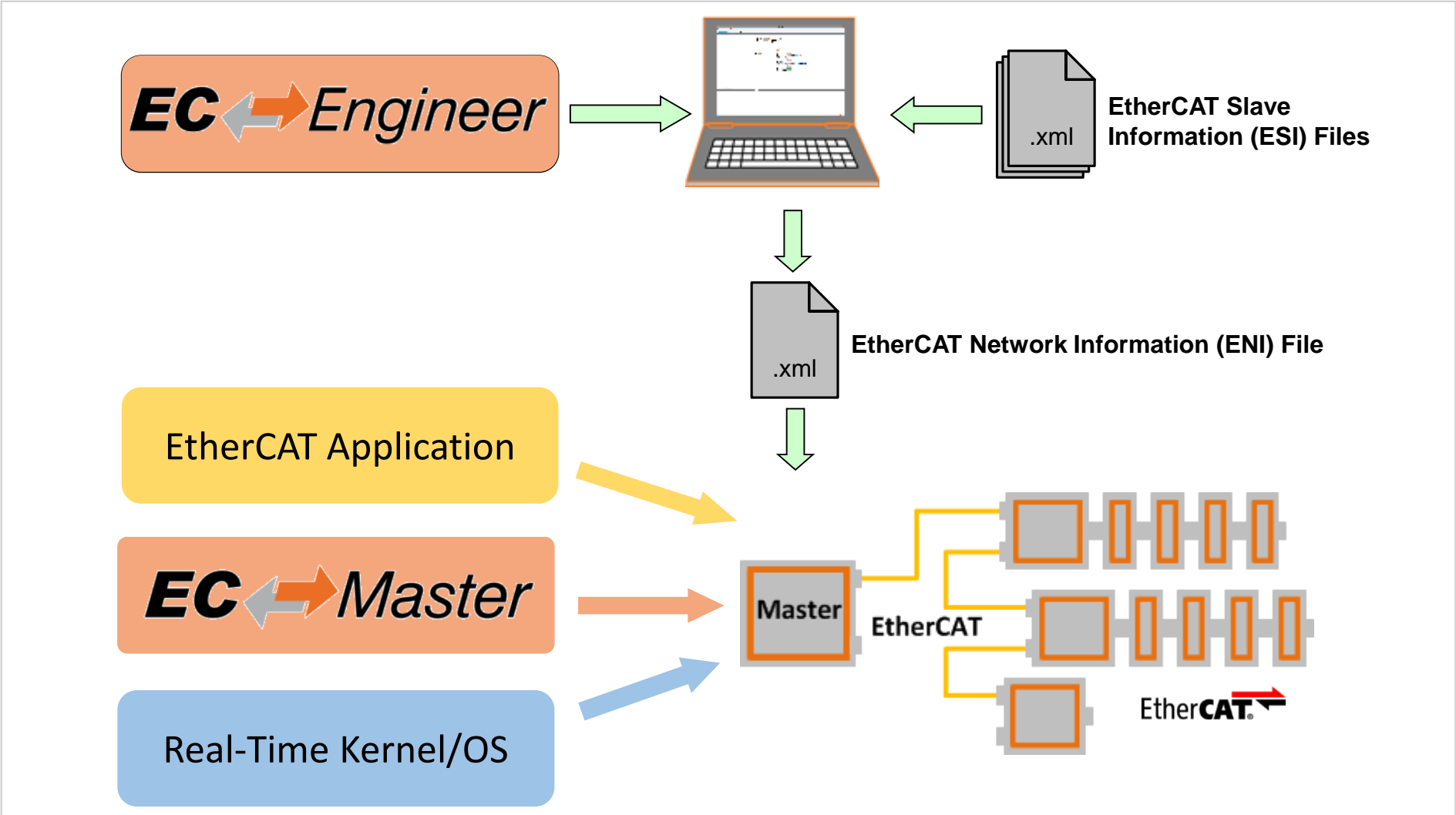


EC ***Master***

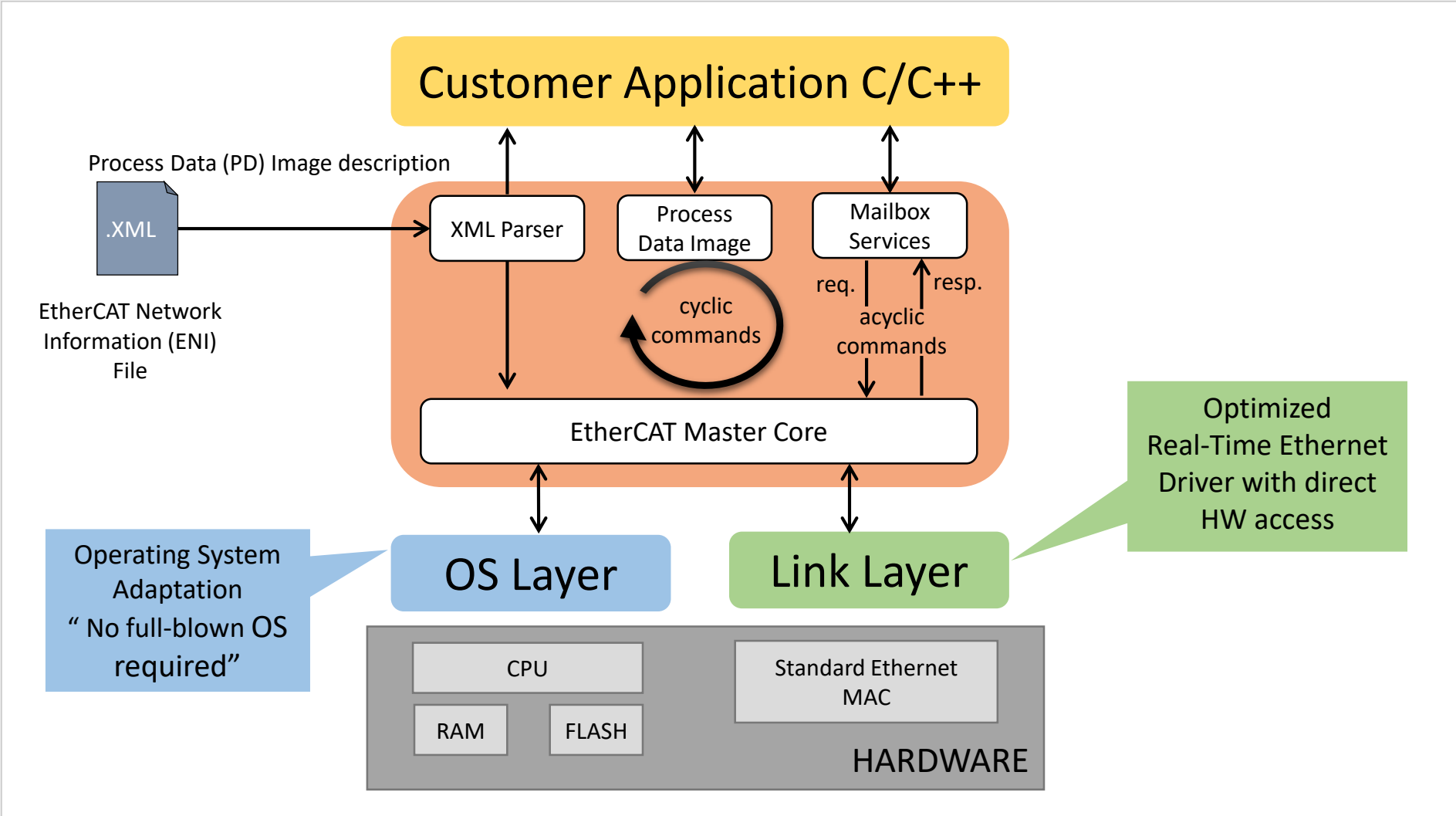
Quick Start Guide

- EtherCAT System Architecture
- EtherCAT Master Architecture
- EtherCAT Master Building Blocks
- Generate bus configuration with EC-Engineer
- Operate slaves with EC-STA EtherCAT Slave Test Application
- Connect EC-Engineer with EC-STA Application
- Next steps

EtherCAT System Architecture



EC-Master Architecture



EC-Master according to ETG.1500 Master Classes Directive

Class B Core

- Compare network configuration
- Cyclic process data exchange
- Slave to slave communication
- Mailbox protocols CoE
- Mailbox protocols SoE
- Mailbox protocols EoE

Class A Core

- All Class B Features
- Mailbox protocol FoE
- Mailbox protocol AoE
- Mailbox protocol VoE
- **Distributed Clocks with master synchronization**

Feature Pack
Cable Redundancy

Feature Pack
Hot Connect

Feature Pack
Remote Access

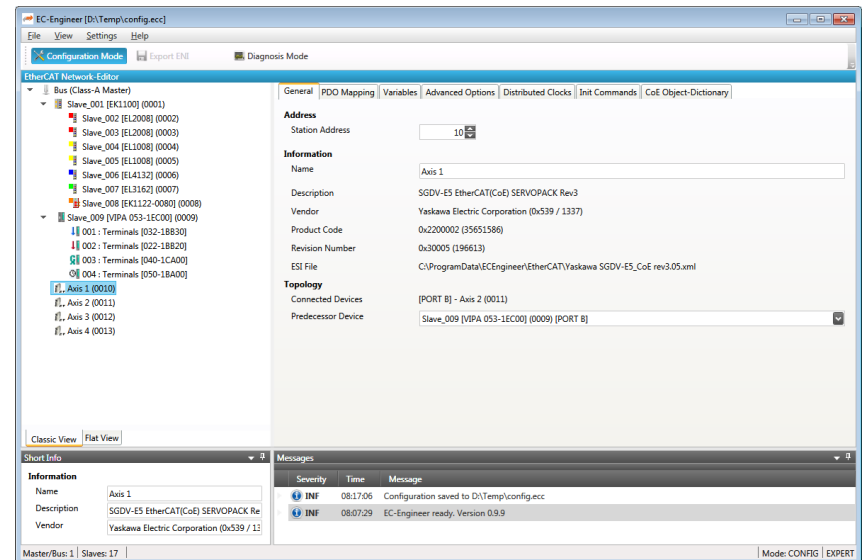
Feature Pack
Superset ENI

Feature Pack
EoE Endpoint

Feature Pack
Master Obj. Dict.

EC-Engineer: Overview

- One single tool for EtherCAT configuration and diagnosis
- Perfect supplement to EC-Master
- Import of EtherCAT Slave Information (ESI) files
- Export of EtherCAT Network Information (ENI) file
- Register here to get a free evaluation version:
<https://www.acontis.com/en/ecdownloads.html>

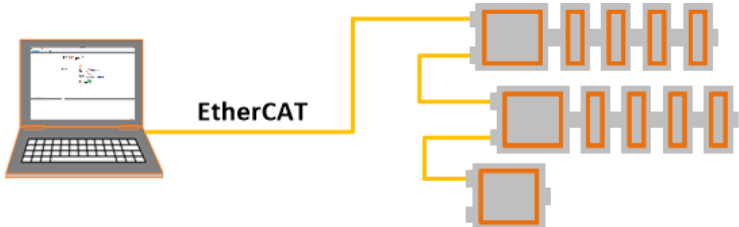


Operating Modes

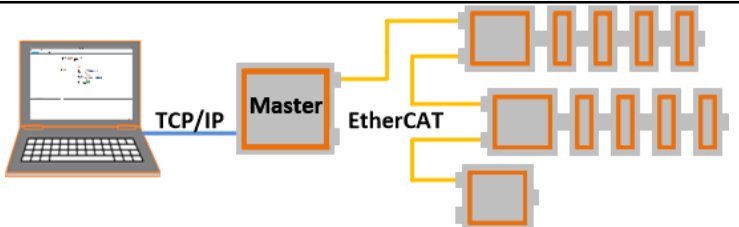
Offline **Configuration:**
(In the Office)



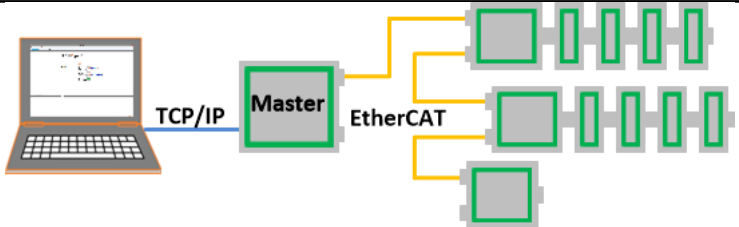
Online **Configuration:**
Slaves connected to
Engineering System



Remote **Configuration:**
Slaves connected to
Target System



Remote **Diagnosis:**
Slaves connected to
Target System



Generate bus configuration with EC-Engineer

Step 1: Connect EtherCAT Slaves

- EC-Engineer comes with an integrated EtherCAT master for scanning the connected EtherCAT slaves
- Every Ethernet Network Interface with an valid Windows driver can be used
- A second, dedicated Network Interface for EtherCAT is recommend
- Warning: Do not connect any EtherCAT slaves to your Office LAN



Generate bus configuration with EC-Engineer

Step 2: Install and start EC-Engineer

The screenshot displays the EC-Engineer software interface. The window title is "EC-Engineer [--]". The menu bar includes "File", "View", "Network", "Settings", and "Help". Below the menu bar, there are buttons for "Configuration Mode" (active), "Export ENI", and "Diagnosis Mode".

The main workspace is divided into two panes:

- Project Explorer:** Currently empty.
- Device Editor:** Shows the "Start Page" with the "EC ↔ Engineer" logo. It features several sections:
 - Add Master Unit:** Lists three options: "EtherCAT Master Unit (Class A)", "EtherCAT Master Unit (Class B)", and "EtherCAT Master Unit (Beckhoff CX5000)".
 - Getting Started:** Contains four diagrams illustrating different configuration scenarios:
 - Offline Configuration:** "In the Office", showing a laptop connected to a bus system.
 - Online Configuration:** "Slaves connected to Engineering System", showing a laptop connected to a bus system via "EtherCAT".
 - Remote Configuration:** "Slaves connected to Target System", showing a laptop connected to a "Master" unit via "TCP/IP", which is then connected to a bus system via "EtherCAT".
 - Remote Diagnosis:** "Slaves connected to Target System", showing a laptop connected to a "Master" unit via "TCP/IP", which is then connected to a bus system via "EtherCAT".

At the bottom of the interface, there are several status and information panels:

- Short Info:** Includes "Information" and "Networks: 0 | Slaves: 0".
- Messages:** A log table with columns "Severity", "Time", and "Message". It contains one entry: "INF 16:45:01 EC-Engineer ready. Version 2.4.0".
- Bottom Bar:** Shows "State: [indicators]" and "Mode: CONFIG | STANDARD".

Generate bus configuration with EC-Engineer

Step 3: Select "Online Configuration" and "EtherCAT Master Unit (Class A)"



The screenshot shows the EC-Engineer software interface. The main window displays the 'EC Engineer' logo and a 'Getting Started' section with four configuration options:

- Offline Configuration**: In the Office
- Online Configuration**: Slaves connected to Engineering System
- Remote Configuration**: Slaves connected to Target System
- Remote Diagnosis**: Slaves connected to Target System

An 'Add Master Unit' dialog box is open, titled 'Select Master Unit Dialog'. It contains the text 'Select the desired master unit from the list:' and a dropdown menu showing 'EtherCAT Master Unit (Class A)'. The dialog has 'OK' and 'Cancel' buttons.

The interface also includes a 'Project Explorer' on the left, a 'Device Editor' at the top right, and a 'Messages' panel at the bottom right showing a message: 'INF 16:45:01 EC-Engineer ready. Version 2.4.0'. The status bar at the bottom indicates 'State: [Indicator] Mode: CONFIG STANDARD'.

Generate bus configuration with EC-Engineer

Step 4: Choose network adapter from list and press "Select"

The screenshot shows the EC-Engineer software interface. The main window is titled "EC-Engineer [---]" and has a menu bar with "File", "View", "Network", "Settings", and "Help". Below the menu bar, there are buttons for "Configuration Mode" (active), "Export ENI", and "Diagnosis Mode".

The interface is divided into several panes:

- Project Explorer:** Shows a tree view with "Class-A Master" selected.
- Device Editor:** Contains configuration fields for the selected device.
 - General:** Unit Name (Class-A Master), Cycle Time [us] (1000), Source MAC address.
 - Slaves connected to local system:** Network Adapter (EtherCAT2 (Realtek RTL8168C(P)/8111C(P) Family PCI-E Gigabit Ethernet NIC (NDIS 6.20))). A red box highlights this section, and a "Select" button is visible.
 - Slaves connected to remote system:** IP Address (127 . 0 . 0 . 1), Port (6000), Master-Instance (0). A "Select" button is next to the Master-Instance field. A tooltip "Master-Instance of the remote system" is shown below the field.
- Short Info:** Information pane showing Name (Class-A Master) and Description (EtherCAT Master Unit (Class-A)).
- Messages:** Log pane showing a message: "INF 16:45:01 EC-Engineer ready. Version 2.4.0".

At the bottom, there are view options: "Classic View", "Flat View", and "Topology View". The status bar at the bottom right shows "State: [indicators] Mode: CONFIG STANDARD".

Generate bus configuration with EC-Engineer

Step 5: The found slave devices are listed in the tree



The screenshot shows the EC-Engineer software interface. The 'Project Explorer' on the left lists a 'Class-A Master' and seven slave devices: Slave_1001 [EK1100] (1001), Slave_1002 [EL2004] (1002), Slave_1003 [EL2004] (1003), Slave_1004 [EL1014] (1004), Slave_1005 [EL1014] (1005), Slave_1006 [EL4132] (1006), and Slave_1007 [EK1110] (1007). The 'Device Editor' on the right shows configuration for the 'Class-A Master' with fields for Unit Name, Cycle Time, Source MAC address, Network Adapter, IP Address, Port, and Master-Instance. A 'Messages' pane at the bottom shows a log entry: 'Master state change from 'Unknown' to 'Init''. The status bar at the bottom indicates 'State: [Icons] Mode: CONFIG STANDARD'.

Generate bus configuration with EC-Engineer

Step 6: Export ENI file



The screenshot shows the EC-Engineer software interface in Configuration Mode. The Project Explorer on the left lists a 'Class-A Master' unit and seven slave units (Slave_1001 to Slave_1007). The right pane shows configuration details for the selected 'Class-A Master' unit, including General settings (Unit Name, Cycle Time, Source MAC address), Slaves connected to local system (Network Adapter), and Slaves connected to remote system (IP Address, Port, Master-Instance). The Messages pane at the bottom shows a log entry: 'Master state change from 'Unknown' to 'Init''. The status bar at the bottom indicates 'State: [Indicator] Mode: CONFIG STANDARD'.

Project Explorer

- Class-A Master
 - Slave_1001 [EK1100] (1001)
 - Slave_1002 [EL2004] (1002)
 - Slave_1003 [EL2004] (1003)
 - Slave_1004 [EL1014] (1004)
 - Slave_1005 [EL1014] (1005)
 - Slave_1006 [EL4132] (1006)
 - Slave_1007 [EK1110] (1007)

Configuration Editor

General

Unit Name: Class-A Master

Cycle Time [us]: 1000

Source MAC address: 00-0A-CD-16-BD-DD

Slaves connected to local system

Network Adapter: EtherCAT2 (Realtek RTL8168C(P)/8111C(P) Family PCI-E Gigabit Ethernet NIC (NDIS 6.20))

Slaves connected to remote system

IP Address: 127 . 0 . 0 . 1

Port: 6000

Master-Instance: 0

Messages

Severity	Time	Message
INF	16:49:01	Master state change from 'Unknown' to 'Init'

State: [Indicator] Mode: CONFIG STANDARD

Generate bus configuration with EC-Engineer

Step 7: Switch to "Diagnosis Mode" and set state to OPERATIONAL



The screenshot shows the EC-Engineer software interface. The main window is titled "EC-Engineer [--]" and has a menu bar with "File", "View", "Network", "Settings", and "Help". Below the menu bar, there are buttons for "Configuration Mode" (highlighted), "Export ENI", and "Diagnosis Mode". The "Project Explorer" on the left shows a tree structure under "Class-A Master" with seven slave units: Slave_1001 [EK1100] (1001), Slave_1002 [EL2004] (1002), Slave_1003 [EL2004] (1003), Slave_1004 [EL1014] (1004), Slave_1005 [EL1014] (1005), Slave_1006 [EL4132] (1006), and Slave_1007 [EK1110] (1007). The main area is divided into "General" and "Slaves connected to local system" sections. A dialog box titled "EC-Engineer" is open in the center, asking "Do you want to set the master state to OPERATIONAL?" with buttons for "Ja", "Nein", and "Abbrechen". The "Messages" panel at the bottom shows a log entry: "INF 16:49:01 Master state change from 'Unknown' to 'Init'". The status bar at the bottom right indicates "State: [indicators] Mode: CONFIG STANDARD".

Generate bus configuration with EC-Engineer

Step 8: Bus is OPERATIONAL



The screenshot shows the EC-Engineer software interface in Diagnosis Mode. The Project Explorer on the left shows a Class-A Master connected to 7 slaves (Slave_1001 to Slave_1007). The Device Editor on the right shows the State Machine and Information sections. The State Machine section shows the Current State and Requested State as 'Op'. The Information section shows the Number of found slaves as 7, Number of slaves in configuration as 7, Number of DC slaves as 0, DC in-sync as '-', Topology Ok as Yes, Link Connected as Yes, and Slaves in Master State as Yes. The Frame Counter section shows Sent frames as 52532, Lost frames as 0, Cyclic frames as 52416, and Acyclic frames as 116. The Messages section at the bottom shows a message: 'Master state change from 'Safe-Op' to 'Op''. The status bar at the bottom right shows State: Mode: DIAGNOSIS | STANDARD.

Section	Parameter	Value
State Machine	Current State	Op
	Requested State	Op
Information	Number of found slaves	7
	Number of slaves in configuration	7
	Number of DC slaves	0
	DC in-sync	-
	Topology Ok	Yes
	Link Connected	Yes
	Slaves in Master State	Yes
Frame Counter	Sent frames	52532
	Lost frames	0
	Cyclic frames	52416
	Acyclic frames	116

Generate bus configuration with EC-Engineer

Step 9: Switch back to "Configuration Mode" and Exit



The screenshot shows the EC-Engineer software interface. The main window is titled "EC-Engineer [--]" and has a menu bar with "File", "View", "Network", "Settings", and "Help". The "File" menu is open, showing options like "New", "Open", "Save", "Save As", "Print", "Add Master-Unit", "ESI Manager", "EMI Manager", "Recent Projects", and "Exit". The "Add Master-Unit" option is selected, and a list of units is visible: "00] (1001)", "L2004] (1002)", "L2004] (1003)", "L1014] (1004)", "L1014] (1005)", "L4132] (1006)", and "K1110] (1007)".

The "Device Editor" window is open, showing the configuration for a "Master" unit. The "Process Data Image" tab is selected. The "General" section contains the following fields:

- Unit Name: Class-A Master
- Cycle Time [us]: 1000
- Source MAC address: 00-0A-CD-16-BD-DD

The "Slaves connected to local system" section contains the following field:

- Network Adapter: EtherCAT2 (Realtek RTL8168C(P)/8111C(P) Family PCI-E Gigabit Ethernet NIC (NDIS 6.20))

The "Slaves connected to remote system" section contains the following fields:

- IP Address: 127 . 0 . 0 . 1
- Port: 6000
- Master-Instance: 0

The "Short Info" panel at the bottom left shows the "Information" section with the following details:

- Name: Class-A Master
- Description: EtherCAT Master Unit (Class A)
- Networks: 1 | Slaves: 7

The "Messages" panel at the bottom right shows a log entry:

Severity	Time	Message
INF	16:53:27	Master state change from 'Op' to 'Init'

The status bar at the bottom right shows "State: [Indicator] | Mode: CONFIG | STANDARD".

- Extract/Install the EC-Master by running setup.exe
 - Note: Some platforms as ZIP/tar.gz archive, not as setup.exe
- The documentation including this Quick Start Guide is in folder “Doc”
- There is an EC-SlaveTestApplication starter in the Windows start menu

Operate slaves with EC-STA Slave Test Application

Step 1: Start EC-STA from the start menu and configure

EC-SlaveTestApplication V2.8.1.01

File Log Help

Configuration Master Slave Process Data CoE FoE AoE SoE EEPROM Notifications DemoMotion

Master Settings

Local

Master Cycle Time (usec): 2000 Use Soft Real-time Timer

Link Layer

WinPCAP

Adapter: EtherCAT2 1

Mode: Polling

Redundancy Link Layer

WinPCAP

Adapter: EoE

Mode: Polling

Enable Remote API Server RAS Port: 6000 2

Remote

IP-Address: 127.0.0.1 Port: 6000 Master-Instance: 0 Download configuration

EtherCAT Network Information file (ENI)

D:\eni.xml 3 Create with EC-Engineer

Hint:
The ENI file can be generated with an EtherCAT Configurator such as our EC-Engineer. An evaluation version can be downloaded from www.acontis.com

Masterstate: Unknown Not Operational Slaves: 0000 Frames Lost: 0 Cyclic WKC Errors: 0



Operate slaves with EC-STA Slave Test Application

Step 2: Initialize and set master state to operational



The screenshot shows the EC-SlaveTestApplication V2.8.1.01 interface. On the left, a tree view shows a 'Master' node with seven slave nodes: Slave_1001 [EK1100], Slave_1002 [EL2004], Slave_1003 [EL2004], Slave_1004 [EL1014], Slave_1005 [EL1014], Slave_1006 [EL4132], and Slave_1007 [EK1110]. The 'Master' node is selected, and a red box with the number '1' highlights the 'Initialize' button in the 'Initialize Master with configuration parameter' section. Below this, the 'Master State' section has buttons for 'Init', 'Pre-Op', 'Safe-Op', and 'Operational'. The 'Operational' button is highlighted with a red box and the number '2'. The 'Current State' and 'Requested State' are both set to 'OP'. The 'State Change Timeout' is set to '15.000'. The 'Bus Topology' section has a 'Scan Bus' button and a 'Scan Bus Timeout' of '3.000'. The 'Connected Slaves' and 'Configured Slaves' are both '7'. The 'Result' is 'SUCCESS'. The bottom status bar shows 'Masterstate: Operational | Not Operational Slaves : 0000 | Frames Lost : 0000 | Cyclic WKC Errors : 0000'. The log window at the bottom contains the following text:

```
EC-Master V2.8.1.01 (Eval) for Windows_x86 Copyright acontis technologies GmbH @ 2016
EcLinkOpen(): Use WinPcap version 4.1.3 (packet.dll version 4.1.0.2980), based on libpcap version 1.0 branch 1_0_re10b (20091008)
EcLinkOpen(): Use network adapter "Realtek RTL8168C/8111C PCI-E Gigabit Ethernet NIC"
Unlicensed version, stop sending ethernet frames after 60 minutes!
Bus scan successful - 7 slaves found
Master state changed from <UNKNOWN> to <INIT>
Master state changed from <INIT> to <PREOP>
Master state changed from <PREOP> to <SAFEOP>
Master state changed from <SAFEOP> to <OP>
```

Operate slaves with EC-STA Slave Test Application

Step 3: Do further tests, e. g., flashing outputs

1

2

acontis technologies

EC-SlaveTestApplication V2.8.1.01

File Log Help

Master

- Slave_1001 [EK1100]
- Slave_1002 [EL2004]
- Slave_1003 [EL2004]
- Slave_1004 [EL1014]
- Slave_1005 [EL1014]
- Slave_1006 [EL4132]
- Slave_1007 [EK1110]

Configuration | Master | Slave | Process Data | CoE | FoE | AoE | SoE | EEPROM | Notifications | DemoMotion

Slave (Fixed Address): 1002

Slave State

Init Pre-Op Safe-Op Operational

Boot Strap State Change Timeout: 3.000

Current State: OP Requested State: OP

Status: No error

Slave Information

Device Name: Slave_1002 [EL2004]

Vendor ID: 0x2

Productcode: 0x7D43052

Revision: 0x110000

Serial: 0x0

Address: 0x3EA

Alias: 0x0

Config Address: 0x3EA

Hot Connect

Present HC Group

Distributed Clocks

32-Bit 64-Bit

System Time Difference (0x92C): 0 ns

ESC Register / Memory

Offset (hex): 0 Data Size: 2

Timeout: 3000

Write

Read

Process Data

Offset (Byte / Bits)	Size (Byte / Bits)	Flash
0.0 / 0	0.4 / 4	<input checked="" type="checkbox"/>

acontis technologies

EC-Master V2.8.1.01 (Eval) for Windows_x86 Copyright acontis technologies GmbH @ 2016
EcLinkOpen(): Use WinPcap version 4.1.3 (packet.dll version 4.1.0.2980), based on libpcap version 1.0 branch 1_0_re10b (20091008)
EcLinkOpen(): Use network adapter "Realtek RTL8168C/8111C PCI-E Gigabit Ethernet NIC"
Unlicensed version, stop sending ethernet frames after 60 minutes!
Bus scan successful - 7 slaves found
Master state changed from <UNKNOWN> to <INIT>
Master state changed from <INIT> to <PREOP>
Master state changed from <PREOP> to <SAFEOP>
Master state changed from <SAFEOP> to <OP>

Masterstate: Operational | Not Operational Slaves: 0000 | Frames Lost: 0000 | Cyclic WKC Errors: 0000

Connect EC-Engineer with EC-STA Application

Step 1: Start EC-Engineer and select "Remote Diagnosis"

The screenshot displays the EC-Engineer software interface. The main window is titled "EC-Engineer [--]" and features a menu bar with "File", "View", "Network", "Settings", and "Help". Below the menu bar, there are buttons for "Configuration Mode" (selected), "Export ENI", and "Diagnosis Mode".

The interface is divided into several sections:

- Project Explorer:** A sidebar on the left, currently empty.
- Device Editor:** The main workspace, showing the "Start Page" with the "EC Engineer" logo.
- Add Master Unit:** A list of three options: "EtherCAT Master Unit (Class A)", "EtherCAT Master Unit (Class B)", and "EtherCAT Master Unit (Beckhoff CX5000)".
- Getting Started:** A diagram illustrating four configuration scenarios:
 - Offline Configuration:** "In the Office", showing a laptop connected to a rack of slave units.
 - Online Configuration:** "Slaves connected to Engineering System", showing a laptop connected to a rack via "EtherCAT".
 - Remote Configuration:** "Slaves connected to Target System", showing a laptop connected to a "Master" unit via "TCP/IP", which is then connected to a rack via "EtherCAT".
 - Remote Diagnosis:** "Slaves connected to Target System", showing a laptop connected to a "Master" unit via "TCP/IP", which is then connected to a rack via "EtherCAT". This section is highlighted with a red box and a red "1".

At the bottom of the interface, there are two panels:

- Short Info:** Contains "Information" and "Networks: 0 | Slaves: 0".
- Messages:** A table with columns "Severity", "Time", and "Message". It shows a message: "INF 17:00:16 EC-Engineer ready. Version 2.4.0".

The bottom right corner shows the status: "State: [indicator] Mode: CONFIG STANDARD".

Connect EC-Engineer with EC-STA Application

Step 2: Choose "Slaves connected to remote system"



The screenshot shows the EC-Engineer software interface. The main window is titled "EC-Engineer [--]" and has a menu bar with "File", "View", "Network", "Settings", and "Help". Below the menu bar are two tabs: "Configuration Mode" (active) and "Diagnosis Mode".

The interface is divided into several panes:

- Project Explorer:** Shows a tree view with "Class-A Master" selected.
- Device Editor:** Contains configuration fields for the selected device.
 - General:** Unit Name (Class-A Master), Cycle Time [us] (1000), Source MAC address.
 - Slaves connected to local system:** Network Adapter (EtherCAT2 (Realtek RTL8168C(P)/8111C(P) Family PCI-E Gigabit Ethernet NIC (NDIS 6.20))).
 - Slaves connected to remote system:** IP Address (127 . 0 . 0 . 1), Port (6000), Master-Instance (0).
- Short Info:** Information pane showing Name (Class-A Master) and Description (EtherCAT Master Unit (Class A)).
- Messages:** Log pane showing a message: "INF 17:00:16 EC-Engineer ready. Version 2.4.0".

At the bottom of the interface, there are view options (Classic View, Flat View, Topology View), a status bar showing "Networks: 1 | Slaves: 0", and a mode indicator "State: Mode: CONFIG | STANDARD".

Connect EC-Engineer with EC-STA Application

Step 3: Check input or output variables

The screenshot shows the EC-Engineer software interface. The Project Explorer on the left shows a tree structure with 'Class-A Master <connected>' and several slave devices. The 'Slave_1002 [EL2004] (1002)' device is selected. The Device Editor on the right has the 'Variables' tab active, displaying a table of variables for the selected device.

Name	Datatype	Group Info	Offset	Size	Value	Forced
Slave_1002 [EL2004].Channel 1.Output	BOOL	[Default]	OUT :	0.0 0.1	0	<input type="checkbox"/>
Slave_1002 [EL2004].Channel 2.Output	BOOL	[Default]	OUT :	0.1 0.1	1	<input type="checkbox"/>
Slave_1002 [EL2004].Channel 3.Output	BOOL	[Default]	OUT :	0.2 0.1	0	<input type="checkbox"/>
Slave_1002 [EL2004].Channel 4.Output	BOOL	[Default]	OUT :	0.3 0.1	0	<input type="checkbox"/>

Below the table is a 'Chart' section showing a digital signal waveform. The 'Edit Variable' section shows the current value is 'False' and includes 'Force' and 'Release' buttons. The 'Messages' panel at the bottom shows a status message: 'INF 17:00:16 EC-Engineer ready, Version 2.4.0'. The bottom status bar indicates 'State: [red dot] [green dot] Mode: DIAGNOSIS | EXPERT'.

- Run EcMasterDemo on your target system
 - 2 Getting Started
 - 2.3 Operating system configuration
 - 2.3.1 Link Layer selection
 - 2.4 Running EcMasterDemo

- Learn more about EcMasterDemo and the application framework
 - 3.1 Application Framework

- Development and runtime licensing process
 - 1.4 Protected version