# HOST Programming Environment Options

<table>
<thead>
<tr>
<th>GMAS .NET API</th>
<th>GMAS Windows Library</th>
<th>PLC Open IEC 61131-3 programing</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMAS .NET API libraries using Standardized PLC Open motion and administrative functionality to program your application on Microsoft Visual Studio IDE Environment.</td>
<td>GMAS Win32 libraries for RPC (Remote Process Control) using C/C++ Microsoft visual Studio environment programing, based on standard PLC Open motion and administrative functions.</td>
<td>Built-in EAS IDE for IEC6113-1 Standardized PLC Open Programming that supports all 5 languages: SFC, FBD, LD, ST, IL.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GMAS Developer Studio C/C++ IDE</th>
<th>Drive .NET API</th>
<th>Drive User program IDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMAS Developer Studio (Eclipse Based) IDE for Native C/C++ Programming languages, based on standard PLC Open motion and administrative functions.</td>
<td>.NET API for Drive level functions such as Download FW, Send/Get drive Commands, Error Handling etc. for direct communication between the Host computer and the drive.</td>
<td>Built-in EAS IDE with up to 48Kbyte for local drive level user programing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modbus TCP protocol</th>
<th>Ethernet IP protocol</th>
<th>GMAS Script Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardized Modbus-UDP protocol for communication with Host Computers, HMI and PLC...</td>
<td>Standardized Ethernet-IP protocol for communication with Host Computers, HMI, and PLC...</td>
<td>Built-in In EAS (Elmo Application Studio) GSM tool for writing fast machine motion sequences.</td>
</tr>
</tbody>
</table>
# Network Group Axis Motion

<table>
<thead>
<tr>
<th>Group motion - By the book PLCopen</th>
<th>Huge Motion and Administrative Buffers</th>
<th>Coordinated Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group motion and API is performed according to the PLCopen Group State machine.</td>
<td>User can insert up to 1000 Group axis motion blocks in advance, while defining real time scenarios to occur between function blocks (Speed Changes, Torque Changes, IO Changes etc.)</td>
<td>PLCopen standard Linear and Circular motions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Synchronized Groups Up to 16 axes</th>
<th>On The Fly End point modification</th>
<th>Full Jerk Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>User can define up to 16 groups with up to 16 axes (physical or virtual) per group, for synchronized motions.</td>
<td>User can modify the endpoint of ongoing motion blocks</td>
<td>64 bit, real-time, double precision profile calculations, allowing full on-the-fly control over speed, acceleration, deceleration and jerk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2D, 3D Error Correction Support</th>
<th>Motion Blending</th>
<th>Arbitrary Path Generation (PVT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error Correction Compensates for pitch variations, stage bowing and misalignment. The feature allows position corrections for 1D, 2D and 3D systems such as XY tables, etc.</td>
<td>Velocity change on the fly to specific velocity command (Previous, Next, High, Low command) without stopping the motion</td>
<td>User can specify a prepared or on the fly path, up to 16 axes - with discrete position, velocity and time. The GMAS will interpolate (5th order) to create a smooth and contiguous path</td>
</tr>
</tbody>
</table>
### Network Group Axis Motion

<table>
<thead>
<tr>
<th>PLCopen Coordinate Systems</th>
<th>Network Group Limits (Safe Zones) Support</th>
<th>Spline Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMAS supports the following PLCopen coordinate systems: ACS – Axis-related coordinate system</td>
<td>Safe Zones can be set to avoid entering prohibited areas.</td>
<td>User can define either to work in Fixed time or Constant Velocity spline modes.</td>
</tr>
<tr>
<td>MCS – Machine-related coordinate system</td>
<td></td>
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</tr>
</tbody>
</table>

**“On the fly” position and velocity offset setting**

Link/Unlink a virtual profile to your real motion profile “On the Fly” during motion trajectory running time.

**Kinematics**

GMAS can execute complex defined real time Kinematic Transformations for machine related coordinated systems.

**Powerful wire and die bonding solutions**

Extremely fast and smooth operation in position, velocity, acceleration and deceleration using special transitions between segmented motion function blocks.

### Transition Curves

Arc segments that are inserted automatically by the GMAS pre-profiler module to guarantee that every two consecutive motions are contentiously and smoothly mandated. GMAS supports 3rd, 5th and 6th polynomial order calculations to promise smooth continuity in velocity and accelerations.
## Network Single Axis Motion

### Axis motion - By the book PLCopen

Single axis motion and API is performed according to the PLCopen Single Axis State machine.

### Huge Motion and Administrative Buffers

User can insert up to 1000 Single axis motion blocks in advance, while defining real time scenarios to occur between function blocks (Speed Changes, Torque Changes, IO Changes etc.).

### Simple Point to Point motion

User can perform any motion. From simple point to point motions to complex synchronized motions.

### Using the Drive Profiler - Distributed Motion

User can choose to use the drives profiler while the GMAS only controls the beginning and end of motion commands.

### On The Fly End point modification

User can modify the endpoint of ongoing motion blocks.

### Full Jerk Support

64 bit, real-time, double precision profile calculations, allowing full on-the-fly control over speed, acceleration, deceleration and jerk.

### Using the GMAS Profiler - Numerical Control (NC) motion

User can choose to use the motion profiles generated by the GMAS. The GMAS will download the target point every defined cycle time.

### Motion Blending

Velocity change on the fly to specific velocity command (Previous, Next, High, Low command) without stopping the motion.

### Arbitrary Path Generation (PVT)

User can specify a prepared or on the fly path with discrete position, velocity and time. The GMAS will interpolate (5th order) to create a smooth and contiguous path.
Network Single Axis Motion

<table>
<thead>
<tr>
<th>Network Limits Support</th>
<th>Optimized Methods for Communicating with native drive protocol over gateway</th>
<th>Virtual Axis Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software and Hardware Limits are handled by the GMAS Network Controller.</td>
<td>Optimized Communication methods with drives with the native drive protocol</td>
<td>User can define and emulate a full motion system without actual drives or mechanics by defining an axis a &quot;Virtual Axis&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In Target Support</th>
<th>Network based Following Error Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Target is handles by the GMAS network controller</td>
<td>User can modify the endpoint of ongoing motion blocks</td>
</tr>
</tbody>
</table>
## Communication To Devices

<table>
<thead>
<tr>
<th>Number of Axes</th>
<th>DS401 - IO Devices Protocol Support</th>
<th>Ether CAT Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMAS supports up to 100 devices on CAN or EtherCAT fieldbuses</td>
<td>Standard CAN Open DS401 IO Protocols supported.</td>
<td>CoE - CAN Over Ethercat. Standard DS402 over the Ethercat Network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EoE - Ethernet Over Ethercat. Ability to communicate with drives with native drive language.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FoE - Ability to download firmware to FULL Ethercat network simultaneously.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard CANopen</th>
<th>DS402 -Drive Motion Protocol Support</th>
<th>DS406 -CAN Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether the device is a motion device, Encoder, or IO - The GMAS can be configured to communicate with the selected device</td>
<td>Protocol to drives is strict DS402 supporting the following protocols:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cyclic Position</td>
<td></td>
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<tr>
<td></td>
<td>• Cyclic Velocity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cyclic Torque</td>
<td></td>
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<tr>
<td></td>
<td>• Interpolated Position</td>
<td></td>
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<tr>
<td></td>
<td>• Profile Position</td>
<td></td>
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<tr>
<td></td>
<td>• Profile Velocity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Profile Torque</td>
<td></td>
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<tr>
<td></td>
<td>• Homing</td>
<td>Ability to configure and read position of CanOpen Encoders on the CAN Network</td>
</tr>
</tbody>
</table>

### 3rd Party EtherCAT IO modules support

- Support 3rd party EtherCAT IO modules for controlling and monitoring analog and digital IO’s.

### Virtual CAN Encoder

- GMAS can simulate a CAN encoder on the network, thus saving on expensive CAN device.
## Special Functionality

### Homing
- Support all DS402 and PLC Open Homing methods such as:
  - RLS, FLS
  - Home Switch
  - Index mark
  - Home On Block
  - Immediate Homing
  - Absolute encoder home

### OC (Output Compare, Pegs) functionality
- Trigger fast digital output as a function of socket position:
  - Tabulated Absolute Position
  - Tabulated Time Duration
  - Absolute Position + Delta Position
  - Absolute Position + time duration

### Master - Slave Follower
- Elmo Gold servo drivers provide built-in capabilities for Master-Slave follower configurations:
  - Position follower
  - Velocity Follower
  - Current follower

### Scaling factors
- Scaling factors using DS402 UU (User Units) for position, Velocity and acceleration scaling.

### Cyclic Modes position/Velocity/Torque offsets
- Position/Velocity & Torque Offset support. Velocity offset (DS402 object 0x60B1) mapping for smooth velocity and acceleration profiles

### Modulo
- 32 bit modulo with special RADO (Rotary Axis Direction Option)
  - Normal positioning
  - Negative movement
  - Positive movement
  - Positioning with shortest way

### Dynamic Braking
- Logical Braking for reduced braking time.

### Sine Sweep Emulation
- Simple BW test by the user using EAS sine sweep interface.

### Reference commands
- Wide range of profiler reference commands:
  - CanOpen/EtherCAT DS402 based standard
  - Analog (+-10V)
  - P&D
  - User Program
### Special Functionality

<table>
<thead>
<tr>
<th>MIMO Based Gantry solution</th>
<th>Gantry Absolute and differential 1D error correction</th>
<th>OC function in Gantry system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Drives’ powerful control enables true synchronization between 2 gold drive without the need to designate, and thus waste, an entire motion controller exclusively on Gantry Realization.</td>
<td>Differential and Absolute 1 Dimension error correction implementation on the drive level. In both Master and slave axes the error correction mechanism is active.</td>
<td>Output compare functionality for triggering external equipment as a function of the Master axis position is supported in Gantry system.</td>
</tr>
</tbody>
</table>

### Gantry Home Offset Measurement

Special procedure for measuring the offset between two indexes located on separate linear scales of a Gantry system. Both Master and Slave motors are powered on and operating in Gantry mode during the whole measurement time.

### Feedback Emulation in Gantry system

Quadrature/Analog/absolute feedback emulation in a standalone or network based Gantry system.

### ECAM and Gearing

Standardized PLC Open ECAM and Gearing functionality. Linear and cyclical ECAM with fixed or different segment gaps.
## Servo capabilities

**PIP cascaded Vector control**
- Advanced and extremely fast vector control

**1:2:2 servo control topology**
- Current Control Loop sampling time down to 40 us (25 kHz)
- Velocity Loop sampling time down to 80 us (12.5 kHz)
- Position Loop sampling time down to 80 us (12.5 kHz)

**High order filters**
- Low Pass, High Pass, Notch, Anti-Notch, Lead lag and 2nd order general filters for overcoming “defects” of the mechanical system

---

### Advanced Tuning
- Fast, easy and efficient advanced Automatic Tuning tool.

### Commutation options
- Choose your most application suitable commutation method:
  - Stepper
  - Digital halls
  - Analog halls
  - Binary search
  - Auto phasing

### System analysis
- System analysis in the time domain (Step Response) and frequency domain (Nichols, Bode)

---

### Plant Identification methods
- Multiple plant, fast identification or Sine sweep Identification

### Controller Design methods
- Automatic Controller design methods or Manual design for the advanced control engineer

### Current Gain Scheduling
- Current gain scheduling to compensate for the motor's non-linear characteristics and for bus voltage variations
## Servo capabilities

<table>
<thead>
<tr>
<th>Friction Compensation</th>
<th>Field weakening (Phase advance)</th>
<th>2000:1 Current dynamic range</th>
</tr>
</thead>
</table>
| • Using nonlinear compensation method to overcome friction by adding an offset command to the integral filter of the velocity loop  
• velocity GS table | Enhanced torque-speed operation using advanced field weakening. | Highest current (Torque/ Force) dynamic range of >2000 |

### 3 step Gain scheduling
- Using 3 controller gain sets before, during and after motion.

### 1 Dimension Error correction
- Error Mapping for high system accuracy.

### Velocity and position Gain scheduling
- Velocity and Position gain scheduling for ultimate servo loop performance.

### Any Servo Motor Control
- Brush and Brushless
- AC Servo
- Rotary & Linear
- Torques (DDR)
- Voice Coil (DC)

### Stepper motor control
- High speed 2 Phase, 3 Phases open and close loop stepper motor control.

### Planar stage control
- MIMO (Multi Input Multi Output) control solution structure for Planar X/Y systems.
### Servo capabilities

#### I²t Protection

Keeping constant Thermal Stress (I²t) for all peak currents and thus avoiding the amplifier from “over stressing” and keeping it within the safety limits.

- 20A, 3 seconds zone
- 15A, 4.7 seconds zone
- 10A, Continuous zone

#### Current Limits

In Elmo Amplifiers & Drives:

- \[ I_p = 2X I_c \]
- Peak Duration for rated \( I_p \) = Typical 3 seconds

#### “R” Type current limits

Instead of having “fuse” \( I^2t \) limits to the \( I_p \), the R type has not \( I_p \) capabilities, but only continuous current capabilities that is higher than the “traditional” \( I_c \) (by 1.5) and is only thermally limited.

### Power Switching- FASST

The FASST Technology is realized in the FID, Elmo’s fully customized analog/digital IC designed to “Optimum Drive” of power MosFETs and IGBTs

- Provides fast and highly efficient switching
- Keeps process “soft” with no stress on power device with very low EMI

### Power Switching- FASST- Low EMI

Low EMI below the conductive medical standard.
## Advanced Feedback Technology

### Simplicity in Feedback Configuration

- Elmo’s “Socket Technology” embedded in Gold Drives and supported by the EAS, enables the quick and simple set-up of any type or configuration of encoders.

### Dual loop options

Gold Servo Drives support Port A and Port B manipulations. This also applies to Dual Loop applications, dual sensor motors, etc.

### Analog Encoder Sin/Cos, Port B

- Using internal Programmable multipliers: x4 to x8192 to achieve high analog encoder resolutions.

### Absolute position sensors

- Absolute encoder masking

  - Gold absolute encoders can reach up to 32 bits per revolution, up to 2.5 MHz clock frequencies and automatic propagation delay compensation.

- For operating higher-resolution absolute encoders, the user can mask both upper and lower bits via the EAS without any performance degradation.

### Emulation, Port C

- Feedback Emulation (socket) into one of the following signals format:
  - A & B quadrature
  - Pulse & direction
  - Up & down
  - Hall signals

### FIR and Glitch Filters

- For “smoother” operation and improved noise immunity, the FIR (Finite Impulse Response) filter and “Glitch” filters can be used.
Advanced Feedback Technology

<table>
<thead>
<tr>
<th>Resolver</th>
<th>Max encoder frequency</th>
<th>Edge Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable reference frequency: $1/(2<em>TS</em>N)$, $N=1/2, 1, 2, 4$ (Ts = sample time in micro seconds)</td>
<td>Up to 18 MHz PPR (Pulses Per Revolution) Maximum incremental encoder frequency.</td>
<td>Quadrature Edge Separation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Digital halls</th>
<th>Analog signal corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td>The “Halls Only” feedback application is used to control the commutation, current loop, velocity loop and position loop.</td>
<td>Correction for offset, amplitude and phase mismatch in analog sensors (Resolver, Analog Hals, Analog Sin/Cos)</td>
</tr>
</tbody>
</table>
## Hardware solutions

### Gold product family Servo Drives

- **Sophisticated Motion Control Solutions for Modern Industrial Automation.**
  - DC Input: 7.5 to 750 VDC - for DC brush, sinusoidal and trapezoidal motors

### Drive Motor solutions

- **“All in One” solutions of motor Drive and feedback combined in one package.**

### SimplIQ product family servo drives

- Elmo Motion Control’s SimplIQ product family is a set of sophisticated AC and DC input voltage based, network-based motion control products for brush, brushless and linear motors

### Power supplies

- **Compact, cost effective, direct-to-mains power supplies, designed for multiple servo drives solutions.**

### ExtrIQ Line Servo Control Products

- **Digital Servo Drives, and Analog Servo Amplifiers suit military and Extreme Environmental Conditions**

### Network Motion Controller

- Elmo’s Gold Maestro leads the market when it comes to advanced, fast, precise, easy-to-use, and cost-effective distributed networking motion controllers.

### Military Motion Controller

- Elmo’s Military Motion Controller, the Puma, has a compact rugged, MIL-style casing, that contains an advanced, easy-to-use, and cost-effective multi-axis Network Motion Controller and 2 extremely powerful Gold Hornet servo drives of up to 20 A/100V (3.3 Kw ) each

### One Solution, Any Application

- **The Elmo Application Studio (EAS) – a multi-functional and friendly design environment**

- **The Gold Maestro - a true network-based, machine motion controller that can handle up to 100 axes**

- **High-performance, advanced and intelligent Servo Drives**