OPERATION MANUAL

For GasFinder analyzers

MODBUS TCP/IP MODULE

For Partnumbers:
BOR01725, Modbus TCP/IP Module with 1 Com Port
BOR01730, Modbus TCP/IP Module with 2 Com Ports

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CONTENTS

1. SYSTEM DESCRIPTION

The **Modbus TCP/IP Module** is a small rackmount device allows the user to request the analyzer data from this device with the use of the Modbus TCP protocol. The user's Master Modbus device can request all available data from the internal registers on a regular base depending on the situation. The Module converts the standard serial data strings from a GasFinder into Modbus registers. The Module analyses the strings sent by the GasFinder and stores the individual data in separate registers.

The **Modbus TCP/IP Module** has standard 2 COM ports each for a GasFinder analyzer or other accepted instruments. Both comports are using the RS232 interface, enabling the Module to use a cable length of maximum 10 meter. The ports are capable of storing the sent values of two GasFinders simultaneously.

The **Module** is using the RJ45 UTP interface, enabling the Module to use the Modbus protocol over an standard UTP network.

2. IMPLEMENTING THE "POLLED" DATA IN THE DCS / SCADA

The data obtained by the ModBus Master, the users OPC server or DCS system has to be handled correctly. Most applications have their own needs and the implementation needs dedicated engineering. However, we hereunder give a guide how to implement the data within the DCS to obtain the maximum up time, minimize service and have the proper warnings and alarms. Note: For each connected channel the data is update in the registers when the GasFinder sends new data. Depending on the setting this can vary. Each channel is, with factory settings, in sequence updated in every 1.2 second.

2.1. MODBUS REGISTERS

The data from the connected GasFinder(s) is stored in the holding registers. These registers have an address range of 40001 to 50000. Depending on which Modbus master software is used to read the holding registers of the **Modbus controller** the registers addresses have to be written differently (consult the user manual of the Modbus master software for the correct notation of the Modbus addresses).
The values of the GFDTA, GFDBG and GFDAC strings are stored in the Modbus registers. The controller supports the input of the GasFinder MC, FC, OP and AB. Each time the **Modbus controller** receives a new string from the connected GasFinder the Modbus registers are updated.
The Tables containing the Modbus register location can be found in Appendix A.

2.2. CONCENTRATION DATA (IN PPMM)

The concentration data is divided over two registers. The "ppmm" gives the concentration without decimals. This is sufficient for most applications.

Example: Open path detection with a 100m pathlength will give an average path concentration divided by 100 to get a path average ppm level. A 1ppmm reading gives a path average of 1/100=0.01ppm. If alarm levels are 2ppm the accuracy is more than sufficient. No need to poll the decimal register.

Example: A stack Ductprobe detection with a 2m pathlenght will give an average path concentration divided by 1 to get a path average ppm level. A 1ppmm reading gives a path average of 1/2=0.5ppm accuracy and minimum detection limit. In this case the decimal is needed to increase the accuracy with 1 decimal to 0.05ppm. If needed the decimal value can only be obtained if the concentration is below 100 or 10ppmm. This depending on the accuracy needed at high levels. The Modbus Master can make the decision.

2.3.   CONCENTRATION QUALITY (IN R2)

The concentration of the gas obtained by the analyser has a quality factor called R2. The R2 can be used to filter out low quality readings.

Example: In a safety application the goal is to have an alarm when the concentration gets to a level that requires a warning or alarm to be set. Lower concentrations can be filtered out by simply setting a R2 filter on 50-80 (on the range to 0-100)

Example: In an emission detection system even the lowest concentration and low quality readings are important. The R2 filter is not used.

2.4.   LIGHT VALUE

The functioning of a connected transmitter head or probe depends on the loop of energy. The loop starts with optical laser energy transported through a fiber to the probe. The probe aims the optical energy on the retro-reflector (mirror). The energy mirrored is reflected back into the probe and is focused on a photodiode. This diode transforms the optical energy into electrical energy. This energy is transported back through the coaxial return cable to the analyser. The level of energy returned is specified as "light level". This light level should always be between a value of 2000-12000.

Example if automatic Light Control is enabled: The lightvalue is always adjusted thus gives no real information. The DAC value should be used.

Example if automatic Light Control is disabled: The value should be used as an indication for pollution of the optic system and is an indication for service. the value drops more than 30%, for longer than 30 minutes, for a particular channel (probe) preventive maintenance must be initiated. It can be planned in advance. Normally within 1-2 weeks is sufficient.

2.5.   DAC VALUE (ONLY IF ALC IS ENABLED, SEE ALSO 2.4)

The lightlevel can be automatically controlled (read; amplified and attenuated) by the analyser. However, when this is automated, by enabling the automatic light level option, the level stays corrected to the set level by the system. The correction is given by the DAC value. If the DAC value increases the probe needs more energy. This can be caused by higher humidity, steam, smoke or other influences in the "optical measurement path". However it is also a good indication of pollution of the optics (The loop of energy!). When the DAC reaches the limit of 4095 the lightlevel will drop and cause low light errors.

Example: When the DAC reaches 3000, for longer than 30 minutes, for a particular channel (probe) preventive maintenance must be initiated. It can be planned in advance. Normally within 1-2 weeks is sufficient.

2.6.   SECONDS (WATCHDOG!)

The second's registers do function as a watchdog. In the case that something in the loop is "frozen" or stuck the seconds will not change. If the value of the seconds doesn't change at every request of the Modbus Master a warning should be generated and the analyser must be inspected immediately. Data in the registers are not longer updated and are no longer actual!

2.7.   STATUS CODE

The Status Code gives all the accumulated errors within the analyser. The system has also a code when it is functioning properly. The code is either 1* or 9*. When the code is different than these all concentration data must be ignored for use as an alarm, warning or registration of the emission.
Status code changes when servicing the analyser. However, when it changes during operation for A LONGER PERIOD THEN 5 MINUTES (and the system doesn't give a normal status code after a stop/start) a Boreal Laser representative should be contacted!

Example: The concentration is 546ppmm and this would generate an alarm. But the status code is 2048. Thus the reading must be ignored. Only the combination with a status code of 1* or 9* is a valid combination.

2.8.   DIAGNOSTIC DATA

Diagnostic data is available for each analyser. Requesting this data on a hourly base enhances the reliability of the system and minimizes the downtime. Values outside the accepted ranges require a service call by the nearest Boreal Laser Specialist. Historic data of these values can be send by email to help diagnose of the failure go faster.

1. Internal temperature Range 10-50 is accepted.
2. Duty Cycle Range between 100 – 200 is accepted.
3. Calibration Ratio Range of 4000 – 150000 is accepted.
4. Reference Cell Quality Range of 40-100 is accepted.

3. DIMENSIONS AND PHYSICAL SPECIFICATIONS

Weight (Grams)   7.4 K g
Dimensions (L x W x H)   38 x 48.5 x 10 cm
Humidity   5–95%, non-condensing
Power requirements   100-240 VAC, 50Hz.
Operation temperature range   –40°C to +70°C
Store rate (maximal)   2 samples / sec / each port
Data output   RJ45, Modbus RTU over TCP

3.1. CE COMPLIANCE

Equipment is usually divided into two classes.

Class A	Class B
Digital equipment meant for light industrial use	Digital equipment meant for home use
Less restrictive emission requirement: less than 40dB µV/m at 10m (40dB relative to 1 µV/m) or 300 µV/m	More restrictive emission requirements: 30dB µV/m at 10m or 100 µV/m

These limits apply over the range of 30–230 MHz. The limits are 7 dB higher for frequencies above 230 MHz. Although the test range goes to 1 GHz, the emissions from the **Modbus TCP/IP Module** systems at frequencies above 300 MHz are generally well below background noise levels.

The **Modbus TCP/IP Module** is CE compliant and therefore has the CE Mark.

FIGUUR 1

3.2. IMMUNITY

The **Modbus TCP/IP Module** meets the following EN55024/1998 immunity standards.

- EN61000-4-3 (Radiated Immunity)
- EN61000-4-4 (EFT)

EN61000-4-6 (Conducted immunity)

3.3. EMISSION

The **Modbus TCP/IP Module** meets the following emission standards.

- EN55022:1998 Class B
- FCC Part 15 Class B

3.4. LABELS

FIGURE 2
Identification Sticker (Do not remove!!)
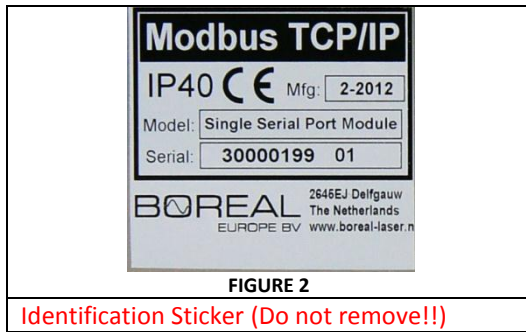
3.5. SAFETY CONCERNS IN ATEX AREA'S

The **Modbus TCP/IP Module** is not intrinsically safe and therefore is normally installed in a "safe area" cabinet near the GasFinder analyzer. All outputs are not intrinsically safe and need additional safety devices according to the applicable ATEX standards.

4. PRE-INSTALLATION CHECKS

Check the following points:

- **Temperature limits**; the **Modbus TCP/IP Module** should be located in an area where the temperature does not go below –40°C or above +70°C.
- **Power supply**; the **Modbus TCP/IP Module** needs power, Voltage: 100 V to 240 VAC, 50Hz, 0.375 A max.
- **Accessibility**; Acvces to the rear of the **Modbus TCP/IP Module** should be possible.
- **Ventilation;** Although the Module is highly efficient and generates minimum heat it needs some ventilation to cool down the inner parts. Therefore a space around the unit of 50mm at the front, back and sides are obliged. It can be horizontally stacked without space between other Boreal GasFinderMC modules.

4.1. TOOLS AND EQUIPMENT

- Site specific personal protective equipment according to the local requirements.
- Set of assorted cable ties if cabling fixing is required.
- Set of screwdrivers.

4.2. EQUIPMENT CHECK

Verify that all the equipment on the order sheet has arrived complete and is in good condition. Any damage due to shipping should be reported immediately and steps taken to obtain replacement parts. Damaged Modules should be replaced immediately and are not allowed to be installed.

5. INSTALLATION

Note: Make sure that during the entire installation process that the TCP/IP Modbus Module is not connected to any kind of power supply.

5.1. CONNECTING THE GASFINDER RS232 OUTPUT

Note: make sure the Serial communication cable is not connected to the GasFinder before connecting it to the Module

There are one or two serial COM ports located on the module depending on the version. COM 1 and an additional COM 2 can be found on the backpanel on the right hand side. A straight Dsub15 Cable is needed to connect the GasFinder analyser to the Modbus TCP/IP module.

PIN Table

Serial COM port pin name	COM Port pin number
TX COM 1	3
RX COM 1	2
Ground COM 1	5
TX COM 2	3
RX COM 2	2
Ground COM 2	5

Figure 6 illustrates the correct way to connect the **Modbus TCP/IP Module** to one or two GasFinders. Depending on your model it has either 1 COM port or 2 COM ports.

FIGUUR 6

5.2. CONNECTING THE MODBUS MASTER TO THE TCP/IP NETWORK

There is one RJ45 port using the Modbus TCP interface, which is needed for the TCP/IP network communication to the Modbus Master / DCS. This port is located in the middle at the back of the module. (Figure 6) To connect the Modbus Master to the **Modbus TCP/IP Module,** the Module must be connected to the same TCP/IP network (subnet) as the Modbus master.

5.3. CONNECTING THE POWER SUPPLY

Note: make sure that the power supply cable is not connected to any power source.

The **Module** can be connected to a power source through a Standard Power Cord (shown on figure 6). The power supply must provide 100 V to 240 V AC. Voltages outside that range could damage the Module.

6. SETTING UP COMMUNICATION PARAMETERS

6.1. INPUT; BETWEEN GASFINDER AND MODULE

The communication between the GasFinder and the **Modbus TCP/IP Module** is done through the RS323 interface. In the following table the communication settings are described. These are standard settings in a GasFinder analyser.

Baud Rate	9600 bps
Parity	None
Bits	8
Stop Bits	1
Handshaking	None

It is important that the GasFinder is setup with these specifications, if it is not the communication will fail and no data will be stored in the Modbus registers.

6.2. OUTPUT; BETWEEN MODBUS TCP/IP MODULE AND THE MODBUS MASTER

Communication is only possible with a Modbus master if the IP address, gateway and network mask are correct. However, normally the settings have to be changed to adapt to a existing network. If the Modbus master is on a different subnet also a gateway must be set correctly to route the data to the other subnet. Most of the times this is the IP-address of the interconnecting switch or router.

The **Modbus TCP/IP Module** is factory programmed with the following network settings:

IP address: 192.168.66.201
Network Mask: 255.255.255.0
Gateway: 192.168.66.19
Modbus Port   502

6.2.1. CONFIGURE THE TCP/IP SETTINGS IN THE CONTROLLER

You can program the correct network settings yourself using dedicated software called "IPchanger" that can be downloaded from www.boreal-laser.nl/downloads/. For this you need the standard 9-15p GasFinder data cable with the RX/TX connected. (Part# BOR06100, production# 3120000 and higher) to connect to a PC with windows and a standard (9p) comport. (Older cables do only receive and have no possibility to send thus can't be used as a programming cable.)

If the network is build from different subnets the routers or switches must accept the Modbus protocol that is standard over port 502. Do request information at your IT department about the possibilities and possible change of settings of the local hardware. Normally these ports have to be opened since not used ports are normally closed.

6.2.2. USING THE IP CHANGER SOFTWARE

This software can only be used on a windows PC. Minimum requirement is windows XP and an available comport. If the PC/laptop has no com port you have to obtain a USB to serial converter.

Doubleclick the icon and the next window will appear:
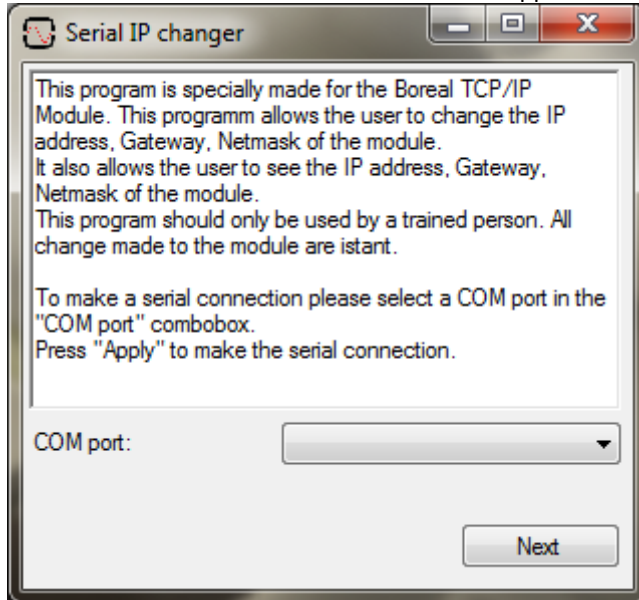
Then chose an available comport. In this case we choose COM9
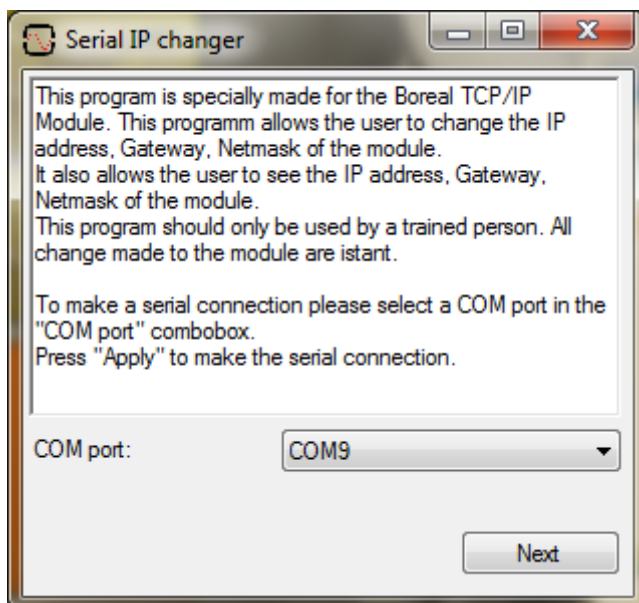
Check the current IP settings by clicking on "fetch". Write them down to be able to re-store the "old" settings. Then the next screen will appear. Fil in the desired network data in the fields and click on change. Be aware that you don't use any 'spaces' while inserting the information.

6.2.3. MODBUS REGISTERS

The data from the connected GasFinder(s) is stored in the holding registers. These registers have an address range of 40001 to 50000. Depending on which Modbus master software is used to read the holding registers of the **Modbus TCP/IP Module** the registers addresses have to be written differently (consult the user manual of the Modbus master software for the correct notation of the Modbus addresses). This is mainly due to the fact that some program start coun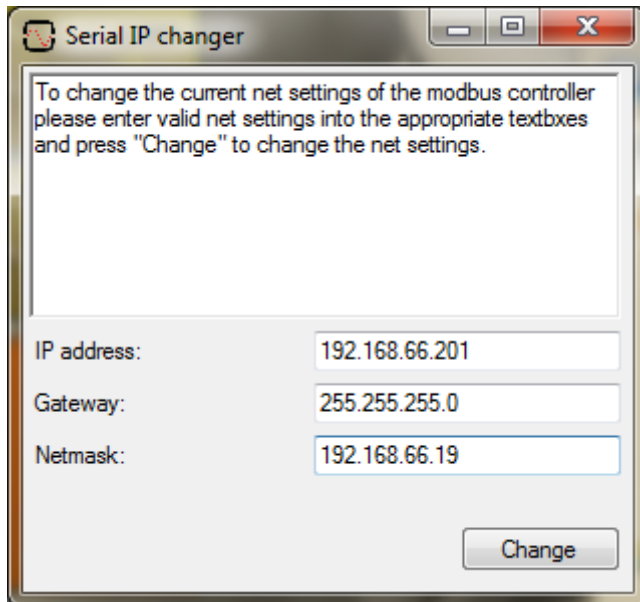ting at '0' and others start counting at '1'. Or some programs want the user to specify which type of register needs to be polled in the register number (4 is holding register and 3 is input register). This may give some problems trying to configure the Modbus master because the polled values will shift by one position.

Here are some notations which in different programs give the same register, for this example register 1234 from the holding registers will be used:

Register[1234]	Modbus master A polling address(**4**1234)
Register[1234]	Modbus master B polling address(**40**1234)
Register[1234]	Modbus master A polling address(**4**123**5**)
Register[1234]	Modbus master A polling address(123**5**)

Because many programs use a different notation it is advised to check if the register values are correct before programming them into the Modbus Master.

The values of the GFDTA, GFDBG and GFDAC strings are stored in the Modbus registers. The Module supports the input of the GasFinder MC, FC, OP and AB. Each time the **Modbus TCP/IP Module** receives a new string from the connected GasFinder the Modbus registers are updated.

The Tables containing the Modbus register locations can be found in Appendix A.

11

7. LED INDICATION

There are two LED bars located on the front panel of the **Modbus TCP/IP Module**. The LEDs are used to indicate the general system status and the strings received from the connected GasFinder(s) and Modbus Master.

The first array gives information about the string received on COM 1 and the second about the strings received on COM 2. Both arrays give information about the general status, strings received and commands received.

The next tables provide the information about the LEDs.

First LED Bar (COM 1)

LED#, counting from left to right	1	2	3	4
Red LED (top)	Wrong checksum	Status code differs from *1 and *9	Buffer overflow (to many wrong NMEA strings are sent)	Modbus timeout (Master has not polled for 2 minutes)
Green LED	Heart beat (blinks when a # of cycles has been completed)	Modbus poll is being processed	DTA string has been received on COM 1	DBG/DAC string has been received on COM 1

Second LED Bar (COM 2)

LED#, counting from left to right	1	2	3	4
Red LED (top)	Wrong checksum	Status code differs from *1 and *9	Buffer overflow (to many wrong NMEA strings are sent)	Modbus timeout (Master has not polled for 2 minutes)
Green LED	Heart beat (blinks when a # of cycles has been completed)	Modbus poll is being processed	DTA string has been received on COM 2	DBG/DAC string has been received on COM 2

7.1. LED INFORMATION EXPLAINED

If the led 1 of the "wrong checksum" is blinking data is damaged. Slow down the measuring interval to see if this is the solution. If the error persists contact you "Boreal representative".

If the status code led blinks service is needed. In principle the Status code is not 1* or 9*

If the Modbus Master doesn't request data #4 will turn red. The connection is lost and the reason should be investigated.

A. APPENDIX

Standard Modbus Output Registers for GasFinder Analysers (BL2030)

Mode: Slave,Binairy/RTU, Decimal Integers.
Comport Out: RS485 1/9600/8/N/1
Channel 0 registers are used for GasFinder OP, FC and FCR
Channel 1-8 registers are used for GasFinder MC systems that have 2 4 or 8 Channels

Register assignments Input COM A (RS232):

Channel	ppmm	R2	Status	Light	Seconds	DAC	Decimal	Distance
0	41000	41010	41020	41030	41040	41050	41060	41070
1	41001	41011	41021	41031	41041	41051	41061	41071
2	41002	41012	41022	41032	41042	41052	41062	41072
3	41003	41013	41023	41033	41043	41053	41063	41073
4	41004	41014	41024	41034	41044	41054	41064	41074
5	41005	41015	41025	41035	41045	41055	41065	41075
6	41006	41016	41026	41036	41046	41056	41066	41076
7	41007	41017	41027	41037	41047	41057	41067	41077
8	41008	41018	41028	41038	41048	41058	41068	41078

$GFDBG	Int. Temp	Duty Cycle	Cal. Ratio	Ref R2	Ref Stat
	41009	41019	41029	41039	41049

Register assignments Input COM B, (RS232):

Channel	ppmm	R2	Status	Light	Seconds	DAC	Decimal	Distance
0	42000	42010	42020	42030	42040	42050	42060	42070
1	42001	42011	42021	42031	42041	42051	42061	42071
2	42002	42012	42022	42032	42042	42052	42062	42072
3	42003	42013	42023	42033	42043	42053	42063	42073
4	42004	42014	42024	42034	42044	42054	42064	42074
5	42005	42015	42025	42035	42045	42055	42065	42075
6	42006	42016	42026	42036	42046	42056	42066	42076
7	42007	42017	42027	42037	42047	42057	42067	42077
8	42008	42018	42028	42038	42048	42058	42068	42078

$GFDBG	Int. Temp	Duty Cycle	Cal. Ratio	Ref R2	Ref Stat
	42009	42019	42029	42039	42049

Example readings:

Channel	ppmm	R2	Status	Light	Seconds	DAC	Decimal	Distance
1	0	0	1	4029	15	2048	5	14
2	15	99	2008	3050	12	3258	2	14
3	35	99	2001	6500	56	4065	0	14
t/m Ch 8	45	100	9	5200	15	1556	4	14

$GFDBG	Int. Temp	Duty Cycle	Cal. Ratio	Ref R2	Ref Stat
	32	120	10520	99	0

Ranges:

	Minimal	Maximal	Info
ppmm	0	32000	Concentration of gas in ppmm
R2	0	100	Quality of detection
Status	0	32000	1 is normal status. Status code (hexadecimal) limited conversion.
Light	0	32000	Between 2000 and 12000
Seconds	0	60	Check for " Alive data"
DAC	0	32000	Light Amplification (Standard=2048)
Decimal	0	99	Decimal value of ppmm, if no value is present then value is 0
Distance	0	32000	Distance that the Gasfinder is set to
Int Temp	0	100	Internal temperature in Celsius
Duty Cycle	0	32000	Duty Cycle
Cal Ratio	0	32000	Calibration ratio
Ref R2	0	99	R2 from the Reference Cell (Quality)
Ref Stat	0	32000	Reference Status

Remark:

These registers are the standard registers since February 7, 2012 for all Modbus controllers available. Older types might have different registers if you have a GasFinderOP or FC/FCR. Check your documents that were shipped with your controller at that time.