Application Note
K-Ducer + Universal Robots

INTRODUCTION

This application note describes how to set up a Universal Robot collaborative robot to communicate with the K-Ducer controller via the Modbus TCP interface.

Because the Fieldbus installation node in PolyScope is limited to cyclical polling requests when working with Modbus TCP requests, not all of the Modbus TCP functionality of the K-Ducer is accessible this way. A URCap for the K-Ducer will be released in 2023 to address this shortcoming.

Specifically, with a K-Ducer firmware version v36 or prior, only remote control of the screwdriver and retrieval of the torque and angle data is possible. It is not possible to switch programs or modify the program parameters such as torque, angle, etc, via Modbus TCP, although it is possible to change programs by wiring the corresponding direct I/O signals.

With a K-Ducer firmware version v37 and later, it is possible to switch between programs (psets) and/or sequences. By pre-configuring one or more of the 64 programs available, it becomes possible to target different torques as needed.

Any KDU-1A controller can be upgraded to the latest firmware version free of charge, contact Kolver to arrange this.

## Tool Center Point and Payload Configuration

The Tool Center Point and Payload Configuration should be set in the installation node according to the mounting position and weight of the screwdriver, flange, and cable.

IP CONFIGURATION

Direct connection or via ethernet switch (static IP)

If connecting the UR directly to the K-Ducer, or directly to an ethernet switch where the K-Ducers is also connected:
- Configure the IP address of the UR to static (manual)
- Configure the K-Ducer controller to "Modbus TCP" protocol (general settings menu)
- Configure the IP address of the K-Ducer so that it uses the same subnet mask of the UR, and an IP address that is identical in the first three groups of digits, and different in the last group of digits
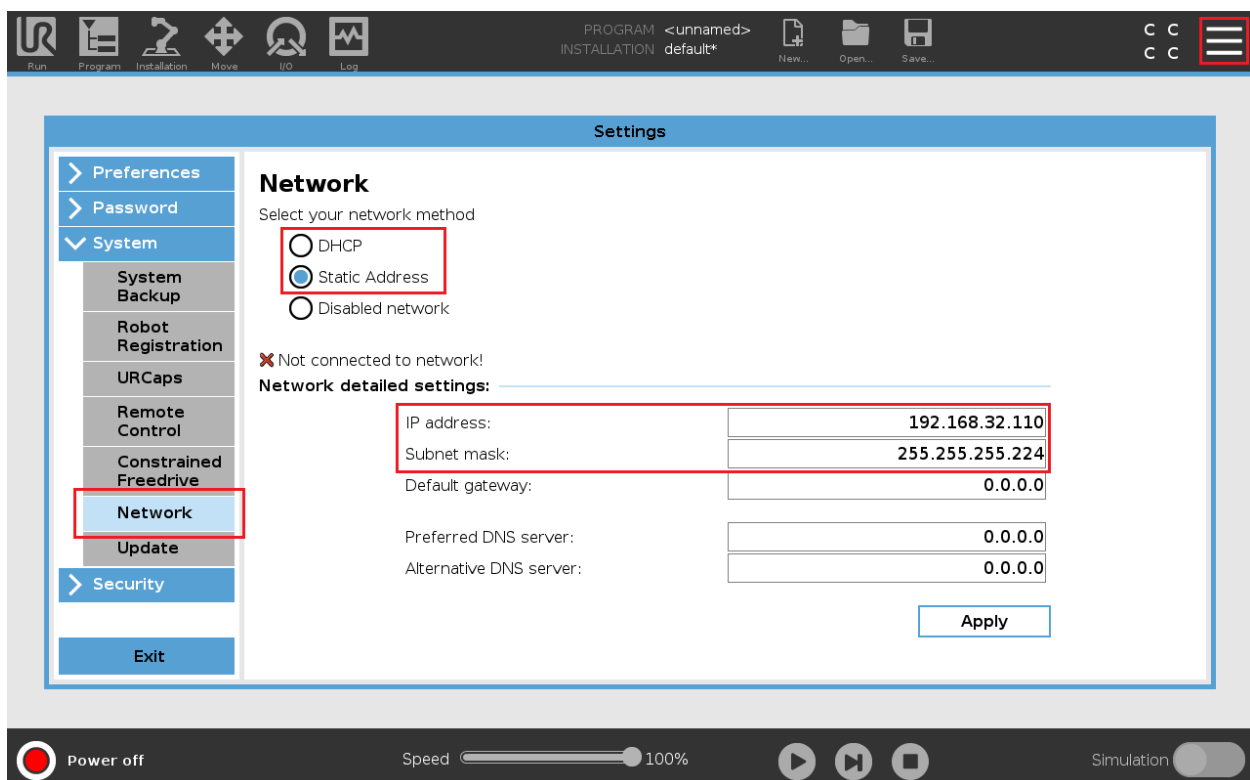
Example with static IP address:

Device	Subnet Mask	IP address
UR	255.255.255.0	192168.100.**22** last digits are different from others in the network
K-Ducer	255.255.255.0 same as UR's	192.168.100.**23** last digits are different from others in the network

On the K-Ducer and UR, leave the gateway IP address to 0.0.0.0 unless otherwise required by your IT infrastructure.

Connection via router or DHCP server (automatic or static IP)

If connecting the UR and the K-Ducer controllers to a LAN network with a router or other DHCP server:
- your router (or other DHCP server) must allow a range of addresses to be used with static IP, with room for at least one address per K-Ducer controller
- configure your UR for either automatic (DHCP) or manual IP address If choosing manual (static) IP, ensure you're using an address that is outside the DHCP address range of your router or DHCP server
- Configure the K-Ducer controller to "Modbus TCP" protocol (general settings menu)
- Configure the IP address of the K-Ducer so that it uses the same subnet mask of the UR, and an IP address outside of the DHCP address range of your router or DHCP server, identical in the first three groups of digits to the DHCP range, and different in the last group of digits

Example with dynamic IP addresses:

Device	Subnet Mask	IP address
Router (DHCP server)	255.255.255.0	192.168.100.**1** DHCP range: 192.168.100.**2** to 192.168.100.**100**
UR	Automatic, or: 255.255.255.0 same as router's	Automatic, or: 192.168.100.**101** last digits are outside the DHCP range and different from others in the network
K-Ducer	255.255.255.0 same as router's	192.168.100.**102** last digits are outside the DHCP range and different from others in the network

On the K-Ducer and UR, leave the gateway IP address to 0.0.0.0 unless otherwise required by your IT infrastructure.

UR MODBUS CONFIGURATION

The KDU MODBUS INSTALLATION file is provided with this manual, however loading this configuration will replace any TCP, Payload, and other settings.

You can find the instructions to manually configure the MODBUS installation below:

On the installation tab of the UR pendant, navigate to the FIELDBUS > MODBUS menu.

- Select "ADD MODBUS UNIT".
- Enter the IP address of the K-Ducer.
- Select "Show advanced options" at the bottom.
- Select "Sequential mode" next to the IP address.

Enter the following signals, using the "Add New Signal" button to add additional signals:

Type	Address	Name	Frequency [Hz]
Digital Output	32	KDS_LEVER	10
Register Input	294	KDU_RESULT_READY	5
Register Input	303	KDU_RESULT_FLAG	5
Register Input	318	KDU_TORQUE_cNm	5
Register Input	323	KDU_ANGLE_deg	5
Register Output*	7372	KDU_PROGRAM_NR	5

*program selection only available with KDU firmware v37 and later.
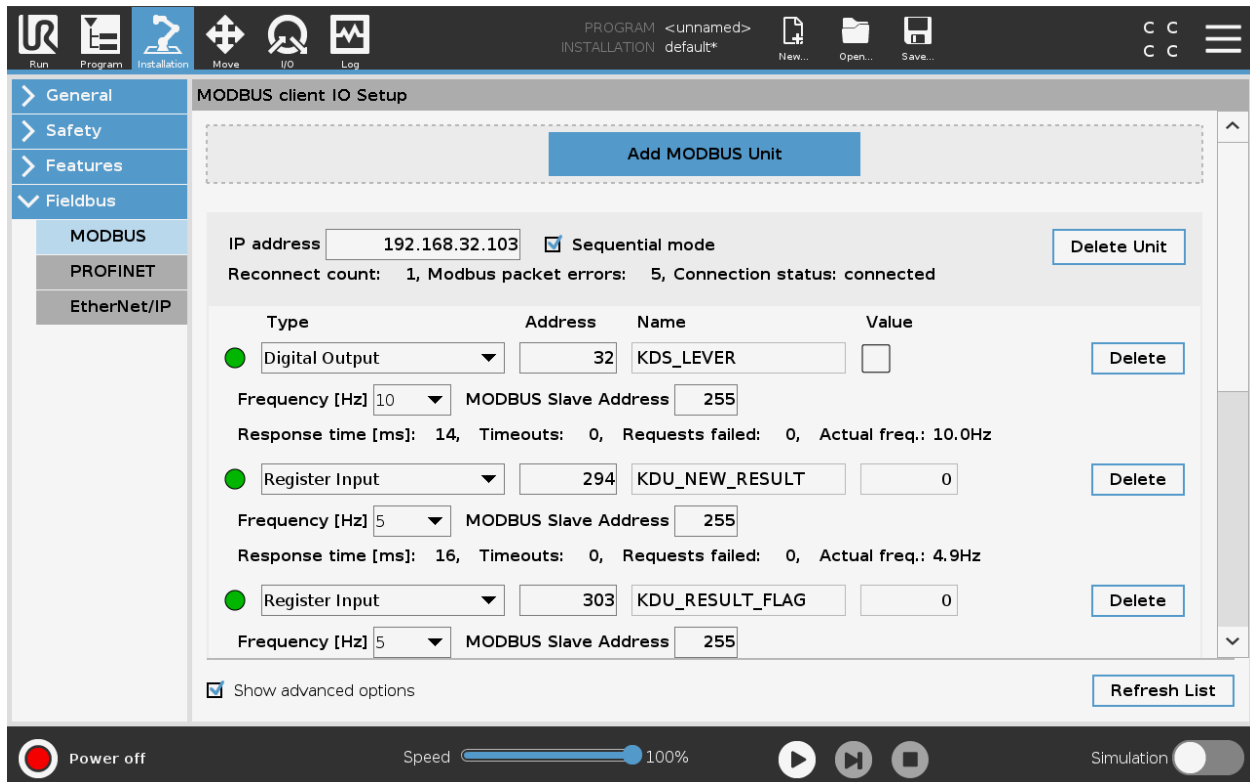
Note: there are many additional signals that can be added to the FIELDBUS > MODBUS installation, for example to retrieve the "peak torque" or the full "torque vs time" or "torque vs angle" graph data for each tightening, to augment your UR programs and torque data collection as needed. Refer to the K-Ducer Modbus map for the list of addresses, and remember to offset the addresses listed on the map by "-1" in order to comply with the UR Modbus addressing convention. For example, the "REMOTE LEVER" coil is listed as address #33 on the Modbus Map. On the UR MODBUS installation, enter this signal as address #32 (the addressing conventions vary by manufacturer).

UR INSTALLATION VARIABLES

Add the following installation variables to hold the torque data and to select the program number on the K-Ducer:
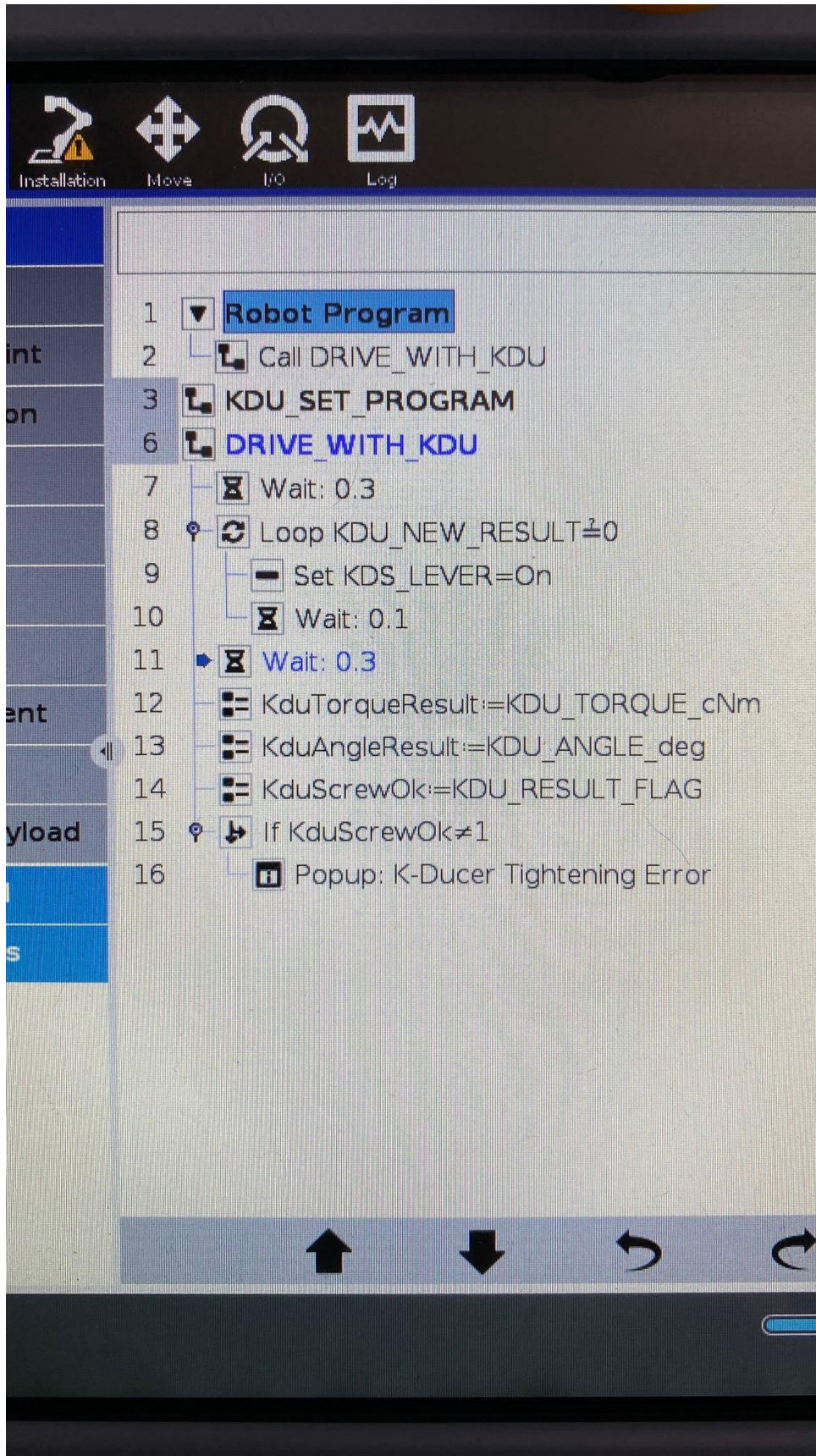
KduScrewOk
KduTorqueResult
KduAngleResult
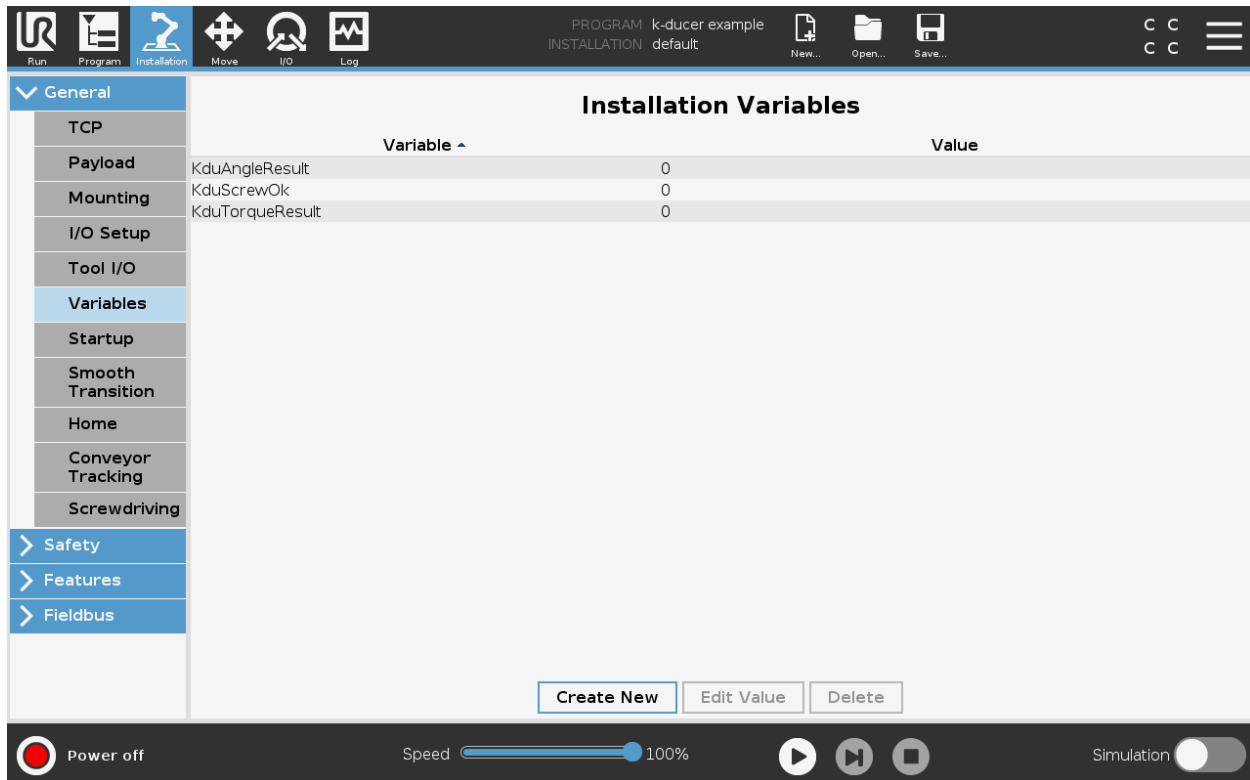
UR PROGRAM CONFIGURATION

You can use the included DRIVE_WITH_KDU UR Program as a "SubProgram" within a larger UR program that includes movement, positioning, etc.
Alternatively, you can take advantage of the built-in "Screwdriving" URCap provided by UR.

Before calling the KDU_SubProgram routine, make sure to assign the KDU_PROGRAM_NR output to select the desired K-Ducer program number 1-64 (only available in KDU firmware v37).
Make sure to wait at least 0.3 seconds after selecting the program before calling the DRIVE_WITH_KDU subprogram. To avoid this wait time, set the KDU_PROGRAM_NR to your desired program *before* moving the robot arm to the desired screwdriving location. Assuming this movement takes at least 0.3 seconds, you can omit the additional wait time before screwdriving, which is required to ensure the KDU has loaded all the new program parameters before starting a tightening.

Toolbar: Installation | Move | I/O | Log

```
1   ▼ Robot Program
2     └ 🖳 Call DRIVE_WITH_KDU
3   🖳 KDU_SET_PROGRAM
6   🖳 DRIVE_WITH_KDU
7     ⏳ Wait: 0.3
8   🔁 Loop KDU_NEW_RESULT≟0
9       ▬ Set KDS_LEVER=On
10      ⏳ Wait: 0.1
11    ➤ ⏳ Wait: 0.3
12    ⬛ KduTorqueResult:=KDU_TORQUE_cNm
13    ⬛ KduAngleResult:=KDU_ANGLE_deg
14    ⬛ KduScrewOk:=KDU_RESULT_FLAG
15  ⤷ If KduScrewOk≠1
16      ⬚ Popup: K-Ducer Tightening Error
```

Screenshot 1 (top):

Tabs: **Command** | Graphics | Variables

Program tree:
1 ▼ Robot Program
2 └ Call DRIVE_WITH_KDU
3 KDU_SET_PROGRAM
6 DRIVE_WITH_KDU
7 Wait: 0.3
8 Loop KDU_NEW_RESULT≠0
9 Set KDS_LEVER=On
10 Wait: 0.1
11 Wait: 0.3
12 KduTorqueResult:=KDU_TORQUE_cN
13 KduAngleResult:=KDU_ANGLE_deg
14 KduScrewOk:=KDU_RESULT_FLAG
15 If KduScrewOk≠1
16 Popup: K-Ducer Tightening Error

Set
Select the action you wish the robot to perform at this point in the program. You also specify changes in the robot's payload.

○ No Action
● Set Digital Output KDS_LEVER ▼ High ▼
○ Set Analog Output <An.Output> ▼   4.0 mA
○ Set <Output> ▼   f(x)
○ Set Single Pulse <Di.Output> ▼   0.500 s
○ Increment installation variable by one: <Variable> ▼

ℹ To set payload, please use the 'Set Payload' node

☐ Set TCP ▼

Screenshot 2 (bottom):

Move   I/O   Log

Tabs: **Command** | Graphics | Variables

Program tree:
1 ▼ Robot Program
2 └ Call DRIVE_WITH_KDU
3 KDU_SET_PROGRAM
6 DRIVE_WITH_KDU
7 Wait: 0.3
8 Loop KDU_NEW_RESULT≠0
9 Set KDS_LEVER=On
10 Wait: 0.1
11 Wait: 0.3
12 KduTorqueResult:=KDU_TORQUE_cN
13 KduAngleResult:=KDU_ANGLE_deg
14 KduScrewOk:=KDU_RESULT_FLAG
15 If KduScrewOk≠1
16 Popup: K-Ducer Tightening Error

Assignment   Source Expression ▼
Assigns the selected *variable* with the value of the *expression*.

Variable   Expression
✎ KduTorqueResult ▼   :=   KDU_TORQUE_cNm