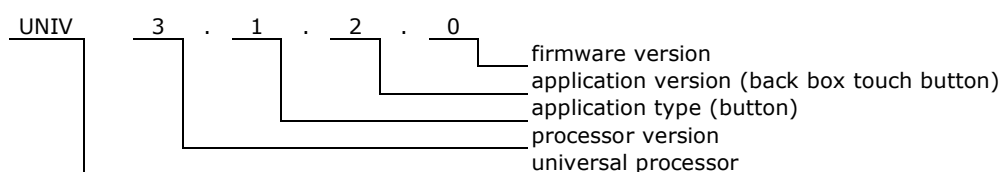## 1. Features

- 6 channel touch button module.
- Another button is recognized when all sensors are touched at the same time.
- 7 types of button behaving is recognized: button pressed, released, pressed for 400ms, pressed for 4s, released within 400ms, released between 400ms and 4s, released after 4s
- There is a 20ms reaction time. Button has to be pressed for at least 20ms to activate module. It avoids contacts bouncing.
- 6 LEDs can be connected to indicate status of other devices on the network.
- Included temperature and thermostat feature when Dallas sensor is connected.
- Temperature measurement in range -55°C to +125°C with 0,0625°C resolution
- Thermostat value in range -55°C to +125° C with 0,0625°C resolution
- Hysteresis value adjustable from 0 to 63,75°C with 0,25°C resolution
- 6 control instructions for LEDs (On, Off, Toggle), and for thermostat (set temp, temp up, temp down)
- 3 blocking instructions
- Allows defining up to 128 CAN messages which can indirectly control the module
- Self-control feature – pressed button can control LEDs in the same module
- Allows writing notes in the processor memory
- Uptime counter
- Health check monitor
- Transmit (42 messages) and receive (42 messages) FIFO buffers

2. Compatibility
- Firmware for **UNIV 3.1.2.x** module
- Firmware can be uploaded into processor with bootloader version 3.1 or compatible.

3. Firmware version

```
UNIV    3  .  1  .  2  .  0
                          └─ firmware version
                       └──── application version (back box touch button)
                    └─────── application type (button)
              └───────────── processor version
       └──────────────────── universal processor
```

4. Communication Frames (messages)

4.1. Button message
Module sends message to the bus, when status of input changes. Module is able to distinguish a few types of button behaving: pressed, released, pressed for 400ms, pressed for 4s, released within 400ms, released between 400ms and 4s , released after 4s. For each situation the unique message is sent to the bus. It is possible to choose for each button separately what massages should be sent. Button 7 is recognized when all sensors are touched at the same time.

This firmware controls LEDs connected to switches. LED can be toggled by message received from the bus or locally by pressed button.

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Table 1. BUTTON frame (0x301)

Frame type	Flags				Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	3	2	1	0	Node Nr	Group Nr	0xFF	0xFF	CHANNEL	BUTTON	LED	0xFF	0xFF	0xFF

0x301	– universal module frame, button
3	-	- not used flag, read as "0"
2	-	- not used flag, read as "0"
1	-	- not used flag, read as "0"
0	RE	- response flag. Flag is equal "1" if node was requested. If flag is equal „0" it means that status of input has just changed.

Node Nr - message sender node number
Group Nr - message sender group number

CHANNEL - input channel 0x01 (button 1) – 0x07 (button 7)

BUTTON - actual input status
0x00 – open
0xFF – closed
0xFE – closed and held for 400ms
0xFD – closed and held for 4s
0xFC – closed and open within 400ms
0xFB – closed and open between 400ms and 4s
0xFA – closed and open after 4s

LED - actual LED status 0x00 – off, 0xFF – on

4.2. Touch button parameters
This frame is sent only as response to STATUS REQUEST (0x109).

Tabela 2. TOUCH BUTTON PARAMETERS FRAME (0x301)

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	CHANNEL	SAMPH	SAMPL	BASEH	BASEL	TRIMBITS

0x3011 - universal module button frame, response to STATUS REQUEST

Node Nr - message sender node number
Group Nr - message sender group number

CHANNEL - input channel 0x21 (button 1) – 0x06 (button 6)

SAMP - current input status SAMPH:SAMPL (0x0000 – 0x0FFF)

BASE - current baseline status (when sensor is not touched) BASEH:BASEL (0x0000 – 0x0FFF)

TRIMBITS - describes calibrated sensor current for particular channel (this byte is copied from CTMUICON processor register)
011111 11 - 550us +62%
011110 11 - 550us +60%
011101 11 - 550us +58%
…
000001 11 - 550us +2%
000000 11 - 550us
111111 11 - 550us - 2%
…
100011 11 - 550us - 58%
100010 11 - 550us - 60%
100001 11 - 550us - 62%

000000 00 – means calibration error

4.3. Current temperature message
The module sends message when sensor temperature changes by 0.5°C.

Table 3. CURRENT TEMPERATURE frame (0x304)

Frame type	Flags				Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x304	3	2	1	0	Node Nr	Group Nr	0xFF	0xFF	0x11	TEMPMSB	TEMPLSB	THERMMSB	THERMLSB	HYSTER

0x304	– universal module frame, temperature sensor application
3	-	- not used flag, read as "0"
2	-	- not used flag, read as "0"
1	-	- not used flag, read as "0"
0	RE	- response flag. Flag is equal "1" if node was requested. If flag is equal „0" it means that status of output has just changed.

Node Nr - message sender node number
Group Nr - message sender group number

0x11 - data type in message (0x11 - temperature frame)

TEMPMSB - most significant byte of measured temperature 0xFC90 – 0x07D0 (-55°C - +125°C), resolution 0,0625°C
TEMPLSB - least significant byte of measured temperature

THERMMSB - most significant byte of thermostat value 0xFC90 – 0x07D0 (-55°C - +125°C), resolution 0,0625°C
THERMLSB - least significant byte of thermostat value

HYSTER - switching hysteresis 0x00 – 0xFF (0- 63,75°C), resolution 0,25°C

The temperature data is presented by TEMPMSB and TEMPLSB registers as 12bit sign extended two's complement number. The sign bits 'S' indicate if temperature is positive or negative. For positive numbers S=0 and for negative S=1. Please refer to Dallas sensor datasheet for details.

TEMPMSB

S	S	S	S	S	2^6	2^5	2^4

TEMPLSB

2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}

Table 4. Temperature register format for Current Temperature frame.

4.4. Thermostat message

When measured temperature drops below, or rises above thermostat switching temperature, the module sends thermostat message. Hysteresis value makes module to not react immediately for temperature changes around switching point. Adequate hysteresis can be set 0 - 63,75°C with resolution 0,25°C. Thermostat switching temperature can be adjusted from other modules on the network eg. button module, or infrared receiver. This message can toggle other modules on the network.

Table 5. THERMOSTAT frame

Frame type	Flags				Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x304	3	2	1	0	Node Nr	Group Nr	0xFF	0xFF	0x12	THERMOS STATUS	0xFF	0xFF	0xFF	0xFF

0x304	– universal module frame, temperature sensor application
3 -	- not used flag, read as "0"
2 -	- not used flag, read as "0"
1 -	- not used flag, read as "0"
0 RE	- response flag. Flag is equal "1" if node was requested. If flag is equal „0" it means that status of output has just changed.

Node Nr - message sender node number
Group Nr - message sender group number

0x12 - data type in message (0x12 - thermostat frame)

THERMOS STATUS - current thermostat status (0x00 - temperature below thermostat switching value, 0xFF - temperature above thermostat switching temperature, 0x80 – power up value)

4.5. Temperature sensor error frame

This message can be sent as response to STATUS REQUEST and when there is a problem with temperature sensor.

Tabela 6. SENSOR ERRROR FRAME

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x304	0x1	Node Nr	Group Nr	0xFF	0xFF	0xF0	ERROR	0xFF	0xFF	0xFF	0xFF

0x304 – universal module frame, temperature sensor application
Node Nr - message sender node number
Group Nr - message sender group number

0xF0 - data type in message (0xF0 – temperature sensor error frame)

ERROR - error codes
0x01 – sensor not connected
0x02 – connected more than one sensor or connected wrong type of sensor
0x03 – connected wrong type of sensor
0x04 – communication problem on 1-wire network (CRC problem)

4.6. Status request

Status of module can be checked by sending from computer STATUS REQUEST frame (0x109) (Table 7).

Table 7. STATUS REQUEST frame (0x109).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x109	0x0	COMP ID1	COMP ID2	0xXX	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1090 – STATUS REQUEST frame

COMP ID1 - computer identifier (must be unique on the network)
COMP ID2 - computer identifier (must be unique on the network)

Node Nr - node number of requested module

Group Nr - group number of requested module

0xXX - inessential data

As response the module will send status frames (Table 8). Meaning of bytes is the same as in Table 1, 2, 3, 5 or 6. Instead of sending current temperature and thermostat frames, the module can send error frame.

Table 8. Response to STATUS REQUEST.

BUTTON FRAMES

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	0x01	BUTTON	LED	0xFF	0xFF	0xFF

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	0x02	BUTTON	LED	0xFF	0xFF	0xFF

...

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	0x06	BUTTON	LED	0xFF	0xFF	0xFF

TOUCH BUTTON PARAMETERS FRAMES

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	0x21	SAMPH	SAMPL	BASEH	BASEL	TRIMBITS

...

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x301	0x1	Node Nr	Group Nr	0xFF	0xFF	0x26	SAMPH	SAMPL	BASEH	BASEL	TRIMBITS

TEMPERATURE AND THERMOSTAT FRAMES

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x304	0x1	Node Nr	Group Nr	0xFF	0xFF	0x11	TEMPMSB	TEMPLSB	THERMMSB	THERMLSB	HYSTER

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x304	0x1	Node Nr	Group Nr	0xFF	0xFF	0x12	THERMOS STATUS	0xFF	0xFF	0xFF	0xFF

4.7. Uptime request

Table 9. UPTIME REQUEST (0x113).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x113	0x0	COMP ID1	COMP ID2	0xXX	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

| 0x1130 | – UPTIME REQUEST frame |

| COMP ID1 | - computer identifier (must be unique on the network) |
| COMP ID2 | - computer identifier (must be unique on the network) |

| Node Nr | - node number of requested module |

| Group Nr | - group number of requested module |

| 0xXX | - inessential data |

Table 10. Response to UPTIME REQUEST (0x113).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x113	0x1	Node Nr	Group Nr	0xFF	0xFF	0xFF	0xFF	UPTIME3	UPTIME2	UPTIME1	UPTIME0

| 0x1131 | – Response to UPTIME REQUEST frame |

| Node Nr | - message sender node number |
| Group Nr | - message sender group number |

| UPTIME | - ($UPTIME3*256^3+UPTIME2*256^2+UPTIME1*256^1+UPTIME3*256^0$) in seconds |

4.8. Health check request

Table 11. HEALTH CHECK - STATUS REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x0	COMP ID1	COMP ID2	0x01	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

| 0x1150 | – HEALTH CHECK REQUEST frame |

| COMP ID1 | - computer identifier (must be unique on the network) |
| COMP ID2 | - computer identifier (must be unique on the network) |

| 0x01 | - status request |

| Node Nr | - node number of requested module |

| Group Nr | - group number of requested module |

| 0xXX | - inessential data |

As response the module will send two frames (Table 12).

Table 12. Response to HEALTH CHECK - STATUS REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x1	Node Nr	Group Nr	0x01	RXCNT	TXCNT	RXCNTMX	TXCNTMX	CANINTCNT	RXERRCNT	TXERRCNT

0x1151	– Response to HEALTH CHECK REQUEST frame

Node Nr	- message sender node number

Group Nr	- message sender group number

0x01	- frame 1 (current values)

RXCNT	- current level of receive FIFO buffer

TXCNT	- current level of transmit FIFO buffer

RXCNTMX	- maximum level of receive FIFO buffer since power up

TXCNTMX	- maximum level of transmit FIFO buffer since power up

CANINTCNT	- number of CAN interface restarts since power up

RXERRCNT	- current receive errors register

TXERRCNT	- current transmit errors register

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x1	Node Nr	Group Nr	0x02	0xFF	0xFF	RXCNTMXE	TXCNTMXE	CANINTCNTE	RXERRCNTE	TXERRCNTE

0x1151	– Response to HEALTH CHECK REQUEST frame

Node Nr	- message sender node number

Group Nr	- message sender group number

0x02	- frame 2 (maximum values saved in eeprom memory)

RXCNTMXE	- maximum ever level of receive FIFO buffer

TXCNTMXE	- maximum ever level of transmit FIFO buffer

CANINTCNTE	- maximum ever number of CAN interface restarts

RXERRCNTE	- maximum ever receive errors

TXERRCNTE	- maximum ever transmit errors

To clear maximum values saved in eeprom memory the frame shown in Table 13 must be sent. There is no response to this message.

Table 13. HEALTH CHECK - CLEAR REQUEST (0x115).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x115	0x0	COMP ID1	COMP ID2	0x02	0xXX	Node Nr	Group Nr	0xXX	0xXX	0xXX	0xXX

0x1150	– HEALTH CHECK REQUEST frame

COMP ID1	- computer identifier (must be unique on the network)

COMP ID2	- computer identifier (must be unique on the network)

0x02	- clear request

Node Nr	- node number of requested module

Group Nr	- group number of requested module

0xXX	- inessential data

5. Module control

The module can be controlled directly from PC, or indirectly by other modules. In both situation all instructions in the table below can be used. Blocking instructions (0xDD-0xDF) can't be used in direct control.

5.1. Control instruction

The Table 14 shows instructions, which can be executed by the module.

Table 14. Module control instructions

Instruction	Instruction coding								Description	Control	
	INSTR1	INSTR2	INSTR3	INSTR4	INSTR5	INSTR6	INSTR7	INSTR8		Direct	Indirect
TURN ON LED	**0x00**	LED1	LED2	0xXX	0xXX	0xXX	0xXX	0xXX	It will turn on chosen LEDs, and the rest will stay unchanged.	√	√
TURN OFF LED	**0x01**	LED1	LED2	0xXX	0xXX	0xXX	0xXX	0xXX	It will turn off chosen LEDs, and the rest will stay unchanged.	√	√
TOGGLE LED	**0x02**	LED1	LED2	0xXX	0xXX	0xXX	0xXX	0xXX	It will toggle chosen LEDs, and the rest will stay unchanged.	√	√

0xXX – inessential data

LED1	Description
0x01	- (00000001) - only LED1
0x02	- (00000010) - only LED2
0x03	- (00000011) - LED1 & LED2
0x04	- (00000100) - only LED3
...	
0x3F	- '00111111' - LED1, 2, 3, 4, 5, 6

bit <5> - LED6, bit <4> - LED5, bit <3> - LED4, bit <2> - LED3, bit <1> - LED2, bit <0> - LED1

Instruction	INSTR1	INSTR2	INSTR3	INSTR4	INSTR5	INSTR6	INSTR7	INSTR8	Description	Direct	Indirect
SET THERMOSTAT	**0x03**	THMSB	THLSB	0xXX	0xXX	0xXX	0xXX	0xXX	It will set thermostat to value indicated in THER1 & THER2 registers	√	√
DECREASE THERMOSTAT	**0x04**	STEP	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	It will decrease thermostat by value STEP*0,0625°C	√	√
INCREASE THERMOSTAT	**0x05**	STEP	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	It will increase thermostat by value STEP*0,0625°C	√	√

THMSB	THLSB	Description
0xFC90 - 0x07D0		Thermostat value 0xFC90 – 0x07D0 (-55°C - +125°C), resolution 0,0625°C, where THMSB – most significant byte, THLSB – least significant byte

STEP	Description
0x01	- thermostat value will be changed (decreased or increased) by 1*0,0625°C=0,0625°C value
0x02	- thermostat value will be changed (decreased or increased) by 2*0,0625°C=0,1250°C value
...	
0xFF	- thermostat value will be changed (decreased or increased) by 255*0,0625°C=15,9375 °C value
0x00	- thermostat value will be changed (decreased or increased) by 256*0,0625°C=16,0000 °C value

Instruction	INSTR1	INSTR2	INSTR3	INSTR4	INSTR5	INSTR6	INSTR7	INSTR8	Description	Direct	Indirect
ENABLE BOX	**0xDD**	BoxX	BoxY	0xXX	0xXX	0xXX	0xXX	0xXX	It enables chosen boxes – these boxes will be compared with next received message from the bus.		√
DISABLE BOX	**0xDE**	BoxX	BoxY	0xXX	0xXX	0xXX	0xXX	0xXX	It disables chosen boxes – these boxes will be passed when next message arrives from the bus.		√
TOGGLE BOX	**0xDF**	BoxX	BoxY	0xXX	0xXX	0xXX	0xXX	0xXX	It toggles boxes – enables when they are disabled and vice versa		√

0xXX – bajt może mieć dowolną wartość

BoxX	Description
0x00	- from Box 1
0x01	- from Box 2
...	
0x7F	- from Box 128

BoxY	Description
0x00	+ 0 -(and not anyone else)
0x01	+ 1 -(and 1 following)
...	
0x7F	+128 -(and 128 following)

5.2. Direct control

It is possible to control module by sending DIRECT CONTROL message. The message contains instruction, which will be executed by the module.

Table 15. DIRECT CONTROL frame (0x10A).

Frame type	Flags	Module	Group	D0	D1	D2	D3	D4	D5	D6	D7
0x10A	0x0	COMP ID1	COMP ID2	INSTR1	INSTR2	Node Nr	Group Nr	INSTR3	INSTR4	INSTR5	INSTR6

| 0x10A0 | – DIRECT CONTROL frame

| COMP ID1 | - computer identifier (must be unique on the network)
| COMP ID2 | - computer identifier (must be unique on the network)

| Node Nr | - node number of requested module

| Group Nr | - group number of requested module

| INSTR1-6 | - 6 byte instruction to be executed

5.3. Indirect control

Indirect control means that module will react to messages sent by other modules on the network. It depends on configuration programmed into the module boxes (memory cells).

This firmware has feature to set simple conditions of executing instruction. To do so, you can use blocking instruction (0xDD – 0xDF) shown in Table 14.

6. Configuration

Parameters that can be configured with this firmware:
- Module identifier (module number and group number);
- Module description (16 chars);
- Button settings
- Touch button settings
- Thermostat value on power up;
- Temperature offset
- Thermostat hysteresis;
- Text notes;
- Linking device with other modules (indirect control of module).

Configuration process can be done using HAPCAN Programmer.

6.1. Module identifier

Every module on the network must have unique identifier. The identifier is made of two bytes, module number (1 byte) and group number (1 byte). Identifier of the Ethernet Interface can be changed in HAPCAN Programmer in software settings.

6.2. Module description

Every module can have 16 char description, which makes easier for user (programmer) to distinguish nodes.

6.3. Button settings

For each button it is possible to configure what type of button behaving is recognized by module. Module can recognize when:
- button is pressed,
- button is released,
- pressed and held for 400ms,
- pressed and held for 4s,
- pressed and released within 400ms (quick click),
- pressed and released between 400ms and 4s,
- pressed and released after 4s.
For each behaving a separate message will be sent on the bus.
WARNING: It is very important to choose only messages which will be used on the network to keep traffic on the bus as low as possible.

6.4. Button settings

For each touch sensor separately can be defined press and release threshold as offsets from the baseline.

6.5. Thermostat value on power up

The thermostat value on power up can be set between 0xFC90 – 0x07D0 (-55°C - +125°C). It can also be chosen last adjusted value before power disconnection (0x0800).

6.6. Temperature offset

It is possible to calibrate the termometer by setting temperaturę offset, which will be added to measured temperaturę. Tempeature with added offset will be displayed as current temperature and will be used to check against the thermostat. The temperature offset value can be chosen from range 0xFC90 – 0x07D0 (-55°C - +125°C) with 0.0625°C resolution. If no calibration is needed the offset should be set to 0x0000.

6.7. Thermostat hysteresis

Hysteresis prevents module from switching constantly around thermostat value. Thermostat will be switched to 0xFF (high state) if temperature rises above thermostat switching value + hysteresis value. It will be switched to 0x00 (low state) if temperature drops below thermostat switching point – hysteresis (see Figure 1). The hysteresis value can be chosen from 0x00 to 0xFF (0°C tp 15.9375°C) with 0.25°C resolution.
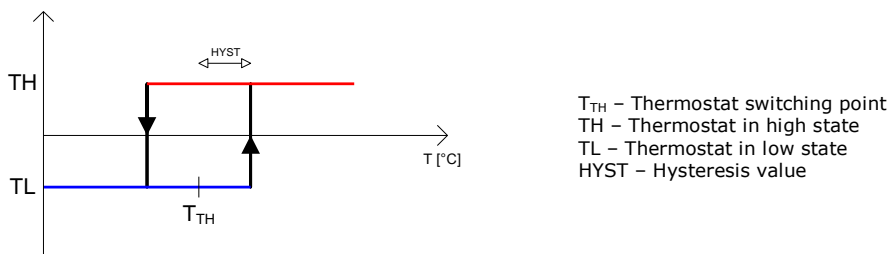

T_{TH} – Thermostat switching point
TH – Thermostat in high state
TL – Thermostat in low state
HYST – Hysteresis value

Figure 1. Switching point and hysteresis.

6.8. Text notes.

Up to 1024 characters can be written into processor's memory.

6.9. Linking devices

The module has 128 memory cells (boxes). Each box can contain information about message sent by other node, and instruction which will be executed when that message is received.

7. License

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8. Document version

File	Note	Date
univ_3-1-2-0a.pdf	Original version	March 2014