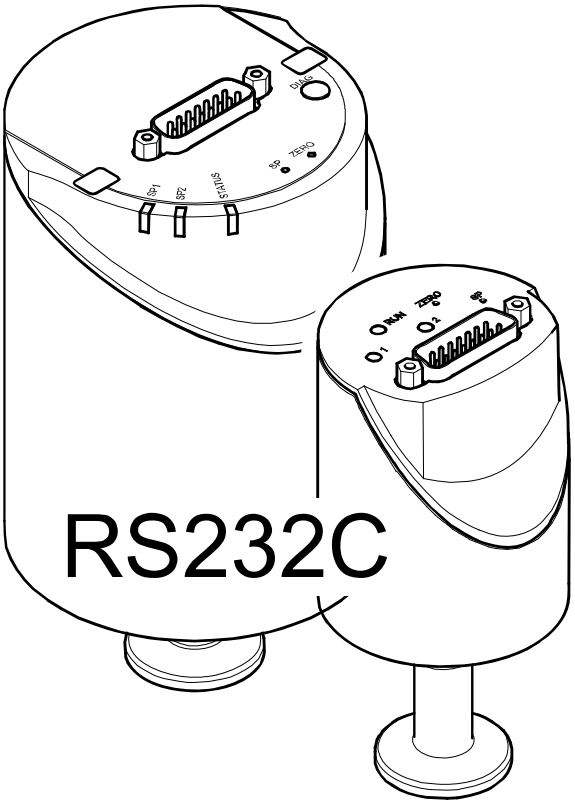
# RS232C

Serial Interface

## KJLC ACG
## KJLC HCG



## General Information

The RS232C Serial Interface permits the communication between the digital Kurt J. Lesker Company Capacitance Gauges and an appropriate vacuum gauge controller.

The RS232C Serial Interface integrated in the Capacitance Gauges allows to digitally transmit measurement values and information on the gauge status as well as to make parameter settings.

## Functional Principle

The RS232C Serial Interface is used in duplex operation. The gauge continuously (approximately every 20 ms) transmits a nine byte send string without request.
Instructions to the gauge are transmitted via five-byte receipt strings.

Data format

- binary
- 8 data bits
- 1 stop bit
- no parity bit
- no handshake

Transmission rate

- 9600 Baud

Pin assignment

- TxD Pin 13
- RxD Pin 14
- GND Pin 5
  (sensor cable connector)

# 1 Interface Protocol

## 1.1 Send String

The complete send string (frame) is nine bytes (byte 0 … 8) long. Bytes 1 … 7 form the data string.

Structure of send string

| Byte No. | Function | Value | Comment |
|---|---|---|---|
| 0 | Data string length | 7 | Parameter |
| 1 | Page No. | 4 | Parameter |
| 2 | Status | | → "Status byte" |
| 3 | Error | | → "Error byte" |
| 4 | Measured value high byte | <value> | → "Calculation of pressure value" |
| 5 | Measured value low byte | <value> | → "Calculation of pressure value" |
| 6 | Read command | <value> | Read value |
| 7 | Sensor type | | → "Sensor type" |
| 8 | Checksum | | → "Synchronization" |

Page No. byte (byte No. 1)

| Value | Definition |
|---|---|
| 2 | Parameter for KJLC ACG |
| 3 | Parameter for KJLC HCG |

Status byte (byte No. 2)

| Bit 0 | | Definition |
|---|---|---|
| 0 | | Continuous output of measured value |
| 1 | | Individual measured value (polling) [1] |

[1] → 8, "DataTxMode". Send a read command of any parameter to the gauge for requesting a send string.

| Bit 2 | Bit 1 | Definition |
|---|---|---|
| 1 | 0 | Manual setpoint setting |
| 1 | 1 | Zero adjust active |

| Bit 3 | | Definition |
|---|---|---|
| 0 ⇔ 1 | | Toggle bit, changes with every string received correctly |

| Bit 5 | Bit 4 | Definition |
|---|---|---|
| 0 | 0 | Current pressure unit mbar |
| 0 | 1 | Current pressure unit Torr |
| 1 | 0 | Current pressure unit Pa |

| Bit 6 | | Definition |
|---|---|---|
| 0 | | Standard measurement mode |
| 1 | | Reserved for internal use |

| Bit 7 | | Definition |
|---|---|---|
| 0 | | Heating [1] |
| 1 | | Sensor temperature attained [1] |

[1] for KJLC HCG only

## Error byte (byte No. 3)

| Bit No. | Definition |
|---|---|
| 0 | RS232 synchronization error |
| 1 | Incorrect command, e.g. inadmissible address (syntax error) |
| 2 | Inadmissible read command |
| 3 | SP1 status |
| 4 | SP2 status |
| 5 | Not used |
| 6 | Not used |
| 7 | Extended error set (→ Read command "Extended Error L-Byte and H-Byte") |

No bit set → value = 0x00 = no error set

## Error handling

Errors are only recorded in the error bytes as long as they persist, except for RS232 interface errors. Errors are not acknowledged.

RS232 errors are signaled by the "toggle bit", i.e. when an RS232 error occurs, the "toggle bit" is not inverted. For checking the status of the "toggle bit", a read operation is required, which also allows to read the error byte for detailed error analysis.

If an "extended error" is set, it has to be read as variable by means of the "read command" (→ table "Variables for bytes No. 2 and 3"). After the read operation, the variable is automatically erased.

## Measurement value high/low bytes

The measurement value is transmitted as <16 bit signed integer value>. The pressure is calculated from bytes 4 and 5 of the send string (decimal presentation) as follows.

$$p = \frac{\text{<pressure\_value>} \times a}{b} \times \text{F.S.R.\_Mantissa} \times 10^{(\text{F.S.R.\_Exp})}$$

| Parameter | Description |
|---|---|
| p | Pressure value in selected pressure unit (→ factor "a", table "Conversion factor for pressure units") |
| F.S.R._Mantissa | F.S.R. factor according to "Sensor type" variable (→ "Byte No. 7") |
| F.S.R._Exp | F.S.R. exponent according to "Sensor type" variable (→ "Byte No. 7") |
| <pressure_value> | Pressure measurement value, converted into decimal format |
| b | Factor for resolution (→ Table "Conversion factor for pressure units") |

## Conversion factor for pressure units

| **Page No.** Byte No. 1 | **Pressure unit** Byte No. 2 bit 4, 5 | **F.S.R. Mantissa** Byte Nr. 7 bit 4-7 | **Factor "a"** | **Factor "b"** | **Comment** |
|---|---|---|---|---|---|
| 2 and 3 | 0 = mbar | 0x0 or >0x1 | 1.3332 | 24'000 | |
| | 1 = Torr | | 1.0000 | 32'000 | |
| | 2 = Pa | | 133.32 | 24'000 | |
| | 0 = mbar | 0x1 | 13332 | 26'400 | F.S.R. 1100 mbar |

### Read command (byte No. 6)

All variables in a receipt string that are addressed for reading are output on this byte. For variable types >1 byte, each byte (e.g. low, high, or further bytes) has to be addressed and read individually.

Read Command L-Byte → Read Data L-Byte
Read Command H-Byte → Read Data H-Byte

- After a write operation, the value of the addressed variable is output.
- After a reset (Power on) the software version is output on byte 6.

### Sensor type (byte No. 7)

| Bit No. 0 … 3 | Description F.S.R._Exp | Comment |
|---|---|---|
| 0x0 | $10^{-3}$ | → Variable "Sensor_pressure_range" |
| 0x1 | $10^{-2}$ | |
| 0x2 | $10^{-1}$ | |
| 0x3 | $10^{0}$ | |
| 0x4 | $10^{1}$ | |
| 0x5 | $10^{2}$ | |
| 0x6 | $10^{3}$ | |
| 0x7 | $10^{4}$ | |

| Bit No. 4 … 7 | Description F.S.R._Mantissa | Comment |
|---|---|---|
| 0x0 | 1.0 | → Variable "Sensor_FSR" |
| 0x1 | 1.1 | |
| 0x2 | 2.0 | |
| 0x3 | 2.5 | |
| 0x4 | 5.0 | |

### Checksum and synchronization (byte No. 8)

The recipient (master) is synchronized by checking three bytes:

| Byte No. | Function | Value | Comment |
|---|---|---|---|
| 0 | Data string length | 7 | Constant value |
| 1 | Page No. | 3<br>2 | Constant value for KJLC HCG<br>Constant value for KJLC ACG |
| 8 | Checksum of bytes No. 1 … 7 | 0 … 255 | Low byte of checksum (possible high bytes are ignored) |

Example

The example is based on the following output string:

| Byte No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Value | 7 | 2 | 16 | 0 | 125 | 0 | 20 | 6 | 69 |

The instrument or controller (receiver) interprets this string as follows:

| Byte No. | Function | Value | Comment |
|---|---|---|---|
| 0 | Length of datastring | 7 | (Set value) |
| 1 | Page No. | 2 | KJLC ACG |
| 2 | Status | 16 | Pressure unit = Torr |
| 3 | Error | 0 | No Error |
| 4<br>5 | Measurement<br>High byte<br>Low byte | 125<br>0 | Calculation of pressure value: Conversion formula → 🗎 4 |
| 6 | Read command | 20 | Software version = 20 / 20 = 1.0 |
| 7 | Sensor type | 6 | F.S.R.= $10^{+3}$ |
| 8 | Check sum | 169 | 2 + 16 + 0 + 125 + 0 + 20 + 6 = $169_{dec}$ ≙ 00 $A9_{hex}$<br>High order byte is ignored ⇒<br>Check sum = $A9_{hex}$ ≙ $169_{dec}$ |

## 1.2 Receipt String

Commands to the gauge are transmitted in receipt strings (frames) consisting of five bytes (without <CR>). The data string is formed by bytes 1 … 3.

Structure of receipt string

| Byte No. | Designation | Value | |
|---|---|---|---|
| 0 | Data string length | 3 | (constant value) |
| 1 | Data | | → "Service command" |
| 2 | Data | | → "Address byte" |
| 3 | Data | | → "Data byte" |
| 4 | Checksum of bytes No. 1 … 3 | <value> | Low byte of checksum [1)] |

[1)] Possible high bytes are ignored.

- The operation selected in byte No. 1 is addressed in byte No. 2.
- Variables are transmitted in byte No. 3. Variables >1 byte have to be transmitted in several receipt strings (splitting).

**Service command (byte No. 1)**

| Description | Data | Comment |
|---|---|---|
| Read command | 0x00 | Read command for variable according to address in byte No. 2 |
| Write command | 0x10 | Write command for variable according to address in byte No. 2 |
| Special services | 0x40 | Direct command (write command) without data information, e.g. Reset, Zero adjust |

**Address byte (byte No. 2)**

Enter the address of the variable to be read/written (→ table "Variables for bytes No. 2 and 3").

**Data byte (byte No. 3)**

When a variable is written (receipt string) the content of byte No. 3 is written to the variable addressed in byte No. 2 (→ table "Variables for bytes No. 2 and 3").

When a variable is read (send string), the value of the variable addressed in byte No. 2 is output in byte No. 6 of the send string. The content of byte No. 3 is not relevant for read operations.

**Checksum (byte No. 4)**

The checksum is calculated from the sum of byte No. 1 to 3.

**Example**

The example is based on the receipt string:

| Byte No. | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Value | 3 | 0 | 2 | 0 | 2 |

The instrument or controller (receiver) interprets this string as follows:

| Byte No. | Designation | Value | Comment |
|---|---|---|---|
| 0 | Data string length | 3 | (constant value) |
| 1 | Service command | 0 | Read command |
| 2 | Address byte | 2 | Filter |
| 3 | Data byte | 0 | |
| 4 | Checksum | 2 | $0 + 2 + 0 = 2_{dec} \triangleq 00\ 02_{hex}$<br>High bytes are ignored ⇒<br>Checksum = $02_{hex} \triangleq 2_{dec}$ |

Variables for bytes No. 2 and 3
(read/write command)

| Parameter name | Data type | Description | Byte No. 2 | Byte No. 3 | Comment |
|---|---|---|---|---|---|
| DataTxMode | uint8_T / RW | | 0 | 0 [1)] | Continued output of measured value |
| | | | | 1 | Individual output of measured value (polling) |
| Unit | uint8_T / RW | | 1 | 0 | Pressure unit "mbar" |
| | | | | 1 [1)] | Pressure unit "Torr" |
| Filter | uint8_T / RW | | 2 | 0 [1)] | Filter dynamic |
| | | | | 1 | Filter time fast |
| | | | | 2 | Filter time slow |
| SP1 Level Low | sint16_T / RW | H-Byte | 4 | <value> | Lower setpoint threshold SP1 [2)] |
| | | L-Byte | 5 | <value> | |
| SP2 Level Low | sint16_T / RW | H-Byte | 6 | <value> | Lower setpoint threshold SP2 [2)] |
| | | L-Byte | 7 | <value> | |
| SP1 Level High | sint16_T / RW | H-Byte | 8 | <value> | Upper setpoint threshold SP1 (hysteresis) [2)] |
| | | L-Byte | 9 | <value> | |
| SP2 Level High | sint16_T / RW | H-Byte | 10 | <value> | Upper setpoint threshold SP2 (hysteresis) [2)] |
| | | L-Byte | 11 | <value> | |
| Software version | uint8_T / Ro | | 16 | <value> | (<value> / 20) = Software Version e.g. 20 = V1.0 |
| Calib date | uint32_T / Ro | MSB | 17 | <value> | Date: YY,MM,DD,HH,MM |
| | | Byte 2 | 18 | <value> | e.g. 1701160923 = |
| | | Byte 1 | 19 | <value> | 2017-01-16 at 09:23 |
| | | LSB | 20 | <value> | |
| Zero_Adjust_Value | sint16_T / RW | H-Byte | 21 | <value> | Zero Offset Adjust Level [3)] |
| | | L-Byte | 22 | <value> | |
| DC Output Offset | sint16_T / RW | H-Byte | 23 | <value> | Customer DC Output Offset [3)] |
| | | L-Byte | 24 | <value> | (Base pressure offset) |
| Production No. | uint8_T / Ro | Byte 0 | 25 | <value> | Production number as ASCII string (barcode) |
| | uint8_T / Ro | Byte 1 | 26 | <value> | (Max. 16 byte) |
| | uint8_T / Ro | … | … | ... | |
| | uint8_T / Ro | Byte 15 | 40 | <value> | (Last digit: null terminator) |
| Software date Year | uint16_T / Ro | H-Byte | 212 | <value> | Software version date Year in Hex e.g. 0x2007 = 2007 |
| | | L-Byte | 213 | <value> | |
| Software date M/D | Uint16_T / Ro | H-Byte | 214 | <value> | Software version date Month in Hex e.g. 0x03 = March |
| | | L-Byte | 215 | <value> | Software version date Day in Hex e.g. 0x19 = 19 |
| Part No. | uint8_T / Ro | Byte 0 | 218 | <value> | Part number as ASCII string |
| | uint8_T / Ro | Byte 1 | 219 | <value> | (Max 20 byte) |
| | uint8_T / Ro | … | … | <value> | |
| | uint8_T / Ro | Byte 19 | 237 | <value> | (Last digit: null terminator) |
| Remaining_Zero | sint16_T / Ro | H-Byte | 72 | <value> | Max. remaining offset value |
| | | L-Byte | 73 | <value> | |

(continued)

(Table "Variables for bytes No. 2 and 3 (read/write command)" completed)

| Parameter name | Data type | Description | Byte No. 2 | Byte No. 3 | Comment |
|---|---|---|---|---|---|
| Extended error H-Byte | uint8_T / Ro | H-Byte | 54 | Bit 0 | PT1000 fault [4] |
| | | | | Bit 1 | Heater block overtemp. [4] |
| | | | | Bit 2 | Electronic overtemp. [4] |
| | | | | Bit 3 | Zero adjust error |
| | | | | Bit 4 | Reserve |
| | | | | Bit 5 | Reserve |
| | | | | Bit 6 | Reserve |
| | | | | Bit 7 | Reserve |
| Extended error L-Byte | uint8_T / Ro | L-Byte | 55 | Bit 0 | Atm. pressure out of range |
| | | | | Bit 1 | Temperature out of range |
| | | | | Bit 2 | Reserve |
| | | | | Bit 3 | Reserve |
| | | | | Bit 4 | Cal. mode wrong |
| | | | | Bit 5 | Pressure underflow |
| | | | | Bit 6 | Pressure overflow |
| | | | | Bit 7 | Zero adjust warning |
| Pressure range (Exponent) | uint8_T / Ro | | 56 | 0 | F.S.R. = E-3 |
| | | | | 1 | F.S.R. = E-2 |
| | | | | 2 | F.S.R. = E-1 |
| | | | | 3 | F.S.R. = E 0 |
| | | | | 4 | F.S.R. = E+1 |
| | | | | 5 | F.S.R. = E+2 |
| | | | | 6 | F.S.R. = E+3 |
| | | | | 7 | F.S.R. = E+4 |
| Pressure range (Mantissa) | uint8_T / Ro | | 57 | 0 | Mantissa = 1.0 |
| | | | | 1 | Mantissa = 1.1 |
| | | | | 2 | Mantissa = 2.0 |
| | | | | 3 | Mantissa = 2.5 |
| | | | | 4 | Mantissa = 5.0 |
| | | | | 5 | Mantissa = 1.14 |
| | | | | 6 | Mantissa = 3.0 |
| Gauge config | uint8_T / Ro | | 58 | 0 | = Analog |
| Gauge type | uint8_T / Ro | | 59 | 0 | = KJLC ACG |
| | | | | 1 | = KJLC HCG (45 °C) |
| | | | | 2 | = KJLC HCG (100 °C) |

RW = Read / Write  Ro = Read only

1) Factory setting

2) Conversion → Section 1.1, byte 6 "Read command"

3) Conversion → Section 1.1, bytes 4 and 5 "Pressure unit"

4) KJLC HCG only

Variables for bytes No. 2 and 3
(special services)

| Parameter name | Data type | Description | Byte No. 2 | Byte No. 3 | Comment |
|---|---|---|---|---|---|
| RESET | uint8_T / W | | 0 | 0 | Power reset: Starts continuous pressure output |
| RESET Factory | uint8_T / W | | 1 | 0 | Factory reset: Sets factory configuration |
| Zero_adjust | uint8_T / W | | 2 | – | Starts zero offset adjustment |

W = Write

Description of variables

Setpoint_level xy

$$\text{Setpoint\_level xy} = \frac{\text{<data\_value>} \times a}{b} \times \text{F.S.R.\_Mantisse} \times 10^{(\text{F.S.R.\_Exp})}$$

| Parameter [1] | Description |
|---|---|
| Setpoint_level xy | Setpoint threshold in the selected pressure unit. |

[1] Further parameter → 11, table "Parameter"

- **Minimum value** lower switching threshold = 0 ; negative values are not admissible.
- **Maximum value** lower switching threshold = F.S.R. – 1 % hysteresis.

Zero_Adjust_Value

Zero_Adjust_Value contains the zero pressure offset value required for zeroing (writable and readable).

- Automatic zero_adjust function via key or command (→ table "Variables for bytes No. 2 and 3 (special services)").
- Base-Pressure-Adjust for adjusting a defined zero offset, e.g. if the required final pressure as indicated in the operating manual is not reached.

The Zero_Adjust_Value consists of the high and low byte and has to be converted with the "Pressure value" formula (→ 4).

$$\text{Zero\_Adjust\_Value} = \frac{\text{<data\_value>} \times a}{b} \times \text{F.S.R.\_Mantisse} \times 10^{(\text{F.S.R.\_Exp})}$$

| Parameter [1] | Description |
|---|---|
| Zero_Adjust_Value | Zero pressure offset in the selected pressure unit (→ 11, table "Parameter"). |

[1] Further parameter → 11, table "Parameter"

Remaining_Zero

Maximal remaining offset value. The Zero_Adjust can only be executed within this value.

## DC Output Level

The "DC Output Level" variable is used for assigning a defined offset level to the analog output signal, e.g. for setting a certain zero offset signal level.

A "DC Output Level" >0 reduces the output range of the measurement range 0 … 10 V by the selected offset value (F.S.R. - DC output level).

The "DC Output Level" parameter (16-Bit) consists of the high and low byte.

$$\text{DC Output Level} = \frac{\text{<data\_value>} \times a}{b} \times \text{F.S.R.\_Mantisse} \times 10^{(\text{F.S.R.\_Exp})}$$

| Parameter [1] | Description |
|---|---|
| DC Output Level | DC-Output-Signal in the selected pressure unit (→ 11, table "Parameter"). |

[1] Further parameter → 11, table "Parameter"

## Software version

$$\text{Software version} = \frac{\text{<data\_value>}}{20}$$ e.g. <data_value> = 20 ≙V1.0

| Parameter | Description |
|---|---|
| <data_value> | 1 byte value (8 bit), data value in decimal format. |

## Parameter

| Parameter | Description |
|---|---|
| <data_value> | Zero offset measurement data, consisting of "low and high byte" (16 bit value), data value in decimal format. |
| a | Conversion factor for pressure units other than "Torr"<br>Torr: a = 1.00<br>mbar: a = 1.3332<br>Pa: a = 133.32 |
| b | Factor for resolution |

| Page No. [1] | b | Output signal |
|---|---|---|
| 2 | 32000 | 10.24 V |
| 3 | 32000 | 10.24 V |

| | |
|---|---|
| F.S.R._Mantisse | F.S.R. factor according to the "Sensor type" variable, which has to be read separately (→ "Read command"). |
| F.S.R._Exp | F.S.R. exponent according to "Sensor type" variable, which has to be read separately (→ "Read command"). |

[1] → 3, tabel "Structure of send string", byte no. 1

*Original: English*

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