

INSTRUCTION MANUAL

AUTOMATIC SYNCHRONIZER

ASY-96

Introduction

Thank you for your purchase of our product.

Read this instruction manual carefully before installation, wiring, and using this product.

Keep this instruction manual handy for reference at any time.

If this instruction manual is lost or damaged, please ask our company or a distributing agent.

<Caution>

Have a contact with us when you have any questions or are aware of missing article.

Safety precaution

Important contents are mentioned in this instruction manual to prevent any damage / use this product appropriately.

Keep the following safety precaution in mind after understanding each sign.



DANGER

Improper use may lead to death or severe injury.



WARNING

Improper use may possibly lead to death or severe injury.



ATTENTION

Improper use may lead to medium injury.

- We are not responsible for the damage caused by following condition (earthquake / fire which is not caused by us, action by third party, other accident, damage caused by our customer, misuse, product usage under abnormal condition).
- We are not responsible for secondary damage caused by product use / product malfunction(loss of profit, halt of business operation). We are also not responsible for damage caused by false operation in combination with connecting equipment which is beyond our control.



DANGER

- Do not disassemble, remodel and repair this product.
Have a contact with us or sales agent when product failure happens to prevent fire / electric shock / injury.
- Do not get this product wet to prevent heat generation / ignition / product failure. When this product gets wet, stop using it.
- Do not connect metal excepting wiring to terminal in order to prevent heat generation/ignition.
- Do not get this product near the inflammables / combustible chemicals / gas to prevent fire.



WARNING

- Connect specified power supply.
Connecting power supply beyond specification causes fire / product failure.
- When dust is on the terminal, wipe it off after power is OFF to prevent fire.
- Follow the below-mentioned procedure when abnormality (fuming / bad odor) happens.
 - (1) Stop a power supply and input, and stop using.
 - (2) Contact our company or a distributing agent.



ATTENTION

- Do not use this product in a environment of high temperature / high humidity to prevent any damage.
- Do not touch the terminal during operation to prevent electric shock.
- Do not pull/bend connecting cable with force. Cable damage causes heat generation / burn and contact failure leads to equipment damage.
- Do not connect/inspect with wet hands to prevent electric shock.

Other precaution

- Don't mount or store this unit in the following environment.
 - Places where corrosive gas (SO₂ / H₂S / etc.)⁽¹⁾ is generated.
 - Places where dust is generated.
 - Places with much vibration and shock.
 - Places with influence of external magnetic field ⁽²⁾.
- Note ⁽¹⁾ Corrosive gas = Sulfur dioxide SO₂ / Hydrogen sulfide H₂S / etc.
- Note ⁽²⁾ Large current bus / saturable reactor / etc.
- Wipe off dirt on the surface with dry cloth softly. Keep in mind that strong rubbing of nameplate leads to character disappearance. Organic solvent is not appropriate for cleaning.
- Mercury component, Nickel-cadmium battery are not used in this product.
- Please dispose of this product as industrial waste (noncombustible).
- This product is not dust-proof structure and not waterproof structure. In using by the outdoor panel, please avoid the place, which dust causes. And, please install in the place that requires neither rain nor waterdrop.

1. Cautions of installation and wiring.

Those who have a professional skill need to perform installation and wiring after consulting a handling covering letter. And, please follow the following notes.

- There is no function that checks the balance of phase-sequence detection and three-phase voltages each. Please inquire separately.
- Please be sure to separate wiring by the strong electric side, and the wiring by the light electrical side. Please carry out consideration (malfunction prevention) to a noise.
- Please be sure to ground grounding terminal E (terminal 9) in order to increase the shield effect.



- Please perform connection after checking schematics.
- Unsuitable connection causes trouble of apparatus, and a fire and an electric shock.
- The power must be turned off before installation and wiring works. It becomes the causality of the trouble, burnout, and fire of an electric shock and apparatus.
- For electric shock prevention, after wiring is completed, please install a terminal cover.

2. Operation method

Special knowledge is required to use this product. Please carry out the right handling with reference to an instruction manual.

- Please do not touch equipment during operation. It becomes the factor that causes a malfunction.
- Please apply bus voltage after establishing voltage (AC90 to 125V). Since the power supply of equipment is shared, if a voltage upsurge is done gradually, it will do a malfunction by the power supply unstable region.
- Please make ac input (bus voltage, generator voltage) into non-voltage after the end of synchronous control. And, please turn OFF a control input (automatic synchronous start, manual synchronous start). However, although ac input is no problem in the state of voltage applying, please give bus voltage as variation within the range (AC90 to 125V).
A SLOW side input designating input is no problem with ON.
- The switching capacity of a control output (optical MOS-FET relay) is DC100V, 50mA or DC24V, 100mA. Please install the element that absorbs the reverse induced voltage that it generates at the time of switching in the coil of the relay use for the outside of this product.
- If it is the waveform that is doing inverter control, and a waveform with a large distortion rate, frequency measurement and phase difference measurement may become unusual.



- Input terminal and output terminal is with a terminal cover. Please install a terminal cover after wiring.
- Please do not touch a terminal during operation. There is a possibility of receiving an electric shock.
- Please do not apply a voltage signal, because control signal input is a non-voltage contact. There is a possibility that apparatus may be damaged by fire. And, if it uses an outside relay for control signal input, please use the relay whose minimum load satisfies switching voltage and current DC12V, 10mA.

3. Setting

Please set up with reference to an instruction manual. And, please follow the following notes.

- Please close a switch cover during operation and after setting up.
- Please set up the next state. Non-voltage (all are non-voltage of bus input, generator input), or control start OFF (all are OFF of automatic synchronous start, manual synchronous start)
If it carries out except future, it will display an error and will become a control stop.
- If it sets up in addition to the setting range, it stops control and displays an error.
Please change into the right set value.

4. Maintenance, check, and the repair method

Please perform maintenance and check periodically after consulting an instruction manual.

If trouble is discovered, please check in a trouble shooting.

In trouble, please contact the distributing agent that purchased.

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1. Description

This is a control device to carry out a synchronizing closing safely and smooth in operation of generators in parallel connections. At time of parallel connection, each voltage and frequency are checked and when the difference is within a given value, closing signal is given to circuit breaker ahead of the synchronizing point, accounting on advance breaking time, so that the circuit breaker (CB) can be closed at an exact synchronizing point.

This unit has also functions of synchronism check signal and synchronizing detecting display.

2. Features of product

- (1) High quality, high reliability by CPU adoption.
- (2) This product is lightweight and compact.
- (3) Display is abundant (Measurement display : 3 points. Status display : 10 points).
- (4) Simple setting from front side. Numerous setting values, yet very simple in setting.
- (5) Synchronizing detection by single-phase circuit, both in bus input and generator input.
- (6) Automatic / Manual synchronization switching function is provided.
- (7) Reverse power preventive function is effective at time of recovery of the receiving power by "SLOW" side closing command ($F_B > F_G$).

3. Functions of product

- (1) Voltage balancing function.
Control pulse output is given so that bus voltage (V_B) and generator voltage (V_G) can be stayed within a given range. (60R, 60L)
Pulse width is V_{pw} set value and pulse period becomes V_{pint} set value.
- (2) Advancing function.
Control pulse output is given so that bus frequency (F_B) and generator frequency (F_G) can stay within a given range. (15R, 15L)
Pulse width is F_{pw} set value and pulse period becomes "1/input frequency difference".
It outputs at 180° of phase difference.
- (3) Synchronism check signal function. ($\pm 15^\circ$).
When voltage difference (V) and frequency difference (F) stay within a given value and phase difference within $\pm 15^\circ$, contact signal output. In case of automatic synchronization closing, synchronizing closing can be done more safely in combined use with circuit breaker closing signal (25) under series connection.
- (4) Synchronizing closing function.
After voltage difference (V) between bus and generator and after frequency difference (F) between them become within a given value, circuit breaker closing signal (25) is output ahead of synchronizing point, accounting on advance time of closing, so that circuit breaker can be closed at synchronizing point.
"ON" time of closing signal (25) is the advance time plus 200ms. After a closing signal output, in case there is no phase shift (10°) for 3 seconds, it becomes a synchronizing success. It becomes an END display and all control is stop. In case a phase shift (10°) is in 3 seconds, it becomes a synchronizing closing failure.
<Cautions> From change of phase difference, the time to a synchronizing point is calculated and a synchronizing closing signal is outputted. For this reason, if a frequency difference is 0.04Hz or less, an input signal is not outputted even if phase difference is 0° (in phase).
- (5) Alarm function.
When synchronizing closing is failed 3 times continuously, alarm "LED" turns on about 3 seconds afterwards and contact signal is output. After alarm is outputted, when there is a control start, F , V , and $\pm 15^\circ$ control action are continued. A circuit breaker closing signal (25) is not outputted. Synchronizing closing failure is in the condition that the phase difference between bus side and generator side exceeds 10° .
Alarm is released at no voltage or synchronizing start (both of auto and manual) is "OFF".
- (6) Setting function.
Voltage difference, frequency difference, advance time, pulse width / cycle of each control can be set.

4. Specification and performance

4.1 Specification

4.1.1 Input

| | | | | | |
|---------------|----------------------|--------|---------|---|--------|
| (1) AC input. | Bus side input | AC110V | 50/60Hz | 1 | 5.0VA. |
| | Generator side input | AC110V | 50/60Hz | 1 | 0.5VA. |

(2) Control signal input.

1a contact input. (Switching voltage and switching current : DC12V, 10mA)

- 1) Automatic synchronization start. (AUTO)
- 2) Manual synchronization start. (MANUAL)
- 3) SLOW side closing designation. (SLOW)

<Note> Relay for control signal input must be selected to satisfy minimum applicable load (mA) in switching load (DC12V, 10mA).

4.1.2 Control output (1a contact, Switching capacity DC100V, 50mA or DC24V, 100mA)

- 1) Voltage increase signal (60R)
- 2) Voltage decrease signal (60L)
- 3) Governor increase signal (15R)
- 4) Governor decrease signal (15L)
- 5) Circuit breaker closing signal (25)
- 6) Synchronism check signal ($\pm 15^\circ$)
- 7) Alarm signal (ALARM) : An a-contact is turned on at the time of alarm detection.

4.1.3 Display

(1) Measuring display

1) Phase difference

(Square type LED, 26 points : 23 points for interval $360^\circ \cdots 15^\circ$, 2 points for more or less 7.5° synchronizing point, color : Amber, 1 point for synchronizing point, color : Green.)

2) Voltage difference.

(Percent display \cdots 7 segment LED 3 digit. Negative (-) polarity display only, color : Green)

3) Frequency difference.

(Hz display \cdots 7 segment LED 3 digit. Negative (-) polarity display only, color : Green)

(2) Mode display (Point LED)

- 1) Power supply (POWER : Green)
- 2) Voltage increase signal.(60R : Red)
- 3) Voltage decrease signal.(60L : Green) □ 2-colored LED
- 4) Governor increase signal.(15R : Red)
- 5) Governor decrease signal.(15L : Green) □ 2-colored LED
- 6) Circuit breaker closing signal.(25 : Green)
- 7) Synchronism check signal. ($\pm 15^\circ$: Amber)
- 8) Within frequency difference setting. (F : Green)
- 9) Within voltage difference setting. (V : Green)
- 10) Alarm signal. (ALARM : Red)

4.1.4 Setting value.

- 1) Voltage difference (V) setting. (Rotary cord switch 1)
Factory setting : 5%. Setting range : 1, 2, 3, 4, 5, 7, 10%. (AC110V = 100%)
- 2) Voltage adjustment pulse width setting. (Rotary cord switch 2)
Factory setting : 0.5 seconds. Setting range : 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0 seconds.
- 3) Voltage adjustment pulse period setting. (Rotary cord switch 3)
Factory setting : 2 seconds. Setting range : 1, 2, 3, 4, 5 seconds.
- 4) Frequency difference (F) setting. (Rotary cord switch 4)
Factory setting : 0.1Hz. Setting range : 0.1, 0.15, 0.2, 0.25, 0.3Hz.
- 5) Governor pulse width setting (Rotary cord switch 5)
Factory setting : 0.5 seconds. Setting range : 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0 seconds.
- 6) Circuit breaker advance time setting (5 bits dip switch)
Factory setting : 50ms. Setting range : 10, 20, 40, 80, 160ms. (Setting value in total sum when switch is "ON")

<Note> There is a limit in circuit breaker advance time setting, depending on frequency difference (F).

| Frequency difference setting (F) | Circuit breaker advance time setting range |
|------------------------------------|--|
| 0.1 Hz | 10 ~ 310ms |
| 0.15Hz | 10 ~ 210ms |
| 0.2 Hz | 10 ~ 150ms |
| 0.25Hz | 10 ~ 100ms |
| 0.3 Hz | 10 ~ 80ms |

<Note> In case of setting at out of the time of the setting range, the control will stop and display "ERROR" (E3).

4.2 Performance

| Item | | Specification | |
|---|--|---|--|
| Accuracy | Voltage difference | $\pm 0.5\%$ | |
| | Frequency difference | $\pm 0.03\text{Hz}$ | |
| | Measurement phase difference | $\pm 1^\circ$ | |
| | Synchronizing closing phase difference | $\pm 5^\circ$ | |
| | Synchronism check signal phase difference | $\pm 5^\circ$ | |
| | Pulse width | $\pm 50\text{ms}$ | |
| | Pulse period | $\pm 10\% + (10 \sim 200\text{ms})$ | |
| Characteristic | Influence of temperature | Within accuracy by 23 ± 20 . | |
| | Influence of frequency | Within accuracy by $\pm 3\text{Hz}$ to bus rated frequency. | |
| | Influence of voltage | Within accuracy by AC90 ~ 125V. | |
| | Other | Complied to JIS C 1111 : 1989 | |
| Strength | Overvoltage AC input | 1.5 times 10 seconds and 1.2 times continuation of rated voltage. | |
| | Insulation resistance | Between electric circuit and case (earth). | Above 30M at DC500V megger. |
| | | Between AC input and output for control and input for control. | |
| | Withstand voltage | Between electric circuit and case (earth). | AC2000V (50/60Hz) 1 minute |
| | | Between AC input and output for control and input for control. | |
| | Impulse withstand voltage | Between electric circuit and case (earth). | 5kV 1.2/50 μs Positive and negative polarity, for each three times. |
| Shock | Acceleration 294m/s ² . X, Y, Z direction for each 3 times. | | |
| Vibration | Frequency 16.7Hz, Double variation 1mm. X, Y, Z direction for each 10 minutes. | | |
| Operating temperature and humidity limits | | 0 to 55 , 5 to 95% RH (Non condensing) | |
| Storage temperature limits | | -10 to +70 | |
| Case color | | Black (Munsell N1.5) | |
| Mass | | 1kg or less | |

5. Control function

5.1 Control range

- Bus voltage : AC90 ~ 125V
- Generator voltage : More than 80V
- Bus frequency : $50 \pm 3\text{Hz}$, $60 \pm 3\text{Hz}$
- Frequency difference : Less than $\pm 4\text{Hz}$

<Note> Control will stop at other ranges than above and display "ERROR" for each.

5.2 Control signal input (1a contact, Switching voltage / current DC12V, 10mA)

(1) Automatic synchronization start and manual synchronization start.

| Start input | | Output |
|---------------------------|------------------------|--|
| Automatic synchronization | Manual synchronization | |
| ON | OFF | 60R/60L, 15R/15L. Synchronism check signal ($\pm 15^\circ$), 25. |
| OFF | ON | Synchronism check signal ($\pm 15^\circ$). |
| OFF | OFF | POWER LED lights. |
| ON | ON | E8 display (Overlap designation) |

<Note> Under above condition, ON is terminal short-circuiting. OFF is terminal disconnection.

(2) Generator SLOW side closing designation.

ON (Terminal short-circuit) : Closing from SLOW side. ($F_B > F_G$)

OFF (Terminal disconnection) : Random closing direction. ($F_B > F_G$ or $F_B < F_G$)

5.3 Control output and contents

(1) Voltage balance function (60R, 60L)

A control pulse is outputted in order that bus voltage (V_B) and generator voltage (V_G) may be put into regulation within the limits.

(2) Advancing function (15R, 15L)

A control pulse is outputted in order that bus frequency (F_B) and generator frequency (F_G) may be put into regulation within the limits.

(3) Within frequency difference setting (F).

When frequency difference continues over 1 second, within setting value (F), F LED is lighted.

Hysteresis 0.03Hz (lights within 0.1Hz in case of $F = 0.1\text{Hz}$).

Return (LED ON LED OFF) will be over $F + 0.03\text{Hz}$ (LED OFF at 0.13Hz in case of $F = 0.1\text{Hz}$).

(4) Within voltage difference setting (V).

When voltage difference comes in within setting value (V), V LED is lighted.

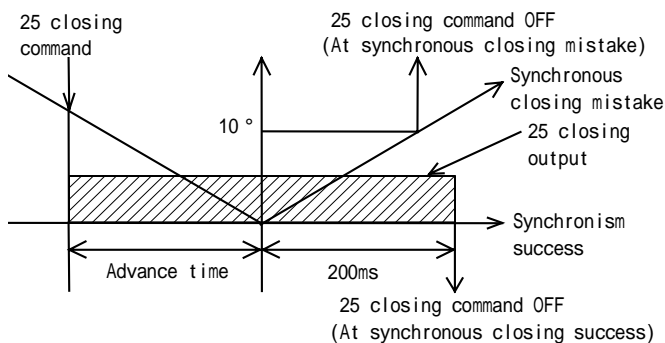
Hysteresis 0.5% (lights within 4.5% in case of $V = 5\%$)

Return to 5.0% or more (LED ON LED OFF).

(5) Synchronism check signaling ($\pm 15^\circ$).

When voltage and frequency difference are within the setting value and phase difference within $\pm 15^\circ$, a contact signal is output and $\pm 15^\circ$ LED turns on.

(6) Circuit breaker closing signal (25).



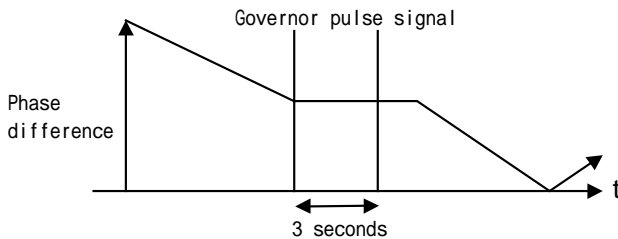
After voltage and frequency difference comes in within the setting value, circuit breaker closing signal (25) is output ahead of synchronizing point, accounting on circuit breaker closing advance time and "LED" (25) turns on. Circuit breaker closing signal (25) must be set at "OFF" after the advance time +200ms. After a closing signal output, in case there is no phase shift (10°) for 3 seconds, it becomes a synchronizing success. It becomes an END display and all control is stop. In case a phase shift (10°) is in 3 seconds, it becomes a synchronizing closing failure.

(7) Synchronizing failure signal (ALARM).

When synchronizing closing is failed 3 times continuously, alarm LED turns on about 3 seconds afterward and contact is output. After alarm is outputted, when there is a control start, F , V , and $\pm 15^\circ$ control action are continued. A circuit breaker closing signal (25) is not outputted.

Synchronizing failure is in the case when phase difference at both of bus and generator side exceeds 10° , though circuit breaker closing signal (25) is output. Alarm can be released at input no voltage or synchronizing start (both of auto and manual) is "OFF".

(8) Synchronous closing promotion facility.



When phase difference comes smaller within $\pm 0.05\text{Hz}$, governor pulse signal is automatically output about 3 seconds. Afterward in order to make the closing speed up.

Governor pulse signal is signal 15L at "SLOW" side closing designation, and signal 15R is output at "SLOW" side closing non-designation.

6. Operation

6.1 Before bus voltage input

Operational power supply of this device is supplied from bus voltage input. Operation should not be made before the bus voltage is input. (All control outputs must be "OFF" signal.)

The wiring confirmation of all signals must be carried out at no voltage condition.

Input LINE side: Bus voltage (Receiving power)

Input generator side: Generator voltage

Change of each setting value must be made before bus voltage input or before control start (refer to 16 pages item 7.6).

The change after control is started is not possible. The control will stop and display "ERROR" (E3).

6.2 After bus voltage input

"POWER LED" (Green) turns on when bus voltage is input.

Change of each setting value must be made before the bus voltage input or before control start.

(Refer to 16 pages item 7.6). The change after control is started is not possible.

The control will stop and display "ERROR" (E3).

When voltage and frequency are within the control range, display of phase difference "LED" turns on around in the speed according to the frequency difference.

7 segment "LED" of voltage (V) and frequency (F) will display the difference (refer to 7 pages item 5.1).

6.3 Automatic synchronization control

6.3.1 In case of synchronizing closing from bus (receiving side) to generator.

Under the bus voltage input condition (AC90 to 125V) and after the generator voltage is stable (more than AC80V), automatic synchronization is done. Under unstable voltage condition, the control will stop and display ERROR (E5). (Will automatically return when the voltage comes in within the range.)

When voltage and frequency are control within the limits (refer to 7 pages item 5.1), the display of phase difference display LED rotates at the speed according to a frequency difference.

7 segment LED of voltage (V) and frequency (F) displays a difference.

“60R,60L” output will control the difference of bus and generator voltage within the setting range (V). “LED” V turns on within the range.

“15R,15L” output will control the difference of bus and generator voltage within the setting range (F). “LED” F turns on within the range.

In case the phase difference is at synchronizing point $\pm 15^\circ$ under the setting range in both voltage and frequency difference, synchronism check signal ($\pm 15^\circ$) is output and “LED” turns on.

Circuit breaker closing signal (25) will be output ahead of synchronizing point, accounting on the advance time of the circuit breaker closing and “LED” turns on, in order to close the circuit breaker at synchronizing point under the setting range in both voltage and frequency difference.

The circuit breaker input signal (25) is OFF after +200ms of advance time. (However, if it comes up to $\pm 10^\circ$ within in 200ms, it becomes an OFF input mistake.)

6.3.2 In case of synchronizing closing from generator to bus (receiving).

Automatic synchronization start can be done under the bus voltage input condition (AC90 to 125V) and “SLOW” side closing designation (more than AC80V in generator voltage) is input. The control will stop under unstable voltage condition in the generator side and “ERROR” (E5) is displayed.

(Will automatically return at when it comes in within the range.)

<Note> Reverse power prevention is possible by “SLOW” side closing designation, in the receiving side at the time of synchronizing closing.)

When voltage and frequency are control within the limits (refer to 7 pages item 5.1), the display of phase difference display LED rotates at the speed according to a frequency difference.

7 segment LED of voltage (V) and frequency (F) displays a difference.

“60R,60L” output will control the difference of bus and generator voltage within the setting range (V). “LED” V turns on within the range.

“15R,15L” output will control the difference of bus and generator voltage within the setting range (0~- F). “LED” F turns on within the range.

In case the phase difference is at synchronizing point $\pm 15^\circ$ under the setting range in both voltage and frequency difference, synchronism check signal ($\pm 15^\circ$) is output and “LED” turns on.

Circuit breaker closing signal (25) will be output ahead of synchronizing point, accounting on the advance time of the circuit breaker closing and “LED” turns on, in order to close the circuit breaker at synchronizing point under the setting range in both voltage and frequency difference.

The circuit breaker closing signal (25) turns off after the advance time plus 200ms. (In case of closing failure, it will turn off at $\pm 10^\circ$, when it comes up to $\pm 10^\circ$ within 200ms.)

6.4 Manual synchronization control.

6.4.1 In case of synchronizing closing from generator to bus (receiving).

Manual synchronization start can be done under the bus voltage input condition (AC90 to 125V) after generator voltage (more than AC80V) is stable. The control will stop under unstable voltage condition and display "ERROR" (F5). (Will automatically return when it comes in within the range.)

When voltage and frequency are control within the limits (refer to 7 pages item 5.1), the display of phase difference display LED rotates at the speed according to a frequency difference. 7 segment LED of voltage (V) and frequency (F) displays a difference.

Voltage difference of bus and generator can be manually controlled within the setting range (V). "LED" (V) turns on within the range.

Frequency difference of bus and generator can be manually controlled within the setting range (F). "LED" (F) turns on within the range.

In case the phase difference is at synchronizing point $\pm 15^\circ$ under the setting range in the voltage and frequency difference, synchronism check signal ($\pm 15^\circ$) is output and "LED" turns on.

Circuit breaker closing signal (25) is manually output ahead of the synchronizing point, accounting on the advance time as well as manual response, in order to close the circuit breaker at synchronizing point within the setting range.

6.4.2 In case of synchronizing closing from bus to generator.

Manual synchronization start can be input under bus (receiving) voltage input condition (AC90 to 125V) and "SLOW" side closing designation (more than AC80V in generator voltage) is input. The control will stop under unstable voltage condition in the generator side and "ERROR" (E5) is displayed. (Automatically returns when it comes in within the range.)

When voltage and frequency are control within the limits (refer to 7 pages item 5.1), the display of phase difference display LED rotates at the speed according to a frequency difference. 7 segment LED of voltage (V) and frequency (F) displays a difference.

Voltage difference of bus and generator can be manually controlled within the setting value (V). "LED" (V) turns on within the range.

Frequency difference of bus and generator can be manually controlled within the setting value (0 - F). "LED" (F) turns on within the range.

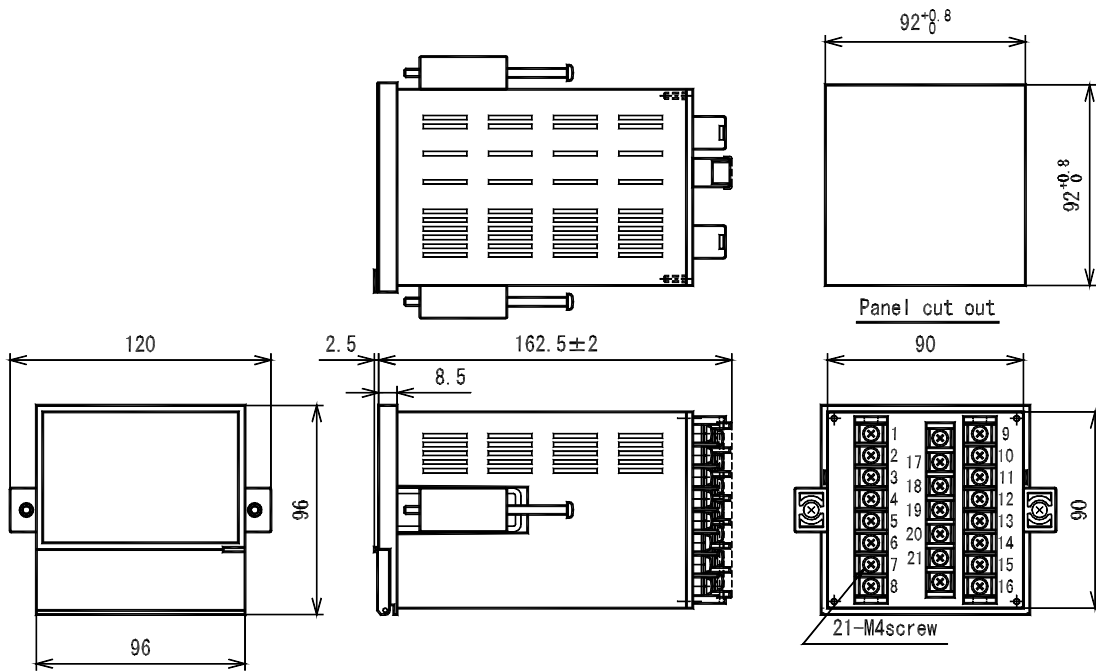
In case the phase difference is at synchronizing point $\pm 15^\circ$ under the setting range in the voltage and frequency difference, synchronism check signal ($\pm 15^\circ$) is output and "LED" turns on.

Circuit breaker closing signal (25) is manually output ahead of the synchronizing point, accounting on the advance time and manual response, in order to close the circuit breaker at synchronizing point under the setting range.

<Note> Closing must be done from "SLOW" side in order to prevent the reverse power from the receiving side.

7. Handling

7.1 Dimension diagram



<Note> This container and spacing with the equipment that is next give a panel cut to for more than 27mm. The thickness of an installation panel is 8mm or less.

Installation environment condition

Installation selects a place suit lower account of environment condition. The place that the vibration that is mechanical and dust and corrosive gas are few. Place that there is not affect of strong electromagnetic field by large current bus and saturable core reactor.

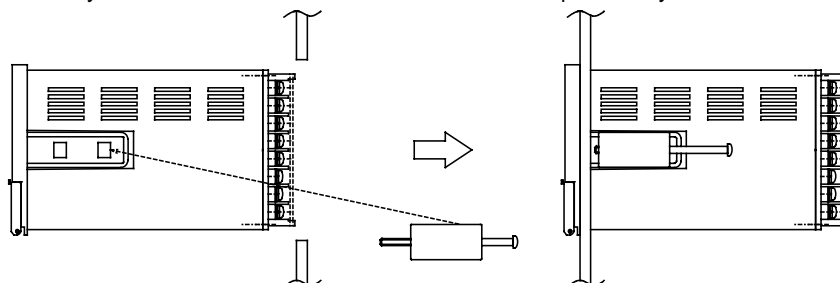
7.2 Installation and remove of product

(1) Installation

They insert a product than the front of panel.

They install attached install tool a hole of product side in panel rear face. (Right and left, 2 places) (A hole of product side set and have pawl of install tool installed to terminal side.

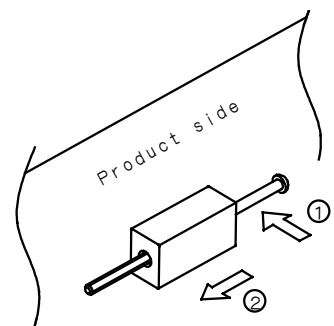
They tighten screw of install tool in a plus driver and they fix a product. (Right and left, 2 places) Binding fast torque : 0.59~1.08N·m (6~11kg·cm). Recommendation binding fast torque : 0.88N·m(9kg·cm) (They don't close only one side when they close screw, and please close screw in turn. And please use screw lock agent when they can installation location to be accompanied by vibration.



(2) Remove way

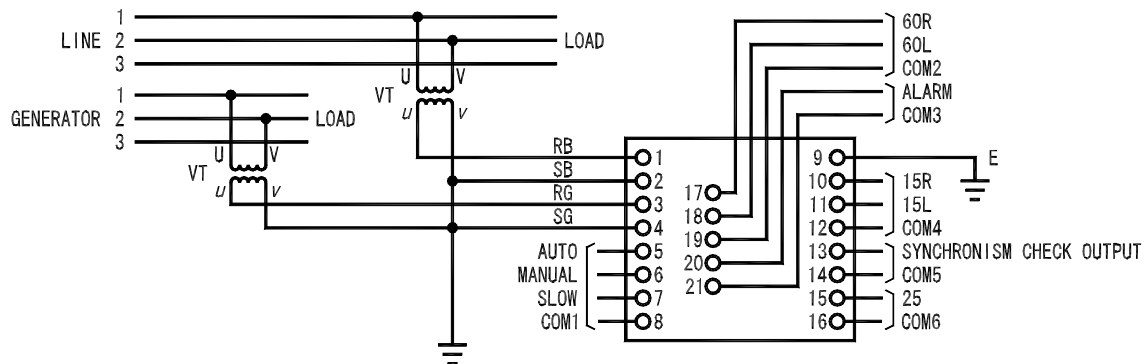
They carry out an install way and reverse work.

When install tool is hard to come off, take off it in the next point. After have loosen a screw, They put a head of screw to direction of main frame () and they begin to put it on the front ().



7.3 Connection

7.3.1 Connection diagram



AUTO : Automatic synchronization start signal.
 MANUAL : Manual synchronization start signal.
 SLOW : SLOW side closing designation signal.

60R : Voltage increase signal.
 60L : Voltage decrease signal.
 ALARM : Alarm signal.
 15R : Governor increase signal.
 15L : Governor decrease signal.
 SYNCHRONISM CHECK OUTPUT : Signal with $\pm 15^\circ$.
 25 : Circuit breaker closing signal.

<Note> Control signal input of AUTO, MANUAL, SLOW is non-voltage contact input.

7.3.2 Precautions for wiring connection

- Set terminal cover for safety, without fail, after finish of the wiring connection.
- Earth terminal "E" (No. 9) must be grounded, without fail, to raise shielding effect.
- Separate the wiring both at power source side and signal side, without fail. Care must be paid for noise.

7.4 Precautions for operation

7.4.1 Input and output signal.

- (1) Input and output terminals are provided with a cover. Set this cover, for safety, without fail, after finish of the wiring connection. Do not touch the terminals during the operating condition.
- (2) Control signal input is no voltage contact. Do not input the voltage signal. In case of setting an external relay for control signal input, select the relay good enough for minimum applicable load (mA) DC12V, 10mA in switching voltage and current.
- (3) Switching capacity of control output (optical MOS-FET relay) is DC100V, 50mA or DC24V, 100mA. An element must be set on the coil of the relay in order to absorb counter voltage at time of switching.

7.4.2 Precautions at time of start of operation

- (1) Bus voltage must be input after the voltage (AC90 to 125V) is stable. Operating failure may happen under unstable range of the power when increasing the voltage, because the power source of this device is in common with bus.
- (2) Control input latch is not provided, so that it must be always short circuit at time of selection.

7.4.3 Precautions during start of operation

- (1) Setting change cannot be performed during action. If it makes a setting change, ac input (bus and generator voltage) non-voltage or a control start input (automatic and manual synchronous start) is set to OFF. The SLOW side closing designation input does not matter with ON.
- (2) If automatic is switched to manual operation during action. After OFF of automatic, it waits 1 second or more, and manual is ON.
- (3) Please do not touch equipment during action. It will cause failure in operation.

7.4.4 Precautions after finish of synchronizing control

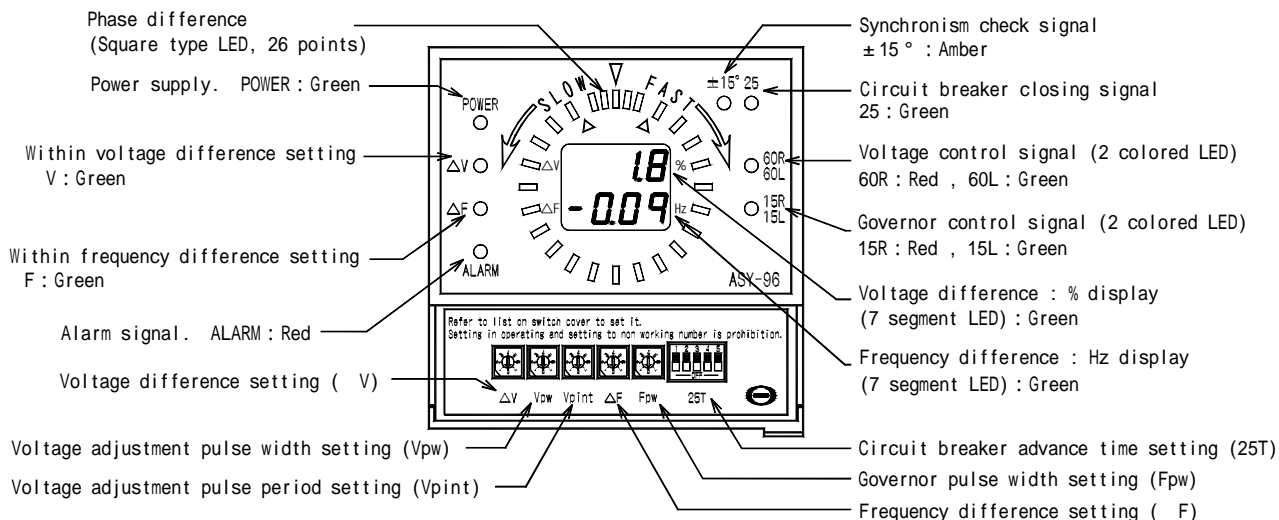
As a rule, AC input (bus voltage and generator voltage) after finish of synchronizing control must be no voltage and control input (automatic and manual synchronization start) must be "OFF". There is no problem if the closing designation input at "SLOW" side is kept at "ON" condition.

7.5 Setting method

Setting must be carried out in reference to the setting arrangement as below.

Setting must be carried out at no voltage (both of bus voltage and generator voltage) or control start at "OFF" position (both of automatic and manual synchronization start). "ERROR" (E3) will display at other setting condition and the control will stop. Reset can be done at no voltage or at control start (both of automatic and manual synchronization start "OFF").

(Setting arrangement)



(Setting procedure)

(1) Voltage difference setting (V) (Rotary cord switch)

Voltage difference setting (V) can be done by rotary cord switch at given value in reference to the following code setting value table. "ERROR" (E3) is display at setting, cords 0.

| Cord | Voltage difference (V) set point |
|------|------------------------------------|
| 1 | 1% |
| 2 | 2% |
| 3 | 3% |
| 4 | 4% |
| 5 | 5% |
| 6 | 7% |
| 7 | 10% |
| 0 | - |

5% factory setting

AC110V = 100%

(2) Voltage adjustment pulse width setting (Vpw) (Rotary cord switch)

Set at given value in reference to code setting value table for voltage adjustment pulse with setting (Vpw). "ERROR" (E3) is display at setting, cords 0.

| Cord | Voltage adjustment pulse width setting point (Vpw) |
|------|--|
| 1 | 0.1s |
| 2 | 0.2s |
| 3 | 0.3s |
| 4 | 0.4s |
| 5 | 0.5s |
| 6 | 0.7s |
| 7 | 1.0s |
| 0 | - |

0.5s factory setting

(3) Voltage adjustment pulse period setting (Vpint) (Rotary cord switch)

Set at given value in reference to code setting value table. "ERROR" (E3) is display at setting, code 6, 7, and 0.

| Cord | Voltage adjustment pulse period setting point (Vpint) |
|------|---|
| 1 | 1s |
| 2 | 2s |
| 3 | 3s |
| 4 | 4s |
| 5 | 5s |
| 6 | - |
| 7 | - |
| 0 | - |

2s factory setting.

(4) Frequency difference setting (F) (Rotary cord switch).

Set at given value in reference to code setting value table. "ERROR" (E3) is display at setting, code 6, 7, and 0.

| Cord | Frequency difference setting point (F) |
|------|--|
| 1 | 0.1 Hz |
| 2 | 0.15Hz |
| 3 | 0.2 Hz |
| 4 | 0.25Hz |
| 5 | 0.3 Hz |
| 6 | - |
| 7 | - |
| 0 | - |

0.1Hz factory setting

(5) Governor pulse width setting (Fpw) (Rotary cord switch).

Set at given value in reference to code setting value table. "ERROR" (E3) is display at setting, codes 0.

| Cord | Governor pulse width (Fpw) setting point |
|------|--|
| 1 | 0.1s |
| 2 | 0.2s |
| 3 | 0.3s |
| 4 | 0.4s |
| 5 | 0.5s |
| 6 | 0.7s |
| 7 | 1.0s |
| 0 | - |

0.5s factory setting

(6) Circuit breaker advance time is setting (5 bits dip-switch).

Set at given value in reference to SW No. Set table. Advance time is the sum at time that "SW" is "ON" condition. There is a limit in the advance time setting, depending on setting of frequency difference (F), in case it is set at out of the time of setting range. The control will stop and display "ERROR" (E3).

(Refer to follows note)

| SW | ON | OFF | Circuit breaker advance time setting value | |
|----|----|-----|--|--|
| 1 | | | 10ms | Advance time is the sum of the time that "SW" is "ON" condition. Advance time = SW1 + SW2 + SW3 + SW4 + SW5 |
| 2 | | | 20ms | |
| 3 | | | 40ms | |
| 4 | | | 80ms | |
| 5 | | | 160ms | |

Setting at time of factory delivery : 50ms under "ON" condition for SW1 and SW3.

Factory setting (SW1 and SW3 : ON, 50ms setting)

| SW | ON | OFF | Circuit breaker advance time setting | |
|----|----|-----|--------------------------------------|--|
| 1 | ○ | | 10ms | Advance time is the sum of the time that "SW" is "ON" condition. Advance time = SW1 + SW2 + SW3 + SW4 + SW5 = 10 + 0 + 40 + 0 + 0 = 50ms |
| 2 | | | 20ms | |
| 3 | ○ | | 40ms | |
| 4 | | | 80ms | |
| 5 | | | 160ms | |

<Note> There is limit in advance time setting, depending on frequency difference setting (F).

| Frequency difference (F) | Setting |
|---------------------------|------------|
| 0.1 Hz | 10 ~ 310ms |
| 0.15Hz | 10 ~ 210ms |
| 0.2 Hz | 10 ~ 150ms |
| 0.25Hz | 10 ~ 100ms |
| 0.3 Hz | 10 ~ 80ms |

In case of setting at out of the time of the setting range, the control will stop and display "ERROR" (E3).

7.6 Setting example

7.6.1 Setting item

Voltage difference (V)
 Frequency difference (F)
 Voltage adjustment pulse width (Vpw)
 Voltage adjustment pulse period (Vpint)
 Governor pulse width (Fpw)
 Circuit breaker advance time (25T)

| Setting item | Default | Setting example |
|---|---------|------------------|
| Voltage difference (V) | 5% | 2% |
| Frequency difference (F) | 0.1Hz | 0.1Hz |
| Voltage adjustment pulse width (Vpw) | 0.5s | 0.5s |
| Voltage adjustment pulse period (Vpint) | 2s | 5s |
| Governor pulse width (Fpw) | 0.5s | 0.5s |
| Circuit breaker advance time (25T) | 50ms | Range 10 ~ 310ms |

7.6.2 Judgment of setting point

Voltage difference (Assumed V = 2% at bus voltage 6600V)
 Control within $\pm 2\% = \pm 132V$ (6468 to 6732V) against bus voltage 6600V.

Voltage adjustment pulse width, pulse period (Assumed Vpw=0.5s, Vpint=5s)
 Voltage control resolution (voltage change per pulse) will be $200V \times 0.5s/6s = 16.7V/pulse$, when advance time is 6s/200V. The change is 16.7V for every 5s, because of the pulse period being 5s.

Frequency difference (Assumed F=0.1Hz.)
 Control within $0.1Hz = 50Hz \pm 0.1Hz$ against bus frequency 50Hz.

Governor pulse width (Assumed Fpw=0.5s.)
 Frequency control resolution (frequency change per pulse) will be $1Hz \times 0.5/15s = 0.033Hz/pulse$.
 The change is 0.033Hz for every $1/F$ (s) because of the pulse period being $1/F$.

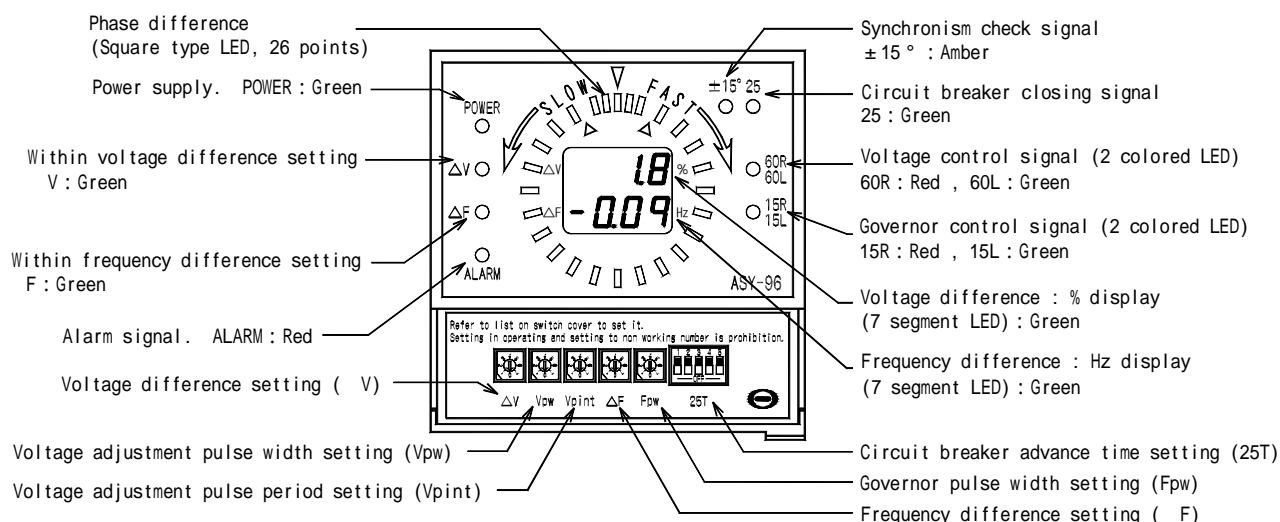
Circuit breaker advance time (25T)
 10 ~ 310ms at F = 0.1Hz
 10 ~ 150ms at F = 0.2Hz
 10 ~ 80ms at F = 0.3Hz
 } This is the setting range.

7.6.3 Counter measure in case of unstable control condition.

- 1) When voltage control becomes hunting.
 - Increase voltage difference (V).
 - Decrease voltage adjustment pulse width (Vpw).
 - Increase voltage adjustment pulse period (Vpint).
 Change can be done by one of the above measures or their combined measures.
- 2) When frequency control becomes hunting.
 - Increase frequency difference (F).
 - Decrease governor pulse width (Fpw).
 Change can be done by one of the above measures or their combined measures.
- 3) When voltage control delays.
 - Increase voltage adjustment pulse width (Vpw).
 - Decrease voltage adjustment pulse period (Vpint).
 Change can be done by one of the above measures or their combined measures.
- 4) When frequency control delays.
 - Increase frequency difference (F).
 - Decrease governor pulse width (Fpw).
 Change can be done by one of the above measures or their combined measures.

7.7 Display

(Display arrangement)



(Measuring display)

- (1) Voltage difference (V) - display (3-digit with polarity for display only : Green).
 Percent (%) display against AC110V in generator voltage difference against bus voltage.

$$\frac{V_G - V_B}{110} \times 100 (\%)$$

$$V_B : \text{Bus voltage}$$

$$V_G : \text{Generator voltage}$$
 - display : When generator side is lower compared with bus side in voltage.
- (2) Frequency difference (F) display (3-digit with polarity for display only : Green)
 Hz display in generator frequency difference against bus frequency.

$$F_G - F_B$$

$$F_B : \text{Bus frequency}$$

$$F_G : \text{Generator frequency}$$
 - display : When generator side is lower compared with bus side in frequency.
- (3) Phase difference display (LED : Amber, however green for synchronizing point only.)
 SLOW : Generator side is lower compared with bus side in frequency.
 FAST : Generator side higher compared with bus side in frequency.

(Status display)

| Display | Status |
|---|--|
| (1) Power supply (POWER) (LED : Green) | Supplies a power supply from a bus input. LED lights by power supply applying. |
| (2) Voltage increase signal (60R) (LED : Red) | LED lights when voltage increase signal (60R) is output. |
| (3) Voltage decrease signal (60L) (LED : Green) | LED lights when voltage decrease signal (60L) is output. |
| (4) Governor increase signal (15R) (LED : Red) | LED lights when governor increase signal (15R) is output. |
| (5) Governor decrease signal (15L) (LED : Green) | LED lights when governor decrease signal (15L) is output. |
| (6) Circuit breaker closing signal (25) (LED : Green) | LED lights when circuit breaker closing signal (25) is output. |
| (7) Synchronism check signal (± 15 °) (LED : Amber) | LED lights when synchronism check signal (± 15 °) is output. |
| (8) Within voltage difference setting (V) (LED : Green) | When voltage difference is within V setting value, LED lights. |
| (9) Within frequency difference setting (F) (LED : Green) | When frequency difference continued more than one second within F setting value, LED lights. |
| (10) Alarm signal (ALARM) (LED : Red) | If a synchronism closing mistake is continued 3 times, LED is lighted after about 3 seconds. Alarm is reset at non-voltage or the control start OFF (automatic synchronization start, manual synchronization start). |

7.8 Error display and treatment

| | Contents of error | Control status | Error output | Reset condition | Note |
|----|---|---------------------|--------------|-------------------------------|------------------------------|
| E1 | ROM/RAM error | Stop | Alarm | | Equipment trouble |
| E2 | A/D error | Stop | Alarm | | Equipment trouble |
| E3 | Setting error | Stop | | Automatic return by reset | |
| E4 | Out of range, bus voltage | Stop | | Automatic return | |
| E5 | Out of range, generator voltage | Stop | | Automatic return | |
| E6 | Out of range, bus frequency | Stop | | Automatic return | |
| E7 | Out of range, frequency difference | Stop | | Automatic return | |
| E8 | Start input designation mistake. (Overlapping designation) | Stop | | Automatic return | |
| E9 | Closing mistake. (3 times continuation) | Closing output stop | Alarm | No input voltage or start OFF | V and F control is continued |

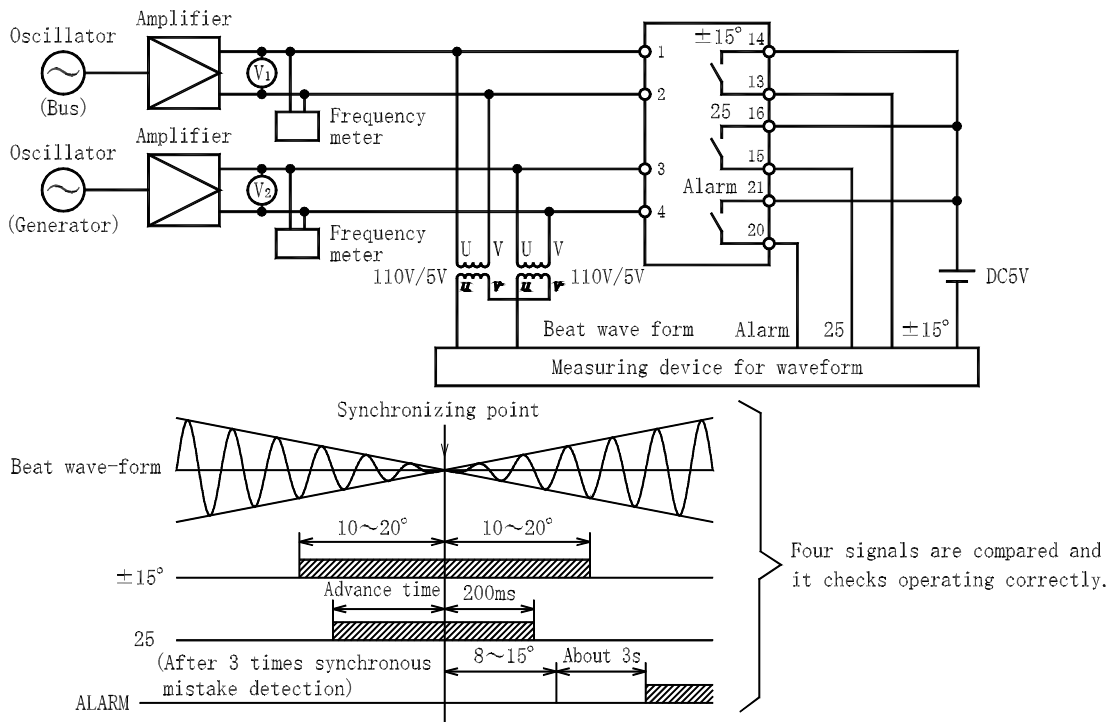
7.9 Trouble shooting

| | Abnormal condition | Probable cause | Treatment |
|---|--|--|---|
| 1 | POWER LED is not lighted. | Bus input is not given. | Validation of bus input. |
| | | Defect in device | Exchange of device. |
| 2 | Figures of voltage and frequency difference don't display. | Out of control range in voltage / frequency of bus and generator. | Confirm of voltage and frequency by bus and generator. |
| | | Defect in device | Exchange of device. |
| 3 | Automatic synchronization closing don't start. | Automatic input (Automatic synchronization closing start) is not given. | Confirm of automatic input. |
| | | Defect in device | Exchange of device. |
| 4 | Manual synchronization closing don't start. | Manual input (Manual synchronization closing start) is not given. | Confirm of manual input. |
| | | Defect in device. | Exchange of device. |
| 5 | Error is displayed. (E1 ~ E9) | E1 : ROM/RAM error | Defect in device, Exchange of device. |
| | | E2 : A/D error | |
| | | E3 : Setting error | Confirm of setting value (Correction). Setting change during operation is not possible. |
| | | E4 : Out of range in bus voltage. | Confirm of voltage range |
| | | E5 : Out of range in generator voltage. | |
| | | E6 : Out of range in bus frequency. | Confirm of frequency range. |
| | | E7 : Out of range in generator frequency. | |
| | | E8 : Error in start input designation. (Repetition designation) | Confirm of start input (Correction). |
| E9 : Closing mistake. (3 times continuation) | Confirm of output (25) or circuit breaker. | | |
| 6 | Voltage don't balance. (V LED is not lighted.) | AVR line, may be inferior if 60R, 60L is output. | Confirm of AVR line. |
| | | Device may be defective if 60R, 60L is not output. | Exchange of device. |
| 7 | Frequency don't balance. (F LED is not lighted.) | Governor line, may be inferior if 15R, 15L is output. | Confirm of governor. |
| | | Device may be defective if 15R, 15L is not output. | Exchange of device. |
| 8 | Closing signal don't display (LED (25) is not lighted.) | Closing conditions are not proper. | Confirm of closing conditions (V and F). |
| | | Device may be defective. | Exchange of device. |
| 9 | Synchronism check signal don't display ($\pm 15^\circ$ LED is not lighted.) | V and F is not within range. | Confirm V and F. |
| | | Device may be defective. | Exchange of device. |
| 10 | Alarm is displayed. | Synchronous closing (25 outputs) mistake occurs by 3 times continuation. | Confirm of circuit breaker line. |
| | | ROM/RAM error. | Exchange of device. |
| | | A/D error. | |

8. Simulation test

Quality of this device is fully confirmed, however, simulating test can be carried out under the following guidance in order to avoid trouble in advance.

1) Simulation test



After giving voltage between bus input (between terminal 1-2) and generator input (between terminal 3-4) and when voltage difference and frequency difference are within the setting value (LED F is "ON" and LED V is "ON") and the pulse difference between them becomes smaller, signal ($\pm 15^\circ$) turns "ON" first and then common signal (25) turns on.

- Voltage difference $V_G - V_B + \text{setting value}$: Voltage decrease signal (60L) turns on.
- Voltage difference $V_G - V_B - \text{setting value}$: Voltage increase signal (60R) turns on.
- Frequency difference $F_G - F_B + \text{setting value}$: Governor decrease signal (15L) turns on.
- Frequency difference $F_G - F_B - \text{setting value}$: Governor increase signal (15R) turns on.
- Control will stop under the range out of $90V - V_B - 125V, 80V - V_G$

In case of $F = 0 \sim \pm 0.05\text{Hz}$, 15R (15L in case of "SLOW" side closing designation) is output at intervals of 3 second.

Under above simulating test, closing command signal (25) is output 3 times continuously every phase at synchronizing point, because bus voltage and generator voltage do not synchronize, it becomes synchronizing failure (ALARM) and the control will stop.

9. Target for synchronizing closing. (Reference data)

In the case of a synchronous closing, a rush current is suppressed and disorder of a system and the shock to a generator are made small. Therefore, it is necessary to make small a voltage difference, a frequency difference, and phase difference.

The following figures 1 and 2 show the size of the rush current by the voltage difference, the frequency difference, and phase difference.

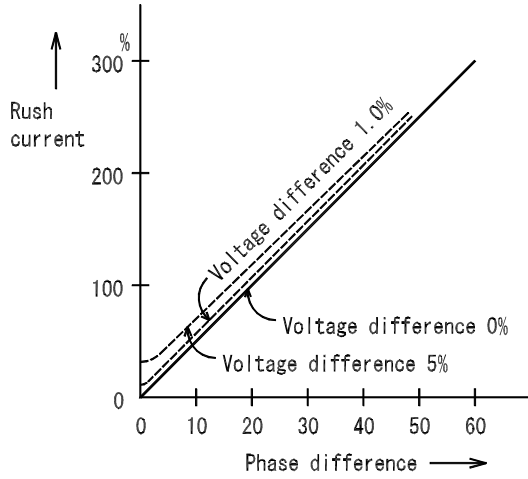


Figure 1

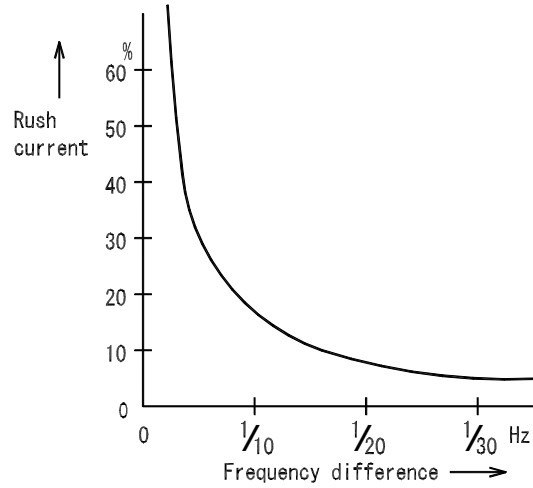


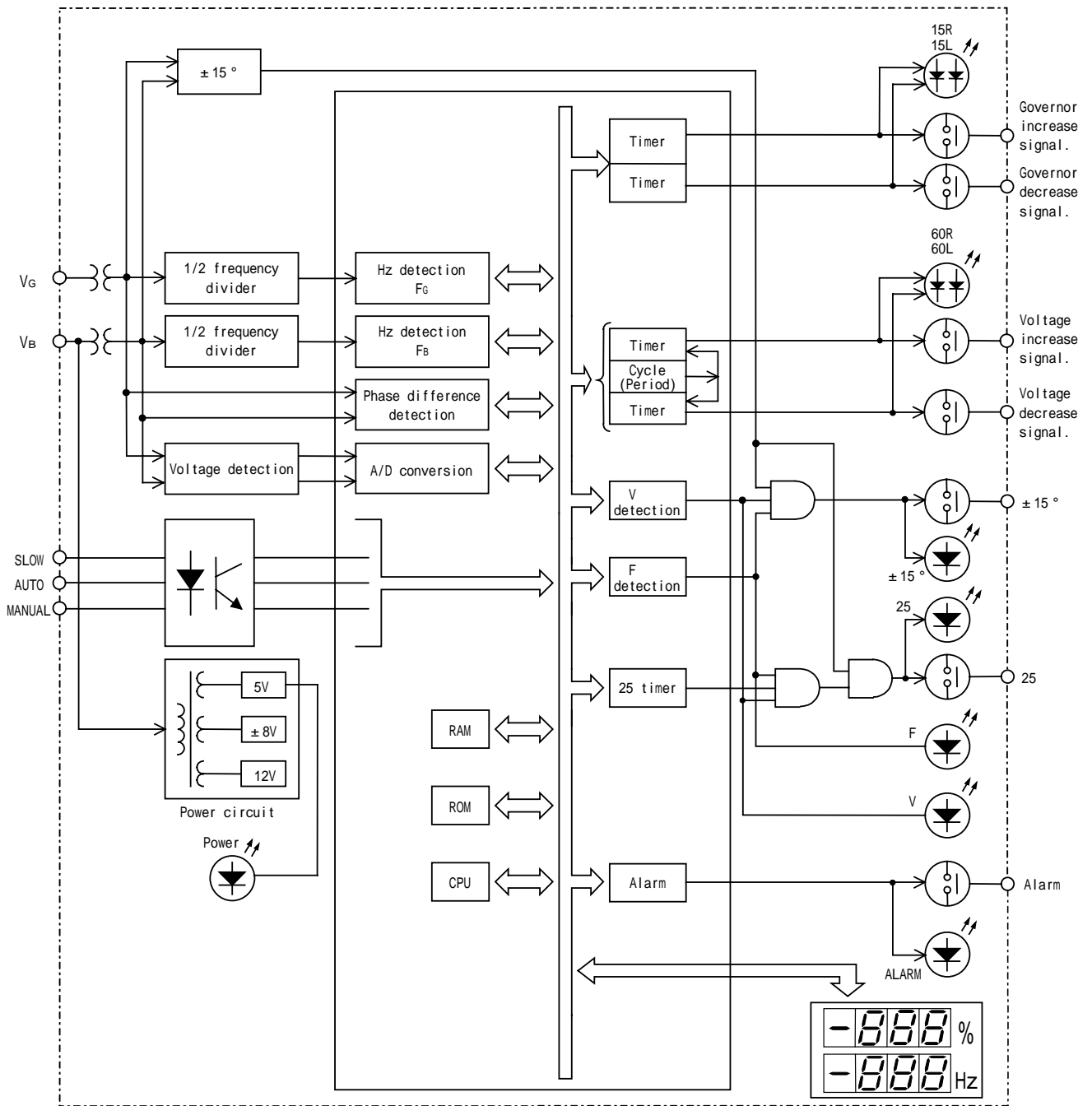
Figure 2

The target of a synchronous closing makes a rush current 50% or less.

Therefore, if it made the voltage difference (about 5%), a phase error (about 5°), and frequency difference (about 0.1Hz or 0.2Hz), the synchronous closing of a target can be performed.

10. Principle of operation

10.1 Block-diagram



10.2 Operating explanation

- (1) Frequency control (Governor increase output, governor decrease output)
 Bus voltage input (V_B) and generator voltage input (V_G) are input into frequency detecting circuit through wave-form adjusting circuit and dividing circuit, after isolation by a VT.
 In the frequency detecting circuit, AC cycle is counted and fed into data bus and the frequency is calculated by soft operation (1/cycle).
 Governor control pulse is output, so that frequency difference becomes within the setting value ($\pm F$) by the measured bus frequency and generator frequency.
 In case of bus frequency (F_B) > generator frequency (F_G), governor increase pulse (15R) is output.
 In case of bus frequency (F_B) < generator frequency (F_G), governor decrease pulse (15I) is output.
 If a frequency difference is within set value ($\pm F$), an output stops. And, it is lighted of LED of F (inside of set value).
- (2) Voltage control (Voltage increase output, voltage decrease output)
 Bus voltage input (V_B) and generator voltage input (V_G) are input into voltage detecting circuit after isolation by VT. In the voltage detecting circuit, effective value (RMS value) of AC voltage is measured and fed into data-bus after A/D conversion.
 The voltage control pulse is output, so that the voltage difference becomes within the setting value ($\pm V$) by the measured bus voltage and generator voltage.
 In case of bus voltage (V_B) > generator voltage (V_G), voltage increase pulse (60R) is output.
 In case of bus voltage (V_B) < generator voltage (V_G), voltage decrease pulse (60L) is output.
 If a voltage difference is within set value ($\pm V$), an output stops. And, it is lighted of LED of V (inside of set value).
- (3) $\pm 15^\circ$ output
 $\pm 15^\circ$ output is measured from the AC signal shaped in waveform. Phase difference is measured by the pulse width from a bus voltage (V_B) input (voltage zero cross point) to a generator voltage (V_G) input (voltage zero cross point).
 If phase difference is $\pm 15^\circ$ of a synchronizing point, a contact signal ($\pm 15^\circ$) is outputted.
 And, it is simultaneously lighted of LED of $\pm 15^\circ$.
- (4) 25 output
 25 outputs count the measured pulse width and incorporate it on a data bus. The attainment time to a synchronizing point is calculated by soft operation $\{(\text{pulse width/period}) \times (1/\text{frequency difference})\}$.
 If the frequency difference F and voltage difference V are within set value, and if phase difference is within $\pm 15^\circ$, if in agreement with the advance time (25T) when the attainment time to a synchronizing point was set beforehand, an input signal (25) is outputted. And, it is simultaneously lighted of LED of 25.
- (5) Control input
 Control input is no voltage contact input. DC12V, 10mA is supplied from the internal of the device.
 The control input is fed to data-bus being isolated by photo-coupler.
- (6) Power supply
 Power supply is supplied from bus voltage and supplied to the circuit after voltage is stabilized at 5V, $\pm 8V$, 12V isolated by VT.

11. Maintenance and check

11.1 Maintenance and check

Please check this product periodically. The contents of inspection are as follows.

- 1) Please check that POWER LED, the status display LED, and digital display are displayed correctly.
- 2) Please check that there are not lights of ALARM LED and an output of an ALARM signal.
- 3) Please check discoloration of LED color, and damage of the case.
- 4) Please check whether wiring and the captive screw are loosening.
- 5) Please remove, if dust adheres to this product.

11.2 Countermeasures against troubles

As our principle, we recall product in question and repair it. If judged as product failure, have a contact with us or sales agent for repairing work (Also have a contact with us or sales agent for specification change).

Product failure which we are not responsible for (When responsibility in manufacturing process is not recognized, when product is disassembled/remodeled, in case of false operation by customer, etc.) is beyond our warranty.

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