INSTRUCTION MANUAL

AUTOMATIC SYNCHRONIZER

ASY-96-A1

(Synchronous closing acceleration function. ±0.05Hz)

ASY-96-A2

(Synchronous closing acceleration function. ±0.02Hz)

DAIICHI ELECTRONICS CO., LTD.

The following rules and warnings must be followed during handling the product.
This instruction manual contains important information to prevent injury to person and damage on the product.
Read entire instruction manual before handling the product.

1. Installation environment
   Do not install the product in the following environment.
   (1) Place where ambient temperature exceeds 50℃.
   (2) Place where humidity level exceeds 90% RH.
   (3) Place where dust or corrosive gases exist.
   (4) Place where vibrate or have impact.
   (5) Place where are subjected to direct sunlight, rain or drop water.
   (6) Place where have much noise.

2. Installation and wirings
   Read entire instruction manual, and the installation and wirings must be carried out by a qualified person only.
   The followings must be followed for the installation and wiring works.
   (1) Check phase sequence and voltage balance.
   (2) Separate power circuit and control/signal circuit wirings, and prevent noise around the product.
   (3) Connect grounding wire to earthing terminal (terminal 9).

⚠WARNING
   1) Wirings must be carried out exactly in accordance with wiring diagram.
   2) Inproper wiring may result in damage on the product, fire and electric shock.
   3) The power must be turned off before installation and wiring works.
   4) Terminal cover must be attached after the installation and wirings.

3. Operation
   Only qualified persons are to install, operate and maintenance.
   Read entire instruction manual and followed proper operation described in the manual.
   (1) Do not touch the product under synchronism check operation condition.
   (2) Please impress an auxiliary supply after establishing voltage (AC･DC80～143V).
       If auxiliary supply is used out of the change range, a possibility of carrying out malfunction will arise.
   (3) In after a synchronous control end, an auxiliary supply and an AC input (bus voltage, generator voltage) should give me non-voltage and a control input (an automatic synchronous start, manual synchronous start) as OFF. However, although an AC input and an auxiliary supply are convenient also with owner voltage, please give an auxiliary supply as change within the limits (AC･DC80～143V).
       The SLOW side closing specification input is convenient with ON.
   (4) Contact capacity of control signal (optical MOS-FET relay) is DC100V, 50mA or DC24V, 100mA.
       Please attach the element which absorbs back starting voltage generated at the time of opening and closing in the coil of the relay used outside.
   (5) At the case of the wave which is doing inverter control and a wave with a large distortion factor, frequency measurement and phase difference measurement may become abnormal.

4. Setting
   Setting must be carried out carefully in accordance with the instruction manual.
   The followings must be followed during the setting.
   (1) Switch must be covered by switch cover during the synchronism check operation condition or after the setting by an operator.
   (2) The auxiliary power must be off before the setting.
   (3) In case of improper setting, the control function will stop and alarm will be on. Change the setting within allowable setting range.

5. Maintenance and check.
   Please give maintenance and check regularly. Please refer to this instruction manual at that occasion.
   If there was a trouble, please check troubleshooting in reference.

CONTENTS

1. Description

This is a control device to carry out a synchronous 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 synchronous point, accounting on advancing breaking time, so that the circuit breaker (CB) can be closed at an exact synchronous point.
This unit has also functions of synchronous check signal (indication only) and synchronous detecting indication.

2. Feature

(1) High quality, high reliability by CPU adoption.

(2) Lightweight, compact size and space saving, being about 1/6 only compared with ordinary device in mounting space.

(3) Numerous in kinds of indication; 3 points for measurement indication and 10 points for status indication.

(4) Simple setting from front side. Numerous setting values, yet very simple in setting.

(5) Synchronous detection by single-phase circuit, both in bus input and generator input.

(6) Auto / Manual synchronous switching function is provided.

(7) Reverse power preventive function is effective at time of recovery of the receiving power by "SLOW" side closing command ($F_B > F_G$).

(8) A power supply is always changed into ON state by separating an AC input and an auxiliary supply.
The stable power supply which is not influenced by the input can be supplied.

3. Functions

(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 Vpw set value and pulse cycle becomes Vpint 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 Fpw set value and pulse cycle becomes "1/input frequency difference". It outputs at 180° of phase difference.

(3) Synchronous check signal function. (±15°).
When voltage difference (ΔV) of a bus and a generator and frequency difference (ΔF) enter in a regulation value and the phase difference becomes less than ±15° further, ±15° LED lights up.
〈Note〉 There is no ±15° control output.

(4) Synchronous closing function.
After voltage difference (ΔV) between bus and generator and after frequency difference (ΔF) between them become within a given value, CB closing signal (25) is output ahead of synchronous point, accounting on advancing time of closing, so that CB can be closed at synchronous point. "ON" time of closing signal (25) is the advancing 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 indication and all control is stop. In case a phase shift (10°) is in 3 seconds, it becomes a synchronizing closing failure.

〈NOTE〉 This product calculates the time to a synchronous point from change of the phase difference, a synchronous closing signal is outputted. For this reason, in case a frequency difference is less than 0.04Hz (a frequency difference is less than 0.01Hz by the case of ±0.02Hz specification) in the case of ±0.05Hz specification, an input signal is not outputted even if the phase difference is 0° (in phase).
However, because ±0.02Hz of accuracy of a frequency difference is contained. in case of ±0.05Hz specification, it is set to less than 0.06Hz (the case of ±0.02Hz specification to less than 0.03Hz) at the case of the maximum accuracy.

(5) Alarm function.
When synchronous closing is failed 3 times continuously, alarm "LED" turns on about one second afterwards and contact signal is output. After alarm is outputted, when there is a control start, ΔF, ΔV, and ±15° (Only indication) control action are continued. A CB closing signal (25) is not outputted. Synchronous closing failure is in the condition that the phase difference between bus side and generator side exceeds 15° . Alarm is released at no voltage or synchronous 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.

(7) Synchronous closing acceleration function.
When the frequency difference of change of the phase difference decreases within ±0.05Hz * (in case of ±0.05Hz specification), in order to promote a synchronous closing, a governor pulse signal is automatically outputted after about 3 seconds.
* (In case of ±0.02Hz specification, with in ±0.02Hz)

4. Specification and performance

4.1 Specification

4.1.1 Input, Auxiliary supply, Output, Indication

Item	Contents		Specification
AC input	Bus side input	(Single-phase)	AC110V, 50/60Hz, 0.5VA
	Generator side input	(Single-phase)	AC110V, 50/60Hz, 0.5VA
Control input	Automatic synchronous start	(AUTO)	1a contact input. Switching voltage and current. DC12V, 10mA (Please use a very small signal relay.)
	Manual synchronous start	(MANUAL)	
	SLOW side closing command	(SLOW)	
Auxiliary supply	—		AC・DC80～143V AC100/110V 50/60Hz Below 4.5VA DC100/110V, DC125V Below 2.5W
Control output	Voltage increase signal	(60R)	Optical MOS-FET relay DC100V, 50mA or DC24V, 100mA 〈NOTE〉 A synchronous check signal (±15°) is nothing.
	Voltage decrease signal	(60L)	
	Governor increase signal	(15R)	
	Governor decrease signal	(15L)	
	Alarm signal	(ALARM)	
	CB closing signal	(25)	
Indication LED	POWER		Green
	Voltage increase signal	(60R)	Red / Green] 2 color LED
	Voltage decrease signal	(60L)	
	Governor increase signal	(15R)	Red / Green] 2 Color LED
	Governor decrease signal	(15L)	
	CB closing signal	(25)	Green
	Synchronous check signal	(±15°)	Amber
	The signal in the frequency difference set point	(ΔF)	Green
	The signal in the voltage difference set point	(ΔV)	Green
	Alarm signal	(ALARM)	Red
Measurement indication	Phase difference		Amber LED (synchronous point, color : Green) A total of 26 points / 360° indication. (15° interval 24 points, and before or after a synchronous point 7.5° interval 2 points)
	Voltage difference : $\frac{V_G - V_B}{110} \times 100(\%)$		Green 7 Segment LED : −□□.□% (% indication to AC110V)
	Frequency difference : $F_G - F_B$ (Hz)		Green 7 Segment LED : −□.□□Hz
Synchronous closing acceleration function	ASY-96-A1 (±0.05Hz specification)		-0.05Hz＜ΔF＜+0.05Hz
	ASY-96-A2 (±0.02Hz specification)		-0.02Hz＜ΔF＜+0.02Hz

4.1.2 Setting value.

1) Voltage difference (ΔV) setting. (By rotary cord switch 1)
   Setting range : 1, 2, 3, 4, 5, 7, 10%. But 100% at AC110V. Factory setting at time of delivery : 5%.
2) Voltage adjusting pulse width setting. (By rotary cord switch 2)
   Setting range : 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0 seconds. Factory setting at time delivery : 0.5 seconds.
3) Voltage adjusting pulse cycle setting. (Rotary cord switch 3)
   Setting range : 1, 2, 3, 4, 5 seconds. Factory setting at time delivery : 2 seconds.
4) Frequency difference (ΔF) setting. (By rotary cord switch 4)
   Setting range : 0.1, 0.15, 0.2, 0.25, 0.3Hz. Factory setting at time delivery : 0.1Hz.
5) Governor control pulse width setting (By rotary cord switch 5)
   Setting range : 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0 seconds. Factory setting time at delivery : 0.5 seconds.
6) CB advancing time setting (By 5 bits dip switch)
   Setting range : 10, 20, 40, 80, 160ms. (Setting value in total sum when switch is "ON")
   Factory setting at time of delivery : 50ms.

〈Note〉 There is a limit in CB advancing time setting, depending on frequency difference (ΔF).

Frequency difference setting (△F)	CB advancing 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〉 ERROR (E3) will indicate when setting is out of range.

4.2 Performance

Item		Specification and performance	
Accuracy	Voltage difference	±0.5%	
	Frequency difference	±0.02Hz	
	Pulse width	±50ms	
	Voltage adjustment pulse cycle	±10%+(10～200ms)	
	Phase difference detection	±1°	
	Synchronous-closing phase accuracy	±5°	
Charac-teristic	Affect of temperature	It is the inside of tolerance at 23±20℃	
	Affect of frequency	It is the inside of tolerance at ±3Hz to a bus rated frequency.	
	Affect of voltage	It is the inside of tolerance at AC90～125V	
	Affect of auxiliary supply	It is the inside of tolerance at AC･DC80～143V	
	Other	JIS C 1111：1989 conformity	
Strength	Over voltage strength	AC input	1.5 times 10 seconds, 1.2 times continuous of rated voltage
		Aux. supply	1.5 times 10 seconds (10 times of 10 seconds interval) of AC･DC100/110V. AC･DC143V continuous.
	Insulation resistance	Above 30MΩ at DC500V megger.	Between electric circuit collective and outer case (Earth).
			Between auxiliary supply terminal and AC input, control input, control output terminal.
			Between AC input and control input, control output terminal.
			Between input terminal and control output terminal.
	Withstand voltage	AC2000V (50/60Hz) 1 minute	Between electric circuit collective and outer case (Earth).
			Between auxiliary supply terminal and AC input, control input, control output terminal.
			Between AC input and control input, control output terminal.
			Between input terminal and control output terminal.
	Impulse withstand voltage	5kV 1.2×50μs Positive negative polarity for each 3 times	Between electric circuit general and a case (Earth).
	Noise-capacity	Square wave impulse noise The indicate and control output error that 1μs, 100ns width add noise to repeatedly 5 minute, Auxiliary supply (Normal / common) Over 1.5kV Bus side input, generator side input (Normal / common) Over 1.5kV Control output (Common) Over 1.0kV	
		Oscillatory surge voltage The indicate and control output error that 2kV add attenuation nature oscillatory wave type to repeatedly, Auxiliary supply (Normal / common) Bus side input, generator side input (Normal / common) Control output (Common)	
		Wave noise The indicate and control output error irradiate wave of 150, 400, 900MHz band in 5W, 1m a intermittent continuation,	
		Electrostatic noise ±8kV(Apply)：An indication and a control output should not carry out a malfunction. ±10kV(Not apply)：There need to be no bad conditions, such as breakage of parts.	
	Shock	Shock 294m/s^2 (30G), X, Y, Z direction for each 3 times to the right and contrary.	
	Vibration	Malfunction：16.7Hz, double vibration 1mm X, Y, Z orientation for each 10 minutes.	
Operation temperature and humidity range		0～50℃, 5～90% RH (Non condensing)	
Storage temperature range		-10～+70℃	
Case color		Black (Munsell N1.5)	
Mass		About 1kg	

5. Control function

5.1 Control range

Bus voltage : AC90～125V
Generator voltage : More than AC80V
Bus frequency : 50±3Hz , 60±3Hz
Frequency difference : Less than ±4Hz
〈Note〉 Control will stop at other ranges than above and indicate "ERROR" for each.

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

(1) Automatic synchronous start and manual synchronous start.

Start input		Output
Automatic synchronous	Manual synchronous	
ON	OFF	Output of 60R/60L, 15R/15L. 25.
OFF	ON	Measurement indication, ±15° (LED indication)
OFF	OFF	Only POWER LED is turned on.
ON	ON	E8 : Start input designating mistake (Repeat designate)

〈Note〉 Under above condition, ON is terminal short-circuiting. OFF is terminal open.
It switches to automatic shell manual operation during control. Please turn on manual operation after turning off automatic more 1 second.

(2) Generator SLOW side closing designation.
ON (Terminal short-circuit) : Closing from SLOW side. ($F_B > F_G$)
OFF (Terminal open) : 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.

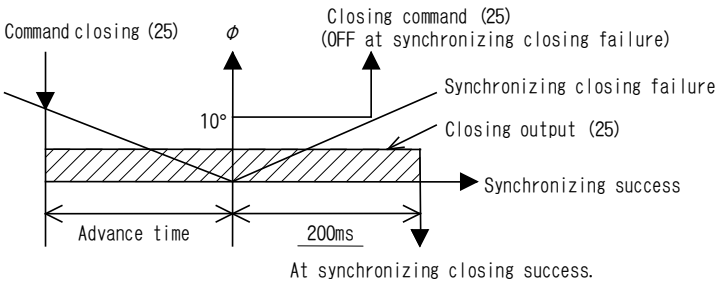
(2) Advancing function (15R, 15L)
A control pulse is outputted in order that bus frequency (F_B) and generator frequency (F_G) may be put into regulation within the limits.

(3) Frequency difference signal within setting value (ΔF).
When frequency difference continues over 1 second, within setting value (ΔF), LED of ΔF turns on.
Hysteresis 0.02Hz (turns on under 0.1Hz in case of ΔF=0.1Hz). Return (turn on → turn off) will be over ΔF+0.02Hz (turns off at 0.12Hz in case of ΔF=0.1Hz).

(4) Voltage difference signal within setting value (ΔV).
When voltage difference comes in within setting value (ΔV), ΔV of LED turns on.
Hysteresis 0.5% (turns on within 4.5% in case of ΔV = 5%)

(5) Synchronous check signal (±15°).
When voltage and frequency difference are within the setting value and phase difference within ±15° , ±15° LED turns on. (There is no ±15° control output)

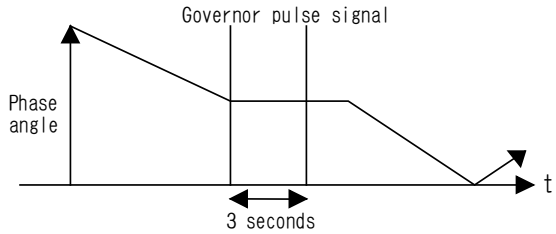
(6) CB closing signal (25).



After voltage and frequency difference comes in Within the setting value, CB closing signal (25) is output ahead of synchronous point, accounting on CB closing advancing time and "LED" (25) turns on. CB closing signal (25) must be set at "OFF" after the advancing 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 indication and all control is stop. In case a phase shift (10°) is in 3 seconds, it becomes a synchronizing closing failure.

(7) Synchronous failure signal (ALARM).
When synchronous closing is failed 3 times continuously, alarm LED turns on about 1 second afterward and contact is output. After alarm is outputted, when there is a control start, ΔF, ΔV, and ±15° (Only indication) control action are continued. A CB closing signal (25) is not outputted. Synchronous failure is in the case when phase difference at both of bus and generator side exceeds 15° , though CB closing signal (25) is output. Alarm can be released at auxiliary supply no voltage or synchronous start (both of auto and manual) is "OFF".

(8) Synchronous closing speed-up function.



When phase difference comes smaller within ±0.05Hz(At the time of ±0.05Hz specification, or ±0.02Hz at the time of ±0.02Hz specification) 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.

±0.05Hz specification (0～±0.05Hz of frequency differences)
±0.02Hz specification (0～±0.02Hz of frequency differences)

6. Operation

6.1 Before auxiliary supply apply.

① 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

② Change of each setting value must be made before auxiliary supply apply or before control start (Refer to item 7.5 in page 12).
The change after control is started is not possible. The control will stop and indicate "ERROR" (E3).

6.2 After auxiliary supply apply.

① "POWER LED" (Green) turns on when auxiliary supply apply.

② Change of each setting value must be made before the auxiliary supply apply or before control start. (Refer to item 7.5 in Page 12). The change after control is started is not possible. The control will stop and indicate "ERROR" (E3).

③ When voltage and frequency are within the control range, indication 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 indicate the difference (Refer to item 5.1 in Page 6)

6.3 Automatic synchronous control

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

① Under the bus voltage input condition (AC90～125V) and after the generator voltage is stable (More than AC80V), automatic synchronous is done. Under unstable voltage condition, the control will stop and indicate "ERROR" (E5). (Will automatically return when the voltage comes in within the range.)

② In case the voltage and frequency are within the control range (Refer to item 5.1 in page 6), phase difference "LED" indication will rotate in the speed according to the frequency difference. 7 segment "LED" will indicate the difference of voltage (△V) and frequency (△F).

③ "60R, 60L" output will control the difference of bus and generator voltage within the setting range (△V). "LED" △V turns on within the range.

④ "15R, 15L" output will control the difference of bus and generator voltage within the setting range (△F). "LED" △F turns on within the range.

⑤ In case the phase difference is at synchronous point ±15° under the setting range in both voltage and frequency difference, synchronous check signal (±15°) is "LED" turns on. (There is no ±15° control output)

⑥ CB closing signal (25) will be output ahead of synchronous point, accounting on the advancing time of the CB closing and "LED" turns on, in order to close the CB at synchronous point under the setting range in both voltage and frequency difference. The CB closing signal (25) turns off after the advancing time plus 200ms. (In case of closing mistake, it will turn off at ±15° , when it comes up to ±15° within 200ms.)

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

① Automatic synchronous start can be done under the bus voltage input condition (AC90～125V) 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) will be indicated. (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 synchronous closing.)

② In case of the voltage and frequency within the control range (Refer to item 5.1 in page 6), phase difference "LED" indication will rotate in the speed according to the frequency difference. 7 segment "LED" will indicate the difference of voltage (△V) and frequency (△F).

③ "60R, 60L" output will control the difference of bus and generator voltage within the setting range (△V). "LED" △V turns on within the range.

④ "15R, 15L" output will control the difference of bus and generator voltage within the setting range (△F). "LED" △F turns on within the range.

⑤ In case the phase difference is at synchronous point ±15° under the setting range in both voltage and frequency difference, synchronous check signal (±15°) is "LED" turns on. (There is no ±15° control output)

⑥ CB closing signal (25) will be output ahead of synchronous point, accounting on the advancing time of the CB closing and "LED" turns on, in order to close the CB at synchronous point under the setting range in both voltage and frequency difference. The CB closing signal (25) turns off after the advancing time plus 200ms. (In case of closing mistake, it will turn off at ±15° , when it comes up to ±15° within 200ms.)

6.4 Manual synchronous control.

6.4.1 In case of synchronous closing form generator to bus (receiving).

① Manual synchronous start can be done under the bus voltage input condition (AC90～125V) after generator voltage (more than AC80V) is stable. The control will stop under unstable voltage condition and indicate "ERROR" (F5). (Will automatically return when it comes in within the range.)

② In case voltage and frequency are within the control range (refer to item 5.1 in page 6), phase difference indication "LED" will rotate (in the speed according to the frequency difference. 7-segment "LED" will indicate

③ Voltage difference of bus and generator can be manually controlled within the setting range (△V). ""LED" (△V) turns on within the range.

④ Frequency difference of bus and generator can be manually controlled within the setting range (△F). ""LED" (△F) turns on within the range.

⑤ In case the phase difference is at synchronous point ±15° under the setting range in the voltage and frequency difference, synchronous check signal (±15°) is "LED" turns on. (There is no ±15° control output)

⑥ CB closing signal (25) is manually output ahead of the synchronous point, accounting on the advancing time as well as manual response, in order to close the CB at synchronous point within the setting range.

6.4.2 In case of synchronous closing from bus to generator.

① Manual synchronous start can be input under bus (receiving) voltage input condition (AC90～125V) 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) will indicate. (Automatically returns when it comes in within the range.)

② In case the voltage and frequency are within the control range (refer to item 5.1 in page 6), phase difference "LED" indication will rotate in the speed according to the frequency difference. 7-segment "LED" indicates the difference of voltage (ΔV) and frequency (△F).

③ Voltage difference of bus and generator can be manually controlled within the setting value (0～+ΔV). "LED" (ΔV) turns on within the range.

④ Frequency difference of bus and generator can be manually controlled within the setting value (0～+ΔF). "LED" (ΔF) turns on within the range.

⑤ In case the phase difference is at synchronous point ±15° under the setting range in the voltage and frequency difference, synchronous check signal (±15°) is "LED" turns on. (There is no ±15° control output)

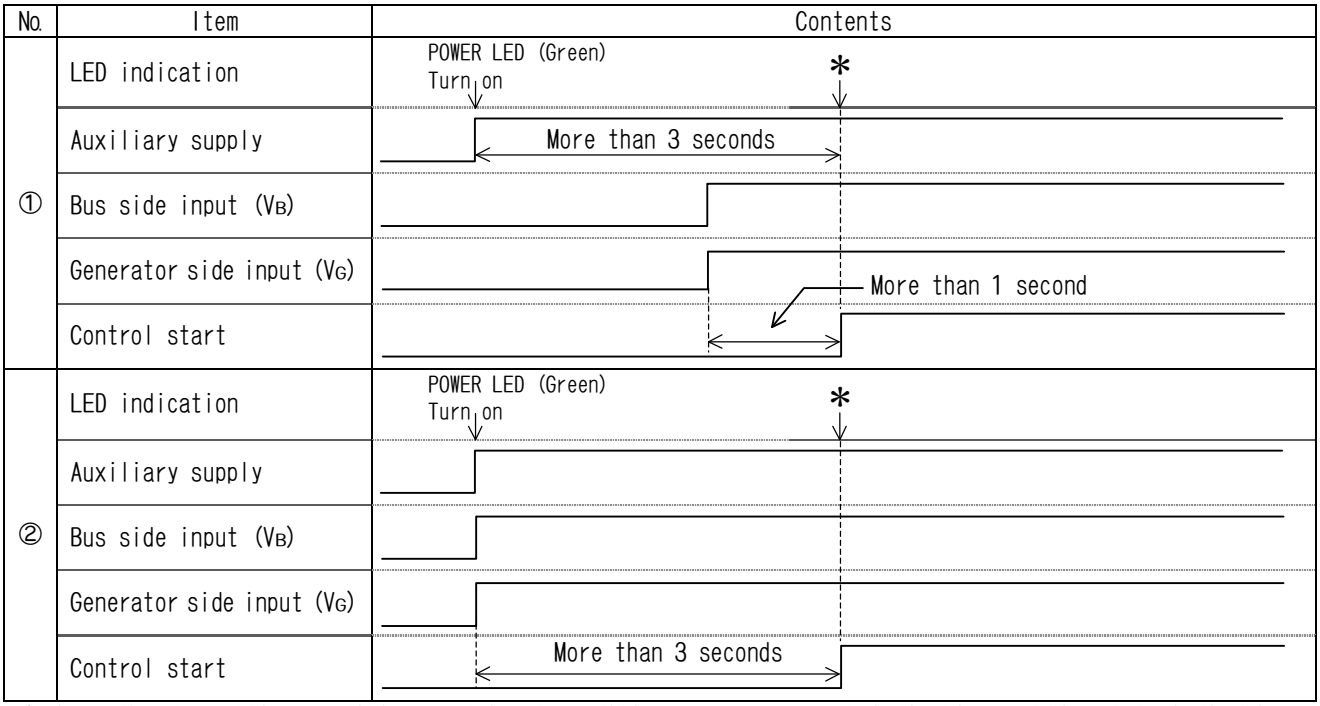
⑥ CB closing signal (25) is manually output ahead of the synchronous point, accounting on the advancing time and manual response, in order to close the CB at synchronous point under the setting range.

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

6.4.3 Timing of a auxiliary supply, bus voltage, generator voltage, control start.
Please carry out on the following conditions.

① A control input is started, after it apply bus voltage and generator voltage simultaneously and more than 1 seconds pass, where an auxiliary supply is apply.
〈Note〉 Only in an auxiliary supply and a control start, the outside of the bus voltage range is displayed (E4).

② An auxiliary supply, bus voltage, and generator voltage are apply simultaneously, and a control input is started after more than 3 seconds pass.

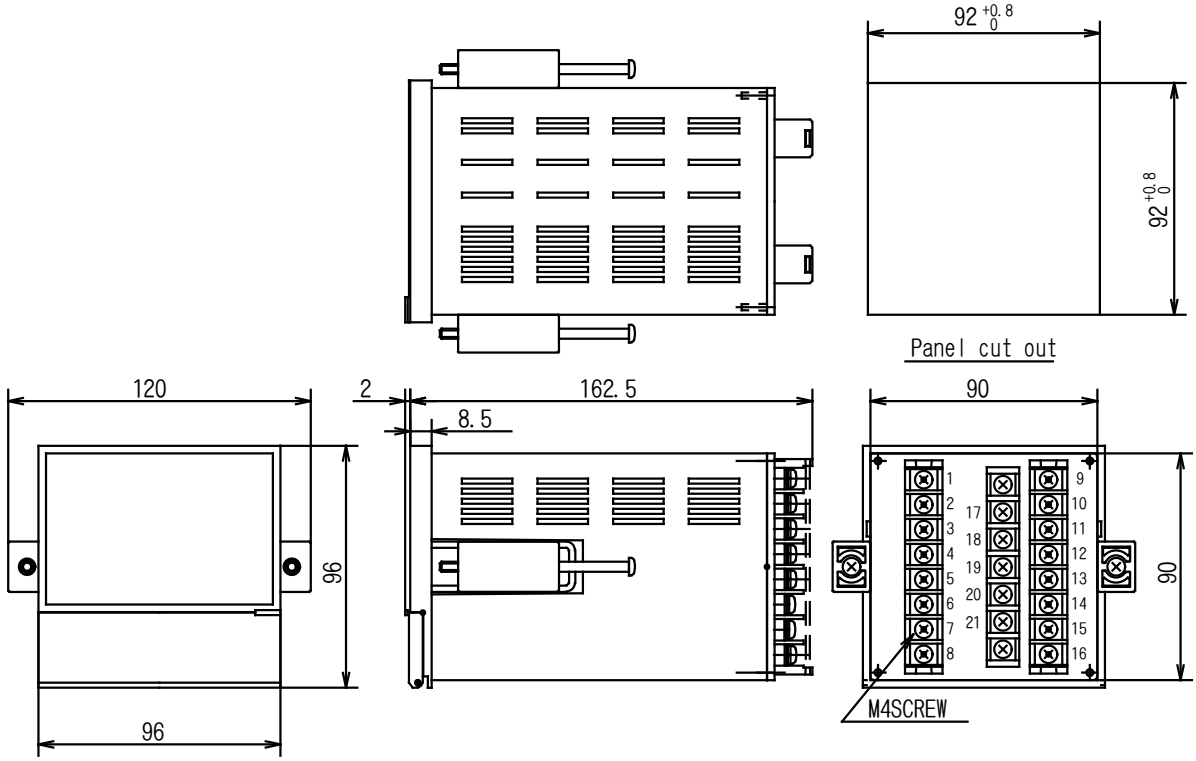


* According to setting conditions and input conditions, a measurement indication and the state indication LED are outputted.

It does not become operation abnormalities in case an auxiliary supply, input (bus side, generator side), and control start are applied simultaneously. In consideration of the control start in a power supply stable period, it may be more than 3 seconds.

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.

■ 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.

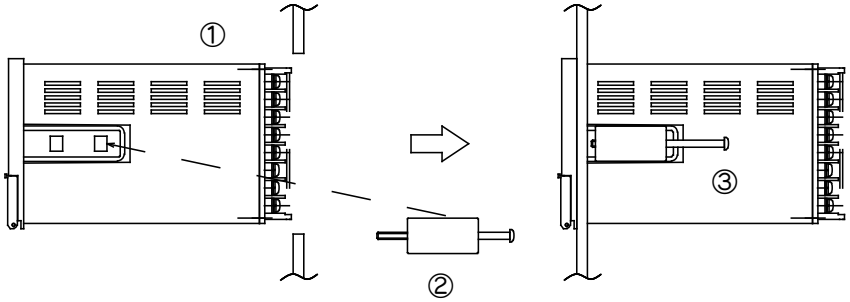
7.2 Mounting and remove of product

(1) Mounting

① They insert a product than the front of panel.

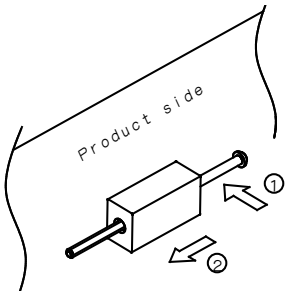
② They mount attached install tool a hole of product side in panel rear face. (Right and left, 2 places)
(A hole of product side set and have pawl of install tool mounted to terminal side.

③ 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 mount location to be accompanied by vibration.



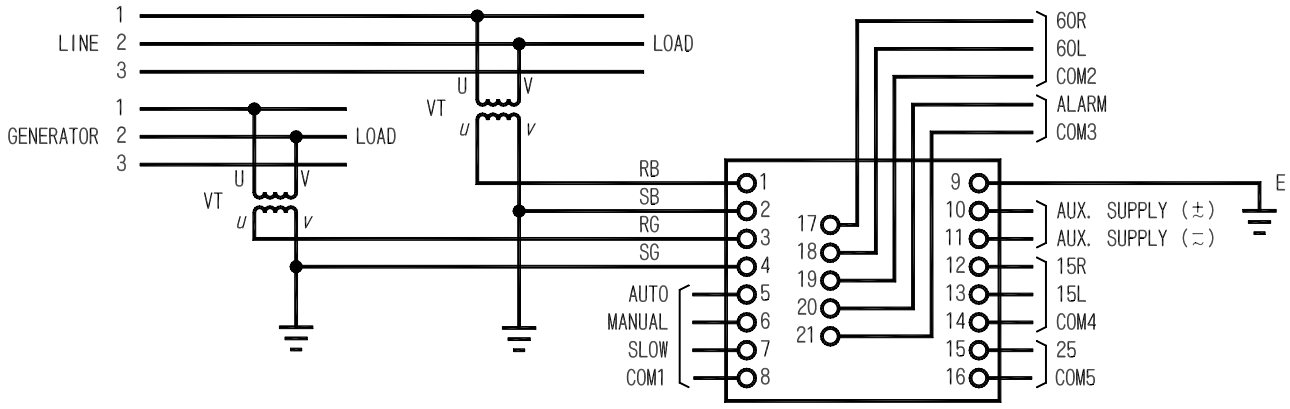
(2) Remove way

They carry out an mount way and reverse work.
When mount 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 (①) and they begin to put it on the front (②).



7.3 Connection

7.3.1 Connection diagram



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

〈Note〉 The control signal input of AUTO, MANUAL, and SLOW is a non-voltage contact input.

60R : Voltage increases signal.
60L : Voltage decreases signal.
ALARM : Alarm signal.
15R : Governor increases signal.
15L : Governor decreases signal.
25 : Synchronous closing signal.

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 increase 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) Auxiliary supply input must be input after the voltage (AC・DC80～143V) is stable. Operating failure may happen under unstable range of the power when increasing the voltage.

(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) Change of setting during operating condition is not possible. Auxiliary supply and control start input (automatic and manual synchronous start) must be "OFF". There is no problem if the closing designation input is kept at "ON" condition.

(2) Please turn on manual operation after turning off automatic more than 1 second, when switching to automatic shell manual operation during operation.
It is also the same as when switching automatically from manual operation.

(3) Do not touch the device during operation. It will cause failure in operation.

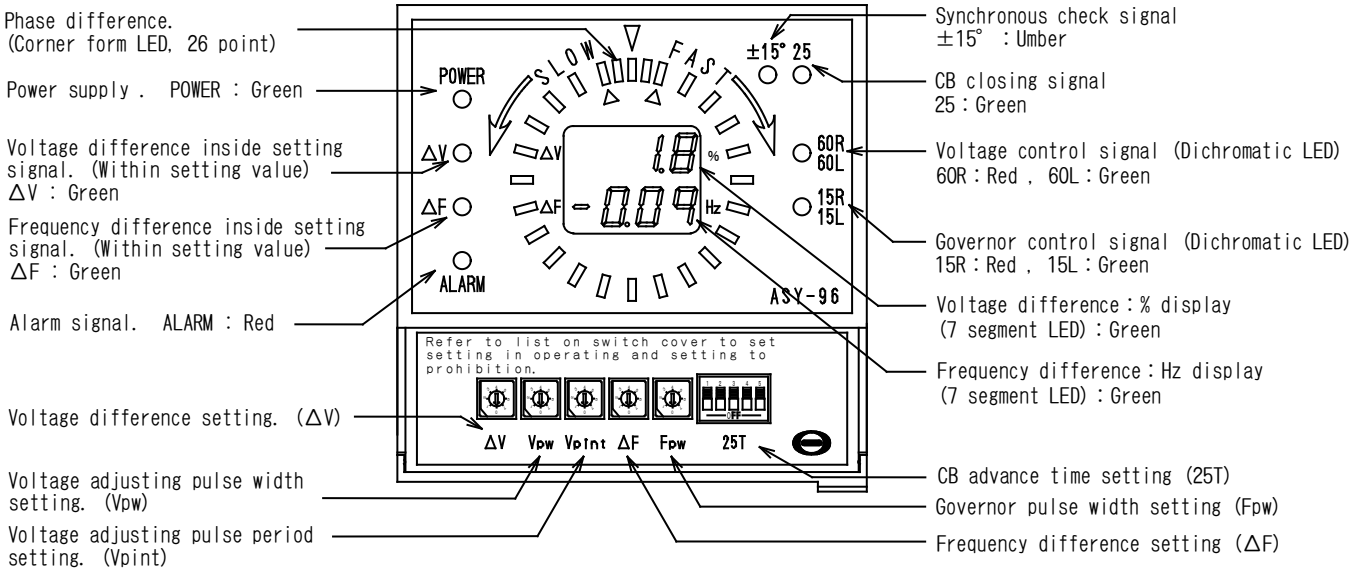
7.4.4 Precautions after finish of synchronous control

As a rule, auxiliary supply, AC input (bus voltage and generator voltage) after finish of synchronous control must be no voltage and control input (auto and manual synchronous 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 auto and manual synchronous start). “ERROR” (E3) will indicate at other setting condition and the control will stop. Reset can be done at no voltage or at control start (both of auto and manual synchronous start “OFF”).

(Setting arrangement)



(Setting procedure)

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

Voltage difference setting (ΔV) can be done by rotary cord switch at given value in reference to the Following code setting value table. “ERROR” (E3) is indicated at setting, cords 0.

Cord	Voltage difference (ΔV) set point	
1	1%	
2	2%	
3	3%	
4	4%	
5	5%	← 5% setting at time of factory delivery
6	7%	
7	10%	
0	—	But, AC110V=100%

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

Set at given value in reference to code setting value table for voltage adjusting pulse with setting (Vpw). “ERROR” (E3) is indicated at setting, cords 0.

Cord	Voltage adjusting pulse width setting point (Vpw)	
1	0.1s	
2	0.2s	
3	0.3s	
4	0.4s	
5	0.5s	← 0.5s setting at time of factory delivery
6	0.7s	
7	1.0s	
0	—	

(3) Voltage adjusting pulse cycle setting (Vpint)(Rotary cord switch)
Set at given value in reference to code setting value table. "ERROR" (E3) is indicated at setting, code 6, 7, and 0.

Cord	Voltage adjusting pulse cycle setting point (Vpint)	
1	1s	
2	2s	← 2s setting at time of factory delivery
3	3s	
4	4s	
5	5s	
6	—	
7	—	
0	—	

(4) Frequency difference setting (ΔF)(Rotary cord switch).
Set at given value in reference to code setting value table. "ERROR" (E3) is indicated at setting, code 6, 7, and 0.

Cord	Frequency difference setting point (Δf)	
1	0.1 Hz	← 0.1Hz setting at time of factory delivery
2	0.15Hz	
3	0.2 Hz	
4	0.25Hz	
5	0.3 Hz	
6	—	
7	—	
0	—	

(5) Governor control pulse width setting (Fpw)(Rotary cord switch).
Set at given value in reference to code setting value table. "ERROR" (E3) is indicated at setting, codes 0.

Cord	Governor control pulse width (Fpw) Set point	
1	0.1s	
2	0.2s	
3	0.3s	
4	0.4s	
5	0.5s	← 0.5s setting at time of factory delivery.
6	0.7s	
7	1.0s	
0	—	

(6) CB advancing time is setting (5 bits dip-switch).
Set at given value in reference to SW No. Set table. Advancing time is the sum at time that "SW" is "ON" condition. There is a limit in the advancing time setting, depending on setting of frequency difference (ΔF), in case it is set at out of the time of setting range. The control will stop and indicate "ERROR" (E3).
(Refer to follows note)

SW No.	ON	OFF	CB advancing time setting value	
1			10ms	Advancing time is the sum of the time that "SW" is "ON" condition.
2			20ms	
3			40ms	Advancing time = SW1 + SW2 + SW3 + SW4 + SW5
4			80ms	
5			160ms	

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

In case of factory setting at SW1 and SW2 for 50ms

SW No.	ON	OFF	CB advancing time setting	
1	○		10ms	Advancing time is the sum of the time that "SW" is "ON" condition.
2			20ms	
3	○		40ms	Advancing time = SW1 + SW2 + SW3 + SW4 + SW5
4			80ms	= 10 + 0 + 40 + 0 + 0 = 50ms
5			160ms	

〈Note〉 There is limit in advancing time setting, depending on frequency difference setting (ΔF).

Frequency difference (ΔF)	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 indicate "ERROR" (E3).

7.6 Setting example

7.6.1 Setting item

① Voltage difference (△V)
② Frequency difference (△F)
③ Voltage adjusting pulse width (Vpw)
④ Voltage adjusting pulse cycle (Vpint)
⑤ Governor pulse width (Fpw)
⑥ CB advancing time (25T)

Setting item	Initial value	Setting example
Voltage difference (△V)	5%	2%
Frequency difference (△F)	0.1Hz	0.1Hz
Voltage adjusting pulse width (Vpw)	0.5s	0.5s
Voltage adjusting pulse cycle (Vpint)	2s	5s
Governor pulse width (Fpw)	0.5s	0.5s
CB advancing time (25T)	50ms	Range 10～310ms

7.6.2 Judgment of setting point

★① Voltage difference (Assumed ΔV＝2% at bus voltage 6600V)
Control within ±2%＝±132V (6468 to 6732V) against bus voltage 6600V.

★② Voltage adjusting pulse width, pulse cycle (Assumed Vpw＝0.5s, Vpint＝5s)
Voltage control resolution (voltage change per pulse) will be 200V×0.5s/6s＝16.7V/pulse, when advancing time is 6s/200V. The change is 16.7V for every 5s, because of the pulse cycle being 5s.

★③ Frequency difference (Assumed △F＝0.1Hz.)
Control within 0.1Hz＝50Hz ±0.1Hz against bus frequency 50Hz.

★④ Governor pulse width (Assumed Fpw＝0.5s.)
Frequency control resolution (frequency change per pulse) will be 1Hz×0.5/15s＝0.33Hz/pulse.
The change is 0.33Hz for every 1/ΔF (s) because of the pulse cycle being 1/ΔF.

★⑤ CB advancing time (25T)
10～310ms at △F＝0.1Hz
10～150ms at △F＝0.2Hz } This is the setting range.
10～ 80ms at △F＝0.3Hz

7.6.3 Counter measure in case of unstable control condition.

1) When voltage control becomes hunting.
① Increase voltage difference (△V).
② Decrease voltage adjusting pulse width (Vpw).
③ Increase voltage adjusting pulse cycle (Vpint).
Change can be done by one of the above measures or their combined measures.

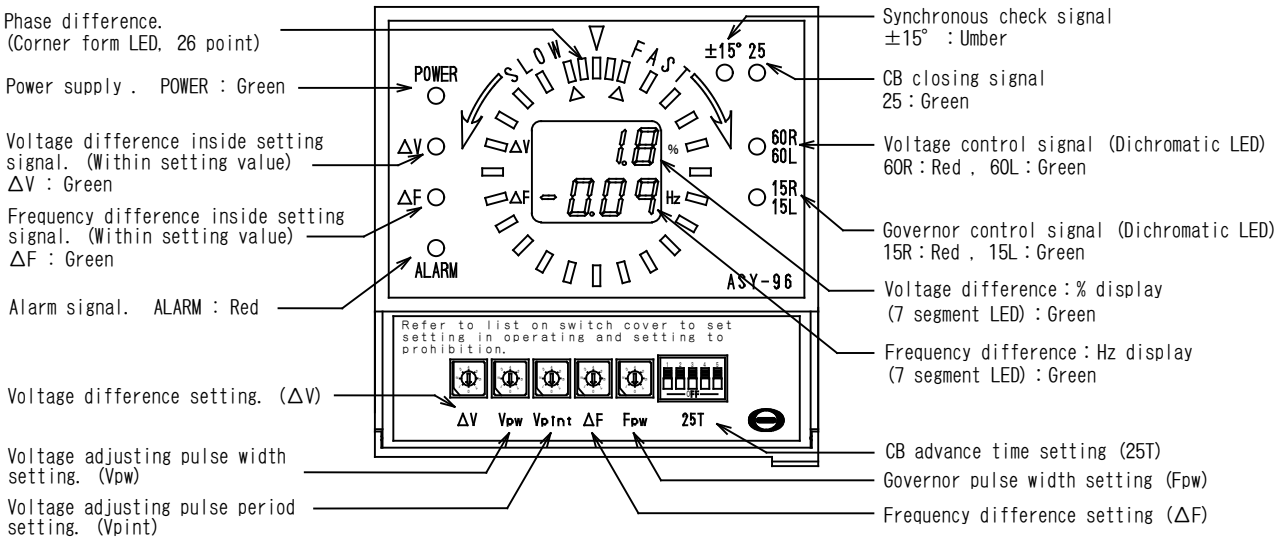
2) When frequency control becomes hunting.
① Increase frequency difference (△F).
② Decrease governor pulse width (Fpw).
Change can be done by one of the above measures or their combined measures.

3) When voltage control delays.
① Increase voltage adjusting pulse width (Vpw).
② Decrease voltage adjusting pulse cycle (Vpint).
Change can be done by one of the above measures or their combined measures.

4) When frequency control delays.
Decrease governor pulse width (Fpw).

7.7 Display

(Indication arrangement)



(Measuring display)

(1) Voltage difference (ΔV) indication (3-digit with polarity for indication only : Green).
Percent (%) indication against AC 110V in generator voltage difference against bus voltage.

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

V_B : Bus voltage
V_G : Generator voltage
Minus (−) Indication, when generator side is lower compared with bus side in voltage.

(2) Frequency difference (ΔF) indication (3-digit with polarity for indication only : Green)
Hz indication in generator frequency difference against bus frequency.

$F_G - F_B$ F_B : Bus frequency
F_G : Generator frequency
Minus (−) indication, when generator side is lower compared with bus side in frequency.

(3) Phase difference indication (LED : Amber. But, green for synchronous point only.)
The phase difference of bus voltage and generator voltage is indicated. 15° interval 24 points, and before or after a synchronous point 7.5° interval 2 points
SLOW ; Generator side is lower compared with bus side in frequency.
FAST ; Generator side higher compared with bus side in frequency.

(Indication condition)

(1) Power supply (POWER) indication (LED : Green)
"LED" turns on when auxiliary power input is apply.

(2) Voltage increase signal (60R) indication (LED : Red)
"LED" turns on when voltage increase signal is output.

(3) Voltage decrease signal (60L) indication (LED : Green)
"LED" turns on when voltage decrease signal is output.

(4) Governor increase signal (15R) indication (LED : Red)
"LED" turns on when Governor increase signal is output.

(5) Governor decrease signal (15L) indication (LED : Green)
"LED" turns on when governor decrease signal is output.

(6) CB closing signal (25) indication (LED : Green)
"LED" turns on when CB closing signal is output.

(7) Synchronous check signal (±15°) indication (LED : Amber)
"LED" turns on when synchronous check signal (±15°) is output.

(8) Voltage difference (ΔV) setting value signal (within setting value) indication (LED : Green)
"LED" turns on when voltage difference between bus and generator becomes within the setting value.

(9) Frequency difference setting (ΔF) value signal (within setting value) indication (LED : Green)
"LED" turns on when frequency difference between bus and generator becomes within the setting value.

(10) Alarm (ALARM) indication (LED : Red)
"LED" turns on about 1 second afterward when synchronous closing failed continuously 3 times. Reset can be done at no voltage or at control start position. ("OFF" at start of both auto. Synchronous start and manual synchronous start.)

7.8 Error management

No.	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		Auto return by reset	
E4	Out of range, bus voltage	Stop		Auto return	
E5	Out of range, generator voltage	Stop		Auto return	
E6	Out of range, bus frequency	Stop		Auto return	
E7	Out of range, frequency difference	Stop		Auto return	
E8	Error in start input designation (Repetition designation)	Stop		Auto return	
E9	Error in closing (3 times continuation)	Stop	Alarm	No input voltage or start OFF	

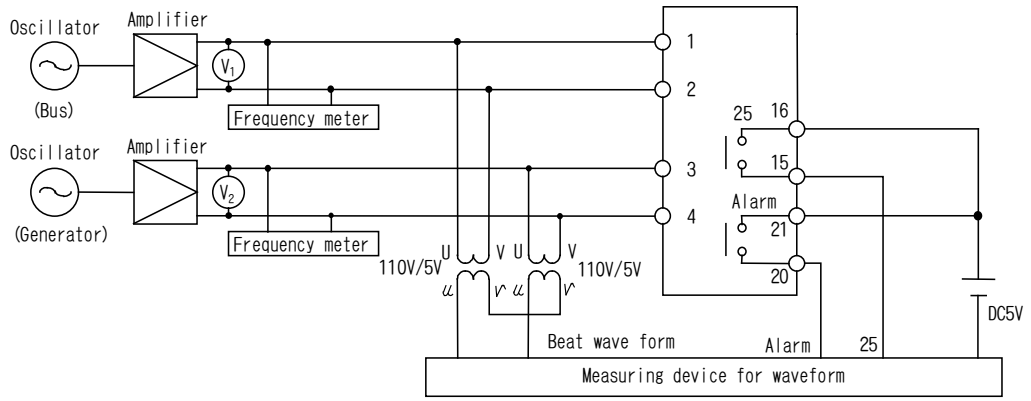
7.9 Troubleshooting

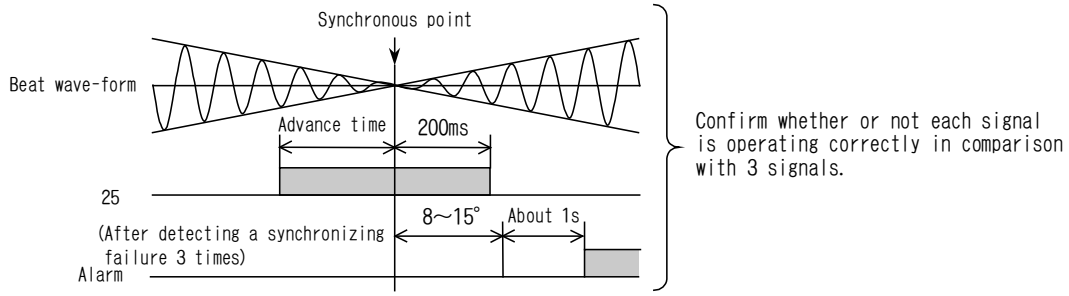
No.	Abnormal condition	Probable cause	Treatment
1	POWER LED don't turn on	Auxiliary supply is not given.	Validation of auxiliary supply input
		Defect in device	Exchange of device
2	Figures of voltage and frequency difference don't indicate	Out of control range in voltage / frequency of bus and generator.	Confirm voltage and frequency of Bus and generator
		Defect in device	Exchange of device
3	Automatic synchronous closing don't start	Auto input (Automatic synchronous closing start) is not given	Confirm auto input
		Defect in device	Exchange of device
4	Manual synchronous closing don't start	Manual input (Manual synchronous closing start) is not given	Confirm manual input
		Defect in device	Exchange of device
5	An error is indicated. (E1～E9)	E1 : ROM/RAM error	Defect in device, Exchange of device
		E2 : A/D error	
		E3 : Setting error	Confirm setting value and correct the value setting change during operation is not possible.
		E4 : Out of range in bus voltage	Confirm voltage range
		E5 : Out of range in generator voltage	
		E6 : Out of range in bus frequency	Confirm frequency range
		E7 : Out of range in generator frequency	
		E8 : Error in start input designation (Repetition designation)	Confirm start input (Correction)
		E9 : Error in closing (3 times continuation)	Confirm output (25) or CB
6	Voltage don't balance (LED △V don't turn on.)	AVR line, may be inferior if 6OR, 6OL is output	Confirm AVR line
		Device may be defective if 6OR, 6OL is not output	Exchange of device
7	Frequency don't balance (LED △F don't turn on.)	Governor line, may be inferior if 15R, 15L is output	Confirm governor
		Device may be defective if 15R, 15L is not output	Exchange of device
8	Closing signal don't indicate (LED (25) don't turns on)	Closing conditions are not proper	Confirm closing conditions (△V and △F)
		Device may be defective	Exchange of device
9	Synchronous check signal don't indicate (LED of ±15° don't turn on)	△V and △F is not within range	Confirm △V and △F
		Device may be defective	Exchange of device
10	Alarm is indicated	Error may happen when synchronous closing	Confirm CB 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 ΔF is "ON" and LED ΔV is "OFF") and the pulse difference between them becomes smaller, then signal (25) turns on.

Voltage difference $V_G \geqq V_B$ + setting value : Voltage decrease signal (60L) turns on.
Voltage difference $V_G \leqq V_B$ − setting value : Voltage decrease signal (60R) turns on.
Frequency difference $F_G \geqq F_B$ + setting value : Governor decrease signal (15L) turns on.
Frequency difference $F_G \leqq F_B$ − setting value : Governor decrease signal (15R) turns on.
Control will stop under the range out of $90V \leqq V_B \leqq 125V$, $80V \leqq V_G$
In case of ±0.05Hz specification (It is within the limits of ΔF=0～0.02Hz at in case of ±0.02Hz specification) of synchronous-closing acceleration functional, within the limits of ΔF=0～0.05Hz, 15R (In SLOW side input designating, it is 15L) is outputted at intervals of 3 seconds.

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

9. Target for synchronous closing. (Reference data)

At time of synchronous closing, it is required to make voltage difference, frequency difference and phase difference smaller, so that the generator will not affect from shock and line disturbance by rush current.

Figure 1

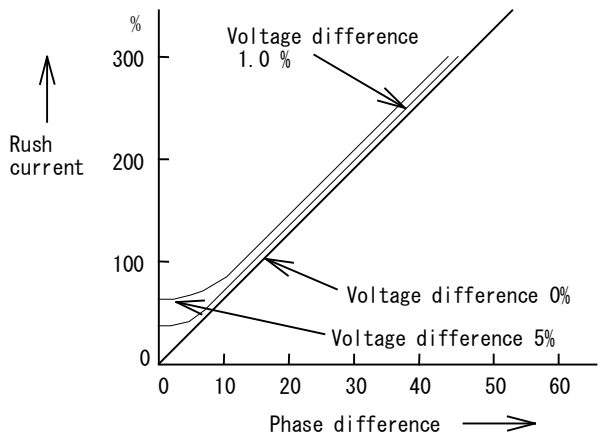
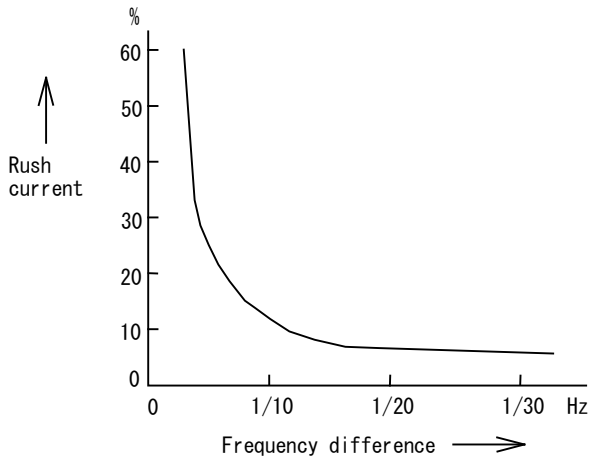


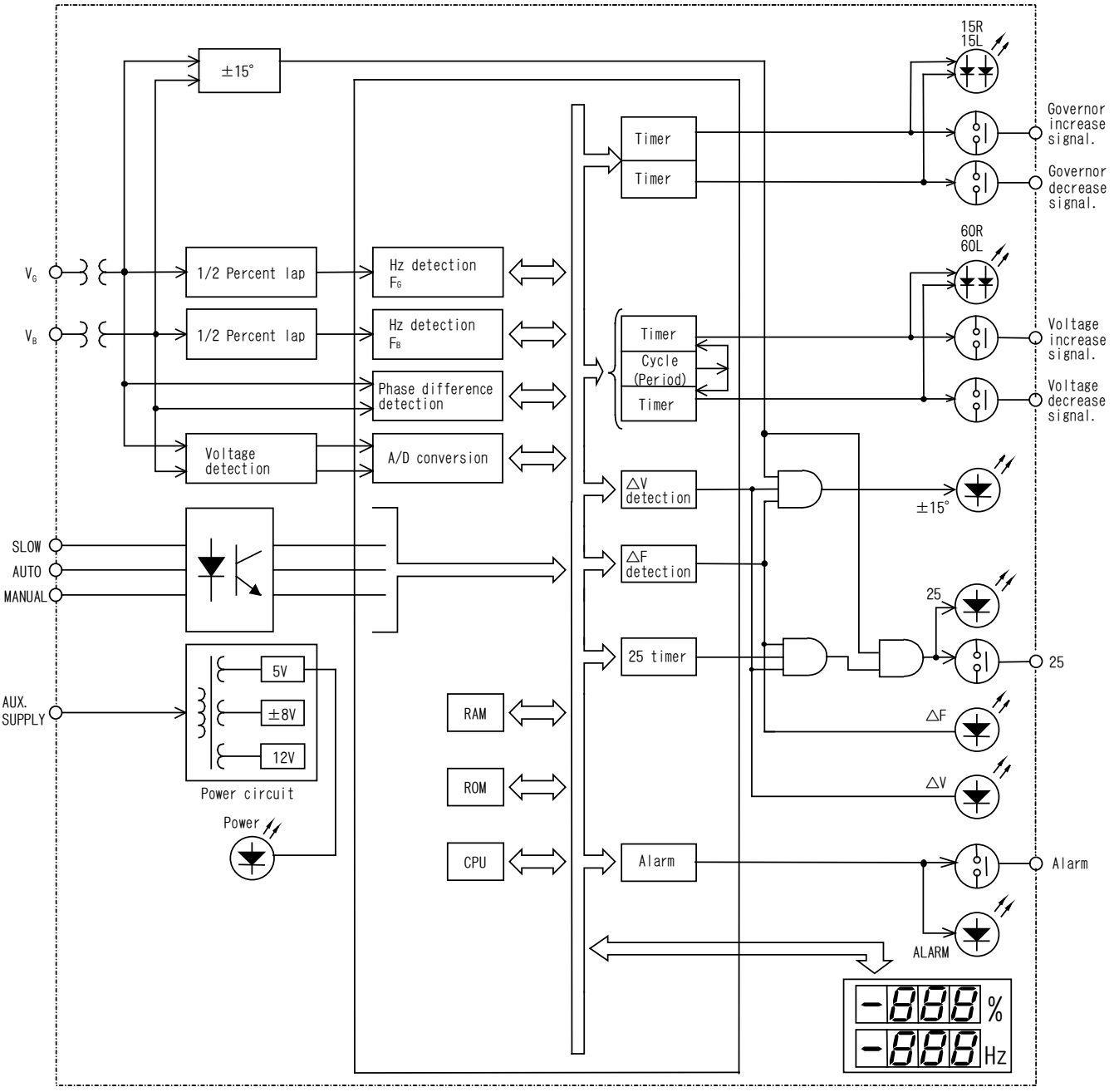
Figure 2



Rush current will be under 50% as a target for synchronous closing. Therefore, synchronous closing can be done under voltage difference 5%, frequency difference 0.1Hz or 0.2Hz and pulse difference 5° as the target.

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 (±ΔF) by the measured bus frequency and generator frequency. In case of bus frequency (F_B) ＞ generator frequency, governor increase pulse (15R) is output and in case of bus frequency (F_B) ＜ generator frequency difference being within the setting value (±ΔF), the output will stop and LED ΔF (within setting value) turns ON.

(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 (±ΔV) 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 and in case of bus voltage (V_B) ＜ generator voltage (V_G), voltage decrease pulse (60L) is output. In case of voltage difference being within the setting value (±ΔV), the output will stop and LED ΔV (within setting value) turns on.

(3) ±15° output
±15° output is LED ±15° turns on when phase difference is at ±15° of synchronous point, measured a pulse difference from the pulse range between input voltage zero cross point of generator voltage input (V_G) in the phase discrimination circuit by adjusted wave-from AC signal.

(4) 25 output
25 output will count phase width measured in phase discrimination circuit and fed into data bus and calculate the time to reach the synchronous point by soft operation {(pulse width/cycle)×(1/frequency difference)}. In case of frequency difference ΔF and voltage difference ΔV being within setting value and phase difference being within ±15° and when the time to reach at synchronous point corresponds with preset advancing time (25), closing signal (25) is output and LED (25) turns on at the same time.

(5) Control input
Control input is no voltage contact input. DC12V, 10mA is supplied from the internal control power of the device. The control input is fed to data-bus being isolated by photo-coupler.

(6) Auxiliary supply
Auxiliary supply (AUX.SUPPLY) is supplied to the circuit after voltage is stabilized at 5V, ±8V, 12V isolated by VT.

11. Maintenance and check

11.1 Maintenance and check

Maintenance should be done periodically in consideration of the following matters.

1) Confirm if power LED, status indication LED and figure indication is being indicated correctly.
2) Confirm always not to overlook alarm LED being indicated and alarm signal being output.
3) Check the color of LED if there is fading in color and damage in the case.
4) Check the wiring if there is looseness in connection and fixing of the screws.
5) Check dust on the device.

11.2 Countermeasures against troubles

If the unit is defective, it is repaired after it has been sent back to our company, in principle.
In such a case, please contact the following address.
For a specifications change or other requests other than trouble repair, please contact the following address.

MANUFACTURER

DAIICHI ELECTRONICS CO., LTD.

Head Office : 11-13 Hitotsuya 1-cyome, Adachi-ku, Tokyo, 121-8639 Japan.
Telephone No. 03-3885-2411 FAX No. 03-3858-3966
Kyoto Office : 1-19 Ichinobe-Nishikawahara, Jyoyou-shi, Kyoto, 610-0114 Japan.
Telephone No. 0774-55-1391 FAX No. 0774-54-1353

Revision B, DATE：December 2, 2003