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mikromedia 3

for TIVA CAPACITIVE

USER MANUAL

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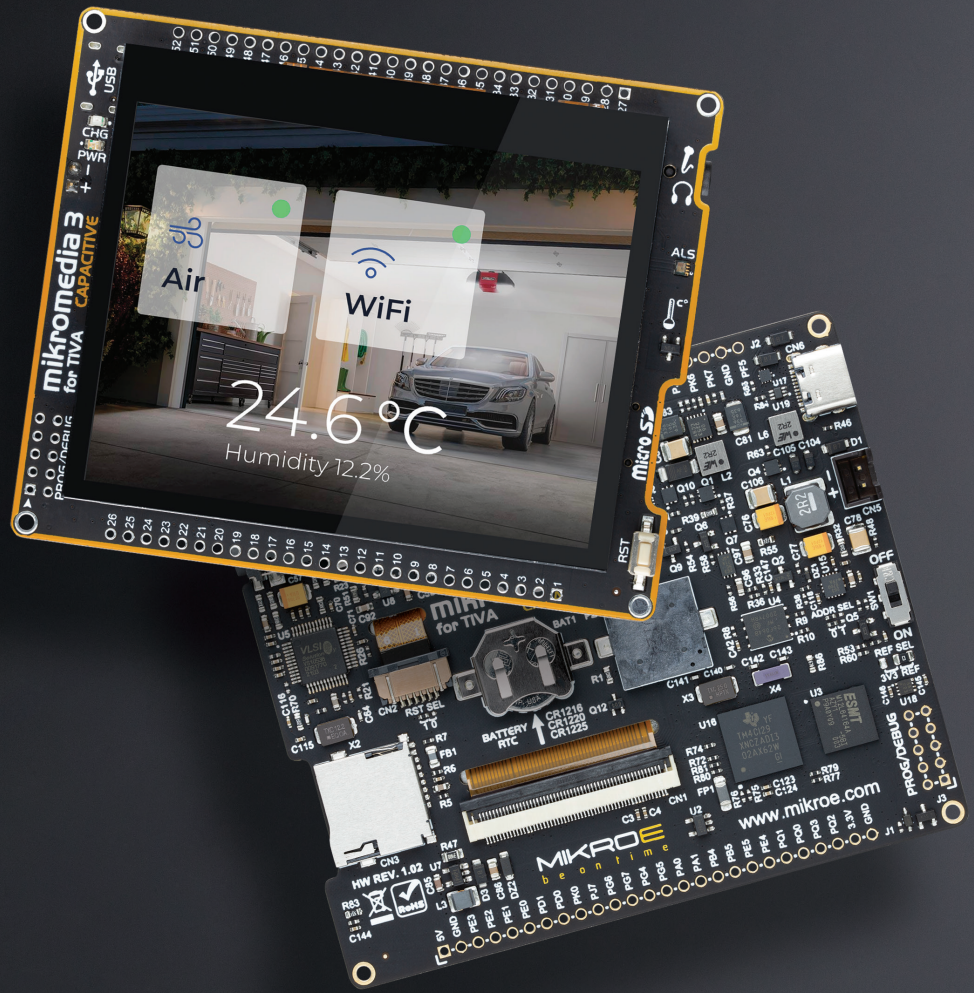
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mikromedia 3 for TIVA CAPACITIVE is a compact development board designed as a complete solution for the rapid development of multimedia and GUI-centric applications. By featuring a 3.5" capacitive touch screen driven by the powerful graphics controller that can display the 24-bit color palette (16.7 million colors), along with a DSP-powered embedded sound CODEC IC, represents a perfect solution for any type of multimedia application.

At its core, there is a powerful 32-bit TM4C129XNCZADI3 microcontroller (referred to as "host MCU" in the following text), produced by Texas Instruments, which provides sufficient processing power for the most demanding tasks, ensuring fluid graphical performance and glitch-free audio reproduction.

However, this development board is not limited to multimedia-based applications only: mikromedia 3 for TIVA CAPACITIVE ("mikromedia 3" in the following text) features USB, digital motion sensor, battery charging functionality, SD-Card reader, and much more, expanding its use beyond the multimedia. Two standardized 1x26 pin headers expose the available MCU pins to the user, adding another layer of expandability. By using mikromedia 3 shield, connectivity can be further expanded with several mikroBUS™ sockets, additional connectors, peripherals, and so on.

The usability of mikromedia 3 does not end with its ability to accelerate the prototyping and application development stages: it is designed as the complete solution which can be implemented directly into any project, with no additional hardware modifications required. Four mounting holes (2mm/0.080") at all four corners allow simple installation with mounting screws. For most applications, a nice stylish casing is all that is needed to turn the mikromedia 3 development board into a fully functional, high-performance, feature-rich design.

1. Key microcontroller features

At its core, mikromedia 3 for TIVA CAPACITIVE uses the **TM4C129XNCZADI3** MCU.

TM4C129XNCZADI3 is the 32-bit ARM® Cortex®-M4 core. This MCU is produced by Texas Instruments, featuring a large variety of rich communication features to enable a new class of highly connected designs with the ability to allow critical, real-time control between performance and power. Among many peripherals available on the host MCU, key features include:

- 1 MB of flash memory
- 256 KB single-cycle System SRAM
- 8-/16-/32- bit dedicated External Peripheral Interface (EPI) for peripherals and memory
- Operating frequency up to 120 MHz
- 150 DMIPS performance

For the complete list of MCU features, please refer to the **TM4C129XNCZADI3** ***datasheet.***

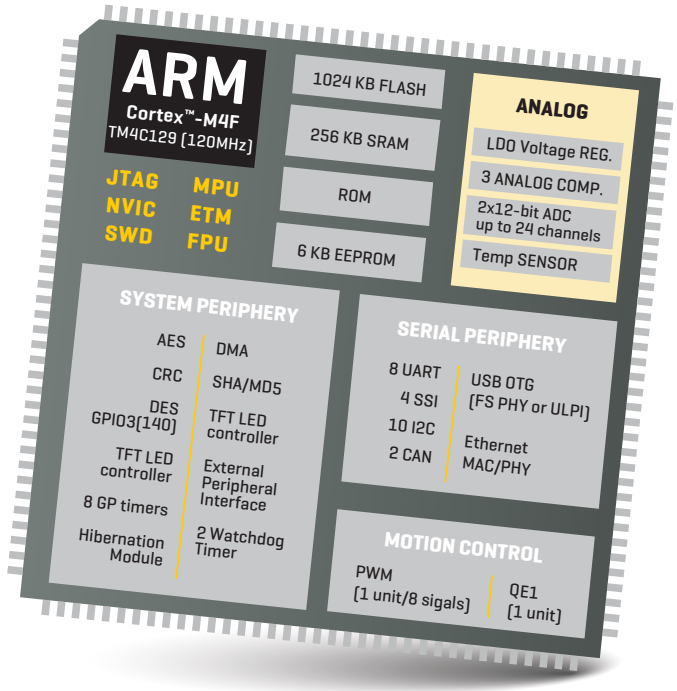
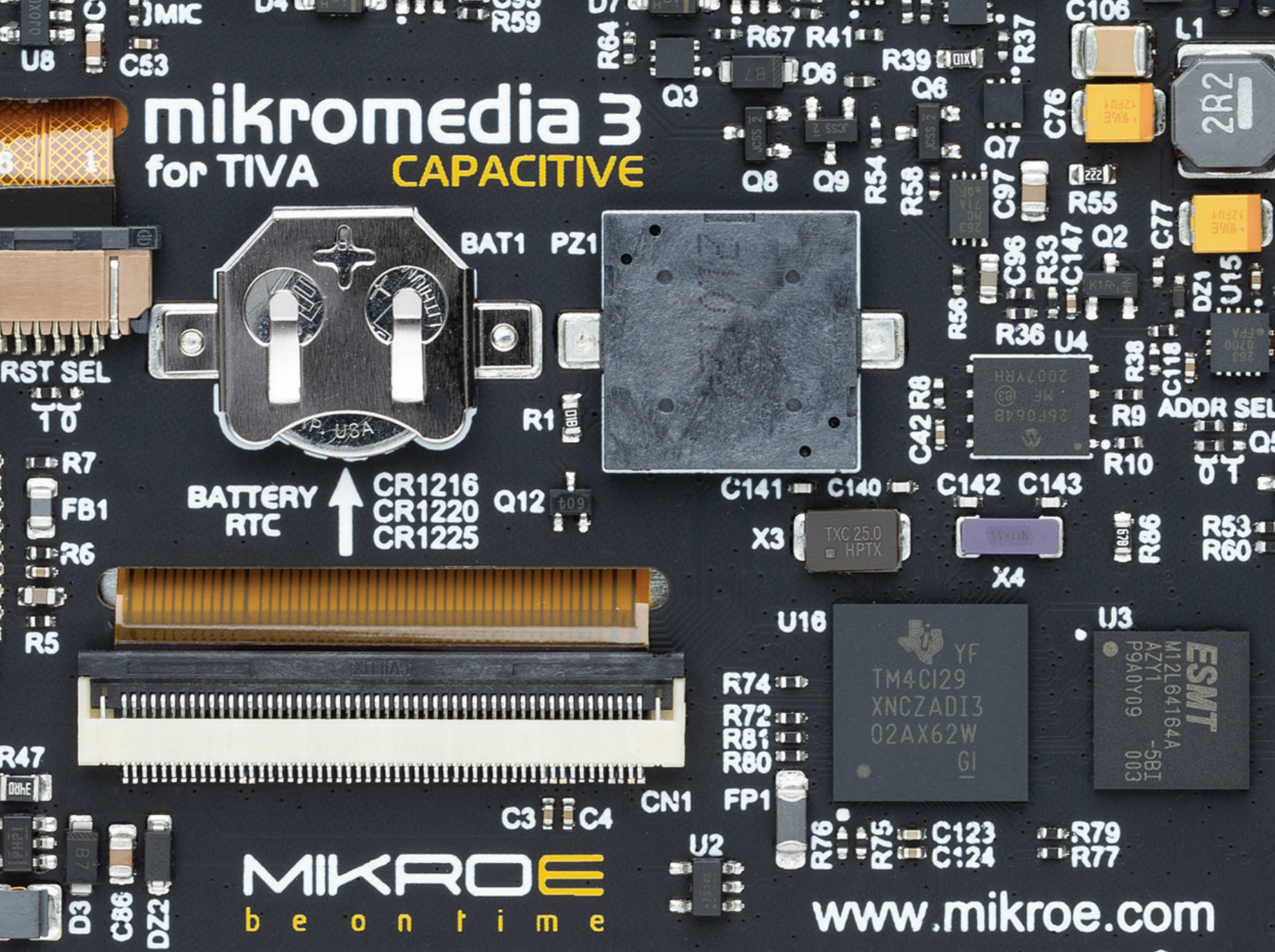


Figure 1: TM4C129XNCZADI3 MCU block schematic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BAT1
PZ1
BATTERY
RTC
CR1216
CR1220
CR1225
RST SEL
ADDR SEL
BOOT SEL
CN1
FP1
U16
U3
U4
U2
X3
X4
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1.1 Microcontroller programming/debugging

The host MCU **(1)** can be programmed and debugged over the JTAG/SWD compatible 2x5 pin header **(2)**, labeled as PROG/DEBUG. This header allows an external programmer (e.g. CODEGRIP or mikroProg) to be used.

Programming the microcontroller can also be done by using the bootloader which is preprogrammed into the device by default. All the informations about the bootloader software can be found on the following page:
www.mikroe.com/mikrobootloader

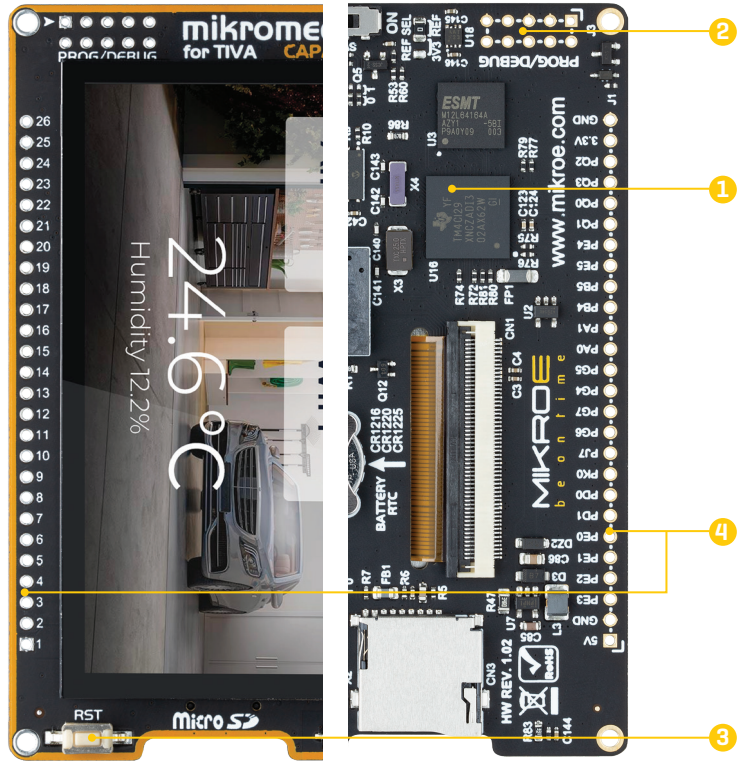

Figure 3: Front and back partial view

1.2 MCU reset

The board is equipped with the Reset button **(3)**, which is located on the front side of the board. It is used to generate a LOW logic level on the microcontroller reset pin. The reset pin of the host MCU is also routed to the pin 1 of the 1x26 pin header **(4)**, allowing an external signal to reset the device.


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2. Power supply unit

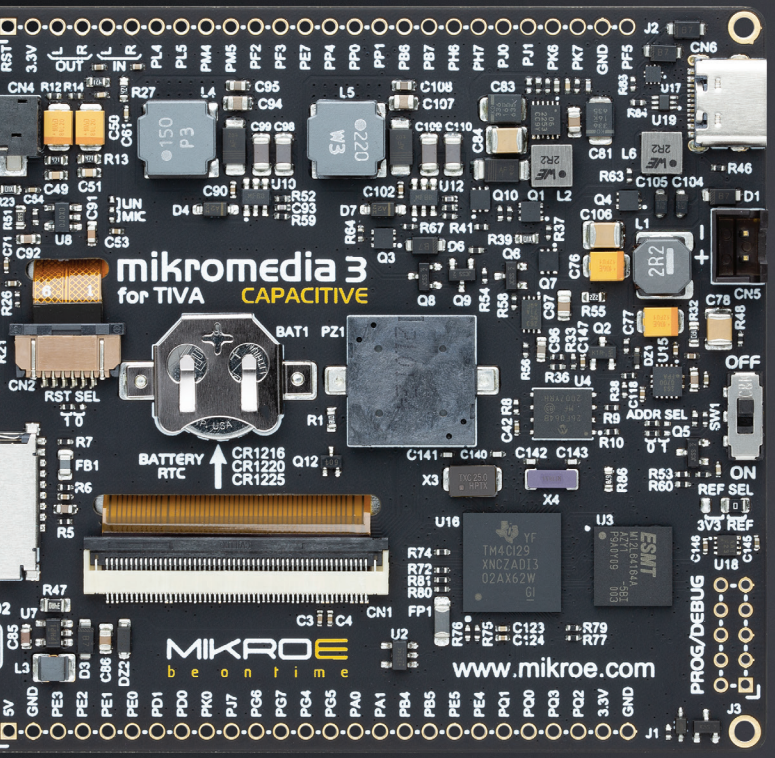


Figure 4: Power supply unit view

The power supply unit (PSU) provides clean and regulated power, necessary for proper operation of the mikromedia 3 development board. The host MCU, along with the rest of the peripherals, demands regulated and noise-free power supply. Therefore, the PSU is carefully designed to regulate, filter, and distribute the power to all parts of mikromedia 3. It is equipped with two different power supply inputs, offering all the flexibility that mikromedia 3 needs, especially when used on the field or as an integrated element of a larger system. In the case when multiple power sources are used, an automatic power switching circuit with predefined priorities ensures that the most appropriate will be used.

The PSU also contains a reliable and safe battery charging circuit, which allows a single-cell Li-Po/Li-Ion battery to be charged. Power OR-ing option is also supported, providing an uninterrupted power supply (UPS) functionality when an USB power source is used in combination with the battery.

2.1 Detailed description

The PSU has a very demanding task of providing power for the host MCU and all the peripherals onboard, as well as for the externally connected peripherals. One of the key requirements is to provide enough current, avoiding the voltage drop at the output. Also, the PSU must be able to support multiple power sources with different nominal voltages, allowing switching between them by priority. The PSU design, based on a set of high-performance power switching ICs produced by Microchip, ensures a very good quality of the output voltage, high current rating, and reduced electromagnetic radiation.

At the input stage of the PSU, the MIC2253, a high-efficiency boost regulator IC with overvoltage protection ensures that the voltage input at the next stage is well-regulated and stable. It is used to boost the voltage of low-voltage power sources (a Li-Po/Li-Ion battery and USB), allowing the next stage to deliver well-regulated 3.3V and 5V to the development board. A set of discrete components are used to determine if the input power source requires a voltage boost. When multiple power sources are connected at once, this circuitry is also used to determine the input priority level: USB has priority over the Li-Ion/Li- Po battery. The transition between available power sources is designed to provide uninterrupted operation of the development board.

The next PSU stage uses two MCP16331, highly integrated, high-efficiency, fixed frequency, step-down DC-DC converters, capable of providing up to 1.2A. Each of the two buck regulators is used to supply power to the corresponding power supply rail (3.3V and 5V), throughout the entire development board and connected peripherals.

2.2 Voltage reference

The MCP1501, a high-precision buffered voltage reference from Microchip is used to provide a very precise voltage reference with no voltage drift. It can be used for various purposes: the most common uses include voltage references for A/D converters, D/A converters, and comparator peripherals on the host MCU. The MCP1501 can provide up to 20mA, limiting its use exclusively to voltage comparator applications with high input impedance. Depending on the specific application, either 3.3V from the power rail, or 2.048V from the MCP1501 can be selected. An onboard SMD jumper labeled as REF SEL offers two voltage reference choices:

- REF: 2.048V from the high-precision voltage reference IC
- 3V3: 3.3V from the main power supply rail

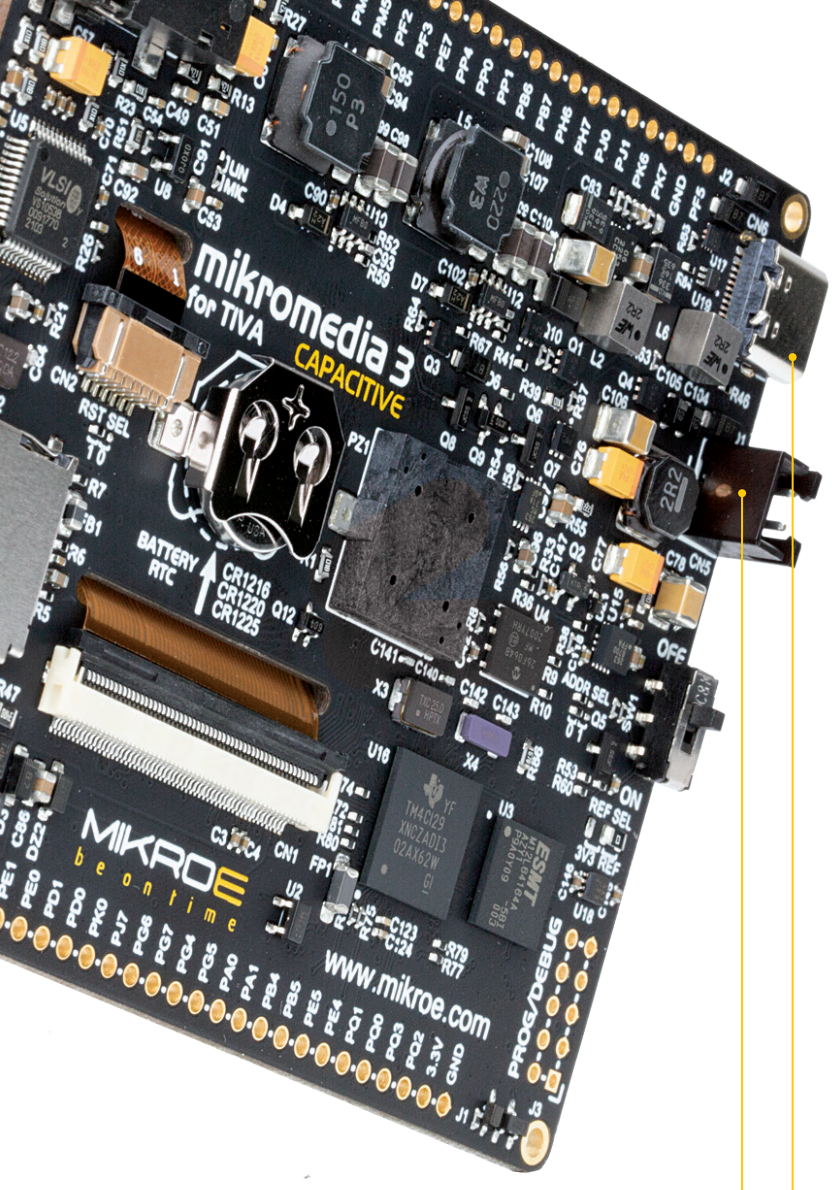


Figure 5: Power supply connectors view

2.3 PSU connectors

As explained, the advanced design of the PSU allows two types of power sources to be used, offering unprecedented flexibility: when powered by a Li-Po/Li-ION battery, it offers an ultimate degree of autonomy. Power is not an issue even if it is powered over the USB cable. It can be powered over the USB-C connector, using power supply delivered by the USB HOST (i.e. personal computer), USB wall adapter, or a battery power bank.

There are two power supply connectors available, each with its unique purpose:

- CN6: USB-C connector **(1)**
- CN5: Standard 2.5mm pitch XH battery connector **(2)**

2.3.1 USB-C connector

The USB-C connector (labeled as CN6) provides power from the USB host (typically PC), USB power bank, or USB wall adapter. When powered over the USB connector, the available power will depend on the source capabilities. Maximum power ratings, along with the allowed input voltage range in the

case when the USB power supply is used, are given on the following page:

USB Power Supply				
Input Voltage [V]		Output Voltage [V]	Max Current [A]	Max Power [W]
MIN	MAX	3.3	1.1	3.63
4.4	5.5	5	1.1	5.5
		3.3 & 5	0.7 & 0.7	5.81

Figure 6: USB power supply table

When using a PC as the power source, the maximum power can be obtained if the host PC supports the USB 3.2 interface, and is equipped with USB-C connectors. If the host PC uses the USB 2.0 interface, it will be able to provide the least power, since only up to 500 mA (2.5W at 5V) is available in that case. Note that when using longer USB cables or USB cables of low quality, the voltage may drop outside the rated operating voltage range, causing unpredictable behavior of the development board.

NOTE *If the USB host is not equipped with the USB-C connector, a Type A to Type C USB adapter may be used (included in the package).*

2.3.2 Li-Po/Li-Ion XH battery connector

Powering mikromedia 3 by a single-cell Li-Po/Li-Ion battery allows complete autonomy, allowing it to be used in some very specific situations: hazardous environments, agricultural applications, etc.

The battery connector is a standard 2.5mm pitch XH connector. It allows a range of single-cell Li-Po and Li-Ion batteries to be used. The PSU of mikromedia 3 offers the battery charging functionality, from the USB connector. The battery charging circuitry of the PSU manages the battery charging process, allowing the optimal charging conditions and longer battery life. The charging process is indicated by BATT LED indicator, located on the front of mikromedia 3.

The PSU module also includes the battery charger circuit. Depending on the operational status of the mikromedia 3 development board, the charging current can be either set to 100mA or 500mA. When the development board is powered OFF, the charger IC will allocate all available power for the battery charging purpose. This results in faster charging, with the charging current set to approximately 500mA. While powered ON, the available charging current will be set to approximately 100 mA, reducing the overall power consumption to a reasonable level.

Maximum power ratings along with the allowed input voltage range when the battery power supply is used, are given in the table below:

Battery Power Supply				
Input Voltage [V]		Output Voltage [V]	Max Current [A]	Max Power [W]
MIN	MAX	3.3	1.1	3.63
3.5	4.2	5	1	5
		3.3 & 5	0.6 & 0.6	4.98

Figure 7: Battery power supply table

NOTE *Using low-quality USB hubs, and too long or low-quality USB cables, may cause a significant USB voltage drop, which can obstruct the battery charging process.*

2.4 Power redundancy and uninterrupted power supply (UPS)

The PSU module supports power supply redundancy: it will automatically switch to the most appropriate power source if one of the power sources fails or becomes disconnected. The power supply redundancy also allows for an uninterrupted operation (i.e. UPS functionality, the battery will still provide power if the USB cable is removed, without resetting mikromedia 3 during the transition period).

2.5 Powering up the mikromedia 3 board

After a valid power supply source is connected in our case with a single-cell Li-Po/Li-Ion battery **(1)**, mikromedia 3 can be powered ON. This can be done by a small switch at the edge of the board, labeled as SW1 **(2)**. By switching it ON, the PSU module will be enabled, and the power will be distributed throughout the board. A LED indicator labeled as PWR indicates that the mikromedia 3 is powered ON.

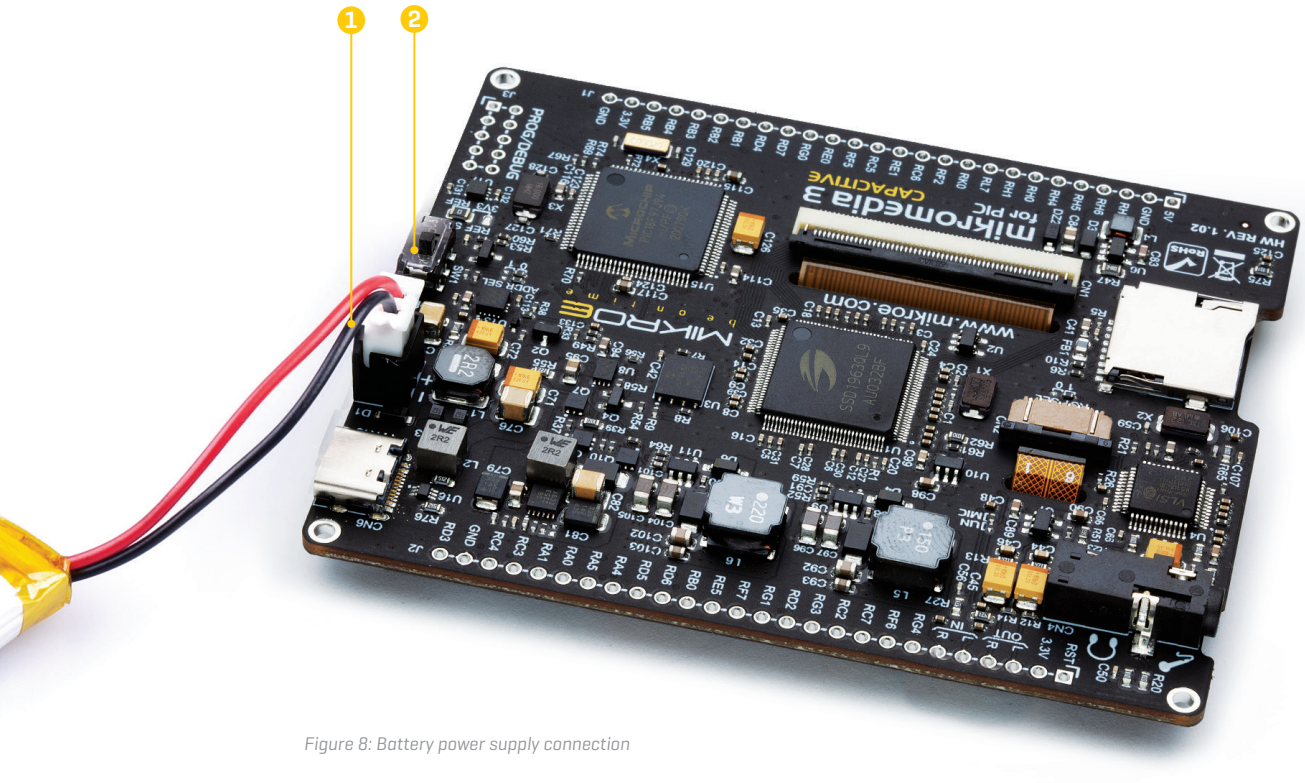


Figure 8: Battery power supply connection

3. Capacitive display

A high-quality 3.5" TFT true-color display with a capacitive touch panel is the most distinctive feature of the mikromedia 3. The display has a resolution of 320 by 240 pixels, and it can display up to 16.7M of colors (24-bit color depth). The display of mikromedia 3 features a reasonably high contrast ratio of 500:1, thanks to 6 high-brightness LEDs used for the backlighting.

The display module is controlled by the internal LCD Controller. The LCD controller consists of two independent controllers, the Raster Controller and the LCD Interface Display Driver (LIDD) controller. Each controller operates independently from the other and only one of them is active at any given time. .

The capacitive multi-touch panel allows the development of interactive applications, offering a touch-driven control interface. The touch panel controller uses the I2C interface for the communication with the host controller. This advanced multi-touch panel controller supports gestures, including zoom and swipe in all four directions.

Equipped with high-quality 3.5" display **(1)** and the multi-touch controller that supports gestures, mikromedia 3 represents a very powerful hardware environment for building various GUI-centric Human Machine Interface (HMI) applications.

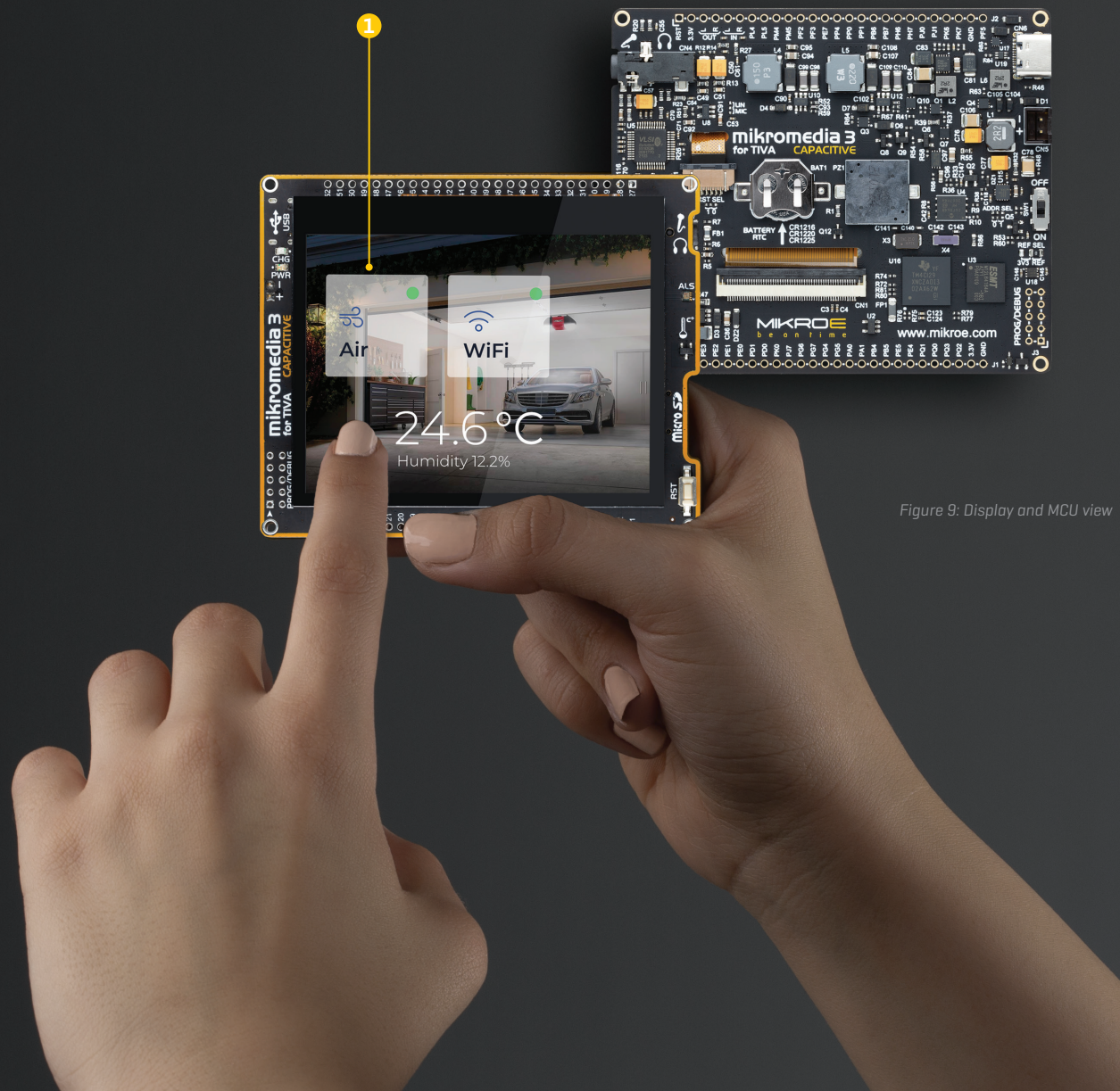


Figure 9: Display and MCU view

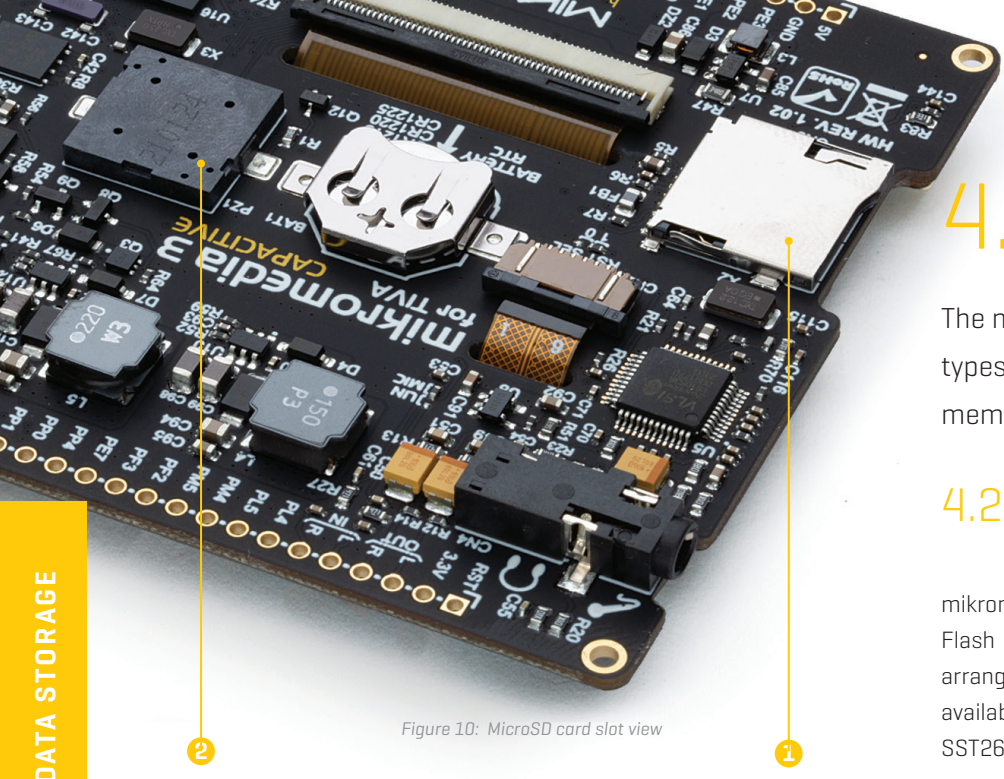


Figure 10: MicroSD card slot view

4. Data storage

The mikromedia 3 development board is equipped with three types of storage memory: with a microSD card slot, a Flash memory module and SDRAM.

4.1 microSD card slot

The microSD card slot **(1)** allows storing large amounts of data externally, on a microSD memory card. It uses the Serial Peripheral Interface (SPI) for communication with the MCU. The microSD card detection circuit is also provided on the board. The microSD card is the smallest SD Card version, measuring only 5 x 11 mm. Despite its small size, it allows tremendous amounts of data to be stored on it. In order to read and write to the SD Card, a proper software/firmware running on the host MCU is required.

4.2 External flash storage

mikromedia 3 is equipped with the SST26VF064B Flash memory **(2)**. The Flash memory module has a density of 64 Mbits. Its storage cells are arranged in 8-bit words, resulting in 8Mb of non-volatile memory in total, available for various applications. The most distinctive features of the SST26VF064B Flash module are its high speed, very high endurance, and very good data retention period. It can withstand up to 100,000 cycles, and it can preserve the stored information for more than 100 years. It also uses the SPI interface for the communication with the MCU.

4.3 SDRAM

The mikromedia 4 board features high-speed 64 Mbit M12L64164A SDRAM (Synchronous Dynamic Random-Access Memory). It is internally organized as 4 x 1,048,576 words by 16 bits. The SDRAM provides for programmable read or write burst lengths of 1, 2, 4, 8 locations, or the full page, with a burst terminate option. SDRAM is connected to the microcontroller via dedicated 16-bit parallel interface providing a highspeed data rate for more demanding multimedia applications, such as TFT display.

5. Connectivity

mikromedia 3 includes support for USB(HOST/DEVICE). Besides that, it also offers two 1x26 pin headers, which are used to directly access the MCU pins.

5.1 USB

The host MCU is equipped with the USB peripheral module, allowing simple USB connectivity. USB (Universal Serial Bus) is a very popular industry standard that defines cables, connectors, and protocols used for communication and power supply between computers and other devices. mikromedia 3 supports USB as HOST/DEVICE modes, allowing the development of a wide range of various USB-based applications. It is equipped with the USB-C connector **(1)**, which offers many advantages, compared to earlier types of USB connectors (symmetrical design, higher current rating, compact size, etc).

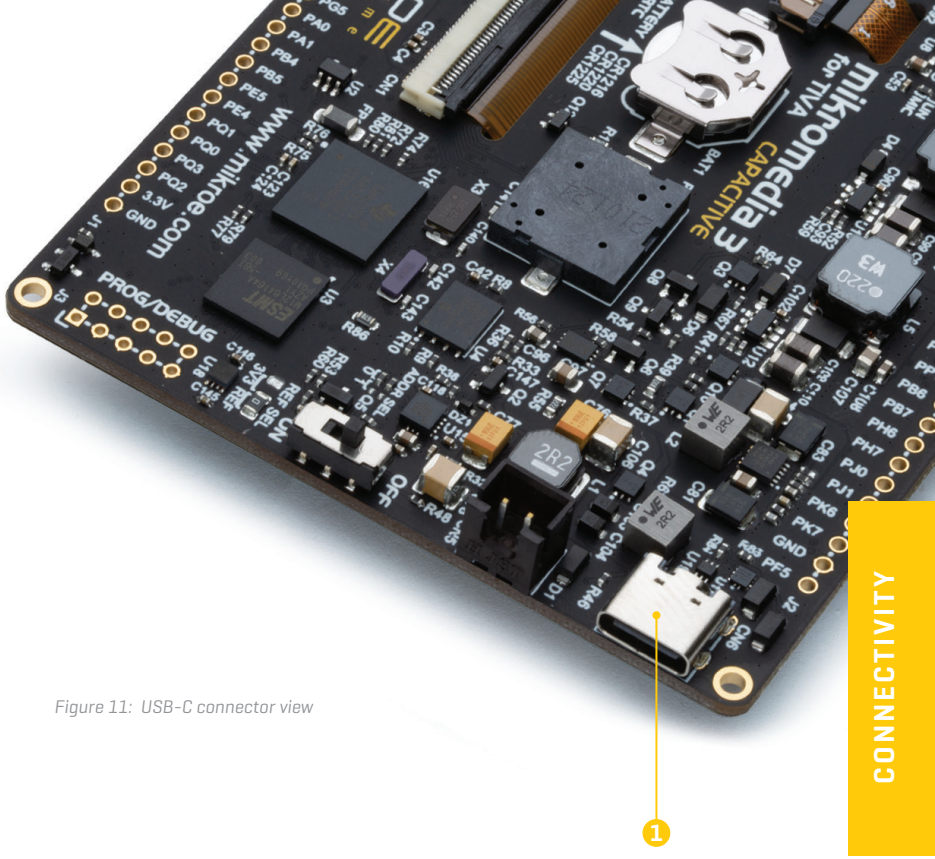


Figure 11: USB-C connector view

The USB ID pin is used to detect the type of the device attached to the USB port, according to the USB OTG specifications: the USB ID pin connected to GND indicates a HOST device, while the USB ID pin set to a high impedance state (HI-Z) indicates that the connected peripheral is a DEVICE.

NOTE

When mikromedia 3 is working in USB HOST mode, it must not be mounted to another USB HOST (such as PC).

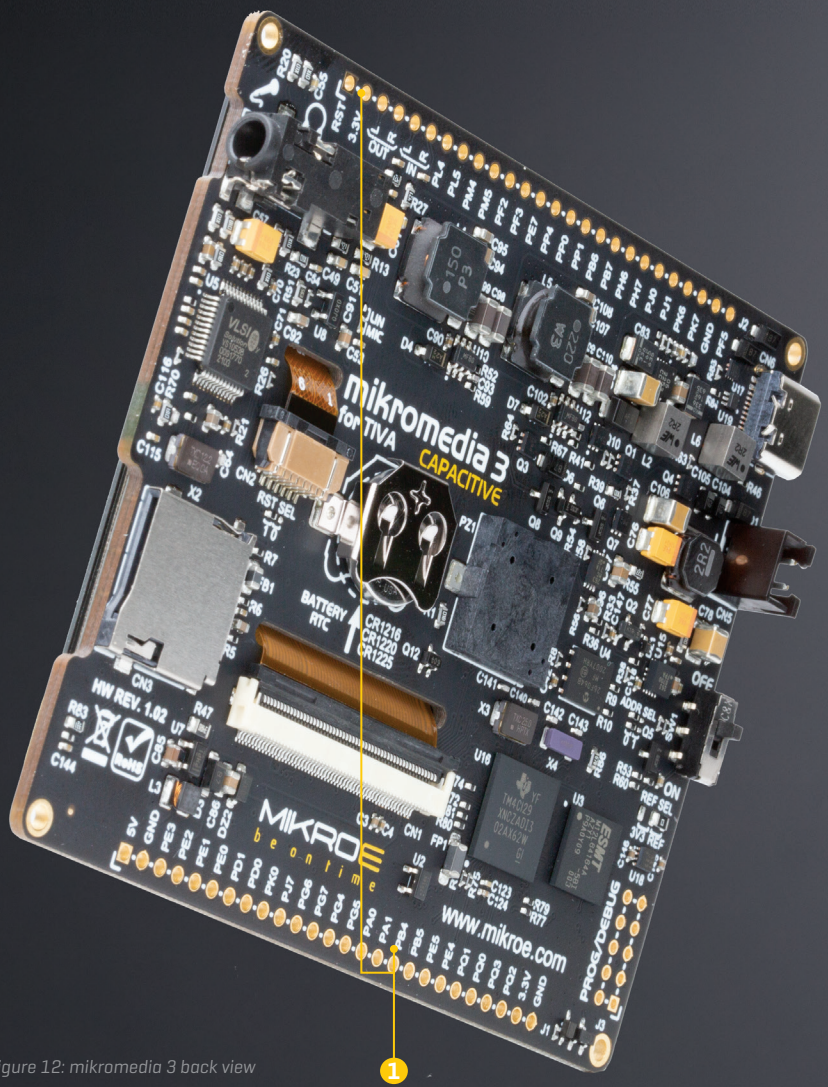


Figure 12: mikromedia 3 back view

5.2 1x26 pin headers

Most of the host MCU pins are routed to the two 1x26 pin headers **(1)**, making them available for further connectivity. In addition to MCU pins, some additional peripheral pins are also routed to this header.

Besides the ability to connect various external devices and peripherals by using wire jumpers, these pins also allow using shields with the additional mikroBUS™ sockets. This allows mikromedia 3 to be interfaced with a huge base of different Click boards™ adding many different functionalities and options, including motor drivers, buck/boost converters, sensors, and much more. For the complete list of all the Click boards™ in our offer, please visit the following link: ***www.mikroe.com/click***

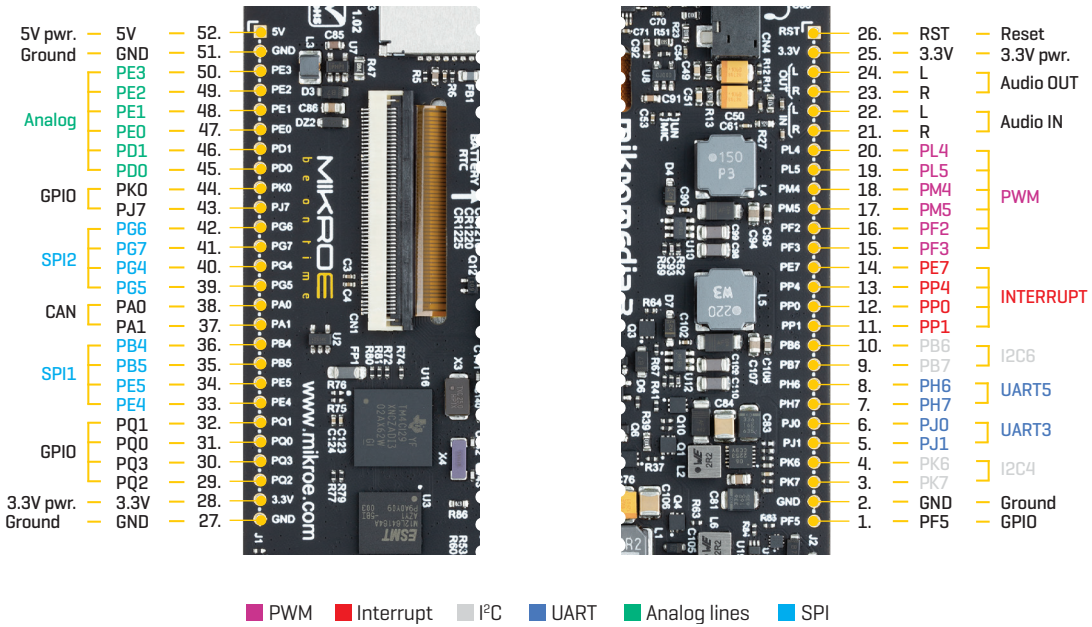
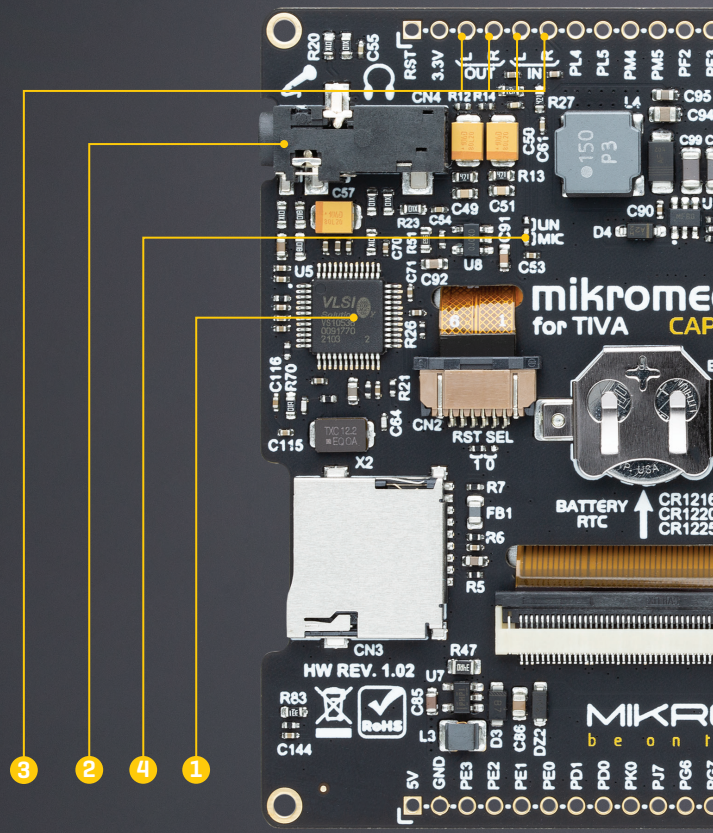


Figure 13: 1x26 pin header view

6. Sound-related peripherals

By offering a pair of sound-related peripherals, mikromedia 4 rounds-up its multimedia concept. It features a piezo-buzzer, which is extremely easy to program but can produce only the simplest sounds, useful only for alarms or notifications.

mikromedia 3 features powerful VS1053B IC. It is an Ogg Vorbis/MP3/AAC/WMA/FLAC/WAV/MIDI audio decoder, and a PCM/IMA ADPCM/Ogg Vorbis encoder, both on a single chip. It features a powerful DSP core, high-quality A/D and D/A converters, stereo headphones driver capable of driving a 30Ω load, zero-cross detection with the smooth volume change, bass and treble controls, and much more.



6.1 Piezo Buzzer

A piezo buzzer **[2]** is a simple device capable of reproducing sound. It is driven by a small pre-biased transistor. The buzzer can be driven by applying a PWM signal from the MCU at the base of the transistor: the pitch of the sound depends on the frequency of the PWM signal, while the volume can be controlled by changing its duty cycle. Since it is very easy to program, it can be very useful for simple alarms, notifications, and other types of simple sound signalization.

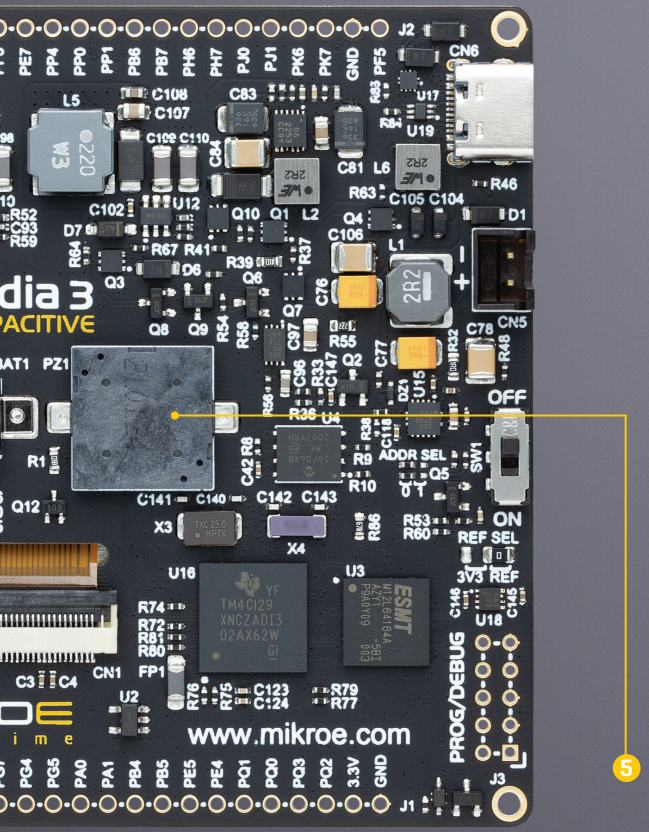


Figure 14: mikromedia 3 back view

6.2 Audio CODEC

Resource-demanding and complex audio processing tasks can be offloaded from the host MCU by utilizing a dedicated audio CODEC IC, labeled as VS1053B **(1)**. This IC supports many different audio formats, commonly found on various digital audio devices. It can encode and decode audio streams independently while performing DSP-related tasks in parallel. The VS1053B has several key features that make this IC very popular choice when it comes to audio processing.

By offering high-quality hardware compression (encoding), the VS1053B allows the audio to be recorded taking up much less space compared to the same audio information in its raw format. In combination with high-quality ADCs and DACs, headphones driver, integrated audio equalizer, volume control, and more, it represents an all-around solution for any type of audio application. Along with the powerful graphics processor, the VS1053B audio processor completely rounds-up the multimedia aspects of the mikromedia 3 development board.

6.3 Audio connectors

The mikromedia 3 board is equipped with the 3.5mm four-pole headphones jack **(2)**, allowing to connect a headset with a microphone. Two line-level audio outputs are also available over the 1x26 pin header **(3)**.

The microphone input from the 3.5mm four-pole headset jack is multiplexed with two line-level audio inputs. By using an SMD jumper **(4)** located near the headphone jack, it is possible to select which audio input will be used by the VS1053B. The choices are:

LIN: two line-level inputs form the 1x26 pin header
MIC: electret microphone, connected over the 3.5mm headphone jack

7. Sensors and other peripherals

A set of additional onboard sensors and devices adds yet another layer of usability to the mikromedia 3 development board.

7.1 Ambient light sensor

An ambient light sensor (ALS) **(1)** can be used for dimming the screen intensity in low-light conditions, allowing for the lower power consumption. It can also be used to detect the proximity and turn on the screen or increase its brightness when the user approaches. The ALS sensor on the mikromedia 7 can be utilized in many ways. The LTR-329ALS-01 sensor uses the I2C interface to communicate with the host MCU.

7.2 Digital motion sensor

The FXOS8700CQ, an advanced integrated 3-axis accelerometer and 3-axis magnetometer, can detect many different motion-related events, including the orientation event detection, freefall detection, shock detection, as well as tap, and double-tap event detection. These events can be reported to the host MCU over two dedicated interrupt pins, while the data transfer is performed over the I2C communication interface. The FXOS8700CQ sensor can be very useful for display orientation detection. It can also be used to turn mikromedia 3 into a complete 6-axis e-compass solution. The I2C slave address can be changed by using two SMD jumpers grouped under the ADDR SEL label **(2)**.

Figure 15: mikromedia 3 partial front view

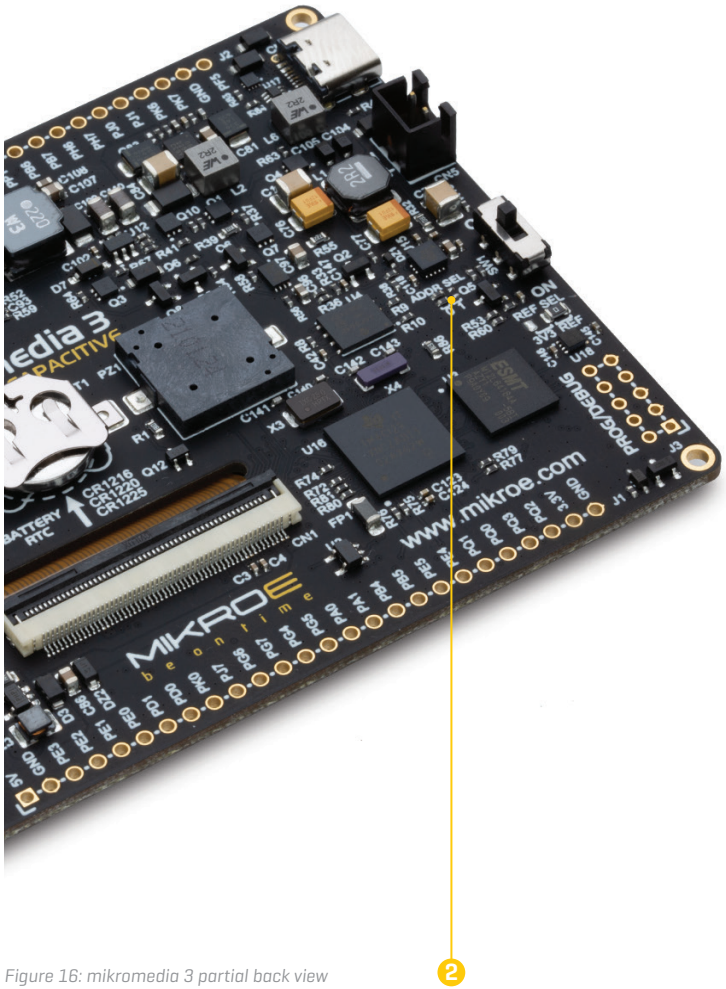


Figure 16: mikromedia 3 partial back view

7.3 Temperature sensor

The MCP9700A **[3]**, an integrated low-power linear active thermistor allows measurement of the ambient temperature. This sensor provides an analog voltage which changes linearly with the applied temperature. This voltage can be sampled by the A/D converter on the host MCU, making it available for various user applications. The MCP9700A can measure the temperature within the range from -40°C to +125°C, but the actual measurement range is limited by the thermal endurance of the mikromedia 3 board itself. Nevertheless, having a thermal sensor on board is very useful, allowing the development of thermal monitoring applications, weather stations, and similar.

7.4 Real-time clock (RTC)

The host MCU contains a real-time clock peripheral module (RTC). The RTC peripheral uses a separate power supply source, typically a battery. To allow continuous tracking of time, mikromedia 4 is equipped with a button cell battery that maintains RTC functionality even if the main power supply is OFF. Extremely low power consumption of the RTC peripheral allows these batteries to last very long. The mikromedia 3 development board is equipped with the button cell battery holder, compatible with the CR1216, CR1220 and CR1225 button cell battery types, allowing it to include a real time clock within the applications.

RAPID DEVELOPMENT OF MULTIMEDIA AND GUI-CENTRIC APPLICATIONS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CHG
PWR
ALS
Micro SD
RST
Air
WiFi
24.6 °C
Humidity 12.2%

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What's Next?

You have now completed the journey through each and every feature of mikromedia 3 for TIVA CAPACITIVE development board. You got to know its modules and organization. Now you are ready to start using your new board. We are suggesting several steps which are probably the best way to begin.

1 COMPILERS

Easy programming, clean interface, powerful debugging, great support - our compilers come in three different flavors: mikroC PRO for ARM, mikroBASIC PRO for ARM and mikroPASCAL PRO for ARM, offering a complete rapid embedded development solution for these 3 major programming languages. ***www.mikroe.com/compilers/compilers-arm***

Fast, professional, multiplatform, and multi-architectural Necto Studio is already in the air. Support for TIVA compiler inside the Necto studio is ready, for more information, please visit: ***www.mikroe.com/necto***

2 PROJECTS

Once you have chosen your compiler, and since you already got the board, you are ready to start writing your first projects. We have equipped our compilers with dozens of examples that demonstrate the use of each and every feature of the mikromedia 3 for TIVA CAPACITIVE development board. This makes an excellent starting point for future custom projects. Just load the example, read well commented code, and see how it works on hardware.

3 COMMUNITY

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