United API

This document describes the United protocol used for controlling and configuring the devices.

Introduction - Basics - UDP

United is based on UDP. The device communicates on port 1337. Unicast the is the primary way of sending messages but broadcast is used for discovering devices.

Messages are limited to 1028 bytes. Larger messages can be used but they are not guaranteed to be parsed properly. All of the United commands can fit into the 1028 bytes limitation.

Data is in little-endian format.

Message Format

United messages have:

- Header - always 3B - used to set the command type, code and sub-command
- Payload - 0B to 1024B - used for data transmission
- Checksum - 1B - used for validating the data values

Header

The message header has three parts:

- Command - 1B
  Command byte is split into two 4 bits values:
  - Command Type - upper 4 bits
  - Command Code - lower 4 bits
- Sub-command - 2B
  Sub-command provides additional data used in command.
  In commands that don't use the sub-command, its value is 0.

All command types, command codes and sub-commands are provided at the end of the document.

Payload

Payload of the message is fully dependent on the message header. In this part of the message the data is stored.

All data structures are provided at the end of the document.

Checksum

Checksum is the last byte of the message. Its value is calculated as XOR of all bytes and 0x55.

When sending a message checksum must be calculated properly or the protocol will return an error.

When a bad checksum is received the command should be resent.

Message Example

Header 3B			Payload 0-1024B	Checksum 1B
Command Type - 4b	Command Code - 4b	Sub-command - 2B		

Communication

Device receives commands and the User sends commands.

The response contains the same command byte.

Commands

The commands are explained by Command Type and Code. The full list of commands are at the end of the document.
Data structures will be mentioned but not in detail.

Basic Commands - 0x0?

Basic commands are used for discovering devices, restarting devices and time synchronization.

Discovery - 0x01

Discovery is **the only** message that should be broadcasted.

Discovery message has no payload.

When device receives the discovery message it will respond to the source of the broadcast. The payload of the response will contain the Basic Info about the device.

Basic Info is part of the Configuration data structure.

Restart - 0x02

Restart message restarts the device after a defined period of time - offset time.

Device will reply before restarting, if able. For example if the offset time is 0 then the device will restart before responding to the command.

Restart has no payload.

The offset time is stored in sub-command bytes and it is in milliseconds.

The minimum allowed time is 100ms and the maximum allowed time is 10s or 10000ms.

Timesync - 0x03

Timesync is used for setting the time on the device. When the device is connected to a WiFi network with internet it collects the time automatically, so this message is not needed in this case.

The payload is an UTC0 timestamp in milliseconds. It is 4 bytes long.

Sub-command is not used.

Global Commands - 0x1?

Global commands are used for errors which will are explained later in this document.

Configuration Commands - 0x2?

Configuration commands are used for reading/writing a configuration from/to device.

Users are to be extremely careful with writing the configuration.

Configuration data type is fully explained at the end of the document. The configuration contains several sub-modules:

- Basic Info - name, id, timezone, device type
- Firmware Info - contains the firmware name and version
- Network - exists for legacy purposes, should be copied as-is from configuration read
- Station - WiFi name and password to which the device connects to
- SoftAP - WiFi parameters of the Direct WiFi network that the device creates
- Hardware - company and model codes

Configuration Read - 0x21

Configuration Read message is used for reading the configuration of the device.

There is no payload (0B) and sub-command is empty (value 0).

The device responds with the configuration data structure in payload.

Configuration Write - 0x22

Configuration Write message is used for writing a new configuration on the device.

The payload is configuration data structure. The sub-command is empty (value 0).

It is extremely important to read the configuration first, then change it and then send it.

The device responds with acknowledge. Sub-command is empty and payload doesn't exist in the response.

Control Commands - 0xF?

Control commands are used for controlling the device state and setting up the plan for schedule mode.

Additional commands for resetting the Smart data and getting the Smart timestamp are also available.

Control Read - 0xF1

Control read is used for reading the current state of the device.

Sub-command is empty and there is no payload.

Device responds with current state, which includes:

- Power
  0 when the device is Off, 1 when the device is On
- Setpoint
  Current setpoint of the device
- Mode
  Current mode of the device
- Temperature High
  Measured temperature on the High sensor
- Temperature Low
  Measured temperature on the Low sensor
- Relay
  0 when the relay is Off, 1 when the relay is On
  Relay state is directly correlated with the heater unit state
- Smart State
  The current state of Smart algorithm, which can be:
  0 - not working
  1 - initializing
  2 - recording
  3 - reproduction
- Error/Warning buffer
  An array of values that represent if there is any problem with the device

Fully detailed explanation of the data structure is at the end of the document.

Control Write - 0xF2

Control write command is used for writing a new state for the device. The sub-command is empty and the payload is Control Write data structure.

The device responds with acknowledge, without payload or sub-command.

The data structure for Control Write is different from Control Read:

- Power
- Mode
- Setpoint

If the value of Power is changed, Mode and Setpoint are ignored.

If the mode isn't Manual Mode, the setpoint is ignored.

Plan Read - 0xF3

Plan Read command is used to read the current plan from the device.

The sub-command is empty and there is no payload.

The device responds with the plan data structure as a payload.

The data structure for plan is at the end of the document.

Plan Write - 0xF4

Plan Write command is used to write a new plan on to the device.

The sub-command is empty and the payload is the plan data structure.

The device responds with acknowledge, with no payload and empty sub-command.

If the device is in Timer mode, it will start using the new plan.

Smart Reset - 0xFA

Smart Reset command is used to clear the Smart data used in Smart mode. When the Smart Data is cleared, the device needs to record new data.

The sub-command is empty and there is no payload.

The device responds with acknowledge, with no payload and empty sub-command.

Smart Time - 0xFB

Smart Time command is used to get the remaining recording time when the Smart Recording phase of the Smart mode is in progress.

The sub-command is empty and there is no payload.

The device responds with an empty sub-command and a payload that contains the timestamp. The payload is 4B and is in UTC0 seconds.

1 Data Structures

Data structures are essential in controlling the device.

Data types in data structures are:

- uint8 - 1 byte integer value
- uint32 - 4 byte integer value
- string - usually 32 bytes value, can be more

Additionally there is one special data type used for timezone.

1.1 Configuration Data Structure

Configuration data structure is the most complex. Its size is 322 bytes.

It is separated in several sections. Values in sections are relative to the section. For example: Firmware Info is at position 39 and Firmware Info Version is at position 1. This means that the Firmware Info Version is at position 40 of configuration.

Name	Position	Length	Description
Basic Info	0	39	Response to Discovery, basic info about the device
Type	0	2	Type of device, can be ignored but don't change it
ID	2	4	ID of the device, can't be changed
Name	6	32	Name of the device, can be changed
Timezone	38	1	Timezone of the device, can be changed.*1
Firmware Info	39	36	Information about firmware of the device
Userbin	0	1	Position of the firmware in use
Version	1	3	Firmware version: major.minor.deployment
Name	4	32	Name of the firmware
Network	75	28	Legacy settings, to be ignored
Station WiFi	103	103	Station Wifi Settings for connecting to a WiFi
SSID	0	32	SSID of the WiFi network to connect to
Password	32	64	Password of the Wifi network
BSSID_Set	96	1	If set, BSSID of router must match with BSSID *2
BSSID	97	6	Used when BSSID_Set is 1 *2

SoftAP WiFi	206	108	Device WiFi settings
Hardware Info	314	8	Device hardware information
Company	0	4	Signature of the company
Model	4	4	Signature of the model

Values marked with '*' are special and explained in more detail bellow.

1.1.1 *1 Timezone

There are two factors for the timezone: offset and factor.

Timezone is in factor of 15 minute values. This is done so that users can fine tune their timezones.

As all integer values in United protocol are unsigned, negative values can't be expressed directly. Because of this, timezone has an offset of 96 (24h * 15 mins).

Example 1: Timezone of UTC0 is 96.

Example 2: Timezone of UTC-1 is 92.

Example 3: Timezone of UTC+1:15 is 101.

1.1.2 *2 BSSID

This hasn't be used or tested, but the option remains.

1.1.3 Important Notice

Users are advised to first read a configuration from the device and then change the values of the read configuration!

If users create their own configuration from scratch system settings that aren't disclosed in this document won't be set.

In worst case this can set the device to work in a such WiFi mode so that the device isn't accessible.

System Restore (hardware reset) is planned in the development and with this feature the mentioned problem would be solvable. As of yet, if a user "breaks" the device settings he won't be able to restore it to the previous state.

1.2 Plan Data Structure

Plan data structure is the same in both Plan Read and Plan Write.

Name	Position	Length	Description
ID	0	8	ID of the plan

Name	8	32	Name of the plan
Length	40	4	Length
Plan Points	44	Length*4B	Points of the plan

This data structure is dynamic, as there can basically be any number of Plan Points.

Plan Point has:

- Setpoint - temperature in C with a factor of *10
  Example: 10.6c is value 106
- Weekday
  0 - Monday, 1 - Tuesday etc
- Hour
  From 0 to 23
- Minute
  From 0 to 59

Setpoint	Weekday	Hour	Minute
16 bits	3 bits	5 bits	6 bits

The Timer mode activates the value of setpoint at the weekday-hour-minute time.

In the Apps each Plan Point is actually two points: the begging and the end.

1.3 Control Read Data Structure

Control Read Data Structure contains information about operational data. Error buffer is explained after this section.

Name	Position	Length	Description
Power	0	1	0 for Off, 1 for On
Setpoint	1	2	In factor of *10
Mode	3	1	Mode values provided below
Measured High	4	2	Measured temperature on the High sensor
Relay	6	1	Relay state, 0 for Off, 1 for On
Smart State	7	1	Smart State values provided below
Measured Low	8	2	Measured temperature on the Low sensor
Error/Warning	10	16	Buffer with system Error/Warning values

1.3.1 Mode values

- 0x00 - Manual
- 0x01 - Eco
- 0x02 - Smart
- 0x03 - Timer
- 0x04 - Travel
- 0x05 - Boost
- 0x21 - Limited - Warning is active
- 0x22 - Critical - Error is active

1.3.2 Smart State Values

- 0x00 - Uninitialized, function can’t be used
- 0x01 - Idle, the function hasn’t started yet
- 0x02 - Recording, the function is recording
- 0x03 - Reproduction, the function is reproducing the recorded results

Values 0x00 and 0x01 indicate an error in the system, but only if they last for more then a minute.

1.3.3 Error/Warning

Errors and Warnings use the same data structure. This data structure is 2 bytes long:

Flag	Counter
1 bit	15 bits

The flag value indicates if the error/warning is currently active.

The counter value indicates how many times error/warning has occured.

The Error/Warning list:

Name	Description	Position
E01 - Broken sensors	Both sensors aren’t working properly	0
E02 - Overheating	Overheating is occurring	2
E03 - Dry heating	Dry heating is occurring	4
E04 - Serial Comm ST	Problems on serial communication	6
W01 - Bad High Sensor	High sensor isn’t working properly	8
W02 - Bad Low Sensor	Low sensor isn’t working properly	10

W03 - Long heating	Unexpectedly long period of heating	12
E05 - Serial Comm ESP	Problems on serial communication	14

1.4 Control Write Data Structure

Control Write Data Structure is used for controlling the device.

Name	Position	Length	Description
Power	0	1	0 for Off, 1 for On
Mode	1	1	Use 0x00-0x05
Setpoint	2	2	In factor of *10, used only in Manual Mode

2 Command Values

In the table bellow are provided the command type - command code value pairs

Type-Code pair	Name
0x01	Discovery
0x02	Restart
0x03	Timesync
0x21	Configuration Read
0x22	Configuration Write
0xF1	Control Read
0xF2	Control Write
0xF3	Plan Read
0xF4	Plan Write
0xFA	Smart Reset
0xFB	Smart Time

3 Error Codes

Error codes are used to indicate a problem with a received message.

Type	Code	Error	Name	Description
0x0	0x0	0x01	Checksum	Bad checksum
0x0	0x0	0x02	Cmd Type	Unrecognized command type
0x0	0x0	0x03	Cmd Code	Unrecognized command code

0x10	0x0	0x01	Flash Write	Writing to flash failed*
0x10	0x0	0x06	Length	Length of payload is bad

3.1 *Writing to flash failed

In the case of writing a new configuration or writing a new plan, flash failed is returned when the system doesn't succeed in writing the data into the flash of the device.

Users are advised to try again.

If the problem continues to occur, then the flash of the device is broken.
Flash memory has a certain number of writes it can handle after which they become unusable.

Users are advised not to write to flash all the time.