Agito Gear & ECAM

Application Note

www.agito-akribis.com
Member of Akribis Systems group

Revision History

Version	Description	Date
1.0	Initial Release	03 February 2026

Contact Information

Manufacturer	Agito Akribis Systems Ltd., Member of Akribis Systems Group
Address	56 Serangoon North Avenue 4 Singapore 555851
Telephone	+65 6484 3357
Website	www.agito-akribis.com

Copyright Notice

Products Rights

AGDx, AGCx, AGMx, AGAx, AGIx, and AGLx are products designed by Agito Akribis Systems Ltd. in Israel. Sales of the products are licensed to Akribis Systems Pte Ltd. under intercompany license agreement.

Agito Akribis Systems Ltd. has full rights to distribute above products worldwide.

Disclaimer

This product documentation was accurate and reliable at the time of its release.

Agito Akribis Systems Ltd. reserves the right to change the specifications of the product described in this manual without notice at any time.

Trademarks

Agito PCSuite is a trademark of Agito Akribis Systems Ltd..

Warranty

This product is warranted to be free of defects in material and workmanship and conforms to the specifications listed in this manual, for a period of 12 months from the shipment date from factory.

Contents

1 Introduction

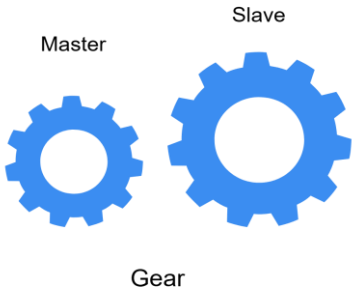
1.1 About This Manual

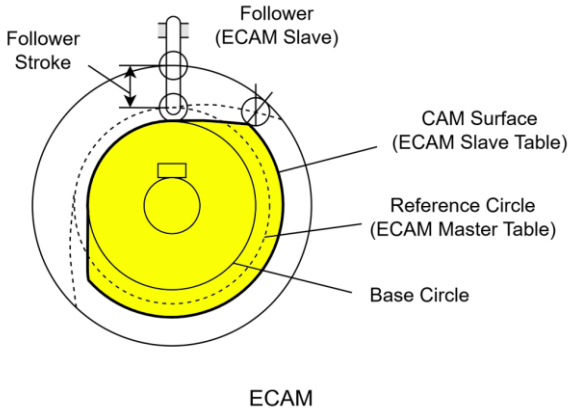
Thank you for choosing Agito series motion control products. We strive to provide high-speed and high-precision motion control solutions with comprehensive technical support.

This manual focuses on the usage of Gear and ECAM (Electronic CAM) functions for Agito motion controllers. Only Gear and ECAM related configurations are detailed here; for other parameter settings, please refer to the Agito Quick Start Manual and other relevant documentation.

1.2 Gear and ECAM Overview

Both Gear and Electronic CAM (ECAM) are master–slave motion control modes. In Gear mode, the slave axis follows the master axis in real time with a fixed proportional ratio. In contrast, ECAM mode enables the slave axis to follow the master axis according to a predefined spline curve or lookup table, allowing for nonlinear and time-varying motion relationships.





- In both Gear and ECAM modes, only the slave axis needs to be configured. The user only needs to enable the slave axis in Gear or ECAM motion mode (MotionMode).

MotionMode	Resulting Motion
5	Gear direct motion
6	Gear indirect motion
7	ECAM direct motion
8	ECAM indirect motion

- The master axis does not require any parameter configuration. However, because Gear and ECAM operate in a master–slave following mode (with Gear being a direct following mode), the slave axis motion profile is derived from the master axis motion commands (such as velocity and acceleration) multiplied by the gear ratio. Therefore, before enabling the following mode, it must be ensured that the slave axis can execute the resulting motion profile after scaling by the gear ratio. Otherwise, abnormal conditions such as alarms or unintended motion stops may occur.

- When using Gear together with ModRev, negative gear ratios (MasterFact) should be avoided. If the user requires the slave axis to move in the opposite direction to the master axis, this can be achieved by reversing both the encoder direction and the current direction of the slave axis (in the Direction page of AutoPhasing). After inversion, the encoder direction will be reversed, which is functionally equivalent to using a negative gear ratio.
- Gear and ECAM parameters cannot be modified while the axis is in the InMotion state. To change any gearing or ECAM parameters, the current motion must first be stopped by issuing a Stop or Abort command.

2 Gear Operation Guide

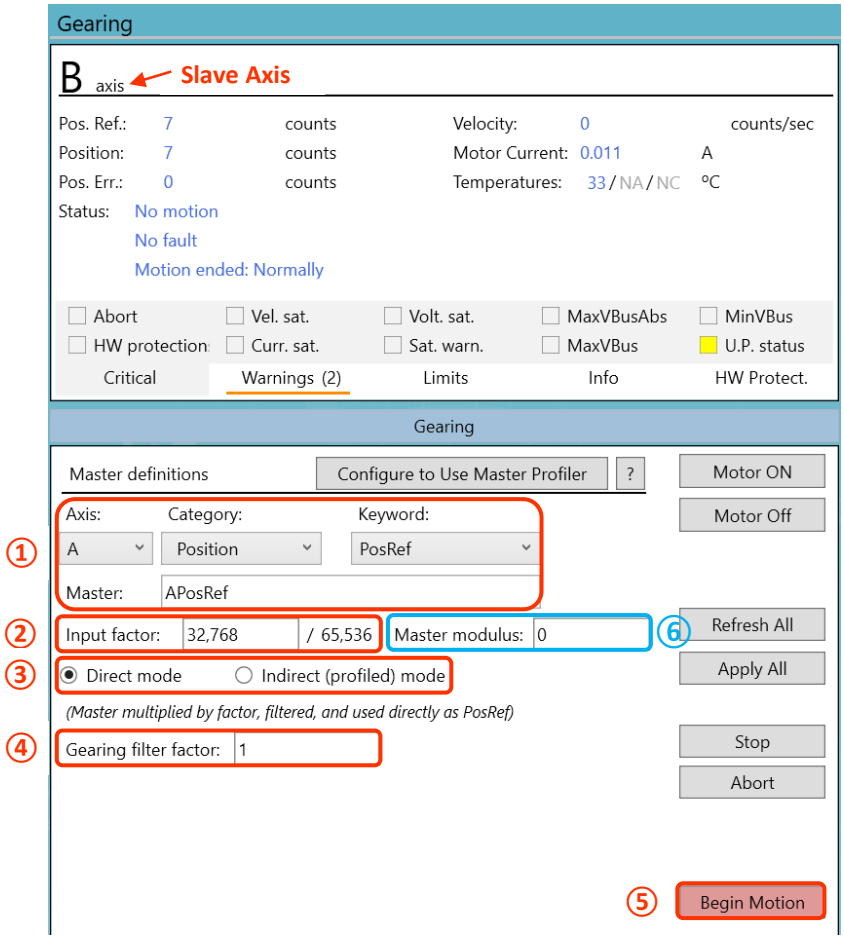
The Agito controller supports user-defined variable following, including but not limited to position. In typical Gear applications, the master axis position reference (PosRef) is used as the following source. The example below illustrates a 2:1 gear-ratio following motion, with Axis A configured as the master axis and Axis B configured as the slave axis.

2.1 Gear in PCSuite

1. Switch to the Gear configuration page of the slave axis.

2. Set salve relevant parameters and enable Gear mode.

After clicking *Begin Motion*, the slave axis enters the "In Motion" state, even if no physical movement occurs.



① **Master [GearMaster]**: The master variable is used in gear motion to define the following command source. It is typically set to the master position command, i.e., PosRef (in this example, the master axis is Axis A, so APosRef is selected). If the application has special requirements, other command sources may also be selected as the follow reference.

② **Input Factor [MasterFact]**: Defines the gear ratio. It's the numerator used in the scaling ratio applied onto the delta of master variable. Once the gear motion is started, the final change in profiler position reference (if MotionMode = 5) or target position (AbsTrgt if MotionMode = 6) is as shown.

$$\Delta ProfilerPosRef/AbsTrgt = \frac{MasterFact}{65536} \times \Delta MasterVariable$$

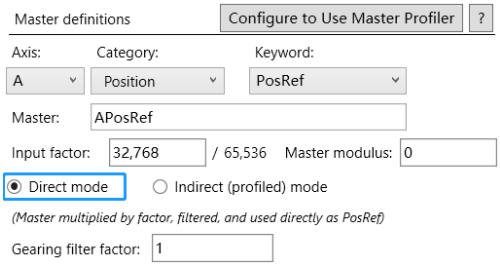
③ **Direct / Indirect Mode [MotionMode]**: Select direct gear coupling or custom trajectory coupling.

- **Direct Mode (MotionMode = 5):** The slave axis follows according to the trajectory planning of the master axis. In cases without special application requirements, direct coupling is typically used.

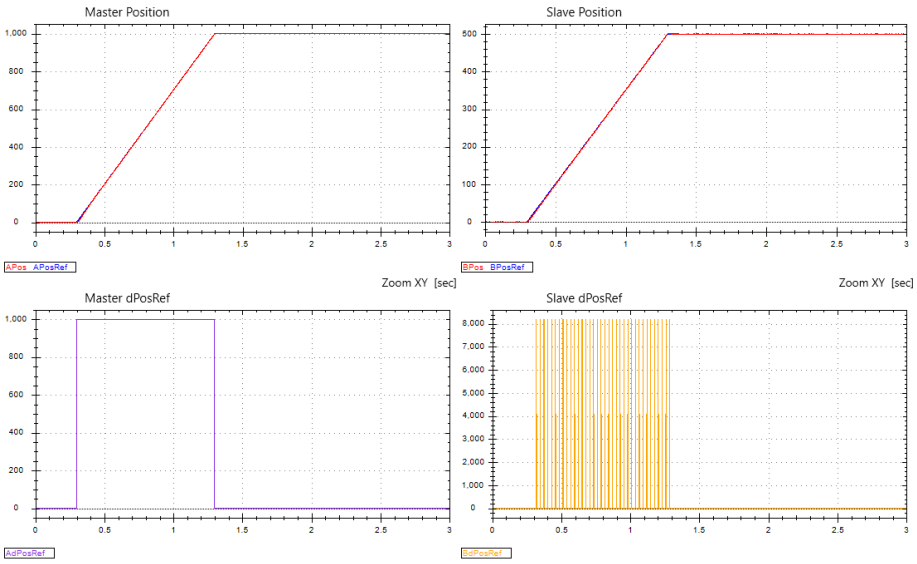
Note

Since the underlying motion profile calculations are executed sequentially—first A, then B, and finally C—when strict following performance is required, Axis A should be configured as the master axis, with Axis B as the slave axis. If Axis B is configured as the master and Axis A as the slave, a 61 µs delay will occur between them.

Direct Mode Parameter Setting:



Gear Motion Graph in Direct Mode:

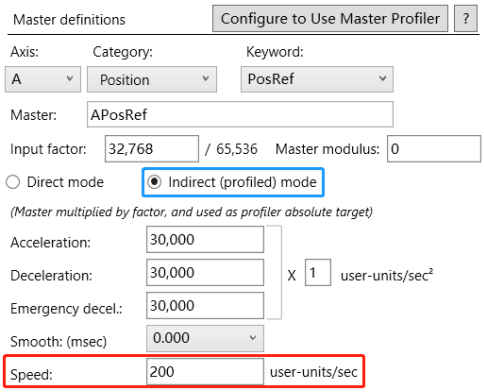


- **Indirect Mode (MotionMode = 6):** The slave axis uses the product of the master axis's absolute travel distance and the gear ratio as its own absolute travel distance and moves according to user-defined parameters such as velocity and acceleration/deceleration.

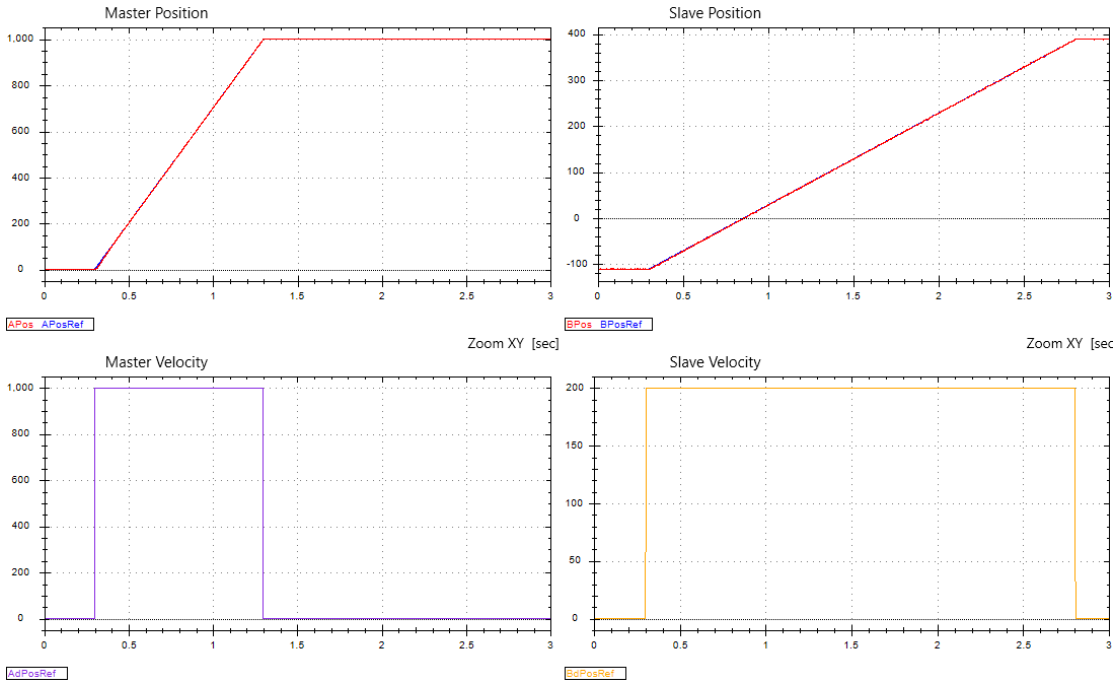
Note

In indirect mode, the profile velocity of the slave axis must not exceed the master axis velocity. Otherwise, the slave axis velocity will be limited and executed as master axis velocity × gear ratio.

Indirect Mode Parameter Setting:



Gear Motion Graph in Indirect Mode:



④ **Gearing Filter Factor**($\frac{[MasterFilt]}{64}$)**:** Only used in the direct gear motion (MotionMode = 5). Filtering is typically used to prevent large jumps in position commands, especially when the MasterFact value is large. The valid range is 0.0156 to 1. In most cases, it is set to 1 (no filtering, strict following), which used to filter large step changes in the master position:

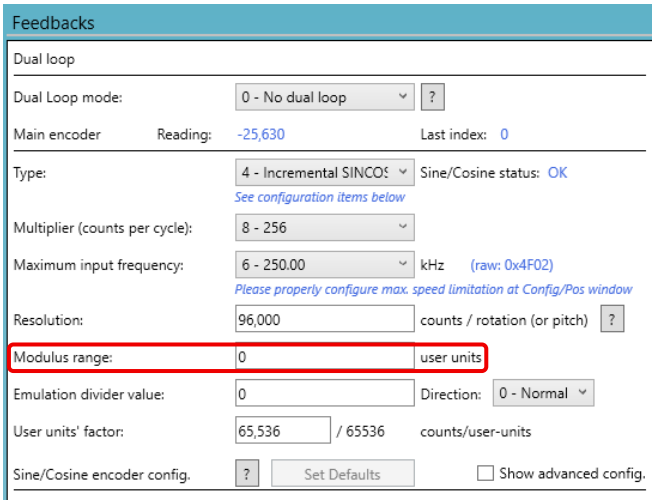
$$PosRef(k) = \frac{MasterFilt}{64} \times MasterPos(k) + (1 - \frac{MasterFilt}{64}) \times PosRef(k-1)$$

⑤ **Begin Motion:** Activates Gear following and its motion state will remain “InMotion” state until Stop or Abort is issued.

⑥ **Master Modulus [MasterModRev]:** User must set MasterModRev to match the ModRev related to the master variable (manual assignment). Conversely, if the master variable does not involve in modulo operation, MasterModRev must be 0. Please refer to details in Chapter 2.2.

2.2 Gear Motion with ModRev Enabled

In some applications, a rotary motor is required to rotate continuously in one direction without limit. In such cases, the ModRev function is used. This function is configured on the Feedbacks page, and both the master and slave axes must be configured. Typically, the ModRev value corresponds to one resolution of the rotary motor.



However, if the user also wants to use gear mode while operating in infinite rotation mode, the MasterModRev parameter must be configured according to the following rules.

Assume Axis A is the master axis and Axis B is the slave axis, with AModRev = a, BModRev = b, and a gear ratio of 1:5.

The MasterModRev settings should be:

- AMasterModRev = 0
- BMasterModRev = a × 5

And so on, following the same rule for additional axes.

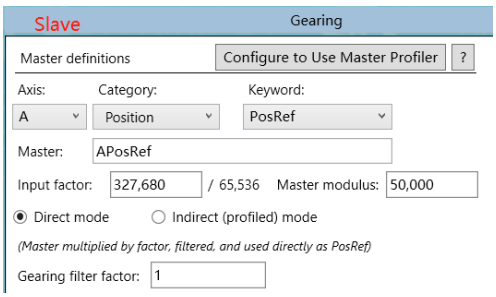
Note

If ModRev is not used, set all MasterModRev values to 0.

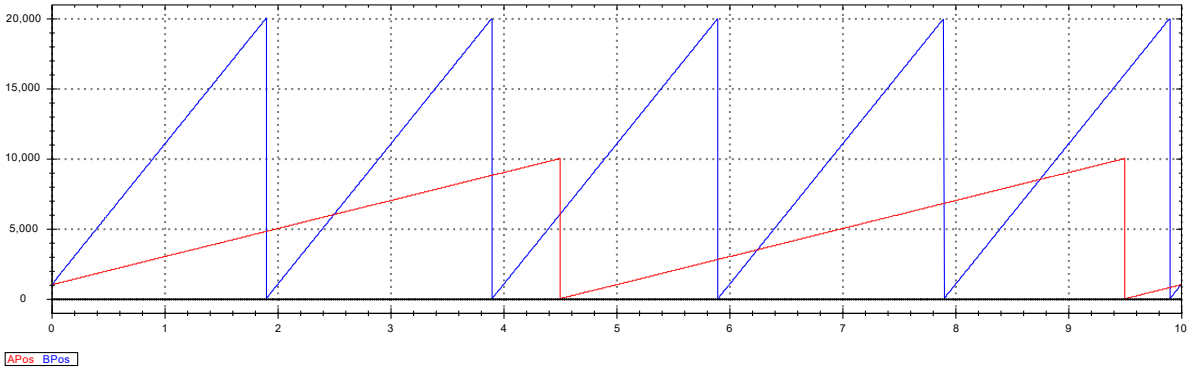
For example, AModRev = 10000, BModRev = 20000, Gear ratio = 1:5.

The Input Factor of the B axis [BMasterFact] should be set to: 65536 × 5 = 327680.

The Master Modulus of the B axis [BMasterModRev] should be set to: AModRev × 5 = 50000.



Motion Graph:



2.3 Gear Motion IDE+ Example

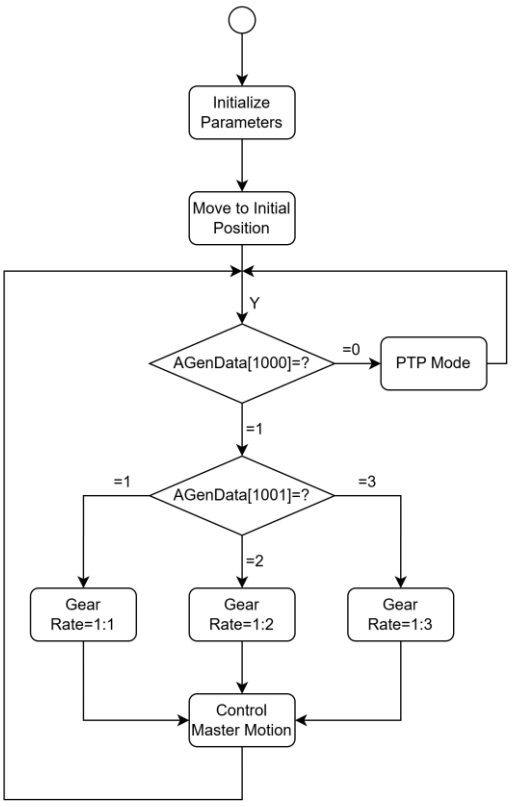
Gear ratio switching can be implemented programmatically in the IDE+.

- Define a variable in the .puh2 file to store the current gear ratio.

```
14  #definevar GearTemp
```

- Update MasterFact dynamically during execution.

Program logic and example diagrams are provided below:



IDE+ Example:

```
// Initialize Parameters
AGenData[1000]=0
AGenData[1001]=1
AGenData[1002]=0
GearTemp=0

// Move to Initial Position
AMotionMode=1
BMotionMode=1
ARelTrgt=0
AAbsTrgt=1000
ASpeed=5000
AAccel=50000
ADecel=50000
BRelTrgt=0
BAbsTrgt=2000
BSpeed=5000
BAccel=50000
BDecel=50000
AMotorOn=1
BMotorOn=1
ABegin
BBegin

// Check whether A axis & B axis have reached the target position
while ((AInTargetStat!=4) || (BInTargetStat!=4))
end

while ((AConFlt==0) && (BConFlt==0))
    if (AGenData[1000]==0)
        if (BMotionMode==5)
            BStop
            while (BMotionStat!=0)
            end
            GearTemp=0
            BMotionMode=1
        end
    else if (AGenData[1000]==1)
        if (GearTemp!=AGenData[1001])
            switch (AGenData[1001])
                case 1
                    BStop
                    while (BMotionStat!=0)
                    end
                    BMotionMode=5
                    BMasterFact=65536
                    GearTemp=AGenData[1001]
                    BBegin
                    break
```

```
72                      case 2
73                          BStop
74                          while (BMotionStat!=0)
75                          end
76                          BMotionMode=5
77                          BMasterFact=131072
78                          GearTemp=AGenData[1001]
79                          BBegin
80                          break
81                      case 3
82                          BStop
83                          while (BMotionStat!=0)
84                          end
85                          BMotionMode=5
86                          BMasterFact=196608
87                          GearTemp=AGenData[1001]
88                          BBegin
89                          break
90                      end
91                  end
92              end
93      end
94  ////////////////////////////////////////////////////////
```

2.4 Gear Motion Keywords

A full explanation of each parameter can be found in the communication and keywords documentation. The recording parameters and functions are listed below for convenience with a short explanation of each:

Keyword	Description
GearMaster	Defines the master variable used in gear motion.
MasterFact	Defines the gear ratio applied onto the delta of master variable.
MasterFilt	Defines the digital filter coefficient of first order low pass filter, applied onto the scaled delta of MasterPos since the start of motion.
MasterModRev	The modulo divisor is used to ensure the correct accumulation of MasterPos. If the master variable is not involved in modulo operation, MasterModRev must be 0.
MasterPos	Tracks the change of master variable after scaling.

3 ECAM Operation Guide

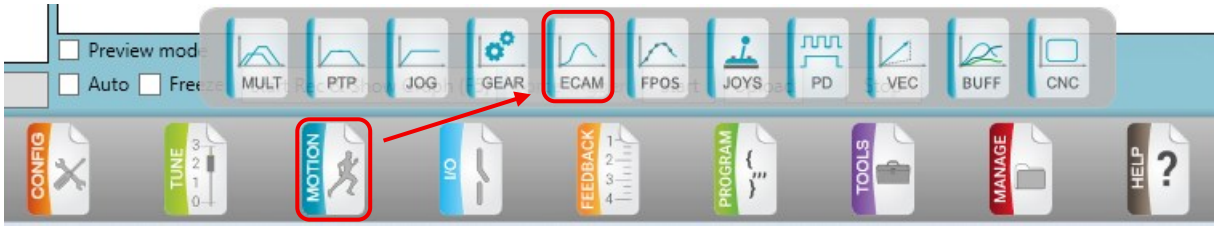
The primary difference between ECAM and gears is that ECAM are typically used for time-varying position following, where the motion position changes in real time based on the master axis position and a user-defined following profile.

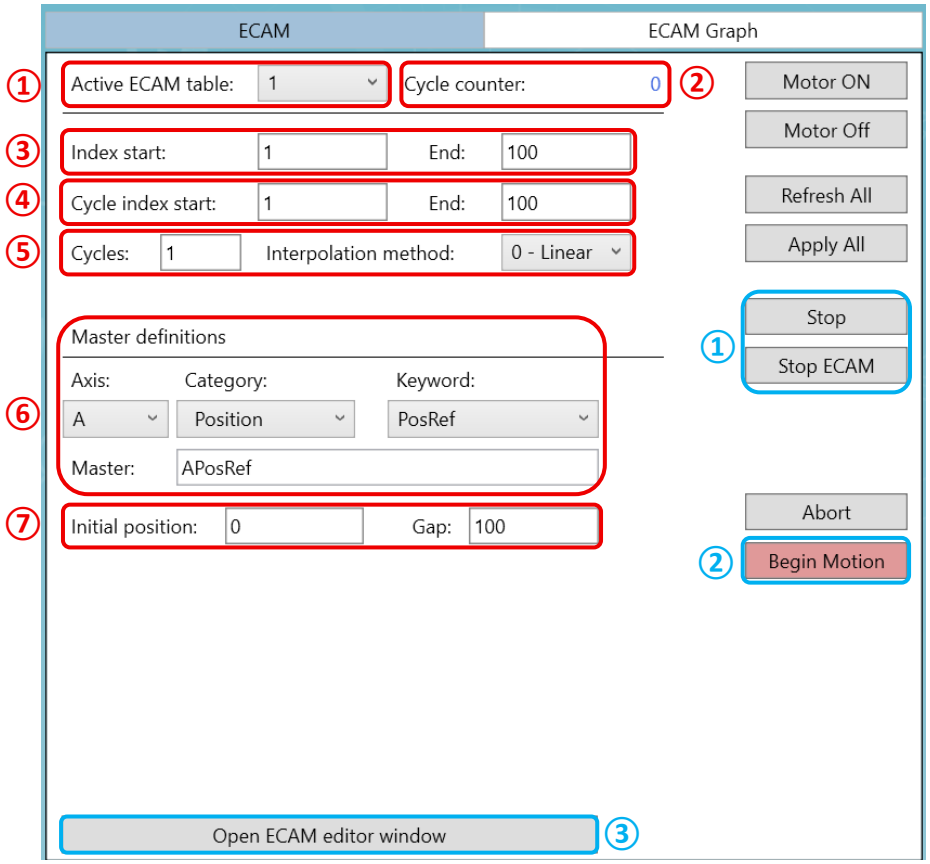
The Agito Electronic Cam (ECAM) mode supports single-cycle, multi-cycle, and infinite-cycle operation. It allows the system to enter the ECAM loop with either blended trajectories or specific trajectories, and to exit the loop with controlled acceleration or deceleration.

3.1 ECAM in PCSuite

3.1.1 ECAM Interface

Switch to ECAM page of slave axis.





Buttons:

① **Stop [Stop]:** Stop current axis motion.

Stop ECAM [StopECAM]: Stop ECAM following.

② **Begin Motion [Motionmode=7 -> MotorOn=1 -> Begin]:** Begin ECAM following.

③ **Open ECAM editor window.** Please refer to details in Chapter *3.1.2*.

Parameters:

① **Active ECAM Table [ECAMTableNum]:** Selects the ECAM table number x used for the current ECAM motion. Currently, max supported ECAM table number is 10. The controller can hold multiple ECAM tables. One of these tables is the active table at any time.

② **Cycle Counter [ECAMCycCount[x]]:** Used to record the current number of completed cycles for the specified ECAM table.

③ **Index Start [ECAMStart[x]]:** Defines the index of the first element in the ECAM table.

Index End [ECAMEnd[x]]: Defines the index of the last element in the ECAM table (GenData[] index).

ECAM table elements are stored in the GenData[] array.

Example:

If the elements of ECAM Table 1 are stored in GenData[1] to GenData[101], then:

ECAMStart[1] = 1

ECAMEnd[1] = 101

④ **Cycle Index Start [ECAMStartCyc[x]]:** Defines the starting index of the cyclic (repeating) portion of the ECAM table, i.e., the first index of the repeated loop.

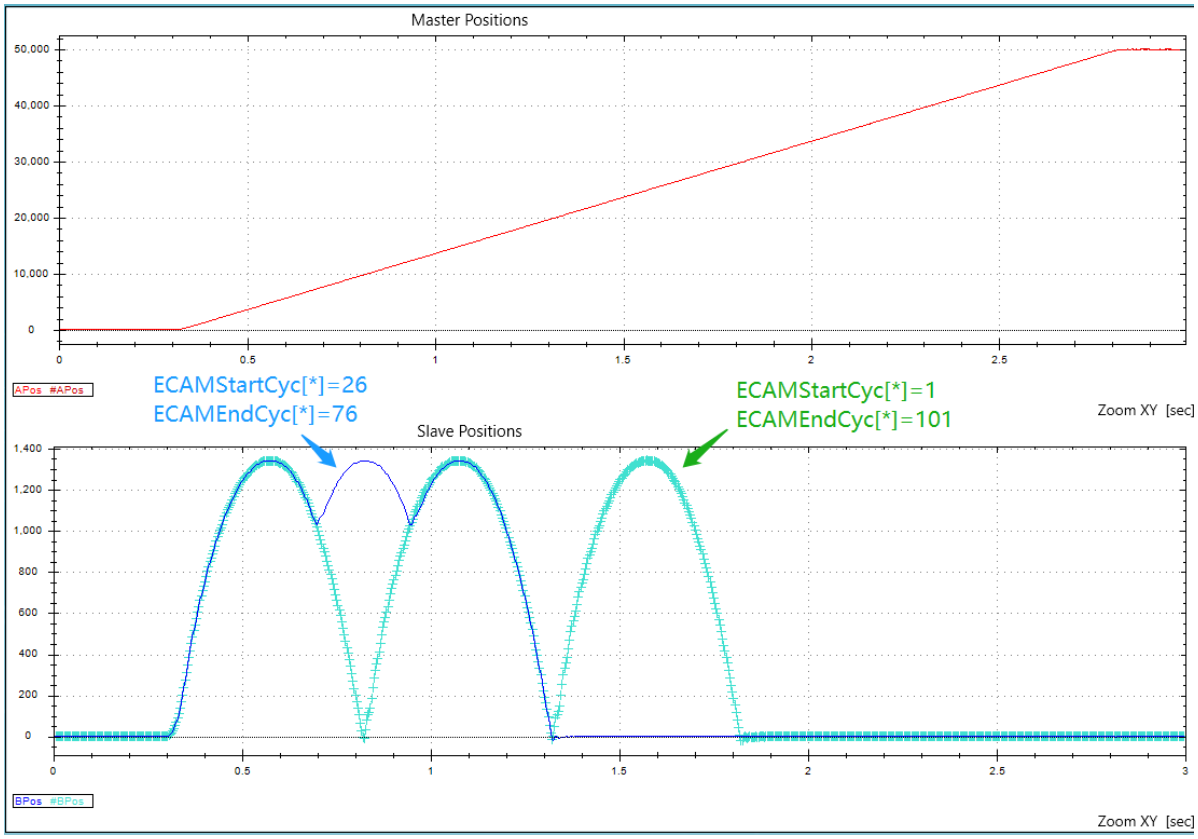
Cycle Index End [ECAMEndCyc[x]]: Defines the ending index of the cyclic (repeating) portion of the ECAM table.

Example:

If ECAM Table 1 contains elements from GenData[1] to GenData[101], and the elements from GenData[26] to GenData[76] are to be repeated cyclically, then:

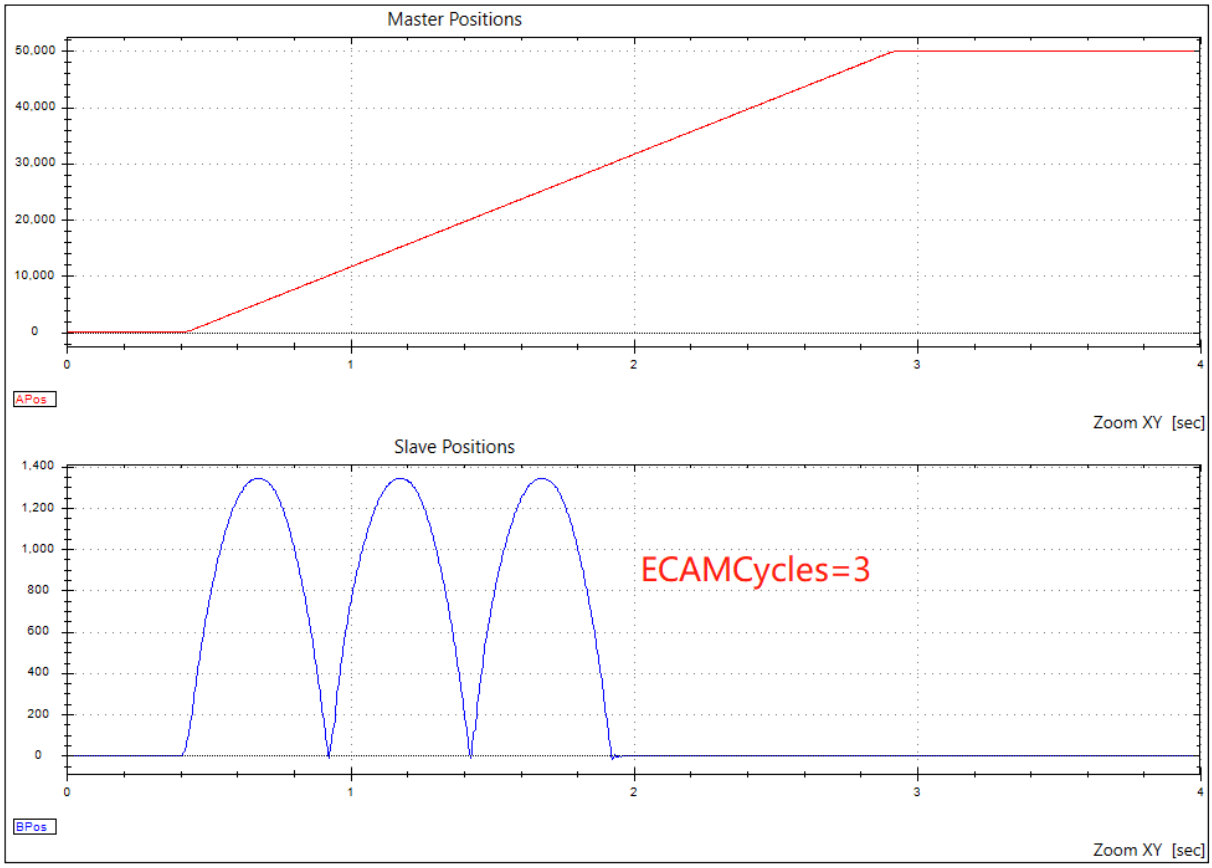
ECAMStartCyc[1] = 26

ECAMEndCyc[1] = 76



⑤ **Cycles [ECAMCycles[x]]:** Defines the number of times the ECAM motion cycle is repeated for ECAM Table x.

Example:
If ECAMCycles[1] = 3, then the portion of the ECAM table 1 between ECAMStartCyc[1] and ECAMEndCyc[1] will be repeated three times during execution.



When ECAMCycles[x] is set to a positive value, ECAM motion is only effective in the positive direction. ECAM execution in the negative direction, symmetric about the cycle start point, will not take effect.

ECAMCycles[x] may also be set to a negative value, indicating that the motion is symmetric about the cycle start point and that the ECAM profile will be repeated the same number of times in both the negative and positive directions. The portions of the ECAM table outside the cyclic range are typically used for acceleration into or deceleration out of the ECAM cycle. When ECAMCycles[x] is negative, after reaching the maximum negative position, the axis will move to a new logical position before continuing execution.

Infinite ECAM:

If ECAMCycles[1] is set to 2147483647, the controller will execute ECAM motion infinitely, until the motion is stopped by an external event, such as:

1) Receiving a Stop or StopECAM command
2) Triggering a limit switch
3) Motor disable
4) Occurrence of a fault

Setting ECAMCycles[1] = -2147483648 also enables infinite ECAM motion, but with bidirectional symmetric behavior.

Interpolation Method [ECAMInterp[x]]: Define the ECAM interpolation method. This parameter is reserved for future development and can currently only be set to 0-linear.

⑥ **Master [ECAMMaster[x]]:** Used to define the CAN code of the ECAM master variable.

Any keyword (including array elements) can be used as the master reference, but the master axis PosRef is typically used. If Axis A is the master axis, then: ECAMMaster[1] = 24

⑦ **Initial Position [ECAMMasterIni[x]]:** Used to compensate the master axis position by subtracting ECAMMasterIni[x] from the starting master position.

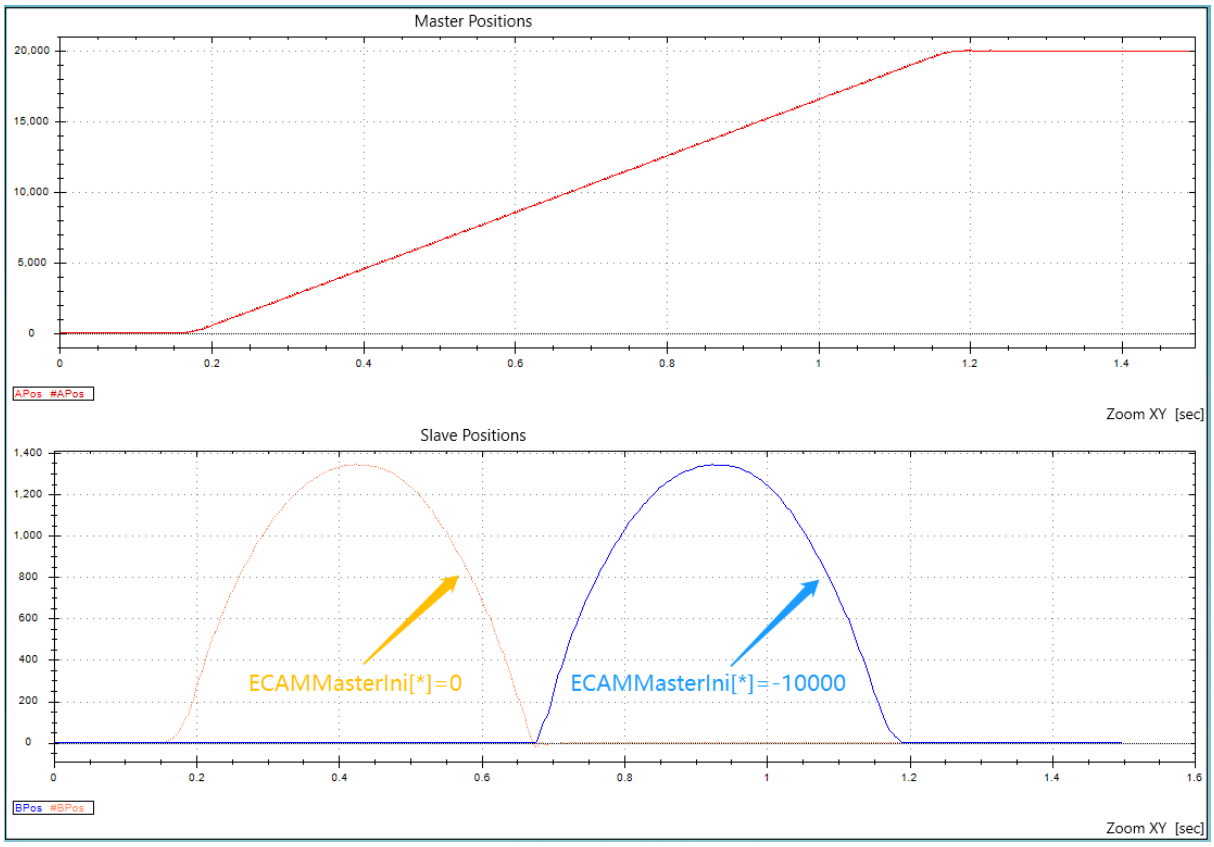
Examples:

If ECAMMasterIni[1] = 0 and the master axis position is 0 when the start command is received, all master positions are referenced to 0, and ECAM motion starts immediately toward the position specified by ECAMStart[1].

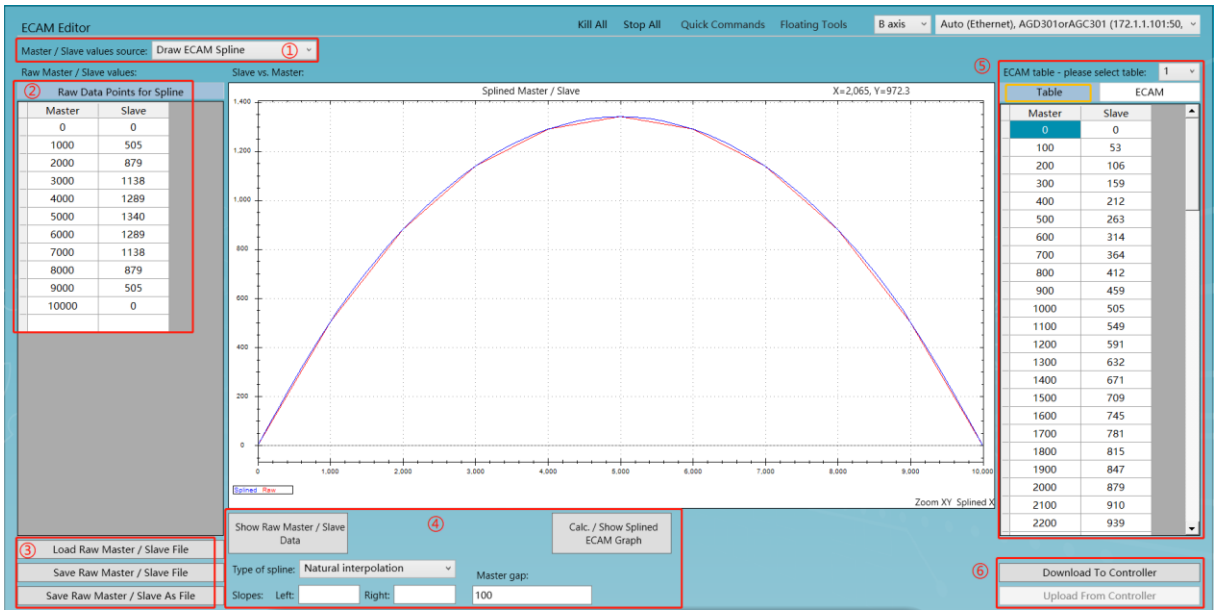
If ECAMMasterIni[1] = -10000 and the master axis position is 0 when the start command is received, all master positions are referenced to +10000, and ECAM motion starts immediately toward the position specified by ECAMStart[1].

Gap [ECAMGap[x]]: Defines the spacing between consecutive master-axis points in the ECAM table.

A negative ECAMGap value can be used to reverse the direction of the master-axis reading.



3.1.2 ECAM Editor



① **Master / Slave Value Source**: Defines the data source for master-slave following values. The source can be selected as either: Draw ECAM Spline (graphically defined trajectory), or ECAM Table Handling (lookup from an ECAM table).

② **Raw Data Points for Spline**: Used to edit the raw data points. Master is relative displacement of the master axis and slave is relative displacement of the slave axis. All displacements are defined relative to the master and slave positions at the moment ECAM is enabled.

③ **Load Raw Master / Slave File:** Imports an ECAM table stored locally in *.msf format.

Save Raw Master / Slave File: Saves the ECAM table to the controller.

Save Raw Master / Slave As File: Saves the ECAM table to a local file in *.msf format.

④ **Show Raw Master / Slave Data:** Displays the raw ECAM data points in the graph.

Calc. / Show Splined ECAM Graph: Calculates the spline curve based on the configured Master Gap, fits the curve, and displays it in the graph.

Type of Spline: Select “Natural Interpolation”.

Master Gap: Defines the point spacing of the spline curve. In theory, smaller spacing results in higher trajectory accuracy.

Note

The total number of ECAM table elements is limited by the GenData array size, which varies by controller model (e.g., AGD301 supports up to 5000 elements).

User-defined variables in the IDE user program are also allocated from GenData[], so ECAM table size must be planned carefully.

⑤ **ECAM Table**: Selects the ECAM table to be used. The table displays the calculated spline data points generated in step ④.

⑥**Download to Controller:** Downloads the ECAM table to the controller. After modifying the ECAM table, this button must be clicked for the changes to take effect.

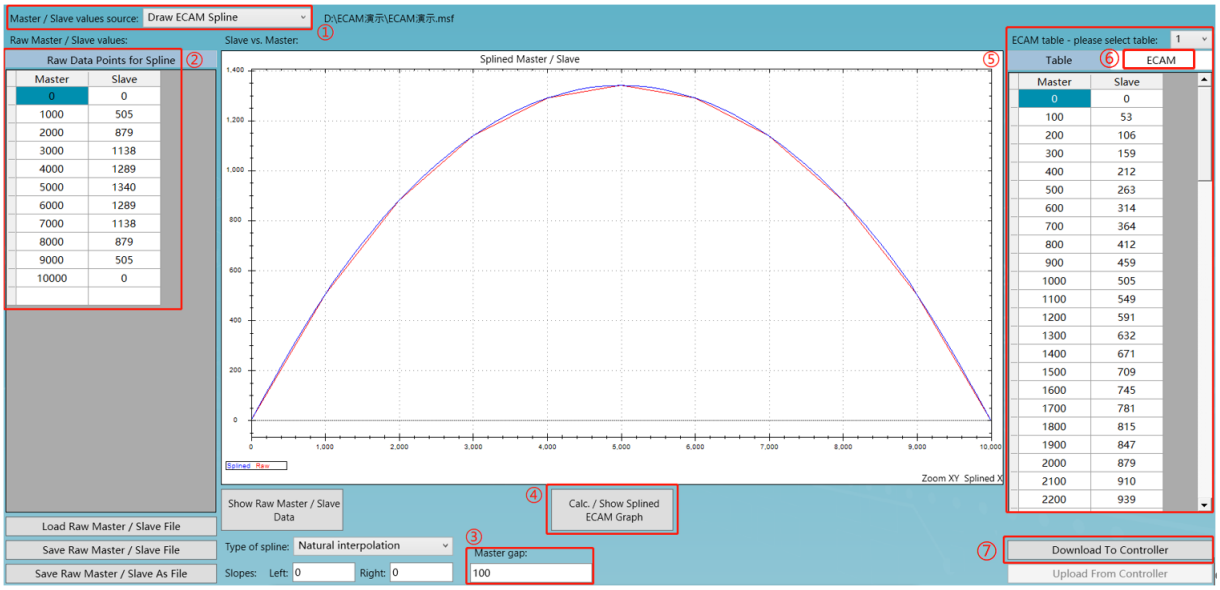
Upload from Controller: When “ECAM Table Handling” is selected in step ①, clicking Upload from Controller reads and uploads the ECAM table data currently stored in the controller.

3.2 Enabling ECAM Motion via PCSuite

The following example uses Axis A as the ECAM master axis and Axis B as the slave axis, with a circular arc segment as the following trajectory.

Step 1: Switch the menu to the slave-axis ECAM table editing interface.

Step 2: Create the ECAM spline curve by following the steps below.



① Select “Draw ECAM Spline”.

② Enter the raw data points according to the application requirements:

- Master represents the relative displacement of the master axis.
- Slave represents the relative displacement of the slave axis.

Note

The first Master data point must be set to 0.

③ Specify the spline spacing [Master Gap] according to the application requirements. Please ensure that the number of generated points does not exceed the system limits.

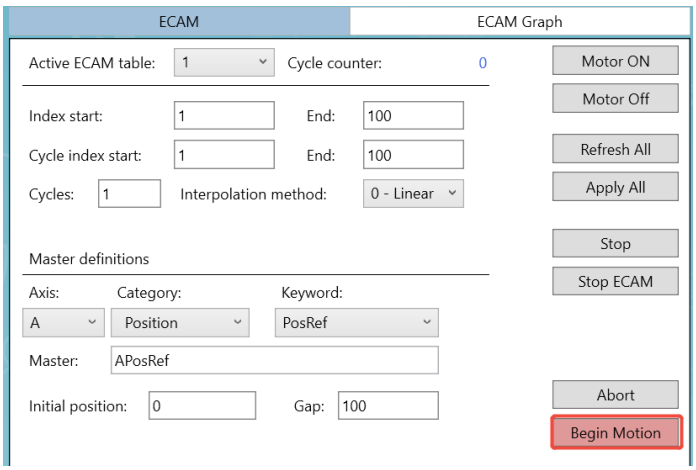
④ Click “Calc. / Show Splined ECAM Graph”.
The system will compute the spline curve based on the configured Master Gap, fit the curve, and display it in the graph. At the same time, the calculated ECAM table elements will be shown in ⑤.

⑤ If required, manually modify the calculated Slave data points in the ECAM table.

⑥ Click “ECAM” and enter the relevant ECAM parameters.

⑦ Click “Download To Controller” to save the ECAM table and parameters to the controller.

Step 3: Switch the menu back to the slave-axis ECAM interface. Click “Begin Motion”, and the slave axis will begin following the master axis.



3.3 ECAM Motion Keywords

A full explanation of each parameter can be found in the communication and keywords documentation. The recording parameters and functions are listed below for convenience with a short explanation of each:

Keyword	Description
ECAMCycCount	Reports the number of the current cycle for each ECAM table.
ECAMCycles	Determines how many times the cyclical part of the motion will be repeated for ECAM table x.
ECAMEnd	The index of GenData[] array holds the last element of the relevant table.
ECAMEndCyc	The index in Gendata[] array holds the last location of the part of ECAM table x that should be cyclically repeated.
ECAMGap	Determines the gap between master points for ECAM table x.
ECAMInterp	Define the ECAM interpolation method.
ECAMMaster	The parameter is used as the master value for ECAM table x.
ECAMMasterIni	Used to compensate the master axis position by subtracting it from the starting master position.
ECAMStart	The index of GenData [] array holds the first element of the relevant table.
ECAMStartCyc	The index in Gendata[] array holds the first location of the part of ECAM table x that should be cyclically repeated.
ECAMTableNum	Selects the ECAM table number x used for the current ECAM motion.