

Operating Instruction Manual for
Dipole Magnet Power Supply

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1. General Description

This equipment is a direct-current power supply which feeds a direct current to the D Magnet. Its configuration is shown in the following block diagram.

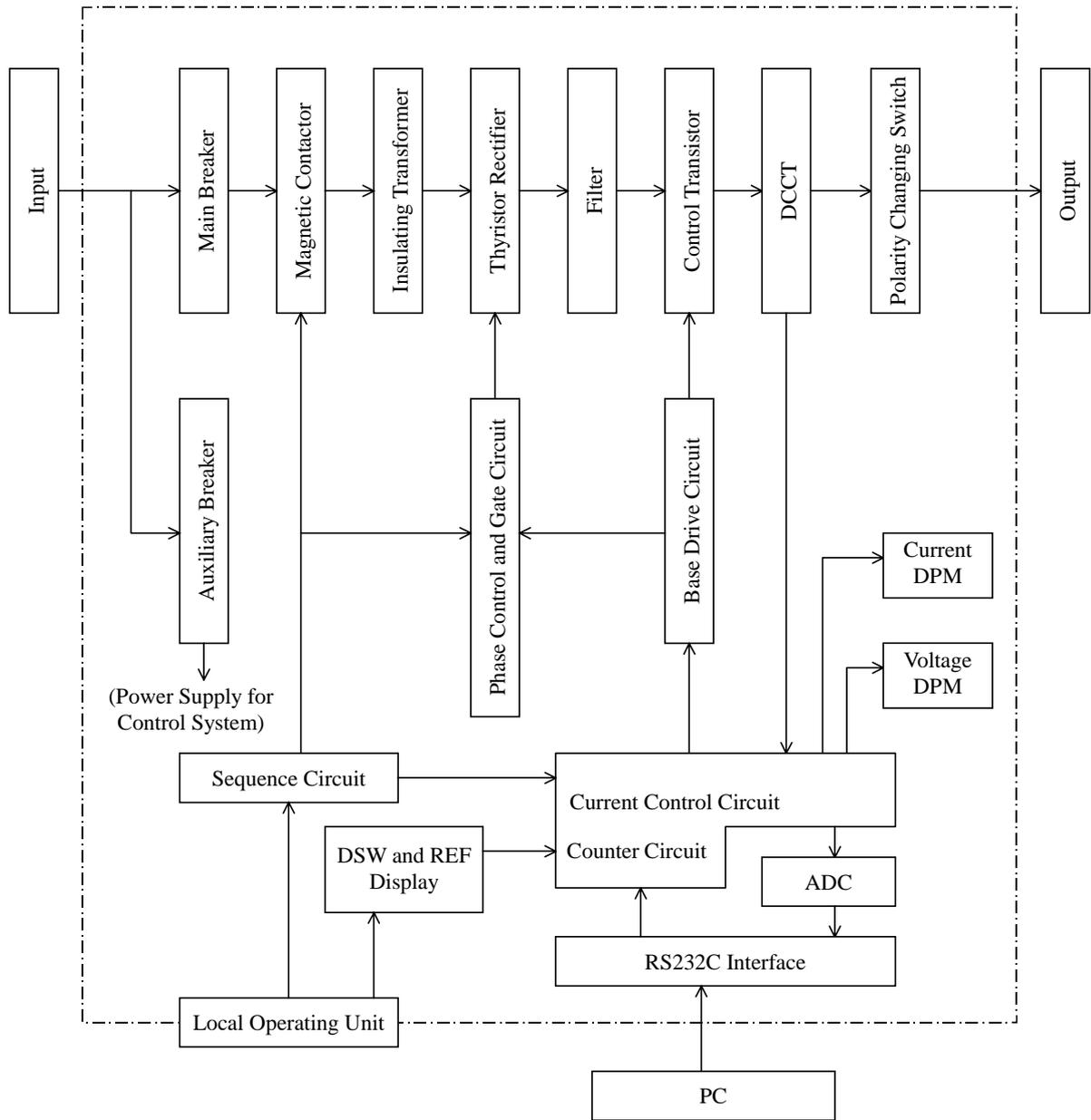


Fig. 1 Power Supply for D Magnet - Block Diagram

2. General Specification

2.1 Ambient Conditions

- | | |
|----------------------------|---|
| 1) Temperature | 5 ~ 44°C |
| 2) Humidity | Less than 10 ~ 98% |
| 3) Location | Indoor, stationary, free from vibration and corrosive gases |
| 4) Elevation | Less than 1000m |
| 5) Anti-radiation standard | 10 ⁵ rad/20 years |

2.2 Power Requirements

- | | |
|------------------------|------------------|
| 1) Voltage | AC 480V (U.S.A) |
| 2) Frequency | 57 ~ 63Hz(U.S.A) |
| 3) Number of phases | 3-phase, 3-wire |
| 4) Voltage variation | Less than ±10% |
| 5) Momentary variation | Less than ±3% |

2.3 Cooling Water Requirements

- | | |
|----------------------|------------------------------|
| 1) Inlet temperature | Less than approximately 35°C |
| 2) Resistivity | More than 1MΩ-cm |
| 3) Inlet pressure | 0.98MPa (maximum) |
| 4) Back pressure | 0.20MPa (maximum) |
| 5) Flow rate | 73 liters/min |

2.4 Electrical Performance

- | | |
|---------------------------------|--|
| 1) Rated output current/voltage | |
| - Output current | 1254A |
| - Output voltage | 252V |
| 2) Operating pattern | 100% continuous |
| - Current setting range | 0% ~ 100% of rated value |
| - Buildup time | Approximately 60 seconds from 0 to 100% |
| - Linking | Less than 1% |
| 3) Current stability | 1 x 10 ⁻⁵ /8h of rated current (absolute value)
(over the range of 10 ~ 100% of rated current) |

- | | |
|--|---|
| 4) Current ripple | 1×10^{-5} as converted from voltage ripple to current ripple under rated operating conditions (absolute value) |
| 5) Reproducibility | Provides output current reproducibility of the order of 1×10^{-5} on digital signal |
| 6) Power supply mode and component parts | |
| - Mode | Constant-current power supply |
| - Component parts | Thyristor regulator + transistor dropper |

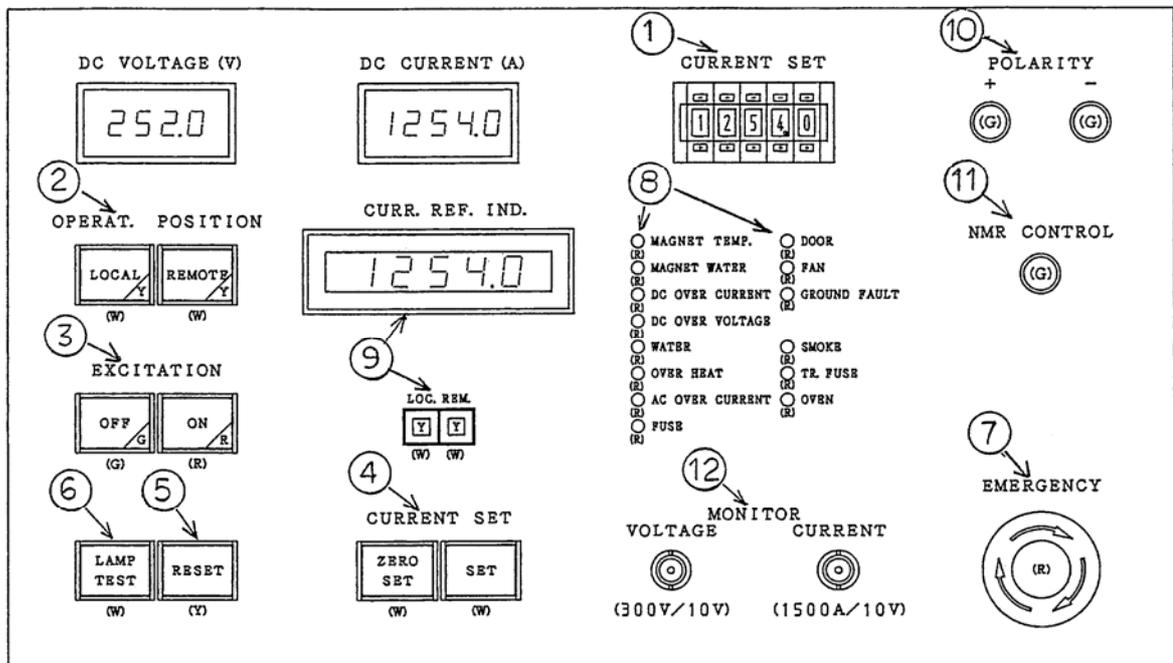
3. Panel Device Description

3.1 Incoming Breakers

The incoming breakers are located at the top left of the panel front.

- 1) **CONTROL** : Turning on of the breaker having this label causes voltage to be supplied to the control circuit.
- 2) **MAIN POWER** : Turning on of the breaker having this label causes voltage to be supplied up to the front of the MC of the main circuit.

3.2 Operating Panel



[1] “CURRENT SET”

This 5-digit switch allows choosing a current setting up to 1254A plus a fractional portion to the first decimal place.

[2] “OPERAT. POSITION”

Pressing the button labeled **LOCAL** enables the equipment to be operated from this panel.

Pressing the button labeled **REMOTE** enables the equipment to be operated via RS232C from an associated PC.

[3] “EXCITATION”

Pressing the button labeled **ON** causes the red lamp to light up and the AC-side MC to be turned on, and places the equipment into operational state.

Note: If “REMOTE” mode is selected and power supply is not in ready state (with the lamp labeled “OFF” extinguished), this switch cannot be turned on.

Pressing the button labeled **OFF** causes the green lamp to light up and the MC to be shut off, and puts the equipment into stopped state.

“OFF” command remains valid regardless of whether “REMOTE” or “LOCAL” mode is selected.

The lamp labeled “OFF” stays lit when power supply is in ready state and “LOCAL” mode is selected. Otherwise, it is extinguished.

[4] “CURRENT SET”

Pressing the button labeled **SET** causes current to rise to a setting chosen in step [1] above.

Buildup time is approximately 60 seconds from 0 to 100%.

Pressing the button labeled **ZERO SET** causes current to fall to 0A at the same rate it rises to a set value.

[5] “RESET”

In case that power supply is shut down with the “trouble” lamp lit, pressing this button after the cause of the trouble is removed enables self-held interlock to be released. When “LOCAL” mode is selected, the equipment can be reset with this button.

If the “REMOTE” mode is selected, equipment resetting can be accomplished only from associated PC.

[6] “LAMP TEST”

Pressing this button turns on the trouble indicator lamp and the bush button lamp.

* If these lamps remain off, they are blown and need to be replaced.

[7] “EMERGENCY”

Pressing this button upon development of any trouble shuts off the MC and places the equipment into stopped state.

[8] Trouble Indicator Lamps and Self-holding of Trouble Status

- Major trouble consists of 11 events. When any of the correspondent indicator lamps lights up, the MC is shut off.
- Minor trouble consists of 3 events. Operation is allowed to continue even when any of the corresponding indicator lamp lights up. When any of the lamps in this group goes on, press the “ZERO SET” button as soon as possible to bring current down to 0A.

When the major trouble or the minor trouble circuit activates, the small trouble indicator lamp located at the top of the door on the panel front shines red.

If any trouble occurs with the equipment in operative state, associated trouble status is self-held. But if any trouble occurs in stopped state, associated trouble status is not self-held.

[9] “CURR. REF. IND.”

Pressing the button labeled **LOC.** displays current setting chosen by the 5-digit switch.

Pressing the button labeled **REM.** displays current setting chosen from a relevant PC.

[10] “POLARITY”

This feature indicates polarity of output. Open the door at the right-hand end of the rear of the panel. A manually operated polarity changing switch is located at the top of the panel’s interior. Manipulate the switch by inserting the furnished rod into the hole in the center of the switch.

[11] “NMR CONTROL”

Open the door at the right-hand end of the front of the panel. A 4P LEMO connector which permits entering a correction signal from the NMR and a toggle switch for adding operation are located inside. Turning this switch on causes the correction signal to be added to existing current setting signal.

[11] “MONITOR”

- VOLTAGE : Produces insulated output voltage at 300V/10V.
- CURRENT : Produces insulated output current at 1500A/10V.

4. Operating Instructions

4.1 Steps To Be Performed Before Initial Startup

- 1) Connect a pipe led from the main to the cooling water IN/OUT flange valve located at the bottom left end of the panel rear, and run water at a specified flow rate (73 liters/min).
 - 2) Pass load cable through the cable entry (labeled **DC Output**) on the top of the panel, and connect it to the output terminal bus bar located inside.
 - 3) Connect a 38mm² ground cable to SG (signal common ground terminal) and FG (ground connection) which are located just to the right of the output terminal.
 - 4) Pass 3-phase input cable through the cable entry (labeled **AC INPUT**) on the top of the panel, and connect it to the input terminal bus bar located inside, ensuring that phase sequence is in the order of U, V, and W. Caution: Use care to avoid incorrect phase sequence.
 - 5) Pass magnet temperature/water interlock signal cable through the cable entry (labeled **CONTROL**) on the top of the panel and connect it to the terminals 1-2 and 3-4 on the terminal block located inside. Also to enable operation from associated PC, pass a cable for RS232C through the cable entry and connect it to the connector CN1. Also to enable operation from associated PC, pass a cable for RS232C
 - 6) Through the cable entry and connect it to the connector CN1. If application is such as to input correction signal from the NMR, join the cable to the 4P LEMO connector installed to the right of CN1, too.
 - 7) Changing transformer tap depending on whether the equipment used at home or abroad:
 - Main transformer tap : Open the door at the left end of the front of the panel. 3 phases' worth of tap changers for the main transformer are located at the bottom. Use them to make a change with respect to all of the three bus bars provided for this purpose.
 - Auxiliary transformer taps : Remove (undo the screws holding) the cover plate at the bottom of the left side of the panel. Auxiliary transformers for T1 (single-phase) and T3 (3-phase) are located at the bottom.
- a) When used in Japan: Change to the AC 420V tap (there are seven of it) with respect to both the main transformer and the auxiliary transformer.
 - b) When used U.S.A: Change to the AC 480V tap (there are seven of it) with respect to both the main transformer and the auxiliary transformer.

- 8) Upon completion of the above step, when the equipment is used at home, close the power board breaker after assuring that line voltage is AC 420V.
- 9) Close the breaker labeled “CONTROL.” This causes the power input indicator lamp labeled “LINE” and associated lamp on the operating panel to be lit, and also causes the exhaust fan to start running.
Then, close the breaker labeled “MAIN POWER.”

4.2 Operating Procedure in “LOCAL” Mode

- 1) Press the button labeled “LOCAL” under the “OPERAT. POSITION” marking.
- 2) Enter a desired current setting using the 5-digit switch under the “CURRENT SET” marking.
- 3) Press the button labeled “LOC.” under the “CURR. REF. IND.” marking. Selected current setting appears on the display window.
- 4) Press the button labeled “ON” under the “EXCITATION” marking. The red lamp lights up to indicate “ON,” and the equipment is placed into operative state.
- 5) Press the button labeled “SET” under the “CURRENT SET” marking. Current increases from 0% to 100% in approximately 60 seconds. If it is desired to change current setting after a set value is reached, enter a new value from the 5-digit switch and press the button labeled “SET” again. If the new value is smaller than the one previously selected, current decreases to the former value.
- 6) Pressing the button labeled “SET” after a set value is reached or during sweeping period causes current to be reduced to 0A.
- 7) After confirming that current is reduced to zero, press the button labeled “OFF” under the “EXCITATION” marking. The equipment is placed into stopped state.
- 8) To shut down the equipment after the occurrence of a trouble, press the button labeled “EMERGENCY.”

In case that the “major trouble” indicator lamp is lit and the equipment is shut down, investigate the cause of the trouble.

In case that the “minor trouble” indicator lamp is lit, press the button labeled “ZERO SET” as soon as possible to bring current down. When current becomes zero, press the button labeled “OFF,” and look for the cause of the trouble.

Operating Precautions

- 1) If the equipment is switched from “LOCAL” to “REMOTE” mode, or vice versa, while in operation, a forced shutoff of power supply results.
- 2) Conditions to be met to keep the equipment ready to operate:

The following four conditions are involved. Unless any one of them is fulfilled in a way to permit operation, arrangement is such that the equipment remains inoperative.

MAIN POWER breaker on/major trouble/minor trouble/DCCT trouble

4.3 Operation in “REMOTE” Mode (Operation via RS232C from PC)

See separate document titled “Bending Magnet Power Supply - Operating Instructions for Remote Control I/F.”

5. Description of Protective Features and Corrective Actions

Severity Rating	Indicator Lamp Labeling	Description	Corrective Action
Major Trouble	MAGNET TEMP.	When the Magnet becomes overheated, the NC contact opens and shuts off output, causing this lamp to light up.	Check the temperature of cooling water supplied to the Magnet.
	MAGNET WATER	When cooling water flow to the Magnet diminishes, the NC contact opens and shuts off output, causing this lamp to light up.	Check cooling water flow to the Magnet.
	DC OVER CURRENT	When output current exceeding 105% of rated value is allowed to flow, the overcurrent detector activates and shuts off output, causing this lamp to light up.	Component parts such as transistors are likely to be damage. Get in contact with us.
	DC OVER VOLTAGE	When output voltage goes beyond 110% of rated value, the overvoltage detector activates and shuts off output, causing this lamp to light up.	Check the Magnet wiring and output cable for loss of continuity and imperfect contact. Get in contact with us.
	WATER	When cooling water flow falls below specified level, the flow switch activates and shuts off output, causing this lamp to light up.	Check cooling water flow. Examine the flow switch for malfunction. Get in contact with us.
	OVER HEAT	When the main transformer, phase-to-phase reactor, DCL, thyristor, or transistor becomes overheated, the thermo-switch activates and shuts off output, causing this lamp to light up.	Check cooling water inlet temperature to see that it is not in excess of 35°C. Examine individual parts for usually elevated temperature. Get in contact with us.
	AC OVER CURRENT	When AC input current goes beyond 110% of rated value, the thermal relay activates and shuts off output, causing this lamp to light up.	Check the main transformer for discoloration, deformation, and foul smell. Get in contact with us.

Severity Rating	Indicator Lamp Labeling	Description	Corrective Action
Major Trouble	FUSE	When the rectifier thyristor protecting quick-blow fuse blows, the alarm fuse installed in parallel therewith blows, too. Associated contact signal shuts off output and causes this lamp to light up.	Open the two doors at the right-hand side of the front of the panel. The quick-blow fuse and alarm fuse are located at the bottom. Failed alarm fuse should be identified with a white mark. Replace this fuse and corresponding quick-blow fuse as a pair. Get in contact with us.
	DOOR	When any door is left open, associated door switch activates and shuts off output, causing this lamp to light up.	Close door that is left open.
	FAN	When the exhaust fan becomes inoperative, the fan sensor activates and shuts off output, causing this lamp to light up.	Inspect the exhaust fan. Get in contact with us.
	GROUND FAULT	When failure in the Magnet allows a ground-fault current in excess of 10mA to flow, the ground-fault detector picks this up and shuts off output, causing this lamp to light up.	Examine the Magnet and look for location of ground fault.
Minor Trouble	SMOKE	When smoke generates within the power supply unit, the smoke sensor mounted on the ceiling of the panel detects it and makes this lamp go on.	Determine where the smoke originates. Get in contact with us.
	TR, FUSE	When excessive current is allowed to flow in the control transistor and the protective alarm fuse blows, associated contact signal turns on this lamp.	Of alarm fuses contained in the individual transistors, those identified with a white mark have blown. Replace them. Get in contact with us.
	OVEN	When abnormal condition occurs in the Peltier temperature control circuit or fan which air-cools the cooling fins of the Peltier constant-temperature bath becomes inoperative, this lamp lights up.	When there is a wide temperature difference with the outside air after the turning on of control power, abnormal condition may arise, too. Get in contact with us.

6. Maintenance and Inspection

6.1 Regular inspection

Check for the following items once or twice a day through regular inspection rounds in order to prevent failures or accidents beforehand:

- [1] Noise, odor, smoke, or anything different from normal operating status.
- [2] Readings of the meters on the board.
- [3] Display lamps lit up on the board.

6.2 Maintenance and inspection items

Check for the items shown in Table 2 at the time of simultaneous regular inspection, etc. 6 months, and 1-2 years after the start of operation.

- [1] Precautions on maintenance and inspection:

This equipment is produced by following the basic principle of high reliability and easy maintenance, thus maintenance like regular inspection is hardly needed. But, over a long time of use, depending on the environment where it is installed or its service conditions, there may arise certain factors leading to a failure. Therefore, regular inspection and cleaning are effective in order to continue stable operation by preventing failures beforehand.

- [2] General precautions:

1. If it becomes necessary to check inside of the equipment, make sure to turn the power OFF as far as possible. If you need to do checking with the power running, pay best attention so as not to receive an electric shock.
2. This equipment uses a large-capacity condenser, and the charged electric charge does not be quickly discharged even after the power is turned OFF. Therefore, when realizing an inspection shortly after stopping the operation, confirm by using a tester, etc. that discharge has been completed.
3. All knobs, including the voltage setting and reference signal setting, inside the control card are all set beforehand in our shop; so, in principle, there is no need to change settings. If changing settings is needed, please contact our company.
4. If connectors, relays, and cards are removed, make sure to securely insert them into their original positions without causing faulty contact. If you remove them for reasons of test or short-circuit, make sure to replace them securely.
5. For inspection of control circuit, etc., the circuit may cause erroneous operation due to noise from lead cables of measuring instruments, so pay best attention to select the suitable inspection method.
6. Check the number of tools at the start and end of the inspection in order to confirm that no tool is left behind inside the equipment. Also make sure that no bolt or nut is left behind.

How to use the polarized magnetic power source remote operation I/F

1. Connecting PC to power source

- Use an RS-232C normal cable (straight type) found on the market.
- An interlock cable (cross type) for inter-link cannot be used.
- For the power source side, a Dsub 9-pin receptacle (CN1) is provided on upper right part when opening the front right door. - - - Connect either part of the cable here.
- For the PC side, connect to the RS-232C port (serial port).

Though slightly different by the model, normally a Dsub 9-pin receptacle is provided.

! Precaution ! When connecting, make sure to first turn off power for both power source and PC sides.

2. PC-side (terminal) setting

Set as follows by referring to the manual of the terminal software to be used:

- Baud rate : 9600 bps : (Choose from ..., 2400, 4800, 9600, 19200, 38400...)
- Data length : 8 bit
(Choose from 7 bit or 8 bit.)
- Stop-bit : 1 bit
(Choose from 1 bit or 2 bit.)
- Parity : Odd parity
(Choose from None, Even, or Odd.)
- Delimiter : CR+LF (Choose from CR only, or CR+LF.)
- Flow control : None
(Choose from None, X flow control, or hardware control.)
- Local echo : Yes
(Choose from Local echo: Yes or No.)

3. Definition of terms

The following is the definition of the terms used in the following explanation:

- Command : Cable message that is outputted from outside (higher-order PC) and is inputted to the power source.
(Cable message used when operating the power source.)
- Response : Cable message that is outputted by the power source and is inputted to outside (higher-order PC).
(Cable message that shows the power source status.)

4. Communication procedures

A response is one-sidedly outputted from the power source only once when the control power is made. Then, the operation that the 'power source returns a response to a command from outside' is repeated.

5. Power source operation command format

The power source operation command is defined by the following 6 bytes. Enter the cable message by using half-size letters.

- 5-1) Operation: ON

C	O	N	SP	CR	LF
---	---	---	----	----	----

Note) Enter a space (H'20).
- 5-2) Operation: OFF

C	O	F	F	CR	LF
---	---	---	---	----	----
- 5-3) Reset

C	R	S	T	CR	LF
---	---	---	---	----	----
- 5-4) Monitor

C	M	O	N	CR	LF
---	---	---	---	----	----

6. Current setting command format

The current setting command is defined by the following 6 bytes. Enter the cable message by using half-size letters.

- 6-1) 0% setting

D	0	0	0	0	CR	LF
---	---	---	---	---	----	----
- 6-2) 50% setting

D	7	F	F	F	CR	LF
---	---	---	---	---	----	----
- 6-3) 100% setting

D	F	F	F	F	CR	LF
---	---	---	---	---	----	----

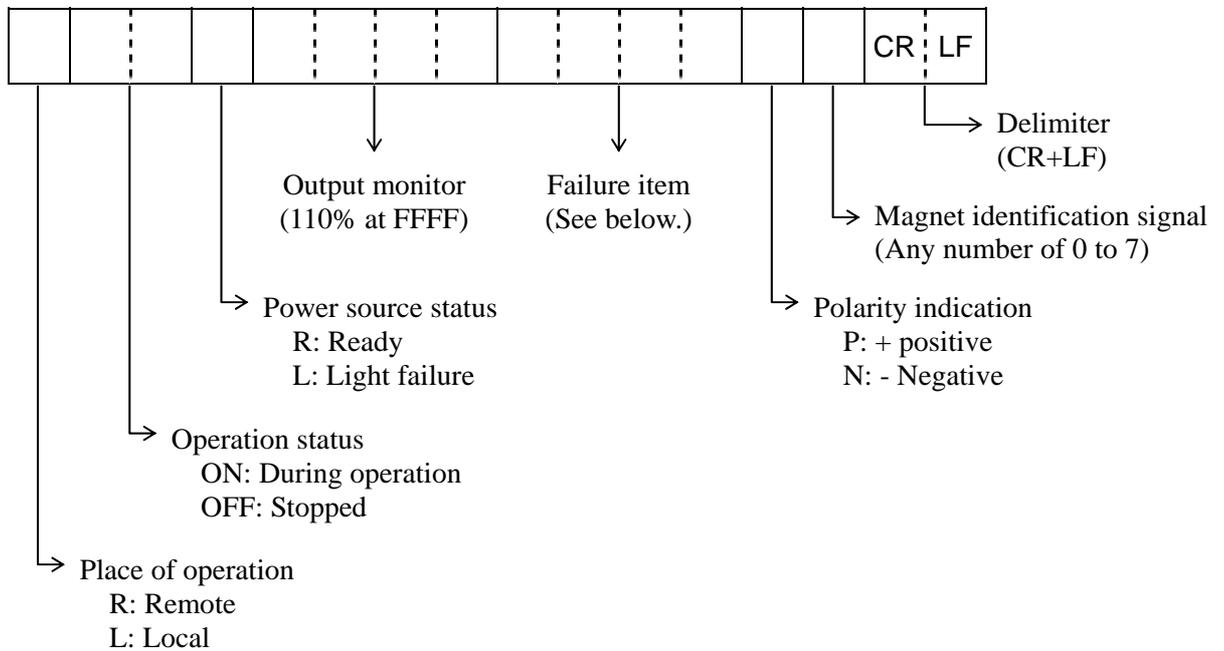
7. Error processing

When an invalid cable message is entered as a command, the power source ignores the command. In this case, no response is returned.

If an unspecified command is entered, or when unsuitable letter (G to Z) is included as the Hex code in the setting command parameter (0000 to FFFF), the power source also ignores the command as an invalid cable message.

8. Response format

The response is defined by the following 16 bytes. The cable message itself, by excluding the delimiter, is outputted entirely in half-size upper-case letters.

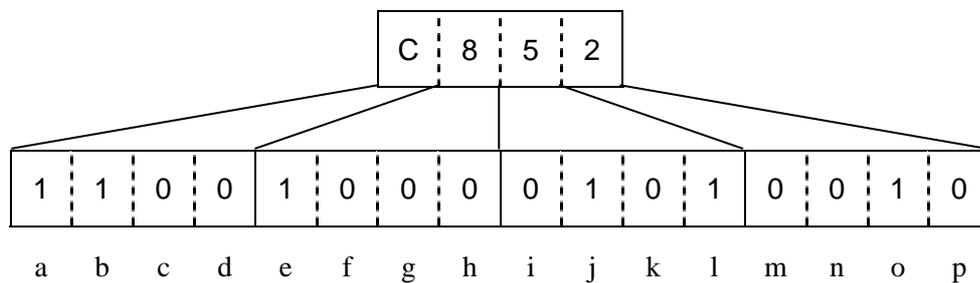


9. Failure item format

The failure item format is defined by the following 4-byte Hex codes.

1-bit corresponds to an item, and coding is Normal: 0, Abnormal: 1.

(e.g.) When the MAGNET TEMP., MAGNET WATER, WATER, FAN, EMERGENCY, and OVEN is in abnormal status, the failure item part shows the following code:0852



bit	Item name
a	MAG. TEMP
b	MAG. WATER
c	DCOC
d	DCOV

bit	Item name
e	WATER
f	OH
g	ACOC
h	FUSE

bit	Item name
I	DOOR
j	FAN
k	GROUND
l	EMERGENCY

bit	Item name
m	SMOKE
n	TR-FUSE
o	OVEN
p	(Normally "0")

10. Some examples of command input and response

When making the control power source: The power source one-sidedly outputs a response.

ROFR00000000P1

(Control power source made)

Power source → Higher-order
Remote, OFF, Ready, Zero output
No abnormality, + Positive, ID: 1

ON command

CON ↵
RONR00000000P1

Higher-order → Power source
(control command input)

Power source → Higher-order (response)
Remote, ON, Ready, Output 0%
(no start-up),
No abnormality, + Positive, ID: 1

Setting input: Setting to 50% output

D7FFF ↵
ROFR00000000P1

Higher-order → Power source
(setting command input)

Power source → Higher-order (response)
Remote, OFF, Ready, Zero output
No abnormality, + Positive, ID: 1

Monitor start: 50% output

CMON ↵
RONR745C0000P1

Higher-order → Power source
(control command input)

Power source → Higher-order (response)
Remote, ON, Ready, 50% output
No abnormality, + Positive, ID: 1

OFF command: OFF at 50% output

COFF ↵
ROFR745C0000P1

Higher-order → Power source
(control command input)

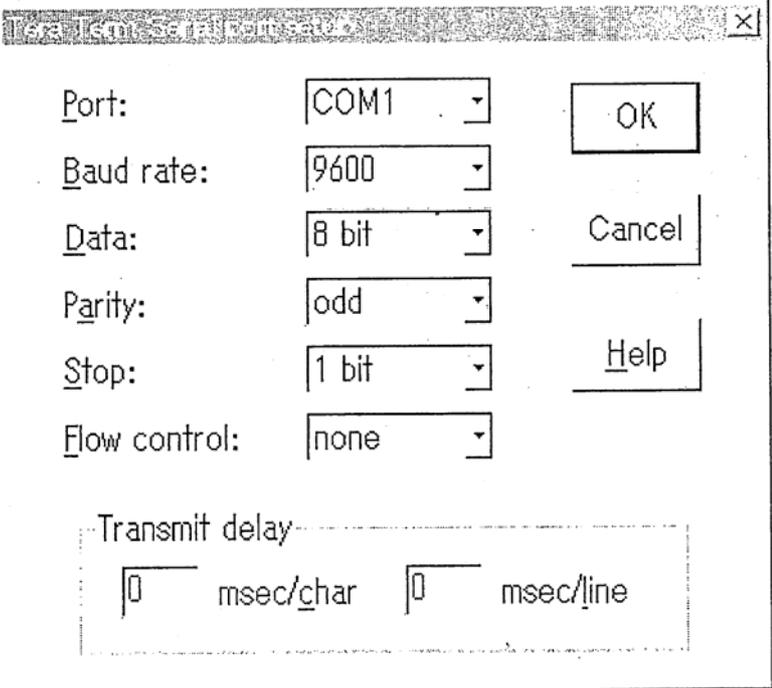
Power source → Higher-order (response)
Remote, OFF, Ready, Zero output
No abnormality, + Positive, ID: 1

11. Some examples of terminal software

Shown below is the setting method when using Tera Term Pro version 2.3. Call up the Serial port sub-menu from the Setup menu and set the following items.

- Communication port : Select the port to match your PC
from Setup → Serial port → Port.
(For an ordinary configuration, COM1 is okay.)
- Baud rate : Select "9600"
from Setup → Serial port → Baud rate.
- Data length : Select "8 bit"
from Setup → Serial port → Data.
- Parity : Select "odd"
from Setup → Serial port → Parity.
- Stop bit : Select "1 bit"
from Setup → Serial port → Stop.
- Flow control : Select "None"
from Setup → Serial port → Flow control.

<An example of Setup → Serial port submenu display>



The screenshot shows a dialog box titled "Tera Term Pro Serial port setup" with a close button (X) in the top right corner. The dialog contains several settings, each with a label and a dropdown menu:

- Port: COM1
- Baud rate: 9600
- Data: 8 bit
- Parity: odd
- Stop: 1 bit
- Flow control: none

On the right side of the dialog, there are four buttons: OK, Cancel, and Help. Below these buttons is a section titled "Transmit delay" with two input fields: "0 msec/char" and "0 msec/line".

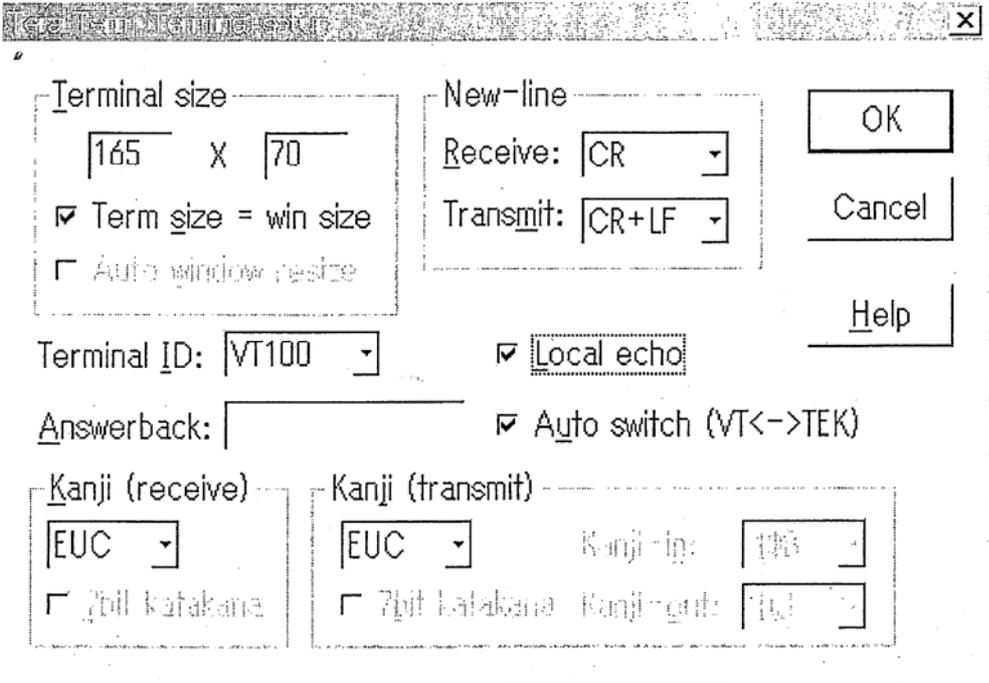
Some examples of terminal software (cont.)

Call up the Terminal submenu from the Setup menu, and set the following items:

Delimiter : Select "CR+LF"
from Setup → Terminal → New-line → Transmit.

Local echo : Tick the check box
from Setup → Terminal → Local echo.

<An example of Setup → Terminal submenu setting display>



The screenshot shows a dialog box titled "Terminal Setup" with the following settings:

- Terminal size:** 165 X 70. Term size = win size. Auto window resize.
- New-line:** Receive: CR. Transmit: CR+LF.
- Terminal ID:** VT100.
- Local echo.
- Answerback:** (empty field).
- Auto switch (VT<->TEK).
- Kanji (receive):** EUC. 7bit katakana.
- Kanji (transmit):** EUC. Kanji-tp: 106. Kanji-ort: 10.

Buttons: OK, Cancel, Help.