DF-C/CC/CM Series
AC Laboratory Power Supplies
User's Manual

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1. Connection

Our devices are pre-configured to the power grid chosen with the order (if not specified otherwise, our devices are manufactured for the EU power grid 1Ph. 230V 50Hz / 3Ph. 400V 50Hz). Subsequent adjustment after delivery is not possible. Connecting the device to an unsuitable power source will void any warranty.

1 Phase / EU Power Grid	
Voltage (Recommended)	230V ± 10% AC
Voltage (Max.)	250V AC
Frequency	50Hz - 60Hz
Circuit breaker minimum requirements	The maximum current of the device shall be determined as follows: I = (maximum power of the device / 230) + 2
1 Phase / American Power Grid	
Voltage (Recommended)	115V ± 10% AC
Voltage (Max.)	130V AC
Frequency	50Hz - 60Hz
Circuit breaker minimum requirements	The maximum current of the device shall be determined as follows: I = (maximum power of the device / 115) + 4

3 Phase / EU Power Grid (TN-S Network)	
Voltage (Recommended)	380V - 410V
Voltage (Max.)	430V
Frequency	50Hz
Circuit breaker minimum requirements	The maximum phase current of the device shall be determined as follows: I = ((maximum power of the device / 400) / 1,73) + 2

2. General

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

Calibration

Before shipment, the instrument has been calibrated carefully in our factory. The calibration procedures and standards are compliant with the national regulations and standards for electronic calibration. If you have requested a certificate with your order, this is enclosed with your device. With ordered off-site calibration (DaKKS) the calibration was not performed in-house; please refer to the laboratory calibration protocol for details.

Warranty

We guarantee that the instrument has undergone a strict quality test before shipment and has passed all prescribed functional tests. We provide our customers with a warranty period of three years from receipt of the device. During the warranty period, all repairs, as well as spare parts, are always free of charge. The warranty is void in the case of defects that have been caused by user fault or in the case of unauthorized opening.

2.1. Safety Instructions

This chapter contains important safety instructions that you must follow when operating the instrument and when keeping it in storage. Read the following before any operation to ensure your safety and to keep the device in proper condition.

Safety Symbols

The following safety symbols may appear in this manual or on the instrument:

	WARNING	Identifies conditions or practices that could result in injury or loss of life.
	CAUTION	Identifies conditions or practices that could result in damage to the instrument or to other properties.
	DANGER	High Voltage
	ATTENTION	Refer to the Manual
		Protective Earth (PE)
		Earth (Ground)

2.2. Safety Guidelines

Please follow the safety guidelines when using and putting the device into operation in order to prevent safety risks and to ensure the correct operation of the product.

- **Before connecting the device to the local power supply, make sure that the device is switched off.**
- **Check if the product is compatible with the local power supply before connecting it.**
- **Be careful with the correct earthing of the device (PE connection).**
- **Do not use the product in humid environments.**
- **Do not touch the output terminals of the product with unprotected hands while it is switched on.**
- **Do not use the device in extremely dusty rooms.**
- **Do not use the device outside the parameters specified in the data sheet.**

2.3. Unpacking and Examination

Our products are delivered carefully packed in cardboard boxes or in wooden crates, depending on the destination and the type of device (dimensions, weight). We pay attention to the environmental compatibility of the upholstery and packaging materials used and ask you to dispose of the filling material correctly if present.

Please unpack the device and check the packaging as well as the product for transport damage. Should you notice any damage to the packaging or the device, we ask you to log it with photos and inform us immediately.

ATTENTION: If the device has been delivered in a wooden box, please do not dispose of it as it can be used for eventual return transport for service procedures. Also, the packaging material of smaller devices can be stored in order to be used if necessary for return transport.

2.4. Customization and Manual Coverage

We manufacture these devices on order, and this manual primarily covers the default configuration. It is important to note that any customizations requested by you during the order may result in modifications to specific characteristics and/or procedures. In such cases, an additional separate document will be included with the manual to detail the changes made to accommodate the custom order.

3. Operation Instructions

3.1. Front Panel Description 3 Phase Series (e.g. 63XXXX)

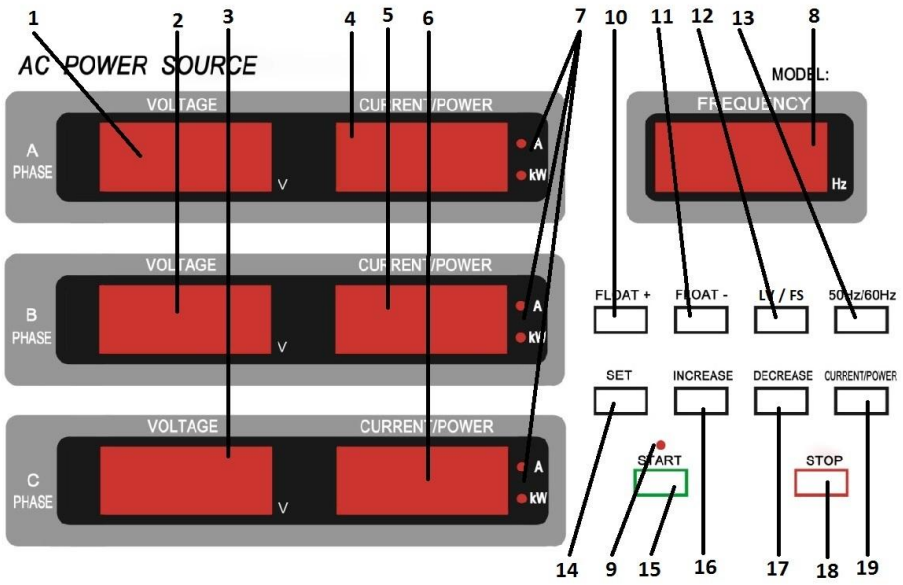


Fig.1: Front Panel 3 Phase Series (CV Version - e.g. 63XXXX)

Nr.	Name	Description
1	Voltage Phase A	Voltage set or actual value of Phase A
2	Voltage Phase B	Voltage set or actual value of Phase B
3	Voltage Phase C	Voltage set or actual value of Phase C
4	Current / Power Ph. A	Current set or actual value of Phase A
5	Current / Power Ph. B	Current set or actual value of Phase B
6	Current / Power Ph. C	Current set or actual value of Phase C
7	Display Mode	Active „A" LED indicates the current value Active „kW" LED indicates the power value No active LED indicates the power factor value
8	Frequency	Output frequency „Hz"
9	Output On/Off Key	Indicates the output status
10	Float + Hot-Key	Raise the value by X percent
11	Float - Hot-Key	Lower the value by X percent
12	LV / FS Key	Switch between Low Voltage range (0 – 150V) and Full Scale range (0 – 300V)
13	Frequency Key	Fast switch between 50Hz / 60Hz
14	Set Key	Settings menu and output value adjustment mode
15	Start Key	Output ON
16	Increase Key	Raise the value
17	Decrease Key	Lower the value
18	Stop Key	Output OFF
19	Display Mode Switch Key	Toggle between Current, Power of Power Factor display

3.2. Front Panel Description 1 Phase Series (e.g. 61XXXX)

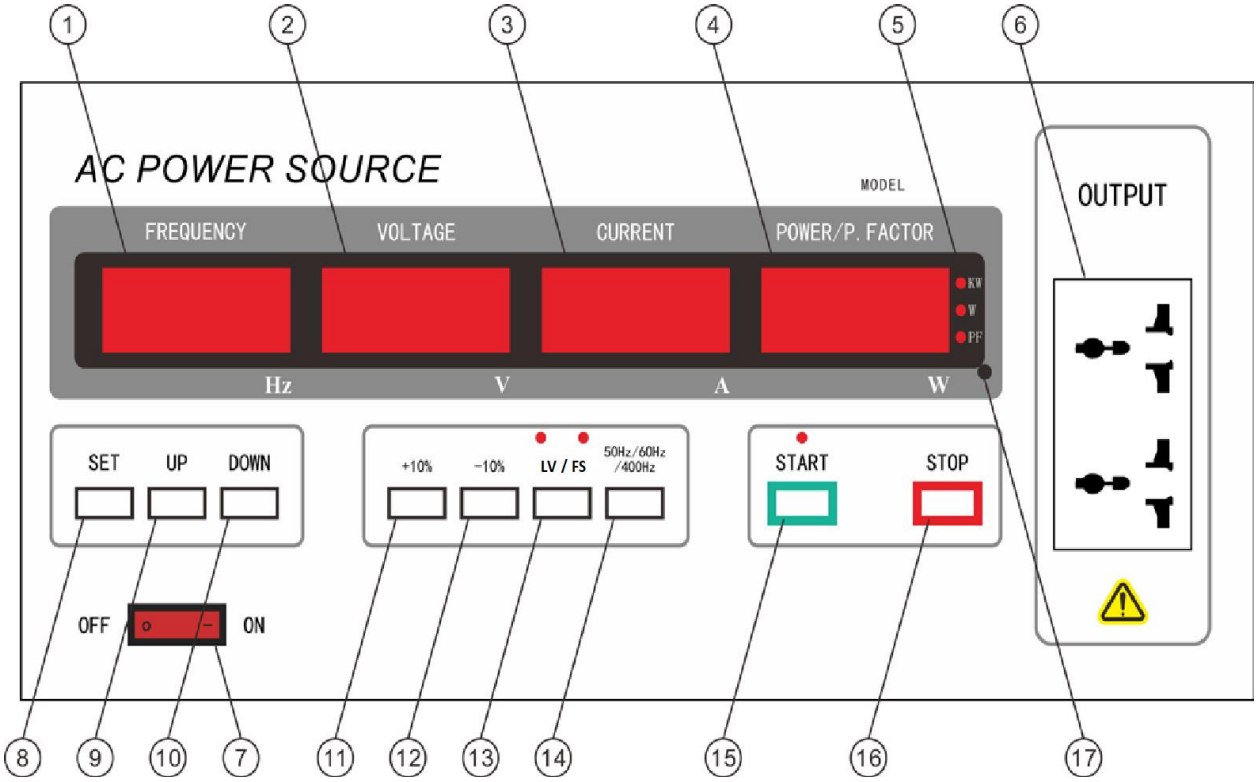


Fig.2: Front Panel 1 Phase Series (CV Version - e.g. 61XXXX)

No.	Name	Description
1	Frequency	Output frequency „Hz“
2	Voltage	Voltage set or actual value
3	Current	Current actual value
4	Power / Power Factor	Power or Power Factor display
5	Display Mode	Active „A“ LED indicates the current value Active „kW“ LED indicates the power value No active LED indicates the power factor value
6	Connections	Secondary connections with universal socket
7	Power On/Off Key	Power On/Off the power supply
8	Setup Key	Settings menu and output value adjustment mode
9	UP Key	Raise the value
10	DOWN Key	Lower value
11	+10% Hot-Key	Raise the value by 10 percent
12	-10% Hot-Key	Lower value by 10 percent
13	LV / FS Key	Switch between Low Voltage range (0 – 150V) and Full Scale range (0 – 300V)
14	Frequency Key	Fast switch between 50Hz / 60Hz
15	Start Key	Output ON
16	Stop Key	Output OFF
17	Display Mode Switch Key	Toggle between Current, Power of Power Factor display

3.3. Power ON

Set the „ON / OFF“ switch to the ON position to turn on the device. The device is equipped with a soft-start delay that slowly charges the capacitors in the power supply to limit the high inrush currents. After about 10 seconds, the power supply will switch into standby mode.

3.3.1. Stand-By Mode

The output is switched off in standby mode, and the device is ready to set the desired output values. The displays show a voltage of 0V and a current of 0A, which corresponds to the actual values at the output.

Press the SET button once to enter the setup menu.

Press the SET button once
- FREQUENCY display flashes -> Frequency setting

Press the SET button 2x
- VOLTAGE display flashes -> Voltage setting

Press the SET button 3x
- VOLTAGE display flashes -> FLOAT + percentage setting (default 10%)

Press the SET button 4x
- VOLTAGE display flashes -> FLOAT- percentage setting (default -10%)

Press the SET button 5x
- CURRENT display flashes -> Setting of over current Protection value

Press the SET button 6x
- AD Setting -> Sets the power supply address for RS232/RS485 communication

Press the SET button 7x
- CTRL Setting -> Enables or disables digital communication over RS232/RS485

Press the SET button 8x
- Save settings, back to standby mode

3.3.2. Setting the output values for constant current sources of the DF-C series (CC version)

Constant current sources of the DF-C series that work in CC mode have no setup menu and a simplified control panel. If you are in standby mode (output OFF), values can be entered directly using the arrow keys below the relevant displays; saving is not necessary.

3.3.3. Voltage Range Setting (LV / FS)

Press the LV / FS key to switch between the voltage ranges; the currently set voltage range is displayed on the frequency display for 3 seconds, with L for LV and F for FS. Normally, the range is LV for 0 - 150V and FS for 0 - 300V, this may differ for custom-made devices.

4. Optional: Analog In- / Outputs

Devices of the DF-C series can optionally be equipped with analog inputs/outputs for setting and reading the output parameters. The analog inputs/outputs are accessible via a labeled terminal block, which is located either on the back, the front, or behind the service door (depending on the device model). The pin assignment is explained on the terminal block for a simple and straightforward connection and may change depending on the configuration ordered.

4.1. Optional: Interlock loop

Two-pin loop, which can be selected during the order to operate either as an interlock or a remote output status control. By default, the interlock loop operates as a security loop that blocks the output if interrupted and thus prevents the output from being enabled or temporarily disables it if the output is in the enabled state while the loop has been interrupted.

Alternatively, the interlock loop can be reprogrammed to operate as a simple remote output status control, triggering the output status to be ON/OFF by closing or opening the loop.

Please note that the operation principle of the interlock loop has to be selected during the order as changing it afterwards requires the physical replacement of a control PCB in the power supply.

4.2. Optional: Grounded output / Floating output / Floating with ELCB (Option O5 / O6 / O7)

The output of DF-C series devices in the basic version has a potential to PE (is grounded), which follows the usual protection regulations. All models can also be ordered in the modifications listed below. Please see the „DF-C Series Function and Wiring Diagram" PDF for details:

Option O6: Floating output without ELCB

The output of the power supply has no potential to the input (PE), so the output of the device has no protective earth for loads that may require a PE connection, and the load is not protected by an ELCB. By bridging output N to input N, the output can be pulled to the input potential; in this case, input PE = output PE and the load is protected by the ELCB installed in the operational environment (Laboratory).

Option O7: Floating output with built-in ELCB

The model with integrated ELCB offers the following possible configurations:

A). Potential-free output with its own ELCB

Connections output
L (1, 2, 3): Phase (floating)
N: Neutral conductor (floating)
GND: In this configuration, to be used as PE connection for the load

Remark: ELCB triggers as soon as a residual current flows through the GND conductor.

Connections input
L1: Input phase 1
L2: Input phase 2
L3: Input phase 3
N: Neutral conductor
PE: Earth conductor

B). Output with potential to input (potential to input PE)

Connections output
L (1, 2, 3): Phase (grounded)
N: Neutral → Bridge to input N (grounded)
GND: Do not connect

Connections input
L1: Input phase 1
L2: Input phase 2
L3: Input phase 3
N: Neutral conductor
PE: Earth conductor

5. Optional: Digital Connections

The DF-C Series can be equipped with digital connections (RS232 / RS485) to read/write output values in real time through a proprietary open protocol or Modbus-RTU. Both protocols are explained in detail in the last chapter of the user's manual. Please note that the communication protocol must be selected during the order. To change the communication protocol afterward, a physical replacement of the controller PCB is required.

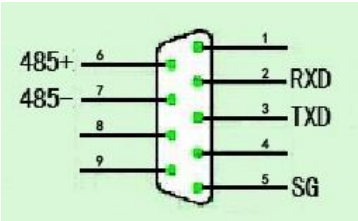
Option D1: RS232

The connection is established through a D-SUB 9 Pin male socket on the side of the device. The pinout meets the defined standard characteristics of the RS232 over D-SUB standard.

Option D2: RS485

The RS232 connection is established through a D-SUB 9 Pin male socket on the side of the device.

The pinout of the digital connection D-SUB 9 Pin socket:



Pin 2: RxD (RS232)
Pin 3: TxD (RS232)
Pin 5: Signal Ground (RS232 & RS485)
Pin 6: 485 + (RS485)
Pin 7: 485 - (RS485)

6. Connection of the load

Depending on the model, the output/input connections are located on the back, on the front, or behind the service door of the device. We recommend protecting the connectors from wear if the load will be frequently connected and disconnected by connecting it not directly to the device, but by using an intermediate bridge. In this case, the intermediate bridge can remain connected to the power supply - so the connection terminal of the power supply is used less often.

Modbus-RTU Communication Protocol for DF-C/CC/CM Series Power Supplies

Interface: RS-232 / RS-485
Command format: Modbus-RTU
Baud rate: 9600
Communication mode: One start bit, eight data bits, two stop bits

1. Command Frame
1.1. Read Device Register (Function Code 0x03)
1.1.1. Command frame sent

Command sample: 64 03 00 00 00 01 8D FF
CRC for 64 03 00 00 00 01 = FF8D

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x03	0x03	Function code for reading register
3	High byte of address of the first register	0x00	Address of the first register
4	Low byte of address of the first register	0x00	
5	High byte of number of registers	0x00	Number of registers
6	Low byte of number of registers	0x01	
7	CRC16 check high byte	0x8D	CRC check data
8	CRC16 check low byte	0xFF	

1.1.2. Command frame returned

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x03	0x03	Function code for reading register
3	Data length (M)		
4	Data of the first reading register		
...	...		
...	Data of the last reading register		
M+4	CRC16 check high byte		CRC check data
M+5	CRC16 check low byte		

If the address of the first register or the number of registers is incorrect, the device returns the following reply:

64 83 02 D0 EE
CRC for 64 83 02 = EED0

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x83	0x83	Function code
3	0x02	0x02	Address error code
4	CRC16 check high byte	0xD0	CRC check data
5	CRC16 check low byte	0xEE	

1.2. Write Device Register (Function Code 0x06)

1.2.1. Write data into a single device register

Command sample: 64 06 00 0D 04 4C 12 C9
CRC for 64 06 00 0D 04 4C = C912

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x06	0x06	Function code for writing register
3	High byte of register address	0x00	Address of the first register
4	Low byte of register address	0x0D	
5	High byte of data	0x04	Data
6	Low byte of data	0x4C	
7	CRC16 check high byte	0x12	CRC check data
8	CRC16 check low byte	0xC9	

Device Return (Write Successful):

64 06 00 0D 04 4C 12 C9
CRC for 64 06 00 0D 04 4C = C912

If the command is found to be correct, the device will return the command and execute it.

1.2.2. If the address of the register is incorrect, the device returns the following:

64 86 02 D3 BE
CRC for 64 86 02 = D3BE

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x86	0x86	Function code
3	0x02	0x02	Address error code
4	CRC16 check high byte	0xD3	CRC check data
5	CRC16 check low byte	0xBE	

1.2.3. If the written data was out of execution range, the device returns as follows:

64 86 03 12 7E
CRC for 64 86 03 = 7E12

No.	Code	Data	Description
1	Device address	0x64	HEX 0x64=Value 100
2	0x86	0x86	Function code
3	0x02	0x03	Data error code
4	CRC16 check high byte	0x12	CRC check data
5	CRC16 check low byte	0x7E	

2.1. Device Register Address for 3 Phase Series (e.g. 63XXXX)

Remarks:

1). All parameters are UINT two-byte data, beginning with the high byte and ending with the low byte.
2). Access rules of the register: R=read only, W=write only, R/W=read and write.

No.	Parameter	Data Type	Unit	Access Rule	Register Address	Description
1	Status of device	UINT		R	0x0000 (40001)	Working status query
2	Output frequency	UINT	0.1Hz	R	0x0001 (40002)	Output parameter query
3	A-phase output voltage	UINT	0.1V	R	0x0002 (40003)	
4	B-phase output voltage	UINT	0.1V	R	0x0003 (40004)	
5	C-phase output voltage	UINT	0.1V	R	0x0004 (40005)	
6	A-phase output current	UINT	0.1A 0.01A	R	0x0005 (40006)	
7	B-phase output current	UINT	0.1A 0.01A	R	0x0006 (40007)	
8	C-phase output current	UINT	0.1A 0.01A	R	0x0007 (40008)	
9	A-phase output active power	UINT	0.01kW	R	0x0008 (40009)	
10	B-phase output active power	UINT	0.01kW	R	0x0009 (40010)	
11	C-phase output active power	UINT	0.01kW	R	0x000A (40011)	
12	A-phase output power factor	UINT	0.001	R	0x000B (40012)	Only available with customized device
13	B-phase output power factor	UINT	0.001	R	0x000C (40013)	
14	C-phase output power factor	UINT	0.001	R	0x000D (40014)	
15	High range and low range status	UINT		R	0x000E (40015)	
16	Control command	UINT		W	0x0012 (40019)	
17	Frequency setting	UINT		R/W	0x0013 (40020)	
18	Voltage setting	UINT		R/W	0x0014 (40021)	

2.2. Device Register Address for 1 Phase Series (e.g. 61XXXX)

Remarks:

1). All parameters are UINT two-byte data, beginning with the high byte and ending with the low byte.
2). Access rules of the register: R=read only, W=write only, R/W=read and write.

No.	Parameter	Data Type	Unit	Access Rule	Register Address	Description
1	Status of device	UINT		R	0x0000 (40001)	Working status query
2	Output frequency	UINT	0.1Hz	R	0x0001 (40002)	Output parameter query
3	Output voltage	UINT	0.1V	R	0x0002 (40003)	
4	Output current	UINT	0.1A 0.01A 0.001A	R	0x0003 (40004)	
5	Output active power	UINT	0.1W 0.01kW	R	0x0004 (40005)	
6	Output power factor	UINT	0.001	R	0x0005 (40006)	
7	High range and low range status	UINT		R	0x0006 (40007)	
8	Frequency setting	UINT	0.1Hz	R/W	0x0007 (40008)	
9	Voltage setting	UINT	0.1V	R/W	0x0008 (40009)	
10	Control command	UINT		W	0x0009 (40010)	

3. Description of Parameters

3.1. Status of Device

No.	Data	Remarks	No.	Data	Description
1	0x0000	Standby mode	5	0x0004	Over temperature alarm
2	0x0001	Started mode	6	0x0005	Over current alarm
3	0x0002	Setting mode			
4	0x0003	Short circuit alarm			

3.2. Output frequency

Unit: 0.1Hz
Example: Data returned as 0x0258
HEX 0x0258 = Value 600, the output frequency of the device is 60.0Hz

3.3. Output voltage

Unit: 0.1V
Example: Data returned as 0x044C
HEX 0x044C = Value 1100, the output voltage of the device is 110.0V

3.4. Output current

Unit: 0.1A or 0.01A
Example: Data returned as 0x00D0

If the output capacity of the device is higher than 15KVA, the unit is 0.1A HEX 0x00D0 = Value 208, the output current of the device is 20.8A.

If the output capacity of the device is lower than 15KVA, the unit is 0.01A HEX 0x00D0 = Value 208, the output current of the device is 2.08A.

3.5. Output Power

Unit: 0.01kW
Example: Data returned as 0x00E4
HEX 0x00E4 = Value 228, the output active power of the device is 2.28kW

3.6. High range and low range status

No.	Data	Description
1	0x01	High range
2	0x00	Low range

3.7. Frequency setting

Unit: 0.1Hz
This parameter has write access.

Example: Set output frequency 62Hz, write 0x026C in register address 0x13
Command sample: 64 06 00 13 02 6C 70 B7
HEX 0x026C = Value 620
CRC for 64 06 00 13 02 6C = B770

3.8. Voltage setting

Unit: 0.1V
This parameter has write access.

Example: Set output voltage 120V, write 0x04B0 in register address 0x14.
Command sample: 64 06 00 14 04 B0 C3 4F
HEX 0x04B0 = Value 1200
CRC for 64 06 00 14 04 B0 = 4FC3

3.9. Control commands

No.	Data	Description
1	0x0000	Output stop
2	0x0001	Output start
3	0x0002	
4	0x0003	Switch to low range
5	0x0004	Switch to full range

Remarks:

1). 0x0000 can be executed under any status.
2). 0x0001 can be executed only in standby mode.

Proprietary Communication Protocol for DF-C/CC/CM Series 3 Phase Power Supplies (e.g. 63XXXX)

Interface: RS-232 / RS-485
Command format: Asynchronous, 1start bit, 8 data bits, 1 stop bit
Baud rate: 9600
Communication mode: ASIIC code, "X" stands for numbers.
Termination: Each command sent by the power supply as a reply is terminated with a ";"

Command	Function	Response	Description
#G	Output START	Received	The command is accepted
		Error	The power supply is not in standby mode, or output may already be active
#U	Output STOP	Received	The command is accepted
		Error	The power supply output is not active
#D	Read the output status	XXX.XHz;A:XXX.XV XXX.XAXX.XXkW; B:XXX.XV XXX.XAXX.XXkW; C:XXX.XV XXX.XAXX.XXkW	The reply is a sequence of output frequency, voltage, current, and power. For example: 060.0Hz;A:090.0V010.0A00.90kW;B:090.0V010.0A00.90kW;C:090.0V010.0A00.90kW.
		Error	The power supply output is not active
#SXXXX XXXX (S followed by 8 data digits.)	Set the output parameter. The first 4 digits are the frequency value (resolution 0.1Hz). The last 4 digits are the voltage setting (resolution 0.1V). The number "0" cannot be omitted in the command. For example, setting the parameters 101Hz 62V would result in: #S10100620	Received	The command is accepted
		Error	The power supply is not in standby mode, or the parameter exceeds range
#H	Switch to FS (0 – 300V) mode	Received	The command is accepted
		Error	Wrong command
#L	Switch to LV (0 – 150V) mode	Received	The command is accepted
		Error	Wrong command
#R	STOP output and CLEAR alarm	Received	The command is accepted
#C	Read the status of the power supply	000	Standby mode
		001	Started
		002	Setup mode
		005	Short circuit alarm
		006	Over temperature alarm
		007	Over current alarm

Proprietary Communication Protocol for DF-C/CC/CM Series 1 Phase Power Supplies (e.g. 61XXXX)

Command	Function	Response	Description
#G	Output START	Received	The command is accepted
		Error	The power supply is not in standby mode, or output may already be active
#U	Output STOP	Received	The command is accepted
		Error	The power supply output is not active
#D	Read the output status	XXX.XHzXXX.XV X.XXXAXXXX.XW	The reply is a sequence of output frequency, voltage, current, and power. For example: 050.0Hz110.2V0.950A0099.5W
		Error	The power supply output is not active
#SXXXX XXXX (S followed by 8 data digits.)	Set the output parameter. The first 4 digits are the frequency value (resolution 0.1Hz). The last 4 digits are the voltage setting (resolution 0.1V). The number "0" cannot be omitted in the command. For example, setting the parameters 101Hz 62V: #S10100620	Received	The command is accepted
		Error	The power supply is not in standby mode, or the setting parameter exceeds range
#H	Switching to FS (0 – 300V) mode	Received	The command is accepted
		Error	Wrong command
#L	Switching to LV (0 – 150V) mode	Received	The command is accepted
		Error	Wrong command
#C	Read the status of the power supply	000	Standby mode
		001	Started
		002	Setting mode
		005	Short circuit alarm
		006	Over temperature alarm
		007	Over current alarm