

Type KT Series Autopilot Steering Gear Room Equipment User's Manual

IM 80B02-74E

**IM 80B02-74E
14th Edition**

Type KT Series Autopilot Steering Gear Room Equipment User's Manual

IM80B02-74E 14th Edition

CONTENTS

Foreword	iii
For safe operation	vi
1. Outline	1-1
1.1 System Features	1-1
1.2 Standard System Model Number	1-1
1.3 System Configuration	1-2
2. Construction	2-1
2.1 Control & Power Box(PC134)	2-1
2.2 μ -Transmitter(PT120 or PT123/MPT123A)	2-5
3. Operation.....	3-1
3.1 Preparation	3-1
3.2 Operation	3-1
4. Basic Function.....	4-1
4.1 Follow-up Steering.....	4-1
4.2 Non Follow-up Steering.....	4-2
5. Maintenance and Inspection	5-1
5.1 Inspection to be performed prior to Entering and Leaving a Port.....	5-1
5.2 Regular Inspection on the Basis Year	5-1
5.3 Periodic replacement of potentiometers.....	5-1
5.4 Troubleshooting	5-1
6. Attached Figure	6-1
Figure 6.1 KT CONTROL BD(TYPE-III/IV) ASSY	6-1
Figure 6.2 Function Diagram of KT CONTROL BD(TYPE-III/IV) ASSY(1/2)	6-2
Figure 6.3 Function Diagram of KT CONTROL BD(TYPE-III/IV) ASSY(2/2)	6-3
Figure 6.4 Connection Diagram for Type KT Control & Power Box	6-4
Annex-1. Repair parts	A-1

Foreword

■ A Brief Word Before Use

This Autopilot instruction manual consists of the following two sections.

- Autopilot system user's manual.
- Type KT series autopilot steering gear room equipment user's manual

This manual instruction covers Autopilot system type steering gear.

For overall autopilot functions, refer to "Autopilot system " instruction manual.

Read this manual carefully and fully understand how to use the instrument before using the instrument.

■ About this manual

- This manual should be read by the end user.
- Read this manual thoroughly and have a clear understanding of the product before operation.
- After you have finished reading this User's Manual, be sure to keep it at your side.
- This manual explains the functions of the product. YDK Technologies Co.,Ltd. does not guarantee that the product will suit a particular purpose of the user.
- Copying or reproducing all or any part of the contents of this manual without the permission of YDK Technologies Co.,Ltd. is strictly prohibited.
- The contents of this manual are subject to change without prior notice.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YDK Technologies Co.,Ltd. dealer.

■ Trademarks

- All the brands or names of YDK Technologies Co.,Ltd.'s products used in this manual are either trademarks or registered trademarks of YDK Technologies Co.,Ltd..
- For purposes of this manual, the TM and ® symbols do not accompany their respective trademark names or registered trademark names.
- Company and product names that appear in this manual are trademarks or registered trademarks of their respective holders.

■ Safety precautions

● Notes about environmental condition for using

To use the type KT series autopilot steering gear room equipment, keep the environment that satisfies "Specification" and "Equipment condition" of this product.

● Notes about installation

If reinstallation will be needed, contact your nearest service agent of YDK Technologies Co., Ltd..

- **Notes about preparation before using**

Read this manual thoroughly and have a clear understanding of the product before operation.

- **Notes about using other than usage**

This products are designed for Autopilot for vessel. Do not use for other purpose.

- **Notes about maintenance and inspection**

- Regular inspection is recommended to keep this system good condition.
- Do not detach the unit cover without the instruction of service engineer.
- Contact your nearest service agent when the inspection which is not permitted in this manual is needed.

- **Notes about abnormal circumstances**

- When abnormal allophone or abnormal smell is generated from this product, turn off the power supply.
- Do not keep using the system , if dealing methods are unknown when the system is under abnormal condition.
- Contact your nearest service or sales agent to repair the system.
- When there is some instruction about the method of trouble shooting from service department of YDK Technologies Co., Ltd. , obey the instructions and work.

- **Notes about disposal of the products**

When this product is scrapped , follow the regulations specified by each country.

- **Precautions related to the protection, safety, and alteration of the product**



"Handle with care." To avoid injury and damage to the instrument, the operator must refer to the explanation in the manual.



"Risk of Electric Shock"



Protective ground terminal



AC



"High temperature." To avoid injury caused by hot surface, do not touch locations where this symbol appears.

- For the protection and safe use of the product and the system controlled by it, be sure to follow the instructions and precautions on safety that are stated in this manual whenever you handle the product. Take special note that if you handle the product in a manner that violate these instructions, the protection functionality of the product may be damaged or impaired. In such cases, YDK Technologies Co., Ltd. does not guarantee the quality, performance, function, and safety of the product.
- When installing protection and/or safety circuits such as lightning protection devices and equipment for the product and control system or designing or installing separate protection and/or safety circuits for fool-proof design and fail-safe design of the processes and lines that use the

product and the control system, the user should implement these using additional devices and equipment.

- If you are replacing parts or consumable items of the product, make sure to use parts specified by YDK Technologies Co., Ltd..
- Do not modify this product without instruction from service engineer of YDK Technologies Co., Ltd. .

■ Exemption from responsibility

- YDK Technologies Co., Ltd. makes no warranties regarding the product except those stated in the WARRANTY that is provided separately.
- YDK Technologies Co., Ltd. assumes no liability to any party for any loss or damage, direct or indirect, caused by the user or any unpredictable defect of the product.

■ About the replacement parts for repair

- After discontinuation of production, the possession period of the replacement parts is ten years.
- The replacement parts for repair are the parts necessary to maintain the function of this product.

■ How to use this manual

The following markings are used in this manual.



Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING

Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

CAUTION

Calls attentions to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

NOTE

Calls attention to information that is important for proper operation of the instrument.

For Safe Operation



WARNING



Electrical shock

- To avoid electrical shock, turn off the power before making wiring connections.
-



CAUTION

- No megger test except the on-board power supply terminals.
The megger test may damage the instrument.
 - In NFU steering mode, if than rudder angle indicator reads 30 degrees, immediately return the steering lever back to the centre position. Otherwise, the rudder will turn all the way to the mechanical stopper.
-

1. Outline

1.1 System Features

A type KT series autopilot is used, coupled with FE or RE series continuous control steering gear manufactured by Kawasaki Heavy Industries, Ltd.

Major features of type KT series are:

The autopilot and the steering gear form a single servo loop control system.

The autopilot does not include its power units but directly conducts continuous proportional control of hydraulic pumps for steering gear. The autopilot and steering gear form a single servo loop by direct feedback of actual rudder angle to the autopilot control circuit.

The number of Control & Power Boxes should be the same as that of the hydraulic pumps for steering gear.

Prepare the Control & Power Boxes in the same number as hydraulic pumps for steering gear. The steering gear starter has the control initiative for the Control & Power Boxes which control the hydraulic pumps, regardless of the "SYSTEM" switch in the Control Stand. Therefore, the number of the Control & Power Boxes to be prepared is the same as those of hydraulic pump and the single or parallel operation of the Control & Power Boxes are commanded by the operation signal from the steering gear starter.

1.2 Standard System Model Number

PT□□□□-□-□KT

Number of the Control & Power Boxes

2 : 2 boxes

3 : 3 boxes

4 : 4 boxes

Style of System

Type of Autopilot system

PT500A : Adaptive autopilot

PT500D : Digital autopilot

PT900A PLUS : Adaptive control(Fully BNAAC function applied)

PT900A : Adaptive control(BNAAC is activated during ECONOMY mode)

PT900D : PID control

1.3 System Configuration

The number of each equipment in every type of the system are as follows:

Product name	Autopilot system	Control & Power Box	μ-Transmitter
Product code	PT500A PT500D PT900A PLUS PT900A PT900D	PC134	PT120 PT123 MPT123A
-K2T	1	2	2
-K3T	1	3	3
-K4T	1	4	4

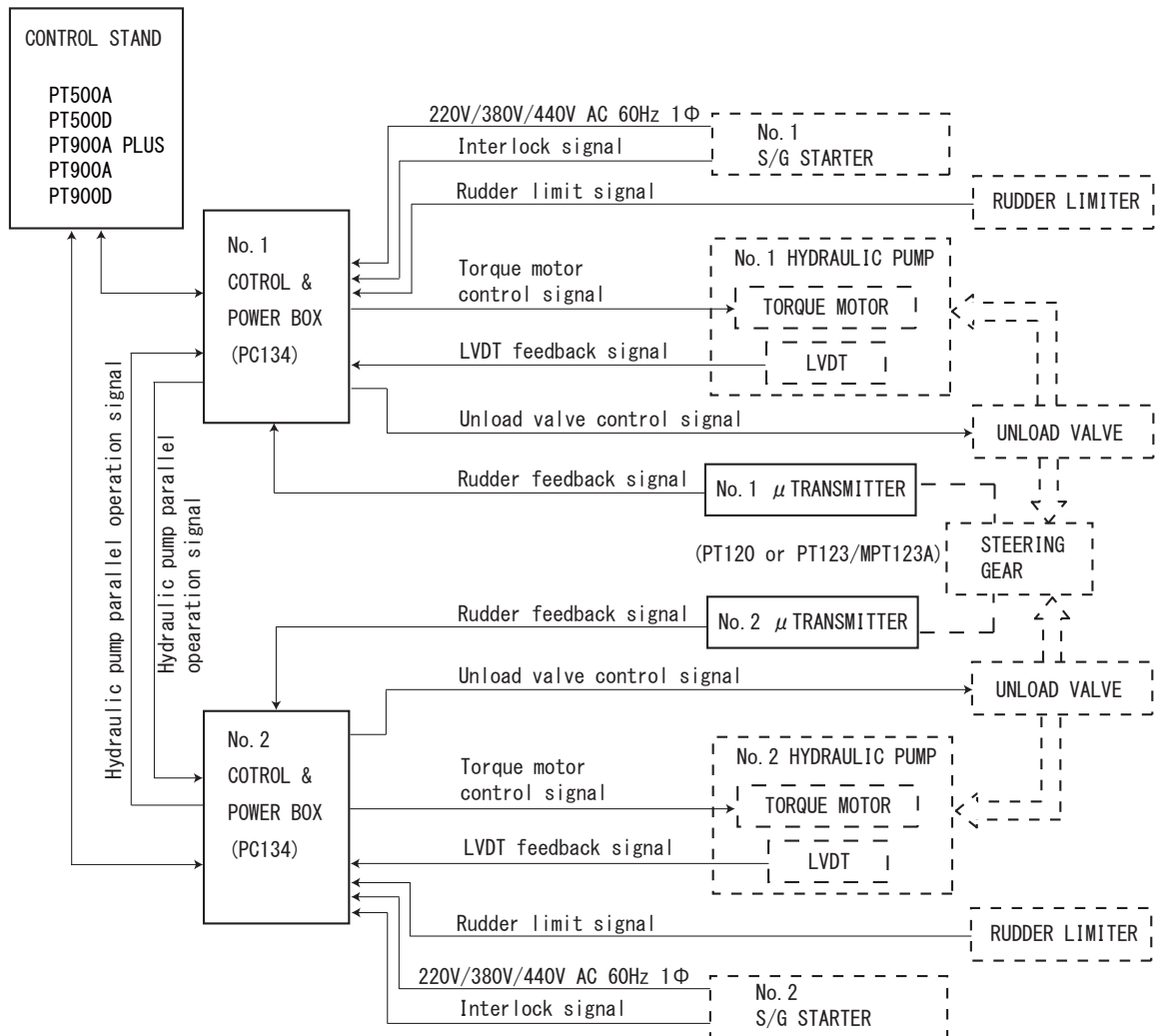


Figure 1.1 Model K2T Autopilot System Configuration

2. Construction

2.1 Control & Power Box (PC134)

In the box, two kinds of power supply unit for the Control Stand and for controlling the torque motor of the steering gear hydraulic pump. KT CONTROL BD ASSY for torque motor which controls hydraulic pump, relays for signal switching, and a timer are housed.....see Figure 2.1.

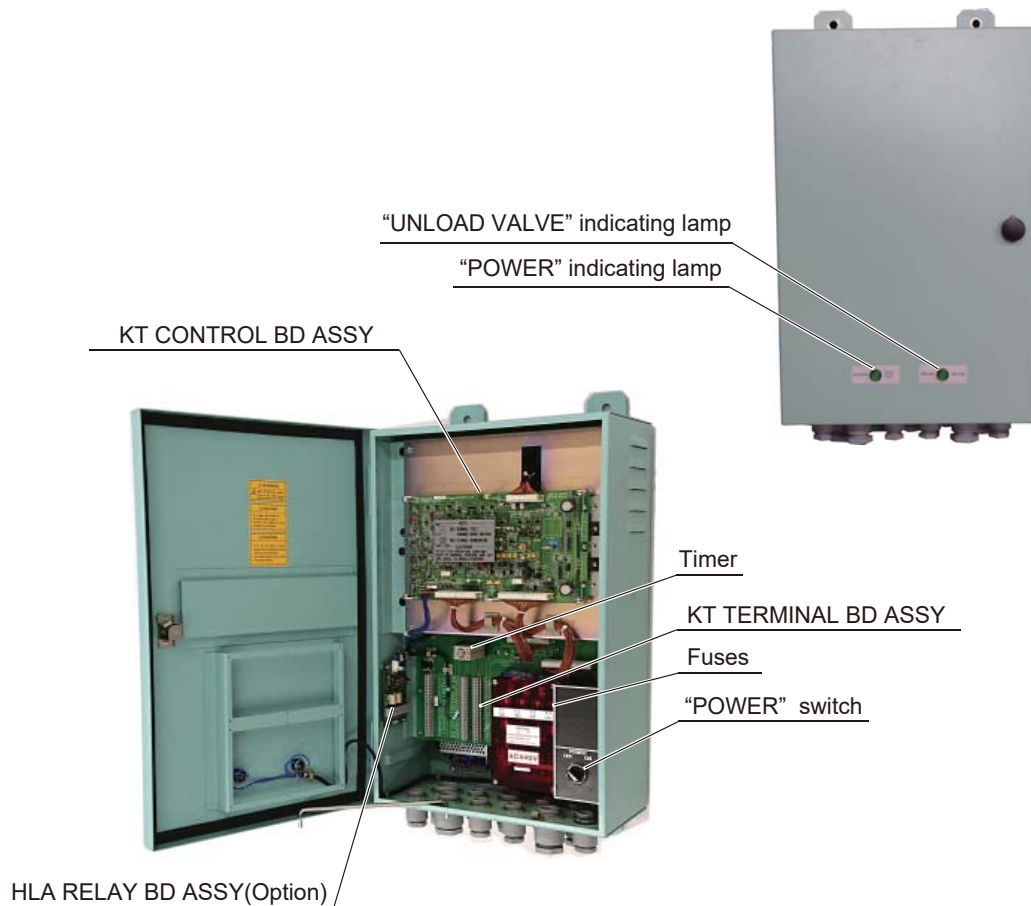


Figure 2.1 Control & Power Box



WARNING

RISK OF ELECTRIC SHOCK

Turn off the power supply before starting the wiring.



CAUTION

No megger test except the on-board power supply terminals. The megger test may damage the instrument.

(1) "POWER" switch

Power of 100V AC is supplied to the Control Stand by turning "ON" of the "POWER" switch. At the same time, power is supplied to the torque motor control circuit for controlling the steering gear hydraulic pump. Unless, however, the operation signal is input from the steering gear starter, the condition controlling the hydraulic pump is not reached. The "POWER" switch must be kept "ON" except defective condition.

(2) Timer

This timer is provided for controlling an autopilot in a condition where pressure of the steering gear hydraulic pump has sufficiently been raised.

Therefore, power is supplied to the torque motor control circuit about 3 seconds (setting range : 0 second to 5 seconds) after the time is actuated by turning "ON" of the "POWER" switch and inputting of operation signal from the steering gear starter. At the same time, the hydraulic pump reaches the controllable condition.

(3) Indication lamps

- a. POWER(NE2) :Lamp is illuminated when the "POWER" switch is turned "ON".
- b. UNLORD VALVE(NE1) :Lamp is illuminated when unload valve in the steering gear system is energized.

(4) Operation signal

The hydraulic pump becomes controllable when the timer has worked after the "POWER" switch turned "ON" and the operation signal reached from the steering gear starter, In this condition, a operation signal is output to the Control Stand as an on-off relay contact signal.

(5) KT TERMINAL BD ASSY

It is consisted of the terminal boards and the control relays.

(6) KT CONTROL BD ASSY

This PCB outputs the torque motor control signal to control the steering gear hydraulic pump by receiving rudder order signal ($\pm 1\text{mA/deg}$) from the Control Stand.

The PCB has several adjusting functions so that it can perform the optimum control matching the steering gear capability. These functions will are discribed below.

a. Test function

By setting the switch SW1 on the PCB in TEST mode, the Control & Power Box can be adjusted with the function of Control Stand interrupted.

The simulation input if generated as a variable continuous signal by means of the current adjuster VR4(TEST).

Adjustment of KT CONTROL BD ASSY and of steering gear function can be carried out by this "TEST" mode.

b. Adjustments of maximum stroke of pump.....See Figure 2.2.

The maximum stroke of hydraulic pump can be adjusted. The stroke defines rudder speed.

The maximum stroke depends on the type of the steering gear. Adjustable range of the maximum stroke of hydraulic pump : $\pm(5 \text{ to } 27)$ deg.

c. Adjustment of proportional band.....See Figure 2.2.

A rudder angle deviation (difference between a rudder order and actual rudder angle) with which the hydraulic pump reaches the maximum stroke is called the “proportional band”.

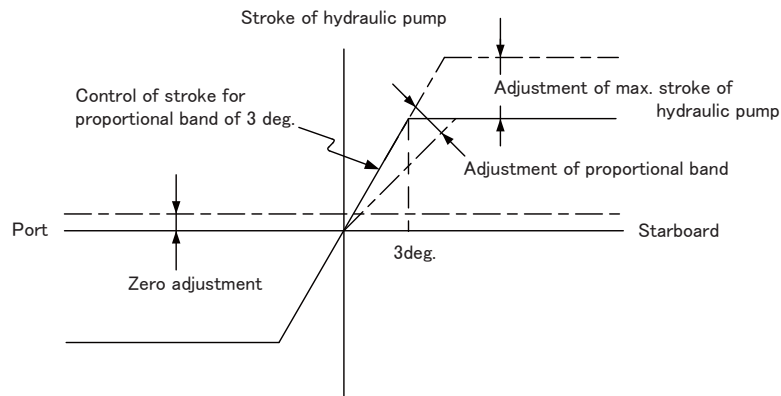


Figure 2.2

d. Automatic gain control.

When the hydraulic pump operation is transferred from single pump operation to parallel operation, the steering gear might be subjected to hunting due to overshoot generated, unless the delivery to the ram cylinder is adjusted. For this purpose, the function is provided, in which the number of operating hydraulic pumps is detected by relay signals and the proportional band is automatically increased (gain is decreased).

Maximum 4 sets of hydraulic pumps can be operated in parallel.

e. Rudder limit control and its releasing level.

The maximum rudder angle (36 deg.) is set with a rudder limit switch equipped on the steering gear. If a rudder angle exceeds the maximum rudder angle, the limit switch operates “open”, deenergizing the solenoid for the unload valve of the steering gear to stop the steering gear. At the same time, it restores the hydraulic pump to its neutral position. Next, the rudder is not operated unless a reverse rudder order is input more than a definite rudder angle (normally set to 1 deg.), is ordered.

f. Actuator failure alarm

The KT CONTROL BD ASSY controls the torque motor in proportion to the rudder angle deviation at the follow-up steering. At the same time, the controlled variable is feed back by LVDT. If the servo system becomes faulty by any cause (s) and that condition continues for about 1seconds(about 3seconds by TYPE- II BD), the steering gear stops by deenergizing of the unload valve. Then KT CONTROL BD ASSY output alarm signal to the Control Stand by means of a relay contact.

g. Unload valve control circuit

Unload valve control circuit provides a function to prevent an overshooting of a steering gear at a rudder angle limit's operating. Unload valve becomes unload in the following conditions.

- ① At rudder angle limit's operating
- ② At actuator failure alarm's issuing

**CAUTION**

When "Actuator failure" is issued, change-over to NFU steering immediately because FU steering may be disabled.

If NFU steering is disabled also, change-over the steering gear hydraulic pump to the back-up system.

(7) HLA RELAY BD ASSY (Option)

This PCB relays the FU contact and the servo loop failure contact sent from the control stand, and outputs the contact to HARS CONTROLLER by the relays.

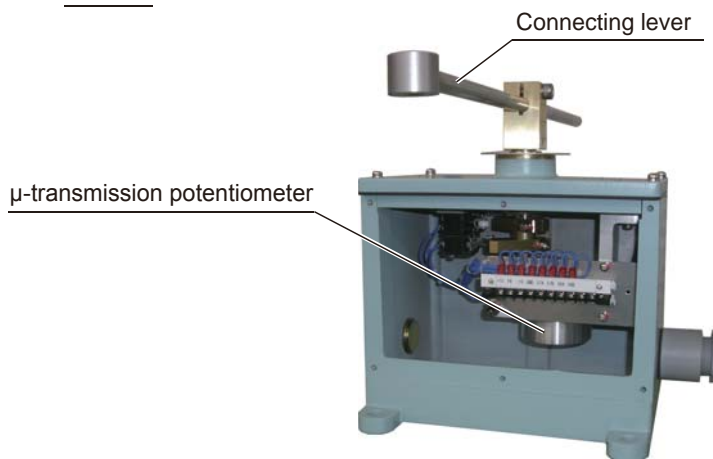
(HARS : Hydraulic locking Alarm and Rudder stop system)

2.2 μ -Transmitter (PT120 or PT123/MPT123A)

The μ -Transmitter detects the rudder angle being connected to the tiller of the steering gear. The transmitter incorporates a μ -transmission potentiometer.

The μ -transmission potentiometer converts the rudder angle to a potentiometer signal and feeds back it to the KT CONTROL BD ASSY in the Control & Power Box.

PT120



PT123/MPT123A

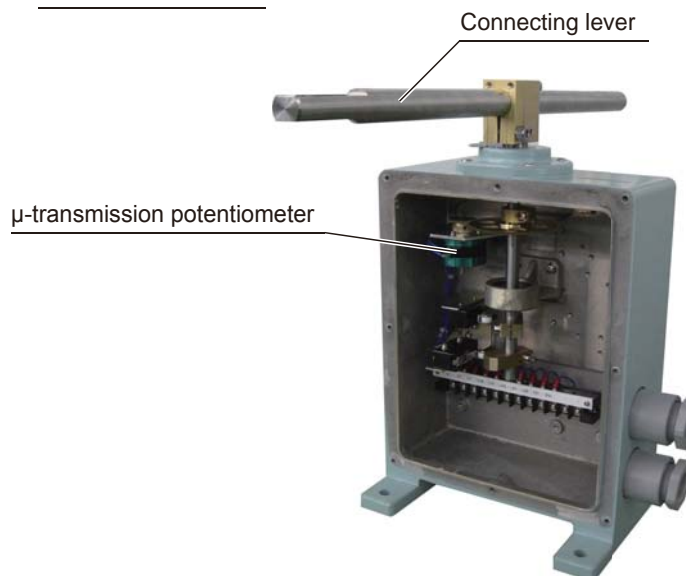


Figure 2.3 μ -Transmitter

3. Operation

3.1 Preparation

To operate the autopilot system, go through the following steps.

- (1) Make sure that the "SYSTEM" switch in the Control Stand is placed in "OFF" position.
- (2) Confirm that the steering gear starter is "ON"
- (3) Check that the steering gear is in a condition that permits remote steering.
- (4) Confirm that the timer in the Control & Power Box is set to a proper value(set at about 3 sec).
- (5) Turn "ON" the "POWER" switch in the Control & Power Box.

3.2 Operation

After the above conditions are completed, turn the "SYSTEM" switch on the Control Stand to FU-1(NO.1) or FU-2(NO.2)

Using one (1) hydraulic pump independently or two(2) hydraulic pumps in parallel for the steering gear is determined by selecting operation signal from the steering gear starter.

Following are operating procedures.

Status				Operating line	
"SYSTEM" switch in the Control stand		Operation signal from the S/G starter		Control form of the hydraulic pump	
No.1	No.2	No.1	No.2	No.1	No.2
○		○		○	
○			○		○
○		○	○	○	○
	○		○		○
	○	○		○	
	○	○	○	○	○

4. Basic Function

4.1 Follow-up Steering(Auto, Hand, or Remote Steering)

The follow-up steering function will be described using Figure 4.1 in which the control circuit schematic is shown.

In the follow-up steering mode, if a rudder order signal of $\pm 1\text{mA/degree}$ is applied to the KT CONTROL BD ASSY in the Control & Power Box from the Control Stand. And, rudder feed back signal of μ -Transmitter is also applied. Above two signals are compared in the KT CONTROL BD ASSY and amplified.

On the other hand, the unload valve for the steering gear is energized by receiving an input signal for operation from the steering gear starter, bringing the steering gear to a condition where it can be controlled, in the Control & Power Box.

The KT CONTROL BD ASSY in the Control & Power Box drives the torque motor which controls the steering gear hydraulic pump. The torque motor is subjected to turning angle control proportional to the rudder order with the maximum stroke of the pump and proportional band adjusted corresponding to the hydraulic pump capability by KT CONTROL BD ASSY. Also, the steering gear hydraulic pump is coupled with LVDT for feeding back the control angle. While the hydraulic pump delivers the amount of working oil proportional to the control angle to the ram cylinder to operate the rudder. The rudder angle is feed back to the KT CONTROL BD ASSY through the μ -Transmitter. As the rudder angle approaches to the rudder order, the torque motor controls the hydraulic pump so that it is returned to its neutral position. When the rudder angle almost corresponds with the rudder order, the steering gear stops.

4.2 Non Follow-up Steering

The non follow-up steering is also described using Figure 4.1.

When the “SYSTEM” switch in the Control Stand is placed in the non follow-up steering position (NFU), the relay N in the Control & Power Box becomes “ON” by a non follow-up mode status signal, and disengage the follow-up steering system and the torque motor control circuit is switched to the non follow-up steering system(on-off control).

If the non follow-up steering lever is thrown to the starboard side, the relay S becomes “ON”, and the positive voltage is applied to the torque motor control circuit through the contact on-off signal.

By these operation, the torque motor actuates the hydraulic pump with the maximum stroke during the lever is thrown.

When the steering lever is placed in its neutral position, the hydraulic pump is returned to the neutral position. Similar to the above, if the steering lever is thrown to the port side, the relay P become “ON” and the negative voltage is applied to the torque motor control circuit through the contact on-off signal, turning the rudder on the port side. As described above, the steering becomes the on-off control in non follow-up steering because of no feed back of actual rudder angle.



CAUTION

If the rudder angle indicator reads 30 degrees, immediately return the steering lever back to the center position. Otherwise, the rudder will turn all the way to the mechanical stopper.

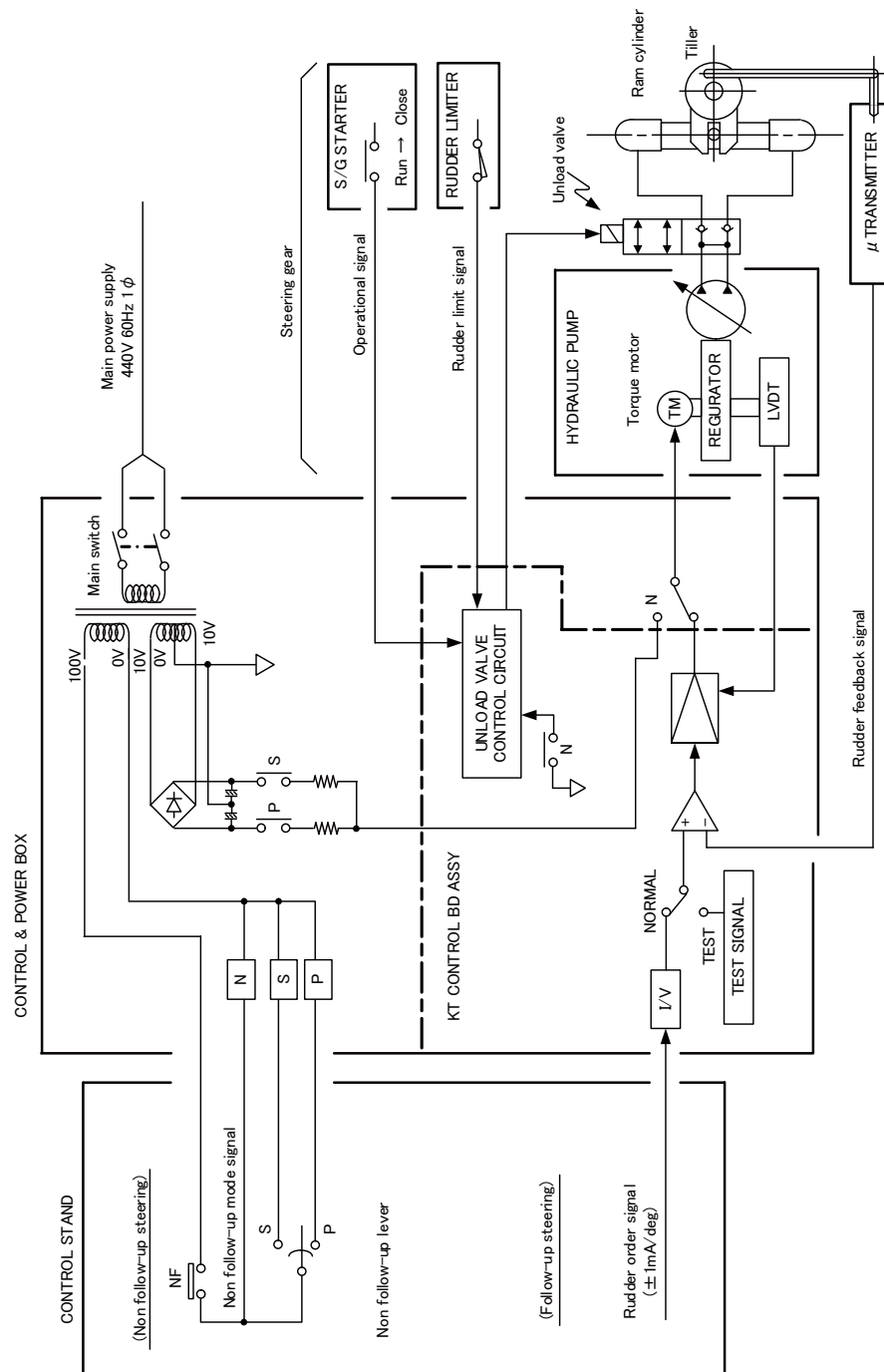


Figure 4.1 Basic Function of Type KT Auto pilot

5. Maintenance and Inspection

Control & Power Box and μ -Transmitter deliver high performance when properly operated.

However, errors on these units may cause a critical situation. Particularly, potentiometers installed in μ -transmitters may deteriorate with long-term use, and may cause abnormal behavior of the rudder.

To avoid such a dangerous situation, the following regular inspection must be implemented for maintaining optimal operating conditions.

5.1 Inspection to be Performed prior to Entering and Leaving a Port

- (1) Be sure that both No.1 and No.2 control systems are exactly transferable and each steering mode operation can be properly performed.
- (2) Make sure that the non follow-up steering can be securely performed.
- (3) Ensure that steering gear hydraulic pumps in each system are accurately operated either individually or in parallel.

5.2 Regular Inspection on the Basis of Year

Check loosening of each terminal screw of the terminal board and other screws at fixed parts and re-tighten those if necessary.

5.3 Periodic replacement of potentiometers

How much the potentiometer has deteriorated will be different, depending on environment of usage. And, it is difficult to know exactly how much the inner part has worn or deteriorated.

Therefore, we recommend periodic replacement of potentiometers once every five (5) years, to prevent the risk of sudden failures.

Please note that alignment must be carried out by a qualified engineer after the replacement.

For more details, contact our Service Dept., or qualified service agents in our network.

5.4 Troubleshooting

Classification of failure type and their countermeasures are shown on the next page and after. Make the most of them in troubleshooting.

Since these classification tables are presented only for steering gear room equipment, failures and measures for the entire autopilot system should be referred to the separate instruction manual for autopilot.

(1) Steering gear does not operate

<PT500 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
The indicator lamp "POWER" of the Control & Power Box does not light.	Fuse F1/F2 are blown.	<ul style="list-style-type: none"> Visual inspection of inside of the Control & Power Box. Transformer failure, Check resistance between transformer primary and case with switch turned "OFF". Faulty if it is not 1M Ω, or less. 	<ul style="list-style-type: none"> Use the other stand by system by changing over the system. Replace the fuse.
The indicator lamp "UNLOAD VALVE" of the Control & Power Box does not light.	Torque motor does not operate.	<ul style="list-style-type: none"> Torque motor burnout or sticking. Fuse F4 is blown. 	<ul style="list-style-type: none"> Use the normally operating hydraulic pump system. Replace use the fuse.
Unload valve does not operate.	Unload valve coil burnout.		<ul style="list-style-type: none"> Use the normally operating hydraulic pump system.
	Unload valve signal is not given.	<ul style="list-style-type: none"> KT CONTROL BD ASSY failure. Relay ACT does not operate. Relay DT1 does not operate. Relay LM does not operate. 	<ul style="list-style-type: none"> Use the normally operating hydraulic pump system. Replace relay(ACT,DT1 or LM)
		<ul style="list-style-type: none"> Timer TR1 does not operate. 	<ul style="list-style-type: none"> Replace timer
Torque motor does not operate	Switch: SW1 is in TEST position.	<ul style="list-style-type: none"> Misoperation. 	<ul style="list-style-type: none"> Return the switch to NOR position.
	Turns to normal when "SYSTEM" switch of the Control Stand is changed over.	<ul style="list-style-type: none"> Inspect the selector circuit of the Control Stand. 	<ul style="list-style-type: none"> Inspect the TERMINAL BOARD PCB in the Control Stand.
	Does not operate only in non follow-up steering.	<ul style="list-style-type: none"> Relay P/S/N1/N2 failure. 	<ul style="list-style-type: none"> Replace the relay.
	Input signal does not reach the Control & Power Box.	<ul style="list-style-type: none"> It operates normally if checked in TEST mode. 	<ul style="list-style-type: none"> Inspect the Control Stand side.

<PT900 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
The indicator lamp "POWER" of the Control & Power Box does not light.	Fuse F1/F2 are blown.	<ul style="list-style-type: none"> • Visual inspection of inside of the Control & Power Box. • Transformer failure, Check resistance between transformer primary and case with switch turned "OFF". Faulty if it is not 1M Ω, or less. 	<ul style="list-style-type: none"> • Use the other stand by system by changing over the system. • Replace the fuse.
The indicator lamp "UNLOAD VALVE" of the Control & Power Box does not light.	Torque motor does not operate.	<ul style="list-style-type: none"> • Torque motor burnout or sticking. • Fuse F4 is blown. 	<ul style="list-style-type: none"> • Use the normally operating hydraulic pump system. • Replace use the fuse.
Unload valve does not operate.	Unload valve coil burnout.		<ul style="list-style-type: none"> • Use the normally operating hydraulic pump system.
	Unload valve signal is not given.	<ul style="list-style-type: none"> • KT CONTROL BD ASSY failure. • Relay ACT does not operate. • Relay DT1 does not operate. • Relay LM does not operate. 	<ul style="list-style-type: none"> • Use the normally operating hydraulic pump system. • Replace relay(ACT,DT1 or LM)
		<ul style="list-style-type: none"> • Timer TR1 does not operate. 	<ul style="list-style-type: none"> • Replace timer
Torque motor does not operate	Switch: SW1 is in TEST position.	<ul style="list-style-type: none"> • Misoperation. 	<ul style="list-style-type: none"> • Return the switch to NOR position.
	Turns to normal when "SYSTEM" switch of the Control Stand is changed over.	<ul style="list-style-type: none"> • Inspect the selector circuit of the Control Stand. 	<ul style="list-style-type: none"> • Inspect the CAN ADAPTER in the Control Stand.
	Does not operate only in non follow-up steering.	<ul style="list-style-type: none"> • Relay P/S/N1/N2 failure. 	<ul style="list-style-type: none"> • Replace the relay.
	Input signal does not reach the Control & Power Box.	<ul style="list-style-type: none"> • It operates normally if checked in TEST mode. 	<ul style="list-style-type: none"> • Inspect the Control Stand side.

(2) The rudder cannot be operated as expected.

<PT500 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
The rudder moves only on one side.	KT CONTROL BD ASSY failure.	• Actuator failure alarm is issued.	• Use the normally operating hydraulic pump system.
	Turns to normal when "SYSTEM" switch of the Control Stand is changed over.	• Is operates normally if checked in the Control Stand. • Servo loop failure is issued.	• Inspect the TERMINAL BOARD PCB in the Control Stand.
	Defective of the limit switch, ULS or ULP relay	• Servo loop failure is issued.	Replace limit switch, ULS or ULP relay
The rudder overshoots.	The rudder turns over the rudder limit.	• Unload valve failure.	• Carry out inspection according to the maintenance manual for steering gear.
	The limit switch does no operate.	• The limit switch setpoint is shifted.	• Readjust the limit switch.
	KT CONTROL BD ASSY failure.	• The unload valve is not de-energized in spite of actuation of rudder limit switch.	• Use the normally operating hydraulic pump system.
The rudder presents hunting.	Misadjustment for KT CONTROL BD ASSY.	• Torque motor control is unstable.	• Use the normally operating hydraulic pump system.
	LVDT failure.	• Actuator failures alarm is issued.	• Use the normally operation hydraulic pump system.

<PT900 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
The rudder moves only on one side.	KT CONTROL BD ASSY failure.	• Actuator failure alarm is issued.	• Use the normally operating hydraulic pump system.
	Turns to normal when "SYSTEM" switch of the Control Stand is changed over.	• Is operates normally if checked in the Control Stand. • Servo loop failure is issued.	• Inspect the CAN ADAPTER in the Control Stand.
	Defective of the limit switch, ULS or ULP relay	• Servo loop failure is issued.	Replace limit switch, ULS or ULP relay
The rudder overshoots.	The rudder turns over the rudder limit.	• Unload valve failure.	• Carry out inspection according to the maintenance manual for steering gear.
	The limit switch does no operate.	• The limit switch setpoint is shifted.	• Readjust the limit switch.
	KT CONTROL BD ASSY failure.	• The unload valve is not de-energized in spite of actuation of rudder limit switch.	• Use the normally operating hydraulic pump system.
The rudder presents hunting.	Misadjustment for KT CONTROL BD ASSY.	• Torque motor control is unstable.	• Use the normally operating hydraulic pump system.
	LVDT failure.	• Actuator failures alarm is issued.	• Use the normally operation hydraulic pump system.

(3) The rudder tends to shift to one side.

<PT500 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
Erroneous input signal.	The V/I converter circuit of TERMINAL BOARD PCB in Control stand is failure.	• It returns to normal when the "SYSTEM" switch on the Control Stand is changed over.	• Use the other system by changing over the system.
Faulty feedback system.	Failure of LVDT with the hydraulic pump.	• Actuator failure alarm is issued.	• Use the normally operating hydraulic pump system.
	μ-Transmitter failure.	• Servo loop failure occurs.	• Use the other system by changing over the system.
	Loose terminal screws.	• Perform visual check for terminal boards in the μ-Transmitter and the Control & Power Box.	• Retighten loose terminals.
	KT CONTROL BD ASSY failure.	• Servo loop failure occurs.	• Use the normally operating hydraulic pump system.
	LVDT zero point has shifted.	• Hydraulic pump is operating at an very small angle even if the input is zero.	• Carry out zero adjustment of the stroke of hydraulic pump.

<PT900 series>

Primary situation	Secondary situation	Criteria for determining the causes	Countermeasures
Erroneous input signal.	The V/I converter circuit of CAN ADAPTER in Control stand is failure.	• It returns to normal when the "SYSTEM" switch on the Control Stand is changed over.	• Use the other system by changing over the system.
Faulty feedback system.	Failure of LVDT with the hydraulic pump.	• Actuator failure alarm is issued.	• Use the normally operating hydraulic pump system.
	μ-Transmitter failure.	• Servo loop failure occurs.	• Use the other system by changing over the system.
	Loose terminal screws.	• Perform visual check for terminal boards in the μ-Transmitter and the Control & Power Box.	• Retighten loose terminals.
	KT CONTROL BD ASSY failure.	• Servo loop failure occurs.	• Use the normally operating hydraulic pump system.
	LVDT zero point has shifted.	• Hydraulic pump is operating at an very small angle even if the input is zero.	• Carry out zero adjustment of the stroke of hydraulic pump.

6. Attached Figure

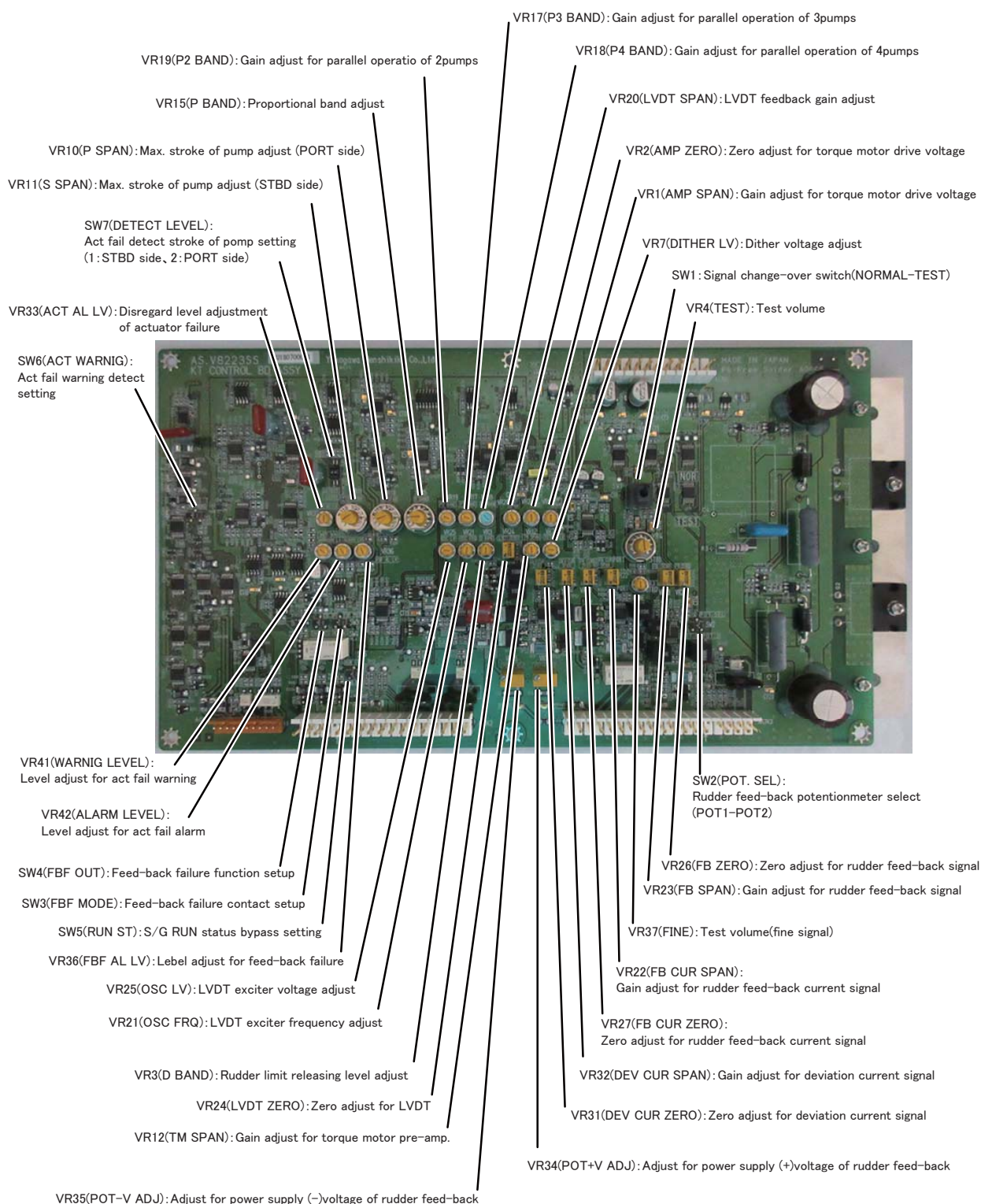


Figure 6.1 KT CONTROL BD(TYPE-III/IV) ASSY

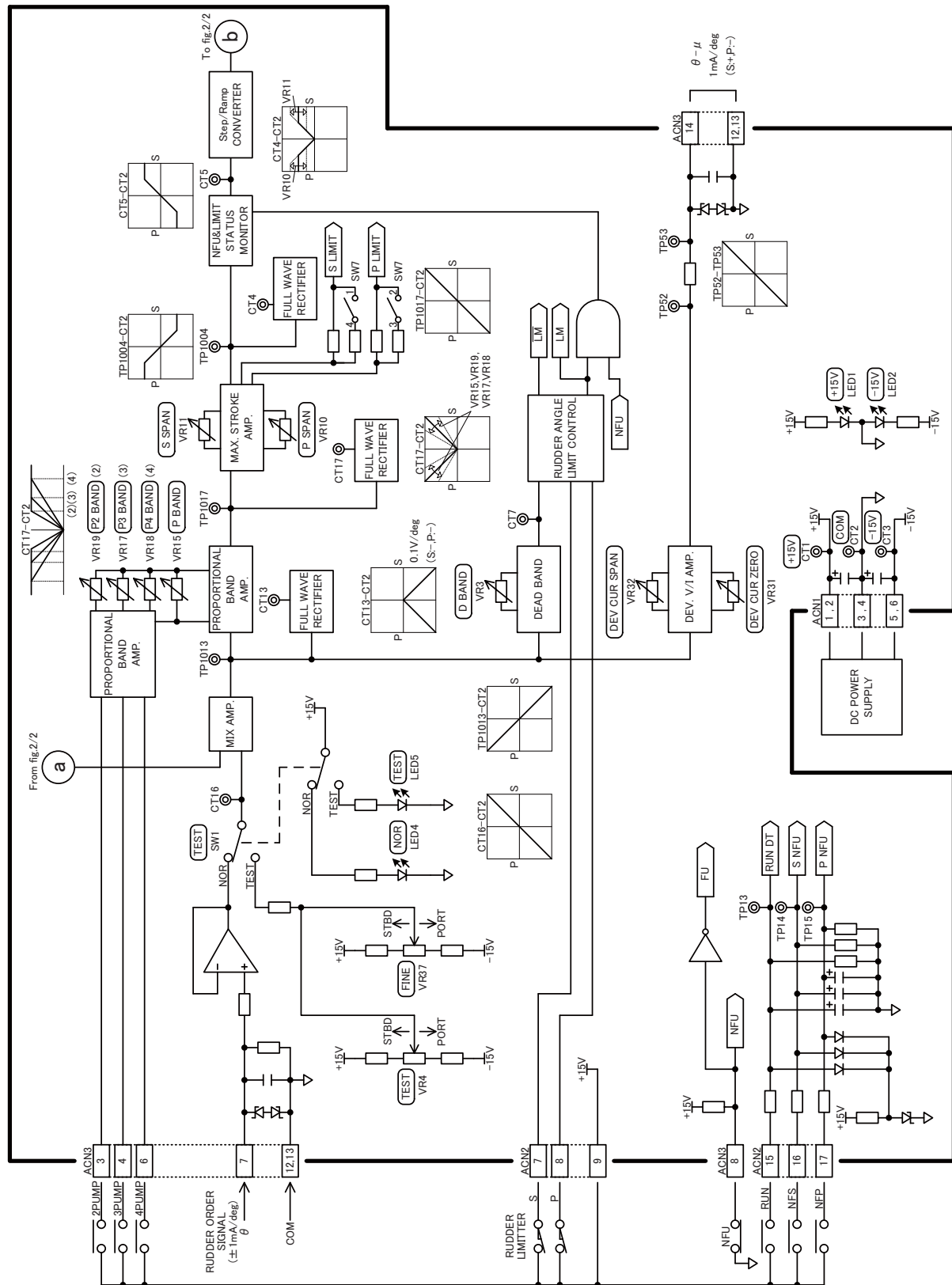


Figure 6.2 Function Diagram of KT CONTROL BD(TYPE-III/IV) ASSY(1/2)

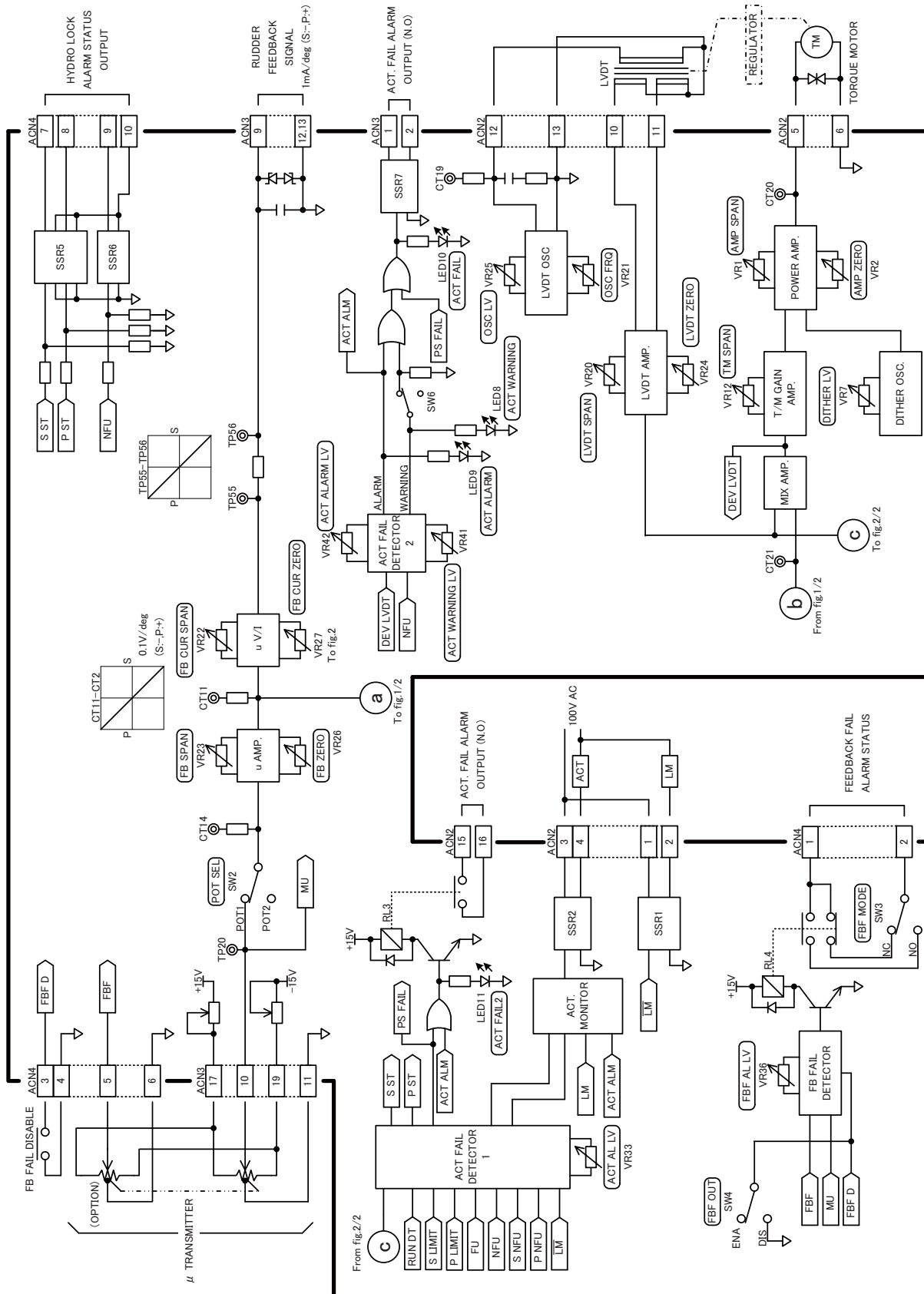


Figure 6.3 Function Diagram of KT CONTROL BD(TYPE-III/IV) ASSY(2/2)

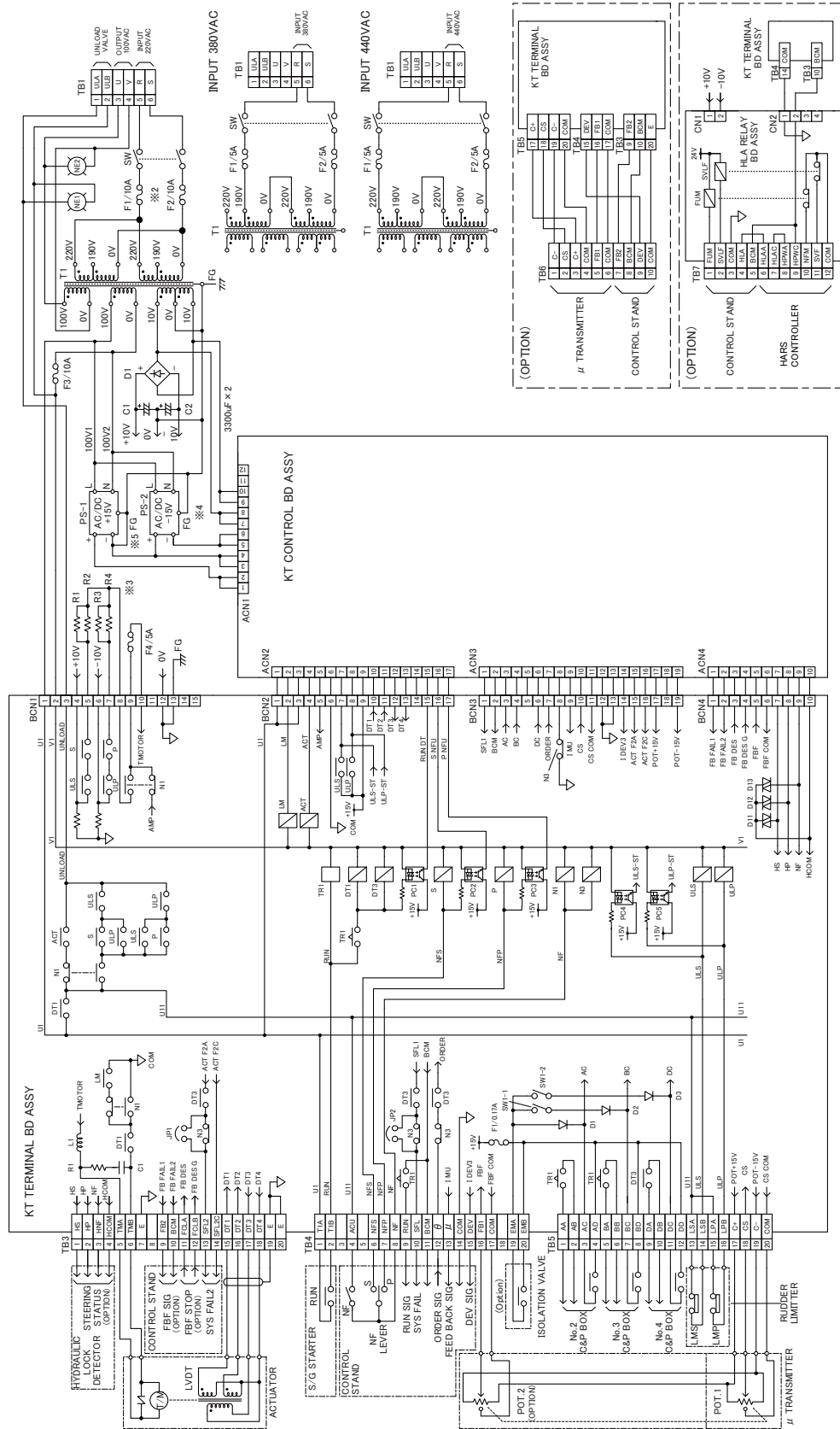


Figure 6.4 Connection Diagram for Type KT Control & Power Box

Annex-1 Repair parts

Repair parts are determined by the type of printed circuit board. Please refer to the table below.

■ Repair parts list

• PCB ASSY

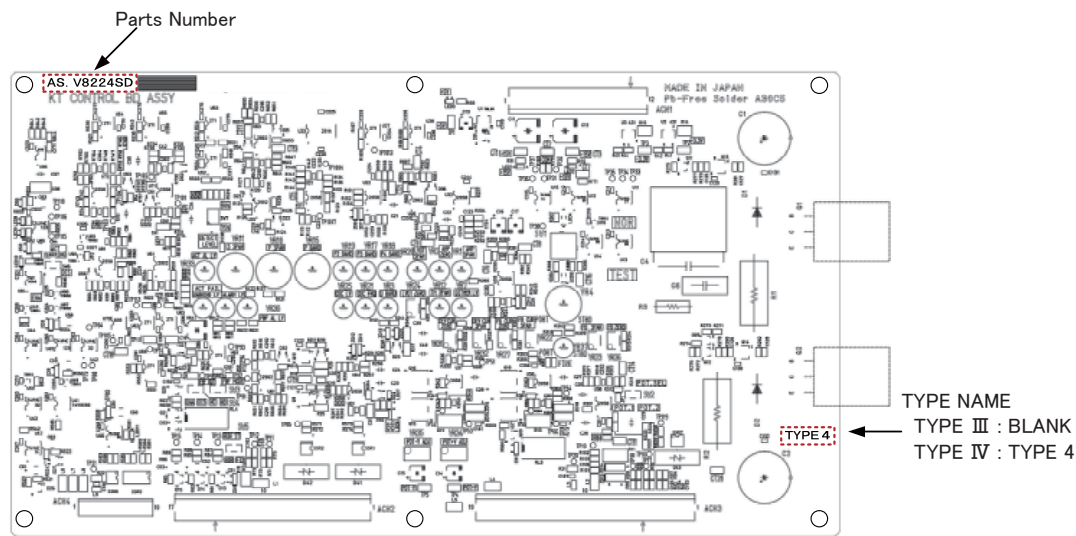
PCB ASSY NAME	PCB ASSY TYPE	Parts Number	Remark
KT CONTROL BD ASSY	Ⅲ	V8223SS	
	Ⅳ	V8224SD	
KT TERMINAL BD ASSY	Ⅰ	V8223SV	
	Ⅱ	V8224SE	

•CABLE ASSY

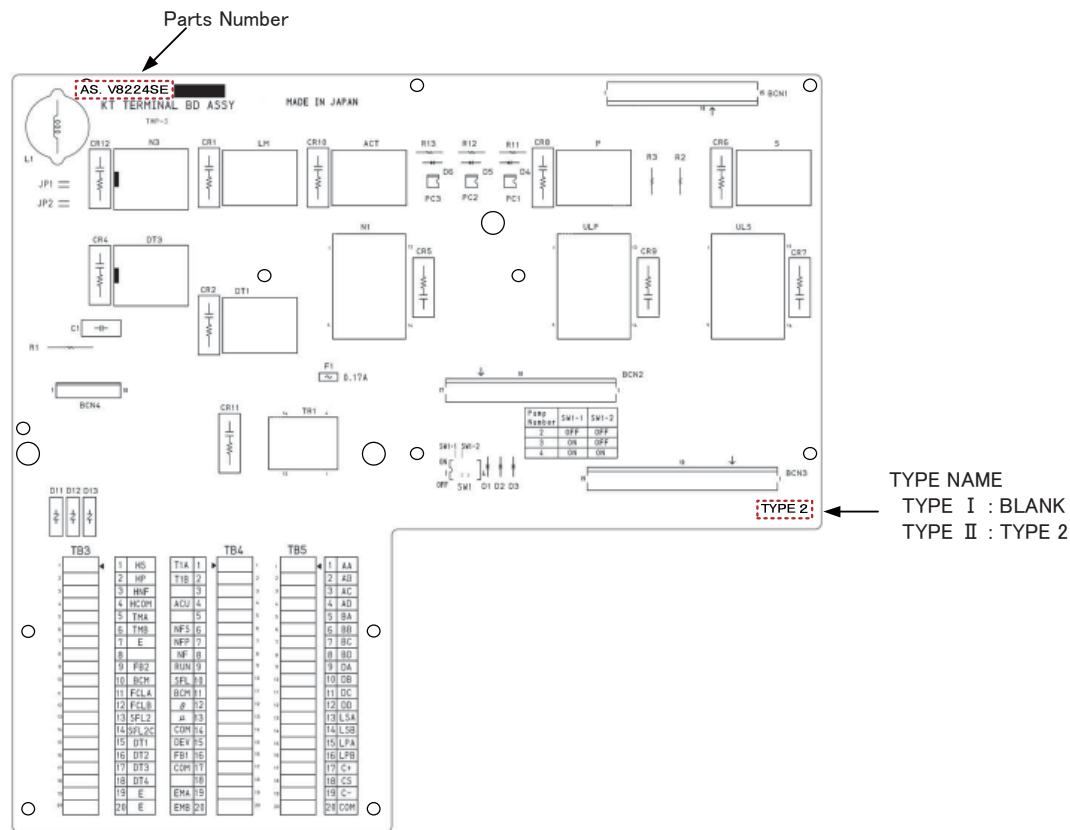
Connector ID	Parts Number		Remark
	KT CONTROL BD ASSY (For TYPE Ⅲ) KT TERMINAL BD ASSY (For TYPE Ⅰ)	KT CONTROL BD ASSY (For TYPE Ⅳ) KT TERMINAL BD ASSY (For TYPE Ⅱ)	
BCN2 - ACN2	V8213MD	V8224TH	
BCN3 - ACN3	V8213ME	V8224TG	
BCN4- ACN4	V8223TF	V8224TS	

* Subject to change without notice.

• KT CONTROL BD ASSY



• KT TERMINAL BD ASSY



Revision Information

- Title : Type KT Series Autopilot
Steering Gear Room Equipment User's Manual
- Manual No. : IM 80B02-74E

Nov,	1996	1st Edition
Aug,	1998	2nd Edition
Apr,	1999	3rd Edition
Jul,	2000	4th Edition
Sep,	2006	5th Edition
Mar,	2012	6th Edition
Apr,	2012	7th Edition
Mar,	2015	8th Edition
Jun,	2016	9th Edition
Dec,	2016	10th Edition
Oct,	2018	11th Edition
Jul,	2020	12th Edition
Dec,	2020	13th Edition
Oct,	2021	14th Edition

