Gigahertz-Optik

Operating Manual
P-9710-1 and P-9710-2
Optometer

(Beginning with item number 100000-1 and 100343-1)

TABLE OF CONTENTS

1 General Information

The operator should carefully read the following instructions to ensure proper and safe use of this equipment.

After unpacking the device, check for any mechanical damage or loose parts inside. Should there be any transportation damage, inform the supplier immediately and do not operate the device.

The authors reserve the right to make changes at any time without prior notice.

2 Liability

Responsibility for the consequences of using the hardware/software and for the intended or achieved results of its use rests with the purchaser.

In no event shall GIGAHERTZ-OPTIK or its suppliers be liable for any loss of use, interruption of business, lost profits, lost data, or indirect, special, incidental or consequential damages of any kind regardless of the form of action, whether in contract, tort (including negligence), strict liability, or otherwise, even if GIGAHERTZ-OPTIK or its suppliers have been advised of the possibility of such damages.

Purchaser understands and agrees that GIGAHERTZ-OPTIK is not responsible or liable for damage to equipment caused by the use of its products. Purchaser understands that it uses GIGAHERTZ-OPTIK products at its own risk and agrees to indemnify, defend, and hold harmless GIGAHERTZ-OPTIK from any and all claims arising from the use of its products.

3 Safety

Use only the plug-in power supply supplied. Check the AC main power voltage level before connecting the plug-in power supply to ensure it is within the specified limits stated on the power supply.

Use only the detector heads supplied with the P-9710.

The instrument should be switched off, disconnected from AC power and secured to prevent unintentional operation if there is any indication that safe operation is not possible. For example:

- if the instrument looks damaged in any way
- if the instrument has any loose parts
- if the instrument does not function

Consider whether safe operation of the device is possible:

- after prolonged storage under unfavourable conditions (outdoors or in moist environments)
- after excessive transportation stress (e. g. due to poor packaging)
- under severe environmental conditions (high temperature, humidity, etc.)
- under dangerous conditions (explosive gas, vapor, dust, etc.)

4 Environmental Considerations

Optical measurement instruments are sensitive to extremes in environmental conditions like high temperature, humidity and contamination. Measurement results can be corrupted under such extreme conditions.

Protect the device and its detector(s) from high humidity, high temperature, direct sunlight and contamination.

Do not use the P-9710 immediately after having taken it from a cold into a warm environment. Under certain circumstances, condensation could develop and may cause corruption of the measurement results. Allow the device to adjust to room temperature before switching it on.

Do not use the P-9710 in powerful magnetic, electromagnetic and electrostatic fields. These disturbances may corrupt the measurement results.

Do not use aggressive detergents to clean the device.

5 Battery

The device has a built-in lead acid rechargeable battery. Make sure that the device is stored only with fully charged battery. After three months or longer in storage the battery should be recharged to avoid a reduction in lifetime.

The battery will charge when the plug-in power supply is connected to the device. It is not necessary to switch on the device. An empty battery is completely charged after 14 hours of charge time.

Obey national environmental laws in the disposal of the battery / device.

6 CE Conformity

The device conforms with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (89/336/EEC). For the evaluation regarding Electromagnetic Compatibility, the following standards were applied:

EN 61326-1 - Class B

7 Warranty

Gigahertz-Optik warrants that the product will be free from defects in materials and workmanship for a period of one (1) year from the date of purchase. If any such product proves defective during this warranty period, Gigahertz-Optik will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Batteries are excluded from this warranty.

In order to obtain service under this warranty, customer must notify Gigahertz-Optik of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the manufacturer. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to locations outside of Germany.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care.

8 Contact Gigahertz-Optik

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9 Product Overview

The P-9710 Optical Multimeter is a microprocessor based measurement instrument for optical quantities. To measure these optical quantities different detectors are used in combination with the optometer. It is common to these detectors, that they transform the optical signal into current. This current is measured, calculated and displayed by the P-9710.

The optometer employs an 8 range (2.0mA to 200pA) current amplifier. The output voltage of this amplifier is sampled and measured by an ADC. A microcontroller calculates the result which is displayed on a LCD-Display.

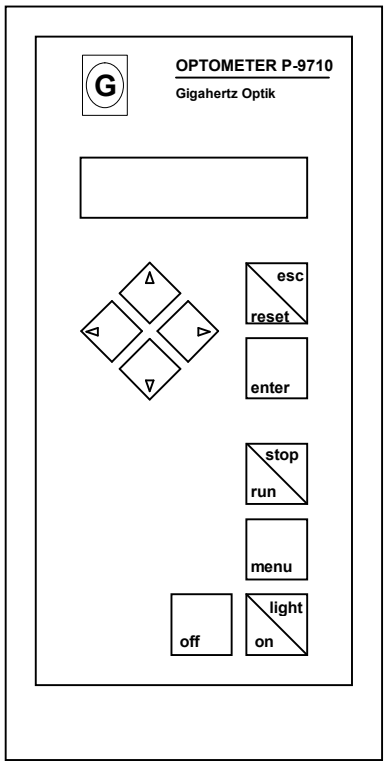
The P-9710 can be controlled manually or via RS232 interface. Measurement parameters can be set and changed manually using front panel keys under a menu function and are stored in continuous memory.

An analog output is available which makes it possible to display the input signal on an oscilloscope.

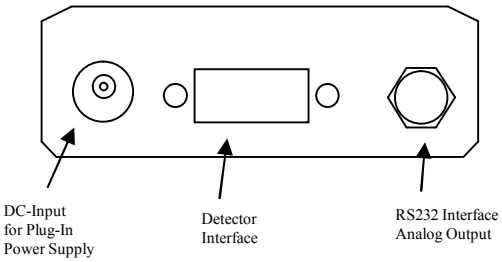
The firmware of the P-9710 is stored in flash-memory allowing simple software updates via the RS232-Interface.

The device has a built-in battery capable of 5 hours of operation with display illumination on (12 hours with backlighting off). A plug-in power supply is supplied to allow charging of the battery during normal operation.

10 Front Panel



11 Connection Panel



12 Technical Specifications

12.1 General Specifications

Power	built-in lead acid battery rated at 6V / 0.5Ah. operating time: 5hr with backlight on 12hr with backlight off plug 5.5mm/2.5mm/9.5mm to connect an external power supply (7.5VDC - 8.0VDC / min. 250mA)
Display	alphanumeric LCD display, 2 rows x 16 chars, character height 5mm, LED-illumination
Detector interface	9pin DSUB
Analog output	output voltage corresponding to detector input current connector: TRIAD01 5pin (Tyco)
Units of measurement	amperes, optical units corresponding to calibration data, factor, percent, log
Measurement ranges	8 (2.000mA to 200.0pA) manual or autorange
CW integration time	100µs - 5.9999s
Pulse integration time	10ms - 199.99s
Offset correction	correction range transcending
Parameter adjustment	remote control or front panel keys (menu), adjusted values permanently stored (eeprom) 10 different overall settings can be stored
Calibration information	stored in the detector connector (eeprom), manual calibration factor (keys), max. 250 calibration table entries + interpolation between the entries
Logger memory	max. 12288 entries, permanently stored in flash memory
Front panel control	10 keys, menu system
Remote interface	RS232 (9600 Baud, 8 Data Bit, 1 Stop Bit, No Parity) Connector: TRIAD01 (Tyco)

Device variants	-1: Input Amplifier Slew Rate 2ms - 10ms -2: Input Amplifier Slew Rate 20ms
Temperature	operating: 5 to 40°C storage: -10 to 50° C
Size / weight	195mm x 100mm x 40mm / 500g
Accessories	plug in power supply

12.2 Range Data Specifications

range (A/V)	**range max.**	**slew rate (10 - 90%) variant -1**	**slew rate (10 - 90%) variant -2**	**gain error *) ± offset error (at 20 °C)**	**gain (A/V) analog output**
$1x10^{-3}$	±2,000mA	2ms	20ms	0.2% ±0.001mA	$1x10^{-3}$
$1x10^{-4}$	±200,0µA	2ms	20ms	0.2% ±0.1µA	$1x10^{-3}$
$1x10^{-5}$	±20,00µA	3ms	20ms	0.2% ±0.01µA	$1x10^{-5}$
$1x10^{-6}$	±2,000µA	3ms	20ms	0.2% ±0.001µA	$1x10^{-5}$
$1x10^{-7}$	±200,0nA	4ms	20ms	0.2% ±0.1nA	$1x10^{-7}$
$1x10^{-8}$	±20,00nA	4ms	20ms	0.2% ±0.01nA	$1x10^{-7}$
$1x10^{-9}$	±2,000nA	10ms	20ms	0.5% ±2pA	$1x10^{-9}$
$1x10^{-10}$	±200,0pA	10ms	20ms	0.5% ±2pA	$1x10^{-9}$

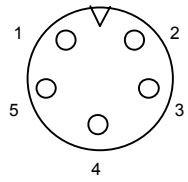
***)** with factory calibration

12.3 Detector Interface

DSUB9 Pin (female)	Function
1	input current (detector current)
2	GND
3	connection detection (has to be connected to GND by the external detector)
4	GND
5	SCL (I2C, eeprom)
6	GND
7	GND
8	+5V Output (Ri = 100 Ohm)
9	SDA (I2C, eeprom)

12.4 RS232 / Analog Out Interface

Pin (TRIAD01 female)	Function
1	Analog Out (Rin = 10k)
2	TxD (has to be connected to RxD of ext. PC)
3	RxD (has to be connected to TxD of ext. PC)
4	GND
5	GND



View of the female connecter at P-9710 from outside the case (Type TRIAD01 5pin /Tyco)

Adapter TRIAD01 5pin connector / DSUB- connector 9pin. (PC RS232-Interface):

Pin TRIAD01 male connector	Pin DSUB 9pin female connector
2	2
3	3
4	5
	connected 1-4-6
	connected 7-8

13 Quick Start Guide

- connect the plug-in power supply to the P-9710 or use the P-9710 under internal battery power
- connect the detector head to the P-9710
- press <on/light> key to switch on the P-9710
- first the P-9710 displays the Firmware Version: P-9710 Vx.x .
- next the P-9710 displays "Detector connected" and the detector serial number
- the meter/detector should now be set-up to default settings, for example with VL-3701-2 photometric detector calibrated in lux, CW illuminance measurements can be performed now with no further meter programming
- if necessary the P-9710 measurement parameters can be reset to the factory default values:
  - press <menu> key
  - <▲> up and <▼> down keys choose menu "Setup", press <enter> key to select
  - with <▲> and <▼> keys choose menu "Configuration", press <enter> key to select
  - with <▲> and <▼> keys choose menu item "Default Init", press <enter> key to select
  - P-9710 asks for confirmation: "Change Data?", press <enter> key to confirm
- now specific measurement parameters can be selected to perform a certain measurement task (see "Menu Tutorial") as required

If the P-9710 does not turn on, verify that the built-in battery is not discharged or that the plug-in power supply is correctly connected to the P-9710 and AC main power.

14 Menu Tutorial

14.1 Version Info

The following information is related to P9710 Firmware Version V4.7.

14.2 General

The P-9710 can be manually operated and set-up for measurement using the front panel keypads (10 keys) to access its menu for function selection.

Pressing <menu> key selects the main menu. There are further sub-menus. The up <▲> and down <▼> arrow keys are used to switch between the different menus. By Pressing <enter> key the menu item displayed is selected. By Pressing key <esc> one can escape from the menu without changing parameters. On selecting a setting, the P-9710 requests confirmation ("Change Data?) to change the parameter. Press key <enter> to confirm that you really want to change the setting.

Use <►> right and <◄> left arrow keys to select the digit position to change numbers. Using <▲> and <▼> arrow keys the selected digit can be changed (as well as the sign). Pressing <enter> key selects the adjusted number.

14.3 Menu Sytem Overview

The following table is a quick reference guide to the different menu selections/functions available.

menu item	submenu item	function
1. Mode	CW	displays the measurement respective of any offset and calibration factors programmed
	CW Maximum	displays the highest detected reading
	CW Minimum	displays the lowest detected reading
	Peak Maximum	shows the maximum detected peak level
	Peak Minimum	displays the minimum detected peak level
	Peak to Peak	displays the difference between the detected peak maximum and peak minimum level
	I-Effective	enables the measurement of pulsed light signals with evaluation of the effective intensity according to the form-factor method defined by Schmidt-Clausen
	Pulse Energy	enables the measurement of short and single light pulses with direct display of exposure for the pulse duration, considering the respectively measured (radiometric) quantity
	Relative (%)	displays the measurement as percentage of a reference value
	Relative (Log)	displays the measurement in dB or dBm in relation to a reference value
	Relative (Fact.)	displays the measurement referred to a reference value
	Hold	enables or disables the display hold function for the instrument

	CW Level Check	compares actual CW reading with previously defined limit values and indicates status
	Dose (C)	accumulates the single readings and displays the result as exposure for measured quantity
	Logger (x)	stores the single readings, which are taken in predefined intervals up to a number of 12288
	Remote RS232	enables the instrument to be controlled by a computer via the built in RS232 interface
2. Range		selects the range 1 to 8 or switches into the autorange mode (9)
3. Detector	Detector information	if a detector with calibration data connector is attached to the instrument, optionally programmed calibration factors can be selected
	Ampere	shows the reading in ampere units
	Manual	allows entering a calibration factor manually
4. Offset		performs an automatic offset adjustment
5. Reference		sets a reference value, used in different display modes
6. Substitution		performes the measurements to get the substitution error compensation factor
7. Setup	Integration time	sets the integration time
	Dose Run Time	sets the maximum time duration for exposure measurement
	Dose Maximum	sets the max. dose level for the exposure measurement mode
	Dose CW Display	sets dose measurement display mode
	Logger Time	sets the sample time interval for the data logger mode
	Display Digits	adjusts the number of displayed digits (4, 5, or automatic)

	Zero Adjust Mode	sets the mode for the internal zero adjustment
	Pulse Meas.-Time	needs to be set for the measuring modes I-Effective and Pulse Energy. It defines the time for collecting readings and shall be a little longer than the expected pulse width.
	IF Time Constant	sets the time constant C in the Schmidt-Clausen formula
	Pulse Offset	determines the method of offset compensation (stray light) for the measuring modes *I-Effective* and *Pulse Energy*
	CW Level Min.	sets the lower limit value required in the *CW Level Check* measuring mode
	CW Level Max.	sets the upper limit value required in the *CW Level Check* measuring mode
	Default Init	resets all instrument settings to the factory default settings
	Synchronisation	selects how the measurement time period is adapted to the input signal
	Substitution	enables / disables substitution error compensation
	Code Number	sets a four digit lock-out access code
	Configuration	Default Init – sets factory default settings. Save Config – stores all current settings. Load Config. – loads setting selection (0-9) for Save Config.
8. Info	Battery Status	displays the battery charge status as percentage value
	Logger data	displays the recorded logger data

14.4 P-9710 Switch On

Pressing <on/light> key turns the P-9710 on.

14.5 P-9710 Switch Off

Pressing <off> key turns off the P-9710.

14.6 Display Illumination On / Off

Pressing <on/light> key (if the P-9710 is already turned on), switches the display illumination on / off.

14.7 Measurement Result Display Update On / Off

Pressing <run/stop> key stops updating the measurement display (the last display will be frozen). The displays upper row will display "Stp" on the right side. Pressing <run/stop> again continues updating the display.

14.8 Menu Mode

Allows selection of the measurement and display mode. The upper row normally displays the CW value. The lower row displays the result depending on the selected mode.

„CW“ displays the average measurement value for the pre-set integration time (upper row). The lower row displays the selected wavelength or name of the connected detector.

„CW Maximum“ displays the max. CW value input signal. Reset with <reset/esc> key.

„CW Minimum“ displays the min. CW value input signal. Reset with <reset/esc> key.

CW Maximum and CW Minimum should not be confused with Peak Values. Peak Values will be calculated for each integration period (integration time) out of the single ADC samples. CW Maximum and CW Minimum stores the largest or smallest CW value since the last <reset> key press.

„Peak Maximum“ displays the max. ADC sample value of the integration period. It will be calculated new for each integration period (see menu "setup" / "integration time").

„Peak Minimum“ displays the min. ADC sample value of the integration period. It will be calculated new for each integration period (see menu "setup" / "integration time").

„Peak to Peak“ displays the difference of max. and the min. ADC sample value of the integration period. It will be calculated new for each integration period (see menu "setup" / "integration time").

The P-9710 can only detect peak values of pulses that are longer than the settling time of the input current amplifier - see table "Range Data Specification"!

„I-Effective“ measures single pulses and calculates the result according to the "Schmidt-Clausen" formula. Pressing <run/stop> key starts the measurement. The measurement time can be adjusted with "Setup \ Pulse Meas. Time". The time constant C (for result calculation) can be adjusted with „Setup / IF Time Constant". See Appendix section for background information.

„Pulse Energy“ measures single pulses and calculates the total energy over the adjusted measurement time. Pressing <run/stop> key starts the measurement. The measurement time can be adjusted with "Setup \ Pulse Meas. Time". See Appendix section for background information.

For modes "I-Effective" and "Pulse Energy" the influence of ambient light can be reduced with „Setup / Pulse Offset“. If "Static" is selected an offset value can be set in "Offset” menu. If "Continuous" is selected, the last CW measurement before the pulse measurement is started will be used as offset value.
If "Auto Range" is set, the P-9710 will display "OVL" (overload) or "UDL" (underload) if the range of the last pulse measurement was not optimal. On next measurement(s) the range is automatically switched one step in the suitable direction until the optimum range is locked-in .

„Relative (%)“ displays the measurement result in percent of the reference value, **„Relative (Fact.)“** as factor to the reference value and **„Relative (Log)“** as dB in relation to the reference value. To adjust the reference value see menu "Reference". See Appendix section 16.3 for background information.

„Hold“ stores and permanently displays the current CW value at the lower display row after Pressing key **„reset“**.

„CW Level Check“ checks the measured CW value against pre-set min. and max. limits. The lower display line displays the status. The limit values can be adjusted with menu „Setup / CW Level Minimum“ and „Setup / CW Level Maximum“.
A relay card (Type 8FA, Conrad Electronic or Gigahertz-Optik) can be connected to the RS232-Interface of the P-9710. Relay 1 will be activated if the CW value is within the limits. If the CW value is beyond the min. value relay 2 will be activated. If the CW value is above the max. value, relay 3 will be activated.

„Dose“ performs an integration of the measurement results and displays the result as a dose value. Key <run/stop> starts or stops the dose measurement. With key <reset/esc> the dose value can be reset to zero. With menu „Setup / Dose Run Time“ the max. dose measurement time and with „Setup /Dose Maximum“ the max. dose value can be adjusted. If dose run time or dose maximum is reached, dose measurement is automatically stopped.
If <◄> key is pressed, the pre-set max. dose measurement time (upper row) and the actual dose measurement time (lower row) will be displayed for 5 seconds. If <►> key is pressed, the pre-set max. dose value (upper row) and the actual dose value (lower row) will be displayed for 5 seconds.

„Logger“ stores the measurement values at the pre-set clock rate (0.1s to 6000s, manual). Max. 12288 values can be stored. Pressing <run / stop> key starts or stops the accumulation. The sampled data is stored in flash memory (no loss of data if device is switched off). Every ‘start’ produces a dataset (DSxxx) with additional device parameters (detector, clock, ...) stored in logger memory. Logger data is erased by pressing <reset / esc> key.

„Remote RS232“ sets P-9710 for control by RS232-Interface (P-9710Z-01 cable required).

14.9 Menu Range

Allows selection of the measurement range (see table Range Data Specification). Fixed range adjustment (Range 0 - 7) or Auto (for automatically range switching depending on the input signal) can be selected.

If the input signal alters rapidly it could be difficult for the autorange function to adjust the correct range (P-9710 will frequent display "OVL" or "UDL"). In this case it would be better to manually adjust to an adequate range!

14.10 Menu Detector

Allows selection of the calibration data used to calculate the measurement result.

"Ampere“ displays the measurement result as current (Ampere units). Using menu item **"Manual“** a calibration factor and calibration unit can be adjusted manually by key entry. Other adjustments include selection of table entries from the calibration data table of the connected detector. A certain table entry can be selected using the <▲> and key <▼> arrow keys. Using the <►> and <◄> arrow keys interpolation between the calibration table entries can be made (1nm step).

14.11 Menu Offset

"0“ sets the offset value to zero. **"CW“** selects the actual measurement value as the new offset value. The offset value will be subtracted from the following measurement results. Offset is useful to compensate ambient light or dark currents of detectors.

14.12 Menu Reference

Selects the reference value used to calculate the measurement results in mode "Relative %“, "Relative (Log) “ and "Relative (Fact)“.
With **"One Unit**“ the reference value is set to 1 (1 A, 1 W, 1cd, ...). **"CW“** selects the actual measurement value as the new reference value. With **"Manual“** a certain reference value can be set manually with the keys. **"1.000mX"** sets the reference value to 1/1000 of the selected unit (could be used to display the result in dBmW).

14.13 Menu Substitution

Performs the measurements to get the factor for substitution error compensation. The factor is calculated from the ratio of a black standard measurement and the probe measurement.

14.14 Menu Setup

"Integrationtime“ sets the measurement time (100µs - 5.9999s). For this period of time the input signal is sampled (every 100µs) and the average value of the samples is calculated and displayed.

If the input signal has big AC components, to obtain a stable measurement result it may be useful to set the integration time to an integer multiple of the AC time period of the input signal!

"Dose Run Time“ sets the max. time for dose measurement (1s to 1000h). After this time dose measurement is automatically stopped.

"Dose Maximum“ sets the max. dose value for dose measurement. If this dose value is reached, dose measurement is automatically stopped.

"Dose CW Display“ sets the display mode for dose measurement. If **"CW Display"** is selected, the upper display row shows the actual CW value and the lower display row shows the dose value. If **"No CW Display"** is selected, the upper display row shows the dose value and the lower display row shows the dose unit.

"Logger Time“ sets the sample time for logger mode (0.1s to 5999.9s and 0). Every elapsed sample time a new actual CW value is stored in the logger memory. If sample time 0 is set, a new CW value is stored in logger memory by Pressing <enter> key.

"Zero Adjust Mode“ selects the mode for the internal electronic zero adjustment (not the external dark current!). If **"Range Switch"** is selected, every time the measurement range is changed an internal zero adjustment is made. **"Each Measurement"** performs an internal zero adjustment each measurement period (integration time). **"Fixed Values"** performs a one time zero adjustment and uses these values for the following measurements.

For fastest measurement range switching "Zero Adjust Mode" should be set to "Fixed Values". For readjusting the zero values, the menu item "Zero Adjust Mode" / "Fixed Values" should be selected again (if environment temperature has changed or after a longer time period).

"Display Digits“ adjusts the number of display digits (**"4“**, **"5“** or **"Auto“)** for the measurement result display. "Auto" automatically accommodates the resolution to the selected calibration factor.

"Pulse Meas.-Time“ adjusts the integration time (0.01s - 199.99s) for pulse measurement ("I-Effective" or "Pulse Energy"). After Pressing "run / stop" key to start the pulse measurement, an integration of measurement samples is made for this set period.

Pulse Meas. Time should be set long enough, to collect the whole pulse into the measurement time slot. On the other hand, the time should be set as short as possible to minimize offset errors produced by ambient light and detector dark current.

"IF Time Constant“ adjusts the time constant for pulse calculation according to the formula of "Schmidt-Clausen" (0.1s - 5.9999s). See Appendix section for background information.

"Pulse Offset" selects the method for offset compensation for modes "I-Effective" and "Pulse Energy". The influence of ambient light and detector dark current can be reduced. If **"Static"** is selected the offset can be adjusted with menu "Offset". If **"Continuous"** is selected, the last CW measurement value before the pulse measurement is started will be used as offset value. The offset value is subtracted from the measurement result.

"CW Level Minimum“ adjusts the minimum CW level for "CW Level Check" mode.

"CW Level Maximum“ adjusts the maximum CW level for "CW Level Check" mode.

"Synchronisation" selects how the measurement time period is adapted to the input signal. If **"Not active"** is selected, no special synchronisation to the input signal is made. If **"Active"** is selected, a synchronisation on the AC component of the input signal is activated that results in a more stable measurement display.

"Substitution“ enables / disables substitution error compensation.

"Code Number“ allows a four-digit code number to be set. If a value other then "0000" is entered, P-9710 parameters can only be changed after entering this code number.

The P-9710 only asks one time for the code number. For all further parameter setting inputs a new code number is not requested unless the P-9710 is switched off and switched on again.

"Configuration“ selects an overall device parameter set-up. **"Default Init"** sets all parameters to factory default values. **"Save Config."** stores the actual configuration (all adjusted device parameters) permanently at the configuration memory (max. 10 different configurations can be stored). **"Load Config."** adjusts the device parameters to certain configuration (before stored with "Save Config."). Number 0 - 9 is used to select the configurations.

14.15 Menu Info

„Battery Status“ displays the charge state of the P-9710 battery (0 - 100%).

„**Logger Data“** shows the logged data. Scroll data with <▲> and <▼> up and down keys and to select a certain entry (using <►> and <◄> keys the step size is increased to 100). By pressing, **„enter“** key other parameters (belonging to that measurement result) can be displayed (sample time, detector name, start, stop, serial number, calibration table entry number).

15 Remote Interface

15.1 General

The P-9710 can be controlled and values read out via RS232 interface by selecting the menu **"Mode" / "Remote RS232"**.

A command string sent to the P-9710 can consist of max. 100 characters and must be terminated with <LF> (Hex.: 0x0A). One command string can include several commands. No special separation between the commands is necessary (but possible - see "Spacer Commands").

The P-9710 sends <LF> after the command string has been executed.

PC: <Command1><Command2*><Command3><LF>* *P-9710: <Answer3><LF>* **) Command1 and Command2 without answer*

15.2 Version Info

The following information is related to P9710 Firmware Version V4.7.

15.3 Commands

15.3.1 Measurement

MV	start measurement of result	answer: +x.xxxxE+xx Measurement with adjusted parameters, output of calculated result (with calibration factor and offset). **example: MV**
MU	start measurement of voltage	answer: +x.xxxxE+xx Measurement with adjusted parameters, output of the current amplifier output voltage. **example: MU**
MA	start measurement of current	answer: +x.xxxxE+xx Measurement with adjusted parameters, output of the input current value. **example: MU**

GA	max. peak value	answer: +x.xxxxE+xx Output of the max. peak value of the last measurement (commands MV, MU or MA). **example: GA**
GB	min. peak value	answer: +x.xxxxE+xx Output of the min. peak value of the last measurement (commands MV, MU or MA). **example: GB**
GD	max. - min. peak value	answer: +x.xxxxE+xx Output of the difference between the max. and the min. peak value of the last measurement (commands MV, MU or MA). **example: GD**
GP	% of range	answer: +xx.x Output of percentage utilisation of adjusted measurement range of the last measurement (commands MV, MU or MA). **example: GP**
GU	unit of measurement result	answer: "xxx" Output of measurement unit. **example: GU**
MI	pulse measurement "Schmidt - Clausen"	answer: +x.xxxxE+xx Pulse measurement and calculation according to the formula of "Schmidt-Clausen". **example: MI**
MJ	pulse measurement energy	answer: +x.xxxxE+xx Pulse measurement and calculation of energy. **example: MJ**

15.3.2 Measurement Parameter

SN[p]	integration time	p = 1 - 59999 (unit 0.1ms) Measurement time for CW measurement. **example: SN2000**
SM[p]	integration time pulse measurement	p = 10 - 19999 (unit 10ms) Measurement time for mode "I-Effective" and "Pulse Energy". **example: SM5000**
SU[p]	time constant C "Schmidt-Clausen"	p = 0.0001 - 5.9999 (unit 1s) Sets the constant C for pulse calculation according the formula of "Schmidt-Clausen". **example: SU0.2**

SS[p]	synchronisation of measurement period	p = 0: no synchronisation p = 1: synchronisation active If active the measurement period is adapted to the AC component of the input signal. **example: SS1**

15.3.3 Offset

SO[p]	offset	p = 0: offset zero p = 1: offset CW value Sets the offset to zero or to the last measured CW value (commands MV, MU or MA). The offset value will be subtracted from the following measurement results. **example: SO1**
SZ[p]	offset mode pulse measurement	p = 0: offset according to command "SO" p = 1: last measured CW value before starting pulse measurement will be used as offset value **example: SZ0**

15.3.4 Calibration Data

SD-2	manual calibration data	Selects the manually adjusted calibration data to calculate the measurement result. **example: SD-2**
SD-1	calibration data Ampere	Selects current (Ampere) as unit for the measurement result. **example: SD-1**
SD[p]	calibration data selection from calibration table	p = 0 - 249: calibration data entry Selects a calibration data entry from the calibration table of the connected detector. **example: SD123**
SY[p]	wavelength selection	p = x (Unit nm) Selects calibration data related to wavelength (only for detectors with wavelength calibration). **example: SY450**
GK	detector name	answer: xxxxxx Answers with the name of the connected detector. **example: GK**

15.3.5 Range

SR[p]	measurement range	p = 0 - 7 (most sensitive) Selects the measurement range. **example: SR3**
SB[p]	autorange	p = 0: autorange off p = 1: autorange on Selects between manual range adjustment and automatically range adjustment. If autorange is off, the range has to be adjusted with command "SR" **example: SB1**

15.3.6 Detector Data

SP[p]	detector data write pointer	p = 0 - 2047 (pointer to detector data array) Selects the detector data write position. **example: SP1284**
SC[p]	detector data byte write	p = 0 - 255 (data byte) Writes the byte to the actual write pointer position (write pointer is incremented afterwards). **example: SC104**
GC[p]	detector data byte read	p = 0 - 2047 (read position) answer: 0 - 255 Reads a byte out of the detector data array. **example: GC1245**
SE[p]	write detector data array to eeprom	p = 1 - 2048 (number of bytes to write) Transfers the detector data from RAM to the connected detector (eeprom). This command is code protected. **example: SE200**
GE[p]	compare detector data array with eeprom	p = 1 - 2048 (number of bytes to compare) answer: Exxx (address of first error) no answer if no error Compares the detector data from RAM with the data of the connected detector (eeprom). **example: GE200**
ST	test ext. detector eeprom	answer: OK ERROR Test write to the external detector eeprom. **example: ST**

15.3.7 Logger Data

SL[p]	logger data read pointer	p = 0 - 12287 Selects the logger data read position. **example: SL2345**
GL	output of logger data	answer: +x.xxxxE+xx_y _: space y: range (0 - 7) Output of logger data. Command SX defines the number of data values read out each command GL. Data values are separated with "space". **example: GL**
SX[p]	number of data values	p = 1 - 255 Defines the number of data values read out each command GL. **example: SX20**
GM[p]	output of logger common data set	p = 0 - 149 output: a_b_c_d_e_f_g _: space a: unit b: detector serial number c: calibration data entry number d: sample clock rate e: detector name f: first data set number g: last data set number Outputs the common data of one logger data set. A common data set is created for each start / stop event. **example: GM12**

15.3.8 Spacer Commands

Spacer commands can be used to separate the answers of a complete command string consisting of more then one command with answer.

,	spacer ","	answer: 1.234,2.345 **example: MA,MU**
[space]	spacer " "	answer: 1.234 2.345 **example: MA MU**
;	spacer ";"	answer: 1.234;2.345 **example: MA;MU**
[tab]	spacer [tab]	answer: 1.234 2.345 **example: MA MU**

15.3.9 Miscellaneous Commands

GI	software version	answer: P-9710 x.x **example: GI**
MB	battery status	answer: xxx% Output of percentage of the actual battery capacity (always 100% with plug-in power supply connected.). **example: MB**
SI[p]	display illumination	p = 0: display illumination off p = 1: display illumination on **example: SI1**
SW[p]	CW limit max. value	p = +x.xxxE+xx Sets the CW limit max. value for mode "CW Level Check" **example: SW+3.2345E-6**
SQ[p][x]	Substitution	p = 0: substitution error compensation disable p = 1: substitution error compensation enable p = 2: substitution measurement reference led on p = 3: substitution measurement reference led off x is not used for p = 0 - 3. p = 4: set substitution error compensation factor x = x.xxxE+xx (substitution error compensation factor) Commands to perform substitution error compensation. **example: SQ2**

GR	adjusted measurement range	answer: 0 - 7 (range number) Output of the adjusted measurement range. **example: GR**
TT	device serial number	answer: xxxx (serial number) Output of P-9710 serial number. **example: TT**
TF	device variant	answer: xxxx (variant number) Output of P-9710 device variant. **example: TF**
TB	ADC reference voltage	answer: x.xxxx (Volt) Output of P-9710 ADC reference voltage. **example: TB**
TV	CW limit min. output	answer: x.xxxxExx Output of min. limit for mode "CW Level Check" **example: TV**
TW	CW limit max. output	answer: x.xxxxExx Output of max. limit for mode "CW Level Check" **example: TW**
RA[p]	code number	p = xxxx Enable command for several protected commands. **example: RAxxxx**
GF[p]	range correction factor output	p = 0 - 7 (range number) answer: x.xxx (0.940 - 1.060) Output of the range correction factor. **example: GF3**
TD[p]	"#" answer	p = 0: no "#" and "*" as answer from P-9710 p = 1: "#" an "*" (error) as answer form P-9710 **example: TD0**

GS[p]	misc. device parameter output	p = 0: autorange answer: x (0: off, 1: on) p = 1: range answer: x (0-7) p = 2: offset current answer: x.xxxxExx p = 3: integration time answer: xxxxx (unit 0.1ms) p = 4: calibration factor answer: x.xxxxExx p = 5: calibration index number answer: x (-2 to 255) p = 6: wavelength answer: xxxxx p = 7: bit variable 1 answer: x (0-255) Bit 1: 1: synchronisation active **example: GS3**

15.3.10 Service Commands

TS[p]	device serial number	p = 0 - 32000 Sets the P-9710 service number. This command is code protected. **example: TS007**
TE[p]	device variant	p = 0 - 32000 Sets the P-9710 variant number. This command is code protected. **example: TE007**
SF[p][x]	range correction factor	p = 0 - 7 (range number) x = 0.040 - 1.060 (correction factor) Sets the range correction factor. This command is code protected. **example: SF00.980**
TA[p]	ADC reference voltage	p = x.xxxx Sets the ADC reference voltage. This command is code protected. **example: TA2.503**

15.4 Error Messages

After the P-9710 has performed a command string without error the sign <LF> is transmitted. If an error occurs during command execution "?x<LF>" will be transmitted (x = error code).

answer :	"?x<LF>"	x = 1:	command not allowed
		x = 2:	command parameter not allowed
		x = 4:	wrong code number
		x = 8:	parameter out of limits
		x = 16:	input signal overload
		x = 32:	input signal underload
		x = 64:	eeprom write error

15.5 Remote Command Examples

15.5.1 CW Measurement

Initialisation:

SN1000	integration time to 100ms
SY1	synchronisation on
SD12	select calibration table entry nb. 12
SB1	autorange on

Measurement (repeated):

MV;GD	measure and read out CW value and peak - peak value

15.5.2 Logger Data Read Out

Initialisation:

SL0	set read pointer
SX10	10 data sets per command GL
GM0	output of logger data common information

Data read out (repeated):

GL	read out of logger data sets

15.5.3 Substitution Error Compensation

Initialisation:

> adjust black standard	
SQ2	reference led on
MV	measurement of black standard

SQ3	reference led off
> adjust probe	
SQ2	reference led on
MV	measurement of probe
SQ3	reference led off
SQ4x.xxxExx	transfer substitution compensation factor factor = measurement black standard / measurement probe
SQ1	enable substitution error compensation

Measurement (repeated):

MV	measurement with substitution error compensation

16 Calibration Data Format

Calibration data is stored in the eeprom of the external detector connector. It consists of a data structure of max. 2048 Bytes. After connection of the detector to the P-9710 the data is transferred to the P-9710 RAM.

0x000 - 0x005: identification string „PT9610“
0x006 - 0x007: serial number
0x008 - 0x02F: not used
0x030 - 0x800: calibration table max. 250 entries each 8 byte

- **0x0 - 0x1:** wavelength or first two byte of name (if Byte 0x6 and 0x7 are not zero)
- **0x2 - 0x3:** calibration factor (unsigned int)
  0x0000 = 0 and 0xFFFF = 0.999985
- **0x4:** exponent (base 10) / signed 8 bit value
- **0x5:** Bit 0: 3er-flag (for P-9710 has to be set to 1)
  Bit 1 - 6 unit code number
  Bit 7: sign calibration factor (0 = positive)
- **0x6 - 0x7:** second two byte of name (if zero byte 0x0 and 0x1 = wavelength)

measurement result = current (mA) * calibration factor * $10^{Exponent}$

Unit code numbers (calibration table byte 5, Bit 1.. 6):

code	unit	dose unit
0	W	J
1	W/m²	J/m²
2	W/sr	J/sr
3	W/m²/sr J/m²/sr	
4	lm	lm*s
5	lx	lx*x
6	cd	cd*s
7	cd/m²	cd*s/m²
8	MED/h	MED
9	mol/m²/s	mol/m²
10	A	C
11	Cdsr	Cdsr*s
12	lm/sr	lm*s/sr
13	lm/m²	lm*s/m²
14	pc	pc*s
15	fc	fc*s
16	E/m²	E*s/m²
17	W/cm²	J/cm²
18	W/cm²*sr	J/cm²*sr
19	lm/cm²	lm*s/cm²
20	cdsr/m²	cdsr*s/m²
21	fL	fL*s
22	sb	sb*s
23	L	L*s
24	nit	nit*s

17 Appendix

17.1 I-Effective

In order to perceive a signal light or warning beacon, the human eye requires a threshold of illuminance or luminance, which is higher for shorter presentation times. The consequence of this is that for equal peak intensities, a narrow pulse signal light (light-flash) can appear less intense to an observer compared to a steady state signal light: the luminous range of rhythmic light is usually smaller compared to that of a fixed light. Therefore the significant quantity is not the peak intensity but the effective intensity. The effective (luminous) intensity of a signal light presented as a brief pulse can be calculated by the *method of Schmidt-Clausen* according to equation (1).

$$i_{eff} = \hat{\imath} \cdot \frac{\int i(t) \cdot dt}{\hat{\imath} \cdot C + \int i(t) \cdot dt} \qquad (1)$$

where

i_{eff} effective intensity
$\hat{\imath}$ peak intensity
$I(t)$ intensity
C time constant, depending upon the level of adaptation, recommended values are
C = 0.1 s for day-time observation
C = 0.2 s for night-time observation

This measuring mode described in equation (1) only applies to the measurement of luminous quantities with a photometer head. Generally the quantity to be evaluated is luminous intensity, which can be derived from an illuminance measurement. Normally a photometer head is delivered calibrated for illuminance, in order to be universal. But on special order the photometer head can also be calibrated in luminous intensity for a fixed distance. The relationship between both quantities is described by the inverse square law as shown in equation (2), which is valid only for large measuring distances compared to the extension of the luminous area. Refer to the calibration certificate for details regarding the calibration of your specific detector head.

$$I = E \cdot r^2 \qquad (2)$$

where

I luminous intensity
E illuminance
r distance from source to acceptance area of photometer head

As a rule of thumb, one can estimate r to be 10 times the largest dimension of the illuminating source area, except for narrow beam sources (half peak angle $\alpha < 5°$).

17.2 Relative Logarithmic

The reading is displayed in dB as the ratio of a defined reference. To define a value, enter the menu item *Reference* (*one unit* → reference value is set to 1, *CW* → reference value is set to actual reading, *manual reference* → manual entry of reference value, *1.000mW* → reference value is set to 1mW, reading is provided in dBm units). If the *Relative (Log)* measuring mode is entered, the db value according to equation (4) is displayed together with the actual reading.

$$X = 10 \cdot \lg_{10} \frac{x}{x_{ref}} \qquad (4)$$

where

X displayed quantity in dB or dBm
x actual reading of the instrument
x_{ref} reference value

17.3 Pulse Energy Measurement

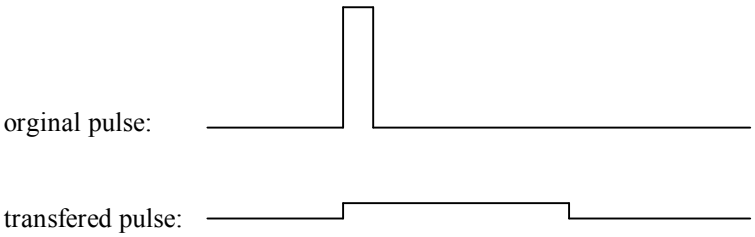
17.3.1 Principle

Pulse energy can be defined as the integral of the input signal over time (which equates to the pulse area).

$$X = \int_T x(t) \cdot dt$$

X	exposure
x(t)	measured quantity as a function of time
T	flash duration time

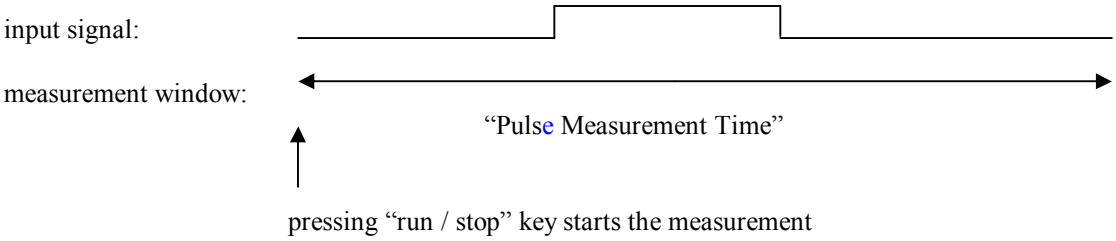
The P-9710-2 can measure pulse energy for pulse lengths down to 1µs, even though the internal Analog to Digital Converter (ADC) can sample the input signal only every 100µs. To perform this measurement task, the shape of the input signal is changed. A short high pulse is transformed into a long low pulse. But the key point is that the area equal that to the energy of the pulse is preserved.



Short pulses are transformed to pulse length greater 20ms. Therefore, with 100µs ADC sample time, every pulse is sampled at a minimum of 200 times.
With optimal offset compensation the total electronic pulse energy measurement error is within ±1%.
This principle of operation is also valid for a chain of pulses (one pulse chain can be considered to be one pulse).

17.3.2 Measurement

The pulse measurement must be started manually by pressing <run / stop> key. Next the pulse signal has to be triggered. The P-9710 samples the input signal for the defined time (“Pulse Measurement Time”) or until <run / stop> key is pressed again. The P-9710 calculates the sum (integral over the time) of the complete measurement window (“Pulse Measurement Time”).



It is important, that the pulse measurement is started (by pressing <run / stop> key) some time (0.5s – 1s) before the pulse signal occurs. The measurement window ("Pulse Measurement Time") should also be set long enough to catch the whole pulse signal.

Offset Compensation:

The P-9710 not only measures and calculates the sum of the pulse signal, but also electronic offset / ambient light or detector dark current are included in the calculated sum. To minimize the error produced by these offset signals, the measurement window should be set as short as possible (but long enough to catch the whole pulse, practical value: pulse time + 2 seconds).
Any offset error produced can also be minimized by measuring the offset signal beforehand without the applied pulse signal. This offset is subtracted later from the measurement result.

The offset must be measured without applied pulse signal!

There are two methods to measure the offset signal:

- If offset compensation "Setup / Pulse Offset" is set to "Static", the offset can be measured under menu "Offset". With menu "Offset" the offset value can be set to the actual CW value (no pulse signal has to be applied) or set to zero.
- If offset compensation "Setup / Pulse Offset" is set to "Continuous" the P-9710 uses the last measured CW value before pulse measurement is started as offset value. This mode has the advantage, that small changes of the offset value are compensated more effectively. For continuous offset compensation it is important, that the pulses are applied only after the pulse measurement is started (not during the preceding CW / offset measurement). This is the reason why for infinite pulse chains "Setup / Pulse Offset" has to be set to "Static".

*The offset signal level can be determined by starting pulse measurement without the presence of the pulses (**the measurement range has to be set to fixed range**). The displayed measurement value represents the error contribution produced by offset signal.*

Measurement Range:

The P-9710 measurement range has to be matched to that of the input signal. This can be done manually be selecting a certain range (manual range selection) or by selecting the autorange function (menu "Range" set to "Auto").
If the autorange function is set, the P-9710 will display "OVL" (overload) or "UDL" (underload) if the range of the last pulse measurement was not optimal (not well matched to the input signal range). On next measurement(s) the range is automatically switched one range step (up or down), as appropriate, until the optimum range is locked-in.
For manual range selection, the optimum range can be found by first selecting the autorange function and following the procedure above. Once this range is identified it can be set as the fixed range.

Infinite Pulse Chains:

For infinite pulse chains "Setup / Pulse Offset" has to be set to "Static". The offset has to be measured explicitly with pulse signal removed (menu "Offset"). "Setup" / "Puls-Meas.-Time" should be set to a multiple of the pulse period (= 1/frequency). If the pulse period is not known, "Puls-Meas.-Time" should be set as long as possible (more then 100 pulses should be covered by the measurement window) to get a stable measurement result.

Example - Pulse Energy Measurement of a Single 10µs Long Pulse

Set P-9710 Parameters:

- set menu “Mode” to “Pulse Energy”
- set menu “Range” to “Auto”
- set menu “Setup” / “Synchronisation” to “Not active”
- set menu “Setup” / “Integration Time” to “0.3000s”
- set menu “Setup” / “Zero Measurement” to “Fixed Values”
- set menu “Setup” / “Pulse Meas.-Time” to “2.000s”
- set menu “Setup” / “Pulse Offset” to “Continuous”

Initiate Measurement:

- press <run / stop> key to start measurement
- trigger pulse source (immediately after pressing <run / stop> key
- read measurement result on P-9710 display
- if “UDL” or “OVL” is displayed repeat measurement until a valid measurement result is displayed

Example - Pulse Energy Measurement of an Infinite Pulse Chain (pulse length: 10µs, pulse frequency: 50Hz)

Set P-9710 Parameters:

- set menu “Mode” to “Pulse Energy”
- set menu “Range” to “Auto”
- set menu “Setup” / “Synchronisation” to “Not active”
- set menu “Setup” / “Integration Time” to “0.3000s”
- set menu “Setup” / “Zero Measurement” to “Fixed Values”
- set menu “Setup” / “Pulse Meas.-Time” to “5.000s”
- set menu “Setup” / “Pulse Offset” to “Static”
- remove pulse signal from detector
- select menu “Offset”, set “Offset = CW”
- adjust pulse signal to detector

Initiate Measurement:

- press <run / stop> key to start measurement
- read measurement result on P-9710 display
- if “UDL” or “OVL” is displayed repeat measurement until a valid measurement result is displayed

17.4 Accessories

BHO-01 Carrying Case: Hard-shell case holds one P-9710, detectors and components with separate document partition

P-9710Z-01 RS232 Cable: Interface cable connects P-9710 with 9 Pin Sub D standard PC connector

P-9710Z-02 RS232 Relay Board: Interfaces with P-9710 for process control functions in CW Level Check operating mode. (3) solid state relays independently trigger based on measured values: less than set minimum, greater than set maximum or within limits. SSR max. 12V/2A.

OS-P9710 Software for radiometric/photometric applications, datalogging and data transfer under Windows.