MAKING MODERN LIVING POSSIBLE

BD Controller 101N07xx Series 48 V DC

with Tool4Cool® LabEdition software

TOOL4COOL®
Flexible settings control

Operating Instructions

1. Introduction

1.1 Applications

The BD 48 V DC compressor systems are intended mainly for shelter cooling and cooling of batteries in radio stations for cellular phones.
Secondary applications could be

- Spot cooling in golf carts, forklifts, etc
- Air cargo cooling

1.2 Capability

The cooling capacities of the compressors are approx. 480 Watt (BD250GH) and 900 Watt (BD350GH) @ Pe/Pc ~+15/+55°C
The system is able to operate in ambient temperatures up to +55 °C (131 F).
The operating conditions are High Back Pressure (HBP).

1.3 Functions

The main functions of the controllers are:

- Motor / Compressor speed control
- Thermostat control (ON / OFF or electronic via NTC temperature sensor)
- ECO function to optimize compressor speed for minimum power consumption
- Condenser fan control
- Evaporator fan control
- Communication interface
- Monitoring function
- Error & event log
- Battery protection functions
- Main Switch
- Log of specific parameters
- Optimization of specific parameters via PC software before commencing mass production

1.4 Programming Interface

The controller can be accessed using either

- The Danfoss software tool, Tool4Cool® LabEdition, or
- A custom interface. Please contact Danfoss for further information regarding custom interfaces.

2. Installation

Installation involves the following steps:

- Checklist
- Cable connection
- Software installation and configuration

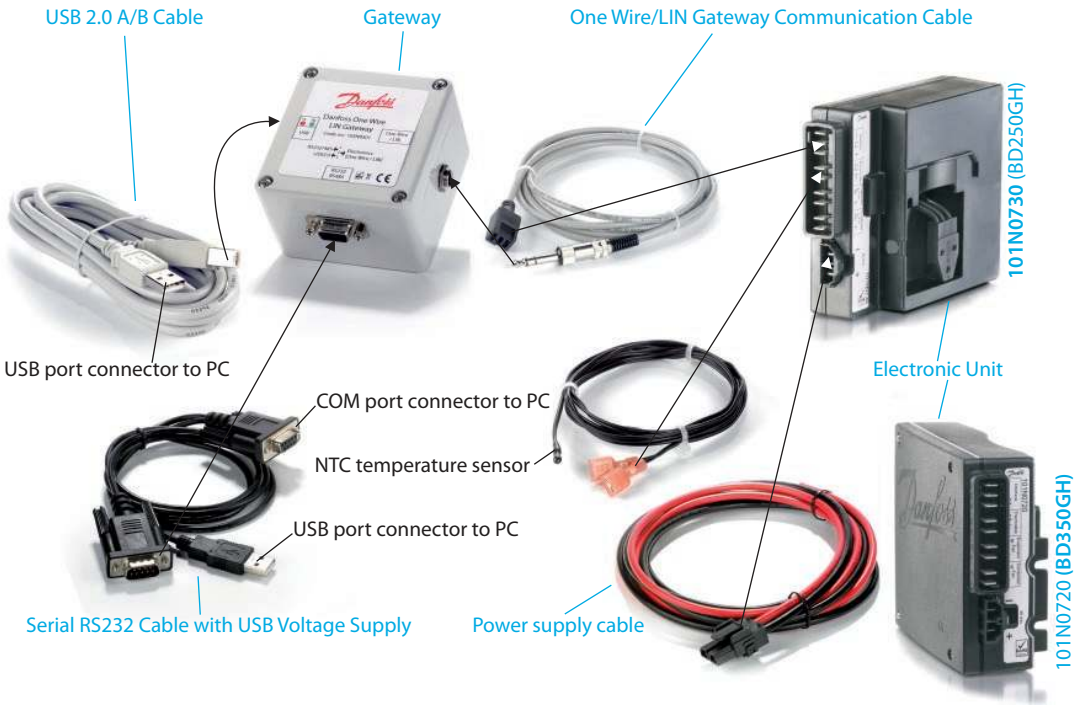
2.1 Checklist

Check that you have the following:

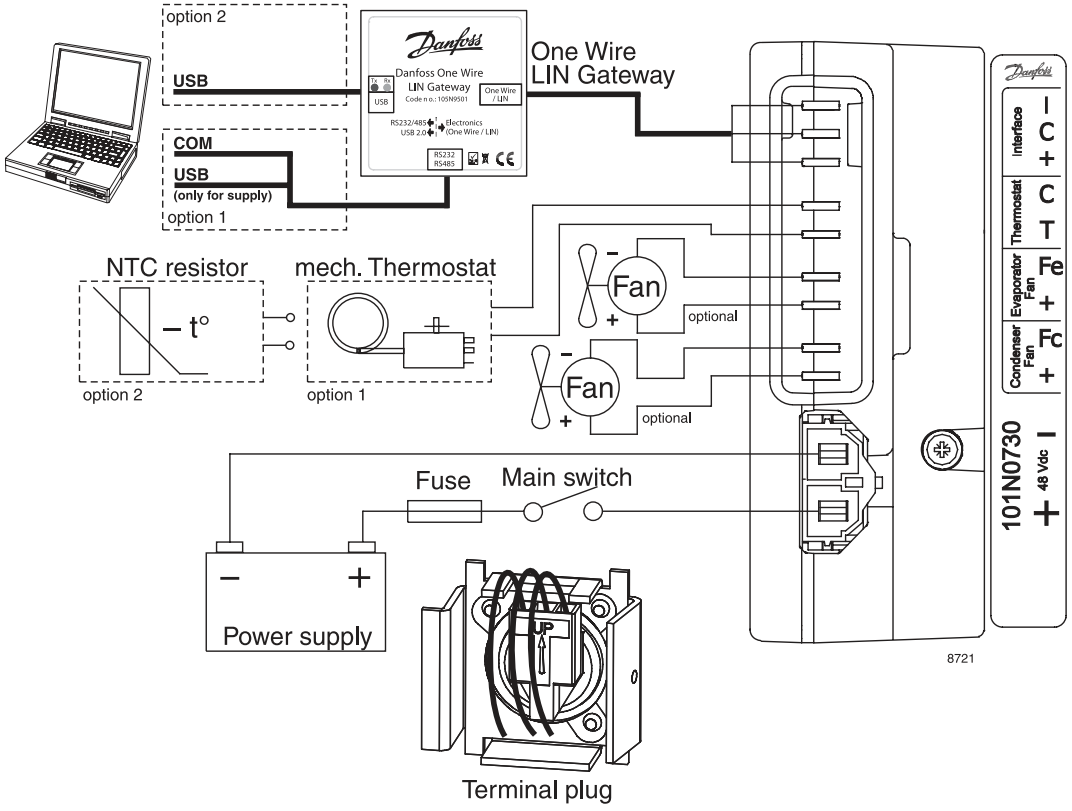
BD electronic controller 101N07xx Series 48V DC • 101N0720 or • 101N0730	
Tool4Cool® LabEdition software installation CD	
NTC temperature sensor (alternative: mechanical thermostat)	
DC line cords	
Product key for BD compressor controller (not necessary with Tool4Cool® Version 1.02)	DH3TT6RBAD1GW8G68ZM1N8G62ZMCOO916IER6GH2YZEIR
Danfoss One Wire/LIN gateway with connection cables • Gateway • One Wire/LIN gateway Communication cable • USB port connector to PC • USB 2.0 A/B cable	

Ordering: See section *5.0*

2.2 Connect cables



Wiring diagram 101N0730 *(wiring for 101N0720 identical)*



The compressor control unit has the following connections:

I, C, + Modbus data communication. I = communication C & + power supply.

C, T Thermostat connection. A Danfoss NTC temperature sensor (option 2) can be connected or a mechanical ON/OFF thermostat (option 1)

Fe, + Evaporator fan (Optional) 48 V DC, 32-60 V, max 60 Watt power output, pulse width modulated.

Fc, + Condenser fan (optional) 48 V DC, 32-60 V max, 60 Watt power output, pulse width modulated.

-, + Main supply voltage. Nominal voltage 48 V DC, range: 32 to 60 V DC

Wire dimensions

Size		Max. length* 48 V DC operation	
Cross section [mm²]	AWG [Gauge]	[m]	[ft.]
2 x 4	11	1.5	4.92
2 x 6	9	2	6.60
2 x 10	7	4	13.12

* Length between battery and electronic unit

2.3 Install and configure software

For brief software installation and configuration instructions please refer to *BD Controller 101N07xx Series 48 V DC with Tool4Cool® LabEdition Software* - ***Quick Start Guide***.

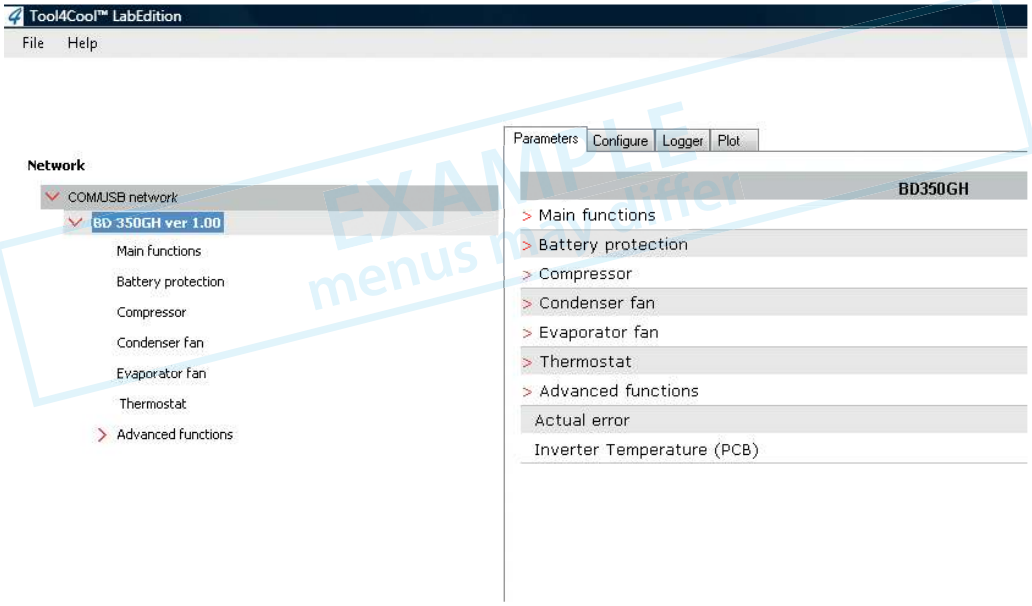
For detailed instructions please refer to *Tool4Cool® LabEdition* ***Operating Instructions***.
These manuals are supplied with the Tool4Cool® software.

3. Tool4Cool® software interface

3.1 User interface

The controller can be programmed and optimized from a PC using the Tool4Cool® software
An example of the Tool4Cool® user interface showing the main parameter groups of the BD350GH compressor is shown below.

Example:



3.2 Operation

The Tool4Cool® software enables the user to observe and document certain aspects of the compressor operation via the controller. The output of the software is in the form of data logs and plots.

Using Tool4Cool® the user can also change the settings of the controller parameters, and copy settings from one controller to another.

Please refer to the *Tool4Cool® LabEdition Operating Instructions* for operation instructions.

4. Parameters

The user can change settings and observe real-time measurements (read-only) in the following parameters.
The table in *4.1 Parameter Overview* is intended for easy reference.
For more detail, please refer to *4.2 Description of Parameter Groups.*

4.1 Parameter Overview

Parameter Group	Parameter	Description	Default	Max value	Min value	Step	Unit	Type
Main functions	Main switch	On/Off regulation of power supply to controller	ON	ON	OFF	1		
Battery protection	Battery cutout level	Battery protection cut-out voltage level	36	60	32	0.1	Volt	Setting
	Battery cutin diff.	Voltage difference between battery cut-in and cut-out	4	10	0.5	0.1	Volt	Setting
	Cutout delay	Time to cut-out when non-critical battery protection implemented	3	60	0	1	Seconds	Setting
	Cut-in level	Calculated value. Cutin = Cutout + Diff.				0.1	Volt	Measurement
	Supply voltage	Real-time voltage measured on + & - terminals				0.1	Volt	Measurement
Compressor BD250GH	Requested speed	Compressor speed and therefore capacity definition	4400	4400	2500	100	rpm	Setting
Compressor BD350GH	Requested speed	Compressor speed and therefore capacity definition	4000	4000	2500	100	rpm	Setting
	Start delay	Time to start after compressor is switched ON	4	240	2	1	Seconds	Setting
	Start time	Period of time elapsing after startup of compressor until Requested speed is reached	30	600	30	1	Seconds	Setting
	Compressor speed	Real-time speed (+/- 10%)				1	rpm	Measurement
Condenser fan	Cond. Fan voltage	Supply voltage to the condenser fan.	48	60	32	1	Volt	Setting
	Fan speed	Condenser fan speed synchronized with compressor operation	100	100	40	10	%	Setting
	Fan start delay	Time to start as a function of Thermostat	0	240	0	1	Seconds	Setting
	Fan stop delay	Time to stop as a function of Thermostat	0	240	0	1	Seconds	Setting
	Fan forced ON	Force condenser fan continuously ON or OFF	OFF	ON	OFF	1		Setting
	Detect missing fan	Detect whether condenser fan is connected	OFF	ON	OFF	1		Setting
	Fan speed	Real-time condenser fan speed				1	%	Measurement
Evaporator fan	Evap. Fan voltage	Supply voltage to the evaporator fan.	48	60	32	1	Volt	Setting
	Fan speed	Evaporator fan speed synchronized with compressor operation.	100	100	40	10	%	Setting
	Fan start delay	Time to fan start as a function of Thermostat	6	240	0	1	Seconds	Setting
	Fan stop delay	Time to fan stop as a function of Thermostat	0	240	0	1	Seconds	Setting
	Fan forced ON	Force evaporator fan continuously ON or OFF	OFF	ON	OFF	1		Setting
	Detect missing fan	Detect whether evaporator fan is connected	OFF	ON	OFF	1		Setting
	Fan speed	Real-time evaporator fan speed				1	%	Measurement

Parameter	Parameter Group	Description	Default	Max value	Min value	Step	Unit	Type
Thermostat	Thermostat type	Detect mechanical or NTC sensor thermostat	Auto	Electronic				Setting
	Cutout temperature	Compressor cuts out below cutout temperature	+25	+40	-40	1	Celsius (°C)	Setting
	Difference		3	15	1	1	Kelvin (K)	Setting
	Forced ON	Force thermostat operation to continuously ON or OFF	OFF	ON	OFF	1		Setting
	Runtime	During cooling OFF (Thermostat cut-out), the Runtime will show the time for the last cooling period. Runtime is reset at cooling ON period. At power-up the reading is reset.				1	Minutes	Measurement
	Actual temperature	Real-time air temperature when an NTC sensor is used. When a mechanical thermostat is used, only thermostat status ON or OFF is displayed.					°C	Measurement
	ECO mode	Turns the ECO mode on and off	0	0	1	1		Setting
	ECO speed BD250GH	Speed applied when temperature falls below ECO temperature	2500	4400	2500	1	rpm	Setting
	ECO speed BD350GH	Speed applied when temperature falls below ECO temperature	2500	4000	2500	1	rpm	Setting
	ECO temperature	Temperature where ECO speed is applied	26.5	-40	40	40	°C	Setting
	Automatic ECO temperature	cut-out + cut-in / 2	1	0	1	1	0 = OFF 1 = ON	Setting
Compressor safety	Compressor restart time	Delay before restart after short cycling	60	120	60	1	Seconds	Setting
Communication	Node Number	Modbus address	1	247	1	1		Setting
	Bits per seconds	Communication speed	19200	9600	19200	9600	bps	Setting
	Communication options	0 = Disabled 1 = Enabled	0	1	0	1		Setting
	Communication timeout	Maximum duration of each communication attempt	900	15	7200	1	seconds	Setting
	Setting protection code & status	Privacy function code must be entered twice	0	9999	0	1		Setting
Product information	Unit name	The user's own identification name for the unit can be entered here (optional)						Setting
	Vendor name	Vendor name						Measurement
	Product code no	Danfoss product code number						Measurement
	Software version	Controller software version						Measurement
	Unit ID	Danfoss unit ID						Measurement
	Production date	Danfoss production date						Measurement
	Lot no	Danfoss lot no.						Measurement
	Serial no	Danfoss serial no.						Measurement
Customer register	Register 1	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 2	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 3	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 4	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 5	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 6	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 7	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 8	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 9	Custom-designed interface parameter	65535	65535	0	1		Setting
	Register 10	Custom-designed interface parameter	65535	65535	0	1		Setting
Actual error	Actual error	0 = No error 1 = Voltage failure 2 = Fan failure 3 = Motor failure 4 = Min. speed failure 5 = Max. speed failure 6 = Thermal failure 7 = NTC Sensor Failure						Measurement
Inverter temperature (PCB)	Inverter temperature (PCB)	Controller overheating protection					°C	Measurement
	Compressor restart delay	Delay before restart after failure	60	120	60	1	Seconds	Setting

4.2 Description of Parameters

4.2.1 Main Functions

In order to start and stop the compressor the Main Switch can be set to ON or OFF .
OEMs making an interface with custom design electronics via Modbus must be able to control the CCU ON / OFF via the Main Switch.

ON: All functions are active.
OFF: All main functions are inactive, however

- Battery monitoring active
- NTC temperature sensor monitoring active
- PCB inverter temperature monitoring active

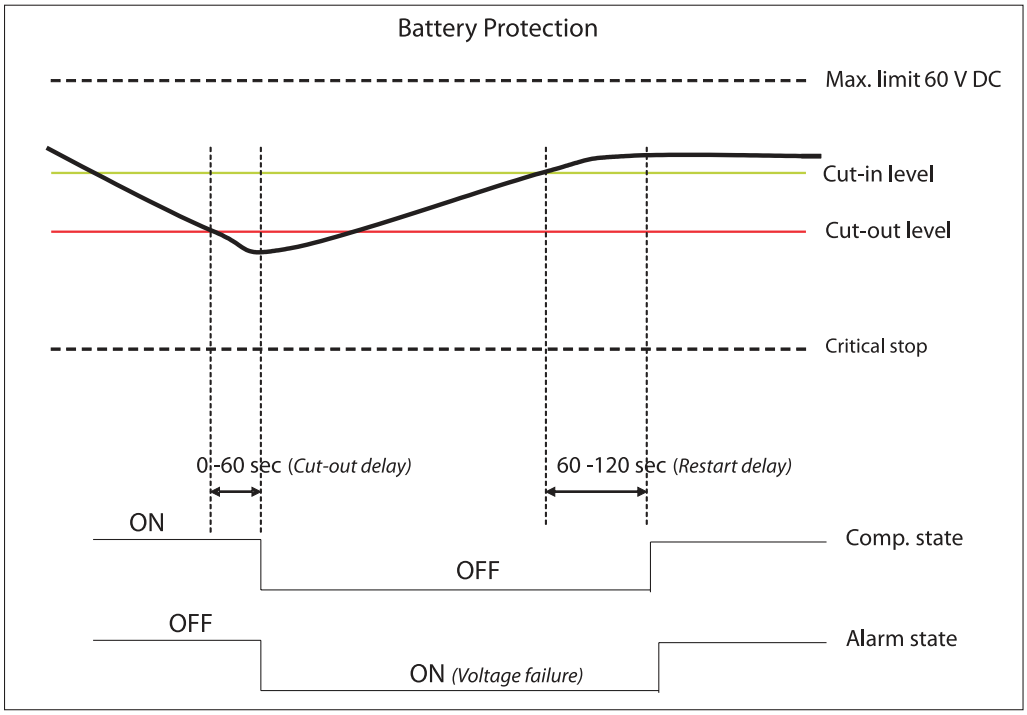
Settings:

Name	Default	Max value	Min value	Step	Unit
Main switch	ON	ON	OFF	1	-

4.2.2 Battery protection

The battery protection serves to avoid permanent damage to the battery by discharge.

The setting range is from 32 to 60 V DC.
Critical stop without delay if voltage drops below 28 V DC
Tolerances are ± 0.30 V DC



Settings

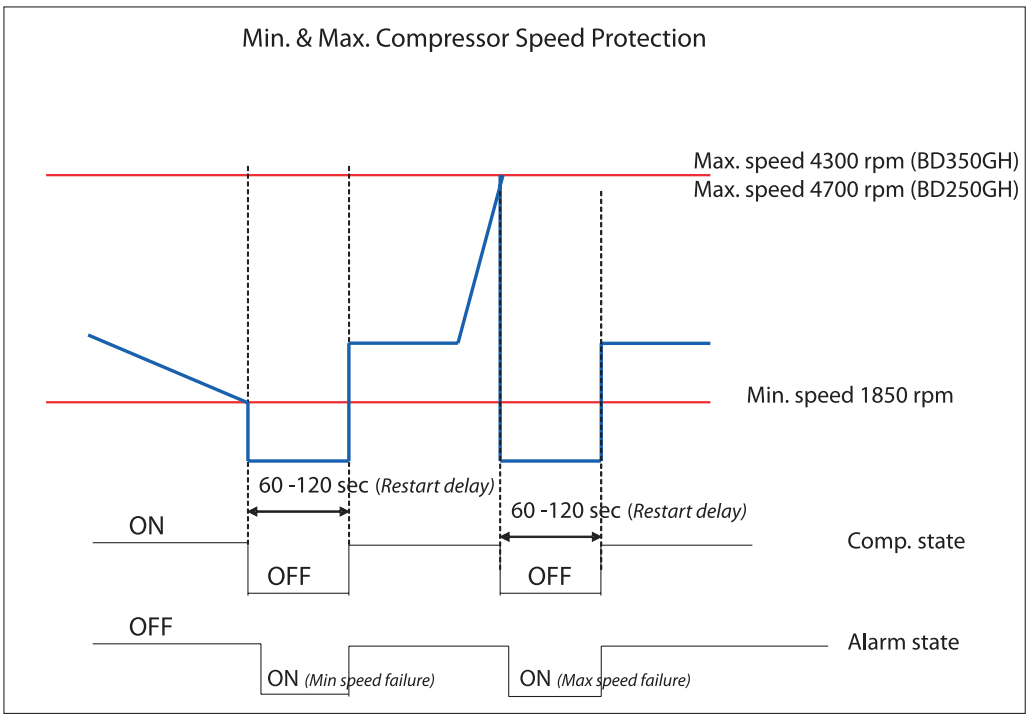
Name	Default	Max value	Min value	Step	Unit
Battery cutout level	36	60	32	0.1	Volt
Battery cutin diff.	4.0	10	0.5	0.1	Volt
Cutout delay	3	60	0	1	Seconds

Measurements

Name	Description	Step	Unit
Cut-in level	Calculated value. Cutin = Cutout + Diff.	0.1	Volt
Supply voltage	Real-time - voltage measured on + & - terminals	0.1	Volt

4.2.3 Compressor

The speed and thereby the capacity of the compressor is set using the *Requested speed* parameter.
During start up, the compressor can be run at a lower speed, *Start speed*, than Requested speed.
The duration of the period running at *Start speed* is set using the *Start time* parameter.
The compressor is protected against operation below minimum speed. Lubrication of the compressor will be very poor at excessively low speed and therefore low speed operation can lead to destruction of the compressor.
Speed limits are: min 1850 rpm; max speed 4700 rpm (BD250GH) & 4300 rpm (BD350GH).
If the compressor speed falls below the minimum or exceeds the maximum speed, the compressor will stop and an alarm *Min speed failure or Max. speed failure* will be sent. The compressor will try to restart after the set *Restart time*. The *Restart time* default is 60 sec.
The fans will continue to run.



Settings

Name	Default	Max value	Min value	Step	Unit
Requested speed (BD250GH)	4400	4400	2500	100	rpm
Requested speed (BD350GH)	4000	4000	2500	100	rpm
Start delay	4	240	2	1	Seconds
Start time	30	600	0	1	Seconds

Measurements

Name	Description	Step	Unit
Compressor speed	Real-time compressor speed(+/-10%)	1	rpm

4.2.4 Condenser fan

The speed of the condenser fan can be controlled in order to save energy, reduce noise and optimize the fan operation.

The fan is synchronized with the compressor operation.
Start and stop delays can be set up as a function of the state of the parameter *Thermostat*.
Furthermore, the fan can be set to run continuously (forced ON operation).
Some fan defects are detectable, and are displayed in the parameter *Error*.
The speed of the fan can be controlled in the range from 40% to 100%.

Settings

Name	Default	Max value	Min value	Step	Unit
Cond. Fan voltage	48	60	32	1	Volt
Fan speed	100	100	40	10	%
Fan start delay	0	240	0	1	Seconds
Fan stop delay	0	240	0	1	Seconds
Fan forced ON	OFF	ON	OFF	1	-
Detect missing fan	OFF	ON	OFF	1	-

Measurements

Name	Description	Step	Unit
Fan speed	Actual fan speed	1	%

4.2.5 Evaporator fan

The speed of the evaporator fan can be controlled in order to save energy, reduce noise and optimize the fan operation.

The fan is synchronized with the compressor operation.
Start and stop delays can be set up as a function of the state of the parameter *Thermostat*.
Furthermore, the fan can be set to run continuously (forced ON operation).
Some fan defects are detectable, and are displayed in the parameter *Error*.
The speed of the fan can be controlled in the range from 40% to 100%.

Settings

Name	Default	Max value	Min value	Step	Unit
Evap. Fan voltage	48	60	32	1	Volt
Fan speed	100	100	40	10	%
Fan start delay	0	240	0	1	Seconds
Fan stop delay	0	240	0	1	Seconds
Fan forced ON	OFF	ON	OFF	1	-
Detect missing fan	OFF	ON	OFF	1	-

Measurements

Name	Description	Step	Unit
Fan speed	Real-time fan speed	1	%

4.2.6 Thermostat

Thermostat type
Two types of thermostat can be utilized for temperature control.

Electronic thermostat (NTC sensor)
Disconnected sensor error alarm *(NTC sensor failure)* is sent when the measured temperature is > +100ºC
Short circuited sensor error alarm *(NTC sensor failure)* is sent when the measured temperature < - 60ºC

Mechanical thermostat
A mechanical ON/OFF thermostat can be connected at terminals C & T.
No detection of faulty thermostat is provided when an ON/OFF thermostat is used.

Automatic thermostat selection
The *Thermostat* parameter displays the type of thermostat connected to the controller: either a mechanical thermostat or NTC temperature sensor.
An NTC sensor is recommended for the temperature range -60 ºC to +100 ºC
A mechanical thermostat is recommended for temperatures below -60 ºC and above +100 ºC

Note: An NTC sensor error is not detectable when the NTC sensor is operating in automatic thermostat selection mode.

Settings

Name	Default	Max value	Min value	Step	Unit
Thermostat type	Auto	Electronic	-	-	-
Cutout temperature	+ 25	+ 40	-40	1	Celcius (ºC)
Difference	3	15	1	1	Kelvin (K)
Forced ON	OFF	ON	OFF	1	-

Measurements

Name	Description	Step	Unit
Runtime	Runtime is provided to record cooling-time (thermostat cut-in period). The runtime is updated during cooling, starting with 0 at start of cooling. During cooling OFF (Thermostat cut-out), the *Runtime* parameter will show the time for the last cooling period. Runtime is reset at the beginning of a cooling ON period, and at power-up.	1	Minutes
Actual temperature	Real-time air temperature when a NTC sensor is used. When a mechanical thermostat is used, only thermostat status ON or OFF is displayed.	-	ºC

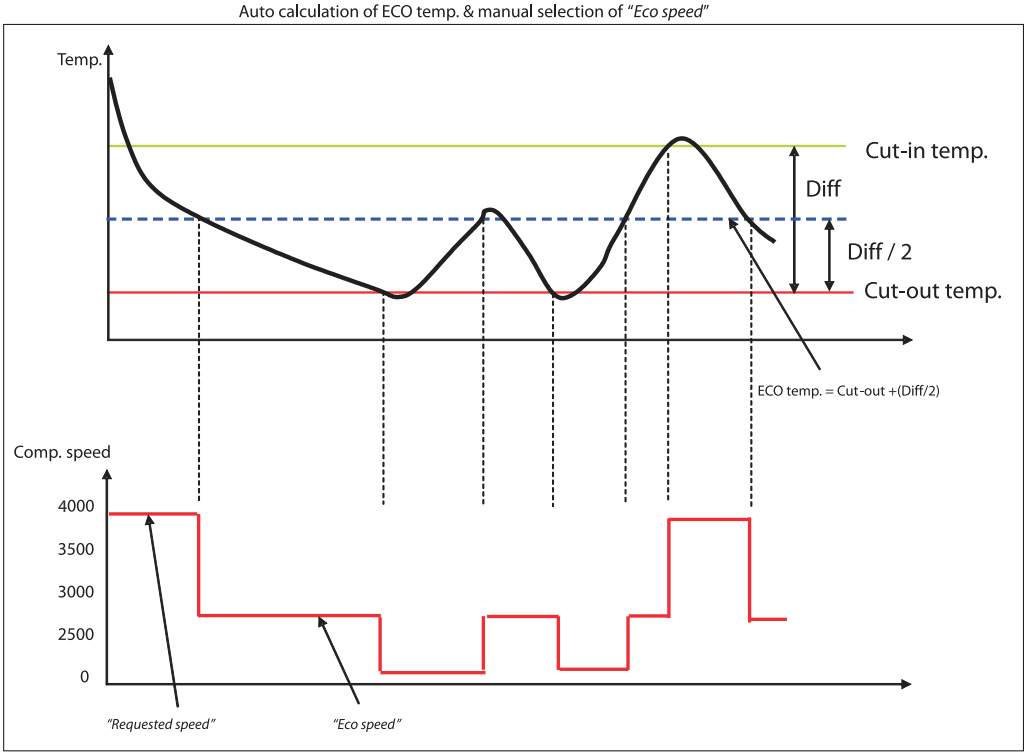
4.2.7 ECO function

Operation in ECO mode reduces energy consumption and noise by controlling compressor speed as a function of temperature. ECO mode can be selected only when using an NTC temperature sensor.

In ECO mode,

- when operating below ECO temperature, compressors run at the set ECO speed, and the *Start speed* setting will be overruled, if it differs from ECO speed.
- when operating above ECO temperature, the compressors run at Requested speed.

ECO mode
Auto calculation of ECO temp. & manual selection of "*Eco speed*"



Settings:

Name	Default	Max value	Min value	Step	Unit
ECO mode	OFF	ON	OFF	1	
ECO speed BD250GH	2500	4400	2500	1	rpm
ECO speed BD350GH	2500	4000	2500	1	rpm
ECO temperature	25	-40	40	0.1	Celsius (°C)
Automatic ECO temperature	1	0	1	1	0 = OFF 1 = ON

4.2.8 Compressor safety

In order to prevent the compressor from short cycling a minimum restart time is built in.
After timeout of *Compressor restart time* a new start of the compressor is permitted.

Settings

Name	Default	Max value	Min value	Step	Unit
Compressor restart time	60	120	60	1	Seconds

4.2.9 Communication

Lost communication
In a network system with custom designed interface modules acting as master on the Modbus, it is desirable to stop the compressor from running when communication to the master is lost.
If communication is lost it will not be possible for the customer to stop the compressor as long as cooling is requested.
The function will stop the compressor after a certain time, *(Communication time out)* when there is no contact to the master controller. The stop is realized through the *MainSwitch*. The *Main Switch* will be set to OFF. It will remain OFF until the master controller sets it back to ON via Modbus.

Protection of settings
A coded privacy function protects customers' settings from being read by third parties.
The code must be verified by entering twice.

Settings

Name	Default	Max value	Min value	Step	Unit
Node number	1	247	1	1	-
Bits per second	19200	19200	9600	9600	0 = Disabled 1 = Enabled
Communication	0	1	0	1	Seconds
Communication timeout	900	7200	15	1	-
Setting protection code & status	0	9999	0	1	-

4.2.10 Product information

Settings

Name	Description
Unit name	Possible to fill in customer name for the unit when presented in PC software programme Tool4Cool®

Measurements

Name	Description
Vendor name	
Product code no	
Software version	
Unit ID	
Production date	
Lot no	
Serial no	

4.2.11 Customer register

The customer register enables the user to set and change values in custom-designed interface modules.
These parameters are visible even when in protected mode.
Contact Danfoss for further information.

Settings

Name	Default	Max value	Min value	Step	Unit
Register 1	65535	65535	0	1	-
Register 10	65535	65535	0	1	-

4.2.12 Actual error

The alarm function notifies the user when an error arises in the system, and implements measures which prevent damage to the refrigeration system.
This parameter is on view in all parameter groups.

Output

Name	Description
Actual error	0 = No error 1 = Voltage failure 2 = Fan failure 3 = Motor failure 4 = Min. speed failure 5 = Max. speed failure 6 = Thermal failure 7 = NTC Sensor Failure

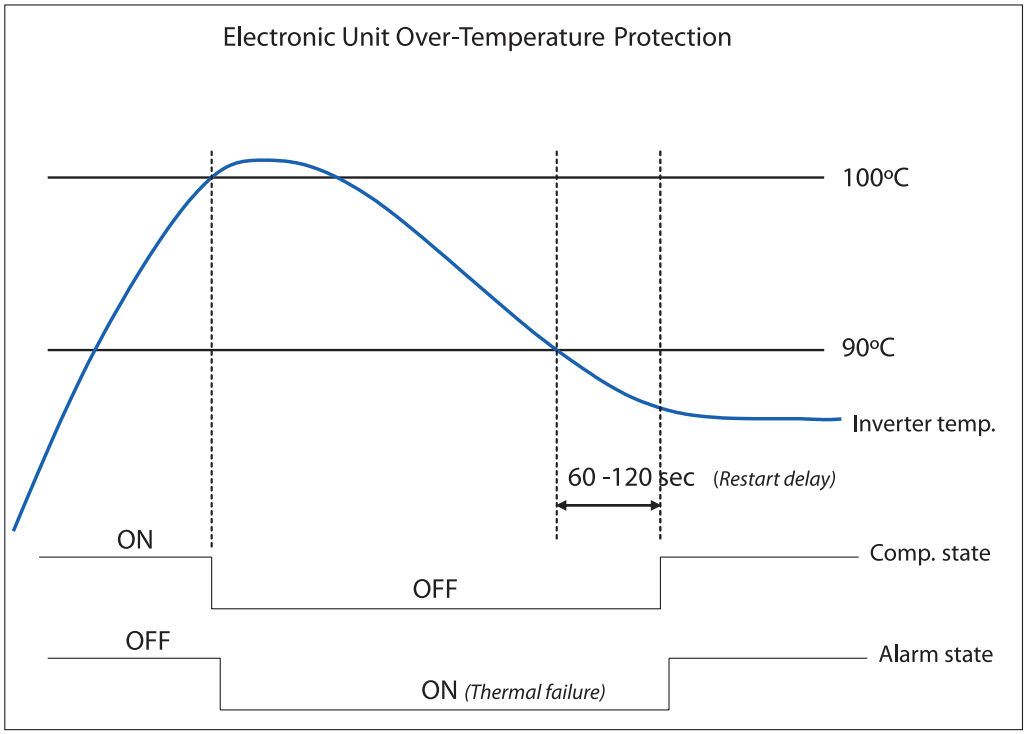
4.2.13 Inverter Temperature (PCB)

The controller overheating protection system ensures that the controller does not operate at extremely high temperatures, because under these conditions the quality of the soldered joints will be endangered.

When the unit reaches 100°C the system will shut down and an alarm error *(Alarm 6: Thermal failure)* will be sent.

The system restarts automatically after the temperature has dropped below 90 °C. Hereafter the set delay *Compressor restart delay* must be terminated. The default duration is 60 sec.

This parameter is not included in the parameter groups, but is accessible on the BD350GH controller main page only.



5. Ordering

	Model	Code number	Description
Compressors	BD250GH 48 V DC supply	101Z0402	
	BD350GH 48 V DC supply	102Z3031	
	BD350/350GH 48 V DC supply - twin compressor	102Z3032	
Single-Pack	Electronic control unit 48 V DC for BD250GH	101N0730	60W fan output, ECO function
	Electronic control unit 48 V DC for BD350GH	101N0720	60W fan output, ECO function
	DC line cord, 900 mm, 6mm^2	105N9542	accessories
	DC line cord, 2000 mm, 6 mm^2	105N9540	accessories
	DC line cord, 5000 mm, 6 mm^2	105N9538	accessories
	Temperature sensor, 470 mm, spade connectors	105N9612	accessories
	Temperature sensor, 1000 mm, spade connectors	105N9614	accessories
	Temperature sensor, 1500 mm, spade connectors	105N9616	accessories
	Danfoss One Wire/LIN gateway with cables & driver	105N9501	accessories
Industrial-Pack (I-Pack)	Electronic control unit 48 V DC for BD250GH	101N0731	36 pcs.
	Electronic control unit 48 V DC for BD350GH	101N0721	36 pcs.
	Communication cable, 1500 mm, AMP connector	105N9545	100 pcs.
	Communication cable, 3000 mm, AMP connector	105N9547	50 pcs.
	DC line cord, 900 mm, 6mm^2	105N9543	36 pcs.
	DC line cord, 2000 mm, 6 mm^2	105N9541	36 pcs.
	DC line cord, 5000 mm, 6 mm^2	105N9539	36 pcs.
	Temperature sensor, 470 mm, spade connectors	105N9613	200 pcs.
	Temperature sensor, 1000 mm, spade connectors	105N9615	100 pcs.
	Temperature sensor, 1500 mm, spade connectors	105N9617	100 pcs.
	Temperature sensor, 400 mm, AMP connector	105N9611	200 pcs.
Software Package	Tool4Cool® LabEdition, 1 license	105N9300	PC software, 1 licence version
	Tool4Cool® LabEdition, 2 license	105N9301	PC software, 2 licence version
	Tool4Cool® LabEdition, 5 license	105N9302	PC software, 5 licence version

6. Further information

For detailed installation and operation instructions, please refer to other literature, currently availabe from Danfoss:

Title	Danfoss Literature Number
Tool4Cool® LabEdition *Operating Instructions* Tool4Cool® LabEdition *Bedienungsanleitung* (German)	DEHC.PI.300.B__.02 DEHC.PI.300.B__.03
BD Controller 101N07xx Series 48 V DC with Tool4Cool® LabEdition software *Operation Instructions*	DEHC.PS.100.Q__.02
BD Controller 101N07xx Series 48 V DC with Tool4Cool® LabEdition software and Danfoss One Wire/LIN gateway *Quick Start Guide*	DEHC.PS.100.R__.02
Danfoss One Wire/LIN Gateway 105N9501 *Instructions*	DEHC.PI.100.K__.02
Electronic Unit for BD250GH Compressor 101N0730 48 V DC *Instructions*	DEHC.EI.100.Y__.02
Electronic Unit for BD350GH Compressor 101N0720 48 V DC *Instructions*	DEHC.EI.101.A__.02
applicable to BD250GH with 101N0730 & BD350GH with 101N0720 DC Line Cords for BD350GH Electronic Unit 24V *Instructions*	DEHC.EI.100.E__.02
applicable to BD250GH with 101N0730 & BD350GH with 101N0720 Temperature Sensors for BD350GH Electronic Unit *Instructions*	DEHC.PI.100.G__.02
applicable to BD250GH with 101N0730 & BD350GH with 101N0720 Communication Cable for BD350GH Electronic Unit *Instructions*	DEHC.PI.100.H__.02

"__" = version number (changes)

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