Ultrasound Controller D255

AQ M-Tech AB

Ultrasound Controller

D255

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- **Manual version** **2.2.0**
- **Software version** **2.2.0**
- **D255 hardware version** **RevC**
- **EDS file version** **2.10**
- **Ethernet/IP version** **2.1**

The manual version should conform to the software and hardware version of the Ultrasound Controller D255.

The software version of the Ultrasound Controller: HELP → DEVICE INFO

This manual is available at www.aqmtech.se

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1. Manufacturer information

AQ M-Tech AB, (previously AQ Elteknik AB) operates a policy of on-going development and reserves the right to make changes and improvements to any of the products described in this manual without prior notice. Under no circumstances shall AQ M-Tech be held responsible for any loss or indirect damage howsoever caused. The content of this document is provided as it is. AQ M-Tech AB reserves the right to revise this document or withdraw it at any time without prior notice.

Manufacturer Declaration of Conformity

Manufacturer AQ M-Tech AB, Sweden declares, that the product: Ultrasound Controller marked with CE-label conforms with the following standards: EN 61000-4, EN 61000-6-4, EN55011 Class A, FCC Part 15B Class A.

Ultrasound Controller marked with  conforms to WEEE directive 2012/19/EU. The Ultrasound Controller also conforms to RoHS directive (EU) 2015/863. When the Ultrasound Controller is to be discarded, send it back to AQ M-Tech AB for safe disposal.

Limited Warranty

AQ M-Tech AB warrants to the original end user that the Ultrasound Controller is free from any defects in materials or workmanship for a period of one year from the date of purchase. During the warranty period, should the Ultrasound Controller have indications of failure due to faulty workmanship or materials, AQ M-Tech AB will replace it with no charge. This warranty shall not apply if the Ultrasound Controller is modified, misused or subjected to abnormal working conditions. Replacement as provided under this warranty is the only remedy of the purchaser. The purchaser pays freight to AQ M-Tech AB. AQ M-Tech AB shall in no event be held liable for indirect or consequential damages of any kind or character to the purchaser.

Warning

The Ultrasound Controller is intended to be used with the Air Sensor or the Level Switch, all of them manufactured by AQ M-Tech AB. AQ M-Tech AB takes no responsibility for any possible damage that could happen if any other sensor not manufactured by AQ M-Tech AB is connected to the Ultrasound Controller.

It is not allowed to repair or modify sensors or Ultrasound Controller.

Certificate of Quality and Function

AQ M-Tech AB guaranties that the Ultrasound Controller has passed function and quality tests.

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2. Introduction

Ultrasound Controller D255

Ultrasound Controller uses ultrasound to make measurements of liquids. It can detect bubbles in flowing liquid, or it can detect presence of liquid behind a container wall or it can measure continuous liquid level. The Ultrasound Controller has four different modes of operation:

Air Sensor mode: The Air Sensor monitors the presence of gas or particles in a liquid medium. The Air Sensor is very reliable and easy to use. Two Air Sensors can be connected simultaniously to one Ultrasound Controller.

Level Switch mode: The Level Switch is a small sensor which attached to the outside of the container can sense the presence of liquid inside the container without making hole in the container. Four Level Switches can be connected to one Ultrasound Controller.

The **software version** of the Ultrasound Controller is shown in the “Device Info” found in the help menu. Software versions may differ slightly and therefore it is usually better to use a manual version corresponding to the software version, even though a later manual version can have less errors.

Installing Ultrasound Controller D255

The Ultrasound Controller should be protected from dust and water. It is made to be attached to a DIN-rail, to which it snaps easily and can be removed by pushing up and bending the top out. Usually it is installed in an electric cabinet. The connector terminals can be removed by pulling the connector straight out. Connections for terminal 1-3, see table.

D255 terminal	Description
1	+ supply PLUS 24V
2	– supply MINUS
3	Ground

Ethernet connection for EtherNet/IP® should be done with a Cat 5e or Cat 6 STP or FTP Ethernet cable. The cable connects to the network connector (RJ45).

Connections for Sensor 1 - Sensor 4 depend on the selected mode, see tables in the corresponding chapter.

The Ultrasound Controller should be installed in accordance with national regulations. A person with the required knowledge should perform the installation.

3. Navigating the menu system

The display is touch sensitive. When choosing a setting, the SET button must be pushed to confirm the choise. When issuing a command, such as calibration, the command button must be clicked twice.

4. Air Sensor Mode

In Air Sensor mode the Air Sensor is used to measure the presence of bubbles in flowing liquid. One or two Air Sensors type for instance a DAP and an APS can be connected simulaniously to one Ultrasound Controller.

Quickstart guide

- Install Air Sensors according to instructions in the Air Sensor Manual.
- Connect cables
- Switch on external power supply
- Change mode to Air Sensor if not already done. Set the parameters for the Air Sensors and for EtherNet/IP
- Fill Air Sensor 1 with liquid. Calibrate it
- Empty Air Sensor 1 of liquid. Calibrate it
- Do the calibration in the same way for Air sensor 2. The calibration can be done in any order as long as both air and liquid will be calibrated.
- A simple validation: AIR should be indicated when the Air Sensor is empty and LIQUID when it is filled with liquid.
- Go to ***SHOW DATA*** and check data.
- Ready.

Functional Description

Bubbles in the liquid flowing through the Air Sensor are monitored using ultrasound. Inside the Air Sensor two low intensity beams of ultrasound are transmitted across the liquid-path in directions perpendicular to the liquid flow.

If a bubble moves into one of the ultrasound-beams the ultrasound will be partially deflected, and the intensity of the ultrasound decreases. The controller constantly measures the intensity of the ultrasound and if the intensity becomes lower than the threshold it detects a bubble. Dense particles in the liquid can also deflect the ultrasound in a similar way and can therefore be detected.

The measurement accuracy depend on how well the Air Sensor is calibrated, the flow-rate, the type of liquid, how the Air Sensor is mounted and whether there is a single bubble or many bubbles and the internal diameter of the Air Sensor.

Orientation of the Air Sensor

If the Air Sensor is mounted horizontally orientation is important. Liquid flowing through the Air Sensor tends to pull bubbles towards the center of the tube but when flow rate decrease bubbles rise to the top. The Air Sensor is more sensitive to bubbles at the top if it is rotated so that the cable connector (and label) is facing up. If instead low bubble sensitivity is desirable rotate the Air Sensor so that the cable connector (and label) is facing down. This makes the Air Sensor less sensitive for bubbles at the upper part of the tube.

Connecting the Air Sensor

Maximum cable length depends on the Air Sensor, see Air Sensor manual. The Air Sensor cable can be ordered in different length and should not be extended. Any unshielded part of the cable should be no longer than 40mm. The cable shield shall if possible be connected to ground via shielded cable glands. Air Sensor 1 can be connected to the ports labeled either Sensor 1 or Sensor 2 and Air Sensor 2 can be connected to the ports labeled Sensor 3 or Sensor 4. Once calibrated, if the Air Sensor connection port is changed it need to be calibrated again.

Termi-nal pin number (RJ45)	color of the RJ45 connector	Term i-nal name (RJ45)		Air Sensor Cable Color			
				APS	DAP		
5	bluewhite	Sensor 1 or Sensor 2	Air Sensor 1	Brown	Brown		
4	blue			White	White		
6	green			Green (black)	Green (black)		
shield	shield			Shield	Shield		
3	greenwhite			Yellow (blue)	Yellow (blue)		
5	bluewhite	Sensor 3 or Sensor 4	Air Sensor 2	Brown	Brown		
4	blue			White	White		
6	green			Green (black)	Green (black)		
shield	shield			Shield	Shield		
3	greenwhite			Yellow (blue)	Yellow (blue)		

Sensitivity settings

When configuring your sensor, it's crucial to select the appropriate sensitivity level to match your application's requirements. The sensitivity levels can be set to high, medium, low, or very low. These settings adjust the sensor's responsiveness to air detection. Detectable bubble size is also somewhat dependent on Air Sensor type and inner diameter:

At high sensitivity, minimum detectable size of a single bubble is approximately 5µl.
(DAP6: 3µl, DAP10: 20µl, DAP22: 60µl)

At medium sensitivity, minimum detectable size of a single bubble is approximately 20µl.
(DAP6: 30µl, DAP10: 60µl, DAP22: 150µl)

At low sensitivity, minimum detectable size of a single bubble is approximately 700µl.
(DAP6: 200µl, DAP10: 500µl, DAP22: 1200µl)

Many small bubbles close together will be detected as a big bubble since their sizes combines.

Along the inner wall of the air sensor there are places having both lower and higher sensitivity. This is more pronounced in air sensors with larger than 15mm diameter. When there is a flow through the air sensor, bubbles tend to become centered and at the center the sensitivity is even.

At a high sensitivity setting, the sensor employs a technique known as "double bounce." This method involves echo reflecting off the opposite side twice, before being measured by the ultrasonic controller. The double bounce allows the sensor to detect smaller bubbles that might otherwise be missed at lower sensitivity settings.

However, due to the double bounce mechanism, sensors set to high sensitivity typically exhibit a lower echo value. This is because the double reflection process attenuates the signal, resulting in a reduced amplitude when the echo finally returns to the sensor.

If the diameter of the sensor is lower than 10mm, the sensor will use the double bounce technique regardless of the sensitivity settings. This is due to physical constraints of the piezoelectric elements.

Sensors with a diameter of 10mm or more and a sensitivity set lower than high (medium, low, and very low), will not utilize the double bounce technique. Instead, it relies on a single reflection of the signal. This approach results in higher echo values compared to the high sensitivity setting, as the signal undergoes less attenuation before being received by the sensor.

High and medium sensitivity is ideal for applications requiring the detection of small bubbles. Keep in mind the difference in signal strength and recalibrate the device when switching from high to medium, low, or very low sensitivity. A new calibration is also required if switching from medium, low, or very low to high sensitivity.

Low sensitivity is achieved by requiring both detectors inside the Air Sensor to detect bubbles at the same time. Many small bubbles together will be detected as if they were a single big bubble. Even tiny (microscopic almost invisible) bubbles will be detected if there are many of them.

Integration and Delay settings

Integration and delay time settings can be used to filter out unwanted detections. In some cases, some amount of bubbles is acceptable. The detection zone is 5mm long so at a flow rate of 0,25m/s (=0,25mm/ms), a bubble will stay approximately 20ms in the detection zone. If integration time is set to 100ms, it means then the total time the bubble is detected is added to the integration sum. So, if each bubble adds 20ms then with the fifth bubble, integration sum reaches 100ms and D255 indicates air. Delay is similar to integration, but it needs a continuous detection of a bubble during the whole delay time.

Sound velocity in the Air Sensor

When two liquids of different sound velocities (like water and alcohol) are not well mixed, the Air Sensor can give wrong indication of air. The sound is refracted due to changes in velocity, as the sound travels through one liquid after another. Very low sensitivity is not affected by this, and settings of long integration times and lower sensitivity can reduce such false indications of air.

5. Level Switch Mode

In Level Switch Mode the Level Switch measures a single level from the side of the container. It measures the presence or no presence of liquid behind the container (or pipe) wall. The Level Switch senses through the wall AND no hole is needed. Four Level Switches can be connected to one Ultrasound Controller.

Quick start guide

- Install Level Switches according to instructions in the Level Switch Manual.
- Attach the included tape, see pag
- Connect cables, see page 10
- Switch on external power supply.

Connecting the Level Switch

Terminal pin number (RJ45)	color of the RJ45 connector		Level Switch MK WG-Cable Color	Level Switch PSF WG-Cable Color	Level Switch PSF M8-connector-terminals on the Level Switch PSF *
1	orangewhite	Level Sensor 1		Brown (LED indication)	1 (LED indication)
2	orange			Green (LED indication)	3 (LED indication)
4	blue		Brown	Yellow	4
5	bluewhite		White	White	2
shield	shield		Shield	Shield	Shield
1	orangewhit	Level Sensor 2		Brown (LED indication)	1 (LED indication)
2	orange			Green (LED indication)	3 (LED indication)
4	blue		Brown	Yellow	4
5	bluewhite		White	White	2
shield	shield		Shield	Shield	Shield
1	orangewhit	Level Sensor 3		Brown (LED indication)	1 (LED indication)
2	orange			Green (LED indication)	3 (LED indication)
4	blue		Brown	Yellow	4
5	bluewhite		White	White	2
shield	shield		Shield	Shield	Shield
1	orangewhit	Level Sensor 4		Brown (LED indication)	1 (LED indication)
2	orange			Green (LED indication)	3 (LED indication)
4	blue		Brown	Yellow	4
5	bluewhite		White	White	2
shield	shield		Shield	Shield	Shield

* The numbering of the Level Switch PSF M8-connector is as shown in Level Switch PSF manual which is different than standard numbering of M8-connectors.

The Level Switch cable should not be extended. Maximum cable length, see Level Switch manual. Any unshielded part of the cable should be no longer than 40mm. The cable shield shall if possible be connected to ground via shielded cable glands

Mounting the Level Switch

Between the Level Switch and the container there must be a tight ultrasound-connection. For Level Switch MK, this is achieved with a soft silicone surface. For the other Level Switches, it is achieved by using glue or compound.

Mounting Level Switch MK

For attaching the Level Switch MK no glue or compound is needed. The Level Switch MK has a flexible surface which acieves a good ultrasound-connection when it is pressed against the container. The pressure needs to be around 15N (minimum 5N and maximum 50N), depending also on the shape of the container. The pressure makes the flexible surface adapt to the container. It is important the Level Switch MK is held in place with a fixture. The fixture should provide the means for applying the pressure on the Level Switch so it will be pressed against the container. Since the Level Switch MK has a rounded surface, the fixture need also to hold the Level Switch MK straight in place. A possible fixture is a plastic block adapted to the shape of the container, with a 25,1mm hole for the Level Switch. More information about how the Level Switch MK can be used for measuring is available in Ultrasound Controller manual.

Mounting Level Switch PSF

Gluing the Level Switch is best attachment technique. Transparent silicone glue is heat-resistant and is a good glue at all temperatures. A Level Switch glued with silicone is easy to remove. The silicone glue can be Loctite 5366 or a similar transparent (1-component moisture curing) silicone. It can take a few days to cure but the Level Switch can be used while the silicone is curing. Put some silicone on the container-facing side of the Level Switch and press it on to the container. The silicone should completely cover the gap between the Level Switch and the container. During the first hours, the Level Switch must be held securely in place with something like a tape or so.

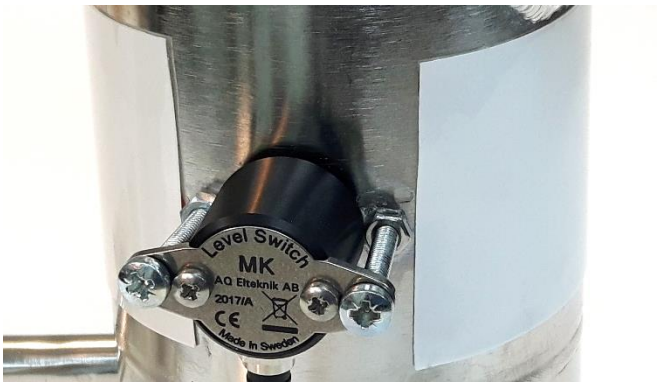
Transparent 1-component MS-polymer can also be used if temperature is not above 80°C. It is flexible like silicone and takes some days to cure.

Hard glues should be avoided since they can come loose by temperature variations.

If the Level Switch is not glued, Sonotech SONO 600 can be used, or Electrolube Heat Transfer Compound. It does not cure so the Level Switch must be held in place by other means. If the Level Switch is removed, the old compound should be wiped off and new used next time. These compounds are not recommended at temperatures above 60°C.

More information about how the Level Switch can be used for measuring is available in Ultrasound Controller manual.

Stainless Steel and Glass Containers



When the Level Switch is mounted on a stainless steel or glass container and the echo-technique is used, it is advisable to also attach a sound absorbing tape on the container. The tape will supress unwanted sound travelling along the container and thereby improve the measurements. The 3M tape 8671 is suitable for this purpose. It withstands high temperature 135°C. The tape is transparent and can be removed without leaving any trace. The picture shows the tape with the protective paper still attached. It should be placed centered over the Level Switch and go around the container, starting and ending near the Level Switch. The important area to cover is about 100mm on each side, close to the Level Switch. On a big container, if the tape is too short, it can be cut in two pieces and placed on each side of the Level Switch. The tape is 50,8mm wide and one tape should be used for each Level Switch. Attaching tape above or below the Level Switch does not help. The tape is supplied with the Level Switch in 500mm length and can also be ordered separately from AQ M-Tech, order number 101310. The material is polyurethane. Acetone should not be used for cleaning the tape.

Sound velocity and the Level Switch

When ***ECHO Technique*** is used and there are two liquids with significant different sound velocity in the container and these liquids are not well mixed, then there can be a false indication of air because the sound is refracted at the surface between the two liquids.

6. EtherNet/IP®

D255 contains ODVA EtherNet/IP® support for reading level switch or air sensor data for 1-4 sensors. Data is presented as a vendor specific class which can be read through explicit message requests (Class 3) in either UCMM or connected mode. Implicit (Class 1) connections utilize two assembly objects, one consuming with id 0x64 and one producing with id 0x65. Further description about the both the Class 1 and Class 3 connections can be found below.

Connecting EtherNet/IP®

Network configuration must be assigned: IP address, netmask and optional gateway and name. Only static assignment is supported, there is no support for DHCP. Please contact the local network administrator if it is unclear what these settings are supposed to be.

Set the IP address:

Settings → Network → Address

Example 192.168.100.10

Netmask also needs to be set:

Settings → Network → Netmask

Example 255.255.255.0

Optionally set the Gateway and Name.

Class 1 Connection (Implicit)

The D255 receives implicit data using an assembly object with instance id 0x64. This consuming assembly (0x64) is used for sensor settings. Assembly id 0x65 is a producing assembly, this assembly contains various information about sensor values and current settings in the D255. When the data is comprised of 2 or more bytes the ordering is LSB to MSB. I.e., the UINT data 0x1234 is transmitted in the order 0x34 0x12. By the way that class 1 data is transmitted, the D255 is set to ignore settings that have not changed since the last packet was received. This means that if for example sensor 1 has been calibrated and sensor 2 changes subtype, then the sensor 1 will not try to calibrate again.

Important!

When calibrating the device using implicit comunication, it is important to set the calibration flag back to 0 after a calibration command. If this is not done and the device is power cycled, a new calibration command will be accepted, recalibrating the device. This can cause an error if for example both the calibrate air and liquid flags are set at the same time. The same holds for setting a calibration value. Once the value is set, the value needs to be reset to 0.

Any air sensor connected to the device utilizes two channels to transmit and receive the ultrasonic signal. Therefore, it is important to set values for both the channels used by the sensor.

I.e., air sensor 1 utilizes channel 1 and channel 2, while air sensor 2 utilizes channel 3 and 4.

So, changing the settings of an air sensor only requires the lower channel byte to be set.

The settings will be the same on both air sensor channels, besides the calibration values which can differ if needed to.

This only applies to the air sensor and not the level switch, since the level switch only utilizes one channel per sensor.

Assembly ID 0x64 Consuming

The consuming assembly is used to change the settings of the D255 and calibrate the connected sensors.

Class Attributes

Byte	Name	Data Type	Description
0	Sensor Type	USINT	The type of the current sensor, see Table 6-3 for more information.
1	Channel 1 Subtype	USINT	The subtype of the sensor connected to the channel, for air sensors see Table 6-4 and for level switches see Table 6-5
2	Channel 2 Subtype	USINT	The subtype of the sensor connected to the channel, for air sensors see Table 6-4 and for level switches see Table 6-5
3	Channel 3 Subtype	USINT	The subtype of the sensor connected to the channel, for air sensors see Table 6-4 and for level switches see Table 6-5
4	Channel 4 Subtype	USINT	The subtype of the sensor connected to the channel, for air sensors see Table 6-4 and for level switches see Table 6-5
5, 6	Channel 1 Diameter	UINT	The diameter of the sensor connected to the channel in mm. See Table 6-6 for minimum and maximum ranges.
7, 8	Channel 2 Diameter	UINT	The diameter of the sensor connected to the channel in mm. See Table 6-6 for minimum and maximum ranges.
9, 10	Channel 3 Diameter	UINT	The diameter of the sensor connected to the channel in mm. See Table 6-6 for minimum and maximum ranges.
11, 12	Channel 4 Diameter	UINT	The diameter of the sensor connected to the channel in mm. See Table 6-6 for minimum and maximum ranges.
13	Channel 1 Technique	USINT	The technique used to measure air, see Table 6-7
14	Channel 2 Technique	USINT	The technique used to measure air, see Table 6-7
15	Channel 3 Technique	USINT	The technique used to measure air, see Table 6-7
16	Channel 4 Technique	USINT	The technique used to measure air, see Table 6-7
17	Channel 1 Sensitivity	USINT	Decides how sensitive the sensor connected to the channel is to air bubbles. See Table 6-8

18	Channel 2 Sensitivity	USINT	Decides how sensitive the sensor connected to the channel is to air bubbles. See Table 6-8
19	Channel 3 Sensitivity	USINT	Decides how sensitive the sensor connected to the channel is to air bubbles. See Table 6-8
20	Channel 4 Sensitivity	USINT	Decides how sensitive the sensor connected to the channel is to air bubbles. See Table 6-8
21	Channel 1 Threshold	USINT	Sets the threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
22	Channel 2 Threshold	USINT	Sets the threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
23	Channel 3 Threshold	USINT	Sets the threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
24	Channel 4 Threshold	USINT	Sets the threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
25	Channel 1 Filter	USINT	The time that the sensor connected to the channel needs to detect air before deciding that there is air in the system, for air sensors see Table 6-9 and for level switches see Table 6-10
26	Channel 2 Filter	USINT	The time that the sensor connected to the channel needs to detect air before deciding that there is air in the system, for air sensors see Table 6-9 and for level switches see Table 6-10
27	Channel 3 Filter	USINT	The time that the sensor connected to the channel needs to detect air before deciding that there is air in the system, for air sensors see Table 6-9 and for level switches see Table 6-10
28	Channel 4 Filter	USINT	The time that the sensor connected to the channel needs to detect air before deciding that there is air in the system, for air sensors see Table 6-9 and for level switches see Table 6-10
29	Channel 1 Frequency	USINT	The frequency of the transmitted signal, see Table 6-11
30	Channel 2 Frequency	USINT	The frequency of the transmitted signal, see Table 6-11
31	Channel 3 Frequency	USINT	The frequency of the transmitted signal, see Table 6-11
32	Channel 4 Frequency	USINT	The frequency of the transmitted signal, see Table 6-11
33	Calibrate Channel 1 Air	USINT	0 = No Calibration, 1 = Calibrate Air, Set to default value 0 after calibration is completed.
34	Calibrate Channel 2 Air	USINT	0 = No Calibration, 1 = Calibrate Air, set to default value 0 after calibration is completed.
35	Calibrate Channel 3 Air	USINT	0 = No Calibration, 1 = Calibrate Air, set to default value 0 after calibration is completed.
36	Calibrate Channel 4 Air	USINT	0 = No Calibration, 1 = Calibrate Air, set to default value 0 after calibration is completed.
37	Calibrate Channel 1 Liquid	USINT	0 = No Calibration, 1 = Calibrate Liquid, set to default value 0 after calibration is completed.
38	Calibrate Channel 2 Liquid	USINT	0 = No Calibration, 1 = Calibrate Liquid, set to default value 0 after calibration is completed.

39	Calibrate Channel 3 Liquid	USINT	0 = No Calibration, 1 = Calibrate Liquid, set to default value 0 after calibration is completed.
40	Calibrate Channel 4 Liquid	USINT	0 = No Calibration, 1 = Calibrate Liquid, set to default value 0 after calibration is completed.
41,44	Calibration Value Channel 1 Air	UDINT	Sets the calibration value for air on channel 1, set to default value 0 after value has been accepted by the device.
45,48	Calibration Value Channel 2 Air	UDINT	Sets the calibration value for air on channel 2, set to default value 0 after value has been accepted by the device.
49,52	Calibration Value Channel 3 Air	UDINT	Sets the calibration value for air on channel 3, set to default value 0 after value has been accepted by the device.
53,56	Calibration Value Channel 4 Air	UDINT	Sets the calibration value for air on channel 4, set to default value 0 after value has been accepted by the device.
57,60	Calibration Value Channel 1 Liquid	UDINT	Sets the calibration value for liquid on channel 1, set to default value 0 after value has been accepted by the device.
61,64	Calibration Value Channel 2 Liquid	UDINT	Sets the calibration value for liquid on channel 2, set to default value 0 after value has been accepted by the device.
65,68	Calibration Value Channel 3 Liquid	UDINT	Sets the calibration value for liquid on channel 3, set to default value 0 after value has been accepted by the device.
69,72	Calibration Value Channel 4 Liquid	UDINT	Sets the calibration value for liquid on channel 4, set to default value 0 after value has been accepted by the device.

Table 6-1

Assembly ID 0x65 Producing

The producing assembly contains information about sensor data and the current settings used by the D255. The members of the producing assembly are listed in Table 6-2.

Byte	Name	Data Type	Description
0, 3	Channel 1 Value	UDINT	The calculated echo value on channel 1
4, 7	Channel 2 Value	UDINT	The calculated echo value on channel 2
8, 11	Channel 3 Value	UDINT	The calculated echo value on channel 3
12, 15	Channel 4 Value	UDINT	The calculated echo value on channel 4
16	Channel 1 Result	USINT	The measurement result of channel 1, see Table 6-12 for details
17	Channel 2 Result	USINT	The measurement result of channel 2, see Table 6-12 for details.
18	Channel 3 Result	USINT	The measurement result of channel 3, see Table 6-12 for details
19	Channel 4 Result	USINT	The measurement result of channel 4, see Table 6-12 for details.
20, 23	Channel 1 Calibration Value Air	UDINT	The calibration value of channel 1 using air
24, 27	Channel 2 Calibration Value Air	UDINT	The calibration value of channel 2 using air
28, 31	Channel 3 Calibration Value Air	UDINT	The calibration value of channel 3 using air
32, 35	Channel 4 Calibration Value Air	UDINT	The calibration value of channel 4 using air

36, 39	Channel 1 Calibration Value Liquid	UDINT	The calibration value of channel 1 using Liquid
40, 43	Channel 2 Calibration Value Liquid	UDINT	The calibration value of channel 2 using Liquid
44, 47	Channel 3 Calibration Value Liquid	UDINT	The calibration value of channel 3 using Liquid
48, 51	Channel 4 Calibration Value Liquid	UDINT	The calibration value of channel 4 using Liquid
52	Channel 1 Calibration Status	USINT	The status of the calibration of the sensor on channel 1, see Table 6-13 for more information
53	Channel 2 Calibration Status	USINT	The status of the calibration of the sensor on channel 2, see Table 6-13 for more information
54	Channel 3 Calibration Status	USINT	The status of the calibration of the sensor on channel 3, see Table 6-13 for more information
55	Channel 4 Calibration Status	USINT	The status of the calibration of the sensor on channel 4, see Table 6-13 for more information
56	Sensor Type	USINT	The type of sensor that is currently in use, see Table 6-3 for more information.
57	Channel 1 Subtype	USINT	The sensor subtype on channel 1, see Table 6-5 if the sensor type is level switch and see Table 6-4 for air sensor.
58	Channel 2 Subtype	USINT	The sensor subtype on channel 2, see Table 6-5 if the sensor type is level switch and see Table 6-4 for air sensor.
59	Channel 3 Subtype	USINT	The sensor subtype on channel 3, see Table 6-5 if the sensor type is level switch and see Table 6-4 for air sensor.
60	Channel 4 Subtype	USINT	The sensor subtype on channel 4, see Table 6-5 if the sensor type is level switch and see Table 6-4 for air sensor.
61, 62	Channel 1 Diameter	UINT	The diameter of the sensor connected to channel 1. See Table 6-6 for minimum and maximum ranges.
63, 64	Channel 2 Diameter	UINT	The diameter of the sensor connected to channel 2. See Table 6-6 for minimum and maximum ranges.
65, 66	Channel 3 Diameter	UINT	The diameter of the sensor connected to channel 3. See Table 6-6 for minimum and maximum ranges.
67, 68	Channel 4 Diameter	UINT	The diameter of the sensor connected to channel 4. See Table 6-6 for minimum and maximum ranges.
69	Channel 1 Technique	USINT	The technique of the sensor connected to channel 1. See Table 6-7 for more information.
70	Channel 2 Technique	USINT	The technique of the sensor connected to channel 2. See Table 6-7 for more information.
71	Channel 3 Technique	USINT	The technique of the sensor connected to channel 3. See Table 6-7 for more information.
72	Channel 4 Technique	USINT	The technique of the sensor connected to channel 4. See Table 6-7 for more information.
73	Channel 1 Sensitivity	USINT	The sensitivity of the sensor connected to channel 1. See Table 6-8 for more information.
74	Channel 2 Sensitivity	USINT	The sensitivity of the sensor connected to channel 2. See Table 6-8 for more information.
75	Channel 3 Sensitivity	USINT	The sensitivity of the sensor connected to channel 3. See Table 6-8 for more information.
76	Channel 4 Sensitivity	USINT	The sensitivity of the sensor connected to channel 4. See Table 6-8 for more information.
77	Channel 1 Threshold	USINT	The threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the

			threshold compared to the liquid calibration value, the device will indicate air.
78	Channel 2 Threshold	USINT	The threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
79	Channel 3 Threshold	USINT	The threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
80	Channel 4 Threshold	USINT	The threshold percentage for detecting air. Value range is [1,99] for LS and [10, 90] for AS. If the echo is below the threshold compared to the liquid calibration value, the device will indicate air.
81	Channel 1 Filter	USINT	The filter of the sensor connected to channel 1. For air sensors see Table 6-9 and for level switches see Table 6-10.
82	Channel 2 Filter	USINT	The filter of the sensor connected to channel 2. For air sensors see Table 6-9 and for level switches see Table 6-10.
83	Channel 3 Filter	USINT	The filter of the sensor connected to channel 3. For air sensors see Table 6-9 and for level switches see Table 6-10.
84	Channel 4 Filter	USINT	The filter of the sensor connected to channel 4. For air sensors see Table 6-9 and for level switches see Table 6-10.
85	Channel 1 Frequency	USINT	The frequency of the sensor connected to channel 1. See Table 6-11 for more information.
86	Channel 2 Frequency	USINT	The frequency of the sensor connected to channel 2. See Table 6-11 for more information.
87	Channel 3 Frequency	USINT	The frequency of the sensor connected to channel 3. See Table 6-11 for more information.
88	Channel 4 Frequency	USINT	The frequency of the sensor connected to channel 4. See Table 6-11 for more information.
89, 92	Serial number	UDINT	The serial number of the device.
93, 96	Power On Time	UDINT	The accumulated time that the device has been turned on. 1 = 15 minutes, 4 = 1 hour etc.
97, 100	Power Cycles	UDINT	The number of times the device has been power cycled.
101, 104	Channel 1 Last Calibration	UDINT	The accumulated time since channel 1 was calibrated. 1 = 15 minutes, 4 = 1 hour etc.
105, 108	Channel 2 Last Calibration	UDINT	The accumulated time since channel 2 was calibrated. 1 = 15 minutes, 4 = 1 hour etc.
109, 112	Channel 3 Last Calibration	UDINT	The accumulated time since channel 3 was calibrated. 1 = 15 minutes, 4 = 1 hour etc.
113, 116	Channel 4 Last Calibration	UDINT	The accumulated time since channel 4 was calibrated. 1 = 15 minutes, 4 = 1 hour etc.
117, 120	Channel 1 Time Since Replaced	UDINT	The accumulated time since the sensor on channel 1 was replaced. 1 = 15 minutes, 4 = 1 hour etc.
121, 124	Channel 2 Time Since Replaced	UDINT	The accumulated time since the sensor on channel 2 was replaced. 1 = 15 minutes, 4 = 1 hour etc.
125, 128	Channel 3 Time Since Replaced	UDINT	The accumulated time since the sensor on channel 3 was replaced. 1 = 15 minutes, 4 = 1 hour etc.
129, 132	Channel 4 Time Since Replaced	UDINT	The accumulated time since the sensor on channel 4 was replaced. 1 = 15 minutes, 4 = 1 hour etc.

Table 6-2

Sensor types

Table 6-3 displays the different types of sensors available for D255.

Value	Name	Description
0	Level Switch	The sensor type is a level switch.
1	Air Sensor	The sensor type is an air sensor.

Table 6-3

Air Sensor SubtypesTable 6-4 displays the subtypes available for air sensor mode.

Value	Name	Description
0	None	No subtype selected
1	APS	The subtype of the air sensor is APS
2	DAP	The subtype of the air sensor is DAP

Table 6-4

Level Switch Subtypes

Table 6-5 displays the subtypes available for level switch mode.

Value	Name	Description
0	None	No subtype selected
1	PSF	The subtype of the level switch is PSF
2	MK	The subtype of the level switch is MK

Table 6-5

Sensor Diameter Limits

Table 6-6 displays the limits of diameters when using the air sensor or level switch.

Value	Name	Description
2	Air Sensor Min	Minimum diameter of the air sensor
70	Air Sensor Max	Maximum diameter of the air sensor
15	Level Switch Min	Minimum diameter of the level switch
600	Level Switch Max	Maximum diameter of the level switch

Table 6-6

Sensor Technique

Table 6-7 indicates the technique used by the sensor.

Value	Name	Description
0	Echo	Standard echo measurement of the signal
1	WR	Short echo measurement
2	Delta	An echo measurement using weighted air and liquid values

Table 6-7

Sensor Sensitivity

A higher sensitivity detects smaller bubbles. When changing the sensitivity from High to Medium or lower or from Medium and lower to High, a new calibration of the device must be done.

Value	Name	Description
0	High	High sensitivity
1	Medium	Medium sensitivity
2	Low	Low sensitivity
3	Very Low	Very low sensitivity

Table 6-8

Air Sensor Filter

Longer delays or integration means that the bubble needs to be larger before detection.

Value	Name	Description
0	Integrate 1ms	Integrate the echo signal over 1ms
1	Integrate 10ms	Integrate the echo signal over 10ms
2	Integrate 100ms	Integrate the echo signal over 100ms
3	Integrate 1s	Integrate the echo signal over 1s
4	Integrate 3s	Integrate the echo signal over 3s
5	Delay 1s	Delay air detection by 1 second
6	Delay 3s	Delay air detection by 3 seconds
7	Delay 10s	Delay air detection by 10 seconds

Table 6-9

Level Switch Filter

Longer delays means that the bubble needs to be larger before detection.

Value	Name	Description
0	0.5s delay	Delays air detection by 0.5 seconds
1	1.0s delay	Delays air detection by 1.0 second
2	2.0s delay	Delays air detection by 2.0 seconds
3	4.0s delay	Delays air detection by 4.0 seconds
4	8.0s delay	Delays air detection by 8.0 seconds

5	12.0s delay	Delays air detection by 12.0 seconds

Table 6-10

Sensor Frequency

The frequency of the transmitted signal. Usually, 2.0MHz or 2.1MHz is the optimal frequency.

Value	Name	Description
0	Auto	Selects the optimal frequency
1	2.4MHz	Frequency of the transmitted signal
2	2.3MHz	Frequency of the transmitted signal
3	2.2MHz	Frequency of the transmitted signal
4	2.1MHz	Frequency of the transmitted signal
5	2.0MHz	Frequency of the transmitted signal
6	1.9MHz	Frequency of the transmitted signal
7	1.8MHz	Frequency of the transmitted signal
8	1.7MHz	Frequency of the transmitted signal
9	1.6MHz	Frequency of the transmitted signal

Table 6-11

Sensor Results

The result of the sensor measurement.

Value	Name	Description
0	No Result	The sensor is not active
1	Air	The sensor indicates air in the system
2	Liquid	The sensor indicates liquid in the system
3	Not Calibrated	The sensor has not been calibrated for both air and liquid
4	Calibration Error	The calibration values of air and liquid are too close to make a proper distinction between air and liquid in the system.
5	Disconnected	No physical sensor is connected to the device.

Table 6-12

Calibration Status

Indication of the sensor's calibration status

Value	Name	Description
0	Uncalibrated	The sensor has not been calibrated
1	Ok	The sensor is correctly calibrated
2	Error	The difference between the air and liquid calibration values is too low
3	No Air	The sensor has not been calibrated using air
4	No Liquid	The sensor has not been calibrated using liquid
5	Calibrating	The sensor has accepted a calibration command and is waiting for the flag to be reset to 0.

Table 6-13

Class 3 Connection (Explicit)

Besides from the ODVA mandated classes, the D255 implements a set of customized classes and services. The tables below describe the implemented classes and services, their responses and behavior.

Class 0x64 Channel

Class Attributes

Number	Access	Name	Data Type	Description
1	Get	Revision	UINT	Current class revision
2	Get	Max Instances	UINT	Maximum number of instances
3	Get	Number of Instances	UINT	Number of instantiated objects
4	Get	Max Class Attributes	UINT	Maximum number of attributes for the class
5	Get	Max Instance Attributes	UINT	Maximum number of attributes for the object instance

Table 6-14

Class Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path

Table 6-15

Instance Attributes

Number	Access	Name	Data Type	Description
1	Get	Echo Strength	UDINT	The measured echo strength on the current channel
2	Get/Set	Calibration Value Liquid	UDINT	The calibration value for liquid on the current channel
3	Get/Set	Calibration Value Air	UDINT	The calibration value for air on the current channel
4	Get	Sensor Type	USINT	The type of sensor associated with the channel, see Table 6-3 for more information

Table 6-16

Instance Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path
0x10	Set Attribute Single	Sets a single attribute according to the application path

Table 6-17

Class 0x65 Air Sensor

The Air Sensor class models the functionality of the connected air sensors. A maximum of two air sensors can be connected simultaneously. Each connected sensor utilizes two channels, A and B.

A table of how to interpret the result attribute data can be found in Table 6-12.

Class Attributes

Number	Access	Name	Data Type	Description
1	Get	Revision	UINT	Current class revision
2	Get	Max Instances	UINT	Maximum number of instances
3	Get	Number of Instances	UINT	Number of instantiated objects
4	Get	Max Class Attributes	UINT	Maximum number of attributes for the class
5	Get	Max Instance Attributes	UINT	Maximum number of attributes for the object instance

Table 6-18

Class Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path

Table 6-19

Instance Attributes

Number	Access	Name	Data Type	Description
1	Get	Result	USINT	The measurement result, Table 6-12 for details
2	Get/Set	Subtype	USINT	The subtype of the air sensor, see Table 6-4 for more information
3	Get/Set	Diameter	UINT	The diameter in mm of the sensor, see Table 6-6 for more information
4	Get/Set	Technique	USINT	The technique used by the sensor, see Table 6-7 for more information
5	Get/Set	Filter	USINT	The current filter used by the sensor, see Table 6-9 for more information
6	Get/Set	Frequency	USINT	The frequency used by the sensor, see Table 6-11 for more information
7	Get/Set	Threshold	USINT	Sets the threshold percentage for detecting air. Minimum value is 10 maximum 90.
8	Get/Set	Sensitivity	USINT	How sensitive the sensor is to air, see Table 6-8 for more information
9	Get	Echo	ULINT	The 4MSB represents the echo strength on channel A and the 4LSB is the echo strength of channel B
10	Get	Calibration Value Liquid	ULINT	The 4MSB represents the liquid calibration value on channel A and the 4LSB is the value of channel B

11	Get	Calibration Value Air	ULINT	The 4MSB represents the air calibration value on channel A and the 4LSB is the value of channel B

Table 6-20

Instance Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path
0x10	Set Attribute Single	Sets a single attribute according to the application path
0x32	Calibrate Liquid	Calibration of sensor using liquid
0x33	Calibrate Air	Calibration of sensor using air

Table 6-21

Class 0x66 Level Switch

The Level Switch class maps each instance to a connector interface on the D255. Each instance is mapped to the same sensor.

Class Attributes

Number	Access	Name	Data Type	Description
1	Get	Revision	UINT	Current class revision
2	Get	Max Instances	UINT	Maximum number of instances
3	Get	Number of Instances	UINT	Number of instantiated objects
4	Get	Max Class Attributes	UINT	Maximum number of attributes for the class
5	Get	Max Instance Attributes	UINT	Maximum number of attributes for the object instance

Table 6-22

Class Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path

Table 6-23

Instance Attributes

Number	Access	Name	Data Type	Description
1	Get	Result	USINT	The measurement result, see Table 6-12 for details
2	Get/Set	Subtype	USINT	The subtype of the level switch, see Table 6-5 for more information
3	Get/Set	Diameter	UINT	The diameter in mm of the sensor, see Table 6-6 for more information

4	Get/Set	Technique	USINT	The technique used by the sensor, see Table 6-7 for more information
5	Get/Set	Filter	USINT	The current filter used by the sensor, see Table 6-9 for more information
6	Get/Set	Frequency	USINT	The frequency used by the sensor, see Table 6-11 for more information
7	Get/Set	Threshold	USINT	Sets the threshold percentage for detecting air. Minimum value is 1 maximum 99.
8	Get	Echo	UDINT	The echo strength measured by the sensor
9	Get	Calibration Value Liquid	UDINT	The liquid calibration value of the sensor
10	Get	Calibration Value Air	UDINT	The air calibration value of the sensor

Table 6-24

Instance Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path
0x10	Set Attribute Single	Sets a single attribute according to the application path
0x32	Calibrate Liquid	Calibration of the sensor using liquid
0x33	Calibrate Air	Calibration of the sensor using air

Table 6-25

Class 0x67 Maintenance

The maintenance class contains information about the device, such as run-time, power cycles and the serial number of the device.

Class Attributes

Number	Access	Name	Data Type	Description
1	Get	Revision	UINT	Current class revision
2	Get	Max Instances	UINT	Maximum number of instances
3	Get	Number of Instances	UINT	Number of instantiated objects
4	Get	Max Class Attributes	UINT	Maximum number of attributes for the class
5	Get	Max Instance Attributes	UINT	Maximum number of attributes for the object instance

Table 6-26

Class Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path

Table 6-27

Instance Attributes

Number	Access	Name	Data Type	Description
1	Get	Power On Time	USINT	The accumulated power on time in 15-minute intervals. I.e., a value of 3 represents 45 minutes.
2	Get	Power On Cycles	USINT	The number of times that the device has been power cycled.
3	Get	Errors	ARRAY of USINT	An array of 16 USINT containing last 16 logged errors in order.
4	Get	Extended Errors	ARRAY of USING	An array of 16 USIT containing the last 16 extended error codes.
5	Get	Time Since Last Calibration.	ARRAY of UDINT	An array of 4 UDINT containing the time in 15-minute intervals since the last calibration.
6	Get	Time Since Last Reset	ARRAY of UDINT	An array of 4 UDINT containing the time in 15-minute intervals since the sensor was replaced.
7	Get	Firmware Version	Array of USINT	An array of 3 USINT containing the firmware version in order x.y.z (major.minor.patch).

Table 6-28

Instance Services

Number	Name	Description
0x0E	Get Attribute Single	Retrieves a single attribute according to the application path
0x34	Start Bootloader	Starts the bootloader by appending the data bytes [0x64, 0x61, 0x77, 0x61].

Table 6-29

7. Software Update Through Bootloader

There are two ways to set the device to bootloader mode so that the firmware can be updated.

The most common way is to access the bootloader through the GUI. This is done by clicking the buttons Menu → Settings → Advanced → FW Update. Click the command button in the middle of the screen twice to start the device in bootloader mode.

The other way is by using EtherNet/IP Class 3 communication. By using the service 0x34 on class 0x67 attribute 0x01 with the appended data [0x64, 0x61, 0x77, 0x61] the bootloader can be accessed.

Once the device has entered bootloader mode the screen will turn on and off indicating that the device is ready to receive the new software.

A PC software must also be installed to transfer the new software to the D255. We recommend that you use the “PIC32 Bootloader Application” found at https://www.microchip.com/en-us/application-notes/an1388.

Download the AN1388 Source Code file and install the application. The software “PIC32UBL.exe” can then be found in “installationdirectory\PIC32_Bootloaders\PC Application\”. Starting the software should result in something resembling Figure 7.1.

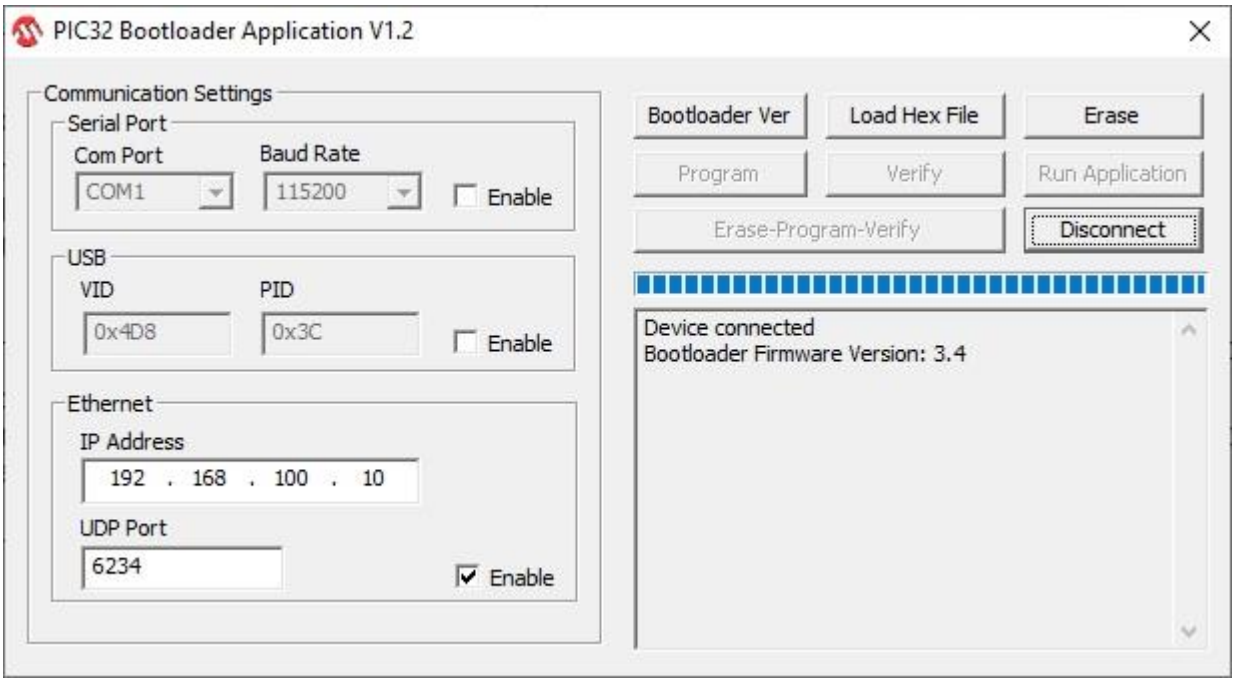


Figure 7.1

Connect the computer to D255 with a network cable. To be able to create a connection with the D255, the computers IP address must be in the same subnet as the D255. This means that the IP address of the computer needs to be 192.168.100.X where X is any value between 1-254 except for 10 which is reserved by the D255.

Click the ethernet enable checkbox and enter the following values

- IP Address = 192.168.100.10
- UDP Port 6234

Push the “Connect” button at the top right and wait for confirmation that the device has connected.

Once connected, click the button labeled “Load Hex File” and locate the file containing the firmware update. After the hex file has been selected click the “Erase” button to ensure that no residual data remains from previous software versions. After confirmation that the flash was erased, press the “Program” button, and wait until the notification “Programming completed” appears. The device is now programmed, however, since we use an encrypted version of the hex-file we cannot use the “Verify” button. Now click the “Run Application” button or power cycle the device to start the software.

To exit bootloader mode, simply power cycle the device and it will enter normal operation if the software has not been erased. If the device does not enter application mode, either an error occurred when installing the software or no installed software could be found.

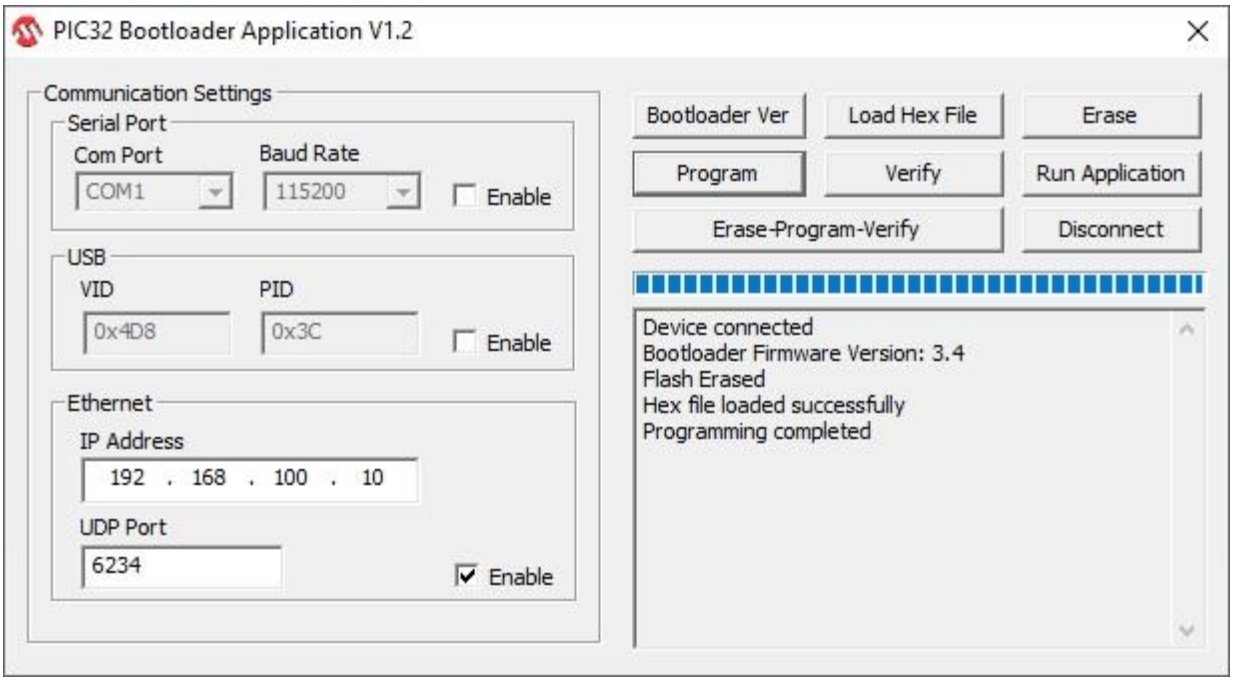

PIC32 Bootloader Application V1.2
Communication Settings
Serial Port
Com Port
COM1
Baud Rate
115200
Enable
USB
VID
0x4D8
PID
0x3C
Enable
Ethernet
IP Address
192 . 168 . 100 . 10
UDP Port
6234
Enable
Bootloader Ver
Load Hex File
Erase
Program
Verify
Run Application
Erase-Program-Verify
Disconnect
Device connected
Bootloader Firmware Version: 3.4
Flash Erased
Hex file loaded successfully
Programming completed

Figure 7.2

8. Technical specifications Ultrasound Controller

Hardware version	See page 3
Software version	See page 3
Weight	330g
Operating temperature	0°C to 50°C
Supply voltage	24V ± 3V DC
Current consumption max	300 mA
EtherNet/IP®	100Mbit Auto Negotiate
Protection class	IP30
Ambient Humidity	0% - 90%
Material	Aluminum, PA, PC, POM
Measurement frequency	1,6 – 2.4 MHz
Average output power	<10 mW