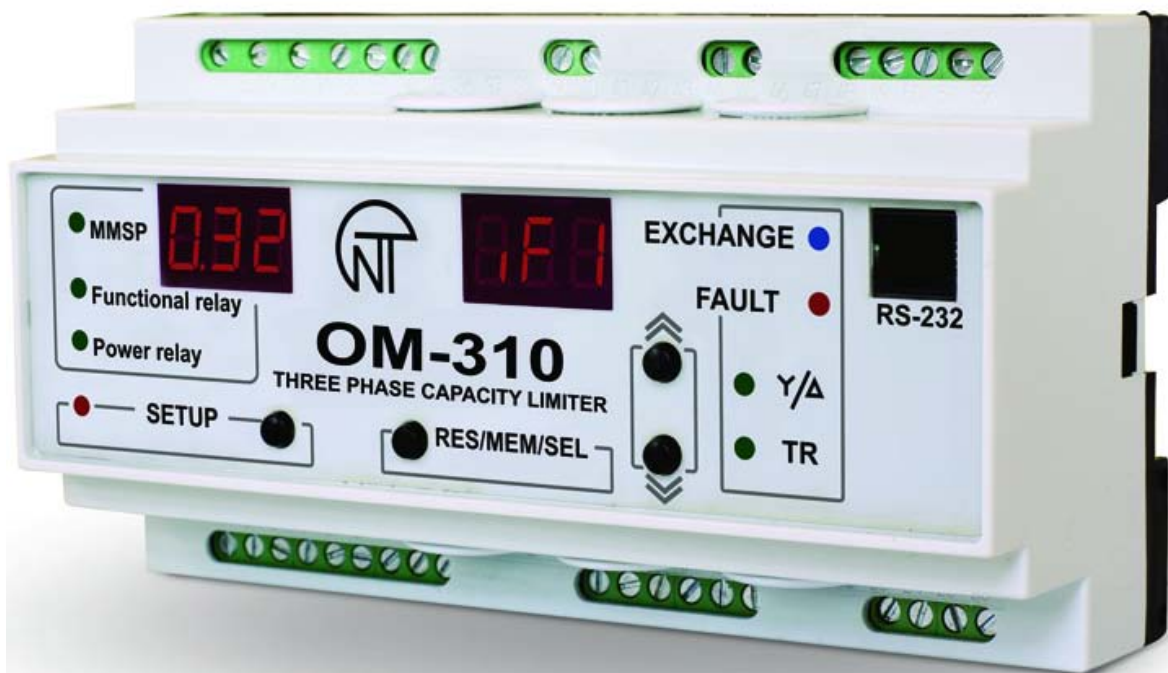


POWER LIMITER

OM-310



USERS MANUAL

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1. DESCRIPTION AND OPERATION

1.1 APPLICATION

1.1.1 OM-310 power limiter is designed for the following applications:

- load protection at poor parameters of the mains;
- complete load cutoff in case if watts input exceeds the main threshold within the user-set time period;
- partial load cutoff in case if watts input exceeds the additional threshold within the user-set time period;
- measurement and indication of 3-phase electric circuit (delta voltage and mesh voltage RMS values; positive phase, negative phase and zero phase sequence voltages; phase currents RMS values; input wattage of active power, wattles power, apparent power, power factor ($\cos \varphi$))
- fault warning;
- remote load on and off via RS-232/RS485 interface or and external switch.

OM-310 provides for operation under loads ranging from 2,5 kW to 30 kW with use of integrated current transformers, and up to 350 kW at use of external current transformers, including when in networks with insulated neutral.

OM-310 device provides the following types of load protection:

- when the mains voltage is of poor quality (impermissible voltage surges, phase loss, incorrect phase sequence and phase "coincidence", phase/line voltage imbalance);
- when maximum specified current in any load phase is exceeded;
- against "ground" leakage currents;

For each separate type of protection, the unit allows to enable or disable automatic load reset (further: AR)

OM-310 provides electric equipment protection by means of a magnetic starter (contactor) coil control.

Using OM-310 the user has possibility to choose functionality of additional relay and use it for following operations:

- signalization emergency situations
- contactor connection of additional loading
- as time relay
- signalization of reactive power excess
- signalization of active power excess

Communication

OM-310 provides for:

- control and parameters transfer via RS-485 interface according to MODBUS protocol,
- control and parameters transfer via RS-232 interface.

Note: Simultaneous use of RS-485 and RS-232 is not possible.

Interaction of PC and OM-310 is possible via "OM-310 Control Panel" Software that can be downloaded from the "Novatek-Electro" website (http://www.novatek-electro.com/production_om.htm).

OM-310 Control Panel software is dedicated for monitoring status and retrieving data from OM-310 devices via standard communication interface (RS-232 or RS-485). The Software allows for saving (loading) various OM-310 settings, retrieving data and saving them for further research. The user can view saved data in a graph, while comparing parameters.

The CP graphic environment allows for real-time viewing the current status of various OM-310 parameters.

The flexible interface design allows tuning it to any user's preferences.

1.1.2 OM-310 application limitations and proper selection of parameters

1.1.2.1 Use of integrated current transformers.

Attention! OM-310 cannot be used for protection of load with wattage over 30 kW.

When measuring load currents from 63A to 300A, the measurement error does not exceed 5%, while at currents over 320A, the current transformer core saturation starts, and the measurement error increases rapidly. Regardless In spite of the actual current value, the current measured by OM-310 will not exceed 400A. Setting up certain programmable parameters (maximum current protection) without regard to current transformers saturation will make protection tripping impossible.

For example, at " I_{nd} "=50 (load rated current), $i^2 P = 0$ (ratio of independent delay current protection), $i^2 S = 9$ (maximum current protection tripping), the maximum current protection would have tripped at current value of 450A. Due to current transformer saturation, the measured current value will not exceed 380-400A, even in case of a short circuit from the load side, and currents of over 1000A, and, therefore, OM-310 will not de-energize the load. In such case (" I_{nd} "=50) the user shall set the overcurrent tripping ratio to not more than 6.

1.1.2.2 Use of external currents transformers.

In case of tested standard transformer samples, the core saturation took place at 4-5 times the rated current value. Therefore, to provide for proper functioning of OM-310 protections, one should select external transformers with rated current value exceeding the rated load currents twice and more, or choose parameters considering the saturation.

1.1.3 Integrated relays output terminals specification

The internal relays output terminals specifications are outlined in Table 1.1 and Table 1.2

Table 1.1 - Load relay

| | Max. current for U~ 250 V | Number of trips x1000 | Max switching power | Max sustained safe AC/DC voltage | Max. current for U = 30V D.C. |
|-------------|---------------------------|-----------------------|---------------------|----------------------------------|-------------------------------|
| Cos φ = 0.4 | 5 A | 200 | 1000 VA | 440/125 V | 1.3 A |
| Cos φ = 1.0 | 8 A | 100 | | | |

Table 1.2 - Characterizing relay

| | Max. current for U~ 250 V | Number of trips x1000 | Max switching power | Max sustained safe AC/DC voltage | Max. current for Упост = 30V D.C. |
|-------------|---------------------------|-----------------------|---------------------|----------------------------------|-----------------------------------|
| Cos φ = 0.4 | 5 A | 400 | 4000 VA | 440/125 V | 3 A |
| Cos φ = 1.0 | 16 A | 100 | | | |

1.1.4 List of abbreviations used

AR – automatic reset

MC – magnetic contactor

PC - personal computer

CT – current transformer

MMSP – mode with minimal number of setting parameters

I_{tt} - rated current of CT. (Specified when external CTs are used. For example, if a CT of T type-0.66 300/5, then I_{tt} will equal 300A)

I_n - rated current of load.

1.2 TECHNICAL BRIEF

1.2.1 Basic technical parameters are shown below in table 1.3

Table 1.3 - Basic Technical Parameters

| | |
|---|-----------------|
| Rated supply voltage: Three-phase 380V 50Hz | |
| Mains frequency, Hz | 48-62 |
| Rated load wattage range (during operation with use of integrated current transformers), kW | 3-30 |
| Tripping threshold accuracy for wattage, % of rated wattage, at most | 5 |
| Tripping threshold accuracy for current, % of rated current, at most | 2 |
| Tripping threshold accuracy for voltage, V, at most | 3 |
| Phase imbalance detection accuracy for voltage, V, at most | 3 |
| Minimum operational voltage: -single-phase voltage power supply when one phase and neutral wires are connected, V, not less - three-phase power supply voltage, V, at most | 180 450 |
| Analog inputs - remote switch connection input - three analog inputs for connecting standard CT with 5A output (of T-0.66 type or similar) - input for connecting differential current transformer (zero sequence transformer) | |
| Main outputs load relay – two groups of changeover contacts -8A 250V cos φ=1; characterizing relay – one group of changeover contacts -16A 250V at cos φ=1 (the relay function is assigned by the user); | |
| Power consumption (under load), VA, at most | 5,0 |
| Enclosure protection degree: - frame - terminal block | IP40 IP20 |
| Climate zone version | Y3.1 (moderate) |
| Operating temperature range, °C | from -35 to +55 |
| Storage temperature, °C | from -45 to +70 |
| Weight, kg, at most | 0,5 |
| Case dimensions (diagram 1.1) - nine S-type modules Mounting onto standard 35 mm DIN-rail Mounting position any | |

1.2.2 Measured and calculated parameters output to the display unit, their effective range limits and tolerances are given below in Table 1.4.

Note: The display device includes:

- two pieces of three-digit, seven segment indicators on OM-310 front panel;

- PC, connected to one of OM-310 interfaces (MODBUS, RS-232).

Table 1.4 - Measured and Displayed Parameters

| Measurement functions | Range | Accuracy | Mnemonics | Address | Measurement units used at data transfer |
|---|-------------------|-----------|--|-----------------|---|
| Currents | | | | | |
| Phase currents RMS values, A | 0,5-999 | 2% | <i>iF1_</i> , <i>iF2_</i> , <i>iF3</i> | 100,101, 102 | 1/10 of an ampere* |
| Zero sequence current RMS value, A | 0,3-9,9 | 2% | <i>iF0</i> | 103 | |
| Each phase average current value at time specified in tSi parameter | | | <i>iS1_</i> , <i>iS2_</i> , <i>iS3</i> | 104,105, 106 | |
| Max each phase average current value obtained (was obtained) since last power on. All average values can be reset with RES/MEM/SEL button at time of max average current value output for any phase (real-time average current value for corresponding phase is assigned). | <3 ltt > 3 ltt | 2% 10% | <i>in1_</i> , <i>in2_</i> , <i>in3</i> | 107,108, 109 | |
| Negative sequence current (current imbalance), A. | 0,2-200 | 5% | <i>ioP</i> | 110 | |
| Voltages | | | | | |
| Phase voltages RMS values (defined by connecting zero wire to OM-310), V | 100-300 | 3 V | <i>UF1_</i> , <i>UF2_</i> , <i>UF3</i> | 111,112 113 | Volts |
| Power voltage RMS values, V | 100-450 | 5 B | <i>UL1_</i> , <i>UL2_</i> , <i>UL3</i> | 114,115 116 | |
| Positive-sequence voltage, V | 100-300 | 3 B | <i>Upp</i> | 117 | |
| Negative-sequence voltage, V | 3 -300 | 3 B | <i>UoP</i> | 118 | |
| Zero-sequence voltage (vector sum of three phase voltages, divided by three), (measurement is possible only when zero wire is connected to OM-310),V | 3-100 | 3 B | <i>UnP</i> | 119 | |
| Wattages and Cosines | | | | | |
| Gross power, KVA** | 0-5000 | 5% | <i>Pot</i> | 120, 121 | W * 10 |
| Active power, KW** | 0-5000 | 5% | <i>POA</i> | 122, 123 | |
| Wattles power, KVAr** | 0-5000 | 5% | <i>POJ</i> | 124, 125 | |
| Phase A active power, KW** | 0-5000 | 5% | <i>PA</i> | 126, 127 | |
| Phase B active power, KW** | 0-5000 | 5% | <i>Pb</i> | 128, 129 | |
| Phase C active power, KW** | 0-5000 | 5% | <i>PC</i> | 130, 131 | |
| Phase A voltage/current angle cosine | 0,00-1,00 | 5% | <i>PCA</i> | 132 | Cosine value *1000 |
| Phase B voltage/current angle cosine | 0,00-1,00 | 5% | <i>PCb</i> | 133 | |
| Phase C voltage/current angle cosine | 0,00-1,00 | 5% | <i>PCc</i> | 134 | |
| Time before load disconnect tripping when the load wattage is exceeded, sec **** | 0-600 | 1s | <i>tOP</i> | 135 | seconds |
| Time before AR delay termination, sec*** | 0-900 | 1s | <i>tAP</i> | 136 | |
| Wait time after de-energizing in case of over wattage (indicates wait time before permit of system restart), min **** | 0-30 | 1s | <i>tEP</i> | 137 | |
| Mains frequency, Hz | 45-65 | 1% | <i>FFF</i> | 138 | 1/10 Hz |

* **Note.** When working with external transformers of rated current over 100A, the currents (measured and calculated), except for the zero sequence current (ground fault) are transferred via RS-232/RS485 in amperes.

** **Note.** If power consumed by the load is over 999 kW (kVA, kVAr), then MW (MVA, MVar) is displayed on screen with a “n” – shaped point in the middle position. For instance, if the display shows 3n4”, it means 3.4 MW (MVA, MVar).

*** **Note.** If automatic reset is forbidden, "not" message is displayed.

**** **Note.** If the time is not defined, "---" is displayed on screen.

1.2.3 Programmable parameters and their variability ranges are shown below in table 1.5.

Table 1.5 - Programmable parameters

| Settings and read-off parameters | Code parameters | Minimum values | Max. values | Default setting | Operation | Address |
|---|-----------------|----------------|-------------|-----------------|---|---------|
| Transformers | | | | | | |
| CT in use | tPt | 0 | 1 | 0 | 0-intergrated CT are in use 1-external CTs are in use | 150 |
| CT rated current, A | tnt | 20 | 800 | 100 | For an external CT | 151 |
| CT rated current, A | ind | 5 | 700 | 10 | Used for calculating the current and the time of overcurrent protection | 152 |
| Power Control | | | | | | |
| Rated power of load, kW | Pnn | 3 | 450 | 5 | | 153 |
| Power limiter tripping thresholds calculation parameter | rPn | 0 | 2 | 0 | 0 – threshold calculation for each phase (power handling capability for each phase equals $Pnn/3$) 1 – threshold calculation for each phase +20% (total power for all phases equals Pnn , but not more than $Pnn*1,2/3$ for each phase) 2 – aggregate threshold calculation (total power for all phases equals Pnn) | 154 |
| Main threshold, % | PIF | 50 | 150 | 110 | | 155 |
| Additional threshold*, % | PZF | 30 | 100 | 90 | | 156 |
| Time before load relay de-energizing, sec (main threshold) | tIn | 0 | 300 | 60 | Time before load disconnect tripping when the load wattage main threshold is exceeded | 157 |
| Time while load relay is open, min (main threshold) | tIF | 1 | 60 | 5 | Time during which load relay is open after tripping when the load wattage main threshold is exceeded | 158 |
| Time before characterizing relay de-energizing*, sec (additional threshold) | tZn | 0 | 300 | 10 | Time after which the characterizing relay will open after tripping when the load wattage main threshold is exceeded | 159 |
| Time while the characterizing relay is open, min (additional threshold) | tZF | 1 | 60 | 5 | Time during which the characterizing relay is open after tripping which take place when the load wattage main threshold is exceeded | 160 |
| Additional threshold of the characterizing relay closure, % | PZn | 3 | 100 | 30 | Threshold for the characterizing relay closure after overload triggered opening | 161 |
| Characterizing relay operation mode | $rr5$ | 0 | 4 | 0 | 0 - the relay is used as an alarm relay 1- the relay is used as a time relay (closes after time specified in tZn parameter after load relay closure) 2-the relay is used for connecting additional load 3- the relay will close when load wattless power threshold Pnn is exceeded 4- relay will be switched on after exceeding of main tripping | 162 |
| Characterizing relay activation mode when $rr5=2$ | rZr | 0 | 2 | 0 | 0 – relay will close after expiration of time tZF 1 – relay will close after reduction of consumed wattage to level PZn | 163 |

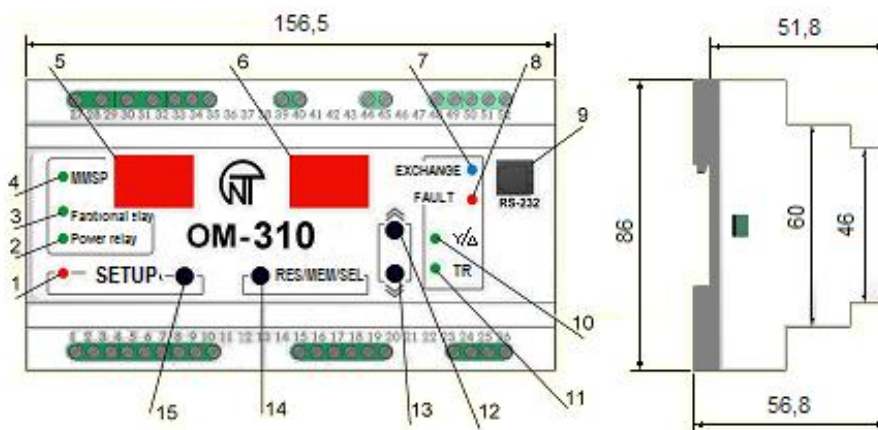
| Settings and read-off parameters | Code parameters | Minimum values | Max. values | Default setting | Operation | Address |
|---|-----------------|----------------|-------------|-----------------|--|---------|
| | | | | | 2 – relay will close after expiration of t_{ZF} time or after reduction of consumed wattage to level of P_{rn} whichever is earlier | |
| Delay of characterizing relay closure relatively to load relay closure | t_{i2} | 0 | 300 | 5 | | 164 |
| Allowable load wattless power, kVar. | P_{rn} | 3 | 450 | 5 | | 165 |
| Current protection. Maximum current protection | | | | | | |
| Maximum current protection type | $i = P$ | 0 | 5 | 0 | 0-protection with independent time delay Dependent time delay protection types: 1-SIT; 2-VIT (LTI); 3-EIT; 4-UIT; 5-RI | 166 |
| Max current protection tripping setting value, ratio | $i = 5$ | 0,8 | 9,0 | 2,0 | ratio to the load rated current is assigned (functions at $i = P = 0$). | 167 |
| Current protection tripping delay, sec | $i = t$ | 0,3 | 600 | 10,0 | | 168 |
| Protection function permission | $i = r$ | 0 | 2 | 0 | 0- protection function prohibited 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | 169 |
| Protection against line-to-earth fault (based on zero sequence current $iF0$) | | | | | | |
| Current fault tripping setting, A | i_{-5} | 0,3 | 5,0 | 0,5 | | 170 |
| Protection tripping delay, s | i_{-t} | 0,3 | 2,0 | 1,0 | | 171 |
| Protection function permission | i_{-r} | 0 | 2 | 0 | 0- protection function prohibited 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | 172 |
| Voltage protection | | | | | | |
| Minimum line voltage, V | U_{-5} | 270 | 415 | 320 | | 173 |
| Min voltage de-energize tripping delay time, sec | U_{-t} | 5 | 30 | 10 | | 174 |
| Minimum voltage protection function permission | U_{-r} | 0 | 2 | 0 | 0- protection function prohibited 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | 175 |
| Maximum line voltage, V | U_{+5} | 330 | 475 | 415 | | 176 |
| Max line voltage de-energize tripping delay time, s | U_{+t} | 1 | 10 | 2 | | 177 |
| Maximum voltage protection function permission | U_{+r} | 0 | 1 | 0 | 0- protection function prohibited 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | 178 |
| Line voltage imbalance, V | $U_{\Delta 5}$ | 15 | 120 | 35 | | 179 |
| Line voltage imbalance de-energize tripping delay time, sec | $U_{\Delta t}$ | 1 | 30 | 5 | | 180 |
| Voltage imbalance protection function permission | $U_{\Delta r}$ | 0 | 2 | 0 | 0- protection function prohibited 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | 181 |
| Phase sequence pro- | $U_{\Delta r}$ | 0 | 2 | 0 | 0- protection function prohibited | 182 |

| Settings and read-off parameters | Code parameters | Minimum values | Max. values | Default setting | Operation | Address |
|--|-----------------------|----------------|-------------|-----------------|--|---------|
| tection function permission | | | | | 1- protection function permitted, after-tripping automatic reset prohibited 2- protection function permitted, after-tripping automatic reset permitted | |
| Load Engagement and Automatic Reset Control | | | | | | |
| Automatic reset (AR) time, sec | <i>ARt</i> | 0 | 900 | 5 | | 183 |
| AR prohibited for all faults (except voltage faults) | <i>ARr</i> | 0 | 1 | 1 | 0 - AR prohibited 1- AR permitted <i>ARr</i> parameter value is effective for all types of faults except voltage faults. <i>U^rr</i> , <i>U_r</i> , <i>U^rr</i> parameters shall be used to prohibit AR in case of voltage faults | 184 |
| Load relay operation permitted after OM device power-on | <i>ARd</i> | 0 | 2 | 1 | 0 – manual load start from OM-310 front panel 1- load start after AR delay time load start after 2 sec delay | 185 |
| Load start/cutoff control with use of OM-310 front panel | <i>ARd</i> | 0 | 3 | 0 | 0 - prohibited 1- load energizing permitted 2- emergency load de-energizing permitted 3- load energizing and de-energizing permitted See par. 2.4.9 | 186 |
| Miscellaneous | | | | | | |
| Time within which average current value is measured, sec | <i>IS_t</i> | 10 | 600 | 60 | Time within which average current value is measured (parameters <i>iS1</i> , <i>iS2</i> , <i>iS3</i> from Table 1.5) | 187 |
| Min number of setting parameters mode enable | <i>SEn</i> | 0 | 1 | 1 | 0-mode disabled 1- mode enabled The mode change is enabled in the service-engineer mode only. | 188 |
| Indication on OM-310 display panel before load energize | <i>SEp</i> | 0 | 2 | 1 | 0- line voltage <i>U_{ab}</i> 1-active power <i>P_{oA}</i> 2-AR time countdown | 189 |
| Parameter indication mode | <i>SEc</i> | 0 | 1 | 1 | 0-parameter value indicated continuously 1-parameter value indicated within 15s | 190 |
| Complete equipment operation time, days | <i>EBU</i> | 0 | 999 | 0 | when MODBUS/RS-232 interface data transfer is utilized, the operation time is transferred in hours | 191 |
| User access code | <i>LOC</i> | 0 | 9 | 0 | 0 – keyboard unlocked 1-9 – user password | 192 |
| Service engineer access code | <i>PEs</i> | 000 | 999 | 123 | 000-access to service engineer level - permitted 000-999 – service engineer password | 193 |
| System reset to factory settings | <i>PPP</i> | 0 | 1 | 0 | After value 1 has been recorded and parameter setup mode exited, the factory set parameters will be restored | 194 |
| (RS-485/ RS-232) serial interface parameters | | | | | | |
| OM-310 device communication address | <i>r5A</i> | 1 | 247 | 1 | | 195 |
| Transfer rate | <i>r5S</i> | 0 | 1 | 0 | 0: 9600 baud; 1: 19200 baud; Transfer rate change will take effect after power-off/ and restarting power-on. | 196 |
| OM-310 response to loss of connection | <i>r5P</i> | 0 | 3 | 0 | 0-continue without warning 1- warning message, continue operation 2-warning message and load relay de-energize, AR permitted after communication has been restored 3-warning message and load relay de- | 197 |

| Settings and read-off parameters | Code parameters | Minimum values | Max. values | Default setting | Operation | Address |
|---|-----------------|----------------|-------------|-----------------|---|---------|
| | | | | | energize, AR prohibited after communication has been restored | |
| Response timeout detection, sec | r5D | 0 | 120 | 0 | 0 - prohibited | 198 |
| OM-310 communication via serial channel permitted | rPP | 0 | 2 | 0 | 0- communication prohibited 1- communication via RS-232 2- communication via MODBUS | 199 |
| Device version | rEL | | | 10 | The parameter value depends on the firmware version | 200 |
| Remotely controlled load energizing and de-energizing via RS-232/RS485 | dUd | 0 | 2 | 0 | 0 – remote control prohibited 1- remote control permitted, load relay closure permitted after OM-310 device energizing 2- remote control permitted, load relay closure prohibited after OM-310 power-on until remote power-on command has been issued | 201 |
| OM-310 Remote Operation control via remote switch | dU | 0 | 4 | 0 | 0 – remote control via the switch prohibited 1-4 see par 2.4.6 | 202 |
| The starter functionality monitoring (presence of currents when load relay is open) | CC , | 0 | 1 | 0 | 0- off 1- on | 203 |

* **Note.** The parameter is utilized if the characterizing relay functions in the additional load relay mode (r5=2)

1.2.4 Operating controls and the dimensions of the OM-310 are shown in fig.1.1.



- 1 – red LED - SETUP glows when the relay is in parameter setup mode
- 2 – green LED - LOAD glows when the load relay is closed
- 3 – green LED - RELAY glows when the characterizing relay is closed
- 4 – green LED - MMSP (mode with minimal number of setting parameters) glows when the relay is in MMSP mode
- 5 - three-digit parameter mnemonic indication display:
 - dot glows in the lower case of the display when OM-310 device is in service engineer access mode;
 - dot glows in the middle case of the display line when a setup parameter value is secured by service engineer password;
 - dot glows in the upper case of the display line when a setup parameter is not included in the MMSP list
- 6 - three-digit parameter value indication display
- 7 – blue LED - EXCHANGE glows during data exchange with PC
- 8 – red LED – FAULT:
 - while load relay is open: the LED glows, when OM-310 is in fault mode (flickers, when AR after fault is possible);
 - while load relay is closed, the LED flickers when the load consumed input power is over the main threshold, but the load relay open time has not yet been reached
- 9 - plug connection for connecting OM-310 to PC via RS-232
- 10 – green LED - glows when the OM-310 characterizing relay works in the mode of controlling additional load (par. 2.4.3)
- 11 – green LED - TR glows when the OM-310 characterizing relay functions in the time relay mode and blinking when OM-310 is working in signalization mode of main tripping exceeding of active power.

- 12 – button \blacktriangleup (marked in text as UP) – used to scroll through indicated parameters in the parameter view mode and scroll through menus in the parameter setup mode
- 13 – button \blacktriangledown (marked in text as DOWN) – used to scroll through indicated parameters in the parameter view mode and scroll through menus in the parameter setup mode
- 14 – key – RES/MEM/SEL – used to record parameters in setup mode; switch between groups of parameters displayed in view mode, reset
- 15 - SETUP button engages the parameter setup mode

Figure 1.1 - OM-310 device controls and dimensions

Note 1 - In order to enhance the OM-310 reliability, for the mains voltage input, terminals with 7.5 mm spacing were used. Standard contact numbering on the device case (5 mm) does not agree with such terminals, that is why terminals in figure 2.1 are marked with intermediate values.

Note 2 – LEDs 10 and 11 glow simultaneously when the OM-310 characterizing relay functions in the wattless power excess alarm mode

1.2.5 Power Limiting Functions

1.2.5.1 Assumptions utilized in power limiter function description:

- a) voltage and current protections are off or corresponding parameters values are within permissible limits;
- b) when energized, the load relay will close after AR time ($rPd=1$ parameter);
- c) time specified by $t1n$ parameter exceeds the AR time (rLt parameter).

1.2.5.2 Limitation of active power if parameter rPn not equal 2 (under all relay activity conditions except of using it for connection of additional loading).

After OM-310 energizing, after AR time (rLt parameter) the load relay will close. If during operation the active power consumed by the load crosses the main threshold for a time that is longer than assigned by “ $t1n$ ” parameter, the load relay will open. The load will be energized again after AR period, or after time specified by $t1F$ parameter (whichever is longer) (Figure 1.2).

The main threshold value and the power overload calculation depend on the “ rPn ” parameter value.

When $rPn=0$, the load consumed wattage is calculated for each phase separately and is compared with the main threshold calculated as:

Main threshold (kW) = (“ Pnn ” * “ $P1F$ ”) / (100*3), where
 “ Pnn ” – cumulative rated load wattage, kW;
 “ $P1F$ ” – main threshold, %.

When $rPn=1$, the cumulative load power input for all three phases is compared with the main threshold calculated as:

Main threshold (kW) = (“ Pnn ” * “ $P1F$ ”) / 100, where
 “ Pnn ” – cumulative rated load wattage, kW;
 “ $P1F$ ” – main threshold, %.

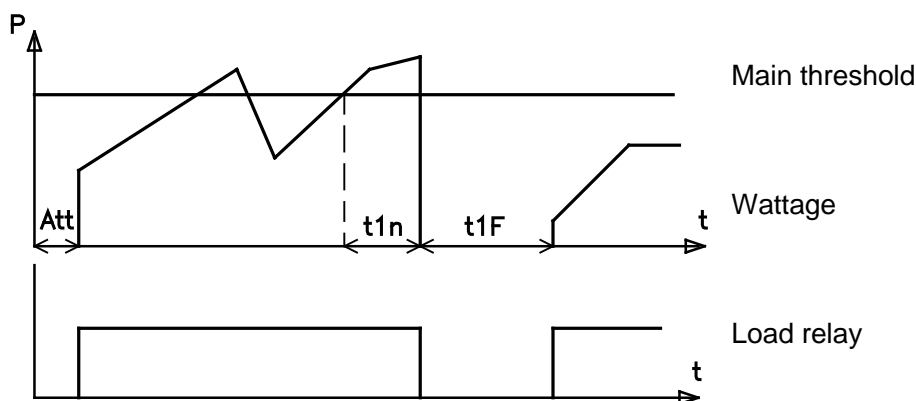
Simultaneously, the load input power is calculated for each phase separately and is compared with the second threshold calculated as (threshold calculation for each phase + 20%):

The second threshold (kW) = (“ Pnn ” * “ $P1F$ ” * 1,2) / (100*3), where
 “ Pnn ” – cumulative rated load wattage, kW;
 “ $P1F$ ” – main threshold, %.

Watt consumption crossing the first and the second thresholds is considered crossing the main threshold.

When $rPn=2$, the cumulative load power input is compared with the main threshold calculated as:

Main threshold (kW) = (“ Pnn ” * “ $P1F$ ”) / 100, where
 “ Pnn ” – cumulative rated load wattage, kW;
 “ $P1F$ ” – main threshold, %.



Att – AR time

t1n - time, after which the load relay will open if the watts input crosses the main threshold

t1F - time, during which the load relay will be open after de-energizing resulting from the watts input crossing the main threshold

Figure 1.2 - OM-310 operation in the power limiting mode when $rP5=0$, $rP5=1$, $rP5=3$

1.2.5.3 Active power limiting during operation of a characterizing relay at $rP5=2$ (relay used for connecting additional load)

After OM-310 energizing, after AR time (Att parameter) the load relay will close. After the delay, defined by “t2F” or “t2n” parameter (whichever time is longer), the characterizing relay closes while connecting additional load. If during operation the active power consumed by the load crosses the additional threshold (line 2 figure 1.3) for a time period that is longer than assigned by “t2n” parameter, the characterizing relay will open.

Characterizing relay will re-close again:

- a) at $rP5=0$, after time, assigned by t2F parameter (instance of the characterizing relay closure - line “b” on fig.1.3.);
- b) at $rP5=1$, when load consumed power will reduce till the additional load power-on threshold (line 3 on fig.1.3) (the characterizing relay engaging point - line “a” on fig.1.3.);
- c) at $rP5=2$ depending on which event (a or b) comes first.

If during operation the active power consumed by the load crosses the additional threshold (line 1 figure 1.3) for a time period that is longer than assigned by “t1n” parameter, the characterizing relay and the load relay will open.

The load relay and characterizing relay will be re-closed after AR period, or after time specified by t1F parameter (whichever of the time periods is longer) (Figure 1.3).

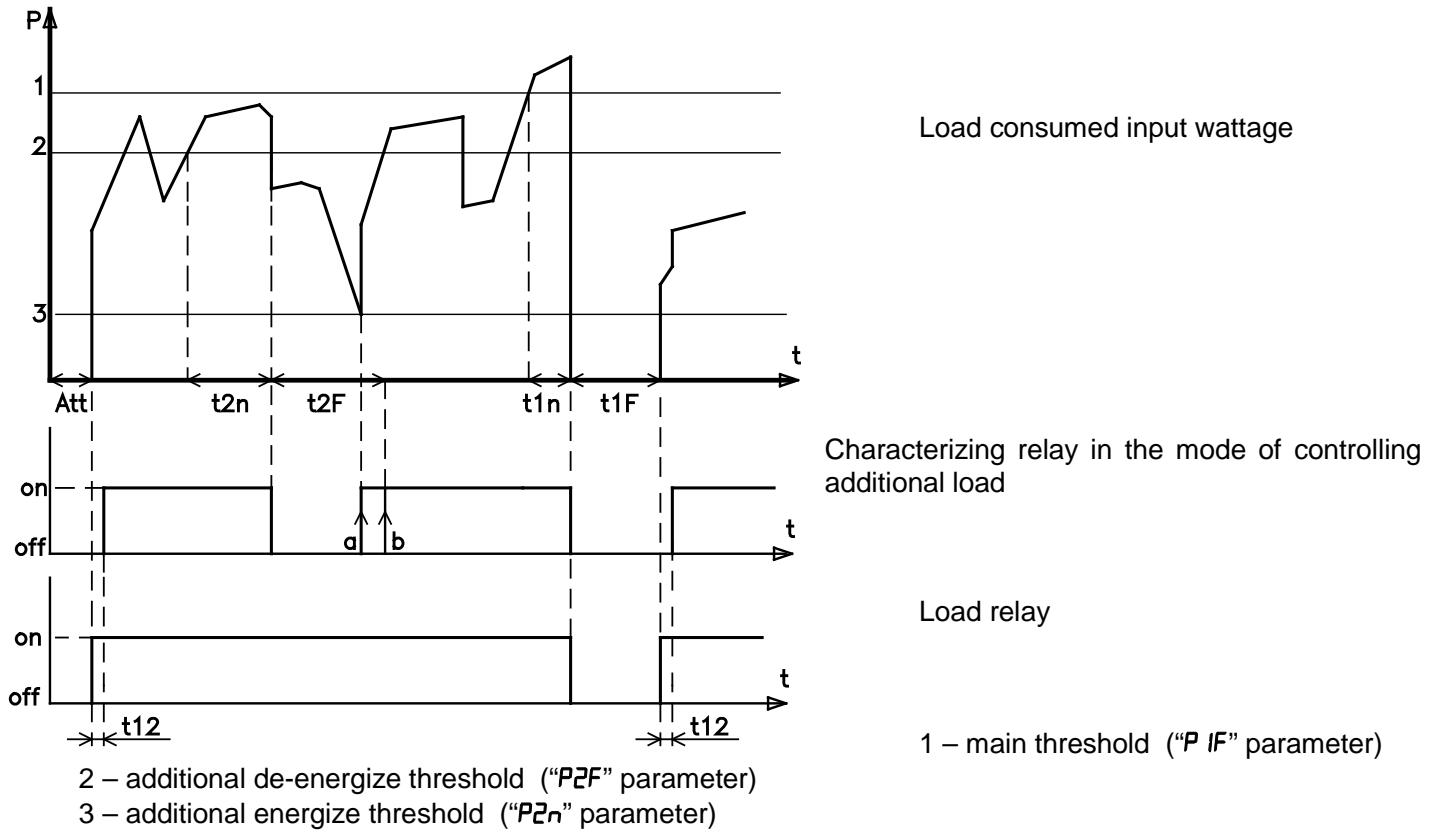


Figure 1.3 - OM-310 operation in the power limiting mode when $rP5=2$

The wattages values for the main threshold, the additional threshold, and the additional load energize threshold depend on the “rPn” parameter value.

When $rPn=0$, the load consumed power is calculated for each phase separately and is compared with the thresholds calculated as:

$$\text{Main threshold (kW)} = (P_{nn} * P_{1F}) / (100 * 3), \text{ where}$$

“Pnn” – cumulative rated load wattage, kW;

“P1F” – main threshold, %.

$$\text{Additional threshold (kW)} = (P_{nn} * P_{2F}) / (100 * 3), \text{ where}$$

“P2F” – additional threshold, %.

When $rPn=1$ the main threshold, the additional threshold and the energizing threshold are calculated similarly to the way described under paragraph 1.2.5.2

When $rPn=2$, the thresholds values (kW) are defined as follows:

Main threshold (kW) = "Pnn" * "P1F" / "100", where

"Pnn" – cumulative rated load wattage, kW;

"P1F" – main threshold, %.

Additional threshold (kW) = "Pnn" * "P2F" / "100", where

"P2F" – additional threshold, %.

At any value of rPn, the additional load energizing threshold shall be determined as:

Energizing threshold (kW) = ("Pnn" * "P2n") / ("100"), where

"P2n" – additional load energizing threshold, %.

1.2.6 Protection functions

1.2.6.1 Protection types

OM-310 device provides the following types of load protection:

- maximum phase current;
- against line-to-earth fault (based on zero sequence current);
- for minimum line voltage;
- for maximum line voltage;
- for line voltages imbalance (voltage negative sequence);
- for phase sequence order;
- starter unit operability control.

1.2.6.2 The overcurrent protection parameters are assigned relatively to the rated load current I_n ("ind" parameter).

1.2.6.3 Overcurrent protection

The overcurrent protection is of three-phase type. It is engaged when at least one of the phase current values reach the tripping threshold.

The protection has a time delay setting. The delay can be independent (constant), or dependent (**SIT** - reverse dependent; **VIT** or **LTI** – very reverse dependent; **EIT** - extremely reverse dependent; **UIT** – ultra reverse dependent; **RI** –type delay) - the tripping curves are displayed in Appendix 1.

When independent time delay protection is activated (fig. 1.4), the load relay is de-energized if one of the phases current exceeds the threshold value within T period of time (parameter "t₅").

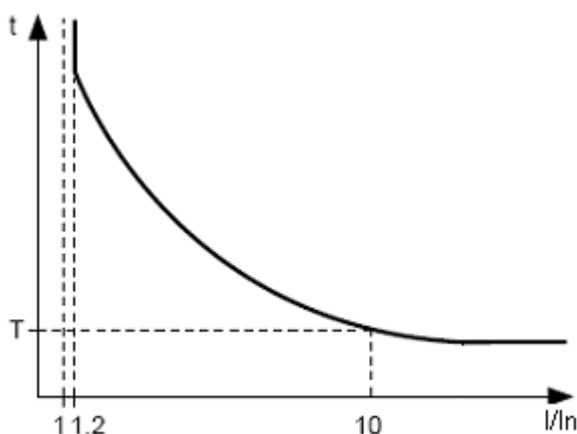


$I_s = "t_5"$ (tripping ratio) * I_n (load rated current), and T – protection tripping delay time

Example. When $t_5 = 4.0$, $I_n = 10$, $t_5 = 10.0$, the load relay shall open in 10 sec after one of the phase currents crosses 40 A value.

Figure 1.4 - Principle of protection with an independent time delay

The operation of the dependent time delay protection (Fig. 1.5) conforms to IEC 60255-3 and BS 142 standards.



I_n corresponds to "ind" setting (rated current of load);

T (parameter "t₅" – protection function time constant) – corresponds to the trip delay time for 10 I_n .

To deal with very high amperage currents the protection has a feature with an independent time delay:

Figure 1.5 - Principle of protection with dependent time delay

Graphs for the protection operation time constant equal to 1 sec (“ $t = 1$ ” parameter) are provided in Appendix 1. When a different value for time constant is set, the protection trip time changes proportionally to the time constant (for example, at “ $t = 10$ ” seconds the protection trip time at the same current ratio will increase 10 times).

1.2.6.4 Ground fault protection:

- is activated when earth fault current reaches the trip threshold (“ I_{5} ” parameter);
- the load relay opens if the earth fault current crosses the trip threshold within T time period (“ t ” parameter).

1.2.6.5 Voltage based protection

In voltage-based protections, before load energizing, OM-310 checks for corresponding threshold settings, and, depending on their value, either permits or prohibits load energization; after load energization the voltage control is retained.

Voltage-based protections include:

- protection for minimum line voltage (it trips when at least one of the line currents is less than the threshold setting (“ U_{5} ” parameter) within time specified by “ t ” parameter);
- protection for maximum line voltage (it trips when at least one of the line currents is greater than the threshold setting (“ U_{5} ” parameter) within time specified by “ t ” parameter);
- protection for line voltages imbalance (trips if difference between **RMS** line voltages exceeds the set threshold (“ U_{5} ” parameter) within time assigned by “ t ” parameter).

1.2.6.6 Protection based on phase sequence order trips in case of phase sequence order fault or phase coincidence it opens the load relay and locks its further operation.

1.2.6.7 Starter unit operability control (at $t = 1$). If currents are present when the relay is open, the starter is considered faulty. Further OM-310 operation is locked. The alarm reset can be performed by de-energizing only.

1.3 PRODUCT PACKAGE CONTENTS

The product package contents are shown in Table 1.7.

Table 1.7 - Product package contents

| Description | Abbreviation |
|---|--------------|
| OM-310 | OM-310 |
| Differential current transformer (zero sequence transformer)* | |
| Cable for communication with PC via RS-232* | KC-01 |
| Transmitter cable for communication with PC via USB* | KC-USB-01 |
| * - supplied optionally | |

1.4 EQUIPMENT FEATURES AND OPERATION

OM-310 is a microprocessor-based digital device that provides a high degree of reliability and accuracy. The device doesn't need any auxiliary supply: it's self-powered by the voltage to be monitored.

OM-310 device is equipped with three built-in CTs, through which power phase mains are conducted.

2. INTENDED USE

2.1. SAFETY

All connections must be performed on dead device.

2.2 OM-310 DEVICE CONTROL

2.2.1 Control Modes

OM-310 has five control modes:

- keyboard lock level;
- mode with minimal number of setting parameters (further on referred to as MMSP);
- user level;
- service engineer level;
- remote control.

In all operation modes the following features are available:

- viewing measured and displayed parameters (Table 1.4). Scrolling through parameters list is performed by DOWN and UP buttons;
- faults log view (n.2.4.8).

2.2.2 Disabled keypad mode

When keypad is locked, viewing and resetting programmable parameters is not possible.

When keypad is locked, pushing SETUP button will result in LOC message display. To unlock the keyboard the SETUP button shall be pressed again. The "SETUP" LED lights up, and figure "0" is blinking on the indicator. With the UP and DOWN buttons user enters a password digit from 1 to 9 and presses the RECORD/RESET/SELECT button. If the password is correct, the keypad will be unlocked. If after the keypad was unlocked no button is pressed during 15 sec and the lockage setting is not released by user, the keypad will relock.

The unblocked keypad allows:

- to operate in MMSP mode;
- to change and to view the user level parameters;
- to view the service engineer level parameters.

2.2.3 MMSP – mode with minimum number of setting parameters

MMSP is devised to ease the service personnel's operations with OM-310.

To employ MMSP mode in OM-310, the user needs to set $S_{in}=1$ parameter, or perform resetting to factory settings. (2.2.4). When OM-310 unit is in this operation mode, green LED "MMSP" is on.

In MMSP for normal activity of OM-310 is enough fix parameter P_{nn} (nominal active power table 1.5 if necessary parameters t_{ln} (time where through loading relay will be switched OFF after of energy input exceedence of main thresholds table 1.5) and t_{IF} (time interval of cut off loading relay on energy input exceedence of main threshold table 1.5)

On duty of external TT is necessary to fix following parameters:

- type of TT (parameter t_{PE} , table 1.5) external;
- nominal current of TT (parameter t_{nE} , table 1.5).

The difference between MMSP mode and the user mode is that the parameters not included in the MMSP register are set to default factory values.

ATTENTION! If some programmable parameters have been modified by the user or service engineer, but not included in the MMSP register, switching to MMSP mode will reset such parameters to factory settings.

The parameters included in this register cannot be viewed or modified. Operations with the MMSP register parameters are similar to the user level operations.

Adding parameters to the MMSP register and MMSP mode disabling is possible only in service engineer access mode.

When switching off the MMSP mode (setting parameter $S_{in}=0$) LED "MMSP" goes off. In the user mode all parameters list is displayed, but to change a parameter, perform the following:

- with DOWN and UP buttons choose the parameter to be added;
- push buttons DOWN and UP simultaneously.

2.2.4 User level

To view and to change the user level parameters one needs to press the SETUP button, then "SETUP" LED will glow. Scroll parameters with DOWN and UP buttons, enter parameter change mode – repeat push SETUP button (the parameter value starts to flicker), change parameters – with DOWN and UP buttons, record parameter - RECORD/RESET/SELECT, to return to menu without change – press SETUP button again. If no button is pressed during 15 sec the OM-310 will transfer to the initial state.

If a parameter change is forbidden (a dot in the middle digit field of the parameter mnemonic indicator glows), then the parameter change is possible only in Service Engineer level after the prohibition has been released.

2.2.5 Service Engineer Level

Access to the Service Engineer level.

Push SETUP button and hold for 5 sec. If the level is protected by a password, the label PAS appears on the indicator. The "SETUP" LED lights up, and indication "000" flickers on the parameter value indicator. With the UP and DOWN buttons enter the three-digit service engineer password, digits from 1 to 9 and separate dialing with pressing the RECORD/RESET/SELECT button. If the password is incorrect, the PAS label lights on blinking in the higher position of the value indicator, and OM-310 goes back to the initial state after 15 sec, otherwise the first parameter of the service engineer menu appears on the indicator.

Scroll parameters with DOWN and UP buttons, enter parameter change mode – repeat push SETUP button (the parameter value starts to flicker), change parameters – with DOWN and UP buttons, record parameter - RECORD/RESET/SELECT, to return to menu without change – press SETUP button again. If no button is pressed during 15 sec the OM-310 will transfer to the initial state.

While OM-310 is in Service Engineer mode, the decimal point in the lower digit position of the mnemonic indicator is on.

In the Service Engineer level the access to any user level parameter can be prohibited or permitted by simultaneous the SET and DOWN buttons pressing. Access denial is indicated by decimal point in the middle digit position of the mnemonic indicator.

While in Service Engineer access mode, any additional parameter can be added to the MMSP parameter register. Action:

- with DOWN and UP buttons choose the parameter to be added;
- push buttons DOWN and UP simultaneously.

To exclude a parameter from the MMSP register:

- with DOWN and UP buttons choose the parameter to be excluded;
- push buttons DOWN and UP simultaneously.

When a parameter is excluded from the MMSP mode register, a decimal point glows in the higher digit position of the mnemonic indicator.

2.2.6 Restoring factory settings.

There are two ways to restore the factory settings.

Way 1. Set up parameter $PPP=1$. Upon exit from the parameter setup mode all factory settings will be restored (except the Service Engineer Password).

Way 2. When powering OM-310 on, hold down SETUP and RES/MEM/SEL buttons for 2 seconds. All factory settings including the Service Engineer will be restored (Service Engineer password – 123).

After completion of the factory settings setup, OM-310 will start operation in MMSP mode, which includes the following parameters:

- CT type (external or integral); LPt ;
- CT rated current (set in case of external CT); Lnt ;
- rated power of load, Pnn .

2.3 OM-310 PRE-OPERATION PROCEDURE

2.3.1 When operating with load power ranging from 3 kW to 30 kW, use of built-in current transformers is allowed. The mains leading to the load must be conducted through openings in OM-310 casing (each phase wire uses a separate opening).

When using other capacity loads, current transformers with 5A rated output current shall be connected in accordance with Fig 2.1. For correct OM-310 operation, the current transformers' polarity must be observed.

2.3.2 Run all three power phase cables through differential current transformer (zero sequence transformer) and connect the DCT to OM-310.

2.3.3 Connect OM-310 to power mains in accordance with figure 2.1.

2.3.4 To operate OM-310 via PC as control or monitoring device with use of "OM-310 Control Panel" software:

- install "OM-310 Control Panel" software to your PC by running setup_UBZ314.msi application;
- connect "ЭБМ" (PC) connection plug on OM-310 front panel to RS-232 plug on PC with use of KC-01 cable or to USB jack of PC via KC-USB-01 cable;
- set parameter " $rPP=1$ ".

Note 1 - "setup_UBZ-OM.msi" software can be downloaded from Novatek-Electro website (http://www.novatek-electro.com/production_ubz.htm).

Note 2 - KC-01, KC-USB-01 cables are optional and can be ordered separately. Users can make KC-01 cable themselves following the diagram shown in Fig. 2.2.

Note 3 - Custom-developed software can also be used to operate OM-310 .

2.3.6 When using MODBUS, connect communication lines to terminals **33, 34, 35** of. Set " $rPP=2$ " parameter.

2.3.7 Energize OM-310.

Note - OM-310 is supplied with rated load power set equal to zero. In this case the OM-310 load relay will not close before the rated load power is set up.

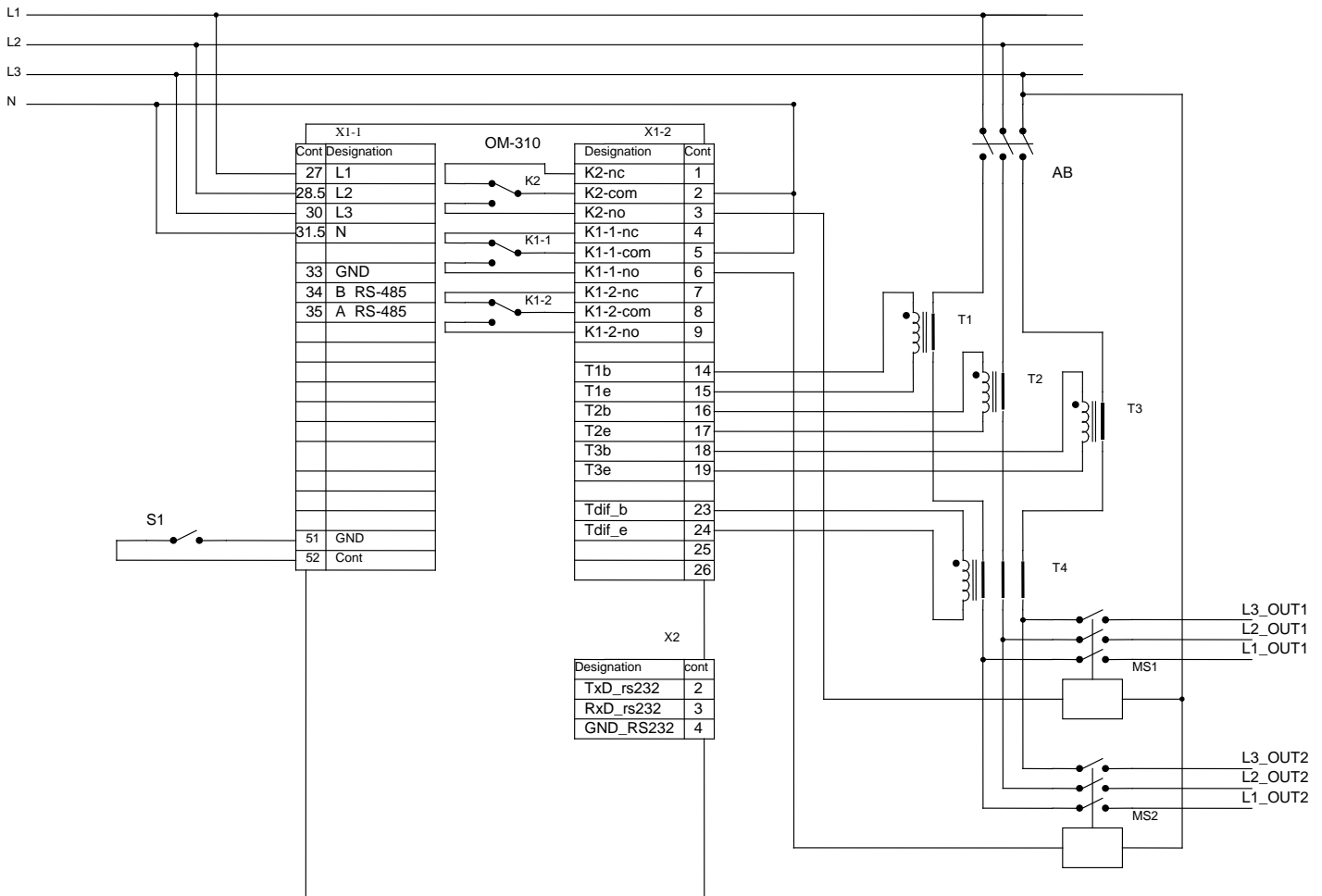
Load relay closing sequence is controlled by RLt и RPd (par. 2.4.1.) parameter values.

2.3.8 Set up required parameter values in the menu.

2.3.9 De-energize OM-310.

2.3.10 Connect the load magnetic contactor (further referred to as MC) according to Fig 2.1.

Note - When the load relay is energized, contacts **5-6** and **8-9** are closed, when the relay is de-energized, contacts **4-5** and **7-8** are closed.



- S1 – remote switch
- AS – automatic switch
- MC1 – additional load magnetic contactor
- MC2 – main load magnetic contactor
- K1 relay – load relay
- K2 relay – characterizing relay
- T1-T3 – external CTs
- T4 – differential current transformer.

Figure 2.1 - OM-310 connection schematic with use of external CTs and at $r=5=2$ (characterizing relay operation in the mode of controlling additional load)

2.4 INTENDED USE

Note: In the OM-310 operation description, it is assumed that the protections described are enabled and all necessary sensors are connected.

2.4.1 OM-310 operation before load relay closure

2.4.1.1. OM-310 operation after power-on (first start)

After power-on, the mnemonic indicator displays **5L1** for 1-2 seconds, and then before load energizing OM-310 tests:

- mains voltage quality: whether voltage is present on all three phases, if the mains voltage is symmetrical, what the RMS line voltage value is;
- correct phase sequence, absence of phase frittling.

When any of inhibiting factors is present, the load relay is not closed, and on the mnemonics indicator **FAULT** LED glows.

Depending on the SiP parameter, the indicator displays:

- line voltage Uab at 5 $iP=0$;
- active power (PoA) at 5 $iP=1$;
- AR time countdown in seconds, (Att) while 5 $iP=2$.

When power-on inhibiting factors are not present, the load relay closure is defined by APd parameter value (OM-310 device operation after power-on) **At APd=0 the load relay will not close. To close load relay in this case both DOWN and UP buttons have to be pressed simultaneously.**

- 1) When APd=1 the load relay will close after AR time.
- 2) When APd=2 the load relay will close in 2 sec after power-on. Simultaneously with the load relay closure, green LED LOAD starts to glow.

OM-310 operation with remote control permitted via RS-232/RS-485 (dUd=1, dUd=2) is covered in paragraph 2.4.5.
OM-310 operation with remote control permitted via switch (dUc=1, dUc=2) is covered in paragraph 2.4.6.

2.4.1.2. OM-310 operation after a fault-caused de-energizing

The OM-310 device operation in such case is similar to the first start operation, but the load relay closure is not dependent on the APd parameter value.

If after a fault AR is prohibited ("Arr=0"), the load power-on is not possible before OM-310 de-energizing. Arr parameter value is effective for all types of faults except voltage faults. U²r, U_r, Uⁿr parameters shall be used to prohibit AR in case of voltage faults.

2.4.1.3. OM-310 operation after de-energizing tripping caused by exceeding the watt input
OM-310 operation in this case is covered under par. 1.2.5.

2.4.2 OM-310 operation before load relay closure

After load relay closure OM-310 performs the following:

- control and limiting the active and wattles power by input load wattage (1.2.5);
- current overload protection (1.2.6.3);
- protection against line-to-earth fault (1.2.6.4);
- voltage protection (maximum, minimum, phase imbalance) (1.2.6.5);
- starter unit operability control (1.2.6.6).

The indicator can display either phase A current or a user-selected parameter value. The value of the user-selected parameter can be displayed either constantly (iL=0), or within 15 sec, and then phase A current (iL=1) indication is displayed again.

2.4.3 Characterizing relay operation

Functions performed by the characterizing relay are defined by r5 parameter.

When r5 = 0, the relay functions as signaling alarm relay (Y_Δ and TR LEDs are off). The relay contacts are closed in case of any fault specified in Table 2.7.

When r5 = 1, the relay functions as time relay (TR LED glows): the relay closes upon expiration of time set by "t_{TR}" parameter, after load relay closing.

When r5 = 2, the relay is used to control switching additional load (Y_Δ LED glows) (1.2.5.3).

When r5 = 3 we use relay for exceedence signalization of reactive power (LEDs Y_Δ and TR are)

Functional relay is switched ON by exceedence of total reactive power across three phases -Prn (admissible reactive power of loading) and switched OFF if not exceedence.

When r5 = 4 we use relay for exceedence signalization of reactive power main threshold (LED is blinking) (p.1.2.5.4.) The threshold value is being calculated according p.1.2.5.2.

Note - When the characterizing relay is closed, contacts 1-2 are open, and contacts 2-3 are closed.

2.4.4 Work with RS-232/RS-485 interface under MODBUS protocol in RTU mode.

The OM allows for data exchange with an external device via serial interface under MODBUS protocol. During data exchange via RS-485 or RS-232 blue LED "EXCHANGE" glows.

2.4.4.1 Communication parameters:

- device address: 1-247 (r5A parameter);
- data transfer rate: 9600 baud, 19200 baud (r55 parameter);
- response to loss of carrier: warning and continue operation, warning and load de-energizing, continue operation without warning (r5P parameter);
- response timeout detection: 1sec - 120sec (r5D parameter);
- transmission word format - 8 bit, no parity check, two stop bits.

2.4.4.2 OM-310 control from PC

Communication between PC and OM-310 is effected through serial interface. The connection schematic is shown in fig. 2.2. Each OM-310 has a unique communication address. PC controls each OM recognizing them by their address.

OM-310 can operate within RTU mode controlled Modbus networks.

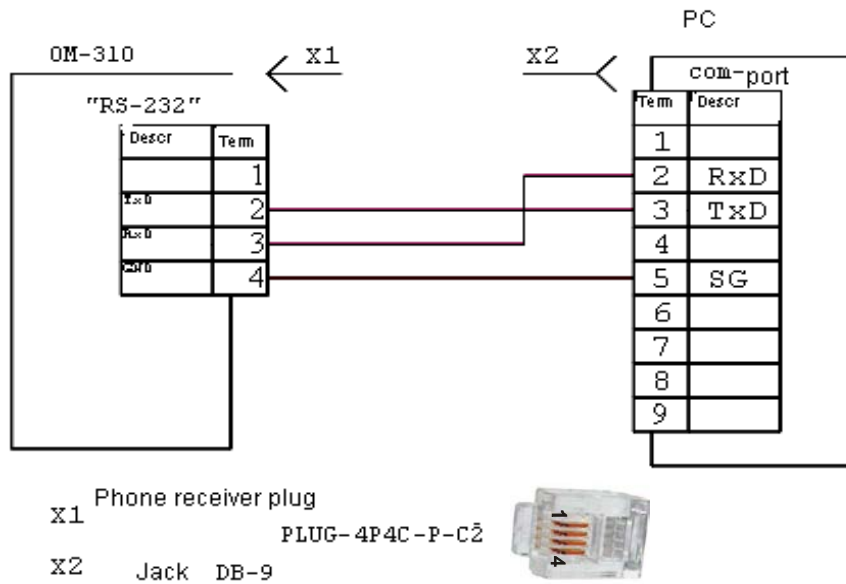


Figure 2.2 - OM-310 connection to PC schematic

2.4.4.3. Communication protocol

The exchange between PC and OM-310 is effected via data packages. Data packet format is given in Table 2.1.

Table 2.1

| | |
|--------------|--|
| START | silence interval – over 2msec at 9600 baud transfer rate, or over 4 msec at 19200 baud transfer rate |
| ADR | OM-310 communication address (8 bit) |
| CMD | Command code 8 bit |
| DATA 0 | Data contents: |
| | N*8 data bit (n<=24) |
| DATA (n-1) | |
| CRC CHK low | CRC checksum |
| CRC CHK high | 16 bit |
| END | silence interval – over 2msec at 9600 baud transfer rate, or over 4 msec at 19200 baud transfer rate |

2.4.4.4 CMD (command code) and DATA (data symbols)

Data symbols format depends on command codes.

Command code –0x03, n-words read.

For example, read 2 continuous words swapped from 2102H in OM-310 initial address with 01H communication address (Table 2.2)

Table 2.2

| Command message | | Response message | |
|----------------------|--------------|--------------------------|--------------|
| ADR | 0x01 | ADR | 0x01 |
| CMD | 0x03 | CMD | 0x03 |
| Start data address | 0x21 0x02 | Data amount, bytes | 0x04 |
| Data amount in words | 0x00 0x02 | Data contents by address | 0x17 0x70 |
| CRC CHK low | 0x6F | Data contents by address | 0x00 0x00 |
| CRC CHK high | 0xF7 | CRC CHK low | 0xFE |
| | | CRC CHK high | 0x5C |

Command code 0x06, record – one word

Using this command is not recommended as recording incorrect data may lead to OM-310 failure.

Data recording is possible only to the programmable parameters addresses (Table 1.5), except for parameters listed in Table 2.3.

Table 2.3

| Settings and read-off parameters | Code parameters | Address |
|--|-----------------|---------|
| Equipment operation time counter, days | <i>t b U</i> | 207 |
| User access code | <i>L D C</i> | 208 |
| Service engineer access code | <i>P A S</i> | 209 |
| System reset to factory settings | <i>P P P</i> | 210 |
| Device version | <i>r E L</i> | 217 |

A parameter recording is performed independently from the installed Service Engineer protection (the entry made via communication line has a higher priority).

When a new parameter value is recorded into a MMSP-protected cell, such parameter will automatically be excluded from this mode.

Recorded parameters must be aliquot to iteration specified in Table 1.5.

For example, record 1000 (0x03E8) to register with 0x00A0 address into OM-310 with 01H communication address.

Table 2.4

| Command message | | Response message | |
|--------------------|--------------|--------------------|--------------|
| ADR | 0x01 | ADR | 0x01 |
| CMD | 0x06 | CMD | 0x06 |
| Start data address | 0x00 0xA0 | Start data address | 0x00 0xA0 |
| Data | 0x03 0xE8 | Data | 0x03 0xE8 |
| CRC CHK low | 0x89 | CRC CHK low | 0x89 |
| CRC CHK high | 0x56 | CRC CHK high | 0x56 |

Command code 08h – diagnostics.

08h function provides a number of tests for checking communication system between PC and OM-310, and for OM-310 integrity control.

The function uses the sub function field to specify the action performed (test).

Sub function 00h – query data return.

Data transferred in the query field must return in the response data field.

Request and response example is given in Fig. 2.3.

Query

| Address | Function | Subfunction HB | Subfunction LB | Data HB | Data LB | CRC LB | CRC HB |
|---------|----------|----------------|----------------|---------|---------|--------|--------|
| 01h | 08h | 00h | 00h | A0h | 3Ch | 98h | 1Ah |

Response

| Address | Function | Subfunction HB | Subfunction LB | Data HB | Data LB | CRC LB | CRC HB |
|---------|----------|----------------|----------------|---------|---------|--------|--------|
| 01h | 08h | 00h | 00h | A0h | 3Ch | 98h | 1Ah |

Figure 2.3 - Example of sub function request and return 00h – data request return.

01h sub function – communication options restart

OM-310 peripheral port shall be initialized and restarted.

Request and response example is given in Fig. 2.4.

Query

| Address | Function | Subfunction HB | Subfunction LB | Data HB | Data LB | CRC LB | CRC HB |
|---------|----------|----------------|----------------|---------|---------|--------|--------|
| 01h | 08h | 00h | 01h | 00h | 00h | B1h | CBh |

Response does not return

Figure 2.4 - Example of sub function request and return 01h – communication options restart.

2.4.4.5 CRC - Cyclic redundancy check code

The checksum (CRC16) is a cyclic redundancy check code based on A001h polynomial. The transmitting device forms the checksum for all bytes of the message transmitted. The receiving device similarly forms the checksum for all bytes of the message received, and compares it to the checksum received from the transmission device. When received and transmitted checksums do not match, an error message is generated.

The checksum field size occupies two bytes. The checksum within message is transferred with low byte coming first.

The checksum is registered under the following algorithm:

- 1) load CRC register (16 bit) with units (FFFFh);
- 2) exclusive OR with first 8 bytes of message and CRC register contents;
- 3) offset the result one bit to the right;
- 4) if the offset bit =1, the exclusive OR of the register contents with A001h value;
- 5) if the offset bit=0, repeat step 3;
- 6) repeat steps 3, 4, 5 until 8 offsets have been completed;
- 7) exclusive OR with the next 8 bits of the message byte and CRC register contents;
- 8) repeat steps 3 – 7, until all bytes of the message have been processed;
- 9) the finite register contents will contain the checksum.

Here is an example of CRC code generation with use of C programming language. The function takes two arguments:

Unsigned char* data <- a pointer to the message buffer
 Unsigned char length <- the quantity of bytes in the message buffer

The function returns the CRC value as a type of unsigned integer.

```

Unsigned int crc_chk(unsigned char* data, unsigned char length)
{int j;
 unsigned int reg_crc=0xFFFF;
 while(length--)
 {
  reg_crc ^= *data++;
  for(j=0;j<8;j++)
  {
   if(reg_crc & 0x01) reg_crc=(reg_crc>>1) ^ 0xA001; // LSB(b0)=1
   else reg_crc=reg_crc>>1;
  }
 }
 return reg_crc;
 }
    
```

2.4.4.6 Register addresses

The register addresses of the measured and calculated parameters of the OM-310 device are given in table 1.4. The addresses of the programmable parameters are given in table 1.5. Additional registers and their functions are shown below in table 2.5.

Table 2.5

| Description | Address | Application | Comment | |
|---------------------------|---------|--|---|--|
| OM status register 240 | | Bit 0 | 0-no fault 1- fault (fault code in register 241) | |
| | | Bit 1 | 0- load relay open 1- load relay closed | |
| | | Bit 2 | 0- characterizing relay open 1- characterizing relay closed | |
| | | Bit 3 | 0 – restart not activated 1- AR expected | |
| | | Bit 5-4 | Characterizing relay operation mode 00 – alarm relay 01 – time relay 10 – additional load 11 – alarm relay for wattles power excess | |
| | | Bit 6 | 0- MMSP mode disabled 1- MMSP mode enabled | |
| Fault register 1 | 241 | bit mapping shown in table 2.8 | 0-no fault 1-fault | |
| Fault register 2 | 242 | bit mapping shown in table 2.8 | | |
| Fault log | | | | |
| Fault code 1 | 243 | fault code according to table 2.8 | | |
| value of parameter 1 | 244 | parameter value according to table 2.8 | | |
| Fault time 1 | 245 | two upper bytes | | |
| | 246 | two lower bytes | | |

| | | | |
|----------------------|-----|--|--|
| Fault code 2 | 247 | fault code according to table 2.8 | |
| value of parameter 2 | 248 | parameter value according to table 2.8 | |
| Fault time 2 | 249 | two upper bytes | |
| | 250 | two lower bytes | |
| Fault code 3 | 251 | fault code according to table 2.8 | |
| value of parameter 3 | 252 | parameter value according to table 2.8 | |
| Fault time 3 | 253 | two upper bytes | |
| | 254 | two lower bytes | |
| Fault code 4 | 255 | fault code according to table 2.8 | |
| value of parameter 4 | 256 | parameter value according to table 2.8 | |
| Fault time 4 | 257 | two upper bytes | |
| | 258 | two lower bytes | |
| Fault code 5 | 259 | fault code according to table 2.8 | |
| value of parameter 5 | 260 | parameter value according to table 2.8 | |
| Fault time 5 | 261 | two upper bytes | |
| | 262 | two lower bytes | |

Note 1 - Fault time – is time period since the OM-310 power-on till the moment of the fault occurrence. Measured in minutes.

Note 2 - Upon OM-310 delivery, or after factory settings reset (2.2.6), error code 40 and parameter value 10000 are written in the log.

2.4.4.7 Communication error handling

When an error situation occurs at time of a frame receipt (parity error, frame error, checksum error), the OM-310 device does not return a response.

When an error occurs in the format or in the value of the data transferred (unsupported function code, etc.), OM-310 receives the request frame and forms a response with the error indicator and code. A high-order function field bit inserted in the unit serves as error indicator. A separate field in the response is allocated for the error code. A response example is given in Fig. 2.5. Error codes are shown in Table 2.6.

Query function 30h not supported

| Address | Function | Data | CRC LB | CRC HB |
|---------|----------|------|--------|--------|
| 01h | 30h | | XXh | XXh |

Response

| Address | Function | Error code | CRC LB | CRC HB |
|---------|----------|------------|--------|--------|
| 01h | B0h | 01h | 94h | 00h |

Figure 2.5 - Example of after-error response

Table 2.6

| ERROR CODE | TITLE | Description |
|------------|----------------------|---|
| 01h | ILLEGAL FUNCTION | Function code received cannot be processed by OM-310 |
| 02h | ILLEGAL DATA ADDRESS | Data address in the query is not accessible by the given subordinate |
| 03h | ILLEGAL DATA ADDRESS | Value contained in the request data field is not a valid value for OM-310 |
| 04h | SLAVE DEVICE FAILURE | While OM-310 attempted to perform the requested action, an unrecoverable error occurred |
| 05h | ACKNOWLEDGE | OM-310 accepted request and is processing it, but it requires a long time. Such response prevents master from timeout error generation. |
| 06h | SLAVE DEVICE FAILURE | OM-310 is busy with command processing. Master must repeat message later when the slave is free. |
| 07h | NEGATIVE ACKNOWLEDGE | OM-310 cannot perform the program function received in the request |

2.4.5 The load energize/de-energize remote control via RS-232/RS-485 interface.

OM-310 operation in the remote control mode is defined by the *dUd* parameter.

When *dUd*=0, the load energize/de-energize remote control is prohibited.

When $dUd=1$, the OM-310 device after power-on works similarly as when the remote control is off (normal operation), but writing to the R_COMMAND command register is permitted.

When $dUd=2$, OM-310 will energize load only after the corresponding command via RS-232/RS-485 has been received.

The R_COMMAND value is regarded by the OM-310 operation algorithm when $dUd=1$, $dUd=2$. If $dUd=0$ and the user sets $dUd=1$ or $dUd=2$, then 0 will be recorded to R_COMMAND.

The list of possible command register settings is shown in Table 2.7

Table 2.7

| R_COMMAND command register Address=220 | Actions performed |
|--|--|
| 0 | De-energize load. If the load is de-energized, then before a power-on command from the Remote Control has been received, the load will not energize. If the load is energized, it will be de-energized. |
| 1 | Normal device operation. If the load was de-energized by the remote control command or by pressing DOWN, UP buttons (while $ACd=3$), or in case of a failure after which automatic restart is permitted, then the load will be energized within specified automatic restart time from the moment of de-energizing while "1" is recorded in the R_COMMAND register. |
| 2 | Early load energizing. Value "2" record will lead to load power-on until expiration of the automatic reset time period. After load power-on, R_COMMAND =1. |

If $dUd=1$, then after energizing "1" value (device normal operation) will be recorded in the command register.

If $dUd=2$, then after energizing "0" value (load de-energized until the command to energize is received) will be recorded in the command register.

In case of an emergency load shutdown by simultaneous pressing DOWN, UP buttons, (while $ACd=2$, $ACd=3$), the command register will be reset to 0.

2.4.6 Load energize/de-energize via remote breaker

OM-310 operation in the remote control mode is defined by the dUc parameter.

When $dUc=0$, the load energize/cutoff by means of remote breaker is prohibited.

When $dUc=1$, OM-310 with the open terminal of the S1 remote breaker (fig.2.1) functions the same way as during normal operation mode. When the remote breaker terminal is closed the load relay opens (when $rr5=2$ besides the load relay, the characterizing relay will also open).

When $dUc=2$, OM-310 with the closed terminal of the S1 remote breaker (fig.2.1) functions the same way as during normal device operation. When the remote breaker terminal is open the load relay opens (when $rr5=2$ besides the load relay, the characterizing relay will also open).

When $dUc=3$ and $dUc=4$ OM-310 functions the same way as $dUc=1$ and $dUc=2$ accordingly, but AR after the remote motor de-energizing is forbidden.

2.4.7 Fault conditions system

In case of fault condition occurrence, the OM-310 performs following actions:

- mnemonic indicator displays error code according to Table 2.8;
- value indicator displays value of the faulty parameter (if given fault does not have numeric value, the indicator displays "----");
- red LED FAULT lights (glows continuously if AR will not initiate, and flickers if AR is expected);
- load relay opens;
- characterizing relay closes (when $rr5=0$).

If OM-310 defines several types of faults simultaneously, the error codes and parameter values are displayed consecutively, one after one.

If AR is permitted, the fault codes and time left till AR are displayed.

2.4.8 Faulty conditions log

When load relay in case of fault opens, the OM-310 device stores the fault code, the parameter value, and time of occurrence.

Note. Time of fault is defined by OM internal clock. As OM-310 has no integral power source, the time when the device was de-energized, is not accounted.

Number of synchronously stored fault codes is five. When next following faults occur, the information of this fault is recorded over the latest fault.

To view log press RES/MEM/SEL button.

Table 2.8 - Fault codes

| Fault description | Fault mnemonic | Parameter value | Parameter value register address | Fault code | Register address bit № |
|--|-----------------|--------------------------------------|----------------------------------|------------|------------------------|
| de-energizing based on main threshold crossing | AP_{\neq} | Main threshold value in 100* W | 300 | 0 | 241:0 |
| additional threshold crossing | AP_d | additional threshold value in 100* W | 301 | 1 | 241:1 |
| maximum phase current fault | $A_{I_{\neq}}$ | maximum phase current | 302 | 2 | 241:2 |
| against line-to-earth fault (based on zero sequence current) | $A_{I_{\perp}}$ | zero sequence current | 303 | 3 | 241:3 |
| currents present when load relay is de-energized (contactor fault) | AC_d | current | 304 | 4 | 241:4 |
| phase sequence order fault | AU | | | 5 | 241:5 |
| minimum line voltage fault | AU_{\leq} | voltage | 306 | 6 | 241:6 |
| maximum line voltage fault | AU_{\neq} | voltage | 307 | 7 | 241:7 |
| phase imbalance fault | AU^{\wedge} | imbalance | 308 | 8 | 241:8 |
| remote control channel fault | AdU | | | 9 | 241:9 |
| emergency load de-energize, automatic restart not possible | ER_d | | | 10 | 241:10 |
| emergency de-energize of load, automatic restart possible by simultaneous pressing buttons UP and DOWN | ED_d | | | 11 | 241:11 |
| Emergency load de-energizing by the remote breaker | Edc | | | 12 | 241:12 |

The SETUP LED will start to flicker, and the OM-310 indicator panels will display line 1 from Table 2.9. Log scrolling performed by pressing UP and DOWN buttons.

To exit log view mode press RECORD/RESET/SELECT button, or the log will close automatically after 30 sec since last button was pressed.

Fault information is displayed on OM-310 device indicators as shown below in table 2.9.

Table 2.9

| Mnemonic indicator output | Value indicator output |
|---|--|
| " Ad_{i} " | number of log record (1- latest record) |
| XXX – fault mnemonic according to table 2.8 | YYY - parameter value according to table 2.8 (if parameter value is negative, "----" is displayed) |
| XXX - hours since fault | YY - number of minutes since fault occurrence |

2.4.9 Load start/cutoff control with use of OM-310 front panel

Depending on the AC_d parameter value, the OM-310 load relay can be controlled by pressing buttons UP and DOWN simultaneously (unless OM-310 is in keypad lock-up mode):

$AC_d=0$ – no response;

$AC_d=1$ (load energizing permitted) – load relay will close, if AR time has not expired;

$AC_d=2$ (emergency load de-energize) –load relay will open and produce " ER_d " fault code. Load restart is possible after disconnecting and re-connecting power to OM-310;

$AC_d=3$ (load energizing and de-energizing permitted) – load relay will open and produce " ED_d " fault code. To close, press UP and DOWN buttons again.

Note-When parameters " $AP_d=0$ " (after power-on, load is energized manually via OM-310 control panel) and " $AC_d=0$ " (load energizing manual control forbidden) are selected, the load relay will not close.

3. MAINTENANCE

3.1. SAFETY

During maintenance operations, OM-310 power supply must be disconnected.

3.2 MAINTENANCE SCHEDULE

Recommended maintenance schedule – semiannually.

Maintenance scheduled operations consist of visual observation, during which wiring connection to OM-310 terminals is checked, casing integrity check for cracking and chipping.

4. TRANSPORTATION AND STORAGE

OM-310 in manufacturer package should be stored in enclosed rooms at -45° to $+70^{\circ}\text{C}$ and exposed to no more than 80% of relative humidity when there are no fumes in the air that have a damaging effect on package and the equipment material. The customer shall provide for the OM-310 equipment protection against mechanical damage while in transport.

5. PERIOD OF SERVICE, STORAGE, AND MANUFACTURER'S WARRANTY

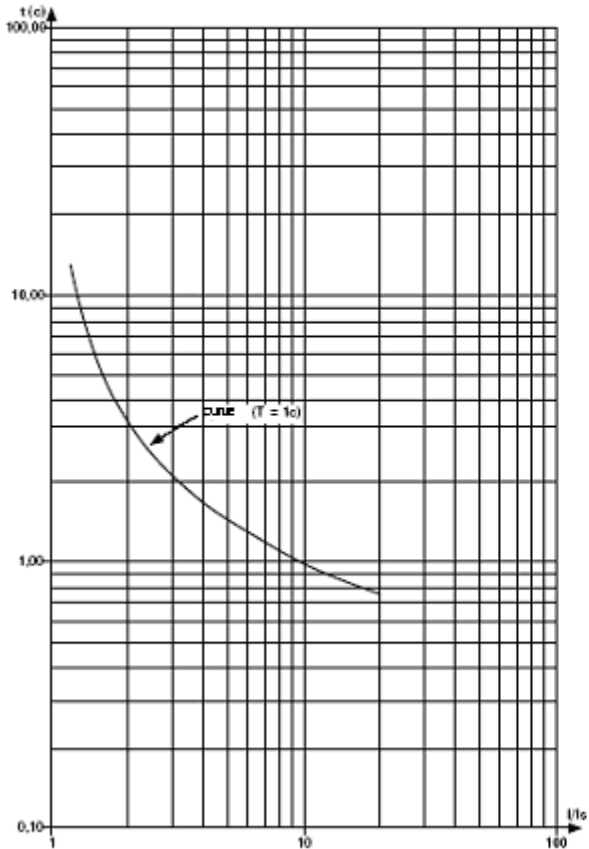
The OM-310 equipment service period is 10 years. Upon expiration of the equipment service period, please, contact the manufacturer.

The manufacturer warrants defect-free performance of OM-310 device within three years after the date of sale provided that the following conditions have been met:

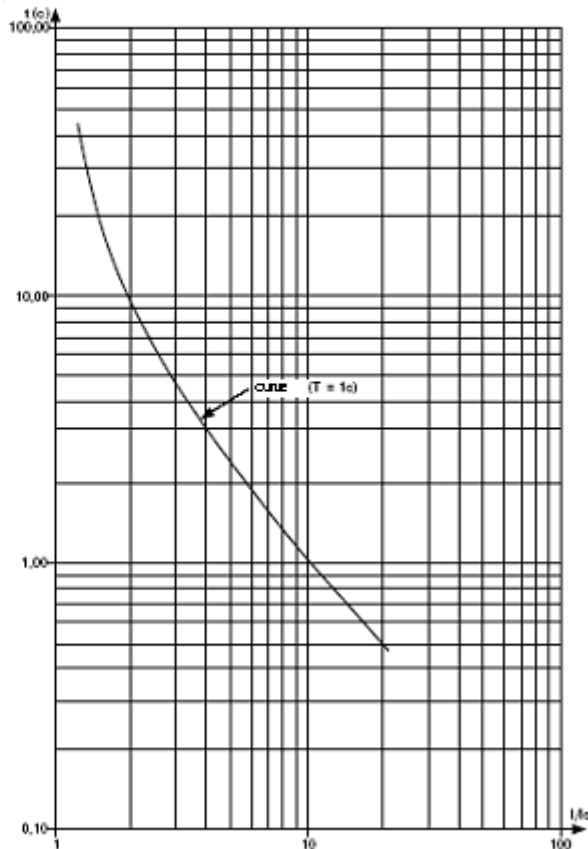
- proper installation;
- manufacturer's QC department inspection seal is intact;
- integrity of the device case, no traces of opening, cracks, chipping, etc.

APPENDIX 1- Dependent time delay current based protection types:

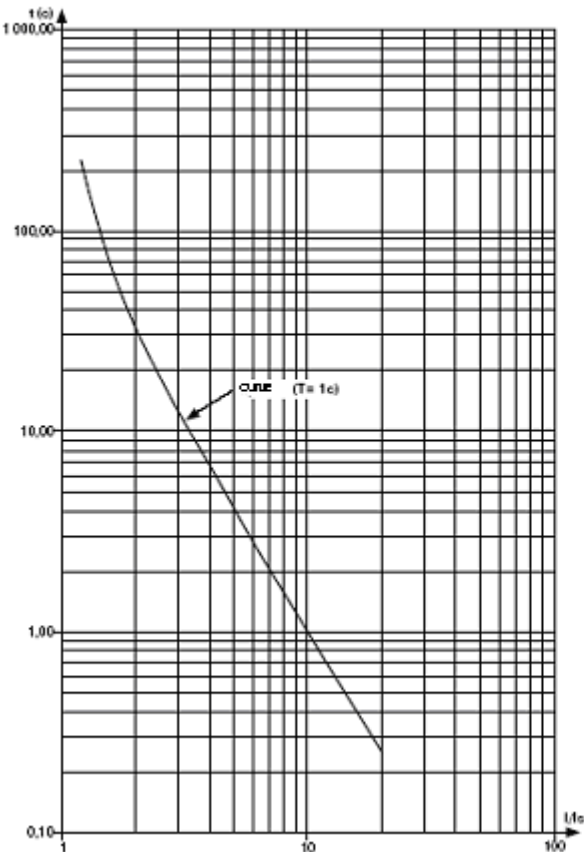
SIT - reverse dependent standard time delay curve



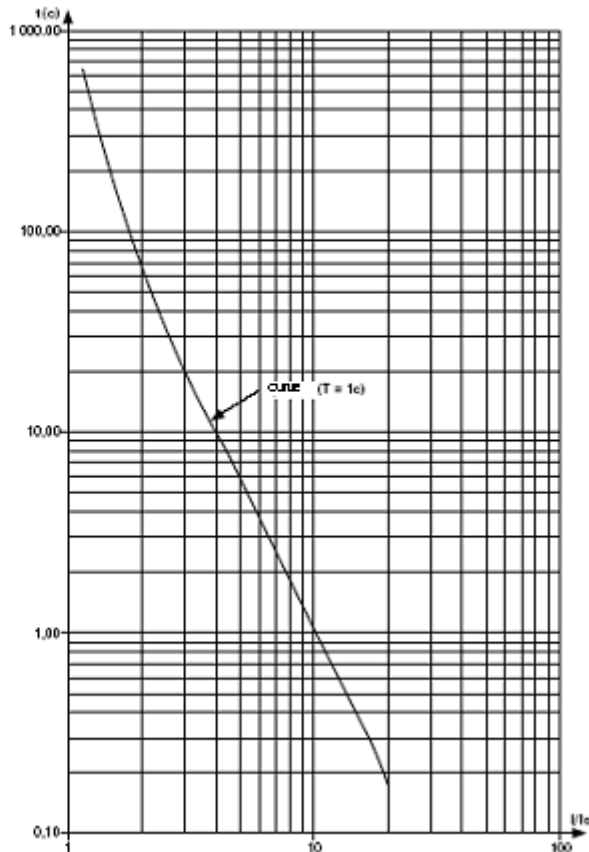
VIT very much reverse dependent curve or LTI – lengthly reverse dependent time delay curve



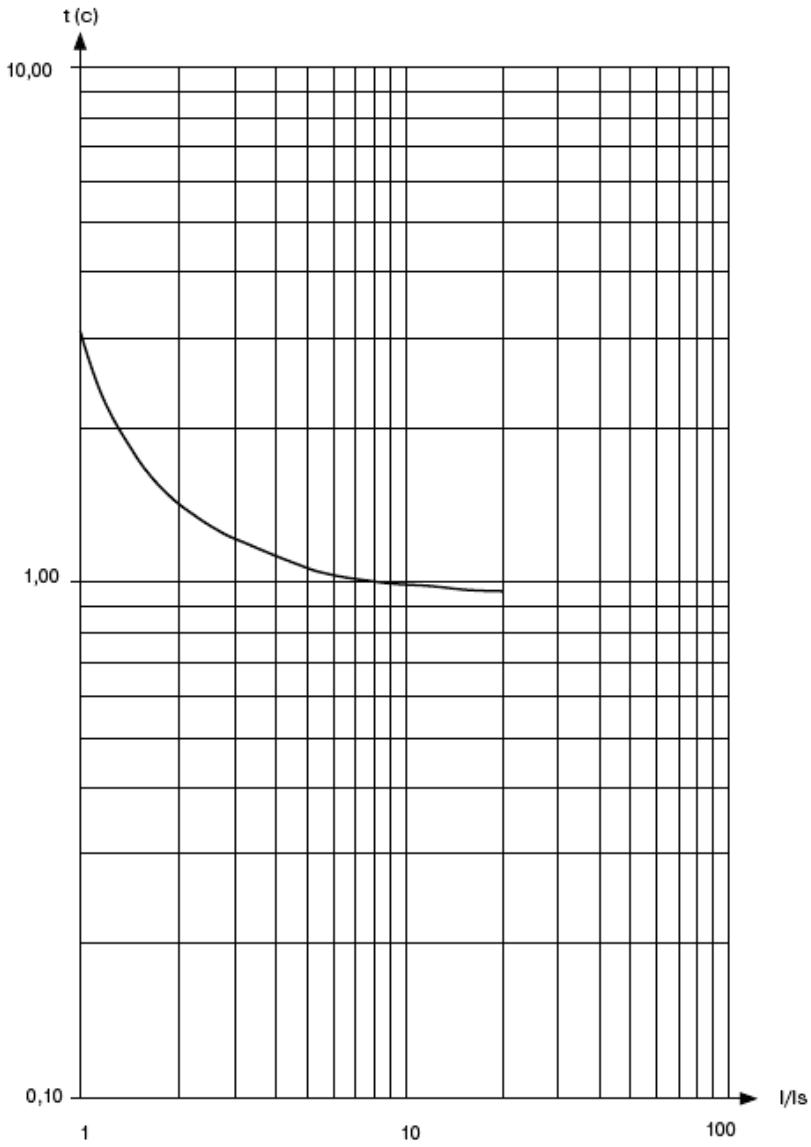
EIT – extremely reverse dependent time delay curve



UIT – ultra reverse dependent time delay curve



RI – time delay curve



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[7-1393144-5](#) [7-1393767-8](#)