

UT8804 Communication Protocol

Version 1.0

Protocol Overview

1. Data Types

uint8_t Unsigned 8-bit integer
uint16_t Unsigned 16-bit integer
uint32_t Unsigned 32-bit integer

1) Date and Time

```
typedef struct {  
    uint32_t year      : 6;  
    uint32_t month     : 4;  
    uint32_t day       : 5;  
    uint32_t hour      : 5;  
    uint32_t minute    : 6;  
    uint32_t second    : 6;  
}date_time_t;
```

Actual year = 2000 + date_time. year;

2) Measurement Status

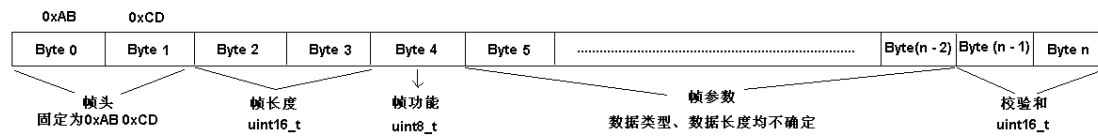
```
typedef struct{  
    uint8_t vst  : 4;  
    uint8_t dot  : 4;  
}value_st_t;
```

value_st.dot specifies the number of decimal places to be displayed.

value_st.vst	0	1	2	Other
Description	Normal Range	Forward OL	Negative OL	Measurement Not Available

2. Data Frame Format

Each data frame is transmitted or received in the following format.



Frame Header

Each frame begins with the fixed sequence 0xAB, 0xCD.

Frame Length

The frame length excludes the 4 bytes occupied by the Frame Header and Frame Length fields and is calculated as: $\text{Frame Length} = (n + 1) - 4$

Frame Function

Specifies the command code or data type associated with the current frame.

Frame Parameters

Contains command parameters or data payload. The length and data type are application-dependent and may be omitted.

Checksum

The checksum is the arithmetic sum of all unsigned 8-bit integers from Byte 2 through Byte (n - 2).

Note

- Multi-byte data is transmitted in little-endian format (**LSB** first).
- For simplicity, when the Frame Function field specifies a data type rather than a command code, it is still treated as a command and described using the same convention throughout this document.

Accordingly, the preceding description may be restated as follows:

Excluding the Frame Length field in the frame prefix and the Checksum field in the frame suffix, the Frame Function and Frame Parameters fields together constitute the command content. For details, refer to the section **Command Details**.

3. Basic Communication Mechanism

Communication Parameters

Baud Rate: 9600
Parity: None
Start Bits: 1
Stop Bits: 1
Data Bits: 8 (LSB first)

After sending a command to the device, the PC shall wait for a response from the device. Depending on the command, the response may consist of an acknowledgment, real-time measurement data, REC_DOT data, or other information. Refer to the detailed description of each command for specific response formats.

If no response is received within 500 ms after command transmission is complete, the communication attempt shall be considered unsuccessful. In this case, the PC may retransmit the command or perform other appropriate error-handling procedures.

The Frame Header indicates the beginning of a frame. However, the occurrence of a Frame Header sequence within the data stream does not necessarily indicate the start of a new frame. During frame reception, the Frame Length field shall be used to determine the end of the current frame. A received Frame Header sequence shall be recognized as the start of a new frame only when the receiver is in the frame synchronization state (receive-ready state).

PC to Device

Command List

	Command Code	Function	Device Response
Measurement Settings	1	Set the measurement function.	Returns Response Data indicating success or failure.
	2	Set the measurement range.	Returns Response Data indicating success or failure.
	3	Configure the relative measurement function.	Returns Response Data indicating success or failure.
	4	Enter, exit, or restart MAX/MIN mode.	Returns Response Data indicating success or failure.
	18	Trigger the HOLD function.	Returns Response Data

			indicating success or failure.
Real-Time Measurement Data	5	Read the current measurement data.	Returns Real-Time Measurement Data or Response Data.
Data Storage	6	Save the current measurement to device memory.	Returns Response Data indicating success or failure.
	7	Read a stored measurement record with the specified record number.	Returns Measurement Record Data or Response Data indicating failure.
	8	Query the number of measurement records stored in device memory.	Returns Query Response Data or Response Data indicating failure.
	9	Delete a specified measurement record or all measurement records from device memory.	Returns Response Data indicating success or failure.
Trend Logging	10	Start trend logging using the specified parameters.	Returns Response Data indicating success or failure.
	11	Stop the current trend recording and save the recorded data.	Returns Response Data indicating success or failure.
	12	Read the summary information of a trend record with the specified record number.	Returns Trend Summary Data or Response Data indicating failure.
	13	Read trend data points from the specified trend record and position.	Returns Trend Data Point Values or Response Data indicating failure.
	14	Query the number of trend records stored in device memory.	Returns Response Data indicating failure.
	15	Delete a specified trend record or all trend records from device memory.	Returns Response Data indicating success or failure.
System Settings and Information	16	Set the system date and time.	Returns Response Data indicating success or failure.
	17	Query device information, including the model number and serial number.	Returns Query Response Data.

Command Details

The following sections describe only the command-specific content and do not include the Frame Header, Frame Length, or Checksum fields required for frame transmission. During actual communication, these fields shall be added in accordance with the frame format. For details, refer to the section **Data Frame Format**.

1. Measurement Function

This command selects the specified measurement function on the device. The available measurement functions depend on the current switch position of the device.

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
1	(uint16_t) MEASURE_CODE	

Frame Function: Command code. The command code for this command is 1.

Frame Parameter: Specifies the measurement function to be selected.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

Function	MEASURE_CODE		Function	MEASURE_CODE
VAC	0x1110		°C_T1,T2	0x8110
VAC+Hz	0x1120		°C_T2,T1	0x8120
VAC_Peak	0x1130		°C_T1-T2	0x8130
VAC_Low Pass	0x1140		°C_T2-T1	0x8140
VAC_dBV	0x1150		°F_T1,T2	0x8210
VAC_dBm	0x1160		°F_T2,T1	0x8220
			°F_T1-T2	0x8230
mVAC	0x2110		°F_T2-T1	0x8240
mVAC+Hz	0x2120			
mVAC_PEAK	0x2130		uADC	0x9110
mVAC_AC+DC	0x2140		uADC_Peak	0x9120
			uADC_AC+DC	0x9130
VDC	0x3110		uAAC	0x9210
VDC_Peak	0x3120		uAAC+Hz	0x9220
VDC_AC+DC	0x3130		uAAC_Peak	0x9230

mVDC	0x4110		mADC	0xA110
mVDC_Peak	0x4120		mADC_Peak	0xA120
			mADC_AC+DC	0xA130
OHM	0x5110		mAAC	0xA210
BEEP	0x5210		mAAC+Hz	0xA220
nS	0x5310		mAAC_Peak	0xA230
DIODE	0x6110		ADC	0xB110
CAP	0x6210		ADC_Peak	0xB120
			ADC_AC+DC	0xB130
FREQUENCY	0x7110		AAC	0xB210
DUTY	0x7210		AAC+Hz	0xB220
Ms-Pulse	0x7310		AAC_Peak	0xB230

2. Range Command

This command changes the measurement range mode or sets the device to a specified range.

Command Format

Byte 0	Byte 1
Frame Function	Frame Parameter
2	(uint8_t) RANGE_CODE

Frame Function: Command code. The command code for this command is 2.

Frame Parameter: Command parameter; specifies the range mode or the selected range.

RANGE_CODE	0	0 < RANGE_CODE < Number of Ranges	RANGE_CODE > Number of Ranges
Description	Enter Auto Range mode.	Enter Manual Range mode and select the specified range.	Enter Manual Range mode and increase the range by one step.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

3. Relative Value Function Settings

This command enables the device to enter or exit Relative Measurement mode, or to set

a reference value.

Command Format

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Frame Function	Frame Parameter				
3	(uint8_t)MODE	(float)REL_REF			

Frame Function: Command code. The command code for this command is 3.

Frame Parameter:

- **MODE:** 0x00 = Exit Relative Measurement mode; 0x01 = Enter Relative Measurement mode.
- **REL_REF:** Specifies the reference value. If the specified value exceeds the maximum value supported by the current measurement range, the device uses the current measurement value as the reference value. If the current measurement value is unavailable (for example, OL or -OL), the device returns an error response.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

4. MAX MIN Command

This command enables the device to enter or exit MAX/MIN mode.

This command is unavailable when the device is operating in Relative Measurement (REL) mode, Peak (PEAK) mode, measurement record recall mode, trend record recall mode, or trend recording mode.

Command Format

Byte 0	Byte 1
Frame Function	Frame Parameter
4	(uint8_t) MAXMIN_CODE

Frame Function: Command code. The command code for this command is 4.

Frame Parameter: Command parameters, as described in the table below.

Device Status	Normal Mode		MAXMIN Mode	
MAXMIN_CODE	0	1	0	1
Action	Error	Enter MAXMIN	Exit MAXMIN	Restart

After receiving the command, the device returns the processing result in the form of

Response Data. For details, refer to the section **Response Data**.

Note

This command is unavailable when the device is operating in Relative Measurement (REL) mode, Peak (PEAK) mode, measurement record recall mode, trend record recall mode, or trend recording mode.

5. Reading Real-Time Measurement Data

The device supports two modes for reading real-time measurement data: Normal Mode and Automatic Mode. By default, the device operates in Normal Mode.

In Normal Mode, the PC sends a single read request, and the device returns a single set of measurement data. In Automatic Mode, the device automatically transmits measurement data at approximately 100 ms intervals.

Command Format

Byte 0	Byte 1
Frame Function	Frame Parameter
5	(uint8_t) READ_CODE

Frame Function: Command code. The command code for this command is 5.

Frame Parameter: Command parameters; specifies the read mode.

Refer to the table below for details.

READ_CODE	0		1	
Device Status	Normal Mode	Automatic Mode	Normal Mode	Automatic Mode
Action	Return one set of measurement data.	Return to Normal Mode.	Enter Automatic Mode.	No action.

After receiving the command, the device returns the corresponding data. If the command causes the device to return to Normal Mode, the device returns Response Data. For details, refer to the section **Response Data**. For all other commands, the device returns Real-Time Measurement Data. For details, refer to the section **Real-Time Measurement Data**.

6. Save a Measurement

Use this command to save the current measurement data to the device memory.

Command Format

Byte 0	—
Frame Function	None
6	—

Frame Function: Command code. The command code for this command is 6.

Frame Parameter: None.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

7. Read a Single Measurement

Use this command to retrieve a single measurement record previously saved in the device memory.

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
7	(uint16_t) READ_INDEX	

Frame Function: Command code. The command code for this command is 7.

Frame Parameter: `READ_INDEX` specifies the index of the measurement record to be retrieved, where $0 < \text{READ_INDEX} \leq \text{Number of Stored Records}$.

After receiving the command, the device returns the processing result. If the retrieval is successful, the device returns Measurement Record Data. For details, refer to the section **Measurement Record Data**. Otherwise, the device returns Response Data. For details, refer to the section **Response Data**.

8. Query the Number of Stored Measurement Records

Use this command to query the number of measurement records stored in the device memory.

Command Format

Byte 0	—
Frame Function	None
8	—

Frame Function: Command code. The command code for this command is 8.

Frame Parameter: None.

After receiving the command, the device returns the processing result. If the query is successful, the device returns Query Response Data. For details, refer to the section **Query Response Data**. Otherwise, the device returns Response Data. For details, refer to the section **Response Data**.

In the returned **Query Response Data**, the data format for this command is as follows:

Byte 0	Byte 1	Byte 2	Byte 3
Frame Function	Frame Parameter		
114	8	(uint16_t) AMOUNT	

9. Delete Stored Measurement Records

Use this command to delete a specified measurement record or all measurement records from the device memory.

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
9	(uint16_t) DEL_INDEX	

Frame Function: Command code. The command code for this command is 9.

Frame Parameter: DEL_INDEX; see the table below:

DEL_INDEX	0<DEL_INDEX≤ Number of Stored Records	0xFFFF	Other Values
Processing Result	Delete the corresponding measurement record.	Delete all measurement records.	Return an error.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

10. Enable Trend Logging

Use this command to enable the devices trend logging function.

Command Format

Byte 0	Byte 1-11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16	Byte 17
Frame Function	Frame Parameter						
10	NAME CHARS	(uint16_t)Interval		(uint32_t)Duration			

Frame Function: Command code. The command code for this command is 10.

Frame Parameter:

- NAME_CHARS: Record name string. Occupies 11 bytes, supports a maximum of 10 characters, and must be terminated with 0.
- Interval: Recording interval, in seconds. $0 < \text{Interval} < 600$.
- Duration: Recording duration, in minutes. $0 < \text{Duration} < 144000$.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

11. Stop Trend Recording

When the device is in Trend Recording mode, this command stops the current recording and automatically saves the recorded data.

Command Format

Byte 0	—
Frame Function	None
11	—

Frame Function: Command code. The command code for this command is 11.

Frame Parameter: None.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

12. Read Trend Record Summary

Use this command to retrieve summary information for a trend record stored in the device memory.

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
12	(uint16_t) READ_INDEX	

Frame Function: Command code. The command code for this command is 12.

Frame Parameter: READ_INDEX specifies the record number to be retrieved, where $0 < \text{READ_INDEX} \leq \text{Number of Stored Trend Records}$.

After receiving the command, the device returns the processing result. If the retrieval is successful, the device returns Trend Summary Data. For details, refer to the section **Trend Summary Data**. Otherwise, the device returns Response Data. For details, refer to the section **Response Data**.

13. Read Trend Data Point Values

Point Value: The value of each sample point recorded during trend recording.

This command retrieves data point values from a specified trend record, starting at a specified position. Depending on the number of remaining sample points, the device returns up to 100 data point values at a time.

Command Format

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Frame Function	Frame Parameter					
13	(uint16_t) Rec_index	(uint32_t) Start dot index				

Frame Function: Command code. The command code for this command is 13.

Frame Parameter:

- REC_INDEX:** Specifies the record number to be retrieved, where $0 < \text{REC_INDEX} \leq \text{Number of Stored Trend Records}$.
- START_DOT_INDEX:** Specifies the index of the first data point to be retrieved, where

$0 < \text{START_DOT_INDEX} \leq \text{Number of Sample Points}$.

After receiving the command, the device returns the processing result. If the retrieval is successful, the device returns Trend Data Point Values. For details, refer to the section **Trend Data Point Values**. Otherwise, the device returns Response Data. For details, refer to the section **Response Data**.

14. Query the Number of Trend Records

Use this command to query the number of trend records stored in the device memory.

Command Format

Byte 0	—
Frame Function	None
14	—

Frame Function: Command code. The command code for this command is 14.

Frame Parameter: None.

After receiving the command, the device returns the processing result. If the query is successful, the device returns Query Response Data. For details, refer to the section **Query Response Data**. Otherwise, the device returns Response Data. For details, refer to the section **Response Data**.

In the returned **Query Response Data**, the data format for this command is as follows:

Byte 0	Byte 1	Byte 2	Byte 3
Frame Function	Frame Parameter		
114	14	(uint16_t) AMOUNT	

15. Delete Stored Trend Records

Use this command to delete a specified trend record or all trend records from the device memory.

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
15	(uint16_t) DEL_INDEX	

Frame Function: Command code. The command code for this command is 15.

Frame Parameter: DEL_INDEX; see the table below.

DEL_INDEX	0<DEL_INDEX≤ Number of Stored Records	0xFFFF	Other Values
Processing Result	Delete the corresponding trend record.	Delete all measurement records.	Return an error.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

16. Set the System Date and Time

Use this command to set the devices system date and time.

Command Format

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
Frame Function	Frame Parameter			
16	(date_time_t) date_time			

Frame Function: Command code. The command code for this command is 16.

Frame Parameter: Specifies the new date and time. For details about date_time_t, refer to the **Data Types** section.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

17. Query Device Information

Use this command to query the device model and serial number.

Command Format

Byte 0	—
Frame Function	None
17	—

Frame Function: Command code. The command code for this command is 17.

Frame Parameter: None.

After receiving the command, the device returns Query Response Data. For details, refer

to the section **Query Response Data**.

In the returned **Query Response Data**, the data format for this command is as follows:

Byte 0	Byte 1	Byte 2-12	Byte 13-n
Frame Function	Frame Parameter		
114	17	MODEL_CHS	SN_CHS

MODEL_CHS: A string representing the device model, terminated with 0x00.

SN_CHS: A string representing the device serial number, terminated with 0x00. The maximum length is 26 bytes.

18. Trigger HOLD

This command triggers the devices HOLD function, causing the device to enter or exit the HOLD state.

Command Format

Byte 0	Byte 1
Frame Function	Frame Parameter
18	(uint8_t) 0x5A

Frame Function: Command code. The command code for this command is 18.

Frame Parameter: The parameter is fixed at 0x5A.

After receiving the command, the device returns the processing result in the form of Response Data. For details, refer to the section **Response Data**.

Device to PC

1. Response Data

Command Format

Byte 0	Byte 1	Byte 2
Frame Function	Frame Parameter	
1	(uint8_t) A	(uint8_t) B

Frame Function: Data type code. The data type code for Response Data is 1.

Frame Parameter: Response data.

Return Result	Success		Failure		Unknown Command	
A B Value	'O'	'K'	'E'	'R'	'N'	'O'

2. Real-Time Measurement Data

As shown in the figure below, the display areas on the device are named as follows.

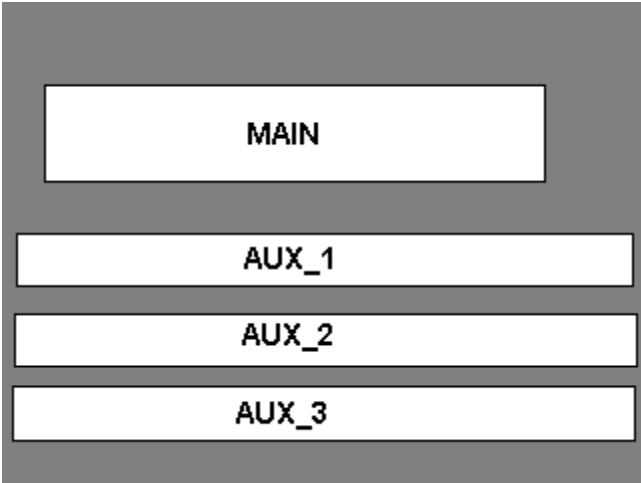


Figure: Display Layout

- **MAIN:** Main display area
- **AUX_1:** Auxiliary Display 1
- **AUX_2:** Auxiliary Display 2
- **AUX_3:** Auxiliary Display 3

Command Format

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	...	Byte n
Frame Function	Frame Parameter							
2	(uint16_t) FLAG	(uint16_t) MEASURE_CODE		(uint8_t) RANGE	Data Segment			

Frame Function: Data type code. The data type code for Real-Time Measurement Data is 2.

Frame Parameter: Measurement data.

- **FLAG:** Status flags. See the table below.
- **MEASURE_CODE:** Specifies the measurement function currently performed by the device. For details, refer to the **Measurement Function** section, which lists the code for each measurement function.
- **RANGE:** Specifies the current measurement range of the device.
- **Data Segment:** Contains the measurement data. The data segment is divided into Standard and MAX/MIN types, as described in the following sections.

Table FLAG Bit Definitions

Bit	Name	Description	
		0	1
0	AUX_1	Auxiliary Display 1 not present	Auxiliary Display 1 present
1	AUX_2	Auxiliary Display 2 not present	Auxiliary Display 2 present
2	AUX_3	Auxiliary Display 3 not present	Auxiliary Display 3 present
3	BAR	Analog bar not present	Analog bar present
4	REL	Non-REL mode	REL mode
5	MAXMIN	Non-MAX/MIN mode	MAX/MIN mode
6	PEAK	Non-PEAK mode	PEAK mode
7	HOLD	Not in HOLD state	In HOLD state
8	AUTO	Manual Range mode	Auto Range mode
9	HV	Normal	High-voltage alarm
10	CAP_DC	Normal	Capacitance discharge indicator
11	LEAD_X	Normal	Incorrect probe connection
12	COMP	Non-COMP mode	COMP mode
13	RECORD	Not in RECORD mode	In RECORD mode

14	Hold	—	—
15	Hold	—	—

The data segment is divided into four types based on the flags in the **FLAG** field. If **MAXMIN** is 1, the data segment is of the **MAX/MIN** type. If **COMP** is 1, the data segment is of the **COMP** type. If **RECORD** is 1, the data segment is of the **RECORD** type. Otherwise, the data segment is of the **General** type.

a. General Data Segment

The length of the general data segment is variable. Its format is as follows.

Byte 6 – 9	Byte 10	Byte 11 – 18	Byte 19 – 31	Byte 32 – 44	Byte 45 – 57	Byte 58 – 61	Byte 62 – 69
MAIN diaplay			AUX_1 diaplay	AUX_2 diaplay	AUX_3 diaplay	BAR	
(float) value	(value_st_ t) vst	unit_chs	Same as Main	Same as Main	Same as Main	(float) value	unit_chs

Note

The fields within the dashed box may be omitted.

- For MAIN, AUX_1, AUX_2, and AUX_3:
value: A floating-point number representing the measured value.
vst: A value_st_t structure that describes the measured value. For details, refer to the **Data Types** section.
unit_chs: A string representing the unit of the measured value. The string is terminated with 0x00.
- For BAR:
value: The measurement value represented by the analog bar. This value is updated at a higher rate but has lower precision than the measurement value and is used to display the analog bar.
unit_chs: A string representing the unit of the analog bar. The string is terminated with 0x00.

Note

unit_chs always occupies 8 bytes, even if the unit string is shorter than 8 bytes. The remaining bytes are reserved for padding.

Symbol	°	Ω
Hexadecimal value	0x60	0x7E

For specific measurement functions, the AUX_1, AUX_2, AUX_3, and BAR fields may be omitted from the General-Purpose Data Segment. Their presence is determined by the corresponding AUX_1, AUX_2, AUX_3, and BAR bits in the FLAG field.

If a corresponding bit in FLAG is set to 1, the associated field is included in the data

segment. Otherwise, the field is omitted from the transmitted data, and the data segment length is reduced accordingly.

For example, if AUX_2 and BAR are set to 1, the data segment format is as follows:

Byte 6 – 9	Byte 10	Byte 11 – 18	Byte 19 – 31	Byte 31 – 34	Byte 34 – 41
MAIN diaplay			AUX_2 diaplay	BAR	
(float) value	(value_st_t) vst	unit_chs	Same as Main	(float) value	unit_chs

b. MAXMIN Data Segment

When the device is operating in MAX/MIN mode, the transmitted data segment is of the MAX/MIN type. The MAX/MIN Data Segment has the following fixed format.

Byte 6 – 9	Byte 10	Byte 11 – 14	Byte 15	Byte 16 – 19	Byte 20 – 28	Byte 29 – 37	Byte 38 – 45	Byte 46 – 49
MAIN diaplay		AUX_1 diaplay			AUX_2 diaplay	AUX_3 diaplay	UNIT	START_TIME
(float) value	(value_st_t) vst	(float) value	(value_st_t) vst	(uint32) time	Same as AUX_1	Same as AUX_1	unit_chs	(date_time_t) Start_time

MAIN: Current measurement value

AUX_1: Maximum value

AUX_2: Average value

AUX_3: Minimum value

UNIT: A string representing the unit shared by all values

START_TIME: Start time

The time field represents the timestamp of the measurement value. It is a relative timestamp rather than an absolute timestamp, expressed in seconds.

Unless otherwise specified, the meanings of all other fields are the same as those in the general data segment.

c. COMP Data Segment

When the device is operating in COMP mode, the transmitted data segment is of the COMP type. The COMP Data Segment has the following format.

[illegible]

6 – 9	10	11 – 18	19 – 22	23 – 30	31	32	33	34 – 37	38 – 41
MAIN diaplay			BAR		MODE	RESULT	DOT	VALUE1	VALUE2
(float) value	(value_st_t) vst	unit_chs	(float) value	unit_chs	(uint8) mode	(uint8) result	(uint8) dot	(float) value1	(float) value2

Note

The fields within the dashed box may be omitted.

MAIN: Main display area

BAR: Analog bar graph display area

MODE: COMP

COMP	bit7-4	bit3-0
0	BEEP OFF	INNER
1	PASS ON	OUTER
2	FAIL ON	<VALUE
3	Hold	>VALUE

RESULT: 0 indicates PASS; 1 indicates FAIL.

DOT: Specifies the number of decimal places for VALUE1 and VALUE2.

VALUE1: When the comparison mode is INNER or OUTER, this field specifies the upper limit. When the comparison mode is VALUE, this field specifies the comparison value.

VALUE2: When the comparison mode is INNER or OUTER, this field specifies the lower limit. When the comparison mode is VALUE, this field is not present.

d. RECORD Data Segment

When the device is operating in RECORD mode, the transmitted data segment is of the RECORD type. The RECORD Data Segment has the following fixed format.

Byte 6 – 9	Byte 10	Byte 11 – 18	Byte 19 – 22	Byte 23 – 26	Byte 27 – 30	Byte 31 – 34
MAIN diaplay			ELAPSE	REMAINING	SAMPLES	START_TIME
(float) value	(value_st_t) vst	unit_chs	(uint32) elapsed	(uint32) remaining	(uint32) samples	(date_time_t) start time

MAIN: Main display value.

ELAPSE: Elapsed recording time, in seconds.

REMAINING: Remaining recording time, in seconds.

SAMPLES: Number of samples recorded.

START_TIME: Date and time when recording started.

3. Measurement Record Data

The format of Readback Measurement Data is similar to that of Real-Time Measurement Data. The differences are as follows:

- Readback Measurement Data includes the time at which the measurement was saved.
- The Frame Function for Real-Time Measurement Data is 2, whereas the Frame Function for Readback Measurement Data is 3.

Command Format

Byte 0	Byte 1-4	Byte 5-6	Byte 3 7-8	Byte 9	Byte 10	...	Byte n
Frame Function	Frame Parameter						
3	(date_time_t) SAVE_TIME	(uint16_t) FLAG	(uint16_t) MEASURE_CODE	(uint8_t) RANGE	Data Segment		

SAVE_TIME: Date and time when the measurement was saved.

For all other fields, refer to ***Real-Time Measurement Data***.

4. Trend Summary Data

Command Format

Byte 0	Frame Function	4	Description
Byte 1-11	Frame Parameter	(uint8_t) Name_chs[11]	Record name string
Byte 12-19		(uint8_t) Unit_chs[8]	Measurement unit string
Byte 20-21		(uint16_t) Interval	Recording interval (seconds)
Byte 22-25		(uint32_t) Duration	Recording duration (seconds)
Byte 26-29		(uint32_t) Samples	Number of sample points in the record
Byte 30-33		(float) Max_value	Maximum recorded value
Byte 34		(value_st_t) Max_vst	
Byte 35-39		(Same as Max) Avg	Average recorded value and its status information
Byte 40-44		(Same as Max) Min	Minimum recorded value and its status information
Byte 45-48		(date_time_t) Start time	Date and time when recording started

Frame Function: Data type code. The data type code for Trend Summary Data is 4.

Frame Parameter: Trend summary information, as shown in the table above.

Note

The unit of Duration in Trend Summary Data is seconds, whereas the Duration parameter used when starting trend recording from the PC is specified in minutes.

5. Trend Data Point Values

Command Format

Byte 0	Byte 1	Byte 2-5	Byte 6	Byte 7-10	Byte 11-19	...	
Frame Function	Frame Parameter						
5	(uint8_t)	(float)	(value_st_t)	(date_time_t)		...	

	DOT_N	Value	Vst	Time			
	Number of Data Points	First Data Point Value			Second Data Point Value	...	Nth Data Point Value

DOT_N: Number of data points included in the current frame, up to 100.

The device reads data point values from the specified trend record, starting at the specified position. If 100 or more sample points remain, the device returns 100 data point values; otherwise, it returns all remaining data point values.

6. Query Response Data

The returned data varies depending on the specific query command.

Command Format

Byte 0	Byte 1	Byte 2.... Byte n
Frame Function	Frame Parameter	
114	(uint8_t) COMMAND	Data Segment

Frame Function: Data type code. The data type code for Query Response Data is 114.

Frame Parameter:

COMMAND: Specifies the query command that triggered the current frame.

Data Segment: The length and data type of the data segment vary depending on the query command. For details, refer to the documentation for the corresponding query command.