MVPC 2001

Miniature Vacuum and Pressure Controller

User's manual

October 2022, v1.0 r.A

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Contents

1. Introduction

The MVPC 2001 is miniature vacuum and pressure generator with integrated pump and isolation valve.

Its main purpose is:

- sourcing vacuum or pressure with controlled flow
- measuring relative pressure
- closing the measured system with isolation valve for leak testing

2. Safety information

T.B.D.

3. Features

The MVPC 2001 has front and rear panel with electrical and pneumatic features.

3.1. DC Power supply

The MVPC 2001 has one connector plug for power supply input. Part number on the PCB is WE-694103107102. Mating plug should have 3,5mm outer diameter and 1,3mm hole as shown in Figure 1.
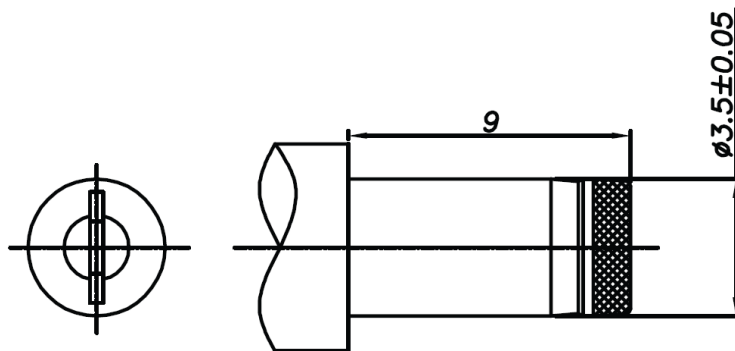

Figure 1 DC supply plug

3.2. USB interface

USB connector is standard Type B device connector.

3.3.   Vacuum/Pressure source (SOURCE)

Source port is connected to the device under test (D.U.T.).

3.4.   Pressure sensor input (SENSE)

Pressure sensor input is connected to internal pressure sensor. The sensor has measuring range of +/-150mbar. The safety measuring range can be reduced to avoid setting pressure or vacuum levels outside safety limits for the measured device.

3.5.   Flow rate adjust

Flow rate can be adjusted separately for vacuum and for over-pressure mode of operation.

3.6.   Internal expansion interfaces

The device has some additional expansion connectors for attaching OLED display, rotary encoder, additional I2C or SPI periphery, and few GPIOs. All those interfaces are provided for individual customisations when needed.

4. Initial setup

The device can source vacuum or over-pressure within specified limits. To measure leakage of the D.U.T. connect source and sense lines to the system with tight connections preventing unwanted parasitic leakage. Separated source and measure ports are suitable for tested devices with two ports (e.g., large reservoir with two connectors).

The pressure or vacuum is generated with internal pump. The pump has large initial flow, which may result in unwanted overshot, when pumping. To avoid pressure or vacuum overshooting reduce the flow rate with manual flow controllers. There are separate flow controls for both directions, indicated on pressure front panel.

5. Remote operation

The controller is remotely controlled with a PC terminal, or by a computer program that runs the automated testing system. A virtual COM port via USB connection is used to communicate with the host computer.

5.1. Virtual COM Port Operation

The virtual COM port configuration is fixed as follows:

- Baud rate 115.200
- 8 data bits
- 1 stop bit
- no parity
- Hardwre (RTS/CTS) flow control
- End of line is CR (ASCII 13)

5.2. Command Summary

Commands that allow a setting to be set usually have a query form ending with a question mark. For example:

CONF:PRES -70 Sets the target pressure to 70mBar

CONF:PRES? Returns the trget pressure value.

Standard commands are used by all SCPI devices and always start with an "*".

5.3. List of commands

All commads are listed in Table 1.

Table 1- Remote commands list

Command	Command description
*IDN?	The Identification (IDN) query outputs an identifying string.
*RST	This reset (RST) command resets most functions to factory-defined conditions. The error queue is not cleared by *RST.
*CLS	The interface-specific error queues are cleared by *CLS.
SYSTem:ERRor[:NEXT]?	Returns Arbitrary ASCII, Error string.
SYSTem:ERRor:COUNt?	Returns the number of errors contained in the error-message buffer.
SYSTem:VERSion?	This command returns the version of the SCPI (Standard Commands for Programmable Instruments) standard with which the instrument is in compliance. The instrument complies with the rules and

Command	Command description
	conventions of the indicated version of the SCPI standard. The command returns a string in the form "YYYY.V", where "YYYY" represents the year of the version and "V" represents a version for that year (e.g., 1994.0).
SYSTem:ECHO [1|0]	Sets the serial port local echo.
MEASure:PRESsure?	Query the current pressure value.
MEASure:TEMPerature?	Query the current temperature at the pressure sensor location.
CONFigure:PRESsure	Sets the target pressure.
CONFigure:PRESsure?	Query the trget pressure.
CONFigure:MAXPressure	Sets the trget pressure upper limit.
CONFigure: MINPressure	Sets the target pressure lower limit.
CONFigure:MAXPressure?	Query the trget pressure upper limit.
CONFigure: MINPressure?	Query the target pressure lower limit.
PUMP:TIMeout	Sets the pumping cycle maximum time (pumping timeout).
PUMP:TIMeout?	Query the pumping cycle maximum time (pumping timeout).
TRIGger:SOURce {IMMediate|EXTernal }	Sets the trigger to immediate or externl trigger via digital input or switch.
PUMP:STArt	Trigger the pumping cycle. When Trigger set to IMM, the pump start with this command. When >trigger is set to EXT, the pump starts after trigger is detected on the pin.
PUMP:STArt?	Query the pump state. Return 0 when pump is not running or 1 when pump is active.
PUMP:STOp	Immediately stop the pump.
PUMP:STArt:TARGet	Start the pump until the target pressure is reached.
PUMP:STArt:TARGet:CLOse	Start the pump until the target pressure is reached and close the sealing valve after that.
PUMP:ABOrt	Aborts the pumping process immediately.
VALve:VACuum	Sets the pressure/vacuum selection valve to vacuum position.
VALve:PRESsure	Sets the pressure/vacuum selection valve to pressure position.
VALve:SEAl	Closes the system sealing valve (position during measuring cycle).
VALve:OPEn	Opens the system sealing valve (position during pumping cycle).
SENSe:AVERage:COUNt	Set the number of samples for pressure measurement averaging
SENSe:AVERage:STATe [ON|OFF]	Set the state of the averaging.

5.4. Command entry and response

The data sent via virtual COM port to the device is processed as follows:

- ASCII characters are discarded if their decimal equivalent is less than 32 (space), except 10 (LF) and 13 (CR):
- Data is taken as 7-bit ASCII.
- The most significant data bit is ignored.
- Upper or lower case is acceptable.

The data sent as a response by the device can be numeric integer, float, or string.

The device stores all received data in the input receive buffer. The buffer holds 256 characters and they are processed on a FIFO basis.

5.5. Detailed commands description

5.5.1. *IDN?

Syntax   ***IDN?**

Description   Identification query for the UNIQUE identification of the device.

Return   The following system parameters will be displayed:

                                           \<vendor>, \<model>, \<serial number>, \<firmware>

                \<vendor> - V4E
                \<model> - MVPC2001
                \<serial number> - serial number in form of ProductionYear-Serial
                \<firmware> - Last build date

Example
```
*IDN?
V4E,MVPC 2001,2022-001,Oct 17 2022
```

5.5.2. *RST

Syntax   ***RST**

Description   Resets the device to the power up state.

Return   None

Example
```
*RST
```

5.5.3. *CLS

Syntax   ***CLS**

Description   Clears the error queue. Also ends all pending operations.

Return   None

Example
```
*CLS
```

5.5.4. SYSTem:ERRor

Syntax SYSTem:ERRor[:NEXT]?

Description This query command reads and clear errors from the error queue. A record of up to 17 errors can be stored in the PSU's error queue. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. The error queue is cleared when power has been off or after a *CLS command.

Return SYSTem:ERRor[:NEXT]? queries and clears the error messages in the error queue. The query returns the number and content of the error message.

Example SYST:ERR?
-113,"Undefined header"

Errors If more than 17 errors have occurred, the last error stored in the queue (the most recent error) is replaced with:
-350,"Queue overflow"

Related *CLS
*RST
SYSTem:ERRor:COUNt

5.5.5. SYSTem:ERRor:COUNt

Syntax SYSTem:ERRor:COUNt?

Description This query command queries the error/event queue for the number of unread items. As errors and events may occur at any time, more items may be present in the queue at the time it is actually read.

Return Number of errors in error queue.

Example SYST:ERR:COUN?
2

Related *CLS
*RST
SYSTem:ERRor[:NEXT]

5.5.6. SYSTem:VERSion?

Syntax SYSTem:VERSion?

Description This command returns the version of the SCPI (Standard Commands for Programmable Instruments) standard with which the instrument is in compliance.

Return   The command returns a string in the form "YYYY.V", where YYYY represents the
            year of the version and V represents a version for that year.

Example   ```
            SYST:VERS?
            1999.0
            ```

### 5.5.7. SYSTem:ECHO

Syntax      SYSTem:ECHO <bool>

Description  This command enables or disables local echo on serial port. The enabled state is 1.

Parameters

| Name | Type | Range | Default |
|------|------|-------|---------|
| <bool> | Boolean | 0\|1 | - |

Return      The query command returns 0 if the output is OFF, and 1 if the output is ON.

Example     ```
            SYST:ECHO 1
            ```

Errors   101, "Parameter out of range"

Related   -

5.5.8. MEASure:PRESsure?

Syntax   **MEASure:PRESsure?**

Description Measure the current pressure at the measure port of the device. Pressure is
            relative to air pressure (Gauge type). The output is in mbar units. Range of the
            internal pressure sensor is +/-100mBar. Output has fixed 2-digit floating point
            format with the "-" prefix when the measured pressure is below the surrounding
            air pressure ("printf()" format string: "%.2f").

Return   Current pressure value in mBar.

Example   ```
            MEASure:PRESsure?
            -82.12
            ```

Errors      102, "Pressure out of range"

Related     SENSe:AVERage:COUNt
            SENSe:AVERage:STATe
            CONFigure:MAXPressure
            CONFigure:MINPressure

### 5.5.9. MEASure:TEMPerature

Syntax **MEASure: TEMPerature?**

Description Measure the current temperature inside the device at the pressure sensor location. The output has 1 digit floating point format ("printf()" format string: "%.1f").

Return Current temperature of the pressure sensor in °C.

Example
```
MEASure:TEMPerature?
23.4
```

### 5.5.10. CONFigure:PRESsure

Syntax **CONFigure: PRESsure <double>**

Description This command sets the target pressure for testing. The value must be within the limits set by commands CONFigure:MINPressure and CONFigure:MAXPressure

Parameters

| Name | Type | Range | Default |
|------|------|-------|---------|
| <double> | Real number | PMIN … PMAX | 0 |

Return The query command returns current configured value.

Example
```
CONF:PRES 85.0

CONF:PRES?
85.0
```

### 5.5.11. CONFigure:MAXPressure

Syntax **CONFigure:MAXPressure <double>**

Description This command sets the upper limit for pressure in mBar. The target pressure could not be set above this limit.

Parameters

| Name | Type | Range | Default |
|------|------|-------|---------|
| <double> | Real number | 0 … Pressure sensor max | 100 |

Return The query command returns current configured value.

Example
```
CONF:MAXP 100.0
```

```
CONF:MAXP?
100.0
```

5.5.12. CONFigure: MINPressure

Syntax **CONFigure:MINPressure <double>**

Description This command sets the lower limit for pressure in mBar. The target pressure could not be set below this limit.

Parameters

Name	Type	Range	Default
<double>	Real number	0 ... Pressure sensor min	-100

Return The query command returns current configured value.

Example
```
CONF:MINP -100.0
```

```
CONF:MAXP?
-100.0
```

5.5.13. PUMP:TIMeout

Syntax **PUMP:TIMeout <double>**

Description This command sets the timeout for the pumping process in ms. When target pressure is not reached after timeout, the pump is turned off and the pumping stops.

Parameters

Name	Type	Range	Default
<double>	Real number	> 0	10000

Return The query command returns current configured value.

Example
```
PUMP:TIM 8500
```

```
PUMP:TIM?
8500
```

5.5.14. TRIGger:SOURce

Syntax **TRIGger:SOURce <source>**

Description   This command selects the source from which the instrument will accept a trigger for starting the pump cycle.

- IMM – The instrument executes a pumping operation immediately after executing the PUMP:STArt[:TARGet[:CLOse]] command.
- EXT – The instrument will wait for external signal after executing the PUMP:STArt[:TARGet[:CLOse]] command.

Parameters

Name	Type	Range	Default
<source>	Discrete	IMM | EXT	IMM

Return   The query command returns current configured value.

Example
```
TRIG:SOUR IMM

TRIG:SOUR?
IMM
```

5.5.15. PUMP:STArt

Syntax   **PUMP:STArt?**

Description   The pump will start and continue operation until pre-set timeout is reached or PUMP:STOp or PUMP:ABOrt command is executed.

When trigger source is set to "IMM", the pumping will start immediately after the command.

When trigger source is set to "ext", the pump will start after active external trigger signal is detected.

Return   The query command return 0 when pump is not running or 1 when pump is active.

Example
```
PUMP:STA

PUMP:STA?
1
```

5.5.16. PUMP:STOp

Syntax   **PUMP:STOp**

Description   The pump is stopped with this command.

Return   None

Example   `PUMP:STO`

5.5.17. PUMP:STArt:TARGet

Syntax   **PUMP:STArt:TARGet**

Description   The pump will start and continue operation <u>until target pressure is reached</u>. If this is not true within the pre-set timeout, the pump will stop after timeout has passed.

When trigger source is set to "IMM", the pumping will start immediately after the command.

When trigger source is set to "ext", the pump will start after active external trigger signal is detected.

Return   None

Example   `PUMP:STA:TARG`

5.5.18. PUMP:STArt:TARGet:CLOse

Syntax   **PUMP:STArt:TARGet:CLOse**

Description   The pump will start and continue operation <u>until target pressure is reached</u>. When measured pressure is reached (in either direction: vacuum or positive pressure), the pump is stopped, and the sealing valve is closed. This command is used for normal, automated cycle for preparing the target system for leak test.

If the pressure is not reached within the pre-set timeout, the pump will stop after timeout has passed.

When trigger source is set to "IMM", the pumping will start immediately after the command.

When trigger source is set to "ext", the pump will start after active external trigger signal is detected.

Note: depending on flow rate of air or pumping air out of the target system, there will be always some overshot in pressure. The pump has some inertia and could not stop instantly, resulting in small excessive vacuum or pressure. To minimize this, there are two separate flow rate adjusters on the instrument front panel. Another option is to set the target pressure to slightly lower value. The amount of this phenomena depends on the volume and flow within the measured device and should be checked during the evaluation of the final measurement system.

Return   None

Example   `PUMP:STA:TARG:CLO`

5.5.19. PUMP:ABOrt

Syntax   **PUMP:ABOrt**

Description   The pumping process initiated with PUMP:STArt:TARGet[:CLOse] is stopped with this command.

Return   None

Example   `PUMP:ABO`

5.5.20. VALve:VACuum

Syntax   **VALve:VACuum**

Description   This command sets the pressure selection valve to vacuum side. When target pressure is set to negative pressure (pumping air out of the target system), this command should be executed before pump starts.

Return   None

Example   `VAL:VAC`

5.5.21. VALve:PRESsure

Syntax   **VALve:PRESsure**

Description   This command sets the pressure selection valve to pressure side. When target pressure is set to positive pressure (pumping air into the target system), this command should be executed before pump starts.

Return   None

Example   `VAL:PRES`

5.5.22. VALve:SEAl

Syntax   **VALve:SEAl**

Description   This command closes the sealing valve. The source output port of the instrument is internally closed and sealed. After pumping, this operation is executed automatically when pump is started with PUMP:STArt:TARGet:CLOse command. The pumping side of the instrument is not sealed and the air could pass the pump with very slow flow rate, preventing the accurate or long-term leakage testing. This valve completely seal the output preventing any leakage caused by the instrument itself.

The pumping is not possible when sealing valve is closed.

Return   None

Example   `VAL:SEA`

5.5.23. VALve:OPEn

Syntax   **VALve:OPEn**

Description   This command opens the sealing valve, connecting the pressure output to the pump. Before any pumping this valve should be opened.

Return   None

Example   `VAL:OPE`

5.5.24. SENSe:AVERage:COUNt

Syntax   **SENSe:AVERage:COUNt <int>**

Description   This command sets the number of readings for averaging when averaging is active.

Parameters

Name	Type	Range	Default
<int>	Intiger number	> 0	1

Return   The query command returns current configured value.

Example   `SENS:AVER:COUN 10`

`SENS:AVER:COUN?`
`10`

5.5.25. SENSe:AVERage:STATe

Syntax   **SENSe:AVERage:STATe <bool>**

Description   This command enables or disables pressure readout averaging. When parameter is 1 and number of samples set with command SENSe:AVERage:COUNt is > 2, the averaging will be activated and measured result of the pressure will be average value of acquired samples.

Parameters

Name	Type	Range	Default
<bool>	Boolean	0|1	-

Return   The query command returns current configured value.

Example
```
SENS:AVER:STAT 1

SENS:AVER:STAT?
1
```

5.6.   Error codes

Error number	Return string	Description
102	"Pressure out of range"	Pressure measured by sensor is out of the pre-set pmin/pmax limits.
101	"Parameter out of range"	Command parameter is out of valid range.
0	"No error"	The queue is completely empty. Every error/event in the queue has been read, or the queue was purposely cleared by a power-on event, *CLS, etc.
-100	"Command error"	Generic syntax error.
-101	"Invalid character"	An invalid character was found in the command string. There may be a character such as #, $, or % in the command keyword or within a parameter.
-103	"Invalid separator"	An invalid separator was found in the command string. There may be a comma instead of a colon, semicolon, or blank space, or a blank space instead of a comma.
-104	"Data type error"	The wrong parameter type was found in the command string. A string might have been sent when a string was expected, or vice versa.
-108	"Parameter not allowed"	More parameters were received than expected for the command. There may be an extra parameter, or parameter added to a command that does not accept a parameter.

Error number	Return string	Description
-109	"Missing parameter"	Fewer parameters were received than expected for the command. One or more parameters that are required for this command was not received.
-113	"Undefined header"	A command was received that is not valid for this PSU. The command may have been misspelled, or it may not be a valid command. Short forms of commands, may contain up to four letters.
-114	"Header suffix out of range"	The numeric suffix attached to a command header is not one of the allowable values.
-131	"Invalid suffix"	A suffix was incorrectly specified for a numeric parameter. It may have been misspelled.
-138	"Suffix not allowed"	A suffix was received following a numeric parameter which does not accept a suffix.
-151	"Invalid string data"	An invalid character string was received. Check to see if you have enclosed the character string in single or double quotes.
-200	"Execution error"	This is the generic execution error when more specific error is not assigned in the case that command execution failed.
-222	"Data out of range"	A numeric parameter value is outside the valid range for the command.
-223	"Too much data"	A character string was received but could not be executed because the string length was more than 32 characters.
-224	"Illegal parameter value"	A discrete parameter was received which was not a valid choice for the command. You may have used an invalid parameter choice.
-310	"System error"	An internal firmware error has been detected.
-350	"Queue overflow"	The error queue is full because more than 16 errors have occurred. No additional errors will be stored until errors have been removed from the queue. The error queue is cleared when power has been turned off, or after a *CLS (clear status) command has been executed.

6. Maintenance

Clean the instrument and pressure hoses with a soft dry cloth.

Store the instrument within the specified storage conditions. Avoid condensing when using in cold environment.

7. Specifications

7.1.   Electrical Specification

Parameter	Symbol	Min	Typ	Max	Units	Note
Supply voltage	V_{SUP}	11		16	V	
Supply current				3	A	

7.2.   Pressure source

Parameter	Symbol	Min	Typ	Max	Units	Note
Min. pressure generated by the device	p_{MIN}		-600		mbar	
Max. pressure generated by the device	p_{MAX}		200		mbar	

7.3.   Pressure sense

Pressure is measured with internal precision differential pressure sensor. The specifications are:

Parameter	Symbol	Min	Typ	Max	Units	Note
Operating Pressure	p_{OP}	-100		+100	mbar	
Proof pressure[1]	p_P	850			mbar	1
Burst pressure[2]	p_B	1034			mbar	2
Common mode pressure[3]	P_{CM}	1034			mbar	3
Accuracy[4]	ε		±0.25		%FSS	4
Total error band[5]	ε_T		±0.5	±1.0	%FSS	5
Response time	t_R		0.46		ms	

Notes:

1 - Proof Pressure: The maximum pressure which may safely be applied to one port of the product for it to remain in specification once pressure is returned to the operating pressure range. Exposure to higher pressures may cause permanent damage to the product.

2 - Burst Pressure: The maximum pressure that may be applied to one port of the product without causing escape of pressure media. Product should not be expected to function after exposure to any pressure beyond the burst pressure.

3 - Common Mode Pressure: The maximum pressure that can be applied simultaneously to both ports of a differential pressure sensor without causing escape of pressure media. Product should not be expected to function after exposure to any pressure beyond this maximum pressure.

4 - Accuracy is the measured deviation based on Best Fit Straight Line (BFSL).

5 - Total Error Band is calculated from a combination of all possible errors, including offset, span temperature, calibration, linearity, pressure hysteresis, offset warm-up shift, offset position sensitivity, and long term offset drift.

7.4. Mechanical Specification

Parameter	Value	Units	Note
Size	t.b.d.	mm	
Weight	t.b.d.	kg	

7.5. Environmental

Parameter	Symbol	Min	Typ	Max	Units	Note
Operating Temperature	T_A	0		+50	°C	
Storage	T_S	-20		+55	°C	
Humidity	RH	10		95	%RH	Non-condensing

8. Block diagram

t.b.d.