The Servo.3M ServoDrive is an integrated axis control system which combines geared motor (with hollow shaft output), position transducer, driver, controller, display, and serial bus interface. Once a position is defined, the unit reaches it automatically with performance determined by a series of parameters which can be set (high speed, low speed, duration of acceleration/deceleration ramps, etc).
The Servo.3M ServoDrive is controlled by a supervision unit (PLC, Industrial PC) through an Ethernet industrial field bus.

After configuration, positioning of the ServoDrive can be controlled either in manual mode or automatic mode:
Manual mode: speed and rotation direction can be set directly by bus commands.
Automatic mode: the system automatically reaches the set target position by bus command. If problems are encountered in automatic mode (e.g. impeded movement or excessive motor temp) the system stops and indicates the fault cause.

Version with POTENTIOMETRIC transducer

In this version, the position transducer is a rotary precision potentiometer which is connected to the output shaft. The current position is given by the potentiometer reading. The entire stroke is covered by 14 bits, i.e. 16384 measurement points.

EthernetIP comunication

The ServoDrive implements the Ethernet/IP IO protocol for IO-Device with Ethernet interface.

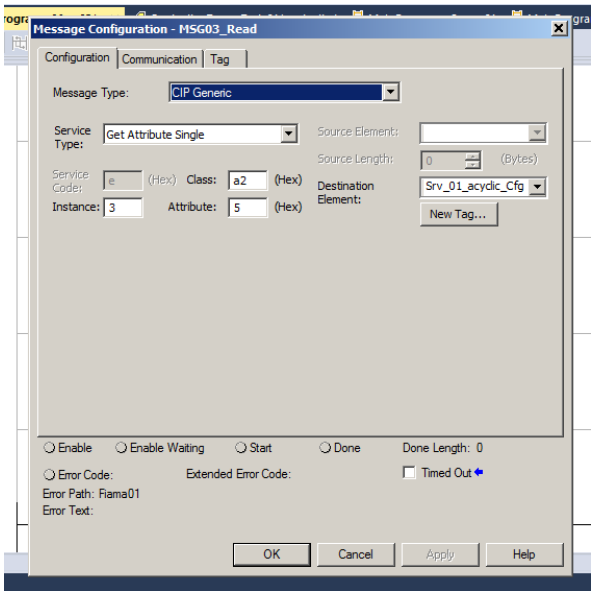
Acyclical comunication

The ServoDrive unit uses 23 configuration parameters (50 bytes) that are sent by the newtwork master (PLC) at every power up. The default value is set in the EDS file and it can be changed in the configuration mode.
These parameters can be acyclically accessed in read and write mode even in operating mode.

Parameter	Word	Value range	Default	Description
Backlash compensation	1	0-255	0	Every unit increase adds 256 to the target position value.
Proportional constant	1	0-255	1	PID proportional constant. Recommended values: <6. Excessive values may cause oscillation around the target position.
Integral constant	1	0-255	0	PID integral constant. Recommended values: <3.
Differential constant	1	0-255	0	PID differential constant. Recommended values: <30.
Integral intervention time	1	0-255	10	Number of cycles after which the integral contribution is updated. Recommended values: <20. Raising this value reduces the effect of the integral constant.
High speed	1	0-100	80	Speed which is maintained when the system is far from the target position in automatic mode. Expressed as a percentage of the max speed.
Low Speed	1	0-100	20	Speed which is maintained when the system is close to the target position in automatic mode. Expressed as a percentage of the max speed.
Stop Time	1	0-255	10	Number of cycles, in automatic mode, after which the system is considered blocked and is therefore set to manual mode. The cause may be actual arrival at the target position or impeded movement. Recommended values: <10.
Ramp Time	1	0-255	1	Duration of the speed variation ramps. Recommended value: 0 < Ramp Time < 8
Calibration	1	0-1-2	1	Setting this parameter to 2 saves the current position of the potentiometer to Point A Measurement. Setting this parameter to 1 saves the current position of the potentiometer to Point B Measurement. When both points have been saved, this parameter is set to 0.
PID Intervention Time	1	0-255	1	Number of cycles after which the PID control is updated. Recommended values: <40. Raising this value reduces the PID refresh rate thereby reducing the control dynamic of the system. Note: Refer to the “PID control system set-up” section to select the kp, ki, kd, tii, tPID parameters.
Slow Position	1	0-255	1	Distance from target value when speed is changed from high to low in automatic mode. Every unit increase causes a speed change 256 units farther from the target position.
Point A Measurement	1	0-65536	2000	Position of transducer in the first calibration point (0-16000)
Point B Measurement	2	0-65536	14000	Position of transducer in the second calibration point (0-16000)
Point A Display Value	2	0-4294967296	2000	Displayed valued corresponding to the first calibration point
Point B Display Value	1	0-4294967296	14000	Displayed valued corresponding to the second calibration point
Decimal Point Position	1	0-4	1	Number of decimal places.

Minimum Position	1	0-65536	100	
Maximum Position	1	0-65536	15000	
Positioning Window	1	0-65536	20	Distance from target position when Target reached bit is raised
Minimum Movement	1	0-65536	10	Minimum movement of the unit from one position to the next. In case of a smaller movement, positioning is attempted again for a number of times specified in the Positioning Attempts parameter.
Positioning Attempts	1	0-65536	5	Max number of unsuccessful attempts before considering positioning fault.
Maximum Acceptable Errors	1	0-65536	100	Reserved. Do not modify default.

The acyclical read and write functions can be done using rslogix5000 msg method.



With this command (get), the entire block of parameter (50 byte) will be read and saved in the “destination element” struct.

Cyclical comunication

The ServoDrive exchanges 5 input words and 4 output words to defined as follows (H and L indicate the high and low part of the corresponding word):

Slave -> Master Comunication Inputs (5 words, 10 bytes):

Word index	Size (bit)	DESCRIZIONE
0	16	Current position
1	16	Target position
2	16	Actual speed
3	16	Status word
4	16	Reserved

QAH:QAL Current Position (1 word) [min 0 - max 16000]; indicates the current position of the system.

Note: the positions are given by the potentiometer reading. It is possible to execute a calibration on the potentiometer stroke to read on the display the position in the desired units. If bit 12 of the status word is set to 1, the display shows the position which is read before turning off the unit.

QTH:QTL Target Position (1 word) [min 0 - max 16000]; indicates the target position which the ServoDrive has accepted.

VAH:VAL Current Speed (1 word) [Min 0 - Max 100]; indicates the current position of the exit shaft.

STAH:STAL Status Word (1 word)

BIT	DESCRIPTION
0	Jog in progress
1	Positioning in progress
2	Target position reached
3	Current position below minimum value. Automatic mode is disabled. It is mandatory to use manual mode with jog+ function.
4	Current position above maximum value. Automatic mode is disabled. It is mandatory to use manual mode with jog+ function.
5	Target position below minimum value. Automatic mode is disabled.
6	Target position above maximum value Automatic mode is disabled.
7	New target position accepted
8	ServoDrive overheating. Automatic and manual modes are disabled. This bit is self clearing.
9	Positioning error. ServoDrive unit couldn't reach the target position. It is recommended to calibrate "low speed" and "slow position"
10	Motor direction (1: increment, 0: decrement)
11	Communication error. The unit will automatically reset every 10s to attempt to restore communication. If the error persists, it will be necessary to automatically reset the unit.
12	24V power connection status (1 off, 0 on)
13	ServoDrive ready

If the 24V power is disconnected, the unit will stop and the display will turn off and provide the following outputs:

- current position: position of the unit before turning off.
  Note: further movements with the motor off will NOT be detected until the unit is powered on.
- Target position: last target position accepted by the unit
- Current speed: last speed which was set.
- Status word: last state before power off and bit 12 set to 1

- **Master -> Slave Comunication** Outputs (4 words, 8 bytes):

Word index	Size (bit)	DESCRIZIONE
0	16	Target position
1	16	Target speed
2	16	Control word
3	16	Reserved

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QTH:QTL Target position (1 word) [Min 0 - Max 16000]; indicates the position to be reached. When a target position is sent, the system verifies that it is within the accepted limits. If verification is positive, the ServoDrive raises the New Target Accepted bit in the status word.

VTH:VTL Target speed (1 word) [Min 0 - Max 100]; indicates the speed with which the ServoDrive will reach the target position or with which it will rotate in manual mode (jog).

CTRH:CTRL Control Word(1 word);

CTRH:CTRL Control Word(1 word);

BIT	DESCRIZIONE
0	Jog +
1	Jog -
2	New positioning in automatic mode.
3	Reserved
4	Emergency stop

Main commands
The following are series of data exchanges for the main functions of the ServoDrive.

1 Manual mode (Jog):
- From the Ctrl value at 0, raise bit 0 or bit 1 to select jog mode
- The target speed determines the ration speed
- Bit 0 of the status word becomes 1

2 Single positioning:
- Update the Target position and Target speed outputs
- Raise only bit 2 of the Control word
- If the target position and the speed are within limits the ServoDrive will raise bit 7 and bit 1 of the Status word
- When the ServoDrive is at a distance from the target which is inferior to the “Positioning window”, the unit raises bit 2 of the Status word
- When the ServoDrive is at a distance from the target which is inferior to the “Minimum movement”, the unit lowers bit 1 of the Status word and stops moving.
- To send a new set point, set the Control word to 0 and raise again bit 2

3 Slow stop
For a slow stop, set all bits of the Control word to 0. The stopping time can be set with parameter number 7 (stop time).

4 Emergency stop
For an emergency stop, set all bits of the Control word to 0.

Display calibration procedure

The transducer which measures the rotation of the exit shaft is based on a precision rotary potentiometer which is linked to the exit shaft through a series of gears. The current position of the motor which is detected by the potentiometer (the full stroke is covered by 14 bits which yields 16384 points), is read by the PLC through the field bus.
While the potentiometer reading always increases with a clockwise rotation of the exit shaft as it is observed from the back side of the motor, it is possible to define as desired the count increment direction shown on the display.
To calculate the total number of rotations of the exit shaft, multiply the potentiometer reduction ratio (specified by “R 1/x” in the motor name on the label) by the number of rotations of the potentiometer (specified by “3G”, “5G”, or “10G).
For example, if the label of the motors specifies R1/10 and 5G then the number of total rotations is 10x5=50.

The position measured by the transducer varies between 0 and 16384 points and increases with a clockwise rotation of the shaft as it is observed from the back side of the motor; this cannot be modified.
The display can be calibrated to show all values between -9999 and 99999 with the possibility to define up the count increment direction as necessary.
The default setup shows directly the measured position (0-16384) with one decimal place.

To calibrate the display it is necessary to assign values to the following parameters:
Measure Point A
Measure Point B
Visualization Point A
Visualization Point B

Changing even just one of these parameters will result in a displayed value which is different from the position measured by the transducer.
The displayed value is calculated with the following formula:

$$\text{Display} = \text{Visualization Point A} + (\text{Actual Position} - \text{Measure Point A}) \frac{(\text{Visualization Point A} - \text{Visualization Point B})}{(\text{Measure Point A} - \text{Measure Point B})}$$

where Display = current displayed value and Actual Position = current position of potentiometer.

The display calibration procedure must be executed with the motor installed on the machine and requires the selection of two points within the stroke, A and B, which are as close as possible to the end points and with the greatest possible separation.

Steps:
application of motor to machine
bring the shaft of the machine approximately to its intermediate position
install motor and lock exit shaft of motor to machine shaft.
Note that the motor is supplied by default with its exit shaft approximately in the intermediate position (displayed value approx. 8000).

Calibration of point A
move axis to first calibration point
ignoring the displayed value, read current position measured by transducer (0-16384) and assign this value to the MisA parameter;
measure with a caliper the actual position of the machine and assign this value to the VisA parameter

Calibration of point B
move axis to second calibration point
ignoring the displayed value, read current position measured by transducer (0-16384) and assign this value to the MisB parameter;
measure with a caliper the actual position of the machine and assign this value to the VisB parameter

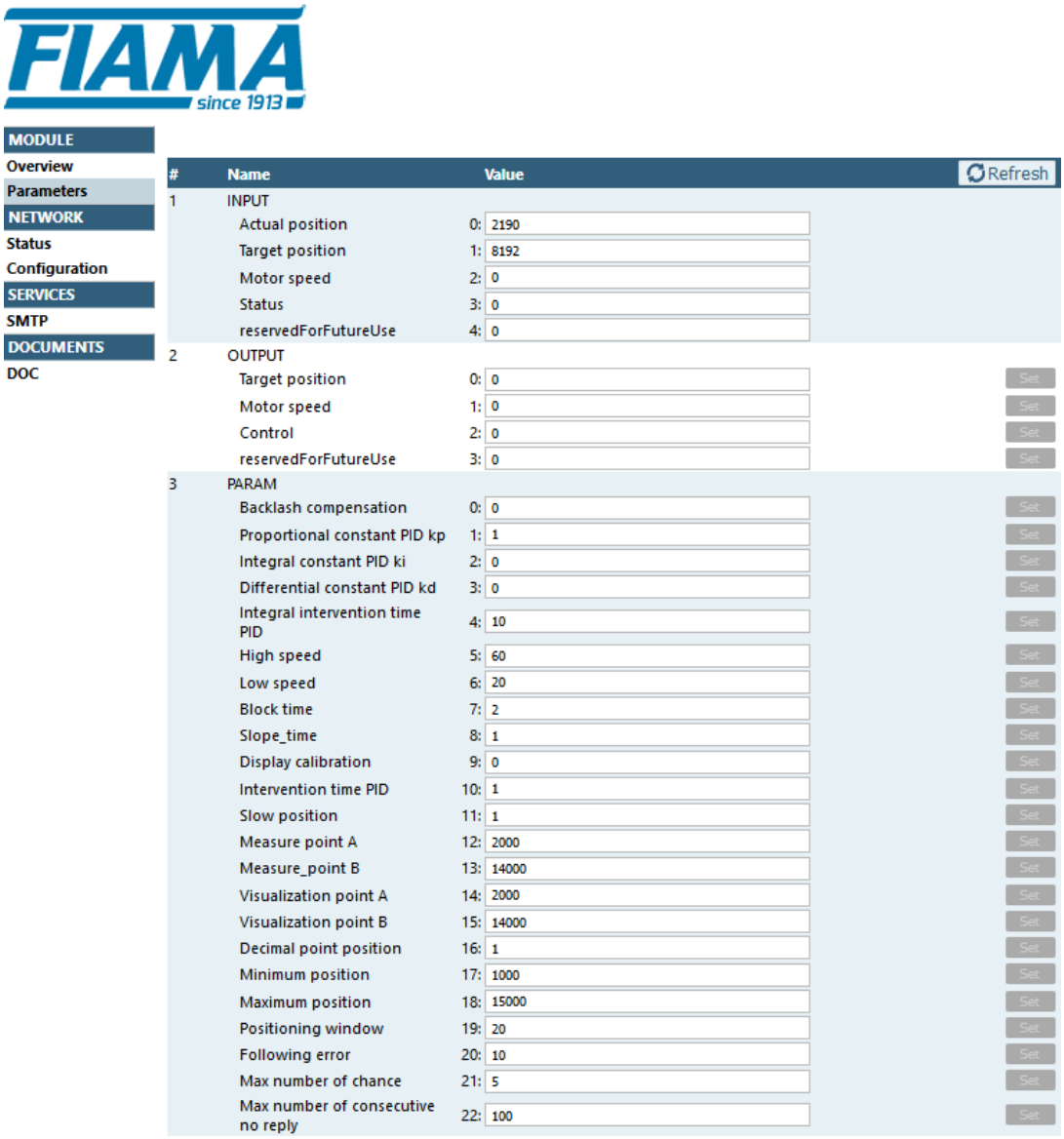
decimal point definition: assign to the “Decimal point position” parameter the desired value (0=no decimal point, 1=single decimal place, etc)

calibration verification: move the machine to an intermediate position and verify that the displayed value is correct.

Procedure to select positioning parameters
The parameters involved in positioning are the PID proportional constant, PID integral constant, PID differential constant, high speed, low speed, slowdown, stop time, ramp time.
Positioning effectiveness depends strongly upon the correct selection of these parameters. It is therefore necessary to execute positioning tests modifying these parameters until an optimal set has been determined.

1) It is necessary to first of all determine the minimum speed at which the system can move with the max load applied; assign this value to the Low Speed parameter.
2) Set the parameters are follows:
    1) proportional constant = 1
    2) integral constant = 0
    3) differential constant = 0
    4) high speed = value between low speed and 100
    5) slowdown = 1
    6) ramp speed = 1
    7) block speed = 10
3) if necessary increase the proportional constant (<&)
4) if necessary set to 1 the integral constant
5) if necessary set a value of the differential constant between 10 and 40
6) if there are oscillations around the set point, reduce the proportional constant

Web Server
The web server is reached using the IP address of the ServoDrive.
To determine and set the desired address we recommend the “Anybus Ipconfig” application.



Using the web server it is possible to set the ServoDrive parameters using the PARAM. Section.
Note: it is not possible to modify the input and output values, which can only be modified by a master device.

In the submenu, in the Status section it is possible to check the network configuration and in the DOC section it is possible to download the manual and the configuration files.

Utility
To correctly operate the unit is it essential to set the device IP address.
This can be done using the HMS free software which can be downloaded from the following link:
https://www.anybus.com/support/file-doc-downloads/anybus-support-tools?orderCode=tools

Led function

LED P1-Net	Description	Function
Off	Offline	• No operating voltage • IP address not set
Green	Online	• Connection extablished
Green flashing	Online	• No connection

LED P2-Net	Description	Function
Off	Offline	• No operating voltage • IP address not set
Red	Wrong IP	• Wrong IP address
Red flashing	Time out	• Connection timeout

LED P1-Mod	Description	Function
Off	Offline	• No operating voltage
Green	RUN mode	• ServoDrive in RUN mode
Green flashing 1x	Not configured	• ServoDrive in STOP mode

LED P2-Mod	Description	Function
Off	Offline	• No operating voltage • No error
Red	Fatal error	• Fatal error
Red flashing 1x	Configuration error	• Configuration mismatch

LED P1-Link	Description	Function
Off	Offline	• No operating voltage • No connection
Green	Link	• 100 Mbit/s connection– PORT 0
Green flashing	Activity	• 100 Mbit/s connection and activity– PORT 0

LED P1-10Mb	Description	Function
Off	Offline	• No operating voltage • No connection
Yellow	Link	• 10 Mbit/s connection– PORT 0
Yellow flashing	Activity	• 10 Mbit/s connection and activity– PORT 0

LED P2-Link	Description	Function
Off	Offline	• No operating voltage • No connection
Green	Link	• 100 Mbit/s connection– PORT 1
Green flashing	Activity	• 100 Mbit/s connection and activity– PORT 1

LED P2-10Mb	Description	Function
Off	Offline	• No operating voltage • No connection
Yellow	Link	• 10 Mbit/s connection– PORT 1
Yellow flashing	Activity	• 10 Mbit/s connection and activity– PORT 1

PORTA 0: right connector
PORTA 1: left connector