ValveInsight Evaluation Kit

For further information please check our landing page: burkert.com/ValveInsight
The software package to integrate the switching detection and switching time measurement is freely available on GitHub. (github.com/buerkert/valveinsight)

We reserve the right to make technical changes without notice.

1 About this document

The document is an important part of the product and guides the user to safe installation and operation. The information and instructions in this document are binding for the use of the product.

- Before using the product for the first time, read and observe the whole safety chapter.
- Before starting any work on the product, read and observe the respective sections of the document.
- Keep the document available for reference and give it to the next user.
- Contact the Bürkert sales office for any questions.

Manufacturer
Bürkert Fluid Control Systems
Christian-Bürkert-Str. 13−17
74653 Ingelfingen
GERMANY

The contact addresses are available at Contact.

Need more information or additional products?
▶ Explore the full range of products on our eShop.

2 Safety

2.1 Intended use: Testing purposes only

Prerequisites for safe and trouble-free operation are proper transport, storage, installation, commissioning, operation and maintenance.
The instructions are part of the device. The device is intended exclusively for use within the scope of these instructions. Uses of the device that are not described in these instructions, the contractual documents or the type label can lead to severe personal injury or death, damage to the device or property and dangers for the surrounding area or the environment.

▶ This Evaluation Kit is for testing purposes only and does not have a CE certification.
▶ It is not intended for productive/serial use.
▶ The included valve Type 6724 is not suitable for fluidic usage, as the diaphragm may be deformed by the blocking mechanism. To use the Evaluation Kit with fluidics, please order Whisper Valves separately.
▶ In outdoor areas, ensure that the device is installed in an electrical box with a degree of protection of minimum IP65.

▶ Do not use rectified alternating voltage without smoothing as the supply voltage.
▶ Do not use the device in potentially explosive atmosphere.
▶ Use the device only in conjunction with third-party devices and components recommended and authorized by Bürkert.
▶ Use the evaluation kit only when it is in perfect condition.

2.2 Safety instructions

Hot surfaces and fire hazard

The surface of the device can become hot with fast-switching actuators.
▶ Wear suitable protective gloves.
▶ Keep highly flammable substances and media away from the device.

Qualification of personnel working with the device

Improper use of the device can lead to serious personal injury or death. To avoid accidents when working with the device, the following minimum requirements must be met:
▶ Carry out work on the device within the scope of these instructions in a safety-compliant manner.
▶ Detect and avoid dangers when working on the device.
▶ Understand the instructions and implement the information contained therein accordingly.

Responsibility of the operator

The operator is responsible for observing the location-specific safety regulations, also in relation to personnel.
▶ Observe the general rules of technology.
▶ Observe precautions for handling electrostatic discharge sensitive devices.
▶ Install the device according to the regulations applicable in the respective country.
▶ The operator must make hazards arising from the location of the device avoidable by providing appropriate operating instructions.

Damage to the device due to condensation

Failure to observe the permissible storage and transport temperature range may result in condensation forming.
▶ Observe the storage and transport temperature.

3 Overview ValveInsight Evaluation Kit

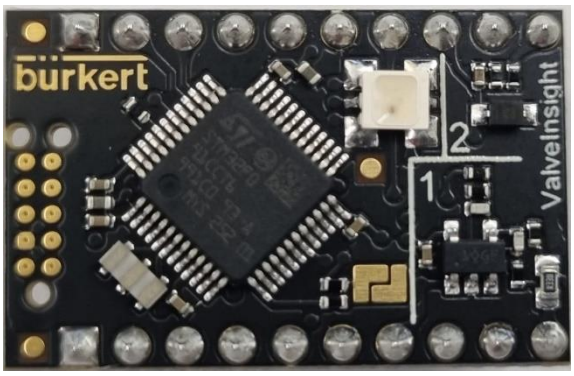
The board simplifies the integration of ValveInsight standard algorithms into your device.
For advanced functions, such as detecting changes in viscosity, pressure, or temperature through analysis of the inrush current, the entire system needs to be analysed, and data needs to be obtained directly in the application to train custom algorithms.

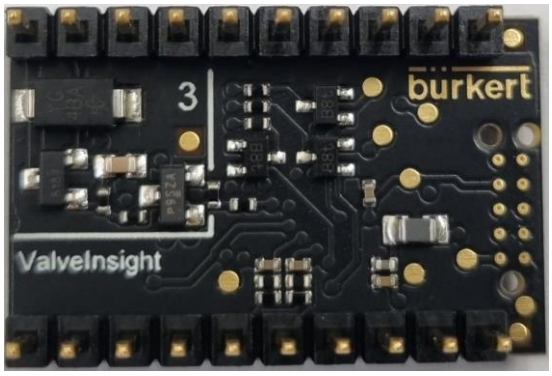
The kit consists of

- Bürkert type 6724 Whisper Valve (20027698, 6724 A 1.2 FFKM 24V) modified to be blockable with a screw
- Cable connectors
- The evaluation board (electronics) with a pre-installed switching detection algorithm

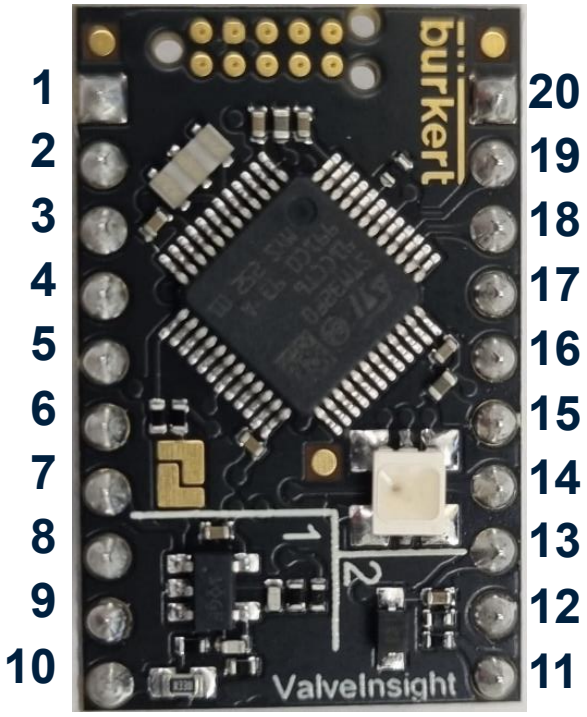
The board consists of

- µC with its peripherals
    - Current measurement circuit (Marked 1)
    - Voltage measurement (Marked 2)
    - Switching circuit (Marked 3)





4 Pinout



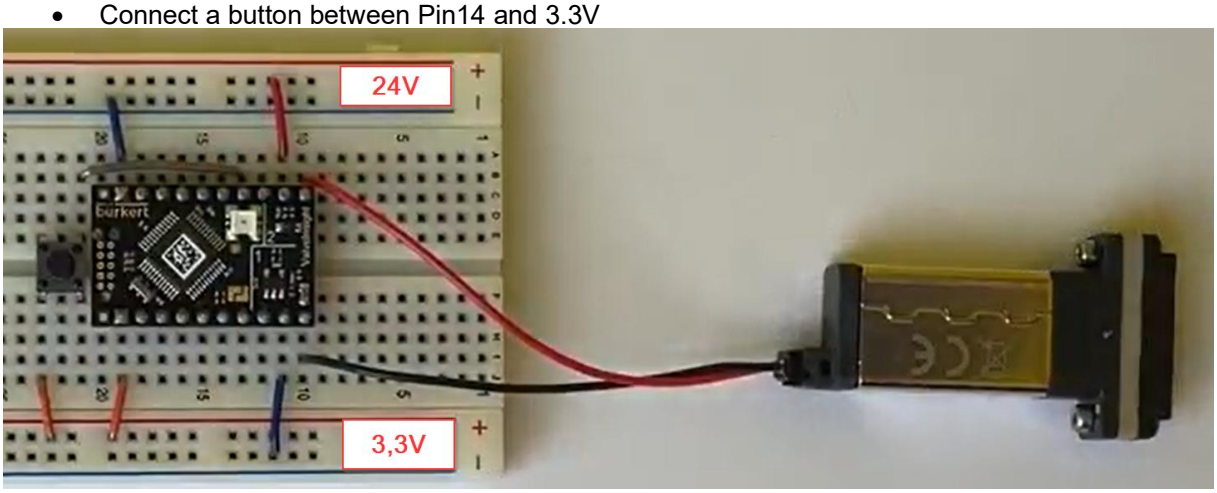
Pin	Function	Note
1	VCC-µC	Power supply of the µC, connect to 3.3V
5	PB12	Valve State Output
6,9,15,20	GND	Ground
7	I-Mess	Output of the current measurement circuit.
8	I-Adj	Connect to I-Mess if valve type 6757 is used otherwise leave open.
10	Valve-	Connect the negative terminal of the valve here.
11	Valve+	Connect the positive terminal of the valve here.
12	VCC-Valve	Valve supply voltage input (Connect to 24V or 12V dependent on your valve)
13	U-Mess	Output of the voltage measurement circuit.
14	Valve Control	Input for the valve control circuit
18	PB3	UART TX (see Communication over UART)
19	PB4	UART RX (see Communication over UART)
2,3,4,16,17	PB11-15	Currently not used, leave open

5 Possible testing setups

In all cases, the current graph, control of the valve, switching time, valve status, and further information are available on the UART interface (see Communication over UART).

5.1 Test Setup 1: Simple Functionality Test

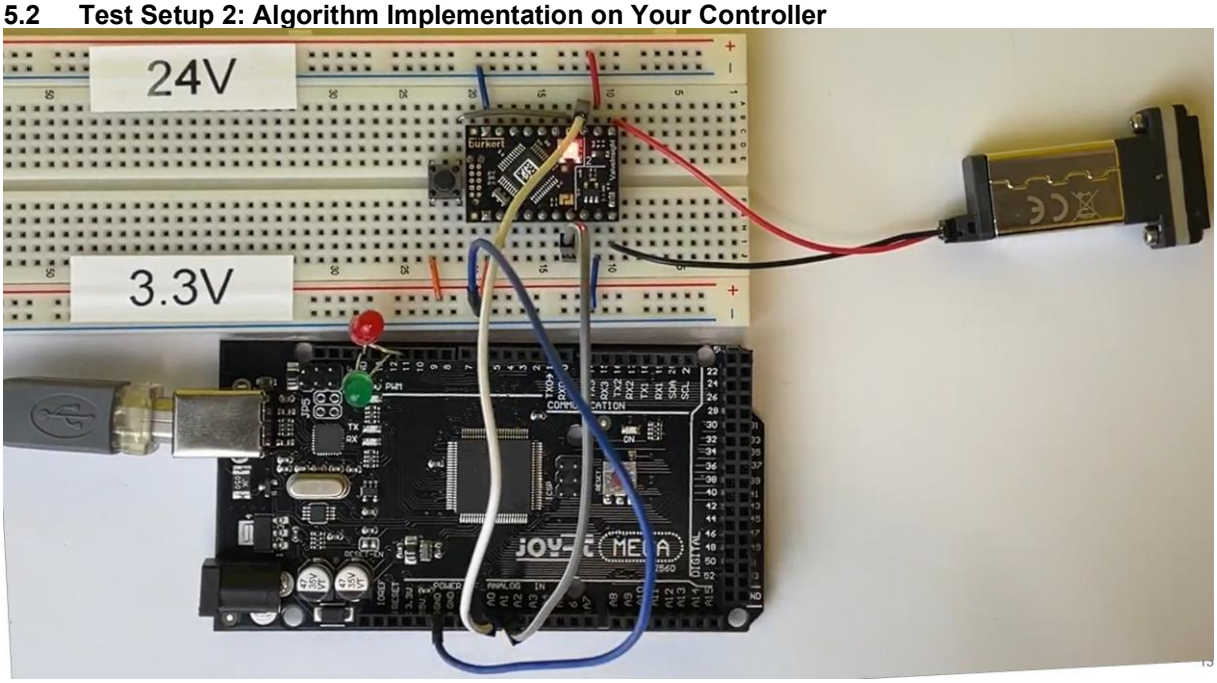
- Connect 24V
- Connect 3.3V
- Connect modified valve (screw can be turned to simulate blocked movement)
- Connect a button between Pin14 and 3.3V



- Press button ➔ Valve switches
- LED green ➔ Valve OK
- LED red ➔ Valve blocked

Different valves need different limits; those can be adjusted over UART (Index 0x40 – 0x47). The values for the different valves can be found on GitHub.

5.2 Test Setup 2: Algorithm Implementation on Your Controller



- Integrate the measurement algorithm on your µC
  (see GitHub repository for more information)
- Connect your µCs ADC for voltage measurement results to pin 13
- Connect your µCs ADC for current measurement results to pin 7

6 UART Communication

The eval board can be controlled via UART with the following configuration: 9600baud, 8 data bits, no parity, 1 stop bit. All the measured data can be streamed out using it. All required information is listed below:

6.1 Communication is based on two different principles

1. Server / Client principle: In this model, the user sends a message to the device, which then responds accordingly. The messages have the following structure:
   - The first byte is always the object index.
   - The second byte is the message size in bytes; this depends on the message type:
     - For a read command it is always 2 (for first and second byte)
     - For a write command it is the size of the whole message (2 + payload size)
   - The bytes following the second byte (i.e., the payload) are only sent in a write command.

2. Subscription principle, the user can subscribe to one of three objects to receive the calculated values or the raw measurement values (voltage or current) after every valve switch event. In case of subscription to the raw values, the received message will have a slightly different structure:
   - The first byte is always the object index.
   - The *second* and *third* bytes are the message size in bytes as uint16 value
- The bytes following represent the data as uint16 values

The Values are encoded as little-endian.

6.2 Example messages for every category

For a complete list of object indexes and their meanings, see the table on the next page.

6.2.1 Read last switching distance (object index 0x05)

Sent message [0x05, 0x02]
Received message [0x05, 0x06, *4 bytes with float value*]

6.2.2 Load default values (This overwrites limit values that were changed by the user.)

Sent message [0x12, 0x03, 0x01]
Received message [0x12, 0x03, 0x01]

6.2.3 Use Current Values Streaming (object index 0x11)

Sent message [0x11, 0x03, 0x02]
Received message [0x11, 0x03, 0x**] 0x** indicating success (0x01) or error (0xE0) when enabling streaming.
If the command was successful, the device would send a streaming message with 1000 current values as uint16 on every ‘on’ switch of the valve:
Received streaming message [0x31, 0x07, 0xD3, *Value1*, *Value2*, ... *Value1000*]
All Values are represented as uint16 in little-endian.

6.2.4 Write Lower Limit Switching Distance Value (object index 0x42)

Sent message [0x42, 0x06, *desired value as float*]
Received message [0x42, 0x03, 0x**] success (0x01) or error (0xE0) of writing this value.

6.3 Communication Objects

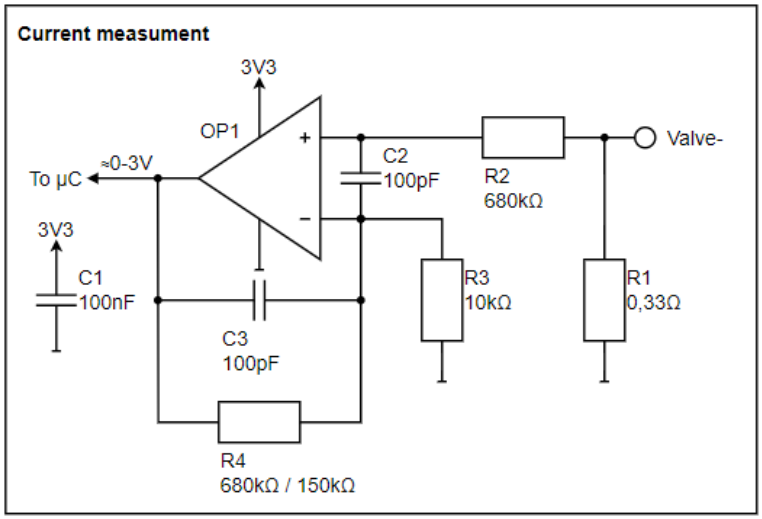
Object	Index	Datatype	Size in Byte	Access	Description
Measurement Values					
Valve State	0x01	uint8	1	RO	0: unknown, 2: closed, 4: blocked
Working Counter	0x02	uint16	2	RO	Number of working cycles since last failure
Failure Counter	0x03	uint16	2	RO	Number of failures
Last Switching Duration	0x04	float	4	RO	
Last Switching Distance	0x05	float	4	RO	
Last Switching Voltage	0x06	float	4	RO	
Last Switching Current	0x07	float	4	RO	
Control Values					
Switch Valve	0x10	bool	1	WO	1: switch valve
Streaming Start / Stop	0x11	uint8	1	WO	0: stop, 1: result values, 2: current, 4: voltage
Load Default Values	0x12	uint8	1	WO	
Streaming Values					
Result Values	0x30	float	17	Streaming	Duration, Distance, Voltage, Current, Valve State (uint8)
Current (raw)	0x31	uint16	2000	Streaming	2 Bytes per Current Measurement Value
Voltage (raw)	0x32	uint16	2000	Streaming	2 Bytes per Voltage Measurement Value
Limit Values					
Upper Limit Switching Duration	0x40	float	4	RW	
Lower Limit Switching Duration	0x41	float	4	RW	
Upper Limit Switching Distance	0x42	float	4	RW	
Lower Limit Switching Distance	0x43	float	4	RW	
Upper Limit Voltage	0x44	float	4	RW	
Lower Limit Voltage	0x45	float	4	RW	
Upper Limit Current	0x46	float	4	RW	
Lower Limit Current	0x47	float	4	RW	

7 Example Schematics

For series applications, we recommend integrating the measurement and control circuits directly into device electronics. This chapter outlines several recommendations from our perspective; however, these are not exhaustive and alternative approaches may also be appropriate. Please note that Bürkert does not provide any guarantees nor accepts responsibility for the information provided in the following recommendations.

7.1 Current Measurement

For the current measurement, a basic combination of a shut and opamp can be used.
On the evaluation board, the circuit below is used (R2 and C1-3 not strictly necessary but are recommended to avoid noise on the measured signal).



	Supplier	Ordercode	EOL [Years] [1]	Overall Risk [1]	Component price [2]	Price * Qty
OP1	Texas Instruments	TLV9001IDBVR	13.9	Low	0.089 €	0.089 €
	Microchip Technology	MCP6006T-E/OT	21.4	Low	0.140 €	
C1	Samsung EM	CL05B104KO5NNNC	4.9	Low	0.004 €	0.004 €
	KEMET	C0402C104K4RAC	10.2	Low	0.007 €	
C2&3	Samsung EM	CL05C101JB5NNNC	4.9	Low	0.003 €	0.006 €
	Kemet	C0402C101J5GAC	6.8	Low	0.005 €	
R1	Panasonic	PAN ERJ3RQFR33V	5.6	Low	0.032 €	0.028 €
	Bourns	CRL0603-FW-R330ELF	6.9	Low	0.028 €	
R2	Yageo	RC0402FR07680KL	6.7	Low	0.003 €	0.003 €
	Vishay	CRCW0402680KFKED	6.1	Low	0.008 €	
R3	Yageo	RC0402FR0710KL	12.7	Low	0.004 €	0.004 €
	Vishay	CRCW040210K0FKED	6.1	Low	0.007 €	
R4[3] 680kΩ	Yageo	RC0402FR07680KL	6.7	Low	0.003 €	0.003 €
	Vishay	CRCW0402680KFKED	6.1	Low	0.008 €	
R4[3] 150kΩ	Yageo	RC0402FR07150KL	6.7	Low	0.004 €	
	Vishay	CRCW0402150KFKED	6.1	Low	0.006 €	
						0.137€[4]

[1] = Source: Siliconexpert / 2025.04.17

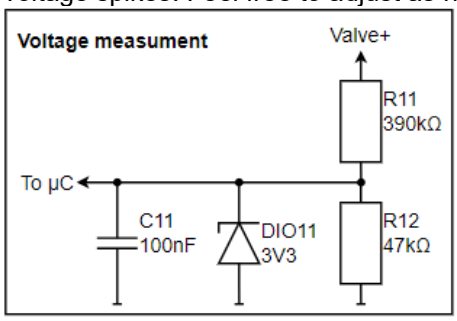
[2] = Source: Producer or Octoparts / 2025.04.17 / Median@Qty1000

[3] = Dependent on max measured current (150kΩ for 6757 otherwise 680kΩ)

[4] = component cost, assembly and handling costs are dependent on customers supply chain

7.2 Voltage Measurement

The voltage divider below is designed for 24V valves and to withstand relatively high positive and negative voltage spikes. Feel free to adjust as needed / convenient.



	Supplier	Ordercode	EOL [Years] [1]	Overall Risk [1]	Component price [2]	Price * Qty
R11	Yageo	RC0402FR-07390KL	12.9	Low	0.003 €	0.003 €
	Vishay	CRCW0402390KFKED	6.1	Low	0.008 €	0.003 €
R12	Yageo	RC0402FR0747KL	6.7	Low	0.004 €	0.004 €
	Vishay	CRCW040247KFKED	6.1	Low	0.006 €	
DIO11	ON Semi	MM3Z3V3T1G	7.3	Low	0.022 €	0.022 €
	Diodes inc	BZT52C3V3S-7-F	6.2	Low	0.042 €	
C11	Samsung EM	CL05C101JB5NNNC	4.9	Low	0.003 €	0.003 €
	Kemet	C0402C101J5GAC	6.8	Low	0.005 €	
						0.032€[3]

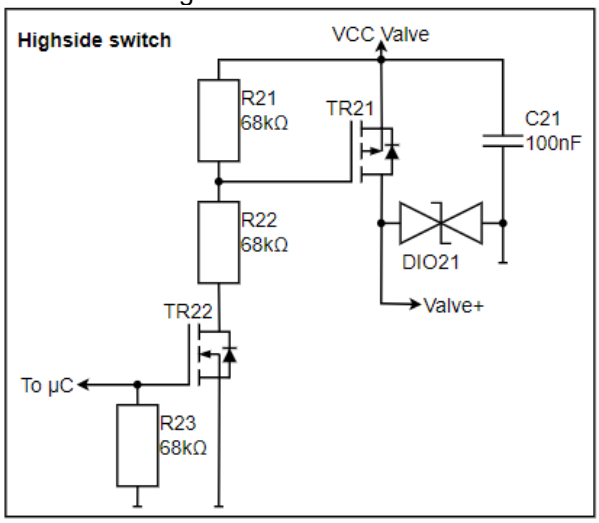
[1] = Source: Siliconexpert / 2025.04.17

[2] = Source: Producer or Octoparts / 2025.04.17 / Median@Qty1000

[3] = component cost, assembly and handling costs are dependent on customers supply chain

7.3 Valve Control

The use of a highside switch is recommended to not interfere with the measurements.



	Supplier	Ordercode	EOL [Years] [1]	Overall Risk [1]	Component price [2]	Price * Qty
C21	Samsung EM	CL05C101JB5NNNC	4.9	Low	0.003 €	0.003 €
	Kemet	C0402C101J5GAC	6.8	Low	0.005 €	
DIO21	Vishay	SMAJ28CA-E3/61	5.9	Low	0.068 €	0.068 €
	Yageo	SMAJ 28CA-TR	11.4	Low	0.075 €	
TR21	Vishay	SI2309CDS-T1-GE3	4.9	Low	0.190 €	0.169 €
	ON Semi	FDN5618P	6	Low	0.169 €	
TR22	Nexperia	PMV30ENEAR	12.7	Low	0.118 €	0.097 €
	Panjit	PJA3440_R1_00001	5.3	Low	0.097 €	
R21-23	Yageo	RC0402FR-0768KL	6.7	Low	0.003 €	0.009 €
	Vishay	CRCW040268K0FKED	6.1	Low	0.003 €	
						0.346€[4]

[1] = Source: Siliconexpert / 2025.04.17

[2] = Source: Producer or Octoparts / 2025.04.17 / Median@Qty1000

[3] = Dependent on max measured current

[4] = component cost. assembly and handling costs are dependent on customers supply chain

Additional Information:

- R22 is used to avoid the maximum gate-source-voltage of TR21 to be exceeded
  ➔it can be removed if lower voltages e.g. 12V are used to switch the valve
- The free-wheeling diode and capacitor should be placed close to the switching transistor. This avoids fast current changes on long connections.
  ➔ lower emission of electromagnetic interference
- Allowing the current to flow through the Lorenz-force actuator through a free-wheeling diode reduces its speed while switching off. But if no path for the current to flow is provided. the voltage increases to damaging levels for the switching circuit.
  ➔ using a TVS-Diode as a free-wheeling diode can maximize switching speeds while protecting the semiconductor components.
  ➔ if the switching speed optimization is not needed. a cheaper option can be a normal diode.

8 Evaluation Board Schematics