EtherNet/IP for Datalogic Laser Marking devices

7TH MAY 2020, LASER MARKING WEBINAR

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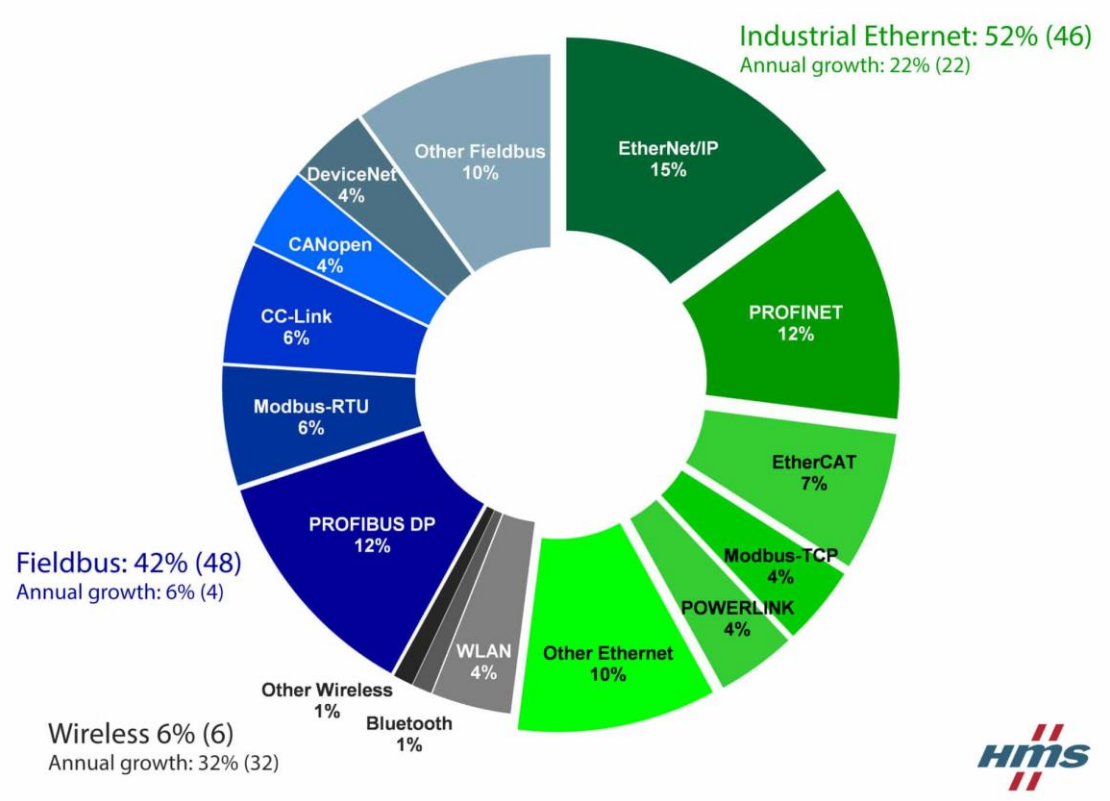
Introduction

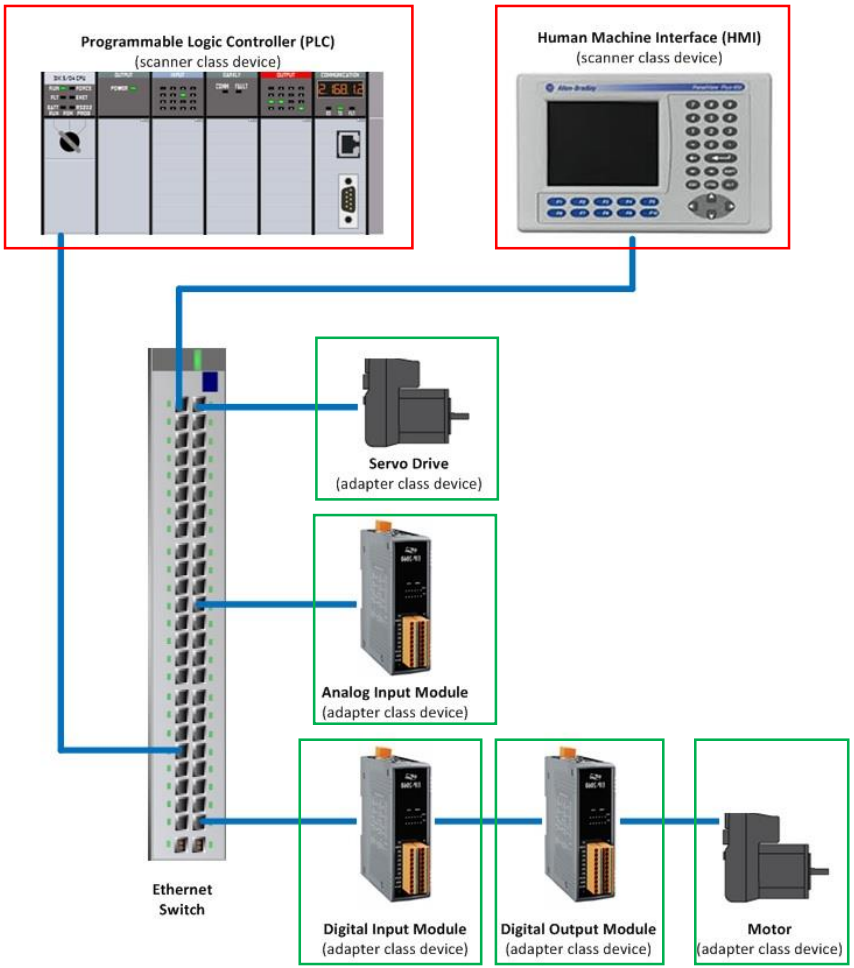
- EtherNet/IP (EIP) is an Application Layer protocol very much used in Industrial Automation for control and management of every device which are logged onto the network.
- EtherNet/IP provides a wide-ranging, comprehensive, certificable standard which is suitable to a very wide range of Automation devices.
- EtherNet/IP uses Transport & Data layer protocols which are used in the most traditional Ethernet devices, such as TCP, UDP and IP. This makes it easily implementable inside many Ethernet devices, and performance depending on the development of these Standard technology platforms.
- Rockwell Automation has focused on EtherNet/IP since its development phase, thanks to the common USA origins; this positions the company as the top PLC make for every EtherNet/IP network.

EtherNet/IP as a common Industrial Network Protocol

- Along with Profinet I/O, it belongs to the Industrial Ethernet connectivity family, which is the most promising in terms of future numbers of connections.



EtherNet/IP device classes

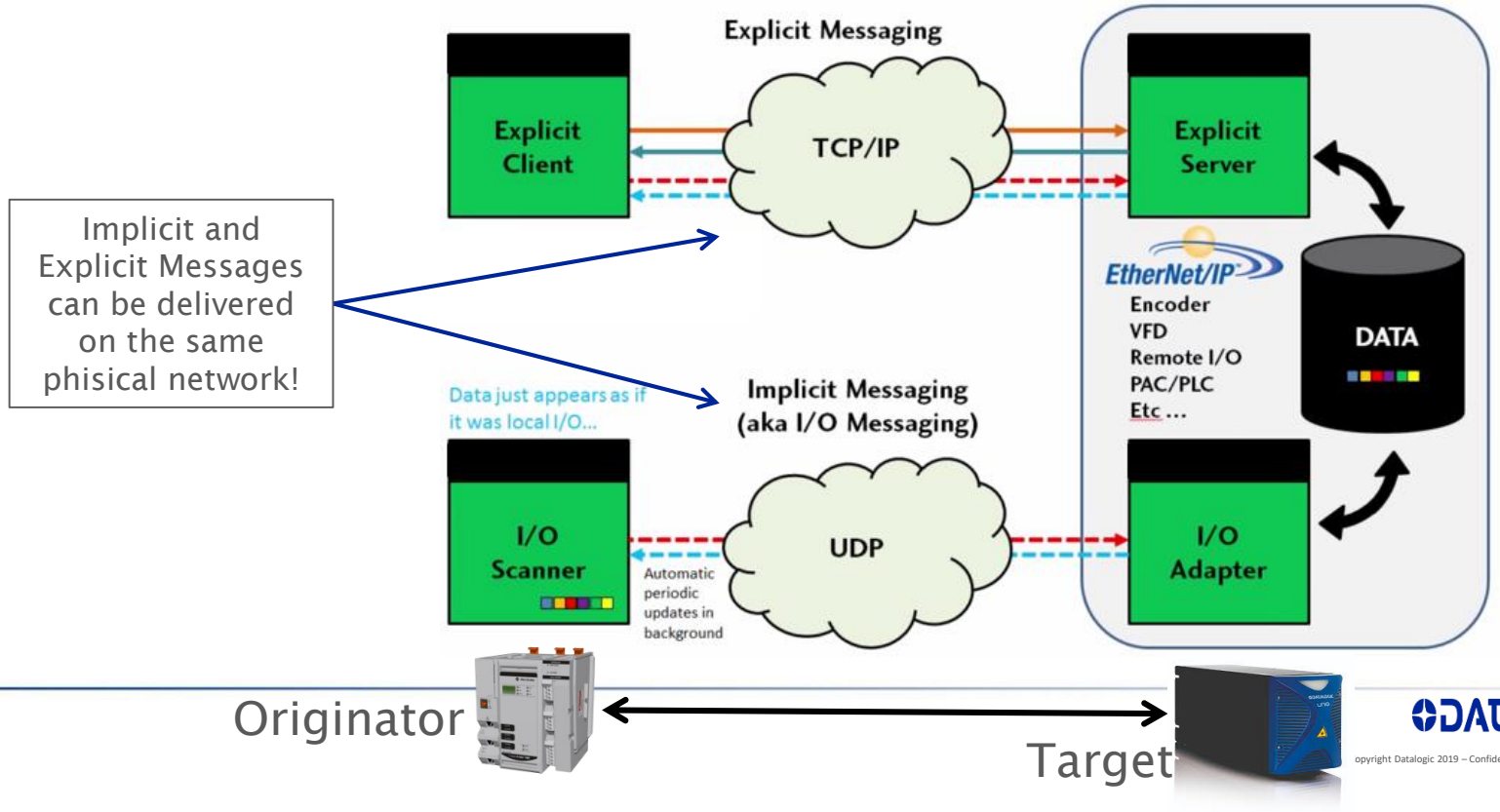


- EtherNet/IP network consists of at least 2 devices belonging to a different class.
- Originators: opens connection and initiates data transfer.
- Targets: provides data to Originators.
- PLCs or HMIs are part of the Originators class, while digital or analog modules, motors or motion robots are part of the Target class, providing information to the Originators in order to elaborate the entire automation.

Implicit and Explicit messaging

Explicit and Implicit messaging

- EtherNet/IP allows 2 ways of communication between the Originator and the Targets/s, and each one relies on different Layer 4 (Transport) protocols:
- **Explicit messages**: these commands are asyncronous due to their nature, without the need of replying to the PLC in real-time of what has happened – uses TCP.
- **Implicit messages:** the information content arrives in real time, so the PLC can react in a lower time to the external stimulation – uses UDP.



Implicit messaging: Memory Maps exchange

- Implicit messaging is used for all those commands where real time is requested: this is permitted by the use of UDP, which allows these quick and latency-free Memory exchanges between the Scanner and the Adapter.
- **At every RPI, the Scanner receives an Input Memory Map from the Adapter and sends to the same Adapter an Output Memory Area via UDP**: according to the values inside each Memory Map and the rules set by the handshake with each device, the Scanner can send commands to the Adapter and/or constanly receive informations from it.

Input Memory Map sent via UDP to the Scanner

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
0	0	1	0	0	0	0
0	0	0	0	0	0	0
...	...	...	...	...	...	...
...						

1 RPI!!

Scanner

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
0	0	0	0	0	1	0
0	0	0	1	0	0	0
...	...	...	...	...	...	...
...						

Output Memory Map sent via UDP to the Adapter

The PLC is the point-of-view for the 'Input' & 'Output' definition

EtherNet/IP networks

EtherNet/IP node recognition

- An EtherNet/IP network is composed by at least 1 originator and as many targets as the PLC can handle: originators are usually PLCs, which have their own programming Software.
- Every node can be added via the PLC programming Software in 2 ways:

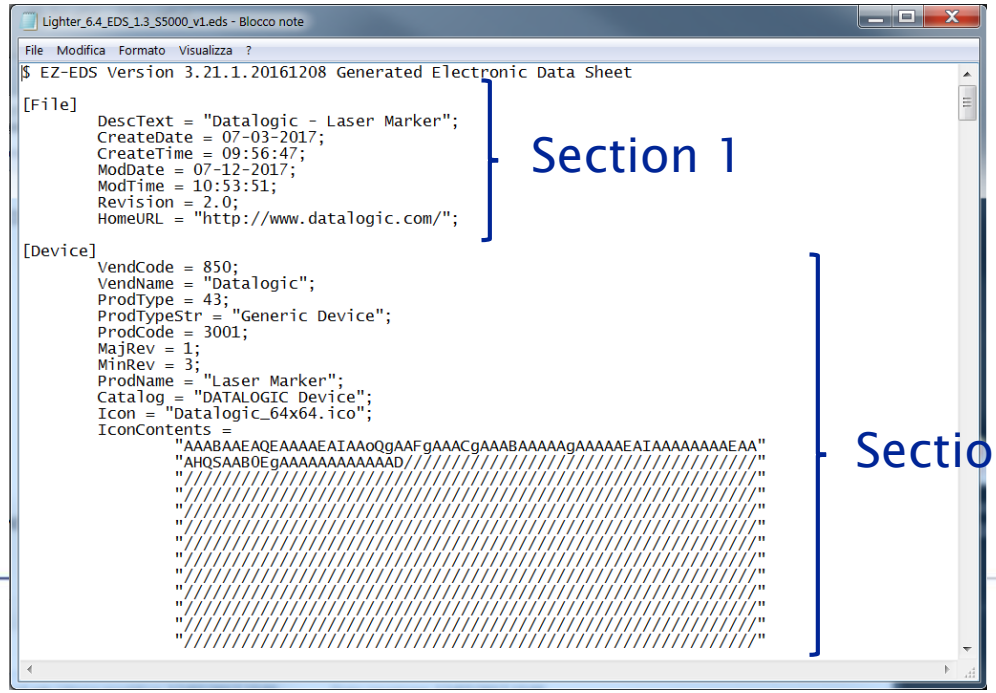
1. Adding the necessary information for the node: enter specific data manually to identify the node on the network and communicate accordingly.
2. Importing the (Electronic Data Sheet) EDS file directly into the Software: all the needed information is specified inside the EDS file, so the set-up phase is shortened.

- The minimum information required for an EtherNet/IP node recognition is:

1. Node IP address;
2. Node Name;
3. Memory Map Adresses ‘Common Format’;
4. Input & Output Assembly Instances & sizes;
5. Configuration Assembly Instance & size.

EDS files

- These files are provided by the Target constructors and allow a stress-free recognition of the EtherNet/IP node.
- An EDS file is composed by sections, in which the PLC programming SW can acces all the information needed: EDS file can contain the minimum information needed, or they can get very long when containing information such as images, HTTP link and so on.



EtherNet/IP connection with a Datalogic Laser Marking device

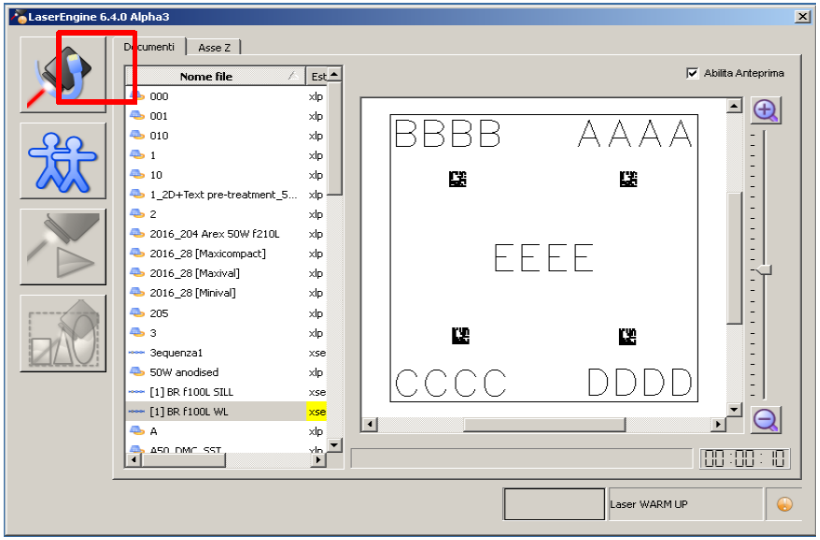
Introduction

- EtheNet/IP is available for free on Datalogic Laser Marking devices when using Lighter v. 6.4.0 onwards.
- Implicit communication is the base for EtherNet/IP on these devices.
- By using EtherNet/IP, a PLC can constantly be informed on:

1. Laser Engine State;
2. Command execution stage;
3. Command result.

- Via Ethernet/IP it is not possible to achieve the Laser Warm Up procedure, which has to be done via digital I/Os.
- A complete User Manual and the EDS file for any supported Datalogic Laser Marker, as well as the latest Lighter installer can be found on the Datalogic website.

Laser Marker set-up for EtherNet/IP



- EtherNet/IP uses ports 44818 (for TCP and UDP) and 2222 (for UDP): these porta must not be controlled by the Windows Firewall, which would block EtherNet/IP communication. To do so, follow the User Manual.
- The Laser Marker's IP address must be constant, so no DHCP assigenment must be made.
- To enable a Laser marker for EtherNet/IP communication, it is sufficient to set Lighter – Laser Engine into Remote mode, by clicking on the highlighted button.

Output Memory Map

Transition 0→1 on this Command Bit is not enough for the Target to execute the command

Command Bit which don't request extra information on the Request Data field

ADDRESS	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
0							Stop system	Start Marking
1	Protocol Error Clear						Get Laser Engine Version	Get EIP Protocol Version
2	Set Global String Value	Get Global String Value	Set Global Counter Value	Get Global Counter Value	Set Data Field Value	Get Data Field Value	Save Document	Open Document from Device
3							Disable Data Filed	Enable Data Field
4							Move Data Field	Move and Rotate Document
5 to 7	Reserved							
8			Set Focus Distance Sensor Reference	Stop Autofocus	Start Autofocus	Stop Axis	Reset Axis	Move Axis
9	Reserved							
10					R Axis	Z Axis	Y Axis	X Axis
11 to 21	Reserved							
22							Reset Output	Set Output
23	Reserved							
24	I/O Port Digital Output (0..7)							
25	I/O Port Digital Output (8..15)							
26 to 31	Reserved							
32				Get ID Marvis Result	Set ID Marvis Configuration	Get ID Marvis configuration	Get ID Match Result	
33 to 53	Reserved							
54	Request Data Size							
55	Reserved							
56 to 255	Request Data							

Input Memory Map

This bit informs the PLC if a command is being executed (0→1) and when it has been completed by the Target (1→0)

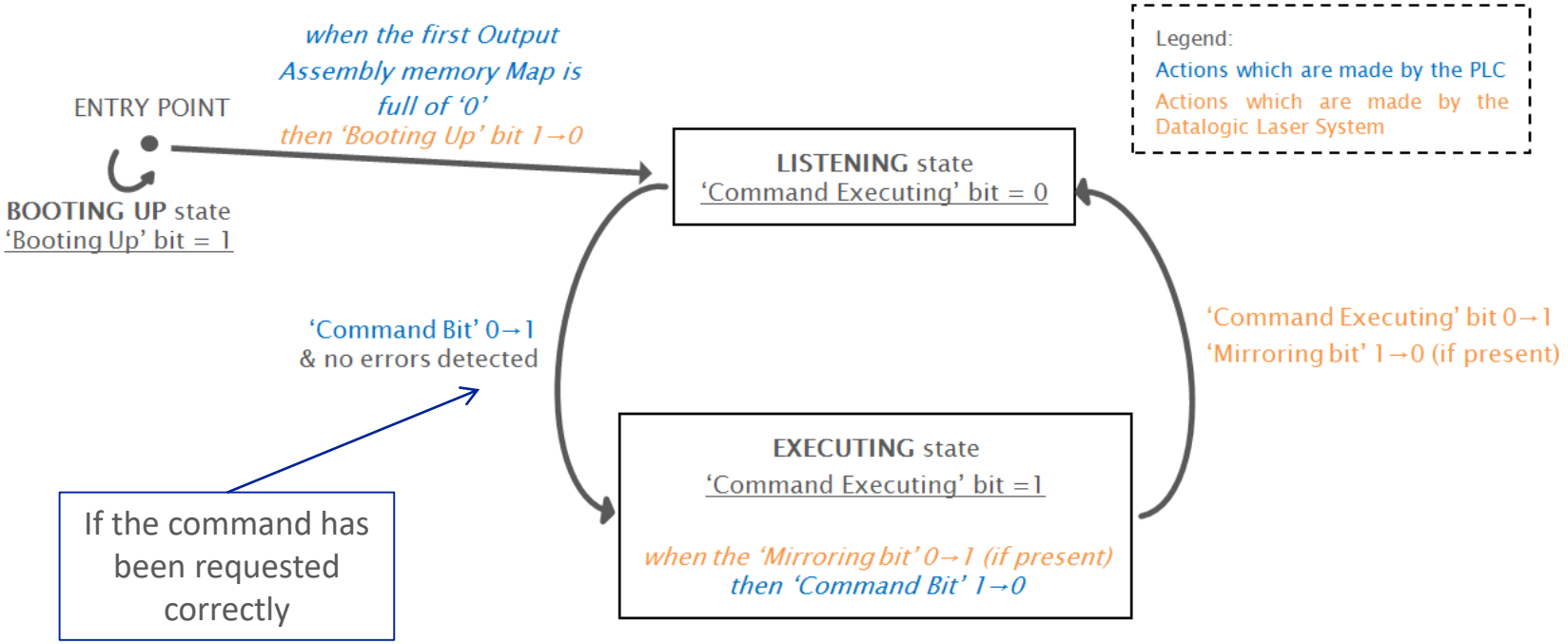
Constant information regarding the Laser Engine current state

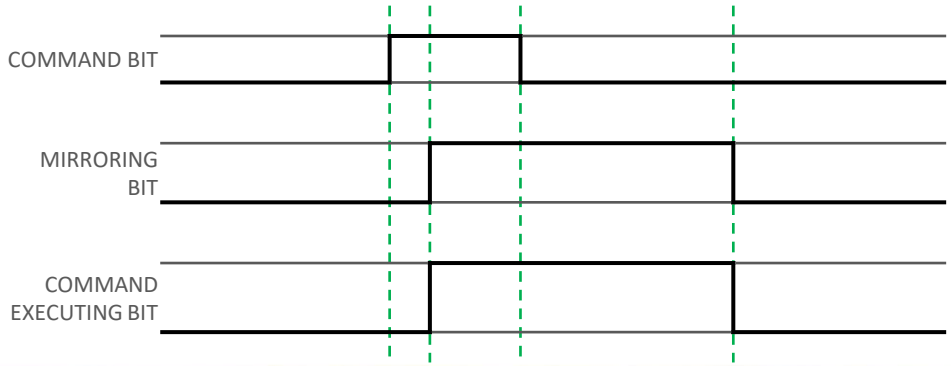
Mirroring bit: informs the PLC when the precise command is being executed (0→1) and when it has been completed (1→0).

Response Data: area where any additional information is placed in reply to a command which requested it.

ADDRESS	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
0	Laser Emission		Laser Ready	Laser Standby Shutter Closed	Laser Standby	Laser Wait for Start	Laser Warm Up	Laser Off
1						Laser Error	Laser Warning	Laser Busy Shutter Closed
2						Protocol Error	Command Error	Command Executing
3	Protocol Boot Up							
4	Command Error Code							
5	Protocol Error Code							
6 to 9	Reserved							
10							Stop System	Start Marking
11							Get Laser Engine Version	Get EIP Protocol Version
12	Set Global String Value	Get Global String Value	Set Global Counter Value	Get Global Counter Value	Set Data Field Value	Get Data Field Value	Save Document	Open Document From Device
13							Disable Data Field	Enable Data Field
14							Move Data Field	Move and Rotate Document
15 to 17	Reserved							
18			Set Focus Distance Reference	Stop Autofocus	Start Autofocus	Stop Axis	Reset Axis	Move Axis
19	Reserved							
20	R Axis is Home	Z Axis is Home	Y Axis is Home	X Axis is Home	R Axis Enabled	Z Axis Enabled	Y Axis Enabled	X Axis Enabled
21			Focus Distance Sensor is available	Z Axis is on Focus	R Axis Movement	Z Axis Movement	Y Axis Movement	X Axis Movement
22 to 23	Reserved							
24							Reset Output	Set Output
25	Reserved							
26	I/O Port Digital Output Status (0..7)							
27	I/O Port Digital Output Status (8..15)							
28	I/O Port Digital Input Status (0..7)							
29	I/O Port Digital Input Status (8..15)							
30 to 33	Reserved							
34				Get ID Marvis Result	Set ID Marvis Configuration	Get ID Marvis Configuration	Get ID Match Result	
35	Reserved							
36	Symbol Match Result Fail	Symbol Match Result OK	Symbol Grade Result Fail	Symbol Grade Result OK	Symbol Read Fail	Symbol Read OK	Marvis Result Fail	Marvis Result OK
37	Reserved							
				Marvis Status Error	Marvis Status Warning	Marvis Status Busy	Marvis Status Available	
39 to 53	Reserved							
54	Response Data Size							
55	Reserved							
56 to 255	Response Data							

EtherNet/IP state diagram for Laser Marking devices



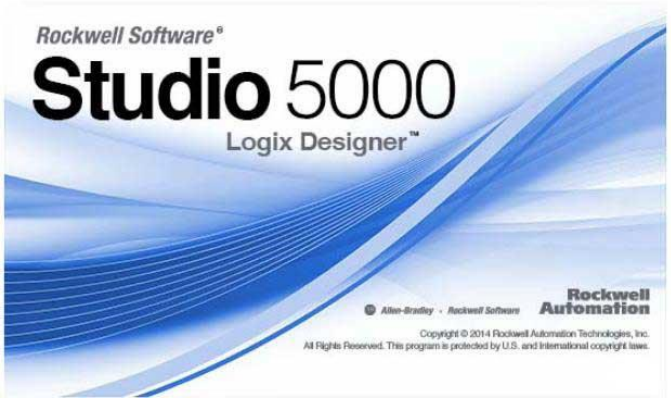


EtherNet/IP on a Rockwell Automation PLC device – using Studio5000

Rockwell Automation

Allen-Bradley • Rockwell Software

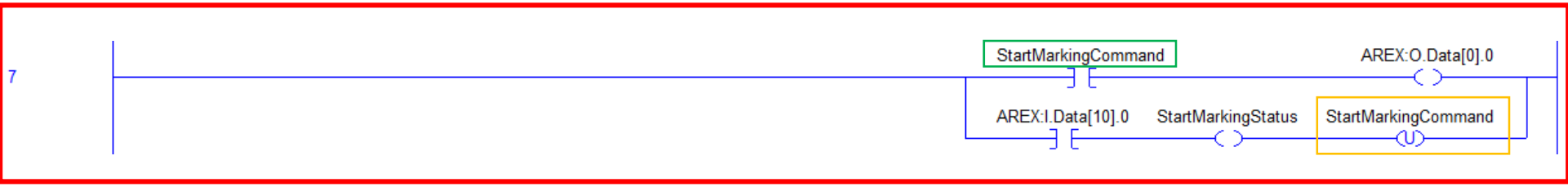
Introduction



- Rockwell is the reference point for EtherNet/IP, and Studio5000 is the up-to-date software they released for PLC control.
- The following screenshots will be shown from Studio5000 v.30; they were entirely tested with a CompactLogix L18ER PLC.
- This chapter doesn't aim at showing how to programme a PLC for EtherNet/IP: we want to show how to manage a Datalogic EtherNet/IP ready device by using Studio5000.

Tips and tricks (1)

- Develop each command and reply analysis on a single Rung, dividing the superior part of the Rung for the Command Request –Command Rung- and the inferior part to monitor the Command execution – Status Rung.
- When assigning names to variables, is it recommendable to use a syntax which allows users to mentally connect immediatly to the functionality. E.g. the 'Start Marking' command must be executed when the 'StartMarkingCommand' bit is Latched, and the Mirroring Bit can be monitored by checking the 'StartMarkingStatus'
- Remember to unlatch the Command bit as soon as the Mirroring Bit has been pulled up, so to perform the handshake.

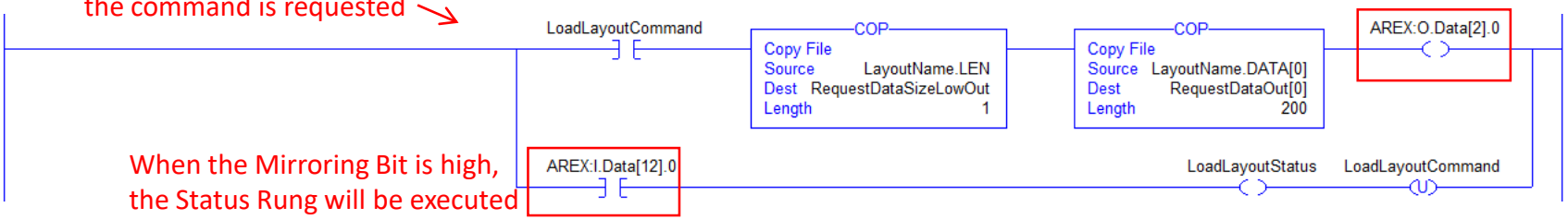


Tips and tricks (2)

- Develop each command and reply analysis on a single Rung, dividing the superior part of the Rung for the Command Request –Command Rung- and the inferior part to monitor the Command execution – Status Rung.

When triggering this Local Tag the command is requested

Piloting the Command Bit



When the Mirroring Bit is high, the Status Rung will be executed

These two Local Tags will be copied on the Output Memory Map:

⊞ RequestDataOut	Local			SINT[200]
⊞ RequestDataSizeLowOut	Local			SINT

.LEN →
.DATA →

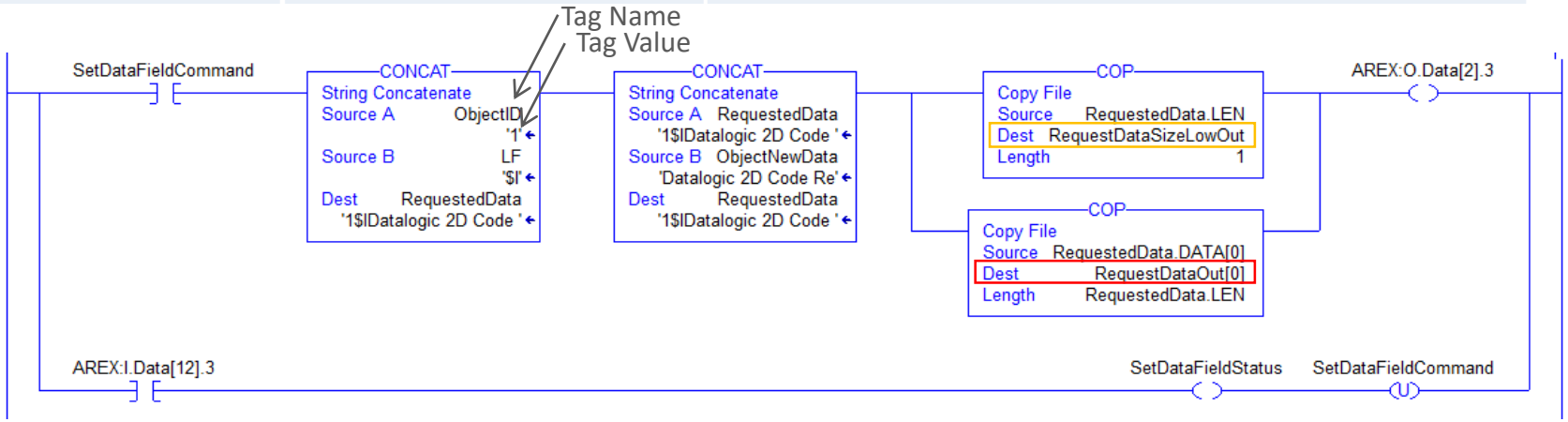
⊟ LayoutName	Local	'Layout1.xlp'	{...}		STRING
⊞ LayoutName.LEN		11		Decimal	DINT
⊟ LayoutName.DATA		{...}	{...}	ASCII	SINT[82]
⊞ LayoutName.DATA[0]		'L'		ASCII	SINT
⊞ LayoutName.DATA[1]		'a'		ASCII	SINT
⊞ LayoutName.DATA[2]		'y'		ASCII	SINT
⊞ LayoutName.DATA[3]		'o'		ASCII	SINT
⊞ LayoutName.DATA[4]		'u'		ASCII	SINT
⊞ LayoutName.DATA[5]		't'		ASCII	SINT
⊞ LayoutName.DATA[6]		'1'		ASCII	SINT
⊞ LayoutName.DATA[7]		'.'		ASCII	SINT
⊞ LayoutName.DATA[8]		'x'		ASCII	SINT
⊞ LayoutName.DATA[9]		'l'		ASCII	SINT
⊞ LayoutName.DATA[10]		'p'		ASCII	SINT
⊞ LayoutName.DATA[11]		'$00'		ASCII	SINT
⊞ LayoutName.DATA[12]		'$00'		ASCII	SINT
⊞ LayoutName.DATA[13]		'$00'		ASCII	SINT

'LayoutName' is a *String* data type local tag: once a String is defined in Studio5000, users can access two proprieties of the variable:

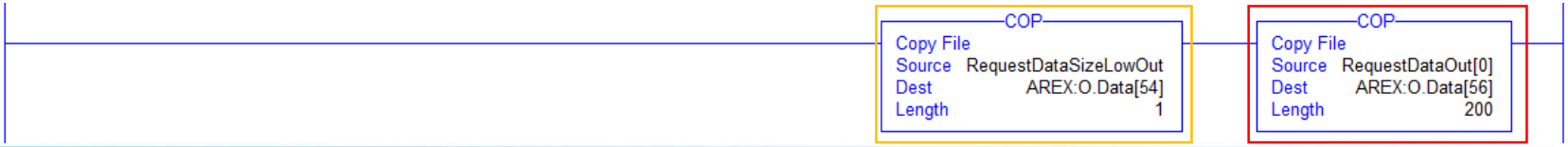
Tips and tricks (3)

- When in need to populate the ‘Request Data’ and the ‘Request Data Size’ field on the Output memory map, concatenate the necessary information on the Command Rung and populate a SINT Array. E.g. RequestData, here shown.

Set Data Field Value	**0→1 Sets the content of the specified Data Field ; 1→0 as soon as the mirroring bit is HIGH**	**Sets the content of the object which ID is specified in the Request Data Field, which should follow this syntax: <FieldID><LF><NewValue>**



Then, you will be able to use the following rung for copying the bytes from the Local Tags onto the Output Memory Map.



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