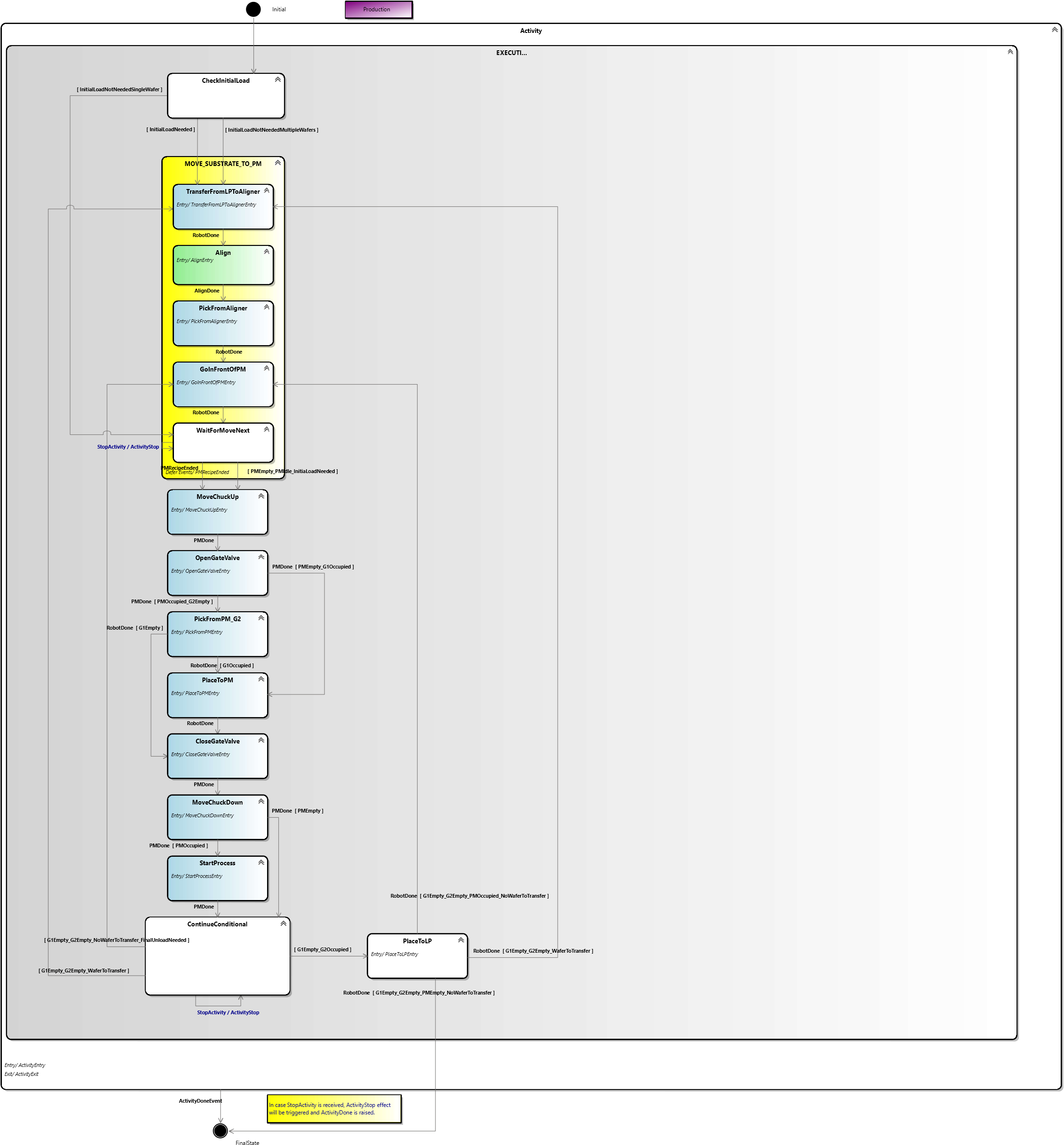
## Definitions, Acronyms and Abbreviations

|  |  |
| --- | --- |
| **Term or Abbreviation** | Description |
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## References

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# Job execution on one process module



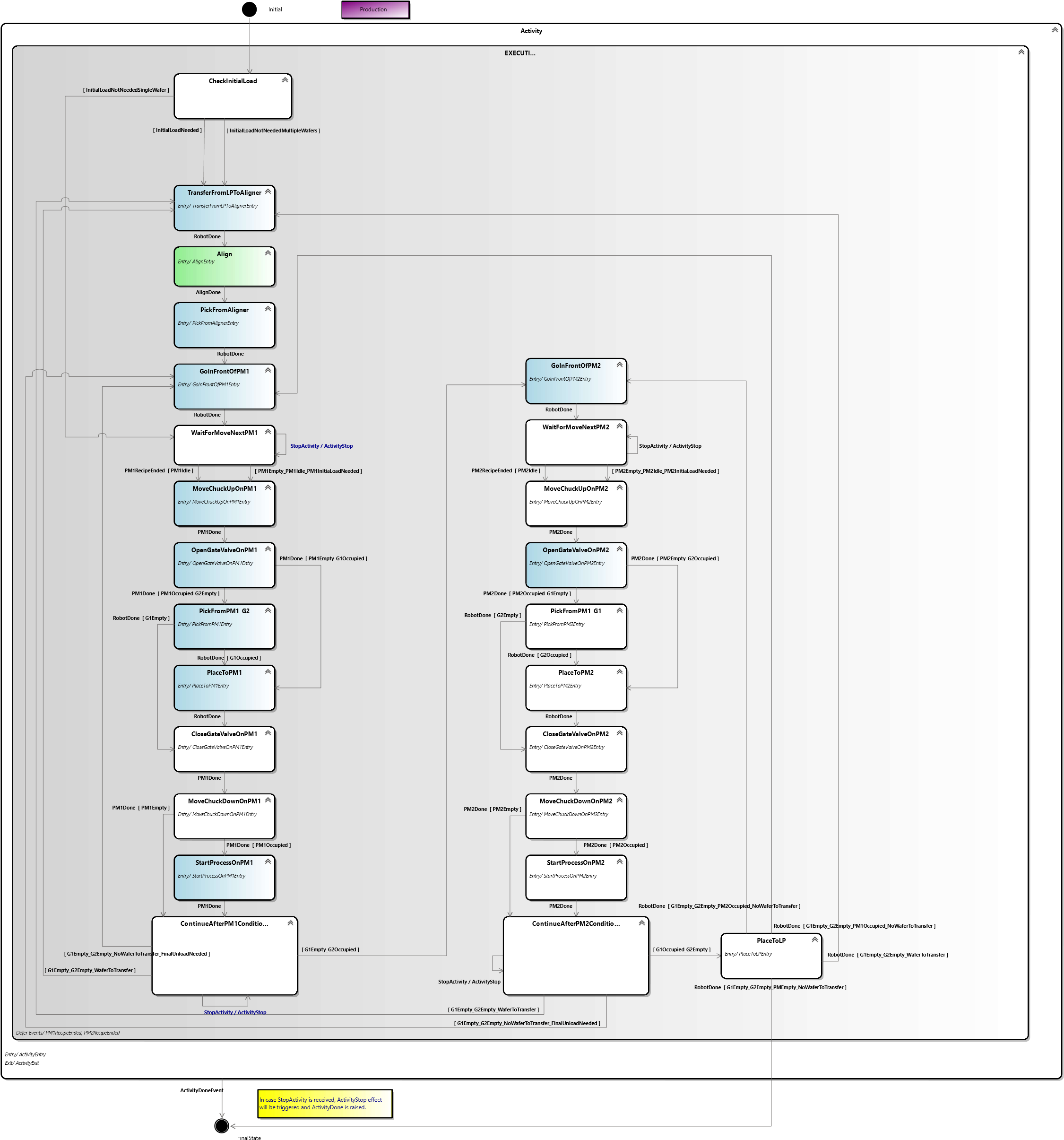
## Job execution on one process module state description

|  |  |
| --- | --- |
| State | Description |
| *Initial* | Initial state of the state machine |
| *Activity* | Macro state for the activity |
| *Executing* | Executing macro state |
| *CheckInitialLoad* | Check if an initial load is needed |
| *MoveSubstrateToPM* | Move substrate to PM macro state |
| *TransferFromLPToAligner* | Transfer the next wafer from load port to aligner |
| *Align* | Align the wafer with desired angle |
| *PickFromAligner* | Pick the wafer on the aligner |
| *GoInFrontOfPM* | Robot moves in front of the process module |
| *WaitForMoveNext* | Waiting that the PM is ready to be loaded/unloaded |
| *MoveChuckUp* | Move the process module’s chuck up |
| *OpenGateValve* | Open the process module’s gate valve |
| *PickFromPM\_G2* | Robot picks the wafer on the process module with lower arm |
| *PlaceToPM* | Robot places the wafer on its upper arm on the process module |
| *CloseGateValve* | Close the process module’s gate valve |
| *MoveChuckDown* | Move the process module’s chuck down |
| *StartProcess* | Start the selected recipe on the process module |
| *ContinueConditional* | Check what is the next move to do |
| *PlaceToLP* | Place the wafer in the load port on its original slot |
| *FinalState* | Final state of the state machine |

## Job execution on one process module transitions description

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Current State | Event | Conditions | New State |
| 1 | Initial |  |  | CheckInitialLoad |
| 2 | CheckInitialLoad |  | A first load is needed | TransferFromLPToAligner |
| 3 | CheckInitialLoad |  | A first load is not needed and there is still wafers to be transfered | TransferFromLPToAligner |
| 4 | TransferFromPLToAligner | Robot command is done |  | Align |
| 5 | Align | Aligner command is done |  | PickFromAligner |
| 6 | PickFromAligner | Robot command is done |  | GoInFrontOfPM |
| 7 | GoInFrontOfPM | Robot command is done |  | WaitForMoveNext |
| 8 | WaitForMoveNext | Process module’s recipe exécution ended |  | MoveChuckUp |
| 9 | WaitForMoveNext |  | Process module is empty and process module is idle and a first load is needed | MoveChuckUp |
| 10 | WaitForMoveNext | Activity has been stopped |  | WaitForMoveNext |
| 11 | MoveChuckUp | Process module command is done |  | OpenGateValve |
| 12 | OpenGateValve | Process module command is done | Process module is occupied and robot’s lower arm is empty | PickFromPM\_G2 |
| 13 | OpenGateValve | Process module command is done | Process module is empty and robot’s upper arm is occupied | PlaceToPM |
| 14 | PickFromPM\_G2 | Robot command is done | Robot’s upper arm is occupied | PlaceToPM |
| 15 | PickFromPM\_G2 | Robot command is done | Robot’s upper arm is empty | CloseGateValve |
| 16 | PlaceToPM | Robot command is done |  | CloseGateValve |
| 17 | CloseGateValve | Process module command is done |  | MoveChuckDown |
| 18 | MoveChuckDown | Process module command is done | Process module is occupied | StartProcess |
| 19 | MoveChuckDown | Process module command is done | Process module is empty | ContinueConditional |
| 20 | StartProcess | Process module command is done |  | ContinueConditional |
| 21 | ContinueConditional |  | Robot’s upper arm is empty and robot’s lower arm is occupied | PlaceToLP |
| 22 | ContinueConditional |  | Robot’s arms are empty and there are still wafers to transfer | TransferFromLPToAligner |
| 23 | ContinueConditional |  | Robot’s arm are empty and there is no wafer left to transfer and final unload is needed | GoInFrontOfPM |
| 24 | ContinueConditional | Activity has been stopped |  | ContinueConditional |
| 25 | PlaceToLP | Robot command is done | Robot’s arms are empty and there are still wafers to transfer | TransferFromLPToAligner |
| 26 | PlaceToLP | Robot command is done | Robot’s arms are empty and process module is occupied and there is no wafer left to transfer | GoInFrontOfPM |
| 27 | PlaceToLP | Robot command is done | Robot’s arms are empty and process module is empty and there is no wafer left to transfer | FinalState |
| 28 | Activity | Activity is done |  | FinalState |

# Job execution on two chained process modules



## Job execution on two chained process modules state description

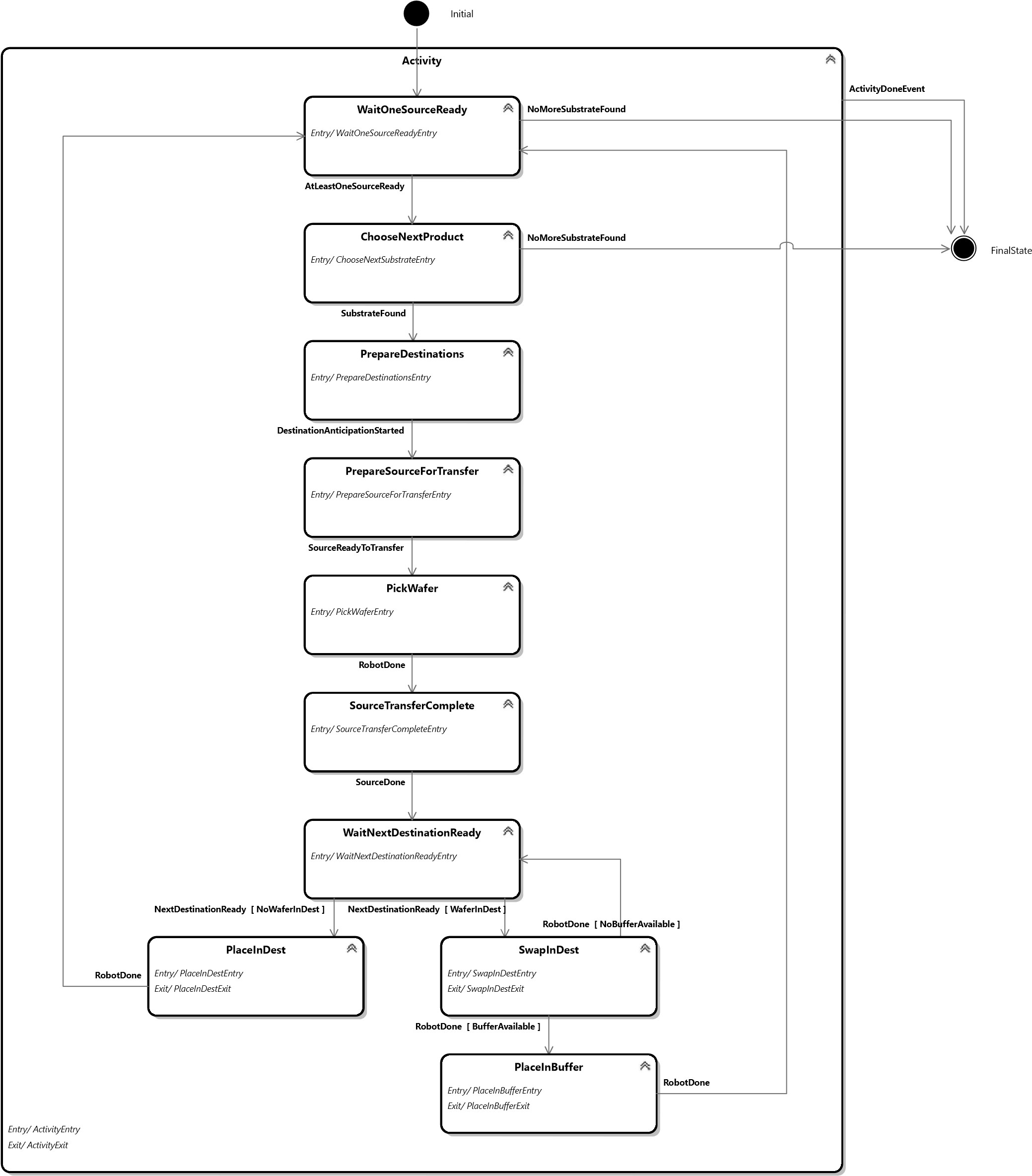
|  |  |
| --- | --- |
| State | Description |
| *Initial* | Initial state of the state machine |
| *Activity* | Macro state for the activity |
| *Executing* | Executing macro state |
| *CheckInitialLoad* | Check if an initial load is needed |
| *TransferFromLPToAligner* | Transfer the next wafer from load port to aligner |
| *Align* | Align the wafer with desired angle |
| *PickFromAligner* | Pick the wafer on the aligner |
| *GoInFrontOfPM1* | Robot moves in front of the first process module |
| *WaitForMoveNextPM1* | Waiting that the first process module is ready to be loaded/unloaded |
| *MoveChuckUpOnPM1* | Move the first process module’s chuck up |
| *OpenGateValveOnPM1* | Open the first process module’s gate valve |
| *PickFromPM1\_G2* | Robot picks the wafer on the first process module with lower arm |
| *PlaceToPM1* | Robot places the wafer on its upper arm on the first process module |
| *CloseGateValveOnPM1* | Close the first process module’s gate valve |
| *MoveChuckDownOnPM1* | Move the first process module’s chuck down |
| *StartProcessOnPM1* | Start the selected recipe on the first process module |
| *ContinueAfterPM1Conditional* | Check what is the next move to do after first process module |
| *GoInFrontOfPM2* | Robot moves in front of the second process module |
| *WaitForMoveNextPM2* | Waiting that the second process module is ready to be loaded/unloaded |
| *MoveChuckUpOnPM2* | Move the second process module’s chuck up |
| *OpenGateValveOnPM2* | Open the second process module’s gate valve |
| *PickFromPM2\_G1* | Robot picks the wafer on the second process module with upper arm |
| *PlaceToPM2* | Robot places the wafer on its lower arm on the second process module |
| *CloseGateValveOnPM2* | Close the second process module’s gate valve |
| *MoveChuckDownOnPM2* | Move the second process module’s chuck down |
| *StartProcessOnPM2* | Start the selected recipe on the second process module |
| *ContinuerAfterPM2Conditional* | Check what is the next move to do after second process module |
| *PlaceToLP* | Place the wafer in the load port on its original slot |
| *FinalState* | Final state of the state machine |

## Job execution on two chained process modules transitions description

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Current State | Event | Conditions | New State |
| 1 | Initial |  |  | CheckInitialLoad |
| 2 | CheckInitialLoad |  | A first load is needed | TransferFromLPToAligner |
| 3 | CheckInitialLoad |  | A first load is not needed and there is still wafers to be transfered | TransferFromLPToAligner |
| 4 | TransferFromPLToAligner | Robot command is done |  | Align |
| 5 | Align | Aligner command is done |  | PickFromAligner |
| 6 | PickFromAligner | Robot command is done |  | GoInFrontOfPM1 |
| 7 | GoInFrontOfPM1 | Robot command is done |  | WaitForMoveNextPM1 |
| 8 | WaitForMoveNextPM1 | First process module’s recipe exécution ended |  | MoveChuckUpOnPM1 |
| 9 | WaitForMoveNextPM1 |  | First process module is empty and first process module is idle and a first load is needed | MoveChuckUpOnPM1 |
| 10 | WaitForMoveNextOnPM1 | Activity has been stopped |  | WaitForMoveNextOnPM1 |
| 11 | MoveChuckUpOnPM1 | First process module command is done |  | OpenGateValveOnPM1 |
| 12 | OpenGateValveOnPM1 | First process module command is done | First process module is occupied and robot’s lower arm is empty | PickFromPM1\_G2 |
| 13 | OpenGateValveOnPM1 | First process module command is done | First process module is empty and robot’s upper arm is occupied | PlaceToPM1 |
| 14 | PickFromPM1\_G2 | Robot command is done | Robot’s upper arm is occupied | PlaceToPM1 |
| 15 | PickFromPM1\_G2 | Robot command is done | Robot’s upper arm is empty | CloseGateValveOnPM1 |
| 16 | PlaceToPM1 | Robot command is done |  | CloseGateValveOnPM1 |
| 17 | CloseGateValveOnPM1 | First process module command is done |  | MoveChuckDownOnPM1 |
| 18 | MoveChuckDownOnPM1 | First process module command is done | First process module is occupied | StartProcessOnPM1 |
| 19 | MoveChuckDownOnPM1 | First process module command is done | First process module is empty | ContinueAfterPM1Conditional |
| 20 | StartProcessOnPM1 | First process module command is done |  | ContinueAfterPM1Conditional |
| 21 | ContinueAfterPM1Conditional |  | Robot’s upper arm empty and robot’s lower arm occupied | GoInFrontOfPM2 |
| 22 | ContinueAfterPM1Conditional |  | Robot’s arms are empty and there are still wafers to transfer | TransferFromLPToAligner |
| 23 | ContinueAfterPM1Conditional |  | Robot’s arm are empty and there is no wafer left to transfer and final unload is needed | GoInFrontOfPM1 |
| 24 | ContinueAfterPM1Conditional | Activity has been stopped |  | ContinueAfterPM1Conditional |
| 25 | GoInFrontOfPM2 | Robot command is done |  | WaitForMoveNextPM2 |
| 26 | WaitForMoveNextPM2 | Second process module’s recipe exécution ended |  | MoveChuckUpOnPM2 |
| 27 | WaitForMoveNextOnPM2 |  | Second process module is empty and second process module is idle and a first load is needed | MoveChuckUpOnPM2 |
| 28 | WaitForMoveNextOnPM2 | Activity has been stopped |  | WaitForMoveNextOnPM2 |
| 29 | MoveChuckUpOnPM2 | Second process module command is done |  | OpenGateValveOnPM2 |
| 30 | OpenGateValveOnPM2 | Second process module command is done | Second process module is occupied and robot’s upper arm is empty | PickFromPM2\_G1 |
| 31 | OpenGateValveOnPM2 | Second process module command is done | Second process module is empty and robot’s lower arm is occupied | PlaceToPM2 |
| 32 | PickFromPM2\_G1 | Robot command is done | Robot’s lower arm is occupied | PlaceToPM2 |
| 33 | PickFromPM2\_G1 | Robot command is done | Robot’s lower arm is empty | CloseGateValveOnPM2 |
| 34 | PlaceToPM2 | Robot command is done |  | CloseGateValveOnPM2 |
| 35 | CloseGateValveOnPM2 | Second process module command is done |  | MoveChuckDownOnPM2 |
| 36 | MoveChuckDownOnPM2 | Second process module command is done | Second process module is occupied | StartProcessOnPM2 |
| 37 | MoveChuckDownOnPM2 | Second process module command is done | Second process module is empty | ContinueAfterPM2Conditional |
| 38 | StartProcessOnPM2 | Second process module command is done |  | ContinueAfterPM2Conditional |
| 39 | ContinueAfterPM2Conditional |  | Robot’s upper arm occupied and robot’s lower arm empty | PlaceToLP |
| 40 | ContinueAfterPM2Conditional |  | Robot’s arms are empty and there are still wafers to transfer | TransferFromLPToAligner |
| 41 | ContinueAfterPM2Conditional |  | Robot’s arm are empty and there is no wafer left to transfer and final unload is needed | GoInFrontOfPM1 |
| 42 | ContinueAfterPM2Conditional | Activity has been stopped |  | ContinueAfterPM2Conditional |
| 43 | PlaceToLP | Robot command is done | Robot’s arms are empty and there are still wafers to transfer | TransferFromLPToAligner |
| 44 | PlaceToLP | Robot command is done | Robot’s arms are empty and first process module is occupied and there is no wafer left to transfer | GoInFrontOfPM1 |
| 45 | PlaceToLP | Robot command is done | Robot’s arms are empty and second process module is occupied and there is no wafer left to transfer | GoInFrontOfPM2 |
| 46 | PlaceToLP | Robot command is done | Robot’s arms are empty and there is no wafer left to transfer | FinalState |
| 47 | Activity | Activity is done |  | FinalState |

# Generic job execution

## General state machine



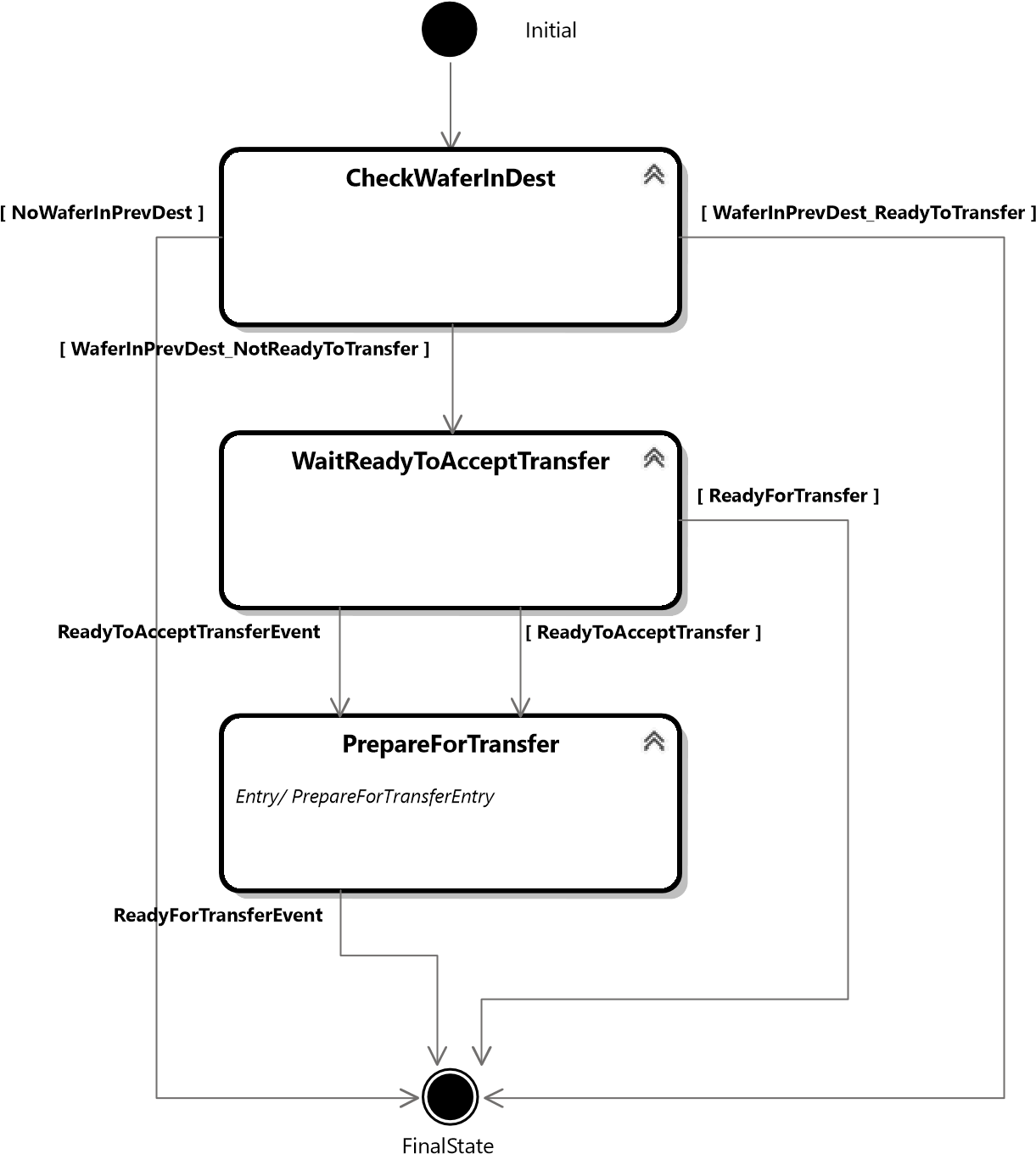
### General state machine state description

|  |  |
| --- | --- |
| State | Description |
| *Initial* | Initial state of the state machine |
| *Activity* | Macro state for the activity |
| *WaitOneSourceReady* | Wait that at least one source is ready to accept transfer |
| *ChooseNextProduct* | Choose the next product to transfer with the desired algorithm |
| *PrepareDestinations* | Generates prepare destination state machines for each potential destinations |
| *PrepareSourceForTransfer* | Prepare the source for the transfer |
| *PickWafer* | Pick the wafer in the source |
| *SourceTransferComplete* | Signal to the source that the transfer is complete |
| *WaitNextDestinationReady* | Wait that the next potential destination is ready for transfer |
| *PlaceInDest* | Place the wafer in the destination |
| *SwapInDest* | Swap wafers in the destination |
| *PlaceInBuffer* | Place the wafer in the buffer |
| *FinalState* | Final state of the state machine |

### General state machine transition description

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Current State | Event | Conditions | New State |
| 1 | Initial |  |  | WaitOneSourceReady |
| 2 | WaitOneSourceReady | At least one source is ready to accept transfer |  | ChooseNextProduct |
| 3 | WaitOneSourceReady | No more substrate to be transferred |  | FinalState |
| 4 | ChooseNextProduct | Substrate has been found in the algorithm |  | PrepareDestinations |
| 5 | ChooseNextProduct | No more substrate to be transferred |  | FinalState |
| 6 | PrepareDestinations | Prepare destination state machines have been started |  | PrepareSourceForTransfer |
| 7 | PrepareSourceForTransfer | Source is ready to transfer |  | PickWafer |
| 8 | PickWafer | Robot command is done |  | SourceTransferComplete |
| 9 | SourceTransferComplete | Source command is done |  | WaitNextDestinationReady |
| 10 | WaitNextDestinationReady | Next destination is ready for transfer | There is no wafer in the destination | PlaceInDest |
| 11 | WaitNextDestinationReady | Next destination is ready for transfer | There is a wafer in the destination | SwapInDest |
| 12 | PlaceInDest | Robot command is done |  | WaitOneSourceReady |
| 13 | SwapInDest | Robot command is done | No buffer available | WaitNextDestinationReady |
| 14 | SwapInDest | Robot command is done | Buffer is available | PlaceInBuffer |
| 15 | PlaceInBuffer | Robot command is done |  | WaitOneSourceReady |
| 16 | Activity | Activity is done |  | FinalState |

## Prepare destination state machine



### Prepare destination state machine state description

|  |  |
| --- | --- |
| State | Description |
| *Initial* | Initial state of the state machine |
| *CheckWaferInDest* | Check if there is a wafer in the previous destination |
| *WaitReadyToAcceptTransfer* | Wait that the destination is ready to accept transfer |
| *PrepareForTransfer* | Prepare the destination for transfer |
| *FinalState* | Final state of the state machine |

### Prepare destination state machine transition description

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Current State | Event | Conditions | New State |
| 1 | Initial |  |  | CheckWaferInDest |
| 2 | CheckWaferInDest |  | There is a wafer in the previous destination and the destination is not ready to transfer | WaitReadyToAcceptTransfer |
| 3 | CheckWaferInDest |  | There is no wafer in the previous destination | FinalState |
| 4 | CheckWaferInDest |  | There is a wafer in the previous destination and the destination is already ready to transfer | FinalState |
| 5 | WaitReadyToAcceptTransfer | Destination is ready to accept transfer |  | PrepareForTransfer |
| 6 | WaitReadyToAcceptTransfer |  | Destination is ready to accept transfer | PrepareForTransfer |
| 7 | WaitReadyToAcceptTransfer |  | Destination is ready for transfer | FinalState |
| 8 | PrepareForTransfer | Destination is ready for transfer |  | FinalState |