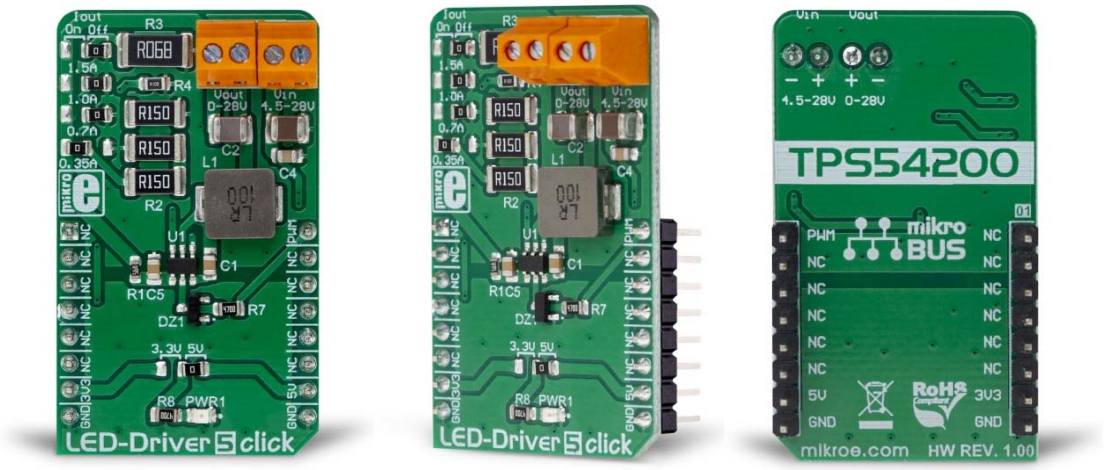


LED Driver 5 click

PID: MIKROE-3297
Weight: 25 g

LED Driver 5 click is a Click board™ capable of driving an array of high-power LEDs with constant current, up to 1.5A. This Click board™ features the TPS54200, a highly integrated LED driver IC, with many useful features. It consists of a synchronous, fixed-frequency buck converter which operates at 600kHz, providing an excellent size/efficiency ratio. LED Driver 5 click can use both analog and PWM control signal for dimming the connected LED array.

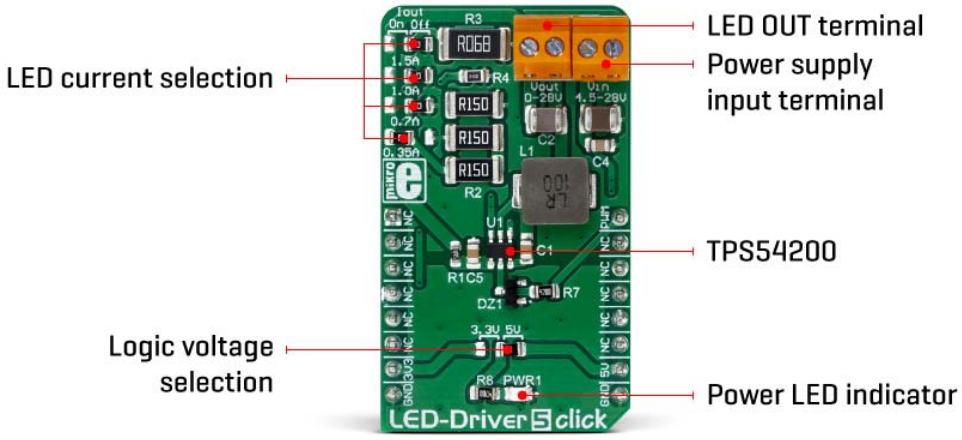
It comes in the package which also includes the mikroSDK™ software and a library with all the functions. The Click board™ comes as a fully tested and approved prototype, making it a reliable device ready to use on the development board.

The TPS54200 supports analog and PWM dimming mode. In analog dimming mode, the internal reference voltage is scaled in the range from 1% to 100%. In the PWM dimming mode, the LED output is synchronized with the PWM control signal at the input. The smart signal-switching logic automatically selects the dimming mode by examining the signal applied to

the PWM pin. LED Driver 5 click is an ideal solution for driving a single or multi-stream LED arrays, including monochrome, white, and IR LED arrays, providing up to 28V at the output.

How does it work?

The main component of the LED Driver 5 click is the TPS54200, a synchronous buck converter designed to drive monochrome, color, and IR LED arrays made by Texas Instruments. The Click board™ is very flexible regarding the input voltage choice, allowing any voltage in the range from 4.5V up to 28V to be used. This is possible thanks to the TPS54200 driver IC, which integrates a buck converter IC, and supports an LED dimming by using the pulse width of the PWM signal on the control input. This IC has a mode selection logic circuitry which is used to select one of two dimming modes, depending on the incoming PWM control signal level.



The PWM pin is used to control more than just one function. Besides choosing the dimming mode (analog or PWM), this pin is also used to enable or disable the IC. If the signal at the PWM pin rises above the threshold value (0.56V typically) the IC will be enabled. Keeping the voltage at the PWM pin lower than 0.56V for at least 40 ms will effectively disable the IC.

After the device is enabled, the magnitude of the PWM signal is detected and stored by an internal peak detector. The voltage of the peak detector is then compared with two threshold values, V_{ADIM} and V_{PDIM}, after 300 µs. If the peak detector output is at a higher voltage than 2.07V, analog dimming mode will be selected and locked. If the peak detector voltage is in the range between 1V and 2.07V, the PWM dimming mode will be selected and locked. If the voltage is less than 1V, the whole detection process will be repeated after

300 µs, until one of two operating modes is selected and locked. Once locked, the dimming mode can only be changed by cycling the VIN voltage or re-enabling the IC. The PWM pin is routed to the PWM pin of the mikroBUS™, allowing it to be controlled by the host microcontroller (MCU). When the analog dimming mode is selected (the magnitude of the control PWM signal is above 2.06V during the boot-up sequence of the TPS54200), the internal reference voltage (V_{REF}) is scaled down according to the duty cycle of the PWM signal applied to the PWM pin. The internal reference voltage for this mode is 200 mV at full-scale (duty-cycle at 100%). As the duty cycle decreases, the reference voltage is scaled down to 1% of its value. This will cause the current through the LED to be scaled as well, effectively dimming the LED. This type of dimming, where the LED intensity is dimmed to a very low-level invisible to the eye, is sometimes referred to as *deep-dimming.* The PWM control signal at the PWM pin should stay within the range of 10 kHz, to reduce the output voltage ripple.

If the PWM dimming mode is selected (the magnitude of the control PWM signal is between 1V and 2.06V during the boot-up sequence of the TPS54200), the internal reference voltage is fixed at 100mA. In this mode, the LED dimming is performed by using the PWM signal applied to the PWM pin, modulating the LED output. Holding the internal reference voltage fixed, the LED at the output will only be switched ON or OFF, according to the duty cycle of the control PWM signal.

The buck converter itself is a very feature-rich circuitry, a synchronous buck converter, operating at the fixed frequency of 600kHz. This offers an excellent size/efficiency ratio, keeping the footprint of the TPS54200 IC very small. Features such as the open LED or shorted LED detection, overvoltage, and under-voltage protection, over-current and open loop protection, thermal shutdown, soft start function that prevents the inrush current, allow the Click board™ to be a very reliable and safe solution for driving high current LEDs or LED arrays.
The Click board™ contains four SMD jumpers used to select the current through the LED array. They are grouped together and labeled as I_{OUT}. There are four different settings: 0.35A, 0.7A, 1A, and 1.5A. Switching the current selection SMD jumper to the ON position will connect a respective sensing resistor (R_S)to the circuit. The value of each $R_S$is calculated using a very simple formula, given in the datasheet of the TPS54200 IC:

$$I_{LED} = V_{REF}/R_S$$

Note that switching two SMD jumpers to the ON position simultaneously will cause them to form a parallel connection with its equivalent resistance. However, this is not recommended since almost all the resistor combinations

will result with the value too low to be used (the LED current will be set to above 1.5A, thus triggering the protection circuit)

Specifications

Type	Buck
Applications	LED Driver 5 click is an ideal solution for a reliable and efficient driving of a single or multi-stream LED arrays, including monochrome LED, white LED, and IR LED arrays, providing up to 28V at the output
On-board modules	TPS54200, a synchronous buck converter for driving monochrome, color, and IR LED arrays
Key Features	Highly regulated, selectable LED current, can use a wide range of power supply voltages, open LED or shorted LED detection, overvoltage and undervoltage protection, over-current and open-loop protection, thermal shutdown, soft start function prevents the inrush current
Interface	PWM
Input Voltage	3.3V or 5V
Compatibility	mikroBUS
Click board size	M (42.9 x 25.4 mm)

Pinout diagram

This table shows how the pinout on **LED Driver 5 click** corresponds to the pinout on the mikroBUS™ socket (the latter shown in the two middle columns).

Notes	Pin	mikroBUS				Pin	Notes
	NC	1	AN	PWM	16	**PWM**	Control PWM Signal
	NC	2	RST	INT	15		
	EN	3	CS	RX	14		
	NC	4	SCK	TX	13		
	NC	5	MISO	SCL	12		
	NC	6	MOSI	SDA	11		
Power supply	**3.3V**	7	3.3V	5V	10	**5V**	Power supply
Ground	**GND**	8	GND	GND	9	**GND**	Ground

Onboard settings and indicators

Label	Name	Default	Description
PWR1	PWR	-	Power LED indicator
TB2	Vin	-	Power supply input terminal

TB1	Vout	-	LED output terminal
JP1-JP3	1.5A, 1A, 0.7A	OFF	LED current selection: left position ON, right position OFF
JP4	0.35A	ON	LED current selection: left position ON, right position OFF

Software support

We provide a library for the LED Driver 5 click on our LibStock page, as well as a demo application (example), developed using MikroElektronika compilers. The demo can run on all the main MikroElektronika development boards.

Library Description
You can find all the functions for controlling LED lighting in the file Click_LED_Driver5_pwm

Key functions:

- `uint32_t leddriver5_pwmInit(uint16_t freq)` - PWM init function
- `void leddriver5_pwmSetDuty(uint16_t duty)` - PWM set duty function
- `void leddriver5_pwmStart()` - PWM start function
- `void leddriver5_pwmStop()` - PWM stop function

Examples description
The application is composed of the three sections :

- System Initialization - Sets PWM pin as OUTPUT
- Application Initialization - Initialization driver init and pwm init
- Application Task - (code snippet) - Controls the brightness of the LED using PWM

```
void applicationTask()
{
    _dutyCycle += 250;
    leddriver5_pwmSetDuty(_dutyCycle);
    if (_dutyCycle > 10000 )
```

```
    {
        _dutyCycle = 0;
        leddriver5_pwmSetDuty(_dutyCycle);
        Delay_ms(2000);
    }
    Delay_ms( 100 );

}
```

The full application code, and ready to use projects can be found on our LibStock page.
Other mikroE Libraries used in the example:

- PWM

Additional notes and information
Depending on the development board you are using, you may need USB UART click, USB UART 2 click or RS232 click to connect to your PC, for development systems with no UART to USB interface available on the board. The terminal available in all MikroElektronika compilers, or any other terminal application of your choice, can be used to read the message.

mikroSDK

This click board is supported with mikroSDK - MikroElektronika Software Development Kit. To ensure proper operation of mikroSDK compliant click board demo applications, mikroSDK should be downloaded from the LibStock and installed for the compiler you are using.

For more information about mikroSDK, visit the official page.