Documentation about

IPC Security

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BECKHOFF

Contents

1.Foreword

1.1. Notes on the documentation

This description is only intended for the use of trained specialists in control and automation technology who are familiar with the applicable national standards. It is essential that the following notes and explanations are considered when installing and commissioning these components. The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

1.1.1. Disclaimer

This documentation has been prepared with care. The security measures described, as well as methods of third parties to attack computers are, however, constantly changing. For that reason it is possible that the security measures described in this documentation are not sufficient to wholly protect computer against illegal attacks. For the most effective security for your Industrial PCs and Embedded PCs you are obliged to engage always the most current security applications available on the market. This documentation can only provide a basis for security and does not release you from your own liability. In the event that the documentation contains technical or editorial errors, we retain the right to make alterations at any time and without warning.

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The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, DE102004044764, DE102007017835 with corresponding applications or registrations in various other countries. The TwinCAT Technology is covered, including but not limited to the following patent applications and patents: EP0851348, US6167425 with corresponding applications or registrations in various other countries.

1.1.4. Copyright

1.1.5. Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH apply.

1.2. Documentation status

Version	Comment
2.0.3	▪ Addressing Windows 10
2.0.2	▪ Layout changes
2.0.1	▪ Revision of the document
2.0.0	▪ New structure for content ▪ Moved step-by-step articles to appendix for better reading experience ▪ Re-design of tables New content: ▪ New chapter: 2 Introduction ▪ New introductory areas for every major chapter ▪ Added “Potential threats” article to every major chapter ▪ New chapter: TwinCAT (Indirect local access) ▪ New chapter: Checklists for specific scenarios
1.1.0	New content: ▪ New chapter: 3.1.2 Deactivating the Webserver ▪ New chapter: 3.2.6 Deactivating the Webserver ▪ New chapter: 4.1 Windows CE ▪ New chapter: 4.1.1 Notes about Updates ▪ New chapter: 7.3 TwinCAT remote control ▪ New chapter: 7.3.1 ADS connection through a firewall ▪ New chapter: 7.3.2 ADS Routing via Gateway-PC ▪ Updated chapter 7.1.1 Notes about the Remote Desktop Protocol (RDP) ▪ Updated chapter 3.2.4 Whitelisting ▪ Updated chapter 6.1: Network-ports and firewalls
1.0.0	First version

2.Introduction

2.1. Abstract

Beckhoff Industrial PCs and Embedded PCs provide a platform based on a standardized and wellsupported operating system to provide a high level of flexibility for developing and executing applications. The Documentation for IPC-Security provides a list of potential security threats and how to protect against them.

The documentation is structured according to different attacker models and countermeasures for the arising potential threats. This documentation is far from being complete but will be frequently updated and maintained in the future. Please note that, depending on the scenario, it may not make sense to activate all of the listed countermeasures. Sometimes it may even prove to be unnecessary. In any case the reader should make sure to fully understand his/her scenario before planning to implement any security mechanisms.

Security is just another view on risk-management, so there definitely is no completely secure state, just as there is no completely risk-free automation process.

However the documentation provides a good baseline protection, which may be sufficient for most applications.

2.2. Target audience and goals

The primary purpose of this documentation is to give customers an overview about standard security measures and strategies on Industrial-PCs (IPC) and Embedded-PCs (EPC) that are based on Microsoft Windows.

In this context, it is important for customers to understand that Microsoft Windows already includes many features to enhance security on an IPC or EPC, e.g. the so-called "*Application Whitelist*". Those features can greatly increase the protection of industrial controllers. Because many people are not aware of them, they sometimes dread choosing Microsoft Windows on their automation systems.

Furthermore it is also important to differentiate the IPC/EPC we use in an automation scenario with the PC we use in a consumer scenario as an engineering computer or at home. Both scenarios have different security requirements and entirely different workflows, e.g. system maintenance and the deployment of Windows Updates.

2.3. Structure of this document

This documentation is split into three main areas.

General overview and content

Chapter 2 provides the reader with an overview about security in industrial automation and describes the content of this documentation.

Security of an industrial controller

Chapters 3, 4 and 5 are based on three different views on a system's security from the perspective of an attacker. Does the attacker have direct access to the industrial controller, e.g. via mouse/keyboard/monitor → chapter 3. Does the attacker have indirect access to the industrial controller, e.g. because he infiltrated the system via a virus→ chapter 3. Or is the attacker located somewhere in the network and tries to infiltrate or even break the network communication between industrial controller and some other network device→ chapter 5. Every chapter provides an overview about corresponding security measures and will occasionally reference to chapter A.

Step-by-Step and checklists

Chapter A provides step-by-step articles for security mechanisms that were discussed in earlier chapters. The checklists mentioned in this chapter should give the reader a better overview about which security mechanisms are important to activate in different scenarios. The chapter also provides more information about third-party connectivity, e.g. how to connect 3rd party products with the TwinCAT PLC runtime, and discusses common solutions from a security point-of-view.

2.4. Further information

A secure IPC can only be effectively achieved when the technical and organizational environment is providing a suitable support.

There are several frameworks to analyze and measure the technical and organizational structures. The following list is not complete but covers the most relevant frameworks.

IEC 62443 is the upcoming standard for industrial communication systems. The documents are still in progress, however there are usable parts already describing both, organizational and technical concepts and measurements for systems and components.

ISO/IEC 27001 standardizes information security management systems in general. The series is targeting standard Information Technology (IT). However the concepts, best practices and processes are also applicable in part for industrial IT.

NIST SP800-82 Guide to Industrial Control Systems (ICS) Security [12] is concretely targeting the measurement and analysis of threats in industrial control systems.

Another applicable guideline is the IT-Grundschutz-Kataloge [5].

2.5. Addressing security concerns

To address security-related concerns, or security-issues with our products, you may contact us per e-mail at `product-secinfo@beckhoff.com`. We will react to your inquiry as soon as possible.

3.Direct Local Access

3.1. Overview

This chapter deals with the scenario that a cyber criminalhas direct, local access to the industrial controller. The term "*direct local access*" means that the attacker can physically "grasp" the computer and interact with it via attached input devices, e.g. mouse and/or keyboard. A regrettably common scenario would be a machine hall in which the industrial controller is simply located on a desk instead of a locked cabinet and therefore in an exposed location. A potential cyber criminal can then interact with the device via its keyboard and/or mouse, attach USB sticks or even damage the device.

3.1.1. Devices

The following table provides an overview about common devices that play an important part in this scenario.

Device	Category	Description
IPC/EPC	Industrial Controller	Beckhoff Industrial-/Embedded-PC
Keyboard	Input devices	Device used to input data
Mouse	Input devices	Device used to interact with on-screen data
Touchscreen	Input devices	Device used to interact with on-screen data
USB storage	Mass storage devices	USB devices used to store data

3.1.2. Software components

The following table provides an overview about software packages that play an important part in this scenario.

Software	Category	Description
BIOS	Firmware	Firmware interface of a computer
Microsoft Windows 10	System software	Operating System
Microsoft Windows XP	System software	Operating System
Microsoft Windows 7	System software	Operating System
Microsoft Windows Embedded	System software	Operating System
Microsoft Windows CE	System software	Operating system

3.1.3. Potential threat scenarios

The following chapter gives a short overview about possible threat scenarios, which may or may not be representative in your environment. We assume that an attacker is able to gain local access to the device itself, just as this may be the case for a regular user. Please take the following chapters as a means to gain a better awareness for this scenario.

3.1.3.1. Manipulated boot device

An attacker is able to attach and mount a prepared storage media and is able to boot from this device. Alternatively, the attacker could also boot from network, if the device is equipped with such a feature. This may either result from default BIOS settings where the boot priority is set accordingly or from the attacker being able to access and change BIOS settings himself. Due to this, the attacker could gain access to the whole system, including reading/writing unprotected information, e.g. passwords, configurations or business know-how. From this point on, the operating system cannot be assumed to be secure anymore.

3.1.3.2. Manipulated USB storage device

By manipulating USB storage devices, an attacker could execute malware during system runtime if no further security measures are taken. Due to this, an attacker gains access to the operating system with at least the same privileges as the currently logged on user account.

3.1.3.3. Abusing password recovery mechanisms

An attacker is able to boot from other storage devices, as described in 3.1.3.1, gaining access to regular or 3rd party password recovery mechanisms. If the same Administrator password is used on several systems, it is sufficient for the attacker to infiltrate one system to gain administrative privileges to all.

3.1.3.4. Guessing passwords

The attacker may execute brute force or dictionary attacks to guess short, weak or default passwords. Due to this, an attacker could gain access to the affected user account and use its privileges to further infiltrate or manipulate the system.

3.2. Hardening

This chapter explains some common strategies that can be deployed to actively secure components that are part of the scenario. Because the operating system architecture of Windows CE differs from Windows XP, Windows 7, Windows 10 or Windows Embedded, each operating system family is represented by an own chapter.

3.2.1. BIOS

It is recommended to set a password for the system's BIOS to ensure that no changes to critical system functions can be made, for example:

- Changing boot priority
- Resetting BIOS settings
- Changing CPU speed (critical for real-time applications)
- Disabling USB input devices (critical for Control Panel touchscreen)

- Deleting drive content (Low-Level format)

3.2.2. Windows CE

3.2.2.1. Setting a password

By default, Windows CE boots into a modified Microsoft Windows CE shell (Windows CE6 and above). This modified shell helps to protect the device by letting the Administrator to configure the following features:

- [Optional] Configure a device password to avoid that users are able to switch to the Microsoft shell and do configurations on their own.
- [Optional] Configure applications to start automatically.

Please see chapter A.4.2.1 for a Step-by-Step guide.

3.2.2.2. Webserver

Beckhoff Windows CE images are delivered with an integrated Webserver. This Webserver hosts different web-based services, for example, the Beckhoff IPC-Diagnostics website. As it may be sufficient to just close the corresponding firewall ports (as explained in chapter 6.4), you should deactivate the Webserver completely if you do not require or do not use these services.

Please see chapter A.4.2.2 for a Step-by-Step guide and A.4.1.1 for a tabular overview about all webbased services in a Beckhoff operating system image.

3.2.2.3. User accounts

Windows CE implements four different user account types: *System User*, *SMB User*, *RAS User*, *FTP User*. Each account type has its own scope – meaning it is used in a different scenario.

System user account

Windows CE only implements one local user account that is used for system logon. You should set a password for this user account to ensure that no undesired personnel can access the device. Chapter A.4.2.3 shows how to set or change this password.

SMB and FTP user accounts

These user accounts are needed to use the integrated FTP Server or to share files and folders via the integrated SMB Server. Beckhoff Windows CE devices include a small management program that allows you to manage SMB and FTP User accounts. Please make sure to change the default password for the guest and webguest user accounts as soon as possible. Chapter A.4.2.4 shows how to set or change this password.

RAS user accounts

Beckhoff Windows CE devices are equipped with an integrated RAS server to allow remote dialin connections to the embedded device. The RAS Server is deactivated by default so you do not need to worry about changing some kind of default password here as long as you do not activate the RAS server. However, if you would like to use remote dialin functionalities and therefore activate the RAS server, you should change its default passwords as explained in chapter A.4.2.5.

3.2.3. Windows XP / Windows 7 / Windows 10

3.2.3.1. Default passwords

Beckhoff Industrial- and Embedded-PCs are delivered with a default password for the local Administrator account. You should change this password as soon as possible and also keep in mind to use strong passwords. Please see chapter A.4.3.1 for a Step-by-Step guide and A.4.1.2 for more information about strong passwords.

3.2.3.2. Audit Policies

You can audit access to a file or folder by configuring an *Audit Policy*. Each time a user accesses the specified file or folder with a so-called Audit Event (e.g. Read or Write access), a new entry will be created in the Windows Eventlog. Please see chapter A.4.3.2 for a Step-by-Step guide.

3.2.3.3. Password policies

Password policies should be used to ensure the usage of strong passwords on your system. It is possible to configure the following password settings:

Setting	Description
Enforce Password history	Remembers the n last used passwords so that you cannot set them again
Maximum password age	Sets the amount of days a password may be used before the system forces the user to change it
Minimum password age	Sets the amount of days that a password must be used before the user can change it
Password must meet complexity requirements	Complexity requirements are described in chapter A.4.1.2.
Store password using reversible encryption	This option shouldn't be used because a reversible encryption always means that the password can be re-calculated according to some decryption algorithm. However, in some scenarios this needs to be possible, for example when using CHAP with Remote Access

Additionally, you can configure settings that will automatically lock the user account, if a user repeatedly enters a wrong password. All of these settings can be made in the Local Security Settings.

Please note: The complexity requirements defined by older version of Microsoft Windows define a minimum count of 6 characters. Today, many sources recommend using at least 8 characters. Please see chapter A.4.3.3 for a Step-by-Step guide and A.4.1.2 for more information about strong passwords.

3.2.3.4. Security templates

Microsoft Windows deploys a set of pre-defined security templates with every Windows XP or Windows 7 installation. These templates can be customized to meet different security requirements. As soon as you apply a template to your system, it will automatically configure the system according to the security settings defined in the template. There are four different template categories:

Category	Description
Default Security	This template represents the default security settings that are applied during installation of the operating system, including file permissions for the root of the system drive. You can use this template to re-create the default installation settings.
Compatible	This template re-configures your system according to the user groups: *Administrator*, *Power Users* and *Users*. Administrators have the most privileges while Users have the least, which is, of course, not surprising. However, what the template really accomplishes, is, that the system will be reconfigured so that members of the *Users* group may also execute non-certified applications, meaning applications which don't take part in the *Certified for Windows* program. That means: If you want members of the *Users* group to execute non-certified applications, and you don't want to add them to the *Power Users* because this would mean too much privileges, you can apply this template and leave them in the *Users* group. The template therefore relaxes security for this particular group.
Secure	This template defines enhanced security settings that are least likely to impact application compatibility. It defines the following things: ▪ Stronger password, lockout and audit settings ▪ It limits the use of LAN Manager and NTLM authentication protocols by allowing only NTLMv2 responses from Clients. Clients which don't support NTLMv2 won't be able to authenticate to the system anymore ▪ It prevents anonymous users from enumerating account names and shares ▪ It prevents anonymous users from performing SID-to-name or the corresponding reverse functions ▪ It enables SMB packet signing, which is disabled by default
Highly Secure	The *Highly Secure* template is a superset of the *Secure* template that impose further restrictions on the levels of encryption and signing that are required for authentication and for the data that flows over secure channels and between SMB clients and servers.

Please see chapter A.4.3.4 for a Step-by-Step guide.

3.2.3.5. Application Whitelist

The so-called "Software Restriction Policy" (or "Application Whitelist") enables Administrators to specify exactly which applications may be executed on a system. All other applications will be blocked by the

Operating System upon program execution. The configuration is easy and straight-forward and can be performed via a Local Security Policy. The following documentation will give a short overview about the different settings.

General information

When using Software Restriction Policies, you can identify and specify the software that is allowed to be executed on the system. This helps to protect your computer environment from untrusted or malevolent code. You can define a default security level (template) of Disallowed, Basic User or Unrestricted for a security policy object but you can also add exceptions to these templates.

Template	Description
Disallowed	Software will not run, regardless of the access rights of the user. Blocks users from executing an application by default – other specific rules (exceptions, see below) may override this one.
Basic User	Allows users to execute applications that do not require administrative privileges – to allow users to run applications with administrative privileges a specific rule must be created.
Unrestricted (default)	Users are able to execute any application by default – other specific rules (exceptions, see below) may override this one.

To create an exception for a security level, you need to create a rule for a specific software. You can create the following rule types:

Exception Type	Description
Hash rule	Sets the exception to the hash value of a given file. This ensures that only the specified file with its unique hash value can be used for this exception. It is important to understand that this hash value usually changes, for example when updating the application (TwinCAT Update!).
Certificate rule	Specifies a certificate for this exception type. This rule degrades the execution of applications as the certificate validity must be checked every time the application is executed.
Path rule	The path can either be a path in the file system or in the Windows registry
Network zone rule	Uses zones as defined in Internet Explorer

Please note that you may use wildcards for a path rule, for example to create an exception for all executable files under *C:\Windows\System32*. Other important settings include the *Enforcement and Designated file types* setting. Enforcement settings allow you to select whether to restrict software execution for ALL user accounts or only for non-Administrators.

The *Designated File types* setting lets you specify which file types should be treated as executable files.

Please see chapter A.4.1.3 for an overview about all Beckhoff software products and their corresponding path to the executable file.

3.2.3.6. Windows AppLocker

Windows AppLocker is a feature in Windows 7 (not included in Windows Embedded Standard 7) and several versions of Windows 10 that further enhances the functionality of Software Restriction Policies (see chapter A.4).

This section of the IPC-Security Whitepaper will be updated in a future release.

3.2.3.7. Autorun

One of the main reasons an industrial controller is infected by a computer virus is through USB drives or other mass-storage devices. Viruses that have been written to spread via attached storage devices often use the Autorun feature of Microsoft Windows to install themselves on the target system. You should disable this feature.

Please see chapter A.4.3.5 for a Step-by-Step guide.

3.2.3.8. Webserver

Beckhoff images that are based on Windows XP, Windows 7 or Windows 10, are delivered with an activated IIS Webserver that hosts different web-based services. As it may be sufficient to just close the corresponding firewall ports of these services (as explained in chapter 6.4), you should deactivate the Webserver completely if you do not require or do not want to use the corresponding services.

Please see chapter A.4.3.6 for a Step-by-Step guide.

3.2.3.9. Windows Registry

The Windows Registry provides many critical system settings. Therefore access to registry editing tools like regedit.exe should be blocked.

Please see chapter A.4.3.7 for a Step-by-Step guide.

3.2.3.10. Windows Command Prompt

Access to the Windows Command Prompt (cmd.exe) should be blocked.

Please see chapter A.4.3.8 for a Step-by-Step guide.

3.2.3.11. Network environment

Access to the network environment icon should be blocked to constrict users to browse network computers. Please note that this only hides the network environment icon from the Windows Explorer's view but does not block access to it. Other restrictions might be needed.

Please see chapter A.4.3.9 for a Step-by-Step guide.

3.2.3.12. Map network drive

Users should not be able to add or remove network drives. You should therefore block access to these features.

Please see chapter refsec:disallowingUsersToAddNetworkDrives for a Step-by-Step guide.

3.2.3.13. Drive letters

If you do not want users to access a local drives, you can restrict access to specific drive letters by altering the Windows registry. You can either block access to specific drive letters or just make them disappear from the Windows Explorer's view.

Please see chapter A.4.3.11 for a Step-by-Step guide.

3.2.3.14. The Encrypting File System (EFS)

With EFS, Windows XP gives you the opportunity to encrypt files and folders on your industrial controller. It uses a certificate to sign and encrypt these resources. You should use this feature if you have critical project files (e.g. TwinCAT project files) stored on your industrial controller.

Please see chapter A.4.3.12 for a Step-by-Step guide.

3.2.3.15. Write Filters

The Write Filter technology in Windows Embedded operating systems provides some advantages compared to the desktop operating systems. A Write Filter minimizes write requests to a storage media by redirecting all writes targeted for a protected volume to a RAM or disk cache called an overlay. This ensures longevity of the used storage media, e.g. Compact Flash cards. However, this chapter gives an overview about Write Filters and how they can also be used to enhance security on your industrial controller because, once activated, all changes to a storage media will be reversed upon system reboot.

Beckhoff Windows Embedded Images (version 1.35 and higher) have both filters (EWF and FBWF) installed, but it is not recommended to use both filters at the same time. EWF catches all writing actions allowed by FBWF, so files will be lost after rebooting the system. We recommend to activate EWF.

For more up-to-date information about this technology please visit [4].

Enhanced Write Filter (EWF)

The Enhanced Write Filter (EWF) is a component on Windows Embedded Operating Systems (not Windows CE). EWF filters write commands to another medium instead of being physically written to the volume itself. It allows write commands to be discarded or committed to the physical volume at a later time. As this minimizes writes to a specified hard disk, EWF and FBWF (see below) have become very popular as a way to decrease wear of drives or security because EWF protects the whole partition from write access. These write accesses will be redirected into the RAM to protect your Flash medium. This also means that, after a reboot, the changes will be reversed and any potential security threat will be deleted. The Enhanced Write Filter is a default component in Beckhoff operating system images for Beckhoff embedded computers and can be activated/deactivated/configured via the Beckhoff EWF Manager.

File-Based Write Filter (FBWF)

The File-based Write Filter (FBWF) differs from the Enhanced Write Filter by protecting files directly on file level instead of protecting a whole partition. With FBWF it is possible to define exclusions to the protection, e.g. you could allow write access to single files on the storage medium. The File-Based Write Filter is a default component in Beckhoff operating system images for Beckhoff embedded computers and can be activated/deactivated/configured via the Beckhoff FBWF Manager.

3.2.3.16. USB drives

Even if the IPC is located in a secure location, e.g. a locked cabinet, there could be situations in which USB ports are extended to the cabinet's outside and therefore at an unsecure location. This could be the case because of maintenance reasons or simply because of an USB port that is integrated directly into the Control Panel. You should control access to these USB ports and also control which USB sticks can be attached to the industrial controller.

Please see chapter A.4.3.14 for a Step-by-Step guide.

3.3. Complementary Hardware mechanisms

It is important to understand that the first layer of security is the physical security of your industrial controller. Questions like "Who has physical access to the controller" and "How can I protect the controller from direct physical access?" should be taken into account. The question about how much physical security you actually need depends on your situation and environment. You also need to differentiate a typical consumer scenario (home user) from an industrial environment where hundreds or thousands of employees work day-in and day-out, often in shift-work. Securing physical access in such a scenario can be a time-consuming task and you need to consider all aspects of your environment to cover all physical security threats.

3.3.1. Locked cabinets

A locked cabinet should be the default way to place an industrial controller. Depending on your environment, this cabinet should be perhaps equipped with additional features like for example climate control, anti-theft alarm, etc. To ensure that only a minimum of people may access the cabinet, an advanced access control system should be used in accordance with the locking mechanism, for example smartcard or fingerprint readers. This also ensures that employees leaving the company can be restricted from accessing the cabinet in a timely manner.

3.3.2. Video surveillance

Video surveillance is often used in environments where employees are organized by shift-work or where the field of work is decentralized and covers a large area. As video cameras can be a good and necessary step to acquire more information about an occurred security issue, they do not actively prevent a security issue and therefore should always be used together with other mechanisms, for example a locked cabinet.

4.Indirect Local Access

4.1. Overview

This chapter is based on the scenario that a cyber criminal has only indirect access to the industrial controller. The term *“indirect local access”* means that the attacker cannot directly interact with the device but has instead infiltrated the system, e.g. via some kind of malwarethat could jam specific functionalities or even cause the system to crash, or by exploiting faulty software components.

4.1.1. Devices

The following table provides an overview about devices that play an important part in this scenario.

Device	Category	Description
IPC/EPC	Industrial Controller	Beckhoff Industrial-/Embedded-PC

4.1.2. Software components

The following table provides an overview about software packages that play an important part in this scenario.

Software	Category	Description
Microsoft Windows 10	System software	Operating System
Microsoft Windows XP	System software	Operating System
Microsoft Windows 7	System software	Operating System
Microsoft Windows Embedded	System software	Operating System
Microsoft Windows CE	System software	Operating system
Windows Update Client	Update Software	Used to receive Windows Updates from a central Windows Update Server
Windows Update Server	Update Software	Used to distribute Windows Updates from a central location to network clients

4.1.3. Potential threat scenarios

The following chapter gives a short overview about possible threat scenarios, which may or may not be representative in your environment. We assume that an attacker is able to gain local access to the device itself, just as this may be the case for a regular user. Please take the following chapters as a means to gain a better awareness for this scenario.

4.1.3.1. Manipulated USB storage device

By manipulating USB storage devices, an attacker could use USB storage devices to distribute malware which is then executed by authorized users.

Due to this, an attacker gains access to the operating system with the same privilegesas the currently logged on user account.

4.1.3.2. Handling untrusted E-Mails

By sending out malware via E-Mail and fooling the user to believe that the content can be trusted, an attacker could spread malware to industrial controllers and gain access to the operating system.

Due to this, an attacker gains access to the operating system with the same privileges as the currently logged on user account.

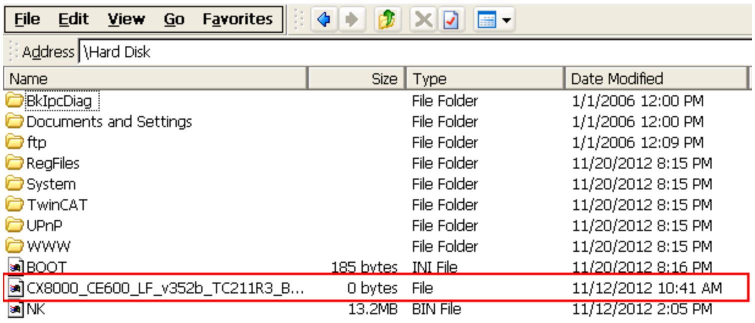
4.2. Hardening

This chapter explains some common strategies that can be deployed to actively secure components that are part of the scenario. Because the operating system architecture of Windows CE differs from Windows XP, Windows 7, Windows 10 or Windows Embedded, each operating system family is represented by an own chapter.

4.2.1. Windows CE

4.2.1.1. Windows Updates

To apply updates on an Embedded-PC or Industrial-PC running Windows CE, Beckhoff periodically releases new images and publishes them on its public FTP Server. Please check `ftp.beckhoff.com/software/embpc-control/` to see if there is a new Windows CE image available for your Embedded- or Industrial-PC. To determine the installed version simply browse to the folder \Hard Disk\. This folder contains a file that is named after the currently installed image version.



Address \Hard Disk

Name	Size	Type	Date Modified
BkIpcDiag		File Folder	1/1/2006 12:00 PM
Documents and Settings		File Folder	1/1/2006 12:00 PM
ftp		File Folder	1/1/2006 12:09 PM
RegFiles		File Folder	11/20/2012 8:15 PM
System		File Folder	11/20/2012 8:15 PM
TwinCAT		File Folder	11/20/2012 8:15 PM
UPnP		File Folder	11/20/2012 8:15 PM
WWW		File Folder	11/20/2012 8:15 PM
BOOT	185 bytes	INI File	11/20/2012 8:16 PM
CX8000_CE600_LF_v352b_TC211R3_B...	0 bytes	File	11/12/2012 10:41 AM
NK	13.2MB	BIN File	11/12/2012 2:05 PM

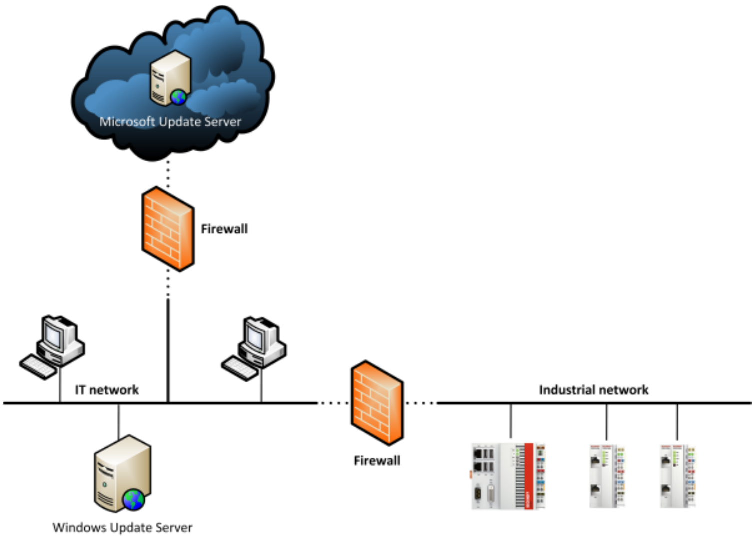
The Beckhoff Information System provides an article about the update procedure. See [3] for more information.

4.2.2. Windows XP / Windows 7 / Windows 10

4.2.2.1. Windows Updates

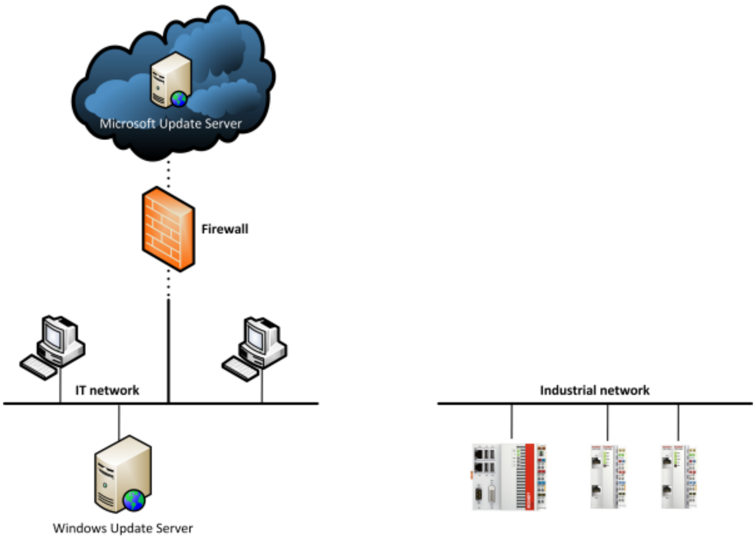
It is important to understand the different update scenarios from an IT infrastructure point-of-view. Depending on the size of your IT infrastructure, one of the following scenarios could exist in your network environment. Please note that there may be variations or even combinations of these scenarios.

Scenario 1: Industrial network separated from IT network with no access to the Internet



This scenario is probably one of the most commonly used setups in an industrial environment. Both, the IT network and the industrial network, are separated by a firewall. The industrial network is not allowed to access the IT network or the Internet and therefore cannot access any external Microsoft Update Servers. However, there may be own Update Servers located in the IT network to distribute Windows Updates which have been approved by the company’s IT department. For more information about these update servers, please view the Microsoft documentation about WSUS.

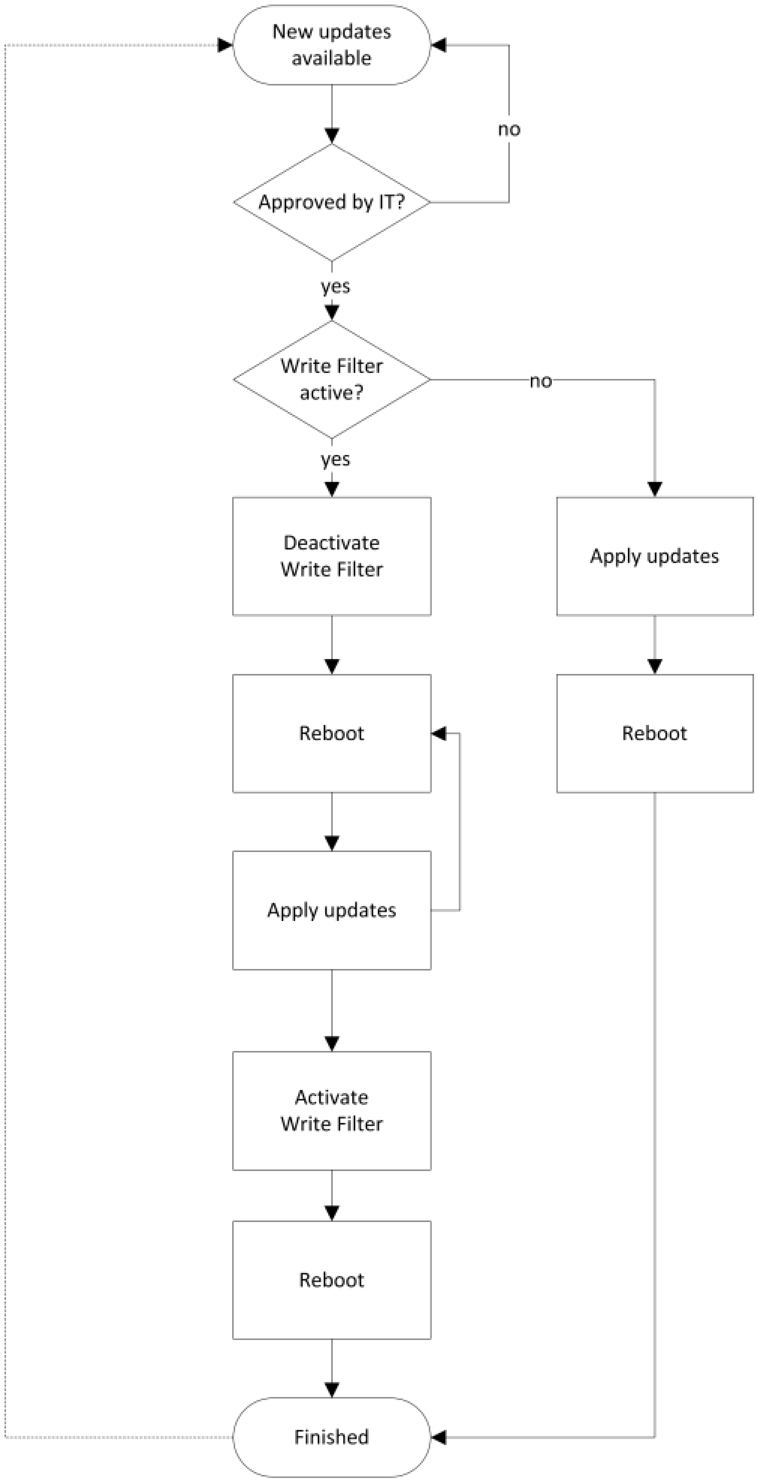
Scenario 2: Industrial network entirely separated from IT network



In this scenario the IT and industrial network are physically separated and there is no connectivity between both networks. Industrial controllers have no way to receive updates from a Windows Update Server, therefore all updates need to be applied manually.

Applying updates to an industrial controller

Engineering computers can and should be kept up-to-date with security updates. However, this procedure may be more difficult in an industrial environment, depending on the IT infrastructure, as shown above. Industrial controllers should be protected by a Write Filter (cf. chapter 3.2.3.15), which automatically leads to another obstacle because as soon as you reboot the machine, all Windows Updates that have been installed previously, will be reverted. Therefore, a typical workflow for maintenance would then look as follows:



TwinCAT – Windows Updates compatibility

We often get the question if TwinCAT has any known issues with Windows Updates. Up to this date there have not been any known issues yet, however we cannot guarantee that for all patches in the future. Beckhoff provides customers with new operating system images every year. These images automatically include all Windows Updates that have been released by Microsoft up to the date of image creation. These images are tested by Beckhoff and should be installed on the corresponding industrial controller if there is the need for an up-to-date system.

4.3. Complementary Hardware mechanisms

4.3.1. Hardware appliances for Anti-Virus

Vendors of Anti-Virus software sometimes offer special hardware appliances that can be used to detect malware as it is transmitted via the network. Please note that these systems may be useful to detect malware as it *“comes through the network”* but does not protect against malware that is distributed for example via mass storage devices like USB or floppy disk.

4.4. Complementary Software mechanisms

4.4.1. Anti-Virus software

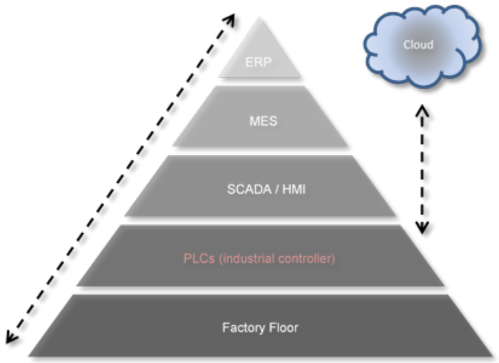
Anti-Virus software is used to prevent, detect and remove malware, such as computer viruses, adware, backdoors, hijackers, keyloggers, etc. Beckhoff does not give any recommendations for specific Anti-Virus software but you can use Anti-Virus software together with TwinCAT. Just make sure to exclude the TwinCAT directory from any background scanning.

Please see chapter A.4.3.13 for a Step-by-Step guide to configure these exclusions in some well-known Anti-Virus software applications.

5.Remote Access

5.1. Overview

This chapter is based on the scenario that a cyber criminal tries to attack the industrial controller from a remote location, e.g. via the local network. Network connectivity provides a cyber criminal with more ways to compromise system security. Industrial controllers are getting more and more connected to systems that reside in other connectivity layers, e.g. visualizations, MES systems or even the Cloud.



5.1.1. Devices

The following table provides an overview about devices that play an important part in this scenario.

Device	Category	Description
IPC/EPC	Industrial Controller	Beckhoff Industrial-/Embedded-PC
Switch	Networking hardware	Connects devices to the network
Router	Networking hardware	Connects different networks with each other
Firewall	Networking hardware	Protects networks
Modem	Networking hardware	Used for incoming/outgoing dialup connections

5.1.2. Software components

The following table provides an overview about software packages that play an important part in this scenario.

Software	Category	Description
Microsoft Windows 10	System software	Operating System
Microsoft Windows XP	System software	Operating System
Microsoft Windows 7	System software	Operating System
Microsoft Windows Embedded	System software	Operating System
Microsoft Windows CE	System software	Operating system
Windows Update client	Update software	Used to receive Windows Updates from a central Windows Update Server
Windows Update server	Update software	Used to distribute Windows Updates from a central location to network clients
Internet Information Service	Webserver software	Default HTTP and FTP server in Microsoft Windows operating systems
Remote Desktop	Maintenance software	Default remote maintenance software distributed in Microsoft Windows operating systems (not Windows CE)
CerHost	Maintenance software	Default remote maintenance software distributed in Windows CE

5.1.3. Potential threat scenarios

The following chapter gives a short overview about possible threat scenarios, which may or may not be representative in your environment. Please take the following chapters as a means to gain a better awareness for this scenario.

5.1.3.1. Manipulated websites

By directing a user to access a manipulated and untrusted website, an attacker could either fool the user to disclose sensitive information, e.g. passwords, or use a vulerability of the web browser to remotely access the operating system.

Due to this, an attacker could gain access to the system with the same privileges asthe user.

5.1.3.2. Man-in-the middle attacks

By intercepting network communiations using a non-secure network protocol, an attacker could expose himself as a trusted source for all participants and as such manipulate or read all transferred information.

5.1.3.3. Open network ports

By scanning the network for open network ports, an attacker could use network services that have been unnecessarily activated because they have no use in the specific system.

Due to this, an attacker may use those services to trigger unwanted events.

5.1.3.4. Exploiting vulnerabilities of the operating system

By reaching a vulnerable network service of the operating system (e.g. SMBas described in MS11-043), an attacker could misuse the target service.

The impact depends on the specific vulnerability, reaching from denial-of-service up to arbitrary remote code execution with system privileges.

5.1.4. Protocols

The following table provides an overview about network protocols that play an important part in this scenario. Each protocol will be classified according to its representation in the OSI model (Open Systems Interconnection model, see ISO/IEC 7498-1 for more information). Please note that some protocols may not fully fit into this model, these are marked with an asterisk *.

Protocol	OSI layer	Description
TCP	4	Network protocol that provides a reliable, ordered, error-checked delivery of a data stream between network programs
UDP	4	Network protocol that has been optimized for performance and throughput and therefore does not provide ordering or reliability
RDP	4-7	Proprietary network protocol designed by Microsoft to control desktop environments of a remote computer
ADS*	4-7	Proprietary network protocol designed by Beckhoff for internal TwinCAT communication
OPC-UA*	7	Standardized communication protocol that provides reliable, secure and cross-platform communication
PPTP	5	Protocol to implement virtual private networks. Internally uses TCP and GRE
GRE*	3	Tunneling protocol used for encapsulating network layer protocols
IPSec	3	Protocol suite that provides security for IP-based communications

5.1.4.1. Network ports

You should use a firewall (see chapter refsec:firewalls) to block all network ports except the ones that are needed in your environment.

Please see chapter A.4.1.4 for a tabular overview about all network services that are either part of a default operating system image or can be installed later via TwinCAT Function/Supplement products.

5.1.4.2. Firewalls

Windows provides a software firewall that is part of every Windows installation. You can use this firewall to block or allow access to specific network ports, as mentioned in chapter 5.1.4.1. When creating a firewall rule to allow access to a specific network port, this rule should be configured in a restrictive way. You should limit access to the network port only to the computers that need to access the port. Do not just allow access to the network port for ALL computers. Instead, specify a single computer or a subnet range so that only the required computers can access the network port.

Please see chapters A.4.2.7 and A.4.3.19 for more information about the firewalls that are integrated into Microsoft Windows.

5.2. Hardening

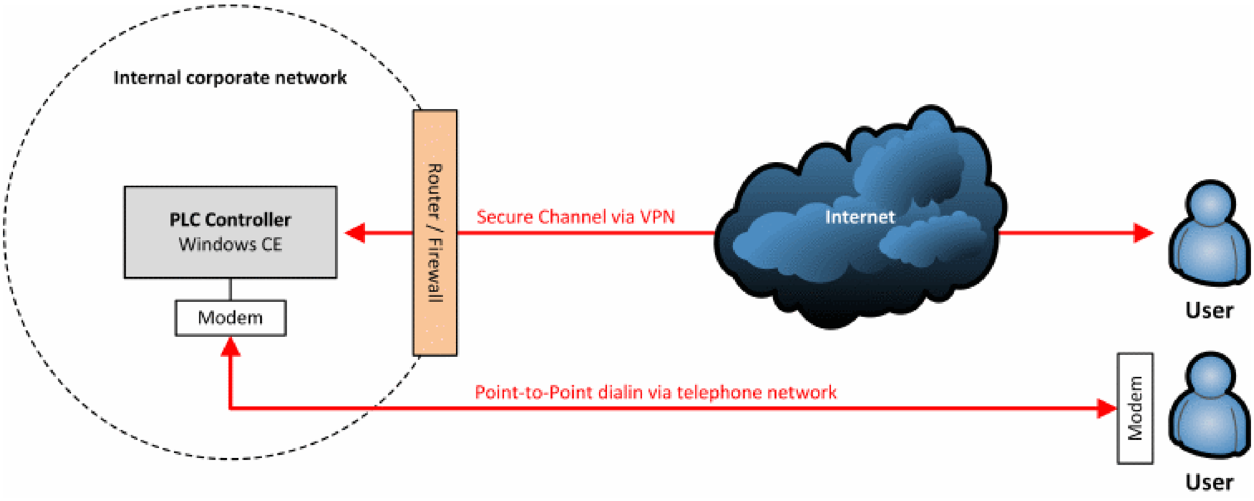
This chapter explains some common strategies that can be deployed to actively secure components that are part of the scenario. Because the operating system architecture of Windows CE differs from Windows XP, Windows 7, Windows 10 or Windows Embedded, each operating system family is represented by an own chapter.

5.2.1. Windows CE

5.2.1.1. Remote dial in

On a Windows CE device, you can configure a remote dial in connection either via an attached modem (using the COM-Port) or via a network connection (using VPN). The following chapter gives an overview about the general settings of the Windows CE RAS Server, before moving on to the necessary configuration settings for each setup (modem or VPN).

Each Beckhoff Windows CE device is being deployed with a build-in RAS Server. This background service manages all incoming dial in connections, which arrive either via an attached modem or via the network (VPN). The following picture shows a typical example for this setup.



The Windows CE RAS Server supports two main scenarios: You can either use an attached modem to configure an incoming dialin connection via a telephone line or you can use the corporate network to dial in via VPN. This flexibility enables you to easily establish a dialin connection to your Windows CE device and to integrate this setup in your IT environment.

5.2.1.2. Remote maintenance

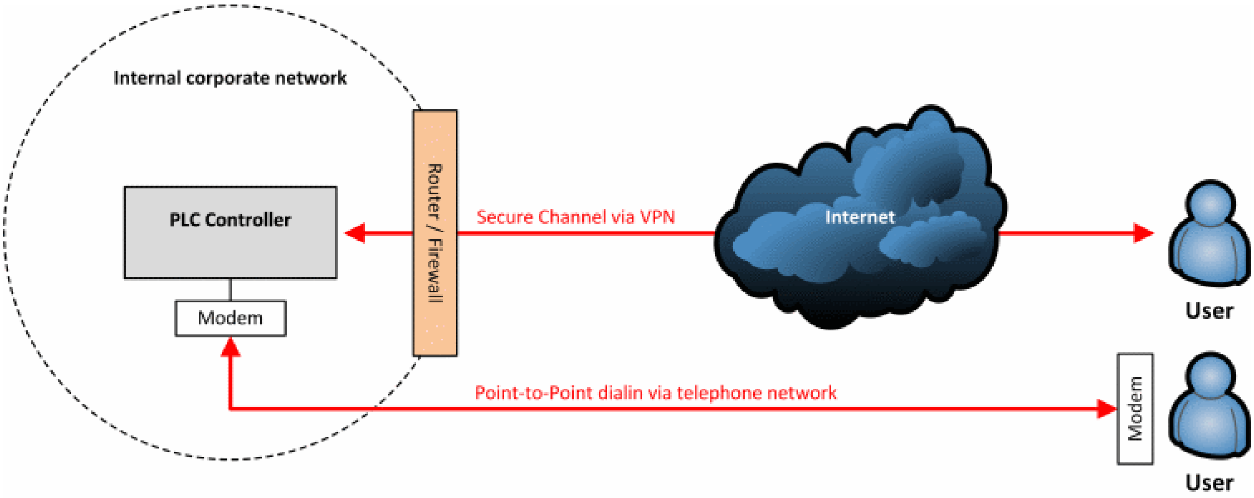
Windows CE provides the possibility to remotely connect to the device and perform maintenance tasks on a desktop level via the tool Cerhost. Because Windows CE only provides one local user account for system access, this user account is also used for the remote Cerhost connection.

Please consult chapter A.4.2.3 to see how to change the password for the system user. We highly recommend you to set a password immediately because otherwise remote users can access the device unauthenticated via Cerhost.

5.2.2. Windows XP / Windows 7 / Windows 10

5.2.2.1. Remote dial in

Windows XP and Windows 7 enable users to configure a remote dial in connection (via VPN or an attached modem) directly to the device. This could come in handy, for example, if your current IT infrastructure does not include enhanced mechanisms like a separate VPN hardware or servers that provide remote access services.



Both, Windows XP, Windows 10 and Windows 7, support two possible scenarios: Dialing in via a telephone line (and therefore via a modem which is attached to the IPC) or via the corporate network (VPN). Both scenarios will be covered in more detail below. Because the configuration steps are more or less the same for Windows XP as they are for Windows 7 and Windows 10, this documentation only covers the configuration settings for the later operating system. In both cases the configuration takes place in the Control Panel. Please note that, when using a VPN dial in, you may need to configure your Internet router, so that the dial in connection gets forwarded to your IPC Controller. Please consult the documentation of your Internet router or ask your IT department about how to do so.

5.2.2.2. Remote maintenance

The Remote Desktop Protocol enables users to establish a remote connection to the desktop of an IPC/EPC. RDP is by default activated in every Beckhoff operating system image. This article discusses how you can make sure that you setup RDP in a securely manner.

5.2.2.3. Remote Desktop Protocol (RDP) and Network Level Authentication (NLA)

Since Windows 7, RDP has used Network Level Authentication (NLA) to reduce the risks of denial-ofservice attacks. Before NLA, an RDP Client was able to establish a connection to the Windows logon screen without actually logging on to the RDP Server. However, by presenting the logon screen, the RDP Server had to allocate resources which could be exploited by an attacker by starting multiple RDP sessions and therefore overstressing the RDP server. Since the implementation of NLA, remote desktop clients need to authenticate themselves to the RDP server even before they see the remote Windows logon screen. However, since NLA is by default enabled in every Windows 7 installation, this is not the case for Windows XP. Since Service Pack 3, users can also use NLA under Windows XP, which is discussed in [10]. Please consult chapter A.4.3.16 to see how NLA can be configured.

Remote Desktop Protocol (RDP) and communication encryption

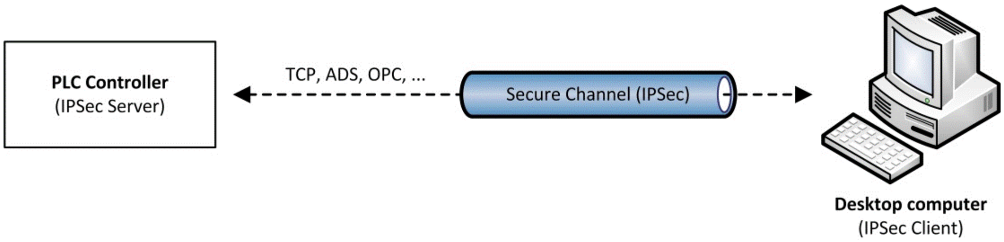
When making a RDP connection to a Windows 7 computer, this computer creates a self-signed certificate used for Transport Layer Security (TLS). This allows data to be encrypted between RDP client and RDP server. However, RDP uses a self-signed certificate by default. To use own certificates for RDP, please take a look at [9].

Select which user accounts are enabled for RDP

By default, the local Administrator account is enabled to access the Controller via RDP. This is also why you should change the default password as soon as possible. If you don't need RDP, you should switch it off. You should also specify which local user accounts should be able to access a computer via RDP. If possible, create a separate user account for RDP access and give it exclusive rights for RDP. Please consult chapter A.4.3.17 to see how RDP can be configured.

5.2.2.4. Network encryption

IPSec enables you to secure your IP-based network communication with regard to the security principles *Authentication*, *Encryption* and *Data integrity*. IPSec is being primarily used in VPN environments but can also be used to establish a secure channel between two internal computers. IPSec is an end-to-end security scheme which operates on layer 3 of the OSI model. This is also a main advantage of IPSec over other security mechanisms (like SSL, TLS, SSH, etc.) because due to this, applications do not need to be specifically designed to use IPSec. To them it just seems to be a normal IP communication. The IPSec configuration in Windows XP consists of two parts: a *Server* and a *Client*. Let's assume that your Controller should be configured as the IPSec Server and a desktop computer running Windows XP as the IPSec Client. Because the configuration of IPSec can be very bulky and can contain hundreds of different scenarios and settings, only a basic example will be given. This example secures the network communication between a desktop computer and the PLC Controller and is illustrated in the picture below. For more information on IPSec please consult the Microsoft Developer Network (MSDN). As a prerequisite, both devices need to be reachable via an IP-based network.



A.Appendix

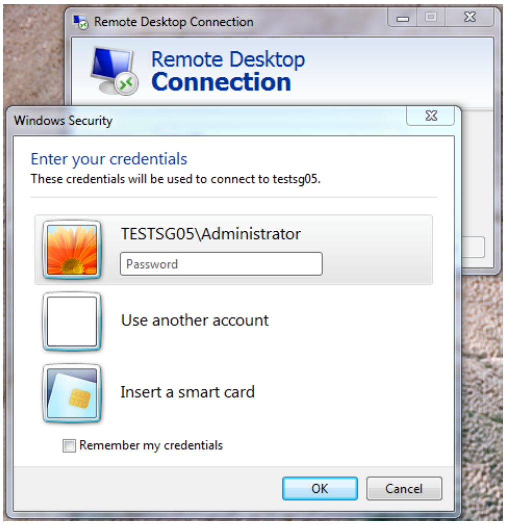
A.1. Remote Maintenance

Remote maintenance has always been an important part of every industrial controller. In case of a problem, service employees or application programmers could remotely connect to the IPC operating system and perform their maintenance operation. This article will cover some of the basic scenarios from an IT infrastructure point-of-view and discusses several possibilities how to secure the communication between service computer and the industrial controller. Please note that this documentation makes use of standard technologies which are available in most IT infrastructures and IPC operating systems. The Remote Desktop Protocol (RDP) will be used as an example remote maintenance tool because it is available by default on Windows 7 based operating systems.

A.1.1. Notes about the Remote Desktop Protocol (RDP)

The configuration of RDP under Windows XP or Windows 7 has already been covered in chapter 5.2.2.3 However, that chapter did not discuss RDP as seen from a security perspective when used in different remote maintenance scenarios as described here in this document. As it may be possible to use a raw RDP connection via the Internet, for example by just creating a port forwarding to the default RDP port 3389/tcp in your router, it is strongly recommended that you always use a secure channel for RDP communications, for example by establishing a VPN/IPSec connection to the desired target first.

Please also make sure that you use an RDP version that supports Network Level Authentication (NLA) to reduce the risk of Denial-of-Service attacks because of a high amount of concurrent RDP sessions. NLA reduces that risk by offering an authentication prompt before the actual RDP session gets established. Therefore, the RDP-Server (in our case: the IPC) only starts to allocate resources for the client session if this pre-authentication was successful.



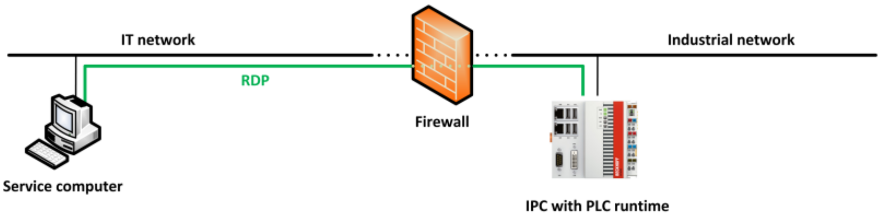
Enter your credentials

These credentials will be used to connect to testsg05.

TESTSG05\Administrator

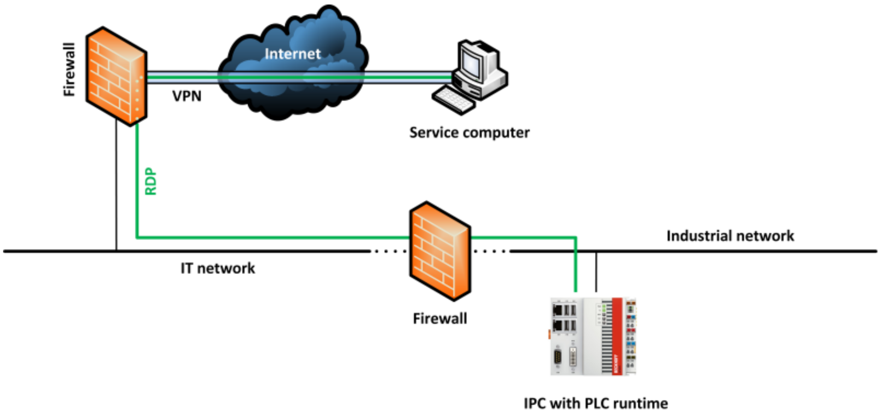
Please also consult [11] for more information.

A.1.2. Remote maintenance from inside the organization



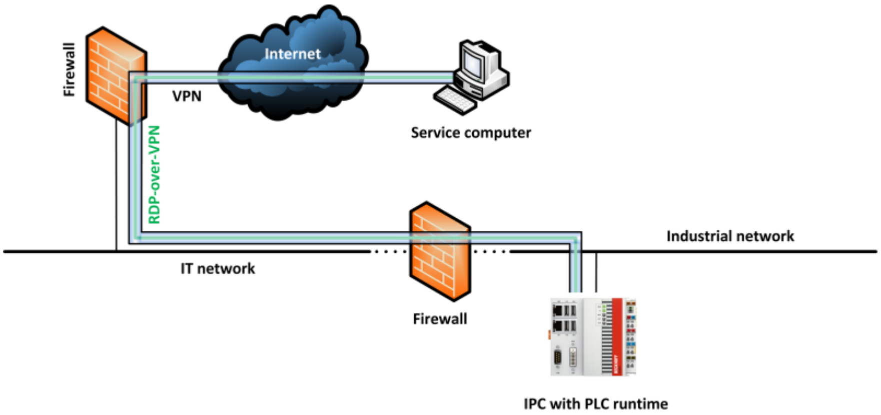
A very common scenario is that the service computer used for remote maintenance is located within the same organization, meaning within the same corporate network. However, as the industrial network is often separated by a Firewall from the regular IT network, the RDP communication needs to travel through that firewall to reach the IPC.

A.1.3. Remote maintenance via central VPN server



In this scenario, the service computer used for maintenance is located outside the IT infrastructure, e.g. in a home office. It is assumed that the IT infrastructure already provides some kind of VPN-Server. In the picture from above, this VPN-Server is integrated into the first firewall (for example: Cisco ASA Firewall). The communication from service computer to IPC will therefore only be encrypted until this VPN endpoint. From that point on, the communication traveling through the IT network is plain RDP.

A.1.4. Remote maintenance via VPN server on IPC



As described in chapter 5.2, Windows CE and Windows XP/7 operating systems provide all necessary functionalities to create an own VPN-Server directly on the embedded device. Therefore, in this scenario the VPN connection only needs to be routed through both firewalls, e.g. by configuring a port-forwarding on these firewalls. The advantage of this setup is that the communication is encrypted during the whole transition from service computer to IPC.

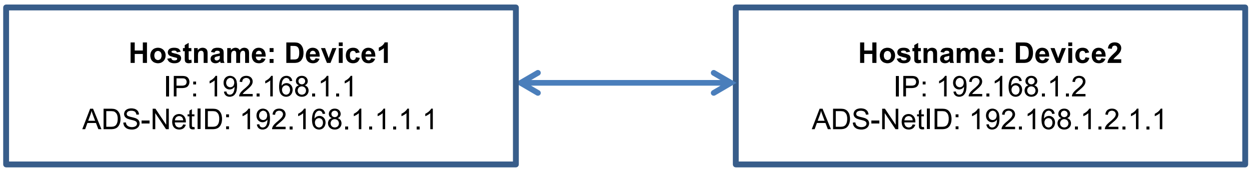
Please note that this setup could also be relevant for scenario A.1.2, e.g. to wrap the RDP communication into a secure VPN / IPSec channel.

A.2. TwinCAT ADS

Connectivity in TwinCAT is generally based on the ADS communication protocol, which ensures a fast transport of data between ADS devices, e.g. between TwinCAT PLC and TwinCAT I/O. ADS is a proprietary communication protocol developed by Beckhoff Automation. ADS has been developed to maximize throughput and data flow between TwinCAT components and to enable communication via different transport protocols, e.g. to transmit ADS over a TCP or even a serial communication channel. Because of this goal, ADS has not been designed to achieve security purposes and therefore does not include any encryption algorithms because of their negative effect on performance and throughput. However, ADS implements user authentication when establishing an ADS route between two TwinCAT devices.

A.2.1. ADS routes

To enable connectvity between ADS devices, a one-time creation of corresponding ADS routes is required. Each ADS device has an identifier, the so-called ADS-NetID. Each ADS application has its own port, the so-called ADS-Port. The ADS communication is independent of the transport protocol, e.g. ADS pakets could be transmitted via a TCP channel. The internal ADS routing table then maps the corresponding transport address to the ADS-NetID. Ín the following scenario two ADS devices should communicate with each other via a TCP/IP network. Each device has its own IP-address and ADS-NetID.



Hostname: Device1
IP: 192.168.1.1
ADS-NetID: 192.168.1.1.1.1

Hostname: Device2
IP: 192.168.1.2
ADS-NetID: 192.168.1.2.1.1

After the ADS route between both devices has been created, the routing table on Device1 will look as follows:

AMS-NetID	Transport address	Hostname (if applicable)
192.168.1.2.1.1	192.168.1.2	Device2

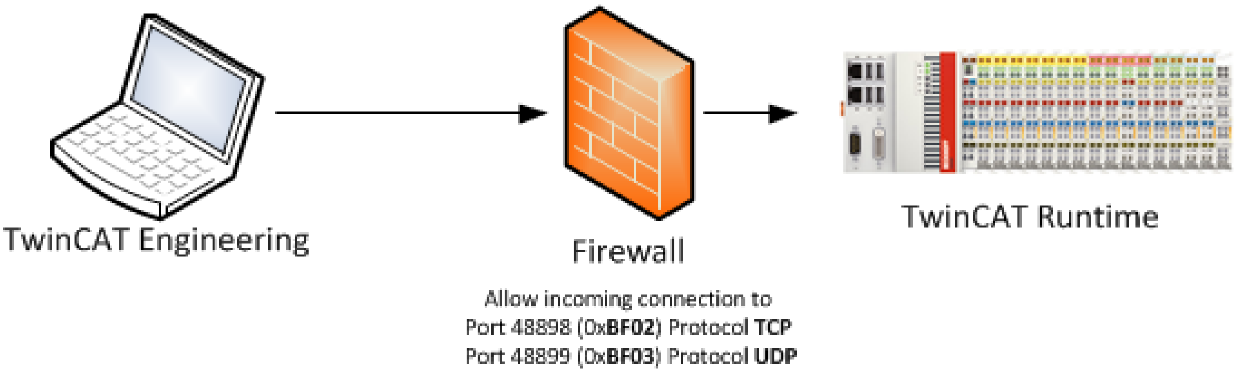
Similarly, the routing table on Device2 will look as follows:

AMS-NetID	Transport address	Hostname (if applicable)
192.168.1.1.1.1	192.168.1.1	Device1

A.2.2. ADS network ports

This scenario describes how a firewall needs to be configured so that ADS devices can communicate with each other. Here, a laptop needs to communicate with an Embedded-PC that hosts the TwinCAT Runtime.

The firewall can either be a hardware firewall or a software firewall like the one that is integrated into Microsoft Windows.


TwinCAT Engineering
Firewall
TwinCAT Runtime
Allow incoming connection to
Port 48898 (0xBF02) Protocol TCP
Port 48899 (0xBF03) Protocol UDP

You need to configure the following rules in your firewall to allow ADS communication from the laptop to the Embedded-PC:

Direction	Port	Protocol	Action
Incoming	48898	TCP	Allow
Incoming	48899	UDP	Allow

A.2.3. ADS via gateway

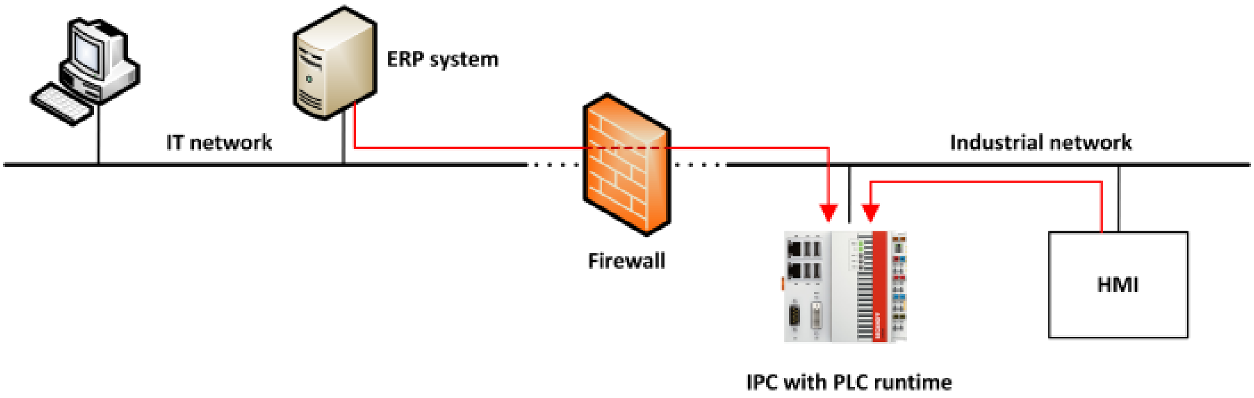
ADS communication can also be routed via a gateway computer that separates two networks from each other. In this case, the gateway computer needs to host a set of hierarchical ADS routes, which can either be configured manually or via the TwinCAT Remote Manager (TwinCAT 2). There are a few important things to consider when adding the ADS routes. Please see [1] for getting up-to-date information about this topic.

A.2.4. ADS via NAT

ADS communication can also be performed via NAT devices, e.g. a firewall. However, there are a few important things to consider when adding the ADS routes. Please see [1] for getting up-to-date information about this topic.

A.3. Third-Party connectivity

Third-party connectivity involves the connection of other systems, e.g. HMI, MES, ERP or other external applications, to the PLC runtime, e.g. to cyclically read or write process values



There are several communication protocols available to achieve this kind of connection. This article describes three common ways to communicate with TwinCAT via well-known communication protocols. For each protocol, the implemented security mechanisms will be briefly described.

A.3.1. ADS

The Automated Device Specification (ADS) is a proprietary communication protocol developed by Beckhoff Automation. ADS has been developed to maximize throughput and data flow between TwinCAT components and to enable communication via different transport protocols, e.g. to transmit ADS over a TCP or even a serial communication channel. Because of this goal, ADS has not been designed to achieve security purposes and therefore does not include any cryptographic algorithms because of their negative effect on performance and throughput. However, ADS implements user authentication when establishing an ADS route between two TwinCAT devices. Please also see chapter A.3 for more detailed information about ADS and its corresponding routes.

A.3.2. ADS-WCF

The Windows Communication Foundation (WCF) represents Microsoft's modern web service technology. WCF provides a single API for cross-process/cross-network communication needs in Microsoft .NET. From a security perspective, WCF already includes security mechanisms which are available in the API via so-called profiles.

Beckhoff provides customers with a WCF web service that can be used to communicate with TwinCAT PLC. All needed binaries for this web service are already included in TwinCAT setup and only need to be activated and used by the customer's application. This application would then act as an WCF-client. Please also see [2] for more information.

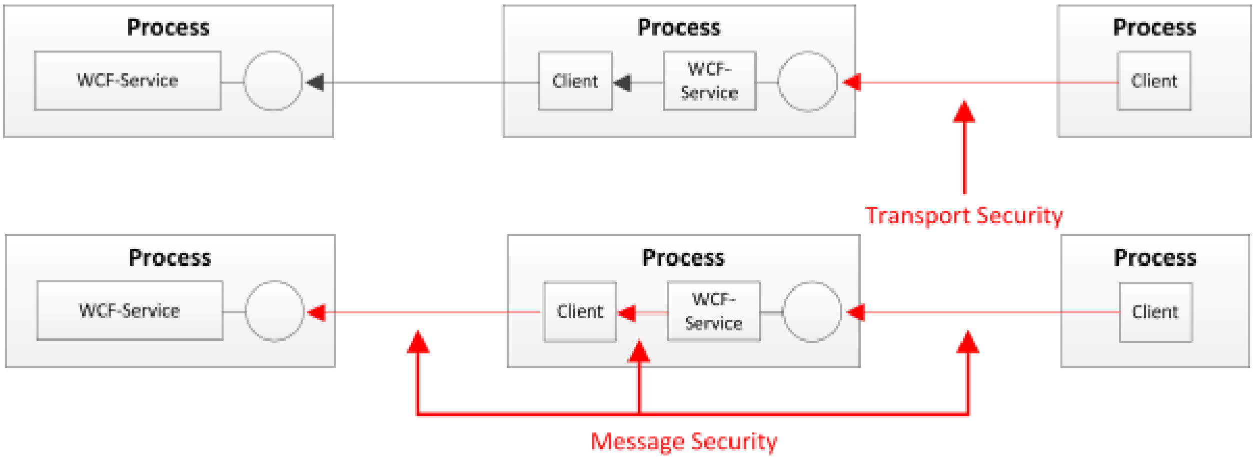
A.3.2.1. Authentication

WCF supports the following models to authenticate a WCF-client:

- Username / password
- Integrated Windows Authentication
- Authentication via a Security Token, for example Windows Azure ACS
- X.509 certificates

A.3.2.2. Confidentiality

WCF supports two different encryption mechanisms: Transport Security and Message Security. Transport security applies security on a point-to-point basis, which means that, for example in an SOA architecture, security can only be guaranteed until the first hop. Instead, Message Security applies security on a message level, which means that the actual payload of the message is encrypted. This automatically implies security on an end-to-end basis, also if the message is being routed through several intermediates.



A.3.3. OPC-UA

OPC Unified Architecture (OPC-UA) is the new technology generation of the OPC Foundation for the secure, reliable and manufacturer-neutral transport of raw data and pre-processed information from the manufacturing level into the production planning or ERP system. With OPC-UA, all desired information is available to every authorized application and every authorized person at any time and in any place.

A.3.3.1. Authentication

Upon connection establishment, the user identifies himself via:

- X.509 certificates
- Username / password
- or Kerberos

A.3.3.2. Integrity

The signing of messages prevents a third party from changing the contents of a message. This prevents, for example, a write statement to open a switch being falsified by a third party and the switch being closed instead.

A.3.3.3. Confidentiality

The confidentiality of the exchanged information is secured by the encryption of the exchanged messages. For this, modern cryptographic algorithms are used. Different security levels can be selected according to the requirements of the respective application. In some areas, it may be sufficient to sign the messages in order to prevent changes being made by third parties, while additional message encryption is necessary in other areas where the data must also not be read by third parties.

A.3.3.4. Authentication and authorization of applications

Each OPC-UA application identifies itself via so-called software and application instance certificates. With the aid of software certificates it is possible to grant certain client applications extended access to the information on an OPC-UA Server. Application instance certificates can be used to ensure that an OPC-UA Server communicates only with preconfigured clients. On the other hand, a client can ensure by means of the server's application instance certificate that it is really speaking to the correct server (similar to the SSL certificates of a website/webserver).

By implementing this protocol in the TwinCAT product "TwinCAT OPC-UA Server", Beckhoff Automation enables customers to use this modern technology to establish a secure connection via a standardized communication protocol between a third party product and TwinCAT PLC.

A.3.4. Modbus

The original Modbus protocol is a serial communications protocol that has been developed in the late 1970s. The main goals were to provide a communication protocol that had industrial applications in mind, is easy to deploy and maintain, and moves raw bits or words without implementing an information model. This simplicity made it very popular during the last 30 years. However, this simplicity also makes it more challenging to use Modbus in modern industrial systems because today we have other, more complex requirements to a communication protocol than 30 years ago, e.g. the need for security and information models to transfer complex data and metadata. The original Modbus protocol does not implement security mechanisms, e.g. it is not possible to encrypt data communications or use client/server authentication.

Although Beckhoff also provides two TwinCAT Functions for Modbus RTU and Modbus TCP, we recommend customers to use more modern communication protocols that already implement security mechanisms, e.g. OPC-UA.

A.4. Step-by-Step

The following chapter provides step-by-step explanations of all previously addressed topics. Please note that some menu items or controls may have other names, depending on the operating system that is used.

A.4.1. General information

A.4.1.1. Overview Beckhoff web-based services

The following table gives an overview about all Beckhoff web-based services that are included by default in operating system images deployed by Beckhoff. These services are hosted by the Internet Information

Service (IIS) by the corresponding operating system.

Name	Description	OS
IPC-Diagnostics	Website that displays Hard- and Software information about the IPC or EPC.	WinCE, WinXP*
TcOpcXmlDa	Provides an OPC-XML-DA endpoint to get data access to PLC symbols.	WinCE

* WinXP = Windows XP Pro, Windows 7 Pro, Windows Embedded

A.4.1.2. Complex passwords

Strong passwords are an important protection that helps to configure safe environments. The following requirements define a strong password and are adapted from a Microsoft article about strong passwords:

- Password length: Make sure that the password consists of at least 8 characters
- Password complexity: Include letters, punctuations, symbols and numbers
- Password variation: Change the password often
- Password variety: Do not reuse password for any service

There are many ways to create a strong password. The following table shows some suggestions that might help you to remember a password easily:

What to do	Example
Start with a sentence or two	Complex passwords are more secure
Turn words into shorthand or intensionally misspell a word	ComplekspasswordsRmorsecur
Add length with numbers and symbols	ComplekspasswordsRmorsecur#2013#

Keep in mind: Cyber criminals use sophisticated tools that can rapidly decipher passwords. Avoid creating passwords that use:

- Dictionary words in any language
- Words spelled backwards, common misspellings and abbreviations
- Sequences or repeated characters, e.g. 12345678 or abcdefgh
- Personal information, e.g. birthday or passport number

A.4.1.3. Overview Beckhoff software paths

The following table gives an overview about all Beckhoff software applications that may be executed in a Windows user context. They are not required to run TwinCAT but usefull for diagnostics (e.g. Scope-View). Other applications, like IPC-Diagnostics or TwinCAT System Service, are not affected by software restriction policies because they run as a Windows Service under the Local System context.

TwinCAT 3 System

Application	Path
TwinCAT XAE	%PF%\Microsoft Visual Studio 10.0\Common7\IDE\devenv.exe
Beckhoff FBWF Manager	%PF%\FBWFMgr\Beckhoff FBWF Manager.exe
TwinCAT ADS Test Tool	%TC%\Common32\TcAdsTest.exe
TwinCAT Scope 2 View	%TC%\Functions\TE130X-TC3-Scope-View\TwinCatScopeView2.exe
TwinCAT Event Bar	%TC3DIR%\Components\TcEventLogger\TcEventBar.exe
TwinCAT SysUI	%TC3DIR%\System\TcSysUI.exe
TwinCAT AMS Remote Manager	%TC%\ADS Api\TcAdsDll\TcAmsRemoteMgr.exe
Beckhoff EWF Manager	%PF%\BEWFMgr\BEWFMgr.exe
TcSwitchRuntime	%TC%\TcSwitchRuntime\TcSwitchRuntime.exe

TwinCAT 3 Functions

Application	Path
TF6100 Configurator	%TCFUN%\TF6100-OPC-UA\Win32\Configurator\TcOpcUaConfigurator.exe
TF6100 Sample Client	%TCFUN%\TF6100-OPC-UA\Win32\SampleClient\UaSampleClient.exe
TF6120 Configurator	%TCFUN%\TF6120-OPC-DA\Win32\Configurator\TcOpcCfg.exe
TF6120 Client	%TCFUN%\TF6120-OPC-DA\Win32\SampleClient\TcOpcClient.exe
TF6250 Configurator	%TCFUN%\TF6250-Modbus-TCP\Win32\Server\TcModbusCfg.exe
TF6420 Configurator	%TCFUN%\TF6420-DatabaseServer\Win32\Configurator\TcDatabaseSrv_Configfileeditor.exe

Abbreviations:

- %TC%: TwinCAT directory, e.g. C:\TwinCAT
- %TC3DIR%: TwinCAT 3 directory, e.g. C:\TwinCAT\3.x
- %TCFUN%: TwinCAT Function directory, e.g. C:\TwinCAT\Functions
- %PF%: Program Files directory, e.g. C:\Program Files

Please note: In order for the TwinCAT startmenu entries to work properly, you also need to add them to the Whitelist if needed.

A.4.1.4. Overview Beckhoff network services

Default network services

The following table provides an overview about network services that are part of a default operating system image that has been deployed by Beckhoff.

Network service	Network ports:	Description
CerHost	987 / tcp (incoming)	Software tool to control a Windows CE device remotely.
FTP-Server	21 / tcp (incoming)	Network service that provides FTP (File Transfer Protocol) access to the industrial controller.
IPC-Diagnostics	4852 / tcp (incoming) 80 / tcp (incoming) 5120 / tcp (incoming)	Service that provides access to hard-/software information of the industrial controller.
Remote Desktop	3389 / tcp (incoming)	Software tool to control a Windows XP or Windows 7 device remotely.
SMB	137 / tcp, udp (incoming) 138 / tcp, udp (incoming) 139 / tcp, udp (incoming) 445 / tcp (incoming)	SMB is used for file and printer shares. The actually used ports depend on the operating system.
TwinCAT ADS	48898 / tcp (incoming, outgoing) 48899 / udp (incoming, outgoing)	Communication ports for the TwinCAT ADS protocol.

Other network services

The following table provides an overview about network services that can be acquired from Beckhoff, e.g. TwinCAT Supplement products.

Service / product	Network ports:
TF6100 OPC-UA	configurable, but by default 4840/tcp (incoming)
TF6120 OPC-DA	dynamic (related to DCOM) between 1024 and 65535 (incoming)
TF6250 Modbus TCP	502/tcp (incoming)
TF6310 TCP-IP	configurable (incoming/outgoing)
TF6300 FTP	20/tcp (outgoing) 21/tcp (outgoing) please also check TF6300 documentation for more information about active/passive FTP
TF6420 Database Server	depends on the database, please check TF6420 documentation for more information. Always outgoing connections.

A.4.2. Windows CE

A.4.2.1. Setting a device password

To configure a device password on Windows CE, please perform the following steps on the CE device:

1. Select Start → Control Panel → Password
2. Enter a password in the filed Password and Confirm password
3. Finish with OK

After a reboot, users will not be able to select a dialog or start an application without entering the password. Please also compare to chapter 3.2.2.1.

A.4.2.2. Deactivate webserver

To deactivate the Windows CE webserver, simply modify the following Registry Key on the Windows CE device:

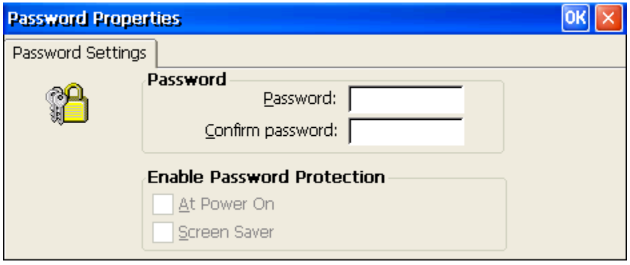
```
HKEY_LOCAL_MACHINE\Services\HTTPD\Flags
```

By setting this DWORD value to “4”, the Webserver gets deactivated completely. Please keep in mind that all services which depend on the Webserver will not work afterwards!

A.4.2.3. Changing password for system user

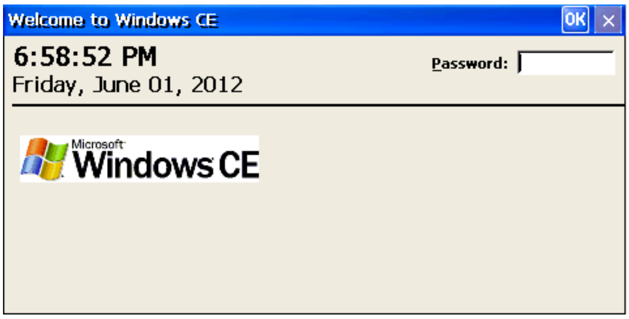
Please perform the following steps to change the password for the System user:

1. Open the Start Menu and go to the *Control Panel*
2. Double-click on Password



Password Properties

3. Enter a password of your choice but remember to use a strong password (a minimum of 8 characters which also includes special characters) see A.4.1.2
4. Enable the checkbox At Power On. This also enables the password for system logon.



Welcome to Windows CE

6:58:52 PM
Friday, June 01, 2012

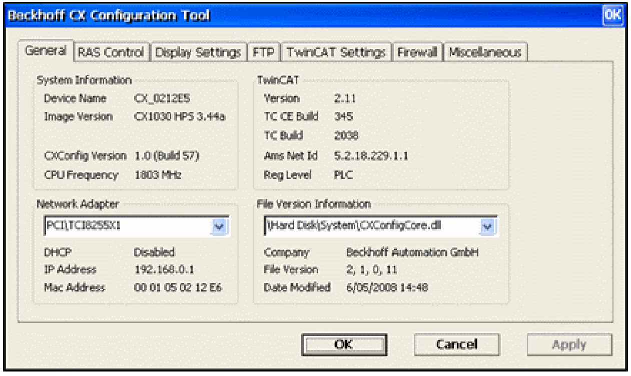
Password:

A.4.2.4. Changing password for SMB and FTP user

To change the password for an SMB or FTP user account, you can use the Beckhoff CX Configuration Tool. To start the program, please perform the following the steps:

1. Open the Start Menu and go to the *Control Panel*

2. Start the program by double-clicking *CX Configuration*



System Information

Device Name	CX_0212E5
Image Version	CX1030 HPS 3.44a
CXConfig Version	1.0 (Build 57)
CPU Frequency	1803 MHz

TwinCAT

Version	2.11
TC CE Build	345
TC Build	2038
Ams Net Id	5.2.18.229.1.1
Reg Level	PLC

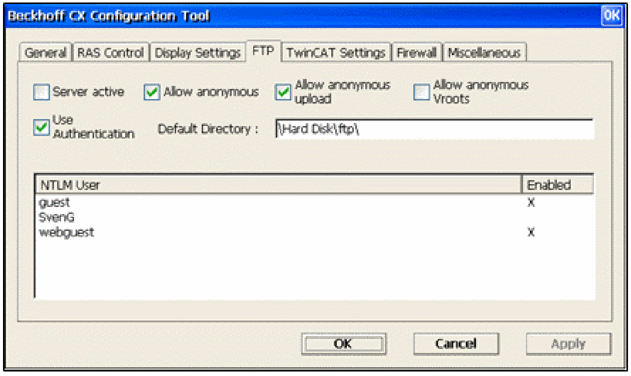
Network Adapter: PCI\TCI8255X1

DHCP	Disabled
IP Address	192.168.0.1
Mac Address	00 01 05 02 12 E6

File Version Information: \Hard Disk\System\CXConfigCore.dll

Company	Beckhoff Automation GmbH
File Version	2, 1, 0, 11
Date Modified	6/05/2008 14:48

3. Local user accounts can then be configured via the tab *FTP*



□ Server active ☑ Allow anonymous ☑ Allow anonymous upload □ Allow anonymous Vroots

☑ Use Authentication Default Directory : \Hard Disk\ftp\

NTLM User	Enabled
guest	X
SvenG	
webguest	X

4. Please do not get confused: User accounts in this tab will both be used for the FTP *and* for the SMB Server

5. You can configure a new user account by right-clicking a blank area in the table and selecting *Add user*

6. After you've entered a username and a password, you can close the *CX Configuration* by clicking on *OK*. Please make sure to restart your device for the changes to take effect

A.4.2.5. Changing password for RAS user

The Beckhoff CX Configuration Tool can also be used to configure user accounts for the integrated RAS Server. Start the tool by performing the following steps:

1. Open the Start Menu and go to the Control Panel

2. Start the program by double-clicking CX Configuration

3. Switch to the tab RAS Control

4. The RAS User Management can then be found on the right hand side in this window

For a detailed description of the RAS Server, please consult the corresponding chapter here in this documentation.

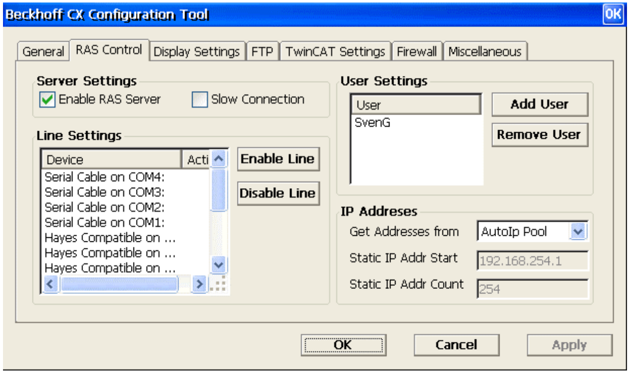
A.4.2.6. Configuring RAS

You can configure the RAS Server via the *CX Configuration* tool in the *Control Panel* on your CE device:

1. Open the Start Menu and go to the *Control Panel*

2. Start the configuration program by double-clicking *CX Configuration*

3. Navigate to the tab *RAS Control*



☑ Enable RAS Server

□ Slow Connection

Device	Acti
Serial Cable on COM4:	
Serial Cable on COM3:	
Serial Cable on COM2:	
Serial Cable on COM1:	
Hayes Compatible on ...	
Hayes Compatible on ...	
Hayes Compatible on ...	

User
SvenG

Get Addresses from: AutoIp Pool

Static IP Addr Start: 192.168.254.1

Static IP Addr Count: 254

The Windows CE RAS Server is disabled by default. To enable it, simply perform the following steps in the *Beckhoff CX Configuration Tool*:

1. Click on the checkbox *Enable RAS Server*

2. Select one or more connection channels (lines) and click on *Enable Line*. These channels configure whether you want to use an attached mode for the dial in or the network (VPN). Both settings will be described in more detail below

3. Add a user account which may dial in via one of the lines. Please note that this user account is not to be mixed with user accounts used for accessing a SMB share!!

4. Optionally, select another IP-Address setting. Each setting changes how clients will receive an IP address. The available options for IP addressing are: *DHCP*, *AutoIP (default)*, *Static*

When finished, click on *OK* and restart your system. You should always use this graphical tool to setup the RAS Server. However, if you want to further customize your RAS setup, you can make more detailed settings by modifying the Windows CE registry:

1. Open the *Start Menu* and click on *Run…*

2. Enter *regedit* and click on *OK*. The Registry Editor opens

3. Navigate to *HKEY_LOCAL_MACHINE\Comm\ppp\Server\Parms*. Here you can set further parameters for the RAS Server. Please note that the key *ppp* only exists after the RAS Server has been enabled!

The following table shows the different attributes in this registry key:

Attribute	Type	Default value	Description
Enable	DWORD	0x00000000	Disables (0) or enables (1) RAS Server
StartupDelaySeconds	DWORD	0x00000000	Specifies the wait time after boot, before the RAS Server is being started.
UseDHCPAddresses	DWORD	0x00000000	Disables (0) or enables (1) the use of DHCP addresses for clients. Should be used if the CE device contains an internal DHCP Server software.
UseAutoIpAddresses	DWORD	0x00000000	See explaination above
AutoIpSubnet	DWORD	0xC0A80000	Subnet IP for AutoIp configuration. The hexadecimal value is determined according to the calculations below.
AutoIpSubnetMask	DWORD	0xFFFF0000	Subnet Mask for AutoIp configuration. The hexadecimal value is determined according to the calculations below.
StaticIpAddrStart	DWORD	0xC0A8FE01	First IP Address for Static configuration. The hexadecimal value is determined according to the calculations below.
StaticIpAddrCount	DWORD	0x000000FE	Amount of IP Addresses for static configuration.
AuthenticationMethods	DWORD	0x00400000	Discussed in more detail below
Flags	DWORD	0x00000000	Discussed in more detail below

The value of each IP address related attribute is determined according to the binary and hexadecimal representation of the address. An IP address consists of 4 values, each value equals 1 byte or rather 8 bits. Therefore the hexadecimal value of this IP address can be derived directly from the binary representation by converting every 4 bits to hex, for example:

IP address 192.168.0.1

Binary 11000000.10101000.00000000.00000001

Hexadecimal C0.A8.00.01 à0xC0A80001

The following table shows some examples for common IP subnets addresses.

Subnet IP	Subnet Mask	Value IP (Hex)	Value Mask (Hex)
192.168.0.0	255.255.255.0	0xC0A80000	0xFFFFFF00
192.168.1.0	255.255.255.0	0xC0A80100	0xFFFFFF00
192.168.2.0	255.255.255.0	0xC0A80200	0xFFFFFF00
172.16.0.0	255.255.0.0	0xAC100000	0xFFFF0000

The attribute *AuthenticationMethods* configures the RAS Server for the usage of different protocols for client authentication. Please note that this value configures protocols which should be prohibited by the Server! That means, if a client tries to establish a RAS connection with an authentication protocol which is prohibited by the server, the connection fails.

Protocol	Value (Hex)	Information
PAP	0x00040000	Password for authentication is being transmitted in clear-text! Insecure!
CHAP	0x00080000	Uses a random value, together with the password, for creating a one-way hash value which is being transmitted to the server for authentication.
MS-CHAP	0x00100000	This is Microsoft's implementation of CHAP. It provides several enhancements to standard CHAP.
MS-CHAP v2	0x00200000	This is version 2 of the MS-Chap protocol. It provides mutual authentication between peers. This protocol should be used!
EAP	0x00400000	Developed by the IETF. Supports several authentication mechanisms like RADIUS, certificates, … . However, this usually implies other software packages to be installed on the CE device and is therefore disabled by default.

To prohibit more than one protocol, you need to interpret the hexadecimal value like a bitmask and add the bit-wise values. For example:

Protocols to prohibit PAP, CHAP, MS-CHAP

PAP value binary 0000 0000 0000 0100 0000 0000 0000 0000

CHAP value binary 0000 0000 0000 1000 0000 0000 0000 0000

MS-CHAP value binary 0000 0000 0001 0000 0000 0000 0000 0000

Overall binary value (sum) 0000 0000 0001 1100 0000 0000 0000 0000

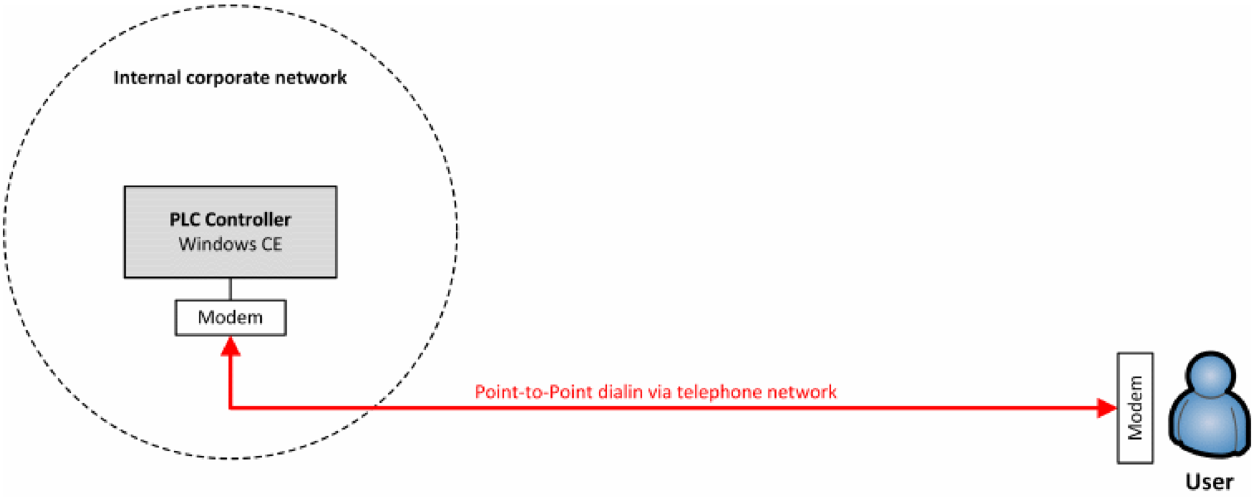
Hex value to configure 0x001C0000

The *Flags* attribute configures if the RAS Server should allow any of the following features. Any of these features can be combined by setting the appropriate bitmask value (similar to the procedure from above).

Feature	Value (Hex)	Information
Data Encryption	0x01	Requires data encryption, if set
Unauthenticated Access	0x02	Allows unauthenticated access, if set
Use of VJ header compression	0x04	Prevents the use, if set
Use data compression	0x08	Prevents the use, if set

Configure a modem connection

You can use a to the CE device attached modem for enabling incoming dial in connections. Therefore, the resulting connection is a point-to-point communication via the telephone network.


Internal corporate network
PLC Controller
Windows CE
Modem
Point-to-Point dialin via telephone network
Modem
User

To configure the RAS Server for incoming modem connections, you need to open the *CX Configuration* tool on your *CE device*:

1. Open the Start Menu and go to the Control Panel

2. Start the configuration program by double-clicking CX Configuration

3. Navigate to the tab RAS Control

4. Select a modem line and click on Enable Line, for example Hayes Compatible...

5. Please makesure that you also made all other necessary settings, like configuring a user account or IP-Address settings. Those settings are described at the beginning of this document (General information...)

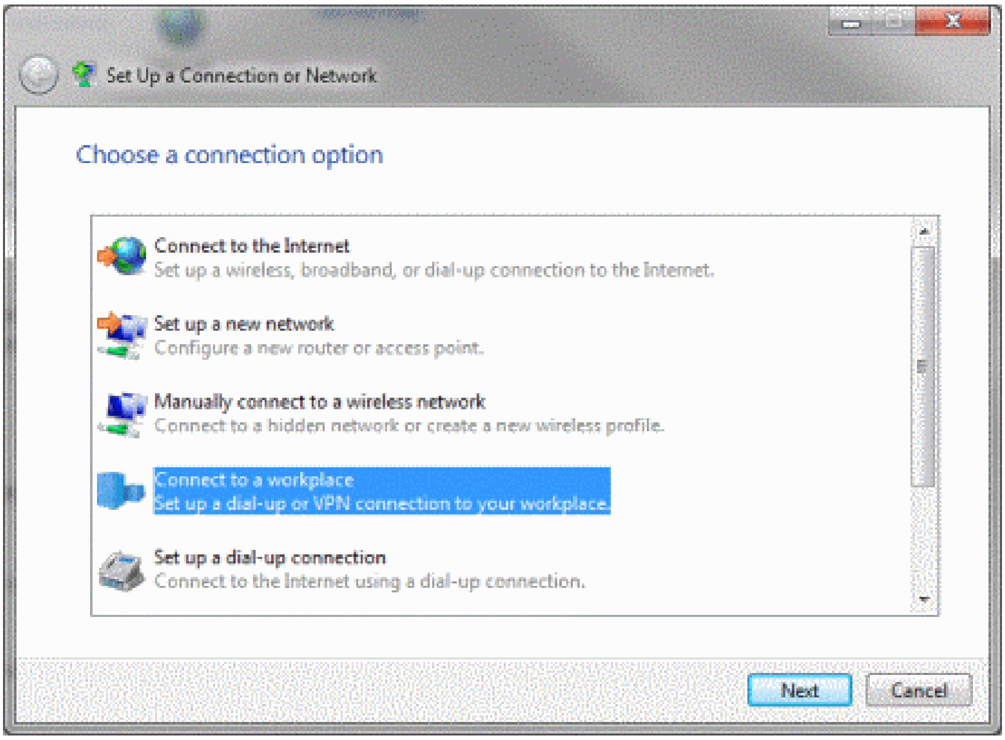
6. Please restart your device

Every Windows version comes with an integrated dial in Client which supports the establishment of an outgoing modem connection. In case of Windows 7, you can configure a modem connection to your CE device as follows:

1. Open the Start Menu and go to the Control Panel

2. Open Network and Internet, then go to Network and Sharing Center

3. Click on Set up a new connection or network



Set Up a Connection or Network

Choose a connection option

Connect to the Internet
Set up a wireless, broadband, or dial-up connection to the Internet.

Set up a new network
Configure a new router or access point.

Manually connect to a wireless network
Connect to a hidden network or create a new wireless profile.

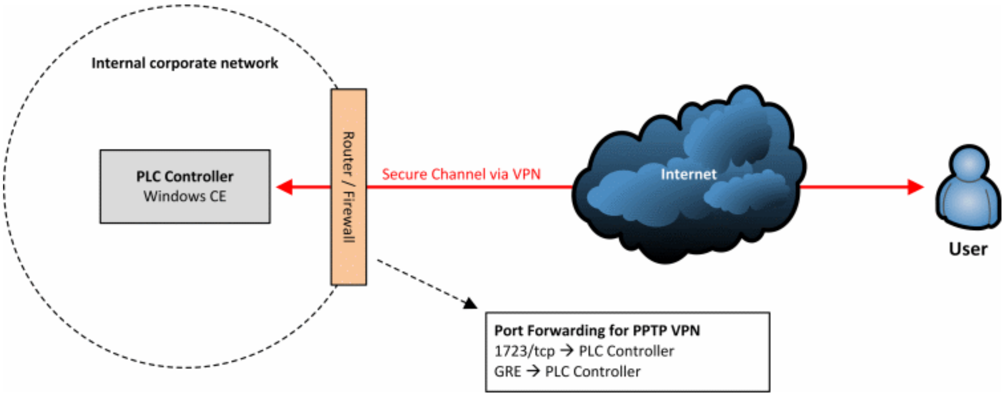
Connect to a workplace
Set up a dial-up or VPN connection to your workplace.

Set up a dial-up connection
Connect to the Internet using a dial-up connection.

4. Select *Connect to a workplace*
5. Select *No, create a new connection* (Please note: This screen only shows if there are any dial in connections configured on your system)
6. Select *Dial directly*
7. Select the modem you would like to use and click on *Next*
8. Enter a *telephone number* and click on *Next*
9. Enter a *Username* and a *Password* for this connection. This is the username you configured in the RAS Server settings on your CE device
10. Finally, click on *Connect* to save this profile and establish a connection to your CE device

Configure a VPN connection

VPN is the abbreviation for *Virtual Private Network*. In Windows CE, VPN is part of the RAS Server and enables you to use an existing network connection to dial in into your PLC controller via a secure channel. As a result, you can get an IP-based connection to your CE device. The CE RAS Server uses by default the PPTP protocol (Point-to-Point Tunneling Protocol) for incoming VPN connections. To enable the connection establishment from outside your corporate network you therefore need to open the ports specific for PPTP on your firewall, which are TCP 1723 for the initialization and GRE for data control. These ports need to be forwarded to your CE device (*Port Forwarding*)! Please consult the documentation of your router/firewall to see how this can be done in your specific case.



To configure the RAS Server for incoming VPN connections, you need to open the *CX Configuration* tool *on your CE device*:

1. Open the *Start Menu* and go to the *Control Panel*

2. Start the configuration program by double-clicking *CX Configuration*

3. Navigate to the tab *RAS Control*

4. Select one or more VPN lines and click on *Enable Line*. The amount of lines equals the number of concurrent VPN connections.

5. Please make sure that you also made all other necessary settings, like configuring a user account or IP-Address settings. Those settings are described at the beginning of this document (*General information...*)

6. Please restart your device

Since Windows XP, every Windows version comes with an integrated VPN Client which also supports the PPTP protocol. In case of Windows 7, you can configure a VPN connection to your CE device as follows:

1. Open the *Start Menu* and go to the *Control Panel*

2. Open *Network and Internet*, then go to *Network and Sharing Center*

3. Click on *Set up a new connection or network*

4. Select *Connect to a workplace*

5. Select *No, create a new connection* (Please note: This screen only shows if there are any dialin connections configured on your system)

6. Select *Use my Internet connection (VPN)*

7. Enter the Internet address of the CE device. Please note: If you want to use this VPN connection from outside your corporate network, you need to enter the IP-Address of your router/firewall where you did the port forwarding settings as mentioned above.

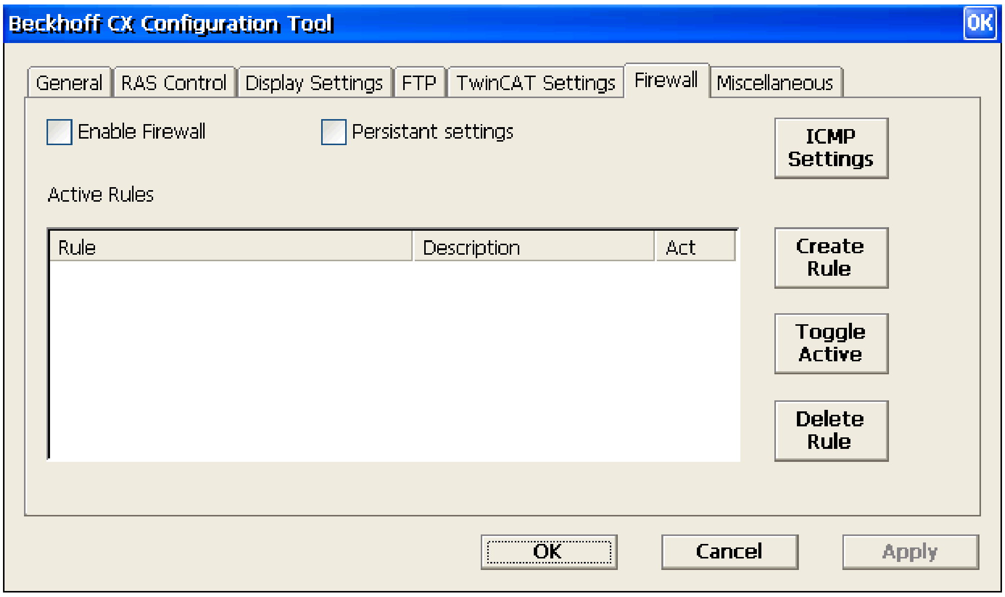
8. Click on *Next*

9. Enter a *Username* and a *Password* for this connection. This is the username you configured in the RAS Server settings on your CE device

10. Finally, click on *Connect* to save this profile and establish a connection to your CE device

A.4.2.7. Configuring the firewall

The firewall for Windows CE can be configured via the *Beckhoff CX Configuration Tool*.



☐ Enable Firewall

☐ Persistant settings

Active Rules

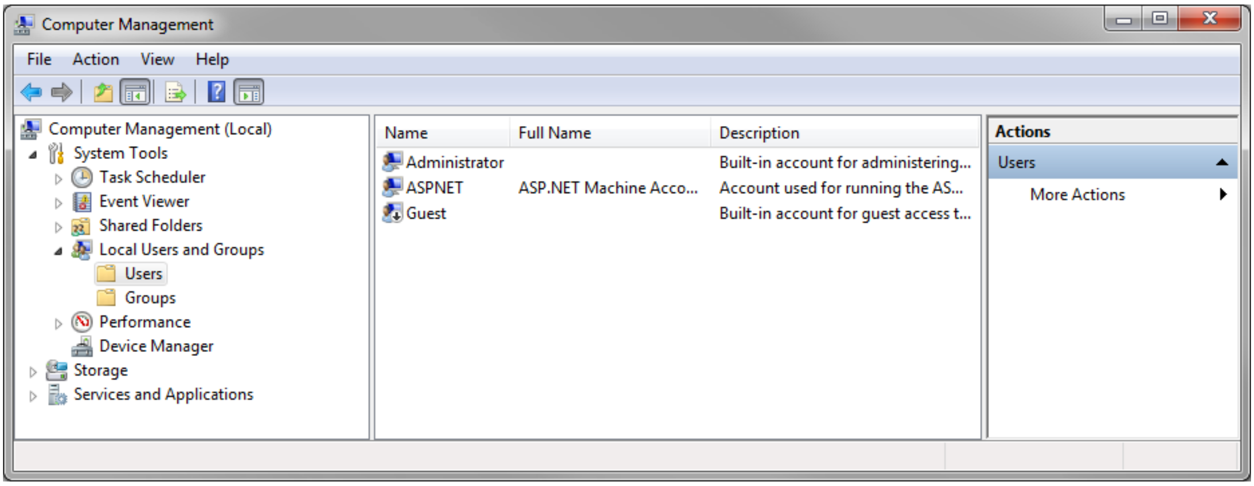
Rule	Description	Act

A.4.3. Windows XP / Windows 7 / Windows 10

A.4.3.1. Changing user passwords

To manage local Windows user accounts on your Windows XP, Windows 7 or Windows 10 based device, simply perform the following steps to open the *User Management Console*

1. Open the start menu and then browse to the Control Panel
2. Open *Administrative Tools* → *Computer Management*
3. Expand the entry *System Tools* → *Local Users and Groups* → *Users*
4. In the context menu at each user use the *Set Password...* menu item to change the password



Name	Full Name	Description
Administrator		Built-in account for administering...
ASPNET	ASP.NET Machine Acco...	Account used for running the AS...
Guest		Built-in account for guest access t...

A.4.3.2. Creating an Audit Policy

To create an Audit Policy, please perform the following steps:

1. Open the *Local Security Settings* (in Windows 10 the item may be named *Security Configuration Management*) by opening the *Control Panel* and starting *Administrative Tools*
2. Expand *Local Policies* and select *Audit Policy*
3. Activate the setting *Audit object access* and restart your system

Now that you have enabled auditing on a file-and-folder level you need to specify which file or folder should be audited:

1. Right-click the corresponding file or folder and select *Properties*
2. Open the *Security* tab and click on *Advanced*
3. Open the *Auditing* tab and click on Add
4. Add a user account or user group which you want to audit, for example *Administrator*
5. Select one or more audit events, for example *Full Control* and click on *OK*
6. Close all open windows

Every time the chosen user account (In our example the *Administrator* account) accesses the file or folder with the selected audit event (In our example *Full Control*), an entry with the category *Object access* will be created in the Windows Eventlog:

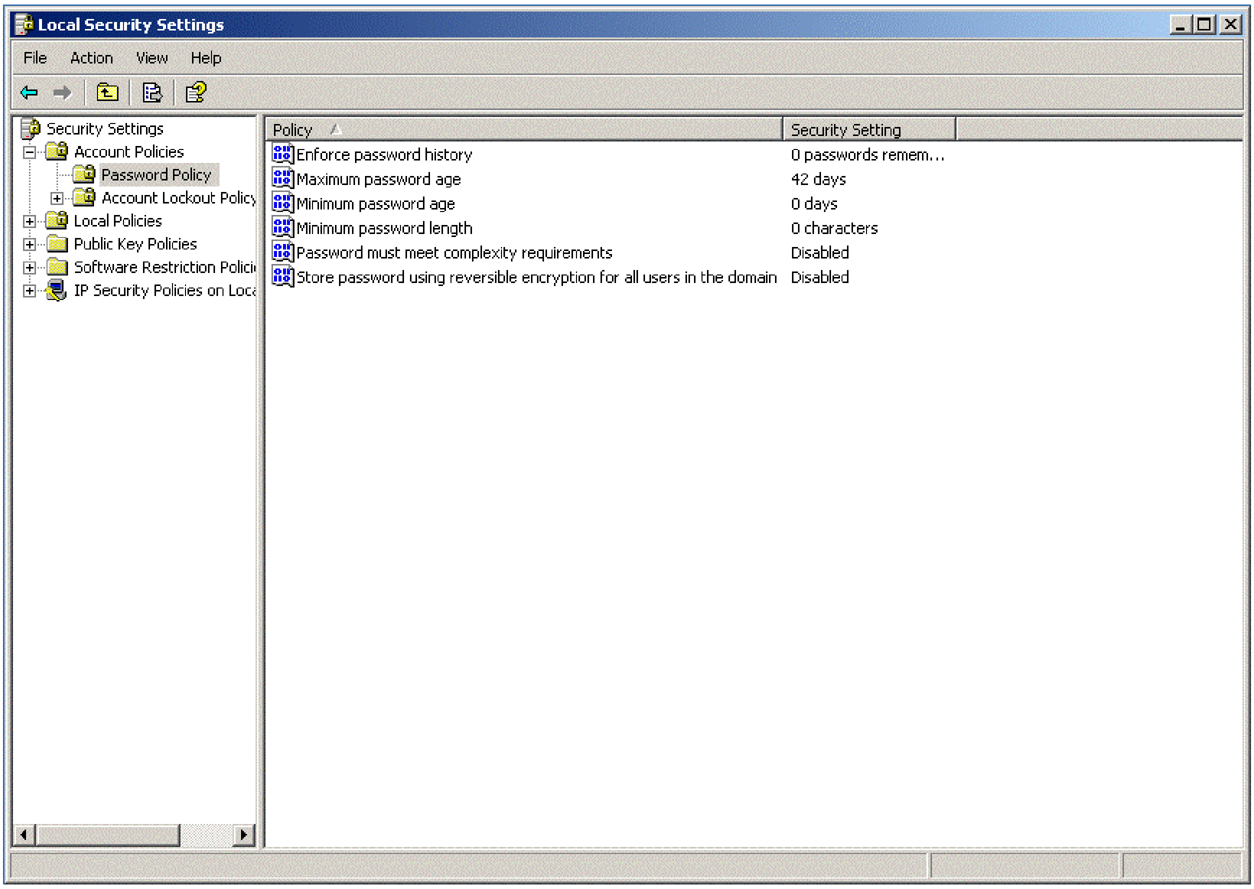
1. Open the *Control Panel* and start the *Administrative Tools*
2. Start the *Event Viewer* and select *Security*

Please always keep in mind that the size of the Eventlog may and should be configured according to the free space on your hard disk.

A.4.3.3. Configuring password policies

To configure a password policy, please perform the following steps:

1. Open the *Control Panel* and start *Administrative Tools*, then *Local Security Settings* (in Windows 10 the item may be named *Security Configuration Management*)
2. Expand *Account Policies* and select *Password Policy*



Policy	Security Setting
Enforce password history	0 passwords remem...
Maximum password age	42 days
Minimum password age	0 days
Minimum password length	0 characters
Password must meet complexity requirements	Disabled
Store password using reversible encryption for all users in the domain	Disabled

A.4.3.4. Configuring security templates

To view the settings of each template in more detail, you can start the Security Templates Snap-in by performing the following steps:

1. Open *Start* and select *Run* (or just begin typing for Windows 10)

2. Enter *mmc.exe* and click on *OK*

3. Go to *File*, select *Add/Remove Snap-in* and click on *Add*

4. Select the *Security Templates* Snap-in, click on *Add* and then on *OK*

5. Expand the entries *Security Templates* and *C:\Windows\Security\Templates*

Then browse the template you wish to view. Please note: In Windows 10 there are no predefined templates. In other Windows versions the templates which are named *dc* are *domain controller* templates and do not apply to your PLC Controller. To apply a template, you need to open the *Security Configuration and Analysis* Snap-in:

1. Open *Start* and select *Run*

2. Enter *mmc.exe* and click on *OK*

3. Go to *File*, select *Add/Remove Snap-in* and click on *Add*

4. Select the *Security Configuration and Analysis* Snap-in, click on *Add* and then on *OK*

5. Right-click the Security Configuration and Analysis entry and select Open Database

6. Enter a name for this database (can be any name)

7. Select the template you wish to apply

8. Right-click the entry again and select *Analyze Computer Now…*

9. Enter a path to the error log file or leave the suggested path and click on OK

10. The system now compares your current security settings with the settings from the template. This gives you the opportunity to double-check the settings before applying them to your system. Here you can also customize the settings so that they suit your needs, for example setting a stronger password policy

11. If you want to apply the settings, right-click the root entry again and select *Configure Computer*

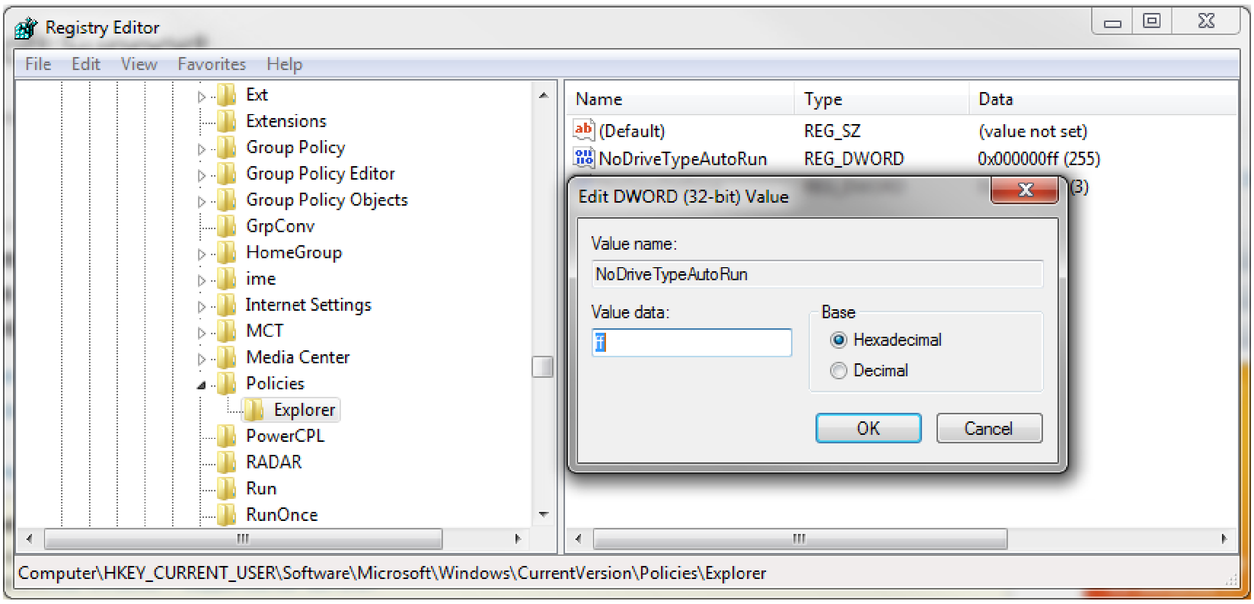
12. Enter a path to the error log file or leave the suggested path and click on OK. Windows now applies the security settings from the template to your system.

13. Please note that you need to restart your system afterwards.

A.4.3.5. Disabling Autorun

You can disable this feature by adding a DWORD key called *NoDriveTypeAutorun* to the Windows registry:

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer



Name	Type	Data
(Default)	REG_SZ	(value not set)
NoDriveTypeAutoRun	REG_DWORD	0x000000ff (255)

Edit DWORD (32-bit) Value

Value name: NoDriveTypeAutoRun

Value data: ff

Base
● Hexadecimal
○ Decimal

Computer\HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer

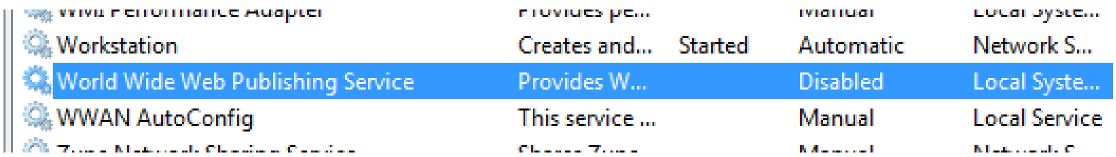
The value of this key depends on which the drives for which you would like to disable AutoRun. The following table shows examples for these values:

Value	Description
0x1	Disables Autorun on drives of unknown type
0x4	Disables Autorun on removable devices
0x8	Disables Autorun on fixed drives
0x10	Disables Autorun on network drives
0x20	Disables Autorun on CD-ROM drives
0x40	Disables Autorun on RAM disks
0x80	See 0x1
0xFF	Disables Autorun on all kinds of drives

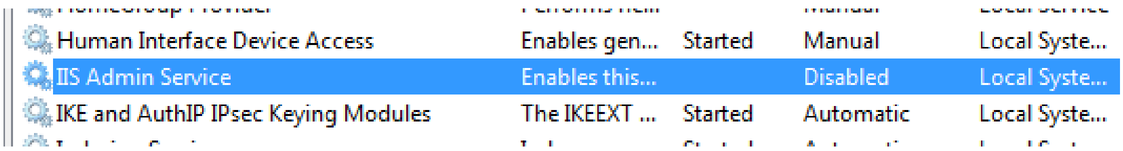
If you would like to configure a mix of the settings shown above, you only need to add the corresponding hexadecimal values, for example 0x4 + 0x10 = 0x14.

A.4.3.6. Deactivating the webserver

To deactivate the IIS Webserver, please open the Windows Service MMC, for example, by going to Start → Run → services.msc and pressing Enter. Deactivate the *World Wide Web Publishing Service* and *IIS Admin Service*.



WMI Performance Adapter	Provides pe...		Manual	Local Syste...
Workstation	Creates and...	Started	Automatic	Network S...
World Wide Web Publishing Service	Provides W...		Disabled	Local Syste...
WWAN AutoConfig	This service ...		Manual	Local Service
Zune Network Sharing Service	Shares Zune ...		Manual	Network S...



HomeGroup Provider	Performs netw...		Manual	Local Service
Human Interface Device Access	Enables gen...	Started	Manual	Local Syste...
IIS Admin Service	Enables this...		Disabled	Local Syste...
IKE and AuthIP IPsec Keying Modules	The IKEEXT ...	Started	Automatic	Local Syste...

Please keep in mind that all services that depend on the Webserver won't work afterwards!

A.4.3.7. Deactivating the Windows registry

Blocking access to Windows Registry tools like regedit.exe or regedt32.exe can be achieved by adding the DWORD value *DisableRegistryTools* to the following registry key:

```
HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\
```

Setting this value to 1 results in an error message as soon as one of the registry editors is started. Please note that you could also block access to these tools by creating a corresponding Software Restriction Policy, as described in chapter 3.2.3.5.

A.4.3.8. Deactivating the Windows command prompt

To block access to the Windows command line, just add the DWORD value DisableCMD to the following registry key:

```
HKEY_CURRENT_USER\Software\Policies\Microsoft\Windows\System\
```

This registry key may contain one of the following values:

Value	Description
0x0	Access to the command line is allowed and batch files may be executed
0x1	Access to the command line is blocked and no batch files may be executed
0x2	Access to the command line is blocked but batch files may be executed

Please note that you may also use a Software Restriction Policy to disable an execution of cmd.exe, as described in chapter 3.2.3.5.

A.4.3.9. Hiding the network environment

To hide the network environment from the user's desktop, simply add the DWORD value `{F02C1A0D-BE21-4350-88B0-7367FC96EF3C}` to the following registry key:

```
HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\NonEum\
```

Setting this key to 1 hides the network environment from the user's desktop.

A.4.3.10. Disallowing users to add network drives

To hide the *Map network drive* feature, simply add the DWORD value *NoNetConnectDisconnect* to the following registry key:

```
HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer\
```

By setting this key to *1* hides that feature from the user's Windows Explorer.

A.4.3.11. Hiding or restricting access to drive letters

To restrict access to drive letters, you need to create a new *REG_DWORD* called *NoViewOnDrive* under the following registry key:

```
HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer\
```

If this registry key does not exist, you need to create it manually. The value of this key depends on the drive letters you want to restrict access to and will be calculated according to the following listing:

A	1
B	2
C	4
D	8
E	16
F	32
G	64
H	128
I	256
J	512
K	1024
L	2048
M	4096
N	8192
O	16384
P	32768
Q	65536
R	131072
S	262144
T	524288
U	1048576
V	2097152
W	4194304
X	8388608
Y	16777216
Z	33554432
All	67108863

If you decide to restrict access to the drive letters A, B, D and P the value of the key would be 1+2+8+32768 = 32779. For a combination of A, B and H it would be 131. After you've entered the value you need to restart the operating system to make the changes become active.

To make a drive letter disappear from the Explorer view, you need to create a new *REG_DWORD* key called *NoDrives* under the registry path from above. This key's value needs to be calculated according to the table above. Be aware that the drive letters are indeed not visible however they can be accessed by directly referencing them using the command line or other file access software!

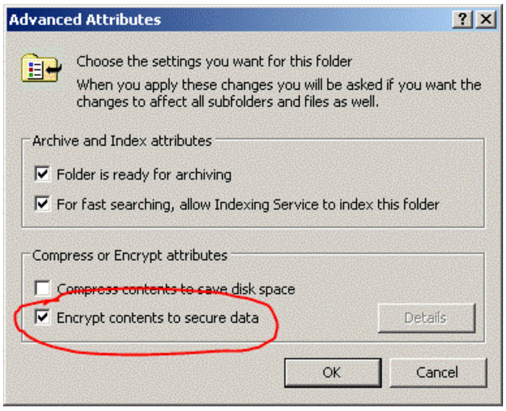
It is possible to use both settings simultaneously.

A.4.3.12. Configuring EFS

To configure the Encrypting File System (EFS), please perform the following steps:

1. Right-click a file or folder and select *Properties*

2. Under the tab General, click on the button Advanced, which will show you a window as follows:



Advanced Attributes

Choose the settings you want for this folder

When you apply these changes you will be asked if you want the changes to affect all subfolders and files as well.

Archive and Index attributes

☑ Folder is ready for archiving

☑ For fast searching, allow Indexing Service to index this folder

Compress or Encrypt attributes

☐ Compress contents to save disk space

☑ Encrypt contents to secure data

3. To encrypt the selected resource, activate the checkbox *Encrypt contents to secure data*

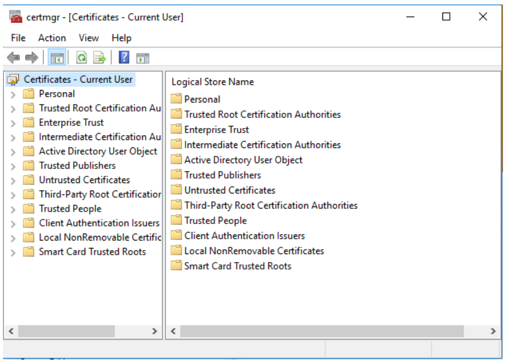
If this is the first time you encrypted a file or folder on this system, Windows automatically adds an EFS certificate to the local certificate store. It is important that you create a backup of this certificate, otherwise you wouldn't be able to recover your encrypted resources in case of a system crash! To view and export the certificate, please do the following:

1. Open *Start* and select *Run*

2. Enter *certmgr.msc*

3. Click on *Add* again and select *My user account*

4. Click on *Finish* and close all open windows. You should now see the following window:

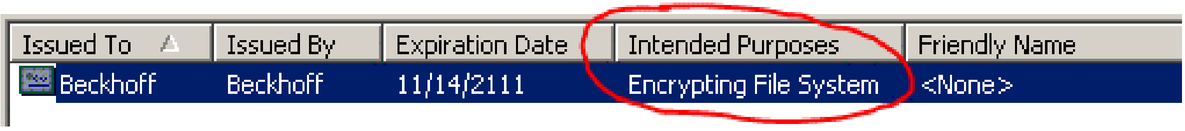


Certificates - Current User
- Personal
- Trusted Root Certification Au
- Enterprise Trust
- Intermediate Certification Au
- Active Directory User Object
- Trusted Publishers
- Untrusted Certificates
- Third-Party Root Certificatior
- Trusted People
- Client Authentication Issuers
- Local NonRemovable Certific
- Smart Card Trusted Roots

Logical Store Name
- Personal
- Trusted Root Certification Authorities
- Enterprise Trust
- Intermediate Certification Authorities
- Active Directory User Object
- Trusted Publishers
- Untrusted Certificates
- Third-Party Root Certification Authorities
- Trusted People
- Client Authentication Issuers
- Local NonRemovable Certificates
- Smart Card Trusted Roots

5. In this window, expand the folder *Personal* and select *Certificates*

6. You should now see a certificate whose *Intended Purpose* shows *Encrypting File System*:



Issued To	Issued By	Expiration Date	Intended Purposes	Friendly Name
Beckhoff	Beckhoff	11/14/2111	Encrypting File System	<None>

This is the certificate which will be used by Windows for signing and encrypting files or folders. To make a backup of this certificate right-click it and select All Tasks → Export. This will start a wizard which will guide you with the export procedure.

1. Select *Export Private Key*

2. Select *Personal Information Exchange*, *Include all certificates…* and *Enable strong protection…*

3. Enter a password of your choice. This password will be needed to import the certificate in case of a system crash so keep it secret!

4. Enter a path where the backup should be stored

After the wizard finishes, a PFX-file will be generated under the specified path. Please save this file to an external and persistent location! In case your system crashes, this file ensures that you will still be able to recover your encrypted files and folders!

Attention: Please make sure to not *encrypt your whole system drive, Windows system files or the TwinCAT folder because this could result in severe issues to your system and could cause your PLC application to not run properly anymore!*

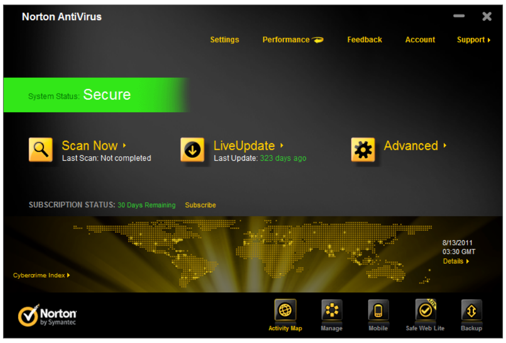
A.4.3.13. Configuring Anti-Virus exclusions

This section shows how to exclude the TwinCAT directory in some prominent Anti-Virus programs.

Norton AntiVirus

The following screenshots are based on Norton AntiVirus 2012. In order to exclude the TwinCAT directory:

1. Open the Norton AntiVirus user interface



Norton AntiVirus

System Status: Secure

Scan Now
Last Scan: Not completed

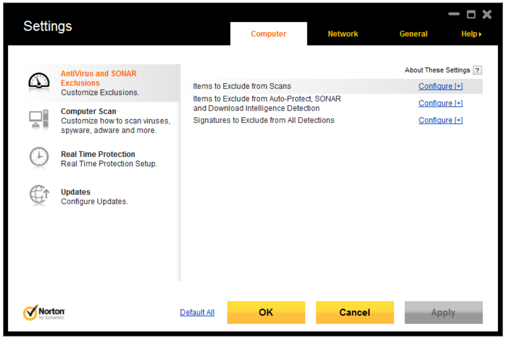
LiveUpdate
Last Update: 323 days ago

Advanced

SUBSCRIPTION STATUS: 30 Days Remaining

8/13/2011
03:30 GMT

2. Click on *Settings* and select the tab *Computer*



Settings

AntiVirus and SONAR Exclusions
Customize Exclusions.

Computer Scan
Customize how to scan viruses, spyware, adware and more.

Real Time Protection
Real Time Protection Setup.

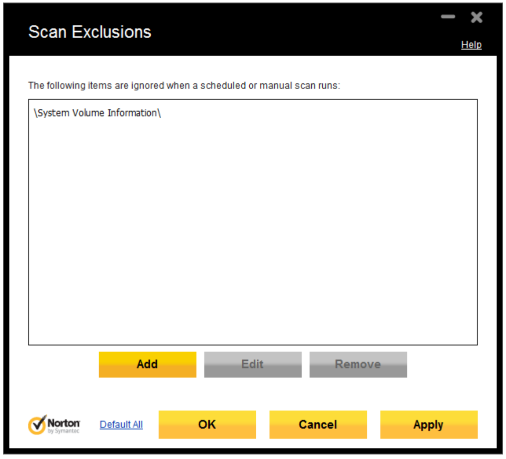
Updates
Configure Updates.

Items to Exclude from Scans — Configure [+]

Items to Exclude from Auto-Protect, SONAR and Download Intelligence Detection — Configure [+]

Signatures to Exclude from All Detections — Configure [+]

3. Click on *Configure items to exclude from Scans*

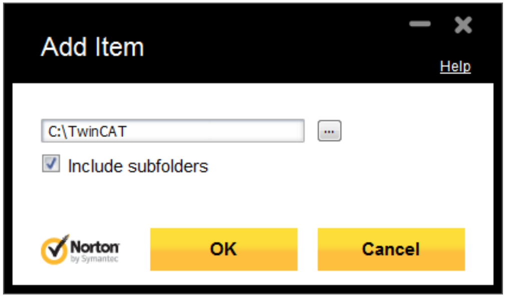


Scan Exclusions

The following items are ignored when a scheduled or manual scan runs:

\System Volume Information\

4. Click on *Add* and select the TwinCAT installation directory, by default C:\TwinCAT\, followed by clicking on *OK*

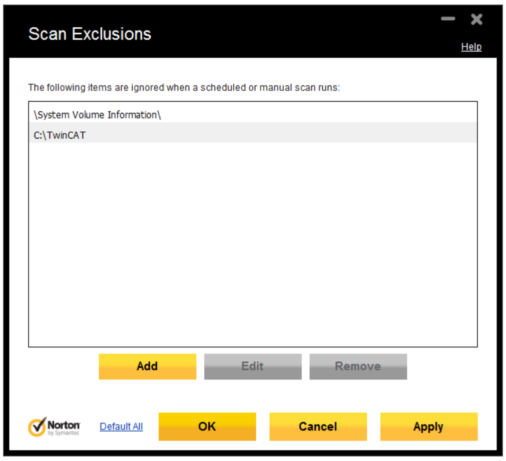


Add Item

C:\TwinCAT

☑ Include subfolders

5. You will now see the TwinCAT directory listed in the exclusion list



Scan Exclusions

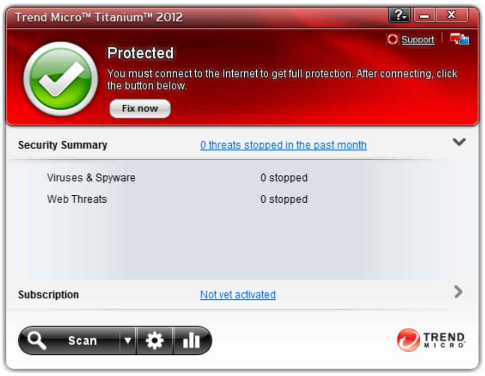
The following items are ignored when a scheduled or manual scan runs:

\System Volume Information\
C:\TwinCAT

Trend Micro

The following screenshots are based on *Trend Micro Titanium AntiVirus Plus 2012*.

1. Open the settings by clicking on the gear icon



Trend Micro™ Titanium™ 2012

Protected

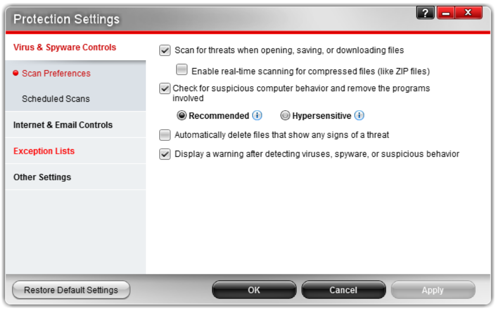
You must connect to the Internet to get full protection. After connecting, click the button below.

Security Summary — 0 threats stopped in the past month

Viruses & Spyware	0 stopped
Web Threats	0 stopped

Subscription — Not yet activated

2. On the left side of the window, click on *Exception Lists*



Protection Settings

☑ Scan for threats when opening, saving, or downloading files

□ Enable real-time scanning for compressed files (like ZIP files)

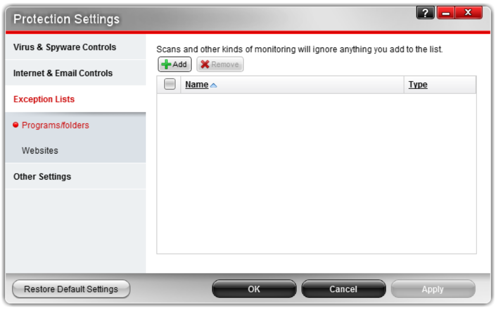
☑ Check for suspicious computer behavior and remove the programs involved

● Recommended ○ Hypersensitive

□ Automatically delete files that show any signs of a threat

☑ Display a warning after detecting viruses, spyware, or suspicious behavior

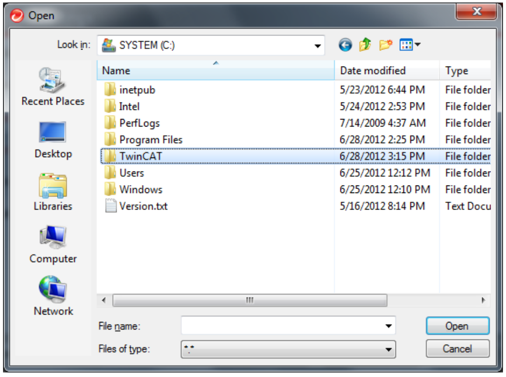
3. Click on *Add*



Scans and other kinds of monitoring will ignore anything you add to the list.

□	Name	Type

4. Click on Browse and select the TwinCAT installation directory, by default C:\TwinCAT\, followed by clicking on Open



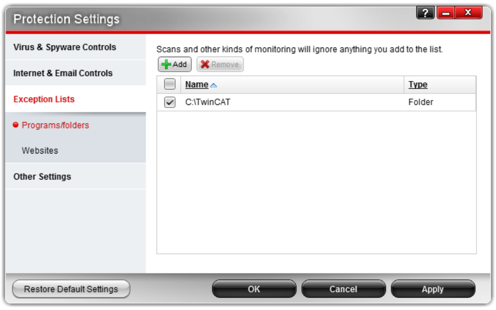
Look in: SYSTEM (C:)

Name	Date modified	Type
inetpub	5/23/2012 6:44 PM	File folder
Intel	5/24/2012 2:53 PM	File folder
PerfLogs	7/14/2009 4:37 AM	File folder
Program Files	6/28/2012 2:25 PM	File folder
TwinCAT	6/28/2012 3:15 PM	File folder
Users	6/25/2012 12:12 PM	File folder
Windows	6/25/2012 12:10 PM	File folder
Version.txt	5/16/2012 8:14 PM	Text Docu

File name:

Files of type: *.*

5. Activate the checkbox next to the TwinCAT directory



Scans and other kinds of monitoring will ignore anything you add to the list.

□	Name	Type
☑	C:\TwinCAT	Folder

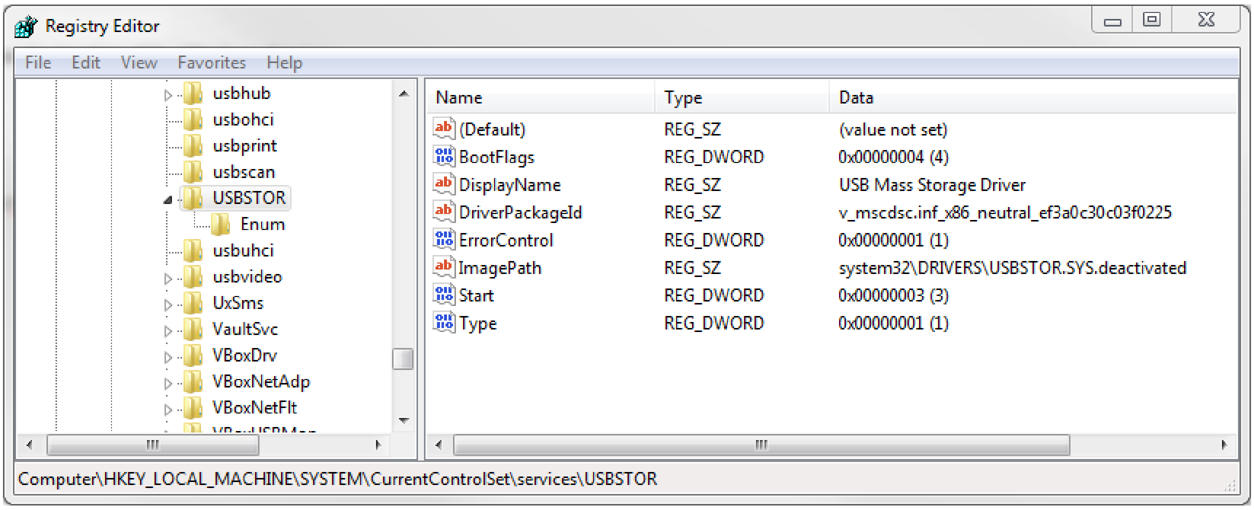
6. Click on *OK* to close the settings window

A.4.3.14. Restricting USB drives

To prevent users from attaching USB Storage devices, for example a USB memory stick, to the IPC, you only need to deny both the local user account and the SYSTEM account access to the following files, where %SystemRoot% defines the location of the Windows directory:

- `%SystemRoot\%\Inf\Usbstor.pnf`
- `%SystemRoot%\Inf\Usbstor.inf`
- `%SystemRoot%\System32\DriverStore\Usbstor.inf*`

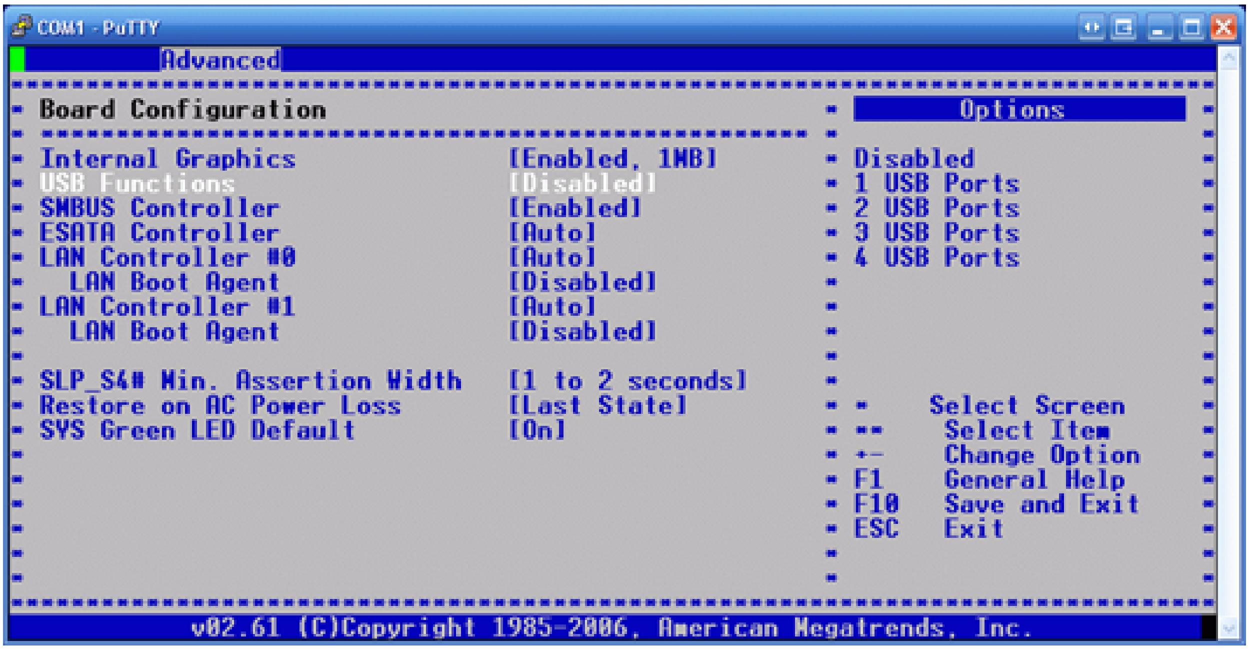
This prevents users to add new USB Storage devices to the system. However, if there have been some previously plugged-in USB devices you need to disable the USB Storage driver completely by changing the *ImagePath* value under *HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\UsbStor* to a value of your choice, for example just add the String .deactivated.



Name	Type	Data
(Default)	REG_SZ	(value not set)
BootFlags	REG_DWORD	0x00000004 (4)
DisplayName	REG_SZ	USB Mass Storage Driver
DriverPackageId	REG_SZ	v_mscdsc.inf_x86_neutral_ef3a0c30c03f0225
ErrorControl	REG_DWORD	0x00000001 (1)
ImagePath	REG_SZ	system32\DRIVERS\USBSTOR.SYS.deactivated
Start	REG_DWORD	0x00000003 (3)
Type	REG_DWORD	0x00000001 (1)

Computer\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\USBSTOR

On the other hand, if you only want specific USB Storage devices to be available on the Controller, the above steps can easily be adapted to your needs. Plug in all USB Storage devices which should be accessible on the Controller and then deny access to the files, as mentioned above. Of course, you can also disable USB devices in the system's BIOS but this would also include non-Storage devices! Please keep in mind, that some USB devices are necessary for your Controller to run properly, for example a Control Panel (CP) which uses the USB port for its touchscreen!



```
              Advanced
 Board Configuration                                  Options
 Internal Graphics          [Enabled, 1MB]            Disabled
 USB Functions              [Disabled]                1 USB Ports
 SMBUS Controller           [Enabled]                 2 USB Ports
 ESATA Controller           [Auto]                    3 USB Ports
 LAN Controller #0          [Auto]                    4 USB Ports
   LAN Boot Agent           [Disabled]
 LAN Controller #1          [Auto]
   LAN Boot Agent           [Disabled]

 SLP_S4# Min. Assertion Width   [1 to 2 seconds]
 Restore on AC Power Loss   [Last State]              ←    Select Screen
 SYS Green LED Default      [On]                      ↑↓    Select Item
                                                      +-    Change Option
                                                      F1    General Help
                                                      F10   Save and Exit
                                                      ESC   Exit

          v02.61 (C)Copyright 1985-2006, American Megatrends, Inc.
```

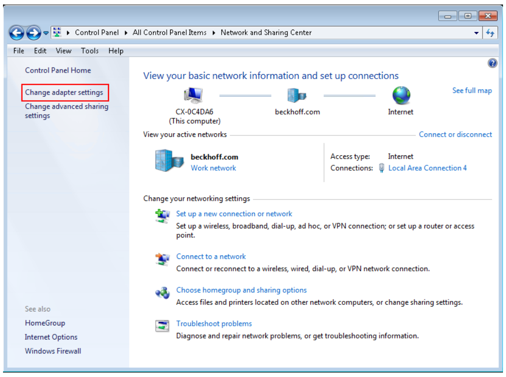
A.4.3.15. Configuring RAS

The following chapters explain how to configure the RAS service.

Configuring a VPN dial in

1. Open the Control Panel and then the Network and Sharing Center (In Windows 10 this dialog is reachable by Windows Settings → Network & Internet)

2. Click on Change adapter settings (In Windows 10: Change adapter options)



Control Panel ▸ All Control Panel Items ▸ Network and Sharing Center

File Edit View Tools Help

Control Panel Home

Change adapter settings

Change advanced sharing settings

See also

HomeGroup

Internet Options

Windows Firewall

View your basic network information and set up connections

See full map

CX-0C4DA6 (This computer) — beckhoff.com — Internet

View your active networks

Connect or disconnect

beckhoff.com
Work network

Access type: Internet
Connections: Local Area Connection 4

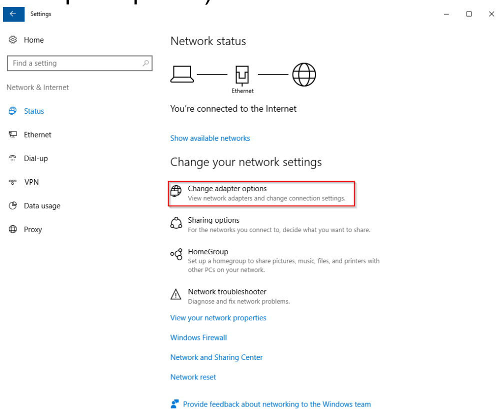
Change your networking settings

Set up a new connection or network
Set up a wireless, broadband, dial-up, ad hoc, or VPN connection; or set up a router or access point.

Connect to a network
Connect or reconnect to a wireless, wired, dial-up, or VPN network connection.

Choose homegroup and sharing options
Access files and printers located on other network computers, or change sharing settings.

Troubleshoot problems
Diagnose and repair network problems, or get troubleshooting information.



Settings

Home

Find a setting

Network & Internet

Status

Ethernet

Dial-up

VPN

Data usage

Proxy

Network status

Ethernet

You're connected to the Internet

Show available networks

Change your network settings

Change adapter options
View network adapters and change connection settings.

Sharing options
For the networks you connect to, decide what you want to share.

HomeGroup
Set up a homegroup to share pictures, music, files, and printers with other PCs on your network.

Network troubleshooter
Diagnose and fix network problems.

View your network properties

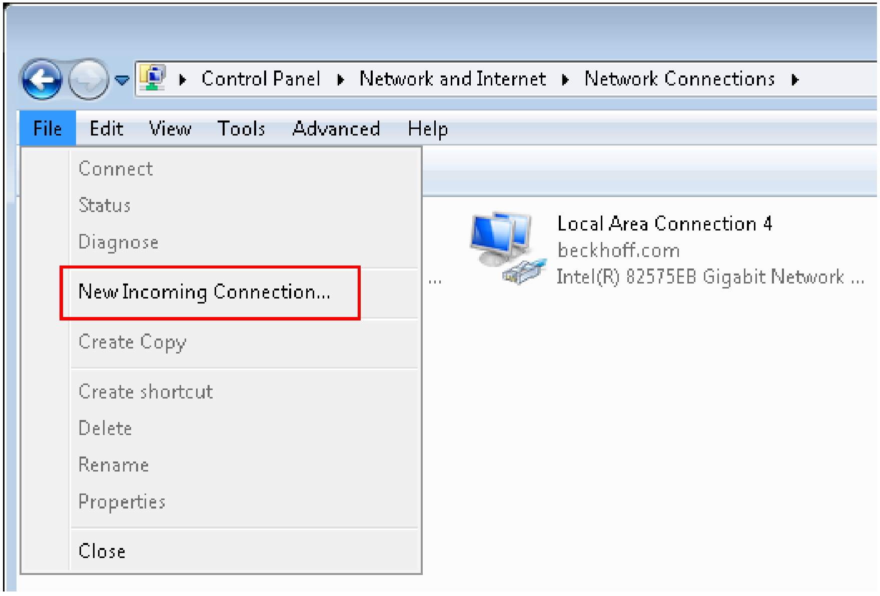
Windows Firewall

Network and Sharing Center

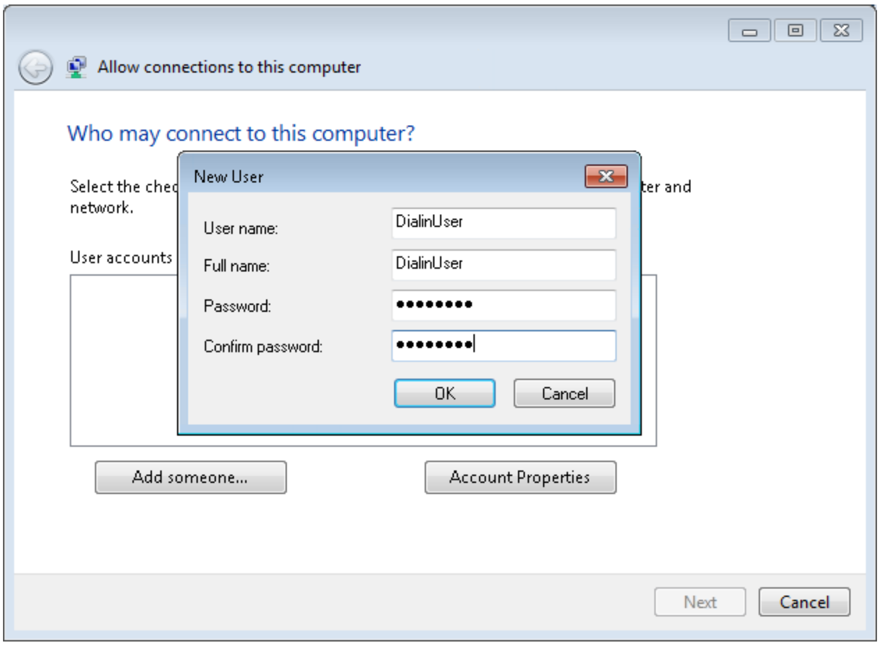
Network reset

Provide feedback about networking to the Windows team

3. Open the File menu and select New incoming connection



4. To configure a new user account which may be used for the dial in connection, please click on Add someone... and specify the user credentials (use a string password) for the new user account. Afterwards click on OK, then on Next.



Allow connections to this computer

Who may connect to this computer?

Select the chec... ter and network.

User accounts

New User

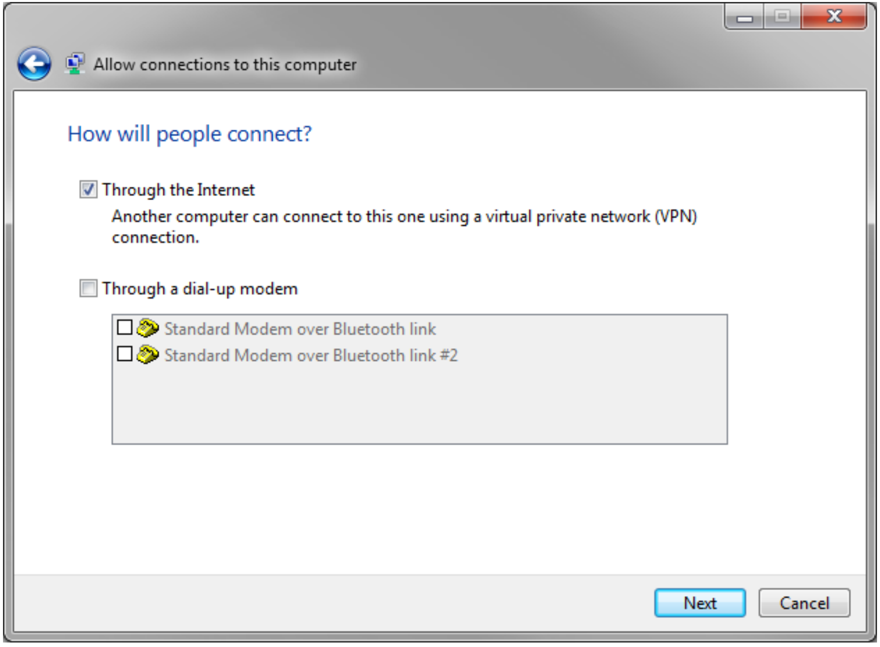
User name: DialinUser

Full name: DialinUser

Password: ●●●●●●●●●

Confirm password: ●●●●●●●●●

5. When asked How to connect?, select Through the Internet and click on Next. This is also the location where you differentiate between a VPN and a modem dialin (see below).



Allow connections to this computer

How will people connect?

☑ Through the Internet

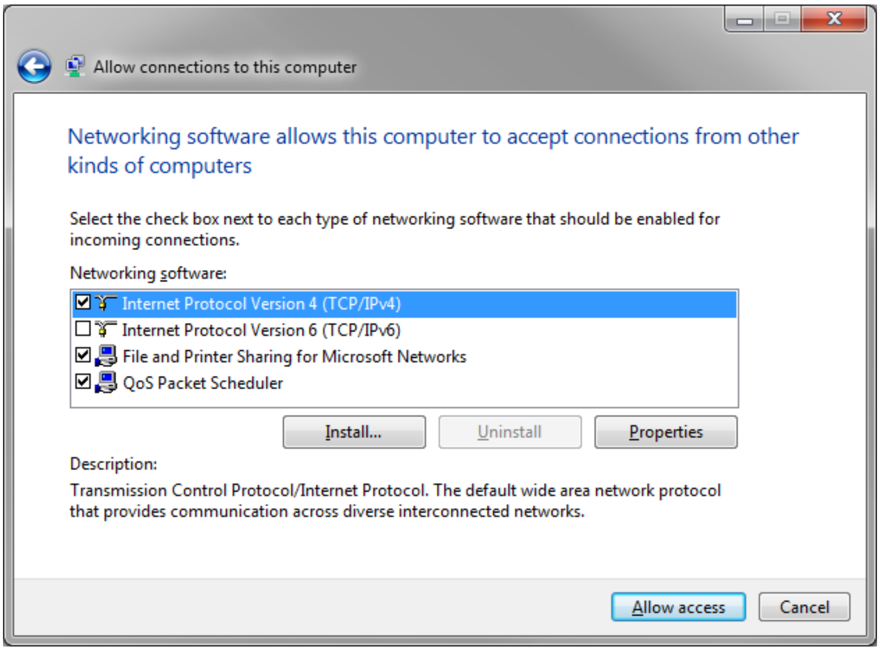
Another computer can connect to this one using a virtual private network (VPN) connection.

☐ Through a dial-up modem

☐ Standard Modem over Bluetooth link

☐ Standard Modem over Bluetooth link #2

6. Make sure that all needed network protocols and services are listed, then click on Allow access



Allow connections to this computer

Networking software allows this computer to accept connections from other kinds of computers

Select the check box next to each type of networking software that should be enabled for incoming connections.

Networking software:

- ☑ Internet Protocol Version 4 (TCP/IPv4)
- ☐ Internet Protocol Version 6 (TCP/IPv6)
- ☑ File and Printer Sharing for Microsoft Networks
- ☑ QoS Packet Scheduler

Description:

Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.

7. After the connection has been set up, you can use the Windows VPN Client to establish a connection to the IPC Controller. Please see below for the necessary configuration steps.

Configuring a modem dial in

Configuring a modem dial in connection is very similar to configure a VPN dial in connection (see above). This option is not supported with Windows 10 anymore. Up to the step where you need to select how people will connect, the configuration is even identical. In this dialog, however, you need to select through a dial-up modem and then select the modem attached to the IPC device. In the next dialog, make sure that all needed network protocols and services are listed, followed by clicking on Allow access.

Configuring the client device

Since Windows XP, every Windows version comes with an integrated RAS Client which supports either an outgoing VPN or Modem connection. In case of Windows 7, you can configure a VPN connection to your CE device as follows:

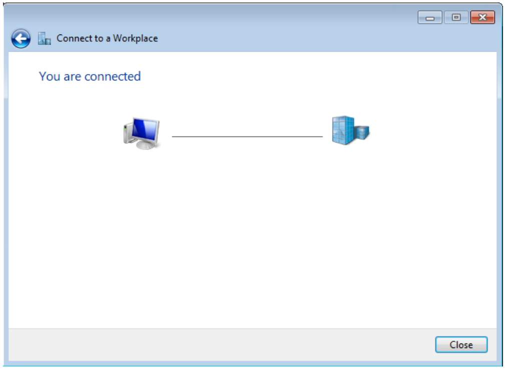
1. Open the Start *Menu* and go to the *Control Panel*
2. Open *Network and Internet*, then go to *Network and Sharing Center*
3. Click on *Set up a new connection or network*
4. Select *Connect to a workplace*
5. Select *No, create a new connection* (Please note: This screen only shows if there are any dial in connections configured on your system)
6. Select *Use my Internet connection (VPN)*
7. Enter the address of the IPC. Please note: If you want to use this VPN connection from outside your corporate network, you need to enter the IP-Address of your router/firewall where you did the port

forwarding settings as mentioned in the documentation of your Internet router.

8. Click on *Next*

9. Enter a *Username* and a *Password* for this connection. This is the username you configured in the RAS Server settings on your CE device

10. Finally, click on *Connect* to save this profile and establish a connection to your CE device



You are connected

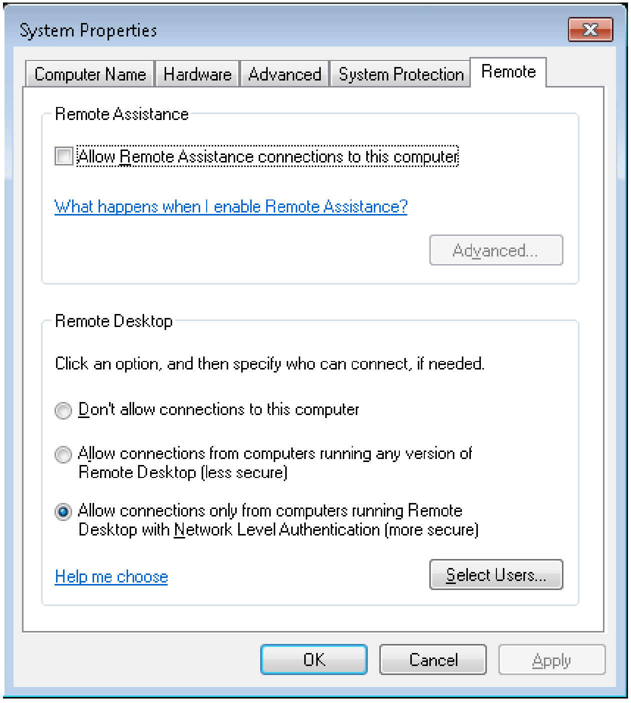
A.4.3.16. Configuring NLA

With Windows 7 and Windows 10, you can restrict access to RDP for NLA-only devices by doing the following:

1. Right-click the symbol *My Computer* and select *Properties* (You may start the explorer first in Windows 10)

2. Open *Remote Settings*

3. Select *Allow connections only from computers running Remote Desktop with Network Level Authentication*



Remote Assistance

□ Allow Remote Assistance connections to this computer

What happens when I enable Remote Assistance?

Remote Desktop

Click an option, and then specify who can connect, if needed.

○ Don't allow connections to this computer

○ Allow connections from computers running any version of Remote Desktop (less secure)

● Allow connections only from computers running Remote Desktop with Network Level Authentication (more secure)

Help me choose

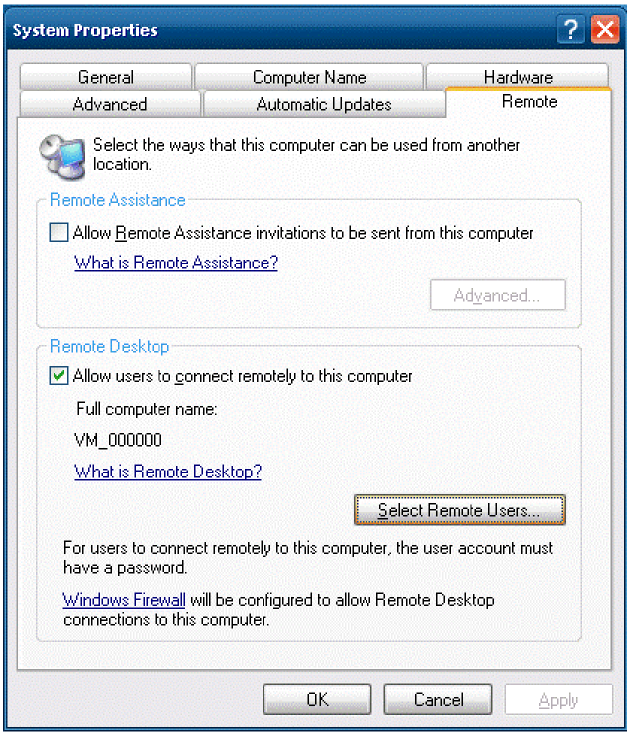
Please note that, even with the use of Network Level Authentication, RDP should only be used over a secure communication channel, as described in our remote maintenance scenarios.

A.4.3.17. Configuring RDP

You can configure which users are able to access a computer via RDP by performing the following steps:

1. Right-click the symbol *My Computer* and select *Properties*

2. Then switch to the tab *Remote* and deactivate the checkbox *Allow users to connect remotely…*



Select the ways that this computer can be used from another location.

Remote Assistance

□ Allow Remote Assistance invitations to be sent from this computer

Remote Desktop

☑ Allow users to connect remotely to this computer

Full computer name:

VM_000000

For users to connect remotely to this computer, the user account must have a password.

Windows Firewall will be configured to allow Remote Desktop connections to this computer.

As mentioned before, the local Administrator account has access to this feature by default. If you also want other user accounts to have access to RDP, you can select those user accounts by clicking on the button *Select Remote Users…*. The shown list represents group membership of the local group *Remote Desktop Users*. Therefore, you can optionally check group membership by going to the *User Management*:

1. Right-click the symbol *My Computer* again and select *Manage*, which opens the *Computer Management*

2. Expand the entry *Local Users and Groups*, then navigate to *Groups*

3. Open the *Remote Desktop Users* group by double-clicking on it

There is also a second option how you can give a user access to RDP:

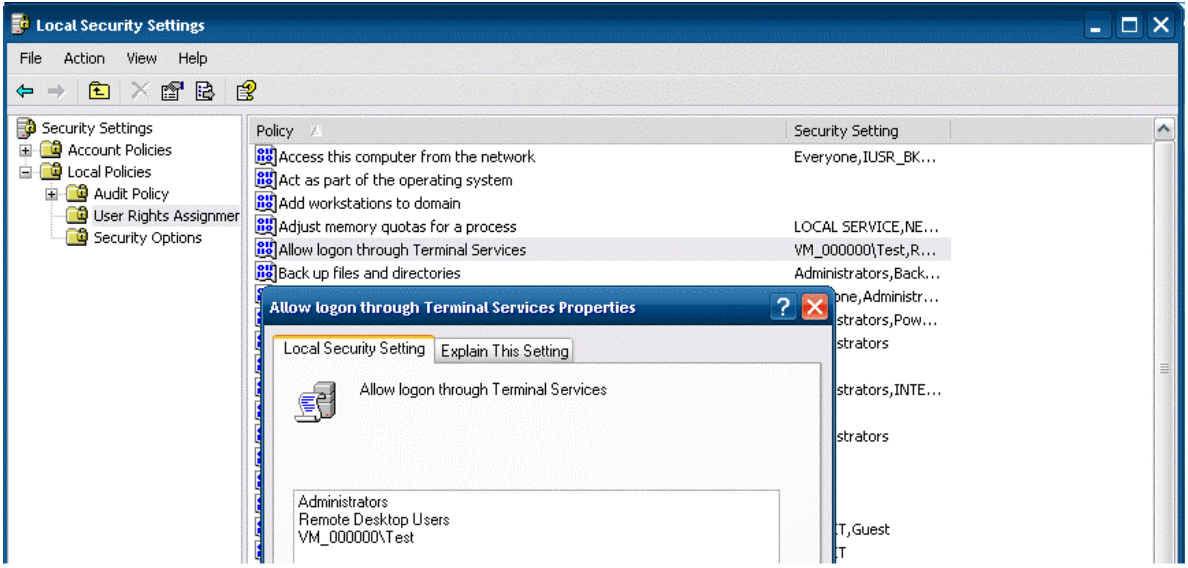
1. Start the Control Panel and open the *Administrative Tools*

2. Start the *Local Security Policy*

3. Expand the entry *Local Policies* and navigate to *User Rights Assignment*

4. There you will see an entry called *Allow logon through Terminal Services*

5. Add user accounts and user groups to grant them access to RDP. Please note, that each additional entry added here will not show up in the *System Properties* because only the group membership of *Remote Desktop Users* will be shown there!



Policy	Security Setting
Access this computer from the network	Everyone,IUSR_BK...
Act as part of the operating system	
Add workstations to domain	
Adjust memory quotas for a process	LOCAL SERVICE,NE...
Allow logon through Terminal Services	VM_000000\Test,R...
Back up files and directories	Administrators,Back...
	one,Administr...
	strators,Pow...
	strators
	strators,INTE...
	strators
	T,Guest
	T

Allow logon through Terminal Services

Administrators
Remote Desktop Users
VM_000000\Test

A.4.3.18. Configuring IPSec

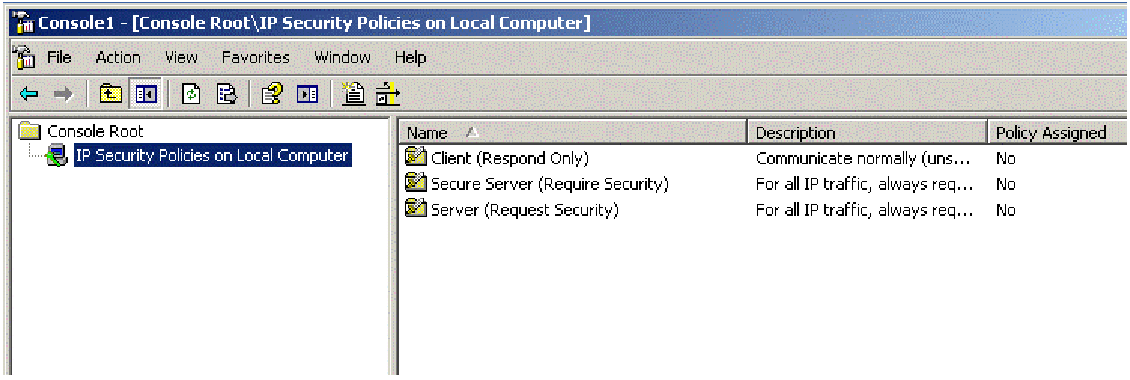
Setting up the IPSec Server (PLC Controller)

To configure the PLC Controller as an IPSec Server you need to open the IP Security Policy Snap-in:

1. Go to *Start* → *Run* and enter *mmc.exe*, then click on *OK*

2. Open *File* and select *Add/Remove Snap-in*

3. Click on *Add* and add the *IP Security Policy Management* from the *Local Computer*


Console1 - [Console Root\IP Security Policies on Local Computer]
File
Action
View
Favorites
Window
Help
Console Root
IP Security Policies on Local Computer

Name	Description	Policy Assigned
Client (Respond Only)	Communicate normally (uns...	No
Secure Server (Require Security)	For all IP traffic, always req...	No
Server (Request Security)	For all IP traffic, always req...	No

With Windows 7 there are already 3 default configurations which can be used for a basic setup. The difference between the two Server configurations is that the Secure Server setting *REQUIRES* IPSec to establish a network communication. Clients which aren't explicitly configured for IPSec won't be able to communicate with the Server if this setting has been activated. In this scenario we would like IPSec to be mandatory and standard IP communications to also work. Do the following steps:

1. Right-click the *Server (Request Security)* and select *Assign*

2. Now you need to specify an authentication method. By default, the IPSec service uses Kerberos

authentication but in this scenario we would like to use Shared Key authentication

3. Right-click the *Server (Request Security)* profile and select Properties

4. Select the *All IP traffic* rule and click on *Edit*

5. Using the tab *Authentication Methods*, edit the currently listed method (Kerberos) and click on Edit

6. Now mark the option box *Use this string (preshared key)* and enter, for example, *test123*

7. Acknowledge all open windows by clicking *OK*

Now the PLC Controller has been set up to request the establishment of an IPSec channel using Shared Key authentication. However, standard IP Clients will also still be able to connect to the Controller. If you want to disable unsecured IP-communications and only want to use IPSec, you need to do the same steps as above, only with the profile *Secure Server (Require Security)*.

Setting up the IPSec Client (Desktop computer)

After the IPSec Server has been set up, you need to configure the desktop computer to act as an IPSec Client. Do the following steps:

1. Open the *IP Security Policy Management* Snap-in as described above

2. Right-click the *Client (Respond Only)* profile and select *Assign*

3. Right-click the profile again and select *Properties*

4. Edit the current security rule and browse to the tab *Authentication Methods*

5. Here you need to edit the current rule (Kerberos) and change it to *Use this string (preshared key)*

6. Enter *test123* as the preshared key

7. Acknowledge all open windows by clicking on *OK*

Try to establish a connection from your desktop computer to the PLC controller, for example try to open the Controller in Windows Explorer:

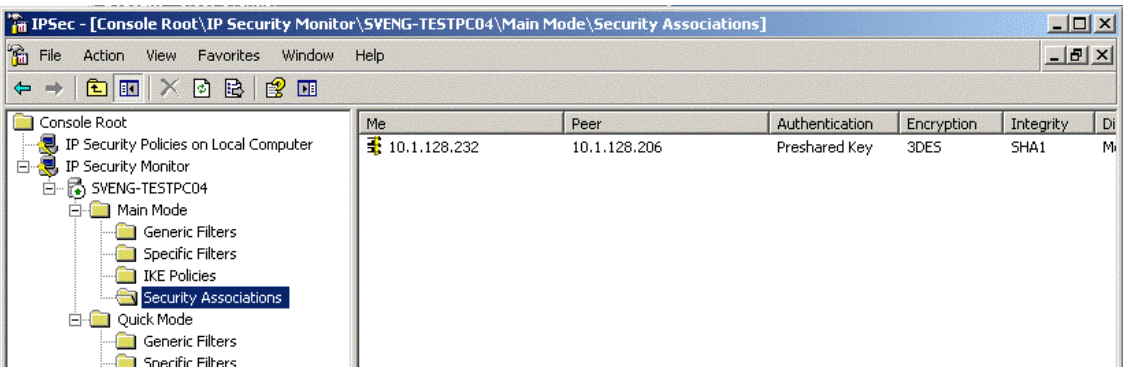
1. Click on Start → Run and enter \\IP-Address-Of-Controller, then click on *OK*

2. You should now see all shares on the PLC Controller

To check if the network communication has really been secured:

1. Open the *IP Security Monitor* Snap-In in MMC. This tool will give you information about currently established IPSec connections

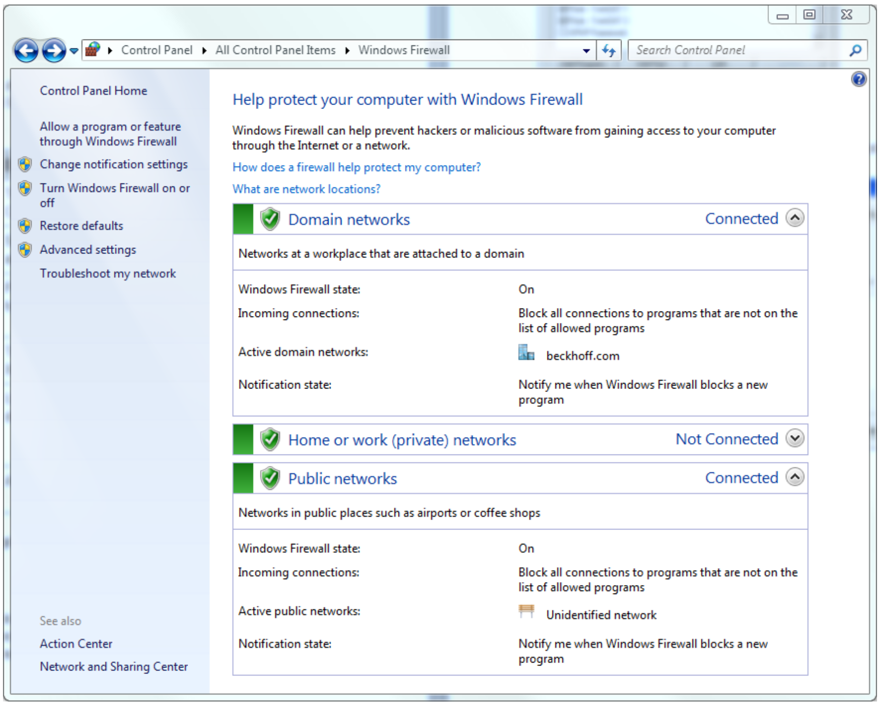
2. Here you can see the currently established connection between Controller and Desktop computer under *Main Mode → Security Associations*, see screenshot below



Me	Peer	Authentication	Encryption	Integrity	Di
10.1.128.232	10.1.128.206	Preshared Key	3DES	SHA1	M

A.4.3.19. Configuring the firewall

Windows Firewall (Windows 7)



Help protect your computer with Windows Firewall

Windows Firewall can help prevent hackers or malicious software from gaining access to your computer through the Internet or a network.

How does a firewall help protect my computer?

What are network locations?

Domain networks — Connected

Networks at a workplace that are attached to a domain

Windows Firewall state:	On
Incoming connections:	Block all connections to programs that are not on the list of allowed programs
Active domain networks:	beckhoff.com
Notification state:	Notify me when Windows Firewall blocks a new program

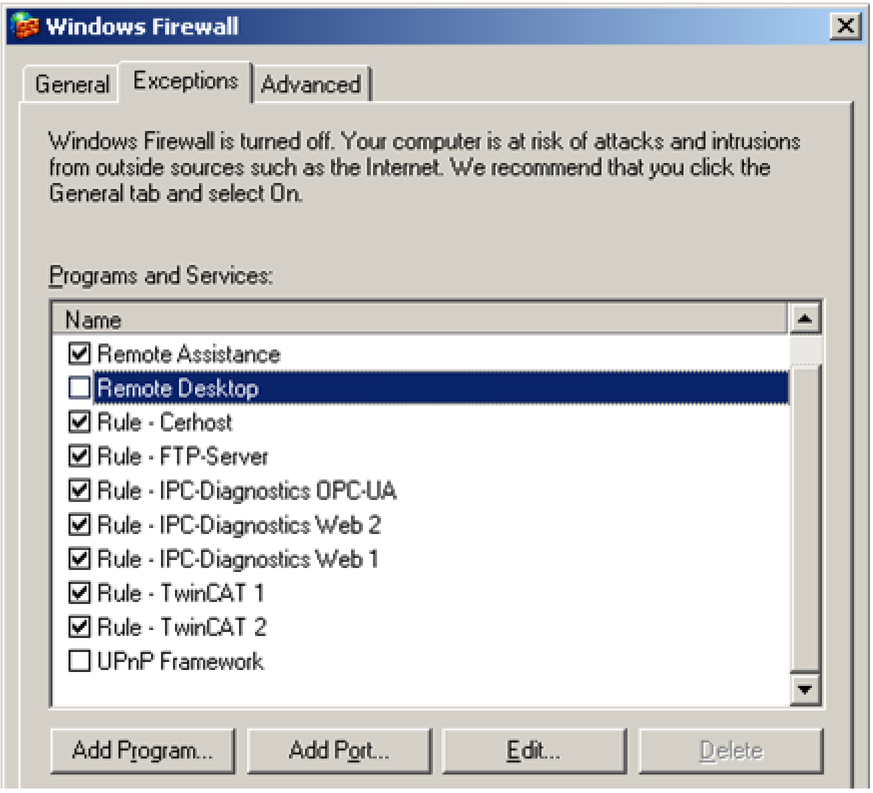
Home or work (private) networks — Not Connected

Public networks — Connected

Networks in public places such as airports or coffee shops

Windows Firewall state:	On
Incoming connections:	Block all connections to programs that are not on the list of allowed programs
Active public networks:	Unidentified network
Notification state:	Notify me when Windows Firewall blocks a new program

Windows Firewall (Windows XP)



Windows Firewall is turned off. Your computer is at risk of attacks and intrusions from outside sources such as the Internet. We recommend that you click the General tab and select On.

Programs and Services:

Name
☑ Remote Assistance
☐ Remote Desktop
☑ Rule - Cerhost
☑ Rule - FTP-Server
☑ Rule - IPC-Diagnostics OPC-UA
☑ Rule - IPC-Diagnostics Web 2
☑ Rule - IPC-Diagnostics Web 1
☑ Rule - TwinCAT 1
☑ Rule - TwinCAT 2
☐ UPnP Framework

B.Contact Information

B.1. Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions. Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products! The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: `http://www.beckhoff.com`. You will also find further documentation for Beckhoff components there.

B.2. Beckhoff Headquarters

Beckhoff Automation GmbH
Eiserstr. 5
33415 Verl
Germany

phone:	+ 49 (0) 5246/963-0
fax:	+ 49 (0) 5246/963-198
e-mail:	`info@beckhoff.com`
web:	`www.beckhoff.com`

B.2.1. Beckhoff Support

Support offers you comprehensive technical assistance, helping you no only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

hotline:	+ 49 (0) 5246/963-157
fax:	+ 49 (0) 5246/963-9157
e-mail:	`support@beckhoff.com`

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The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service

- hotline service

hotline:	+ 49 (0) 5246/963-460
fax:	+ 49 (0) 5246/963-479
e-mail:	`service@beckhoff.com`

B.2.3. Product security

For more information about this whitepaper or security in Beckhoff products, please send an E-Mail to `product-secinfo@beckhoff.com`.

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