NOVATEK-ELECTRO Ltd.
Research and Manufacturing Company

TECHNICAL DESCRIPTION AND SERVICE MANUAL

MCK-301-8

CONTROLLER UNIT FOR HEATER & FREEZER WITH VOLTAGE PROTECTION

www.novatek-electro.in

1. Applications

The MCK-301 is designed to control freezers, refrigerating counters, monoblocs and other refrigerating shop and industrial equipment.

The MCK-301 allows to monitor freezer and evaporator temperature and also, depending on a specified mode of operation, to monitor the second evaporator temperature or fan air stream temperature. The device permits to start automatic defrost at temperature difference between refrigerating chamber and fan air stream.

The MCK-301 can perform protective compressor cut-out if PTC- or NTC-type temperature sensor of compressor is connected to the MCK-301.

The MCK-301 provides safety compressor and fan stop under abnormal supply line parameters (the unit performs monitoring of RMS phase voltage and line voltage, phase imbalance, correct phase sequence and power contacts state of external magnetic starter before and after compressor cut-in) and also accomplishes a consequent automatic reset when voltage parameters regenerated after user-ser time delay has expired.

Front panel, indications and buttons diagram. Dimensions diagram.

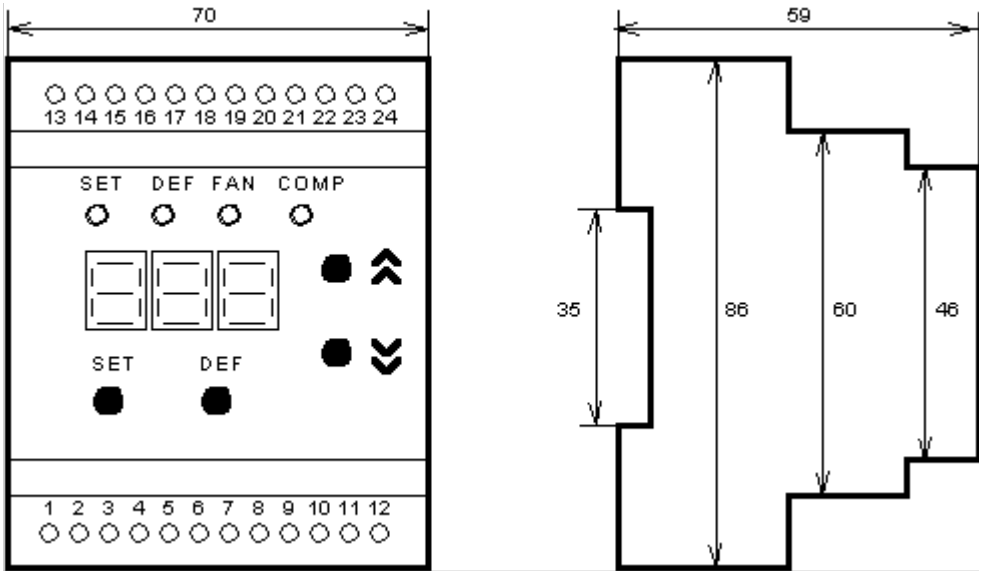


Fig. 1. MCK-301 front panel, controls and dimensions.
Note . Button "▲" - UP in the text, button "▼" - DOWN in the text.

LED COMP glows when compressor is ON;
LED FAN glows when fan is ON;
LED DEF glows when defrost conditions is ON;
LED SET glows when parameters setting mode is ON.

2. TECHNICAL BRIEF

2.1. Analog inputs: there are 3 inputs for NTC/PTC sensors with reinforced electric insulation for temperature monitoring and defrost control;

2.2. A digital input: can be used to connect a door alarm sensor or to control defrost (the decision is made according to «closed/open» state) and as an input for external alarm signal;

2.3. Main outputs:
- two-way break-before make relay output for the compressor control - 8A 250V at cos φ =1;
- a normally open relay output for the evaporator fan control - 8A 250V at cos φ =1;
- a normally open relay output for the electric heater control - 8A 250V at cos φ =1;
- an opto-triac output to start an alarm signalling - 60 mA 50Hz

2.4. Temperature resolution - 0.1 °C;
2.5. Trip threshold accuracy for voltage is no more than 3V;
2.6. Nominal supply voltage: one-phase voltage is 220V/50Hz or three-phase voltage is 380V/50Hz;
2.7. Operating voltage: 160V - 330V;
2.8. Power consumption is no more than 5W;
2.9. Enclosure: IP40;
2.10. Terminal block enclosure: IP20;
2.11. Operating temperature: -35 °C¸ +55 °C;
2.12. Storage temperature: -45 °C¸ +75 °C;
2.13. Weight is no more than 0,3kg;
2.14. Mounted on the standard 35 mm DIN-rail;
2.15. Mounting position is arbitrary;
2.16. Operating controls and the dimensions of the device are shown on fig.1.

3. PRE-SRARTING PROCEDURE

3.1. Connect compressor starter, fan, alarm bell, temperature sensors to the MCK-301 according to fig.2.
3.2. Plug-in the MCK-301.
3.3. Power ON and set required operation modes according to the table 2.
NOTE. All connections must be performed on dead device.

WIRING DIAGRAM

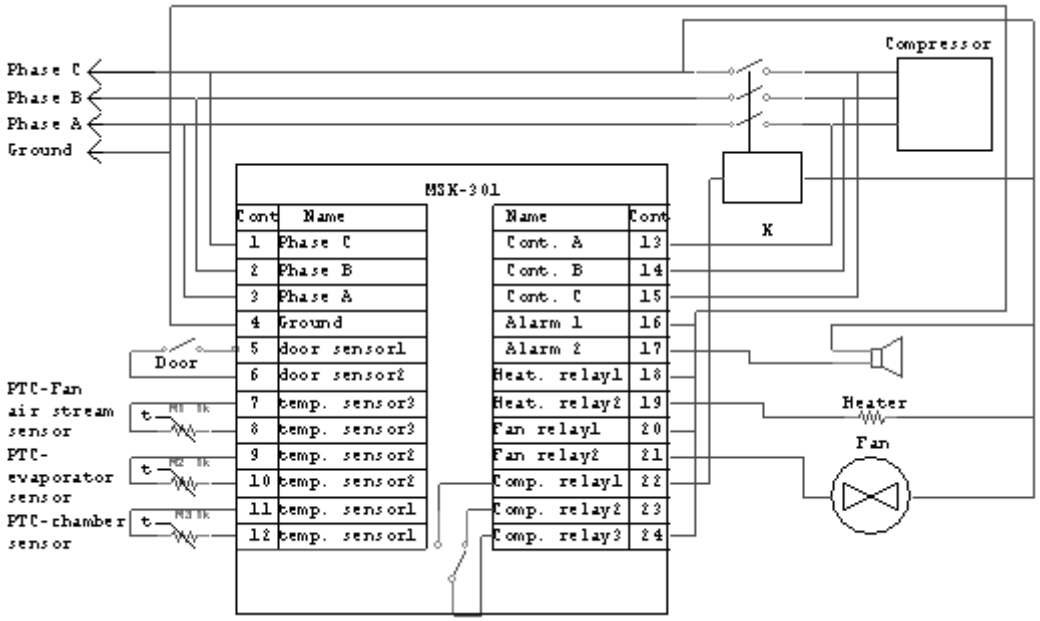


Fig. 2. The MCK-301 connections to the three-phase mains supply.

Note1. For the MCK-301 connection to single-phase mains supply the 1,2,3 terminals must be connected in parallel.

Note2. Consumers are free to take their choice how to use three temperature sensors. For instance, the sensor inputs can be use as «two evaporators - the chamber», or «two evaporators - compressor», or just two temperature sensors etc.

4. The MCK-301 control levels

4.1. In the initial state the MCK-301 indicator displays an actual temperature of refrigerating chamber.
The MCK-301 provides three control levels.
4.2. A keyboard locking level.
Only viewing of the following parameters is available on this level:

temperature setting, SP;
first evaporator temperature, tS1;
second evaporator temperature, tS2 (if parameter oO7=1) or fan air stream temperature, tEn (if parameter oO7=2);
MCK-301 operation time, tbU;
compressor operating time, tCO;
compressor operating time to the MCK-301 operation time *relation* for the time set by user, dtt;
A-phase voltage when U01=0 or AB-line voltage when U01=1, U_1;
B-phase voltage when U01=0 or BC-line voltage when U01=1, U_2;
C-phase voltage when U01=0 or CA-line voltage when U01=1, U_3;

To view parameters one needs to press simultaneously the DOWN and the UP buttons, the parameters scrolling is performed by the DOWN and the UP buttons, to access a parameter it's necessary to press the SET button.

When the keyboard is locked any button pressing (except simultaneous the UP and the DOWN buttons pressing) makes to appear the LOC label on the indicator. To unlock the keyboard the SET button is pressed. The «SET» LED lights up, and label «0» is blinking on the indicator. By the UP and DOWN buttons user enters a password digit from 1 to 9 and presses the DEF button. If the password is correct, the keyboard is unlocked. If after the keyboard unlocked no button is pressed during 16 sec and the lockage setting is not released by user, the keyboard is relocking.

4. 3 User level when keyboard is unlocked
This level allows:

to start defrost or to stop defrost ahead-of-schedule and to go into the thermostat conditions by the DEF button pressing;
to start refrigeration conditions by simultaneous the SET and DOWN buttons pressing;
to change and to view the user level parameters;
to view the adjuster level parameters.

To view and to change the user level parameters one needs to press the SET button, then «SET» LED will glow. Parameters scrolling is performed by the DOWN and UP buttons, to access a parameter one needs to press the SET button, parameter changing is effected by the DOWN and UP buttons, to set the parameter and go back into the MENU one needs to press the DEF button, going back to the menu without parameter setting is effected by the SET button. If no button is pressed during 16sec the MCK-301 goes into the initial state.

4. 4 Adjuster level

To access the adjuster level one needs to press and hold down SET button for 5sec. If the level is protected by a password, the label PAS appears on the indicator. Then press the SET button again. The «SET» LED lights up and the label «000» starts blinking on the indicator. Step-by-step enter three digits (from 1 to 9) of the adjuster password, pressing the DEF button on each digit entry. If the password is incorrect, the PAS label lights on (S is blinking), and the MCK-301 goes back to the initial state in 16 sec, otherwise the first parameter of the adjuster menu appears on the indicator;

Parameters scrolling is performed by the DOWN and UP buttons, to access a parameter one needs to press the SET button, parameter changing is effected by the DOWN and UP buttons, to set a parameter and go back into the menu one needs to press the DEF button, going back to the menu without parameter setting is effected by the SET button. If no button is pressed during 16 sec the MCK-301 goes into the initial state;

On the adjuster level the access to any user level parameter can be inhibited or permitted by simultaneous the SET and DOWN buttons pressing. If the access is inhibited a point indication appears on the right digital indicator when one is viewing the parameter value.

5.The MCK-301 modes of operation

5.1. The MCK-301 supports the following modes of operation:

thermostat conditions;
refrigeration conditions;
alarm conditions.

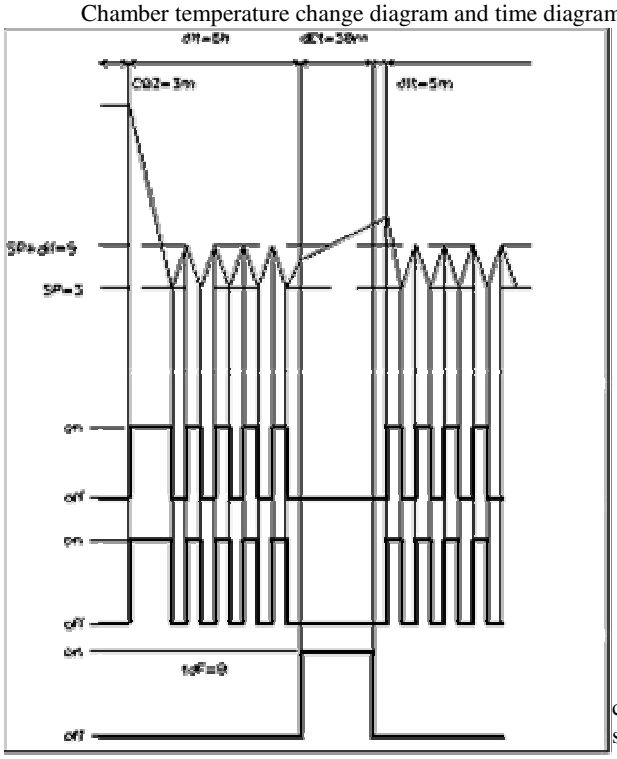
The MCK-301 in the thermostat conditions maintains preset temperature in the chamber, performs defrost and the condensate drip-off.

The MCK-301 in the refrigeration conditions performs refrigeration, defrost delay, defrost.

5.2. Thermostat conditions

5.2.1 When working in the thermostat conditions the MCK-301 holds the user-preset chamber temperature by the compressor and the fan operation control.

Chamber temperature change diagram and time diagrams of the MCK-301output relays operation (for producer-set parameter values by default).



c 02 –compressor start delay
dit – chamber temperature maintenance
dEt – defrost
ddt – drip- off
SP – setting (temperature set by user)
DiF – differential

Compressor relay

Fan relay
Fans are ON and OFF together with the compressor (FCo=0)
Heater relay
Defrost by the electric heater (tdF=0)
Fan relay
Fans are ON and OFF together with the compressor (FCo=0)
Heater relay
Defrost by the electric heater (tdF=0)

5.2.2. Compressor operation

SP (Set Point) and dif (differential) parameters specify chamber temperature condition. If chamber temperature raised and reached value equal to SP+dif, compressor starts and it would stop only when temperature is down again reaching Set Point value.

LSE and HSE (a minimum and a maximum Set Point values) limit SP change area for user.

On the chamber sensor fault the compressor control is performed in fault condition (alarm conditions) according to the Con and COF parameters that specify compressor operation time and compressor stop time. In this case a corresponding Er2 or Er3 indication label appears on the indicator.

5.2.3. Fan operation.

Fan control type is selected according to FCo parameter:
FCo =0 - fans start and stop together with compressor;
FCo=1-fans operate without interruption.
If a maximum temperature value specified by FSt parameter is exceeded the fan is always off.
On the evaporator sensor fault MCK-301 initiates the label Er4 or Er5 appearance on the indicator (as well as the chamber temperature).

5.3 Defrost

5.3.1. The MCK-301 allows to specify defrost type, defrost stop type and between-defrost delay count method.
The defrost type can be specified according to tdF parameter:
tdF=0 - defrost by electric heater (compressor is off, electric heater is on);
tdF=1 - defrost by hot gas (compressor is on, electric heater is on);
tdF=2 - free defrost (compressor is on, electric heater is off);
Defrost stop type is specified according to EdF parameter:
EdF=0 - according to time (dEt parameter specifies defrost duration, min);
EdF=1 - when preset evaporator temperature is reached (dSt parameter specifies defrost stop temperature, ° C);
EdF=2 - according to time and when preset evaporator temperature is reached (defrost stop is specified by dEt ***or*** dSt parameter depending on the parameter value which is reached first).
Between-defrost-cycles interval count method is specified by dCt parameter:
dCt=0 - according to user-set time (dit parameter specifies time interval between two defrost cycles);
dCt=1 - according to compressor operating time (DIGIFROST â method, dit parameter specifies compressor operating hours between two defrost starts);
dCt=2 - compressor stop (defrost starts on every defrost stop).
Defrost start conditions is specified by d13 parameter:
d13=0 - according to time (dCt parameter is used);

d13=1 - defrost start is specified by temperature difference (d14 parameter, ° C) between refrigerating chamber and fan output stream (if the third temperature sensor either is absent/ out of order or used as the second evaporator temperature sensor, the 0 mode is effected).

5.3.2. Condensate drip-off.

On defrost stop the MCK-301 starts time delay for condensate drip-off (ddt parameter). Besides, it's specified the fan start delay after defrost (Fdt parameter, min). The compressor and the electric heater are also off. The label SLI appears on the indicator.

5.4. Refrigeration conditions.

This mode of operation is designed for a quick refrigeration of the chamber filled with a new (warm) product. The FrE label appears on the indicator for the short time.

5.5. First start features.

User is free to pre-specify a performance type the unit will follow when power is ON:

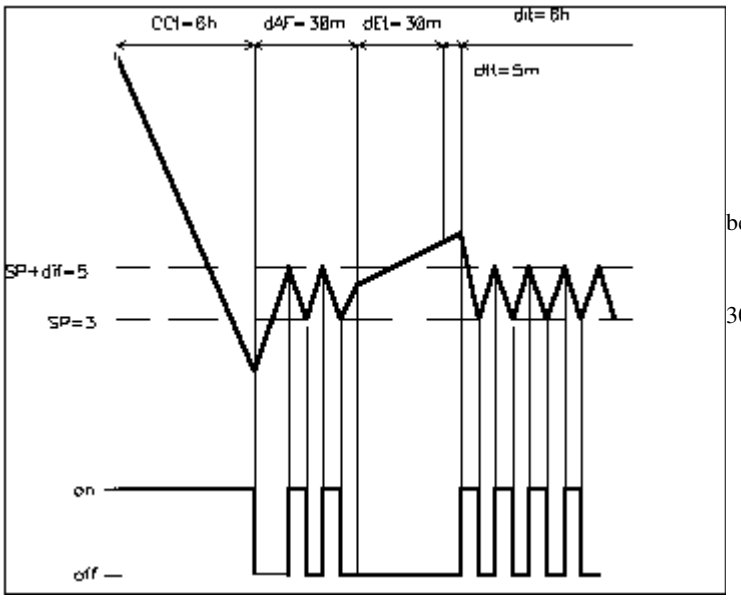
The performance type can be selected as:

- an operation in the thermostat conditions immediately after power is ON (dPO =0)

during the time set by c 02 parameter (this mode of operation starts with 30 sec delay after StA indication appears);

- first defrost after 30sec delay from the unit start-up moment has expired (dPO=1).

The MCK-301 operation diagram in the refrigeration conditions (for the parameter values preset by producer).



CCt parameter specifies the refrigeration time.

dAF parameter specifies the start-of-defrost delay, i.e. the time before the start of the first defrost after the refrigeration time has expired.

When the refrigeration/ the defrost conditions is over, the MCK-301goes into the thermostat conditions automatically.

Compressor relay

6. Fault states control system.

In the thermostat conditions the unit performs the chamber temperature monitoring and detects when the temperature is outside the preset range (LAL and HAL parameters). This kind of monitoring is not performed in the refrigeration conditions and defrost conditions.

According to the preset additional temperature sensors (d10, o07) connection parameters the unit performs sensors short-circuit & disconnection monitoring.

If an open door state time exceeds user-preset time (AO7) parameter the situation considered to be a fault state.

To block premature trippings for temperature fault the tAO, PAO and dAo parameters are used.

The MCK-301 performs power supply voltage parameters monitoring in all modes of operation and when the power supply parameters deviate from the set range, the MCK-301 stops the compressor, the fan, the electric heater and cuts-in the alarm signal. On return to normal operating conditions for power supply parameters the MCK-301 resets back to the conditions where voltage fault occurred after U05 reset delay has expired, if only user-set power voltage regeneration time doesn't exceed Utt parameter. If yes, the MCK-301 begins to perform the program executing from the start-up.

When U08=1 the MCK-301 performs a voltage monitoring at the compressor starter output terminals and stops the compressor, the fan, the electric heater and triggers the alarm signal if the starter contacts stick. To recover from this fault and from the fault induced by incorrect phase sequence one needs to restart the MCK-301.

When U08=2 the MCK-301 performs a voltage monitoring at the compressor starter output terminals and if all the starter contacts open simultaneously it doesn't considered to be a fault but when only one or two contacts remain open it's considered to be the fault.

When o07=3 or o07=4 (the third temperature sensor is used as the compressor temperature sensor) MCK-301 determines the compressor temperature sensor resistance and if the resistance is above (below) the resistance set by rd3 parameter, it stops the compressor. The compressor will reset when the time delay specified in td3 parameter has expired.

When o01=3 or o01=4 it's considered by the MCK-301 to be an external fault: the controller cuts out the compressor and the fan immediately and the "A5" code appears on the indicator. After the external alarm signal has disappeared the controller will continue the normal operation.

All fault state codes are displayed on the digital indicator according to the table 1.

6. Fault codes
Table 1

Fault signals on the indicator		**Alarm signals on the indicator**	
Fault in controller	Er1	High temperature	A1
Disconnected refrigerating chamber sensor	Er2	Low temperature	A2
Short-circuited refrigerating chamber sensor	Er3	Open door	A3
Disconnected (evaporator) defrost sensor	Er4	Compressor temperature is exceeded	A4
		Digital indicator fault	A5
Short-circuited (evaporator) defrost sensor	Er5	Minimum voltage	U1
Disconnected the third temperature sensor	Er6	Maximum voltage	U2

Short-circuited the third temperature sensor	Er7	Phase imbalance	U3
		Voltage failure at starter terminals	U4
		Incorrect phase sequence	U5
		Phase failure	U6

Note: In the standard conditions ("rrS=0") the alarm relay energizes when any alarm signal appears on the indicator.
When "rrS"=1 the alarm relay will be energized as long as there is no fault for voltage ((U1,U2,U3,U4,U5,U6).

7. Programmable and used parameters are given in table 2.

Refrigerator control unit modes of operation

Table 2

Settings and read-off parameters	**Parameter codes**	**Minimum values**	**Maximum values**	**Factory Setting**	**Operation**
Temperature control Temperature SP		-45 °C	50 °C	3 °C	Setting (refrigeration chamber temperature value set by user)
Thermostat					In thermostat mode compressor starts if temperature reaches SP plus differential, and stops if temperature reaches SP
Differential	diF	1 °C	20 °C	2 °C	Difference between the set temperature and the compressor start temperature
Upper temperature bound	HSE	LSE	50 °C	50 °C	Adjuster level The limitation means that temperature which is higher than HSE can not be set by user
Lower temperature bound	LSE	-45 °C	HSE	-60 °C	Adjuster level The limitation means that temperature which is lower than LSE can not be set by user
Chamber temperature sensor calibration	CA1	-9,9°C	+9,9°C	0 °C	CA1 scale shift from chamber temperature read by sensor
Evaporator temperature sensor calibration	CA2	-9,9°C	+9,9°C	0 °C	CA2 scale shift from evaporator temperature read by sensor
Fan air stream temperature sensor calibration	CA3	-9,9°C	+9,9°C	0 °C	CA3 scale shift from fan air stream temperature read by sensor (the second evaporator)
Temperature scale	C_F	0	1	0	0-Celsius degrees 1- Fahrenheit degrees - Fahrenheit temperature scale is not used in this version
Alarm signalling					
Fault temperature setting mode 0 - absolute temperature value 1 - temperature value relative to the setting	Att	0	1	1	Interpretation HAL and LAL values Alarm starts: a) in "0" mode - when set HAL and LAL values are reached b) in "1" mode - when upper temperature is SP+ diF+HAL - when lower temperature is SP-LAL
Positive temperature deviation	HAL Att=0 Att=1	LAL+1 1	50 50	5	
Negative temperature deviation	LAL Att=0 Att=1	-45 1	HAL- 1	5	
Temperature alarm delay	tAO	0	90 min	30 min	
Temperature alarm delay after power is ON	PAO	0	48 hours	2 hours	
Temperature alarm delay after defrost and refrigeration mode	dAo	0	10 hours	1 hour	
Door alarm trip delay	A07	0	90 min	30 min	
Compressor					
Minimum ON-time	c01	1 min	15 min	5 min	Compressor protection against frequent cut-ins.
Minimum OFF-time	c02	1 min	15 min	5 min	
Compressor ON-time at refrigerating chamber sensor failure	COn	5 min	120 min	20 min	Controller will use this value throughout the first three days and nights, then it will calculate the value by itself
Compressor OFF-time at refrigerating chamber sensor failure	COF	5 min	120 min	30 min	Controller will use this value during the first three days and nights, then it will calculate the value by itself
Compressor and fan status at open door	CFo	0	3	0	0 - normal mode of operation 1 - compressor is ON, fan is OFF 2 - compressor is OFF, fan is ON 3 - compressor is OFF, fan is OFF
Compressor protection at thermal sensor failure	cPP	0	2	2	0- Compressor is constantly OFF 1- Compressor is constantly ON 2- COn and COF parameters are used
Compressor ON-time in refrigeration mode	CCt	1 h	24 h	6 h	
Defrost					

Defrost method (gas -1, electricity-0)	tdF	0	2	0	0 - compressor is OFF, electric heater is ON 1 - hot steam defrost - compressor is ON, electric heater is ON 2 - compressor is ON, electric heater is OFF
Defrost stop temperature	DSt	0 °C	25°C	6 °C	Temperature is measured on the evaporator
Interval between defrost starts	Dit	1 h	48 h	6 h	
Between-defrost- starts interval counting method	DCt	0	2	1	Between-defrosts counting method 1 - DIGIFROST method. Defrost start time (dit) is specified by the compressor total ON-time 0 - real time - defrost starts frequency is specified by real time elapsed; the interval between defrosts is always alike 2 - compressor stop; defrost starts with every compressor stop
Maximum defrost duration	DEt	0 min	180 min	30 min	
First defrost start delay after the refrigeration mode has been completed	dAF	0 min	60 min	0 min	
Condensate drip-off time	ddt	0 min	90 min	3 min	
Fan start delay after defrost	Fdt	0 min	20 min	1 min	
Fan cut-in during defrost	dFd	0	1	0	0 - OFF 1 - ON
Defrost sensor	d10	0	1	1	0 - no 1 - yes
Indicator readings during defrost	ddL	0	3	0	0- real temperature 1- defrost start temperature 2- Setting value (SP) 3- Label dEF
Defrost after start-up	dPO	0	1	0	0 - no 1 - yes
Defrost start mode	d13	0	1	0	0 - according to time 1 - according to temperature difference between refrigerating chamber temperature and fan output stream temperature. If the third temperature sensor is absent or used as the second evaporator temperature sensor the "0" mode is performed
Temperature difference in the 1 defrost start mode of operation (d13=1)	d14	1 °C	30 °C	3 °C	
Defrost stop type	EdF	0	2	0	EdF=0 - according to time (parameter dEt) EdF=1 - when preset evaporator temperature is reached (parameter dSt) EdF=2 - according to time and temperature (depending on which of the parameter value is reached first).
FAN					
Fan cut-out at compressor stop	Fco	0	1	1	0 - yes 1 - no
Fans cut-out temperature	FSt	-20 °C	30 °C	2 °C	When this temperature is exceeded, the fan always stops. -- measured on the evaporator
VARIA					
Digital input signals	o01	0	4	1	0 - not used 1 - door alarm 2 – defrost 3 – fault at closed digital contact 4 – fault at open digital contact Door alarm: if single-pole N.C. contact is broken down, door alarm starts Defrost: if single-pole contact is broken down, defrost starts Fault – compressor relay, fan relay and heater relay are de-energized at once
Alarm relay mode of operation	rrS	0	1	0	0 – standard mode of operation 1—alarm relay is used as voltage relay output. If voltage is normal optorelay is energized
MCK-301 ON time (1 unit == twenty four hours)	tbU	0 u.	999 u.	0 u.	
Compressor ON time (1 unit == twenty four hours)	tCO	0 u.	999 u.	0 u.	
Time (1 unit == twenty four hours)	ttt	1 u.	15 u.	1 u.	The time for calculation of the dtt relation
User access code	LOC	0	9	0	0 - keyboard is unlocked 1-9 - user password
Adjuster access code	PAS	000	999	123	000 - access to the adjuster level is permitted 000-999 - adjuster password
Temperature sensors type	tPd	0	1	1	0 - NTC, 1 - PTC
Third temperature sensor	o07	0	4	0	0 - OFF 1 - used as the second evaporator temperature sensor 2 - used as output air stream fan temperature sensor 3 - used as compressor temperature PTC-sensor

					4 - used as compressor temperature NTC- sensor
Reset delay	td3	10 min	300 min	30 min	Compressor reset delay after temperature fault
Third temperature sensor critical resistance	rd3	0.3 kOhm	8 kOhm	1.00 kOhm	When the third temperature sensor resistance is exceeded (o07=3), compressor stops. If o07=4, compressor stops when the resistance is lower than the specified one.
VOLTAGES					
Measured voltage	U01	0	1	0	0 - phase voltage 1 - line voltage
Minimum voltage	U02	160-277 V	240-415 V	185-320 V	U01=0 U01=1
Maximum voltage	U03	165-329 V	280-475 V	245-415 V	U01=0 U01=1
Phase imbalance	U04	5 V 5 V	70 121 V	20 35 V	U01=0 U01=1
Reset delay	U05	5 s	300 s	10 s	
Cut-out delay for minimum voltage	U06	5 s	30 s	10 s	
All fault types delay	U07	0 s	30 s	1 s	
Starter terminals voltage monitoring	U08	0	2	0	0 - cut-out 1 - cut-in 2 – cut-in, when there is no voltage on all phases or the starter starts it's not considered to be a fault
Program start-up delay after voltage fault	Utt	0 min	180 min	10 min	
Device version	rEL			80	

STORAGE AND SHIPPING CONDITIONS

The unit in manufacturer package should be stored in enclosed rooms at –45° -- +70° C and exposed to no more than 80% of relative humidity when there are no fumes in the air that exert a deleterious effect on package and the unit material. The Buyer must provide the protection of the unit against mechanical damages in transit.

WARRANTY

Novatek company warrants a trouble-free operation of the MCK-301 unit manufactured by it within 36 months from the date of sale, provided:
-- the proper installation;
-- the safety of the inspection quality control department seal;
-- the integrity of the case, no traces of an opening, cracks, spalls etc.

Production date_____

Serial No_____

Quality control department seal_____

Sale date_____

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