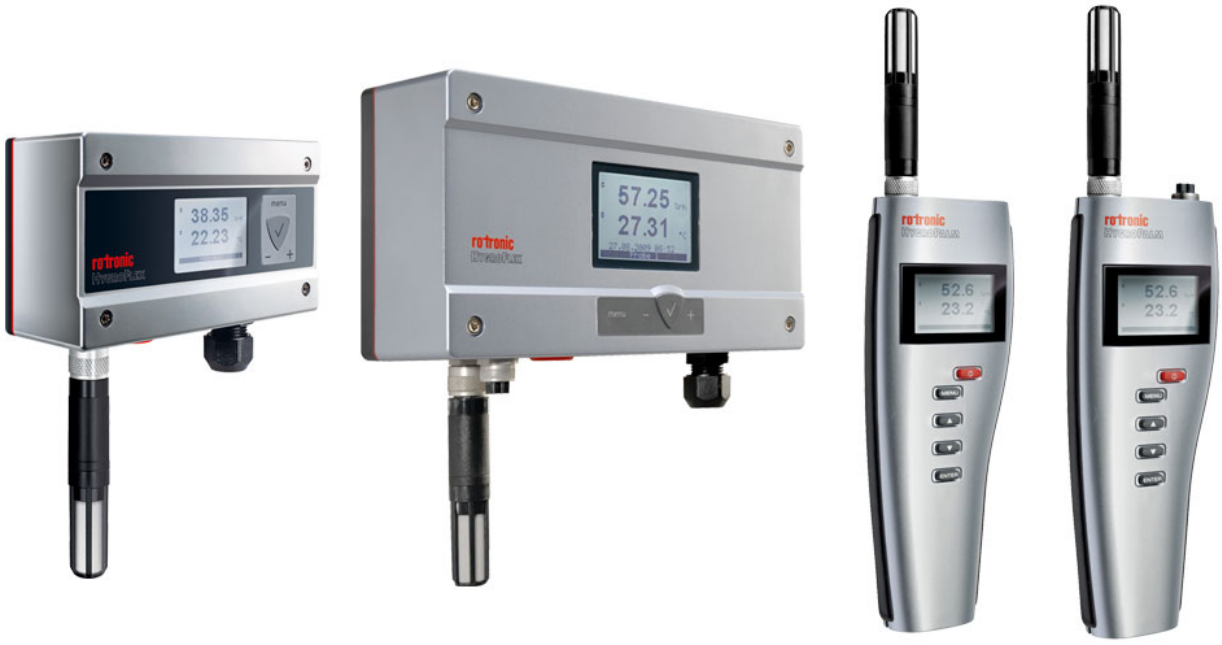
HF / HP
Digital Communication Protocol



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1 Applicability

This document applies to the following instruments:

Model	Version
HF52	V1.9
HF53, HF54, HF556, HF557	V2.2
HF56	V2.3
HF83, HF84, HF85, HF86	V2.1a
HP22	V2.4
HP23-A	V2.1a

2 Overview

The instruments covered in this document are microprocessor based devices. Depending on the model, these instruments are equipped with either one or two probe inputs. Some instrument models can be configured to accept either a digital HygroClip 2 probe or a 1-channel analog probe.

The communications protocol described in this document makes it possible for the user to digitally read measurement and other instrument data and to some extent configure an instrument without having to use a PC with the HW4 software installed. This document is limited to describing the communication protocol that should be used and does not provide explanations on how to design a suitable application based on a PC or other device.

The communication protocol presented in this document is based on command and response strings consisting of ASCII characters. The protocol can be used to communicate with instruments that are connected to a USB port or to an Ethernet LAN. The protocol can be used with devices that are used as slaves within a RS-485 drop-down network.

3 Digital connection methods

Depending on the instrument model and options, the following methods are available for a digital communication between the instrument and a PC or other device:

Instrument	Available digital connection methods
HF53, HF54, HF556, HF56, HF566	• Connection to a USB port as a master device using the instrument service connector and service cable AC3006 • Connection to a USB port as a master device (requires USB option) • Connection to a LAN as a master device (requires Ethernet option) • Connection to a RS-485 network as a slave device (requires RS-485 option and a master device such as another HF5 with RS-485 option)
HF557 (PoE)	• Connection to a USB port as a master device using the instrument service connector and service cable AC3006 • Connection to a LAN as a master device
HF83, HF84, HF86	• Connection to a USB port as a master device using the instrument service connector and service cable AC3006 • Connection to a LAN as a master device (requires Ethernet option) • Connection to a RS-485 network as a slave device (requires RS-485 option and a master device such as another HF8 with RS-485 option)
HF85 (PoE)	• Connection to a USB port as a master device using the instrument service connector and service cable AC3006 • Connection to a LAN as a master device
HP22	• Connection to a USB port as a master device using the instrument service connector and service cable AC3006
HP23-A	• Connection to a USB port as a master device using the instrument service connector (no service cable required)

4 General structure of the communication string

As a general rule, the HF5, HF8, HP22 and HP23 do not send unsolicited data. Communication must be directed to the port to which the instrument is connected and must be initiated by a command string sent to the instrument by a PC or other device. Communication ends with a response string retuned by the instrument. Both strings are constituted of ASCII characters and must use the general structure described below:

Command string:

RS-485 prefix	{	ID	Address	Command	Parameters	Checksum	CR

Response string:

{	ID	Address	Command	Parameters	Checksum	CR

4.1 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.

4.2 Response time

The maximal response time of all devices described in this document is 300 ms.

4.3 Retry time

If a device doesn't answer within the maximal response time, a new request must not be sent before 2.5 s after the last request.

4.4 Communication string components

4.4.1 RS-485 prefix

Use of the RS-485 prefix is limited to command strings that are addressed to a slave device that is part of a RS-RS-485 multi-drop network. The command must be directed to the port to which the RS-485 master is connected.

When sending a command to a RS-485 slave device, begin the string with a vertical bar | (ASCII: 124_d, $7C_h$)

Upon receiving the string, the master device (RS-485 network) strips the vertical bar and sends the rest of the string to its RS-485 driver provided that the ID and address contained in the string are not identical to the master ID and address. All slave devices in the RS-485 network receive the stripped string. Any slave device with a matching ID and address sends back a response string.

Depending on the device, the stripped command string may also be sent to the PC. The software application used by the PC should be designed so as not to confuse this string with an answer string (see Command and Response set).

Note: Do not use the vertical bar | as the start character when sending a data request to a master device

4.4.2 Beginning of the string

The opening curly bracket **{** (ASCII: 123_d, $7B_h$) is used to mark the beginning of either a command or response string.

4.4.3 ID

Each type of instrument has its own ID consisting of one ASCII character:

HP22 / HP23	ID = P
HF5 / HF8	ID = H

Space character can be used temporarily to communicate with an instrument with unknown ID.

4.4.4 Address

Each instrument has a RS-485 address (0 to 63) that can be configured by the user. To get a response, the address defined in the command string must agree with the instrument address.

Address 99 can be used temporarily to communicate with an instrument of unknown address, provided that the instrument is not a slave device within a RS-485 multi-drop network. This address causes all instruments with the ID specified in the command string to answer regardless of their address. The actual instrument address is returned as part of the answer string.

Preferably, address 99 should be used only when a single instrument is connected to the PC or device that issues the commend string.

4.4.5 Command

Commands consist of three ASCII characters. For details see “Command Set” further in this document.

4.4.6 Parameters

Depending on the command, either the command string or the response string may include a number of data elements constituted of ASCII characters. Each individual data element (including the last) is followed by a semi-colon separator (ASCII: 59_d, $3B_h$).

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

For details see “Command Set” further in this document.

4.4.7 Checksum

The checksum consists of one ASCII character that is used to verify the integrity of the data transmission both in the case of a command string or a response string.

In the case of a command string, the checksum can be replaced with a closing curly bracket } (ASCII: 125_d, $7D_h$). When the ASCII character } is used in a command string, the instrument does not attempt to evaluate a checksum.

The ASCII character representing the checksum is determined as follows:

Hex value of the 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: RS-485 character (|), closing curly bracket (}) and (CR). The initial opening curly bracket ({) must be counted.

Example: checksum character for the string {F09RDD = $

4.4.8 End of the string

The end of the string is marked by a carriage return CR (ASCII: 13_d, $0D_h$).

5 Command set

5.1 Read the instrument firmware version, serial number and device description: STA

Note: this command **applies only to the HF8 transmitter and HP23-A indicator**

Command string:

{	ID	Address	**STA**	Checksum	CR

Response string:

{	ID	Address	**sta**	Parameters	Checksum	CR

Please note that the command is repeated in lower case characters within the response string.

Parameters:

V2.0a	Firmware version
12345678	10 character serial number
HP23 Lab	12 character device description

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.2 Read the instrument serial number: SRC

Note: this command **applies only to the HF5 and HF8 transmitters**

This command is used to read the serial number of an instrument located in a RS-485 drop-down network when the RS-485 address is not known.

Command string:

{	ID	99	**SRC**	Parameter	Checksum	CR

Parameter:

0, 3 Time delay (used when data packet collisions occur)

Response string:

{	Serial number	}

The answer is sent back after a time out that is determined on the basis of the instrument serial number.

5.3 Read the instrument status and settings: RDS

This command is used to read the status of the instrument and some of its settings.

Command string:

{	ID	Address	**RDS**	Checksum	CR

Response string:

{	ID	Address	**rds**	Parameters	Checksum	CR

Please note that the command is repeated in lower case characters within the response string.

Parameters for the HF5 and HP22 :

0…12000	Battery voltage [mV] (HF5: this parameter is irrelevant)
0…1	Display status (0 = no display, 1 = instrument with display)
1…5	Analog output signal type (HP22: this parameter is irrelevant)
	1 = 0…1V 2 = 0…5V 3 = 0…10V 4 = 0…20 mA 5 = 4…20 mA
0…3	Analog output stage activated: bit-coded Bit0 = output 1, Bit1 = output 2
English	Language used for the instrument the internal menu
0…200	Seconds since power up (maximum 200s)
0…1	Device write protection (0= ON 1= OFF)

Note: each individual data element (including the last) is followed by a semi-colon (separator).

Parameters for the HF8 and HP23:

0123456789	Real clock date and time, counting since 01/01/2000 00:00
0…12000	Battery voltage [mV] (HF8: this parameter is irrelevant)
0…12000	Internal Supply voltage [mV] (HP23: USB interface voltage)
0…3	Battery status 0 = no battery 1 = empty battery 2 = low battery 3 = good
0…2	Supply voltage status 0 = no power supply 1 = power is available 2 = unknown status
0…1	Battery charge function setting (0 = do not charge 1 = recharge)
0…1	Data logging function status (0 = OFF 1 = ON)
0…40000	Current size of the log file size [Byte]
0…250	Number of entries in data bin 1
0…250	Number of entries in data bin 2
0…250	Number of entries in data bin 3
0…250	Number of entries in data bin 4
0…250	Number of entries in data bin 5
0…250	Number of entries in data bin 6
0…250	Number of entries in data bin 7
0…250	Number of entries in data bin 8
0…250	Seconds since power up (maximum 200s)
0…1	Display Status (0 = no display 1 = display)
English	Language used for the instrument the internal menu
0…2	Device write protection (0= ON 1= OFF)

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.4 Change the instrument RS-485 address: REN

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

Note: this command does not apply to the HF52 (2-wire, loop powered)

Command string:

{	ID	Current Address	**REN**	Parameters	Checksum	CR

Parameters:

1234567890	10 character serial number of the instrument
0 to 63	New RS-485 address

Note: each individual data element (including the last) is followed by a semi-colon (separator).

Response string:

{	ID	New Address	**ren**	OK	Checksum	CR

Please note that the command is repeated in lower case characters within the response string.

5.5 Read measurement data from the instrument: RDD (HF5 / HP22)

This command is used to read the data measured or calculated by the instrument as well as other relevant information.

Command string:

{	ID	Address	**RDD**	Checksum	CR

Response string:

{	ID	Address	**rdd**	Parameters	Checksum	CR

Parameters:

► Probe data (HygroClip 2 probe):

1	Data source (1 = digital HygroClip 2 probe - HC2)
1234.56	Humidity value (--.-- when no connection with a probe)
%RH	User defined humidity unit (%RH or other)
0...1	Humidity alarm status (0 = no alarm, 1= alarm)
+	Humidity trend (+,-,= or space, when no values are available for the trend)
1234.56	Temperature value (--.-- when no connection with a probe)
°C	Temperature unit (°C or °F)
0…1	Temperature alarm status (0 = no alarm, 1= alarm)
=	Temperature trend (+,-,= or space, when no values are available for the trend)
Dp	Calculated parameter (Prefix)
1234.56	Calculated value (--.-- when no value is available)
°C	Calculated parameter unit
0…1	Calculated parameter alarm status (0 = no alarm, 1= alarm)
+	Calc. Parameter trend (+,-,= or space, when no values are available for the trend)
1..255	Device type (1 = HygroClip 2)
V1.7-1	Probe firmware version
1234567890	Probe serial number (10 characters)
Probe	Probe input description (12 characters)
000…255	Probe alarm byte: bit coded Bit0 = measured or calculated value, Bit1 = low battery, Bit2 = power, Bit3 = FDA, Bit4 = data recording, Bit5 = sensor test, Bit6 = humidity simulator, Bit7 = temperature simulator

► Instrument data:

6	Data source (6 = instrument)
1..255	Instrument type (53 = HF53…)
V2.0-1	Firmware version
1234567890	Instrument serial number (10 characters)
HF53	Instrument description (12 characters)
000…255	Instrument alarm byte: bit coded Bit0 = measured or calculated value, Bit1 = low battery (HF5: always 0), Bit6 = humidity simulator, Bit7 = temperature simulator

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.6 Read measurement data from the instrument: RDD (HF8 / HP23)

This command is used to read the data measured or calculated by the instrument as well as other relevant information.

Command string:

{	ID	Address	**RDD**	Checksum	CR

Response string:

{	ID	Address	**rdd**	Parameters	Checksum	CR

Parameters:

► Probe data (digital HygroClip 2 probe connected to input 1):

1	Data source (1 = digital HygroClip 2 probe - HC2)
1234.56	Humidity value (--.-- when no connection with a probe)
%RH	Humidity unit (%RH or Aw)
0...1	Humidity alarm status (0 = no alarm, 1= alarm)
+	Humidity trend (+,-,= or space, when no values are available for the trend)
1234.56	Temperature value (--.-- when no connection with a probe)
°C	Temperature unit (°C or °F)
0…1	Temperature alarm status (0 = no alarm, 1= alarm)
=	Temperature trend (+,-,=or space, when no values are available for the trend)
Dp	Calculated parameter (Prefix)
1234.56	Calculated value (--.-- when no value is available)
°C	Calculated parameter unit
0…1	Calculated parameter alarm status (0 = no alarm, 1= alarm)
+	Calc. parameter trend (+,-,= or space, when no values are available for the trend)
1..255	Device type (1 = HygroClip 2)
V1.0	Probe firmware version
1234567890	Probe serial number (10 characters)
Probe 1	Probe input description (12 characters)
000…255	Probe alarm byte: bit coded Bit0 = measured or calculated value, Bit1 = low battery, Bit2 = power, Bit3 = FDA, Bit4 = data recording, Bit5 = sensor test, Bit6 = humidity simulator, Bit7 = temperature simulator

► Probe data (1-channel analog probe connected to input 1):

2…3	Data source (2 = analog probe, 3 = analog pressure probe)
1234.56	Analog signal value (--.-- when no connection with a probe)
abcd	Analog signal unit
0..255	Analog alarm byte (Bit0 = analog value, Bit6 = fixed value - simulator)
+	Analog signal trend (+,-,= or space, when no values are available for the trend)
Probe 1	Probe input description (12 characters)

NOTE: any digital or analog probe connected to probe input 2 is processed in the same manner

► Relay data (HF8 only):

5	Data source (5 = Relay)
1	Relay status (1 = energized, 0 = de-energized)
0…1	Alarm
Relay	Relay description (12 characters)

Note: this is repeated for each relay, starting with relay 1 (ascending sequence)

► Instrument data:

6	Type (6 = Instrument)
1..255	Instrument type (23 = HP23, 83 = HF83 …)
V2.0	Instrument firmware version
1234567890	Instrument serial number (10 characters)
HP23	Instrument description (12 characters)
000…255	Instrument alarm byte: bit coded Bit0 = measured or calculated value, Bit1 = low battery (HF8: always 0), Bit6 = fixed value 1 – humidity simulator, Bit7 = fixed value 2 – temperature simulator

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.7 Adjust the instrument internal clock: TID (HF8 / HP23)

This command is used to adjust the date and time of the instrument real time clock.

Command string:

{	ID	Address	**TID**	Parameter	Checksum	CR

Parameter:

Time in seconds (maximum 10 characters) counting from 01/01/2000 at 00:00 (leap years and DST should be both taken into consideration)

Example: 0341319857 → Oct. 25, 2010 11:06:

Response string:

{	ID	Address	**tid**	OK	Checksum	CR

Please note that the command is repeated in lower case characters within the response string.

5.8 Read or write the log function configuration settings: LGC (HF8 / HP23)

This command is used to read and write the settings of the data logging function.

► ***Read the configuration settings:***

Command string:

{	ID	Address	**LGC**	Checksum	CR

Response string:

{	ID	Address	**lgc**	Parameters	Checksum	CR

Parameters:

0…1	Log function status (0 = ON, 1 = OFF)
0…1	Log function mode (0 = start-stop, 1 = loop)
3, 24, 27	Recorded probe inputs: 3 = probe input 1 24 = probe input 2 27 = probe input 1 and probe input 2
5…43200	Log interval [s] 5s…12h
0…40000	Current size of the log file in Bytes (read only)

Note: each individual data element (including the last) is followed by a semi-colon (separator).

► ***Write the configuration settings:***

Command string:

{	ID	Address	**LGC**	Parameters	Checksum	CR

Parameters:

0…1	Log function status (0 = ON, 1 = OFF)
0…1	Log function mode (0 = start-stop, 1 = loop)
3, 24, 27	Recorded probe inputs: 3 = probe input 1 24 = probe input 2 27 = probe input 1 and probe input 2
5…43200	Log interval [s] 5s…12h

Note: each individual data element (including the last) is followed by a semi-colon (separator).

Response string:

{	ID	Address	**lgc**	OK	Checksum	CR

NOTES:

- When the log function is ON, it must be turned OFF prior to starting a new recording.
- When a new recording is started any previously recorded data is erased.

5.9 Write custom calculation formulas: LF1/LF2 (HP23)

This command is used to write the formulas used for up to two custom calculations (LF1 and LF2).

- A formula must be error free in order to be accepted by the instrument.
- When there is an error in the new formula, any previous formula remains in effect.
- The response string returns the index (position) of the first erroneous character.

Command string:

{	ID	Address	**LF1** **LF2**	Parameter	Checksum	CR

Parameter:

Examples: "HU1 – HU2" or "19.45/16.2*HU1"	Custom calculation

Response string:

{	ID	Address	**lfQ** **lfR**	Parameters	Checksum	CR

Parameters:

OK	The custom calculation formula has been accepted
1…64	Error in the formula, position of the first erroneous character

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.10 Write additional custom calculation settings: LFD (HP23)

This command is used to further configure the custom calculations.

Command string:

{	ID	Address	**LFD**	Parameters	Checksum	CR

Parameters:

XX	2- character prefix – custom calculation 1
YY	2- character prefix – custom calculation 2
AAAA	4-character unit – custom calculation 1
BBBB	4-character unit – custom calculation 1
ABCDEFGHIJKL	Description (12 characters)
1…0	Enable or disable custom calculations (0 = OFF, 1 = ON)

Note: each individual data element (including the last) is followed by a semi-colon (separator).

Response string:

{	ID	Address	**lfd**	OK	Checksum	CR

5.11 Read the custom calculations results: RDF (HP23)

This command is used to read the results of the custom calculations.

Command string:

{	ID	Address	**RDF**	Checksum	CR

Response string:

{	ID	Address	**rdf**	Parameters	Checksum	CR

Parameters:

XX	2- character prefix – custom calculation 1
22.231	Value returned by custom calculation 1
AAAA	4-character unit – custom calculation 1
XX	2- character prefix – custom calculation 2
22.231	Value returned by custom calculation 2
BBBB	4-character unit – custom calculation 2

Note: each individual data element (including the last) is followed by a semi-colon (separator).

5.12 Read all psychrometric values: RDP (HF53)

This command returns all psychrometric values as well as the information necessary to interpret the data (calculated parameter type, engineering units).

Command string:

{	ID	Address	**RDP**	Checksum	CR

Response string:

{	ID	Address	**rdp**	Parameters	Checksum	CR

Parameters:

1..3	Probe type (1= digital probe, 2=analog probe, 3=pressure probe)
Dp	Calculated parameter type: Dew point
1234.56	Dew point
°C	Temperature engineering unit
Fp	Calculated parameter type: Frost point
1234.56	Frost point
°C	Temperature engineering unit
Tw	Calculated parameter type: Wet-bulb temperature
1234.56	Wet-bulb temperature
°C	Temperature engineering unit
H	Calculated parameter type: Enthalpy
1234.56	Enthalpy
KJkg	Enthalpy engineering unit
Dv	Calculated parameter type: Vapor concentration
1234.56	Vapor concentration
g/m3	Concentration engineering unit
Q	Calculated parameter type: Specific humidity
1234.56	Specific humidity
g/kg	Specific humidity engineering unit
R	Calculated parameter type: Mixing ratio by weight
1234.56	Mixing ratio by weight
g/kg	Ratio by weight engineering unit
Ds	Calculated parameter type: Saturation vapor concentration
1234.56	Saturation vapor concentration
g/m3	Concentration engineering unit
E	Calculated parameter type: Vapor partial pressure
1234.56	Vapor partial pressure
hPa	Pressure engineering unit
Ew	Calculated parameter type: Vapor saturation pressure
1234.56	Vapor saturation pressure
hPa	Pressure engineering unit

Note: each individual data element (including the last) is followed by a semi-colon (separator).

Example:

{H00rdp 1;Dp;-24.31; °C;Fp;-21.99; °C;Tw;-12.31; °C;H ;-8.737;kJkg;Dv; 0.707;g/m3;Q ; 0.527;g/kg;R ; 0.527;g/kg;Ds; 2.356;g/m3;E ; 0.859; hPa;Ew; 2.862; hPa;A

6 Device identifiers

Device	ID
HP22	P
HP23	P
HF5 - all models	H
HF8 - all models	H

7 Document releases

Doc. Release	Date	Notes
_10	Dec. 14, 2010	Original release
_11	Aug. 21, 2012	Release with description of the command RDP
_12	Nov. 21, 2013	- HCC command removed - command timing added in general description
_13	Sept. 03, 2015	Correction of relays status on page 16