Service Manual

PARAMAGNETIC OXYGEN ANALYZER

TYPE: ZAJ

Fuji Electric Co., Ltd.

TN512955b-E

PREFACE

- This service manual contains information required for service engineers to perform maintenance and check of the paramagnetic oxygen analyzer. Since this manual does not provide basic description such as operating principle and key operation, you are requested to use this service manual together with related instruction manual.
- First read the instruction manual and the service manual carefully until an adequate understanding is acquired, and then proceed to installation, operation and maintenance of the gas analyzer. Wrong handling may cause an accident or injury.
- The specifications of this analyzer will be changed without prior notice for further product improvement.
- Modification of this gas analyzer is strictly prohibited unless a written approval is obtained from the manufacturer. Fuji Electric will not bear any responsibility for a trouble caused by such a modification.

Delivered items

Name	Q'ty	Remarks
Analyzer main frame	1	————
Filter	2	Spare
Restrictor	1	Spare
Packing	2	Spare (filter area)
Packing	4	Spare (for restrictor)
Fuse	2	2A
Instruction manual	1	————
Test report	1	————
Wrench	2	For reference gas joint

Manufacturer: Fuji Electric Co., Ltd.
Type: Described in Fuji Electric's company nameplate on main frame
Date of manufacture: Described in Fuji Electric's company nameplate on main frame
Product nationality: Japan

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Request

- It is prohibited to transfer part or all of this manual without Fuji Electric's permission in written format.
- Description in this manual will be changed without prior notice for further improvement.

CONTENTS

CAUTION ON SAFETY

First of all, read this "Caution on safety" carefully, and then use the analyzer in the correct way.

- The cautionary descriptions listed here contain important information about safety, so they should always be observed. Those safety precautions are ranked in 2 levels; DANGER and CAUTION.

⚠ DANGER	Wrong handling may cause a dangerous situation, in which there is a risk of death or heavy injury.
⚠ CAUTION	Wrong handling may invite a dangerous situation, in which there is a possibility of medium-level trouble or slight injury or only physical damage is predictable.

Caution on installation and transport of gas analyzer	
⚠ DANGER	• This unit is not explosion-proof type. Do not use it in a place with explosive gases to prevent explosion, fire or other serious accidents.
⚠ CAUTION	• This unit should be installed in a place which conforms to the conditions noted in the instruction manual. Otherwise, it may cause electric shocks, fire or malfunction of the unit. • During installation work, care should be taken to keep the unit free from entry of cable chips or other foreign objects. Otherwise, it may cause fire, trouble or malfunction of the unit. • For lifting the gas analyzer, be sure to wear protective gloves. Bare hands may invite an injury. • Before transport, fix the casing so that it will not open. Otherwise, the casing may be separated and fall to cause an injury. • The gas analyzer is heavy. It should be transported carefully by two or more persons if manually required. Otherwise, body may be damaged or injured.

Caution on piping	
⚠ DANGER	**In piping, the following precautions should be observed. Wrong piping may cause gas leakage.** **If the leaking gas contains a toxic component, there is a risk of serious accident being induced.** **Also, if combustible gas is contained, there is a danger of explosion, fire or the like occurring.** • Connect pipes correctly referring to the instruction manual. • Exhaust should be led outdoors so that it will not remain in the locker and installation room. • Exhaust from the analyzer should be relieved in the atmospheric air in order that an unnecessary pressure will not be applied to the analyzer. Otherwise, any pipe in the analyzer may be disconnected to cause gas leakage. • For piping, use a pipe and a pressure reducing valve to which oil and grease are not adhering. If such a material is adhering, a fire or the like accident may be caused.

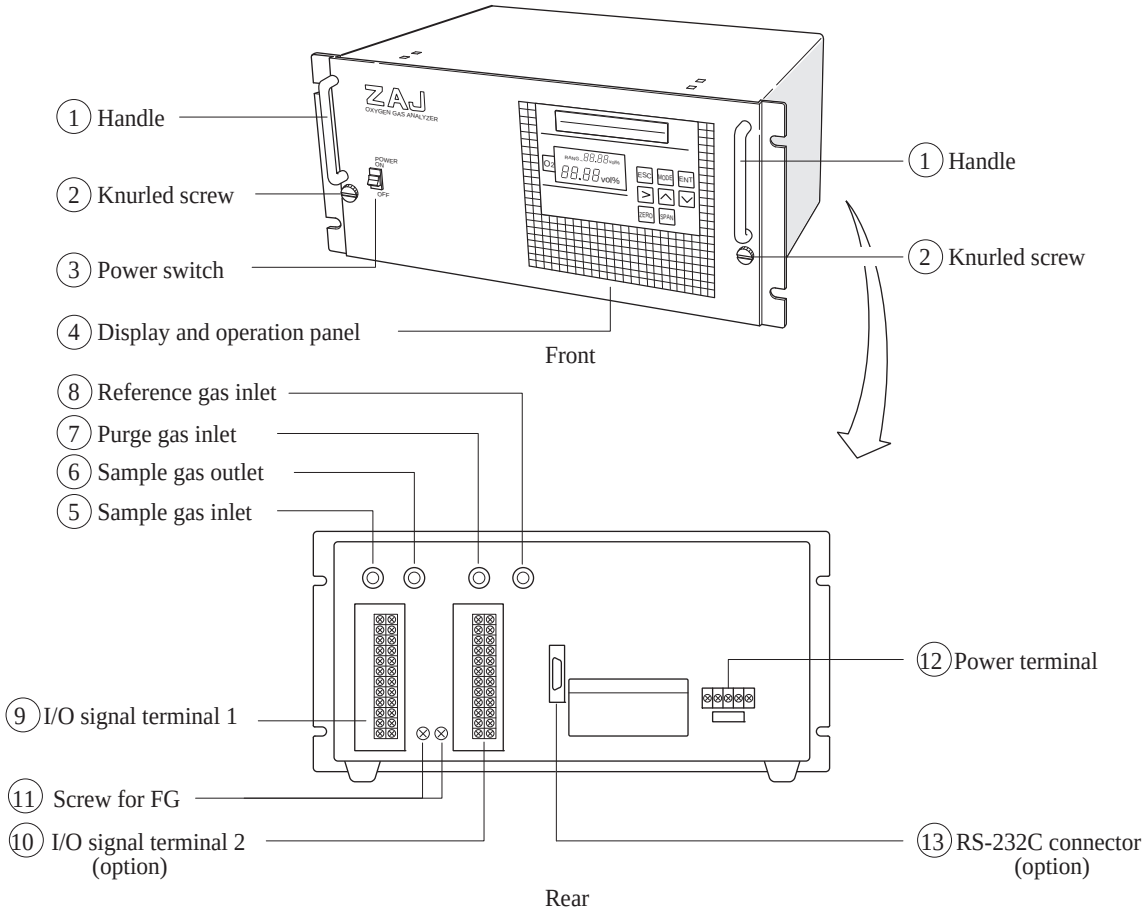
Caution on wiring	
⚠ CAUTION	• The unit must be earthed as specified. Otherwise, it may cause electric shocks, malfunction, etc. • Be sure to use a power supply of correct rating. Connection of power supply of incorrect rating may cause fire. • Wiring work must be performed with the main power set to OFF to prevent electric shocks. • Wires should be the proper one meeting the ratings of this instrument. If using a wire which cannot endure the ratings, a fire may occur.

Caution on use	
⚠ DANGER	• When handling the standard gas such as calibration gas, read the instruction manual of the standard gas carefully and use the gas correctly.
⚠ CAUTION	• Avoid continuous operation with the casing drawn out. Otherwise, the casing may fall to cause an injury. • During operation, avoid opening the casing and touching the internal parts. Otherwise, you may suffer a burn or shock hazard.

Caution on maintenance and check	
⚠ DANGER	• Before working such as restrictor replacement with the casing open, be sure to turn off power supply, and perform air and N_2 gas purging of not only the analyzer inside, but also the sample gas line and reference gas line. In addition, carefully prevent oil and grease from adhering to the restrictor, filter, packing, etc. Otherwise, poisoning, fire or explosion may be caused due to gas leakage, etc.
⚠ CAUTION	• Before working, take off a wrist watch, finger ring or the like metallic accessories. And never touch the instrument with a wet hand. Otherwise, you will have a shock hazard. • If the fuse is blown, eliminate the cause, and then replace it with the one of the same capacity and type as before. Otherwise, shock hazard or fault may be caused.

Others	
⚠ CAUTION	• If the cause of any fault cannot be determined despite reference to the instruction manual, be sure to contact your dealer or Fuji Electric's technician in charge of adjustment. If the instrument is disassembled carelessly, you may have a shock hazard or injury. • Do not use a replacement part other than specified by the instrument maker. Otherwise, adequate performance will not be provided. Besides, an accident or fault may be caused. • Replacement parts such as a maintenance part should be disposed of as incombustibles.

1. NAME OF EACH PART



2. BEFORE MAINTENANCE

2-1. How to stop analyzer

If sample gas includes flammable, corrosive, and toxic gases, purge the inner case by supplying a safe gas such as N2 or air from the cylinder, and then pull it out. To stop the gas, supply zero gas for a few minutes for protection of the sensor. First, stop the sample gas and then stop supplying the reference gas in 10 minutes. Turn OFF the power and disconnect the power cable except for LCD contrast adjustment given in Section 3-1, output adjustment in 3-2, and signal check in 5.

2-2. How to operate analyzer

After sensor replacement, restrictor replacement or internal piping replacement has been completed, be sure to perform an airtightness test and flow check for reference gas according to "preparation for operation" in the instruction manual. Turn ON the power while supplying the reference gas to warm up the instrument. After replacement of a printed circuit board, sensor or switching power supply has been performed, carry out the signal check as described in Section 5. After that, perform zero calibration and span calibration and flow sample gas.
(Caution) For protection of the sensor, be sure to flow reference gas first, and then sample gas.

2-3. How to pull out inner case

Be sure to purge the cylinders and give protection to the sensor according to "How to stop analyzer" given in section 2-1. Turn the knurled screw on the front panel counterclockwise (as shown in Photo 2-1) and pull out the inner case by holding the handles with hands (refer to Photo 2-2.). In the inner case, the sensor, printed circuit boards and switching power supply are arranged. The sensor in the inner case is connected to the gas inlet of the outer case by Teflon tube. The printed circuit boards in the inner case are wired to output printed circuit boards of the outer case by cables. So, be careful when pulling out the inner case to avoid confusing the piping or wiring.

Photo 2-1 Description of knurled screw

Loosen the 2 knurled screws as shown in the Photo by turning them counterclockwise with a driver or fingers.

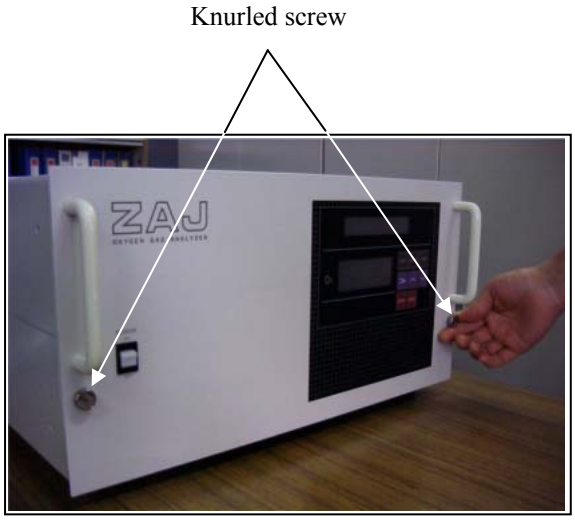


Photo 2-2 Inner case drawn

Pull the handles toward you by holding them with hands. A stopper provided on the outer case prevents the inner case from being removed fully.

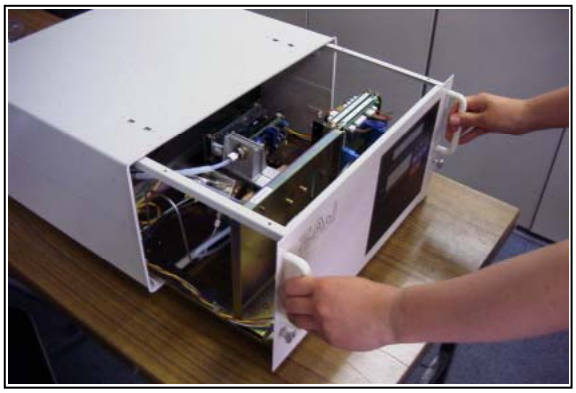
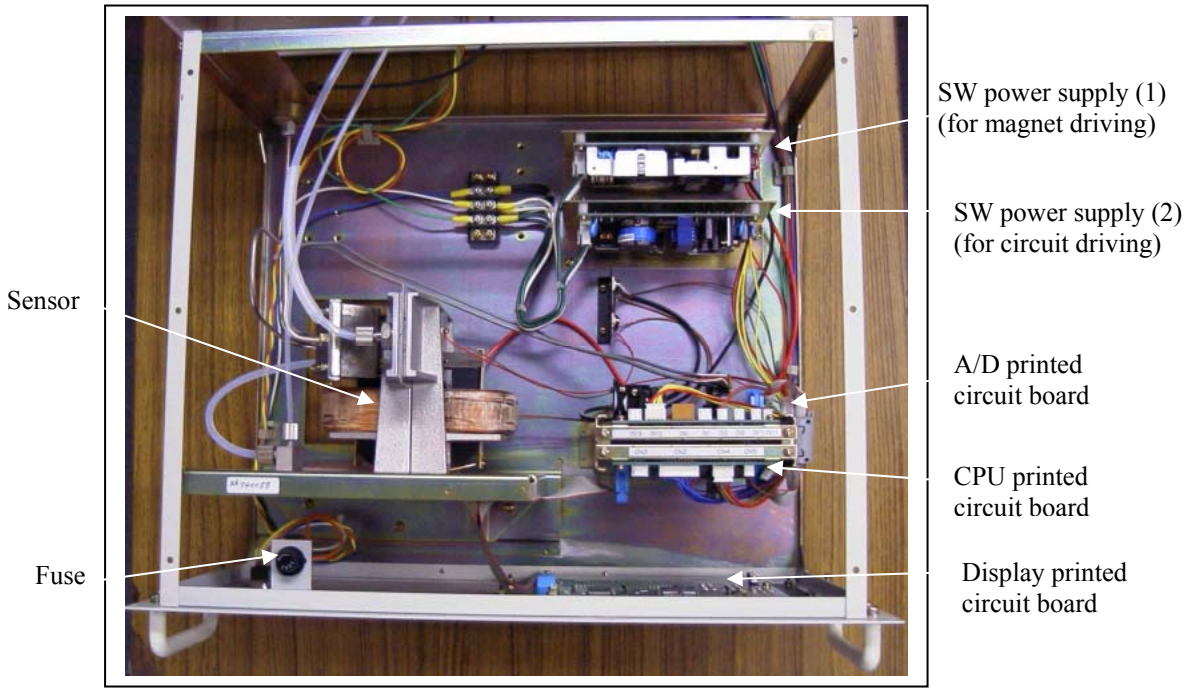


Photo 2-3 Components inside the inner case

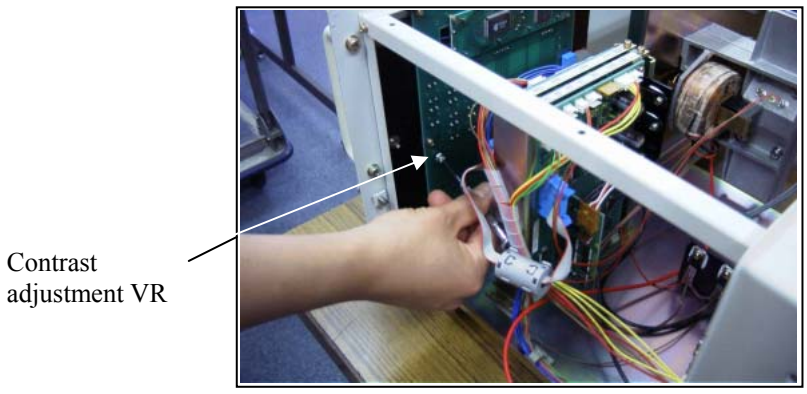


3. ADJUSTMENT

3-1. LCD contrast adjustment (Display 1: LCD at the top-front)

The LCD of the concentration display is not provided with a means of performing contrast adjustment. The LCD contrast adjustment is performed by means of the VR of the display printed circuit board. When the VR is turned clockwise by a precision driver, display characters turn dark, and when it is turned counterclockwise, they turn light.
Adjust the contrast to make it easy for the users to see the display.

Photo 3-1 Contrast adjustment



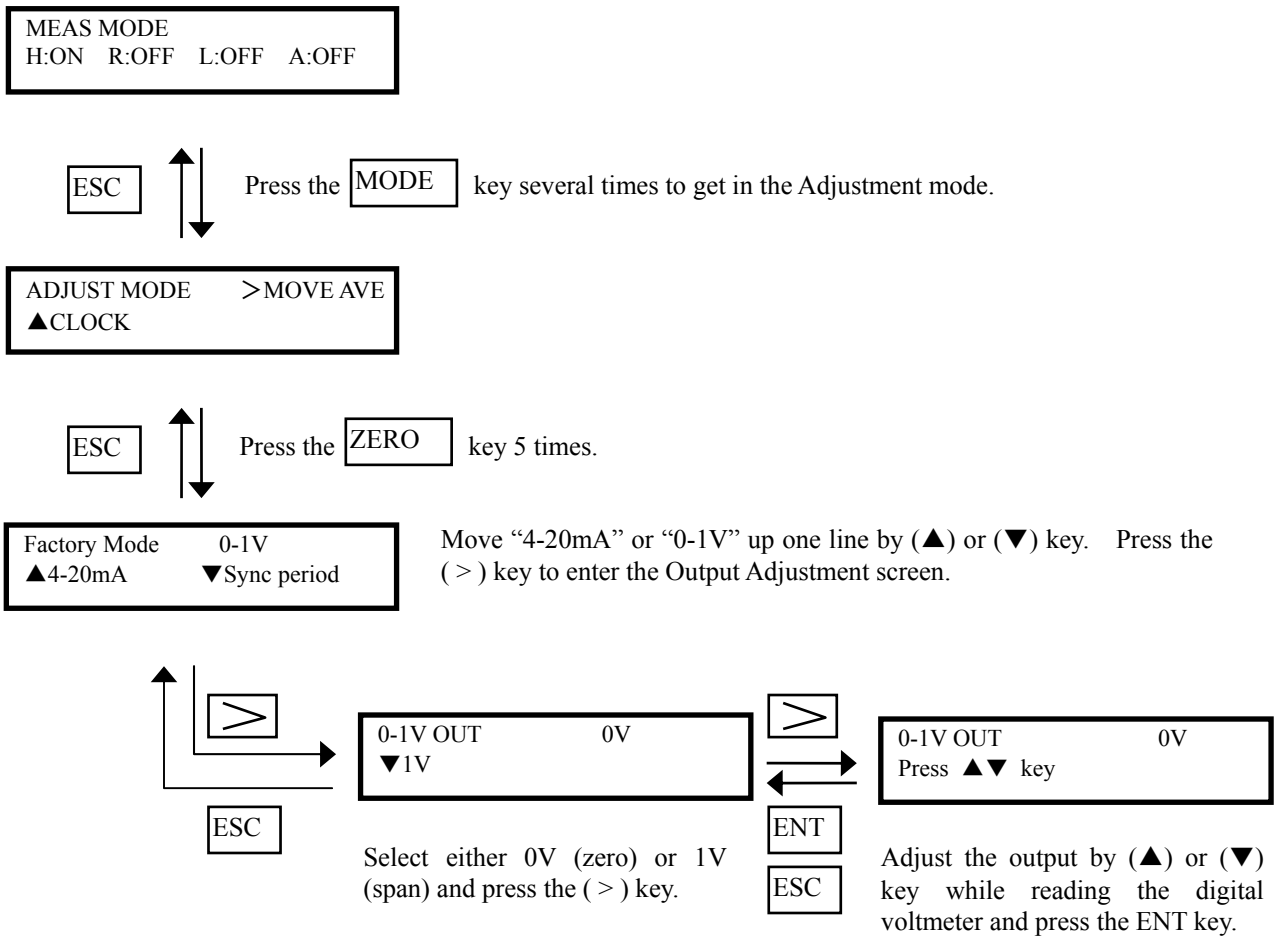
3-2. Output adjustment (4 to 20mA, 0 to 1V)

To perform output adjustment, connect a digital voltmeter to the output terminal and set the measurement screen in the Factory Adjustment mode.

Caution: Perform the output adjustment within the range of 4 to 2mA and 0 to 1V on the Adjustment screen. If other adjustment screen appears and you are at a loss what to do on the screen, press the ESC key several times to change it to the Measurement mode. In this case, don't press the ENT key. Otherwise the adjustment contents would change, and disable adjustment.

- **Factory adjustment mode**

  Press the MODE key several times on the Measurement screen, and the User Adjustment screen appears. Press the ZERO key 5 times on the User Adjustment screen, and the Factory Adjustment mode will be selected. This mode contains 4 to 20mA output, 0 to 1V output, coil pulse, manual gain, synchronous pulse, zero memory, span memory, magnet, reset, and peak code input. Be careful not to get in items other than "4 to 20mA output" and "0 to 1V output". In 4 to 20mA output and 0 to 1V output, be sure to press the ENT key to save the change that is adjusted by (▲) or (▼) key. After adjustments, press the ESC key to escape to the Measurement mode.



* Adjustment of 4 to 20mA should be performed in the same procedure as in 0 to 1V.

4. REPLACEMENT OF PARTS

4-1. Replacement of restrictor

Stop the analyzer as described in section 2.1, “How to stop analyzer”. Then, pull out the inner case. The restrictor for reference gas line should be replaced when it is clogged (if gas flow is reduced to less than 5 mL.) Be careful when handling the restrictor to prevent it from being clogging with foreign matter since the restrictor diameter is very small.

Never touch the restrictor directly. If the restrictor is dropped or touched in error, rinse it with acetone for about 10 seconds and mount it after drying.

After restrictor replacement, apply soapy water to the connections of the pipe and joint and check for a gas leak. After confirming that there is no sign of a gas leak, check the gas flow to the restrictor (5 to 20 mL).

Photo 4-1 Replacement of restrictor

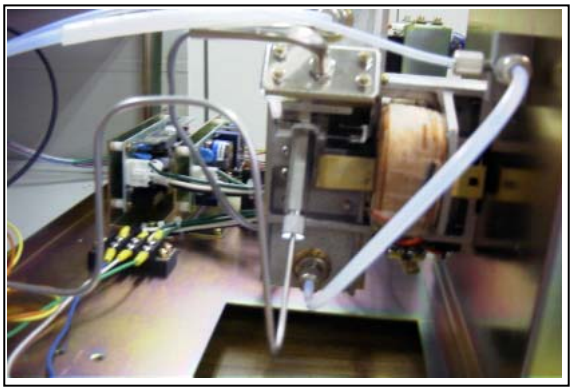
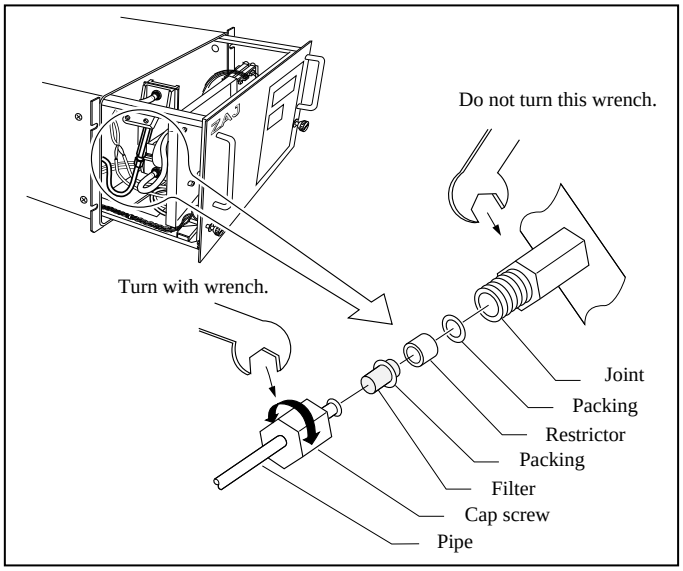


Illustration of disassembly



4-2. Replacement of switching power supply

The switching power supply is classified into two types for magnet driving and for circuit use.

As shown in the Photo 2-3, SW power supply (1) is used for magnet driving and SW power supply (2) for circuit use. To replace the switching power supply, perform “how to stop analyzer” given in section 2-1. Turn OFF this instrument power switch and disconnect the AC power cable. Then, pull the inner case out of the instrument as described in section 2-3, and remove the mounting board on which the switching power supply is mounted by loosening 2 screws from the top. Disconnect the primary and secondary connectors. Remove 4 screws and insulation washers fastening the mounting board and switching power supply to remove the switching power supply from the mounting board. When mounting a new switching power supply, reverse the removal procedure. Be sure to attach insulation screw washers required for mounting the new switching power supply on the mounting board. For replacement of switching power supply (1), check the magnet driving pulse (section 5-2), and for switching power supply (2), check voltage for the printed circuit board as shown in section 5-1.

4-3. Replacement of sensor

Caution: Since accuracy cannot be guaranteed when sensors are replaced at the site, sensors must be factory-adjusted at replacement.

First, be sure to turn OFF the power switch to the instrument. Disconnect the AC power cable. Supply a zero gas and then pull out the inner case from the instrument, and detach cap nuts for pipes ① and ② which are connected to the sensor (as shown in Photo 4-2). Next, remove the SUS pipe for the reference gas in the same procedure as when the restrictor has been replaced. Remove thermistor (soldered) cable, magnet driving cable (screwed to the sensor lower part), and sensor signal cable (connector). Unscrew 3 screws from the mounting board while holding the sensor by hand and remove the sensor and mounting board from the instrument. Unscrew 4 screws fastening the mounting board so that the sensor can be separated from the mounting board. When mounting a new sensor, reverse the removal procedure. Before connecting the sensor signal cable, adjust voltage with VR1 until voltage specified on the replacement sensor is obtained from between CN 2 pins 1 and 4 on the A/D printed circuit board. After sensor voltage adjustment has been completed, connect the sensor signal cable and check the sensors against the operation check list.

Photo 4-2 Sensor piping

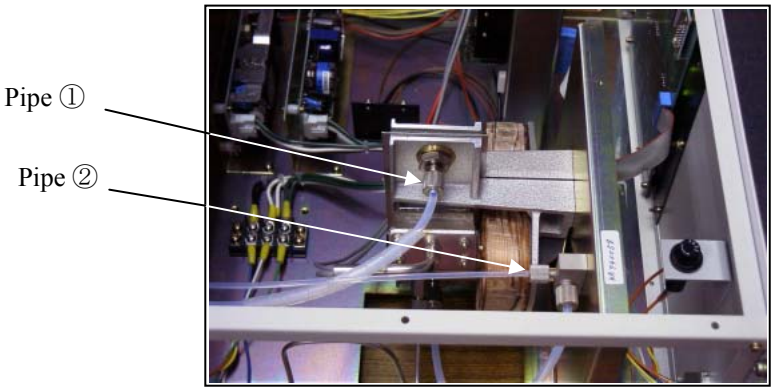


Photo 4-3
Inner case as viewed from upper part

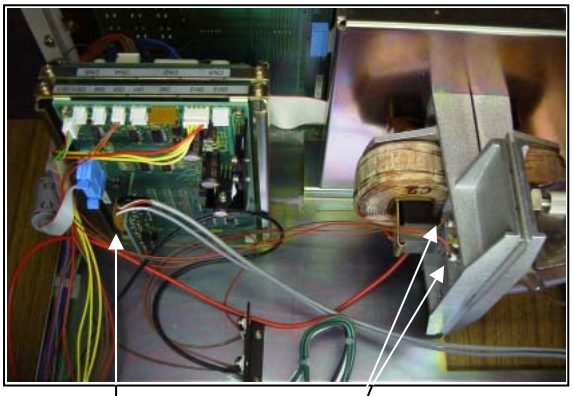
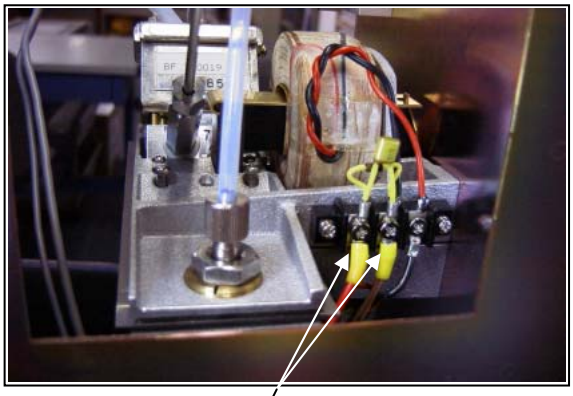


Photo 4-4
Inner case as viewed from lower part



4-4. Replacement of display unit

First, turn OFF the instrument power switch. Pull out the AC power cable. Draw the inner case from the instrument as described in section 2-3. Unscrew 6 screws from the side panel, 2 screws from the lower part of the inner case and remove the front frame from the inner case. Note that the soldered AC power cable cannot completely be removed from the instrument. Unscrew 6 screws fastening the display printed circuit board from the rear of the frame. Replace the display printed circuit board. After replacement, measure contrast of LCD according to section 3-1.

Photo 4-5 Removal of front frame

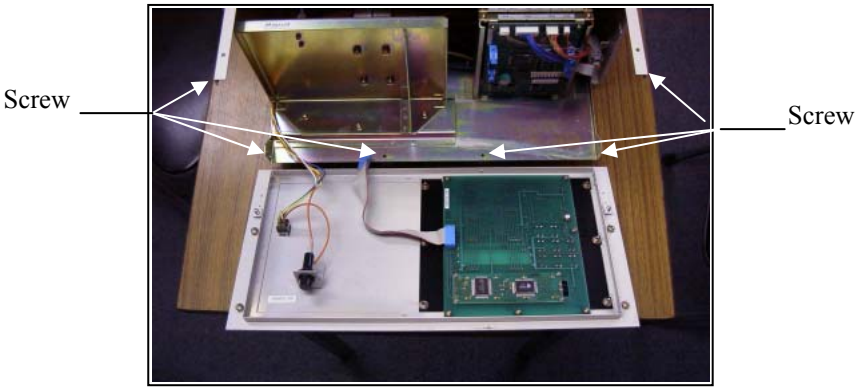
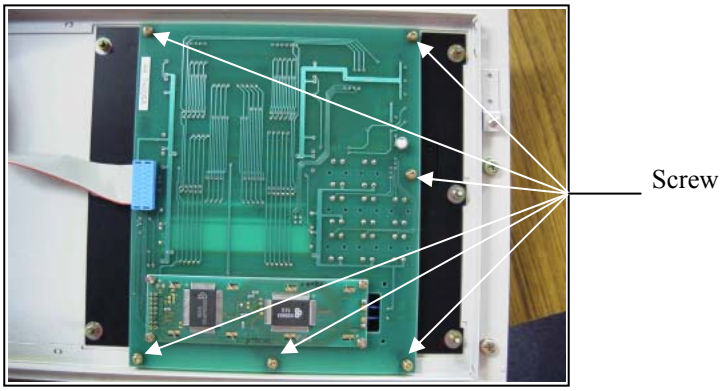


Photo 4-6 Removal of display printed circuit board.



5. CHECK FOR SIGNALS

5-1. Check of voltage across printed circuit board

Check of power supply voltage

- CPU board

  J6 (GND) – J5 (+5V) ····· +5.0 ±0.3V

- A/D board

  J13 (GND) – ····· J11 (+15V) +15.0 ±0.5V

  J13 (GND) – ····· J12 (-15V) -15.0 ±0.5V

  J13 (GND) – ····· J14 (-12V) -12.0 ±0.5V

  J13 (GND) – ····· J15 (+5V) +5.0 ±0.5V

- Output board

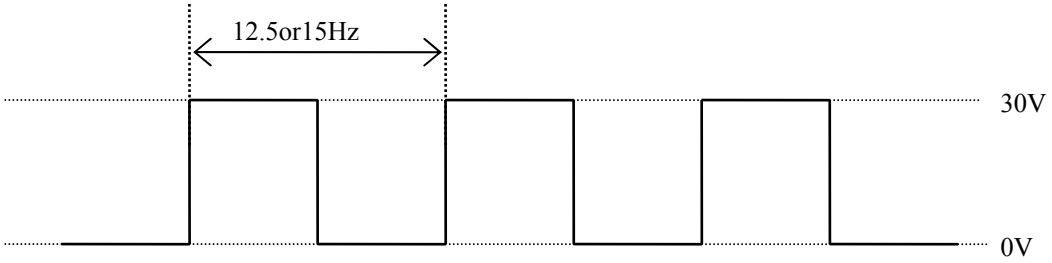
  CN1 11 pin (Vss) – CN1 - 10 (+5V) ····· +5.0 ±0.3V

  CN5 2 pin (VG) – CN5 - 1 (+15V) ····· +15.0 ±0.5V

  CN5 2 pin (VG) – CN5 - 3 (-15V) ····· -15.0 ±0.5

5-2. Check of magnet driven pulse

- Check the pulse between terminals at the lower part of the sensor using an oscilloscope.



Pulse cycles depend on power frequencies:

At power frequency of 50Hz, 12.5 ±0.5Hz

At power frequency of 60Hz, 15.0 ±0.5 Hz

5-3. Check and adjustment of synchronous rectification waveforms

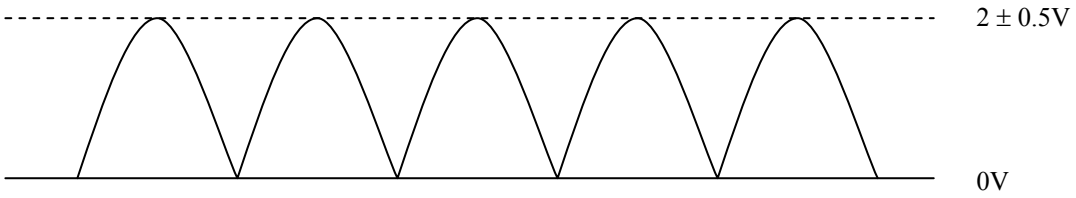
Synchronous rectification waveforms should be checked if they vary widely.

- Check points

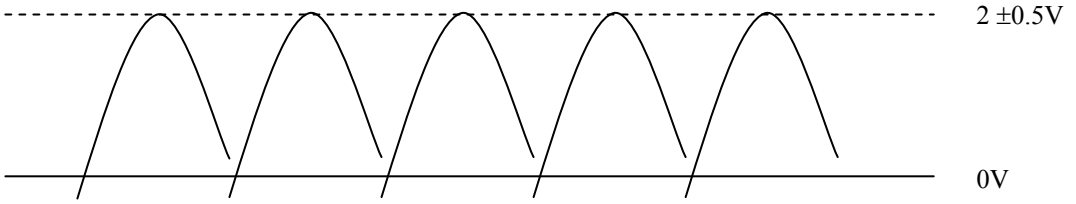
  Use an oscilloscope to check waveforms between pin 4 of AC amplifier board Q7 and A/D board J13. Note that the tester should be directly applied to the IC pin since pin 4 of the AC amplifier board Q7 is not provided with a check terminal. Be careful not to short between adjacent pins.

  Observe and check the waveforms according to waveform examples.

• **Good**



• **Not good**



Perform the following procedure when synchronous rectification waveforms are widely different from the good example.

Caution:
- Failure to adjust synchronous rectification waveforms may result in inaccurate measurement.
- If you go into a wrong Adjustment Item screen of the Factory mode, be sure to press the ESC key, and then retry from the first step. On the different Adjustment Item screen, don't press the "ENT" key or the > key, or accurate measurement cannot be performed and poor measurement results will be obtained.

MEAS MODE
H:ON R:OFF L:OFF A:OFF

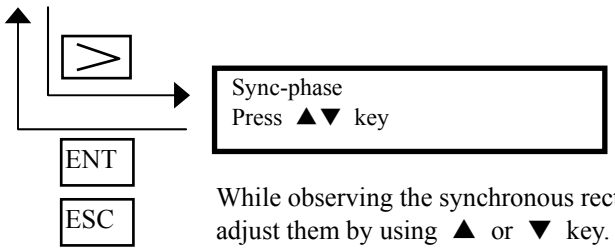
ESC ⇅ MODE Press the key several times to change to the Adjustment mode.

ADJUST MODE >MOVE AVE
▲ CLOCK

ESC ⇅ ZERO Press the key 5 times.

Factory Mode Sync phase
▲Amp gain ▼Zero save

In the Factory mode that is displayed, move Synchronous Pulse one line up by using ▲ or ▼ key. Press the (>) key to go into the Synchronous Pulse Phase adjustment screen.



Sync-phase
Press ▲▼ key

ENT

ESC

While observing the synchronous rectification waveforms with an oscilloscope, adjust them by using ▲ or ▼ key. Establish waveforms with the ENT key. If you want to stop halfway, press the ESC key.

6. Countermeasures against trouble

6-1. Error code and countermeasures

Error code	Error message	Cause	Check and measures
Err1	AUTO ZERO CAL ERR	Calibration value is more than 20% FS different from previous value.	・Confirm the set zero or span calibration value. ・Confirm the gas concentration in gas cylinder. ・Confirm the range.
Err2	AUTO SPAN CAL ERR		
Err3	INPUT OVER ERR	Sensor input value is abnormal.	・Check if gas outside effective range is flowing.
Err4	INPUT UNDER ERR		
Err5	OUTPUT DEVICE ERR	Output printed circuit board is abnormal.	・Check if the connector of output printed circuit board is unplugged. ・Replace the output printed circuit board. ・Contact the nearest Fuji representative.

- Errl Auto zero calibration error (AUTO ZERO CAL ERR)

  This code is displayed if zero calibration values as measured in the automatic calibration fluctuate 20% larger than previous calibration value.

  If an error occurs, the instrument will be stopped without calibration.

  Countermeasures

  Perform zero point calibration manually.

  If an error does not occur with manual zero calibration, there is nothing wrong with the instrument. Check the settings for gas flowing time in the automatic calibration and the sampling system that is different between manual calibration and automatic calibration. If the MANUAL ZERO CAL ERR code appears in the manual calibration, check calibration gas, range settings, and calibration concentration settings.

  Caution) If the range settings have changed, an error may be displayed in an initial calibration. But, this is not an error. Perform zero-point calibration forcedly in the manual zero calibration.

- Err2 Auto span calibration error (AUTO SPAN CAL ERR)

  This code is displayed if span calibration value as measured in the automatic calibration fluctuates 20% larger than previous calibration value.

  If an error occurs, the instrument will be stopped without calibration.

  Countermeasures

  Perform span point calibration manually.

  If a span calibration error does not occur with manual span calibration, there is nothing wrong with the instrument. Check the settings for gas flow time in the span calibration and sampling system that is different between manual calibration and automatic calibration. If the MANUAL SPAN CAL ERR code is displayed in the manual calibration, check if calibration gas, range settings, and calibration concentration settings are proper.

  Caution) If the range setting has changed or when a gas cylinder for span calibration that is widely different from previous concentration value has been replaced, an error may occur in an initial calibration, but it there is nothing wrong with the instrument. Perform span-point calibration forcedly in the manual span calibration.

- Err3 Input over error (INPUT OVER ERR)

  This code is displayed when the sensor signal is large.

  Countermeasures

  This error relates to reference gas, sample gas and range settings.

  First, check if the range settings are proper.

  Check if the reference gas is properly selected within the range to be set. (Starting from 0, N_2 gas is selected. From 21, air gas is selected, and from 100, O_2 is selected.) If the reference gas is correctly selected, check if there is possibility that any of the sample gases exceeds the range (oxygen is included too much). If the sample gas is beyond the range, change the range.

- Err 4 Input under error (INPUT UNDER ERR)

  This code is displayed when the sensor signal is larger in the negative direction.

  Countermeasures

  This error relates to reference gas, sample gas and range settings.

  Check for the range settings.

  Check if the reference gas is properly selected within the range to be set. (Starting from 0, N_2 gas is selected. From 21, air gas is selected, and from 100, O_2 is selected.) If it is properly selected, check if some gas among the sample gases is included as set in the range, or if even a small quantity of oxygen is contained in the reference gas, for example.

  If the sample gas is not included as set in the range, change the reference gas and range.

- Err 5 Output device error (OUTPUT DEVICE ERR)

  This code is displayed when a response is not received from an output printed circuit board.

  Countermeasures

  Check the cable between the CPU printed board and output printed board. Check if there is poor contact between the connector and receptacle or if the cable is disconnected.

- Manual zero calibration error (MANUAL ZERO CAL ERR)

  When zero calibration has been performed in the manual mode (via key operation), this code appears when calibrated values fluctuate 20% larger than previous calibrated values.

  Countermeasures

  Check that the range and calibration concentration settings are proper.

  Check the sampling system and calibration gas.

  Caution) If the range settings have changed, an error may be displayed in an initial calibration. But, this is not an error. Perform zero-point calibration forcedly in the manual zero calibration.

- Manual span calibration error (MANUAL SPAN CAL ERR)

  When span calibration has been performed in the manual mode (via key operation), this code appears when calibrated values fluctuate 20% larger than previous calibrated ones.

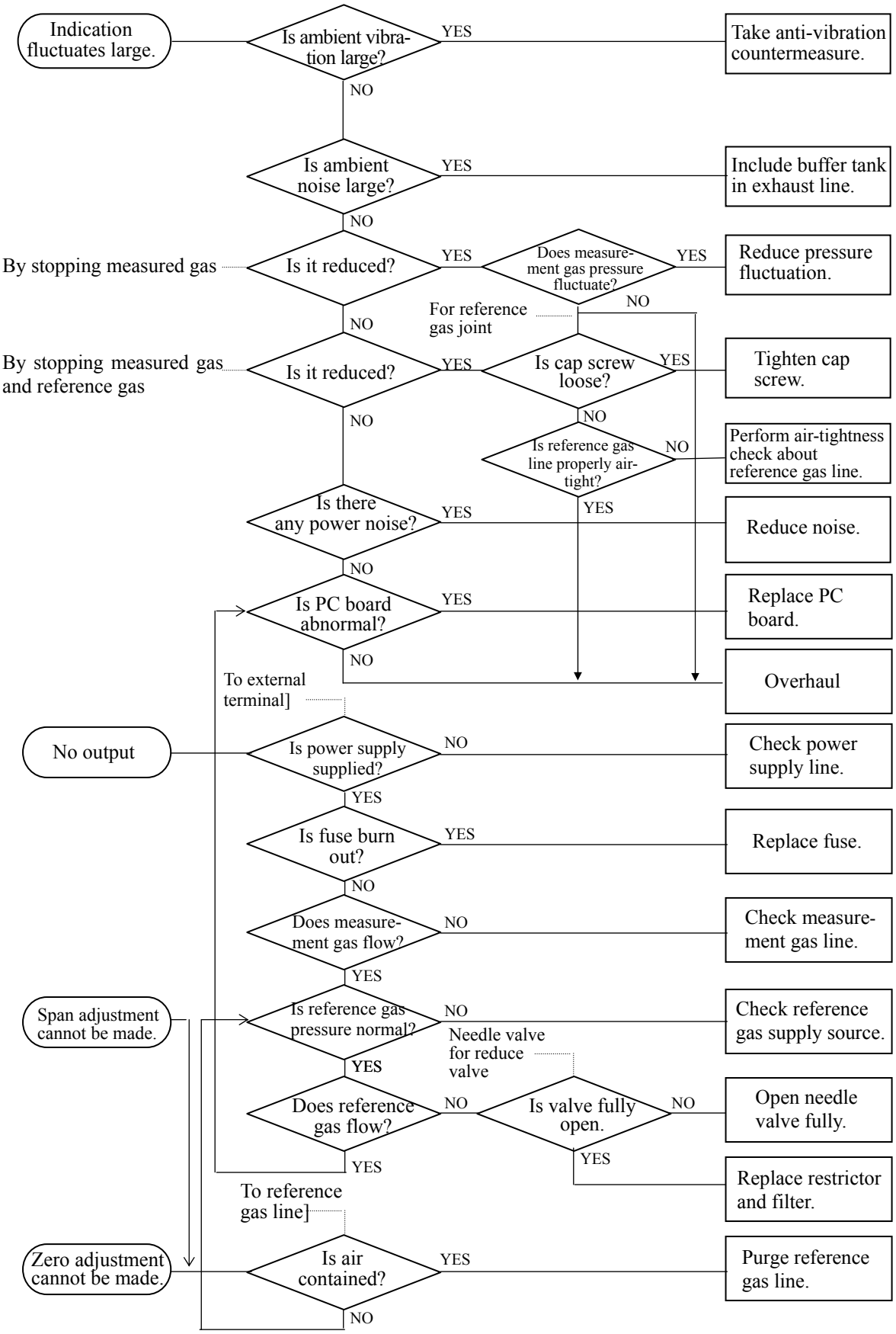
  Countermeasures

  Check that the range and calibration concentration settings are proper.

  Check the sampling system and calibration gas.

  Caution) If the range settings have changed, an error may be displayed in an initial calibration. But, this is not an error. Perform span-point calibration forcedly in the manual span calibration.

6-2. Troubleshooting



7. Maintenance parts

No.	Name	Man. Drawing No.	Remarks	Recommended replacement cycle
1	Restrictor	TK708941C1	Reference gas joints	2 years
2	Filter	TK708922P2	Reference gas joints	2 years
3	Packing	TK722676P4	Near the filter	2 years
4	Packing	TK722676P4	For restrictor	2 years
5	Fuse	757642	2A, ϕ6, 4 x 30 mm	2 years

* Recommended replacement cycle for maintenance parts is at least 2 years. Prepare maintenance parts every 2 years.
* Maintenance parts including No. 1 to No. 4 used near the reference gas should be replaced every 2 years. However, if there is no problem with reference gas flow (a constant flow of 5 to 20 mL is maintained) or indication (does not fluctuate), there is no need to replace them.

8. Others

If transmission function (RS232C) is available as an option, the following parameters can be viewed by a dedicated tool.

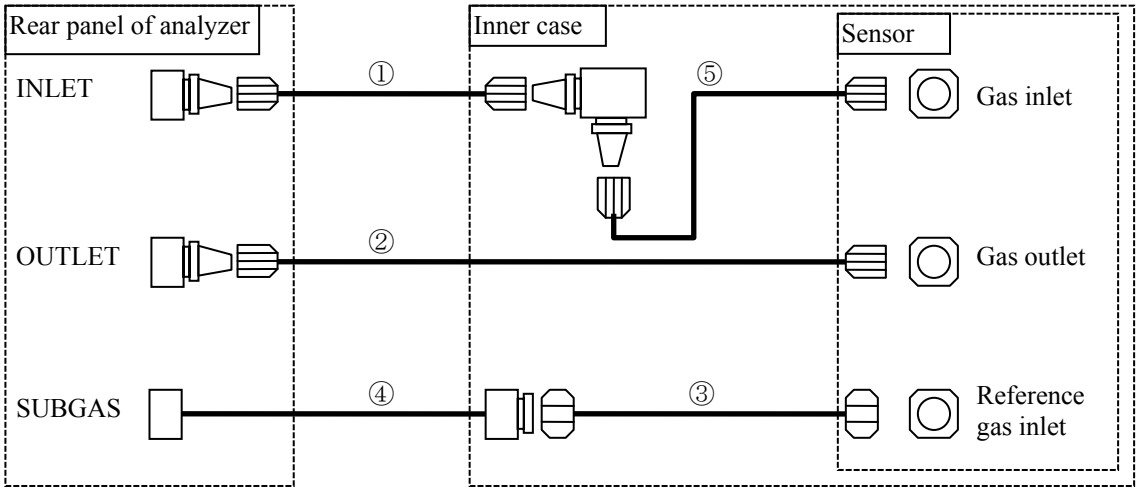
Zero and span calibration coefficients : A/D counted value at calibration
Temperature table : Temperature table for temperature compensation
Span temperature compensation table : Temperature compensation table for span point
Zero temperature compensation table : Temperature compensation table for zero point
2% gain : 2% O_2 gain
100% gain : 100% O_2 gain

Name	First address	Length of data Byte	Number of data	Type of data
Zero and span calibration coefficients	E00C6	8(8)	4	Word
Temperature table	E011A	12 (C)	3	Long
Span temperature compensation table	E00DA	36 (24)	9	Long
Zero temperature compensation table	E034E	12 (C)	3	Long
2% gain	E00C4	1 (1)	1	Byte
100% gain	E00C5	1 (1)	1	Byte

* Length of data is expressed in bytes. Figures in parenthesis are expressed in hexadecimal.

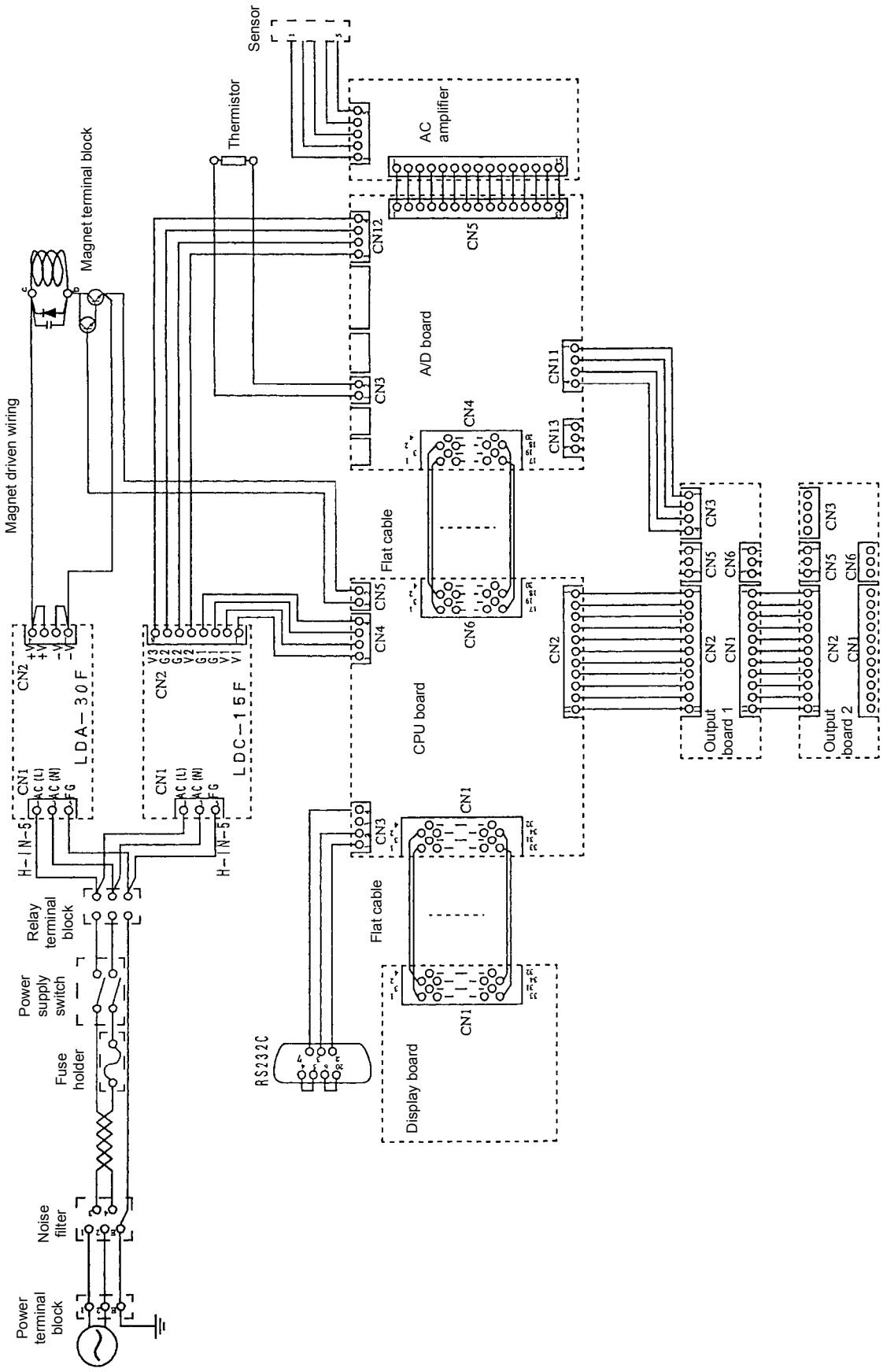
Appendix

Appendix-1. Piping diagram

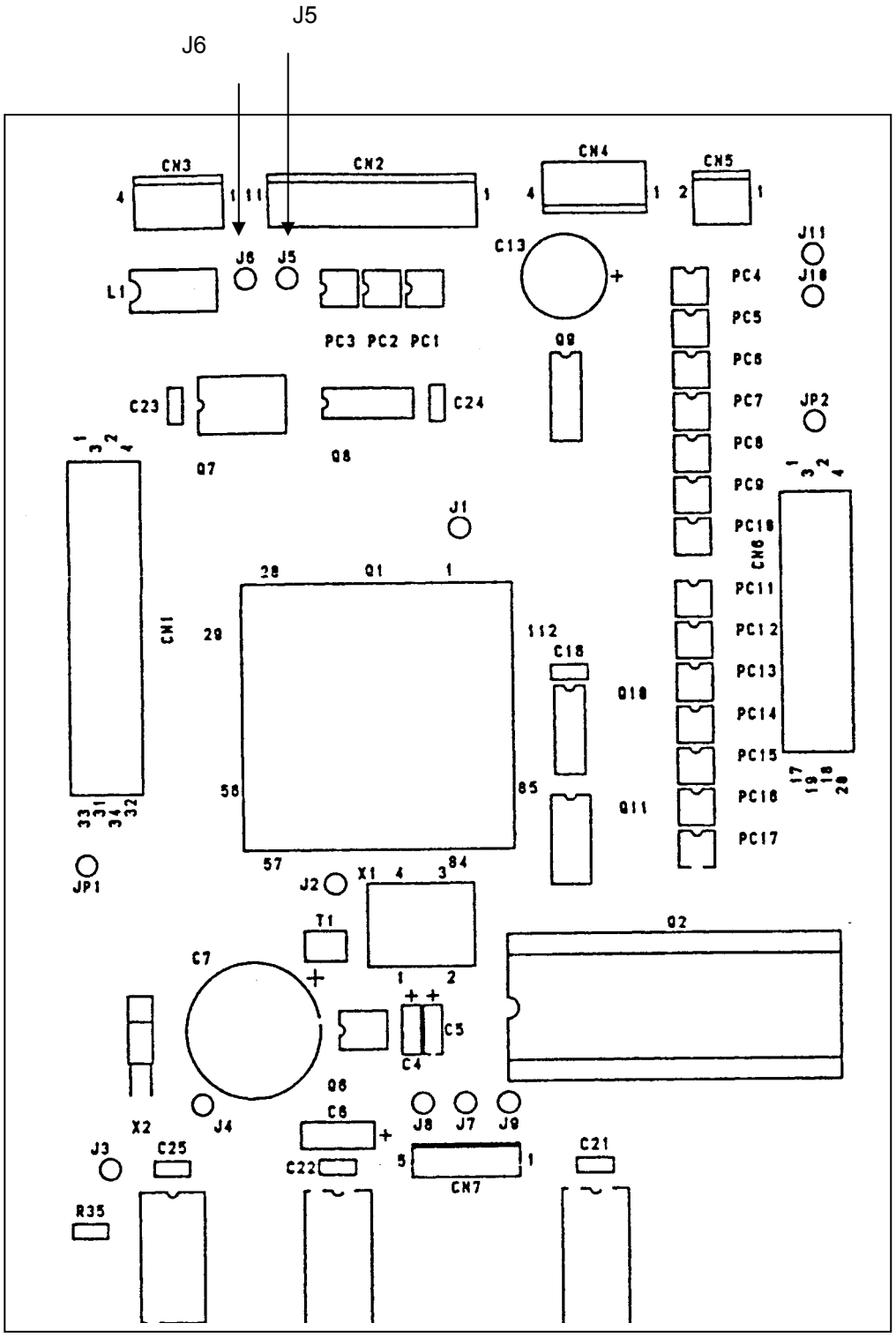


No.	Name of product	Applicable length	Piping diameter
①	Teflon tube	About 0.5 m	ϕ3 mm/2mm
②	Teflon tube	About 0.5 m	ϕ5 mm/4mm
③	SUS tube		
④	Nylon tube	About 0.5 m	ϕ3 mm/2mm
⑤	Teflon tube	About 0.5 m	ϕ5 mm/4mm

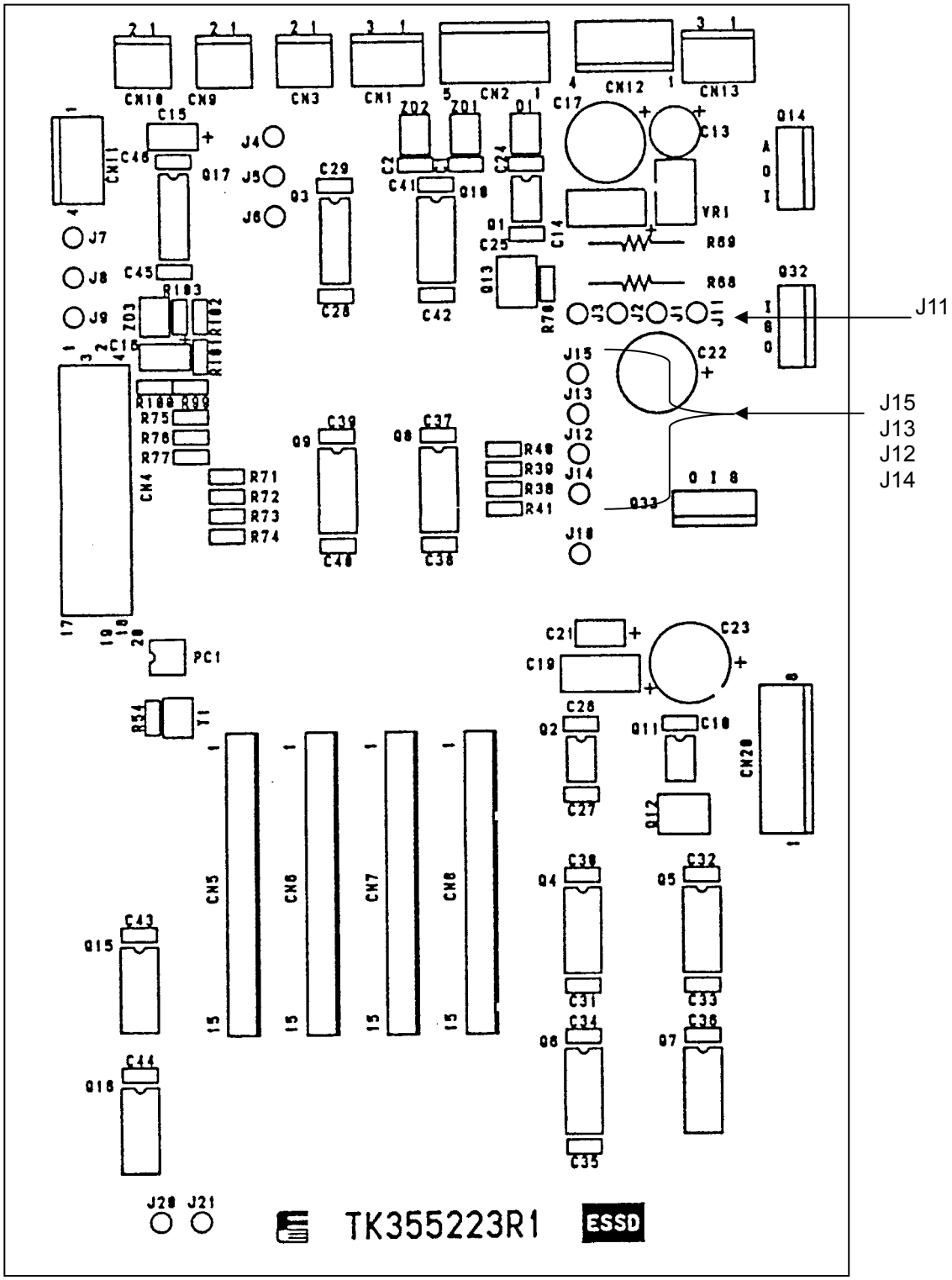
Appendix-2. Wiring diagram



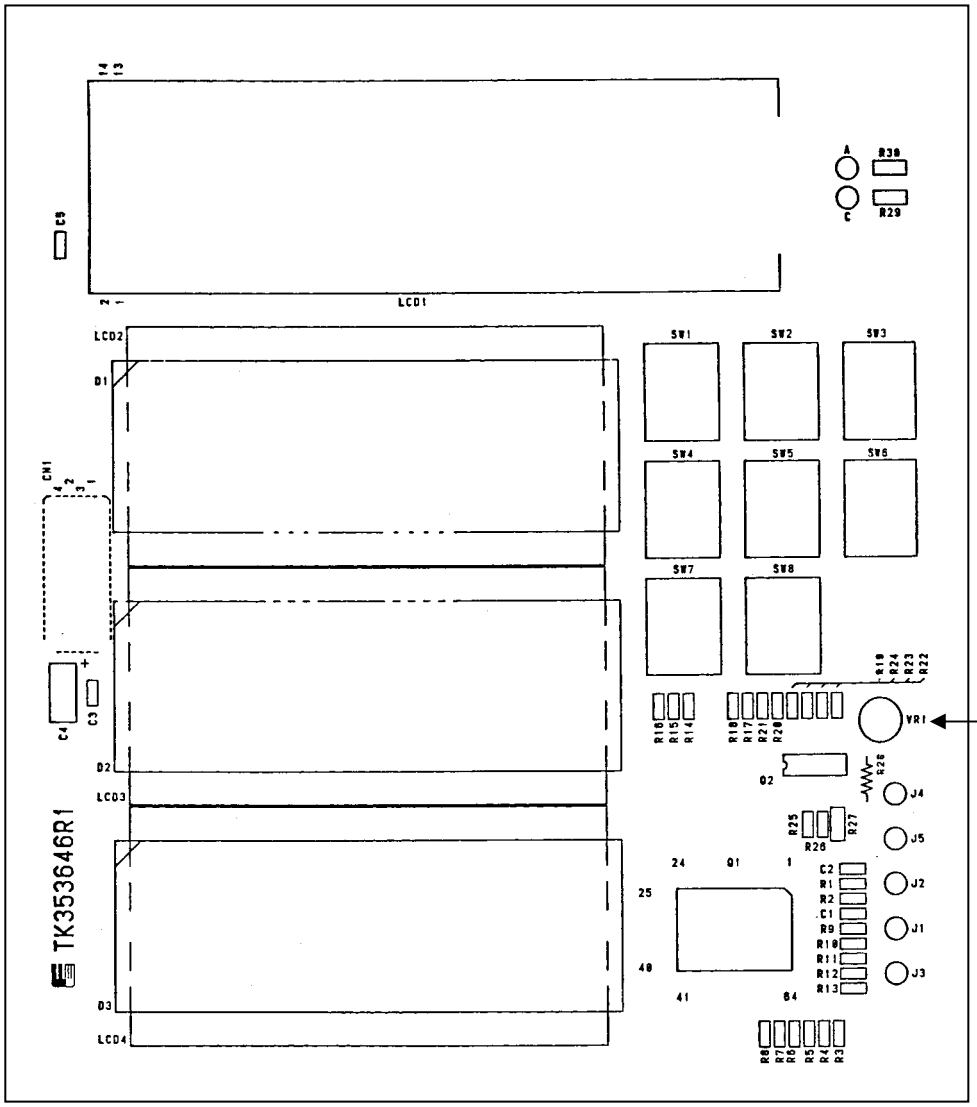
Appendix 3-1 CPU printed board



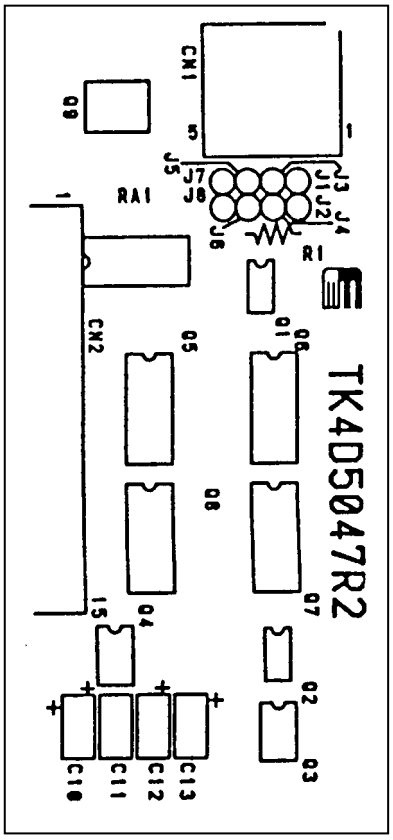
Appendix 3-2 A/D printed circuit board



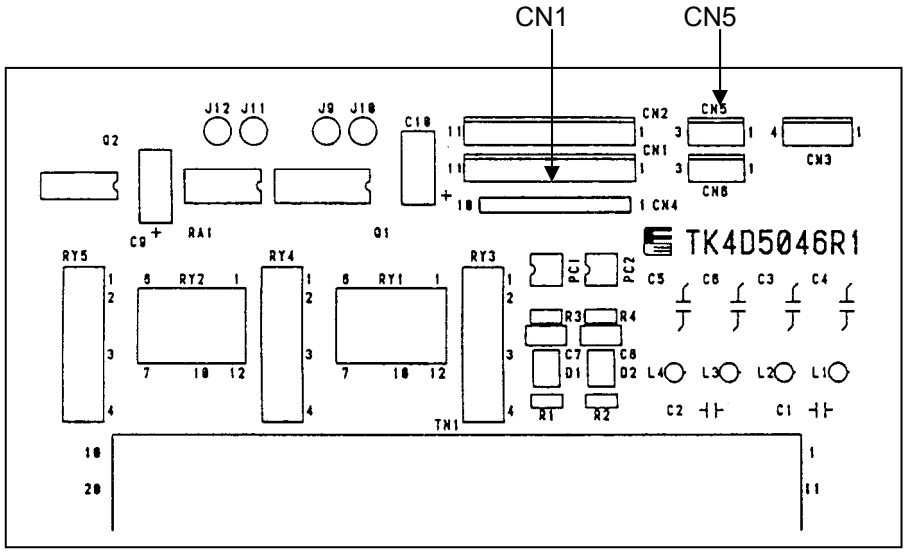
Appendix 3-3 Display output printed circuit board



Appendix 3-4 Analyzer printed circuit board



Appendix 3-5 Output printed circuit board



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