



## O & M Manual



# Model Q46 Ethernet-IP Communications Manual

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# Part 1 – Ethernet/IP Description

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## 1.1 General

Q46 Analyzers are available with four digital communication options. Profibus-DP, Modbus-RTU, Modbus-TCP/IP, or Ethernet/IP. This manual applies only to instruments supplied with the Ethernet/IP communication option. It is critical to note that Ethernet/IP devices only communicate with other systems running the Industrial Protocol of Ethernet. You cannot plug a Q46 into your office Ethernet and expect to have the Q46 talk to your computer.

**The discussion of standard Ethernet and Ethernet/IP is vast, and well beyond the ability to discuss here in great detail. The documentation for this option assumes working network knowledge by the user.**

## 1.2 Ethernet/IP Communication

Ethernet/IP was first introduced in 2001, and is a highly developed and complete protocol for an industrial Ethernet network solution. Intended for automation applications, EtherNet/IP is a member of a family of networks that implement the Common Industrial Protocol (CIP) at its upper layers of the standard ISO/OSI 7-layer model. CIP defines the object structure, specifies the message transfer, provides users with a unified communication architecture, and encompasses a comprehensive suite of services for a variety of manufacturing automation applications which include data, control, safety, and configuration.

In the CIP Protocol, every network device represents itself as a series of objects. Each object is simply a grouping of the related data values in a device. The identity object contains related identity data values called attributes. Attributes for the identity object include the vendor ID, date of manufacture, device serial number and other identity data.

The Q46 utilizes a gateway device inside the analyzer that maps an internal Modbus data structure into the required Ethernet/IP data object. This is done to maintain plug-and-play compatibility to all Q46 digital communication options. Any communication option can be plugged into any Q46 for immediate conversion to a new protocol.

Because this gateway device is part of the Q46 interface, the ID and device type show up on the interface as the gateway device. However, the Q46 variation type is mapped into the application data object as the last byte.

## 1.3 Ethernet/IP Transmission Details

It should be understood that Ethernet/IP is simply an application layer protocol that is transferred over an Ethernet hardware link. The word "Ethernet" simply refers to the common physical cable, perhaps running to an office PC.

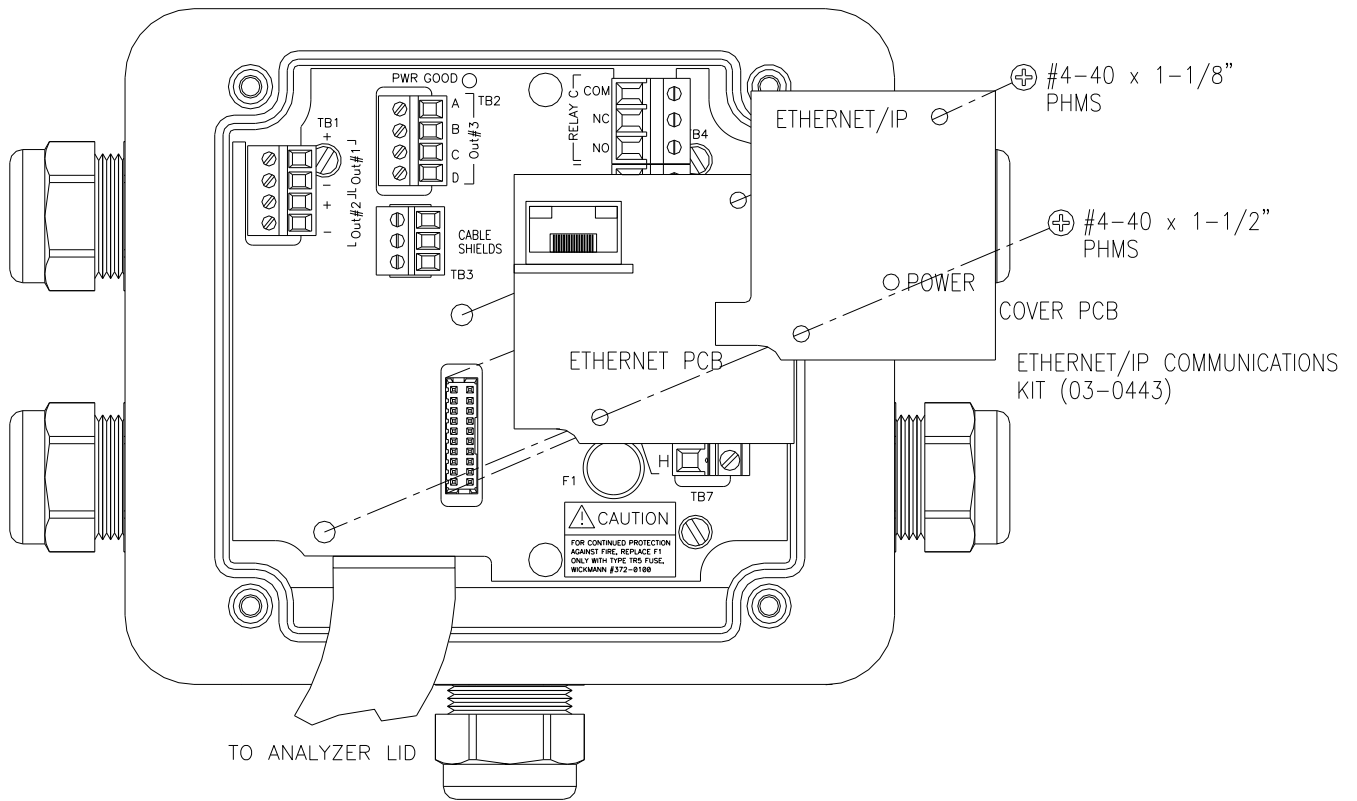
In the OSI model, "Ethernet" is the lower part of the model, the physical transfer method or the hardware. It says nothing about the way information is transferred, which is specified near the top of the OSI model. In the common office network, many different standard communication protocols are operating during normal office use, like IP, TCP, etc. None of these are designed to handle the CIP industrial format, so that interface must be handled by a specific program that recognizes the format. Because of this, an Ethernet/IP device cannot be directly connected to your office network for transferring information.

The data for the protocol is constructed into a specific structure inside a standard TCP/IP Packet. A user application program simply decodes the structure inside the received TCP or UDP packet. The data structure consists of a grouping of data values called Attributes inside other sets of containment data called Objects. There are Ethernet/IP required Objects and application Objects. Required objects are typically - Identity, TCP, and Router. Application objects consist of some defined data types, like a Motor Object, and some user specific data types.

## 1.4 Ethernet/IP Card Installation Instructions

Use the following instructions to install the Ethernet/IP Communications Option into an existing Q46 Analyzer. Monitors ordered with the Ethernet option will be supplied with the board already installed.

1. Disconnect power to the Q46 prior to installation of the board.
2. Remove the connector cover on the power supply circuit board located next to the fuse.
3. Carefully plug the Ethernet/IP circuit board into the connector on the power supply board.
4. Align the cover board holes with the holes in the circuit board and use the screws supplied to secure the assembly. Refer to Figure 1 on the next page for the proper assembly.



*Figure 1 – Ethernet/IP Card Installation*

## 1.5 Cable Connection

The cable used for Ethernet/IP communication should meet the CAT5 standard defined by the Electronic Industries Association and Telecommunications Industry Association. It is readily available in lengths up to 100 ft. (30 m) with plugs on each end.

To install an Ethernet cable in the Q46, pass the unterminated cable through the cable gland nearest the location of the RJ45 connector on the Ethernet/IP option board. Termination of Cat5/5e/6 cables is very easy and can be completed quickly with the commonly available RJ45 crimp tool.



*Figure 2 - RJ45 Crimp Tool*

While professional results are optimized with the use of the termination tool and custom cable lengths, patch cord style connection can be completed in some cases by passing the finished RJ45 connectors through the Q46 cable gland. The connector will fit through the plastic part of the cable gland, and the rubber grommet can be slit (some RJ45s may be too big for this.) Once the connector is inside the enclosure, simply plug it into the jack provided on the Ethernet/IP communication board. Be sure to adjust the rubber insert in the cable gland so that the slit is on the bottom and then tighten the gland to seal around the wire.

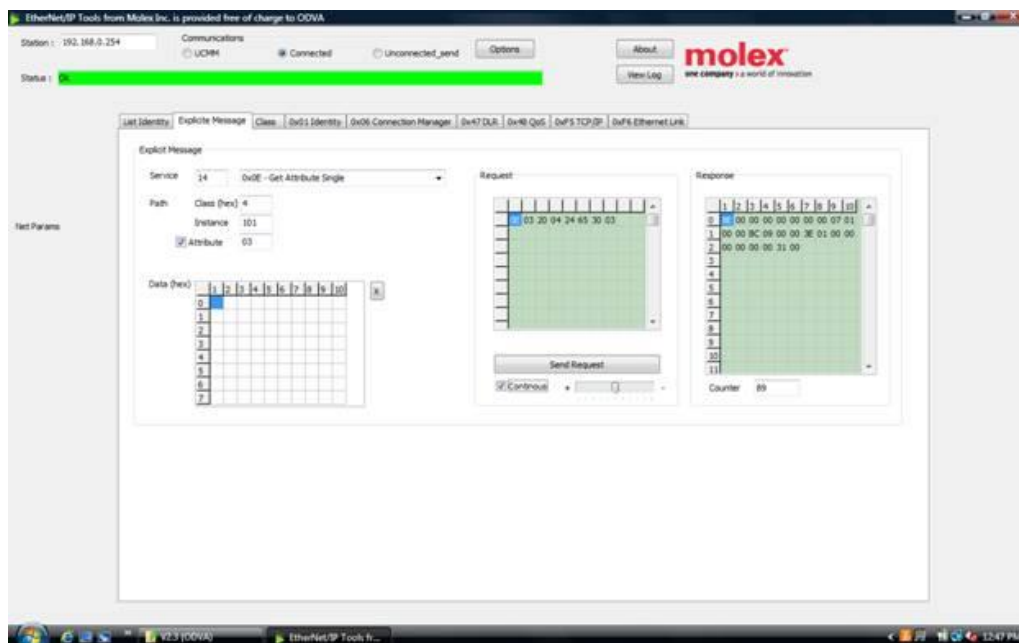
## 1.6 Interface Operation

Once the proper power is applied to the Q46 monitor, select “**Ethr**” in the **^Host Comms** listing of the **OPTIONS** menu on the Q46 to enable Ethernet/IP functionality.

On power-up, the Q46 looks for a BOOTP server to assign an IP address. Standard PLC networks (like Rockwell-RSLinx) include this server as part of the system. If no response from BOOTP occurs after about 60 seconds, the Q46 system defaults to an IP address at 192.168.0.254. The data is stored in an object with the attributes shown below, and can be acquired with an Ethernet/IP PC test program using the explicit message format as follows –

**Service: 14**                   **(0x0E hex, Get\_Attribute\_Single)**  
**Class: 4**                      **(0x04 hex, Assembly Object)**  
**Instance: 101**               **(0x65 hex, Input Instance)**  
**Attribute: 3**                 **(0x03 hex, Data Attributes)**

As an example, this call is shown in the Molex Ethernet/IP software tool screen shot below, run on the default IP address of a Q46D. This free Molex PC tool can be used to test explicit messages on the Q46 interface. To run this on a PC for check-out, the user must first be sure to set the IP address of the PC Ethernet port to the 192.168.0 subnet range, like 192.168.0.20 (or, manually run a BOOTP server.) **This tool cannot be used to set a fixed IP, and is primarily useful as a quick verification tool.**



**Figure 3 - Molex Ethernet/IP Explicit Message Tool Example**

In the Molex example, the explicit message sent to the Q46D is (all hex) –  
**14, 03, 20, 04, 24, 65, 30, 03**

This “Get Attribute Single” call requests the EIP data object at  
 Class = 4  
 Instance = 101  
 Attribute = 3

The raw response shown above from the Q46 is shown below -  
**8E, 00, 00, 00, 00, 00, 00, 07, 01,  
 00, 00, BC, 09, 00, 00, 3E, 01, 00, 00,  
 00, 00, 00, 00, 31, 00**

Since Ethernet/IP is a Little Endian protocol, the raw response format above is byte-swapped. To more easily see the data, flip every odd byte to Big Endian format. Then, underline our Q46 defined data sets –

**00, 8E, 00, 00, 00, 00, 00, 01, 07**  
**00, 00, 09, BC, 00, 00, 01, 3E, 00, 00,**  
**00, 00, 00, 00, 31**

Breaking up the groups, here is how the response corresponds to the Q46D instrument data set. The first 4 bytes are header info for the interface. Two bytes for status will appear in the data object and then 20 data bytes start after those status bytes -

<b>0x008E0000 =</b>	<b>4 bytes (32 bits) of header (not visible to PLC)</b>
<b>Data object next...</b>	
<b>0x0000 =</b>	<b>2 bytes (16 bits) of internal status info (ignore)</b>
<b>0x00000107 =</b>	<b>32-bit value = 263 = 2.63 ppm      Dissolved Ox</b>
<b>0x000009BC =</b>	<b>32-bit value = 2492 = 24.92 C      Temperature</b>
<b>0x0000013E =</b>	<b>32-bit value = 318 = 31.8 %      Saturation</b>
<b>0x00000000 =</b>	<b>32-bit value = 0      PID</b>
<b>0x00 =</b>	<b>8-bit binary value = 0x00000000      Status 1 flags</b>
<b>0x00 =</b>	<b>8-bit binary value = 0x00000000      Status 2 flags</b>
<b>0x00 =</b>	<b>8-bit binary value = 0x00000000      Alarm flags</b>
<b>0x31 =</b>	<b>8-bit value = 49      ID</b>

In most PLC’s, the 4-byte header will not show in the data object, but the 2-byte internal status header will. You can just ignore that status register when parsing data that starts at the 7<sup>th</sup> byte.

Note that in the section **1.9 Data File** tables below, we count the first table byte as the first data byte – starting after the 6 byte header/status info. So, the first 32-bit data value is listed as bytes 1-4, the second data value is at bytes 5-8, and so on.



## 1.7 PLC Settings

PLCs handle this exchange in a wide variety of configurations, and the configuration of a class 1 connection in every PLCs software is different, but there should be a place to enter the following information. If this doesn't seem to make sense, follow the explicit info above.

**Data Type: "INT" or "16-Bit"**

**Input T->O Assembly Instance: 0x65 or 101 decimal**

**Input T->O Size: 11 words (16-bit)**

**Output O->T Assembly Instance: 0x66 or 102 decimal**

**Output O->T Size: 1 word (16-bit)**

**Configuration Assembly Instance: 0x80 or 128 decimal**

**Configuration Size: 0**

\*Note that there may be a byte swap occurring on each set of registers as Ethernet/IP is Little Endian (see parse above in section 1.6). So you may have to byte swap each 16-bit register to recombine the data.

\*\*Note that section 1.6 shows that first raw 4 header bytes as being ignored, as the raw bytes are all shown with a Molex PC tool. The 2 raw bytes will show on the PLC, and are simply an internal status register. So, actual data shows right after those 6 bytes.

Note that some Ethernet/IP Master simulators such as EIP Scan do not have data type settings, everything is in bytes. In that case, the input above would be 22 instead of 11. Make sure to double check whether entry values are in hex or decimal.

## 1.8 Configuring fixed IP with BOOTP

The Q46 acquires a dynamic network IP address from the network client/master through the BOOTP service, which is enabled by default for ODVA EIP-CIP conformance. However, a fixed IP can be set using BOOTP on a PC.

BOOTP is a very simple software server application that waits for a specific MAC address to appear on the network, and then assigns it a pre-determined IP address that has been set-up by the user. In the most actual applications, BOOTP runs right on the PLC alongside tools like Rockwell's Studio 5000. For manual fixed settings, this same BOOTP server tool can be easily run on a PC. The current Rockwell version of this tool (recommended) is –

**“BootP-DHCP Ethernet/IP Commissioning Tool Version 3.03.00”**

This BOOTP tool is available from the Rockwell Automation website for free. For optimum security, only download this tool directly from Rockwell Automation.

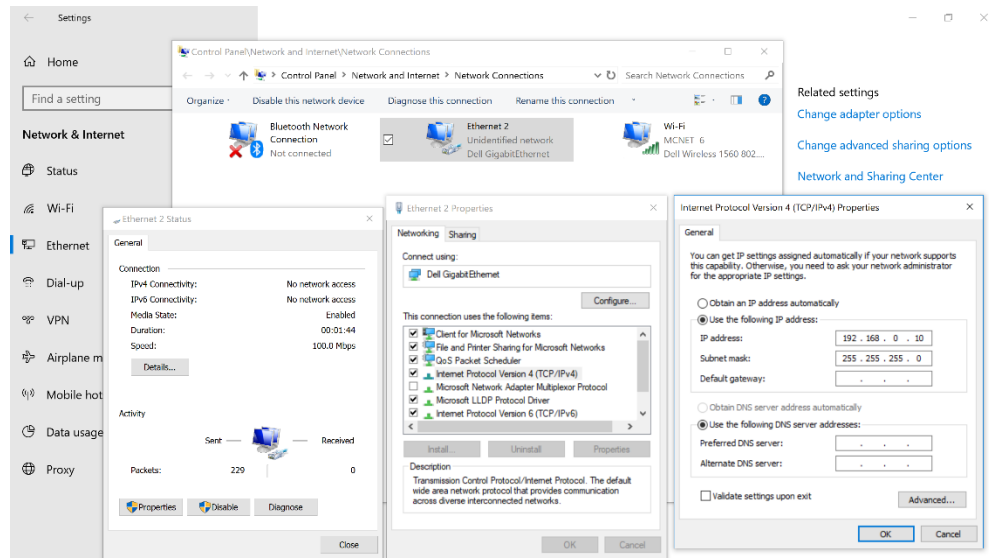
<https://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?crumb=112>

While this tool is normally used for dynamic assignment, the Q46 will remember the last successful assignment made by BOOTP, and it will retain that assignment after cycling instrument power. Therefore, the tool can be used to lock in a fixed IP address assignment, and then the BOOTP service will not actually be required after that first assignment.

In order to use BOOTP properly on a PC, some careful NIC adjustment settings must be made to the PC Ethernet port prior to running the BOOTP service. The PC can only reach IP addresses at the predetermined IP/subnet level, so we must force the PC to a subnet that can reach the existing Q46.

- 1) **Turn off Q46.** Connect Q46 to laptop with direct cable. Set laptop NIC port on a locked IP and subnet to stop DHCP service. This is critical. In IPV4 properties on your PC's Ethernet connection port, select "Use the following IP Address" and set the PC to -  
**IP Address = 192.168.0.10**  
**Subnet Mask = 255.255.255.0**

See below –

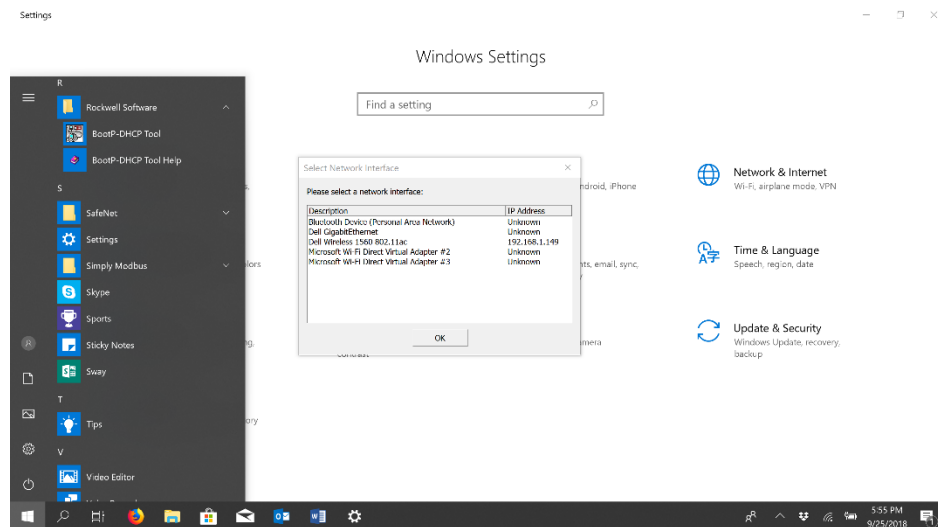


**Figure 4 – Force PC to Specific Network Subnet Prior to Running BOOTP**

- 2) Once this IP/subnet is set, click OK to save and then close it all out. Turn

PC off then back on to place it on the new IP address set in step 1. The PC will now be able to access any network device on 192.168.0.X, as the subnet mask 255.255.255 locks in the first three variables. The default value for the Q46 is 192.168.0.254, so it can now be reached by the PC.

- 3) Find the Rockwell BOOTP PC application and launch it. Select your Ethernet Adapter as the network interface.

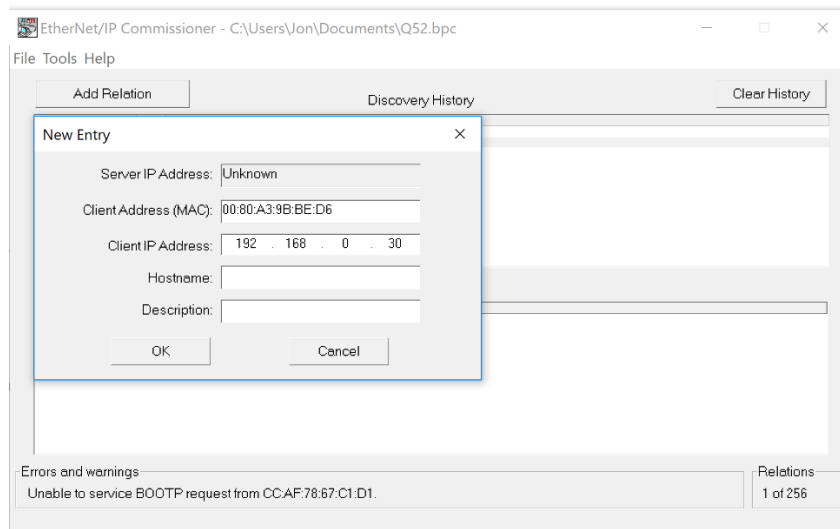


**Figure 5 – Launching BOOTP server**

- 4) On next screen, you must create an assignment relationship to match a known MAC ID with a desired IP address. The MAC ID for your Q46 is written on a label inside the enclosure, and always starts with 00:80.

For this example, we will use the MAC ID - **00:80:A3:9B:BE:B6** and assign it a fixed IP of **192.168.0.30**. Hit OK after this information is filled in, and you will see this entry appear in the bottom half of the window under “Entered Relations.”

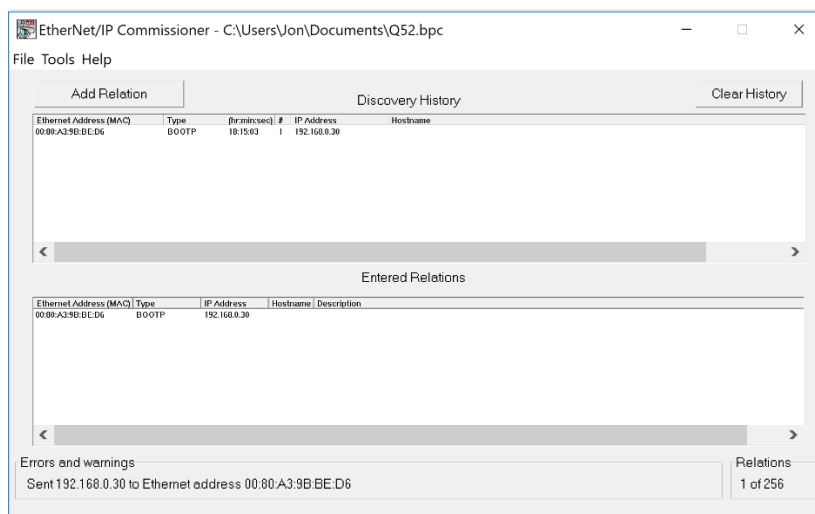
Once the MAC assignment has been entered, it is ready for a BOOTP IP request to come in for assignment. Requests for assignment will appear in the upper window as they come in.



**Figure 6 – Setting IP/mask Assignment in BOOTP Server**

- 5) Now, plug the cable from Q46 into the PC Ethernet port, turn on power to the Q46, and wait for BOOTP to detect the request from the Q46 for an IP address.

The upper “Discovery History Window” will show new IP requests coming in on the Ethernet port, and when the specific MAC ID in our relation shows up, the IP will be automatically assigned per our relation entry and sent to the Q46. Note that you may see requests from other devices as they come in, but only the specific MAC ID from the assignment will be acknowledged.



**Figure 7 – Successful Detection of MAC ID and IP Address Assignment in BOOTP Server**

Once the assignment has been made and the IP has been sent to the Q46, disconnect power to the Q46 and that IP will be stored in the instrument. The Q46 stores the very last successful IP address assignment. Then close out all BOOTP server windows.

- 6) Now, to check that the IP address has been properly saved, apply power to Q46 again and make sure it is connected to PC Ethernet port. Do not launch BOOTP server this time, as you don't need it.

Wait 1 minute, as Q46 will search for a BOOTP server for about 30 seconds on power up and won't find the service because you are not using it here. It will then revert to the stored default – the last successful BOOTP assignment. You can check the IP connection to the Q46 at that address by entering a ping command at the Windows OS command prompt, for example “>ping 192.168.0.30.” You should see a response as shown below. In addition, you can try and “>arp -a” command to show all current connections and associated MAC addresses. You should see the new IP address of 192.168.0.30 showing up.

```

Microsoft Windows [Version 10.0.17134.285]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\Jon>ping 192.168.0.30

Pinging 192.168.0.30 with 32 bytes of data:
Reply from 192.168.0.30: bytes=32 Time=1ms TTL=64
Reply from 192.168.0.30: bytes=32 Time=1ms TTL=64
Reply from 192.168.0.30: bytes=32 Time=1ms TTL=64
Reply from 192.168.0.30: bytes=32 Time=1ms TTL=64

Ping statistics for 192.168.0.30:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milliseconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\Jon>arp -a

Interface: 192.168.0.10 --- 0xd
Internet Address      Physical Address      Type
192.168.0.30          00-80-a3-0b-be-d6    dynamic
192.168.0.255         ff-ff-ff-ff-ff-ff    static
224.0.0.2             01-00-5e-00-00-02    static
224.0.0.22           01-00-5e-00-00-16    static
224.0.0.251          01-00-5e-00-00-fb    static
224.0.0.252          01-00-5e-00-00-fc    static
239.255.255.250      01-00-5e-7f-ff-fa    static
255.255.255.255      ff-ff-ff-ff-ff-ff    static

Interface: 192.168.1.149 --- 0x13
Internet Address      Physical Address      Type
192.168.1.1           c0-56-27-c7-c2-6e    dynamic
192.168.1.115         0c-47-e9-2d-a8-23    dynamic
192.168.1.170         50-dc-e7-0c-9d-0a    dynamic
192.168.1.197         74-c2-46-8d-18-80    dynamic
192.168.1.255         ff-ff-ff-ff-ff-ff    static
224.0.0.2             01-00-5e-00-00-02    static
224.0.0.22           01-00-5e-00-00-16    static
224.0.0.251          01-00-5e-00-00-fb    static
224.0.0.252          01-00-5e-00-00-fc    static
239.255.255.250      01-00-5e-7f-ff-fa    static
255.255.255.255      ff-ff-ff-ff-ff-ff    static
    
```

**Figure 8 – PING and ARP Command Tests for IP Address Setting.**

Note that the “arp -a” listing still shows this IP as a “dynamic” assignment,

as this is the fall-back IP that has been stored in the Q46. On power up, the Q46 will still try and find a BOOTP server for 30 seconds, and then default to this stored value as the fallback. If you do not see your new connection, two troubleshooting notes –

1-You must always be careful to place the new IP address on the proper subnet level so the PC can still reach it with the settings made in step 1. If the PC is on 192.168.0.X, then any assigned IP must be on the X level – and don't place the Q46 on the same IP as the PC. During BOOTP server assignment, if you place the Q46 on a vastly different IP like 10.20.120.100, you must repeat step 1 before step 6 above to place the PC at something like 10.20.120.10. This can get tricky, as you can make assignments anywhere, but then the PC must be re-established on that new net to find the new assignment.

2-Remember to wait a minute before the ping test if you verify a connection. The Q46 runs BOOTP by default on power-up, so it will be searching for that server for about 30 seconds on power up, and then will default to the stored IP.

**1.9 Ethernet/IP Data Files**

The data organization shown in section 1.6 corresponds to the same mapping as all the other communication interfaces on the Q46. All Q46 instruments provide 20 bytes of input data to the master, and the meaning of the bytes changes slightly depending on which Q46 instrument is used.

Byte	Data Type	Sensor	Description	Data Format
1 to 4	long(32)	Main	Measured Main	See Figure 11
5 to 8	long(32)	Main	Measured Temperature	25.00° C = 2500
9 to 12	long(32)	Aux1	Measured Aux1	See Figure 11
13 to 16	long(32)	Aux2	Measured Aux2	See Figure 11
17	Char(8)	NA	System Status 1	(binary) 00000000
18	Char(8)	NA	System Status 2	(binary) 00000000
19	Char(8)	NA	Alarm Status	(binary) 00000000
20	Char(8)	NA	Instrument ID	See Figure 11

**Figure 9 - Q46 Ethernet/IP Register Data Format**

Byte	Bitfield	Description
17	0 (lsb)	Raw Hi <sup>1</sup>
17	1	Raw Lo <sup>1</sup>
17	2	Main Hi
17	3	Main Lo
17	4	Temp Hi
17	5	Temp Lo
17	6	Aux1 Hi <sup>2</sup>
17	7	Aux1 Lo
18	0	NU
18	1	NU
18	2	LCD Controller Fail
18	3	Cal Main Fail
18	4	PID Controller Fail
18	5	Cal TC Fail
18	6	TC Error
18	7	Acknowledge Fail (global)
19	0	Alarm 1, Relay A
19	1	Alarm 2, Relay B
19	2	Alarm 3, Relay C
19	3	Alarm 4, Relay D (optional)
19	4	Alarm 5, Relay E (optional)
19	5	Alarm 6, Relay F (optional)
19	6	NU
19	7	NU

**Figure 10 – Base Status Register Bitfield Flags**

Instrument	Main	Aux1	Aux2	Main Data Format	Aux1 Data Format	Aux2 Data Format
Q46H/62/63 /79PR ID=41	Chlorine	pH	PID	14920= 1.4920 ppm	700= 7.00pH	475= 47.5%
Q46S/66 ID=81	Sulfite	None	PID	14920= 1.4920 ppm	None	475= 47.5%
Q46S/81 ID=81	Sulfide	None	PID	14920= 1.4920 ppm	None	475= 47.5%
Q46H/64 ID=41	Ozone	pH	PID	14920= 1.4920 ppm	700= 7.00pH	475= 47.5%
Q46H/65 ID=41	Chlor Diox	pH	PID	14920= 1.4920 ppm	700= 7.00pH	475= 47.5%
Q46D ID=49	D.O.	Sat	PID	840= 8.40 ppm	980= 98.0% sat	475= 47.5%
Q46P ID=53	pH	None	PID	700= 7.00 pH	None	475= 47.5%
Q46R ID=57	ORP	None	PID	-137= -137 mV	None	475= 47.5%
Q46N ID=45	Total Amm	Mono Chloramine	Free Amm	100= 1.00 ppm	51= 0.51 ppm	321= 3.21 ppm
Q46C2 ID=69	Conductivity	<sup>3</sup> Concentration	<sup>3</sup> TDS	100123= 100.123 uS	13= 1.3%	2235= 223.5 mg/L
Q46C4 ID=65	Conductivity	<sup>3</sup> Concentration	<sup>3</sup> TDS	2238= 2.238 mS	13= 1.3%	2235= 223.5 mg/L
Q46CT ID=61	Conductivity	<sup>3</sup> Concentration	<sup>3</sup> TDS	2238= 2.238 mS	13= 1.3%	2235= 223.5 mg/L
Q46F ID=73	Fluoride	None	PID	1000= 1.000 ppm	None	475= 47.5%
Q46T ID=85	Turbidity	None	PID	16= 0.16 NTU	None	475= 47.5%

**Figure 11 – Parameter Specific Data Formats**

<sup>1</sup> Raw Hi/Lo is an internal sensor flag signal that indicates the raw signal is measuring too high or low, and can indicate sensor service is required or it may simply mean the sensor is presently out of the process liquid. This signal does not apply to the Q46T/C2/C4/CT.

<sup>2</sup> This bit flag is the glass break diagnostic for pH.

<sup>3</sup> For Conductivity units, concentration data shows for concentration instruments, and TDS shows for standard conductivity units (not both.)



## **PRODUCT WARRANTY**

Analytical Technology, Inc. (Manufacturer) warrants to the Customer that if any part(s) of the Manufacturer's equipment proves to be defective in materials or workmanship within the earlier of 18 months of the date of shipment or 12 months of the date of start-up, such defective parts will be repaired or replaced free of charge. Inspection and repairs to products thought to be defective within the warranty period will be completed at the Manufacturer's facilities in Collegeville, PA. Products on which warranty repairs are required shall be shipped freight prepaid to the Manufacturer. The product(s) will be returned freight prepaid and allowed if it is determined by the manufacturer that the part(s) failed due to defective materials or workmanship.

This warranty does not cover consumable items, batteries, or wear items subject to periodic replacement including lamps and fuses.

Gas sensors carry a 12 months from date of shipment warranty and are subject to inspection for evidence of misuse, abuse, alteration, improper storage, or extended exposure to excessive gas concentrations. Should inspection indicate that sensors have failed due to any of the above, the warranty shall not apply.

The Manufacturer assumes no liability for consequential damages of any kind, and the buyer by acceptance of this equipment will assume all liability for the consequences of its use or misuse by the Customer, his employees, or others. A defect within the meaning of this warranty is any part of any piece of a Manufacturer's product which shall, when such part is capable of being renewed, repaired, or replaced, operate to condemn such piece of equipment.

This warranty is in lieu of all other warranties (including without limiting the generality of the foregoing warranties of merchantability and fitness for a particular purpose), guarantees, obligations or liabilities expressed or implied by the Manufacturer or its representatives and by statute or rule of law.

This warranty is void if the Manufacturer's product(s) has been subject to misuse or abuse, or has not been operated or stored in accordance with instructions, or if the serial number has been removed.

Analytical Technology, Inc. makes no other warranty expressed or implied except as stated above.

## WATER QUALITY MONITORS

Dissolved Oxygen  
Free Chlorine  
Combined Chlorine  
Total Chlorine  
Residual Chlorine Dioxide  
Potassium Permanganate  
Dissolved Ozone  
pH/ORP  
Conductivity  
Hydrogen Peroxide  
Peracetic Acid  
Dissolved Sulfide  
Residual Sulfite  
Fluoride  
Dissolved Ammonia  
Turbidity  
Suspended Solids  
Sludge Blanket Level  
**MetriNet** Distribution Monitor

## GAS DETECTION PRODUCTS

NH<sub>3</sub> Ammonia  
CO Carbon Monoxide  
H<sub>2</sub> Hydrogen  
NO Nitric Oxide  
O<sub>2</sub> Oxygen  
CO Cl<sub>2</sub> Phosgene  
Br<sub>2</sub> Bromine  
Cl<sub>2</sub> Chlorine  
ClO<sub>2</sub> Chlorine Dioxide  
F<sub>2</sub> Fluorine  
I<sub>2</sub> Iodine  
H<sub>x</sub> Acid Gases  
C<sub>2</sub>H<sub>4</sub>O Ethylene Oxide  
C<sub>2</sub>H<sub>6</sub>O Alcohol  
O<sub>3</sub> Ozone  
CH<sub>4</sub> Methane  
(Combustible Gas)  
H<sub>2</sub>O<sub>2</sub> Hydrogen Peroxide  
HCl Hydrogen Chloride  
HCN Hydrogen Cyanide  
HF Hydrogen Fluoride  
H<sub>2</sub>S Hydrogen Sulfide  
NO<sub>2</sub> Nitrogen Dioxide  
NO<sub>x</sub> Oxides of Nitrogen  
SO<sub>2</sub> Sulfur Dioxide  
H<sub>2</sub>Se Hydrogen Selenide  
B<sub>2</sub>H<sub>6</sub> Diborane  
GeH<sub>4</sub> Germane  
AsH<sub>3</sub> Arsine  
PH<sub>3</sub> Phosphine  
SiH<sub>4</sub> Silane  
HCHO Formaldehyde  
C<sub>2</sub>H<sub>4</sub>O<sub>3</sub> Peracetic Acid  
DMA Dimethylamine