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MC-6410 Multi-Gas Monitor

Operator Manual

P/N: 180-0674 g

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Applies to versions 4.4 to 5.1

Contents

Description.....	4
Overview:.....	4
Highlights:	4
Supported Communication Interfaces:	4
List of Gasses Currently Supported:	5
User Interface	6
Internal Settings:.....	6
Front Panel Controls:	7
Keypad Layout	7
Keypad Shortcuts.....	7
Operating Modes:.....	8
Menu System:.....	10
Installation	11
Wi-Fi (Wireless) System Interface:	11
AMR Wireless Multi-Gas Dip Switch Settings:.....	14
RS-485 (Wired) System Interface:	15
Starting with version 5.0:.....	15
Starting with version 4.4:.....	15
Prior to version 4.4:	15
AMR Wired (serial communications) Multi-Gas Dip Switch Settings:.....	15
4-20mA Current Loop Interface:.....	16
AMR Wired (current loop) Multi-Gas Dip Switch Settings:	16
Bridge (Wireless/Wired) System Interface:.....	17
AMR Wireless to Wired Bridge Dip Switch Settings:	18
Calibration	19
Procedure:	19
Errors:	19
Maintenance.....	20
Batteries:	20
Gas Cells:.....	20
Specifications.....	21
Sensors:.....	21
Approved Batteries:.....	21

Wireless Interfaces:	21
Wired Interfaces:	21
Factory Default Configuration Settings:	22
Factory Default Configuration Settings (cont.).....	23
ADVANCED WI-FI CONFIGURATIONS.....	24
WARRANTY	25

Description

Overview:

The AMR Multi-Gas Monitor is an extremely versatile, self-contained, solid state gas monitoring instrument. It is capable of monitoring up to four gas sensors (up to six gas values) simultaneously, while independently keeping track of the alarm states of each and reporting all of the data to a central monitoring station. The design currently supports several different gas monitoring options, which can be mixed and matched as needed. The instruments can be reconfigured with different sensor modules without changing firmware or hardware beyond the modules themselves (power must be cycled).

The instrument is housed in a dust tight enclosure which uses a front panel “keypad” and display for access to most features and functions. There are no mechanical switches on the outside of the enclosure, but the label indicates the active areas on the panel where a magnet will close a switch on the inside of the unit. There is a large, four digit display that identifies which gas value will be displayed, followed by the value itself. There are three rotary switches inside of the unit for setting the address, as well as some dip switches for additional settings. There is a swappable memory module inside the unit that holds the configuration settings for that instrument.

Highlights:

- The Wireless version operates on four D cell alkaline batteries and is approved by MSHA (# 18-A130001-0) for use in permissible areas. When using all electro-chemical gas sensors (most of them are of this type), the batteries will last months.
- The Wired version has a low power budget, in most cases, drawing the same or less power than a single cell gas sensor and is approved by MSHA (#18-ISA150005-0) for use in permissible areas with approved barriers of type G, H, and J.
- No tools are required to replace the gas sensor modules, simply unplug the connector and (by hand) unscrew the nut from the bottom of the gas sensor module.
- In most cases, the communication protocol is the limiting factor in the number of discrete addresses available.
- The calibration procedure is similar yet easier than our legacy products.
- The Wireless version (when a time server is accessible) will have the current time and date maintained automatically.

Supported Communication Interfaces:

Wi-Fi:

Standard 802.11b/g 2.4 GHz Wi-Fi radio connects into network via 2.4 GHz b/g access point or router

RS-485:

AMR Protocol (uses Winmac top end software)

Modbus Protocol (typical interface for most Pillar top ends)

AMR Modbus (generally uses AMR gateways)

Warrior Mines (4 wire RS-485 interface using proprietary top end software MCP)

Many Hybrid and Custom Protocols are also available

4-20mA Current Loop Interface:

Four independent sourcing 4-20mA current loop outputs are available.

Bridge Interface:

A separate AMR Bridge Unit creates a connection between a Wireless Multi-Gas Monitor and a wired RS-485 connection. This is very useful when the application requires monitoring in permissible areas, especially where cables may be inconvenient or impractical.

List of Gasses Currently Supported:

Carbon Monoxide (CO) (can be corrected for diesel fumes and Hydrogen levels)
Carbon Dioxide (CO₂) (Infrared Sensor)
Hydrogen (H₂)
Hydrogen Sulfide (H₂S)
Methane (CH₄) (Infrared Sensor)
Nitric Oxide (NO)
Nitrogen Dioxide (NO₂)
Oxygen (O₂)
Sulfur Dioxide (SO₂)
Ammonia (NH₃)
Methane content in Natural Gas* (Currently only available for the Industrial Gas Sensor)

In addition to these, when populated with CO and NO, both the Carbon Monoxide (CO) reading and the Corrected Carbon Monoxide (CCO) reading are available to be read and reported.

Note: The Carbon Monoxide cell that we use has a Hydrogen element built into it, so it is displayed as “coh” to indicate the extra capability. This is so, regardless of whether the Hydrogen element is used or not.

Other gasses are available upon request.

User Interface

Internal Settings:

On the inside of the enclosure door, is a PCB (printed circuit board) stack. The top board in this stack is the processor board and has three rotary switches and an eight position dip switch. There is also a "Configuration Module" plugged into this board. The rotary switches are for setting the instrument number/address which is used in communications to identify the device. The dip switches are used for some of the special settings (not usually needed). The "Configuration Module" can be seen below in the upper left corner (plugged into a connector), and is used to store the configuration settings that can be changed from the front panel. This module can be used to transfer settings when a quick swap with a replacement is desired.

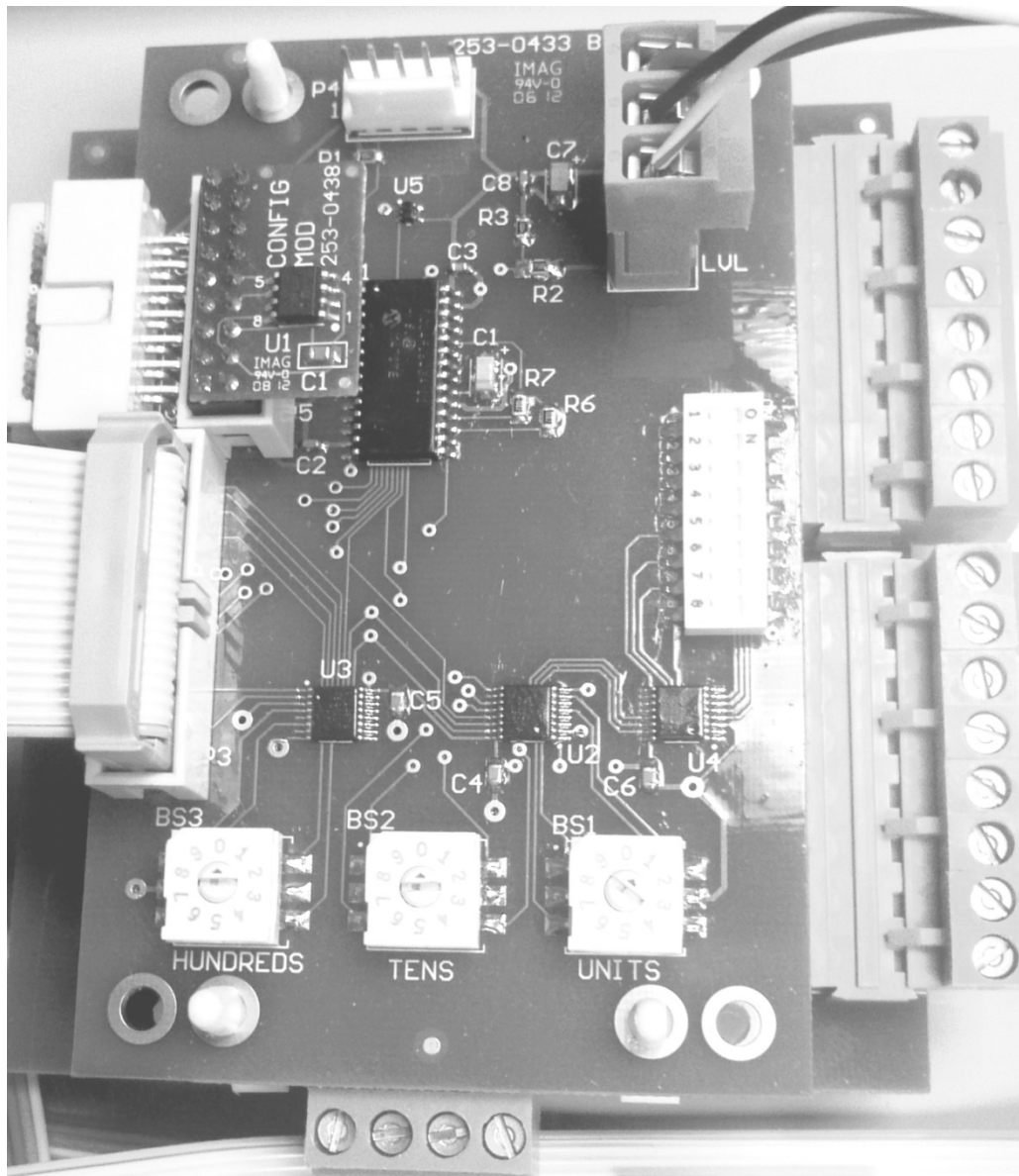


Figure 1

Front Panel Controls:

Although there are no actual buttons on the front panel, this document will refer to them as such for convenience. There are 5 button locations on the front panel, which can be identified as five circles with symbols in them to indicate up, down, left, right, and enter (in the center position). These buttons are actuated using a magnetic screwdriver provided by AMR with each instrument purchased.

Keypad Layout

The five panel buttons are shown in the following image, just below the display. The button in the center of the group is the “Enter” button. The buttons above and below the “Enter” button will be referred to as the “Up” and “Down” buttons. The buttons to the left and right of the “Enter” button will be referred to as the “Left” and “Right” buttons. The Button position and naming was intended to be obvious, and somewhat helpful in navigating through the user interface menu.



Figure 2

Keypad Shortcuts

Hold, Test, Calibrate, Silence Audible Alarm, and Menu (see Operating Modes for details), can be accessed directly from the normal operating mode (Auto).

Hold: Activate either the left or right buttons to enter the Hold mode. Use the same buttons to select the gas to monitor. This will remain active for about 1 minute, after which the normal display cycle will resume.

Test: Activate the enter button (center) momentarily (at least $\frac{1}{4}$ of a second and not more than 3 seconds). Use the left and right buttons to change which gas to run the test sequence on.

Calibrate: Activate the enter button (center) for at least 5 seconds. Use the left and right buttons to change which gas to calibrate. Refer to the Calibration portion of this manual for the complete procedure.

Silence Audible Alarm: Activate the down button while in the normal operating mode (Auto) to silence the audible alarm. **Note:** Does nothing on units lacking the Audio/Visual Alarm (AVA) option.

Menu: Activate the up button to access the Menu. All modes and functions can be accessed from there. See the “Operating Modes” section starting on page 8.

Operating Modes:

- **AUTO RUN (Run):** The auto run mode is the default mode of operation and the instrument will return to this mode when completing or timing out from any of the other modes. In auto mode, the unit cycles through the available gases (determined when first powered on). For each available gas, text identifying the gas is displayed first, followed by the current gas value in either ppm (parts per million – most gasses) or percent (CH₄, CO₂, and O₂).
- **HOLD (hold):** The Hold mode allows the operator to pause the cycling through gasses in order to focus on a single gas. After about a minute with no additional operator actions, this mode will timeout and the unit will return to the auto run mode.
- **TEST (tEst):** The test mode allows the operator quick access to information about an individual gas sensor. The information provided (in order) is: Scale (used for value scaling in wired configurations), Test (tests circuitry, readings should be increasing during this phase), Warning Level (threshold at which warning is indicated for that gas), Alarm Level (threshold at which alarm is indicated for that gas), Status (a coded status value for the sensor), Address (current address setting for the instrument), and the Firmware Version.
- **CALIBRATION (cAL):** The calibration mode allows the operator to calibrate the zero and span values for any of the populated sensors (our CO cell also contains H₂ which requires calibration only if being utilized). The operator input required is limited to selecting the gas, starting the zero calibration process, starting the span calibration process, and confirming or setting the value of the span gas that was used.
- **CONFIGURATION (cNFg):** The configuration mode is where almost all of the settings for the instrument are defined and changed.
 - **SENSORS (SEnS):** This section yields access to settings for each of the gas sensors.
 - SO₂ (So2) – Sulfur Dioxide
 - CO₂ (Co2) – Carbon Dioxide
 - COH (COH) – Carbon Monoxide and Hydrogen (CO & H₂ in the same sensor)
 - H₂ (H2) – Hydrogen (these settings are used even when the Hydrogen is from the COH cell)
 - H₂S (H2S) – Hydrogen Sulfide
 - CH₄ (CH4) – Methane
 - O₂ (O2) – Oxygen
 - NO (NO) – Nitric Oxide
 - NO₂ (NO2) – Nitrogen Dioxide
 - CCO (CCO) – Corrected Carbon Monoxide (CO level minus what diesel fumes added)
 - NH₃ (NH3) – Ammonia
 - Meth (Meth) – Methane (special sensor used exclusively for Methane rich natural gas)
 - The following sub-menu options are available for each of the gasses:
 - SCAL (ScAL) – (Scale) Used to Calculate the Transmission Value
 - WARN (Warn) – The Threshold at which the unit will initiate Warning Actions
 - ALRM (ALRM) – The Threshold at which the unit will initiate Alarm Actions
 - SAVE (SAVE) – Save Changes and return to the Auto Run mode
 - QUIT (Quit) – Abandon Changes and return to the Auto Run mode
 - Special sub-menu options: Hydrogen Nullifying CO Options (under COH):
 - H ON (H ON) – Enable Measurements of the H₂ portion of the CO-H cell
 - HDSP (HDSP) – Enable Display of the H₂ measurements
 - HRPT (HRPT) – Enable Reporting of the H₂ measurements
 - HNUL (HNUL) – Enable CO compensation for the H₂ levels

- CONFIGURATION (CnF9): (continued)
 - SENSORS (SEn5): (continued)
 - Special sub-menu options: Diesel Nullifying CO Options (under NO):
 - DNUL (dnUL) – Create a Corrected CO value used for early fire detection in the presence of diesel fumes
 - *Wi-Fi (WiFi): This section provides control over network settings for wireless communications.
 - IP (iP) – IP Address: The IP address for this individual instrument (not needed on DHCP Networks).
 - MASK (iR5T) – Subnet mask: The Subnet mask identifies the network segment that the device is operating in. This value is required to match the Subnet mask that the server is using.
 - SERV (SERV) – Server IP Address: The IP address of the host computer for reporting sensor readings.
 - GWIP (GWiP) – Gateway IP Address: The IP address for the network gateway (not always needed).
 - IP T (iP T) – IP Addressing Type: Select between static and dynamic IP addressing (DHCP).
 - If using static addressing, the user must enter the IP address and Subnet mask.
 - If using DHCP then the network must support DHCP through a server, router, or some other method that will hand out addresses to clients.
 - WEBP (WEBP) – Launch Webpage: This option will place the Wi-Fi module into a temporary access point mode where the user may connect to it via a laptop or mobile device with an address of <http://config> in a web browser. Once in the web configuration page, the user may change the wireless SSID and if necessary, a WPA passphrase can be entered (or cleared).
 - *WIRED COMMUNICATIONS (CWi): No longer available starting with Bridge and Sensors Ver. 4.4
- Each of the three remaining configuration options at this level require a confirmation step to minimize time consuming mistakes.
 - SAVE (SAVE) – Save Changes and return to the Auto Run mode.
 - DEFAULT (dFLE) – Reset Configuration Values to Factory Defaults and return to the Auto Run mode.
 - QUIT (QUIT) – Abandon Changes and return to the Auto Run mode.

* NOTE: Starting in version 4.4, the wired communications menu option (and in the Wired Multi-Gas, the WiFi option) no longer exists.

Menu System:

Maneuvering within the menu is relatively straight forward. Within any level, use the left and right buttons to step through the options for that level. Use the enter button to select the desired option (descends into the next level). On the bottom level, the enter button will temporarily store the selection and return to the previous level. To save, quit, or restore default values, use the up button to return to level two and the left or right buttons to select the desired operation. Changes are only saved when the save operation is selected, confirmed, and executed. If left in this mode, the configuration mode will timeout (~3 minutes) and all changes will be lost.

Caution: Executing the Default (DFLT) option will return all settings to Factory Defaults, which is not likely to fully comply with the end users requirements. The default values are listed on page 22 of this manual.

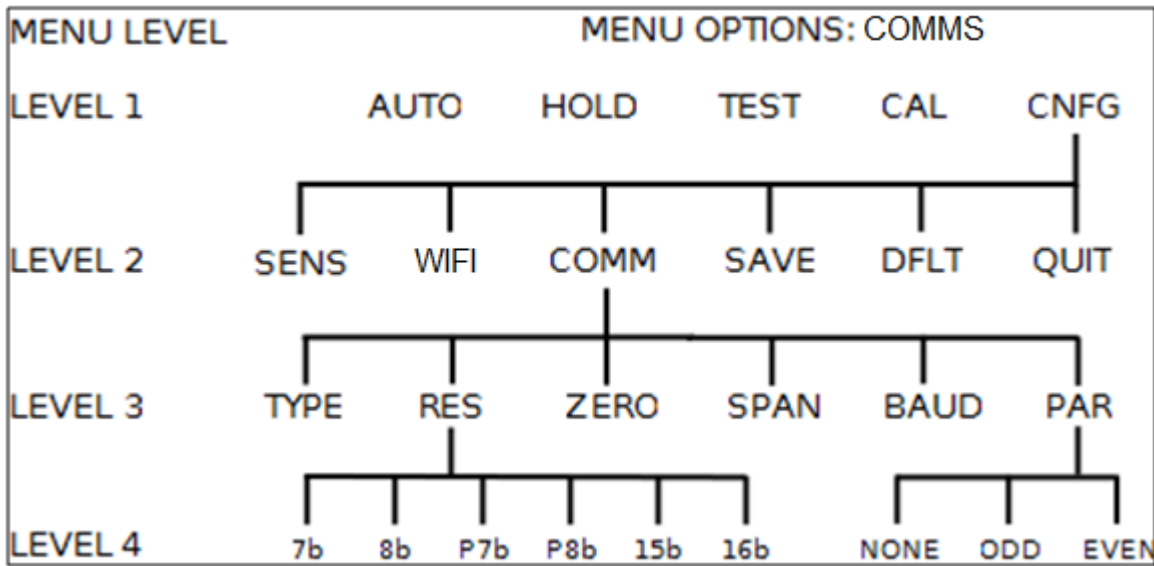


Figure 3: Obsolete starting with Ver. 4.4 - Menu Tree for Comm Options.

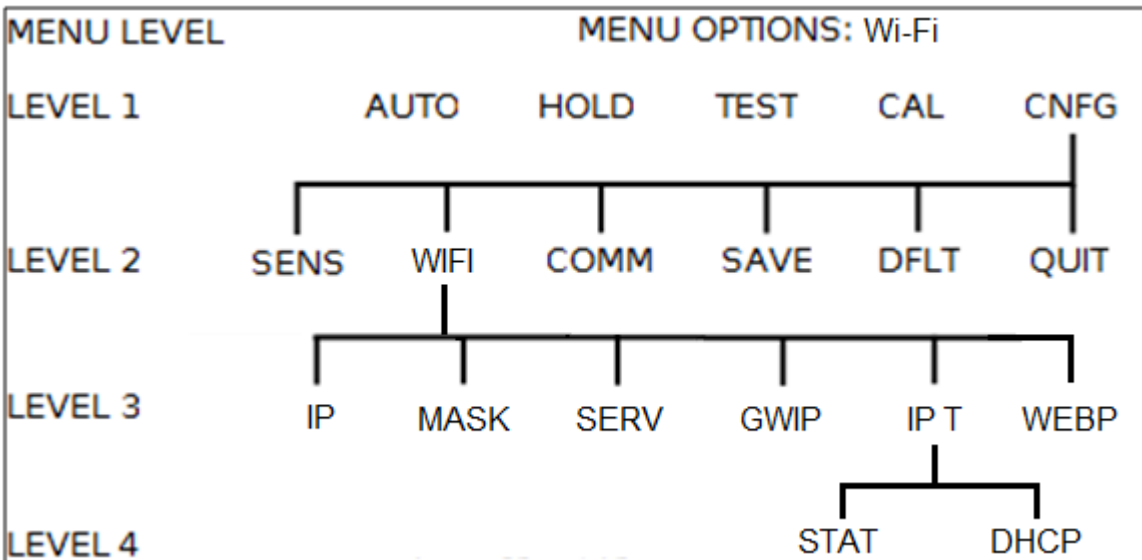


Figure 4: Menu Tree for Wi-Fi Wireless Options.

* NOTE: Starting in version 4.4, the wired communications menu option (and in the Wired Multi-Gas, the WiFi option) no longer exists.

Installation

Wi-Fi (Wireless) System Interface:

Wi-Fi Configuration

First, set the dip switches on the processor board (inside the unit on the door). Set dip switch (SW1) position 8 to the ON position and the rest to the OFF position. Setting number 8 switch to the ON position tells the unit to configure the Wi-Fi module for TCP packets. The three rotary switches are used to assign an address to the wireless sensor. Each address should be unique.

The server IP address must be set to match the server address and the Subnet mask must be appropriate for communications with the server and other network components. The sensor acts as a Wi-Fi client so it will need a wireless access point within range to connect with. By default the Wi-Fi is configured to operate with an SSID of AMR_MESH (AMR_BRIDGE if available) on channels 1, 6, or 11, with an open security protocol but many of these options can be changed.

* NOTE: If there are multiple bridge units in the area they will need to be assigned unique server and gateway IP addresses. These IPs should match. The wireless sensors will need to be configured to match the bridge unit it is supposed to be talking to.

Continue with these next steps only if there are multiple bridges within range of each other.

In order to find the Wi-Fi configuration options in the menu, navigate the menu as follows:

1. Enter the menu mode from the normal operating mode using the up button.
2. Use the left or right buttons to cycle through the menu options until you reach configuration (CFG).
3. Use the enter button to descend into the configuration menu one level.
4. Use the left or right buttons to cycle through the configuration options until you reach Wi-Fi (Wi-Fi).
5. Use the enter button to descend into the Wi-Fi menu, from this level the user may change the IP address, Netmask, Server address, Gateway address, IP type, or launch the web configuration server.

Changing Wi-Fi values in the Menu

Note: If the unit is operating in DHCP mode then the IP address, Subnet mask, and Gateway options will not be available to the user, the addressing menus will say DHCP (DHCP).

1. IP ADDRESS
 - a. Use the left or right buttons to cycle through the Wi-Fi options until you reach IP (IP).
 - b. Use the enter button to view/edit the IP address.
 - i. Note: The first (left most) value will have no decimal displayed, the second will have the right most decimal point displayed, and for each successive value the decimal point will shift left.
 - ii. The first value shown is the left most (most significant) of the four that make up an IPv4 address and the default setting is "0192". The four, three digit (0-255) values must be set individually and will be encountered from left to right, or most significant to least significant. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to set the selected digit (0-9). Repeat this for each digit that you must change. When the number is correct, use the enter key to advance to the next value.

- iii. The next values shown should be (by default) 0168 for the second value, 0001 for the third value, and 0029 for the fourth value. Follow the same steps as necessary to set each of the four values making up the IPv4 address.
- iv. Using the enter key after setting the fourth value, will return to the IP option in the Wi-Fi menu. You must cycle through all 4 IP address values before the unit will return to the IP option. It is not necessary to make any changes, so this same technique can be used to check the current setting.
- v. **NOTE: This new value will not be saved until you explicitly do so.**

2. SUBNET MASK

- a. Use the left or right buttons to cycle through the Wi-Fi options until you reach SUBNET MASK (子网掩码).
- b. Use the enter button to view/edit the mask value. The net-mask must be appropriate for communications with the PC and other network components.
 - i. Change the values as necessary using same procedure as setting the IP address. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to change the value. Repeat this for each digit that must change.
 - ii. When the number is correct, use the enter key to advance to the next value to the right.
 - iii. The Mask option in the Wi-Fi menu will be displayed after cycling through all 4 mask values.
 - iv. **NOTE: This new value will not be saved until you explicitly do so.**

3. SERVER ADDRESS

- a. Use the left or right buttons to cycle through the Wi-Fi options until you reach Server (服务器).
- b. Use the enter button to view/edit the Server IP address. This address must match the IP address of the server you wish to connect to.
 - i. The default values will be (first to last & left to right) 0192, 0168, 0001, & 0001.
 - ii. Change the values as necessary using same procedure as setting the IP address. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to change the value. Repeat this for each digit that must change.
 - iii. When the number is correct, use the enter key to advance to the next value to the right.
 - iv. The Server option in the Wi-Fi menu will be displayed after cycling through all 4 values in the IPv4 address.
 - v. **NOTE: This new value will not be saved until you explicitly do so.**

4. GATEWAY ADDRESS

- a. Use the left or right buttons to cycle through the Wi-Fi options until you reach Gateway IP (网关 IP).
- b. Use the enter button to view/edit the Gateway IP address. If there is no gateway, this address must match the IP address of the PC (Server) you wish to connect to.
 - i. The default values will be (first to last & left to right) 0192, 0168, 0001, & 0001.
 - ii. Change the values as necessary using same procedure as setting the IP address. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to change the value. Repeat this for each digit that must change.
 - iii. When the number is correct, use the enter key to advance to the next value to the right.
 - iv. The Server option in the Wi-Fi menu will be displayed after cycling through all 4 values in the IPv4 address.
 - v. **NOTE: This new value will not be saved until you explicitly do so.**

5. IP TYPE

- a. Use the left or right buttons to cycle through the Wi-Fi options until you reach IP TYPE (IP 类型).
- b. Use the enter button to view/edit the IP type.
 - i. The current type will be displayed as Static (静态) or Dynamic (动态).
 - ii. Change the value by using the left/right buttons.

iii. When the correct mode is selected, press the enter key.

iv. **NOTE: This new value will not be saved until you explicitly do so.**

6. LAUNCH CONFIGURATION WEBPAGE

- a. Use the left or right buttons to cycle through the Wi-Fi options until you reach Webpage (WebP).
- b. Use the enter button to view the current status of the web page mode.
- c. If the menu displays "Strt" (Strt), then press enter to start the web server (in this mode the sensor will not transmit packets to the server).
 - i. If the module has successfully entered the web page mode, the menu will cycle between "Serv" (Serv) and "Open" (Open). If the module did not enter the web page mode successfully then the menu will display "Werr" (Werr).
 - ii. Once in the web page mode, use a laptop or tablet with DHCP enabled (obtain an IP address automatically) and connect wirelessly to the network labeled "AMR-WIFI-CONFIG".

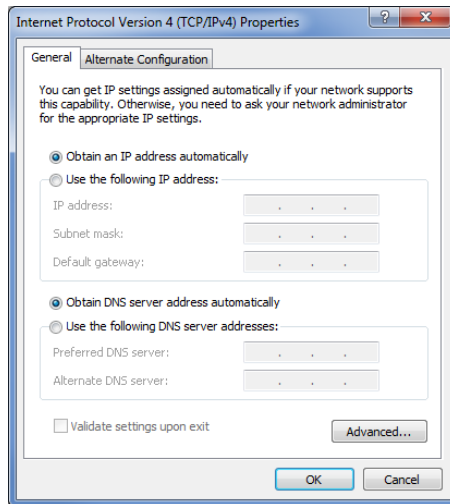


Figure 5: Setting DHCP in a PC



Figure 6: Selecting Network

- iii. Once the device is connected, open the web browser (Internet Explorer, FireFox, Chrome, Safari) and enter <http://config> in the address bar (the webpage may also be reached by an IP address depending on the firmware label on the Wi-Fi module, where IP = 1.2.3.4 if the firmware version on the Wi-Fi module is 4.00 or the IP = 192.168.1.1 if the version if 4.40 or higher).
- iv. Once the webpage loads, as shown in Figure 7, the user will have the option of entering the Access Point SSID and the passphrase if using a WPA encryption. The Access Point SSID must match the same setting as the wireless infrastructure. If WEP128 is required, please view "ADVANCED WI-FI CONFIGURATIONS" on page 24 as it requires additional steps.
 - 1. The setting for DHCP and/or addressing that is entered in this web page is not saved so it will not overwrite the options set in the menu on the sensor. Do not use the web page for setting the unit's IP addressing or IP type, use the menu system on the sensor as described above.

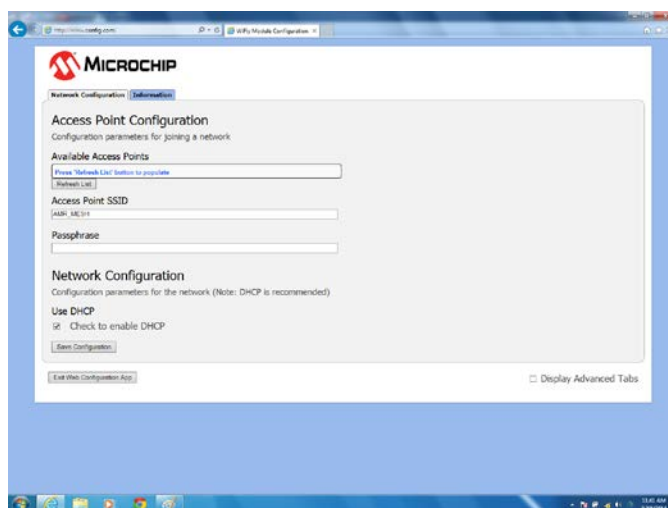


Figure 7: Configuration Webpage

- v. Once the SSID and optional passphrase has been entered, click on the Save Configuration button to save the values to the module.
- vi. Once the configuration is saved, click the Exit Web Configuration App button at the bottom of the page. The browser window may now be closed.
- vii. The configuration menu on the sensor will indicate “Fin” (F in) when the module is back in client mode or “Werr” (WErr) if there was an issue.
 1. Should the user forget to press the Exit Web Configuration App button, the module will eventually timeout and return to normal mode. The “WebP” menu will notify the user when the module has returned to normal by displaying “Strt” (Strt).
 2. The user may hit the enter button while in the webpage mode to stop the process and place the module back into normal mode.

7. SAVING CHANGES

- a. Use the up button to return to the Wi-Fi option in the Configuration Menu.
- b. Use the right button to go to the save option (SAVE).
- c. Use the enter button to select save.

You will be prompted to confirm. It will (by default) show “no”. If you do wish to save then you must use the left/right buttons to show “YES”, then use the enter key to execute. When it is done, it will show “SUCCESS”. Use the enter key to return to normal mode.

AMR Wireless Multi-Gas Dip Switch Settings:

- | | |
|-------|---|
| DS1.1 | On = DO NOT USE, Off = Normal CH4 Operation (better performance) |
| DS1.2 | On = ASCII Wi-Fi packets and unique UDP destination ports for each sensor address |
| DS1.3 | Currently Undefined (set to Off) |
| DS1.4 | Currently Undefined (set to Off) |
| DS1.5 | On = Wired Communications Matches Legacy Protocols, Off = Standard Multi-Gas Data Format |
| DS1.6 | Currently Undefined (set to Off) |
| DS1.7 | On = Polled Wi-Fi (not used at this time), Off = Timed Reporting |
| DS1.8 | On = Use TCP (use with Bridge applications), Off = Use UDP (use with Mine Net Mesh, etc.) |

* Intermittent CH4 operation is NOT recommended for general use.

Bridge applications (both bridge and multi-gas): Switch 8 = On, all others = Off (Switch 5 = On for legacy applications)
 Wireless Multi-Gas through access points to top end software: All Switches = Off

RS-485 (Wired) System Interface:

Note: There are some wired interfaces that require hardware adapters. Contact the factory for help in this matter.

The system requires 2 wires to supply DC power (10-30vdc) and 2-4 wires for the communications. Four wire systems require a different back panel board which should be specified when ordered. As of version 5.0, the setup procedure has changed so please follow the set of instructions for your version. The version number appears on the display just prior to normal operation after powering up the unit. It can also be seen by performing a Test operation from the front panel.

Starting with version 5.0:

The protocol can now be selected manually using dip switches 2, 3, & 4 (see table on next page). The auto-detect feature is still available at this time but may be deprecated in future versions. Set the device address and the dip switches before applying power. If using auto-detect, set dip switches 2, 3, & 4 to the off position.

Starting with version 4.4:

The firmware can now auto-detect the connected protocol (as supported). The auto-detection procedure only needs to be done once unless the unit is restored to factory defaults (see menu section for more information on that). First, set the dip switches on the processor board (inside the unit on the door, see figure 1). Set all switches to the OFF position. The address switches must also be set for this interface. With the power off, set the 3 address switches to 0 (an invalid address for all protocols). Apply power to the unit and watch the display. When the version number disappears, the startup sequence is complete and the unit will now be monitoring the communications and testing for a match with one of the protocols. You can now set the rotary address switches to the address by which your system will recognize it. As soon as the process is done (could take up to 3 minutes) the unit will start responding to system polls.

Prior to version 4.4:

Please request manual version E or earlier. It may be beneficial to contact AMR for a firmware upgrade plan. The

AMR Wired (serial communications) Multi-Gas Dip Switch Settings:

DS1.1	On = DO NOT USE, Off = Normal CH4 Operation (better performance)
DS1.2	Manual Communications Protocol Selection (see table below)
DS1.3	Manual Communications Protocol Selection (see table below)
DS1.4	Manual Communications Protocol Selection (see table below)
DS1.5	On = Wired Communications Matches Legacy Protocols, Off = Standard Multi-Gas Data Format
DS1.6	Currently Undefined (set to Off)
DS1.7	Currently Undefined (set to Off)
DS1.8	Currently Undefined (set to Off)

* Intermittent CH4 operation is NOT recommended for general use.

RS-485 Wired Multi-Gas (single sensor applications, i.e. replacing legacy sensor): Switch 5 = On, all others = Off

RS-485 Wired Multi-Gas (when monitoring multiple sensors from 1 multi-gas unit): All Switches = Off

DS1.4	DS1.3	DS1.2	Protocol (Version 5.0 and later, these do not need to be off)
OFF	OFF	OFF	Last Configured
OFF	OFF	ON	AMR
OFF	ON	OFF	PILLAR (CONSPEC MODBUS – RS485)
OFF	ON	ON	AMR MODBUS
ON	OFF	OFF	CONSPEC (CENTURION – Not Compatible with RS485)
ON	OFF	ON	WARRIOR Met Mines (DS1.5 ON for Single Analog Protocol)
ON	ON	OFF	UNDEFINED
ON	ON	ON	UNDEFINED

4-20mA Current Loop Interface:

Four independent, sourcing, 4-20mA current loop outputs are available. These are similar to “3 wire” current loop configurations. The system requires two wires to supply DC power (10-30vdc) and one additional wire for each current loop output to be used (assumes that ground is common between instrument and telemetry equipment). If the power source is separate, and isolated from the telemetry equipment, then the telemetry equipment will also need a circuit ground connection (one will be sufficient) to complete the output circuits.

1. Remove power from devices prior to making or breaking electrical connections between the equipment.
2. Feed the cable into the Industrial Gas Monitor through the strain relief connection.
3. Connect the circuit ground (supply negative) to the terminal labeled “GND” in P1 or P2 near the top of the back panel board (253-0436). Note: if a separate ground connection is required for the telemetry unit, it can be connected to one of those or to the connection labeled “GND” on the current loop board (253-0505).
4. Connect the 4-20mA outputs to the appropriate terminals on the current loop board (253-0505) labeled “A1” through “A4”. See the table below for help identifying which gas will be on which output.
5. Connect the circuit power (supply positive) to the terminal labeled “V+” in P1 or P2 near the top of the back panel board (253-0436).
6. Verify that the “V+” terminal is already connected on the current loop board (253-0505). If it is not, then connect it at this time to one of the following locations: “V+” in P1 or P2, or “E1”, or terminal #3 of P4 on the back panel board (253-0436).
7. Verify the switch settings on the processor board (inside the unit on the door). Set the rotary address switches to 0-0-1 (behavior when set to all zeros may differ from the desired operating behavior). The dip switches (S1) should have switch 5 on for the single gas version (if so, use A1). See the table below for the other switch settings.

AMR Wired (current loop) Multi-Gas Dip Switch Settings:

DS1.1	On = DO NOT USE, Off = Normal CH4 Operation (better performance)
DS1.2	CURRENT LOOP CHANNEL DEFINITION (see table below)
DS1.3	CURRENT LOOP CHANNEL DEFINITION (see table below)
DS1.4	CURRENT LOOP CHANNEL DEFINITION (see table below)
DS1.5	On = Wired Communications Matches Legacy Protocols, Off = Standard Multi-Gas Data Format
DS1.6	Currently Undefined (set to Off)
DS1.7	Currently Undefined (set to Off)
DS1.8	Currently Undefined (set to Off)

* Intermittent CH4 operation is NOT recommended for general use.

DS1.4	DS1.3	DS1.2	Channel 1 Gas	Channel 2 Gas	Channel 3 Gas	Channel 4 Gas
OFF	OFF	OFF	CO	CH4	O2	CO2
OFF	OFF	ON	CO	NO	NO2	H2
OFF	ON	OFF	CO	NO	CCO	H2
OFF	ON	ON	CO2	SO2	NH3	H2S
ON	OFF	OFF	CO2	NATURAL GAS	H2S	TBD
ON	OFF	ON	TBD	TBD	TBD	TBD
ON	ON	OFF	TBD	TBD	TBD	TBD
ON	ON	ON	TBD	TBD	TBD	TBD

Current Loop Wired Multi-Gas (all applications): Set Switch 2, 3, & 4 from table above, all others = Off

Bridge (Wireless/Wired) System Interface:

Wired Connections: Refer to “RS-485 (Wired) System Interface” on Pg. 15.

The Bridge unit is designed to connect multiple Wi-Fi enabled sensors to a wired interface such as Modbus. The Wi-Fi enabled sensors will not “hop” through each other so the Bridge will have to be within wireless distance of all the client sensors.

To configure a sensor for a Bridge install, set the dip switches on the processor board (inside the unit on the door, see figure 1). Set all switches except for #8 to the OFF position. Number 8 switch should be set to the ON position; this tells the unit to configure the Wi-Fi module for TCP packets. This is mandatory for proper Bridge communications.

The address switches on the processor board must also be set for this interface. These rotary switches are also inside the unit on the door (see figure 1). It is necessary for these address switches to match the address used by your wired system to poll this device. This is also the reference number that will be displayed on the Bridge Unit when it is successfully communicating with this instrument.

Note 1: For reference, understand the following networking information regarding the Wi-Fi Bridge-Client Sensor configuration:

1. **IP type must be set to static on the client sensor.**
2. **The Subnet mask must be identical on the bridge unit and on the client sensor.**
3. **The bridge unit will broadcast an SSID of AMR_BRIDGE and the security will be OPEN.**

Note 2: Instructions for setting the IP address and the server address are repeated here for convenience, and are the same as those in the Wi-Fi (Wireless) System Interface section.

The default IP address for each Sensor Unit is 192.168.1.29. This can be changed if desired. Addresses from 192.168.1.29 up to (and including) 192.168.1.254 (in this block) have been reserved in our equipment for this purpose. Other address blocks can be utilized as necessary, as well as other addressing schemes. Use the following steps to change this address:

1. **IP ADDRESS:** Enter the menu mode from the normal operating mode using the up button (magnet required).
2. Use the left or right buttons to cycle through the menu options until you reach configuration (CFG).
3. Use the enter button to descend into the configuration menu one level.
4. Use the left or right buttons to cycle through the configuration options until you reach Wi-Fi (Wi-Fi).
5. Use the enter button to descend into the Wi-Fi menu one level.
6. Use the left or right buttons to cycle through the Wi-Fi options until you reach IP (IP).
7. Use the enter button to view/edit the IP address.
 - a. The first value shown is the left most, and by default will be set to 0192. Use the enter button to advance to the next value.
 - b. The next values shown should be (by default) 0168 for the second value, 0001 for the third value, and 0029 for the fourth value.
 - c. Change the fourth value as necessary. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to change the value. Repeat this for each digit that you must change. When the number is correct, use the enter key again to return to the IP option in the Wi-Fi menu. You must use the enter key to cycle through all 4 IP address values before the unit will return to the IP option. This new value will not be saved until we explicitly do so.
 - d. **NOTE: This new value will not be saved until you explicitly do so.**
8. **SERVER IP ADDRESS:** Use the left or right buttons to cycle through the Wi-Fi options until you reach Server (SERV).
9. Use the enter button to view/edit the Server IP address. This address must match the IP address of the Bridge unit you wish to connect through.

- a. The default values will be (first to last & left to right) 0192, 0168, 0001, & 0001. Use the enter button to advance to the value that you need to change (using the enter button 4 times will return to the Server option of the Wi-Fi menu).
 - b. Change the fourth value as necessary. Using the left/right buttons, select the digit to change (the selected digit will be flashing). Use the up/down buttons to change the value. Repeat this for each digit that you must change. When the number is correct, use the enter key again to return to the Server option in the Wi-Fi menu. You must use the enter key to cycle through all 4 IP address values before the unit will return to the Server option. This new value will not be saved until we explicitly do so.
 - c. **NOTE: This new value will not be saved until you explicitly do so.**
10. Use the up button to return to the Wi-Fi option in the Configuration Menu.
 11. DATA FORMAT SETTINGS: Use the right button to show the Communications option (C O N F I G) of the Configuration Menu.
 12. Use the enter button to descend into the Communications menu.
 13. Use the left or right buttons to cycle through the Communications options until you reach type (TYPE), which refers to the communications protocol to use.
 14. Use the enter button to view/edit the communications protocol.
 15. Use the left or right buttons to cycle through the communications protocols until you reach the desired type. For the purpose of brevity, Modbus will be selected in this example (MODBUS).
 16. Use the enter button to return to the Communications options menu.
 17. Use the left or right buttons to cycle through the Communications options until you reach resolution (RES), which refers to the number of bits of resolution to use for scaling. You need to know what is used by the system that you are connecting to (typically 15b for Modbus).
 18. Use the enter button to view/edit the resolution.
 19. Use the left or right buttons to cycle through the resolution options until you reach the desired resolution. Note that there are 2 options showing for 7b and 8b. The ones preceded by P (i.e. P7b) indicate a packed format in which each register contains 2 distinct values.
 20. Use the enter button to return to the Communications options menu.
 21. Use the up button to return to the Configuration Menu options (it should say "CONFIG").
 22. Use the right button to go to the save option (SAVE).
 23. Use the enter button to select save.
 24. You will be prompted to confirm. It will (by default) show "no". If you do wish to save then you must use the left/right buttons to show "YES", then use the enter key to execute. When it is done, it will show "SUCCESS". Use the enter key to return to normal mode.

You must cycle power to make sure that all changes are implemented.

AMR Wireless to Wired Bridge Dip Switch Settings:

- | | |
|-------|---|
| DS1.1 | Currently Undefined (set to Off) |
| DS1.2 | Manual Communications Protocol Selection (see table on Pg. 15) |
| DS1.3 | Manual Communications Protocol Selection (see table on Pg. 15) |
| DS1.4 | Manual Communications Protocol Selection (see table on Pg. 15) |
| DS1.5 | On = Wired Communications Matches Legacy Protocols, Off = Standard Multi-Gas Data Format |
| DS1.6 | Currently Undefined (set to Off) |
| DS1.7 | Currently Undefined (set to Off) |
| DS1.8 | On = Use TCP (use with Bridge applications), Off = Use UDP (use with Mine Net Mesh, etc.) |

* Intermittent CH4 operation is NOT recommended for general use.

Bridge applications (both bridge and multi-gas): Switch 8 = On, all others = Off (Switch 5 = On for legacy applications)

Calibration

Procedure:

1. Starting from the normal operating mode (*Run*), or the holding mode (*hold*) hold magnet on center button for 4 or more seconds
2. Use magnet on right and/or left buttons to select the gas to be calibrated
3. Apply zero gas
4. Use magnet on enter button to begin zero
5. Wait for zero to complete (you will be prompted to begin the span calibration)
 - a. Now connect the span gas that is appropriate for this sensor
 - b. Once connected and flowing, use magnet on enter button to begin span
6. When span gas calibration has completed, the unit will display (in edit mode) its best “guess” at the span that was used.
 - a. If this is the correct value, Use magnet on enter button to accept the value.
 - b. If this value is not the correct span, you may now set the correct value using the up/down and left/right buttons (magnet required). The up and down buttons change the value of an individual digit. The left and right buttons allow you to select the digit to edit. The currently selected digit for edit will be blinking on and off. When the value is correct, use magnet on enter button to enter the new span.
7. The unit will now save the new calibration values to the sensor board.
8. When the unit indicates success (*Success*) on the display, use the enter key one more time to return to normal operation.

Errors:

The sensor will fail to calibrate if the readings do not reach a reasonable level of stability within ~3 minutes of the beginning of either the zero, or span calibration processes.

The following questions direct attention to several possible causes (assuming that the sensor is in good working order):

- Is the flow rate dropping due to a nearly empty canister?
- Has the instrument reached (temperature) stability in its current environment yet?
- Is the flow regulator set to the correct level for the gas?
- Is the gas canister (and thus, the gas) changing temperature due to a relatively quick transition between temperatures (i.e. 85 deg. above ground to 50 deg. below ground)?

Any of these issues can impact the stability of the readings which will cause them to be rejected.

Recommended Minimum Flow Rates for Calibration:

<u>Gas</u>	<u>Minimum Flow Rate</u>
CO Carbon Monoxide	150 ml/min
H ₂ Hydrogen	100 ml/min
H ₂ S Hydrogen Sulfide	250 ml/min
NH ₃ Ammonia	250 ml/min
NO Nitric Oxide	250 ml/min
NO ₂ Nitrogen Dioxide	1000 ml/min
SO ₂ Sulfur Dioxide	400 ml/min

For all others we recommend 300-400 ml/min

With flow rates above 1l/min special care must be taken not to pressurize the sensor as this will lead to inaccurate calibration.

Maintenance

Batteries:

The batteries listed on the MSHA label, have been deemed IS by MSHA for use and replacement in this equipment, and may be replaced in permissible areas of the mine. Battery life will vary greatly between an instrument that contains only Electro-Chemical gas sensors and one that includes an Infrared gas sensor (Methane or Carbon Dioxide). Battery levels are available via any of the remote monitoring methods.

Gas Cells:

- Life Expectancy: The gas sensors employed in these instruments fall into one of two types: Electro-Chemical cells, or Infrared cells. Electro-Chemical cells are consumed as part of the measurement process, and their life span will vary with exposure levels. The life span of an Infrared cell is not limited or directly tied to exposure levels. As long as there is no physical or electrical damage, an Infrared cell will continue to function until the internal electronics can no longer compensate for aging components.
 - If a gas sensor is suspect, swap the sensor module out and send the suspect module to AMR Repair, with any pertinent notes or information. They will be able to diagnose and repair the module as necessary.
- MSHA Required Calibration Interval: 30 days (Please consult your regulating bodies for different requirements that may apply to you).
- The Nitric Oxide (NO) sensor module contains a non-rechargeable battery to minimize stabilization time when first applying power. Unless shelving the instrument or sensor module for an extended period, the battery should last the life of the sensor.
 - If excessive drift in the NO reading is noticed when first applying power, swap the sensor module out and send the suspect module to AMR Repair, with any pertinent notes or information. They will be able to diagnose and repair the module as necessary.

Specifications

Sensors:

Range and resolution values for each of the available sensors:

• GAS	RANGE	RESOLUTION
• SO ₂ – Sulfur Dioxide	0-100ppm	0.5ppm
• CO ₂ – Carbon Dioxide	0-5%	1% of Range
• COH – Carbon Monoxide*	0-1000ppm	1ppm
• COH – Hydrogen *	0-2000ppm	**
• H ₂ – Hydrogen	0-2000ppm	2ppm
• H ₂ S – Hydrogen Sulfide	0-200ppm	0.25ppm
• CH ₄ – Methane	0-5%	1% of Range
• O ₂ – Oxygen	0-25%	**
• NO – Nitric Oxide	0-100ppm	0.5ppm
• NO ₂ – Nitrogen Dioxide	0-20ppm	0.1ppm
• NH ₃ – Ammonia	0-100ppm	1ppm
• Meth – Methane (Nat. Gas)	0-100%	**

*COH is a Carbon Monoxide cell that has an additional element for measuring Hydrogen.

**Not specified by manufacturer.

Approved Batteries:

The following batteries are approved for use in the Wireless MC-6410:

- Energizer P/N E95
- Energizer P/N EN95
- Duracell P/N MN1300
- Rayovac P/N AL-D

Wireless Interfaces:

- Protocol: 802.11b/g (Wi-Fi)
- Frequency: 2.4 GHz
- Output Power: +18dbm
- The approved minimum safe distance from blasting circuits for this device is 8 feet.
- Antenna Options:
 - 6" Whip Antenna
 - YAGI Antenna
 - Circular Polarized Antenna

Wired Interfaces:

- Supports most common protocols, including AMR, Modbus, and others
- Supported Hardware Interfaces (all require 10-30vdc power)
 - RS-485 (2 or 4 wire)
 - Alternate Serial Multi-drop Interfaces
- Support for most Baud Rates from 2400 to 38,400
- Support for all Parity options
- Support for various data resolutions, as well as zero and span offsets
- Support for up to four 4-20mA current loop outputs (not approved for use in permissible locations as of 5/3/16).

Factory Default Configuration Settings:

- Sensor Settings
 - SO₂ – Sulfur Dioxide
 - Scale: 50.0ppm
 - Warn Level: 2.5ppm
 - Alarm Level: 5.0ppm
 - CO₂ – Carbon Dioxide
 - Scale: 5.0%
 - Warn Level: 3.0%
 - Alarm Level: 5.0%
 - COH – Carbon Monoxide
 - Scale: 50ppm
 - Warn Level: 5ppm
 - Alarm Level: 10ppm
 - H₂ on ON
 - H₂ display ON
 - H₂ report ON
 - H₂ compensation ON
 - H₂ – Hydrogen
 - Scale: 1500ppm
 - Warn Level: 1000ppm
 - Alarm Level: 1200ppm
 - H₂S – Hydrogen Sulfide
 - Scale: 200ppm
 - Warn Level: 10ppm
 - Alarm Level: 15ppm
 - CH₄ – Methane
 - Scale: 2.5%
 - Warn Level: 1.0%
 - Alarm Level: 2.0%
 - O₂ – Oxygen
 - Scale: 25.0%
 - Warn Level: 23.0%
 - Alarm Level: 19.5%
 - NO – Nitric Oxide
 - Scale: 25.0ppm
 - Warn Level: 5.0ppm
 - Alarm Level: 10.0ppm
 - Diesel nullification ON
 - NO₂ – Nitrogen Dioxide
 - Scale: 10.0ppm
 - Warn Level: 2.0ppm
 - Alarm Level: 3.0ppm
 - CCO – Corrected Carbon Monoxide
 - Scale: 50ppm
 - Warn Level: 5ppm
 - Alarm Level: 10ppm

Factory Default Configuration Settings (cont.)

- Sensor Settings (Cont.)
 - NH₃ – Ammonia
 - Scale: 50.0ppm
 - Warn Level: 15.0ppm
 - Alarm Level: 25.0ppm
 - Meth – Methane content in Natural Gas
 - Scale: 100.0%
 - Warn Level: 1500% (not typically used)
 - Alarm Level: 1500% (not typically used)
- Wi-Fi Settings
 - IP Address 192.168.1.29
 - Network Mask 255.255.255.0
 - Server IP Address 192.168.1.1
 - Gateway IP Address 192.168.1.1
 - IP Type STATIC
 - *SSID AMR_MESH (AMR_BRIDGE if available)
 - *Security Type OPEN
 - *Security Key "" (none/null)
- Wired Communication Settings
 - Protocol Type MODBUS
 - Data Resolution 15 Bit
 - Zero Offset 0 (none)
 - Span Offset 0 (none)
 - Baud Rate 19.2K
 - Parity Even

Note: * These settings reside in the Wi-Fi module and are not changed when restoring default factory settings from the menu. They must be changed manually see “LAUNCH CONFIGURATION WEBPAGE” on page 13.

ADVANCED WI-FI CONFIGURATIONS

In normal deployments, the advanced should not be required. In the event that the Wi-Fi module needs to have changes implemented such as WEP security or changing the port number for the server application, use the following guide.

1. Place the sensor into the webpage configuration mode (go to page 11).
2. Open the configuration webpage.
3. Click on the Display advanced tabs checkbox in the lower right corner.
4. Find the Terminal tab at the top and click it.
5. The Terminal webpage will have a blank box with a text box below it for entering commands as shown below. Type a command into the text box and press enter.

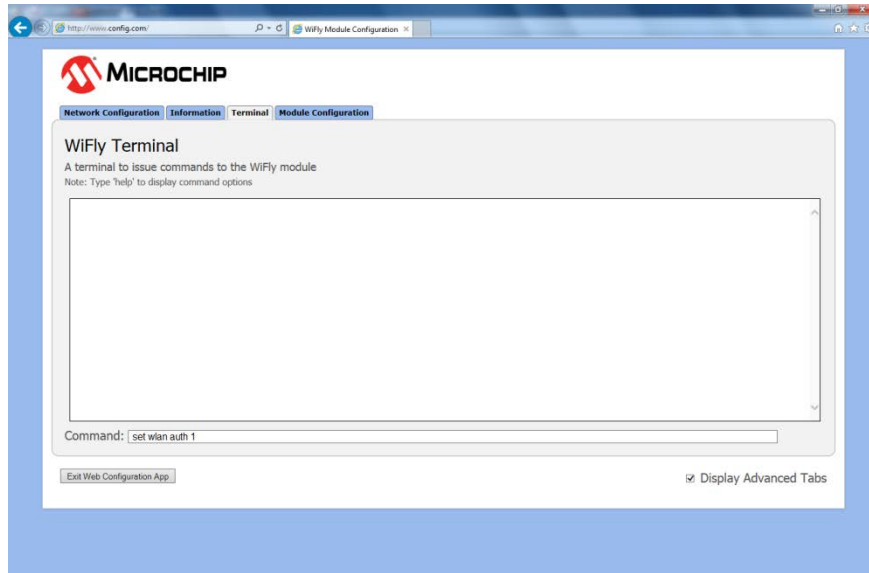


Figure 8: Advanced Terminal Tab of Webpage

6. Use the following table to make changes as needed:

set wlan auth 1		1 sets the security to WEP128 0 clears the security
set wlan key AABBCCDDEEFFGGHHIIJJKLLMM		Sets the WEP128 key where the key is 26 characters long.
set ip remote xxxx		Sets the port number for the server application. Replace xxxx with the desired port number.
save		Issues save command (required to keep changes)

7. If a command was entered, make sure to type save into the text box and press enter.

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