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AirChip 3000 **Communication Protocol Options**



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1 OVERVIEW

The AirChip 3000 is a programmable, custom designed integrated circuit developed by ROTRONIC and is at the core of an entire family of humidity-temperature measuring devices:

- HygroClip 2 (HC2) probes
- HF3 transmitters and thermo-hygrostats series
- HF4 transmitter series
- HF6 transmitter series
- HL20 data logger
- HP21 hand-held indicator
- Custom designed OEM products

RO-ASCII is the default communication protocol used by the HW4 software to communicate with an AirChip 3000 device. Users can always use this protocol to communicate directly with an AirChip 3000 device without HW4. Starting with firmware version 1.3, the AirChip 3000 offers 3 additional communication protocol options:

- Modbus: this protocol is applicable to all AirChip 3000 devices that can be connected to a RS-485 network
- I2C: this protocol complies with the standard I2C protocol and is meant for OEM users. When set to use the I2C protocol, the AirChip 3000 always act as master writing to the bus. The AirChip 3000 does not allow the networking of several devices and is limited to a one way communication where the AirChip 3000 device automatically sends data during each refresh interval to an external device with I2C input. The I2C protocol option is available with the HygroClip 2 probes (HC2) and with some OEM products.
- Custom: this is a simple protocol that can be customized by the user to provide compatibility of the AirChip 3000 device with an exiting communication system. The Custom protocol is applicable to all AirChip 3000 devices with a digital interface and allows RS-485 networking.

It is important to note that the Modbus, I2C and Custom protocols available with the AirChip 3000 devices are limited to reading measurement data from the AirChip 3000 device. Functions such as device configuration, humidity and temperature adjustment, etc. are not supported by these protocols.

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IMPORTANT:

- The HW4 software is required to set the AirChip 3000 device to use any protocol other than RO-ASCII
- When communicating with the HW4 software the AirChip 3000 device automatically switches to the RO-ASCII protocol (ROTRONIC standard).
- After using HW4 to configure the AirChip 3000 device to use one of the available protocols power down the device. When the device is powered up, it automatically starts using the selected communication protocol as long as it is not communicating with the HW4 software.

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2 AIRCHIP 3000 DIGITAL INTERFACE

| AirChip 3000 Digital interface | |
|--------------------------------|---|
| Interface type (default) | UART (Universal Asynchronous Receiver Transmitter) |
| Organization | Dialog, duplex |
| Default configuration | Baud rate : 19200 Parity : none Data bits : 8 Stop bits : 1 Flow Control : none |
| Tolerance | 3 % |
| Baud rate configuration: | No |
| Logical levels | Logical 0: $\leq 0.3V \cdot VDD$ Logical 1: $\geq 0.8V \cdot VDD$ |
| Maximum cable length | 5 m (16.4 ft) w/o signal booster |

Note: a number of devices based on the AirChip 3000 also feature a RS-485 interface

2.1 Communication schematic

Communication between the initiator (PC) and the measurement device must also follow the request-answer schematic. It's not allowed to send a second request before the answer from the measurement device is received.

2.2 Response time

The maximal response time of all devices described in this document is 500 ms.

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3 RO-ASCII PROTOCOL

RO-ASCII is the default communication protocol used by both the AirChip 3000 devices and the HW4 software. This document describes only some of the commands and functions available with the RO-ASCII communication protocol. In particular, the following functions are not covered here:

- Device configuration
- 2-point temperature adjustment

These functions can be accessed with the ROTRONIC HW4 software.

Users who require additional functionality should contact ROTRONIC. Please note that some of the commands and functions not included in this document require a certain amount of computations to be carried out by a device external to the AirChip 3000 (such as a PC). A typical example is the 2-point temperature adjustment function of the AirChip 3000.

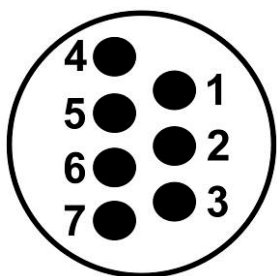
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3.1 Physical interface

HC2 probe: Use a cable that converts the probe UART interface into an existing PC interface or Ethernet port (for example cable AC3001 allows connection to a USB port). The function of the 7 pins of the HygroClip 2 probe connector is the same as in the RO-ASCII mode.

Pin-out diagram: Probe connector (7-pin male – looking at probe)

RO-ASCII mode



| Pin # | Name | Function |
|-------|------------------|---|
| 1 | VDD (+) | 3.2 to 5 VDC |
| 2 | GND | Power ground and digital signal ground |
| 3 | RXD | UART |
| 4 | TXD | UART |
| 5 | Out 1 analog (+) | Humidity 0...100%RH (default) |
| 6 | Out 2 analog (+) | Temperature -40...60°C (default) |
| 7 | AGND | Analog signal ground |

Other AirChip 3000 devices: Depending on the model, instruments based on the AirChip 3000 feature a USB interface, a RS-485 interface or an Ethernet interface.

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3.2 Command overview

The following RO-ASCII commands are described in this document:

| Command | Function |
|------------|---|
| RDD | Read the humidity and temperature measured by the HygroClip 2 device, the calculated parameter (dew or frost point) and additional information such as: engineering unit, trend and out-of-limits alarm flag for each individual parameter, general alarm Byte for the device, device type, firmware version, serial number and device name |
| REN | Change the RS-485 address of the device |
| HCA | Adjust the device against a reference temperature value (1-point adjustment only). Adjust the device against one or several humidity reference values (1-point and multi-point adjustment). Document E-T-2P TempAdj is available from ROTRONIC for users who are interested in doing a 2-point temperature adjustment. |
| LGC | Program the device data recording function |
| ERD | Download the recorded humidity and temperature data (the calculated parameter is not recorded) |

The RO-ASCII communication protocol uses exclusively ASCII characters. With the exception of the ERD command, most commands and answers requires very little formatting.

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3.3 General command structure

| | | | | | | | |
|-------|---|----|-----|---------|------|--------|----|
| RS485 | “ | ID | Adr | Command | Data | Chksum | CR |
|-------|---|----|-----|---------|------|--------|----|

RS485 | (vertical bar) this character is required only when the device being addressed is a RS-485 slave (the string is to be passed to the device by another device such as the master or another slave in the RS-485 multi-drop).

An AirChip 3000 device may be directly connected by RS-485 to a device such as an Ethernet Server. In that case the AirChip 3000 device is a master device. Do not use the vertical bar | as the start character when sending a data request to a master device.

{ Beginning of the string (curly bracket)

ID Device type identifier (one ASCII character). Use space for unknown identifier (all devices will respond, collisions may occur).

Adr RS485 Address of the device (00-64). Use 99 for unknown address (any address will respond, collisions may occur).

Command 3 ASCII characters

Data ASCII characters, each individual data element is followed by a semi-colon (separator)

Chksum Checksum. When sending a data request this can be replaced with a string end } (curly bracket)

CR End of the string (Carriage Return)

- Leading and trailing space characters are allowed
- The decimal symbol is always a dot

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Notes:

○ **RS485**

The vertical bar | is used to indicate that the command string is to be passed to another device connected by RS-485 (multi-drop network with a master and one or several slaves). Upon receiving the string, the master device strips the vertical bar and sends the rest of the string to the RS-485 driver.

Depending on the device, the stripped string may also be sent to the PC. The software used by the PC should be designed so as not to confuse this string with an answer.

○ **Adr**

Address 99 can be used temporarily to communicate with a single device of unknown address. This address causes the device to answer regardless of its address. The actual device address is returned as part of the answer string. Address 99 should not be used when several devices are connected to a network.

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o **Checksum character calculation**

Hex value of checksum character = [(sum of all character Hex values) AND 0x003F] + 0x0020

Note: AND = bitwise AND logical operation

This is equivalent to the following Visual Basic code lines:

Private Function Checksum(ByVal Data As String) As Char

Dim Sum, i As Integer

For i = 0 To Data.Length - 1

Sum += Asc(Data.Chars(i))

Next

Checksum = Chr(Sum Mod 64 + 32)

End Function

NOTE: The following characters are not used for the checksum calculation: RS485 character (I), the String end (}) and (CR). The initial ({) must be counted.

Example: checksum character for the string {F09RDD = \$

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3.4 RDD command: read values

Returns the measured and calculated values as well as the information necessary to interpret the data (calculated parameter type, engineering units, status, serial number and name of the device, etc.)

Command format:

| | | | | | |
|---|----|-----|-----|-------------|----|
| { | ID | Adr | RDD | Chksum or } | CR |
|---|----|-----|-----|-------------|----|

Answer format:

| | | | | | |
|---|----|-----|-----|------|--------|
| { | ID | Adr | rdd | Data | Chksum |
|---|----|-----|-----|------|--------|

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The data are returned according to the following structure:

| Example | Type | Description |
|-----------|--------|--|
| 1..3 | Byte | Probe type (1= digital probe, 2=analog probe, 3=pressure probe) |
| 1234.56 | Float | Relative humidity or analog value |
| %RH | String | Humidity or analog value engineering unit |
| 0..1 | Bool | Humidity or analog value alarm (out-of-limits) |
| + | Char | Humidity or analog value trend (+,-,= or “ ”) |
| 1234.56 | Float | Temperature value |
| °C | String | Temperature engineering unit |
| 0..1 | Bool | Temperature alarm (out-of-limits) |
| = | Char | Temperature trend (+,-,= or “ ”) |
| Dp | String | Calculated parameter type (nc: no calculation, Dp: dew point, Fp: frost point) |
| 1234.56 | Float | Calculated numerical value |
| °C | String | Calculated parameter engineering unit |
| 0..1 | Bool | Calculated parameter alarm (out-of-limits) |
| + | Char | Calculated parameter trend (+,-,= or “ ”) |
| 1..255 | Byte | Device type (HygroClip, Logger, HF, HM, ...) |
| V1.0 | String | Firmware version |
| 12345678 | String | Device serial number |
| Name | String | Device name |
| 000...255 | Byte | Alarm Byte: (Bit0=out-of-limits value, Bit5= sensor quality, Bit6 = humidity simulator, Bit7= temperature simulator) |

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Each individual data element, including the last, is followed by a semi-colon (separator)

Examples:

{F04RDD}

{F04rdd 001; 4.45;%RH;000;=; 20.07;°C;000;=;Fp;-19.94;°C;000;+;001;B2.8;0000000002;HyClp 2 ;006;J^M

{F04RDD}

{F04rdd 001; 4.45;%RH;000;=; 20.06;°C;000;=;nc;---;°C;000; ;001;B2.8;0000000002;HyClp 2 ;006;6^M

{F04RDD}

{F04rdd 001; 4.47;%RH;000;=; 20.04;°C;000;=;nc;-19.92;°C;000;=;001;B2.8;0000000002;HyClp 2 ;006;4^M

Note: after changing the HC2 from dew or frost point to “no calculation”, the probe will still send a value after the characters “nc”. This value has no meaning and will disappear after a power reset.

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3.5 REN command: change the RS-485 address

This command is used to change the RS-485 address of the device

Command format:

| | | | | | | |
|---|----|-----------------------|-----|----------------------------|-------------|----|
| { | ID | Current Address or 99 | REN | Serial number; New Address | Chksum or } | CR |
|---|----|-----------------------|-----|----------------------------|-------------|----|

Answer format

| | | | | |
|---|----|-------------|--------|--------|
| { | ID | New address | ren OK | Chksum |
|---|----|-------------|--------|--------|

Example: change RS address of probe serial number 0000000002 from 5 to 4

```
{F05REN 0000000002;4;}
```

```
{F04ren OKD^M
```

- o Note: Address 99 can be used temporarily to communicate with a single device of unknown address. This address causes the device to answer regardless of its address. The actual device address is returned as part of the answer string. Address 99 should not be used when several devices are connected to a network.

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3.6 HCA command: probe adjustment

This command is used to adjust the probe against a reference (humidity and temperature)

Command format

| | | | | | | |
|---|----|-----|-----|------------|--------|----|
| { | ID | Adr | HCA | Parameters | Chksum | CR |
|---|----|-----|-----|------------|--------|----|

Answer format

| | | | | |
|---|----|-----|--------|--------|
| { | ID | Adr | hca OK | Chksum |
|---|----|-----|--------|--------|

Command parameter structure:

| | |
|-----------|--|
| 0 | <ul style="list-style-type: none"> Individual probe and instrument with integral probe: always use 0 as the probe input number All other devices: use the probe input number |
| 0..2 | 0 = Humidity adjustment (against a ROTRONIC standard – RHS) 1 = Humidity adjustment against a reference instrument 2 = Temperature adjustment against a reference instrument |
| 0..3 | 0 = Save both the current measurement and the reference value 1 = Adjust 2 = Return to factory original adjustment 3 = Delete all saved calibration points |
| -50...200 | Reference Value |

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Notes:

- The HCA command can be used to do a 1-point adjustment of temperature or humidity as well as a multi-point adjustment of humidity. The HCA command cannot be used for a 2-point temperature adjustment. Document **E-T-2P TempAdj** is available from ROTRONIC for users who are interested in doing a 2-point temperature adjustment.
- Adjustment of the HC2 probe is always a two step process. The first step consists in saving at least one calibration point to the probe memory. The second step consists in carrying out the actual probe adjustment.

Example of a correct sequence of commands:

{F01HCA 0;0;0;20.00;} Save humidity calibration point (20 %RH)

{F01hca OK(^M

{F01HCA 0;0;1;;} Adjust humidity using all calibration points in memory – note that no reference value is required

{F01hca OK(^M

- When the third parameter of the HCA command is set to 1 (adjust), no reference value needs to be specified. Any reference value (last parameter) is ignored by the HC2 probe.

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- The effect of an adjustment depends on the number of calibration points present in the probe memory prior to the adjustment:
 - 1 calibration point: offset adjustment (equivalent to a 1-point adjustment)
 - 2 calibration points: offset and slope adjustment
 - 3 or more calibration points: offset, slope and linearization adjustment
- Following an adjustment, all calibration points should be deleted from the probe memory

Example:

{F01HCA 0;0;3;;} Erase all humidity calibration points

{F01hca OK(^M

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3.7 LGC command: status and programming of the data recording function

This command has two different formats and is used either to read (query) or to program the log function

Command format 1 (used to read the status of the data recording function):

| | | | | | |
|---|----|-----|-----|----------|----|
| { | ID | Adr | LGC | Checksum | CR |
|---|----|-----|-----|----------|----|

Answer format

| | | | | | |
|---|----|-----|-----|------------------|----------|
| { | ID | Adr | lgc | Recording Status | Checksum |
|---|----|-----|-----|------------------|----------|

Structure used for the recording status data (answer to command format 1):

| | | |
|-----------|---------|--|
| 0..3 | Boolean | 0 = not recording data, 1 = recording data Loop recording only: 2 = recording data and memory full (see note below) Loop recording only: 3 = not recording data and memory full (see note below) |
| 1..2 | Byte | 1 = Start-Stop mode (record until memory is full) 2 = Loop recording (dump oldest data when memory is full and keep recording) |
| 1..65535 | Word | Log interval (in multiples of 5 seconds) 1 = 5s, 2 = 10s, etc. |
| 123456789 | Long | Date and time of the first data sample referenced to Jan, 01, 2000 and expressed in increments of 5 seconds – see note 2 below |
| 0...2000 | Word | Number of data records (see note below) |

Note: when the memory is full (2000 data records) the first element of the answer structure is equal to either 2 or 3, depending on whether data is being recorded or not. In this situation, the number of data records given in the answer should be disregarded and replaced with the number 2000.

Command format 2 (used to program the data recording function):

| | | | | | | |
|---|----|-----|-----|--------------------|----------|----|
| { | ID | Adr | LGC | Recording Settings | Checksum | CR |
|---|----|-----|-----|--------------------|----------|----|

Answer format:

| | | | | |
|---|----|-----|--------|----------|
| { | ID | Adr | lgc OK | Checksum |
|---|----|-----|--------|----------|

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Structure used for programming the recording settings (command format 2):

| | | |
|-----------|---------|---|
| 0..1 | Boolean | 0 = Stop recording data, 1= Start recording data (see note 1 below) |
| 1..2 | Byte | 1 = Start-Stop mode (record until memory is full) 2 = Loop recording (dump oldest data when memory is full and keep recording) |
| 1..65535 | Word | Log interval (in multiples of 5 seconds) 1 = 5s, 2 = 10s, etc. |
| 123456789 | Long | Current date and time referenced to Jan, 01, 2000 and expressed in increments of 5 seconds – see note 2 below |

Note 1:

- The command to stop recording must be sent before a new recording can be started
- Whenever the probe starts recording data, all previously recorded data is erased from the memory

Note 2:

The current date and time must be written to the HC2 whenever recording is started because the HC2 itself does not have an internal real time clock. An internal time counter ensures that data is recorded at fixed intervals of time (the log interval) as configured by the user (multiples of 5 seconds). Accuracy of the log interval depends on the accuracy of the quartz oscillator used by the HC2 and is not comparable to the accuracy provided by a real time clock. When using the LGC command to stop data recording, the user must decide whether to send the date and time of the first data sample or the date and time of the last data sample (or the date and time when the stop command was issued).

Date and time are referenced to January 1, 2000, 00:00 and are expressed in increments of 5 seconds counting from the reference date and time: 1 = Jan, 01, 2000, 00:00:05, 2 = Jan, 01, 2000, 00:00:10, etc.

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Example1: Start recording data in the Start-Stop Mode with a 10s log interval

{F05LGC 1;1;2;50746164;}

{F05lgc OK6^M

Check function status (Query)

{F05LGC}

{F05lgc 001;001;00002;0050746164;00000;H^M

Example 2: Stop recording data

{F05LGC 0;1;2;50746164;}

{F05lgc OK6^M

Check function status (Query)

{F05LGC}

{F05lgc 000;001;00002;0050746164;00037;Q^M

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3.8 ERD command: read recorded data

This command is used to read data from the memory (the data are read Byte after Byte)

Command format:

| | | | | | | |
|---|----|-----|-----|------------|--------|----|
| { | ID | Adr | ERD | Parameters | Chksum | CR |
|---|----|-----|-----|------------|--------|----|

Command parameter structure:

| | |
|----------|---|
| 0..1 | 0 = internal memory 1 = reserved – do not use |
| 2176 | Use address 2176 when downloading recorded data samples |
| 0..65535 | Number of Bytes to be read |

Answer format

| | | | | | |
|--|----|-----|-----|------|--------|
| | ID | Adr | erd | Data | Chksum |
|--|----|-----|-----|------|--------|

The recorded data is transmitted Byte by Byte, in the same order as it was recorded:

Proceed as follows:

- 1) Use the LGC command to read the recording status of the HC2. Note or capture the following:
 - Recording mode
 - Log interval (multiple of 5 seconds)
 - Recording start date and time (see note below)
 - Number of recorded data samples (in the loop recording mode, disregard the information returned by the LGC command whenever the LGC command reports that the memory is full. In this situation, use 2000 as the number of data samples).
- 2) Use the ERD command to trigger the downloading of recorded data:

Example of data request: {F00ERD 0;2176;0006} + CR

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Address 2176 is always the address of the first byte of the first recorded data sample. The above example assumes that 2 data samples were recorded. The number of bytes to be downloaded (0006) is equal to 3 times the number of recorded data samples (each data sample uses 3 Bytes)

Example of reply: {F00erd 016;202;038;017;198;038;Y

- 3) To convert the Bytes into relative humidity and temperature data, group the downloaded Bytes in blocks of 3 Bytes and proceed for each block as explained below:

| Procedure | Example |
|---|---|
| Block of 3 Bytes: $\text{Value} = \text{Byte1} + 2^8 * \text{Byte2} + 2^{16} * \text{Byte3}$ | First block of 3 Bytes: Byte1 = 016 Byte 2 = 202 Byte3 = 038 $\text{Value} = 16 + 256 * 202 + 65536 * 38 = 2542096$ |
| Calculate the value of %RH as follows: $\%RH = (\text{Value} \bmod 1024) / 10$ | $2542096 \bmod 1024 = 528$ $528 / 10 = 52.8 \%RH$ |
| Calculate the value of temperature as follows: $\text{Temperature} = \text{floor}(\text{Value} / 1024) / 20 - 100$ | $\text{floor}(2542096 / 1024, 1) = 2482$ $2482/20 - 100 = 24.1$ |

As mentioned before, the HC2 does not have an internal real time clock and the data samples are not date and time stamped. Depending on the recording mode, the date and time of each recorded sample can be reconstituted as follows:

- **Start / Stop Recording Mode**

If the LGC command was not used to stop recording data, the date and time returned by the LGC command is the date and time of the first data sample. Use the log interval to find the date and time of the subsequent data samples.

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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If the LGC command was used to stop recording data, the date and time returned by the LGC command is the date and time of either the first or the last data sample, depending on which date and time was sent as part of the LGC command. Depending on the situation, use the log interval to find the date and time of either the subsequent or previous data samples.

- **Loop Recording Mode**

When less than 2,000 data samples have been recorded, proceed as for the Start / Stop Mode

When 2,000 data samples have been recorded the memory is full and it is very likely that the oldest data samples have been erased to make room for additional data samples. In this situation, the first element of the answer returned by the LGC command is equal to either 2 or 3. This indicates that 2,000 data samples have been recorded. Make a note of the date and time when the ERD command was issued. Proceed as follows to determine the time and date of the most recent data sample:

. Use both the recording start time and the value of the log interval to determine when data samples were being recorded. Example: if the recording started exactly at the top of an hour with a log interval of 10 minutes, samples have been recorded at HH:00:00, HH:10:00, HH:20:00, etc. If the ERD command was sent at 14:15:00, then the time of the latest data sample is 14:10:00.

. Knowing the date and time of the latest data sample, as well as the value of log interval, the date and time of the preceding data samples can be found.

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
| Document code | Unit |
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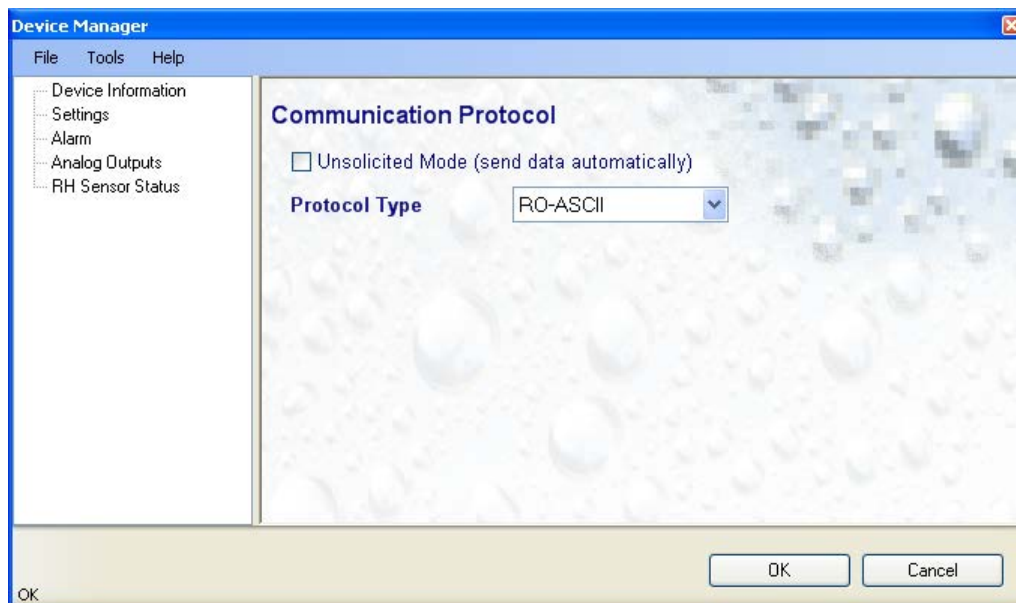
3.9 Configuration with the HW4 software

RO-ASCII is the default communication protocol used by AirChip 3000 devices. The structure of this protocol cannot be modified by the user. As an option, the AirChip 3000 device can be set to use a monologue communication mode by placing a check mark in the box labeled “unsolicited mode”. In this mode the AirChip 3000 device sends the measurement data automatically with each data refresh cycle, as opposed to waiting for a data request. To get the data, the receiving device must be listening at all times.

The HW4 software (Device Manager) is required to set the AirChip 3000 device to send data automatically, without requiring a data request. For a list of the HW4 manuals corresponding to the different AirChip 3000 devices, please consult the following document:

E-M-HW4v3-DIR This document can be downloaded from several of the ROTRONIC websites.

HW4 configuration screen for RO-ASCII (HW4 Device Manager):



| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
| Document code | Unit |
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4 MODBUS PROTOCOL

The AirChip 3000 Modbus protocol is limited to reading measurement data from the AirChip 3000, HC2-S and AC3005 devices. Functions such as device configuration, humidity and temperature adjustment, etc. are not supported by the AirChip 3000 Modbus protocol.

4.1 Physical interface

The Modbus protocol can be used only with an AirChip 3000 device that features a RS-485 interface. As with any RS-485 network, the Modbus network should be installed as per the instructions provided in the following document:

E-DV04-RS485.01

Note:

The Modbus protocol and the RO-ASCII protocol used by the HW4 software cannot be used simultaneously on the same RS-485 network. For RS-485 networks the addressing of the device must be individual for each device in the network (can be set in the device manager).

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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| AirChip 3000 Communication Protocol Options | Description |
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4.2 Data request structure

| Start | Address | Function | Data | Checksum | End |
|-------------|--------------|--------------|--------------|--------------|--------------|
| 1 Character | 2 Characters | 2 Characters | n Characters | 2 Characters | 2 Characters |
| : | ADR | FC | Adr Anz | LRC | CR LF |

| | |
|-----|--|
| : | Modbus start character |
| ADR | Device RS-485 address (2 characters) – can be changed with the HW4 software |
| FC | Function code (2 characters) |
| Adr | Register Address (optional in a data request, will be ignored) |
| Anz | Number of registers to be read (optional in a data request, will be ignored) |
| LRC | Checksum (optional in a data request, 2 characters, will be ignored) |
| CR | 1 st Modbus end character (Carriage Return) |
| LF | 2 nd Modbus end character (Line Feed) |

Example: :0103CRLF

Function code: one of four values used to either read or write information:

03 = Read a value from one or more holding registers

04 = Read a value from one or more input registers

06 = Write a value into one holding register

10 = Write a value into two or more holding registers

The AirChip 3000 supports only function code 03

| | |
|--|---|
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4.3 Response structure and data encoding

| Start | Address | Function | Data | Checksum | End |
|-------------|--------------|--------------|--------------|--------------|--------------|
| 1 Character | 2 Characters | 2 Characters | n Characters | 2 Characters | 2 Characters |
| : | ADR | FC | Nbr Hex | LRC | CR LF |

| | |
|-----|---|
| : | Modbus start character |
| ADR | Device RS-485 address (2 characters) – can be changed with the HW4 software |
| FC | Function code (2 characters) |
| Nbr | Number of data bytes |
| Hex | Data in Hex format |
| LRC | Checksum (will be ignored) |
| CR | 1 st Modbus end character (Carriage Return) |
| LF | 2 nd Modbus end character (Line Feed) |

Example: :010306**015E04CE042B**96CRLF (note: the CR and LF characters are not visible)

In the above example, the measurement data is returned in the Hex format as a group of 6 bytes: 015E04CE042B and is interpreted as follows:

| | | |
|-----------------------------|---------------|---------------|
| Data 1 : Humidity | = 015E | = 350 |
| Data 2 : Temperature | = 04CE | = 1230 |
| Data 3 : Dew or frost point | = 042B | = 1067 |

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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Please note that the HW4 software is used to determine which parameters are transmitted in the response (Data1 to 3) and in which sequence. The unit system used for both temperature and the calculated parameter (dew or frost point) is also set with HW4 as part of the device configuration.

In the decimal format, the data are numerically scaled as follows:

Humidity : 0...100% = 0...1000

Temperature und calculated parameter : -100...600°C = 0...7000

In the above example of a response, the result is as follows:

| | | |
|--------------------|---|--------|
| Humidity | = | 35.0% |
| Temperature | = | 23.0°C |
| Dew or frost point | = | 6.7°C |

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
| Document code | Unit |
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4.4 Configuration with the HW4 software

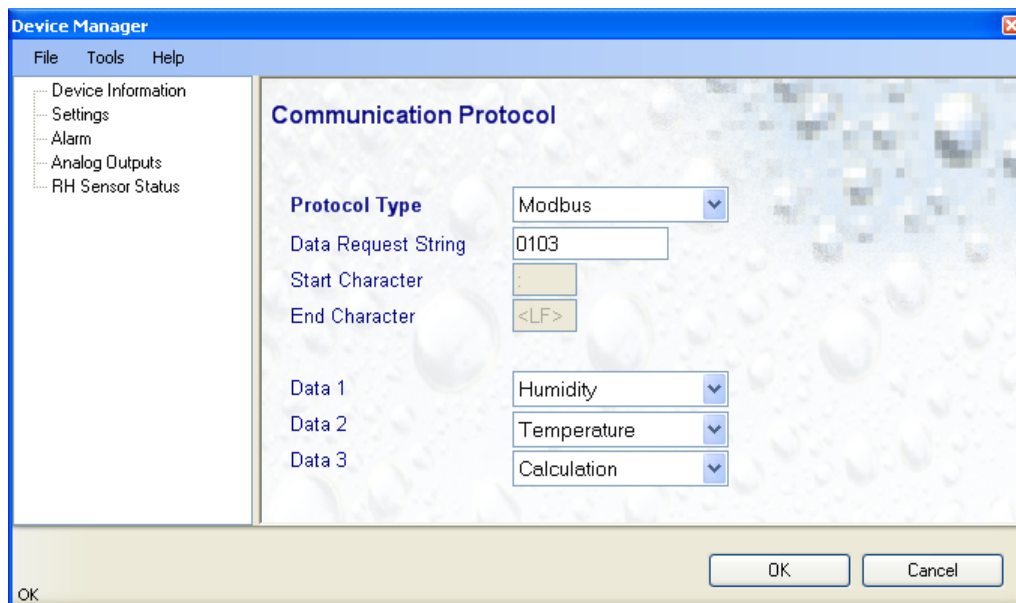
The HW4 software (Device Manager) is required to set the AirChip 3000 device to use the Modbus protocol. For a list of the HW4 manuals corresponding to the different AirChip 3000 devices, please consult the following document:

E-M-HW4v3-DIR This document can be downloaded from several of the ROTRONIC websites.

The AirChip 3000 device supports only a single Modbus command which can be configured with the HW4 software. This command allows reading measurement data from the AirChip 3000 device. No other type of information can be read.

Both the start and the stop characters cannot be changed. The transmission of Data1 to Data 3 can be either disabled or enabled. The device response will contain only the selected data in the selected sequence.

Example of a HW4 configuration screen (HW4 Device Manager):



| | |
|--|---|
| E-M-AC3000-CP_22 Document code | Rotronic AG Bassersdorf, Switzerland Unit |
| AirChip 3000 Communication Protocol Options Document title | Description Document Type Page 31 of 43 |

5 I2C PROTOCOL

The I2C protocol option is available only with the HygroClip 2 probes and some AirChip 3000 based OEM products. While the structure of the data string generated by the AirChip 3000 fully complies with the I2C requirements, the AirChip 3000 has the following limitations:

- The AirChip 3000 always acts as a I2C Master writing to the bus. After the START condition (S), a slave address is sent. In accordance with the I2C protocol, this address is 7 bits long followed by an eighth bit which is the data direction bit (R/W). With the AirChip 3000 this bit is always a 'zero' indicating a transmission (WRITE). The AirChip 3000 device sends a data string automatically with each data refresh cycle (unsolicited data), as opposed to waiting for a data request. To get the data, the receiving device must be listening at all times
- In spite of the fact that the I2C data string includes an address, the AirChip 3000 is not addressable and communication is limited to a single AirChip 3000 device (no networking of several devices, AirChip 3000 or other).
- The I2C protocol can only be used to read measurement data from the AirChip 3000 device. Functions such as device configuration, humidity and temperature adjustment, etc. are not supported.

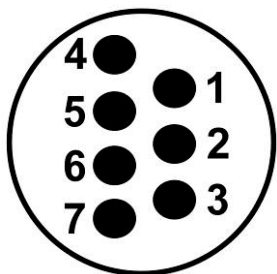
| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
| Document code | Unit |
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5.1 Physical interface

The HygroClip 2 probe can be connected directly to the I2C input of another device. When configured to use the I2C communication protocol, the function of the 7 pins of the HygroClip 2 probe connector is changed as follows:

HygroClip 2 probe: Probe connector (7-pin male – looking at probe)

RO-ASCII mode



| Pin # | Name | Function |
|-------|------------------|--|
| 1 | VDD (+) | 3.2 to 5 VDC |
| 2 | GND | Power ground and digital signal ground |
| 3 | RXD | UART |
| 4 | TXD | UART |
| 5 | Out 1 analog (+) | Humidity 0...100%RH (default) |
| 6 | Out 2 analog (+) | Temperature -40...60°C (default) |
| 7 | AGND | Analog signal ground |

I2C mode

| Pin # | Name | Function |
|-------|------------------|--|
| 1 | VDD (+) | 3.2 to 5 VDC |
| 2 | GND | Power ground and digital signal ground |
| 3 | SDA | I2C |
| 4 | CLK | I2C |
| 5 | Out 1 analog (+) | Humidity 0...100%RH (default) |
| 6 | Out 2 analog (+) | Temperature -40...60°C (default) |
| 7 | AGND | Analog signal ground |

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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Other AirChip 3000 devices:

Some AirChip 3000 based OEM products can be set to use the I2C protocol option. Please consult the hardware manual of the device.

5.2 Data string structure and data encoding

| | | | | | | | | |
|-----|------|------|------|------|------|------|------|-----|
| STR | ADDR | HMSB | HLSB | TMSB | TLSB | CMSB | CLSB | STP |
|-----|------|------|------|------|------|------|------|-----|

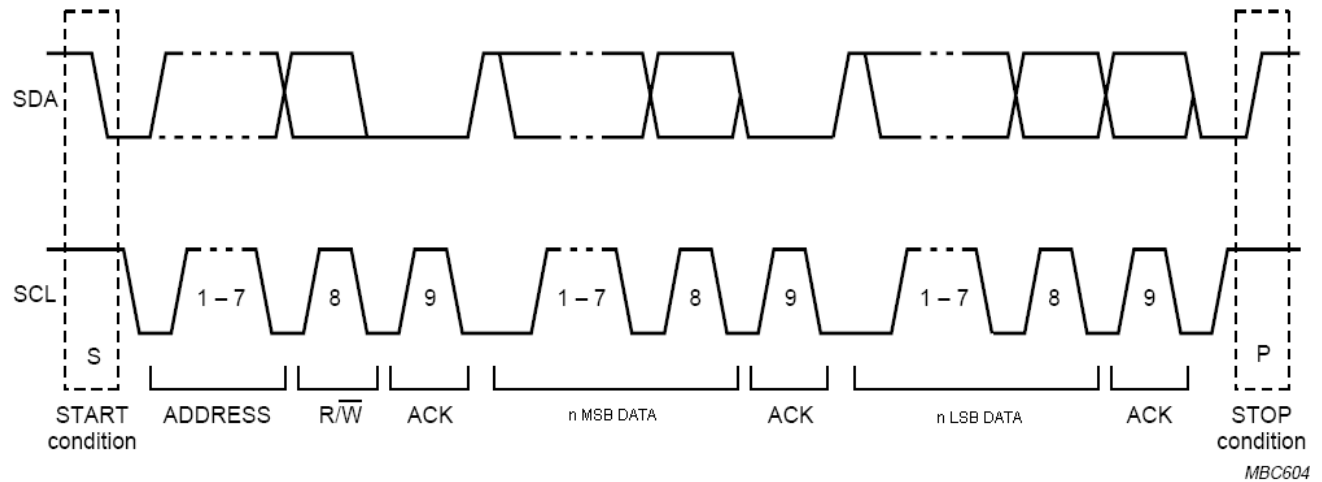
| | |
|------|--|
| STR | I2C Start Condition |
| ADDR | Slave Address (MSB: 7-bit address + LSB: "zero" bit) |
| HMSB | Relative humidity MSB |
| HLSB | Relative humidity LSB |
| TMSB | Temperature MSB |
| TLSB | Temperature LSB |
| CMSB | Calculated parameter MSB |
| CLSB | Calculated parameter LSB |
| STP | I2C Stop Condition |

Every data byte is 8-bits long and is followed by an acknowledge bit (ACK). Data is transferred with the most significant bit (MSB) first. The measurement data are transmitted in the Hex format and are numerically scaled as follows in the decimal format:

Humidity : 0...100% = 0...1000
Temperature und calculated parameter : -100...600°C = 0...7000

Data Transfer example:

| | |
|--|---|
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| | |
|--|---|
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5.3 Configuration with the HW4 software

The HW4 software (Device Manager) is used to enable the I2C protocol option and to configure the following:

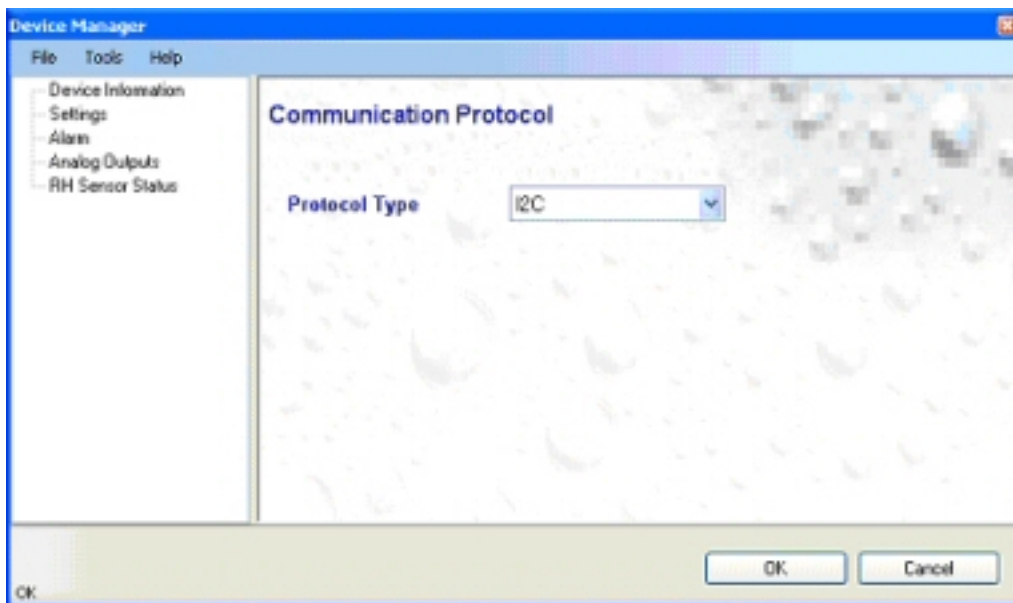
- Calculated parameter (dew point or dew / frost point)
- Temperature unit (°C/°F) – also used for the dew or frost point
- RS-485 address – used as the slave address to conform with the I2C protocol

Please note that the user cannot select which parameters are transmitted by the data string and cannot modify the sequence of the parameters.

For a list of the HW4 manuals corresponding to the different AirChip 3000 devices, please consult the following document:

E-M-HW4v3-DIR This document can be downloaded from several of the ROTRONIC websites.

Example of a HW4 configuration screen (HW4 Device Manager):



| | |
|--|---|
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The RS-485 address of the AirChip 3000 device can be changed with HW4 > Device Manager > Device Information and is used within the I2C data string as the slave address:



Click on the blue link next to the RS-485 address to open the following form and change the address:

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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6 CUSTOM PROTOCOL

The Custom communication protocol can be used to provide compatibility of the AirChip 3000 device with an existing communication system. The Custom communication protocol is limited to reading measurement data from the AirChip 3000 device. Functions such as device configuration, humidity and temperature adjustment, etc. are not supported.

The Custom protocol is applicable to all AirChip 3000 devices with a digital interface and allows RS-485 networking

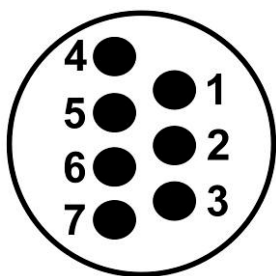
6.1 Physical interface

HygroClip 2 probe:

Use a cable that converts the probe UART interface into an existing PC interface or Ethernet port (for example cable AC3001 allows connection to a USB port). The function of the 7 pins of the HygroClip 2 probe connector is the same as in the RO-ASCII mode.

Pin-out diagram: Probe connector (7-pin male – looking at probe)

RO-ASCII mode



| Pin # | Name | Function |
|-------|------------------|--|
| 1 | VDD (+) | 3.2 to 5 VDC |
| 2 | GND | Power ground and digital signal ground |
| 3 | RXD | UART |
| 4 | TXD | UART |
| 5 | Out 1 analog (+) | Humidity 0...100%RH (default) |
| 6 | Out 2 analog (+) | Temperature -40...60°C (default) |
| 7 | AGND | Analog signal ground |

Other AirChip 3000 devices:

Depending on the model, instruments based on the AirChip 3000 feature a USB interface, a RS-485 interface or an Ethernet interface.

| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
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6.2 Data request structure

| | | |
|-----|-----|-----|
| STR | REQ | STP |
|-----|-----|-----|

STR Start character. Use the character | (vertical bar) when the string is to be passed to a slave device within a RS-485 multi-drop

REQ Data request string (maximum 4 characters). In the case of a network, use a different data request string for each individual device as a means of specifically addressing data requests to each device.

STP Stop character

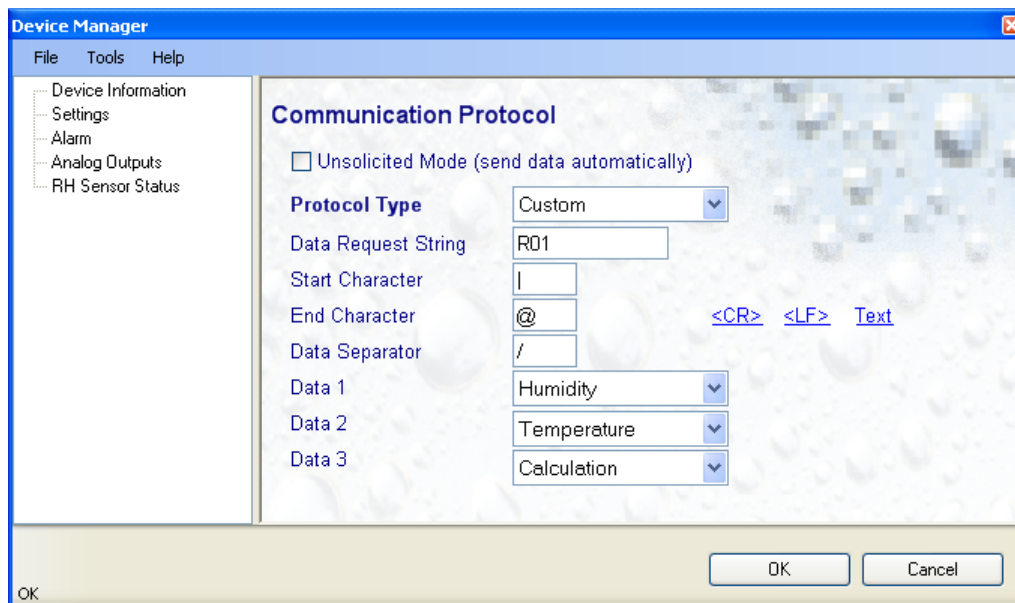
| | |
|--|---|
| E-M-AC3000-CP_22 | Rotronic AG Bassersdorf, Switzerland |
| Document code | Unit |
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6.3 Configuration with the HW4 software

The HW4 software (Device Manager) is required to define a custom communication protocol and to set the AirChip 3000 device to use this protocol. As an option, the AirChip 3000 device can be set to use a monologue communication mode by placing a check mark in the box labeled “unsolicited mode”. In this mode the AirChip 3000 device sends the measurement data automatically with each data refresh cycle, as opposed to waiting for a data request. To get the data, the receiving device must be listening at all times.

For a list of the HW4 manuals corresponding to the different AirChip 3000 devices, please consult the following document: **E-M-HW4v3-DIR**. This document can be downloaded from several of the ROTRONIC websites.

All parameters can be freely configured (data request string: limited to a maximum of 4 characters). Up to 3 measurement values can be included in the response (humidity, temperature and calculated parameter). These values can be set in any sequence within the response.



| | |
|--|---|
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Data Request String : Maximum 4 ASCII characters. In the case of a network, use a different string for each individual device as a means of addressing each data request.

Start Character : Use any ASCII character. Please note that the Start character cannot be repeated anywhere else within the data request string.

An AirChip 3000 device may be directly connected by RS-485 to a device such as an Ethernet Server. In that case the AirChip 3000 device is a master device. Do not use the vertical bar | as the start character when sending a data request to the AirChip 3000 device.

When the data request is to be passed to a slave device within a RS-485 multi-drop, be sure to use the character | (vertical bar) as the Start character.

End Character : This can be CR (Carriage Return), LF (Line Feed) or an ASCII character. Use the blue links to select one of these options

Data Separator : This ASCII character will be used in the answer after each block of data: Data 1, Data 2 and Data 3

Data 1, 2 and 3 : Use these fields to select which parameters will be returned in the answer and in which sequence

| | |
|--|---|
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6.4 Response structure

| | | | | | |
|--------|----|--------|----|--------|----|
| Data 1 | DS | Data 2 | DS | Data 3 | DS |
|--------|----|--------|----|--------|----|

Data 1, 2 and 3 : Corresponds to the parameter selected for each data block (if enabled)

DS : Data separator

Notes:

- Regardless of the numerical value of the data, each data element always consists of 6 characters. Positive values are formatted as xxx.xx and negative values as -xx.xx. The numerical limits are 999.99 for positive values and -99.99 for negative values.
- When the numerical value is less than maximum allowed by the formatting, the space character (shown here as _) is used as a place holder. Examples: 125.34, _15.34 (15.34 is preceded by one space character), -25.67, __-.05 (-0.05 is preceded by two space characters). Data blocks that are not enabled are represented by 3 space characters followed by a period and 2 space characters. Example: ____.
- Based on the above, the answer string always consists of 21 characters (3 data blocks with 6 characters each, separator after each data block) + one end character as selected by the user.
- The data format does not include any engineering unit. The unit system used for both temperature and the calculated parameter (dew or frost point) is set with HW4 as part of the device configuration.

| | |
|--|---|
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7 DEVICE IDENTIFIERS

| Device | ID | Device type |
|----------------|----|-------------|
| HP21 | F | 021 |
| HP22 | P | 022 |
| HP23 | P | 023 |
| | | |
| HF32 | F | 032 |
| HF33 | F | 033 |
| HF34 | F | 034 |
| | | |
| HF42 | F | 042 |
| HF43 | F | 043 |
| HF45 | F | 045 |
| | | |
| HF52 | H | 052 |
| HF53 | H | 053 |
| HF55 | H | 055 |
| | | |
| HF72 | F | 072 |
| HF73 | F | 073 |
| | | |
| HF83 | H | 083 |
| | | |
| HL20 | F | 120 |
| HygroLog HL-NT | K | 050 |
| | | |
| HC2 probes | F | 001 |
| HC2-S-HEATED | F | 014 |
| HC2-IC | F | 002 |
| HC2-WIN-USB | F | 005 |

| | |
|--|---|
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8 DOCUMENT RELEASES

| Doc. Release | Date | Notes |
|--------------|---------------|---|
| _10 | Aug. 18, 2008 | Original release |
| _11 | Oct. 31, 2008 | Added to following communication protocol options, available with devices with firmware version 1.3 or higher: - Modbus - I2C - Custom |
| _12 | Nov. 21, 2008 | Added a reference to document E-T-2P TempAdj for users interested in doing a 2-point temperature adjustment |
| _13 | Feb. 4, 2009 | Reference to HW4 manuals: changed file name of document E-M-HW4v2.1-DIR to E-M-HW4v2-DIR |
| _14 | Mar. 25, 2009 | RO-ASCII protocol: corrected an error in the calculation of the checksum character for command and answer strings |
| _15 | Jul. 08, 2009 | Changed the description of the LGC and ERD RO-ASCII commands |
| _16 | Sep. 17, 2009 | Corrected the value of the dew point in the example provided under 4.3 |
| _17 | Sep. 29, 2009 | Expanded the Device Identifiers list |
| _18 | Nov. 6, 2009 | Additional information regarding the answer string of the custom protocol |
| _19 | Jan. 20, 2010 | I2C protocol option: corrected the structure of the data string |
| _20 | Jun. 18, 2010 | Updated document for HW4 software v.3 |
| _21 | Nov. 21, 2013 | Updated device identifiers TST command removed |
| _22 | Dez. 03, 2014 | Response time specification |