

How to RTDE

Practical tips to set up "Real Time Data Exchange"

by Henning Forbech, 4TECH Robotics ApS Version: 1.0 Last update: 20/10 2023

Scope:

The purpose of this document is to help users to get through the RTDE setup process with less practical problems.

When I first time have to set up a RTDE connection to a UR robot I ran into more practical problems than expected. I started this document to collect and save all information on how to setup a UR robot with data input from an external computer.

During the process is also grow into a history of all the complications and hints on how to solve some of the more practical problems in getting a RTDE connection up and running. So, it is not just a straight forward blueprint for setting up RTDE. In between there are some of my mishaps in this journey.

Universal Robots have some information on how to setup RTDE and more help can be found on different internet fora. But a lot of the more practical problem are not documented or, at least, I have not been able to find this information.

Tips on programming and using RTDE is not a part of this document.

Help with updates:

If you find this document useful, please help improving it by adding more information. You can also help by clearing out misunderstandings and errors that I have made.

When you make changes to the document, please update the version number and date in the header. You are also welcome to add our name to the document.

Background:

As part of a project, I wanted to send information from a Raspberry Pi to a UR robot. It should be easy to send this one-way information by the Real Time Date Transfer (RTDE).

Universal Robots have published a small Python module that should make it possible to make a direct connection from a Raspberry Pi to the UR controller. I couldn't get this program to compile and went for a solution where a Windows PC should make the connection between the Raspberry Pi and the UR controller. Data was then sent from the Raspberry Pi to this Connecting PC by WiFi and UDP. The challenge was now to get the Connection PC to send data to the UR controller by RTDE.

This description is based on a connecting between a PC running Windows 10 and a UR5 CB31 running PolyScope 3.15.



Windows PC for connecting to UR-controller with RTDE:

The RTDE connection to the UR controller is made from a PC running Windows 10 Pro. This computer must be set up with Python to run the program that make the RTDE connection to the UR controller.

IP-address and ports must also be set up to match the UR controller and the LAN cable must be connected.

In this document I will only describe how to setup the PC, the robot and the connection between them.

SimpleStudent have made a nice series of videos on how to set up and run RTDE for the first time. This is a must see when you are ready run the RTDE connection.

The first three videos give a good understanding of how to get RTDE going. https://youtube.com/playlist?list=PLnJ9fSRnDN3B1wEuxQY4thTWyGoT2N0yd https://www.youtube.com/@simplestudent279

I will only describe how to install the programs and set up the computer.

Python program:

The RTDE program for the Windows computer is a small program that must run from Python.

If you are not familiar with programming in Python the smartest is to install and use the same programs as SimpleStudent is using for his nice video tutorials on how to set up the communication.

First you must install an editor, PyCharm, for Python. Go to the address below, download and install the program. "PyCharm Community" is the free version of the program: https://www.jetbrains.com/pycharm/download/other.html https://download.jetbrains.com/python/pycharm-community-2023.1.2.exe?_ga=2.210391829.167791767.1686485657-512205707.1686485657

😰 PyCharm Commu	nity Edition Setup		_		\times
PC	Choose Install Choose the folder	Location r in which to install Py	/Charm Com	munity Edi	tion.
Setup will install PyC folder, dick Browse a	harm Community Edition in and select another folder. (the following folder. Click Next to continue	To install in a e.	a different	t
Destination Folder	JetBrains\PyCharm Commu	nity Edition 2023.1.2	Brov	vse	
Space required: 1.6	GB				
space available: 20.	8 68	< Back	Next >	Cano	el



PyCharm Comm	unity Edition Setup)		_		×
	Installat i Configure	ion Options your PyCharm (Community E	dition installa	ation	
Create Desktop S PyCharm Com Update Context I Add "Open Fol Create Associatio	Shortcut munity Edition Menu der as Project" ons	Update	PATH Variabl "bin" folder to	le (restart ne	eeded)	
		< Bi	ack N	Next >	Can	cel





Installing Python:

When you install the PyCharm editor, it will also install Python on your computer. But that version of Python will be installed under UserApps and it may be difficult/impossible to update this program. Windows will block it from running an automatically update!

You can solve this by installing Python in a folder outside UserApps. Go to Python.org and download a free version of Python. Link: https://www.python.org/downloads/windows/

Make sure to get a version that fit your computer and it should be version 3.9 or later.

Make a new folder for this program (e.g. C:/Python or C:\Program Files/Python) and run the installation as Administrator.









Once installed open the command prompt with "Window"+R and CMD, go to the folder and run the pyton.exe

At the top of the window, you will see the version number for your Python.



From the command prompt you can also just type: python --version



Python for PyCharm:

When you are about to run a python program from the PyCharm editor it will ask you which Python to use.

Make sure to use the one you installed outside UserApps.



Installing the RTDE program for Python:

Python uses a lot of libraries for running programs. These libraries must be installed for the Python to use them.

Most important for this project is the RTDE library from Universal Robots. This program can be downloaded for free from GitHub but the simplest is just to let Python find and install it by running the PIP program. But first you must be sure to have the right version of the PIP program.

PIP:

You will need at least version 19.3 of PIP (RTDE will not install with older versions of PIP).

Check your PIP version from the command prompt: pip --version



If you need to install a newer version of the PIP program, use the command: python -m pip install --upgrade pip

For Python to install RTDE it will need two programs called Cmake and Boost. It can be a nightmare to get these programs installed but here we go:

Cmake:

Download and install Cmake from: https://cmake.org/download/





	A Download	l CMake	× +		\sim	_		×
$\leftarrow \rightarrow$	Cŵ	O A https	s:// cmake.org /dov	/nload/	E \$	${\times}$	பி	≡
	Platform			Files				^
	Unix/Linux S	Source (has \n l	line feeds)	cmake-3	3.26.4.tar.gz			
	Windows So	ource (has \r\n l	line feeds)	cmake-3	3.26.4.zip			
	Binary distributi	ions:						1
	Platform		Files					
	Windows x6	4 Installer:	cmake-3.2	cmake-3.26.4-windows-x86_64.msi				
	Windows x6	4 ZIP	cmake-3.2	6.4-windows-x8	86_64.zip			
	Windows i38	86 Installer:	cmake-3.2	6.4-windows-i3	86.msi			~

🖟 CMake Setup	_		×
Installing CMake			
Please wait while the Setup Wizard installs CMake.			
Status: Creating shortcuts			
Back	lext	Cano	el

Boost:

You will also need a program called Boost. It is a free C++ source library. Go to: https://www.boost.org

Warning:

This first attempt to install Boost will fail! Look below for a fix



🗉 🕹 Boost C++ Libraries X +	✓ - □	×						
\leftarrow \rightarrow C \textcircled{a} \bigcirc A https://www.boost.org	☆ 🛛 🖄	≡						
one of the most highly regarded and experimentary end of the most highly end of the	ertly designed C++ library projects in the world." Id <u>Andrei Alexandrescu, C++ Coding Standards</u>							
WELCOME TO BOOST.ORG! Boost provides free peer-reviewed portable C++ source libraries.								
We emphasize libraries that work well with the C++ Standard Library. Boost libraries are intended to be widely useful, and usable across a broad spectrum of applications. The Boost license encourages the use of Boost libraries for all users with minimal restrictions.								
We aim to establish "existing practice" and provide reference implementations so that Boost libraries are suitable for eventual standardization. Beginning with the ten Boost Libraries included in the Library Technical Report (TR1) and continuing with every release of the ISO standard for C++ since 2011, the C++ Standards Committee has	ENHANCED BY Go							
continued to rely on Boost as a valuable source for additions to the Standard C++ Library.	Donate							
BOOST AS AN ORGANIZATION	Welcome							
The Boost organization and wider Boost community supports research and education into the best possible uses of C++ and libraries developed for it, particularly, but not exclusively those contained in the Boost Library.	Getting Started Download Libraries							
The organization and community support mailing lists and chat rooms to educate about best practices and cutting edge techniques for the user of Boost Libraries and C++ in general	Mailing Lists Reporting and Fixing Bugs Wiki							
a	INTRODUCTION							
Since 2006 an intimate week long annual conference related to Boost called C++ Now has been held in Aspen. Colorado each May, The conference is an educational	Community							
opportunity focused on cutting-edge C++. Boost has been a participant in the annual	DEVELOPMENT							
Google Summer of Code since 2007, in which students develop their skills by working on Boost Library development.	DOCUMENTATION							

Go to "Download" and download the 200 Mb zip file and unzip on your hard disk (704 Mb unzipped).

lndex of main/release/	1.82.0/source × +	\sim	-		>
$\leftarrow \rightarrow$ C \textcircled{a} C	https://boostorg.jfrog.io/artifactory/main/release/1.82.0/sou	rce/ 🗉 🏠	⊚ ⊻	பி	Ξ
Indax of main/	rologgo/1 87 0/gourgo				
Index of main/	lelease/1.02.0/source				
lame	Last modified Size				
<u>./</u>	10 Are 2022 14:25 08 01 ND				
005t 1 82 0.72	10-Apr-2023 14:25 98.91 MB				
oost 1 82 0 tar h72	14-Apr-2023 02:32 196 Dytes				
post 1 82 0 tar hz2 ison	14-Apr-2023 02:52 201 bytes				
post 1 82 0.tar.gz	10-Apr-2023 14:23 135.98 MB				
oost 1 82 0.tar.gz.ison	14-Apr-2023 02:52 200 bytes				
post 1 82 0.7in	10-Apr-2023 14:24 198.54 MB				
poost 1 82 0.zip.ison	14-Apr-2023 02:52 197 bytes				
oost 1 82 0 rc1.7z	05-Apr-2023 20:36 98.90 MB				
oost 1 82 0 rc1.7z.json	06-Apr-2023 14:02 200 bytes				
oost 1 82 0 rc1.tar.bz2	05-Apr-2023 20:43 115.69 MB				
oost 1 82 0 rc1.tar.bz2.json	06-Apr-2023 14:02 205 bytes				
oost 1 82 0 rc1.tar.gz	05-Apr-2023 20:42 135.98 MB				
oost 1 82 0 rc1.tar.gz.json	06-Apr-2023 14:02 204 bytes				
oost 1 82 0 rc1.zip	05-Apr-2023 20:36 198.54 MB				
oost <u>1 82 0 rc1.zip.json</u>	06-Apr-2023 14:02 201 bytes				
oost 1 82 0 rc2.7z	10-Apr-2023 14:25 98.91 MB				
<u>oost 1 82 0 rc2.7z.json</u>	10-Apr-2023 14:31 200 bytes				
oost 1 82 0 rc2.tar.bz2	10-Apr-2023 14:23 115.70 MB				
oost 1 82 0 rc2.tar.bz2.json	10-Apr-2023 14:31 205 bytes				
<u>oost 1 82 0 rc2.tar.gz</u>	10-Apr-2023 14:23 135.98 MB				
oost <u>1</u> 82 0 rc2.tar.gz.json	10-Apr-2023 14:31 204 bytes				
000st 1 82 0 rc2.zip	10-Apr-2023 14:24 198.54 MB				
	10-Apr-2023 14:31 201 bytes				



🛃 🔄 ╤ boost_1_82	2_0		_	□ ×
File Home Share	View			~ 🥐
\leftarrow \rightarrow \checkmark \uparrow \square \Rightarrow This	s PC > Documents > b	oost_1_82_0	✓ O Search boo	ost_1_82_0
A Quick accord	Name	Date modified	Туре	Size
	boost	13-06-2023 13:36	File folder	
Desktop 🗶	doc	13-06-2023 14:01	File folder	
Uownloads 🖈	libs	13-06-2023 13:56	File folder	
🔮 Documents 🖈	more	13-06-2023 14:01	File folder	
📰 Pictures 🛛 🖈	status	13-06-2023 14:01	File folder	
HøjeTaastrup	tools	13-06-2023 14:01	File folder	
This DC	🔬 boost	13-06-2023 13:31	Cascading Style Sheet Document	1 KB
inis PC	🔳 boost	13-06-2023 13:31	PNG File	7 KB
3D Objects	📄 boost-build.jam	13-06-2023 13:31	JAM File	1 KB
E. Desktop	📄 boostcpp.jam	13-06-2023 13:31	JAM File	20 KB
🔮 Documents	💿 bootstrap	13-06-2023 13:31	Windows Batch File	3 KB
boost_1_82_0	bootstrap.sh	13-06-2023 13:31	SH File	11 KB
PyCharmInstal	index 🔤	13-06-2023 13:31	Firefox HTML Document	1 KB
L Downloads	index 🔤	13-06-2023 13:31	Firefox HTML Document	6 KB
Music	INSTALL	13-06-2023 13:31	File	1 KB
	Jamroot	13-06-2023 13:31	File	12 KB
Pictures	LICENSE_1_0	13-06-2023 13:31	Text Document	2 KB
📑 Videos	README.md	13-06-2023 13:31	MD File	1 KB
🏪 Local Disk (C:)	🚓 rst	13-06-2023 13:31	Cascading Style Sheet Document	3 KB
19 items				

You only need to install the BoostBuild.

Follow this description from the "Boost Getting Started on Windows" documentation.



Open the folder and run the bootstrap.bat

4TECH

C:\Windov	vs\system32	\cmd.exe		-		×
Volume in	drive C	has no la	abel.		j	^
Volume Ser	rial Numb	per is BA9	99-4E63			
Directory	of C:\Us	ers\Forbe	ech\Docur	ments\boost_1_82_	0	
13-06-2023	14:44	<dir></dir>				
13-06-2023	14:44	<dir></dir>				
13-06-2023	13:36	<dir></dir>		boost		
13-06-2023	13:31		850	boost-build.jam		
13-06-2023	13:31		989	boost.css		
13-06-2023	13:31		6.308	boost.png		
13-06-2023	13:31		20.013	boostcpp.jam		
13-06-2023	13:31		2.486	bootstrap.bat		
13-06-2023	13:31		10.811	bootstrap.sh		
13-06-2023	14:01	<dir></dir>		doc		
13-06-2023	13:31		769	index.htm		
13-06-2023	13:31		5.418	index.html		
13-06-2023	13:31		291	INSTALL		
13-06-2023	13:31		11.947	Jamroot		
13-06-2023	13:56	<dir></dir>		libs		
13-06-2023	13:31		1.338	LICENSE_1_0.txt		
13-06-2023	14:01	<dir></dir>		more		
13-06-2023	13:31		542	README.md		
13-06-2023	13:31		2.608	rst.css		
13-06-2023	14:01	<dir></dir>		status		
13-06-2023	14:01	<dir></dir>		tools		
	13 Fi	le(s)	64.	.370 bytes		
	8 Di	lr(s) 23	.446.142	.976 bytes free		
C:\Users\Fo	orbech\Do	cuments\	boost_1_8	32_0>bootstrap.ba	t	

This is what I got:



There is a bug in the program and it will not install!!!!



How to fix the Boost problem:

I'm not sure what the problem is with the Boost 1.82.0 but I have earlier used the Boost 1.81.0. This program also has a bug (!) but I have found a way to bypass this problem.

You will find the install files for Boost 1.18.0 here: https://www.boost.org/users/history/version_1_81_0.html

Unzip the files to your hard disk, e.g., C:\boost_1_81_0

Bootstrap.bat will go to C:\boost_1_81_0\tools\build\src\engine and look for b2.exe and then delete this file. But there is no b2.exe here and the program stop with an error.

This bug can be fixed by creating a b2.exe file and put it in the C:\boost_1_82_0\tools\build\src\engine directory. This fake b2.exe file will be found and deleted by the bat program and then it will build the real b2.exe program.

Stupid error but this fix solves the problem. Now we can run the b2 program to install Boost.

Boost path update in Windows:

Now we must add the path for the new boost directory to the windows environmental variables. Follow this description:

To add a path to the PATH environment variable

- 1. On the Start menu, right-click Computer.
- 2. On the context menu, click Properties.
- 3. In the System dialog box, click Advanced system settings.
- 4. On the Advanced tab of the System Properties dialog box, click Environment Variables.
- 5. In the **System Variables** box of the **Environment Variables** dialog box, scroll to **Path** and select it.
- 6. Click the lower of the two Edit buttons in the dialog box.
- 7. In the Edit System Variable dialog box, scroll to the end of the string in the Variable value box and add a semicolon (;).
- 8. Add the new path after the semicolon.
- 9. Click OK in three successive dialog boxes, and then close the System dialog box.



← Settings			- 🗆 X
ம் Home	About		
Find a setting	P Your PC is m	onitored and protected.	This page has a few new settings
System	See details in Win	dows Security	Some settings from Control Panel have moved here, and you can copy your PC info so it's easier to share.
Display	Device speci	fications	
	Device name	DESKTOP-9E22IV1	Related settings
句》) Sound	Processor	Intel(R) Core(TM) i5-4570T CPU @ 2.90GHz 2.90 GHz	BitLocker settings
Notifications & actions	Installed RAM Device ID	8,00 GB (7,89 GB usable) FFF46387-FA8A-45C6-B32A-152249485038	Device Manager
N - ··	Product ID	00325-80000-00000-AAOEM	Remote desktop
 Focus assist 	System type Pen and touch	64-bit operating system, x64-based processor No pen or touch input is available for this display	System protection
O Power & sleep			Advanced system settings
📼 Storage	Сору		Rename this PC (advanced)
-B Tablet	Rename this PC		
			Help from the web
目 Multitasking	Windows spo	ecifications	Finding out how many cores my
Projecting to this PC	Edition	Windows 10 Home	Checking multiple Languages support
	Version	22H2	cheddarg montpie congologes support
X Shared experiences	Installed on	24-03-2023	1
19 Clinhoard	US build	19045.2965 Windows Eastura Experience Pack 1000 19041 1000 0	Get help
	Experience	windows readure Experience Pack 1000.15041.1000.0	Give feedback
✓ Remote Desktop	Сору		
① About	Change product k	ey or upgrade your edition of Windows	
	Read the Microso	ft Services Agreement that applies to our services	
	Read the Microso	ft Software License Terms	





Variable	Value
OneDrive	C:\Users\Forbech\OneDrive
Path	C:\Program Files\Python\Scripts\;C:\Program Files\Python\;C:\User
PyCharm Community Edition	C:\Program Files\JetBrains\PyCharm Community Edition 2023.1.2\b
TEMP	C:\Users\Forbech\AppData\Local\Temp
TMP	C:\Users\Forbech\AppData\Local\Temp
	New Edit Delete
stem variables	New Edit Delete
stem variables Variable	Value
stem variables Variable OS	Value Windows_NT
stem variables Variable OS Path	Value Windows_NT C:\Windows\System32;C:\Windows;C:\Windows\System32\Wbem;
stem variables Variable OS Path PATHEXT PROCESSOR ARCHITECTURE	Value Windows_NT C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem; .COM;.EXE;.BAT;.CMD;.VBS;.VBE;JS;JSE;.WSF;.WSF;.WSF;.MSC
stem variables Variable OS Path PATHEXT PROCESSOR_ARCHITECTURE PROCESSOR_IDENTIFIER	Value Value Windows_NT C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem; .COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;.MSC AMD64 Intel64 Esamily.6 Model 60 Stepping 2. GenuineIntel
stem variables Variable OS Path PATHEXT PROCESSOR_ARCHITECTURE PROCESSOR_IEVEI	Value Windows_NT C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem; .COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;.MSC AMD64 Intel64 Family 6 Model 60 Stepping 3, GenuineIntel 6
stem variables Variable OS Path PATHEXT PROCESSOR_ARCHITECTURE PROCESSOR_IDENTIFIER PROCESSOR_LEVEL PROCESSOR_REVISION	New Edit Delete Value Windows_NT C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem; .COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;.MSC AMD64 Intel64 Family 6 Model 60 Stepping 3, GenuineIntel 6 3c03
stem variables Variable OS Path PATHEXT PROCESSOR_ARCHITECTURE PROCESSOR_IDENTIFIER PROCESSOR_LEVEL PROCESSOR_REVISION	Value Windows_NT C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem; .COM;.EXE;.BAT;.CMD;.VBS;.VBE;JS;JSE;.WSF;.WSH;.MSC AMD64 Intel64 Family 6 Model 60 Stepping 3, GenuineIntel 6 3c03

Edit environment variable	×
%SystemRoot%\system32	New
%SystemRoot%	
%SystemRoot%\System32\Wbem	Edit
%SYSTEMROOT%\System32\WindowsPowerShell\v1.0\	
%SYSTEMROOT%\System32\OpenSSH\	Browse
C:\Program Files\CMake\bin	
C:\boost_1_82_0\boost\bin	Delete
	Move Up
	Move Down
	Edit text
ОК	Cancel



Installing RTDE:

Now you are finally ready to install RTDE.

The latest RTDE can be found here: https://pypi.org/project/ur-rtde/ From the command prompt use the command: pip install ur-rtde

If everything goes as planned you will get a confirmation the RTDE program is installed and can be used from your Python program.

When I first installed RTDE on an old laptop I got this conformation:

Forbech 4TECH Aps



This old laptop was unstable and I decided to setup a new Connection PC for my project. I went through all these steps but when I finally tried to install RTDE, it failed!

After spending a lot of time trying to solve the problem I gave up and made a desperate attempt to get the new PC running with setup from the old laptop. I made a copy of the laptop hard disk to the PC hard disk. This is normally not possible but to my big surprise the PC booted into Windows. After a lot of updates and restarts I had the Windows installation from the laptop running on the PC.

And RTDE was even running on the new hardware!!!

Later I realized that RTDE will only run on Windows Pro, not the Home edition!



Windows network settings:

We are now ready to check the settings for the network adapter on the Connection PC. We have to find the IP address for the adapter where the net cable is attached.

Open Windows Settings and click on the Network & Internet.

÷	Settings						-		×
				8	Forb Local Act Sign In	ech ^{count}			
		I	(1)	Windows Update Last checked: 8 hours ago	¢	Web browsing Restore recommended			
			F	ind a setting		Q			
		旦	System Display, s power	sound, notifications,	ËØ	Devices Bluetooth, printers, mouse			
			Phone Link you	r Android, iPhone		Network & Internet Wi-Fi, airplane mode, VPN		-	
			Person	alization		Apps			

Go to "Ethernet" and open "Change adapter options"





Here you will see all the network connections on the computer. WiFi, Bluetooth and different network adapters. The adapter for your LAN cable will be named "Ethernet" and maybe a number. You can check if it the right adapter by plugging or unplugging the LAN cable.

Click on the Ethernet to see status of the adapter and continuer by clicking on "Details".

You will now get a lot of information on this adapter. Look for the "IPv4 Address" for the adapter.

It is this IP address you will need to set up the connection on the UR controller.





If you are more hardcore you can also just open the Windows commando line and use "ipconfig" to get the information.

👞 cmd.exe ipconfig 🔫 Connection PC: Wireless LAN adapter LAN-forbindelse* 14: 16/10 2023 Media State : Media disconnected Connection-specific DNS Suffix . : Wireless LAN adapter LAN-forbindelse* 15: . . . : Media disconnected Media State Connection-specific DNS Suffix . : Ethernet adapter VMware Network Adapter VMnet1: Connection-specific DNS Suffix . : Link-local IPv6 Address : fe80::5896:1258:6c70:4bbd%27 IPv4 Address. 192.168.56.3 Subnet Mask 255.255.255.0 Default Gateway Ethernet adapter VMware Network Adapter VMnet8: Connection-specific DNS Suffix . : Link-local IPv6 Address : fe80::27b2:3099:e8fd:d1aa%18 Default Gateway Ethernet adapter Ethernet 2: -Connection-specific DNS Suffix . : Link-local IPv6 Address : fe80::186c:66db:3fc5:4e77%4 Default Gateway Wireless LAN adapter Wi-Fi 4: Connection-specific DNS Suffix . : Link-local IPv6 Address : fe80::40ad:ff65:8f77:de9c%5 IPv4 Address. 192.168.0.102 Subnet Mask 255.255.255.0 Default Gateway : 192.168.0.1 Ethernet adapter Bluetooth-netværksforbindelse 3: Media State Media disconnected Connection-specific DNS Suffix . :



Allowing a program through Windows firewall:

Windows firewall may give some problems when the RTDE program try to send data to the UR controller.

You can allow python through the firewall with these steps:



For a start it is probably easier just to turn off the Firewall. When you got RTDE running you can try to turn the Firewall back on again. There are two ways to turn off Firewall:





Setting up the UR controller:

To prepare for a RTDE connection both the UR controller and the computer to connect to it need to be setup.

Here follow first a description on how to set up the UR controller and then how to setup the computer to make the connection.

Go to the opening screen for the UR controller start by checking the status of your robot. Next you must do some settings from this start screen and later you must start programming the robot to some more settings to the installation.

PolyScope Robot User Interface		
	Please select	
	Run Program	
ROBOTS 3-	Program Robot	
2 <u>1</u>	Setup Robot	
About	Shutdown Robot	

The "About" button will give you information on the IP address for the robot.

PolyScope Robot User Inte	rface 🕜
k About - + ×]
About	elect
Version Legal	
	ram
Universal Robots Software: URSoftware 3.15.4.106291 (Aug 16 2021)	
Safety Processor A: URSafetyA (471)	
Safety Processor B: URSafetyB (211)	obot
Hostname: ursim	
IP address: 192.168.114.128 (Not connected to network!)	
S/N: 2018359999	hat
R	
UNIVERSAL ROBOTS	
www.universal-robots.com	Robot
Copyright © 2009-2021 - Universal Robots A/S Covered by U.S. Patent No. 8,779,715	
Close	



From the "Setup Robot" button you must set the network and check the URcaps.

Setup Robot		
Initialize Robot		
Calibrate Screen	2	
URCaps		
Network	in the second	
Language		
Set Password	URSoftware 3.15.4.106291 (Aug 16 2021)	
Time		
Update		
Back		

Network:

To use RTDE the UR controller must be setup with a fixed IP address.

	Setup Robot	
Initialize Robot	Network Select your network method	
Calibrate Screen	DHCP Static Address	
URCaps	Disabled network	1
Network	X Not connected to network! Network detailed settings:	/
•	IP address:	192.168.114.128
Language	Subnet mask:	255.255.255.0
Set Password	Default gateway:	192.168.114.2
	Preferred DNS server:	192.168.114.2
Time	Alternative DNS server:	0.0.0.0
Update]	Apply
Back		

The IP address on the UR controller and the Windows PC must belong to the same IP subnet. That is the numbers in the first tree groups must be the same but the last group must be close, but not the same.

Example: If your PC is 192.168.1.1 the UR controller could be 192.168.1.2



If you cannot change the IP address on the Windows computer you must change the IP address on the UR controller.

Subnet mask must be set to 255.255.255.0 Default gateway and DNS information will probably be applied automatically by the controller.

Go back and click the "About" button again to check the new IP address.

UR Cap: External Control:

The UR controller will need a UR cap for external communication.

From the startup screen you can choose "Setup Robot" and "URCaps" to check if this UR Cap is installed.

	Setup Robot	0
Initialize Robot	URCaps Active URCaps	
Calibrate Screen	External Control	
URCaps		
Network	URCap Information	
Language		
Set Password		
Time		
Update		
Back	а Сорона и с	lestart

If "External Control" is not on the list of active Caps it must be installed. If the CAP is missing PolyScope will also later show an error massage.

This CAP is free and can be downloaded here:

https://github.com/UniversalRobots/Universal_Robots_ExternalControl_URCap /releases

I'm not sure if this UR cap is necessary for robots in the e-Series. More information here: https://github.com/UniversalRobots/Universal_Robots_ROS_Driver/blob/mast er/ur_robot_driver/doc/install_urcap_e_series.md





Installation:

From the start screen press "Program Robot"

You don't need to start a new program or open a program. You only have to go to "Installation". Here you have to do some settings.

<u> </u> File		22:20:05	cccc 🕜
Program Installation Move	I/O Log		
	New Program		
Load From File			
	Load Program		
Use Template			
	Pick and Place		
	Empty Program		



Disable Profinet:

Under the "Installation" in Polyscope you must disable "PROFINET" The Profi network will block the RTDE communication.



Disable Ethernet:

Under "Installation" and "EtherNet/IP" you must also disable the ethernet/IP adapter. This may seem odd when you try to setup an external connection with a LAN cable to this adapter.

<u> (</u> File		00:03:03	сссс	\bigcirc
Program Installation	Move I/O Log			
TCP Configuration	EtherNet/IP Adapter: D	isabled		
Mounting	1			
I/O Setup	•			
🔁 Safety			, 3	
Variables				
MODBUS				
Features 2	Enable	Disable		
Smooth Transition	Program action upon loss of EtherNet/IP	Scanner connection:		
Conveyor Cacking	-			
EtherNet/IP				
PROFINET	The LED indicates the status of the conn	ection to an EtherNet/IP Scanne	n	
External Control	 Gray indicates that this functiona Yellow indicates that no scanner 	lity is disabled is connected to the robot		
Default Program	 Green indicates that the robot is 	connected to an EtherNet/IP sca	anner	
Load/Save				

It's a little different for eSeries but this link shows how: https://github.com/UniversalRobots/Universal_Robots_ROS_Driver/issues/204



External Control:

To use RTDE the External Control must be setup under "Installation".

The "Host IP" is the IP address for the remote host. That is the IP address for the net card on the Windows PC. The "Custom port" must be 30004 for RTDE



Ping the connection:

To check the cable connection before you start the RTDE program you can ping the UR controller from the Windows PC.

Open the commando prompt and ping the IP address for the UR controller. If the network connection is running you will get something like this:





IP reset:

After a restart of the UR controller there is a good chance that the IP addressers have been reset to old values. This is an issue with Linux. But now you know how to set them again.

LAN cable:

RTDE is based on direct LAN cable connection between a computer and the UR controller.

Normally you connect two computers in a network via a router, but it is also possible to connect two computers directly. To do this direct connection you have to use a cross over cable. In this cable the data lines are "crossed over" to feed the output from the first computer into the input on the second computer.

In a network with a router the LAN cables are straight through patch cables. The router will be handling the connection of the send and receive lines.

For the RTDE connection to the UR controller, you must use a patch cable. This is the same cable as you would use to connect a computer to a router. The UR controller must have a build in router or must have been set up to handle the switch over of the incoming and outgoing data.

Data registers:

When you send data to the UR controller these data must be sent to registers where the PolyScope program can get access to them.

The different data registers will accept one type of data. The register you plan to use must fit with the data you want to send.

Check out here:

https://www.universal-robots.com/articles/ur/interface-communication/real-time-data-exchange-rtde-guide/

The naming of some of the data registers are a little odd.

In the data transfer program on the Windows computer the ini file set the registers to receive the data.

The input registers for data with double precision are named "double", e.g. "Input_doubble_1".

When you want to use the date in PolyScope you must assign the data from the register to a variable. But these registers are now named "single" The date you just send via RTDE to "Input_doubble_1" must now be loaded from "Input_single_1"

This is a bug in the PolyScope program. The incoming data must be 32 bit (double precision) but in the UR controller tread these date as 16 bit data (single precision). On bit level the 32 bit data is truncated to 16 bit and saved as single precision data.

More info at the UR forum:

https://forum.universal-robots.com/t/rtde-precision-lost-from-double-to-float-precision/7623/13



Ready to go:

You should now be ready to go.

I will strongly recommend you to take a look at the videos from SimpleStudent. They will guide you through the setup of RTDE.

The first three videos give a good understanding of how to get RTDE going. https://youtube.com/playlist?list=PLnJ9fSRnDN3B1wEuxQY4thTWyGoT2N0yd https://www.youtube.com/@simplestudent279



More links:

https://pypi.org/project/ur-rtde/

https://github.com/UniversalRobots/RTDE_Python_Client_Library

https://www.universal-robots.com/articles/ur/interface-communication/real-time-data-exchange-rtde-guide/