KETCube (0.1.1)

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General Description

KETCube is the prototyping and demo platform developed at the Department of Technologies and Measurement (KET), University of West Bohemia in Pilsen.

KETCube platform consist of a *main board* and *extension boards*. These boards can be stacked to achieve the intended functionality. The basic autonomous battery-powered RHT (Relative Humidity & Temperature) sensor node functionality is achieved by stacking main and battery boards only.

The additional sensors can be connected to the main board by connecting KETCube sensor extension board or by using mikroBUS™ pinout-compatible sensor boards, as KETCube main board is equipped with the mikroBUS™ pinout-compatible socket.

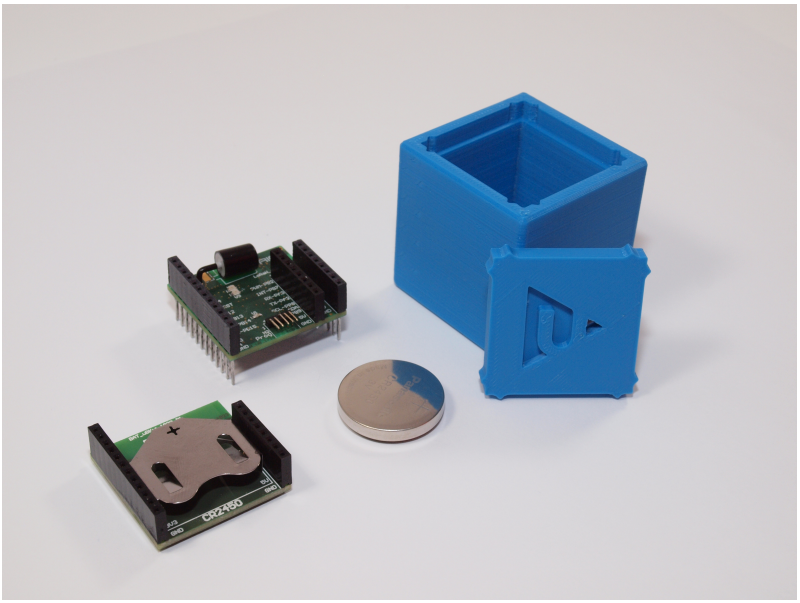
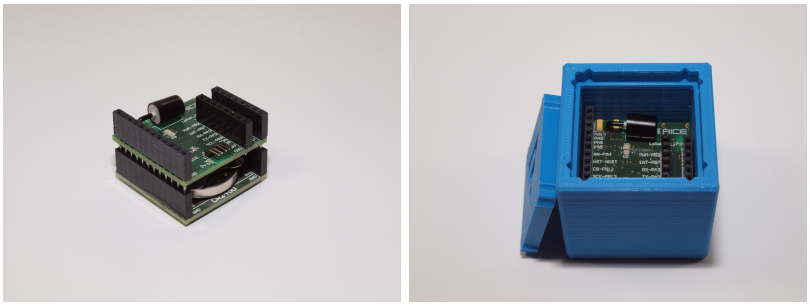


Figure 1: KETCube platform parts

Figure 2: Stacked KETCube boards – out of the box and in-box



Main Features

- Supported Frequencies [1]: 868MHz, 915MHz
- Supported Wireless communication protocols: LoRaWAN (Class A), Sigfox (planned), Proprietary P2P (experimental)
- Interfaces [1]: UART, SPI, I2C, ADC, DAC, PWM, INT, GPIO
- mikroBUS^{TM} compatible pinout, custom KETCube pinout
- Key circuits: Murata Type ABZ (CMWX1ZZABZ) [1], TI HDC1080 [2]
- Recommended Battery (for evaluation only): Panasonic CR-2450/BN (620 mAh)
- Recommended Antenna: ANT-868-JJB-RA

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Revision History

Revision	Date	Author	Note
draft	09.12.2017	JB	draft
02/2018	16.02.2018	JB	Initial version (v0.1.0)
05/2018	07.05.2018	JB, KV, MU	Text review, minor fixes
0.1.1	25.01.2019	JB	KETCube-fw 0.1.1 updates

1 Specifications

1.1 Absolute Maximum Ratings

Parameters	Symbol	MIN	TYP	MAX	UNIT
Supply Voltage	3V3	-0.3	–	3.9	V
	Vref	-0.3	–	3V3 + 0.4	V
	GPIO	-0.3	–	3.9	V
Storage Temperature		-40	25	90	°C
Storage Humidity		20	–	70	%RH
Input RF Level		–	–	10	dBm

1.2 Operating Conditions

Parameters	Symbol	MIN	TYP	MAX	UNIT
Supply Voltage	3V3	2.2 (3.0[1]) [1]	–	3.6	V
	Vref	1.8	–	3V3	V
Operating Temperature		-40	25	85	°C
RF Output Power		–	± –	14 (18.5)	dBm
HDC1080 RHT Sensor [2]					
Operating Humidity		0	–	100	%RH
Operating Temperature (functional)		-20	–	85	°C
RH Measurement Accuracy		–	± 2	–	%RH
Temperature Measurement Accuracy		–	± 0.2	± 0.4	°C

1.3 Typical Behaviour

Parameters	Conditions	MIN	TYP	MAX	UNIT
Battery Life	Recommended battery; RHT measurement and unconfirmed LoRa Tx: 1x/30 minutes; Ideal RF conditions	–	16	–	week

[1] When USB is used 3V3 $\geq$ 3.0

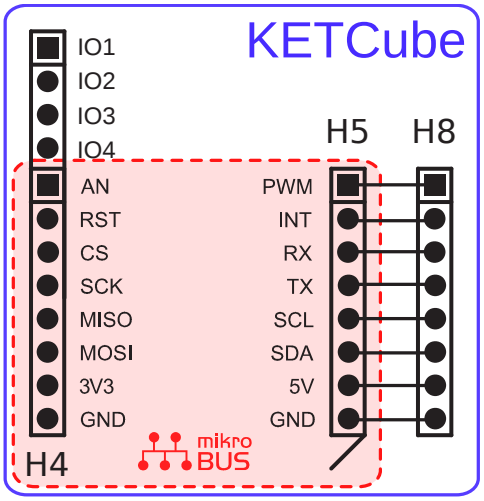
2 Socket Description

The KETCube socket is the superset of the mikroBUS™ socket defined by MikroElektronika d.o.o. The KETCube pinout was defined due to lack of pins available in the mikroBUS™ pinout and due to limiting size of mikroBUS™ itself (e.g. battery size). The detailed view of both pinouts is in Figure 3.

The mikroBUS™ pinout is defined in the mikroBUS™ Specification [3]. This document briefly describes the KETCube pinout/layout extension. The KETCube pinout extends the mikroBUS™ pinout by additional 4 IO pins to header denoted H4 in Figure 3. Additionally, header H5 is replaced by header H8, while conserving the pin composition and increasing the header's distance from 22.86mm = 0.9"at mikroBUS™ to 29.21mm = 1.15".

As the KETCUBE socket is the superset of mikroBUS™, both sockets can be placed on the same board to enable both – mikroBUS™ and KETCube – module connection. If pass-through sockets are assembled, KETCube pinout enables (almost) infinite stacking of KETCube pinout-compatible boards.

Figure 3: KETCube Pinout



3 Boards

3.1 KETCube Main Board

KETCube main board is the core part of the KETCube platform. It is equipped with mikroBUS^{TM}/KETCube sockets to enable connection of mikroBUS^{TM} and KETCube pinout-compatible boards – see Figure 3.

The main board application processor is the STM32L0 [4] integrated in the Murata Type ABZ [1] module.

Some of the STM32L082 pins are available on board and on sockets, some of them are dedicated for Type ABZ's radio and thus cannot be used by application.

Main board is equipped with the HDC1080 RHT sensor, which can be used to monitor Relative Humidity (RH) and Temperature.

The recommended antenna (ANT-868-JJB-RA) respects the board dimensions but it provides low performance for distant communication – the board can be assembled with SMA connector and any appropriate antenna could be used.

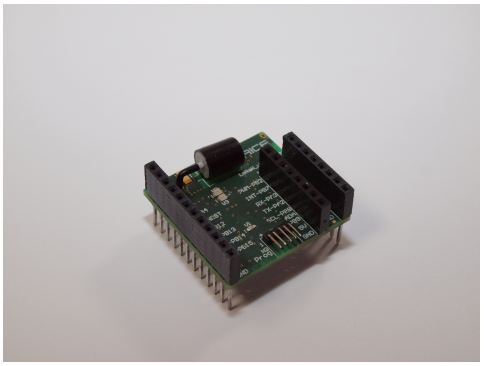


Figure 4: KETCube Main Board

3.1.1 Main Board Pinout (rev. E2)

PIN Name	STM32L0 PIN	Description (selected alternate functions – AF)
KETCube-only pins		
IO1	PA10	USART1 RX (AF4)
IO2	PA9	USART1 TX (AF4)
IO3	PA8/Vref	Configurable by J1 and J7
IO4	PA5/NRST	Configurable by J9
KETCube and mikroBUS™ pins		
AN	PA4	ADC_IN4; DAC_OUT1
RST	PA0	mikroBUS™ reset
CS	PB12	SPI2 CS (AF0)
SCK	PB13	SPI2 SCK (AF0)
MISO	PB14	SPI2 MISO (AF0)
MOSI	PB15	SPI2 MOSI (AF0)
3V3	VDD_MCU, VDD_RF	Power supply
GND	GND	Ground
PWM	PB2	
INT	PB5	
RX	PA3	USART2 RX
TX	PA2	USART2 TX
SCL	PB8	I2C1 SCL PIN
SDA	PB9	I2C1 SDA PIN
5V	NC	typically not used; it can be connected to 5V from USB by shorting J4
Debug LEDs		
V2	PB6	LED_GREEN
V3	PB7	LED_RED

3.1.2 PCB Settings – Solder Jumpers and Optional Parts (rev. E2)

Settings[2]		Pads	Description
J1	•	1 – 2	Connect PA8 to IO3 (do not use with J7)
J2	•	1 – 2	Enable power for the radio part of the MuRaTa module
J3	•	1 – 2	MCU control of radio sleep mode (PA12; do not use with J8)
J3		2 – 3	Turn radio permanently ON (do not use with J8)
J4		1 – 2	Enable USB-delivered 5V power supply to be available on the board 5V pin; if not shorted, the 5V pin is floating
J5	•	1 – 2	Connect HDC1080 RHT sensor SCL to I2C bus
J6	•	1 – 2	Connect HDC1080 RHT sensor SDA to I2C bus
J7		1 – 2	Connect Vref to IO3 (do not use with J1)
J8		1 – 2	MCU control of radio sleep mode (PA5; do not use with J3)
J9		1 – 2	Connect NRST to IO4
J9	•	2 – 3	Connect PA5 to IO4
J10	•	1 – 2	Connect Vref to 3V3
R7	•	1 – 2	Assembly 2k2 pull-up resistor to enable I2C bus SDA
R8	•	1 – 2	Assembly 2k2 pull-up resistor to enable I2C bus SDA
V1		1 – 2	POWER LED – do not assembly when power consumption should be as low as possible
V2	•	1 – 2	LED_GREEN
V3	•	1 – 2	LED_RED

3.1.3 Programming Connector – SWD

The main board contains 1.27 SWD connector denoted H3.

H3 PIN	SWD Name	Description
1	VDD_TARGET	VDD from application
2	SWCLK	SWD clock
3	GND	Ground
4	SWDIO	SWD data in/out
5	NRST	Target MCU reset

[2] Note that recommended settings are denoted by •.

3.2 Battery Board

The KETCube battery board is equipped with KETCube socket only – see Figure 3. This board is equipped with the CR-2450 battery holder and pass-through KETCube sockets enabling (almost) infinite stacking with other KETCube compatible boards.

The battery board provides a 3V3 power supply to connect KETCube platform modules.

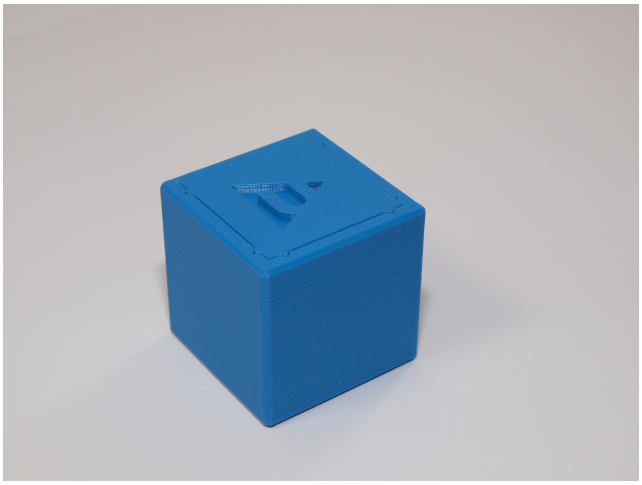
Figure 5: KETCube Battery Board

3.3 Extension Boards

The KETCube platform extension board is any KETCube or mikroBUS™ pinout-compatible board.

4 KETCube Box

Figure 6: KETCube Box



The KETCube Box is the plastic housing for up to three stacked KETCube boards.

It can be equipped with the magnetic holder enabling the box fastening to a metal surface.

5 KETCube Terminal

When programmed by the supplied software stack, the KETCube serial line called *KETCube Terminal* is available on USART1 (IO1 and IO2) – see Figure 7. KETCube Terminal allows to configure KETCube modules (e.g. HDC1080, batVoltage, LoRa ...) and module parameters (e.g. devEUI, appKEY, ... for LoRa module). The KETCube terminal is case-sensitive.

The Terminal commands follow the hierarchical tree arrangement. The basic help including root commands is printed after device reset. The command `help` can be used anytime to display root commands.

Inline help is displayed when `[TAB]` key is pushed (e.g. write "s`[TAB]`" and all commands with leading "s" will be printed – these are: "set" and "show"). Inline help is usefull especially for commands hidden deeply in the tree structure.

To display list of modules use `list` command. Commands `enable`/`disable` are used to turn ON/OFF KETCube modules (e.g. `enable HDC1080`). When module is enabled, it starts to perform defined operation (e.g. measure RH and Temperature and send results through LoRa).

The `enable` command can be additionally used for debugging – the second (optional) parameter of the command sets the module *severity level*. The *severity levels* are: *NONE (1)*, *ERROR (1)*, *INFO (2)* and *DEBUG (3)*. The *severity level* defines the amount of information provided by the specified module to the *terminal* interface. The default *severity level* is *ERROR*. Use the following command to enable `HDC1080`, while setting the *severity level* to *INFO*: `enable HDC1080 2`.

Commands `show`/`set` are used to show/set KETCube settings (e.g. `show LoRa devEUI`). Parameters are saved into on-chip EEPROM.

The command history is available through `+` and `-` keys.

All settings are applied after device reset (use command `reload`).

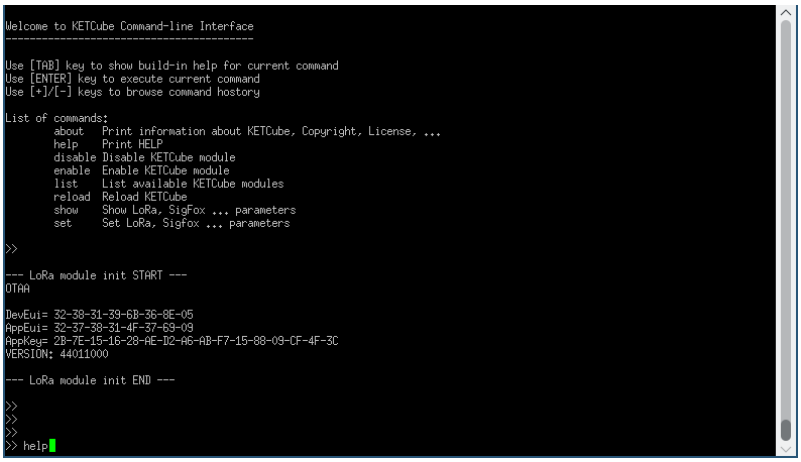


Figure 7: KETCube Terminal in Putty

5.1 Default KETCube Terminal Settings

- Tx PIN: PA9
- Rx PIN: PA10
- Speed: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity: No
- HW Flow control: No
- End-of-line: CR+LF or LF

References

[1] Murata, "LoRa Module Data Sheet," 2017, -. [Online]. Available: https://wireless.murata.com/datasheet?/RFM/data/type_abz.pdf

[2] Texas Instruments, "HDC1080 Datasheet," 2016, -. [Online]. Available: http://www.ti.com/lit/ds/symlink/hdc1080.pdf

[3] MikroElektronika d.o.o., "mikroBUS^{TM} standard specifications," 2015, -. [Online]. Available: https://download.mikroe.com/documents/standards/mikrobus/mikrobus-standard-specification-v200.pdf

[4] STMicroelectronics, "STM32L082CZ," 2017, -. [Online]. Available: http://www.st.com/content/ccc/resource/technical/document/datasheet/54/e1/a7/ba/64/37/44/49/DM00141132.pdf/files/DM00141132.pdf/jcr:content/translations/en.DM00141132.pdf

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