Bellnix® BDG-200 Series

This product is a semi-custom AC-DC power supply with full digital control. Up to three channels of different type with different output voltage can be selected in arbitrary combination. The PMBus communication function allows to change the output voltage setting, overcurrent protection threshold, turn-on and turn-off sequences, switching frequency, etc., and also to monitor the status of power supply.

■ Characteristics

- Power supply with full digital control
- Input voltage: AC85V to 264V
- Output voltage in each of 3 channels can be selected separately.
- Adjustable output voltage range: ±15%
- High efficiency: 87%
- Withstand input-output voltage: AC 3kV
- UVLO function
- Overvoltage protection function, overheat protection function
- The overcurrent protection threshold can be modified
- Output current can be increased by parallel connection (90% derating required)
- Switching frequency can be modified
- Residual life prediction function
- Remote control, changing various settings and monitoring the status of power supply is possible using PMBus (serial communication)
- IEC60950 compliant design

■ Models and ratings

Table1

Models BDG Series	Input V Vac	Channels	Output V Vdc	Output I A	Output P W	Efficiency %(typ.)
BDG-200	85 to 264	3	5 (4.25 to 5.75)	14	216 (total for 3 outputs)	87
			12 (10.2 to 13.8)	6		
			24 (20.4 to 27.6)	3		

Note 1: Output voltage setting range is given in brackets () after the output voltage. The output voltage can be changed using PMBus.
Note 2: Each channel of a unit can be selected arbitrarily from the three channels above. Unit cannot be modified after shipment.
Note 3: The efficiency is given for output voltage Ch 1: 5V, Ch 2: 12V, Ch 3: 24V, input voltage 200V, rated output, SW frequency 260kHz and normal temperature.
Note 4: Depending on ambient temperature, temperature derating may be required.

■ Specifications

Table 2

Input voltage range	Refer to Table 1.
Rated input voltage	100VAC
Rated output voltage	5V±2% (5V output), 12V±2% (12V output), 24±2% (24V output)
Output voltage setting range	Refer to Table 1.
Line regulation	1% max (for rated output, input voltage range given in the Table 1)
Load regulation	2% max (for rated input/output voltage, load varying from 0 to 100%)
Temperature regulation	2% max. (for rated input/output, operating temperature range −10°C to +50℃)
Integrated regulation	±3% max. (Including input, load and temperature regulations)
Ripple noise	50mVp-p typ. (5V output), 100mVp-p typ. (12V output), 150mVp-p typ. (24V output) (for rated input/output, normal temperature, measurement frequency band 20MHz)
Efficiency	87% typ. (for Ch 1: 5V, Ch 2: 12V, Ch 3: 24V, input voltage 200V, rated output, normal temperature)
Overcurrent protection	Triggers at 110% or more of the rated load current (constant current dropping type, automatic restoration)
Output overvoltage protection	Yes (shutdown, restored when input voltage is reapplied)
Under voltage lock out	Yes
Input overcurrent protection	Built-in input fuse (T6.3A, AC250V), both poles
Overheat protection	Yes (shutdown, restored when input voltage is reapplied)
Remote ON/OFF	Output is ON when terminals ON/OFF and SB_GND are open, and OFF when these terminals are closed.
Input OK signal output	When input voltage is OK: Low, when input voltage is too low or too high: open
Power failure signal output	Normal output: Low, failure: open
Parallel operation	Yes
Output hold time	20ms: output dip not exceeding 90% (for rated input)
Standby power supply	5V±5%、0.2A
Remote sensing	Yes
Withstand voltage	Between input and output: AC3000V during 1 minute, between input and FG: AC2500V during 1 minute, between output and FG: AC500V during 1 minute, between outputs: AC500V during 1 minute.
Insulation resistance	Between input and output, between input and FG, between output and FG, between all outputs: not less than 50MΩ (at DC500V)
Operating temperature range	Operating temperature -10°C to +50°C (Refer to temperature derating on separate sheet)
Storage temperature range	Storage temperature −20°C to +85°C
Humidity range	20 to 95%R.H. (max. wet bulb temperature 35°C without condensation)
Cooling conditions	Natural air cooling, refer to temperature derating on separate sheet
Vibration	5 to 10Hz total amplitude 10mm, 10 to 55Hz acceleration 2G (1 hour in each of 3 directions)
Shock	Acceleration 20G (3 times in each of 3 directions), shock time 11±5ms
Weight	850g typ.
Outer dimensions	W=195 L=100 H=47 typ. (mm) (excluding protrusions. Refer to outer dimensions on separate dimension/shape specifications)

* The above specifications are provided for rated values, unless otherwise specified.

1. Scope

These specifications apply to the isolated type AC/DC converter of BDG-200 series.

2. Models and ratings

Model	Rated input voltage	Rated output (Select any 3 outputs below)	Rated output of the standby power supply	Max output current
BDG-200-### *	AC 100V	5V, 14A(70W) 12V, 6A(72W) 24V, 3A(72W)	5V, 0.2A	216W max. (total for 3 outputs, excluding standby power source)

Unless otherwise specified in the specifications, rated input, rated output and ambient temperature 25°C±5°C are used.

* ### indicates the output voltage of each channel.

BDG-200-# # #

- Channel 1 rated output voltage (1: 5V, 2: 12V, 3: 24V. 0: no unit)
- Channel 2 rated output voltage (1: 5V, 2: 12V, 3: 24V. 0: no unit)
- Channel 3 rated output voltage (1: 5V, 2: 12V, 3: 24V. 0: no unit)

Examples:

Channel 1: 5V, channel 2: 12V, channel 3: 24V
BDG-200-123

Channel 1: no unit, channel 2: 12V, channel 3: 12V
BDG-200-022

Also see chapter 14. Model names and configurations

3. Environmental conditions

3-1 Temperature range

Operating temperature −10°C to +50°C (temperature over 40°C requires derating)
Storage temperature −20°C to +85°C

3-2 Humidity range

Operating humidity 20 to 95% R.H. (max. wet bulb temperature 35°C without condensation)
Storage humidity 20 to 95% R.H. (max. wet bulb temperature 53°C without condensation)

4. Specifications and standards

This product is RoHS compliant.

4-1 Input characteristics

Item	Specifications and standards	Conditions
Input voltage	AC85 to 264V (rated 100V)	
Input frequency	AC47 to 63Hz (rated 50 / 60Hz)	
Input current	2.6A typ., 2.7A max.	Ch 1: 5V, Ch 2: 12V, Ch 3: 24V, rated input, rated output, switching frequency 260kHz
Power factor	0.9 or higher	Rated input and rated output
Inrush current	20A or lower for rated input	Output power 200W
Leakage current	1mA max.	Input voltage 264V, 60Hz
Input protection	Built-in fuse (T6.3A, AC250V), both poles	

4-2 Output characteristics and functions

4-2-1 Channels 1-3

*1, *2

Parameter	Specifications and standards			Conditions
	5V output	12V output	24V output	
Rated output voltage	5V	12V	24V	
Output voltage tolerance	±2%			
Output voltage setting range	±15%			Configured via serial communication. Setting range of control target value. The actual output voltage depends on the output voltage deviation setting.
Output current	0 to 14A	0 to 6A	0 to 3A	
Max output power	70W	72W	72W	
Line regulation	1% max.			Input voltage from 85 to 264V
Load regulation	2% max.			For load regulation in the range 0 to 100%
Temperature regulation	2% max.			For temperature in the range -10 to +50°C
Integrated regulation	±3% max.			Including input voltage, load current and temperature regulation. *3
Ripple noise	50mVp-p typ., 100mVp-p max.	100mVp-p typ., 200mVp-p max.	150mVp-p typ., 300mVp-p max.	BW = 20MHz
Efficiency	87% typ. (depends on combination)			Ch 1: 5V, Ch 2: 12V, Ch 3: 24V, input voltage 200V, rated output, switching frequency 260kHz
Overcurrent protection	Triggers at 110% or higher Fixed current drooping type, automatic restoration			Threshold can be changed using serial communication

Under voltage lock out		Yes Activation voltage: 79V typ. Deactivation voltage: 75V typ.	
Input overvoltage detection		Yes Shutdown, restored when input voltage is reapplied	
ON/OFF control	For each channel	Yes	Via serial communication
	For all outputs	Terminals CN2 ON/OFF – SB_GND open: ON closed or Low: OFF	ON/OFF control via serial communication is supported. The control logic shown to the left is used by default. The control logic can be changed using serial communication.
Input OK signal output		Input voltage OK: Low Input voltage too low or too high: Open	
Power failure signal output		Output OK: Low Failure: Open	
Output overvoltage protection		Shutdown, restored when input voltage is reapplied	Threshold can be changed using serial communication
Overheat protection		Shutdown, restored when input voltage is reapplied	
Parallel operation		Yes	Connect the same CS terminals N+1 parallel redundant operation requires external OR connection circuit
Switching frequency setting		Yes (260kHz to 300kHz, rated 260kHz)	Configured via serial communication Derating may be required depending on usage conditions
Output hold time		20ms: output dip not exceeding 90%	
Start-up time	Input voltage application	Channels 1 to 3: 1.6s typ., 1.8s max. Standby power: 0.3s typ., 0.5s max.	For turn-on delay 0ms, turn-on rise 100ms
	ON/OFF control	Channels 1 to 3: 0.6s typ.	
Communication function		Yes	PMBus Rev.1.1 compliant
Sequence setting		Yes	Configured via serial communication
Sequence set time deviation		±2% max.	
Operation monitoring		Yes	Configured via serial communication

*1 Measured using measurement circuit in the chapter 4-6

*2 Unless otherwise mentioned, measured at rated input, rated output and ambient temperature 25°C±5°C.

*3 A design value; not confirmed for all values.

4-2-2 Standby output

Parameter	Specifications and standards	Conditions
Rated output voltage	5V	
Integrated fluctuation	±5%	Including input, load and temperature fluctuations
Ripple noise	50mVp-p max.	
Output current	0 to 0.2A	
Overcurrent protection	No	
Short circuit protection	Yes	

*1 Measured using measurement circuit in the chapter 4-6

*2 Unless otherwise mentioned, measured at rated input, rated output and ambient temperature 25°C±5°C.

4-3 Withstand voltage, isolation resistance

1) Withstand voltage

Between input and output: AC3000V during 1 minute
Between input and FG: AC2500V during 1 minute
Between output and FG: AC500V during 1 minute
Between outputs: AC500V during 1 minute

2) Insulation resistance

Between input and output, input and FG, output and FG: 50MΩ or higher (at DC500V)
Between outputs: 50MΩ or higher (at DC500V)

* At temperature 25°C±5°C. Humidity conditions according to JEITA RC-9131C.

4-4 Safety standards

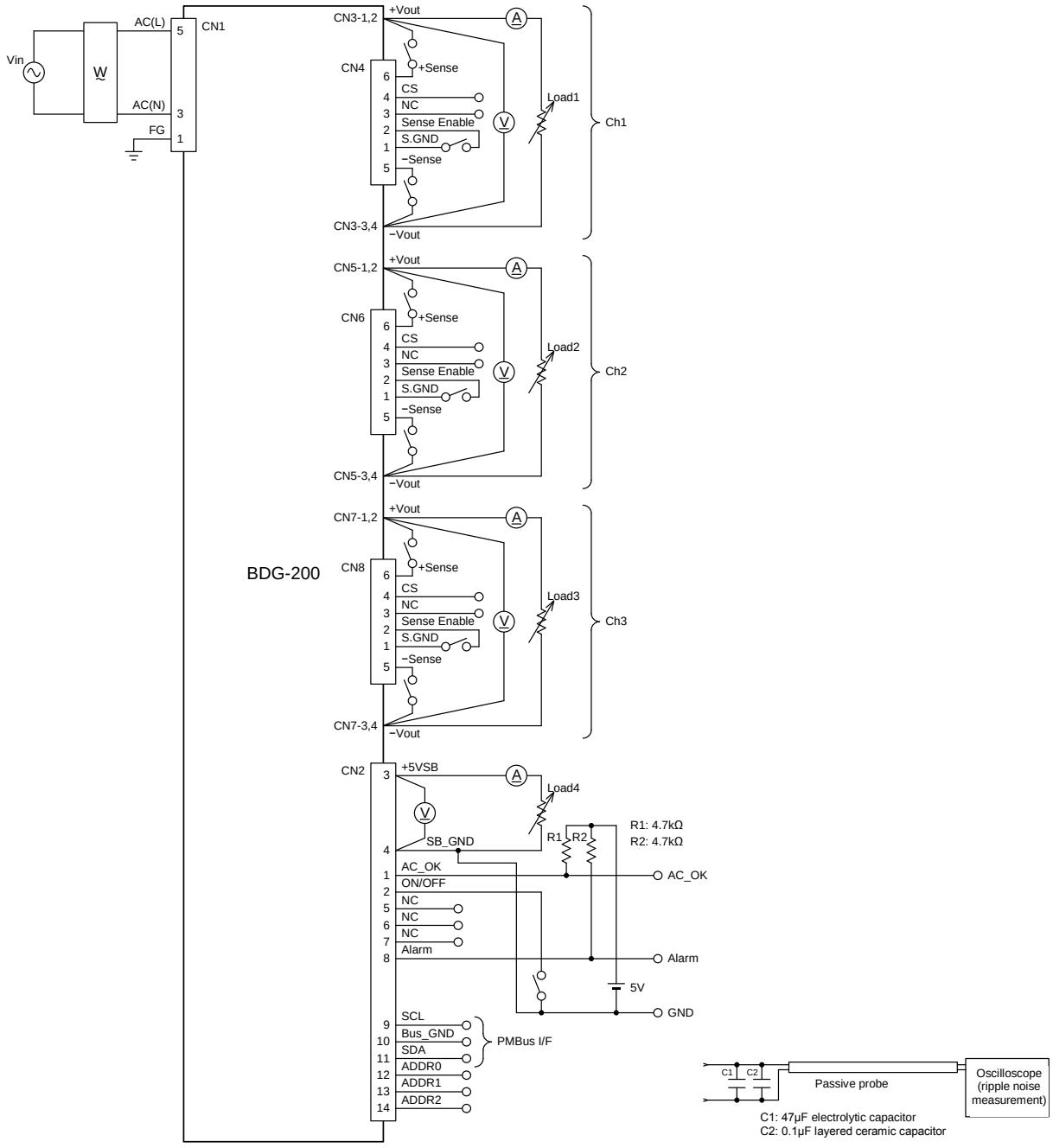
IEC60950 compliant design

4-5 EMC standard

- Conduced Emissions CISPR pub11 Group I Class A
- Radiated Emissions CISPR pub11 Group I Class A
- Harmonic Currents IEC61000-3-2 Class A
- Voltage Flicker IEC61000-3-3 Level 4 Operation standard B
- ESD Immunity IEC61000-4-2 Level 4 Operation standard B
- Radiated Immunity IEC61000-4-3 Level 2 Operation standard B
- EFT/Burst IEC61000-4-4 Level 4 Operation standard B
- Surge IEC61000-4-5 Class 4 Operation standard B
- Conducted Immunity IEC61000-4-6 Level 3 Operation standard B
- Dips & Interruptions IEC61000-4-11 Operation standard B

* This product is designed according to the above standards.

4-6 Measurement circuit

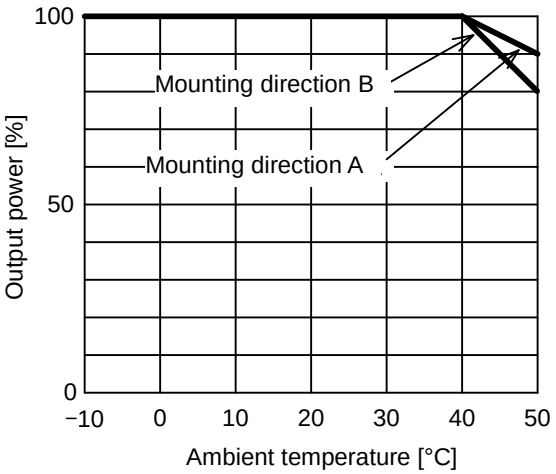


5. Temperature derating

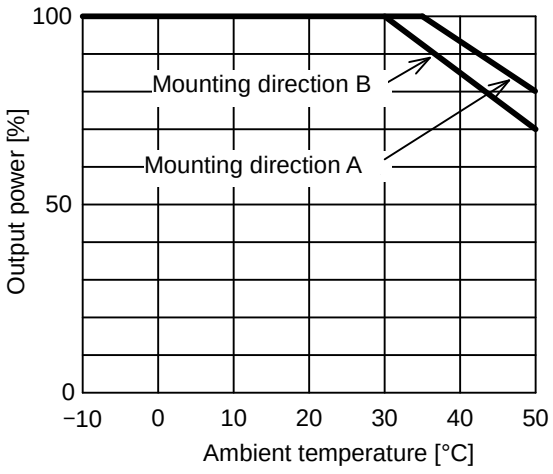
Install the converter in a place with good air convection and apply derating according to usage conditions.

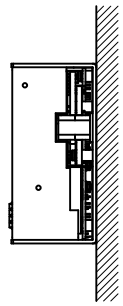
The derating graph below applies to environment with good air convection. The device in which the converter is installed should have proper thermal design so that the internal temperature does not exceed temperature conditions of the converter.

Natural air cooling, switching frequency 260kHz

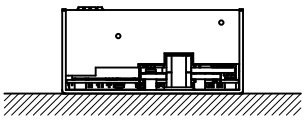


Natural air cooling, switching frequency 300kHz





Mounting direction A

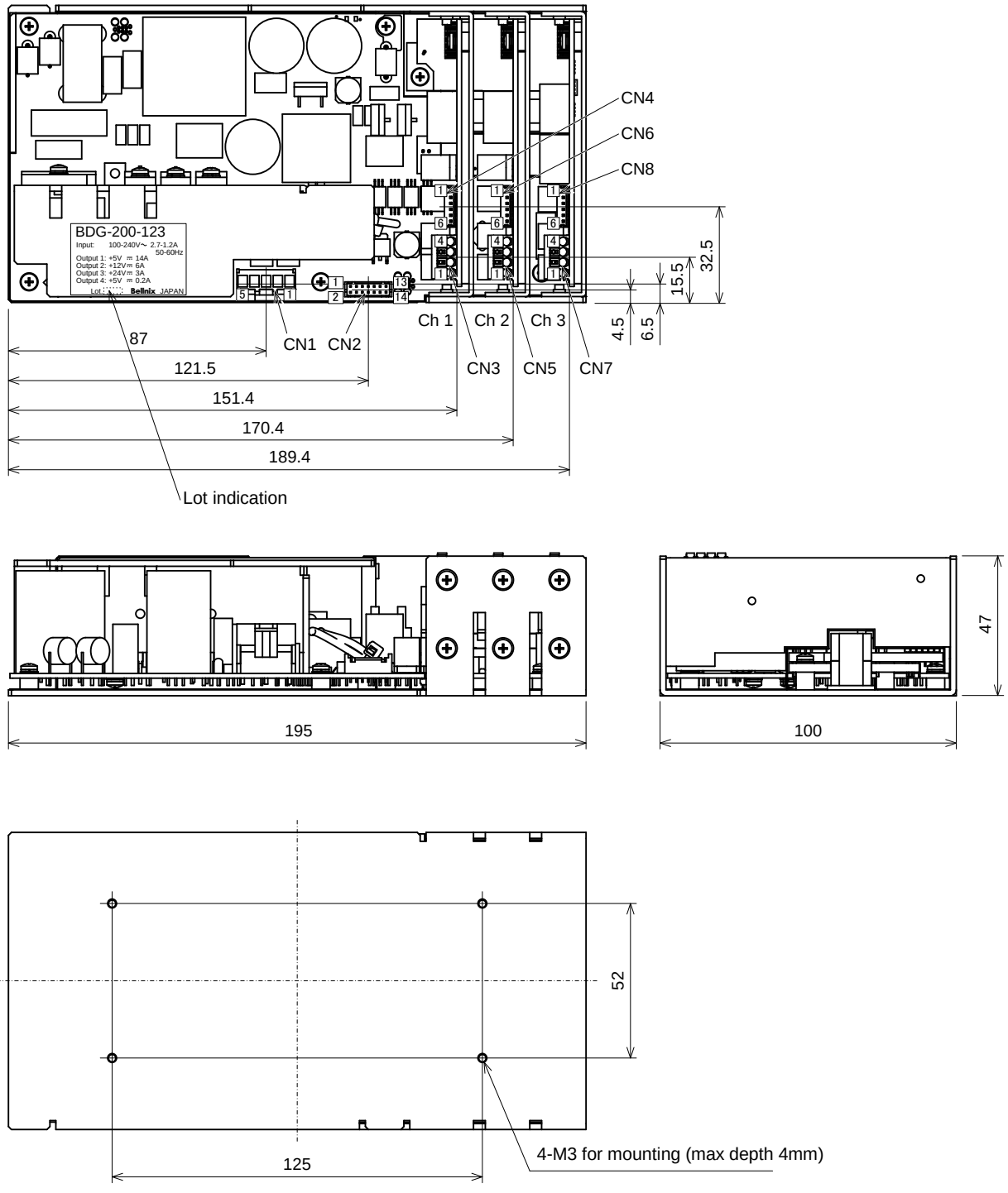


Mounting direction B

6. Outer dimensions and terminals

6-1

6-2 Shape and dimensions



・Units: mm
・Dimensional tolerance: ±0.5

6-3 Description of terminals

6-3-1 Global

1) Power supply input connector CN1 (B3P5-VH: J.S.T. MFG.Co., LTD.)

Pin	Name	Function
1	FG	Frame ground terminal
3	AC(N)	AC power supply terminal
5	AC(L)	AC power supply terminal

2) Control connector CN2 (B14B-PHDSS: made by J.S.T. Connector)

Pin	Name	Function
1	AC_OK	Input OK output terminal
2	ON/OFF	Remote ON/OFF control (for all channels) input terminal
3	+5VSB	Standby power output terminal
4	SB_GND	GND terminal for standby power output
5	NC	Not connected. Do not connect it electrically.
6	NC	Not connected. Do not connect it electrically.
7	NC	Not connected. Do not connect it electrically.
8	Alarm	Power failure output terminal
9	SCL	Serial communication clock input terminal
10	Bus_GND	Serial interface GND terminal. Connected to SB_GND terminal internally.
11	SDA	Serial interface data terminal
12	ADDR0	Device address setting terminal
13	ADDR1	Device address setting terminal
14	ADDR2	Device address setting terminal

6-3-2 For each channel

1) Output voltage terminals CN3, 5, 7 (0138-5104: DINKLE)

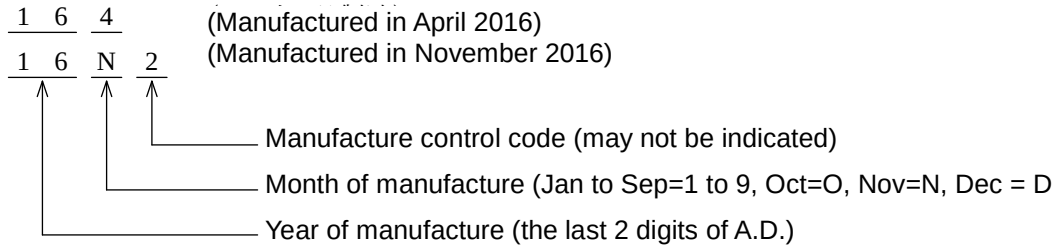
Pin	Name	Function
1	+Vout	Positive voltage output terminal
2	+Vout	Positive voltage output terminal
3	−Vout	Negative voltage output terminal
4	−Vout	Negative voltage output terminal

Proper wire diameter: 28 to 16AWG (18AWG recommended)
Wire strip length: 9mm min.

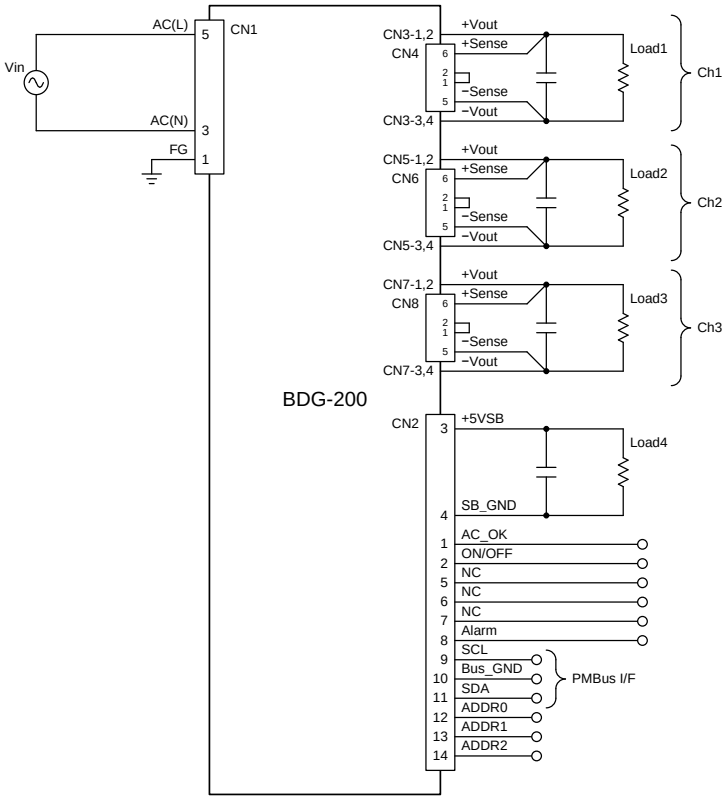
2) Output control connectors CN4, 6, 8 (53254-0670: Molex)

Pin	Name	Function
1	S.GND	Signal GND terminal
2	Sense Enable	Remote sensing ON/OFF switch terminal Connect to S.GND when remote sensing is used Leave open when remote sensing is not used
3	NC	Not connected. Do not connect it electrically.
4	CS	Parallel operation input/ output terminal
5	−Sense	Negative remote sensing terminal
6	+Sense	Positive remote sensing terminal

6-4 Lot indication



7. Standard connection circuit

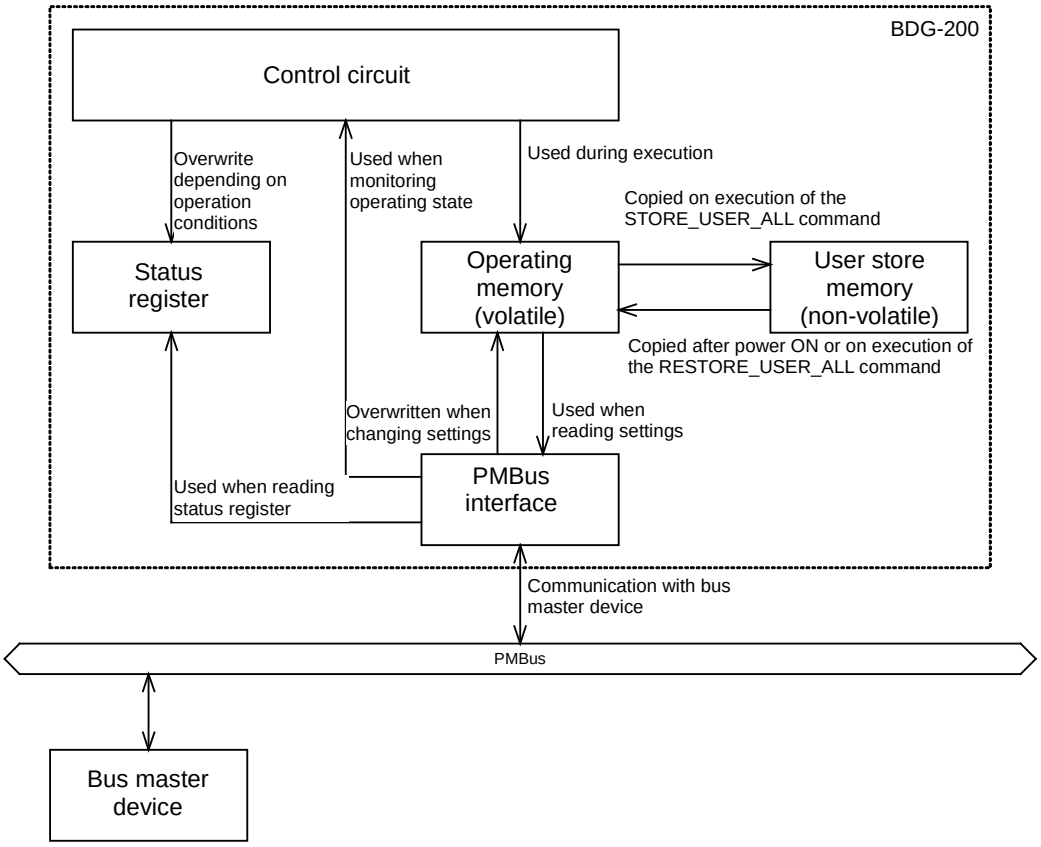


8. Functions

8-1 Digital control

The converter allows setting of output voltage, sequence and other parameters, and also reading of input voltage, output current and other information using serial interface PMBus.

The serial interface allows setting of control target values. Since actual operation is influenced by variation in products, actual and set values will be slightly different.



Digital control conceptual diagram

8-1-1 Internal memory

The converter is equipped with volatile operating memory and non-volatile user store memory. Converter settings are stored in the user store memory. The contents of the user store memory is copied into operating memory when power is turned ON.

The control circuit of this converter operates using contents of the operating memory. When settings are changed using serial communication, they are written into the operating memory. Because the operating memory is volatile, the modified settings will be lost when power is turned OFF.

To change settings used when power is turned ON, they need to be saved in the non-volatile user store memory by STORE_USER_ALL command after the operating memory is overwritten.

RESTORE_USER_ALL command can be used to replace the contents of the operating memory with the data stored in the user store memory (revert to the settings when the previous STORE_USER_ALL command was executed).

Settings made by the following commands can be stored and restored using STORE_USER_ALL and RESTORE_USER_ALL commands.

- ON_OFF_CONFIG
- VOUT_COMMAND
- VOUT_TRIM
- FREQUENCY_SWITCH
- VOUT_OV_FAULT_LIMIT
- IOUT_OC_FAULT_LIMIT
- TON_DELAY
- TON_RISE
- TOFF_DELAY

Setting items	PMBus command
Store settings	STORE_USER_ALL
Restore settings	RESTORE_USER_ALL

8-2 Output voltage setting method

The converter allows setting of the output voltage using serial communication within the range ±15% of the rated voltage. Since changing the output voltage is impossible due to volume, etc, when output voltage other than factory setting is required, the output voltage setting must be changed using serial communication.

Setting items	PMBus command	Setting range	Setting resolution		Factory setting
Output voltage setting	VOUT_COMMAND	Rated voltage ±15%	5V (with remote sensing): 5V (without remote sensing): 12V (with remote sensing): 12V (without remote sensing): 24V (with remote sensing): 24V (without remote sensing):	App. 9mV App. 8mV App. 21mV App. 19mV App. 36mV App. 37mV	Rated voltage

8-3 Output voltage trimming function

The output voltage trimming function can be used to increase or decrease the output voltage.

The set value of the output voltage trimming function can be modified using serial communication.

Setting items	PMBus command	Setting range	Setting resolution	Factory setting
Output voltage trimming setting	VOUT_TRIM	5V: −100 to 100 mV 12V: −240 to 240 mV 24V: −480 to 480 mV	Same as output voltage setting resolution	0mV

8-4 Remote sensing function

The remote sensing function can be used to obtain load fluctuation characteristics on the load side. The sensing line is a part of the feedback loop, and since it has very high sensitivity, careful attention is required when making routing. +Sense and −Sense wires should be routed to a load as twisted pair.

When using this function, the output voltage (voltage between +Vout and -Vout terminals) will be higher than voltage in the output voltage control point (between +Sense and -Sense terminals), so make sure that the output voltage do not exceed the allowable output voltage range. Also make sure that the output power does not exceed the rated maximum output power.

When using this function, connect Sense Enable terminal to S.GND terminal. Connect Sense Enable and S. GND terminals at the base of the connector; do not extend these wires.

If this function is not used, leave +Sense, −Sense, Sense Enable and S.GND terminals open.

8-5 ON/OFF control function

This function can be used to turn output voltage ON and OFF without connecting or disconnecting the input voltage. This converter supports ON/OFF control for all output channels at the same time, as well as individual ON/OFF control for each channel.

The ON/OFF control of all output channels at the same time can be done by two methods: using ON/OFF terminal and serial communication.

Individual ON/OFF control of each output channel can be performed by serial communication only.

It is possible to enable and disable ON/OFF control by ON/OFF terminal and serial communication separately. ON/OFF control can be enabled and disabled using serial communication. Modules are shipped with ON/OFF control enabled only for ON/OFF terminal.

ON/OFF control command has a high OFF priority. When ON/OFF control by the ON/OFF terminal and by serial communication are both enabled, the output will not turn ON until both controls are set to ON.

ON/OFF control of the standby power is not supported.

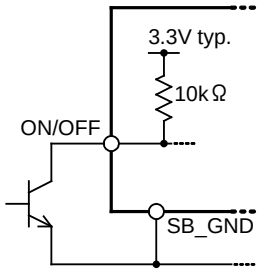
8-5-1 ON/OFF control by the ON/OFF terminal

All outputs can be turned ON or OFF by opening or closing ON/OFF and SB_GND terminals.

The ON/OFF terminal is connected internally to 3.3V typ. power voltage via 10kΩ resistor.

The control logic of the ON/OFF terminal can be set to positive logic (output ON when open) or negative logic (output OFF when open). The control logic of the ON/OFF terminal can be set using serial communication. It is set to positive logic and the factory.

Terminals ON/OFF – SB_GND	Positive logic (factory setting)	Negative logic
Open	Output ON	Output OFF
Closed (0 to 0.6V, 0.5mA max.)	Output OFF	Output ON



Note: Avoid chattering on the ON/OFF terminal. The chattering may cause malfunction of internal circuits.

When turning the output OFF using the ON / OFF terminal, it is possible to set whether to use the turn-off sequence or not at this time (whether or not turn-off delay is applied). The stop method is selected using serial communication (ON_OFF_CONFIG command). In factory settings the turn-off sequence is disabled.

8-5-2 ON/OFF control via serial communication

Output voltage can be turned ON and OFF using serial communication.

When turning the output OFF using the serial communication, it is possible to set whether to use the turn-off sequence or not at this time.

The serial communication can be used to turn ON/OFF all channels simultaneously or individually each channels.

Setting item	PMBus command	Factory setting
ON/OFF control via serial communication	OPERATION	Output OFF*
ON/OFF control configuration	ON_OFF_CONFIG	ON/OFF control by the ON/OFF terminal ENABLED ON/OFF control via serial communication DISABLED ON/OFF terminal logic POSITIVE When turning output OFF by ON/OFF terminal the falling sequence is NOT USED

* When power is applied, this setting is set to output OFF by default. This setting can not be stored in the user store memory.

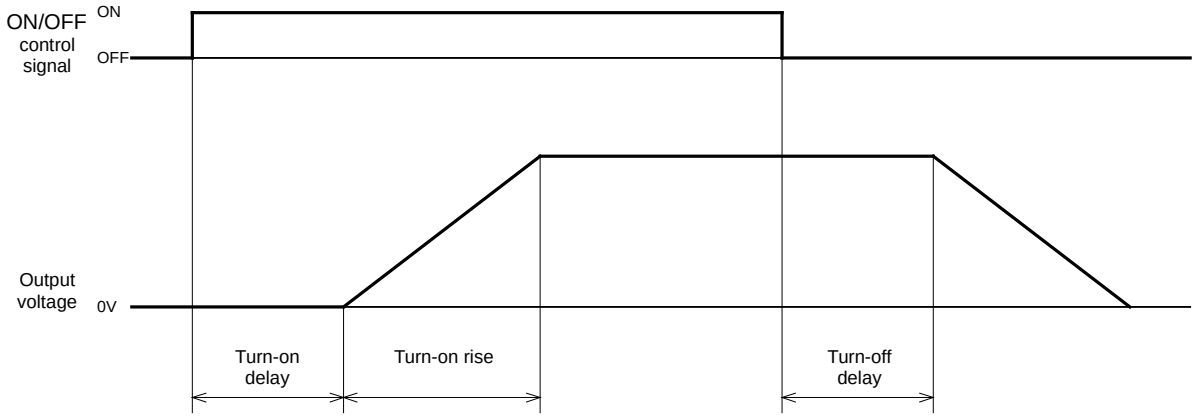
8-6 Sequence setting function

The sequence setting function can be used to set the following items.

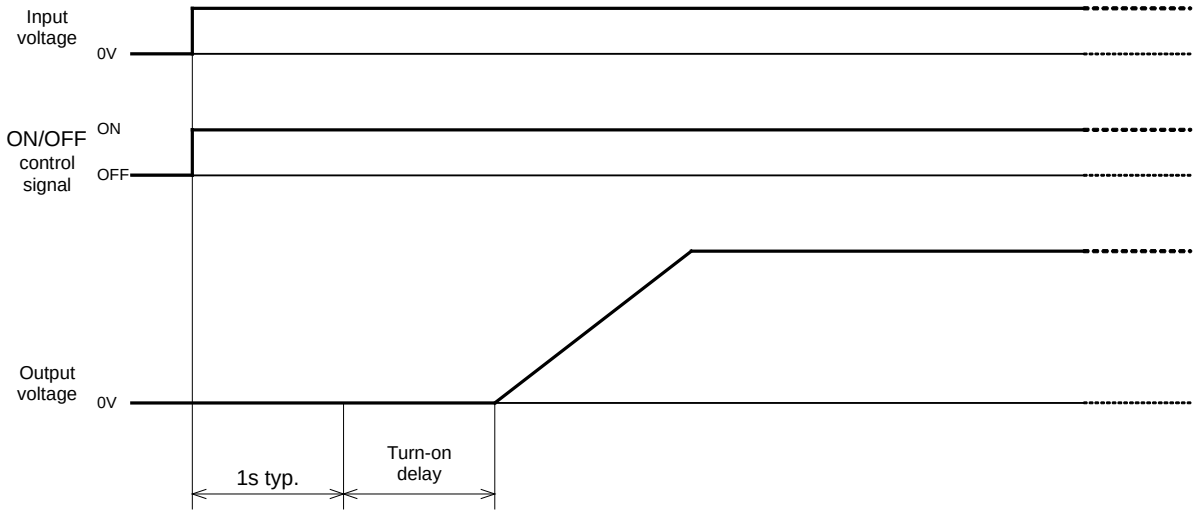
- Turn-on Delay
- Turn-on Rise
- Turn-off Delay

The turn-on delay is the time from issuance of the ON command by ON / OFF control (ON / OFF terminal or serial communication) until the output voltage starts to rise (see figure below).

The turn-off delay is the time from issuance of the OFF command by ON / OFF control (ON / OFF terminal or serial communication) until the output voltage starts to fall (see figure below).



When input voltage is applied, a waiting time of 1s typ. is inserted before start of the turn-on sequence (see figure below).



The setting of the sequence function can be modified using serial communication.

However, depending on the load capacitance, the actual turn-on rise time may differ from the set time.

Also, during parallel operation, the rise may be stepwise and may not rise completely within the set time.

Setting items	PMBus command	Setting range	Setting resolution	Factory setting
Turn-on delay	TON_DELAY	0 to 5000ms	1ms	0ms
Turn-on rise	TON_RISE	5 to 1000ms	1ms	100ms
Turn-off delay	TOFF_DELAY	0 to 500ms	1ms	0ms

When all output channels are turned ON at the same time by ON/OFF terminal or serial communication, a delay of at least 500 ms is used, even if the turn-on delay setting is less than 500 ms.

When turning ON all output channels at the same time by applying input voltage, waiting time of 1s typ. is inserted before the turn-on delay (see previous page). Even if the turn-on delay setting is less than 500 ms, a delay of 500 ms is used during actual operation.

When all output channels are turned OFF at the same time by ON/OFF terminal or serial communication, a delay of at least 20 ms is used, even if the turn-off delay setting is less than 20 ms.

When output channels are turned ON/OFF individually by serial communication, a delay of at least 1 ms is used, even if the turn-on or turn-off delay setting is less than 1 ms.

The turn-off delay setting is not used in the following cases.

- When turning output OFF by serial communication with turn-off sequence disabled for serial communication control
- When turning output OFF by ON/OFF terminal with sequence disabled for the ON/OFF terminal control
- When output is turned off by triggered protection function

8-7 Operation monitoring

Information about input voltage, output voltage, output current, device temperature, total operating time and estimated lifetime of the converter can be obtained using serial communication.

The converter contains 8 following status registers: STATUS_BYTE, STATUS_WORD, STATUS_VOUT, STATUS_IOUT, STATUS_INPUT, STATUS_TEMPERATURE, STATUS_CML and STATUS_MFR_SPECIFIC. By checking contents of status registers, it is possible to determine the error status of this product.

The status registers are set when protection function operates, and contents of the registers is retained even if the cause of the register setting is no longer exists. However, the status of under voltage lock out is cleared automatically. The status registers can be cleared in one of the following conditions.

- CLEAR_FAULTS command is executed
- Input voltage is reapplied

Bits of the status register linked to the protection function that latches the stop state are not cleared by the CLEAR_FAULTS instruction.

When reapplying the input voltage, keep input in OFF state for more than 30 seconds.

The contents of each register can be read via serial communication. For detailed information about contents of each register refer to sections describing reading instructions for correspondent registers.

Item	PMBus command
Input voltage monitoring	READ_VIN
Output voltage monitoring	READ_VOUT
Output current monitoring	READ_IOUT
Device temperature monitoring	READ_TEMPERATURE_1, READ_TEMPERATURE_2
Total operating time	READ_OPERATING_TIME
Estimated life	READ_ESTIMATED_LIFE
STATUS_BYTE register	STATUS_BYTE
STATUS_WORD register	STATUS_WORD
STATUS_VOUT register	STATUS_VOUT
STATUS_IOUT register	STATUS_IOUT
STATUS_INPUT register	STATUS_INPUT
STATUS_TEMPERATURE register	STATUS_TEMPERATURE
STATUS_CML register	STATUS_CML
STATUS_MFR_SPECIFIC register	STATUS_MFR_SPECIFIC

8-8 Status register history function

This converter can save values of the status registers in nonvolatile memory when the under voltage lock out function operates. The saved data can be read via serial communication.

Item	PMBus command
STATUS_BYTE register history	STATUS_BYTE_HISTORY
STATUS_WORD register history	STATUS_WORD_HISTORY
STATUS_VOUT register history	STATUS_VOUT_HISTORY
STATUS_IOUT register history	STATUS_IOUT_HISTORY
STATUS_INPUT register history	STATUS_INPUT_HISTORY
STATUS_TEMPERATURE register history	STATUS_TEMPERATURE_HISTORY
STATUS_CML register history	STATUS_CML_HISTORY
STATUS_MFR_SPECIFIC register history	STATUS_MFR_SPECIFIC_HISTORY

Since the status register history is saved when the under voltage lock out function operates, the bit indicating the under voltage condition is always set.

Because the status register history is overwritten each time the under voltage lock out function operates, it is not possible to obtain register values other than those that were in registers at the time of the latest operation of the under voltage lock out function.

8-9 Under voltage lock out

The converter is equipped with under voltage lock out (UVLO) function preventing malfunction when input voltage is low. When input voltage exceeds the activation voltage (79V typ.), the converter starts switching operation. If the input voltage falls below the deactivation voltage (75V typ.), the switching operation is stopped.

8-10 Input overvoltage detection

When the input voltage exceeds the threshold of the input overvoltage protection function, the converter stops switching operation. Because internal parts are not protected, they can be damaged by excessive input voltage.

Since this function is a latch-type function, it does not restore automatically. To release the latched condition, reapply the input voltage. When reapplying the input voltage, keep input in OFF state for more than 30 seconds.

8-11 Output overvoltage protection

When the output voltage (the voltage between +Vout and -Vout terminals) exceeds the threshold of the output overvoltage protection function, the converter stops switching operation. However, the function does not activate if overvoltage is caused by damaged unit.

When the remote sensing function is enabled, the voltage at output voltage control point (between +Sense and −Sense terminals) and overvoltage detection point (between +Vout and −Vout terminals) will be different. Consider voltage drop caused by wiring when setting the protection threshold.

Since this function is a latch-type function, it does not restore automatically. To release the latched condition, reapply the input voltage. When reapplying the input voltage, keep input in OFF state for more than 30 seconds.

The operation threshold of the output overvoltage function can be configured via serial communication.

Setting items	PMBus command	Setting range	Setting resolution	Factory setting
Output overvoltage protection threshold	VOUT_OV_FAULT_LIMIT	5V: 0 to 6.75V 12V: 0 to 16.2V 24V: 0 to 32.4V	5V (with remote sensing): App. 7 mV 5V (without remote sensing): App. 8mV 12V (with remote sensing): App. 18 mV 12V (without remote sensing): App. 20 mV 24V (with remote sensing): App. 33mV 23V (without remote sensing): App. 34 mV	5V: 6.75V 12V: 16.2V 24V: 32.4V

8-12 Output overcurrent protection

When the output overcurrent protection function operates, the output voltage is decreased to limit the output current. When the overcurrent condition is canceled, the output voltage will be restored automatically.

The operation threshold of the output overcurrent function can be configured via serial communication.

Setting items	PMBus command	Setting range	Setting resolution	Factory setting
Output overcurrent protection threshold	IOUT_OC_FAULT_LIMIT	5V: 7 to 16.1A 12V: 3 to 6.9A 24V: 1.5 to 3.7A	5V: App. 26mA 12V: App. 12 mA 24V: App. 6 mA	5V: 16.1A 12V: 6.9A 24V: 3.7A

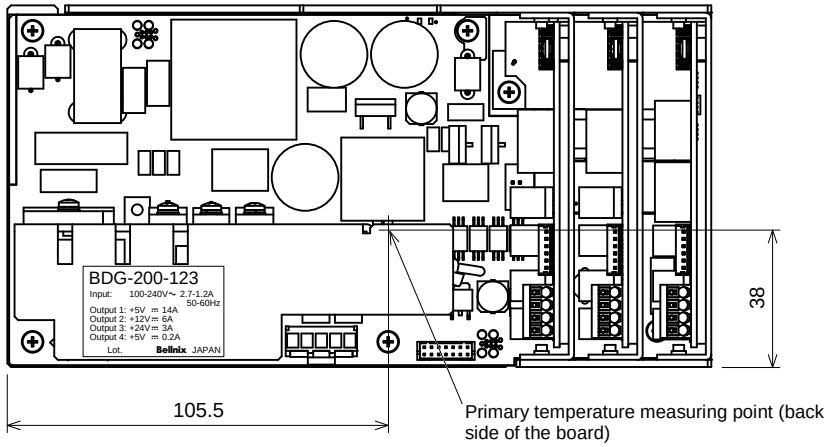
8-13 Overheat protection

When measured temperature of the converter exceeds the overheat protection threshold, the overheat protection function operates, stopping the switching operation.

Since this function is a latch-type function, it does not restore automatically. To release the latched condition, reapply the input voltage. When reapplying the input voltage, keep input in OFF state for more than 30 seconds.

One temperature sensor is mounted on the primary side (place shown on the figure below), and one sensor is installed for each output channel.

The temperature at which the overheat protection function triggers is not the maximum operating temperature. Therefore, do not use the converter at temperatures outside the derating range shown in the chapter 5. Temperature derating, even if this temperature is below the overhead protection threshold.



8-14 Parallel operation

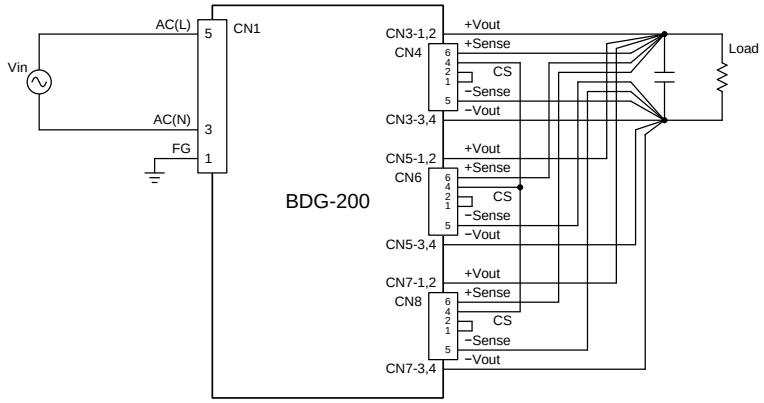
Parallel operation can be performed by connecting the same terminals +Vout and -Vout of all channels, and then connecting CS terminals to each other. Always use the remote sensing function during parallel operation.

Set the same output voltage settings for all output channels used in parallel.

The wiring of +Vout and -Vout terminals should have the same length for all output channels.

Load derating is required during parallel operation. Load factor should not exceed 90%.

Connection example



8-15 Switching frequency setting

Using this function, the switching frequency can be set in the range from 260 kHz to 300 kHz.

The switching frequency can be set using serial communication. Settings can be changed only when all output channels are OFF.

Setting items	PMBus command	Setting range	Setting resolution	Factory setting
Switching frequency	FREQUENCY_SWITCH	260 to 300kHz	1kHz	260kHz

8-16 Input OK signal (AC_OK) output

The Input OK signal output can be used to notify the state of input voltage.

When the input voltage exceeds the operation start voltage, this output is in Low state. When the input voltage falls below the operation stop voltage, this output is open (high impedance).

It also becomes open (high impedance) when input overvoltage voltage detection function operates. After the input overvoltage detection function is triggered, this output remains open even if the input voltage is reduced below the threshold.

Applicable voltage: 30V max.
Output Low level: 0.4V max. (sink current 20mA max.)

8-17 Power failure signal (Alarm) output

The Power failure signal output can be used to notify about presence or absence of power failures. The power failure signal is synchronized with status registers.

Normally Low, when at least one bit of the status register is set, this output becomes open (high impedance).

Applicable voltage: 30V max.
output Low level: 0.4V max. (sink current 20mA max.)

9. Serial interface

9-1 Definitions of symbols and terms

9. The symbols and terms used in this chapter are defined as follows.

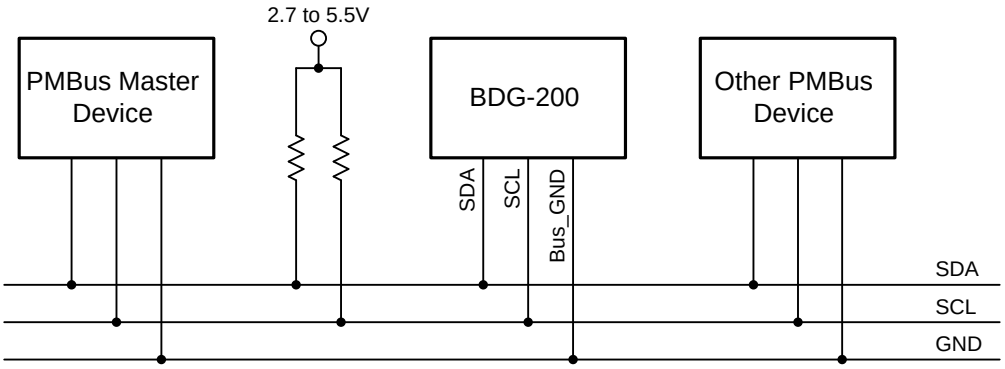
Symbols and terms	Definition
Byte	8 bits
Word	16 bits (2 bytes)
Set	Set bit to logical ’1’ state
Clear	Set bit to logical ’0’ state
nnb	Number ’nn’ as a binary number .
nnh	Number ’nn’ as a hexadecimal number.

9-2 Communication method

The serial interface of the converter complies with PMBus Specification Revision 1.1. For detailed information about instruction transfer method, etc., refer to PMBus specification (PMBus Power System Management Protocol Specification Part I, General Requirements, Transport And Electrical Interface – Revision 1.1 and PMBus Power System Management Protocol Specification Part II, Command Language – Revision 1.1).

9-3 Communication terminals

Connect PMBus communication terminals (SDA, SCL) to a 2.7V to 5.5V power supply through a pull-up resistor or by a similar circuit. When serial communication is not used, leave PMBus communication terminals open.



GND terminal of PMBus interface (Bus_GND) is internally connected to the GND terminal of standby power supply (SB_GND). Therefore, if ground may be unstable, for example, due to pulse load connected to the standby output, the stability of communication may be affected.

9-3-1 SDA terminal

The SDA terminal is used for data input and output in the serial interface. When used as output, the pin is configured as an open drain output.

- Input Low level: 0 to 0.8V
- Input High Level: 2.1V min.
- Output Low level: 0.4V max. (sink current 5mA max.)

9-3-2 SCL terminal

The SCL terminal is used for clock input in the serial interface.

The SCL terminal is not driven by the converter. The SCL terminal is driven by bus master.

- Input Low level: 0 to 0.8V
- Input High level: 2.1V min.

9-4 Device address setting

Since in the PMBus interface multiple devices share the same bus, each device can be identified by its own device address. A device address should be unique on the same bus.

A device address can be specified by connecting between ADDR0, ADDR1, ADDR2 and SB_GND terminals or leaving the open. The correspondence between state of ADDR0, ADDR1 and ADDR2 terminals and device addresses are shown below. Device address is set at power up according to the state of ADDR0, ADDR1 and ADDR2 terminals. Changing the state of ADDR0, ADDR1 and ADDR2 terminals after power is applied will not affect the device address.

Device address	ADDR2 – SB_GND	ADDR1 – SB_GND	ADDR0 – SB_GND
1011 000	Closed	Closed	Closed
1011 001	Closed	Closed	Open
1011 010	Closed	Open	Closed
1011 011	Closed	Open	Open
1011 100	Open	Closed	Closed
1011 101	Open	Closed	Open
1011 110	Open	Open	Closed
1011 111	Open	Open	Open

9-5 Data format

9-5-1 DIRECT Data Format

The data format consists from the following elements.

- *X*: Actual value
- *Y*: A value read or written in Data Byte of a PMBus command (2-byte signed integer represented as 2's complement)
- *m*: Slope coefficient
- *b*: Offset value
- *R*: Exponent

* For *m*, *b*, *R* values refer to descriptions of correspondent PMBus commands.

The relationship between elements is shown by the following expression.

$$X = \frac{1}{m}\ (Y \times 10^{-R} - b)$$

$$Y = (m\,X + b) \times 10^{R}$$

9-6 PMBus command

9-6-1 The list of PMBus command

The converter supports the PMBus commands shown in the following table.

PMBus command	Command code	Transaction type	Data size (Byte)	Data format	Factory setting
PAGE	00h	R/W Byte	1	—	00h
OPERATION	01h	R/W Byte	1	—	00h
ON_OFF_CONFIG	02h	R/W Byte	1	—	17h
CLEAR_FAULTS	03h	Send Byte	0	—	—
STORE_USER_ALL	15h	Send Byte	0	—	—
RESTORE_USER_ALL	16h	Send Byte	0	—	—
VOUT_COMMAND	21h	R/W Word	2	DIRECT	5V: 1388h (5V) 12V: 2EE0h (12V) 24V: 5DC0h (24V)
VOUT_TRIM	22h	R/W Word	2	DIRECT	0000h (0V)
FREQUENCY_SWITCH ※	33h	R/W Word	2	DIRECT	0104h (260kHz)
VOUT_OV_FAULT_LIMIT	40h	R/W Word	2	DIRECT	5V: 1A5Eh (6.75V) 12V: 3F48h (16.2V) 24V: 7E90h (32.4V)
IOUT_OC_FAULT_LIMIT	46h	R/W Word	2	DIRECT	5V: 3EE4h (16.1A) 12V: 1AF4h (6.9A) 24V: 0E74h (3.7A)
TON_DELAY	60h	R/W Word	2	DIRECT	0000h (0ms)
TON_RISE	61h	R/W Word	2	DIRECT	0064h (100ms)
TOFF_DELAY	64h	R/W Word	2	DIRECT	0000h (0ms)
STATUS_BYTE	78h	Read Byte	1	—	—
STATUS_WORD	79h	Read Word	2	—	—
STATUS_VOUT	7Ah	Read Byte	1	—	—
STATUS_IOUT	7Bh	Read Byte	1	—	—
STATUS_INPUT	7Ch	Read Byte	1	—	—
STATUS_TEMPERATURE	7Dh	Read Byte	1	—	—
STATUS_CML	7Eh	Read Byte	1	—	—
STATUS_MFR_SPECIFIC	80h	Read Byte	1	—	—
READ_VIN	88h	Read Word	2	DIRECT	—
READ_VOUT	8Bh	Read Word	2	DIRECT	—
READ_IOUT	8Ch	Read Word	2	DIRECT	—
READ_TEMPERATURE_1	8Dh	Read Word	2	DIRECT	—
READ_TEMPERATURE_2	8Eh	Read Word	2	DIRECT	—

READ_OPERATING_TIME	D0h	Read Word	2	DIRECT	—
READ_ESTIMATED_LIFE	D1h	Read Word	2	DIRECT	—
STATUS_BYTE_HISTORY	D8h	Read Byte	1	—	—
STATUS_WORD_HISTORY	D9h	Read Word	2	—	—
STATUS_VOUT_HISTORY	DAh	Read Byte	1	—	—
STATUS_IOUT_HISTORY	DBh	Read Byte	1	—	—
STATUS_INPUT_HISTORY	DCh	Read Byte	1	—	—
STATUS_TEMPERATURE_HISTORY	DDh	Read Byte	1	—	—
STATUS_CML_HISTORY	DEh	Read Byte	1	—	—
STATUS_MFR_SPECIFIC_HISTORY	E0h	Read Byte	1	—	—

* Settings can be changed only when all output channels are OFF.

The meaning of the Transaction type column from the previous table is shown below.

Transaction type	Communication protocol
Send Byte	Send Byte Protocol
Read Byte	Read Byte Protocol
Read Word	Read Word Protocol
R/W Byte	Read Byte Protocol and Write Byte Protocol
R/W Word	Read Word Protocol and Write Word Protocol

9-6-2 PAGE command (00h)

This command is used to select the output channel for control.

Data size: 1 byte.

Data byte	Control channel
00h	Ch1 output
01h	Ch2 output
02h	Ch3 output
03h	Primary side (STATUS_TEMPERATURE only. Not used in other commands.)
04h~FEh	Not used
FFh	All channels (OPERATION only.) Not used in other commands.)

The setting made by the PAGE command affects the following commands. Command other than below are not affected by the setting made by the PAGE command.

- OPERATION
- VOUT_COMMAND
- VOUT_TRIM
- VOUT_OV_FAULT_LIMIT
- IOUT_OC_FAULT_LIMIT
- TON_DELAY
- TON_RISE
- TOFF_DELAY
- STATUS_VOUT
- STATUS_IOUT
- STATUS_TEMPERATURE
- READ_VOUT
- READ_IOUT
- READ_TEMPERATURE_2
- STATUS_VOUT_HISTORY
- STATUS_IOUT_HISTORY
- STATUS_TEMPERATURE_HISTORY

9-6-3 OPERATION command (01h)

This command is used for ON/OFF control.

Data size: 1 byte. Function of each bit is shown in the following table.

Bit				Output		Factory
7 – 6	5 – 4	3 – 2	1 – 0	ON/OFF		setting
00	XX	XX	XX	OFF	Turn-off sequence disabled Stop output without using the sequence specified by TOFF_DELAY command	●
01	XX	XX	XX	OFF	Turn-off sequence enabled Stop output using the sequence specified by TOFF_DELAY command	
10	00	XX	XX	ON	—	

Bits marked by X can have either 0 or 1 value; they do not affect the operation.

If a combination of values not shown above is set, the behavior is undefined.

The read/write target is set by the PAGE command. PAGE 00h~02h sets the output channel 1~3, PAGE FFh sets all output channels. For example, when turning ON the output channel 1, the output will not turn ON unless PAGE 00h is set to ON and PAGE FFh is set to ON (the order of setting is irrelevant).

When ON / OFF control by serial communication is disabled using the ON_OFF_CONFIG command (bit 4 or bit 3 cleared), ON / OFF control can not be performed using this command.

9-6-4 ON_OFF_CONFIG command (02h)

This command is used to set the ON/OFF control operation.

Data size: 1 byte. Function of each bit is shown in the following table.

Bit	Purpose	Value	Description	Factory setting
7–5	Reserved	Ignored	Not used	
4	ON/OFF control enable / disable	0	Disable ON / OFF control by ON / OFF terminal and serial communication	
		1	Enable ON / OFF control by ON / OFF terminal and serial communication *	●
3	Enable / disable ON/OFF control by serial communication	0	Disable ON/OFF control by serial communication	●
		1	Enable ON/OFF control by serial communication	
2	Enable / disable ON/OFF control by ON/OFF terminal	0	Disable ON/OFF control by ON/OFF terminal	
		1	Enable ON/OFF control by ON/OFF terminal	●
1	Select control logic for ON/OFF terminal	0	Negative logic (ON when closed)	
		1	Positive logic (ON when open)	●
0	Enable / disable turn-off sequence when turned OFF by ON/OFF terminal	0	Stop output using the sequence specified by TOFF_DELAY command	
		1	Stop output without using the sequence specified by TOFF_DELAY command	●

※ Follow the setting of bits 3-0.

When ON / OFF control by the ON / OFF terminal and by serial communication are both enabled (bits 4-2 are all set), the output will not turn ON until both controls are set to ON.

9-6-5 CLEAR_FAULTS command (03h)

This command is used to clear the status register.

Bits of the status register linked to the protection function that latches the stop state are not cleared by the CLEAR_FAULTS instruction.

This command only clears the status register, but it does not release the latch stop state set by the protection.

9-6-6 STORE_USER_ALL command (15h)

This command stores the contents of operating memory in nonvolatile user store memory.

Note: Always maintain the input voltage for 1 second after execution of this command. Otherwise the contents of the user store memory may be destroyed, making its recovery impossible.

9-6-7 RESTORE_USER_ALL command (16h)

This command overwrites the contents of operating memory with the data stored in the nonvolatile user store memory.

9-6-8 VOUT_COMMAND command (21h)

This command is used to set the output voltage.
Data size: 2 bytes, DIRECT Format is used (units: V). Coefficients: m = 1, b = 0, R = 3.
The target output channel for read/write operation is set by the PAGE command.

9-6-9 VOUT_TRIM command (22h)

This command is used to set output voltage trimming.
Data size: 2 bytes, DIRECT Format is used (units: V). Coefficients: m = 1, b = 0, R = 3.
The target output channel for read/write operation is set by the PAGE command.

9-6-10 FREQUENCY_SWITCH command (33h)

This command is used to set the switching frequency.
Data size: 2 bytes, DIRECT Format is used (units: kHz). Coefficients: m = 1, b = 0, R = 0.

9-6-11 VOUT_OV_FAULT_LIMIT command (40h)

This command is used to set the output overvoltage protection threshold.
Data size: 2 bytes, DIRECT Format is used (units: V). Coefficients: m = 1, b = 0, R = 3.
The target output channel for read/write operation is set by the PAGE command.

9-6-12 IOUT_OC_FAULT_LIMIT command (46h)

This command is used to set the output overcurrent protection threshold.
Data size: 2 bytes, DIRECT Format is used (units: A). Coefficients: m = 1, b = 0, R = 3.
The target output channel for read/write operation is set by the PAGE command.

9-6-13 TON_DELAY command (60h)

This command is used to set the Turn-on Delay parameter.
Data size: 2 bytes, DIRECT Format is used (units: ms). Coefficients: m = 1, b = 0, R = 0.
The target output channel for read/write operation is set by the PAGE command.

9-6-14 TON_RISE command (61h)

This command is used to set the Turn-on Rise parameter.
Data size: 2 bytes, DIRECT Format is used (units: ms). Coefficients: m = 1, b = 0, R = 0.
The target output channel for read/write operation is set by the PAGE command.

9-6-15 TOFF_DELAY command (64h)

This command is used to set the Turn-off Delay parameter.
Data size: 2 bytes, DIRECT Format is used (units: ms). Coefficients: m = 1, b = 0, R = 0.
The target output channel for read/write operation is set by the PAGE command.

9-6-16 STATUS_BYTE command (78h)

This command is used to read the STATUS_BYTE register.

The STATUS_BYTE is a 1 byte register. Function of each bit is shown in the following table.

Bit	Bit name	Description
7	BUSY	Normally 0
6	OFF	Normally 0
5	VOUT_OV	Set when overvoltage protection triggers for one or more channels
4	IOUT_OC	Set when overcurrent protection triggers for one or more channels
3	VIN_UV	Set when undervoltage lock out function triggers
2	TEMPERATURE	Set when overheat protection triggers
1	CML	Set when one or more bits of the STATUS_CML register are set
0	NONE OF ABOVE	Set when input overvoltage protection triggers, or when one or more bits of the STATUS_MFR_SPECIFIC register are set.

9-6-17 STATUS_WORD command (79h)

This command is used to read the STATUS_WORD register.

The STATUS_WORD is a 2 byte register. Function of each bit is shown in the following table.

	Bit	Bit name	Description
Lower part	7	BUSY	Normally 0
	6	OFF	Normally 0
	5	VOUT_OV	Set when overvoltage protection triggers for one or more channels
	4	IOUT_OC	Set when overcurrent protection triggers for one or more channels
	3	VIN_UV	Set when undervoltage lock out function triggers
	2	TEMPERATURE	Set when overheat protection triggers
	1	CML	Set when one or more bits of the STATUS_CML register are set
	0	NONE OF ABOVE	Set when input overvoltage protection triggers, or when one or more bits of the STATUS_MFR_SPECIFIC register are set.
Upper part	7	VOUT	Set when one or more bits of the STATUS_VOUT register for one or more channels are set
	6	IOUT	Set when one or more bits of the STATUS_IOUT register for one or more channels are set
	5	INPUT	Set when one or more bits of the STATUS_INPUT register are set
	4	MFR	Set when one or more bits of the STATUS_MFR_SPECIFIC register are set
	3	POWER_GOOD#	Normally 0
	2	FANS	Normally 0
	1	OTHER	Normally 0
	0	UNKNOWN	Normally 0

9-6-18 STATUS_VOUT command (7Ah)

This command is used to read the STATUS_VOUT register.

The STATUS_VOUT is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Set when output overvoltage protection triggers
6	Normally 0
5	Normally 0
4	Normally 0
3	Normally 0
2	Normally 0
1	Normally 0
0	Normally 0

The target output channel for read operation is set by the PAGE command.

9-6-19 STATUS_IOUT command (7Bh)

This command is used to read the STATUS_IOUT register.

The STATUS_IOUT is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Set when output overcurrent protection triggers
6	Normally 0
5	Normally 0
4	Normally 0
3	Normally 0
2	Normally 0
1	Normally 0
0	Normally 0

The target output channel for read operation is set by the PAGE command.

9-6-20 STATUS_INPUT command (7Ch)

This command is used to read the STATUS_INPUT register.

The STATUS_INPUT is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Set when input overvoltage detection triggers
6	Normally 0
5	Normally 0
4	Set when undervoltage lock out function triggers
3	Normally 0
2	Normally 0
1	Normally 0
0	Normally 0

9-6-21 STATUS_TEMPERATURE command (7Dh)

This command is used to read the STATUS_TEMPERATURE register.

The STATUS_TEMPERATURE is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Set when overheat protection triggers
6	Normally 0
5	Normally 0
4	Normally 0
3	Normally 0
2	Normally 0
1	Normally 0
0	Normally 0

The target of read operation is set by the PAGE command. PAGE 00h to 02h sets the output channel 1 to 3, PAGE 03h sets primary side.

9-6-22 STATUS_CML command (7Eh)

This command is used to read the STATUS_CML register.

The STATUS_CML is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Set when a command code not found in the list of PMBus command codes is used
6	Set when invalid data are received
5	Set when Packet Error Check fails
4	Set when memory read/write error occurs
3	Normally 0
2	Normally 0
1	Normally 0
0	Normally 0

9-6-23 STATUS_MFR_SPECIFIC command (80h)

This command is used to read the STATUS_MFR_SPECIFIC register.

The STATUS_MFR_SPECIFIC is a 1 byte register. Function of each bit is shown in the following table.

Bit	Description
7	Normally 0
6	Set when internal error 6 occurs
5	Set when internal error 5 occurs
4	Set when internal error 4 occurs
3	Set when internal error 3 occurs
2	Set when internal error 2 occurs
1	Set when internal error 1 occurs
0	Set when internal error 0 occurs

The meaning of internal errors is not disclosed.

If an internal error occurs repeatedly even after input voltage is reapplied, this may mean that module is damaged. When internal error occurs, please contact manufacturer.

9-6-24 READ_VIN command (88h)

This command is used to read the actual input voltage.

Data size: 2 bytes, DIRECT Format is used (units: V). Coefficients: m = 1, b = 0, R = 1.

9-6-25 READ_VOUT command (8Bh)

This command is used to read the output voltage.

Data size: 2 bytes, DIRECT Format is used (units: V). Coefficients: m = 1, b = 0, R = 3.

The target output channel for read operation is set by the PAGE command.

9-6-26 READ_IOUT command (8Ch)

This command is used to read the output current.

Data size: 2 bytes, DIRECT Format is used (units: A). Coefficients: m = 1, b = 0, R = 3.

The target output channel for read operation is set by the PAGE command.

9-6-27 READ_TEMPERATURE_1 command (8Dh)

This command is used to read temperature in the device (primary side).

Data size: 2 bytes, DIRECT Format is used (units: °C). Coefficients: m = 1, b = 0, R = 0.

9-6-28 READ_TEMPERATURE_2 command (8Eh)

This command is used to read temperature in the device (secondary side).

Data size: 2 bytes, DIRECT Format is used (units: °C). Coefficients: m = 1, b = 0, R = 0.

The target output channel for read operation is set by the PAGE command.

9-6-29 READ_OPERATING_TIME command (D0h)

This command is used to read the total operating time.

Data size: 2 bytes, DIRECT Format is used (units: days). Coefficients: m = 1, b = 0, R = 0.

9-6-30 READ_ESTIMATED_LIFE command (D1h)

This command is used to read the estimated life.

Data size: 2 bytes, DIRECT Format is used (units: days). Coefficients: m = 1, b = 0, R = 0.

9-6-31 STATUS_BYTE_HISTORY command (D8h)

This command is used to read the history of the STATUS_BYTE register.

Data size: 1 byte.

9-6-32 STATUS_WORD_HISTORY command (D9h)

This command is used to read the history of the STATUS_WORD register.

Data size: 2 bytes.

9-6-33 STATUS_VOUT_HISTORY command (DAh)

This command is used to read the history of the STATUS_VOUT register.

Data size: 1 byte.

9-6-34 STATUS_IOUT_HISTORY command (DBh)

This command is used to read the history of the STATUS_IOUT register.

Data size: 1 byte.

9-6-35 STATUS_INPUT_HISTORY command (DCh)

This command is used to read the history of the STATUS_INPUT register.

Data size: 1 byte.

9-6-36 STATUS_TEMPERATURE_HISTORY command (DDh)

This command is used to read the history of the STATUS_TEMPERATURE register.

Data size: 1 byte.

9-6-37 STATUS_CML_HISTORY command (DEh)

This command is used to read the history of the STATUS_CML register.

Data size: 1 byte.

9-6-38 STATUS_MFR_SPECIFIC_HISTORY command (E0h)

This command is used to read the history of the STATUS_MFR_SPECIFIC register.

Data size: 1 byte.

10. Vibration and shock testing

Vibration: 5 to 10Hz total amplitude 10mm, 10 to 55Hz acceleration 2G (1 hour in each of 3 directions)
Shock: acceleration 20G (3 times in each of 3 directions)
shock time 11±5ms

11. Expected life

The expected life of the converter is given in the following table.

Mounting direction*	Ambient temperature	Expected life (switching frequency 260kHz, output power 100%)
A	40°C or less	6.3 years
B	40°C or less	4.2 years

* See chapter 5. Temperature derating

12. Precautions for use

To ensure user's safety, check specifications before using the product and always observe the following precautions when using it.

- The product is intended for use in general electronics equipment (office equipment, communication equipment, measurement equipment). Do not use the product in medical equipment, nuclear equipment, trains, and other areas, where human life or property may be directly affected by damaged product, or in the environment with constant vibration. For any use other than in general electronics equipment please consult the manufacturer.
- While the product has a built-in overcurrent and short-circuit protection, a prolonged short circuit condition should be avoided as it can damage the product.
- The product may be damaged if used under nonstandard electrical or environmental conditions including temperature, etc. The product must be always used within specifications.
- Avoid storing or using the product in places where corrosive gas or dust are generated.
- The product may be damaged by static electricity. Take measures against static electricity in the working environment, such as using grounding straps to discharge the static charge on workers, etc.
- Do not replace fuses.
- The product contains parts under high voltage. Do not touch the product when input voltage is applied or right after input voltage is disconnected.
- The product contains hot parts. Do not touch the product when input voltage is applied or right after input voltage is disconnected.
- The product does not come with a test report.

13. Warranty

The warranty period of this product is one year. Should the product become defective within the warranty period due defects in design or manufacture, it will be repaired or replaced free of charge. However, this warranty does not cover products which have been subjected to internal modifications, etc.

The scope of the warranty is limited to this product only.

14. Model names and configurations

The following table shows the correspondence between model names and unit configurations. If a configuration absent in the table is required, please contact manufacturer.

Model	Rated output		
	Channel 1	Channel 2	Channel 3
BDG-200-001	No unit	No unit	5V
BDG-200-002	No unit	No unit	12V
BDG-200-003	No unit	No unit	24V
BDG-200-011	No unit	5V	5V
BDG-200-012	No unit	5V	12V
BDG-200-013	No unit	5V	24V
BDG-200-022	No unit	12V	12V
BDG-200-023	No unit	12V	24V
BDG-200-033	No unit	24V	24V
BDG-200-111	5V	5V	5V
BDG-200-112	5V	5V	12V
BDG-200-113	5V	5V	24V
BDG-200-122	5V	12V	12V
BDG-200-123	5V	12V	24V
BDG-200-133	5V	24V	24V
BDG-200-222	12V	12V	12V
BDG-200-223	12V	12V	24V
BDG-200-233	12V	24V	24V
BDG-200-333	24V	24V	24V