

Time-saving embedded tools

MIKROELEKTRONIKA D.O.O, Batajnički drum 23, 11000 Belgrade, Serbia VAT: SR105917343 Registration No. 20490918 Phone: + 381 11 78 57 600 Fax: + 381 11 63 09 644 E-mail: office@mikroe.com www.mikroe.com

# VCP Monitor 2 Click





PID: MIKROE-4126

**VCP Monitor 2 Click** is a three-channel, high-side current and bus voltage monitor with alert indication function ensuring the intended application works within desired operating conditions. Featured chip INA3221-Q1, by Texas Instruments, monitors both shunt voltage drops and bus supply voltages, in addition to having programmable conversion times and averaging modes for these signals. The INA3221-Q1 offers both critical and warning alerts to detect multiple programmable out-of-range conditions for each channel. The INA3221-Q1 senses current on buses that can vary from 0V to 26V. The device is powered from a single 2.7V to 5.5V supply, and draws 350 µA (typical) of supply current. The I2C and SMBUS-compatible interface features four programmable addresses.

VCP Monitor 2 Click is supported by a mikroSDK compliant library, which includes functions that simplify software development. This Click board<sup>M</sup> comes as a fully tested product, ready to be used on a system equipped with the mikroBUS<sup>M</sup> socket.

#### How does it work?

VCP Monitor 2 Click performs two measurements on up to three power supplies of interest (CH3 - CH1). The voltage developed from the load current passing through a shunt resistor creates a shunt voltage that is measured between the IN+ and IN- pins. The device also internally measures the power supply bus voltage at the IN- pin for each channel. The differential shunt voltage is measured with respect to the IN- pin, and the bus voltage is measured with respect to ground. The featured chip which is used for channel measurements, INA3221-Q1, is typically powered by a separate power supply that ranges from 2.7V to 5.5V. The monitored supply buses range from 0V to 26V.

Mikroe produces entire development toolchains for all major microcontroller architectures. Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.





MIKROELEKTRONIKA D.O.O, Batajnički drum 23, 11000 Belgrade, Serbia VAT: SR105917343 Registration No. 20490918 Phone: + 381 11 78 57 600 Fax: + 381 11 63 09 644 E-mail: office@mikroe.com www.mikroe.com



The INA3221-Q1 takes two measurements for each channel: one for shunt voltage and one for the bus voltage. Each measurement can be independently or sequentially measured, based on the Configuration mode settings. When the INA3221-Q1 is in the normal operating mode the device continuously converts a shunt-voltage reading followed by a bus-voltage reading. This procedure converts one channel, and then continues to the shunt voltage reading of the next enabled channel, followed by the bus-voltage reading for that channel, and so on, until all enabled channels have been measured. The programmed Configuration register mode setting applies to all channels. Any channels that are not enabled are bypassed in the measurement sequence, regardless of mode setting.

The INA3221-Q1 has two operating modes, continuous and single-shot, that determine the internal ADC operation after these conversions complete. When the INA3221-Q1 is set to continuous mode, the device continues to cycle through all enabled channels until a new configuration setting is programmed. The Configuration register MODE control bits also enable modes to be selected that convert only the shunt or bus voltage. This feature further allows the device to fit specific application requirements. In single-shot (triggered) mode, setting any single-shot convert mode to the Configuration register triggers a single-shot conversion. This action produces a single set of measurements for all enabled channels. To trigger another single-shot conversion, write to the Configuration register a second time, even if the mode does not change. When a single-shot conversion is initiated, all enabled channels are measured one time and then the device enters a power-down state. The INA3221-Q1 registers can be read at any time, even while in power-down. In addition to the two operating modes, the INA3221-Q1 also has a separate selectable power-down mode that reduces the quiescent current and turns off current into the INA3221-Q1 inputs. Power-down mode reduces the impact of the supply drain when the device is not used. Full recovery from power-down mode requires 40 µs. The INA3221-Q1 registers can be written to and read from while the device is in power-down mode. The device remains in power-down mode until one of the active MODE settings are written to the Configuration register.

VCP Monitor 2 Click also provides programmable thresholds that make sure the intended application operates within the desired operating conditions. Multiple monitoring functions are available using four alert pins: Critical, Warning, PV (power valid), and TC (timing control). The status of these alert pins are accessible over PCA9538A, a low-voltage 8-bit GPIO expander with interrupt and reset. The open-drain interrupt (INT) output is activated when any of the alert pins state has changed. This signal is used to inform the microcontroller that the bus voltage is not within the desired operating conditions. The PCA9538A uses the I2C communication protocol to read the current states of the alert monitoring pins with the

Mikroe produces entire development toolchains for all major microcontroller architectures.

Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.





changeable slave address to avoid bus conflict in advanced systems. For the visual representation of any deviation from programmed thresholds, alert monitoring pins are connected to 4 LEDs located on Click board<sup>™</sup>.

The VCP Monitor 2 Click supports the I2C communication protocol. Since there are two slave devices on the Click board<sup>™</sup>, the solderable SMD jumpers are conveniently placed for easy I2C slave address reconfiguration. The INA3221-Q1 has one cross-shaped jumper selection for one address pin with four possible addresses with connections to GND, VCC, SDA or SCL. The other one, PCA9538A, has two jumpers for address pins A1 and A0 with the possibility of four different slave addresses, making this Click board<sup>™</sup> flexible for implementation in other systems with various peripherals sharing the same bus.

#### **I2C Slave address selection**

A1	A0		PCA9538A	
GND	GND		0x70	
GND	VCC		0x71	
VCC	GND		0x72	
VCC	VCC		0x73	
A0		INA3221-Q1		
GND		0x40		
VCC		0x41		
SDA		0x42		
SCL		0x43		

This Click board<sup>™</sup> can be supplied and interfaced with both 3.3V and 5V without the need for any external components. The onboard SMD jumper labeled as VCC SEL allows voltage selection for interfacing with both 3.3V and 5V microcontrollers.

# **Specifications**

Туре	Measurements
Applications	Electronic control units, digital clusters, rear- seat entertainment, infotainment, computers, power management, telecom equipment, battery chargers, power supplies, test equipment.
On-board modules	VCP Monitor 2 Click uses the INA3221-Q1, a three-channel, high-side current and bus voltage monitor, from Texas Instruments and PCA9538A, an IO expander with interrupt and reset, from NXP Semiconductors.
Key Features	Shunt voltage drops and bus supply voltages monitoring, programmable conversion times, critical and warning alerts, single power supply, 350 µA of supply current
Interface	12C
Feature	No ClickID
Compatibility	mikroBUS™
Click board size	L (57 15 x 25 4 mm)

Mikroe produces entire development rooichains for all major microcontroller architectures.

Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.





Time-saving embedded tools

MIKROELEKTRONIKA D.O.O, Batajnički drum 23, 11000 Belgrade, Serbia VAT: SR105917343 Registration No. 20490918 Phone: + 381 11 78 57 600 Fax: + 381 11 63 09 644 E-mail: office@mikroe.com www.mikroe.com

Input Voltage	13.3V or 5V
in part i orital go	

### **Pinout diagram**

This table shows how the pinout on VCP Monitor 2 Click corresponds to the pinout on the mikroBUS<sup>m</sup> socket (the latter shown in the two middle columns).

Notes	Pin	● ● mikro™ ● ● ● BUS			TM-	Pin	Notes
	NC	1	AN	PWM	16	NC	
	NC	2	RST	INT	15	INT	Interrupt
Reset	RST	3	CS	RX	14	NC	
	NC	4	SCK	ТΧ	13	NC	
	NC	5	MISO	SCL	12	SCL	I2C Clock
	NC	6	MOSI	SDA	11	SDA	I2C Data
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		
LD1	PWR	-	Power LED Indicator		
LD2	PV	-	Power Valid Alert LED		
			Indicator		
LD3	WRNG	-	Warning Alert LED		
			Indicator		
LD4	CRTCL	-	Critical Alert LED		
			Indicator		
LD5	TC	-	Timing-Control Alert		
			LED Indicator		
JP1	VCC SEL	Left	Power Supply Voltage		
			Selection 3V3/5V, left		
			position 3v3, right		
			position 5v		
JP2	VPU SEL	Right	INA3221-Q1 bias		
			supply voltage for		
			power valid output		
			circuitry: left position -		
			External supply, right		
			position - On-board		
100 105			supply		
JP3, JP5	ADDR SEL	Left	PCA9538A slave		
			address selection: left		
			position 0, right		
		Dawn			
JP4,JP0	ADDK SEL		addross 4 position		
			coloction: down CND		
			Up VCC loft SDA		
			up - VCC, IEIL - SDA,		
			ngni - SCL		

Mikroe produces entire development toolchains for all major microcontroller architectures.

Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.





# VCP monitor 2 Click electrical specifications

Description	Min	Тур	Max	Unit
Supply Voltage (VCC)	0	3.3	6	V
Analog Inputs (IN+,IN-)	-0.3	-	26	V
Bus Power Supply Rail (VPU)	0	-	26	V
Operating Temperature Range	-40	-	125	°C

### Software Support

We provide a library for the VCP Monitor 2 Click on our <u>LibStock</u> page, as well as a demo application (example), developed using MikroElektronika <u>compilers</u>. The demo can run on all the main MikroElektronika <u>development boards</u>.

#### **Library Description**

The library contains basic communication with the module and allows the user to read and write data to the module. The user can read the current data of current, voltage and power measured by the sensor.

Key functions:

- float vcpmonitor2\_get\_shunt\_voltage ( uint8\_t channel ) Get Shunt voltage in mV
- float vcpmonitor2\_get\_current ( uint8\_t channel ) Get Current data in mA
- float vcpmonitor2\_get\_power ( uint8\_t channel ) Get Power in W

#### Examples description

The application is composed of three sections :

- System Initialization Initialization I2C module and RST pin on OUTPUT
- Application Initialization Initialization driver init, device configuration for measurement, alert status reset and configuration
- Application Task Display Voltage on the BUS and Shunt, current and power data. Display Alert status informations.

Additional Functions :

- display\_alert\_status() Alert status
- display\_channel\_data() Channel data

The full application code, and ready to use projects can be found on our <u>LibStock</u> page.

Other mikroE Libraries used in the example:

- I2C Library
- UART Library

#### Additional notes and informations

Depending on the development board you are using, you may need <u>USB UART click</u>, <u>USB UART</u> <u>2 click</u> or <u>RS232 click</u> to connect to your PC, for development systems with no UART to USB Mikroe produces entire development roolchains for all major microcontroller architectures.

Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.





interface available on the board. The terminal available in all MikroElektronika <u>compilers</u>, or any other terminal application of your choice, can be used to read the message.

## mikroSDK

This Click board<sup> $\mathbb{M}$ </sup> is supported with <u>mikroSDK</u> - MikroElektronika Software Development Kit. To ensure proper operation of mikroSDK compliant Click board<sup> $\mathbb{M}$ </sup> demo applications, mikroSDK should be downloaded from the <u>LibStock</u> and installed for the compiler you are using.

For more information about mikroSDK, visit the <u>official page</u>. **Resources** 

mikroBUS™

<u>mikroSDK</u>

Click board<sup>™</sup> Catalog

Click Boards<sup>™</sup>

#### **Downloads**

VCP monitor 2 Click schematic

VCP monitor 2 click 2D and 3D files

INA3221-Q1 datasheet

VCP monitor 2 click example on Libstock

Mikroe produces entire development toolchains for all major microcontroller architectures.

Committed to excellency, we are dedicated to helping engineers bring the project development up to speed and achieve outstanding results.



ISO 27001: 2013 certification of informational security management system. ISO 14001: 2015 certification of environmental management system. OHSAS 18001: 2008 certification of occupational health and safety management system.



# **Mouser Electronics**

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Mikroe:

MIKROE-4126