Manual No.: M501-E332
Revision : First Edition

# X-RAY HIGH-VOLTAGE GENERATOR FOR DIAGNOSES (X) UD150B-30 / L-30 TECHNICAL DOCUMENT DESCRIBES

SHIMADZU CORPORATION
KYOTO JAPAN

## Contents

# 1. Introduction

This technical document describes an X-ray high-voltage generator for diagnoses (X) UD150B-30 / L-30. Use this document to help understand the performance of the generator and assist repair works in case of failure of the generator.

Also, refer to relevant documents such as connection diagrams, installation manual, photo-timer installation manual, and photo-timer technical descriptions as well.

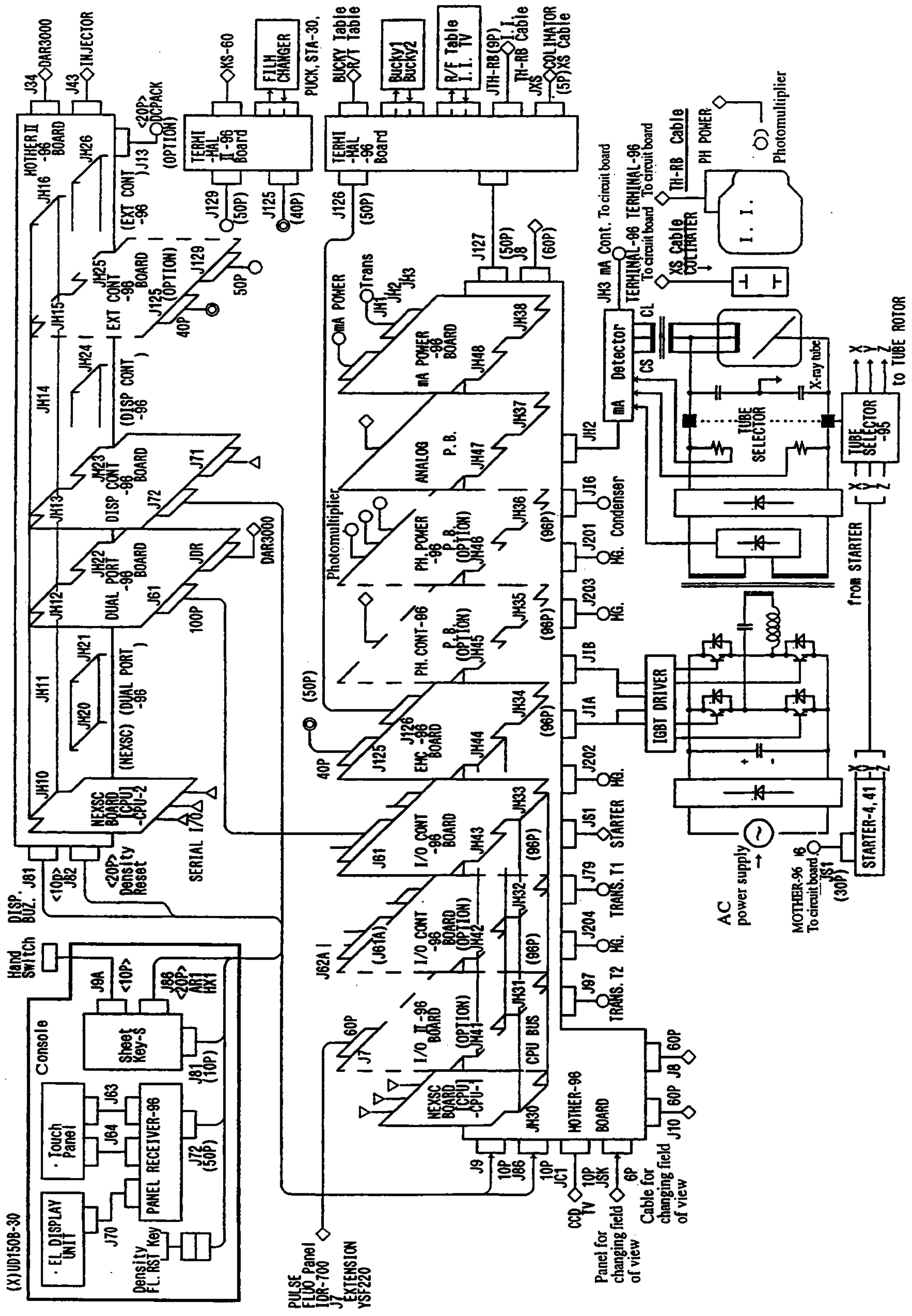


4

# 2. Outlines

## 2.1 Outline of circuit board configuration

Schematic diagram of (X) UD150B-30 / L-30 is shown below.






5

## 2.2 Outline of circuit board functions

(1) Circuit boards in control cabinet

(a) Control circuit boards connected with MOTHER-96

| Board | Functions | Remark |
|---|---|---|
| MOTHER-96 board | ○ Charging voltage detection<br>○ Supply voltage detection, power ON/OFF, and 24-V supply for relays<br>○ Control of each magnet in main circuit | |
| NEXSC board (BASE) | ○ Memory of operation method, X-ray tube No., radiographic method, focusing, radiographic conditions, fluoroscopic conditions, etc.<br>○ Memory communication with extended NEXSC board<br>○ Overload estimation, and HU calculation<br>○ Fluoroscopic and radiographic timer count<br>○ Signal input/output condition control for radiography, operation method, and faults | |
| I/O CONT-96 board | ○ Set signal output of operation method, X-ray tube No., radiographic method, focusing, radiographic conditions (RkV, RmA, FVR), fluoroscopic conditions (FkV, FVF), etc.<br>○ Photo-timer signal output<br>○ Iris value signal output<br>○ Radiography timer<br>○ RS422 I/F circuit with DUAL PORT RAM board | |
| EMC-96 board | ○ X-ray radiation control for radiography<br>• General radiography — GR<br>• BUCKY radiography — BUCKY1, BUCKY2<br>• Tomography — PLANI<br>• Auto-changer radiography — OX<br>• Spot filming — FSP<br>• I.I. indirect spot filming — IFG, CRS<br>• Film changer radiography — SER<br>• DSA — DSP<br>○ Radiography backup timer<br>○ X-ray radiation control for fluoroscopy (including pulsed fluoroscopy)<br>○ I.I. field-of-view control<br>○ Lower extremity step control<br>○ 3-tube system processing | |

| Board | Functions | Remark |
|---|---|---|
| ANALOG-96 board | ○ Tube voltage control<br>(1) Set tube voltage input<br>(2) Measured tube voltage input<br>(3) Fluoroscopic tube voltage control<br>(4) Radiographic tube voltage control<br>(5) Tube voltage measurement<br>○ IBS control<br>○ Abnormality detection circuit<br>○ Reset circuit (for resetting at power ON)<br>○ "KVT" detection | kVT = Measured Tube Voltage |
| mA POWER-96 board | ○ Power circuit<br>(1) Power supply and smoothing circuit<br>(2) Inverter circuit<br>(3) Focus switching circuit<br>○ Filament heater control<br>(1) Filament current setting circuit<br>(2) Filament current measuring circuit<br>(3) Heater confirmation circuit<br>(4) Abnormality detection circuit<br>(5) Reset circuit (for resetting at power ON)<br>○ Fluoroscopic tube current control<br>○ Tube current measurement<br>○ Over current protection<br>○ Tube current drop compensation | |
| TERMINAL-96 board | ○ Interfaces with externally connected devices (Relays, etc.)<br>• BUCKY radiography: BUCKY1, BUCKY2<br>• Tomography: PLANI<br>• Auto-changer radiography: OX<br>• Spot filming: FSP<br>• I.I. indirect spot filming: IFG, CRS<br>○ I.I. field-of-view signal input/output (connectors)<br>○ 3-tube system signal output | |
| I/O Ⅱ-96 board [Option] | ○ Operation method, and APR signal input/output (J8 [interlocked with fluoroscopic bed])<br>○ Interfacing with YSF220 (J7)<br>○ EEPROM (32 kbyte) extension (currently unused)<br>○ Pulse-related signal outputs<br>○ CINE backup timer (currently unused)<br>○ CINE-related signal outputs (currently unused) | |

| Board | Functions | Remark |
|---|---|---|
| I/O CONT-96 board [Option] | ○ Signal output for setting a high voltage for photomultiplier (PH-HVS) | |
| PH CONT-96 board [Option] | ○ Photo-receptor selective circuit and photo-pickup selective circuit<br>○ Current-voltage conversion circuit for photomultiplier signal<br>○ Integrating circuit for photomultiplier signal<br>○ Reference voltage comparator circuit for photomultiplier signal<br>○ Cutoff signal generating circuit<br>○ Reference voltage generating circuit<br>○ Long-term characteristics correction circuit | |
| PH POWER-96 board [Option] | ○ High voltage generating circuit for photomultiplier<br>○ Photo-receptor selective circuit<br>○ Integrating circuit and comparator cutoff circuit<br>○ Reference voltage generating circuit and reference voltage switching circuit<br>○ Compensation circuit for contrast medium covering ratio<br>○ Pulsed fluoroscopy IBS circuit | |

(b) Control boards connected with MOTHER II-96

| Board | Functions | Remark |
|---|---|---|
| MOTHER II-96 board | ○ Whereas connectors for various devices are mounted, no circuits are installed. | |
| NEXSC board (EXT) | ○ Memory communication with basic NEXSC board (CPU-1)<br>○ EL display control (for DISPCONT-96 board as well)<br>○ Touch-panel reading control (for DISPCONT-96 board as well)<br>○ Reading of density knob position on X table and fluoroscopy timer reset key status (for DUAL PORT-96 board as well)<br>○ Buzzer sound for sheet-key-small, and Ready and X-ray display (for DUAL PORT-96 board as well)<br>○ Communication with DAR300 (JDA connector) | |

| Board | Functions | Remark |
|---|---|---|
| DUAL PORT-96 board | ○ Memory communication between basic NEXSC board (CPU-1) and extended NEXSC board through J61 cable of I/O CNT-96 board<br>○ Communication between extended NEXSC board (CPU-2) and DAR300 (JDA)<br>○ Reading of density knob position on X table and fluoroscopy timer reset key status, and display of the fluoroscopy timer reset key through J82 cable of MOTHER Ⅱ-96<br>○ Buzzer sound for sheet-key-small, and Ready and X-ray display through J81 cable of MOTHER Ⅱ-96 board<br>○ A following optional function is available when added to JM11 and 21 side.<br>• Memory communication between extended NEXSC board (CPU-2) and optional NEXSC board (CPU-3) (added to JM20) through MOTHER Ⅱ-96 board | (Communication Error |
| DISP CONT-96 board | ○ EL display control through PANEL RECEIVER-96 board and panel signal cable [RS422 I/F] (for NEXSC board as well)<br>○ Touch panel reading control through PANEL RECEIVER-96 board and panel signal cable [RS232C] (for NEXSC board as well) | |
| EXT CONT-96 board [Option] | ○ X-ray radiation control function in accordance with DAR3000<br>○ Connection to film changer [PUCK, and others]<br>○ Connection to stereo controller [STA-30]<br>○ Connection to injector [MARK V, and others]<br>○ Connection to examination table [KS-60] | To J38, J41, J42, J43 through J34 of MOTHER Ⅱ-96 |
| TERMINAL Ⅱ-96 board [Option] | ○ Interface with externally connected devices (relays, etc.)<br>• Film changer<br>• Stereo controller [STA-30]<br>• DAR-1200<br>• Old CINE cameras [Contact point output of each X-ray radiation timing]<br>• Connection to examination table [KS-60] | Through J41, J42, J34 |

(2) Circuit boards in console

| Board | Functions | Remark |
|---|---|---|
| PANEL RECEIVER-96 board | ○ Relays EL display control signals from DISP CONT-96 to EL display unit.<br>○ Relays touch panel control signals to DISP CONT-96, and NEXSC (EXT). | [422 I/F circuit] J72, J70, [RS232C signal line] J72, J63, J64 |
| SHEET KEY SMALL board | ○ Buzzer (according to control signals from DUAL PORT-96 board)<br>○ Ready, and X-ray switch display (same as above)<br>○ Relaying of hand switches | J81<br>J81 |

## 2.3 Brief description of software

### 2.3.1 Functions

(1) Outline of software processing in the basic NEXSC board (CPU-1)

Software processing in the basic NEXSC board (CPU-1) is as follows.

(a) Memory communication with the extended NEXSC board (CPU-2) (I/O CONT-96 board)

(b) HU calculation and X-ray prohibition in excessive HU value (*LOVE, *NOX) (I/O CONT-96 board)

(c) Time counter and cutoff signal output for fluoroscopy (*FOVE) (I/O CONT-96 board)

(d) Overload check of radiography condition and radiography prohibition in overload (I/O CONT-96 board)

(e) Signal input/output of radiography, operation method, and faults (I/O CONT-96 board)

(f) Signal input/output on J7 EXTENTION board and PULSE I/F-94 board (I/O II-96 board)

(g) Timer count setting according to radiography time setting (Subtraction and cutoff signal output (*SOF) are controlled by hardware timer IC.) (I/O CONT-96 board)

(h) Reading of measured time for taking radiography (I/O CONT-96 board)

(i) Analog outputs (RkV, RmA, FVR, LMT, FkV, FVF, IRIS, Photo-s, Photo-s [high-vol.])

In ordinary fluoroscopy, the real FVF is determined by a feedback control to the tube current corresponding to a measured tube voltage in reference to a FVF value derived from the filament heater output at the start of fluoroscopy. In pulsed fluoroscopy, FVF value is output in accordance with a measured tube voltage during fluoroscopic operation. IRIS and Photo-s [high-vol.] are switched for either fluoroscopy or radiography according to KC signal input. (I/O CONT-96 board)

Photo-s [high-vol.] (I/O CONT-96 option board)

(j) Reading analog values (PkV, TmA)

PkV is read as a measured FkV value during fluoroscopy and as a measured RkV value during radiography.

TmA is read as a measured FmA value during fluoroscopy and as a measured RmA value during radiography.

(2) Outline of software processing in the extended NEXSC board (CPU-2)

Software processing in the extended NEXSC board (CPU-2) is as follows.

(a) Memory communication with the basic NEXSC board (CPU-1) (DUAL PORT-96 board)

(b) EL display (DISP CONT-96 board)

(c) Reading touch panel output (DISP CONT-96 board, NEXSC board)

(d) Reading a position of the density adjusting knob on the X table and a status of the fluoroscopy timer reset key (DUAL PORT-96 board)

(e) Buzzer sound for sheet-key-small, and display of Ready and X-ray ( DUAL PORT-96 board)

(f) Communication with DAR3000 ( DUAL PORT-96 board)

2.3.2 Reference data on software

**NEXSC. BASE**

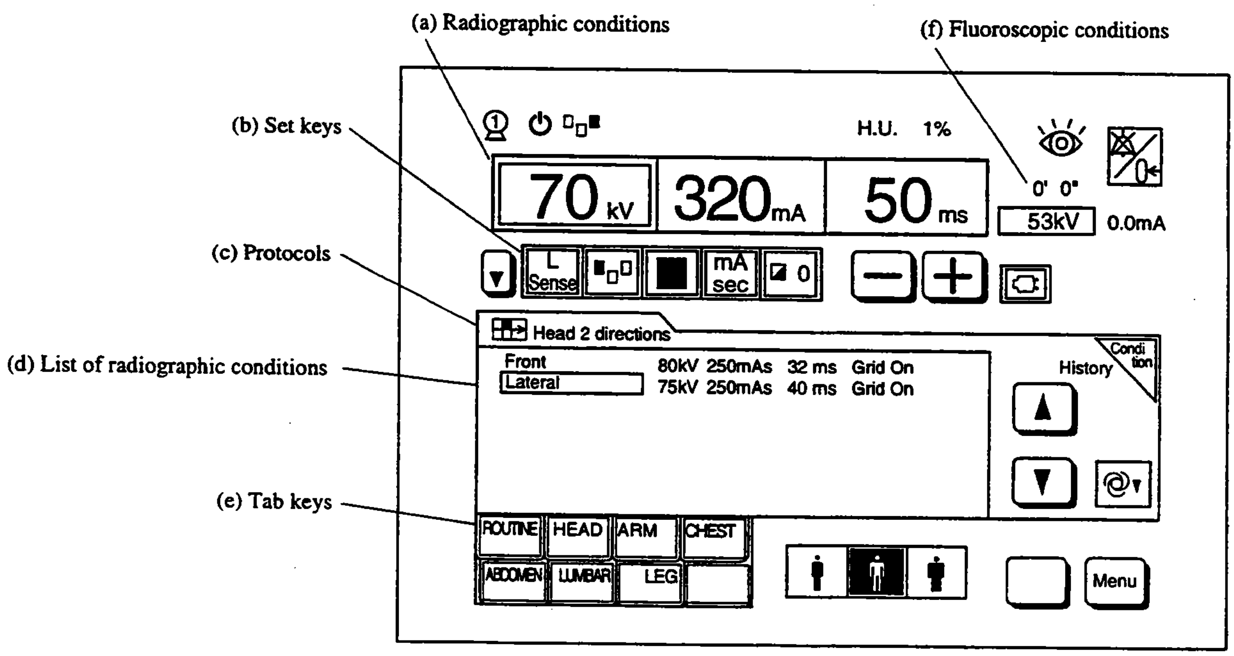
S-RAM
- Radiographic conditions currently set
- Information on input and output signals

EE-PROM
- Radiographic conditions on each APR
- Information on various initial settings
- Information on various adjusting modes
- Data for calculation on tubes
- Data for each memory shot

**NEXSC. EXT**

S-RAM
- Radiographic conditions currently set
- Information on input and output signals
- Information on various initial settings

EE-PROM
- Radiographic conditions on each APR



(a) Radiographic conditions

The radiographic condition data are stored in each S-RAM in the basic NEXSC board (CPU-1) and extended NEXSC board (CPU-2).

CPU-1 ....... Sets analog outputs and timer count values according to the data.

CPU-2 ....... Shows the radiographic conditions on EL display.

(b) Set keys

The set key data are stored in each S-RAM in the basic NEXSC board (CPU-1) and extended NEXSC board (CPU-2).

CPU-1 ....... Outputs data signals and analog signals according to the data.

CPU-2 ....... Shows the set keys on EL display.

(c) Protocols

The data on operation method are stored in each EE-PROM of CPU-1 and CPU-2.

CPU-1 ....... Outputs data signals and analog signals according to the data.

CPU-2 ....... Shows the protocols on EL display.

The character string data of "Head 2 directions" are stored in the EE-PROM of CPU-2 and shown on EL display.

(d) List of radiographic conditions

The number of steps in each protocol (c) is stored in each EE-PROM of CPU-1 and CPU-2.

The character string data of "Front", "Lateral", and "Grid ON" are stored in the EE-PROM of CPU-2 and shown on EL display.

The data of radiographic conditions such as RkV and RmA are stored in the EE-PROM of CPU-1. When a protocol is selected, the data are read from the EE-PROM of CPU-1 and written in each S-RAM of CPU-1 and DPU-2. CPU-2 displays the data list. The radiographic conditions are changed in the S-RAM.

(e) Tab keys

The character string data of "Head, etc." are stored in the EE-PROM of CPU-2 and shown on EL display.

(f) Fluoroscopic conditions

The fluoroscopic condition data are stored in each S-RAM of CPU-1 and CPU-2.

CPU-1 ....... Outputs analog signals and calculates fluoroscopy time according to the data.

CPU-2 ....... Shows the fluoroscopic conditions on EL display.

### 2.3.3 Examples of the software operation

Example 1) Changing a radiographic condition (when selecting RkV and pressing "+" key.)

(1) The data flow on RS232C from the touch panel to the extended NXSC board (CPU-2) through the panel receiver, J71 cable, and DISP CONT-96 board. The CPU-2 reads by interruption handling which portion of the touch panel (coordinate) has been depressed.

(2) The CPU-2 increases a current set RkV value by 1, writes the increased value in a calculation data area, and sends it to CPU-1 through the memory communication.

(3) The CPU-1 receives the data and checks whether the radiographic condition is an overload or not.

(4) If the condition is an overload, the CPU-1 terminates the data processing. If not, the CPU-1 copies the received data onto the previous data as a new radiographic condition.

(5) The CPU-1 outputs analog signals and sets timer count values according to the new radiographic condition.

(6) The CPU-1 sends the new radiographic condition to the CPU-2 through the memory communication.

(7) The CPU-2 copies the received photographic condition data onto the previous data.

(8) The CPU-2 displays the newly set radiographic condition.

Example 2) Selecting a protocol (when selecting a protocol from protocol list.)

(1) The data flow on RS232C from the touch panel to the extended NXSC board (CPU-2) through the panel receiver, J71 cable, and DISP CONT-96 board. The CPU-2 reads by interruption handling which portion of the touch panel (coordinate) has been depressed.

(2) The CPU-2 selects the new protocol and changes the display to a list of radiographic conditions.

(3) The CPU-2 reads from the EE-PROM and displays a operation method, title, body orientation, and remarks of the newly selected protocol.

(4) The CPU-2 sends the new protocol to the CPU-1 through the memory communication.

(5) The CPU-1 reads the list of the new radiographic conditions from the EE-

PROM according to the received new protocol and copies the new conditions onto the previously set conditions.

(6) According to the new radiographic conditions, the CPU-1 checks an overload, outputs analog data, sets timer count values, and outputs necessary data signals.

(7) The CPU-1 sends the new radiographic conditions and the overload information to the CPU-2 through the memory communication.

(8) The CPU-2 copies the received radiographic condition data onto the previously set data.

(9) The CPU-2 displays the newly set radiographic conditions and the overload information.

2.3.4 Protection for X-ray tube rating

In (X) UD150B-30/L-30, a microcomputer determines whether set radiographic conditions are overloads or not. In case of an overload, the computer comes to OVER, thus protecting the generator. The determination depends on two large factors, a short-time rating and device rating of X-ray tube. The permissible loads for the short-time rating differ in setting methods of radiographic conditions, a 2-control method (kV, mAs) and 3-control method (kV, mAs, sec).

(1) 2-control method

(a) The short-time rating of X-ray tube is generally shown in Fig. 2.4.1. This is the 100% rating. By eliminating the parameter of kV, this figure can be modified to Fig. 2.4.2 where a single curve is shown with a vertical axis of kW. The figure means that a permissible power is determined with a given exposure time.

Fig.2.4.2 can be further modified to Fig.2.4.3 that has a vertical axis of kWs. Multiplying a sec by the corresponding kW in Fig.2.4.2 derives this figure.

(b) In 2-control method, when a radiographic condition is given by kVo and

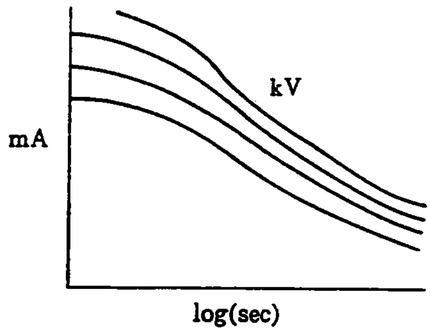


Fig. 2.4.1

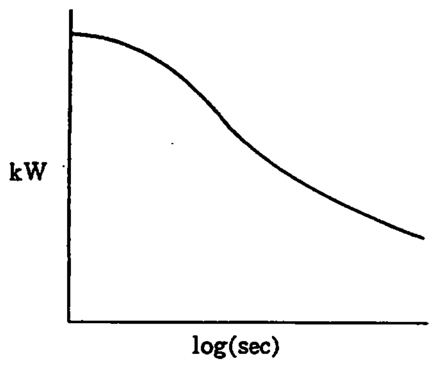


Fig. 2.4.2

mAso, the product of the two gives kWso. The sec0 corresponding to the kWso on the vertical axis in Fig. 2.4.3 means the permissible shortest radiographic exposure time for a given kVo × mAso (= kWso). Further, dividing the given mAso by the sec0 gives mAso / sec0 = mA0, which is the maximum permissible tube current.

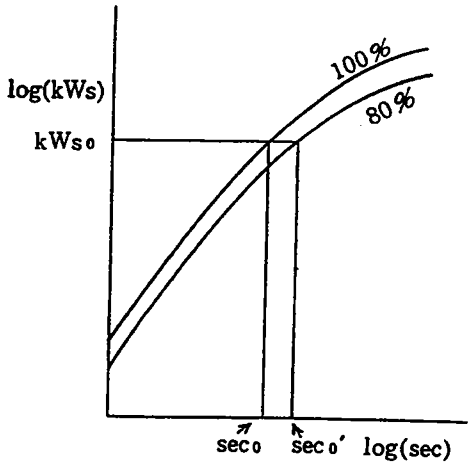



Fig. 2.4.3

(c) As described above, the 2-control method decomposes a given radiographic condition (kV, mAs) into the maximum permissible tube current and the shortest radiographic time. Any combination of kV and mAs hold the same relation as described above and a tube is always used under a constant load factor. In the above example the load factor is assumed to be always 100%. In actual cases, an operation method specifies its load factor. For example, if the specified load factor is 80%, the derived time is sec'0 as shown in Fig.2.4.3, which is longer than that for the load factor of 100%.

(d) In the 2-control method, the X-ray tube rating is stored in the form of Fig.2.4.3 and decomposed into the shortest time sec and the maximum current mA in considering the specified load factor.

(2) 3-control method

In the 3-control method, the short-time rating of X-ray tube is also stored in the same form of Fig.2.4.3 as in the 2-control method. A product of three values for a specified radiographic condition, kVo, mA0, and sec0, gives a value kWso, and the kWso derives the shortest radiographic time sec1 from Fig.2.4.3. If the derived time sec1 is shorter than the specified time sec0, the radiographic operation is possible under the specified condition. That is:

if sec0 ≧ sec1, the operation is possible, and

if sec0 = sec1, this means an overload for the tube.

2.3.5 Protection for a emission characteristics

When a tube voltage is low, an emission from the filament of the X-ray tube will be insufficient, and a large current will not be able to flow.

This characteristic is shown in Fig.2.4.4. When a current that exceeds the curve is set for a given tube voltage, the radiographic operation is made OVER (3-control method). Or, a tube current that does not exceed the curve in Fig.2.4.4 is automatically set for a given tube voltage (2-control method).

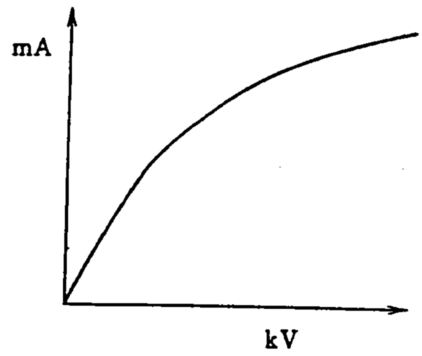


**Fig. 2.4.4**

2.3.6 Amount of heat accumulated on anode

(1) Unit of loaded heat amount "HU"

An amount of heat that is generated when a load is applied to an X-ray tube is proportional to a tube voltage [kV] × tube current [mA] × loaded time [sec]. It is convenient for the X-ray tube to take the value as a unit of loaded heat amount. The unit is HU, which is defined as follows:

$$HU = 1.41 \times kV \times mA \times sec$$

$$HU/S = 1.41 \times kV \times mA$$

(2) Amount of heat accumulated on anode

For example, the amount of heat that is accumulated on anode when a fluoroscopic photograph is taken for a condition, 80 kV, 420 mA, and 1.4 sec, is:

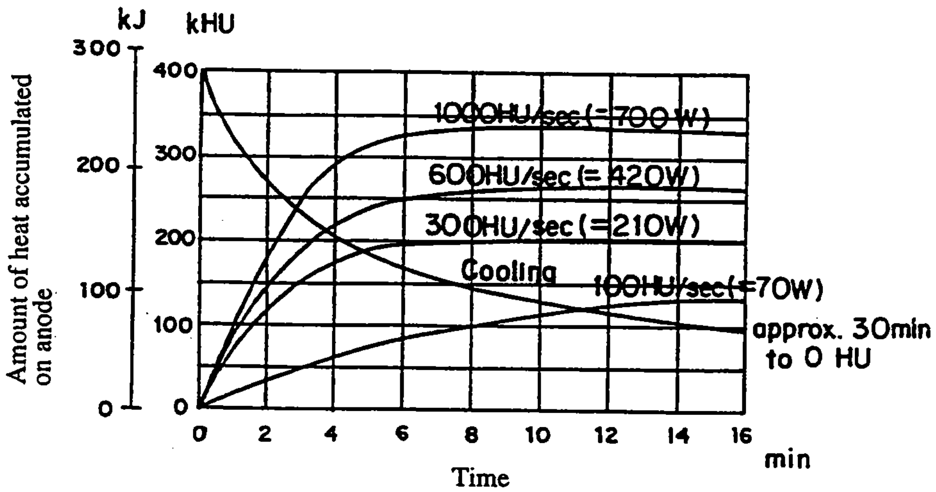
$$1.41 \times 80 \times 420 \times 1.4 = 66326 \text{ [HU]}.$$

That is, an about 66 kHU is accumulated.

(3) Cooling diagram

This shows a cooling diagram for a heat of 400 kHU in P-type CIRCLEX.

Accumulated heat in terms of load parameter




In computation of heat accumulation in a fluoroscopic or radiographic operation, the amount of heat dissipated according to the cooling curve in the figure is taken into account.

# 3. Main circuit

## 3.1 Outline of inverter circuit

### 3.1.1 Introduction

(X) UD150L-30/B-30 is an X-ray high-voltage generator, which uses an inverter of the same series resonance type as that used in conventional L/B-10 series. While using the same IGBT as a switching element, the operational frequency of the inverter is increased up to 50 kHz by improving the drive circuit and high voltage transformer for the inverter.

### 3.1.2 Features

The 50-kHz inverter has:

(a) A small size and lightweight .... the high voltage transformer is stored in a cabinet,

(b) Low operation noise,

(c) A kV waveform corresponding to a constant voltage,

(d) A constant kW from 80 kV to 150 kV, and

(e) A high-frequency filament heater (20 kHz).

### 3.1.3 Series resonance type inverter

(X) UD150L-30/B-30 uses an inverter of the same series resonance type as that used in conventional L/B-10 series.

Because, the series resonance inverter can decrease the switching loss due to its sinusoidal current waveform, facilitate high frequency operation, and lower electro-magnetic wave noise.

(1) Principle of operation of series resonance circuit

Fig.3.1.1 shows a circuit where a power source E, load R, inductance L, and capacitor C, are connected in series.

The impedance of the circuit seen by the source Z is

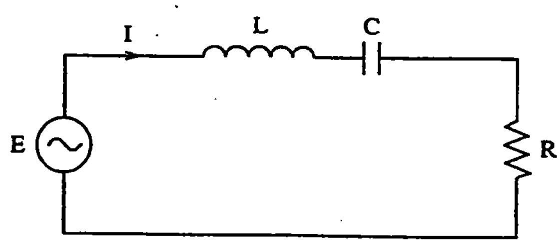



**Fig. 3.1.1 LCR series resonance circuit**

$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right) \quad \text{①}$$

Its absolute value is

$$|Z| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \quad \text{②}$$

When $\omega = \omega_o = \frac{1}{\sqrt{LC}}$, Z = R. Here, the impedance Z becomes its minimum value R and the maximum power is supplied to the load R.

The power dissipated in the resistor is

$$P = R|I|^2$$

$$= R \cdot \left(\frac{E}{|Z|}\right)^2$$

$$= \frac{R \cdot E^2}{R^2 + (\omega L - 1/\omega C)^2} \quad \text{③}$$

The equation ③ is graphed in Fig.3.1.2, where L and C are assumed to be a constant, and R is a parameter. It is understood from Fig.3.1.2 that varying the frequency ω enables control of the power dissipated in the load R.

This principle of operation is applied to the series resonance inverter of the X-ray high-voltage generator.

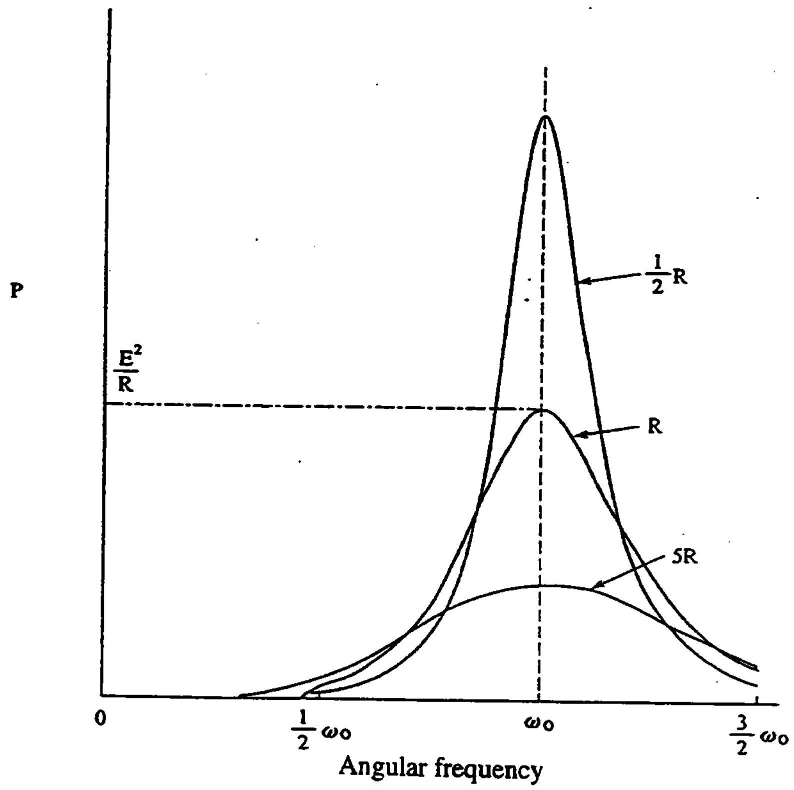



**Fig. 3.1.2 Relation between power and frequency in series resonance circuit**

(2) Circuit configuration of series resonance inverter

The main circuit configuration of the device is shown in Fig.3.1.3. The resonance circuit of Fig.3.1.1 is shown on the top in contrast to L and C of the main circuit.

In Fig.3.1.3 the circuit from the high voltage transformer to X-ray tube corresponds to the load R, and AC/DC converter and the full-bridge inverter correspond to the power source E.

As described in section (1), varying the frequency while keeping L and C fixed controls the output power. To vary the frequency, the oscillation frequency of the full bridge inverter is varied.

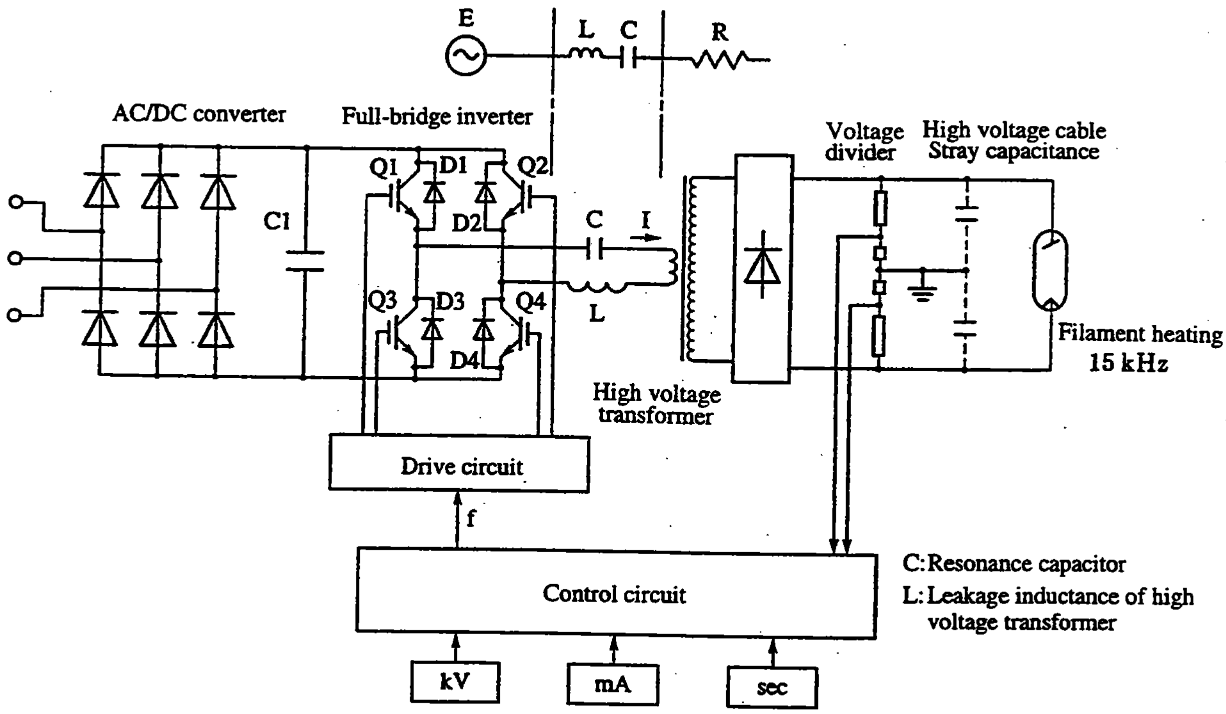



**Fig. 3.1.3 Main circuit configuration**

(a) Principle of operation

The three-phase or single-phase supply voltage is rectified by AC/DC converter and smoothed by C1. The smoothed DC voltage is constant.

When an X-ray exposure signal turns on IGBT Q1 and Q4, switching elements of the inverter, a current shown in Fig.3.1.4 ① flows through the resonance capacitor C, the primary winding of the high voltage transformer, and resonance inductance L. The current waveform is sinusoidal and the value is $\pi\sqrt{LC}$ for a period of $t_0 \sim t_1$. During the next period $t_1 \sim t_2$, the energy stored in

L and C is discharged through D1 and D4.

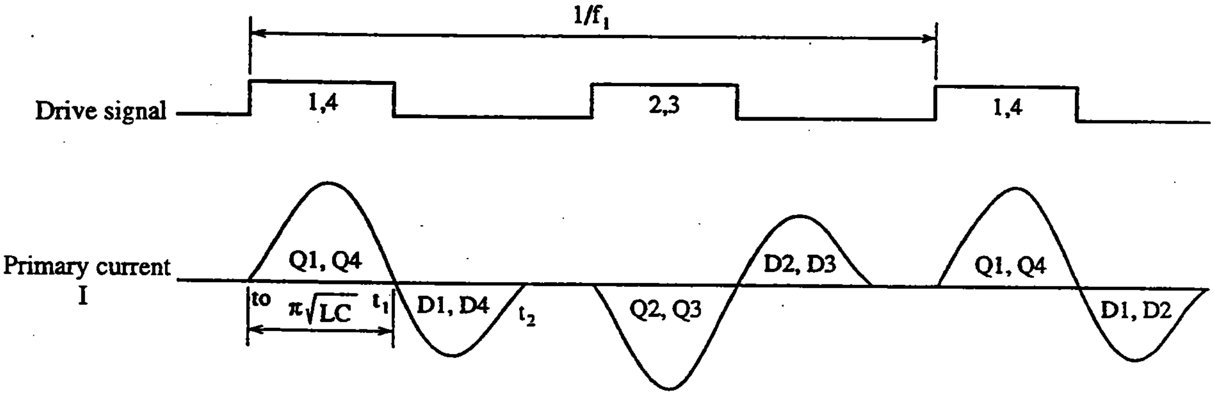
For a heavy load, the inverter frequency is increased, and while the discharge current is flowing through the diode D1 and D2, other IGBT Q2 and Q3 are turned on, so that the primary current has a continuous waveform.

Whereas the resonance frequency of this device is about 50 kHz, the maximum operational frequency is limited to about 45 kHz, taking a switch-off delay time of IGBT into account.

The tube voltage builds up in a frequency corresponding to the load condition. When the voltage reaches a value close to a set voltage (94%), the frequency is switched to another memorized value and after that controlled so that and the feedback value is equal to a set value.

This device does not use a high voltage capacitor in the secondary circuit, but uses only a stray capacity of the high voltage cable for smoothing the tube voltage supply.

① For a light load




② For a heavy load

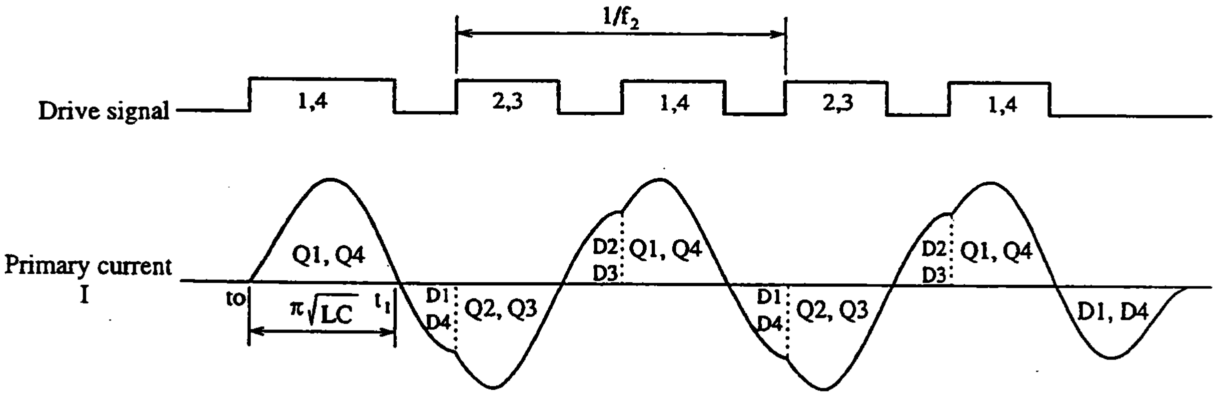



**Fig. 3.1.4 Primary current for each load**

(b) Performance characteristics

Fig. 3.1.5 shows examples of the tube voltage waveform. ① shows short-time characteristics and ② shows long-time characteristics for different tube currents.

The rise time of the voltage is 0.5 ~ 1 msec, because the high voltage capacitor is not applied. The voltage is substantially constant with small ripple due to the high frequency operation.

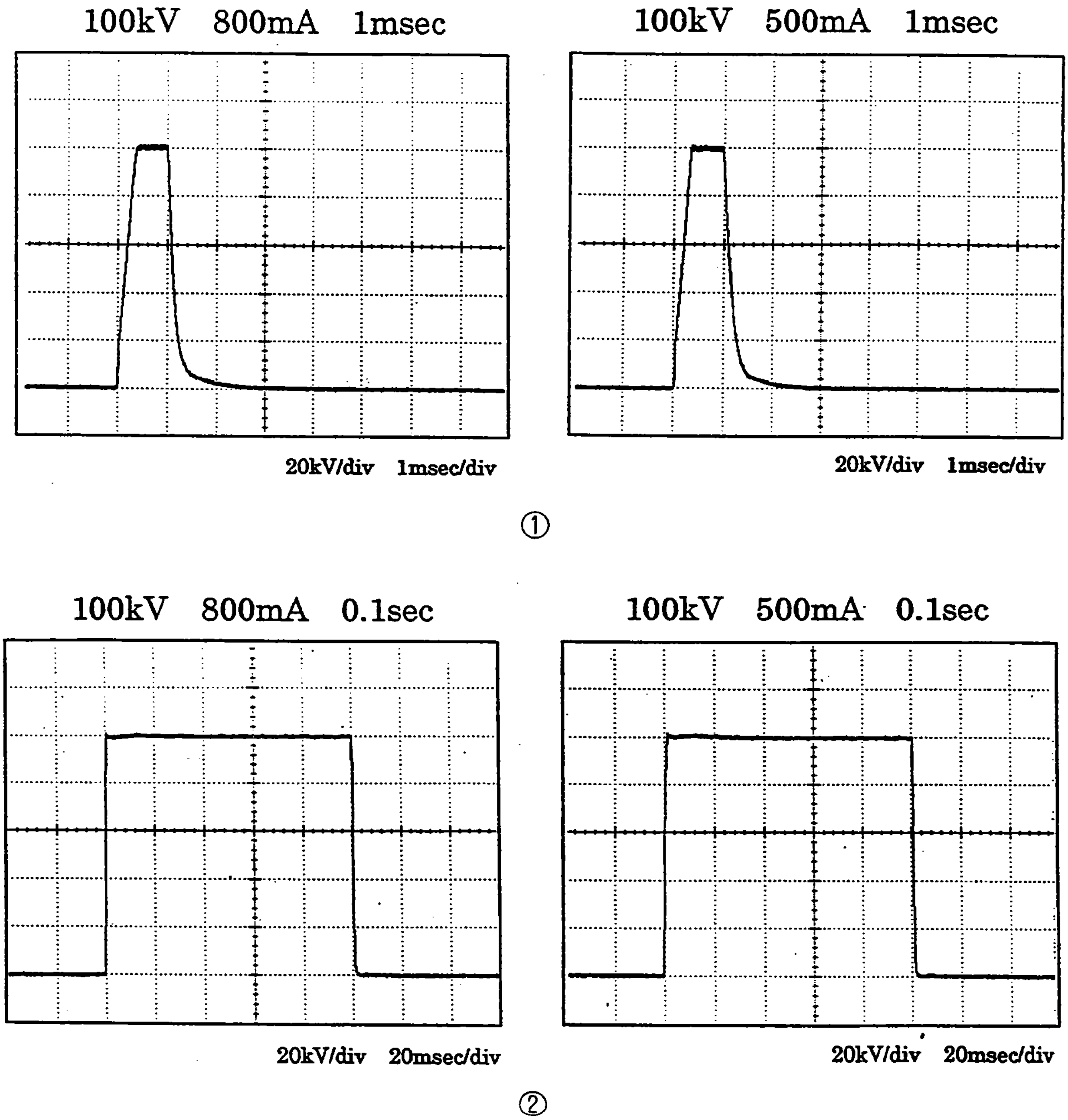



**Fig. 3.1.5 Examples of tube voltage waveform**

## 3.2 DC power circuit

(1) Rectifying and smoothing circuit

Refer to Table 3.2.1.

When the generator is turned on, a power is supplied to MGRS terminals 2, 4, 6 of the inverter unit (terminals 4, 6 for single phase power).

The power goes through resistors RSU, RSV, and RSW, and is full-wave rectified by a diode module and charges electrolytic capacitors $C_1$ ~ $C_4$. The charged voltage depends on the supply voltage as shown in Table 3.2.1.

**Table 3.2.1**

| Supply voltage | Voltage across electrolytic capacitor |
|---|---|
| 3 φ 380V ± 10% | DC537 ± 54V |
| 3 φ 400V ± 10%, 1 φ 200V $^{+10\%}_{-5\%}$ | DC566 ± 57V, DC566 $^{+57V}_{-28V}$ |
| 3 φ 415V ± 10% | DC587 ± 59V |
| 3 φ 440V ± 10% | DC622 ± 62V |
| 3 φ 480V ± 10%, 1 φ 240V ± 10% | DC679 ± 68V |
| 3 φ 240V, 220V, 20V ± 10% | DC566 ± 57V |

Note) With a supply voltage 3 φ -240, 220, 200V, a voltage 3 φ -400V is supplied through an automatic transformer XAT-2.

A magnet switch MG-D becomes OPEN when power is turned ON. (Refer to section (3) for a detail.)

The resistors RSU, RSV, and RSW control the current charging electrolytic capacitors $C_1$ ~ $C_4$.

The charging time constant is (with 3 φ supply):

$$R = 10 \times 2 = 200 \text{ [ohm]}$$

$$C = 10 \times 2 \times \frac{1}{2} = 10 \text{ [mF]}$$

time constant $CR = 20 \times 10 \times 10^{-3} = 0.2$ [sec].

Within about 1 second after power has been turned on, the magnet switch MG-RS will be switched ON and the resistors RSU, RSV, and RSW will be short-circuited.

(2) Discharging circuit for smoothing capacitor

After power is turned off for circuit inspection, electric charge may remain in the smoothing capacitor. Because it is dangerous, this circuit discharges the remaining charge in the capacitor after power has been turned off.

Refer to Fig. 3.2.1.

When power is turned OFF, the magnet switch MG-D closes and the charges in the capacitor $C_1$ and $C_2$ are discharged through the resistor RD+.

The charges in the capacitor $C_3$ and $C_4$ are discharged through the resistor RD-.

The discharge time constant is:

$$CR = 10 \times 2 \times 10^{-3} \times 200 = 4 \text{ [sec]}$$

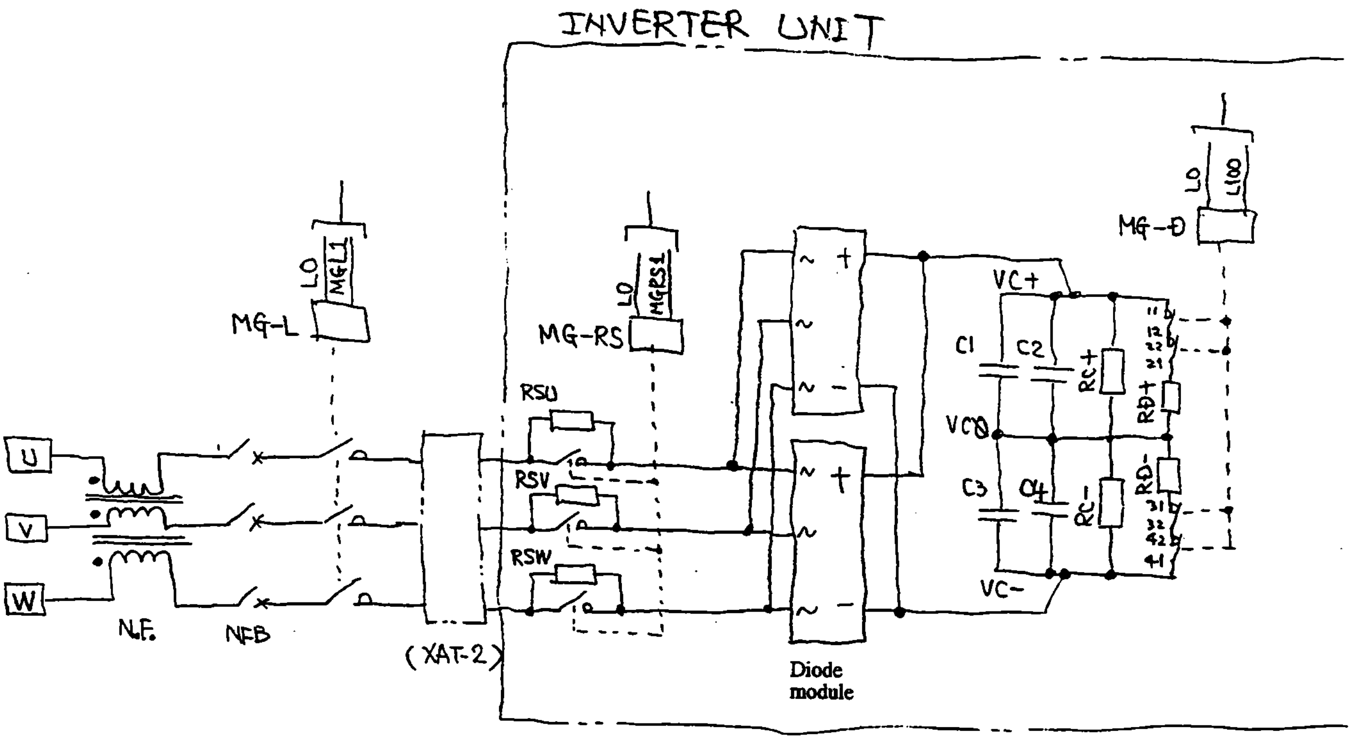



**Fig. 3.2.1**

(3) Charging voltage detection circuit

Refer to Fig. 3.2.2.

This circuit sends voltage signals that correspond to the charging voltages across $C_1$, $C_2$ and $C_3$, $C_4$ to ANALOG-96 board.

The voltage across capacitor $C_1$ and $C_2$ is supplied to terminal VC+ and VC0 on MOTHER-96 board and applied to the terminal 1, 2 of a photo-coupler M4 through resistors $R_{21}$, $R_{22}$, $R_{23}$, and $LD_2$. The output 3 of M4 enters the non-reversal input terminal of an operational amplifier A1. The output of A1 goes to a terminal $VP_1$ through the input terminal 1, 2 of a photo-coupler M10. The output 3 of M10 is fed back to the reversal input terminal 2 of the operational amplifier A1.

The output current from $VP_1$, therefore, is proportional to the input voltage across the terminals VC+ and VC−. The two photo-couplers, M4 and M10, are selected as a pair to compensate their temperature dependent characteristics each other.

The input current to the terminal $VP_1$ on ANALOG-96 board produces a voltage across resistors $VR_{18}$ and $R_{93}$.

The voltage is output to a check terminal $VP_1$ through a operational amplifier A12.

Similarly, a voltage that corresponds to the voltage across capacitors $C_3$, $C_4$ is generated at a check terminal $VP_2$.

At a check terminal VP, a voltage $VP_1 + VP_2$ is produced.

The output voltage from the terminal VP is input to a voltage control circuit for radiographic tube (refer to (4) in section 3. 4). The output voltages from $VP_1$ and $VP_2$ are input to a detection circuit of abnormal operation (refer to (1) in section 3.7).

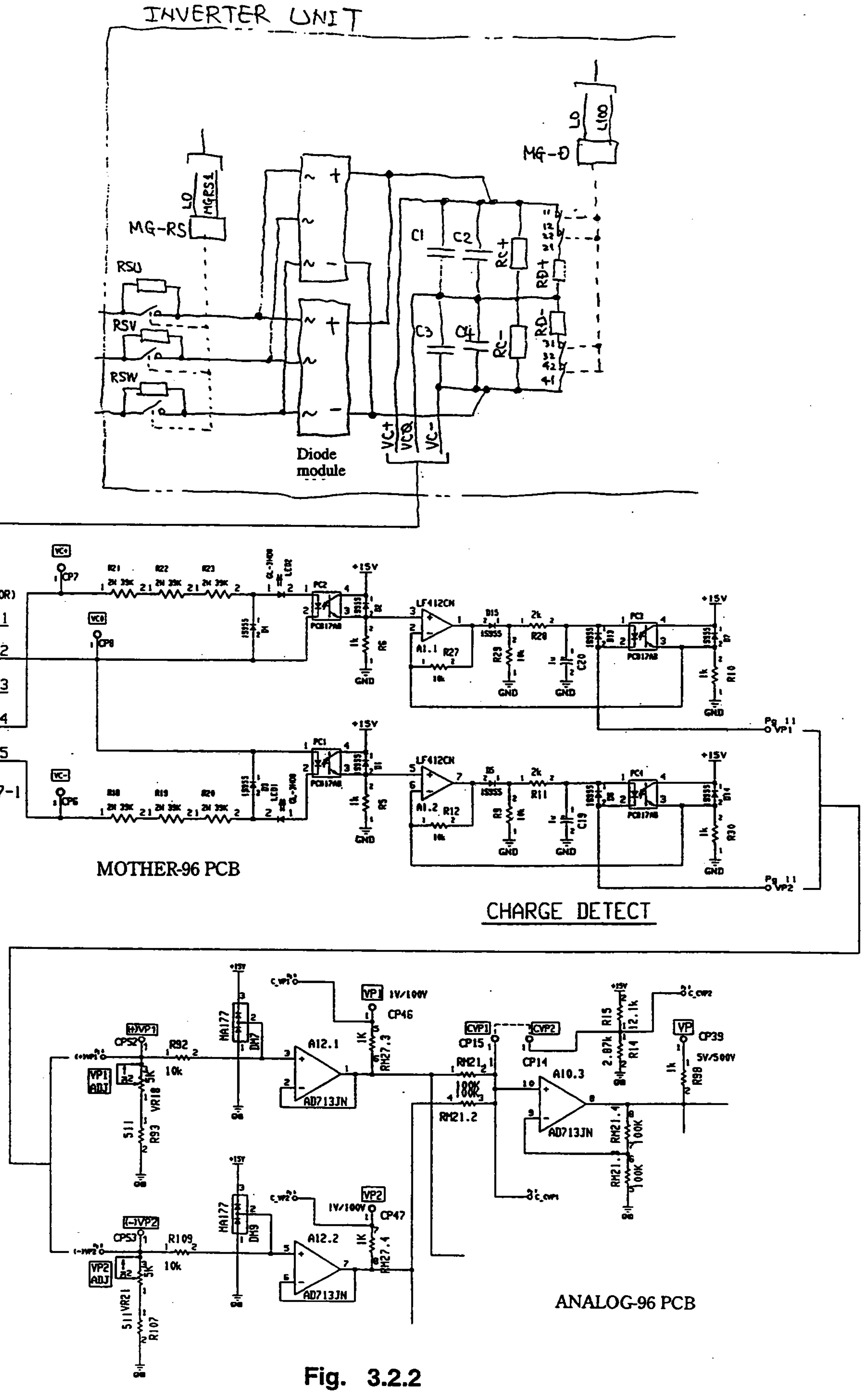

INVERTER UNIT
MG-RS
MG-D
RSU
RSV
RSW
C1
C2
C3
C4
Rc+
Rc-
RD+
RD-
Diode module
VC+
VCO
VC-
J16
(TO CAPACITOR)
VCO 2
VC+ 4
VC- 5
CN, 172037-1
LF412CN
PC817AB
+15V
GND
MOTHER-96 PCB
CHARGE DETECT
AD713JN
HA177
ANALOG-96 PCB

Fig. 3.2.2

## 3.3 Inverter circuit

(1) Oscillation circuit (ANALOG-96 board)

Refer to Fig. 3.3.1.

The oscillation circuit consists of a V/F converter M28 and a one-shot multivibrator M24.

When the radiographic operation is selected, the output signal from a voltage control circuit for radiographic tube (refer to (4) in section 3.4) is input to an input terminal 4 [VIN] of the V/F converter M28. When the fluoroscopic operation is selected, a voltage of about 2.9 V is input to [VIN] (refer to (3) in section 3.4).

The Relation between the input and output of M28 is determined in terms of the capacitor C connected between terminals 6 and 7 and the resistor between terminal 3 and GND by an equation,

$$F\,[Hz] = VIN\,[V] / 10 \times R\,[\,\Omega\,] \times C\,[F].$$

A variable resistor [VF ADJ] is adjusted so that 10V/109 kHz.

The output [F] of M 28 goes to the output terminal 10 of M 22 through M20, M21, and M22. The relation between the outputs of M28 and M22 is shown in Fig. 3.3.2. The table of truth value of M21 is shown in Fig. 3.3.2.

When the radiographic operation is selected, or READY is executed in the fluoroscopic operation, the input terminal of M23 becomes HIGH (except a case that LOW mA is selected and the tube current is lower than 50 mA). The signal from the output terminal 10 of M22 enters the terminal 12 of the one-shot multivibrator M24 through terminals 13 and 11 of M22, terminals 2 and 3 of M23, and terminals 5 and 4 of M13.

When fluoroscopic X-ray operation is executed, or LOW mA is selected, the signal from the output terminal 10 of M22 enters the terminal 12 of the one-shot multivibrator M24 through a voltage control circuit for fluoroscopic tube (refer to (3) in section 3.4), terminals 2 and 3 of M22, and terminals 5 and 4 of M13.

The output pulse width of M24 is adjusted by VR4 [PULSE ADJ].

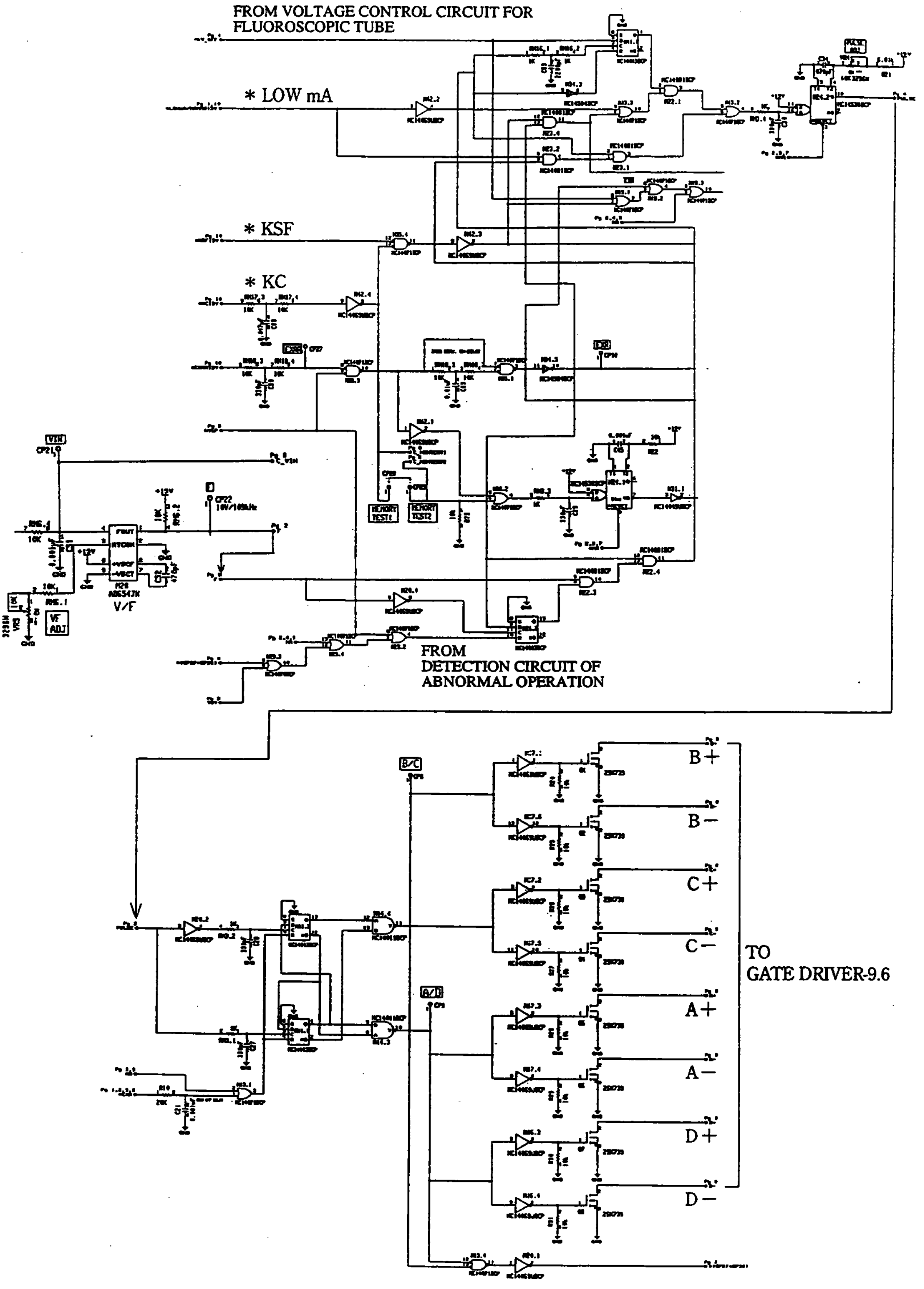
(2) Divider circuit (ANALOG-96 board)

Refer to Fig. 3.3.1.

An output signal from M24 in the oscillation circuit is divided by two pairs of flip-flop of M11 and becomes an inverter drive signal.

The timing chart of the divider circuit is shown in Fig.3.3.4.

Fig. 3.3.3 shows the table of truth value of M11.



FROM VOLTAGE CONTROL CIRCUIT FOR
FLUOROSCOPIC TUBE
* LOW mA
* KSF
* KC
V/F
FROM
DETECTION CIRCUIT OF
ABNORMAL OPERATION
B+
B−
C+
C−
A+
A−
D+
D−
TO
GATE DRIVER-9.6


**Fig. 3.3.1**

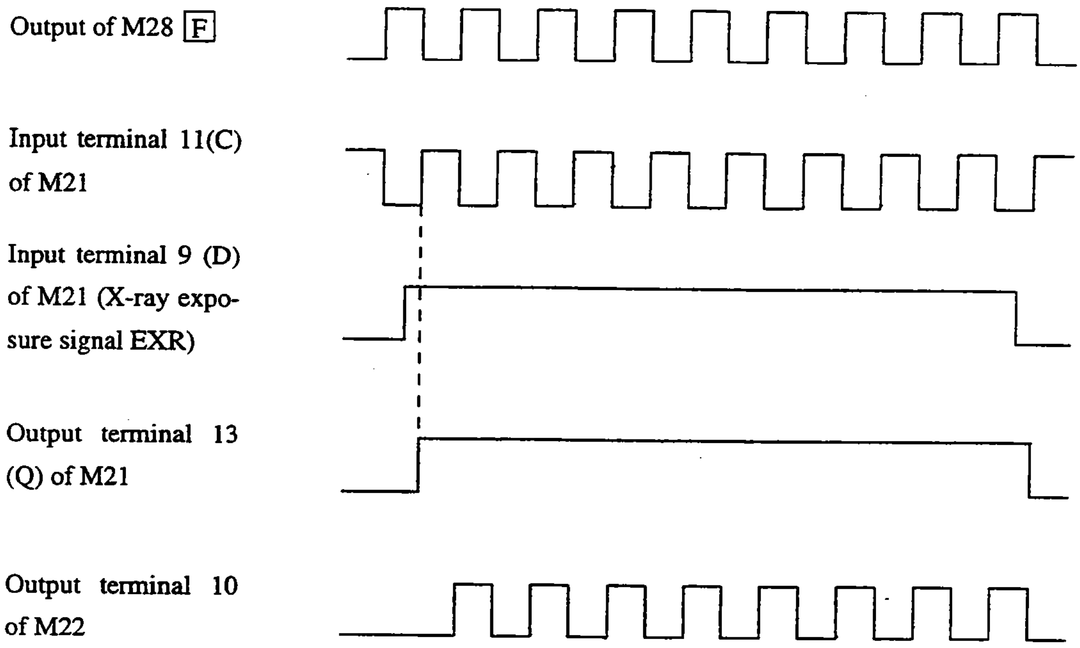



**Fig. 3.3.2**

## TRUTH TABLE

| IN PUTS | | | | OUT PUTS | |
|---|---|---|---|---|---|
| CLOCKt | DATA | RESET | SET | Q | $\overline{Q}$ |
| _/¯ | 0 | 0 | 0 | 0 | 1 |
| _/¯ | 1 | 0 | 0 | 1 | 0 |
| ¯_ | X | 0 | 0 | Q | Q |
| X | X | 1 | 0 | 0 | 1 |
| X | X | 0 | 1 | 1 | 0 |
| X | X | 1 | 1 | 1 | 1 |

NO Change

X = Don'tCare
t = Level Change

MC14013 BP

**Fig. 3.3.3**

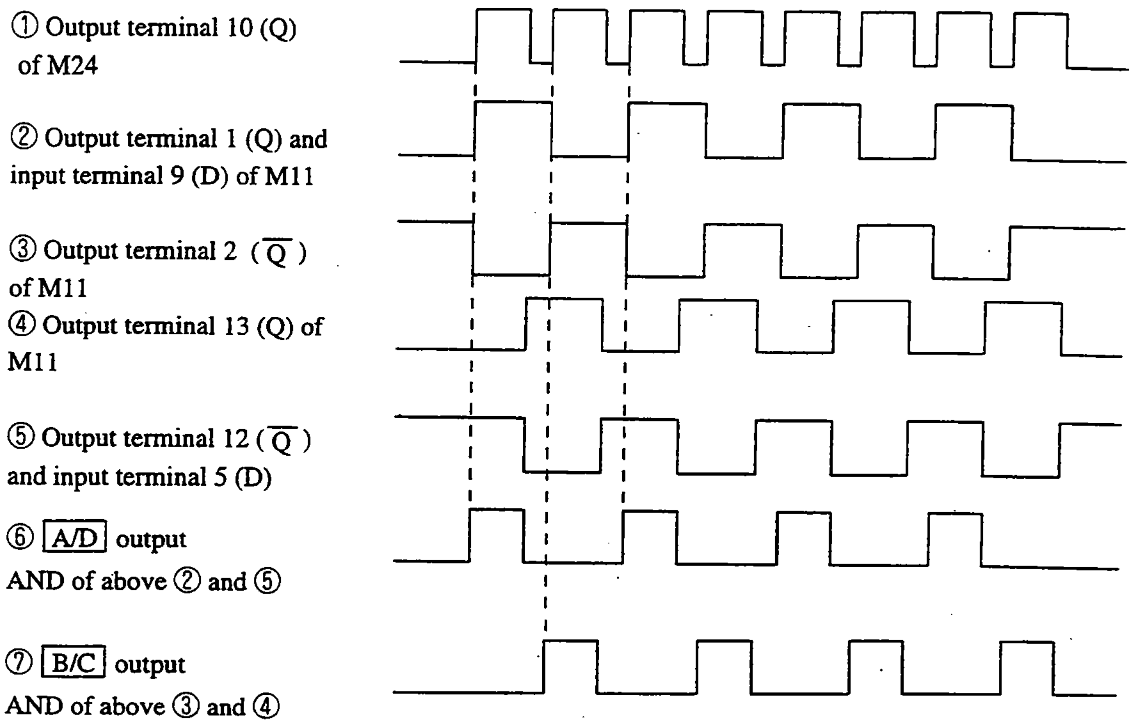



**Fig. 3.3.4**

(3) GATE DRIVER-96 board

Refer to Fig. 3.3.5.

GATE DRIVER-96 board receives the output signal from the divider circuit on ANALOG-96 board and supplies power to an IGBT gate.

In the inverter unit, a GATE DRIVER-96 board is mounted for each of four IGBT's and a circuit shown in Fig. 3.3.5 is included in the board.

GATE DRIVER-96 board uses two pulse transformers. One is used to drive the gate and the other is used to supply a negative bias for IGPT during its OFF period. These actions are described below about IGBT QA as an example.

The output from the oscillation circuit is supplied to A– (pin 1 of J1) and transformed by the transformer T2 and rectified by diodes D5 ~ D9. The rectified voltage is defined to about 8.2 V by a voltage regulating diode D9 and charges a capacitor C1. Because the capacitance of C1 is much larger than the input capacitance of the IGBT, a substantially ripple-free voltage is produced across C1. This voltage supplies the negative bias voltage for the IGBT.

To turn the IGBT on, the circuit works as follows.

When A+ (pin 5 of J1) is brought to LOW, a voltage of 24 V is generated at pin 3 of the pulse transformer T1. This voltage is applied to a path through D2, D1, R1, QA gate, QA emitter, and C1 to pin 4 of the T1. Because C1 is eventually charged to about

8.2 V, the voltage applied to the gate of the IGBT becomes about 15.8 V.

When the IGBT is turned off, the circuit works as follows.

Releasing the A+ (pin 5 of J1) generates a reverse voltage between pin 1 and 2 of the pulse transformer T1 and current flows through a path from pin 2 to pin 1 of T1 through D3 and D4. At the same time a reverse voltage occurs between pin 3 and pin 4 of T1, but this voltage does not cause the IGBT to be turned off – only resets magnetic flux in the core of the transformer –, because D2 blocks the reverse current. The IGBT is turned off when Q1 is switched on and the negative bias is applied to the gate of the IGBT by the voltage across the charged capacitor C1.

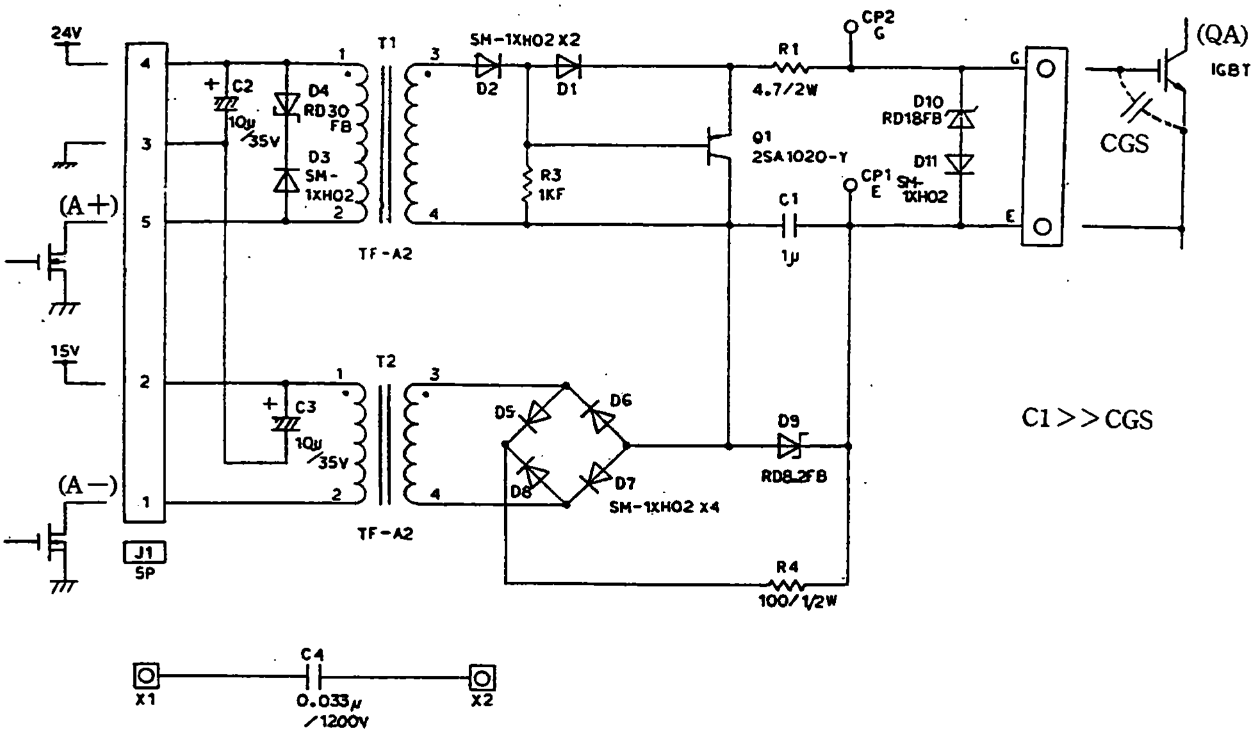



**Fig. 3.3.5**

**Note**

The 24 V to drive the gate is supplied from an independent switching power supply to the pin 4 of J1. So, do not connect the pin to the other 24-V sources.

## 3.4 Tube voltage control circuit (ANALOG-96 board)

(1) Signal input circuit for setting tube voltage

Refer to Fig. 3.4.1.

Switching four signals for setting tube voltage, RKV, FKV, FKVA, PULKV, by signals, $\overline{\text{IBS}}$, $\overline{\text{KSF}}$, $\overline{\text{KC}}$, $\overline{\text{PFLUO}}$, generates PKV signal.

The ratio of the setting signal voltage to actual tube voltage is 5V /100kV. The PKV signal is used in a voltage control circuit for fluoroscoic tube (refer to (3) in section 3.5) and a detection circuit for abnormal operation (refer to (1) in section 3.5).

(2) Input circuit for measured tube voltage signal

Refer to Fig. 3.4.2.

The tube voltage measured by tube voltage detecting resistors in the high voltage generator is supplied to KVFB+ and GND, and KVFB− and GND.

When the measured tube voltage is 100 kV, the voltage at a check terminal [KVFB+] is

$$\frac{100 \times 10^3}{2} \times \frac{6.8 \times 10^3}{50 \times 3 \times 10^6} = \frac{6.8}{3} = 2.26 \text{ [V]}$$

and the voltage at a check terminal [KVFB−] is −2.26 [V].

Variable resistors [KV+ADJ] and [KV−ADJ] are adjusted so that the voltages at check terminals [KV+] and [KV−] are 2.5 [V].

At a check terminal [TKV], a sum of the voltages at [KV+] and [KV−] appears. (5V when the tube voltage is 100 kV.)

Variable resistors [WF ADJ+] or [WF ADJ−] makes the time constant including R95 or R110 equal to the time constant including the tube voltage detecting resistors (50 MΩ × 3), respectively.

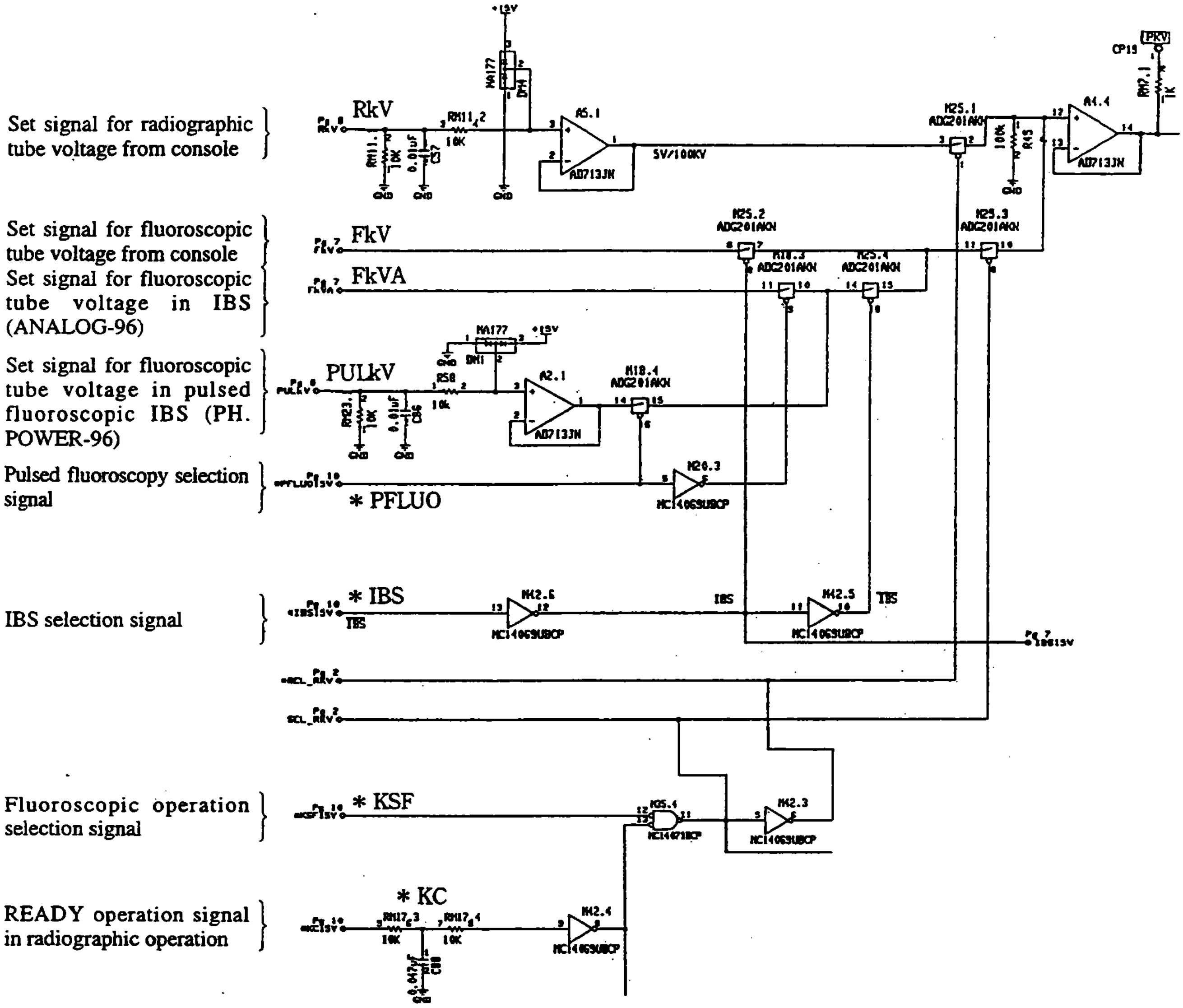



Fig. 3.4.1

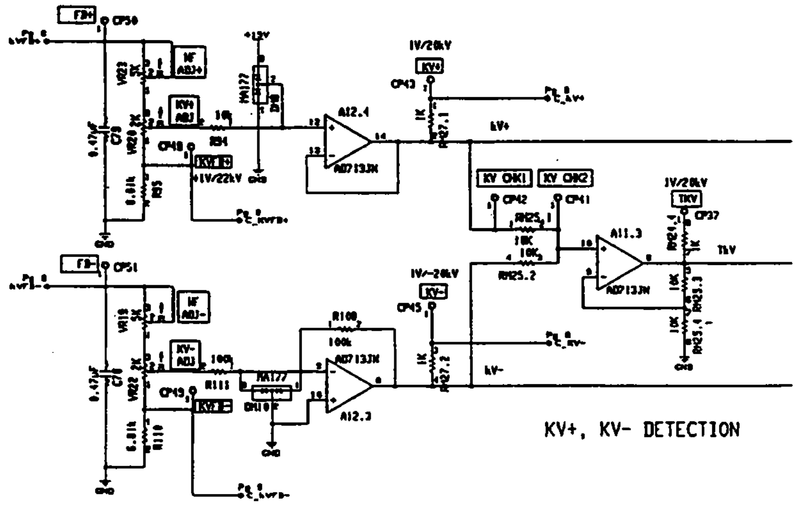



Fig. 3.4.2

(3) Voltage control circuit for fluoroscopic tube (in fluoroscopic and radiographic operation with tube current less than 50 mA)

Refer to Fig. 3.4.3 and Fig. 3.4.4.

Fig. 3.4.3 shows a circuit that supplies a 2.9V signal to the oscillation circuit (refer to (1) in section 3.3) when X-RAY ON is executed in fluoroscopic operation. (Oscillator frequency: 31 kHz, inverter frequency: 15.5 kHz)

When fluoroscopic operation is selected, an analog switch M33 is turned ON between terminal 3 and 2, because an input $\overline{KSF}$ is turned LOW and $\overline{KC}$ is HIGH. The switch between terminal 6 and 7 of M33 is turned ON, because the reset terminal 10 and the output terminal 12 ($\overline{Q}$) of a flip-flop M41 is turned HIGH.

When X-RAY ON is executed, $\overline{EXR}$ is LOW and the switch between terminal 10 and 11 of M33 is ON.

As a result, a voltage 2.9 V at the input terminal of an operational amplifier A4 is supplied to the input terminal VIN of the oscillation circuit (refer to (1) in section 3.3) through terminals 3 and 2, 10 and 11, 6 and 7 of the analog switch M33 and terminals 3 and 1 of an operational amplifier A9. The circuit including a check terminal VINLMT will be described in (1) of section 3.4.

Fig. 3.4.4 shows a circuit in which the inverter is turned ON and OFF (15.1 kHz) so that the measured tube voltage and the set tube voltage are made equal in fluoroscopic operation.

The signal for setting tube voltage PKV from the signal input circuit passes through two stages in the operational amplifier A4 and becomes a signal FKVREF.

The voltage at each portion is:

- Check terminal PKV : 5V/100KV
- Output terminal 1 of operational amplifier A4 : $(PKV-3) \times (0.5 \sim 2.0)$ [V]
- Output voltage from variable resistor F60KV ADJ1 : $(1.4 \sim 4.3)$ [V]
- Check terminal FKVREF : $-\{(PKV-3) \times (0.5 \sim 2.0) + (1.4 \sim 4.3)\}$ [V]

As shown in Fig. 3.4.4, a comparator M30 compares the FKVREF signal with the measured tube voltage TKV.

When FKVREF > TKV, a check terminal $\overline{KV\ OFF}$ (DATA input terminal 5 of flip-flop M41) becomes HIGH.

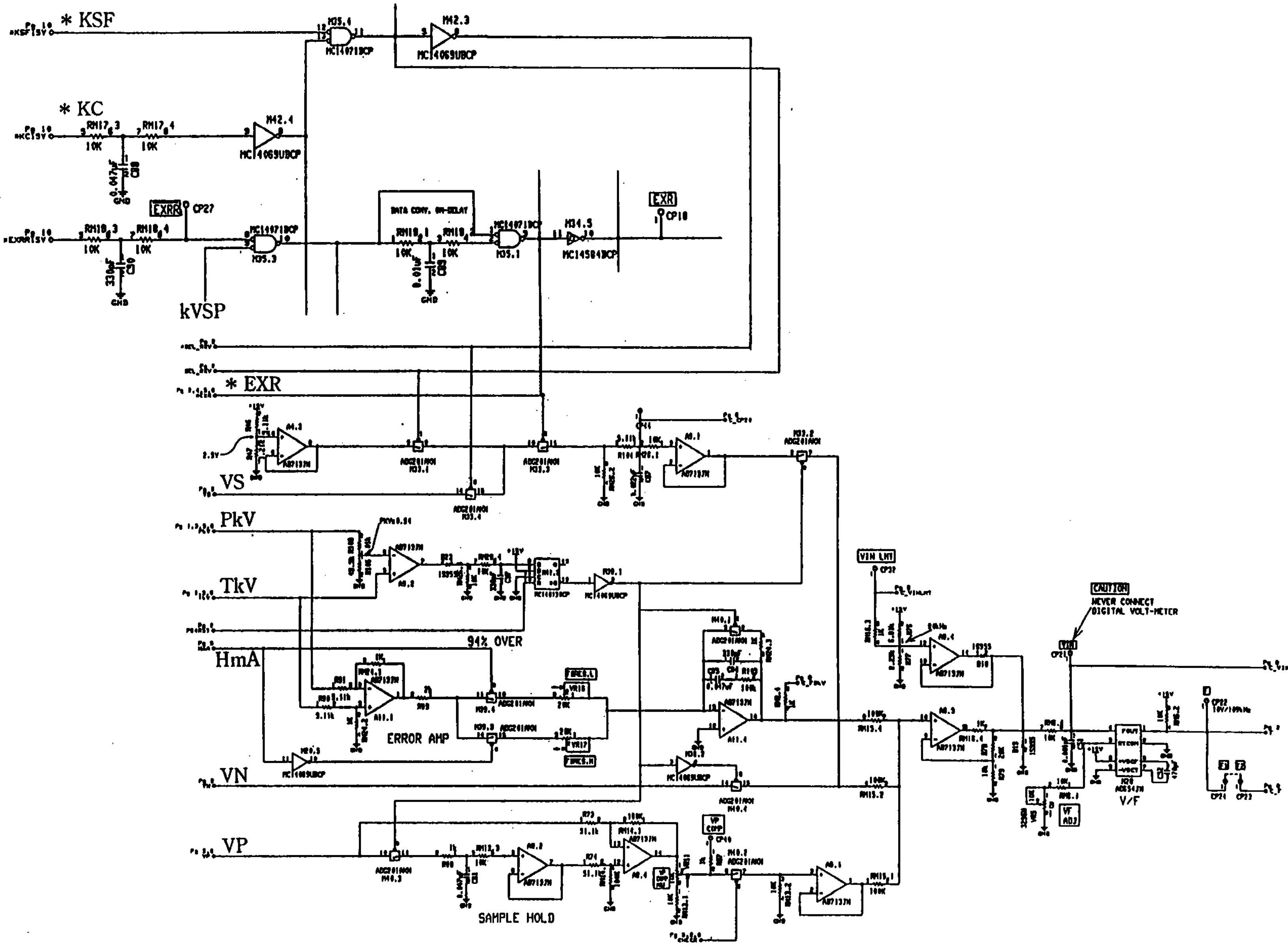
When FKVREF < TKV, the terminal becomes LOW.

During KV OFF is HIGH, the signal at the output terminal 10 of M22 in the oscillation circuit (refer to (1) in section 3.3) enters the input terminal 2 of M22 through terminals 3 and 1 of the flip-flop M41.

When X-RAY ON is executed in fluoroscopic operation, HIGH signal at terminal 1 of M22 goes through terminal 3 of M22 and terminals 5 and 4 of M13 to M24 and causes the inverter to oscillate. (Refer to (1) in section 3.3, "oscillation circuit", for further explanation.)

When KV OFF is LOW, the signal from the oscillation circuit is blocked at M41 and the inverter stops to oscillate. With above circuit operations, the tube voltage in fluoroscopic operation ( TKV ) is controlled to be equal to the set tube voltage PKV .

Variable resistors F60KV ADJ1 and F GAIN ADJ1 adjust FKVREF signal so that it becomes a little lower than PKV signal for any tube voltage (refer to Fig. 3.4.5). This can correct the cutoff delay of the inverter, thus making it possible to derive a correct tube voltage. (Note: when the tube current is less than 50 mA in radiographic operation, variable resistors F60KV ADJ2 and F GAIN ADJ2 adjust FKVREF.)



* KSF
* KC
EXRR
CP27
kVSP
DATA CONV. ON-DELAY
EXR
CP18
* EXR
VS
PkV
TkV
94% OVER
HmA
ERROR AMP
VN
VP
SAMPLE HOLD
VIN LMT
CAUTION
NEVER CONNECT
DIGITAL VOLT-METER
V/F
PRIMARY CHARGE VOLTAGE
RIPPLE COMPENSATION


Fig. 3.4.3

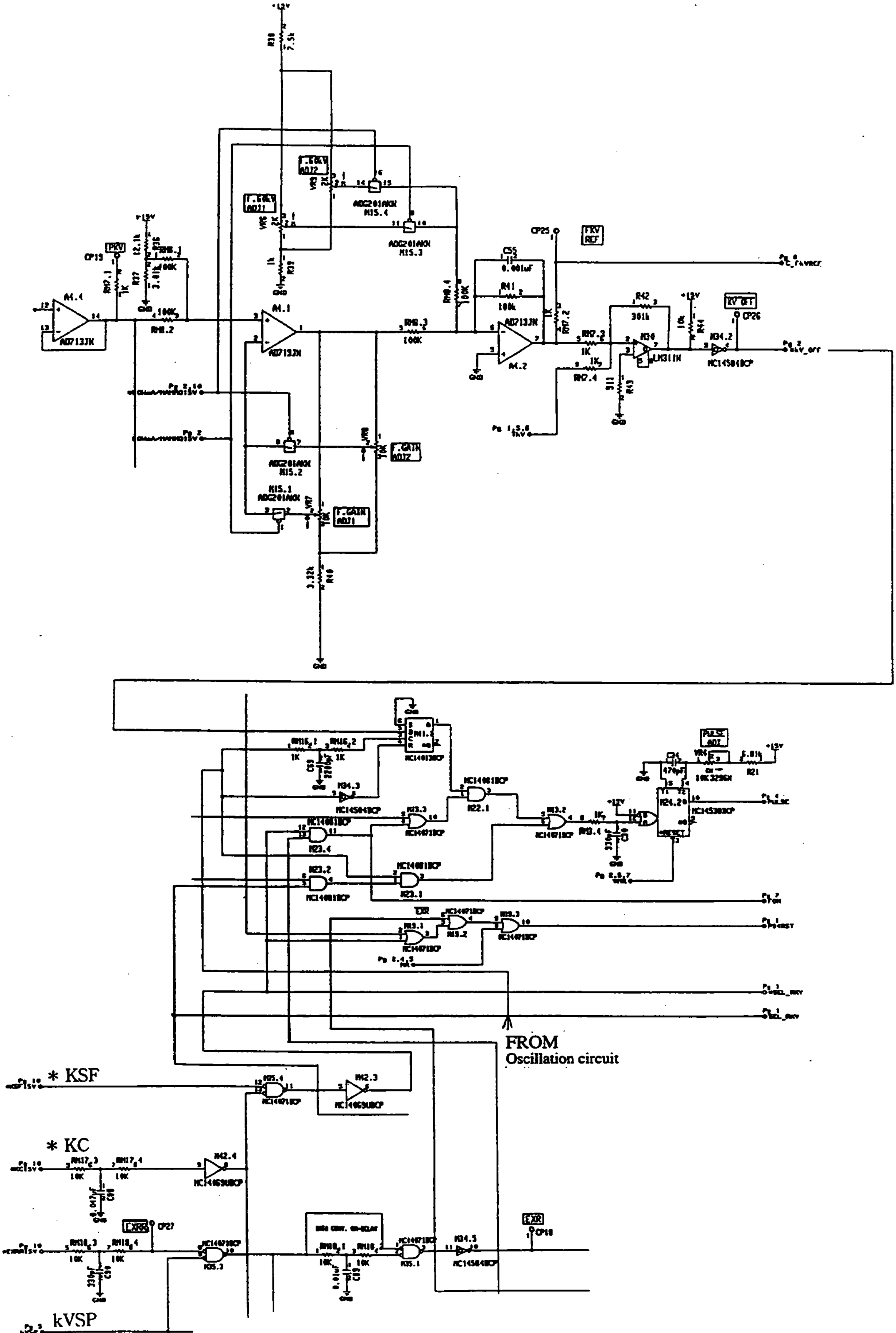



Fig. 3.4.4

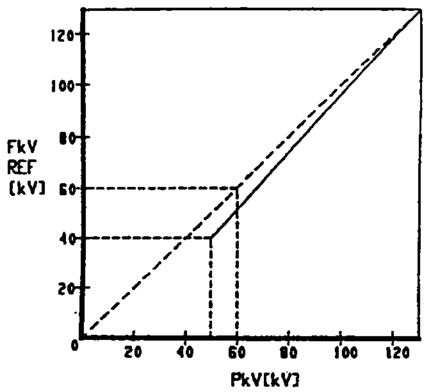



**Fig. 3.4.5**

(4) Voltage control circuit for radiographic tube

When X-RAY ON is executed in radiographic operation, the inverter oscillates at a memorized frequency in accordance with radiographic tube voltage, current, and power supply voltage. When a measured tube voltage approaches a set tube voltage, the frequency is switched to another memorized value (a value a little lower than at start time and close to a final stable value) and then feedback-controlled so that the measured voltage becomes equal to the set voltage.

(a) PKV, RMA, and VP input circuit

Refer to Fig. 3.4.6.

The relation between input and output of an analog multiplier AD633 is given by

$$W = \frac{(X_1 - X_2) \times (Y_1 - Y_1)}{10} + Z = \frac{(X_1) \times (Y_1)}{10} \text{ [V]}$$

where $X_2 = Y_2 = Z = 0$ [V].

Applying this relation to the circuit including M45 and terminals 5, 6, 7 of A11 gives

$W = PKV/2$, $X_1 = VP$, $Y_1 =$ (terminal 7 of A11)

$$\text{(Terminal 7 of A11)} = \frac{10W}{X_1} = \frac{5 \times (PKV)}{Vp} \text{ [V]}$$

The voltage at terminal 7 of A11 is amplified by the circuit of terminals 10, 9, 8 of A8 and output to a check pin [PRKV].

A variable resistor [PRKV ADJ] is adjusted so that the voltage at [PRKV] becomes 5.56 [V] when supply voltage is 400 V (Vp = 5.66 [V]) and set tube voltage is 100 kV (PKV = 5 [V]). (The relation is given by 180 kV / 10 V.)

Similarly, a voltage is generated at terminal 7 of A1 as,

$$(\text{Terminal 7 of A1}) = \frac{5 \times (\text{RMA})}{\text{Vp}} \ [\text{V}]$$

The voltage at terminal 7 of A1 is amplified by the circuit of terminals 1, 2, 3 of A1 and output to a check pin PRMA .

A variable resistor PRMA ADJ is adjusted so that the voltage at PRMA becomes 3.33 [V] when supply voltage is 400 V (Vp = 5.66 [V]) and set tube current is 400 mA (RMA = 2 [V]). (The relation is given by 1200 mA / 10 V.)

(b) Frequency memory circuit

Refer to Fig. 3.4.7.

The analog output PRKV in prior section (a) enters A/D converter M2 and PRMA enters M1.

When X-RAY is executed, $\overline{\text{EXRR}}$ signal becomes LOW, the output terminal $\overline{\text{Q}}$ (7) of one-shot multivibrator M24 becomes LOW for 10μ sec, and CONV terminal (12) of M2 and M1 becomes HIGH. Hence, A/D conversions are practiced, outputting 7-bit (128) digital signal from M2 and 9-bit (512) signal from M1.

This 16-bit digital signal enters P-ROM and address terminals of M3 and M4.

Six bits (64) of 16-bit data in M3 and M4 enter D/A converter M9 and an analog voltage corresponding to the digital input is derived at a check terminal VS .

VR2 adjusts the voltage at VS so as to be 10V at maximum.

Ten bits (1024) of 16-bit data in M3 and M4 enter D/A converter M8 and an analog voltage corresponding to the digital input is derived at a check terminal VN .

VR1 adjusts the voltage at VN so as to be 10 V at maximum.

When checking the memory contents without generating X-ray, short-circuit check terminals MEMORY TEST1 and MEMORY TEST2 . Then READY operation generates voltages at VS and VN .

(c) Oscillation frequency control circuit

Refer to Fig. 3.4.3.

When the radiographic operation is selected, an input $\overline{\text{KSF}}$ becomes HIGH. When READY operation is executed, an input $\overline{\text{KC}}$ becomes LOW (in fluoroscopic operation, too). In these cases, the terminal 16 of analog switch M33 becomes LOW and the switch between terminal 14 and 15 is turned ON.

Next, when X-RAY is executed, the switch between terminal 10 and 11 of M33 is turned ON. During the time TKV < 0.94PKV, the set terminal 8 of flip-flop M41 is LOW. Then, the output terminal 12 of $\overline{\text{Q}}$ is HIGH and the analog switch between terminal 6 and 7 of M33 is ON.

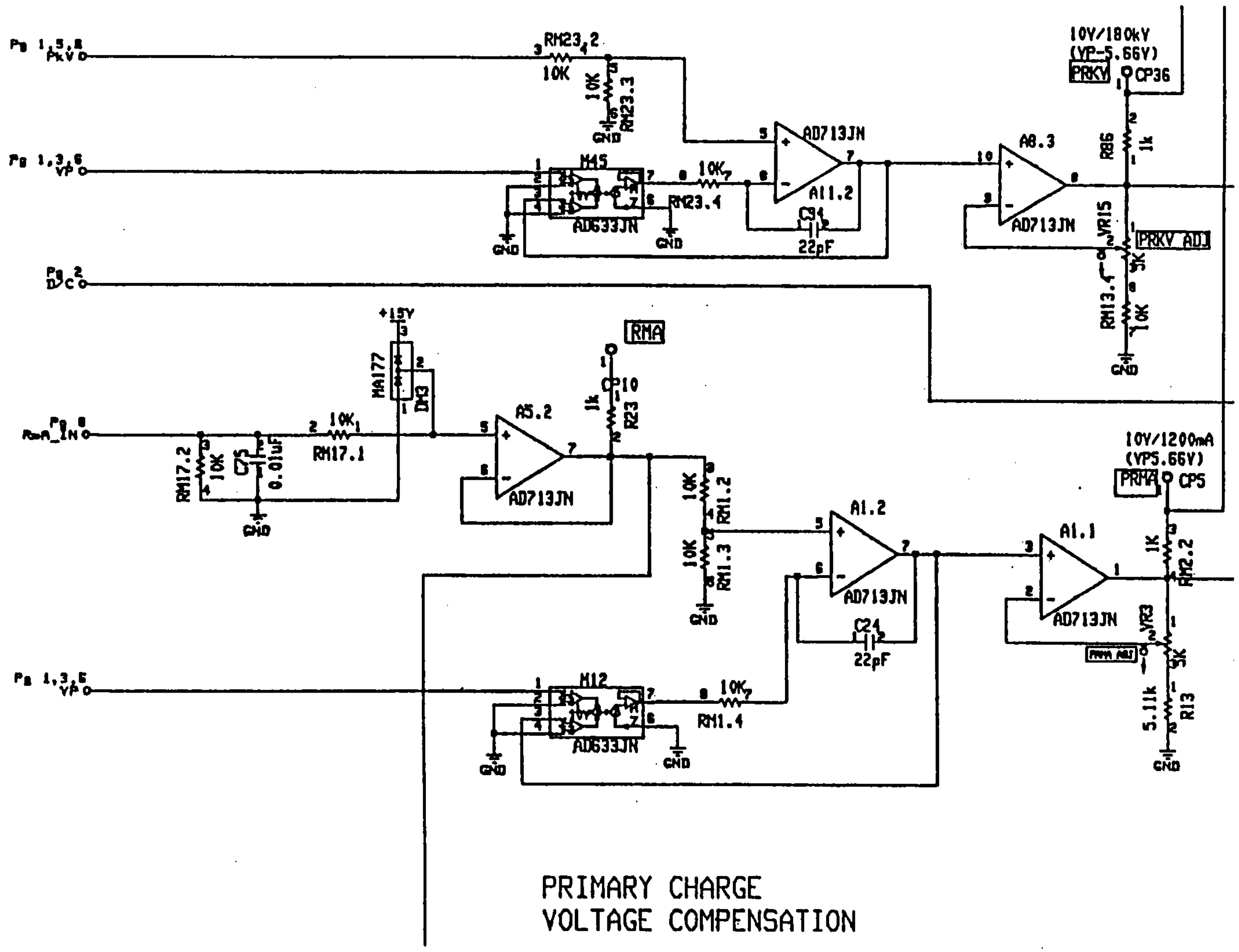
As a result, the output VS of the frequency memory circuit (refer to (4) (b) in section 3.4) enters the input terminal VIN of the oscillation circuit (refer to (1) in section 3.3) through terminals 14, 15 and 10, 11 of the analog switch M33, terminals 3, 1 of the operational amplifier A9, terminals 6, 7 of the analog switch M33, and terminals 10, 8 of the operational amplifier A9.

Then, the inverter starts to work and when a condition (TKV > 0.94PKV) is reached, the set terminal 8 of flip-flop M41 becomes HIGH, and the output terminal $\overline{Q}$ becomes LOW. Hence, the analog switch between terminal 6 and 7 of M33 is turned OFF, the switch between terminal 14 and 15 of M40 becomes ON, and the input signal to the oscillation circuit is switched from VS to VN.

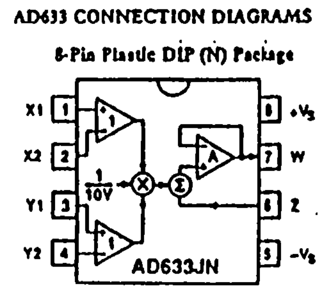
At the same time the analog switch between terminal 2 and 3 of M40 is turned OFF. Then, a correction voltage generated by the voltage difference between PKV and TKV is output from the output terminal 14 of the operational amplifier A11 to VN, and the voltage at VN controls so that the voltages at PKV and TKV are made equal. Also, at the same time by the turn-OFF of the analog switch between terminal 10 and 11 of M40, a correction voltage corresponding to the ripple voltage of the DC power supply is output at the output terminal 14 of the operational amplifier and supplied to VN.

Yet, when CHECK signal (refer to (1) "Abnormal operation detecting circuit" in section 3.5) is HIGH, these correction voltages are not output, because the analog switch between terminal 6 and 7 is turned OFF.

The circuit including terminals 12, 13, and 14 of the operational amplifier A9 limits the voltage output to the oscillation circuit to 8.25 [V] at maximum. (Oscillator frequency: 90 kHz, inverter frequency: 45 kHz)

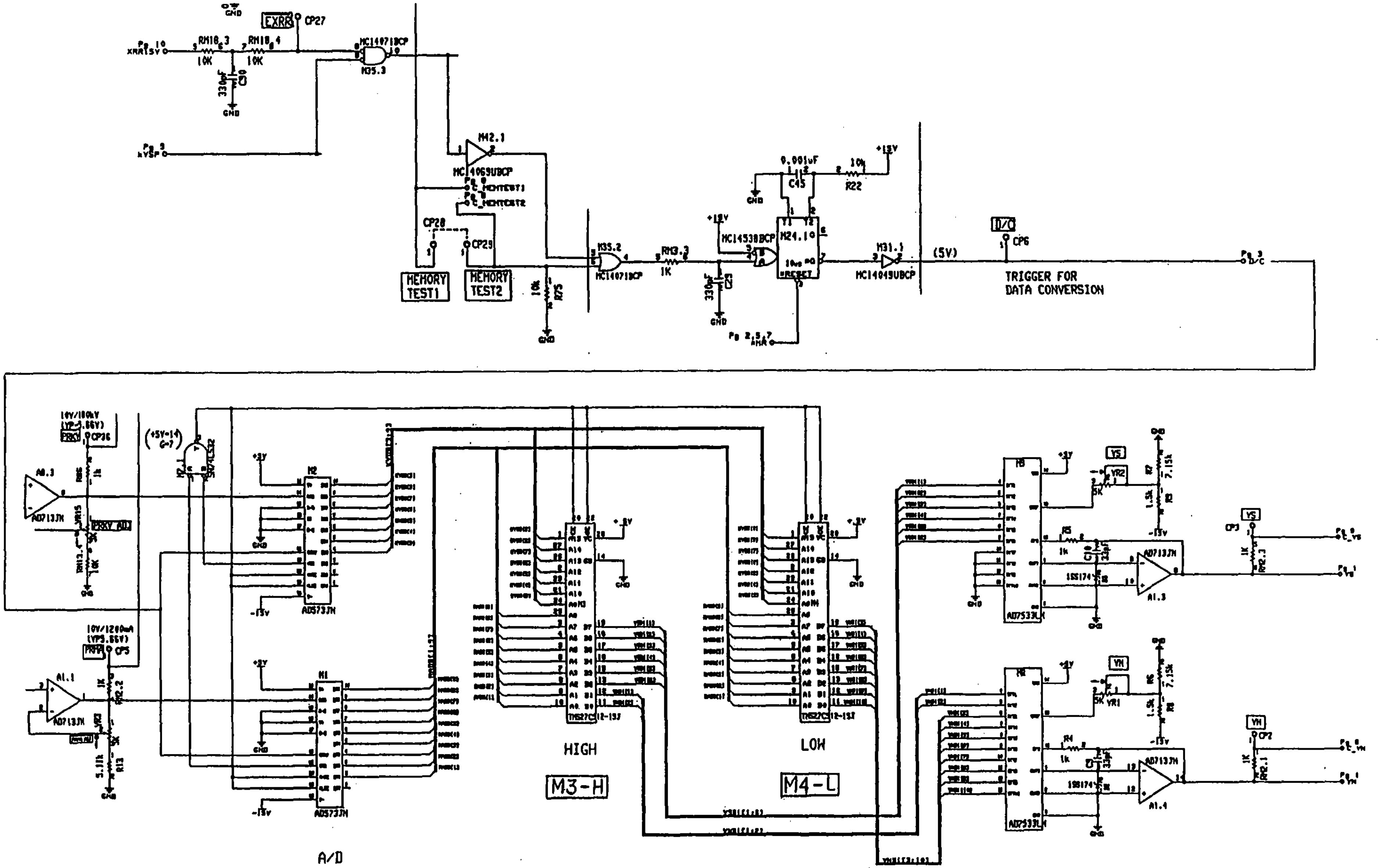



PRIMARY CHARGE
VOLTAGE COMPENSATION




$$W = \frac{(X_1 - X_2)(Y_1 - Y_2)}{10V} + Z$$

**Fig. 3.4.6**




MEMORY TABLE OF VS AND VN

D/A

**Fig. 3.4.7**

(5) Tube voltage measurement circuit

Refer to Fig. 3.4.8.

This circuit supplies set tube voltage and measured tube voltage to other units.

Generally, at check terminal TKV OUT, measured tube voltage signal TKV (refer to (2) in section 3.4) is output after it has been current-buffered. However, in CHECK mode set tube voltage signal PKV is output.

At check terminal PKV OUT set tube voltage signal is always output after having been current-buffered.

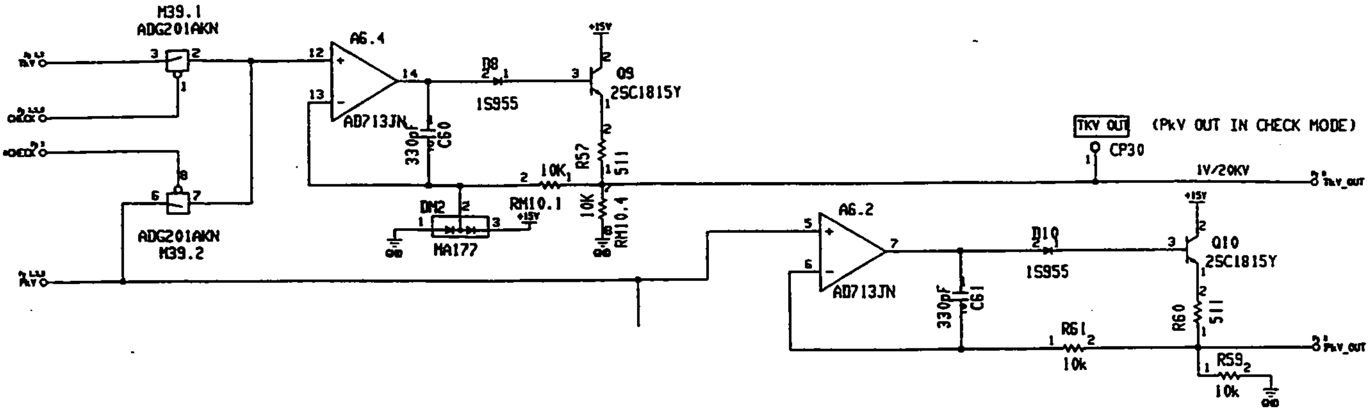



Fig. 3.4.8

## 3.5 KVT circuit

Refer to Fig. 3.5.1.

Operation time, radiographic and fluoroscopic, is defined as the time tube voltage is higher than a specified value (about 75% of peak value). A startup confirmation signal of a measured tube voltage, KVT, is generated when the voltage reaches about 75% of its peak value.

This signal is sent to EMC-96PCB and used as a start signal for a operation timer.

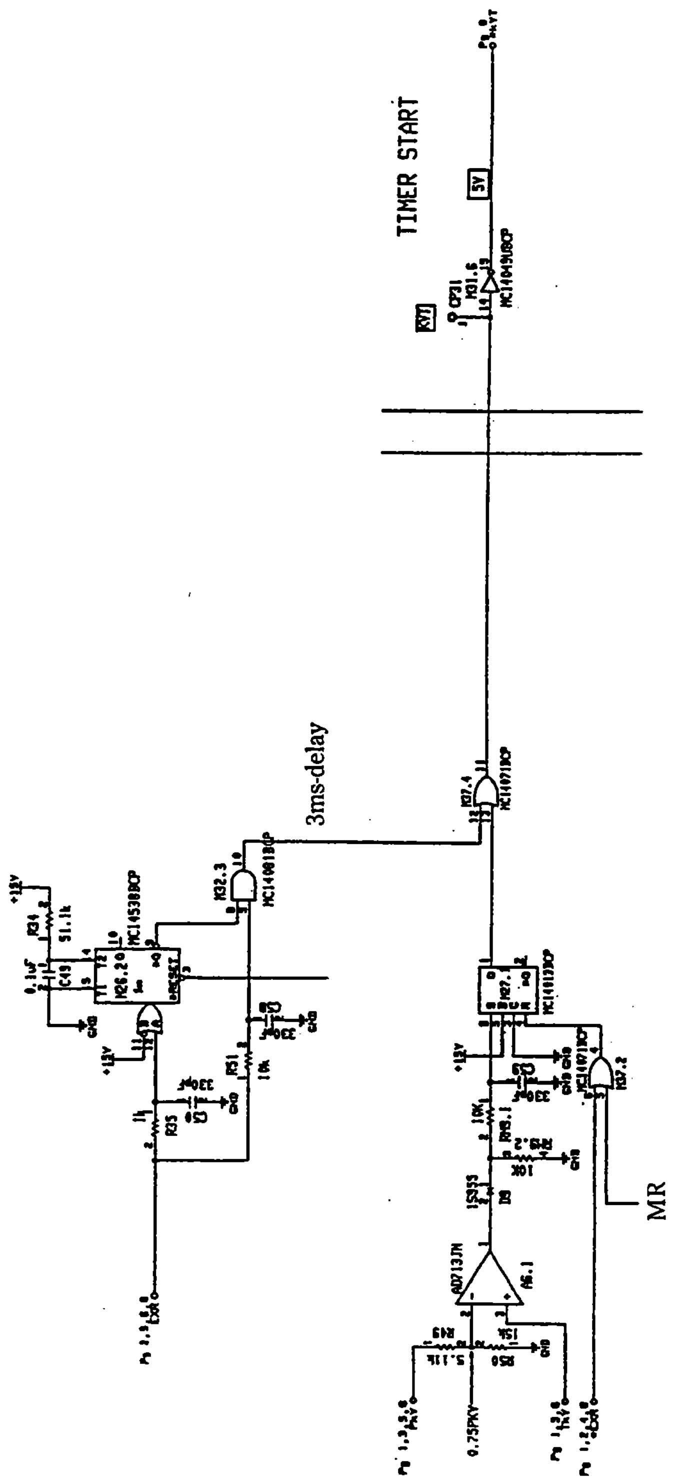



Fig. 3.5.1

### 3.6 IBS control section

(1) Outline

IBS (automatic fluoroscopic brightness controller) holds a fluoroscopic brightness constant by varying the fluoroscopic tube voltage in relation to the luminance signal from a monitor television.

(2) IBS circuit

When "IBS" is selected and fluoroscopic operation starts, a signal proportional to the luminance signal of the television camera enters terminals TV7 and TV2. This signal voltage enters pin 10 of A5 and IBS reference voltage, about 6 V, enters pin 9 of A5. (This voltage is determined because IBS reference value of television is about 6 V.) The two signals are amplified by A5 and the difference signal is integrated by A3. [IBS RES] VR11 adjusts the response of kV by varying the integral time constant. The voltage at CP7 "FKVA" varies so that the voltages at pin 9 and 10 of A5 have no difference, thus holding the brightness of the television screen. VR12 [FKV MAX. ADJ] is adjusted so that a fluoroscopic tube voltage in IBS does not exceed the maximum fluoroscopic tube voltage of the X-ray tube.

When IBS is used, a microcomputer stores the last value of the fluoroscopic tube voltage in previous operation and assigns the value for the startup voltage in the next operation.

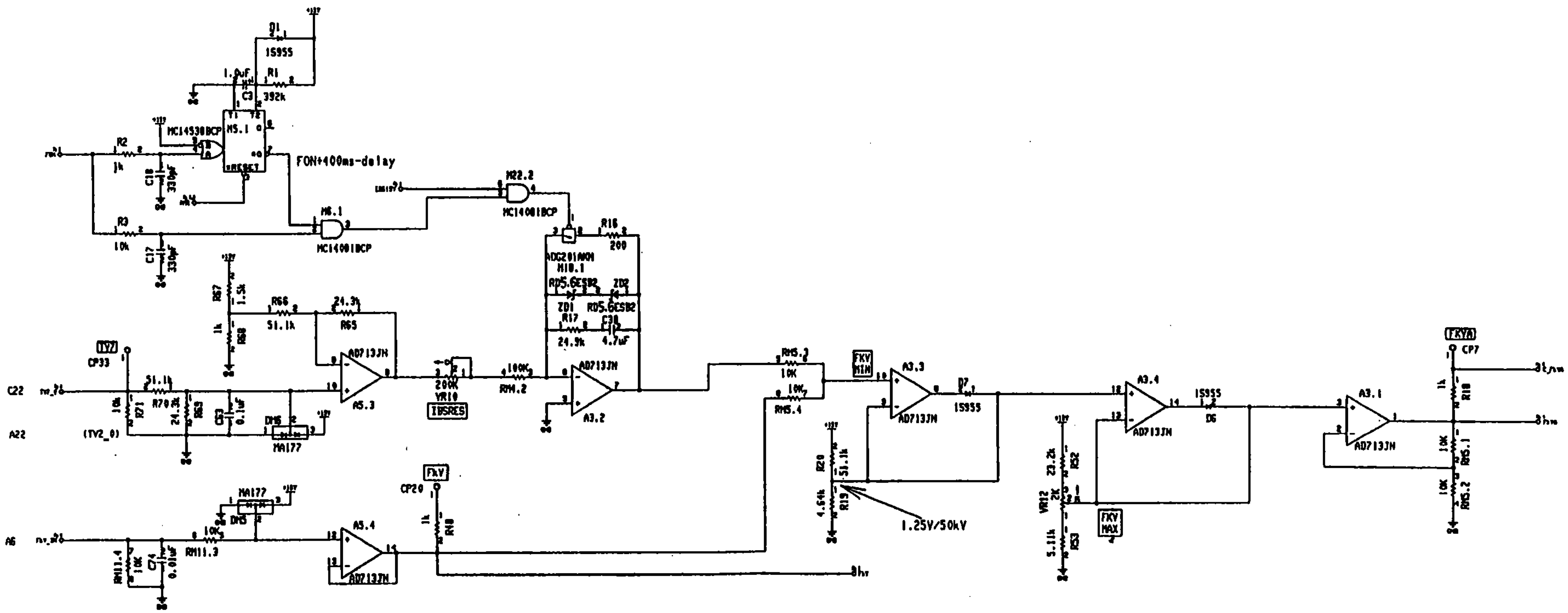

FON+400ms-delay
MC14538BCP
MC14081BCP
ADG201AKN
AD713JN
1S955
IBSRES
FKV
MIN
FKV
MAX
FKYA
1.25V/50kV
MA177
C22
A22
A6

Fig. 3.6.1

(3) Pulsed fluoroscopy IBS

IBS in pulsed fluoroscopy is controlled in PH CONT-96 (refer to section 12). As a result, a set tube voltage enters as a PUL kV.

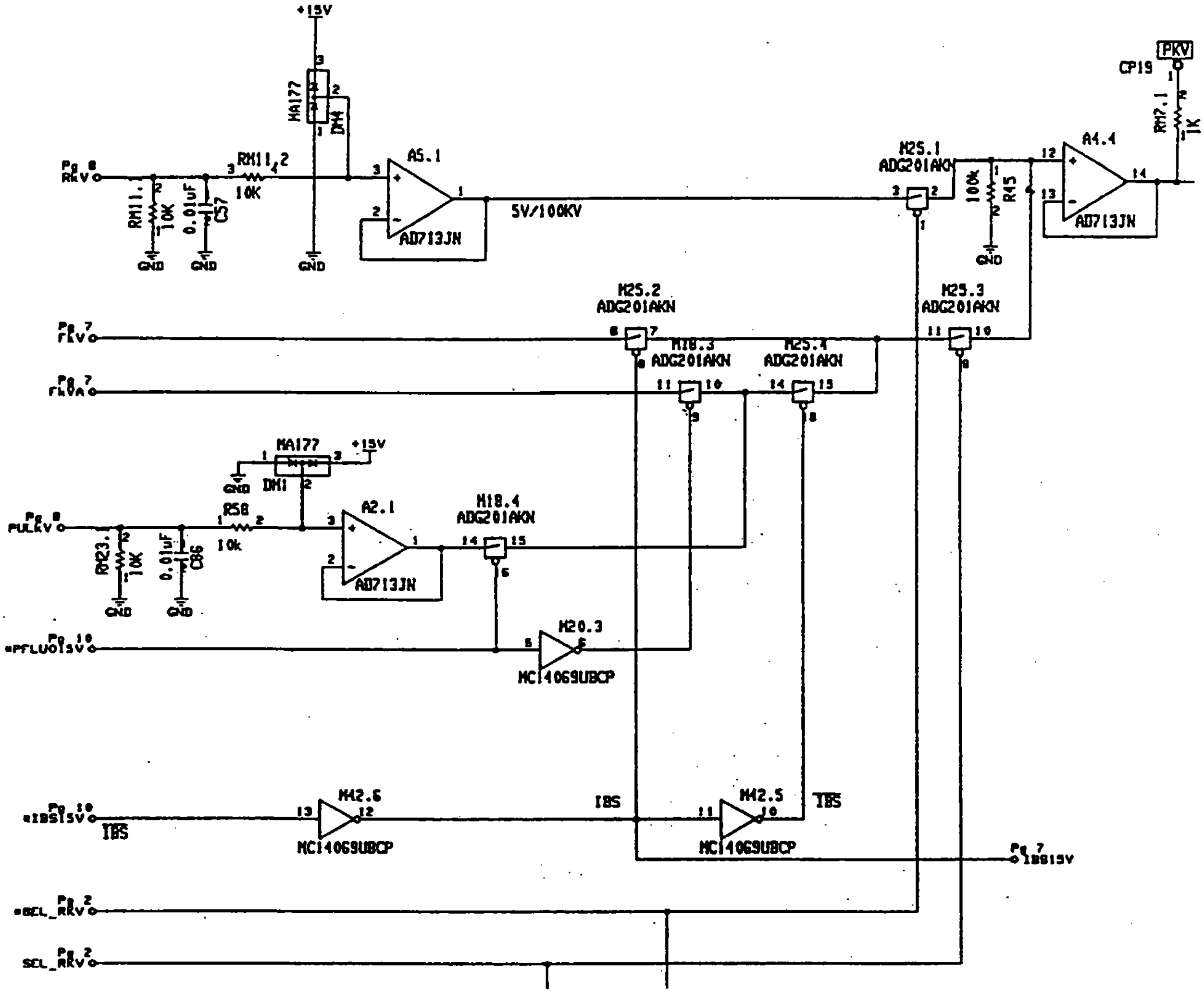



Fig. 3.6.2

## 3.7 Others

(1) Detection circuit for abnormal operation

(a) FAULT signal

This circuit detects abnormal operations of the main circuit and outputs them to the console as FAULT signals.

Refer to Table 3.7.1.

**Table 3.7.1**

| FAULT signal | Abnormal operation signal | Significance |
|---|---|---|
| TKV BR | TKV OVER | Measured tube voltage KV+, KV– > 90KV |
| | TKV UNDER | Measured tube voltage 67% UNDER |
| PKV OVER | PKV OVER | Set tube voltage signal, when PKV exceeds 157 kV. |
| CHG BR | CHG OVER | Charging voltage for main circuit capacitor is more than 395V. |

(b) TKV OVER

Refer to Fig. 3.7.1.

When a measured tube voltage KV+ or KV– is more than 90 kV, the output terminal 1.14 of operational amplifier A7 becomes HIGH, the set terminal 8 of flip-flop M36 becomes HIGH, and LED [TOV] is turned on. Then, FAULT signal is output to the console. At the same time, the reset terminal 10 of flip-flop M21 in the oscillation circuit (refer to (1) in section 3.3) becomes HIGH and the inverter stops oscillating.

(c) TKV UNDER

Refer to Fig. 3.7.1.

When a measured tube voltage is less than 67% of the set tube voltage, the output terminal 8 of operational amplifier A6 becomes HIGH, the set terminal 6 of flip-flop M36 becomes HIGH, and LED [TUN] is turned on. When the operation is not in check mode (check terminals [CHK1] and [CHK2] are not short-circuited), FAULT signal, TKVBR, is output to the console. The circuit including a diode D11 clamps TKV so that it does not become less than 2.5 V, in order to prevent circuit malfunctions. (When the set tube voltage is less than 75 kV, TKV UNDER does not work.)

Whereas this abnormal operation detection works only during X-ray exposure period, it does not work during the startup delay time of TKV signal. The period the detection is stopped is defined as 5 msec by a one-shot muotivibrator M26.

(d) PKV OVER

Refer to Fig. 3.7.3.

When the set tube voltage signal PKV exceeds 7.85 V (157 kV), the terminal 7 of operational amplifier A10 becomes HIGH and LED [PKO] is turned on. Then, FAULT signal, PKV OVR, is output to the console.

(e) CHG OVER

Refer to Fig. 3.7.3.

Output voltages from the charging voltage detection circuit (refer to (3) in section 3.2) appear at check terminals [$VP_1$] and [$VP_2$] . The relation between these signals and the capacitor charging voltage is given by 1 V / 100 V.

When the voltage at [$VP_1$] or [$VP_1$] is more than 3.95 V (capacitor charging voltage: 395V), the output terminal 1 or 14 of operational amplifier A10 becomes HIGH and LED [CHO] is turned on. Then, FAULT signal, CHG BR, is output to the console.

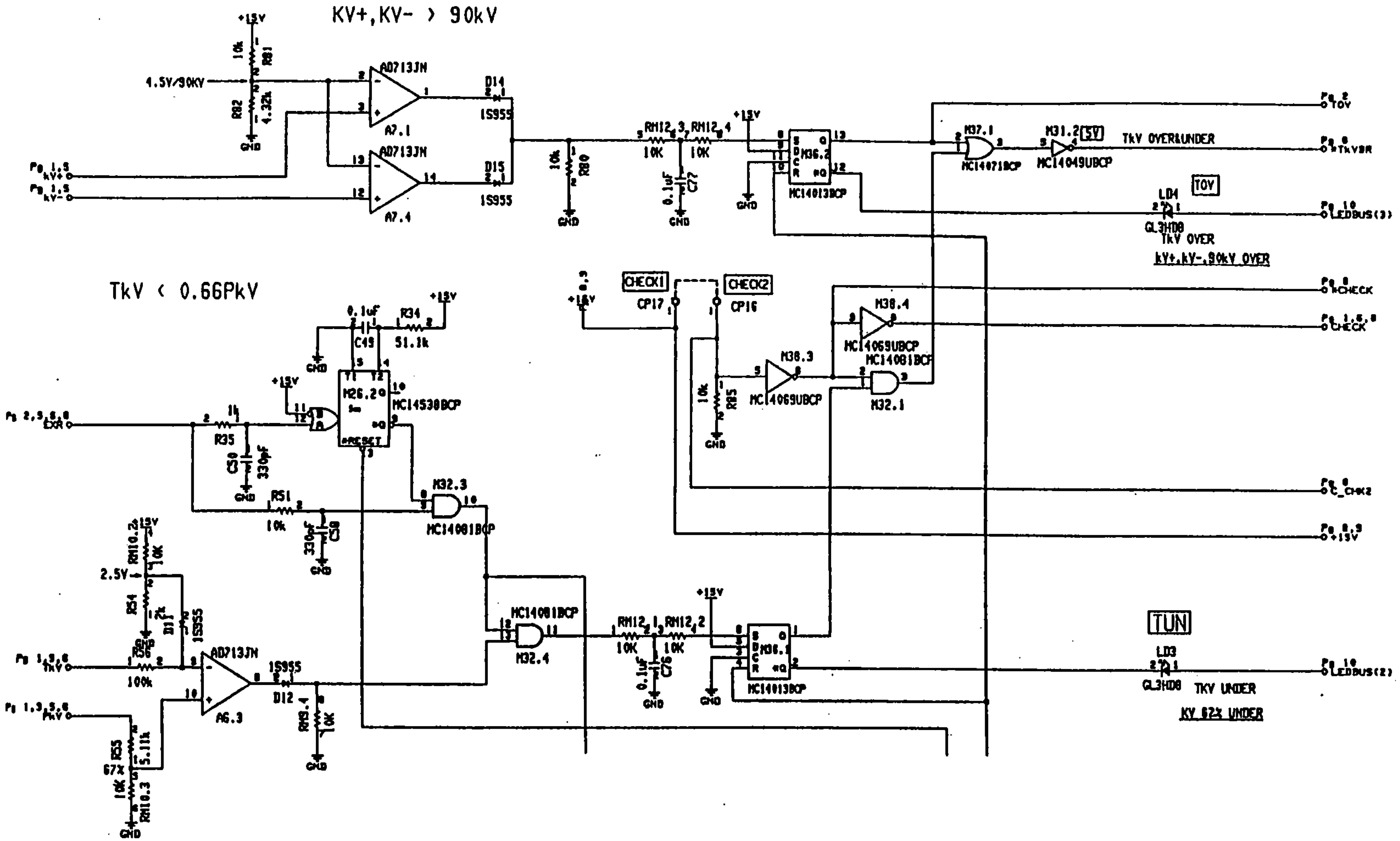
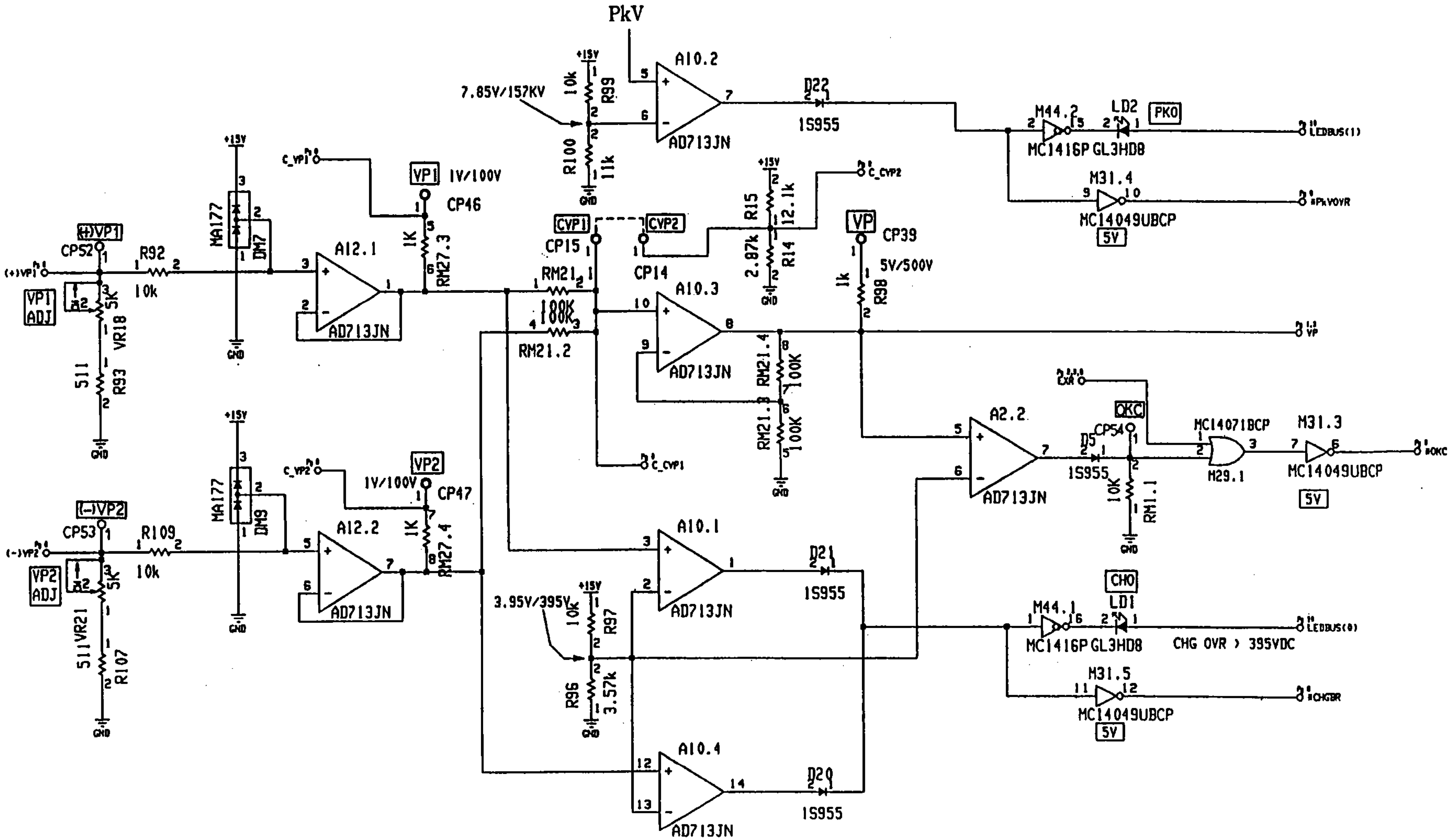

KV+,KV- > 90kV
+15V
4.5V/90KV
R81
R82
AD713JN
A7.1
A7.4
D14
D15
1S955
R80
RM12
10K
0.1uF
C77
GND
M36.2
MC14013BCP
M37.1
MC14071BCP
M31.2
5V
MC14049UBCP
TkV OVER&UNDER
TOV
LD4
GL3HD8
TkV OVER
kV+,kV-,90kV OVER
TkV < 0.66PkV
CHECK1
CHECK2
CP17
CP16
M38.4
MC14069UBCP
MC14081BCP
M38.3
M32.1
R85
0.1uF
R34
51.1k
C49
M26.2
MC14538BCP
R35
C50
330pF
R51
10k
C58
M32.3
2.5V
R54
D11
1S955
R56
100k
R55
67%
5.11k
A6.3
D12
1S955
M32.4
M36.1
C76
TUN
LD3
GL3HD8
TKV UNDER
KV 67% UNDER
TOV
LEDBUS(3)
CHECK
C_CHK2
+15V
LEDBUS(2)

Fig. 3.7.1



PkV
A10.2
7.85V/157KV
R99
10k
R100
11k
AD713JN
D22
1S955
M44.2
LD2
PKO
MC1416P
GL3HD8
M31.4
MC14049UBCP
5V
VP1
1V/100V
CP46
(+)VP1
CP52
R92
10k
VP1 ADJ
VR18
5K
R93
511
MA177
DM7
A12.1
AD713JN
1K
RM27.3
CVP1
CVP2
CP15
CP14
RM21.1
100K
RM21.2
A10.3
AD713JN
R15
12.1k
2.87k
R14
C_CVP2
VP
CP39
5V/500V
R98
1k
RM21.4
RM21.3
100K
C_CVP1
A2.2
AD713JN
QKC
CP54
D5
1S955
10K
RM1.1
MC14071BCP
M29.1
M31.3
MC14049UBCP
5V
VP2
1V/100V
CP47
(-)VP2
CP53
R109
10k
VP2 ADJ
VR21
5K
511
R107
MA177
DM9
A12.2
AD713JN
1K
RM27.4
A10.1
AD713JN
D21
1S955
3.95V/395V
R97
10K
R96
3.57k
CHO
M44.1
LD1
MC1416P
GL3HD8
CHG OVR > 395VDC
M31.5
MC14049UBCP
5V
A10.4
AD713JN
D20
1S955


Fig. 3.7.2

(f) Discharge detection circuit

Refer to Fig. 3.7.3.

While X-ray tube cannot avoid micro discharge, the current flowing through IGBT may exceed the rating if the discharge continues. The discharge detection circuit detects the discharge in terms of a sharp change of tube voltage KV+ or KV– and stops X-ray exposure for 15 msec. After 15 msec it restarts the exposure.

The measured voltage KV+ and KV– enters a differentiating circuit and the rate of change is monitored. When the tube voltage decreases rapidly and the output of the differential circuit exceeds -0.75 V, the terminal 7 and 8 of A7 become HIGH. The one-shot multivibrator M26 is triggered by the rising edge of the HIGH transition and outputs a pulse of 15-msec length (KVSP signal). The exposure is stopped for 15 msec by the pulse signal.

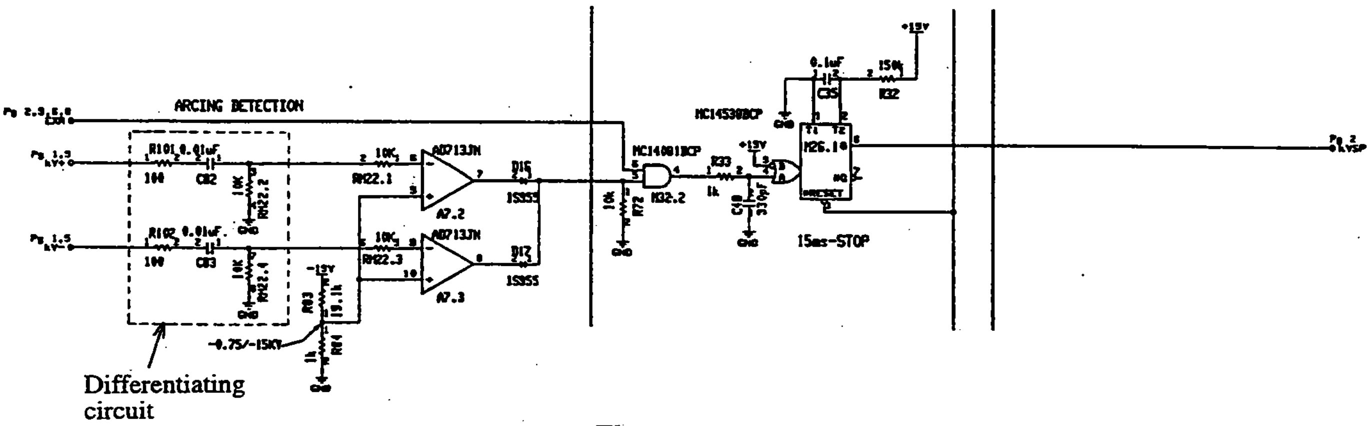



**Fig. 3.7.3**

(2) Reset circuit

Refer to Fig. 3.7.4.

At power-ON of the generator, a signal MR becomes HIGH and $\overline{MR}$ becomes LOW for about 1 msec. With these signals all flip-fops and one-shot multivibrators come to reset.

When FAULT signals occur, a reset signal FRST from the console can reset flip-flops of the abnormal operation detecting circuit.

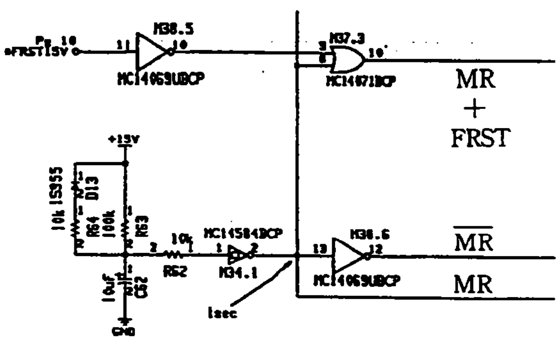



**Fig. 3.7.4**

(3) Signal table of ANALOG-96 board

| Signal | Content | Remark |
|---|---|---|
| RKV | Set signal for radiographic tube voltage | 7.5V/150KV |
| CHECK | CHECK mode | |
| FKV | Set signal for fluoroscopic tube voltage (not in IBS) | 7.5V/150KV |
| LOW mA/MAMMO | Control of voltages by comparator in low tube current (MAMMO) | |
| FKVA | Set signal for fluoroscopic tube voltage in IBS | 7.5V/150KV |
| IBS | Automatic fluoroscopic brightness control | |
| PULKV | Set signal for fluoroscopic tube voltage in pulse fluoroscopic IBS | |
| PFLUO | Pulse fluoroscopic operation | |
| KSF | Fluoroscopic operation | |
| KC | Ready signal | |
| EXRR | X-ray exposure command | INPUT |
| EXR | X-ray exposure command | OUTPUT |
| KVFB+ | Tube voltage feedback signal (anode) | |
| KVFB– | Tube voltage feedback signal (cathode) | |
| RMA | | 5V/1000mA |
| A+, A– | IGBT, ON signal (QA) | |
| B+, B– | IGBT, ON signal (QB) | |
| C+, C– | IGBT, ON signal (QC) | |
| D+, D– | IGBT, ON signal (QD) | |
| VP1 | Electrolytic capacitor charging voltage signal at positive side | |
| VP2 | Electrolytic capacitor charging voltage signal at negative side | |
| FRST | FAULT circuit reset | |
| TKV OUT | Measured tube voltage signal (set tube voltage signal in CHECK mode) | 7.5V/150KV |
| PKV OUT | Set tube voltage signal | 7.5V/150KV |
| TKVBR | TKV OVER or TKV UNDER signal | |
| KVT | Operation timer start signal | |
| PKVOVR | PKV has exceeded 7.85 V (157 kV). | |
| CHGBR | Electrolytic capacitor charging voltage has exceeded 395 V. | |
| TV7 | Television luminance signal in IBS | Standard: 6V |

# 4. Filament heating circuit

## 4.1 Introduction

This device is provided with control circuits with following features in order to control X-ray current with precision and good reproducibility.

1) Constant-current control in primary circuit
2) Filament heating by inverter method (20 kHz)
3) Preheating current proportional to filament current in use
4) Feedback control of tube current during X-ray exposure
5) Flashing circuit in relation to using filament current (only for X-ray tube with less than 5 A)

| Operation method | Focus | Ratio of flash current | Trimmer No. | Remark |
|---|---|---|---|---|
| Operation without fluoroscopy | Small focus | About 20% | None | Target startup time within 1.2 sec |
| | Large focus | About 34% | | |
| Operation with fluoroscopy | Small focus | 0 ~ About 66% | FLS VR 1 | Target startup time of 0.8 sec |
| | Large focus | 0 ~ About 20% | FLL VR 2 | |

## 4.2 Outline

(1) Configuration

Filament current of X-ray tube is controlled in mA POWER-96 board.

(2) Specifications

(a) Power supply AC 135 V

DC ± 15 V (DC stabilized power supply)

(b) Rating

**Usable maximum power**

| | Current | Voltage |
|---|---|---|
| Secondary circuit | 5.2 A | 20 V (MAX) |

(c) Insulation transformer

Transformer for insulating low-voltage filament circuit from high-voltage side

Winding ratio: 5.5 : 1

(3) Outline of filament heating circuit

Fig. 4.2.1 shows a block diagram of this circuit.

(a) Power circuit

AC power supply (single phase, 135VAC) is rectified by diode D7 and smoothed by capacitor C17. The derived DC power is converted to AC power of 20 kHz by an inverter consisting of FET Q2 ~ Q5.

The output from the inverter is input to a focus switching relay circuit, switched either for large focus or small focus by a focus switching control circuit, and output to X-ray filament through a filament transformer.

A resonance capacitor C12 is added to the inverter output in series, making a resonance type inverter.

(b) Control circuit

The tube currents of radiographic tube and fluoroscopic tube are feedback-controlled so that they become equal to their set value.

The tube current measured by the mA DETECTOR board is input to an error signal amplifier 1 and subtracted from the output from the tube current set circuit (RmA/FmA). The error signal amplifier 1 controls its output voltage so that the error becomes sufficiently small. That is , when (measured value) < (set value), the amplifier output a positive signal, and when (measured value) > (set value) , it outputs a negative value.

The output from the error amplifier 1 is added to the value stored in a filament current set circuit (microcomputer) and corrects the set value. The output of the adder is input to another error amplifier 2 as a new set value of filament current and compared with the output from a filament current measuring circuit. The error amplifier 2 feedback-controls with a PWM control circuit so that the two values become equal to each other.

According to the process described above, the tube current is feedback-controlled so that it becomes equal to the set value.

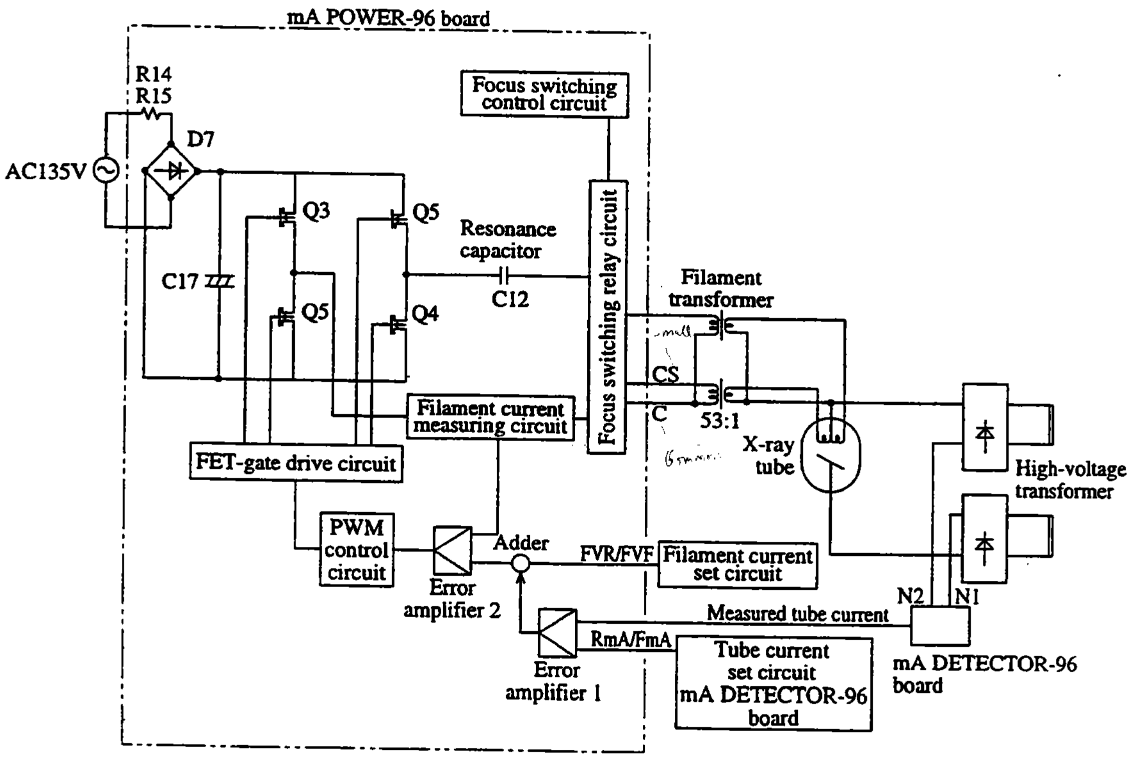



Fig. 4.2.1

## 4.3 Power circuit

(1) Rectifying and smoothing circuit

Refer to Fig. 4.3.1.

When power of the generator is turned ON, AC 135 V power comes in. A diode bridge D7 rectifies the input power with resistors R14 and R15 and a capacitor smoothes it.

Because it is not stabilized, this output voltage varies with a variation of the input power.

(2) Inverter circuit

Refer to Fig. 4.3.1.

(a) Full-bridge type inverter

Four MOS-FET's (Q2 ~ Q5) make a full-bridge type inverter. By Q2 / Q5 and Q3 / Q4 being alternatively and repeatedly turned on, AC output of 20 kHz is generated.

(b) Gate drive circuit

A drive method with pulse transformer is used.

When a drive signal turns on a small signal transistor 2SC3733, a voltage is applied to the pulse transformer. Then, a voltage is induced on the secondary winding of the transformer and supplied to a gate of MOS-FET through a 47.5 Ω resistor. When the voltage at the gate exceeds a threshold, the MOS-FET is turned on.

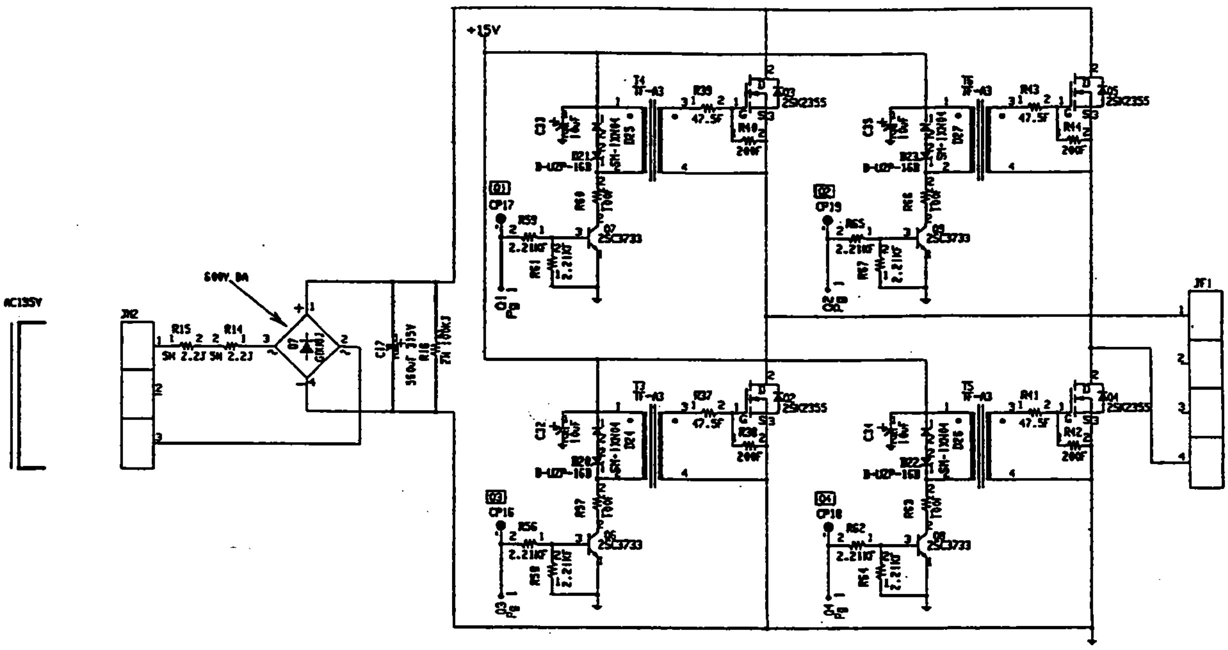



**Fig. 4.3.1**

(3) Focus switching circuit

(a) When the operation does not include fluoroscopy,

Refer to Fig. 4.3.2.

When small focus is selected, an input $\overline{FOSM}$ becomes LOW, terminal 2 of M5 becomes HIGH, and a relay K2 is turned on. Then, the output voltage of the inverter circuit is supplied to a filament transformer for small focus through terminals C0 and CL.

When large focus is selected, an input $\overline{FOSM}$ becomes HIGH, terminal 2 of M5 becomes LOW, and a relay K2 is turned off. Then, the output voltage of the inverter circuit is supplied to a filament transformer for large focus through terminals C0 and CL.

When the operation does not include fluoroscopy, relays K1 and K3 are always OFF.

(b) When the operation includes fluoroscopy (fluoroscopy is operated with small focus),

Refer to Fig. 4.3.3.

When fluoroscopy is operated with small focus, S2-1 FLUO LARGE is turned OFF. When the operation including fluoroscopy is selected, input $\overline{FL}$ becomes LOW and terminal 4 of M5 HIGH. Then, terminals 1 and 2 of M13 become HIGH and terminal 6 of M13 HIGH. Relays K1, K2, and K3 are ON until READY operation is executed, because input $\overline{KC}$ is HIGH and terminal 4 of M13 HIGH.

Then, the output voltage of inverter circuit is supplied in series to transformers for large and small focus through terminals CL and CS and also supplied between terminals CL and C0 through resistor R1 (300Ω, 40 W ).

According to the process described above, a little smaller filament current flows for large focus than for small focus. R1 is adjusted so that a filament current is derived which does not cause X-ray to be generated for large focus in fluoroscopic operation. By preheating the filament for large focus in an extent that X-ray is not generated, the rise time of the filament temperature is shortened in a high-speed radiography.

Next, when READY operation is executed, the signal $\overline{KC}$ becomes LOW, terminal 4 of M13 HIGH, and relays K1, K2, and K3 OFF. Then, the output voltage of the inverter circuit is supplied to the filament transformer for large focus through terminals C0 and CL. When small focus is selected for radiography, the input $\overline{FOSM}$ is LOW and the relay K2 is turned ON. Then, the output voltage of the inverter circuit is supplied to the filament transformer for small focus through the terminals C0 and CL.

(c) When the operation includes fluoroscopy (both fluoroscopy and radiography are operated with large focus),

Refer to Fig. 4.3.3.

In this case S2-1 FLUO LARGE is turned on. Then, terminal 3 of M13 is LOW. Accordingly, terminal 4 of M13 is always LOW whether the signal $\overline{KC}$ is LOW or HIGH.

When radiography is also operated with large focus, terminal 2 of M5 is LOW because the signal $\overline{FOSM}$ is HIGH.

According to the process described above, the relays K1, K2, and K3 are always HIGH and the output voltage of the inverter circuit is supplied to the filament transformer for large focus through the terminals C0 and CL.

When large focus is changed to small focus in radiographic operation, it is changed to small focus in fluoroscopic operation, too. That is, it is not possible to use large focus in fluoroscopy and small focus in radiography simultaneously.

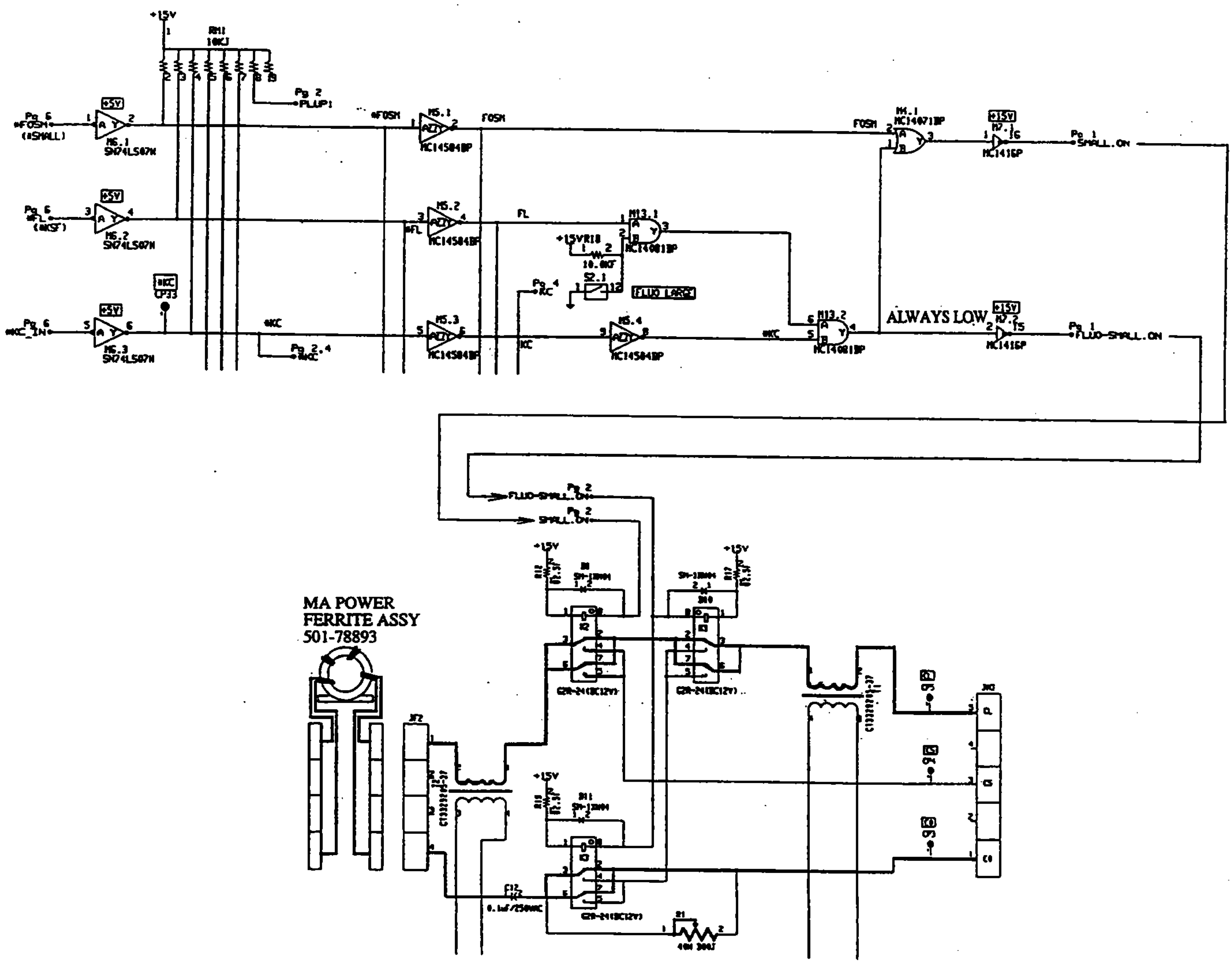



**Fig. 4.3.2 Operation that does not include fluoroscopy**

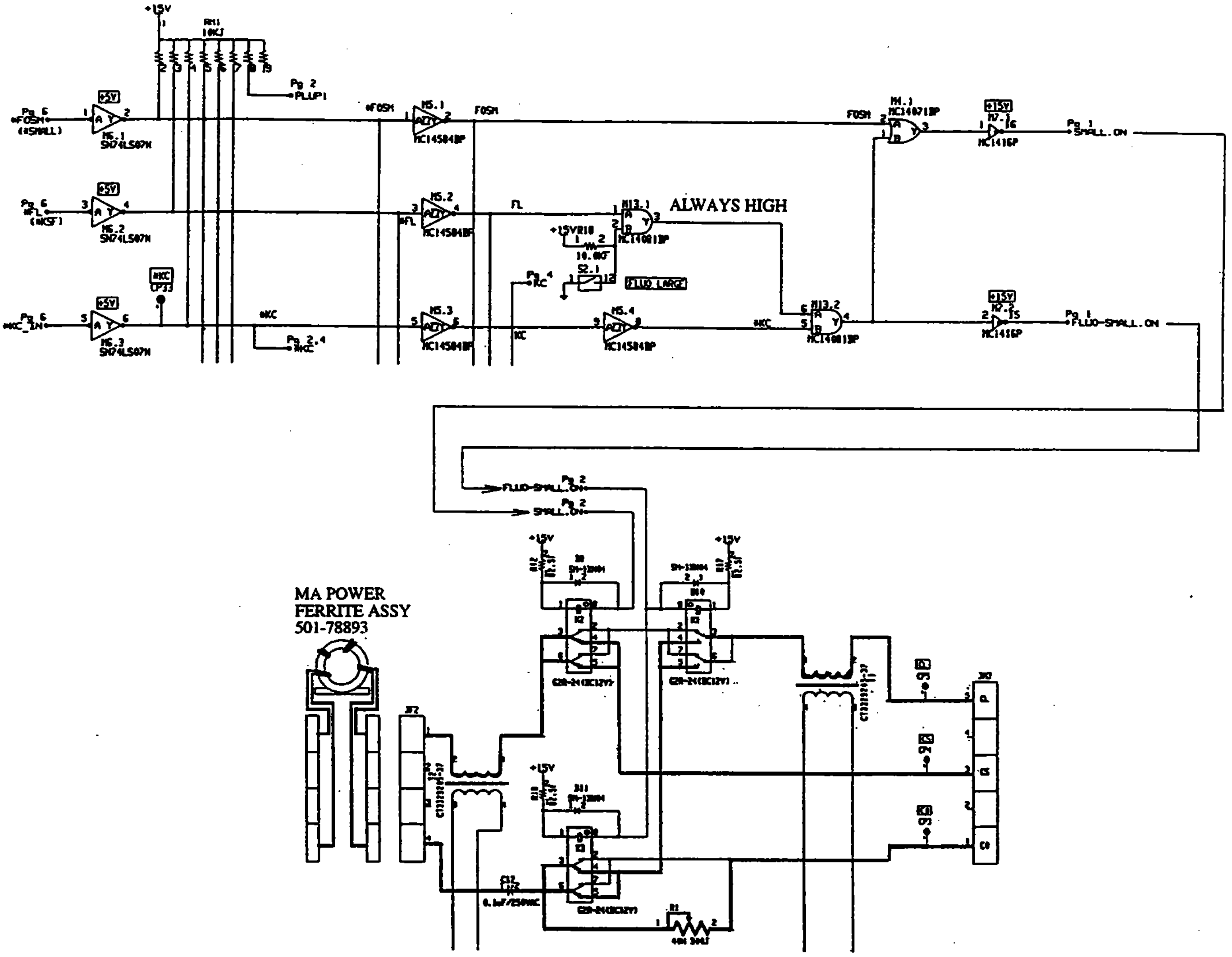



**Fig. 4.3.3 Operation that includes fluoroscopy (fluoroscopy is operated with small focus)**

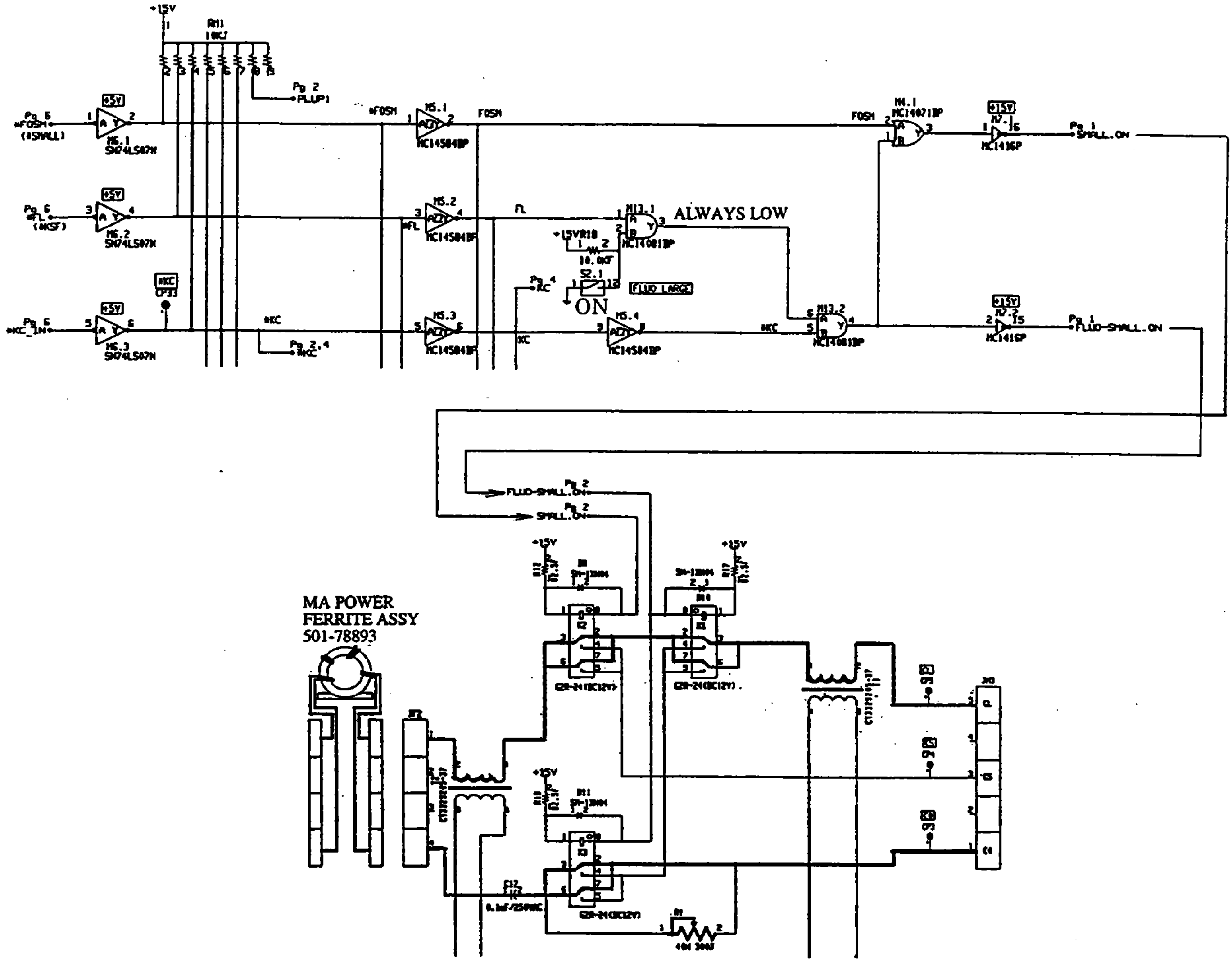



**Fig. 4.3.4 Operation that includes fluoroscopy (both fluoroscopy and radiography are operated with large focus.)**

## 4.4 Control circuit

(1) Filament current set circuit

Refer to Fig. 4.4.1.

The IFST signal shown in Fig. 4.4.1 is derived from the input signal FVR from the console in radiographic operation and from the input signal FVF in fluoroscopic operation, and determines the filament current.

(a) Radiographic operation

The input signal FVR from the console is output to a check pin C25 FVR through a buffer of operational amplifier A5.1. The relation between [FVR] and the filament current (secondary side) is given by 5 V / 5 A approximately.

Before READY operation is executed, an analog switch M24.3 is OFF and M27.1 is ON, because inputs *KC and *KCP are HIGH. Then, a half voltage of FVR, derived by dividing FVR by resistors R102 and R126 (+RM15.4), is input to terminal 5 of a buffer A19.2, and output from the buffer as it is.

Because the operation in this case does not include fluoroscopy or pulse fluoroscopy, analog switches M27.2 and M 28.3 are ON. Then, a non- inverting adder A20.2 adds 1/2FVR and MAFC, and outputs the added value to IFST. Here, the value is 1/2FVR because MAFC is zero when X-ray exposure is not working.

According to the process described above, the value at IFST is about 2.5 V when FVR is 5 V. That is, when FVR is 5 V, a preheating current of about 2.5 A flows through the filament.

Next, when READY operation is executed, switches between terminals 2 and 3 and between 10 and 11 of M24 are turned ON, because an input signal *KCP becomes LOW, and terminals 1 and 9 of M24 become LOW. Terminal 8 of M24 becomes HIGH, and a switch between terminals 6 and 7 is turned OFF.

When radiographic operation is selected, a terminal 8 of M23 is LOW, and a switch between terminals 6 and 7 of M23 is ON. Then, the signal [FVR] is reduced to one third by resistors R51 and R52, and outputs its differentiated waveform through A19 to a check pin CP 31 [FLR] as shown in Fig. 4.4.1. This waveform is added to the signal [FVR] for 0.8 seconds at its maximum. With small focus, an input signal *FOSM is LOW, the terminal 1 of the analog switch M23 is LOW, and a switch between terminals 2 and 3 is ON. Therefore, the voltage [FLR] is a half of that with large focus.

When READY operation is executed, a terminal 1 of analog switch M27 becomes

LOW, and a switch between terminals 2 and 3 of M27 is turned on. Then, a resistor RM15③–④ is short-circuited.

According to the process described above, a voltage derived by adding the signal FLR to FVR is output as the signal IFST . Incidentally, the filament temperature rises fast to a specified value by preheating before READY operation and a flashing current at READY operation.

The input signal MAFC works to compensate with feedback a tube current during X-ray exposure. When a measured current decreases during X-ray exposure, this signal is added to FVR to increase the filament current.

(b) Operation including fluoroscopy

In operation including fluoroscopy, an input signal *FL becomes LOW. In fluoroscopic operation, a signal IFST IFST is output which is derived by adding a tube current compensated with feedback, MAFC , to the set signal from the console, FVF.

In radiographic operation, IFST signal is derived from the FVR signal sent from the console in the same way as described in the previous section (a). On READY operation, a switch between terminals 10 and 11 of M27 is turned OFF, and another switch between terminals 6 and 7 ON.

In fluoroscopy with large focus, a switch between terminals 10 and 11 of M 23 is ON, because a terminal 9 of M23 is LOW. On READY operation, switches between terminals 2 and 3 and terminals 10 and 11 of M24 are turned ON, and another switch between terminals 6 and 7 is OFF. At this time, a differentiated voltage waveform proportional to FLL at trimmer VR2 is generated at a check pin CP31 as FLR , and added to FVR for 0.8 seconds at its maximum (refer to Fig. 4.4.1).

Further, a switch between terminals 2 and 3 of M27 becomes ON, the resistor RM15③–④ is short-circuited, and the signal IFST is generated in the same way as in section (a).

With small focus fluoroscopy, IFST signal is generated in the same way, too.

(2) Filament current measuring circuit

A current transformer is connected in the output side of the inverter circuit in mA POWER-96 board.

Refer to Fig. 4.4.2 to understand the following description.

The turn ratio of the filament transformer (not shown in the Figure) in the high-voltage generator is 5.5 to 1. That of the current transformer is 1 to 3000. The secondary



34

side of the current transformer is connected to a resistor R7 through full-wave rectifier diodes D3 ~ D6. The relation between the filament current, Ifi [A], and the voltage across R7, E7 [V], is given by

$$E7 = I_{fi} \times \frac{1}{5.5} \times \frac{1}{3000} \times 750$$

When If1= 5 [A], the voltage across R7 (effective value) is given by

$$5 \times \frac{1}{5.5} \times \frac{1}{3000} \times 750 = 0.23 \text{ [V]}$$

This voltage is input to a terminal 2 of rms/D.C converter M3, and the same value of DC voltage as the effective value of the input voltage is output from the terminal 6. The DC voltage goes through an operational amplifier and becomes P.CUR signal.

When the filament current If is 5 [A], P.CUR signal is

$$0.23 \times \frac{51.1K}{2.55K} = 4.61 \text{ [V]}$$

In above calculations, the filament current includes a real filament current If and an exciting current of the filament transformer. Therefore, the relation between P.CUR signal and If is given by 5V / 5A. The P.CUR signal is sent to the DC power supply circuit (refer to (1) in section 4.3) and used to control the filament current.

The P.CUR signal becomes IFV signal after going through an operational amplifier A17, and is output to an output terminal JM1 through a dipswitch S1 and an operational amplifier A12. The dipswitch S1 is usually turned to S side. A filament ammeter is connected to the output terminal JM1. The ammeter has a full scale of 10 A and a sensitivity of 150μA. A variable resistor VR5 [IFM ADJ] is adjusted so that the meter indicates 5A when the signal voltage IFV is 5 V.

Filament ammeter : P/N 080-48054-57

When the ammeter reads a preheating current for large focus in fluoroscopic operation, the dipswitch S1 is turned to L side. Then, an output of the current transformer connected to the output side of the focus switching circuit (refer to (3) in section 4.3) is output to the output terminal JM1 through diodes D12 ~ D15, rms/D.C converter M17, an operational amplifier A13, and the dipswitch S1. Then, the filament current for large focus can be measured at JM1.

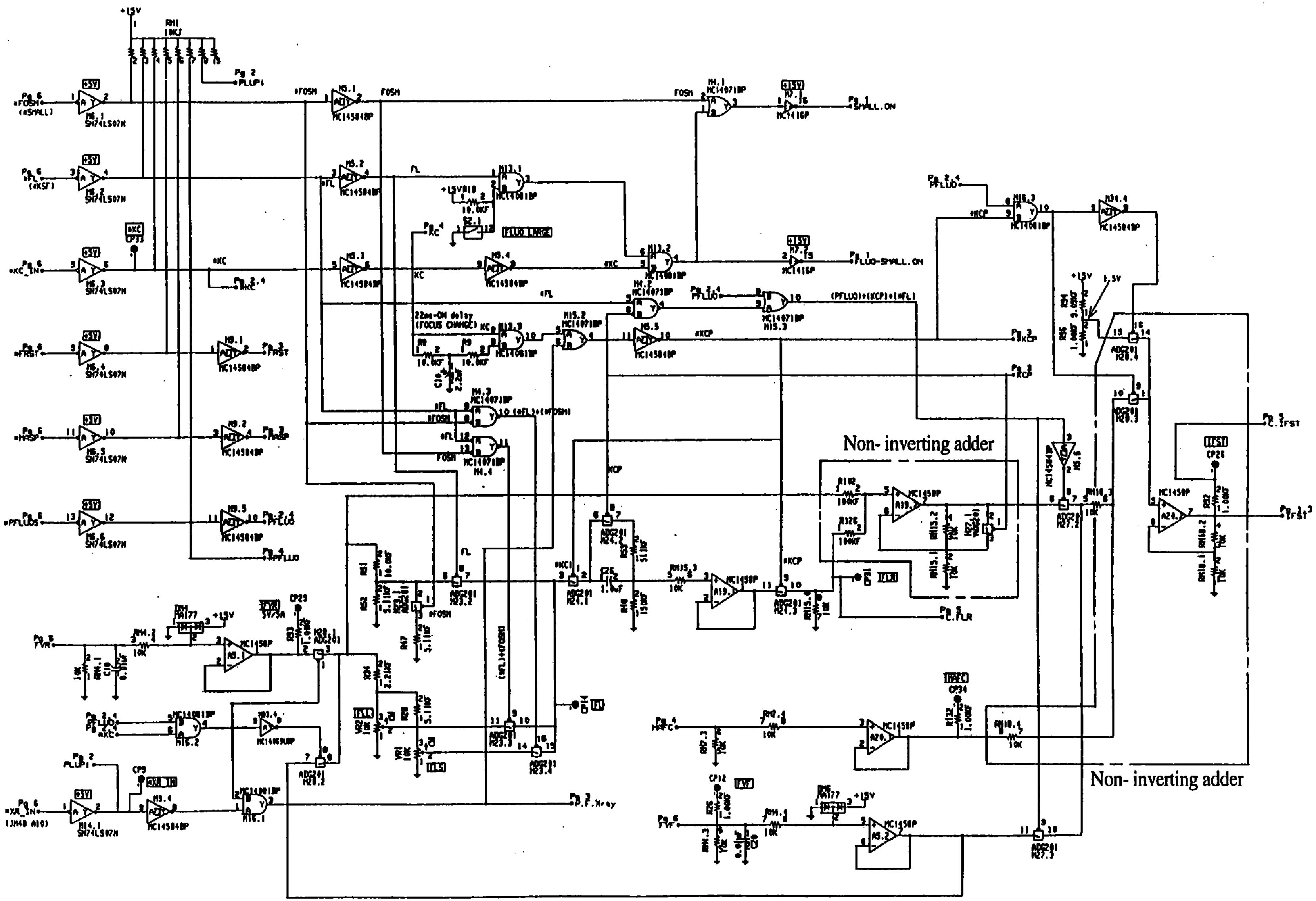



Fig. 4.4.1

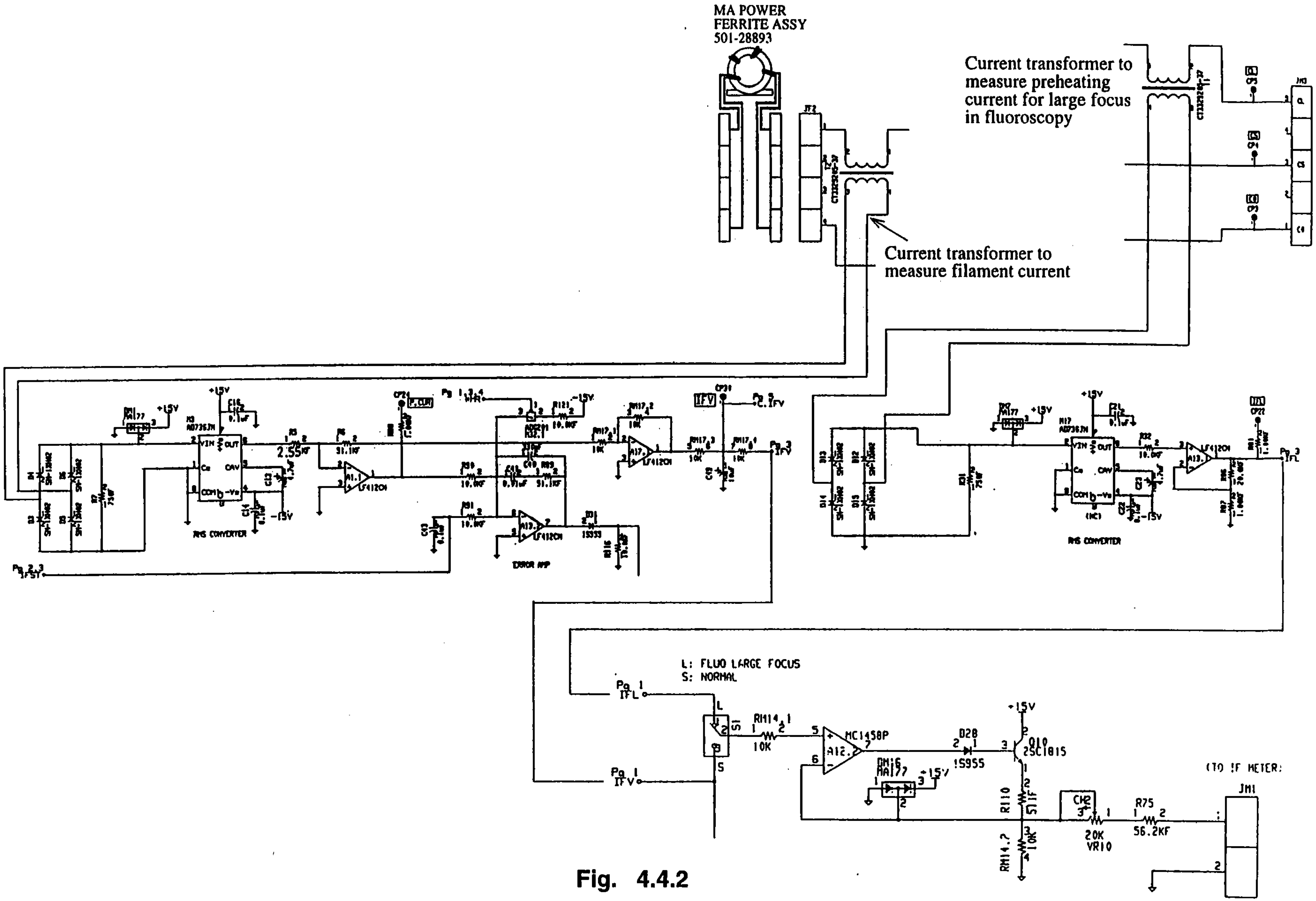

MA POWER
FERRITE ASSY
501-28893
Current transformer to measure preheating current for large focus in fluoroscopy
Current transformer to measure filament current
RMS CONVERTER
ERROR AMP
RMS CONVERTER
L: FLUO LARGE FOCUS
S: NORMAL
MC1458P
2SC1815
1S955
(TO IF METER)
JM1
R75
56.2KF
VR10
20K

Fig. 4.4.2

(3) Heating acknowledgment circuit

Refer to Fig. 4.4.3.

A measured filament current signal IFV from the filament current measuring circuit (refer to (2) in section 4.4) is supplied to the non-reversal input terminal 3 of a comparator A12. Because about 0.9 V is applied to the reversal input terminal 2 of A12, the output terminal 1 of A12 and the terminal 12 of M16 becomes HIGH when IFV exceeds 0.9 V.

When READY operation is executed, a signal *KCP becomes LOW. Then, the output terminal 7( $\overline{Q}$ ) of an one-shot multivibrator M1 becomes LOW for about 0.8 seconds, and becomes HIGH after that.

According to the process above, a *OKF signal is output to EMC when the filament current exceeded 0.9 A and about 0.8 seconds has passed after READY operation was executed.

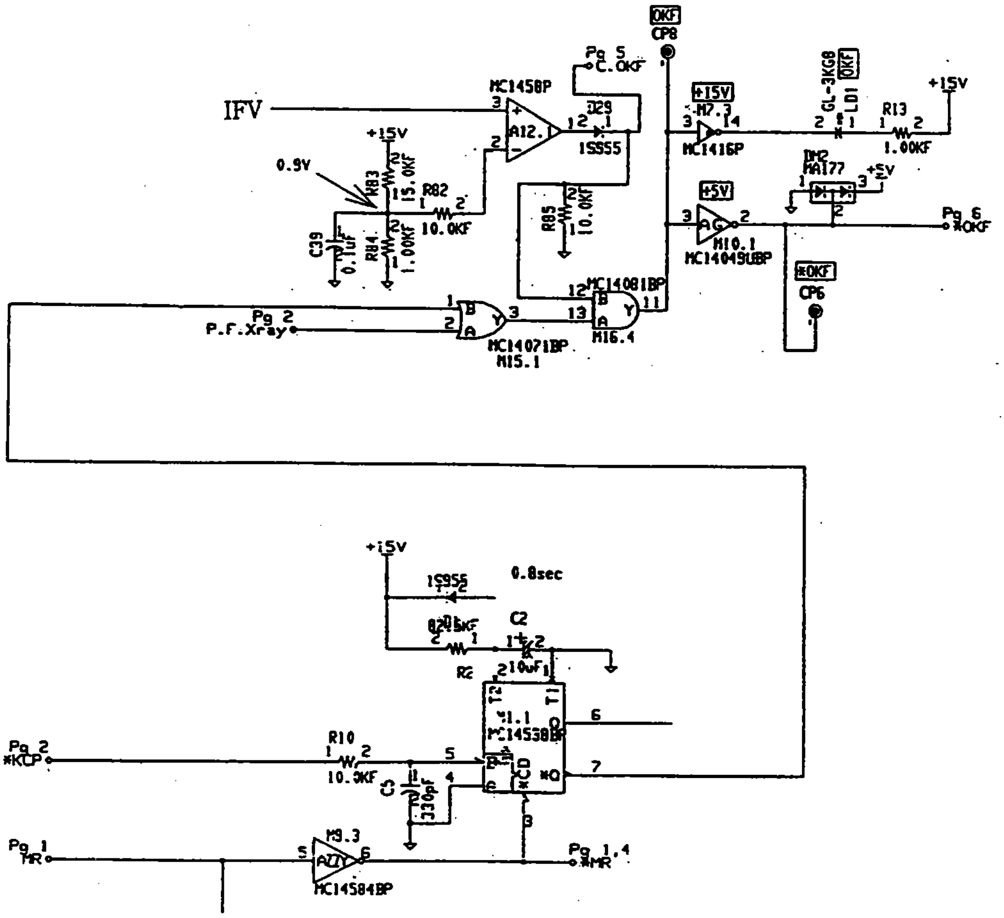



**Fig. 4.4.3**

(4) Faulty operation detecting circuit

(a) IFO circuit

Refer to Fig. 4.4.4.

The measured filament current signal is supplied to the non-inverting input terminal 3 of an operational amplifier A2. A signal of maximum filament current LMT from the console is supplied to the inverting input terminal 2 of A2. Before READY operation is executed, a switch between terminals 7 and 8 of M22 is ON, because the terminal 8 is LOW. When READY operation is executed, a signal *KCP becomes LOW and the output terminal 6 of a one-shot multivibrator M1 becomes HIGH for about 0.8 seconds. During that time a switch between terminals 6 and 7 of M22 becomes OFF, and the input voltage to the terminal 7 of A3 becomes about 1.4 times larger than the signal voltage LMT.

When the voltage at terminal 3 of A2 is higher than that of terminal 2 (when IFV signal is larger than LMT signal, and when IFV is 1.4 times larger than LMT for 0.8 seconds after READY operation due to an increase of IFV by flashing), terminal 1 of A2 becomes HIGH and a flip-flop M11 is set, then a terminal 1 of M11 becomes HIGH. As a result, LED [IFO] is turned on and an output *IFOVER becomes LOW.

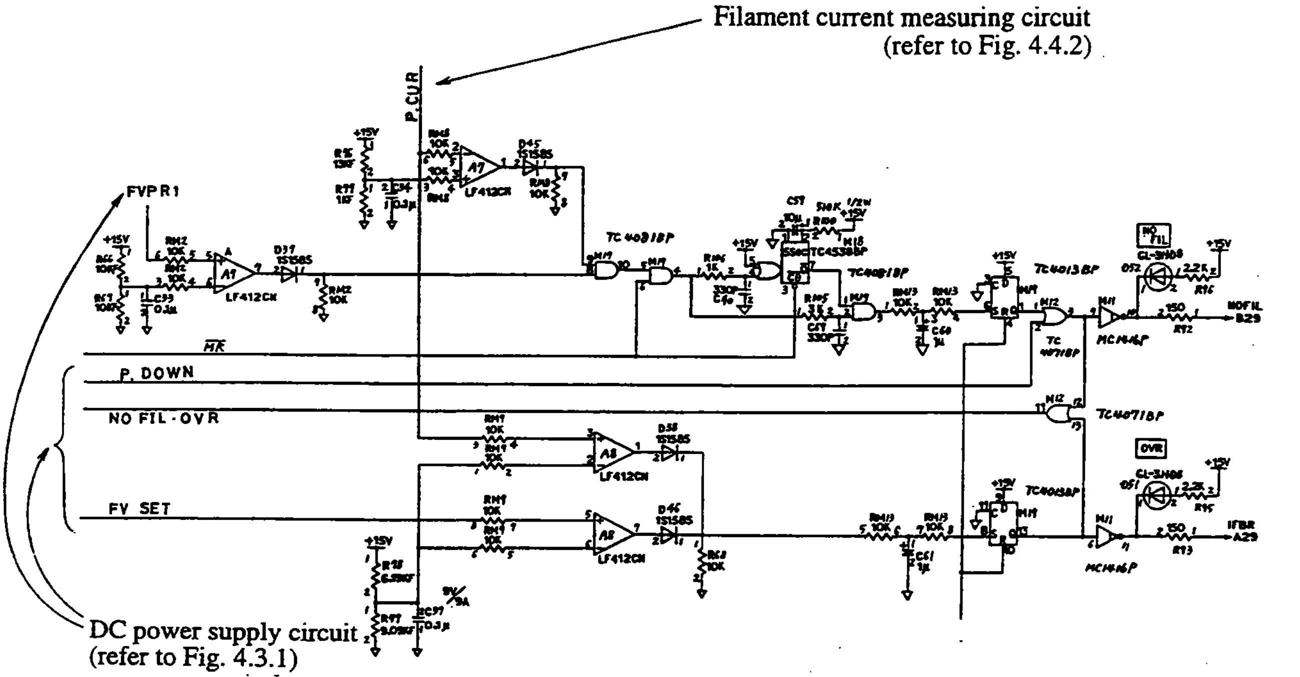
(b) IFSO circuit

Refer to Fig. 4.4.4.

The set signal of filament current IFST enters the non-inverting input terminal 5 of an operational amplifier A2. 4 V is applied to the inverting input terminal 6 of A2.

When the voltage at terminal 5 of A2 is higher than 4 V (when IFST signal is larger than 4 V), terminal 7 of A2 becomes HIGH and the flip-flop M11 is set, and the terminal 1 of M11 becomes HIGH. As a result, LED [IFOS] is turned on and an output *IFOVER (output signal to EMC circuit) becomes LOW.

During X-ray exposure and during READY operation, this faulty operation detecting circuit is stopped to work.




P.C.B. mA POWER UD

**Fig. 4.4.4**

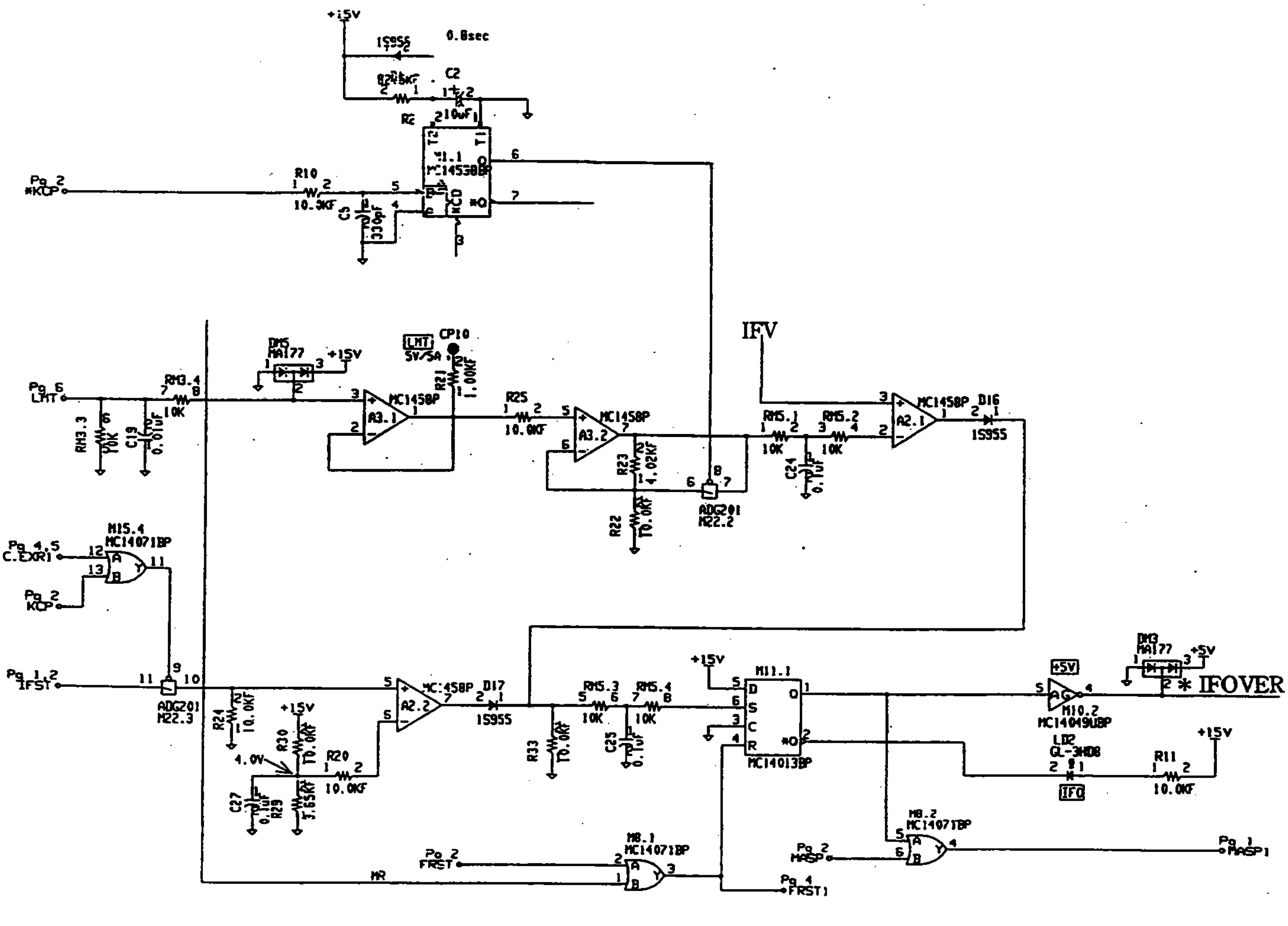



**Fig. 4.4.5**

(5) Reset circuit

Refer to Fig. 4.4.6.

The reset circuit is included in mA POWER-96 board. When the generator is turned on, a signal MR becomes HIGH and $\overline{MR}$ becomes LOW for about 2.5 seconds and all flip-flops and one-shot multivibrators are reset. Also, the DC power supply (refer to (1) in section 4.3) and the inverter circuit (refer to (2) in section 4.3) are stopped to work.

When FAULT signals are generated, the flip-flop in the faulty operation detecting circuit can be reset by a reset signal *FRST from the console.

## 4.5 Tube current control

The mA POWER-96 board detects tube currents at a neutral point and feedback-controls in both fluoroscopic and radiographic operation. (In pulsed fluoroscopic operation the feedback is made in vain, because pulse lengths are short.)

(1) Feedback circuit (for both fluoroscopy and radiography)

Refer to Fig. 4.5.1.

A difference voltage between a measured radiographic tube current MAM (fluoroscopic tube current AMA ) and its set tube current RMA ( FMA3 ) appears at the output terminal 7 of a differential amplifier A4. The error voltage is input to an integrator A4 and its output becomes MAFC , and the error is corrected (refer to section 4.4).

The speed of response of the feedback circuit is changed according to operation method. In fluoroscopic operation the response is made slow to prevent hunting and DC gain is made large to enhance feedback accuracy. On the contrary, the speed of response is made fast in radiographic operation.

The feedback circuit does not work in check mode.

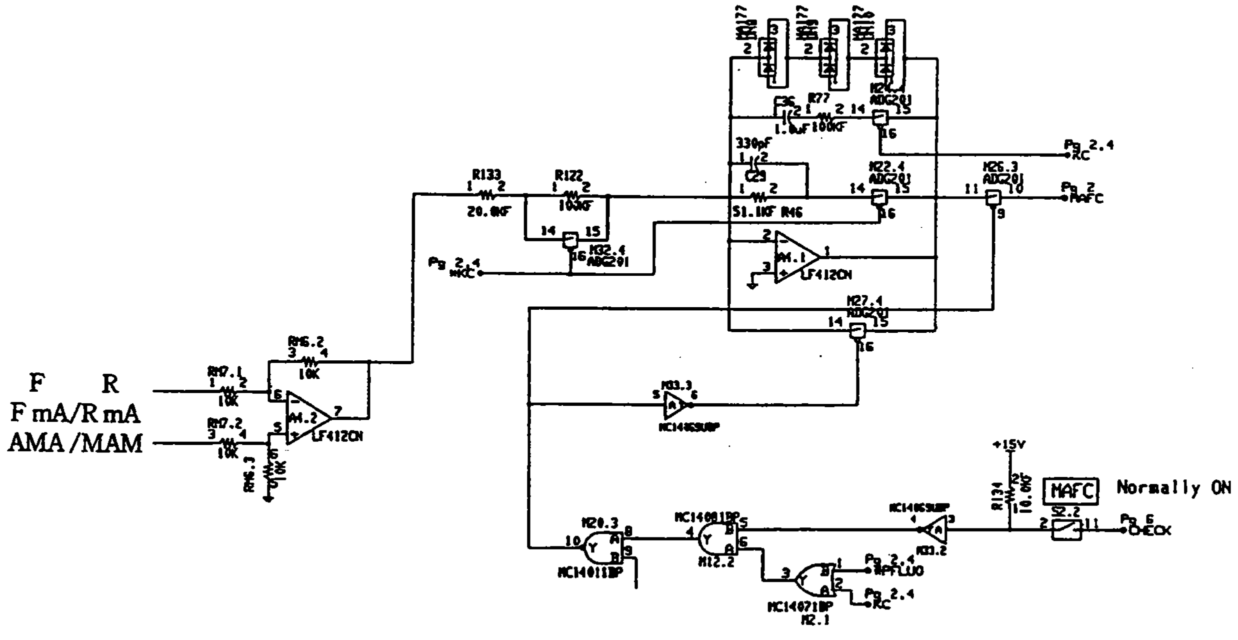



**Fig. 4.5.1**

(2) Tube current setting circuit for fluoroscopic tube

Refer to Fig. 4.5.2.

Trimmers [A] ~ [G] establishes the relation between fluoroscopic tube voltage [FKV] and set fluoroscopic tube current [FmA3] .

Function of each trimmer is:

- [A] : total gain
- [B] : flexion point
- [C] : gain (positive)
- [D] : flexion point
- [E] : gain (positive)
- [F] : flexion point
- [G] : gain (negative)

S2-3 [FMC] is not used now. (Normally OFF)

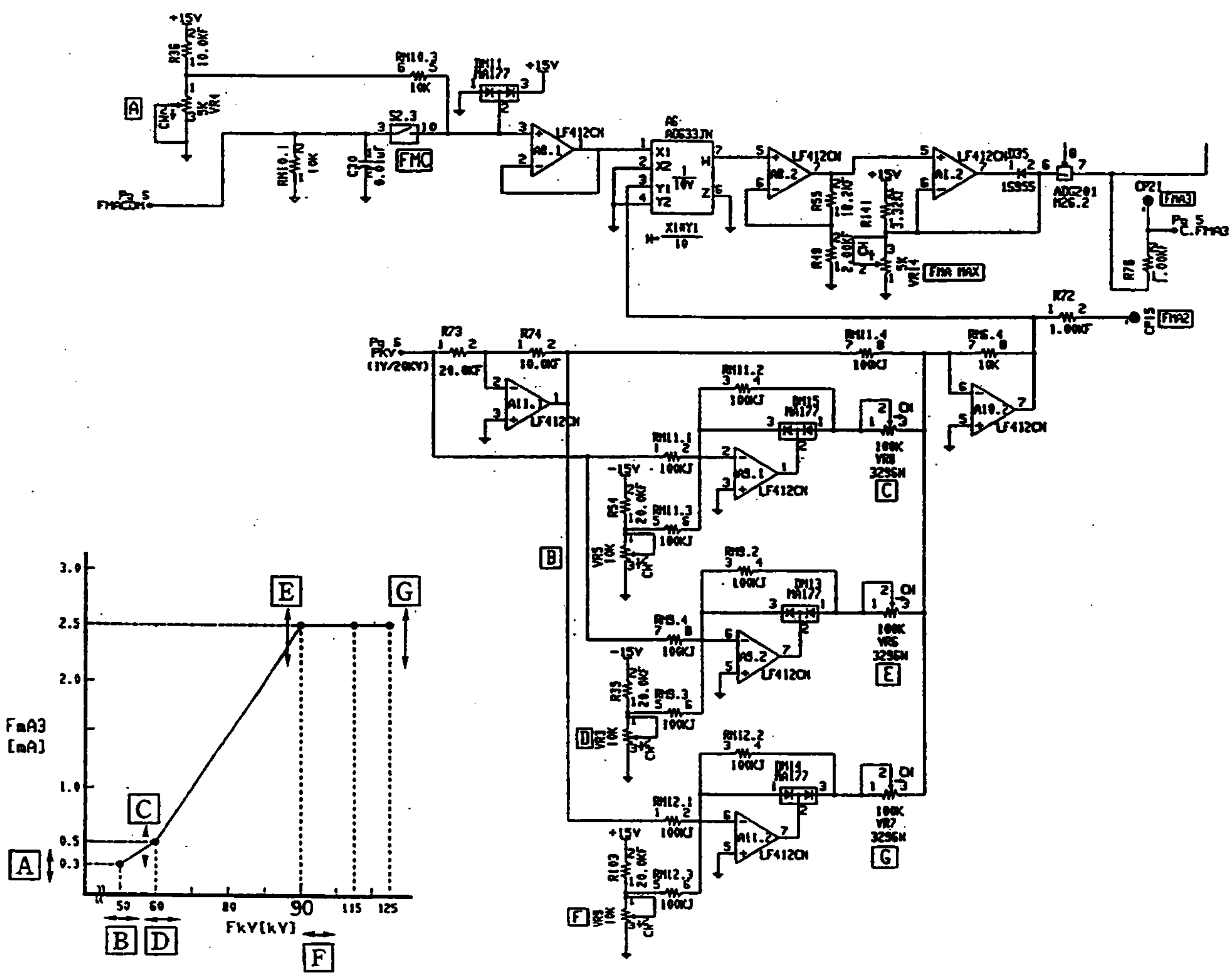



**Fig. 4.5.2**

(3) Tube current measuring circuit

(a) Outline

This circuit measures X-ray tube current. Fig. 4.5.3 shows an outline of the tube current measuring circuit.

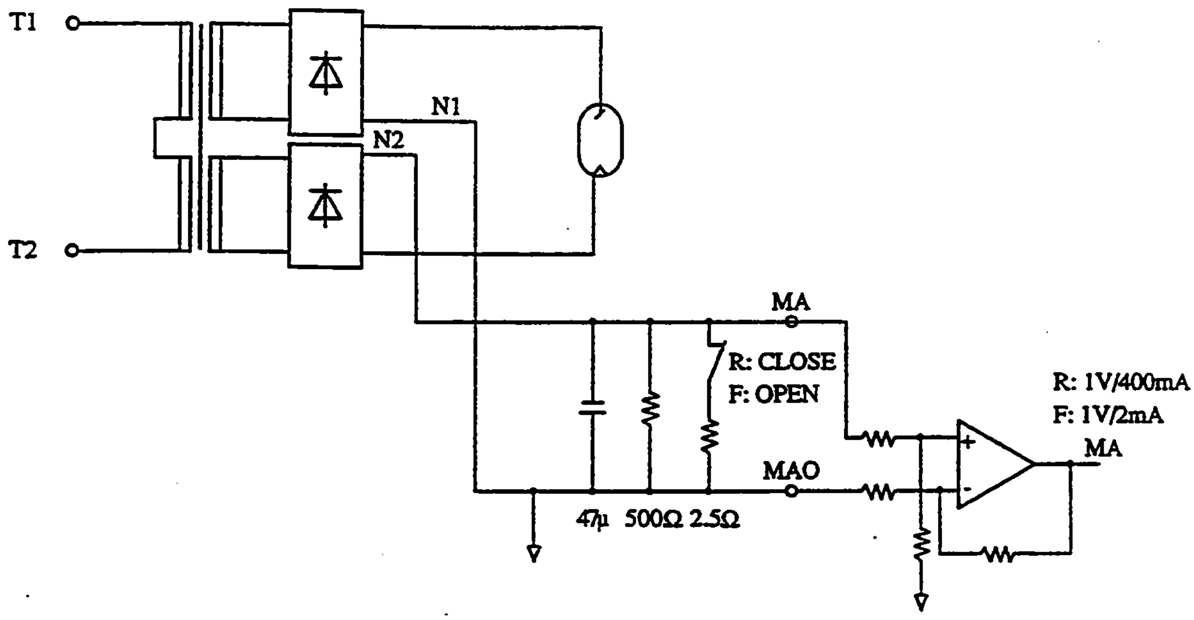



**Fig. 4.5.3 Outline of tube current measuring circuit**

As shown in Fig. 4.5.3, a current at the neutral point of high-voltage circuit is measured as a tube current.

The detecting resistor portion is mounted on MA DETECTOR-96 board in the high-voltage generator.

In fluoroscopic operation the detecting resistors 2.5Ω and 500Ω are connected in parallel by a relay, and in fluoroscopic operation the relay opens and the resistor is 500Ω alone.

The detected current enters A22 and appears at CP27 [MA]. The relation between the voltage at CP27 [MA] and the tube current is given by a ratio of about 1 V /2 mA in fluoroscopy and about 1 V /400 mA in radiography.

(b) Tube current measuring circuit for radiography

As shown in Fig. 4.5.4, a measured tube current signal MA and a set current signal MAO is input to a differential amplifier A22 and the differential output is input to pin 5 of A22. The output level of A22 is adjusted by VR1 [MAM ADJ] and appears at CP38 [MAM] . The relation between the voltage at CP38 MAM and the tube current is given by a ratio of 5 V /1000 mA in radiography.

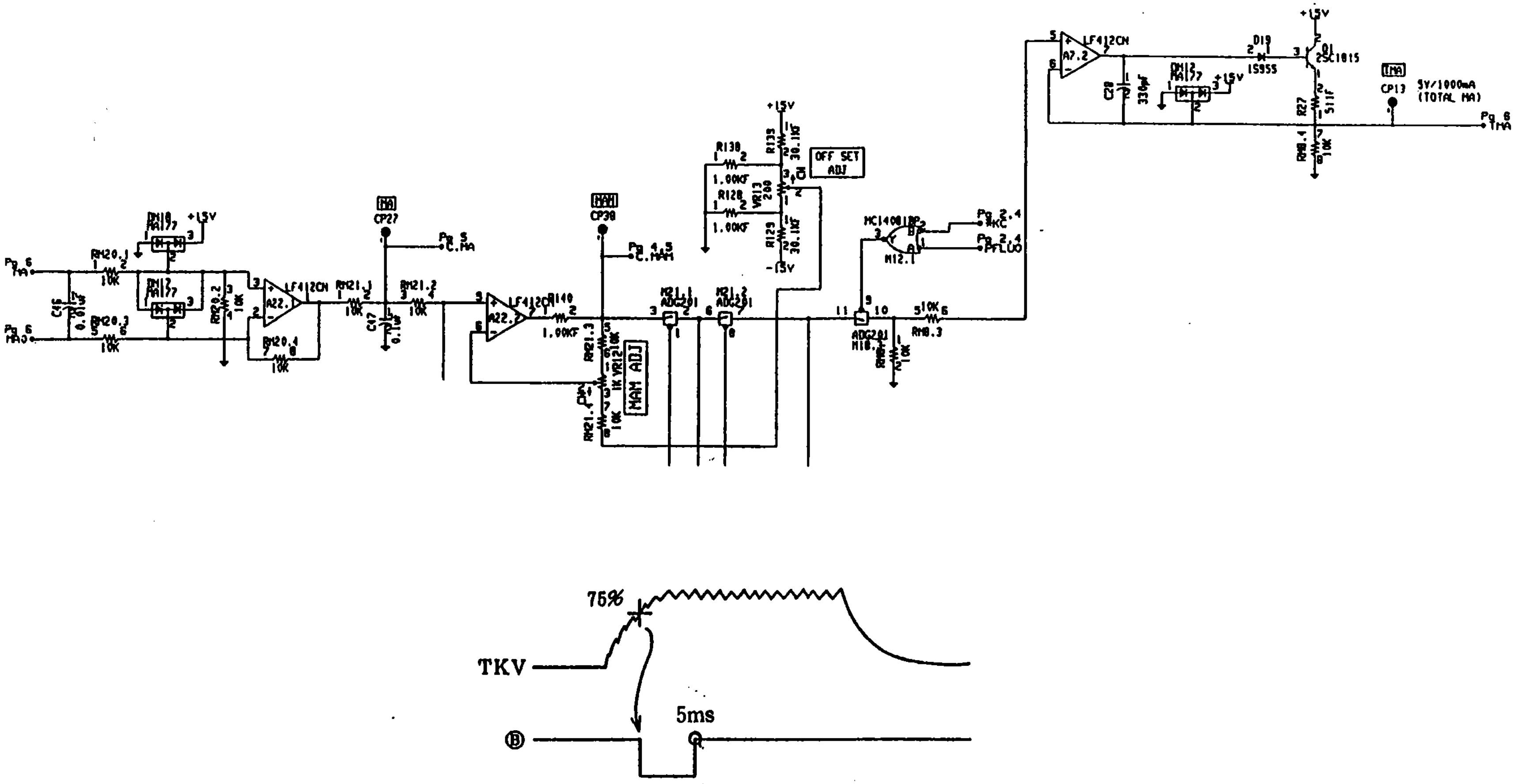



**Fig. 4.5.4 Tube current measuring circuit for radiography**

Whereas this "MAM" is output to the console as "TMA" in radiographic operation, the set current signal for radiographic tube "RMA" is output as "TMA" for 5 msec from the beginning of tube current measurement in radiographic operation.

(c) Tube current measuring circuit for fluoroscopy

As described in section (a), the tube current detecting resistor is about 500Ω in fluoroscopic operation. In the same way as in radiographic operation, a voltage proportional to a tube current appears at CP27 "MA" with a relation of about 0.5V / 1mA.

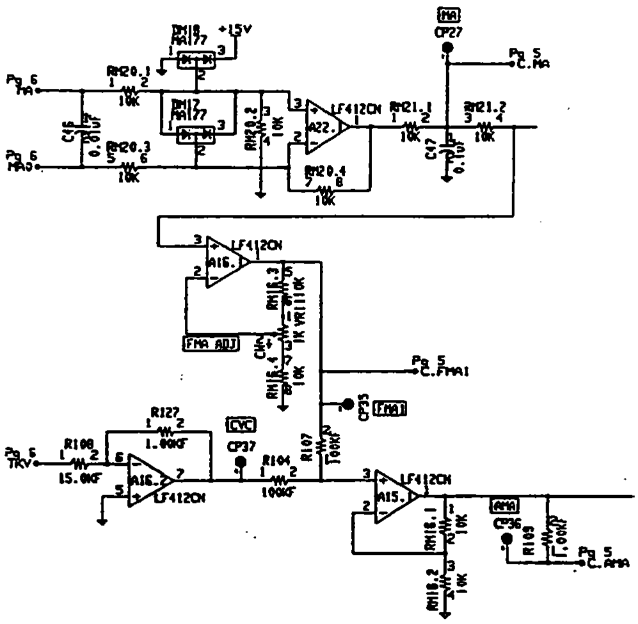



**Fig. 4.5.5 Tube current measuring circuit for fluoroscopy**

CVC corrects MA, because it includes a current flowing through the voltage-dividing resistor in the high-voltage transformer.

Note: When the high voltage is 100 kV, the leak current is $\frac{100kV}{150M \times 2} = 0.333$ mA. Because a tube current of 1 mA leads to 1 V at FMA, the correction voltage 0.333 V should be subtracted.

The input voltage at pin 3 of A15 is adjusted by VR11, FMA ADJ , so that the voltage at CP36, AMA , is related to the tube current by a ration of 4 V/4 mA.

(4) Over-current protection circuit

This circuit checks over-currents in radiographic and fluoroscopic operation.

The following cases are determined as an over-current.

In radiography: Set value + 200 mA

600 mAs

In Fluoroscopy: 10 mA

(a) RmA OVER

Refer to Fig. 4.5.6.

This circuit operates when a measured tube current MAM in radiographic operation exceeds 200 mA more than a set value RMA. In pulsed fluoroscopic operation it operates when a measured tube current MAM exceeds 200 mA.

(b) 600 mAs OVER

Refer to Fig. 4.5.6.

This faulty operation detecting circuit functions when S-24 is turned ON. It operates when mAs value in fluoroscopic operation exceeds 540 mAs.

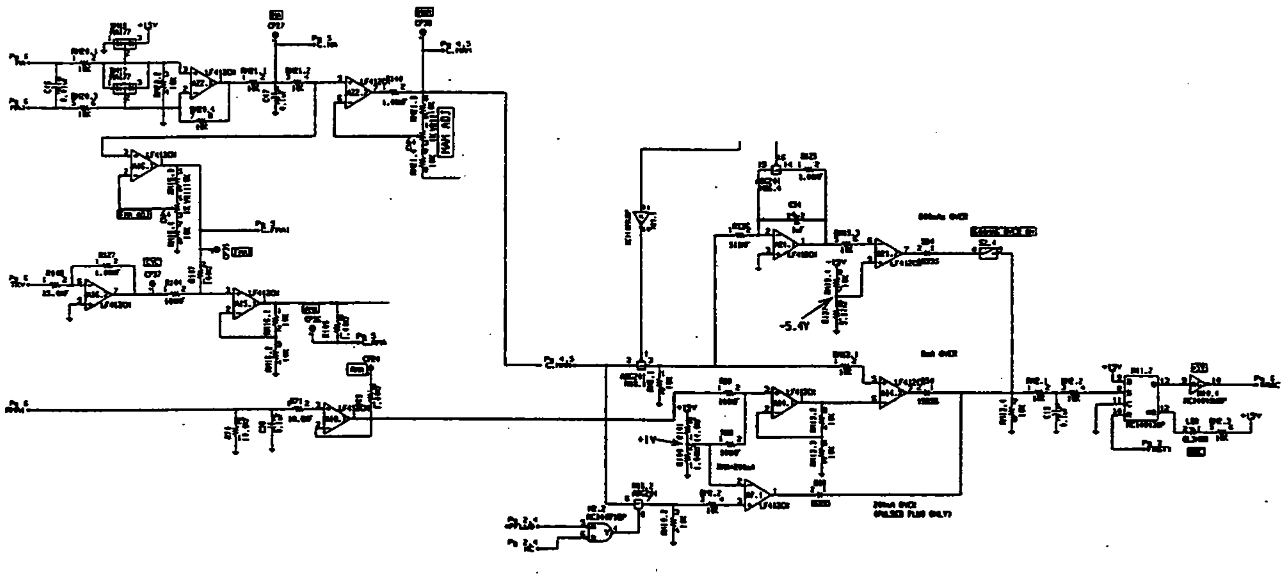



**Fig. 4.5.6**

(c) FOC

Refer to Fig. 4.5.7.

This circuit operates when a measured tube current AMA in fluoroscopic operation exceeds 10 V (corresponding to 10 mA). The FOC signal is transmitted to EMC-96 board and stops the fluoroscopic operation. Releasing a foot-switch can reset FOC.

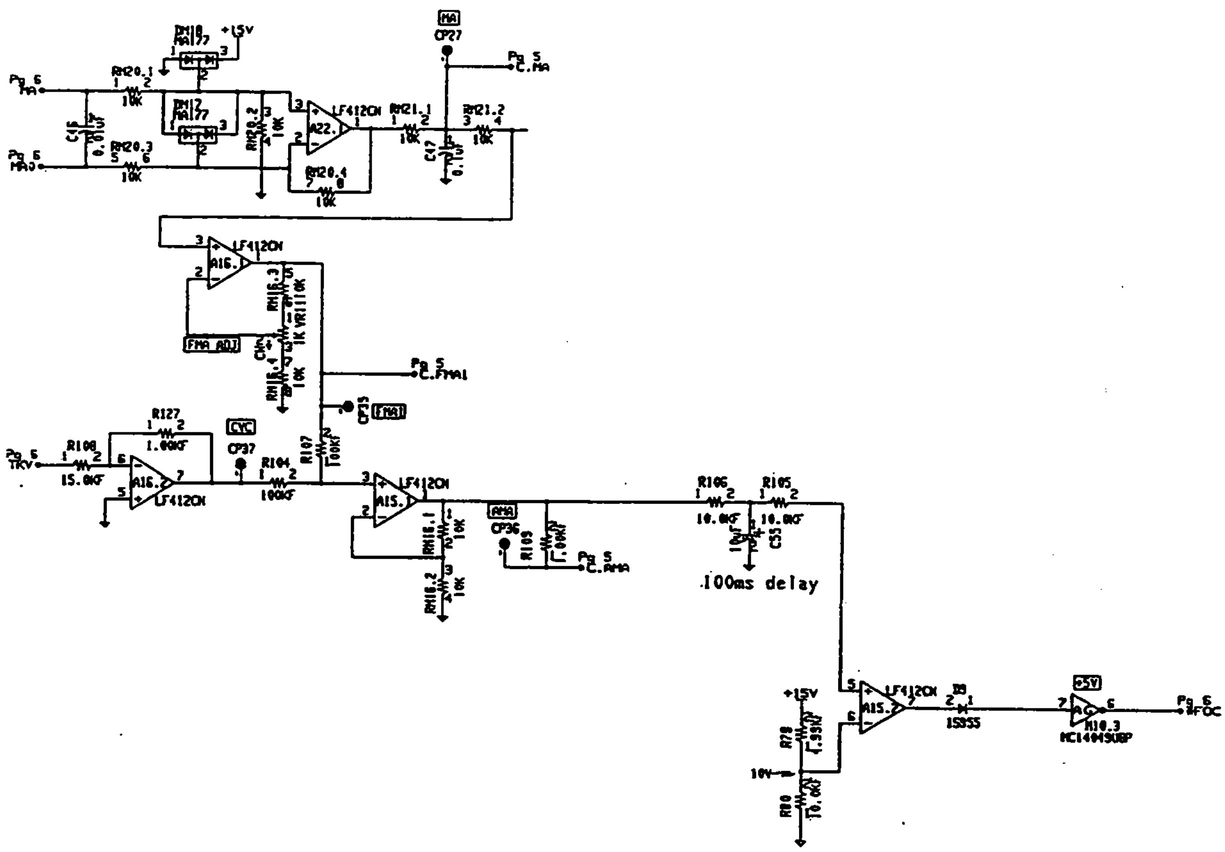



Fig. 4.5.7

## 4.6 Signals in mA POWER-96 board

| Signal | Content | Remark |
|---|---|---|
| *ROC | Radiographic tube over-current signal | |
| *FOC | Fluoroscopic tube over-current signal | |
| *EXR 1 | X-ray ON signal | |
| *FRST | FAULT reset signal | |
| PKV | Set tube-voltage signal (in all operational modes) | 7.5V/150kV |
| TKV | Measured tube-voltage signal | 7.5V/150kV |
| RMA 1 | Set radiographic tube current signal | 5V/1000mA |
| TMA | Measured radiographic tube current signal | 5V/1000mA, 1V/1mA |
| MA | } Measured tube current signal | |
| MAO | | |
| FVF | Setting signal for fluoroscopic filament voltage | |
| TV 7 | } Signal proportional to TV brightness | |
| TV 2 | | |
| *FOSM | Selection signal for small focus | |
| *PFLUOS | Selection signal for pulsed fluoroscopic operation | |
| FMACOM | Unused (for SID correction) | |
| *MASP | Stop signal for filament heating | |
| LMT | Limit value of filament heating | |
| *FL | Selection signal for fluoroscopic operation | |
| FVR | Setting signal for radiographic filament voltage | |
| CHECK | Check mode signal | |
| *IFOVER | Signal of faulty filament heating | |
| *XR IN | Exposure signal | |
| *KC IN | READY signal | |
| *OKF | Acknowledge signal of filament heating | |

# 5. Mother-96 board

## 5.1 Input/output signal for power supply

When supply voltage is +10% more or –25% less than the standard value, a signal LVOVR is output. In READY operation this signal is inoperative.

Refer to Fig. 5.1.1, where the power on/off and FRST (fault reset) circuits are shown.

(1) J96 connector

| Signal | Content | Remark |
|---|---|---|
| LN12 | Power (12 V) | |
| LNON | Power ON signal | |
| LNOF | Power OFF signal | |
| PGND | GND signal | |
| FRST | FAULT releasing signal | |
| +15V | +15 V power | |
| GND | GND signal | |
| KCC | READY operation signal | |
| FON | Fluoroscopic operation ON signal | |
| LOCK | Power supply voltage OK signal | |
| LVOVR | LV CONT trouble signal | |

(2) J97 connector

| Signal | Content | Remark |
|---|---|---|
| 0LA | AC 10 V input | AC 10V |
| 10LA | Power for LN 12 | |
| 0LB | AC 100 V input | AC 100V |
| 100LB | Power for magnet | |

(3) J98 connector

| Signal | Content | Remark |
|---|---|---|
| 0LB | AC 100 V output | AC 100V |
| 100LB | | |

(4) J100 connector (5P)

| Signal | Content | Remark |
|---|---|---|
| 0LB | AC 100 V output | AC 100V |
| MGL 1 | LINE magnet ON signal | |

**Note**

24 V rectified by 0T-20T are used in EMC-96, TERMINAL-96, etc. On the other hand, 24 V for driving gates are supplied by an independent switching power. Do not connect each other.

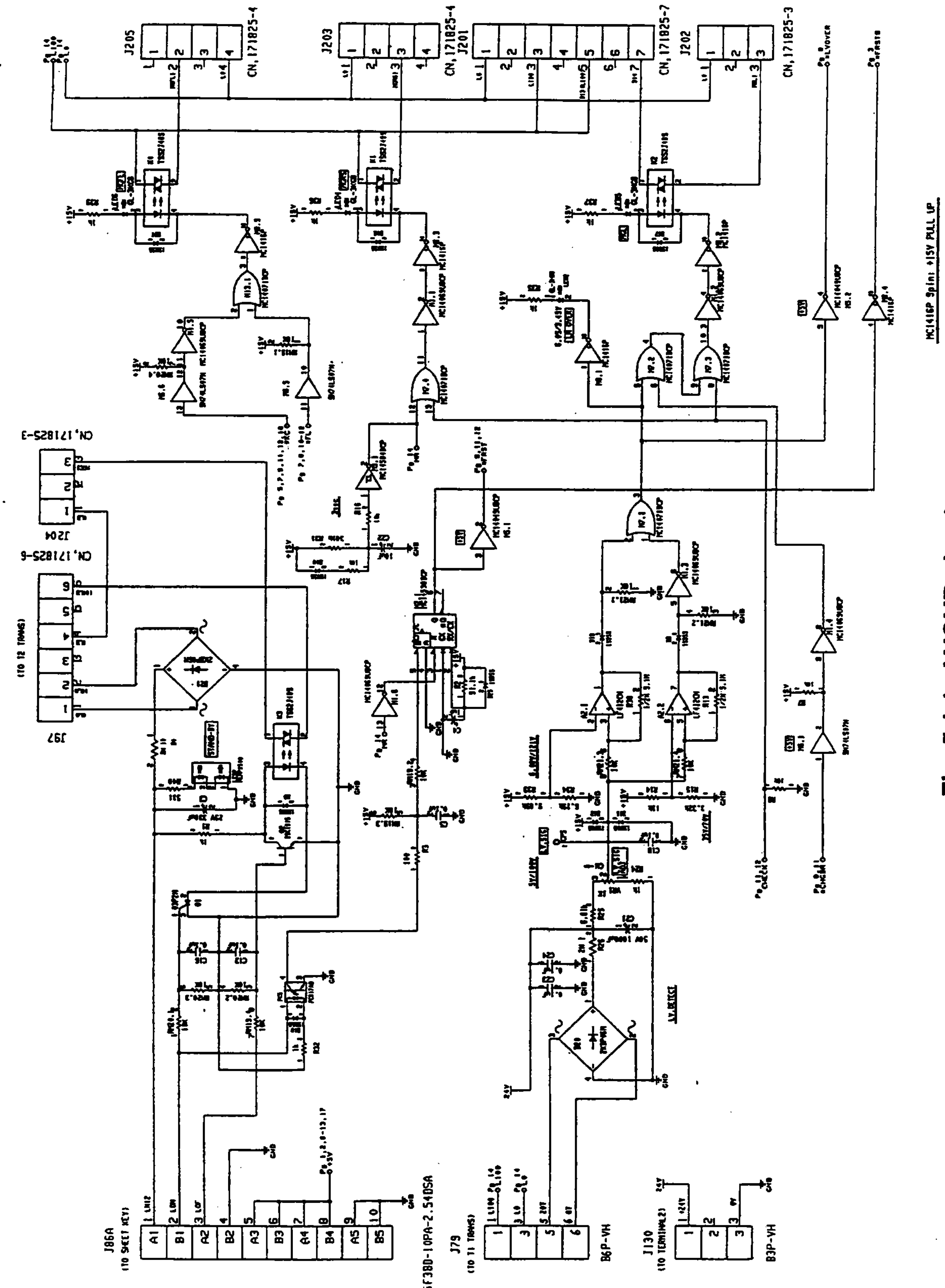
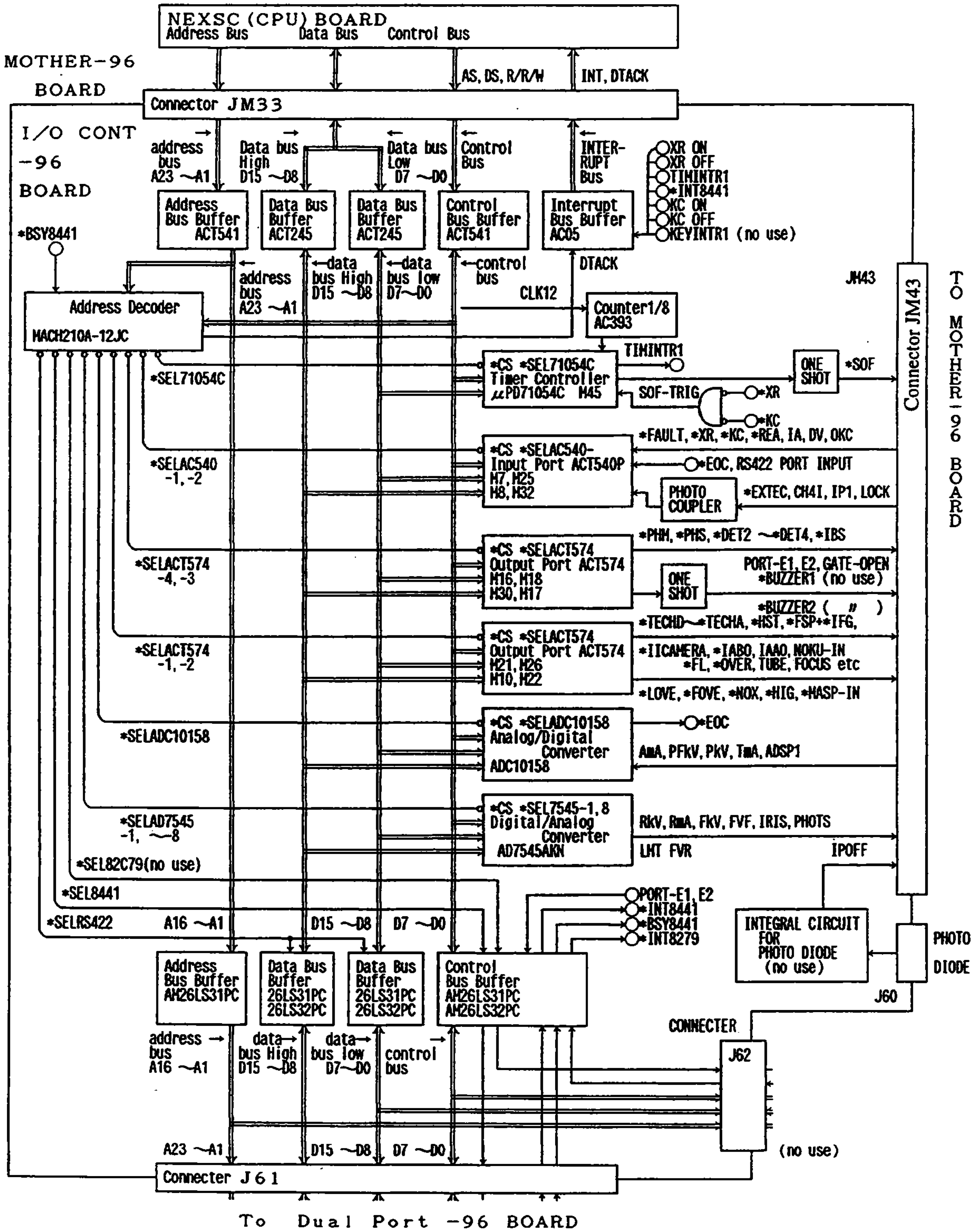



Fig. 5.1.1 LVOVR circuit

# 6. I/O CONT-96 board

## 6.1 Schematic diagram of I/O CONT-96 board

Schematic block diagram of I/O CONT-96 board is shown including MEXSC (CPU) board, Timer IC (μPD71054C), A/D converter IC (ADC10158), D/A converter IC (AD7545), INPUT IC (ACT540, 373), OUTPUT IC (ACT574), connectors, data buses, etc.






43

## 6.2 Input/output signals of I/O CONT-96 board

[1] Table of input/output signals

Input/output signals on I/O CONT-96 board are shown below.

For circuit mark r~w, refer to "6.2 Input/output signals of I/O CONT-96 board, [2] Input/output circuit", for k~p refer to "13.3 EXT CONT-96 board, [2] Input/output circuit", and for a~j refer to "7.31 Input/output signals on EMC-96 board, [2] Input/output circuit".

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM33 | 11/12 | A-1<br>B-1<br>C-1<br>A-2<br>B-2<br>C-2 | +5V | In | | DC power<br>+5 V input | MOTHER-96 |
| | | A-3<br>B-3<br>C-3 | +15V | In | | +15 V input | |
| | | A-4<br>B-4<br>C-4 | −15V | In | | −15 V input | |
| | 9/12 | A-6<br>B-6 | *IPOF | Out | | X-ray cutoff signal from photodiode integrating circuit (unused) | E. M. C.-96 P. C. B. |
| | | C-6 | *EXR | In | | Radiographic and fluoroscopic XRAYON signal | |
| | 1/12 | A-11 | *0-EXTINTR7 | Out | g | Interrupt Signal | NEXSC (BASE) |
| | | B-11 | 〃 6 | 〃 | 〃 | | |
| | | C-11 | 〃 5 | 〃 | 〃 | | |
| | | A-12 | 〃 4 | 〃 | 〃 | | |
| | | B-12 | 〃 3 | 〃 | 〃 | | |
| | | C-12 | 〃 2 | 〃 | 〃 | | |
| | | A-13 | *0-EXTINTR1 | 〃 | 〃 | | |
| | | B-13 | O-GATE | In | a | Control Signal | |
| | | C-13 | OUT-FC2 | 〃 | 〃 | | |
| | | A-14 | OUT-FC1 | 〃 | 〃 | | |
| | | B-14 | OUT-FCO | 〃 | 〃 | | |
| | | C-14 | *OUT-AS | 〃 | 〃 | | |
| | | A-15 | *OUT-LDS | 〃 | 〃 | | |
| | | B-15 | *OUT-UDS | 〃 | 〃 | | |
| | | C-15 | OUT-R/*W | 〃 | 〃 | | |
| | | A-16 | O-DTACK | Out | g | | |
| | | B-16 | OD [15] | In | a | Data Bus | |
| | | C-16 | 〃 [14] | 〃 | 〃 | | |
| | | A-17 | 〃 [13] | 〃 | 〃 | | |
| | | B-17 | 〃 [12] | 〃 | 〃 | | |
| | | C-17 | 〃 [11] | 〃 | 〃 | | |
| | | A-18 | 〃 [10] | 〃 | 〃 | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM33 | 1/12 | B-18 | OD [ 9] | In | a | Data Bus | NEXSC (BASE) |
| | | C-18 | 〃 [ 8] | 〃 | 〃 | | |
| | | A-19 | 〃 [ 7] | 〃 | 〃 | | |
| | | B-19 | 〃 [ 6] | 〃 | 〃 | | |
| | | C-19 | 〃 [ 5] | 〃 | 〃 | | |
| | | A-20 | 〃 [ 4] | 〃 | 〃 | | |
| | | B-20 | 〃 [ 3] | 〃 | 〃 | | |
| | | C-20 | 〃 [ 2] | 〃 | 〃 | | |
| | | A-21 | 〃 [ 1] | 〃 | 〃 | | |
| | | B-21 | 〃 [ 0] | 〃 | 〃 | | |
| | 1/12 | C-21 | OA [23] | In | a | Adress Bus | |
| | | A-22 | 〃 [22] | 〃 | 〃 | | |
| | | B-22 | 〃 [21] | 〃 | 〃 | | |
| | | C-22 | 〃 [20] | 〃 | 〃 | | |
| | | A-23 | 〃 [19] | 〃 | 〃 | | |
| | | B-23 | 〃 [18] | 〃 | 〃 | | |
| | | C-23 | 〃 [17] | 〃 | 〃 | | |
| | | A-24 | 〃 [16] | 〃 | 〃 | | |
| | | B-24 | 〃 [15] | 〃 | 〃 | | |
| | | C-24 | 〃 [14] | 〃 | 〃 | | |
| | | A-25 | 〃 [13] | 〃 | 〃 | | |
| | | B-25 | 〃 [12] | 〃 | 〃 | | |
| | | C-25 | 〃 [11] | 〃 | 〃 | | |
| | | A-26 | 〃 [10] | 〃 | 〃 | | |
| | | B-26 | 〃 [ 9] | 〃 | 〃 | | |
| | | C-26 | 〃 [ 8] | 〃 | 〃 | | |
| | | A-27 | 〃 [ 7] | 〃 | 〃 | | |
| | | B-27 | 〃 [ 6] | 〃 | 〃 | | |
| | | C-27 | 〃 [ 5] | 〃 | 〃 | | |
| | | A-28 | 〃 [ 4] | 〃 | 〃 | | |
| | | B-28 | 〃 [ 3] | 〃 | 〃 | | |
| | | C-28 | 〃 [ 2] | 〃 | 〃 | | |
| | | A-29 | 〃 [ 1] | 〃 | 〃 | | |
| | | B-29 | *O-RESET | In | a | RESET INPUT SIGNAL | |
| | | C-29 | O-CLK12 | 〃 | 〃 | CLOCK [12MHz] INPUT SIGNAL | |
| | 5/12 | A-30 | *TID | Out | g | Backup-timer set signal (negative logic) {1 : 5V, 0 : 0V} | → EMC-96 |
| | | B-30 | *TID | 〃 | 〃 | | |
| | | C-30 | *TIB | 〃 | 〃 | | |

| Set second | Backup-timer time selection signal (binary) | | | Backup time |
|---|---|---|---|---|
| | *TID | *TIC | *TIB | |
| 1.0ms ~ 120ms | 1 | 1 | 1 | 250msec |
| 140ms ~ 250ms | 1 | 1 | 0 | 0.5 sec |
| 280ms ~ 500ms | 1 | 0 | 1 | 1.0 sec |
| 560ms ~ 1.0sec | 1 | 0 | 0 | 2.0 sec |
| 1.1sec ~ 2.0sec | 0 | 1 | 1 | 4.0 sec |
| 2.2sec ~ 4.0sec | 0 | 1 | 0 | 8.0 sec |
| 4.5sec ~ 8.0sec | 0 | 0 | 1 | 16.0 sec |
| 9.0sec ~ 10.0sec | 0 | 0 | 0 | 32.0 sec |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM33 | 5/12 | A-31 | GND | In | | GND inputs | Mother-96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | | |
| | | A-32 | 〃 | 〃 | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM43 | 6/12 | A-1 | AMA | In | r | Measured fluoroscopic tube current (now unused) (4V/4mA) (Adjustment trimmer VR4) (CP5) | mA POWER -96 P. B. |
| | | B-1 | TMA | In | 〃 | Measured (fluoroscopic / radiographic) tube current (5V/1000mA) (Adjustment trimmer VR3) (CP4) | |
| | | C-1 | PFkV | In | 〃 | Measured fluoroscopic tube voltage (5V/100kV) (Adjustment trimmer VR1) (CP3) | ANALOG-96 P. B. |
| | | A-2 | PkV | In | 〃 | Measured radiographic tube voltage (5V/100kV) (Adjustment trimmer VR5) (CP2) | |
| | | B-2 | A/DSP1 | In | 〃 | Preparatory A/D input (Adjustment trimmer VR2) (CP1) | |
| | 7/12 | C-2 | LMT | Out | s | Maximum heating current for filament protection M58 (7V/700 A) (Adjustment trimmer VR8) (CP6) | mA POWER -96 P. B. |
| | | A-3 | RkV | Out | 〃 | Set value of radiographic tube voltage M47 (5V/100kV) (Adjustment trimmer VR10) (CP10) | ANALOG-96 P. B. |
| | | B-3 | FVF | Out | 〃 | Set current for fluoroscopic filament heating M43 (5 V/5.00 A) (Adjustment trimmer VR7) (CP8) | mA POWER -96 P. B. |
| | | C-3 | RMA | Out | 〃 | Set value of radiographic tube current M51 (5V/1000mA) (Adjustment trimmer VR11) (CP11) | |
| | | A-4 | FVR | Out | 〃 | Set current for radiographic filament heating M72 (5V/5.00 A) (Adjustment trimmer VR13) (CP13) | |
| | | B-4 | FkV | Out | 〃 | Set value of fluoroscopic tube voltage M79 (5V/100kV) (Adjustment trimmer VR12) (CP12) | ANALOG-96 P. B. |
| | | C-4 | IRIS | Out | 〃 | Set value of iris release M66 (Adjustment trimmer VR9) (CP9) | MOTHER-96 JM2 → IRIS |
| | | A-5 | PHOTO | Out | 〃 | Set reference voltage for cutoff by photo-timer density M37 (Adjustment trimmer VR6) (CP7) | PH. CONT PH. POWER |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM43 | 3/12 | B-5 | *FLTD | In | a | Fault input signal (negative logic) {1 : 5V, 0 : 0V} | EMC-96 → |
| | | C-5 | *FLTC | 〃 | 〃 | | |
| | | A-6 | *FLTB | 〃 | 〃 | | |
| | | B-6 | *FLTA | 〃 | 〃 | | |

| *FLT DCBA | | Significance | Indication |
|---|---|---|---|
| 1 1 1 1 | not fault | Not fault | ——— |
| 1 1 1 0 | not fault | Not fault | ——— |
| 1 1 0 1 | S6, S7Open | Visual fluoroscopic position is not confirmed. | S6, S7Open |
| 1 1 0 0 | S4, S5Open | Visual radiographic position is not confirmed. | S4, S5Open |
| 1 0 1 1 | Door Open | Door of operational room is open. | Door Open |
| 1 0 1 0 | THERMAL OVER | Thermal circuit of X-ray tube has worked. | THERMAL OVER |
| 1 0 0 1 | STARTOR BRAKE | Starter is faulty. | STARTOR BRAKE |
| 1 0 0 0 | HVT NOt CONNECTED | High-voltage generator is not connected. | H.V.T.NOT CONNECTED |
| 0 1 1 1 | Charge Brake | Charged voltage of primary smoothing capacitor is faulty. | CHARGE OVER |
| 0 1 1 0 | IF over | Filament heating current is faulty. | IF OVER |
| 0 1 0 1 | PkV over (set kV over) | Set tube voltage is faulty. | PkV OVER |
| 0 1 0 0 | TkV over (mesured kV over) | Measured tube voltage is out of permissible range. | TkV OVER |
| 0 0 1 1 | Radio. Over current | Measured radiographic tube current is out of permissible range. | RADIOGRAPHY OVER CURRENT |
| 0 0 1 0 | Fluo. Over current | Measured fluoroscopic tube current is out of permissible range. | FLUOGRAPHY OVER CURRENT |
| 0 0 0 1 | Line Voltage Over | Power supply voltage is out of permissible range. | LINE VOLTAGE OVER |
| 0 0 0 0 | Power Down | Voltage of -15 V power is down. | −15V POWER DOWN |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | 3/12 | C-6 | *IAB | In | a | *IAB, *IAA: Input signal for changing visual field (negative logic) {1 : 5V, 0 : 0V} | EMC-96 → |
| | | A-7 | *IAA | 〃 | 〃 | | |
| | | B-7 | *DV1 | In | a | *DV1, *DV2, *DV3: Selection signal for operation with divided film | TERMINAL -96 |
| | | C-7 | *DV2 | 〃 | 〃 | | |
| | | A-9 | *DV3 | 〃 | 〃 | | |
| | | B-9 | *GR1 | In | a | *GR1 Grid signal | |
| | | A-8 | *KC | In | a | Preparation start signal for operation (starter, start of heating) | EMC-96 → |
| | | B-8 | *REA | 〃 | 〃 | Preparation finish signal for operation | |

| *IAB-IN | *IAA-IN | Visual field | |
|---|---|---|---|
| 1 | 1 | the largest | IF1 |
| 1 | 0 | the large | IF2 |
| 0 | 1 | the middle | IF3 |
| 0 | 0 | the small | IF4 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM43 | 3/12 | C-8 | *OKC | In | a | Charging voltage acknowledge signal for primary smoothing capacitor | ANALOG-96 → |
| | | C-9 | *INPSP7 | In | a | Spare input [TTL level] | |
| | | A-10 | *INPSP8 | 〃 | 〃 | Spare input [TTL level] | |
| | | B-10 | *XR-IN | 〃 | 〃 | Radiographic X-ray signal | EMC-96 → |
| | 4/12 | C-10 | *EXTEC | In | t | *EX-TECHC ┐ External selection signal | J8 → MOTHER-96 → |
| | | A-11 | *EXTEB | 〃 | 〃 | *EX-TECHB │ for operation method | |
| | | B-11 | *EXTEA | 〃 | 〃 | *EX-TECHA ┘ (code) (negative logic) {1: 5V, 0: 0V} | |
| | | | | | | *EX-TECH | |
| | | | | | | CBA / Operation method / Abbreviation | |
| | | | | | | 111 / Unused / — | |
| | | | | | | 110 / General radiography / GR | |
| | | | | | | 101 / Bucky's radiography 1 / BU1 | |
| | | | | | | 100 / Auto-changer / OX | |
| | | | | | | 011 / Tomography / PL | |
| | | | | | | 010 / Bucky's radiography 2 / BU2 | |
| | | | | | | 001 / Unused / — | |
| | | | | | | 000 / Unused / — | |
| | | C-11 | *RDER | In | t | Selection signal for reader operation | |
| | | A-12 | EXPWB | In | t | Common power supply for signal input | |
| | | B-12 | *INSP12 | 〃 | 〃 | Spare input [current loop] | |
| | | C-12 | *INSP13 | 〃 | 〃 | Spare input [current loop] | |
| | | A-13 | *OUTSP2 | Out | g | Spare output | |
| | | B-13 | *OUTSP3 | 〃 | 〃 | 〃 | |
| | | C-13 | *OUTSP4 | 〃 | 〃 | 〃 | |
| | | A-14 | *OUTSP5 | 〃 | 〃 | 〃 | |
| | | B-14 | *OUTSP6 | 〃 | 〃 | 〃 | |
| | | C-14 | *OUTSP7 | 〃 | 〃 | 〃 | |
| | | A-15 | *OUTSP8 | 〃 | 〃 | 〃 | |
| | | B-15 | *FDS3 | Out | g | ┐ Pick-up field selection signal for photo-timer | → PH. CONT PH. POWER -96 |
| | | C-15 | *FDS2 | 〃 | 〃 | │ Three selection signals input to PH | |
| | | A-16 | *FDS1 | 〃 | 〃 | ┘ POWER-96 board (negative logic) {1: 5V, 0: 0V} | |
| | | | | | | *FDS1 / *FDS2 / *FDS3 / Pick-up field | |
| | | | | | | 0 / 1 / 1 / | |
| | | | | | | 1 / 0 / 1 / | |
| | | | | | | 1 / 1 / 0 / | |
| | | B-16 | *Bacomp | Out | g | Selection signal for compensating barium covering ratio | → PH POWER-96 |
| | | C-16 | *OUTSP0 | Out | g | Spare output | |
| | | A-17 | *OUTSP11 | 〃 | 〃 | 〃 | |
| | | B-17 | *OUTSP12 | 〃 | 〃 | 〃 | |
| | | C-17 | *OUTSP13 | 〃 | 〃 | 〃 | |
| | | A-18 | *OUTSP14 | 〃 | 〃 | 〃 | |
| | 3/12 | B-18 | *PHM | Out | g | PH. Multi selection signal | → PH. CONT PH. POWER |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM43 | 3/12 | C-18 | *DET4 | Out | g | Photo-timer receptor number 4 (IFG) selection signal | → PH. CONT PH. POWER -96 |
| | | A-19 | *DET3 | 〃 | 〃 | Photo-timer receptor number 3 (IFG) selection signal | |
| | | B-19 | *DET2 | 〃 | 〃 | Photo-timer receptor number 2 (IFG) selection signal | |
| | | C-19 | *IBS | Out | g | IBS selection signal | → PH. POWER ANALOG-96 |
| | | A-20 | *PHS | Out | g | PH. Single selection signal | → PH. CONT PH. POWER -96 |
| | | B-20 | *Buzzer1 | Out | g | [Unused] | |
| | | C-20 | *Buzzer2 | 〃 | 〃 | [Unused] | |
| | 5/12 | A-21 | *SOF | Out | g | X-ray cutoff signal from timer | → EMC-96 |
| | | B-21<br>C-21<br>A-22<br>B-22 | *TECHA<br>*TECHB<br>*TECHC<br>*TECHD | Out<br>〃<br>〃<br>〃 | g<br>〃<br>〃<br>〃 | Selection signal output for EMC operation {1: 5V / 0: 0V}<br><br>*TECH<br>DCBA — Operation method — Code<br>1111 — Unused — —<br>1110 — General radiography — GR<br>1101 — Bucky's radiography 1 — BU1<br>1100 — Bucky's radiography 2 — BU2<br>1011 — Tomography — PL<br>1010 — Auto-changer — OX<br>1001 — MAMMO radiography (unused) — MAMM<br>1000 — Direct spot filming — FSP<br>0111 — Indirect spot filming — IFG<br>0110 — Indirect serial radiography — CRS<br>0101<br>0100 — Direct serial radiography — SEST<br>0011<br>0010<br>0001 — DSA radiography — DSP<br>0000 — CINE radiography — CIN | |
| | | C-22 | *OUTSP16 | Out | g | Spare output signal [TTL level] | |
| | | A-23 | *HST | Out | g | Hand switch effective signal | → EMC-96 |
| | | B-23 | *FSP1+ *IFG | 〃 | 〃 | Direct high-speed radiography or I.I. indirect high-speed radiography High-speed radiography selection signal | |
| | | C-23 | *IICAME RA-IN | Out | g | I.I. indirect camera selection signal | |
| | | A-24<br>B-24 | *IAB-0<br>*IAA-0 | Out<br>〃 | g<br>〃 | *IAB0, *IAA0: Signal output for changing visual field (negative logic) {1: 5V / 0: 0V}<br><br>*IAB0 — *IAA0 — Visual field<br>1 — 1 — largest IF1<br>1 — 0 — large IF2<br>0 — 1 — middle IF3<br>0 — 0 — small IF4 | → EMC-96 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM43 | 5/12 | C-24 | *NOKU-IN | Out | g | Signal to invalidate double exposure prevention circuit | → EMC-96 P. B |
| | | A-25 | *LOWmA | 〃 | 〃 | Selection signal for low tube current | |
| | | B-25 | *FSAON | 〃 | 〃 | Signal to rotate X-ray tube anode in fluoroscopic operation | |
| | | C-25 | *SPSWE | 〃 | 〃 | Signal to validate high-speed operation | |
| | | A-26 | *OUTSP15 | 〃 | 〃 | Spare output signal [TTL level] | |
| | | B-26 | *FL | 〃 | 〃 | Signal to enable fluoroscopic operation | |
| | | C-26 | *LOVE | 〃 | 〃 | Signal indicating to be out of conditions for radiographic operation | |
| | | A-27 | *HOVE | 〃 | 〃 | Signal indicating to be over anode-heat-capacity of X-ray tube (unused) | |
| | | B-27 | *FOVE | 〃 | 〃 | Signal indicating 5 minutes over in fluoroscopic operation | |
| | | C-27 | *NOX | 〃 | 〃 | Signal to prohibit X-ray exposure | |
| | | A-28 | *HIG | 〃 | 〃 | Signal to rotate X-ray tube anode in high speed | |
| | | B-28 | *MASP-IN | 〃 | 〃 | Signal to stop operation of heating circuit | |
| | | C-28 | *SCD | 〃 | 〃 | Signal to invalidate a circuit function to assure actions of general radiographic devices | |
| | | A-29 | *OUTSP1 | 〃 | 〃 | Spare output signal [TTL level] | |
| | | B-29 | *TUA | Out | g | X-ray tube number selection signal (negative logic) {1: 5V, 0: 0V}<br>*TUA / *TUB / X-ray tube number<br>1 / 1 / Unused<br>1 / 0 / TUBE 1<br>0 / 1 / TUBE 2<br>0 / 0 / TUBE 3 | → EMC-96 |
| | | C-29 | *TUB | 〃 | 〃 | | |
| | | A-30 | *OUTSP19 | Out | g | Spare output signal [TTL level] | |
| | | B-30 | *FOB | Out | g | X-ray tube focus selection signal (negative logic) {1: 5V, 0: 0V}<br>*FOB / *FOA / X-ray tube focus<br>1 / 1 / Unused<br>1 / 0 / Unused Small focus<br>0 / 1 / Large focus<br>0 / 0 / Micro focus (unused) | → EMC-96 |
| | | C-30 | *FOA | 〃 | 〃 | | |
| | | A-31 | GND | In | | GND input | Mother-96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | | |
| | | A-32 | 〃 | 〃 | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J60 | 10/12 | 1 | PH-DET | In | | Photo-current input signal from photo-diode (unused) | PH. DIODE |
| | | 2 | GND | Out | | GND output | |
| | | 3 | +15V | 〃 | | +15 V output | |
| | | 4 | −15V | 〃 | | −15 V output | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J61 | 8/12 | A-1 | A1− | Out | v | | DUAL PORT -96 J61 |
| | | B-1 | A1+ | 〃 | 〃 | | |
| | | A-2 | A2− | 〃 | 〃 | | |
| | | B-2 | A2+ | 〃 | 〃 | | |
| | | A-3 | A3− | 〃 | 〃 | | |
| | | B-3 | A3+ | 〃 | 〃 | | |
| | | A-4 | A4− | 〃 | 〃 | | |
| | | B-4 | A4+ | 〃 | 〃 | | |
| | | A-5 | A5− | 〃 | 〃 | | |
| | | B-5 | A5+ | 〃 | 〃 | | |
| | | A-6 | A6− | 〃 | 〃 | | |
| | | B-6 | A6+ | 〃 | 〃 | | |
| | | A-7 | A7− | 〃 | 〃 | | |
| | | B-7 | A7+ | 〃 | 〃 | | |
| | | A-8 | A8− | 〃 | 〃 | | |
| | | B-8 | A8+ | 〃 | 〃 | Adress Bus OUT PUT | |
| | | A-9 | A9− | 〃 | 〃 | | |
| | | B-9 | A9+ | 〃 | 〃 | | |
| | | A-10 | A10− | 〃 | 〃 | | |
| | | B-10 | A10+ | 〃 | 〃 | | |
| | | A-11 | A11− | 〃 | 〃 | | |
| | | B-11 | A11+ | 〃 | 〃 | | |
| | | A-12 | A12− | 〃 | 〃 | | |
| | | B-12 | A12+ | 〃 | 〃 | | |
| | | A-13 | A13− | 〃 | 〃 | | |
| | | B-13 | A13+ | 〃 | 〃 | | |
| | | A-14 | A14− | 〃 | 〃 | | |
| | | B-14 | A14+ | 〃 | 〃 | | |
| | | A-15 | (A15−) | 〃 | 〃 | | |
| | | B-15 | (A15+) | 〃 | 〃 | | |
| | | A-16 | (A16−) | 〃 | 〃 | | |
| | | B-16 | (A16+) | 〃 | 〃 | | |
| | 9/12 | A-17 | D0− | In/out | w | | |
| | | B-17 | D0+ | 〃 | 〃 | | |
| | | A-18 | D1− | 〃 | 〃 | | |
| | | B-18 | D1+ | 〃 | 〃 | Data Bus | |
| | | A-19 | D2− | 〃 | 〃 | | |
| | | B-19 | D2+ | 〃 | 〃 | | |
| | | A-20 | D3− | 〃 | 〃 | | |
| | | B-20 | D3+ | 〃 | 〃 | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J61 | 9/12 | A-21 | D4– | In/out | w | Data Bus | DUAL PORT -96 J61 |
| | | B-21 | D4+ | 〃 | 〃 | | |
| | | A-22 | D5– | 〃 | 〃 | | |
| | | B-22 | D5+ | 〃 | 〃 | | |
| | | A-23 | D6– | 〃 | 〃 | | |
| | | B-23 | D6+ | 〃 | 〃 | | |
| | | A-24 | D7– | 〃 | 〃 | | |
| | | B-24 | D7+ | 〃 | 〃 | | |
| | | A-25 | D8– | 〃 | 〃 | | |
| | | B-25 | D8+ | 〃 | 〃 | | |
| | | A-26 | D9– | 〃 | 〃 | | |
| | | B-26 | D9+ | 〃 | 〃 | | |
| | | A-27 | D10– | 〃 | 〃 | | |
| | | B-27 | D10+ | 〃 | 〃 | | |
| | | A-28 | D11– | 〃 | 〃 | | |
| | | B-28 | D11+ | 〃 | 〃 | | |
| | | A-29 | D12– | 〃 | 〃 | | |
| | | B-29 | D12+ | 〃 | 〃 | | |
| | | A-30 | D13– | In/out | w | Data Bus | |
| | | B-30 | D13+ | 〃 | 〃 | | |
| | | A-31 | D14– | 〃 | 〃 | | |
| | | B-31 | D14+ | 〃 | 〃 | | |
| | | A-32 | D15– | 〃 | 〃 | | |
| | | B-32 | D15+ | 〃 | 〃 | | |
| | 8/12 | A-33 | *READ– | Out | v | READ SIGNAL | → DUAL PORT -96 J61 |
| | | B-33 | *READ+ | 〃 | 〃 | | |
| | | A-34 | *WRL– | Out | v | WRITE SIGNAL (LOW D0 ~ D7) | |
| | | B-34 | *WRL+ | 〃 | 〃 | | |
| | | A-35 | *WRH– | 〃 | 〃 | WRITE SIGNAL (HIGH D8 ~ D15) | |
| | | B-35 | *WRH+ | 〃 | 〃 | | |
| | | A-36 | *SEL8441– | Out | v | 8224 menory Select SIGNAL | |
| | | B-36 | *SEL8441+ | 〃 | 〃 | | |
| | | A-37 | *BSY8441– | In | u | 8224 menory BUSY INPUT SIGNAL | DUAL PORT -96 J61Æ |
| | | B-37 | *BSY8441+ | 〃 | 〃 | | |
| | | A-38 | *INT8441– | In | u | 8224 menory INTERRUPT INPUT SIGNAL | |
| | | B-38 | *INT8441+ | 〃 | 〃 | | |
| | | A-39 | *SPE1– | Out | v | | → DUAL PORT -96 J61 |
| | | B-39 | *SPE1+ | 〃 | 〃 | | |
| | | A-40 | *SPE2– | 〃 | 〃 | | |
| | | B-40 | *SPE2+ | 〃 | 〃 | | |
| | 9/12 | A-41 | PW (+15V) | In | v | Acknowledge signal for cable connection | DUAL PORT -96 J61 → |
| | | B-41 | *CNET (GND) | 〃 | 〃 | | |
| | 8/12 | A-42 | *XR– | Out | v | X-ray radiation signal [for LED display, BUZZER] | → DUAL PORT -96 J61 |
| | | B-42 | *XR+ | 〃 | 〃 | | |
| | | A-43 | *KC– | 〃 | 〃 | Signal for preparation of radiographic operation [for LED display] | |
| | | B-43 | *KC+ | 〃 | 〃 | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J61 | 8/12 | A-44 | (unused) | — | — | | → DUAL PORT -96 J61 |
| | | B-44 | 〃 | 〃 | 〃 | | |
| | | A-45 | 〃 | 〃 | 〃 | | |
| | | B-45 | 〃 | 〃 | 〃 | | |
| | | A-46 | 〃 | 〃 | 〃 | | |
| | | B-46 | 〃 | 〃 | 〃 | | |
| | | A-47 | 〃 | 〃 | 〃 | | |
| | | B-47 | 〃 | 〃 | 〃 | | |
| | | A-48 | 〃 | 〃 | 〃 | | |
| | | B-48 | 〃 | 〃 | 〃 | | |
| | | A-49 | GND | In | | GND output | |
| | | B-49 | 〃 | 〃 | | | |
| | | A-50 | 〃 | 〃 | | | |
| | | B-50 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J62 | 8/12 | A-1 | A1− | Out | v | All J62 connectors unused<br>Adress Bus Out PUT | SHEET PANEL [no use] |
| | | B-1 | A1+ | 〃 | 〃 | | |
| | | A-2 | A2− | 〃 | 〃 | | |
| | | B-2 | A2+ | 〃 | 〃 | | |
| | 9/12 | A-3 | D0− | In/out | w | Data Bus | |
| | | B-3 | D0+ | 〃 | 〃 | | |
| | | A-4 | D1− | 〃 | 〃 | | |
| | | B-4 | D1+ | 〃 | 〃 | | |
| | | A-5 | D2− | 〃 | 〃 | | |
| | | B-5 | D2+ | 〃 | 〃 | | |
| | | A-6 | D3− | 〃 | 〃 | | |
| | | B-6 | D3+ | 〃 | 〃 | | |
| | | A-7 | D4− | In/out | 〃 | | |
| | | B-7 | D4+ | 〃 | 〃 | | |
| | | A-8 | D5− | 〃 | 〃 | | |
| | | B-8 | D5+ | 〃 | 〃 | | |
| | | A-9 | D6− | 〃 | 〃 | | |
| | | B-9 | D6+ | 〃 | 〃 | | |
| | | A-10 | D7− | In/out | 〃 | | |
| | | B-10 | D7+ | 〃 | 〃 | | |
| | 8/12 | A-11 | *READ− | Out | v | READ SIGNAL | |
| | | B-11 | *READ+ | 〃 | 〃 | | |
| | | A-12 | *WRL− | Out | v | WRITE SIGNAL (LOW D0 ~ D7) | |
| | | B-12 | *WRL+ | 〃 | 〃 | | |
| | | A-13 | A8− | Out | v | adress Bus OUT PUT | |
| | | B-13 | A8+ | 〃 | 〃 | | |
| | | A-14 | RESET− | Out | v | RESET SIGNAL OUTPUT | |
| | | B-14 | RESET+ | 〃 | 〃 | | |

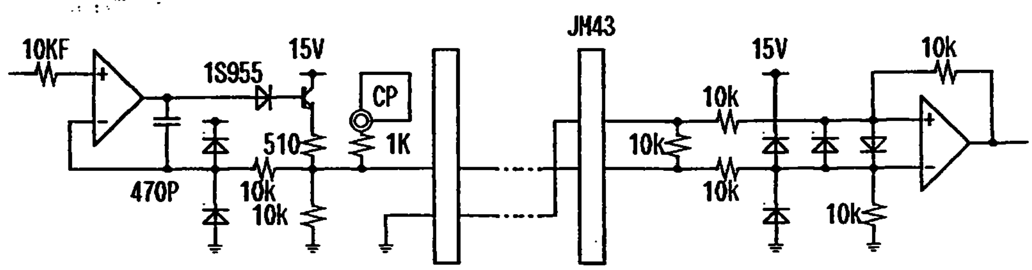
| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J62 | 8/12 | A-15 | *SEL8279-1– | Out | v | IC [8279] SELECT SIGNAL OUT PUT | SHEET PANEL [no use] |
| | | B-15 | *SEL8279-1+ | 〃 | 〃 | | |
| | | A-16 | *SEL8279-2– | 〃 | 〃 | | |
| | | B-16 | *SEL8279-2+ | 〃 | 〃 | | |
| | | A-17 | *SEL8279-3– | 〃 | 〃 | | |
| | | B-17 | *SEL8279-3+ | 〃 | 〃 | | |
| | | A-18 | *SEL8279-4– | 〃 | 〃 | | |
| | | B-18 | *SEL8279-4+ | 〃 | 〃 | | |
| | | A-19 | *EXTINT1– | In | u | IC [8279] INTR. SIGNAL IN PUT | |
| | | B-19 | *EXTINT1+ | 〃 | 〃 | | |
| | | A-20 | *EXTINT2– | 〃 | 〃 | | |
| | | B-20 | *EXTINT2+ | 〃 | 〃 | | |
| | | A-21 | *SEL8279-5– | In/out | 〃 | IC [8279] SELECT SIGNAL OUT PUT | |
| | | B-21 | *SEL8279-5+ | 〃 | 〃 | | |
| | | A-22 | *SEL8279-6– | 〃 | 〃 | | |
| | | B-22 | *SEL8279-6+ | 〃 | 〃 | | |
| | 9/12 | A-23 | PW (+15V) | In | 〃 | Acknowledge signal for cable connection | |
| | | B-23 | *CNET (GND) | 〃 | | | |
| | | A-24 | GND | Out | | GND output | |
| | | B-24 | 〃 | 〃 | | | |
| | | A-25 | 〃 | 〃 | | | |
| | | B-25 | 〃 | 〃 | | | |

[2] Input and output circuit

Input and output circuits for each signal are as follows.

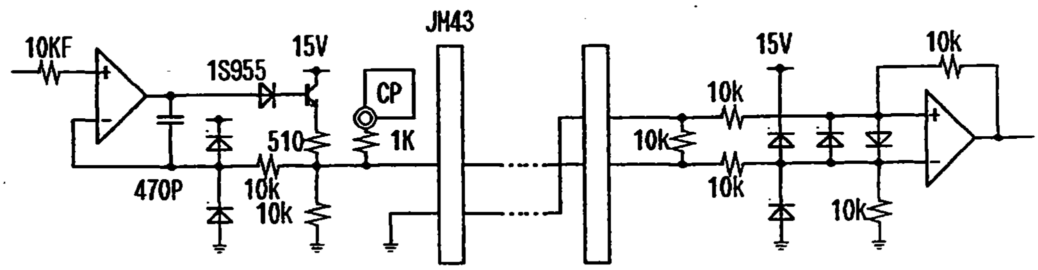
[r] Analog signal input circuit [No. 1]

ANALOG-96 board mA POWER-96 MOTHER-96 I/O CONT-96 board



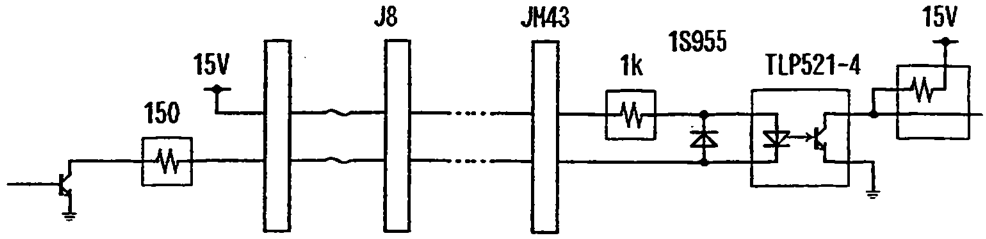

[s] Analog signal output circuit [No. 1]

I/O CONT-96 board MOTHER-96 ANALOG-96 board mA POWER-96



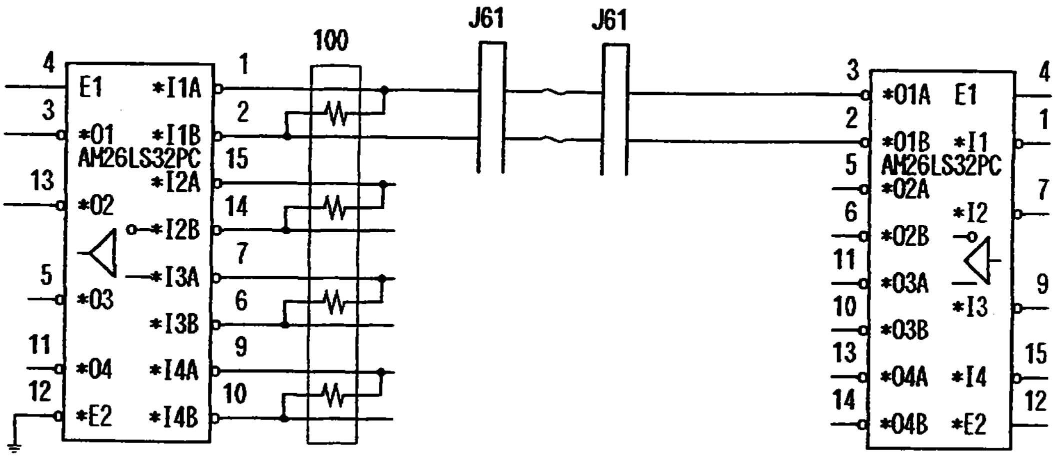
## [t] Digital signal input circuit [No. 9]

External devices (YSF220, etc) MOTHER-96 I/O CONT-96 board



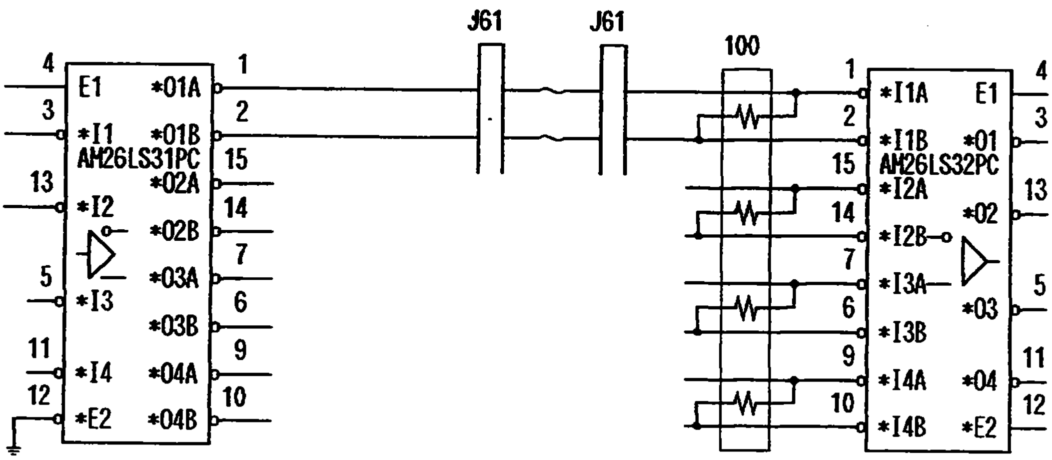

## [u] Digital signal input circuit [422 I/F input]

I/O CONT-96 board Cable DUAL PORT-96 board




## [v] Digital signal input circuit

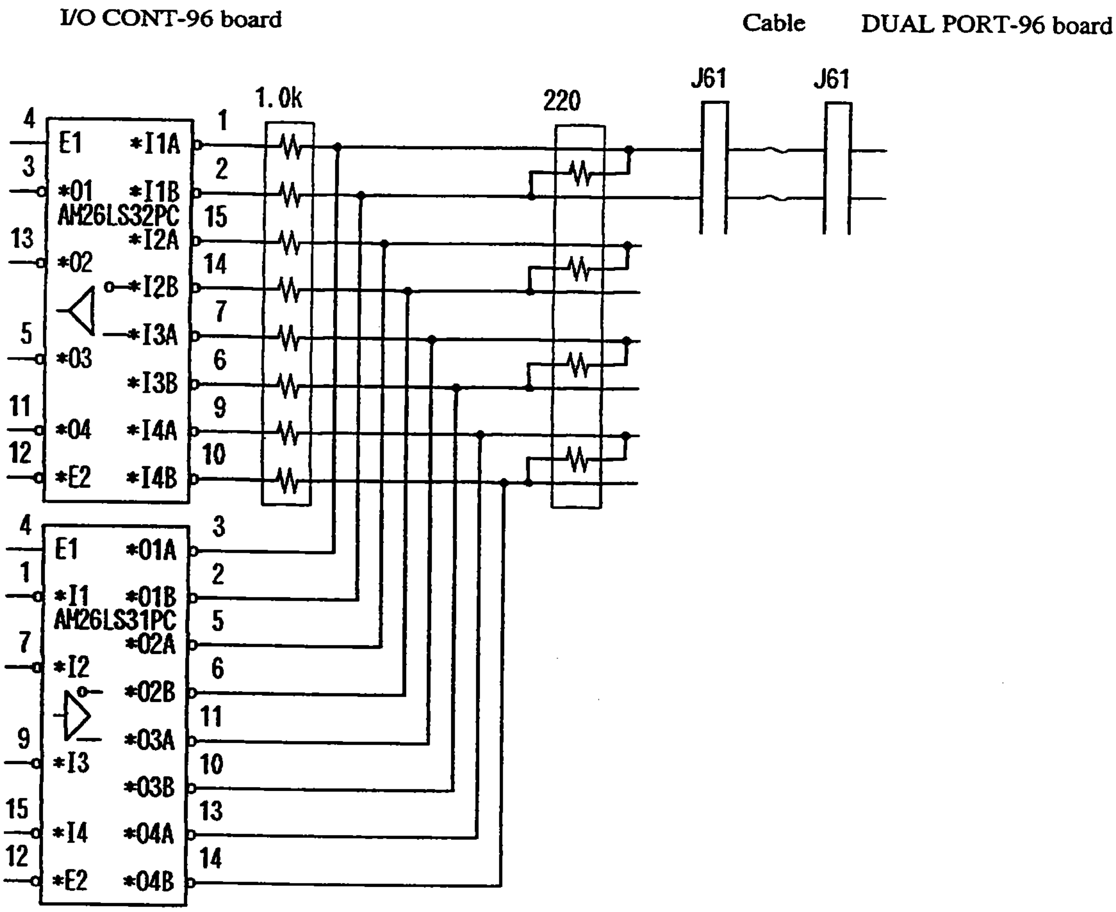
I/O CONT-96 board Cable DUAL PORT-96 board






49

[w] Digital Input and output circuits [No. 1] (Data Bus)

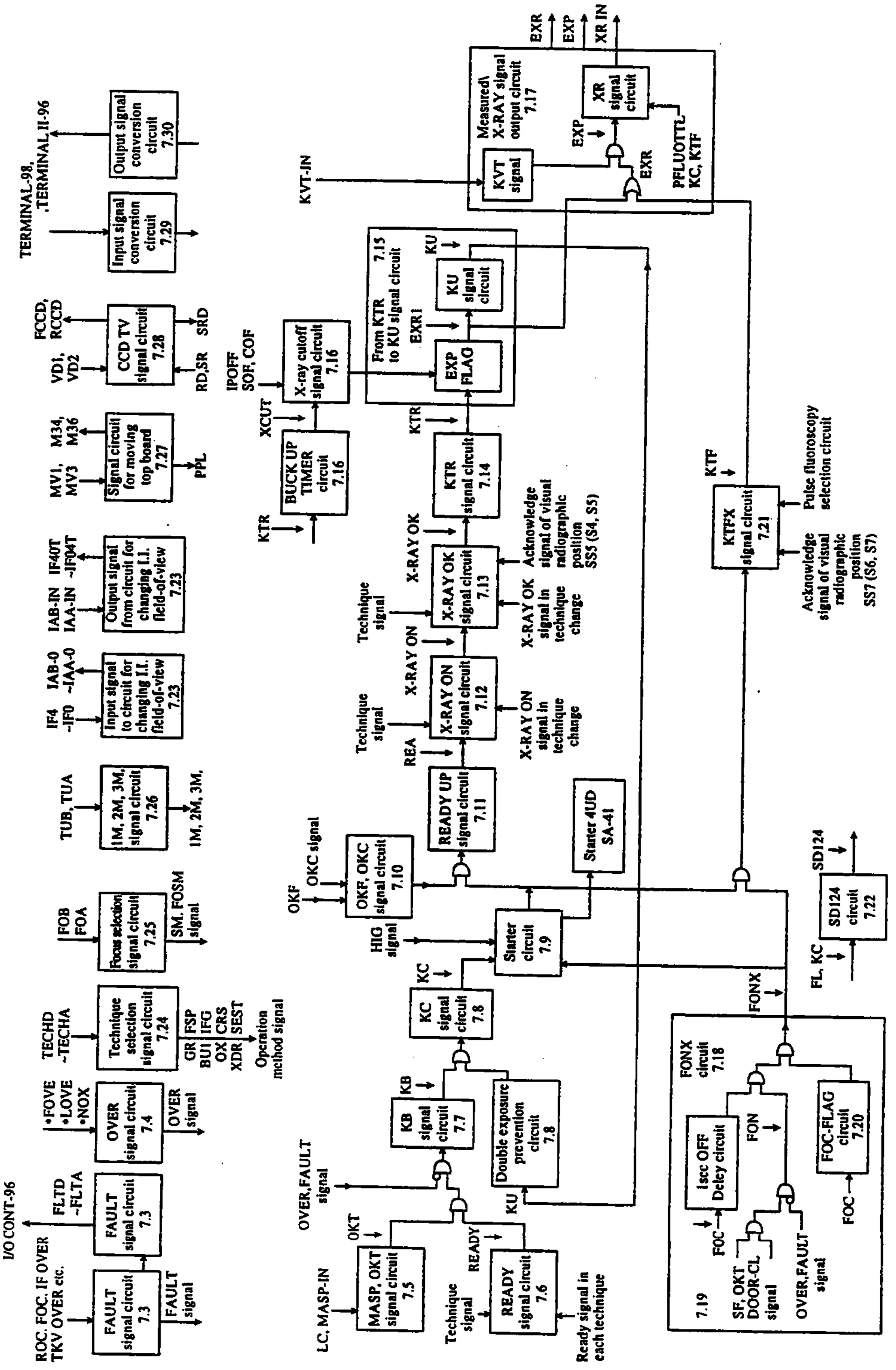


# 7. EMC-96 board

EMC-96 board controls external devices for X-ray radiation through TERMINAL-96 and TERMINAL II -96 (in both radiographic and fluoroscopic operation).

## 7.1 Block diagram of EMC-96 board

Block diagram of X-ray radiation control (in both radiographic and fluoroscopic operation) is shown below.

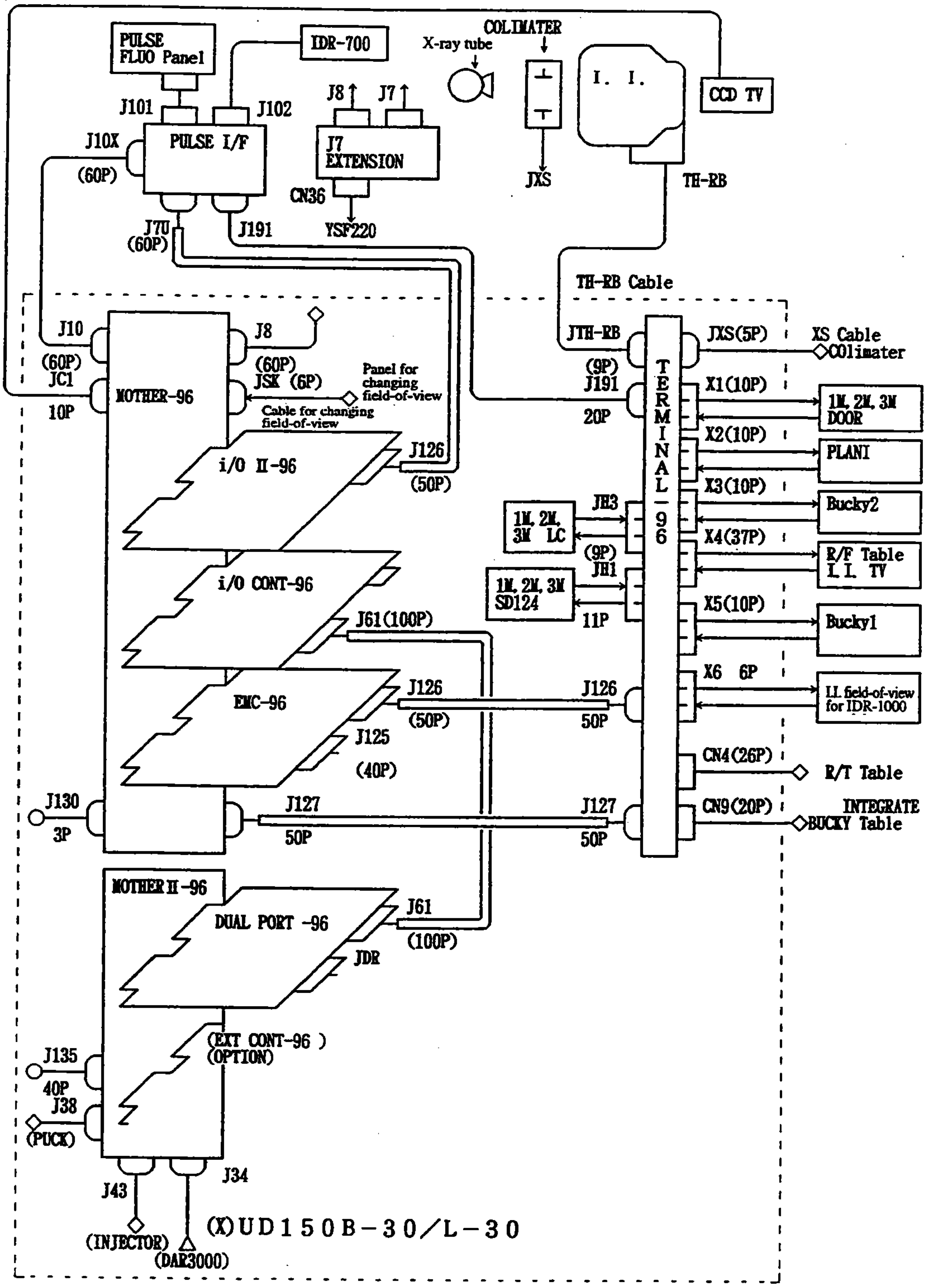



Block diagram of EMC-96

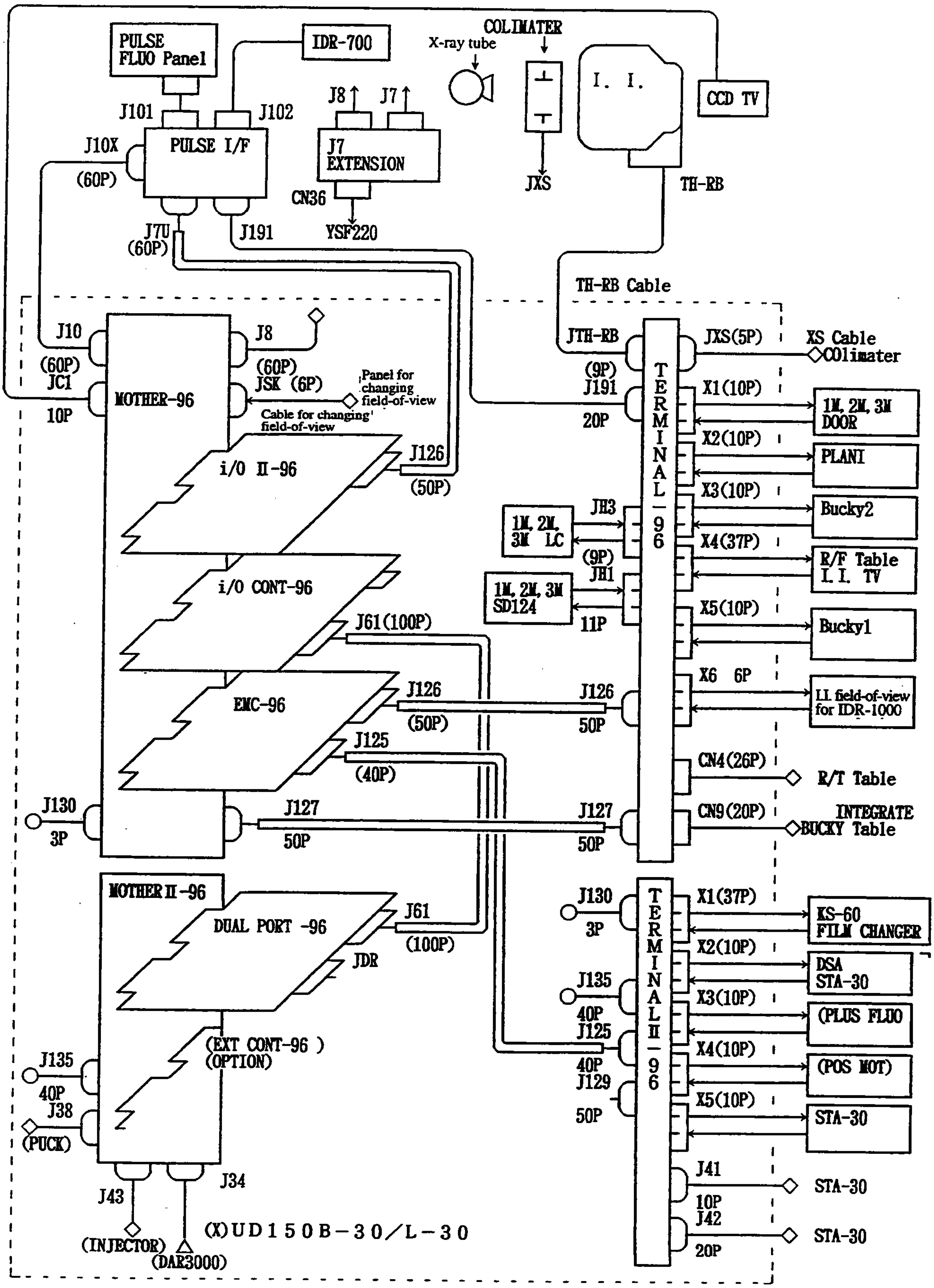
## 7.2 External device connection diagram

In accordance with combined external devices (film changer, DAR3000, etc.) optional control boards are added and their connections are changed.

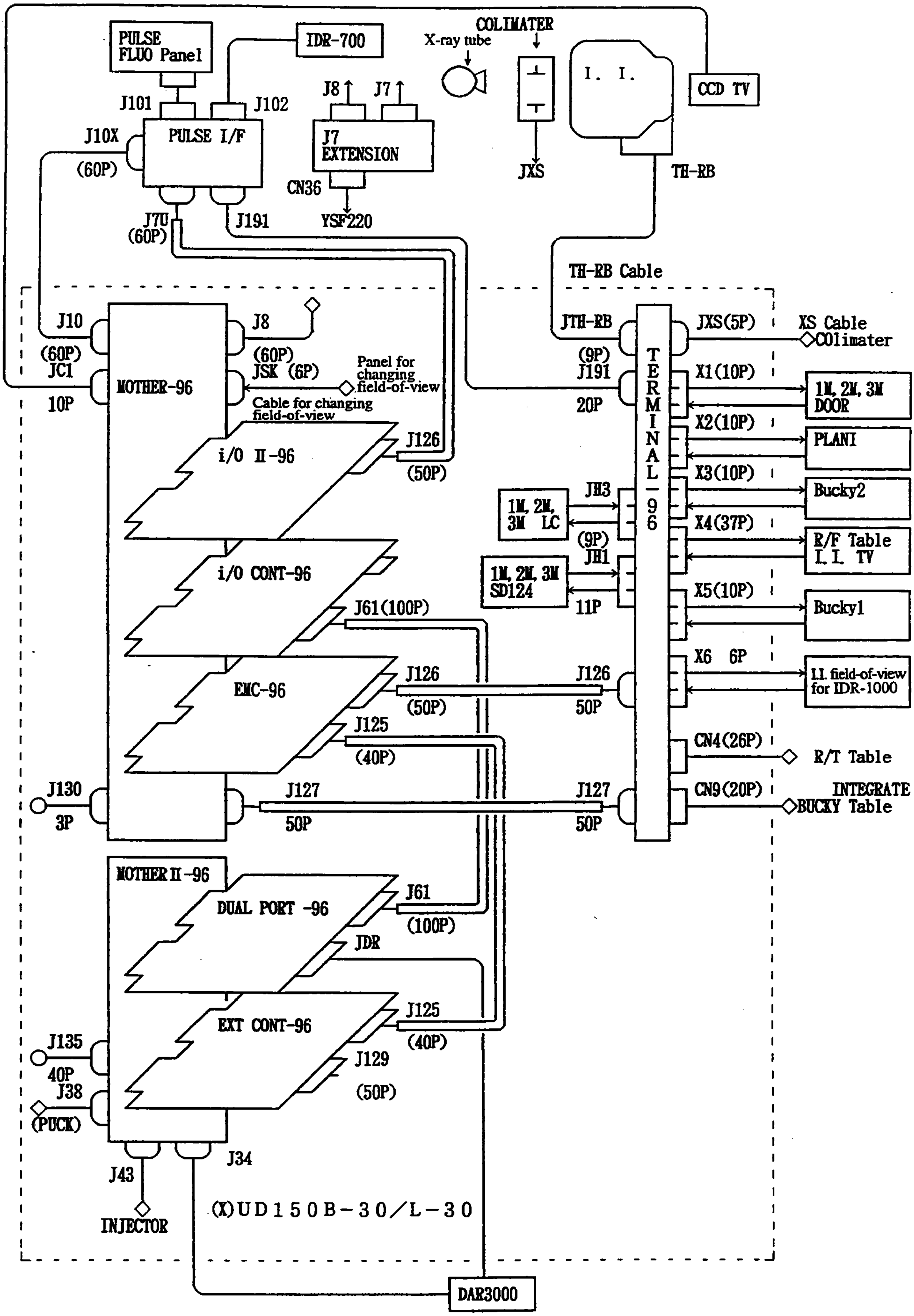
Connections between external devices and EMC-96 board, EXT CONT-96 board, TERMINAL-96, and TERMINAL II -96 board are shown below.



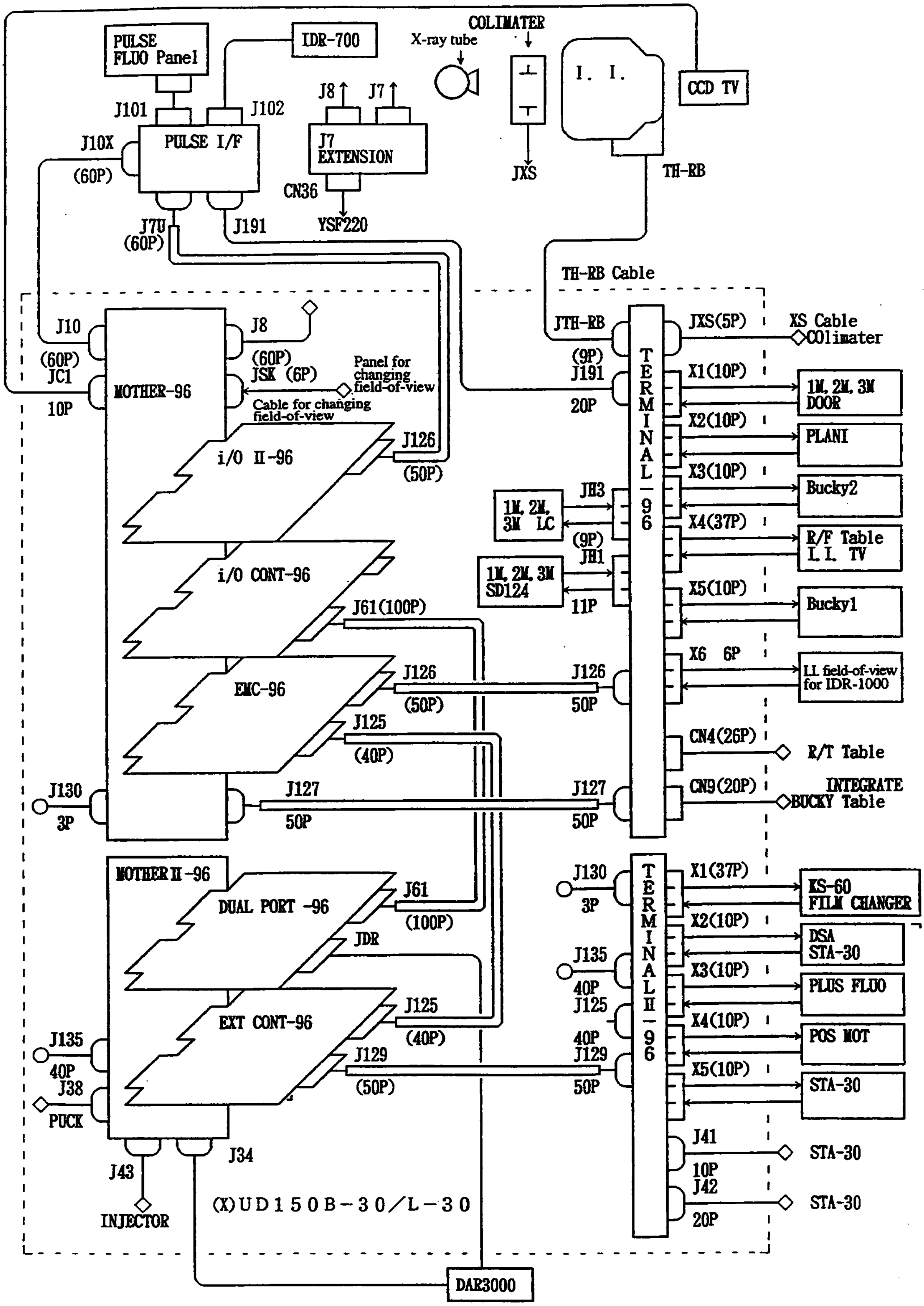

**(X) UD150B-30/L-30 Connections of external devices (standard configuration)**




**(X) UD150B-30/L-30 Connections of external devices (standard configuration + ANGIO I/F)**




**(X) UD150B-30/L-30 Connections of external devices (standard configuration + DAR3000)**



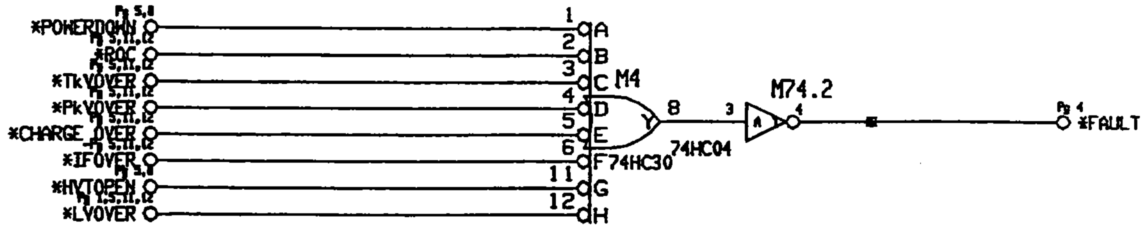

**(X) UD150B-30/L-30 Connections of external devices (standard configuration + DAR3000 + ANGIO I/F)**

## 7.3 FAULT signal circuit

(1) OVER-Brake signals from MOTHER-96

OVER-Brake signals from MOTHER-96 are transmitted to EMC-96 board through connector JM34.

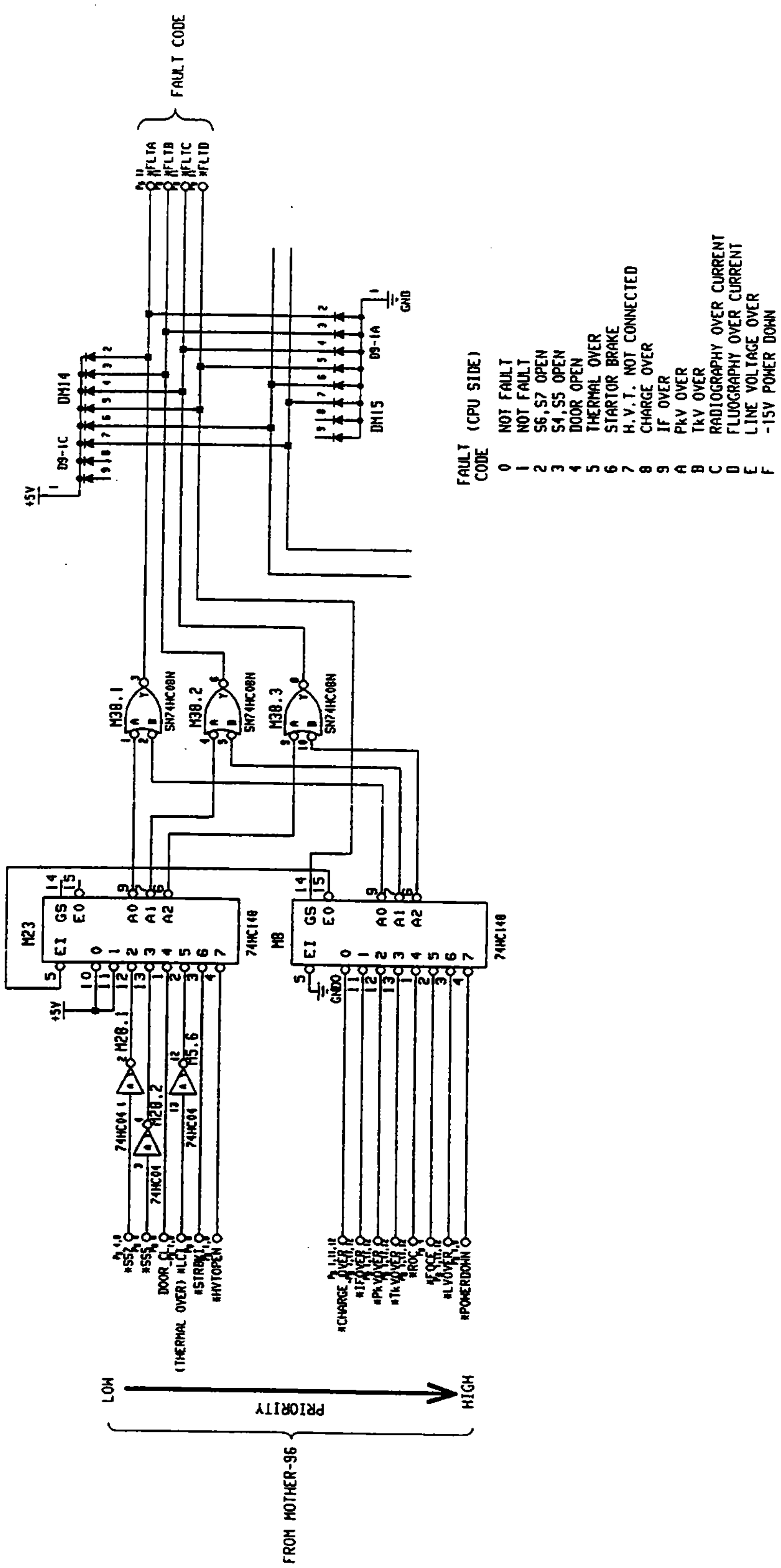
While these signals are outputted, READY operation for fluoroscopy can not be executed.




| Signa | JM34 Pin No | Significance | Indication |
|---|---|---|---|
| *POWER DOWN | —— | Voltage of −15 V power is down | −15 Power Down |
| *ROC | C-10 | Measured radiographic tube current is out of permissible range. | RADIO GRAPHY OVER current |
| *TkVOVER | A-11 | Measured tube voltage is out of permissible range. | TkV over |
| *PkVOVER | B-11 | Set tube voltage is faulty. | PkV over |
| *CHARGE-OVER | C-11 | Charged voltage of primary smoothing capacitor is faulty. | CHARGE OVER |
| *IFOVER | A-12 | Filament heating current is faulty. | IF over |
| *HVT OPEN (*OKHVT) | B-12 | High-voltage generator is not connected. | H.V.T.NOT CONNECTED |
| *LVOVER | C-12 | Power supply voltage is out of permissible range | Line Voltage Over |

(2) FAULT signal to I/O CONT-96 board

OVER-Brake signals from MOTHER-96 are encoded to 4-bit signals (FLTA, FLTB, FLTC, and TLTD) and transmitted to I/O CONT-96 board through connectors JM44 and JM34.








53

| FLTA ~ FLTD | FAULT signal output to I/O CONT-96 board |
|---|---|

OVER-Brake signals inputted from each board in base rack are encoded to FAULT signals *FLTA ~ *FLTD (binary) (negative logic) and outputted to I/O CONT-96 board.

The CPU on NEXSC board reads the FAULT signals from I/O CONT-96 board and shows their messages on EL display.

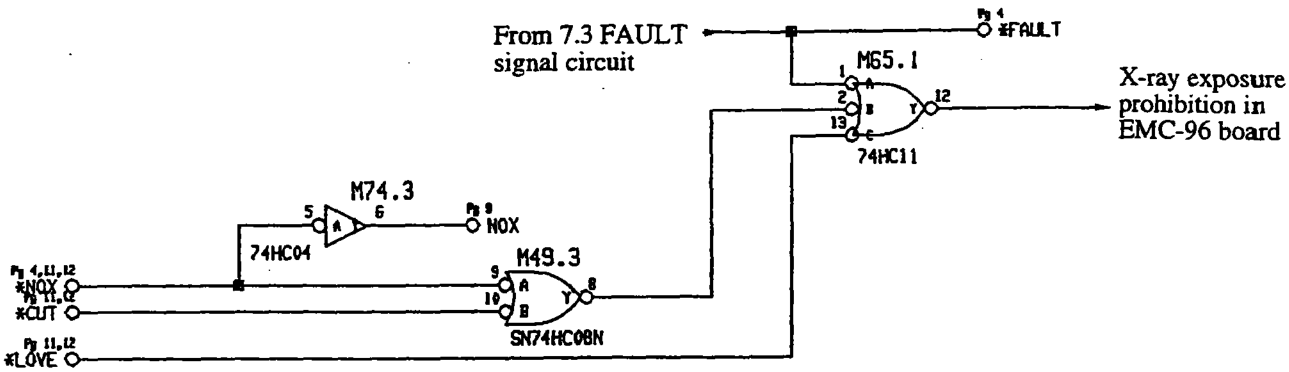
| FAULT signal (binary) | | | | | OVER-Brake signals inputted from each board in base rack | | |
|---|---|---|---|---|---|---|---|
| Signal | *FLT | | | | Encoder input signal | Significance | Message on EL display |
| | D | C | B | A | | | |
| JM44 Pin No | B-5 | C-5 | A-6 | B-6 | | | |
| Value | 1 | 1 | 1 | 1 | not fault | Not fault | ——— |
| | 1 | 1 | 1 | 0 | not fault | Not fault | ——— |
| | 1 | 1 | 0 | 1 | S6, S7Open | Visual fluoroscopic position is not confirmed. | S6, S7 OPEN |
| | 1 | 1 | 0 | 0 | S4, S5Open | Visual radiographic position is not confirmed. | S4, S5 OPEN |
| | 1 | 0 | 1 | 1 | Door Open | Door of operational room is open. | Door Open |
| | 1 | 0 | 1 | 0 | THERMAL OVER | Thermal circuit of X-ray tube has worked | Thermal Over |
| | 1 | 0 | 0 | 1 | STARTOR BRAKE | Starter is faulty. | Startor Brake |
| | 1 | 0 | 0 | 0 | HVT OPEN | High-voltage generator is not connected. | H.V.T.NOT CONNECTED |
| | 0 | 1 | 1 | 1 | CHARGE OVER | Charged voltage of primary smoothing capacitor is faulty | Charge OVER |
| | 0 | 1 | 1 | 0 | IF OVER | Filament heating current is faulty. | IF.OVER |
| | 0 | 1 | 0 | 1 | PkV OVER | Set tube voltage is faulty. | PKV OVER |
| | 0 | 1 | 0 | 0 | TkV OVER | Measured tube voltage is out of permissible range. | TKV OVER |
| | 0 | 0 | 1 | 1 | ROC | Measured radiographic tube current is more than set value of +200 mA. | RADIO GRAPHY Over Current |
| | 0 | 0 | 1 | 0 | FOC | Measured fluoroscopic tube current is more than 10 mA. | FLUOGRAPHY Over Current |
| | 0 | 0 | 0 | 1 | LVOVER | Power supply voltage is out of permissible range. | Line Voltage OVER |
| | 0 | 0 | 0 | 0 | POWER DOWN | Voltage of −15 V power is down. | −15 Power Down |

{1 : 5V, 0 : 0V}

## 7.4 OVER-Prohibition signal from I/O CONT-96 board

OVER-Prohibition signals (CUT, LOVE, NOX, and HOVE) are transmitted to EMC-96 board through MOTHER-96 board and connector JM44.

While these signals are outputted, READY operation can not be executed.

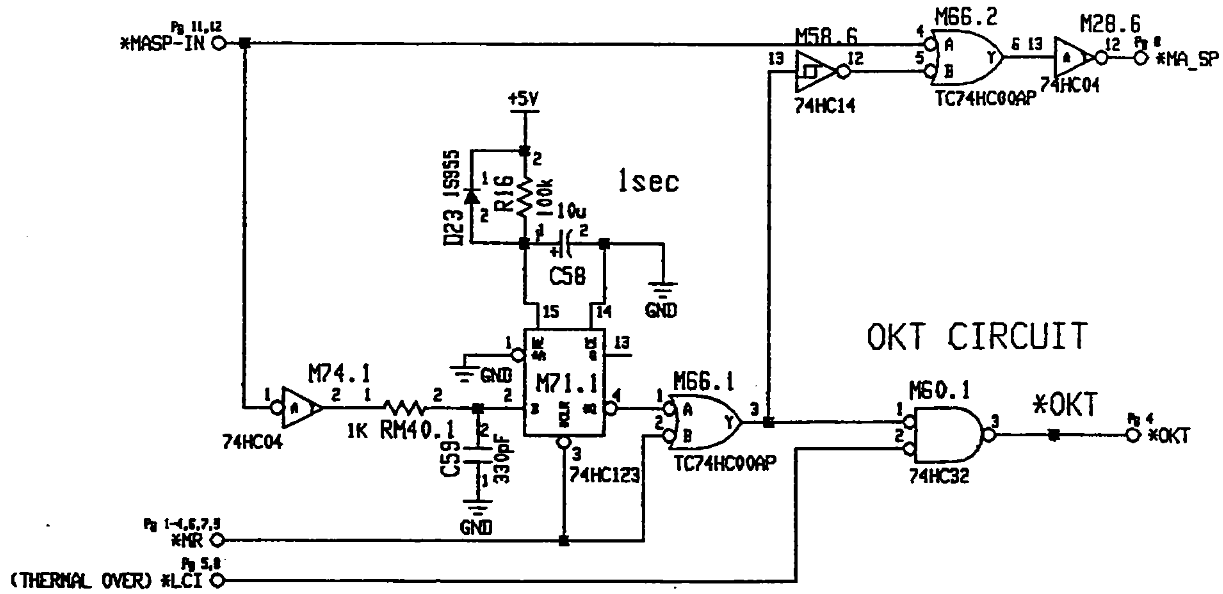



| OVER-Prohibition signals from I/O CONT-96 board | | | |
|---|---|---|---|
| Signal (negative logic) | JM44 Pin No | Significance | Destination |
| *NOX | C-27 | Signal to prohibit X-ray exposure | I/O CONT-96 |
| *CUT | A-16 | Signal to cutoff CINE-cut | I/O II -96 |
| *LOVE | C-26 | Signal indicating to be out of conditions for radiographic operation | I/O CONT-96 |
| *HOVE | A-27 | Signal indicating to be over anode-heat-capacity of X-ray tube (unused) | 〃 |

## 7.5 MASP-OKT signal circuit

In heating by externally combined devices (STA-30, etc.) or changing a tube and focus, MASP-IN signal is output from I/O CONT-96 board and stops a heating control circuit in the apparatus.

At the same time, after confirming that the thermal switch of X-ray tube is not operative, OKT signal is output.




| | |
|---|---|
| MASP-IN | Signal to stop filament-heating control in mA POWER-96 board |
| OKT | Acknowledge signal for thermal switch of X-ray tube and MASP OK |

MASP signal is output in the following two cases.

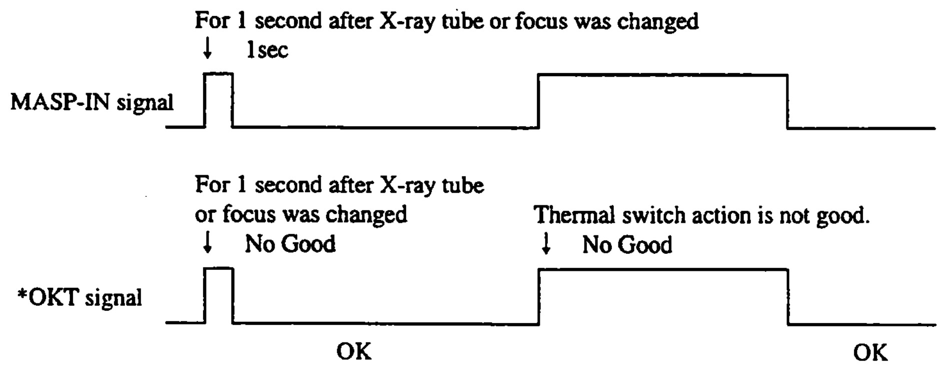
MASP-IN signal continues to be output from I/O CONT-96 board (when STA-30 is selected).

For 1 second after MASP-IN signal was output from I/O CONT-96 board (when X-ray tube or focus was changed).

OKT signal is output when both of the following conditions are satisfied.

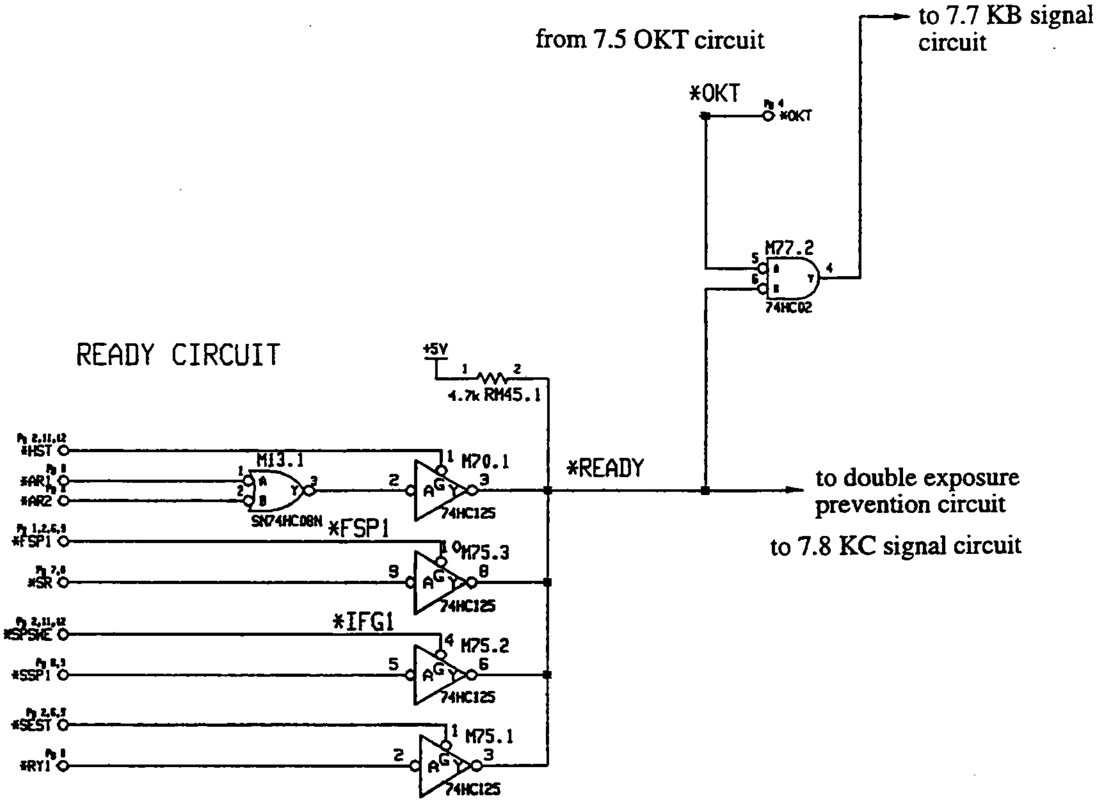
After 1 second has passed from the time MASP-IN signal was output from I/O CONT-96 board (from the time X-ray tube or focus was changed).

The thermal switch of X-ray tube is OK.



## 7.6 READY signal circuit

This circuit makes a READY signal in accordance with a selected operation method.

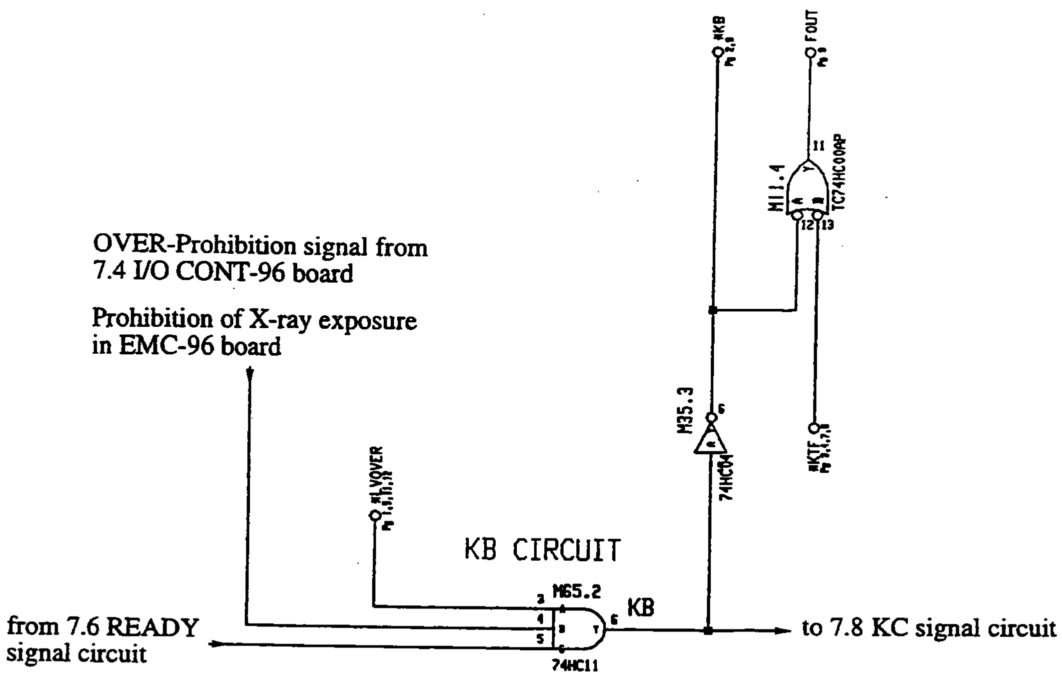



| | |
|---|---|
| *READY | READY operation signal (negative logic) |
| This circuit outputs a READY operation signal by closing only the gate corresponding to a selected operation method. | |

| Selected operation method | Corresponding READY operation signal | Content of the READY operation |
|---|---|---|
| HST | AR1 or AR2 | AR1: READY signal of the hand switch on the console<br>AR2: READY signal from terminal AR2 on TERMINAL II-96 board |
| FSP<br>Direct high-speed radiography | SR | SR: READY signal from the high-speed operation switch of the fluoroscopic operation bed |
| SPSWE | SSP1 | SPSWE: A signal to validate the high-speed operation switch of the fluoroscopic operation bed and is output when the indirect high-speed operation (IFG) and DSA operation (DSP) are executed.<br>SSP1: READY signal from the high-speed operation switch of the fluoroscopic operation bed |
| SEST | RY1 | RY1: READY signal from the READY switch for the direct continuous operation |

## 7.7 KB signal circuit

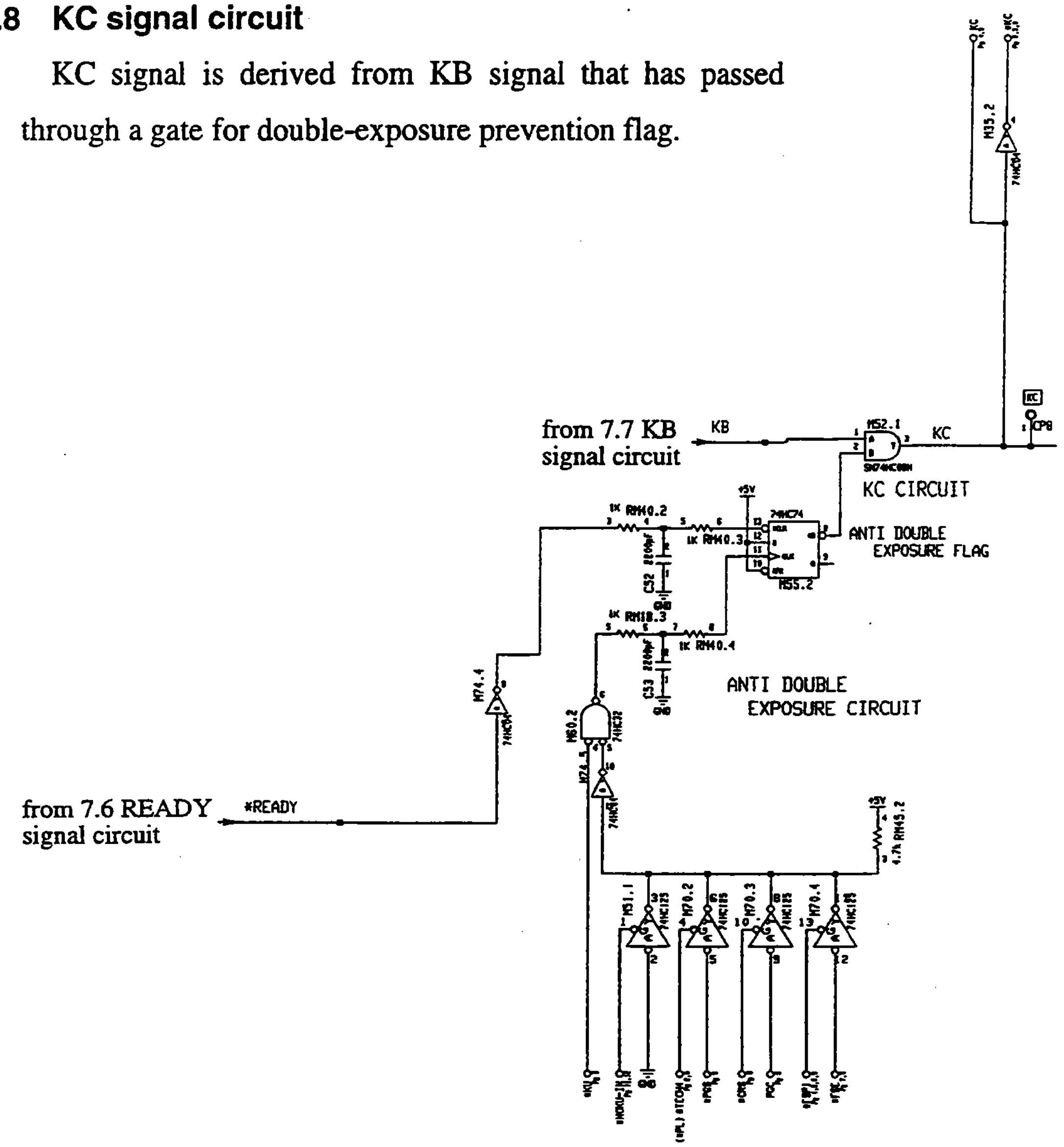
KB signal is a READY signal that passed through OKT gates.




<table>
<tr><td>*KB</td><td>READY start signal (negative logic)</td></tr>
<tr><td colspan="2">KB signal is output when all the conditions ② ~ ⑤ are satisfied for the READY signal.<br>① READY signal is ON (from section 7.6).<br>② OKT signal is OK.<br>③ HOVE signal from I/O CONT-96 board is OFF (unused, always OFF).<br>④ Among the following OVER-Prohibition signals from I/O CONT-96 board, a signal that is relevant to the next operation is not output.<br>CUT<br>LOVE<br>NOX<br>⑤ Among the following OVER-Brake signals from MOTHER-96 board, a signal that is relevant to the next operation is not output (all are negative logic).<br>POWER DOWN<br>ROC<br>TkVOVER<br>PKVOVER<br>CHARGE OVER<br>IFOVER<br>HVT OPEN<br>LVOVER</td></tr>
<tr><td>FOUT</td><td>I.I. getter suspension signal</td></tr>
<tr><td colspan="2">I.I. getter suspension signal FOUT is output when one of the following signals is output.<br>① KB signal is ON.<br>② KFT signal is ON. (from section 7.21)<br>KTF signal [Fluoroscopic X-RAY ON signal]</td></tr>
</table>

## 7.8 KC signal circuit

KC signal is derived from KB signal that has passed through a gate for double-exposure prevention flag.




| | |
|---|---|
| *KC | READY start signal in which a condition of double exposure prevention is added to READY start signal KB. |

In the following operation methods or modes, however, KB signal directly makes KC signal, because the condition of double exposure prevention is not needed.

<Operation method> <Mode>

① In PL and PGS (in tomographic operation and intermittent exposure)

② In the following operation methods or modes, the double exposure is not prevented.

FSP and FSE (consecutive operation)

CIN

SEST

DSP

XDR

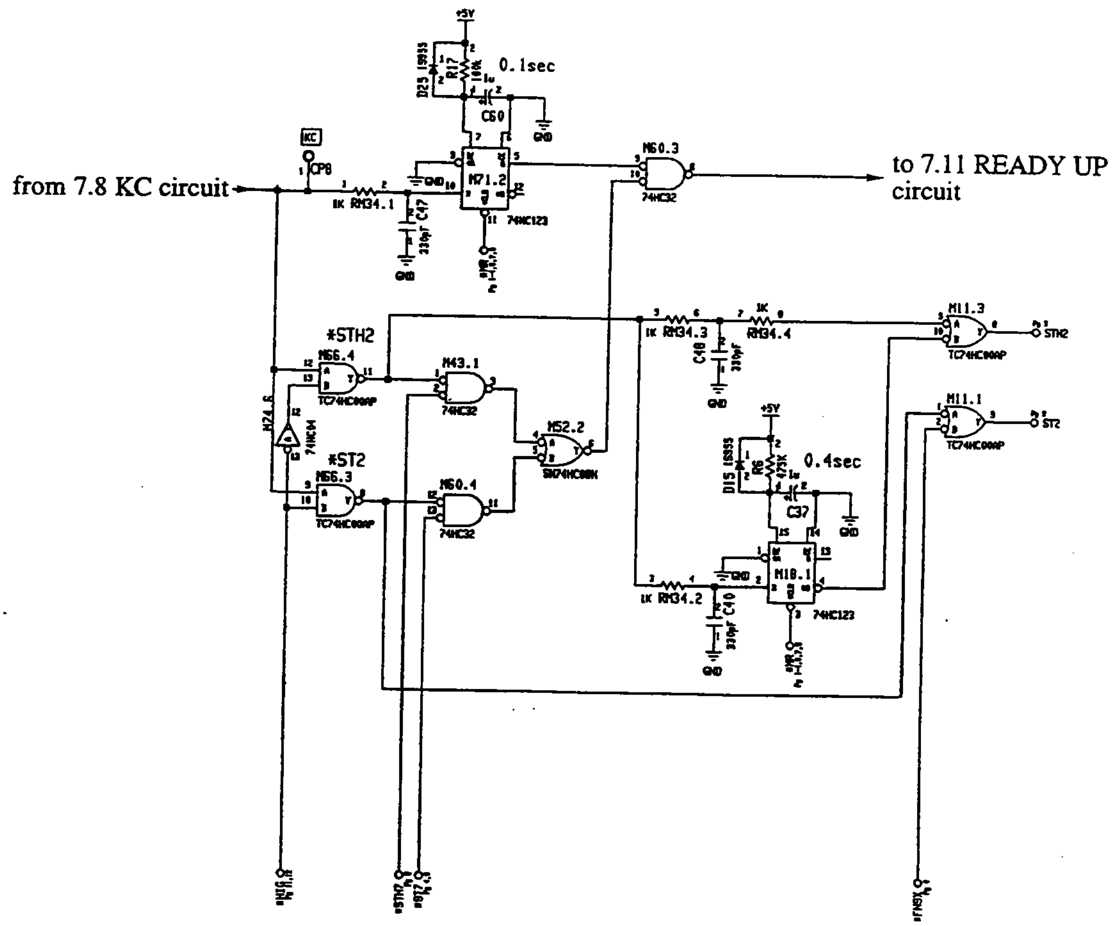
CRS and no PGC (consecutive operation by indirect camera)

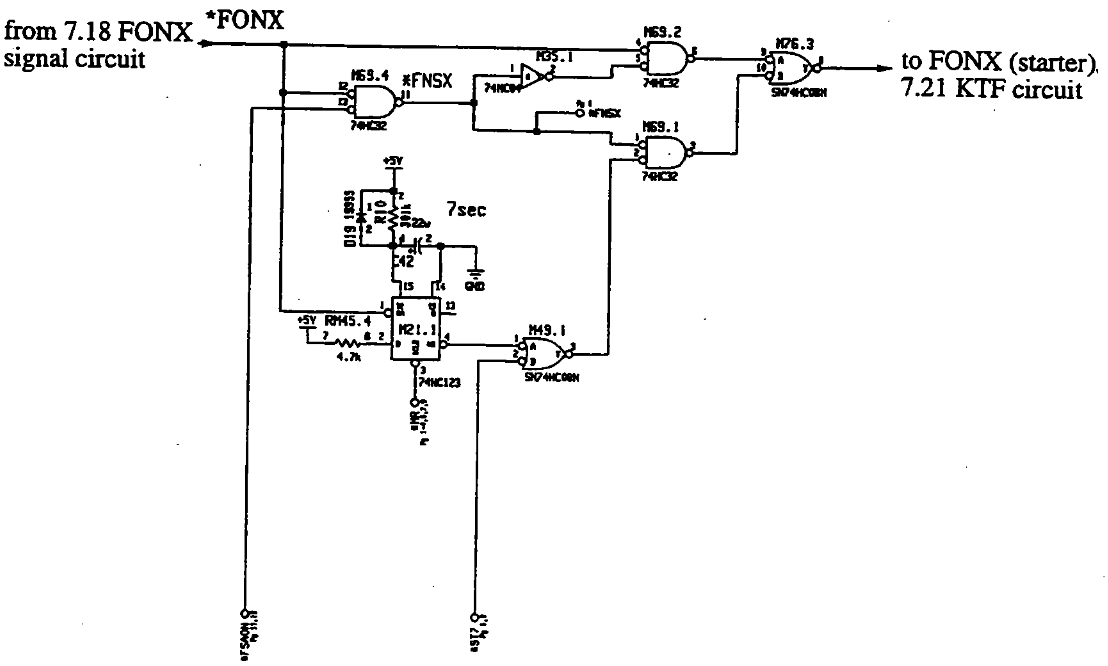
| Double exposure prevention circuit |
|---|
| In double exposure operation, this circuit allows an X-ray exposure only when READY start signal KB is once made OFF and made ON again. |

## 7.9 Starter circuit

Receiving a switch signal between high-speed and normal-speed rotation from I/O CONT 96 board, this circuit supplies a drive signal for each rotation.

When required to rotate the X-ray tube rotor in normal speed, FSAON signal is output from I/O CONT-96 board.

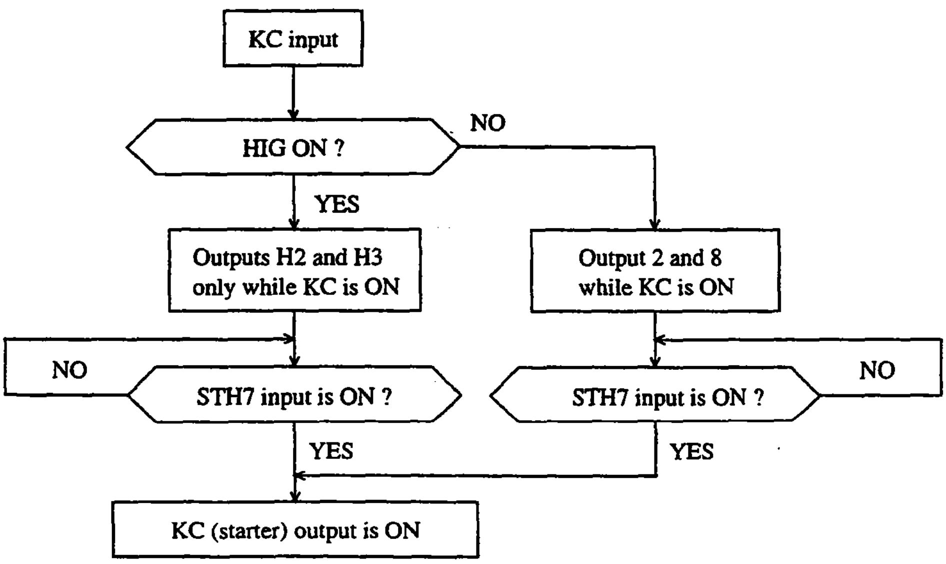


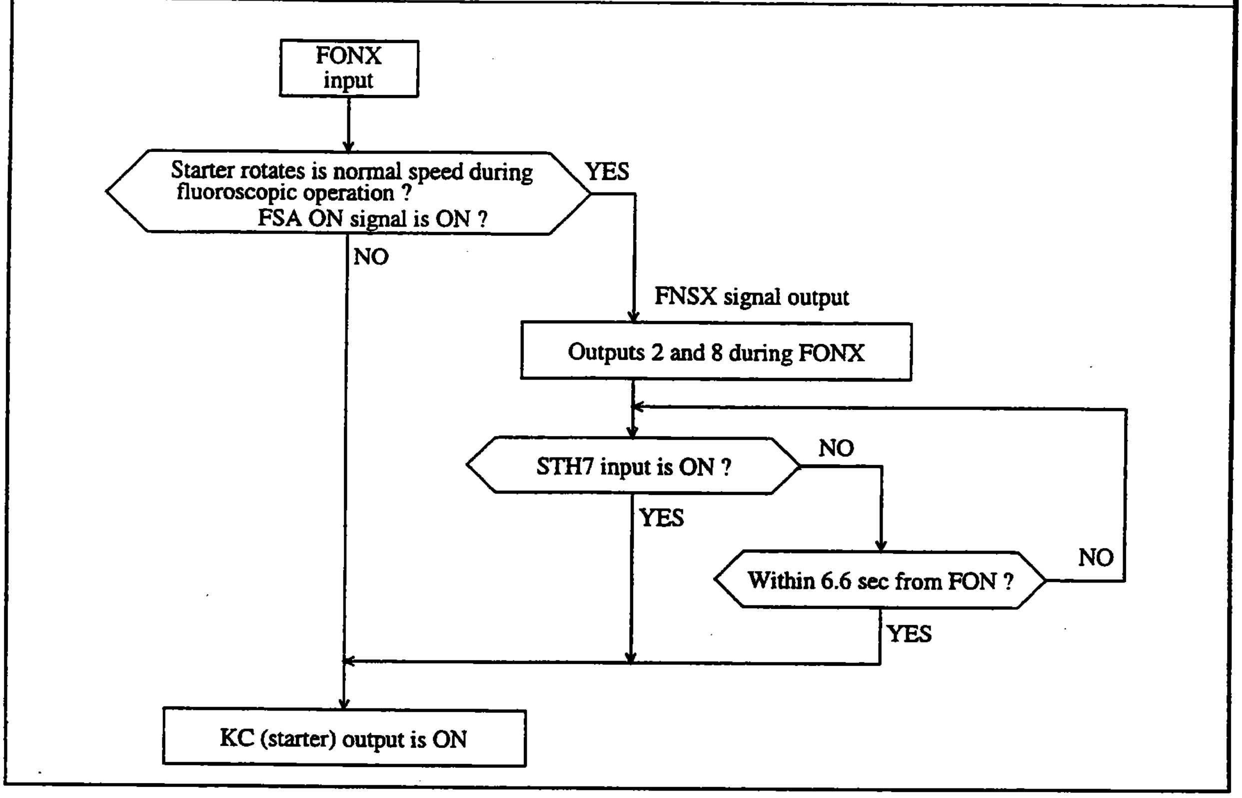
| Connector terminals for X-ray tube anode starter | | |
|---|---|---|
| JM34 connector | | Function |
| Name | Pin No | |
| HON | A14 | +15 V power supply (+15 V current-loop input) |
| *1MS | A15 | First tube selection signal (+15 V current-loop output) |
| *2MS | B15 | Second tube selection signal (+15 V current-loop output) |
| *3MS | A18 | Third tube selection signal (+15 V current-loop output) |
| *2 | C15 | Normal-speed rotation ON signal (+15 V current-loop output) |
| *7 | B14 | Normal-speed rotation start OK signal (+15 V current-loop input)<br>(Starter outputs *7 in startup.) |
| *H2 | A16 | High-speed rotation ON signal (+15 V current-loop output) |
| *H7 | C14 | High-speed rotation start OK signal (+15 V current-loop input)<br>(Starter outputs *H7 in startup.) |
| *H11 | B16 | Drive power stop signal (+15 V current-loop output)<br>(X-RAY ON signal outputs this signal.) |
| *H12 | C16 | Starting-time switching signal output (+15 V current-loop output)<br>(This signal is output when *(FSPI+IFG) signal is output.) |
| *TRST | C17 | X-ray exposure prohibition signal output (+15 V current-loop output)<br>(This signal is output when *NOX signal is output.) |
| *STRBK | B17 | Starter failure signal input (+15 V current-loop input) |
| *FRST | (A17) | FAULT reset signal output (+15 V current-loop output)<br>(Note: this signal is output from MOTHER-96 board.) |

| Starter signal from I/O CONT-96 board | |
|---|---|
| Signal | Content |
| HIG | Starter high-speed rotation selection signal |
| FSAON | Starter normal-speed rotation signal during fluoroscopic operation |

| KC (starter) | This signal includes an acknowledgement of starting-up of starter in addition to READY signal KC. |
|---|---|



| | |
|---|---|
| FONX (starter) | This signal includes an acknowledgement of starting-up of starter in addition to fluoroscopic X-RAY ON signal FONX. |

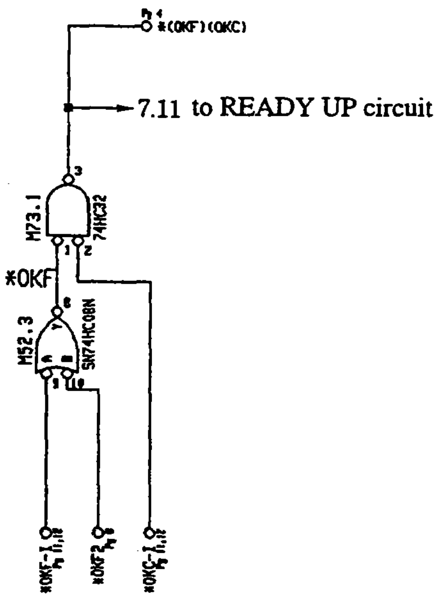


## 7.10 OKF and OKC signal circuit

OKF signal circuit is the acknowledgement circuit of filament heating.

When controlling an ordinary X-ray tube (using mA POWER-96 board), the acknowledging method is different from when externally controlling a stereo X-ray tube.

OKC signal circuit is the acknowledging circuit for charging voltage of the main circuit capacitor.




**OKF signal circuit**

| Class of X-ray tube | Necessary signal |
|---|---|
| When controlling an ordinary X-ray tube (using mA POWER-96 board) | Only OKF- I |
| When externally controlling a stereo X-ray tube (using STA-30) | Trequires OKF2. |

| Signal from MOTHER-96 board (mA POWER-96 board) | |
|---|---|
| OKF- I | Signal of filament heating OK (mA POWER-96 board) |

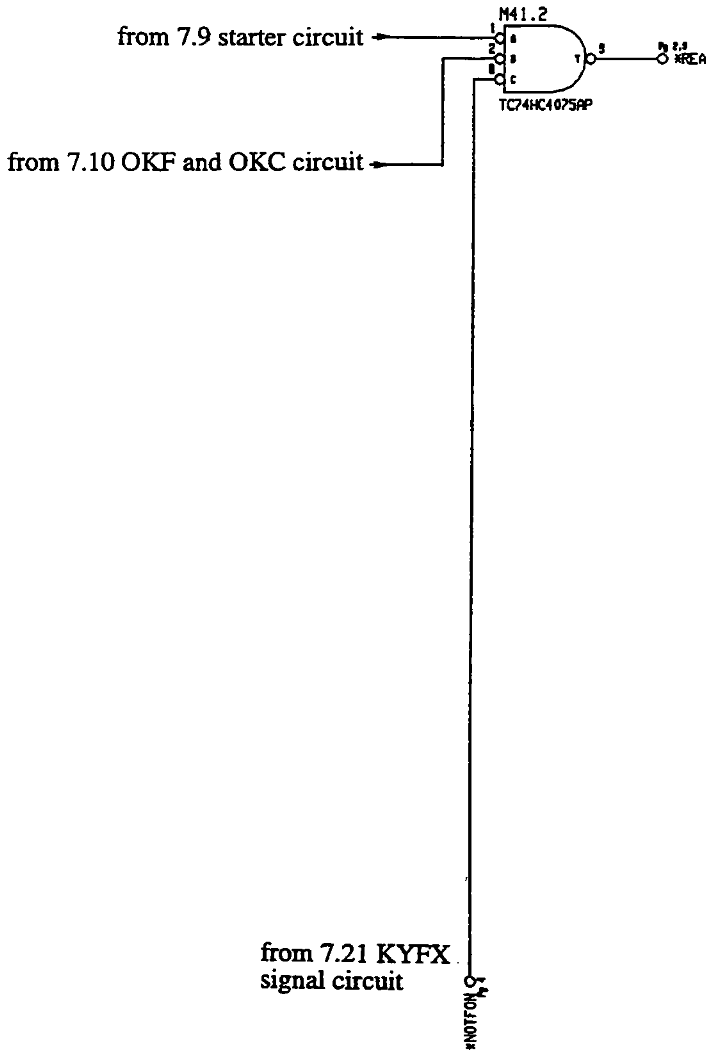
| Signal from TERMINAL 2-96 board (STA-30): | |
|---|---|
| OKF2 | Operates when CU1 and CU2 of the connector J41 on TERMINAL 2-96 board are short-circuited. (This signal is required when STA-30 is combined.) |

| OKF• OKC(OUT) | Signal to indicate that heating of filament and charging of main circuit capacitor are OK: |
|---|---|
| Output to READY UP circuit and KTF circuit, after confirming that filament-heating necessary for X-ray exposure and charging of main circuit capacitor are OK. | |

| Signal from MOTHER-96 board (ANALOG-96 board): | |
|---|---|
| OKC- I | Indicates that charging of main circuit capacitor is OK. (ANALOG-96 board) |

## 7.11 READY UP signal circuit

This signal indicates that the preparation for a radiographic operation has been finished and illuminates READY display light on the console.

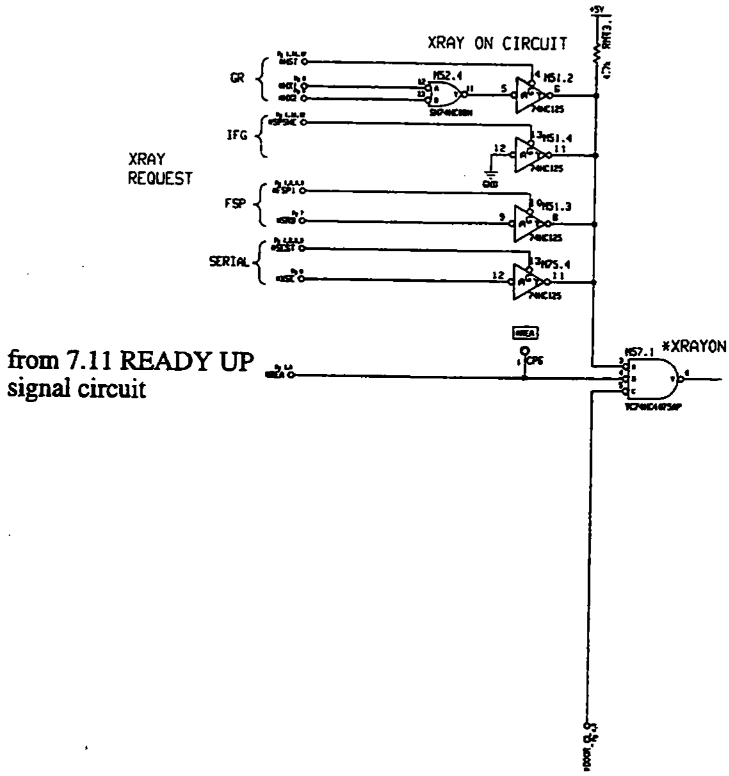



**READY UP (REA) signal circuit**

<table>
<tr><td>READY UP<br>(REA)</td><td>Signal to indicate that all conditions for the READY were OK, the READY operation has been finished, and the apparatus is now in standby.</td></tr>
<tr><td colspan="2">This signal is output when the following conditions ② and ③ are established in addition to ①.<br>① Signal KC (starter) is ON.<br>② Signals OKF and OKC (OUT) are OK.<br>③ Signal NOTFON (fluoroscopic X-RAY ON) is OFF. (inoperative)</td></tr>
</table>

## 7.12 X-RAY ON signal circuit

This circuit outputs X-RAY ON signal by gating various X-ray operation signals with each operation method.



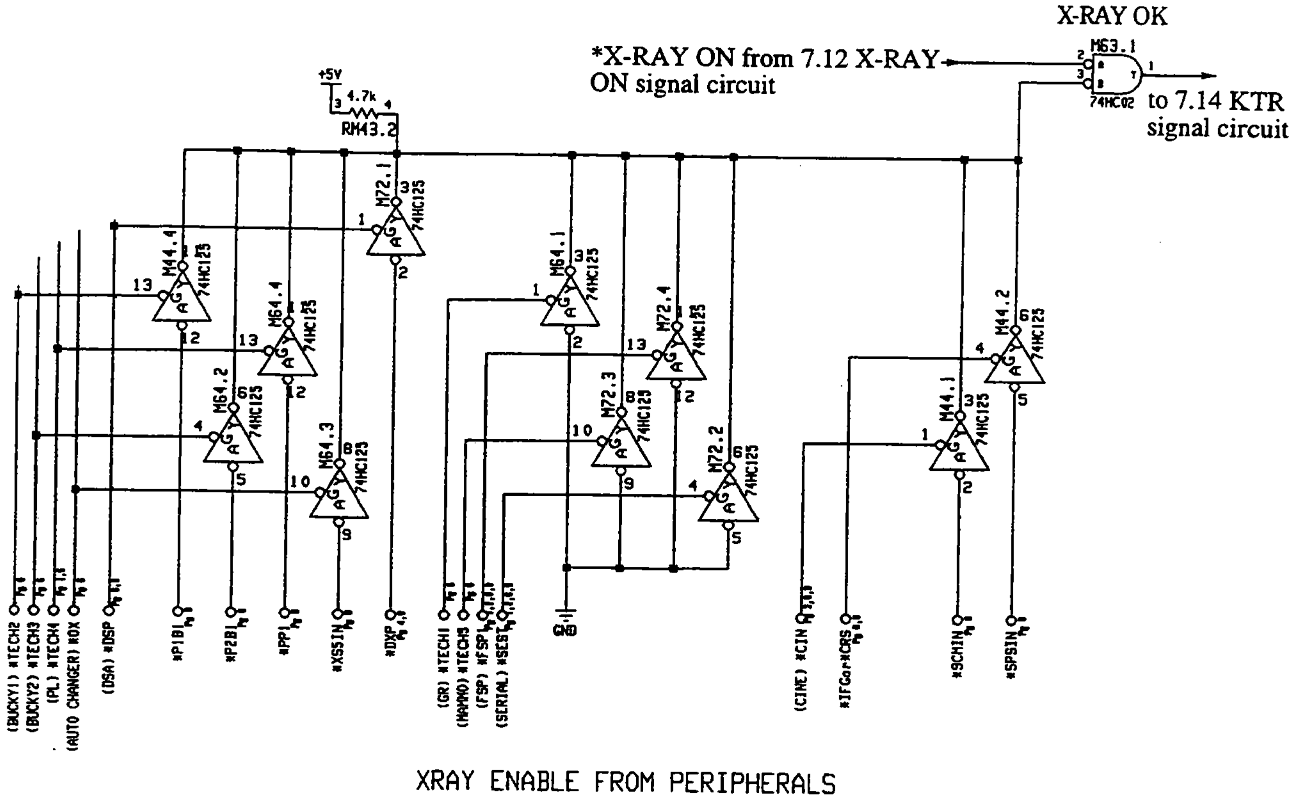

**X-RAY ON signal circuit**

| X-RAY ON | X-RAY start signal |
|---|---|
| This signal is output when the following conditions ② and ③ are established in addition to ①.<br>① Signal X-RAY is ON. ③ Signal DOOR-CL (door-interlock signal) is OK.<br>② Signal READY UP is OK. | |

| X-RAY | X-RAY operation signals | |
|---|---|---|
| Closing only the gate for a selected operation method outputs the X-RAY operation signal. The necessary X-RAY operation signal for each operation method is shown below | | |
| <Operation method> | <X-RAY operation signal which is:> | |
| HST | HX1 | Generated by the hand-switch on the console, |
| | or HX2 | Inputted from TERMINAL 2-96 board, |
| FSP | SRD | The signal RD received at the terminal RD of TERMINAL-96 board from the high-speed operation switch on the fluoroscopic operation bed, |
| SPSWE | —— | Always outputted, so that the next X-RAY ON signal is READY UP (REA) signal alone, |
| SEST | XSE | Derived from the X-RAY switch for direct consecutive operations. |

## 7.13 X-RAY OK signal circuit

X-RAY OK signals are output by gating with each operation method.

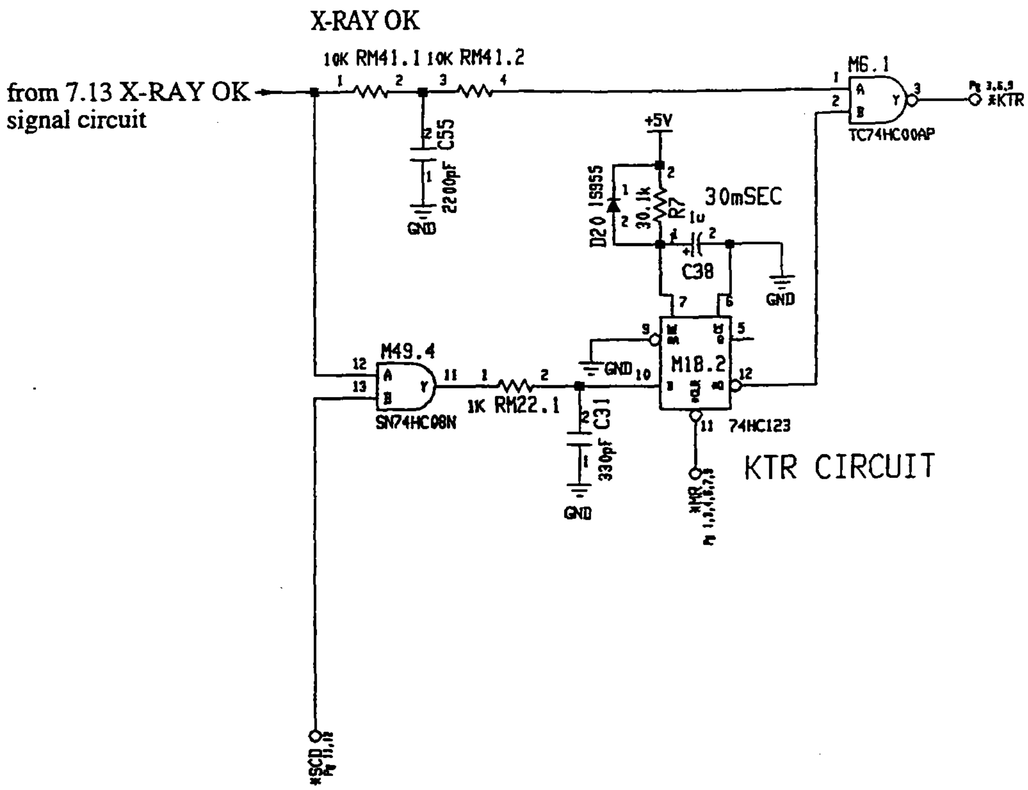



**X-RAY OK signal circuit**

| X-RAY OK | X-RAY OK acknowledge signal | |
|---|---|---|
| Closing only the gate for a selected operation method outputs the X-RAY operation signal. The necessary X-RAY operation signal for each operation method is shown below | | |
| <Operation method> | <X-RAY operation signal which is:> | |
| (BUCKY1) TECH2 | P1B1 | (received from Bucky's radiographic device 1 at terminals [1B1] and [1B11] of TERMINAL-96 board), |
| (BUCKY2) TECH3 | P2B1 | (received from Bucky's radiographic device 2 at terminals [2B1] and [2B11] of TERMINAL-96 board), |
| (PL) TECH4 | PP1 | (received from the tomographic device at terminals [P1] and [P11] of TERMINAL-96 board), |
| (AUTO CHANGER) OX | XS5IN | (received from the auto-changer radiographic device at terminals [XS6] and [XS5] of TERMINAL-96 board), |
| (GR) TECH1 | Unneeded (X-RAY OK signal is always in OK), | |
| (MAMMO) TECH5 | Unneeded (X-RAY OK signal is always in OK), | |
| FSP | Unneeded (X-RAY OK signal is always in OK), | |
| SEST | Unneeded (X-RAY OK signal is always in OK), | |
| (DR) DR1 | Unused | |
| CIN | Unused | |
| IFG+CRS | SPSIN | (received from I.I. indirect camera and rapid sequence camera at terminals [XS3] and [XS4] of TERMINAL-96 board), |
| | SS7 | (a logic level signal converted from a contact-point signal at terminals [S4] and [S5] of TERMINAL-96 board which acknowledges moving of the mirror in I.I. optical system toward the operating position), |
| DSP | DXP | (received from the DSA device at terminals [EXP1] and [EXP2] of TERMINAL-96 board), |
| | SS5 | (a logic level signal converted from a contact-point signal at terminals [S4] and [S5] of TERMINAL-96 board which acknowledges moving of the mirror in I.I. optical system toward the operating position). |

## 7.14 KTR signal circuit

This signal is output after acknowledging X-RAY OK signal derived from X-RAY ON signal.



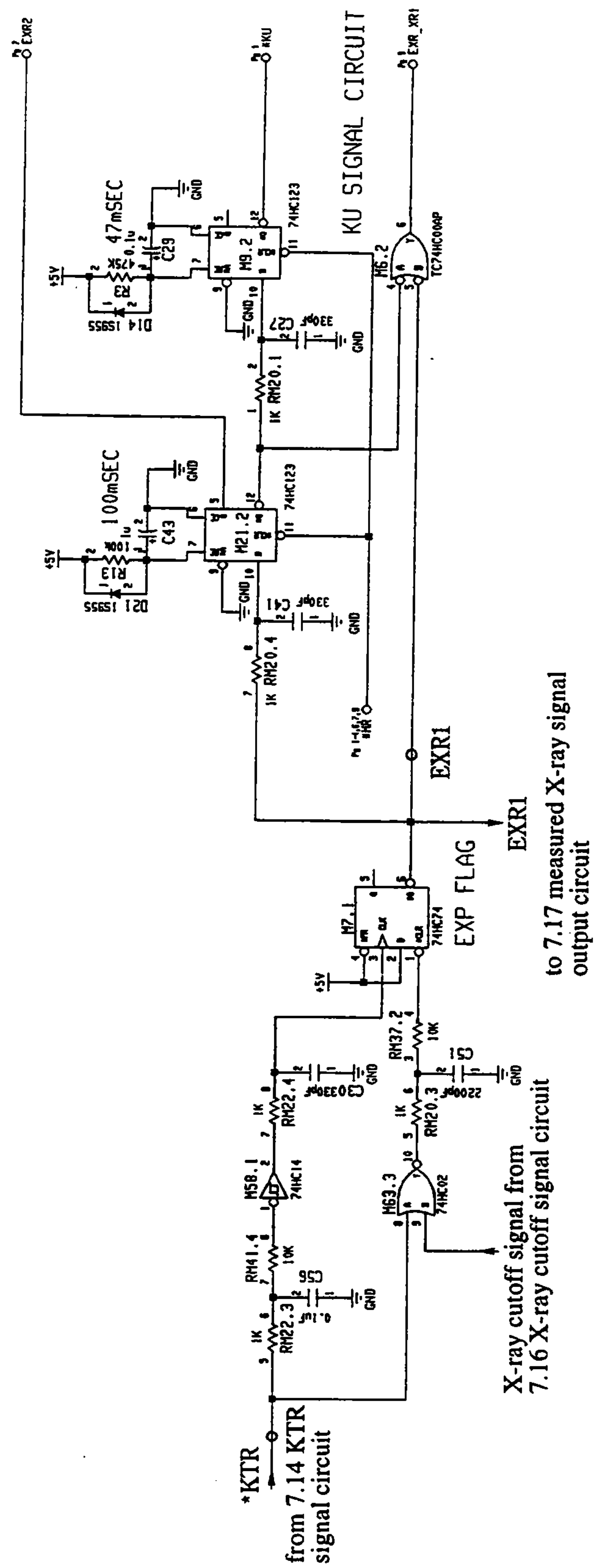

**KTR signal circuit**

| KTR | Take X-RAY ON signal (X-RAY OK acknowledge signal must be in OK.) |
|---|---|
| This signal is output 30 msec after the following two conditions have been established.<br>X-RAY ON signal is ON.<br>X-RAY OK signal is OK.<br>Provided that *SCD signal (signal to invalidate a circuit function to assure actions of general radiographic devices [negative logic]) is input, KTR signal is immediately output after above two conditions have been established. | |

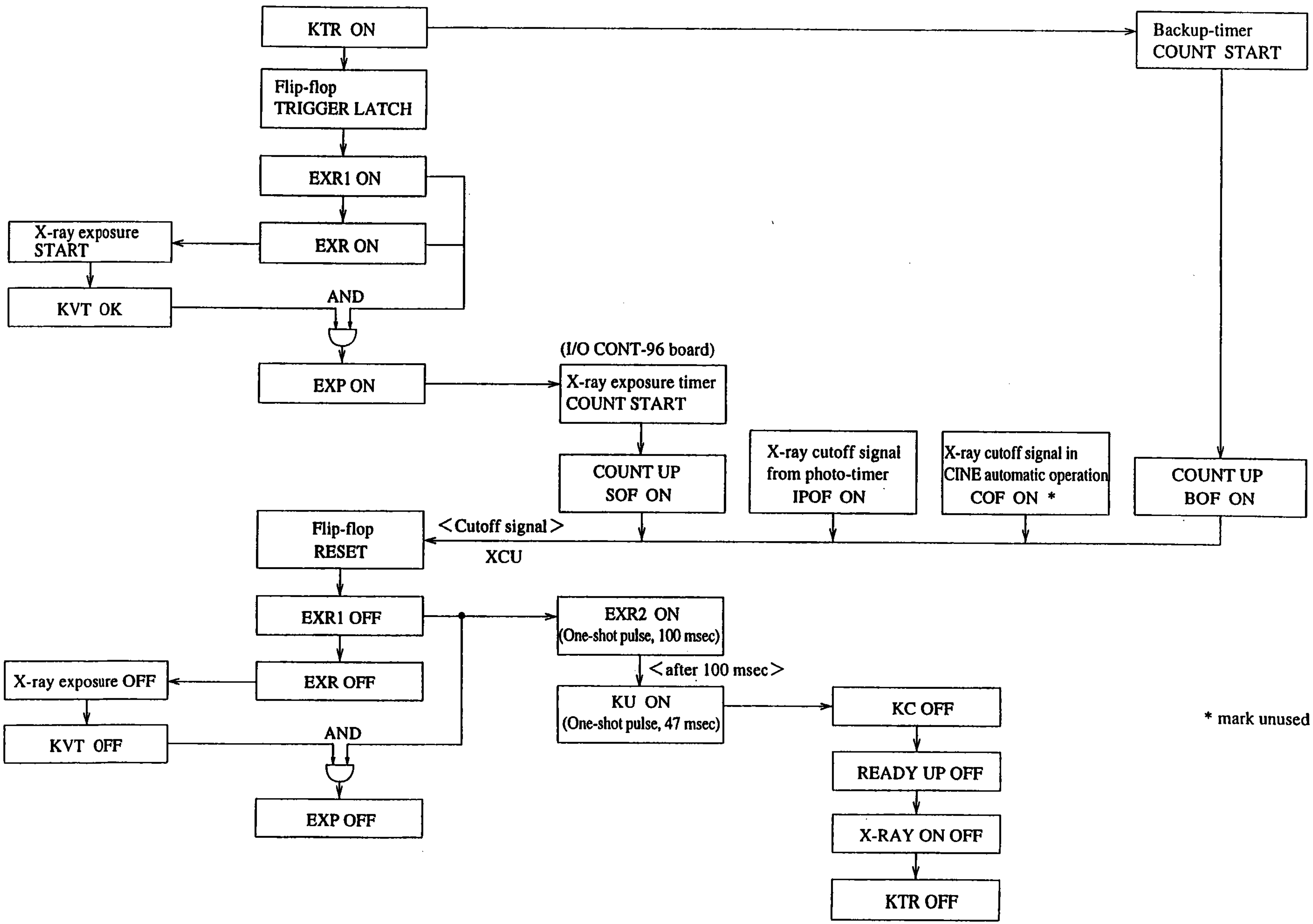
| *SCD signal | Signal to invalidate a circuit function to assure actions of general radiographic devices [negative logic] |
|---|---|
| SCD signal is output in the following operation methods.<br>① FSP<br>② IFG<br>③ CRS<br>④ DSP<br>⑤ SER (SEST)<br>⑥ XDR<br>⑦ CIN | |

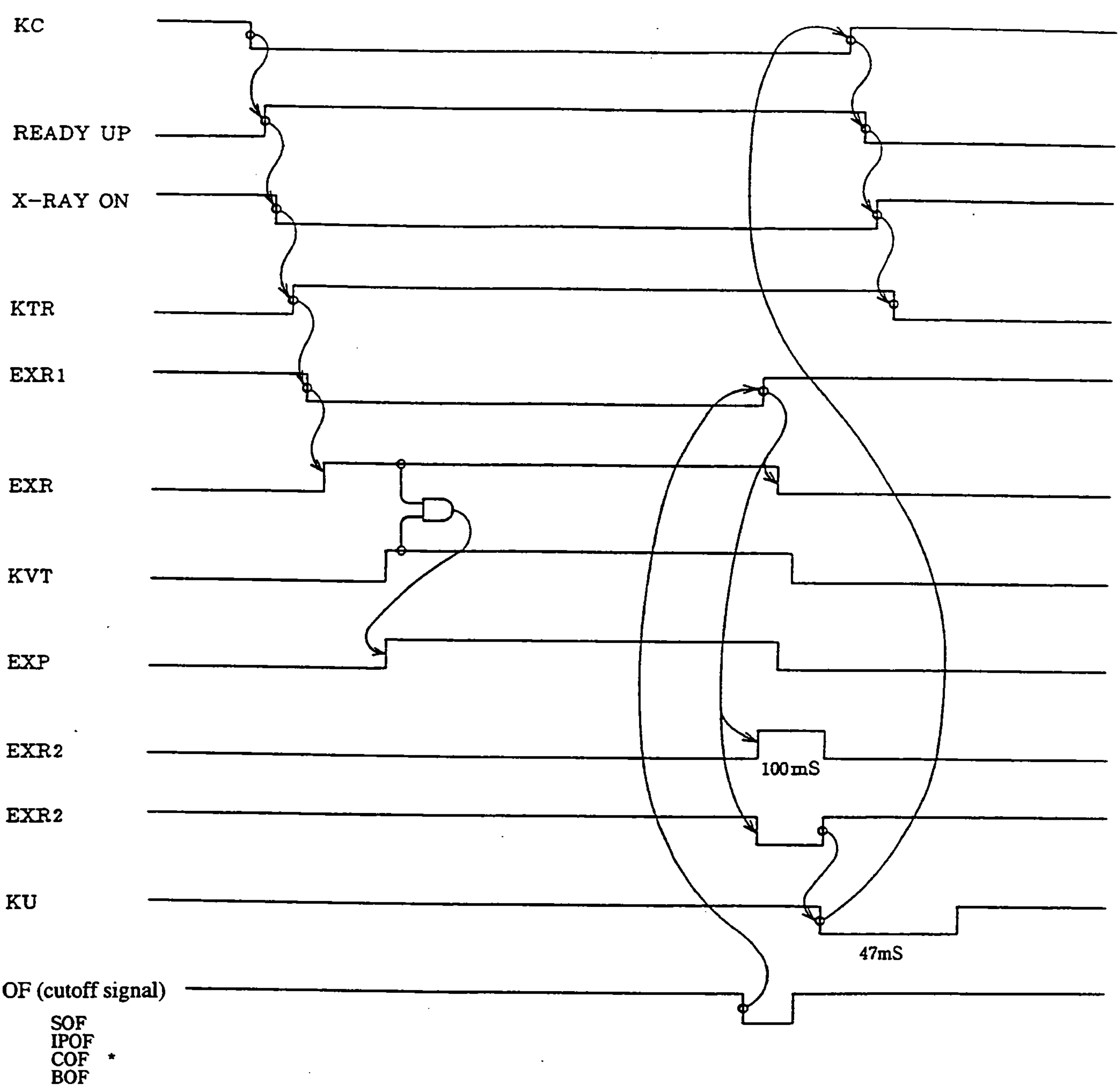
## 7.15 Signal circuit from KTR to KU

Block diagram and timing chart of signal circuit from KTR to KU are shown below.




**Signal circuit from KTR to KU**


KTR ON
Backup-timer COUNT START
Flip-flop TRIGGER LATCH
EXR1 ON
X-ray exposure START
EXR ON
KVT OK
AND
EXP ON
(I/O CONT-96 board)
X-ray exposure timer COUNT START
COUNT UP SOF ON
X-ray cutoff signal from photo-timer IPOF ON
X-ray cutoff signal in CINE automatic operation COF ON *
COUNT UP BOF ON
Flip-flop RESET
<Cutoff signal>
XCU
EXR1 OFF
EXR2 ON (One-shot pulse, 100 msec)
<after 100 msec>
X-ray exposure OFF
EXR OFF
KU ON (One-shot pulse, 47 msec)
KC OFF
KVT OFF
AND
READY UP OFF
EXP OFF
X-RAY ON OFF
KTR OFF
* mark unused


KC
READY UP
X-RAY ON
KTR
EXR1
EXR
KVT
EXP
EXR2
100mS
EXR2
KU
47mS
OF (cutoff signal)
SOF
IPOF
COF *
BOF

* mark unused

Signal circuit from KTR to KU

| | |
|---|---|
| EXR1 | Take X-RAY ON signal |
| Signal that is triggered by KTR and reset by KTR OFF or cutoff signal | |

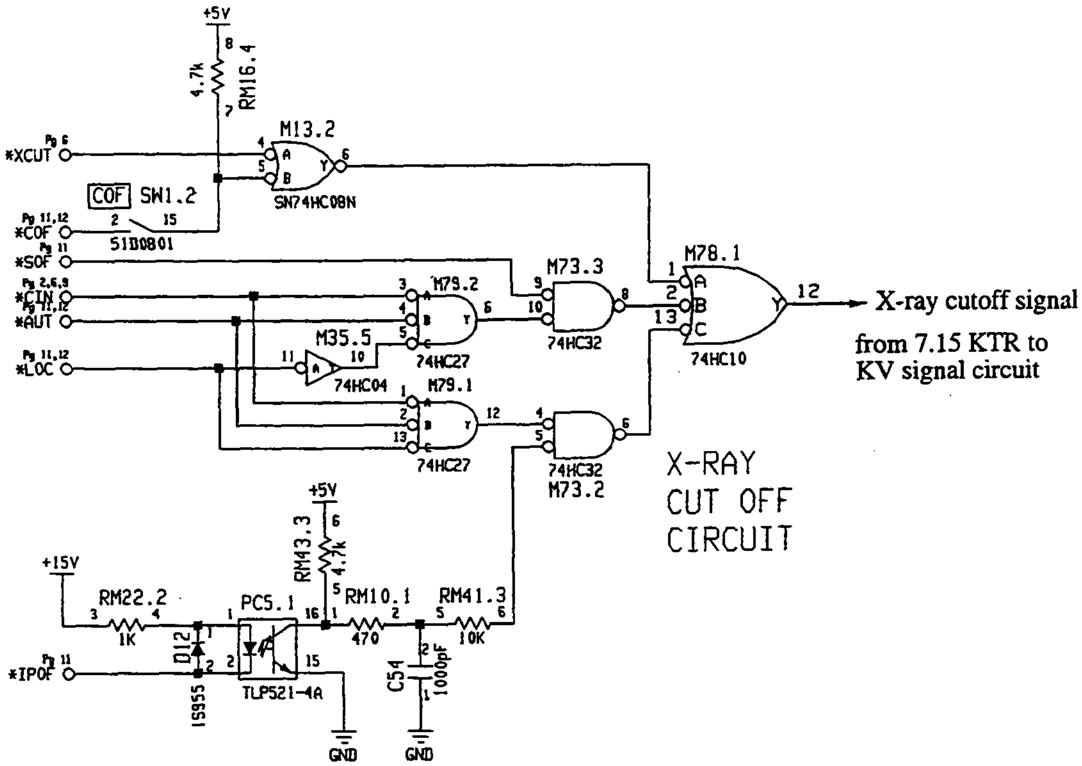
| | |
|---|---|
| EXR__XR1 | Take X-RAY ON signal (EXR1 + 100ms) |
| Signal that extends Take X-RAY ON signal by 100 msec | |

| | |
|---|---|
| EXR2 | Take X-RAY OFF signal |
| One-shot pulse signal (for 100 msec) triggered by the ending-edge of EXR1 | |

| | |
|---|---|
| KU | Take X-RAY OFF signal |
| One-shot pulse signal (for 47 msec) triggered by the ending-edge of EXR2<br>KU resets READY start signal KC and finishes Take X-RAY | |

## 7.16 X-ray cutoff signal circuit

This circuit generates four X-ray cutoff signals, COF, IPOF, SOF, and XCUT. Effectiveness and priority of these signals are determined in accordance with a specified operation method.




| ? OF | X-ray cutoff signals in accordance with selected operation method |
|---|---|

Resetting Take X-RAY ON signal EXR1 cuts X-ray radiation.
X-ray cutoff signals are:

① COF    Note) COF is now unused
② IPOF
③ SOF
④ XCUT

When X-ray exposure is regularly controlled, the X-ray cutoff signals are output in the following order.

<In all operation methods except CINE>
① SOF
② XCUT
(No input of COF and IPOF)

<In all operation method with selecting photo-timer except CINE>
① IPOF
② SOF
③ XCUT

<In CINE manual mode> (unused)
① SOF
② COF
③ XCUT
(No input of IPOF)

<In CINE auto-mode> (unused)
① IPOF
② COF
③ XCUT
(Input of SOF is cut at gate.)

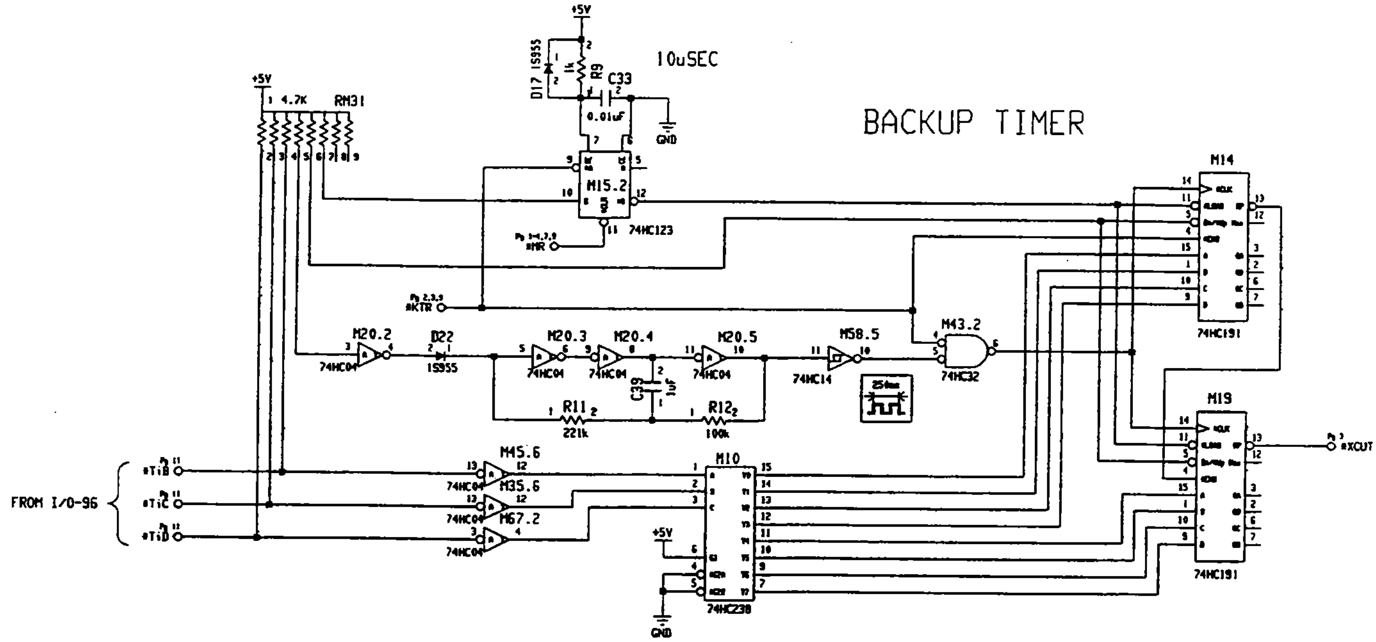
<In CINE auto-mode and LOC signal ON> (unused)
① SOF
② COF
③ XCUT
(Input of IPOF is cut at gate.)

| COF | X-ray cutoff signal for backup-timer in CINE (unused) |
|---|---|
| This signal is output from I/O Ⅱ -96 board with a length of about 1.5 ~ 2 times the set take time.<br>When IPOF signal is not output because the photo-timer does not work due to a light density of the film, COF cuts the X-ray. | |

| IPOF | X-ray cutoff signal by photo-timer |
|---|---|
| This signal is output from PH POWER-96 and PH CONT-96 board when an exposure level specified by the selected photo-timer has been reached. | |

| SOF | X-ray cutoff signal from the sec timer of I/O CONT-96 board |
|---|---|
| I/O CONT-96 board receives a measured X-RAY signal EXP (XR-IN) and counts up to a set seconds, and then outputs this signal to EMC-96 board. | |

| XCUT | X-ray cutoff signal from backup-timer |
|---|---|
| In I/O CONT-96 board a timer counter is preset by a signal decoded from backup time signal (binary) TIB ~ TIC which is selected in accordance with a set seconds.<br>Take X-RAY ON signal KTR starts the timer counter, and the counter outputs his XCUT signal at the preset time.<br>A CR oscillator with a period of 250 msec (4 Hz) generates the clock for the counter.<br>This XCUT signal is used as a backup when the X-ray cutoff signal SOF from the sec timer of I/O CONT-96 board is not regularly output. | |

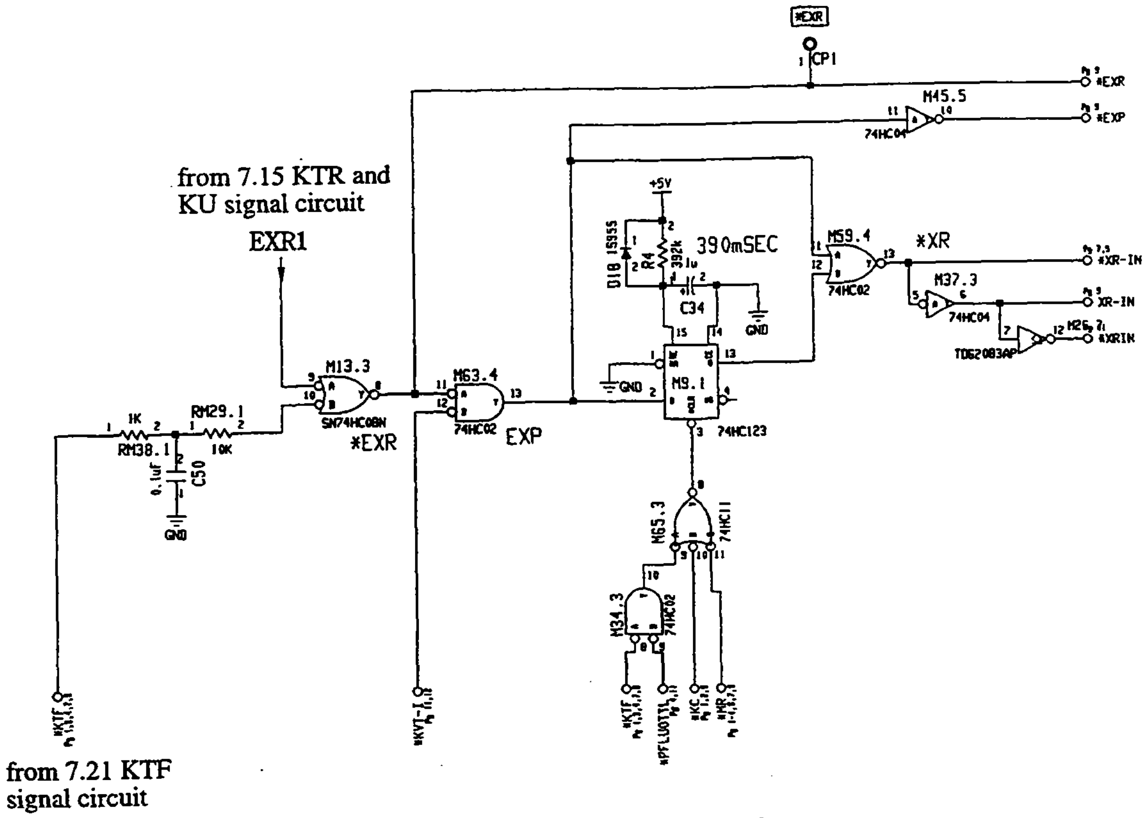



| Set sec value | Backup time selection signal (binary) | | | Backup time |
|---|---|---|---|---|
| | *TID | *TIC | *TIB | |
| 1.0ms ~ 120ms | 1 | 1 | 1 | 250 msec |
| 140ms ~ 250ms | 1 | 1 | 0 | 0.5 sec |
| 280ms ~ 500ms | 1 | 0 | 1 | 1.0 sec |
| 560ms ~ 1.0sec | 1 | 0 | 0 | 2.0 sec |
| 1.1sec ~ 2.0sec | 0 | 1 | 1 | 4.0 sec |
| 2.2sec ~ 4.0sec | 0 | 1 | 0 | 8.0 sec |
| 4.5sec ~ 8.0sec | 0 | 0 | 1 | 16.0 sec |
| 9.0sec ~ 10.0sec | 0 | 0 | 0 | 32.0 sec |

{1: 5V, 0: 0V}

## 7.17 Measured X-RAY signal output circuit (for both fluoroscopy and fluoroscopy)

Radiographic and fluoroscopic (including pulse fluoroscopy) X-RAY ON signals start build up of tube voltage. After acknowledging the measured tube voltage build up, the measured X-RAY signal is generated.




**Measured X-RAY signal**

| | |
|---|---|
| KTF | Fluoroscopic X-RAY ON signal (the acknowledge signal must be OK.) |

| | |
|---|---|
| KVT | Acknowledge signal of build up of measured tube voltage |
| This signal is output from ANALOG-96 board as an acknowledge signal of the tube voltage build up when the measured tube voltage has reached a specified value (76% of kV peak value). | |

| | |
|---|---|
| PFLUOTTL | Pulse fluoroscopy selection signal |
| This signal is output from I/O Ⅱ -96 board when pulse fluoroscopy is selected. | |

| | |
|---|---|
| KC | This signal is a READY start signal that includes a condition of double exposure prevention. |

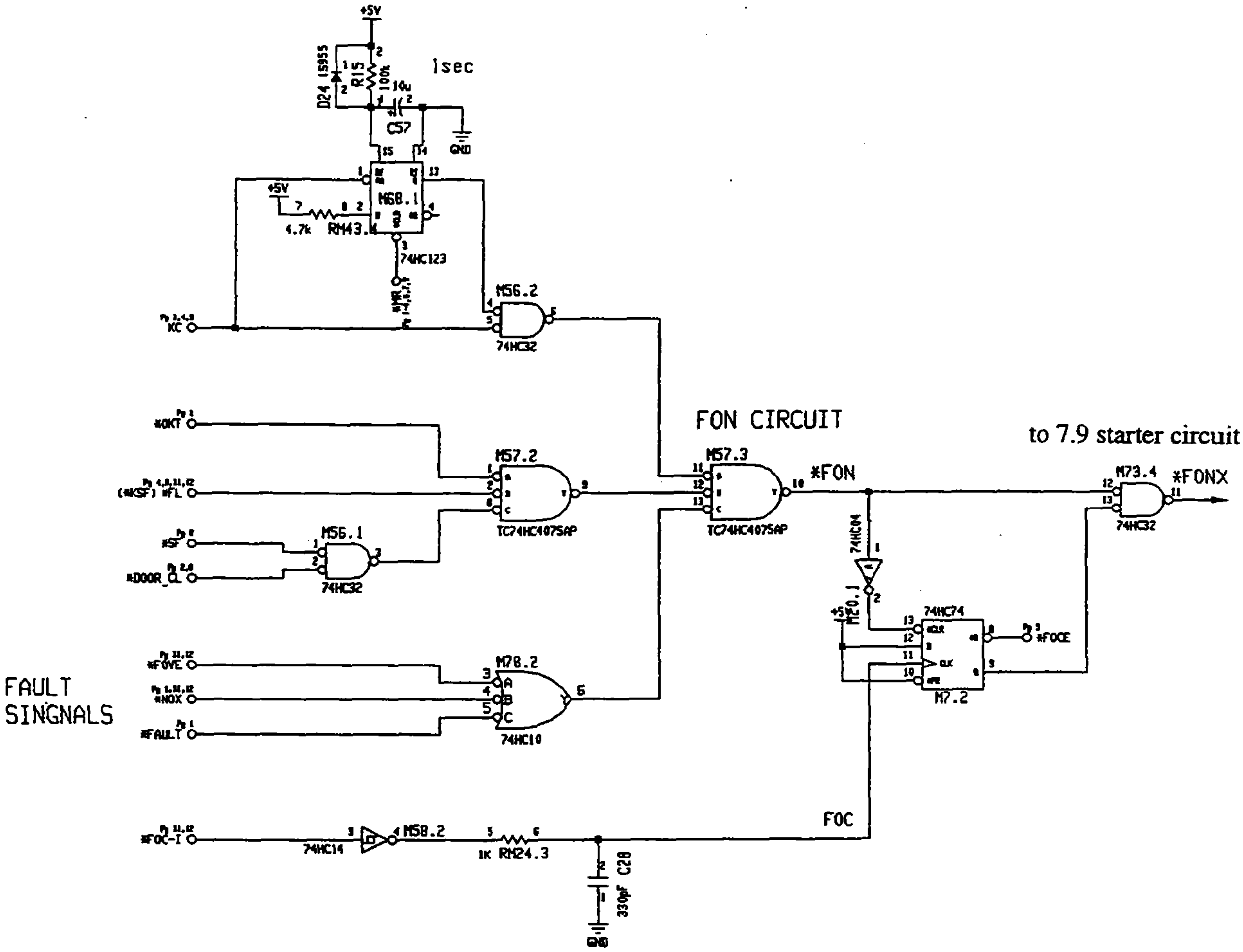
| | |
|---|---|
| EXR | Radiographic or fluoroscopic X-RAY ON signal |
| OR signal of EXR1 (fluoroscopy) or KTF (fluoroscopy) | |

| | |
|---|---|
| EXP | Measured X-RAY signal (radiography and fluoroscopy) |
| AND signal of EXR and KVT | |

| | |
|---|---|
| XR-IN | Measured X-RAY signal (in both fluoroscopy and fluoroscopy) |
| EXP signal is extended by one-shot pulse (390 msec) to a continuous signal. | |

## 7.18 FONX signal circuit

This circuit generates fluoroscopic X-RAY ON signal.




<table>
<tr><td>FONX</td><td>Fluoroscopic X-RAY ON signal</td></tr>
<tr><td colspan="2">This signal FONX is output when all conditions ② ~ ⑨ are satisfied in addition to ①<br>① SF is ON.<br>② OKT is OK.<br>③ FOVE form I/O CONT-96 board is OFF.<br>④ FAULT is OFF<br>⑤ KC (OFF DELAY0.5S) is OFF.<br>⑥ FOC FLAG is OFF.<br>⑦ FL (fluoroscopy enable signal) is OK.<br>⑧ DOOR-CL (door lock signal) is OK.<br>⑨ NOX (X-ray exposure prohibition) from I/O CONT-96 board is OFF.</td></tr>
</table>

## 7.19 SF signal circuit

This signal is for fluoroscopic X-ray operation.

| | |
|---|---|
| *SF | Fluoroscopic X-ray operation signal in selected operation method (negative logic) |
| A TTL level signal that is converted from fluoroscopic X-ray operation signal from foot switch F. | |

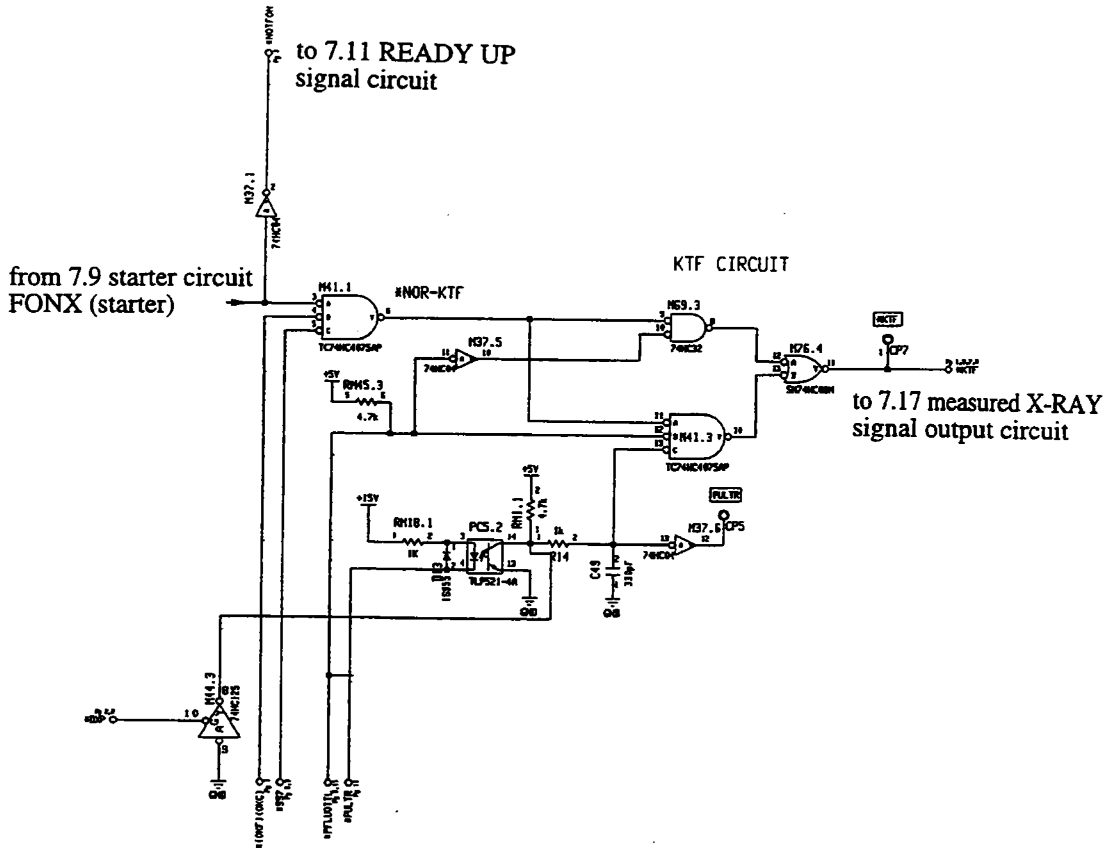
## 7.20 FOC-FLAG signal circuit

This circuit latches fluoroscopic over-current signal FOC supplied from mA POWER-96 board.

| | |
|---|---|
| FOC-FLAG | Latched signal caused by fluoroscopic over-current signal FOC supplied from mA Power-96 board. |
| To reset the latch, any one of the conditions ① ~ ⑤ for signal FON must be once canceled, and these conditions ① ~ ⑤ must be satisfied again. | |

## 7.21 KTF signal circuit

This circuit generates fluoroscopic X-RAY ON signal.




**KTF signal circuit**

| KTF | Fluoroscopic X-RAY ON signal |
|---|---|
| This signal is output when conditions ② and ③ are established in addition to condition ①.<br>① Signal FON (starter) is ON.<br>② Signals OKF and OKC are OK. (acknowledge signals for heating and charging)<br>③ I.I. mirror acknowledge signal is OK.<br>In pulse fluoroscopy, an additional condition ④ must be satisfied.<br>④ Signal PLTR (pulse trigger) is ON.<br>Note) When the operation method is DSP, signal DXP (radiation) must be ON. | |

| SS7 | I.I. mirror acknowledge signal |
|---|---|
| This signal is a logic level signal converted from a contact-point signal at terminals [S6] and [S7] of TERMINAL-96 board which acknowledges moving of the mirror in I.I. optical system in the direction of TV camera. | |

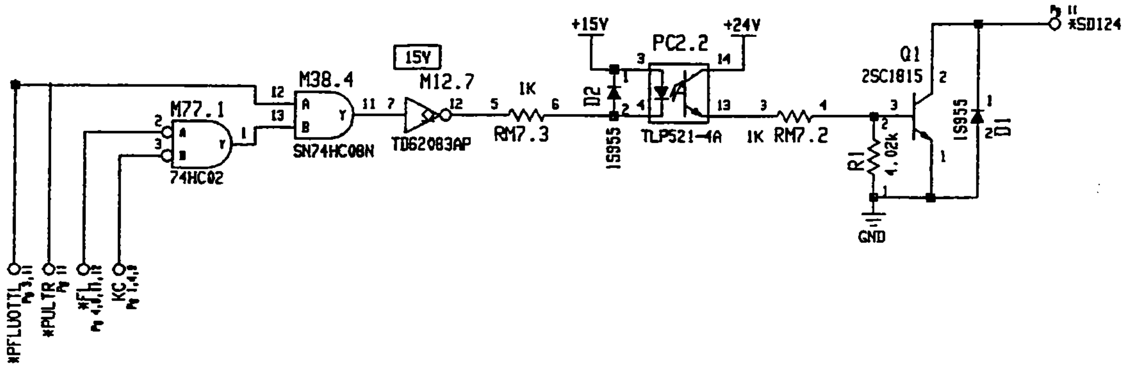
| PFLUOTTL | Pulsed fluoroscopy selection signal |
|---|---|
| This signal is output when pulsed fluoroscopy is selected on the fluo-panel or the console | |

| PLUTR | Pulsed fluoroscopy trigger signal |
|---|---|
| This signal is pulsed fluoroscopy trigger signal gated by pulse fluoroscopy selection signal and is output as fluoroscopic X-RAY ON signal | |

| DXP | X-RAY acknowledge signal |
|---|---|
| This signal is received from DSA device at terminals [EXP1] and [EXP2] of TERMINAL II -96 board. (option) | |

## 7.22 SD124 signal circuit

This signal switches mA detection resistor on TUBE SELECTOR board of the high-voltage generator in terms of fluoroscopic and radiographic operation.

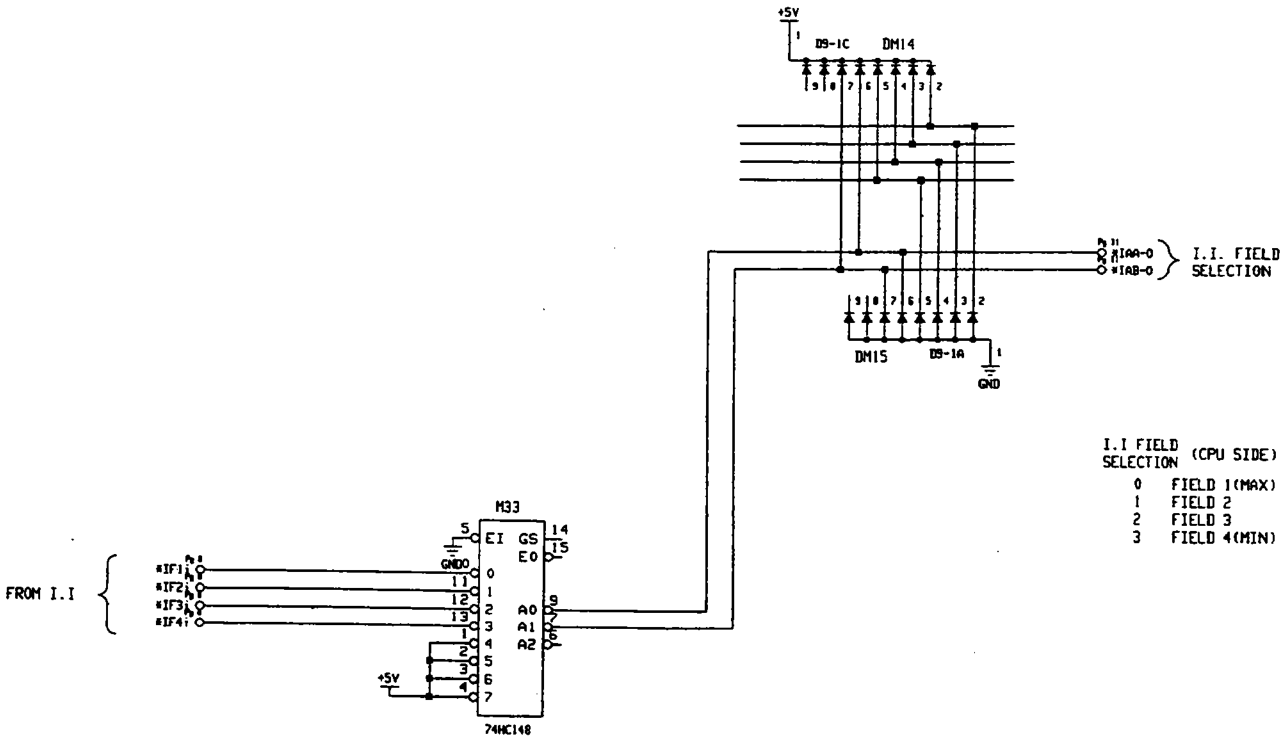



| | |
|---|---|
| SD124 | Signal to switch the tube current detection circuit of the high-voltage generator to fluoroscopy side.<br>This signal is output when conditions ② and ③ are established in addition to condition ①. |
| <Operation method> <Mode><br>① (FL) when fluoroscopy enable signal is output<br>② (KC) when READY operation is not executed<br>③ (PFLUOTTL) when pulse fluoroscopy is not selected<br>[This signal drives DC24 V relay.] | |

## 7.23 I.I. field-of-view switching signal circuit

(1) Input circuit

With I.I. of field-of-view switching type, a signal from a field-of-view changing switch on fluoroscopic operation bed is sent to EMC-96 board and encoded to *IAA-O and *IAB-O signal there, and sent to I/O CONT-96 board through connector JM44.

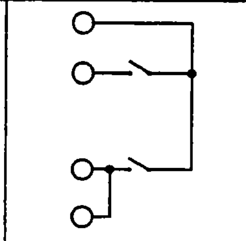
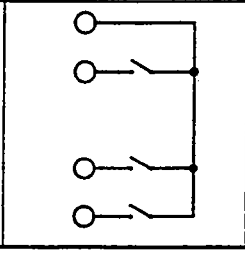
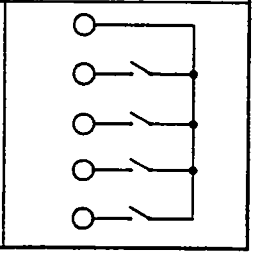



**I.I. field-of-view switching signal circuit (input)**

| I.I. field-of-view switching signal circuit (input) |
|---|
| With I.I. of field-of-view switching type, signals IF0, IF1 ~ IF4 is input to connector JSK of MOTHER-96 board and further input to EMC-96 board through connector JM34. The signal is encoded to binary signals IAA-O and IAB-O, and sent to I/O CONT-96 board through connector JM44.<br>CPU uses this signal to:<br>[1] Calculate an object thickness from fluoroscopic condition of memory-shot, and<br>[2] Correct mAs value in an operation method IFG. |

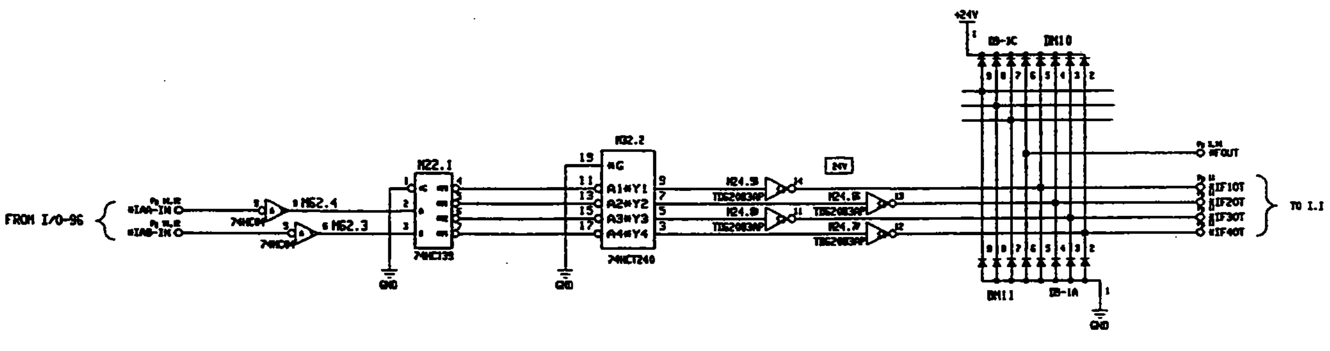
| I.I. field-of-view switching signals (connector JSK) from the field-of-view change switch | | | | | Field-of-view switching signals to I/O CONT-96 board | |
|---|---|---|---|---|---|---|
| IF0 | IF1 | IF2 | IF3 | IF4 | *IAB-IN | *IAA-IN |
| O— | —O | | | | 1 | 1 |
| O— | — | —O | | | 1 | 0 |
| O— | — | — | —O | | 0 | 1 |
| O— | — | — | — | —O | 0 | 0 |

{1:5V, 0:0V}

| I.I. field-of-view switching signals IF0, IF1 ~ IF4 | | | | |
|---|---|---|---|---|
| The field-of-view changing switch is connected as follows in accordance with the number of changing steps. | | | | |
| Connector JSK | | Two steps | Three steps | Four steps |
| IF0<br>IF1<br>IF2<br>IF3<br>IF4 | Large field-of-view<br>≀<br>Small field-of-view |  |  |  |

(2) Output circuit

The CPU on I/O CONT-96 board processes the input field-of-view changing signals in section (1) and outputs *IAA-IA and *IAB-IN signals to EMC-96 board. The EMC-96 board decodes the input signals to *IF10T ~ *IF40T signals and sends them to TERMINAL-96 board through connector JM34.




| I.I. field-of-view switching signal circuit (output) |
|---|
| EMC-96 board receives *IAA-IA and *IAB-IN signals outputted from I/O CONT-96 board, decodes them to *IF10T ~ *IF40T signals, and sends the decoded signals to TERMINAL-96 board through connector JM34. The signals are sent to the collimator through connector JXS of TERMINAL-96 board and to the I.I. through connector JTH-RB. |

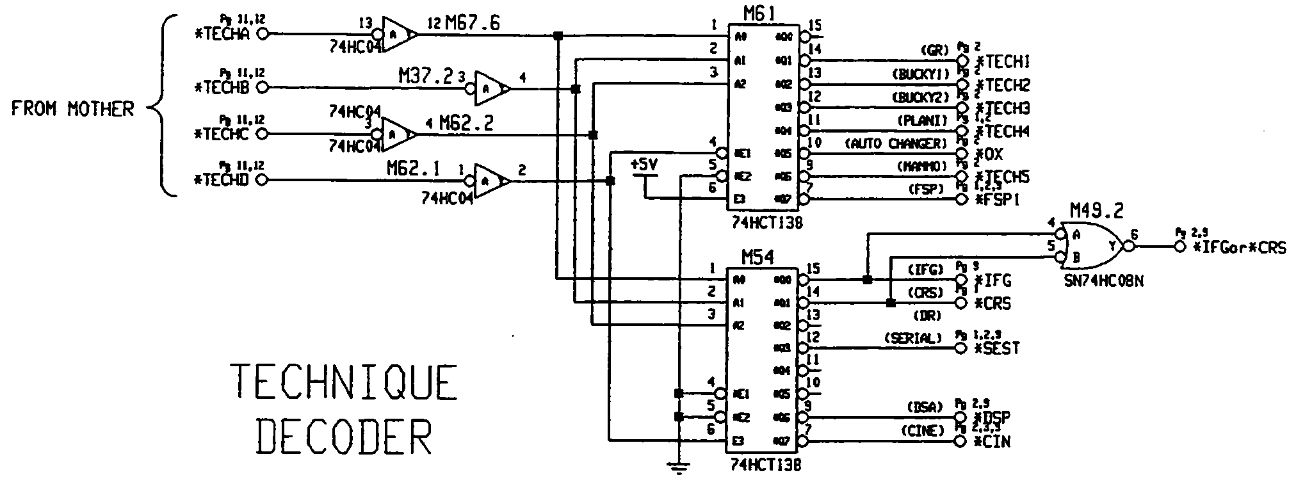


69

## 7.24 Operation method selection signal circuit

The operation method (terminal code) selection signals (*TECHA ~ *TECHD) are transmitted from I/O CONT-96 board to EMC-96 board through MOTHER-96 board and connector JM44.

Operation methods (terminal codes), signal notations, abbreviations, and control signals are shown below.




### Operation method selection signals from I/O CONT-96 board

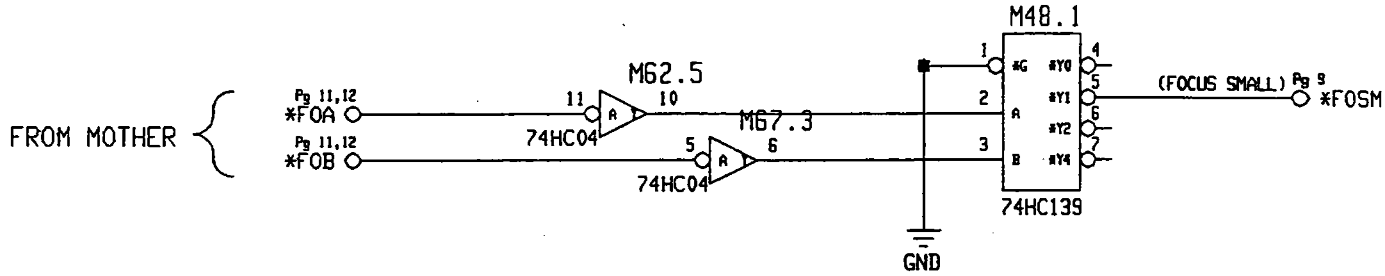
| Signal notation (negative logic) | JM44 Pin No |
|---|---|
| *TECHA | B-21 |
| *TECHB | C-21 |
| *TECHC | A-22 |
| *TECHD | B-22 |

| Operation method selection signals from I/O CONT-96 board (binary) (negative logic) | | Operation signals in EMC-96 board |
|---|---|---|
| *TEC -D-C-B-A | Operation methods (terminal codes) Designation | |
| 1 1 1 1 | Unused | —— |
| 1 1 1 0 | General radiography | GR |
| 1 1 0 1 | Bucky's radiography 1 | BU1 |
| 1 1 0 0 | Bucky's radiography 2 | BU2 |
| 1 0 1 1 | Tomography | PL |
| 1 0 1 0 | Auto-changer radiography | OX |
| 1 0 0 1 | MAMMO radiography (unused) | MAMM |
| 1 0 0 0 | Direct spot filming | FSP |
| 0 1 1 1 | I.I. indirect spot filming | IFG |
| 0 1 1 0 | I.I. indirect serial radiography | CRS |
| 0 1 0 1 | | |
| 0 1 0 0 | Serial radiograph | SEST |
| 0 0 1 1 | | |
| 0 0 1 0 | | |
| 0 0 0 1 | DSA radiography | DSP |
| 0 0 0 0 | CINE radiography (unused) | CIN |

{1:5V, 0:0V}

## 7.25 Focus selection signal circuit

Focus selection signals (*FOA, *FOB) are sent from I/O CONT-96 board to EMC-96 board through MOTHER-96 board and connector JM44.



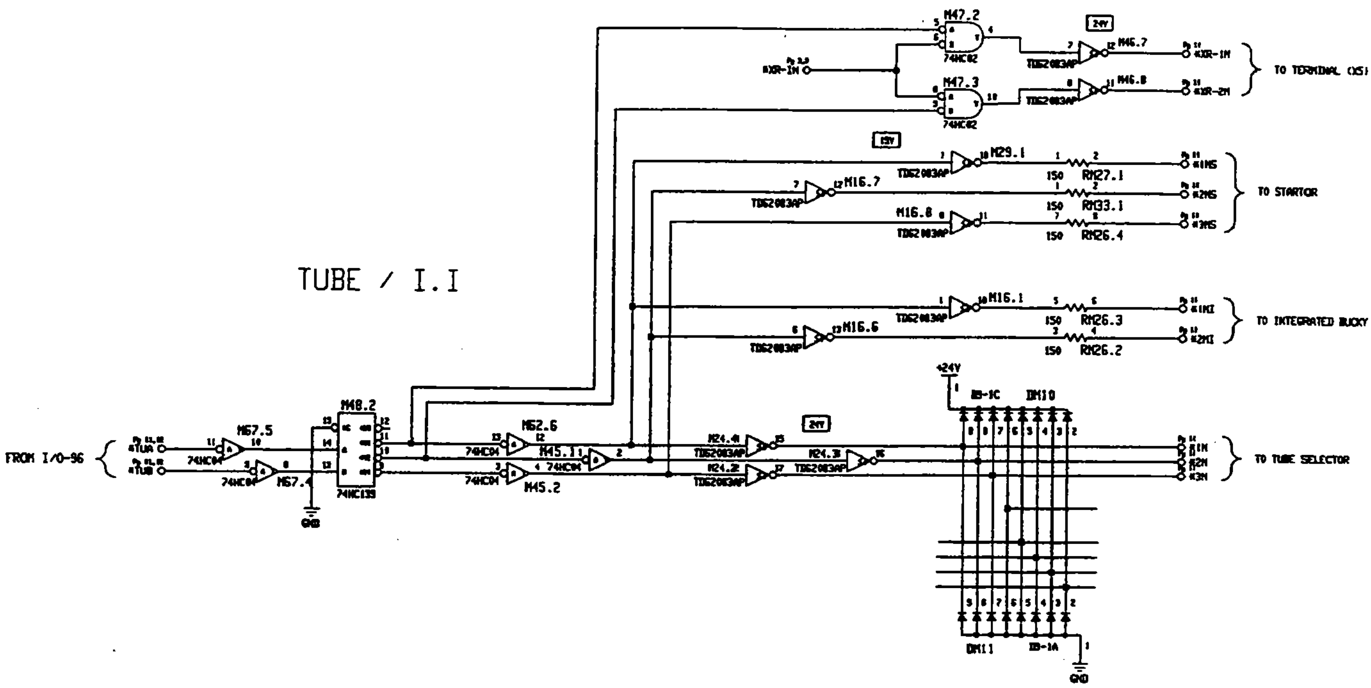

| Focus | Focus selection signals from I/O CONT-96 board (binary) (negative logic) | | EMC-96 (TERMINAL II -96) Focus selection signals for EMC-96 (TERMINAL II -96) board |
|---|---|---|---|
| | *FOB JM44C-29 | *FOA JM44B-29 | |
| Unused | 1 | 1 | —— |
| Small focus | 1 | 0 | *FOSM |
| Large focus | 0 | 1 | —— |
| Micro focus | 0 | 0 | —— |

{1:5V, 0:0V}

Note) Micro focus cannot be used at present.

## 7.26 1M ~ 3M signal circuit

Tube selection signals (*TUA, *TUB) are sent from I/O CONT-96 board to EMC-96 board through MOTHER-96 board and connector JM44.




| *1M ~ *3M | Tube selection signal circuit (Tube No. 1 ~ No. 3) (negative logic) | | | | | |
|---|---|---|---|---|---|---|
| X-ray tube number | X-ray tube selection signals from I/O CONT-96 board (binary) (negative logic) | | Tube selection signals for TUBE SELECTOR board | Tube selection signals for INTEGRATE BUCKY device | Tube selection signals for STARTOR device | X-ray exposure signal for each X-ray tube |
| | *TUB JM44B-29 | *TUA JM44C-29 | | | | |
| Unused | 1 | 1 | —— | —— | —— | —— |
| TUBE1 | 1 | 0 | *1M | *1MI | *1MS | *XR-1M |
| TUBE2 | 0 | 1 | *2M | *2MI | *2MS | *XR-2M |
| TUBE3 | 0 | 0 | *3M | —— | *3MS | —— |

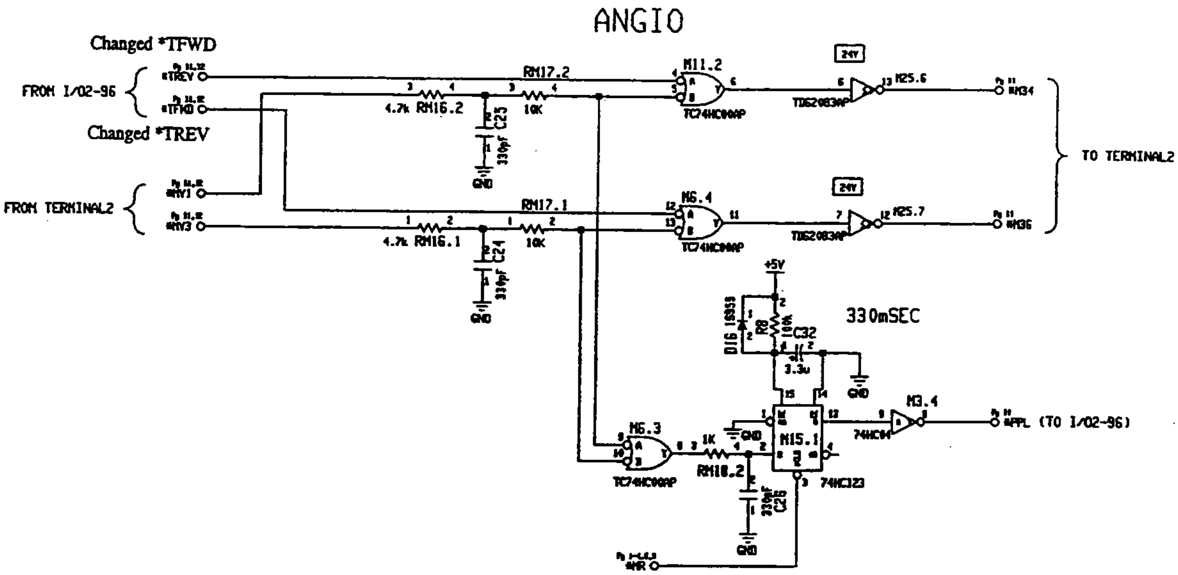
{1:5V, 0:0V}

## 7.27 Top-panel move signal circuit

This circuit generates signals to move the top-panel of the examination bed forward and backward in angiography of lower limbs.

Correct errors in the circuit diagram below.

Change a signal *TREV to *TFWD at pin④ of M11 and *TFWD to *TREV at pin⑪ of M6.




**Top-panel move signal circuit**

| *TFWD(negative logic) | Signal to move the panel forward [output from the console (I/02)] |
|---|---|
| This signal is output from I/O Ⅱ-96 board by console operation to move the panel forward. | |

| *TREV(negative logic) | Signal to move the panel backward [output from the console (I/02)] |
|---|---|
| This signal is output from I/O Ⅱ-96 board by console operation to move the panel backward. | |

| *MV1(negative logic) | Signal to move the panel forward [output from the film-changer device] |
|---|---|
| This signal is output from the film-changer device to TERMINAL Ⅱ-96 board to move the panel forward. | |

| *MV3(negative logic) | Signal to move the panel backward [output from the film-changer device] |
|---|---|
| This signal is output from the film-changer device to TERMINAL Ⅱ-96 board to move the panel backward. | |

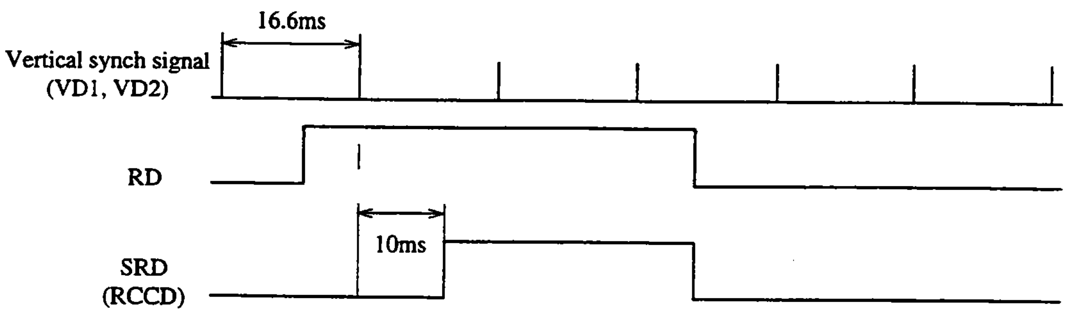
| M34 | Signal to move the panel forward |
|---|---|
| This signal is output from EMC-96 board to move the panel forward by driving the relay of TERMINAL Ⅱ-96 board. | |

| M36 | Signal to move the panel backward |
|---|---|
| This signal is output from EMC-96 board to move the panel backward by driving the relay of TERMINAL Ⅱ-96 board. | |

| PPL | Signal to move the panel [output from the film-changer device] |
|---|---|
| This signal is output from the film-changer device to TERMINAL Ⅱ-96 board to move the panel. This signal is used to change radiographic conditions at the console. CPU in I/O Ⅱ-96 board processes the signal from EMC-96 board for the change. | |

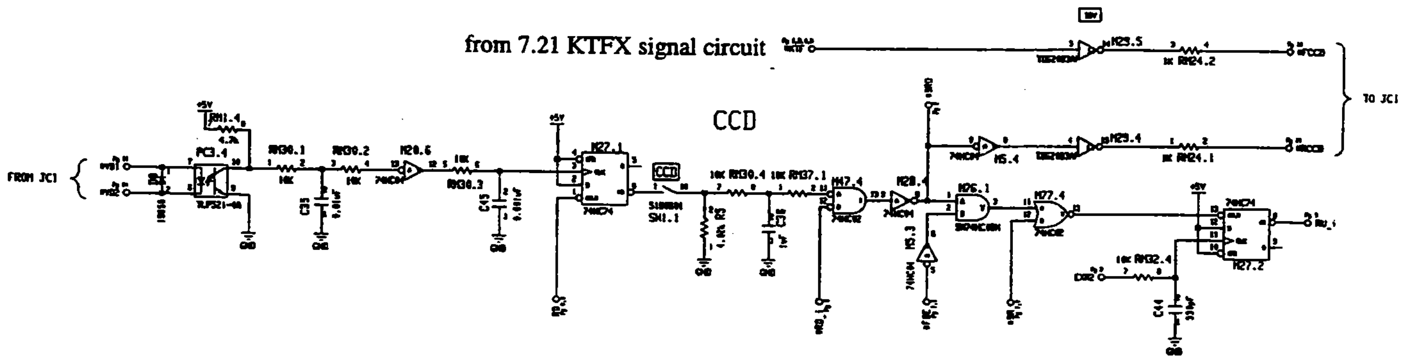
## 7.28 Input/output signals and timing chart on CCD camera device

(1) Timing chart




(2) Input/output signals on CCD camera device

| Input/output signals on CCD camera device | | |
|---|---|---|
| VD1 | Vertical synch signal input from CCD camera device | The first vertical signal after RD signal triggers a flip-flop with a pulse width of 10 msec. After the delay time of 10 msec, SRD signal is sent to X-ray signal circuit. |
| VD2 | | |
| RCCD | Radiographic sequence signal output to CCD camera device | This signal is sent to X-ray signal circuit as SRD signal in EMC-96 board. |
| FCCD | Fluoroscopic sequence signal output to CCD camera device | This signal is KTF (fluoroscopic radiation signal) in EMC-96 board.。 |



### 7.29 Input signal conversion circuit

The circuit on EMC-96 board is made of HC-CMOS powered by 5 V supply.

It converts input signals to the same level as those of external devices and other boards.

The circuit diagram of the input signal conversion circuit is shown on Page 8.

Refer to 7.31 "Input/output signals on EMC-96 board" for significance of input signals and class of circuit configurations.

### 7.30 Output signal conversion circuit

The circuit on EMC-96 board is made of HC-CMOS powered by 5 V supply.

It converts output signals to the same level as those of external devices and other boards.

The circuit diagram of the output signal conversion circuit is shown on Page 9.

Refer to 7.31 "Input/output signals on EMC-96 board" for significance of output signals and class of circuit configurations.

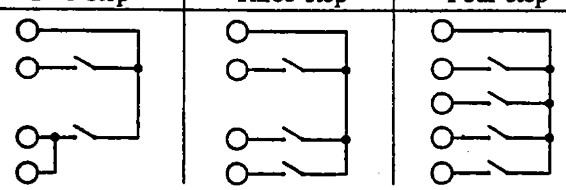
## 7.31 Input/output signals on EMC-96 board

[1] Table of input/output signals on EMC-96 board

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM34 | 10/12 | A-1 | +5VM | In | | +5 V input | Mother-96 |
| | | B-1 | 〃 | 〃 | | | |
| | | C-1 | 〃 | 〃 | | | |
| | | A-2 | +5VM | In | | | Mother-96 |
| | | B-2 | 〃 | 〃 | | | |
| | | C-2 | 〃 | 〃 | | | |
| | 10/12 | A-3 | +15VM | In | | +5 V input | Mother-96 |
| | | B-3 | 〃 | 〃 | | | |
| | | C-3 | 〃 | 〃 | | | |
| | | A-4 | -15VM | In | | -15 V input | Mother-96 |
| | | B-4 | 〃 | 〃 | | | |
| | | C-4 | 〃 | 〃 | | | |
| | 8/12 | A-5 | *AR1I | In | e | Hand-switch READY operation signal | J9→ |
| | | B-5 | *HX1I | 〃 | 〃 | Hand-switch X-RAY operation signal | Mother-96 |
| | | C-5 | (no use) | — | | | |
| | 7/12 | A-6 | *RCCD | Out | i | Radiographic sequence signal to CCD camera device | JC1→ |
| | | B-6 | *FCCD | 〃 | 〃 | Fluoroscopic sequence signal to CCD camera device | Mother-96 |
| | | C-6 | *VD2 | In | f | Vertical synch signal input from CCD camera device | →JC1 |
| | | A-7 | *VD1 | 〃 | 〃 | | |
| | | B-7 | (no use) | — | | | |
| | | C-7 | (no use) | — | | | |
| | 1/12 | A-8 | *OKF-I | In | a | Filament heating OK signal [TTL level] | mA POWER -96 |
| | 1/12 | B-8 | *OKC-I | 〃 | 〃 | Main circuit capacitor charging OK signal [TTL level] | ANALOG-96 |
| | 3/12 | C-8 | *KVT-I | 〃 | 〃 | Acknowledge signal of measured tube voltage build-up | ANALOG-96 |
| | 3/12 11 | A-9 | *IPOF | In | e | X-ray cutoff signal from photo-timer | PH POWER -96 PH CONT-96 |
| | 4/12 | B-9 | *FOC-I | In | a | Fluoroscopic over-current signal | mA POWER -96 |
| | | C-9 | (no use) | — | | | |
| | | A-10 | (no use) | 〃 | | | |
| | | B-10 | (no use) | 〃 | | | |
| | 1/12 5 | C-10 | *ROC | In | a | Radiographic over-current signal | ANALOG-96 |
| | | A-11 | *TkVOVER | 〃 | 〃 | Measured tube-voltage over permissible range | |
| | | B-11 | *PKVOVER | 〃 | 〃 | Faulty set-value of tube voltage | |
| | | C-11 | *CHARGE OVER | 〃 | 〃 | Faulty charging-voltage of primary smoothing capacitor | |
| | | A-12 | *IFOVER | In | a | Faulty filament-heating-current | mA POWER -96 |
| | 8/12 | B-12 | *OKHVT | 〃 | b | High-voltage generator connected | |
| | 1/12 | C-12 | *LVOVER | In | a | Power supply voltage over permissible range for apparatus | Mother-96 |
| | | A-13 | (no use) | — | | | |
| | | B-13 | (no use) | — | | | |
| | | C-13 | (no use) | 〃 | | | |

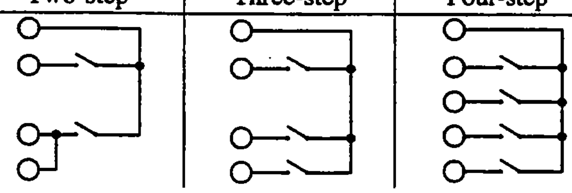
| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | 8/12 | A-14 | HON | In | c | +15 V power for current-loop input | JS1→ |
| | | B-14 | *7 | 〃 | 〃 | Normal-speed revolution startup OK signal (+15 V current-loop input) | (SA-41) (Starter 4UD) |
| | | C-14 | *H7 | 〃 | 〃 | High-speed revolution startup OK signal ( 〃 ) | |
| | 9/12 | A-15 | *1MS | Out | i | First tube selection signal (+15 V current-loop output) | |
| | | B-15 | *2MS | 〃 | 〃 | Second tube selection signal ( 〃 ) | |
| | | C-15 | *2 | 〃 | 〃 | Normal-speed revolution drive ON signal ( 〃 ) | |
| | | A-16 | *H2 | 〃 | 〃 | High-speed revolution drive ON signal ( 〃 ) | |
| | | B-16 | *H11 | 〃 | 〃 | Driving power stop signal ( 〃 ) | |
| | | C-16 | *H12 | 〃 | 〃 | Output signal for switching of startup time ( 〃 ) | |
| | | A-17 | (no use) | — | | | |
| | 8/12 | B-17 | *STRBK | In | c | Input signal for faulty starter (+15 V current-loop input) | |
| | 9/12 | C-17 | *TRST | Out | i | Output signal for X-ray exposure prohibition (+15 V current-loop output) | |
| | | A-18 | *3MS | 〃 | 〃 | Third tube selection signal ( 〃 ) | |
| | | B-18 | (no use) | — | | | |
| | | C-18 | (no use) | 〃 | | | |
| | 8/12 | A-19 | IF1 | In | b | I.I. field-of-view switching signal (input) | JSK→ MOTHER-96 |
| | | B-19 | IF2 | 〃 | 〃 | | |
| | | C-19 | IF3 | 〃 | 〃 | | |
| | | A-20 | IF4 | 〃 | 〃 | | |

| Connector JSK | | Two-step | Three-step | Four-step |
|---|---|---|---|---|
| IF0 | Large field | | | |
| IF1 | -of-view | | | |
| IF2 | ~ | | | |
| IF3 | Small field | | | |
| IF4 | -of-view | | | |



| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | 7/12 | B-20 | *IF1OT | Out | h | I.I. field-of-view switching signal (output) | TERMINAL -96 →JTH-RB →JXS |
| | | C-20 | *IF2OT | 〃 | 〃 | | |
| | | A-21 | *IF3OT | 〃 | 〃 | | |
| | | B-21 | *IF4OT | 〃 | 〃 | | |

| Connector JSK | | Two-step | Three-step | Four-step |
|---|---|---|---|---|
| IF0 | Large field | | | |
| IF1 | -of-view | | | |
| IF2 | ~ | | | |
| IF3 | Small field | | | |
| IF4 | -of-view | | | |



| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | | C-21 | (no use) | 〃 | | | |
| | 9/12 | A-22 | *S100 | Out | h | Output signal indicating of selection of operation methods including fluoroscopy | TERMINAL -96 |
| | | B-22 | *S2 | 〃 | 〃 | Signal to move two-way (three-way) distributor of I.I. device toward indirect camera | |
| | | C-22 | *S3 | 〃 | 〃 | Signal to move three-way distributor of I.I. device toward CINE camera | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM34 | 8/12 | A-23 | S5 | In | b | Acknowledge input signal indicating that mirrors of two-way (three-way) distributor have finished to move toward indirect camera or CINE camera | TERMINAL -96 |
| | | B-23 | S7 | In | 〃 | Acknowledge input signal indicating that mirrors of two-way (three-way) distributor have finished to move toward fluoroscopic TV camera | |
| | | C-23 | (no use) | — | | | |
| | 9/12 | A-24 | *FSP1C | Out | i | FSP output (selection signal for direct high-speed radiographic operation) (+15 V current-loop output) | TERMINAL -96 →DFS700 |
| | | B-24 | *TSC2C | 〃 | 〃 | IFG output (selection signal for indirect high-speed radiographic operation) (+15 V current-loop output) | |
| | | C-24 | *XR4 | 〃 | 〃 | X-RAY ON output in operation methods DSP, IFG, and CRS (+15 V current-loop output) | |
| | 9/12 | A-25 | *FSP1PH | Out | g | FSP output (selection signal for direct high-speed radiographic operation) (TTL level output) | PH POWER -96 PH CONT-96 |
| | | B-25 | *TS2PH | 〃 | 〃 | IFG output (selection signal for indirect high-speed radiographic operation) (TTL level output) | |
| | | C-25 | (no use) | — | | | |
| | 9/12 | A-26 | *2B2I | Out | i | Drive signal output to Bucky's device 2 (X-RAY ON signal output in operation method BU2) | TERMINAL -96 → INTEGRATE BUCKY |
| | | B-26 | *1B2I | 〃 | 〃 | Drive signal output to Bucky's device 1 (X-RAY ON signal output in operation method BU1) | |
| | | C-26 | *P2I | 〃 | 〃 | Drive signal output to tomography device (X-RAY ON signal output in operation method PL) | |
| | | A-27 | *KC2I | 〃 | 〃 | Preparation signal output to tomography device (KB signal output in operation method PL) | |
| | 9/12 | B-27 | *KCLV | Out | i | KC signal output to AVR-UD device (+15 V current-loop output) | MOTHER-96 terminal board X1 →AVR-UD |
| | | C-27 | (no use) | — | | | |
| | 9/12 | A-28 | *SP2CN4 | Out | i | Signal output on input of SP1 signal in the operation method FSP (for film exposure) (+15 V current-loop output) | TERMINAL -96 →CN4 |
| | | B-28 | (no use) | — | | | |
| | | C-28 | (no use) | 〃 | | | |
| | | A-29 | (no use) | 〃 | | | |
| | 9/12 | B-29 | O*RESET | In | a | Reset signal input from NEXSC board | NEXSC |
| | | C-29 | (no use) | — | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM34 | 6/12 | A-30 | *TID | In | a | Time selection signal of backup timer (negative logic) | I/O CONT -96→ |
| | | B-30 | *TIC | 〃 | 〃 | | |
| | | C-30 | *TIB | 〃 | 〃 | | |
| | | A-31 | GND | In | | GND input | Mother-96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | | |
| | | A-32 | GND | In | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Set value in sec | Time selection signal of backup timer (binary) | | | Backup time |
|---|---|---|---|---|
| | *TID | *TIC | *TIB | |
| 1.0ms ~ 120ms | 1 | 1 | 1 | 250msec |
| 140ms ~ 250ms | 1 | 1 | 0 | 0.5 sec |
| 280ms ~ 500ms | 1 | 0 | 1 | 1.0 sec |
| 560ms ~ 1.0sec | 1 | 0 | 0 | 2.0 sec |
| 1.1sec ~ 2.0sec | 0 | 1 | 1 | 4.0 sec |
| 2.2sec ~ 4.0sec | 0 | 1 | 0 | 8.0 sec |
| 4.5sec ~ 8.0sec | 0 | 0 | 1 | 16.0 sec |
| 9.0sec ~ 10.0sec | 0 | 0 | 0 | 32.0 sec |

{1:5V, 0:0V}

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM44 | 11/12 | A-1 | +24V | In | | +24 V input | Mother-96 |
| | | B-1 | 〃 | 〃 | | | |
| | | C-1 | 〃 | 〃 | | | |
| | | A-2 | (no use) | — | | | |
| | | B-2 | 〃 | 〃 | | | |
| | | C-2 | 〃 | 〃 | | | |
| | | A-3 | 〃 | 〃 | | | |
| | | B-3 | 〃 | 〃 | | | |
| | | C-3 | 〃 | 〃 | | | |
| | 9/12 | A-4 | *KC700 | Out | j | READY start signal (+15 V current-loop output) | J10→ PULSE I/F |
| | | B-4 | *XR700 | 〃 | 〃 | X-RAY signal (in both fluoroscopy and radiography) ( 〃 ) | 〃 |
| | 9/12 | C-4 | *MASP | 〃 | g | Signal to stop filament heating | mA POWER -96 |
| | | A-5 | (no use) | — | | | |
| JM44 | 5/12 | B-5 | *FLTD | Out | g | FAULT output signal (negative logic) {1: 5V, 0: 0V} | I/O.CONT -96P.C.B. |
| | | C-5 | *FLTC | 〃 | 〃 | | |
| | | A-6 | *FLTB | 〃 | 〃 | | |
| | | B-6 | *FLTA | 〃 | 〃 | | |

| *FLT DCBA | | Significance | Notation |
|---|---|---|---|
| 1111 | not fault | Not faulty | ———— |
| 1110 | not fault | Not faulty | ———— |
| 1101 | S6, S7Open | Fluoroscopic position in visual system is not acknowledged. | S6, S7Open |
| 1100 | S4, S5Open | Radiographic position in visual system is not acknowledged. | S4, S5Open |
| 1011 | Door Open | Door of operation room is open. | Door Open |
| 1010 | THERMAL OVER | Thermal circuit of X-ray tube has been operated. | THERMAL OVER |
| 1001 | STARTOR BRAKE | Starter device is faulty. | STARTOR BRAKE |
| 1000 | HVT NOt CONNECTED | High-voltage generator is not connected. | H.V.T.NOT CONNECTED |
| 0111 | Charge Brake | Charging voltage of primary smoothing capacitor is irregular. | CHARGE OVER |
| 0110 | IF over | Filament heating current is irregular. | IF OVER |
| 0101 | PkV over (set kV over) | Set value of tube voltage is irregular. | PkV OVER |
| 0100 | TkV over (mesured kV over) | Measured tube voltage is over permissible range. | TkV OVER |
| 0011 | Radio. Over current | Measured radiographic tube current is over permissible range. | RADIOGRAPHY OVER CURRENT |
| 0010 | Fluo. Over current | Measured fluoroscopic tube current is over permissible range. | FLUOGRAPHY OVER CURRENT |
| 0001 | Line Voltage Over | Power supply voltage is over permissible range. | LINE VOLTAGE OVER |
| 0000 | Power Down | -15 V supply voltage is down. | -15V POWER DOWN |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM44 | 5/12 | C-6 | *IAB-O | Out | g | *IAB-O I.I. field-of-view switching | →I/O.CONT |
| | | A-7 | *IAA-O | 〃 | 〃 | *IAA-O signal output (negative logic) | -96P.C.B. |
| | | | | | | *IAB-O / *IAA-O / Field-of-view | |
| | | | | | | 1 / 1 / Largest IF1 | |
| | | | | | | 1 / 0 / Large IF2 | |
| | | | | | | 0 / 1 / Middle IF3 | |
| | | | | | | 0 / 0 / Small IF4 | |
| | | | | | | {1:5V, 0:0V} | |
| JM44 | 9/12 | B-7 | (no use) | — | | | |
| | | C-7 | 〃 | 〃 | | | |
| | | A-8 | *KC-O | Out | g | READY start signal [TTL level] | MOTHER-96 |
| | | B-8 | *REA-O | 〃 | 〃 | READY operation finish signal [TTL level] | 〃 |
| | | C-8 | (no use) | — | | | |
| | | A-9 | 〃 | 〃 | | | |
| | | B-9 | 〃 | 〃 | | | |
| | | C-9 | 〃 | 〃 | | | |
| | | A-10 | *INPSP8 | — | | Spare input | |
| | | B-10 | *XR-O | Out | g | Measured X-RAY signal [TTL level] | MOTHER-96 |
| | | C-10 | *KTR-O | 〃 | 〃 | Radiographic X-RAY ON signal [ 〃 ] | 〃 |
| | | A-11 | *KTF-O | 〃 | 〃 | Fluoroscopic X-RAY ON signal [ 〃 ] | 〃 |
| | | B-11 | *KB-O | 〃 | 〃 | READY start signal [ 〃 ] | 〃 |
| | | C-11 | *EXR-O | 〃 | 〃 | Radiographic, fluoroscopic X-RAY ON signal [ 〃 ] | 〃 |
| | | A-12 | *EXP-O | 〃 | 〃 | Measured X-RAY signal [ 〃 ] (radiography, fluoroscopy) | 〃 |
| | | B-12 | *XRAYON | 〃 | 〃 | Radiographic X-RAY start signal[ 〃 ] | 〃 |
| | | C-12 | (no use) | — | | | |
| | 8/12 | A-13 | *PUL | Out | g | Pulsed radiography selection signal (unused) | TERMINAL II |
| | 7/12 | B-13 | *PPL | Out | g | Signal to move top-panel of examination bed [TTL level] | →I/O2 |
| | | C-13 | *CM4 | — | | CINE camera exposure signal (unused) | |
| | 7/12 | A-14 | *TFWD | In | | Signal to move top-panel of examination bed forward [ 〃 ] | I/O2→ |
| | | B-14 | *TREV | 〃 | | Signal to move top-panel of examination bed backward [ 〃 ] | 〃 |
| | | C-14 | 0V | — | | 0 V for CM4 (unused) | |
| | 3/12 | A-15 | *AUT | In | a | CINE AUTO selection signal [TTL level] | I/O2→ |
| | | B-15 | *LOC | 〃 | 〃 | Signal to fix radiographic conditions (for CINE AUTO) (unused) [ 〃 ] | 〃 |
| | | C-15 | *COF | 〃 | 〃 | X-ray cutoff signal from CINE 1 exposure timer (unused) [ 〃 ] | 〃 |
| | 1/12 | A-16 | *CUT | 〃 | 〃 | CINE CUT cutoff signal [ 〃 ] | I/O2→ |
| | 8/12 | B-16 | *SCM | In | a | CINE camera exposure signal [ 〃 ] | 〃 |
| | 9/12 | C-16 | *TEST | 〃 | a | CINE test signal [ 〃 ] | 〃 |
| | | A-17 | (no use) | — | | | |
| | 9/12 | B-17 | *Pk | Out | h | Cathode blanking signal (unused) | TERMINAL II |
| | | C-17 | (no use) | — | | | |
| | 4/12 | A-18 | *PFLUOTT | In | a | Pulsed fluoroscopy selection signal | I/O II -96 |
| | 4/12 | B-18 | *PULTR | In | e | Pulsed fluoroscopy X-ray radiation trigger signal | PULSEI/F |
| | | C-18 | (no use) | — | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM44 | | A-19 | (no use) | — | | | |
| | | B-19 | ( 〃 ) | 〃 | | | |
| | | C-19 | ( 〃 ) | 〃 | | | |
| | | A-20 | ( 〃 ) | 〃 | | | |
| | | B-20 | ( 〃 ) | 〃 | | | |
| | | C-20 | ( 〃 ) | 〃 | | | |
| | 3/12 | A-21 | *SOF | In | a | X-ray cutoff signal from timer | I/O CONT -96→ |
| | 6/12 | B-21 | *TECHA | In | a | *Input selection signal for the operation method *TECHBEMC (negative logic) {1: 5V / 0: 0V} | I/O CONT -96→ |
| | | C-21 | *TECHB | 〃 | 〃 | | |
| | | A-22 | *TECHC | 〃 | 〃 | | |
| | | B-22 | *TECHD | 〃 | 〃 | | |

| *TECH DCBA | Operation method | Code |
|---|---|---|
| 1 1 1 1 | Unused | |
| 1 1 1 0 | General radiography | GR |
| 1 1 0 1 | Bucky's radiography 1 | BU1 |
| 1 1 0 0 | Bucky's radiography 2 | BU2 |
| 1 0 1 1 | Tomography | PL |
| 1 0 1 0 | Auto-changer radiography | OX |
| 1 0 0 1 | MAMMO radiography (unused) | MAMM |
| 1 0 0 0 | Direct spot filming | FSP |
| 0 1 1 1 | I.I. indirect spot filming | IFG |
| 0 1 1 0 | I.I. indirect serial | CRS |
| 0 1 0 1 | | |
| 0 1 0 0 | Serial radiography | SEST |
| 0 0 1 1 | | |
| 0 0 1 0 | | |
| 0 0 0 1 | DSA radiography | DSP |
| 0 0 0 0 | CINE radiography | CIN |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM44 | | C-22 | *OUTSP16 | — | | Spare signal | |
| | 1/12 2 | A-23 | *HST | In | a | Hand-switch valid signal | I/O CONT -96→ |
| | 9/12 | B-23 | *FSP1+ *IFG | In | a | Input selection signal for direct high-speed radiography (FSP) or I.I. indirect high-speed radiography (IFG) (for fast startup of starter) | |
| | 8/12 | C-23 | *IICAME RA-IN | In | a | Input selection signal for I.I. indirect camera (for confirmation of visual radiographic position) | |
| JM44 | 7/12 | A-24 | *IAB-IN | In | a | *IAB-IN, *IAA-IN: I.I. field-of-view switching input signal (negative logic) {1: 5V / 0: 0V} | |
| | | B-24 | *IAA-IN | 〃 | 〃 | | |

| *IAB-IN | *IAA-IN | Field-of-view | |
|---|---|---|---|
| 1 | 1 | Largest | IF1 |
| 1 | 0 | Large | IF2 |
| 0 | 1 | Middle | IF3 |
| 0 | 0 | Small | IF4 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | 1/12 | C-24 | *NOKU-IN | In | a | Signal to invalidate double exposure prevention circuit | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM44 | | A-25 | *OUTSP14 | — | | Spare signal | |
| | 4/12 | B-25 | *FSAON | In | a | Input signal for X-ray tube anode rotation in fluoroscopy | From I/OCONT-96 |
| | 1/12<br>2 | C-25 | *SPSWE | In | a | Input signal to validate high-speed operation button | |
| | | A-26 | *OUTSP15 | — | | Spare input signal [TTL level] | |
| | 4/12<br>9 | B-26 | *FL | In | a | Fluoroscopy enable input signal | |
| | 1/12 | C-26 | *LOVE | In | a | Input signal indicating over radiographic conditions | |
| | | A-27 | *HOVE | 〃 | 〃 | Signal indicating over anode heat-capacity of X-ray tube (unused) | |
| | 4/12 | B-27 | *FOVE | 〃 | 〃 | Input signal indicating over 10 minutes in fluoroscopy | |
| | 1/12<br>4 | C-27 | *NOX | 〃 | 〃 | Input signal of X-ray exposure prohibition | |
| | 1/12 | A-28 | *HIG | 〃 | 〃 | Signal of high-speed anode rotation of X-ray tube | |
| | | B-28 | *MASP-IN | 〃 | 〃 | Signal to stop heating circuit of the apparatus | |
| | 2/12 | C-28 | *SCD | In | a | Signal to invalidate operation assurance circuit of general radiographic devices | From I/OCONT-96 |
| | | A-29 | *OUTSP14 | — | | Spare signal [TTL level] | |
| JM44 | 7/12 | B-29 | *TUB | In | a | X-ray tube number selection signal (negative logic) {1: 5V, 0: 0V} | |
| | 11<br>12 | C-29 | *TUA | 〃 | 〃 | | |

| *TUB | *TUA | X-ray tube number |
|---|---|---|
| 1 | 1 | Unused |
| 1 | 0 | TUBE1 |
| 0 | 1 | TUBE2 |
| 0 | 0 | TUBE3 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | | A-30 | *OUTSP11 | — | | | |
| | 6/12 | B-30 | *FOB | In | a | X-ray tube focus selection signal (negative logic) {1: 5V, 0: 0V} | |
| | | C-30 | *FOA | 〃 | 〃 | | |

| *FOB | *FOA | X-ray tube focus |
|---|---|---|
| 1 | 1 | Unused |
| 1 | 0 | Small focus |
| 0 | 1 | Large focus |
| 0 | 0 | Micro focus (unused) |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | | A-31 | GND | In | | GND input | Mother-96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | | |
| | | A-32 | GND | In | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J125 | 10/12 | A-1 | +15V | Out | | +15 V output | TERMINAL II -96 |
| | | B-1 | 〃 | 〃 | | | |
| | | A-2 | +24V | 〃 | | +24 V output | |
| | | B-2 | 〃 | 〃 | | | |
| | 9/12 | A-3 | *TS14 | Out | h | DSA operation selection signal | TERMINAL II -96 |
| | | B-3 | *KC14 | 〃 | 〃 | Radiography preparation signal output to DSA device | |
| | | A-4 | *XR14 | 〃 | 〃 | X-RAY signal output to DSA device | |
| | 8/12 | B-4 | *EXP1 | In | f | X-RAY OK input signal from DSA device | TERMINAL II -96 |
| | | A-5 | *EXP2 | 〃 | 〃 | | |
| | | B-5 | *AR2I | In | b | READY operation second input signal | |
| | | A-6 | *HX2I | 〃 | 〃 | X-RAY operation second input signal | |
| | | B-6 | *PUL2 | 〃 | 〃 | Pulse radiography selection signal input (unused) | |
| | 7/12 | A-7 | *MV1 | In | a | Signal to move top-panel of examination bed forward [output from film-changer device] | |
| | | B-7 | *MV3 | 〃 | 〃 | Signal to move top-panel of examination bed backward [output from film-change device] | |
| | | A-8 | *M36 | Out | h | Signal to move top-panel backward, which drives relay of TERMINAL2-96 board | |
| | | B-8 | *M34 | 〃 | 〃 | Signal to move top-panel forward, which drives relay of TERMINAL2-96 board | |
| | 9/12 | A-9 | *XROB | Out | 〃 | X-RAY ON signal output | |
| | 3/12 | B-9 | *XRIN | 〃 | 〃 | Output signal for X-RAY exposure | |
| | | A-10 | (no use) | — | | | |
| | 9/12 | B-10 | *SR2 | Out | h | SEST operation selection signal output | TERMINAL II -96 |
| | 8/12 | A-11 | *RY3 | In | b | READY operation signal input from film-changer device | PUCK→ |
| | 9/12 | B-11 | *KCS2 | Out | h | Radiographic preparation signal output to STA-30 device (KC signal output) | →STA-30 |
| | 8/12 | A-12 | *CU2 | In | b | Acknowledge signal of heating from STA-30 device | STA-30→ |
| | 9/12 | B-12 | *UP2 | Out | h | READY UP signal output to film-changer device | →PUCK |
| | 8/12 | A-13 | *SE2 | In | b | X-ray operation signal input from film-changer device | PUCK→ |
| | 9/12 | B-13 | *EPS2 | Out | h | X-ray radiation signal output to STA-30 device (EXR signal output) | →STA-30 |
| | 9/12 | A-14 | *Ci2 | Out | h | CINE operation selection signal output (unused) | TERMINAL II -96→CINE |
| | | B-14 | *KC8 | Out | h | Radiographic preparation signal output for CINE operation (unused) (KC signal output) | →CINE |
| | | A-15 | *KCB | Out | h | Radiographic preparation signal output (KC signal output) | TERMINAL II -96 |
| | | B-15 | *CA2 | Out | h | X-RAY ON signal output to CINE camera device (〃) | →CINE |
| | | A-16 | *XR8 | 〃 | 〃 | 〃 (〃) | |
| | | B-16 | (no use) | — | | | |
| | | A-17 | *CM4 | — | | CINE camera exposure signal (unused) | |
| | | B-17 | 0V | — | | 0 V for CM4 (unused) | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J125 | 8/12 | A-18 | FOOT2 | In | b | Foot-switch signal input | TERMINAL Ⅱ |
| | | B-18 | (no use) | | | | -96 |
| | | A-19 | GND | In | | GND input | Mother-96 |
| | | B-19 | 〃 | 〃 | | | |
| | | A-20 | 〃 | 〃 | | | |
| | | B-20 | 〃 | 〃 | | | |

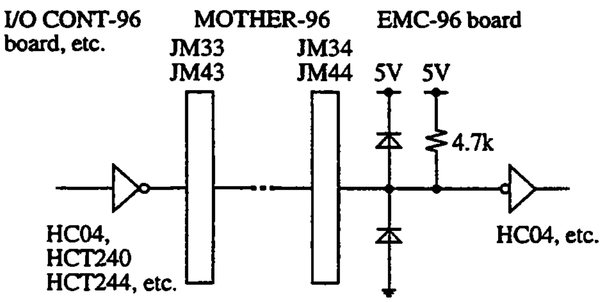
| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J126 | 10/12 | A-1<br>B-1 | +15V<br>〃 | Out<br>〃 | | +15 V output | TERMINAL -96 |
| | | A-2<br>B-2 | +24V<br>〃 | 〃<br>〃 | | +24 V output | |
| | 4/12 | A-3 | *SD124 | Out | h | Output signal to switch tube current detecting circuit of high-voltage generator to fluoroscopy side. | TERMINAL -96 JH1 |
| | 7/12 | B-3<br>A-4<br>B-4 | *3M<br>*2M<br>*1M | Out<br>〃<br>〃 | h<br>〃<br>〃 | Signal to select third tube<br>Signal to select second tube<br>Signal to select first tube | TUBE SELEC -TOR-96 |
| | 7/12 | A-5<br>B-5 | *XR-1M<br>*XR-2M | Out<br>〃 | h<br>〃 | First tube X-ray radiation signal<br>Second tube X-ray radiation signal | TERMINAL -96 |
| | 8/12 | A-6 | *LC | In | a | X-ray tube thermal condition acknowledge signal | JH3 |
| | 9/12 | B-6 | *1B22 | Out | h | Drive signal output to Bucky's device 1 (X-RAY signal output) | TERMINAL -96 |
| | 8/12 | A-7 | *1B1 | In | d | X-RAY OK signal input from Bucky's device 1 | |
| | 9/12 | B-7 | *2B22 | Out | h | Drive signal output to Bucky's device 2 (X-RAY signal output) | |
| | 8/12 | A-8 | *2B1 | In | d | X-RAY OK signal input from Bucky's device 2 | |
| | 9/12 | B-8<br>A-9 | *KC1 (PL)<br>*P22 | Out<br>Out | h<br>〃 | Preparation signal output to tomographic device (KB)<br>Drive signal output to tomographic device | TERMINAL -96 |
| | 8/12 | B-9<br>A-10 | *P1<br>*PG2 | In<br>〃 | d<br>b | X-RAY OK signal input from tomographic device Intermittent exposure signal input from tomographic device (to stop the operation of double exposure prevention flag) | |
| | 7/12 | B-10<br>A-11 | *1MI<br>*2MI | Out<br>〃 | i<br>〃 | Signal to select first tube<br>Signal to select second tube | TERMINAL -96 →INTEGRA-TE BUCKY |
| | 9/12 | B-11<br>A-12 | *KC5 (OX)<br>*XR5 | Out<br>Out | h<br>〃 | Radiography preparation signal output to auto-changer device<br>X-RAY signal output to auto-changer device | TERMINAL -96 →OX |
| | 8/12 | B-12 | *XS5 | In | d | X-RAY OK signal input from auto-changer device | |
| | 9/12 | A-13<br>B-13 | *REAO<br>*SMALL | Out<br>〃 | h<br>〃 | READY UP signal output<br>Output signal to select small focus | TERMINAL -96 |
| | 8/12 | A-14 | DOOR | In | b | Input signal of short-circuited door contact (for confirmation of closed door) | |
| | 9/12 | B-14<br>A-15<br>B-15 | *KC34<br>*XR1<br>*XR34 | Out<br>〃<br>〃 | h<br>〃<br>〃 | Preparation signal output to I.I. indirect high-speed radiographic camera device<br>Radiographic X-ray radiation signal output to I.I. indirect high-speed radiographic camera device<br>X-RAY signal output to I.I. indirect high-speed radiographic camera device | TERMINAL -96<br>Camera |
| | 8/12 | A-16<br>B-16 | *XS4<br>*PG4 | In<br>〃 | b<br>〃 | X-RAY OK signal input from I.I. indirect high-speed radiographic camera device<br>Signal to select consecutive radiographic operation in indirect camera operation (CRS) (Input for one-sheet film operation) | TERMINAL -96 |
| | 9/12 | A-17 | *SRD1 | Out | j | Signal to output X-RAY OK signal inputted from fluoroscopic operation bed to DSF700 | TERMINAL -96 →DFS700 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J126 | 8/12 | B-17 | *SP1 | In | d | Radiographic operation signal input from f luoroscopic operation bed | TERMINAL -96 |
| | 9/12 | A-18 | *SP2 | Out | h | Output signal on input of SP1 signal in FSP operation (for film exposure) | |
| | | B-18 | *FOOT1 | 〃 | 〃 | Foot-switch input enable signal output | |
| | 8/12 | A-19 | *F | In | d | Fluoroscopic X-RAY signal input from foot-switch | TERMINAL -96 |
| | | B-19 | *R | 〃 | 〃 | READY operation signal input from fluoroscopic operation bed | |
| | 9/12 | A-20 | *RE | Out | h | READY UP signal output to fluoroscopic operation bed | |
| | 8/12 | B-20 | *RD | In | d | X-RAY OK signal input from fluoroscopic operation bed | |
| | | A-21 | *FSE1 | In | a | Input signal to select consecutive operation from fluoroscopic operation bed | |
| | 9/12 | B-21 | *PRU | Out | h | TIME UP signal output to fluoroscopic operation bed | |
| | | A-22 | *FOUT | 〃 | 〃 | Output contact of KB or KTF signal (Signal output from I.I. getter interruption contact point) | →JTH-RB |
| | | B-22 | *RUC4 | Out | j | TIME UP signal output to fluoroscopic operation bed | →CN4 |
| | | A-23 | *REC4 | 〃 | 〃 | READY UP signal output to fluoroscopic operation bed | →CN4 |
| | | B-23 | *S100C4 | 〃 | 〃 | Fluoroscopy enable signal output to fluoroscopic operation bed | →CN4 |
| | | A-24 | GND | In | | GND input | Mother-96 |
| | | B-24 | 〃 | 〃 | | | |
| | | A-25 | 〃 | 〃 | | | |
| | | B-25 | 〃 | 〃 | | | |

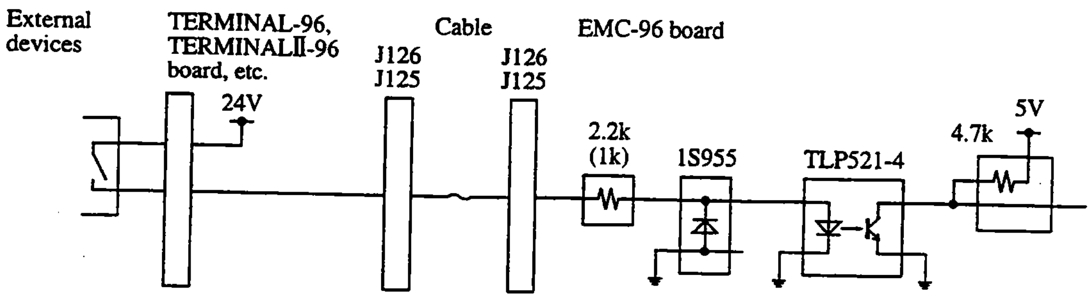
[2] Input/output circuit

Input/output circuits for the signals are as follows

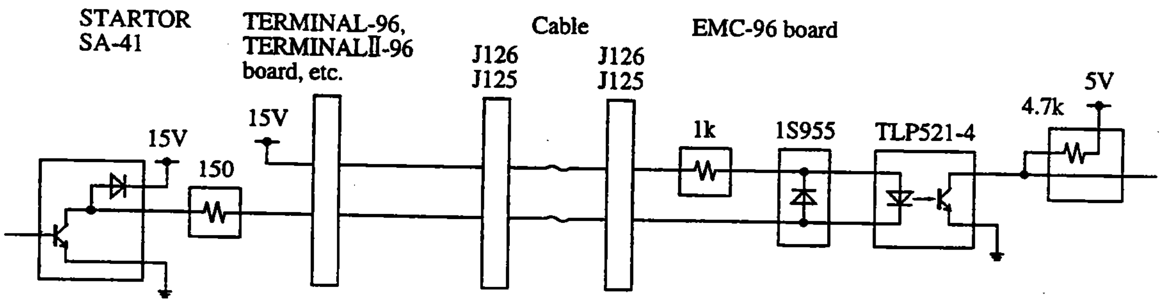
(a) Input circuit [No. 1] {HC-CMOS (5 V) level}



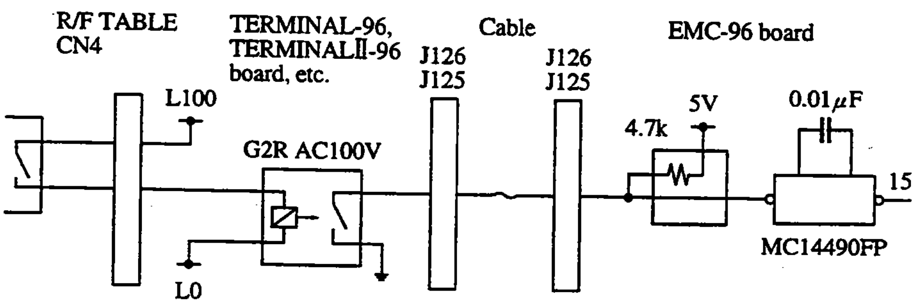
(b) Input circuit [No. 2]



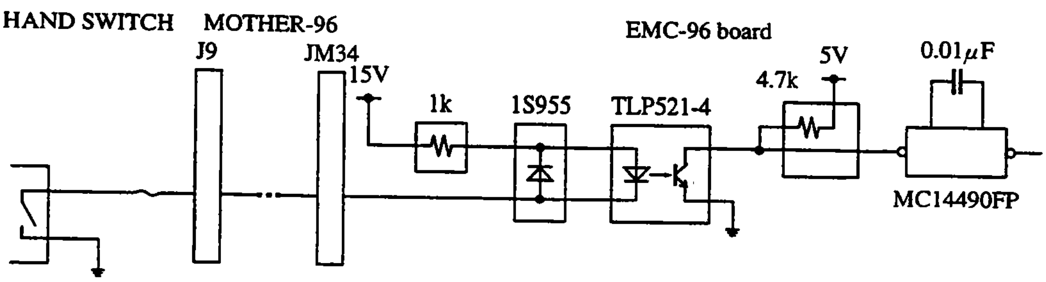

(c) Input circuit [No. 3]



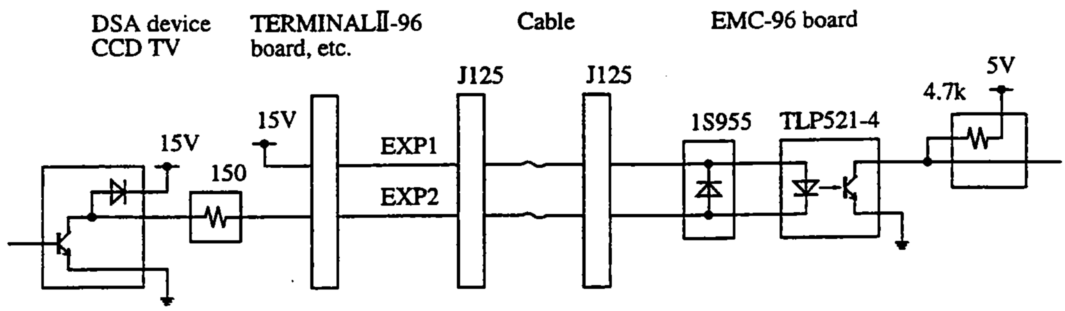

(d) Input circuit [No. 4]



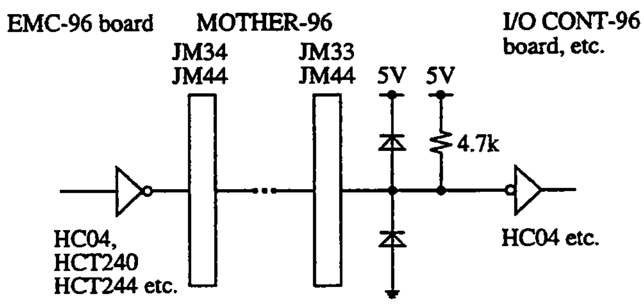

(e) Input circuit [No. 5]



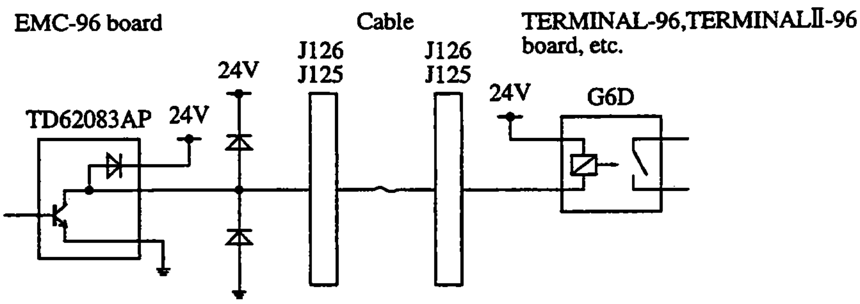
(f) Input circuit [No. 6]



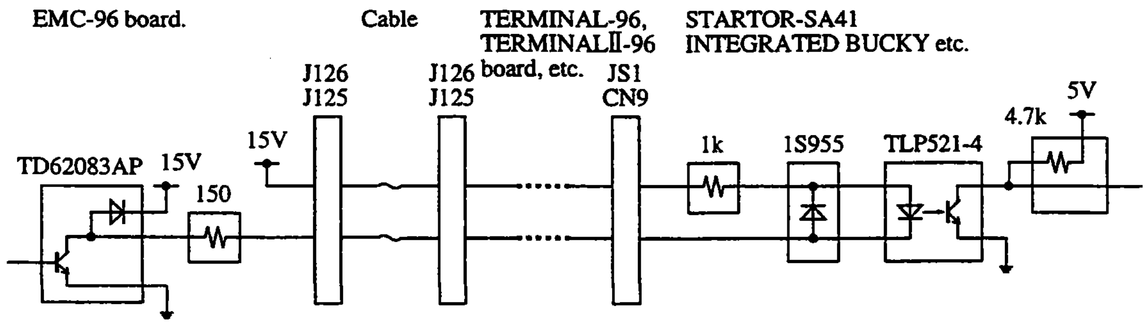

(g) Output circuit [No. 1] {HC-CMOS (5 V) level}



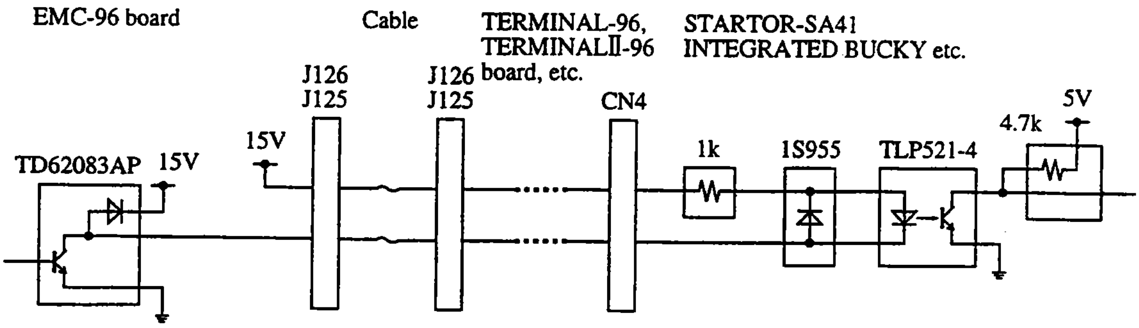

(h) Output circuit [No. 2] {Relay drive (24 V) from transistor}




(i) Output circuit [No. 3] {Current-loop drive (15 V) from transistor}



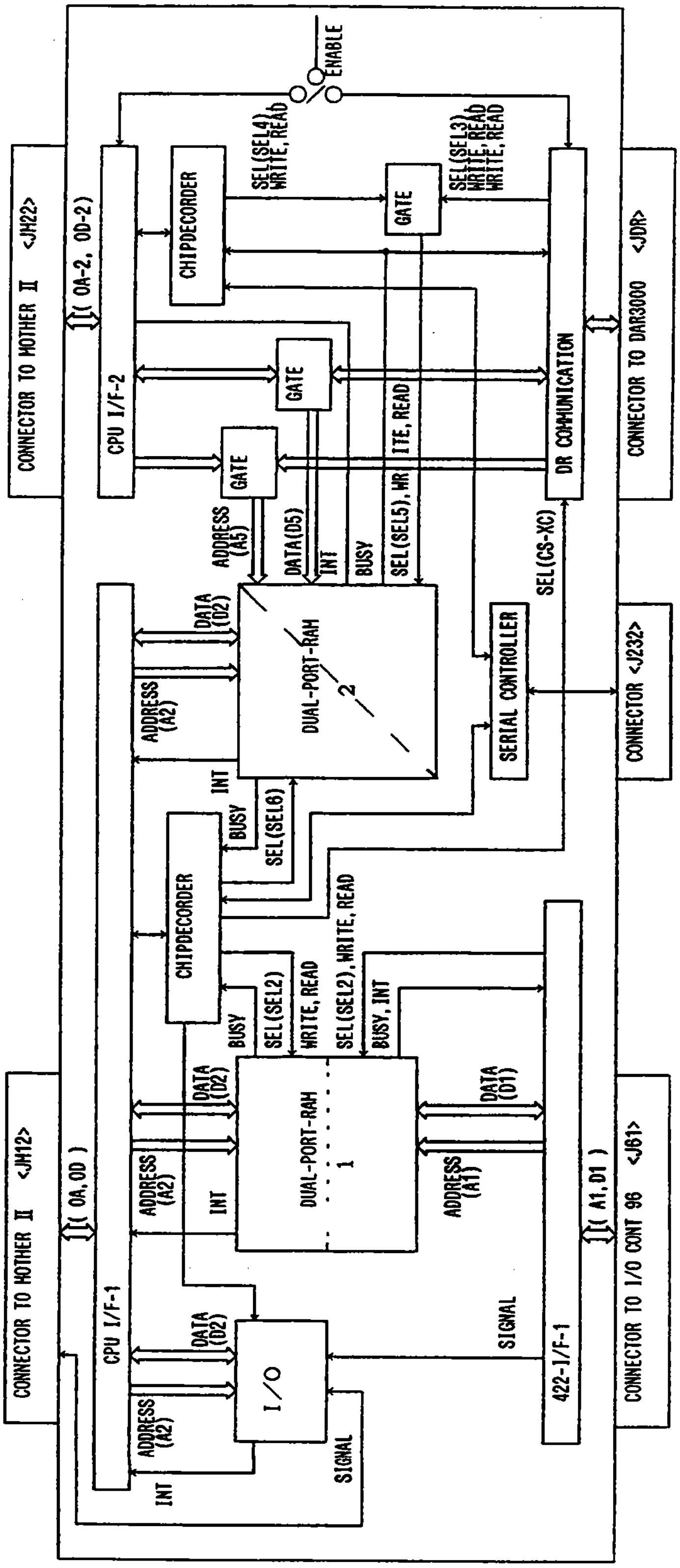
(j) Output circuit [No. 4] {Current-loop drive (15 V) from transistor}



# 8. DUAL PORT-96 board

## 8.1 Schematic diagram of DUAL PORT-96 board

Block diagram of DUAL PORT-96 board is shown below.






58

## 8.2 Functions

For functions of DUAL PORT-96 board, refer to [1] (b) "DUAL-PORT-96 board" in 2.2 "Outline of circuit board functions".

## 8.3 Phenomena in failures

When DUAL PORT-96 board is in failures, following symptoms appear.

1) When power is turned ON, Communication ERR is displayed.
2) While fluoroscopic tube voltage varies, radiographic conditions cannot be changed.
3) The density control knob and reset key of fluoroscopic timer on X-ray console do not work.
4) Buzzer sound of small sheet-key and displays of READY and X-RAY do not appear.
5) Displays on DAR3000 are not shown.

## 8.4 Circuit descriptions and significance of signals

**Circuit diagram on Page 2**

This circuit shows the interfaces of buses, interruption lines, control lines, etc. with NEXSC.EXT board.

A1 [1] ~ A1 [23] → Address bus for CPU-2
S1 [0] ~ D1 [5] → Data bus for CPU-2
FC0 ~ FC2, *AS, *LDS, *UDS, R/*W
→ Control signals for CPU-2
RESET, *RESET → Reset signals
CLK12 → Clock-line for CPU-2 (12 MHz)
*O_DTACK → Control finish of CPU-2

**Circuit diagram on Page 3**

This circuit generates signals to access the IC's in accordance with controls of CPU-2.

*SEL8441_1 → Signal to select 2PORT-memory-1 (for memory communication with CPU-1)
*WRH_1 → Write signal to 2PORT-memory-1 (M27 side)
*WRL_1 → Write signal to 2PORT-memory-1 (M36 side)
*RD_1 → Read signal from 2PORT-memory-1
*GATE → To open the data transfer gate with CPU-2
O_DTACK → Control finish of CPU-2

*SEL8441_6 → Signal to select 2PORT-memory-2 (for memory communication with DAR3000)

*SEL540-3 → Signal to select the IC's to read the density switch and fluoroscopic timer reset button on X-ray console

*SEL540-1 → To read in-line package switch setting

*SEL574-1 → Signal to select the IC's for displays of small sheet-panel buzzer, READY, X-RAY, and X-ray console fluoroscopic-timer reset

*CS_XC → Signal to select the IC for DAR3000 communication control

*CS_MPSC_1 → Signal to select the IC for RS232C communication control

## Circuit diagram on Page 4

This circuit shows the interfaces of buses, interruption lines, control lines, etc. with optional NEXSC board (CPU-3).

A2 [1] ~A2 [23] → Address bus for CPU-3

D2 [0] ~ D2 [15] → Data bus for CPU-3

FC0_2 ~ FC2_2, *AS_2, *LDS_2, *UDS, R/*W_2

→ Control signals for CPU-3

RESET_2, *RESET_2 → Reset signals

CLK12_2 → Clock-line for CPU-3 (12 MHz)

*O_EXITIR2_2 → Interruption signal for DAR3000 communication completion

*ODTACK_2 → Control finish of CPU-2

---

*ENCPU_2 → Communication enabled signal between extended NEXSC board (CPU-2) and optional NEXSC board (CPU-3)

*EM422_2-2 → Communication enabled signal with DAR3000

*EN422_1 → Communication enabled signal with basic NEXSC board (CPU-1)

*UP2SHEET → To use the second board of DUAL PORT-96 (JM11, 21)

## Circuit diagram on Page 5

This circuit generates signals to access the IC's in accordance with controls of CPU-3.

*SEL8441_2 → Signal to select 2PORT-memory-2 (for memory communication with CPU-2)

*WRH_2 → Write signal to 2PORT-memory-2 (M40 side)

*WRL_2 → Write signal to 2PORT-memory-2 (M45 side)

*RD_2 → Read signal from 2PORT-memory-2

*GATE_2 → To open the data transfer gate with CPU-3

O_DTACK_2 → Control finish of CPU-3

### Circuit diagram on Page 6

This circuit input/outputs signals through NEXSC.BASE board (CPU-1) and J61 cable of I/O CONT-96 board.

A3 [1] ~ A3[23] → Address bus for CPU-1

### Circuit diagram on Page 7

D3 [0] ~ D3 [15] → Data bus for CPU-1

### Circuit diagram on Page 8

This circuit controls communication with DAR3000.

*SEL8441_4 → Signal to select 2PORT-memory-2 (for memory communication with DAR3000) (from DAR3000 or CPU-3)

*WRH_4 → Write signal to 2PORT-memory-2 (M40 side) (from DAR3000 or CPU-3)

*WRL_4 → Write signal to 2PORT-memory-2 (M45 side) (from DAR3000 or CPU-3)

*RDH_4 → Read signal from 2PORT-memory-2 (M40 side)

*RDL_4 → Read signal from 2PORT-memory-2 (M45 side) (from DAR3000 or CPU-3)

INT89372 → Interruption signal for data transfer completion to DAR3000

### Circuit diagram on Page 9

This circuit switches the signals in accordance with the switch settings.

### Circuit diagram on Page 10

This circuit is for RS2332C communication control.

### Circuit diagram on Page 11

This circuit switches the interruption lines.

Signals for passing various data

### Circuit diagram on Page 12

This circuit deals with signal input/outputs.

*TRESET → Fluoroscopic timer reset button on X-ray console

*DE+3, +2, +1, 0, -1, -2, -3

→ Density switches on X-ray console

*BUZ1 → Buzzer for small sheet-panel, high-tone

*BUZ2 → Buzzer for small sheet-panel, low-tone

*TIMDISP → Display of fluoroscopic timer reset button on X-ray console

*XRDISP → X-RAY display for small sheet-panel

*READISP → REACY display for small sheet-panel

*O_EXITIR1 → Interruption input of X-RAY (unused)

**Circuit diagram on Page 13**

Memory for the communication between basic NEXSC board (CPU-1) and extended NEXSC board (CPU-2)

**Circuit diagram on Page 14**

Memory for the communication between extended NEXSC board (CPU-2) and optional NEXSC board (CPU-3)

# 9. DISPCONT-96 board

## 9.1 Outline of functions

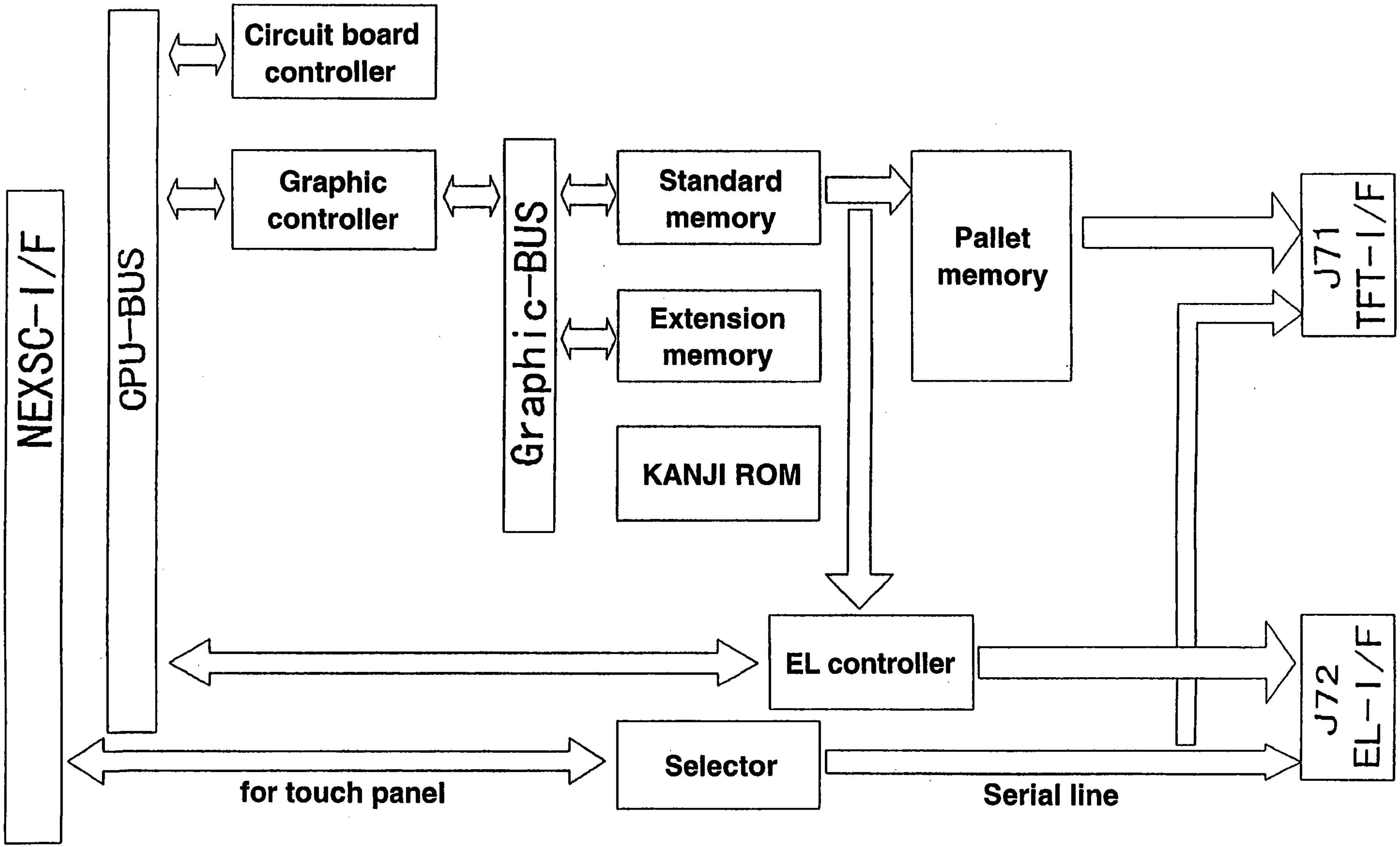
### 9.1.1 Functions in color display

| | |
|---|---|
| Control LSI | AGDC |
| | IC, µ PE72123GJ-5BG (075-31909-01) |
| Display memory | RAM 2MByte (Dualport Graphtics Buffer) |
| | IC, MB818251-70PZS-G (075-32696) |
| | RAM 4MByte (Dualport Graphtics Buffer) |
| | IC, MB818251-70PZS-G (075-32696) |
| | Font ROM 1 MByte |
| | IC, MB834200-B-003 (075-32685-02) |
| | (First grade, Second grade) |
| Display area | 640 * 480 Dot * 4 Plane |
| | 640 * 480 Dot * 8 Plane (Option) |
| Display colors | Digital 16 colors |
| | 16 colors in 32768 colors |
| | 256 colors in 32768 colors (option) |
| | IC, |
| Host I/F | In conformity with NEXSC-I/F |
| | VRAM area is set on CPU memory-map. |
| | Possible to set every 1 MByte from 600000H to 7FFFFFH |
| | AGDC register area is set on CPU-IO map. |
| | Offset 000H-0FFH. |
| | Refer to 9.2 "In-line package switch setting". |
| Display device | TFT color LCD (640*480) |
| | LCD, LQ10D021 (078-1211701-02) |
| | or interchangeable one |
| Device I/F | Differential-type line-drive (Quasi ECL level) |
| | IC, MB571PF (075-32713-02) |
| Operational clock | CLK: 8.000 MHz |
| | SCLK: 3.375 MHz |
| | DCLK: 27.000 MHz |

### 9.1.2 Functions in monochrome display

| | |
|---|---|
| Control LSI | LCD controller |
| | IC, HD66850 (075-35705-01) |
| Display memory | RAM 256KByte (Dualport Graphics Buffer) |
| | IC, TC524256Z-10 (075-3362-05) |
| | or interchangeable one |
| Display area | 640 * 480 Dot * 1 Plane |
| | 640 * 480 Dot * 4 Plane |
| Display color | Monochrome |
| Host I/F | In conformity with NEXSC-I/F |
| | LCDC register area is set on CPU-IO map. |
| | Offset 140H-14FH |
| | Refer to 9.2 "In-line package switch setting". |
| Display device | ELDisplay |
| | EL DISPLAY, LJ64H052 (078-12301-07) |
| | or interchangeable one |
| Device I/F | Differential-type line-drive (RS422 level) |
| | IC, DS26C31CM (075-11927-02) (*3) |
| | or interchangeable one |
| Operational clock | DCLK: 32 MHz |

**Block diagram of DISPCONT-96 board**



## 9.2 In-line package switch setting

### 9.2.1 SW1

1-5 ............ Standard value setting of I/O addresses.

| 1 | 2 | 3 | 4 | 5 | Set value | |
|---|---|---|---|---|---|---|
| OFF | OFF | OFF | OFF | OFF | F20000 | (standard) |
| OFF | OFF | OFF | OFF | ON | F21000 | |
| OFF | OFF | OFF | ON | OFF | F22000 | |
| OFF | OFF | OFF | ON | ON | F23000 | |
| OFF | OFF | ON | OFF | OFF | F24000 | |
| OFF | OFF | ON | OFF | ON | F25000 | |
| OFF | OFF | ON | ON | OFF | F26000 | |
| OFF | OFF | ON | ON | ON | F27000 | |
| OFF | ON | OFF | OFF | OFF | F28000 | |
| OFF | ON | OFF | OFF | ON | F29000 | |
| OFF | ON | OFF | ON | OFF | F2A000 | |
| OFF | ON | OFF | ON | ON | F2B000 | |
| OFF | ON | ON | OFF | OFF | F2C000 | |
| OFF | ON | ON | OFF | ON | F2D000 | |
| OFF | ON | ON | ON | OFF | F2E000 | |
| OFF | ON | ON | ON | ON | F2F000 | |
| ON | OFF | OFF | OFF | OFF | F30000 | |
| ON | OFF | OFF | OFF | ON | F31000 | |
| ON | OFF | OFF | ON | OFF | F32000 | |
| ON | OFF | OFF | ON | ON | F33000 | |
| ON | OFF | ON | OFF | OFF | F34000 | |
| ON | OFF | ON | OFF | ON | F35000 | |
| ON | OFF | ON | ON | OFF | F36000 | |
| ON | OFF | ON | ON | ON | F37000 | |
| ON | ON | OFF | OFF | OFF | F38000 | |
| ON | ON | OFF | OFF | ON | F39000 | |
| ON | ON | OFF | ON | OFF | F3A000 | |
| ON | ON | OFF | ON | ON | F3B000 | |
| ON | ON | ON | OFF | OFF | F3C000 | |
| ON | ON | ON | OFF | ON | F3D000 | |
| ON | ON | ON | ON | OFF | F3E000 | |
| ON | ON | ON | ON | ON | F3F000 | |

6 ............ EL controller (for cost-down); Yes, or No

OFF : Yes (standard)

ON : No

7 ............ Extension memory (option); Yes, or No

OFF : No (standard)

ON : Yes

8 ............ Color pallet memory (option); Yes, or No

OFF : No (standard)

ON : Yes

9.2.2 SW2

1 ............ Video memory area setting

OFF : 600000-6FFFFF are used. (standard)

ON : 700000-7FFFFF are used.

2 ............ Spare; OFF

3, 4 ....... Interruption level setting of AGDC

| 3 | 4 | Setting |
|---|---|---|
| OFF | OFF | ADGC interruption is not used. (standard) |
| ON | OFF | Interruption level 3 is used. |
| OFF | ON | Interruption level 4 is used. |
| ON | ON | (Setting prohibited) |

5 ............ Spare; OFF

6 ............ Spare; OFF

7 ............ Spare; OFF

8 ............ Spare; OFF

## 9.3 Memory map

9.3.1 MPU memory map

| | |
|---|---|
| 600000-6FFFFF | VRAM area (SW2-1 = OFF) |
| 6F0000-6FFFFF | Pallet memory area,<br>(in pallet direct access mode) |
| 700000-7FFFFF | VRAM area (SW2-1 = ON) |
| 7F0000-7FFFFF | Pallet memory area,<br>(in pallet direct access mode) |
| F20000-F3FFFF | I/O area |
| 000-0FF | AGDC register area |
| 100-10F | MB82365-A register area |
| 110-11F | MB82365-B register area |
| 140-14F | CLNE (LCD Controller) register area |
| 200-21F | Pallet area in 16-color mode |
| 200-3FF | Pallet area in 256-color mode |

### 9.3.2 Details of I/O map

Refer to each manual for AGDC register area and CLINE register area.

PIO bit map

100 : Reading SW1 (input)

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| SW1- | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Input is H in SW ON, and L in SW OFF.

102 : Reading SW2 (input) for RS232C control signal input

| BIT | 7 | 6 | 5 | 4 | 3 | 2 |
|---|---|---|---|---|---|---|
| SW1- | 1 | 2 | 3 | 4 | 5 | 6 |

Input is H in SW ON, and L in SW OFF.

BIT1 ......... CTS signal input

BIT0 ......... DSR signal input

104 : LED block (output) light

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| LED | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

LED is OFF in output H, and ON in output L.

110 : Operation mode control (output)

BIT7 ......... Setting of pallet memory direct access mode; Yes, or No
- 0 = Yes
- 1 = No (standard)

BIT6 ......... Setting of EL memory direct access mode; Yes, or No
- 0 = Yes
- 1 = No (standard)

BIT5 ......... Spare, output H

BIT4 .......... Setting of color mode
- 0 = Analog mode setting
- 1 = Digital mode setting (standard)

BIT3 ......... Setting of color pallet mode
- 0 = 256-color mode setting
- 1 = 16-color mode setting (standard)

BIT2 ......... Setting of color mode for EL
- 0 = Monochrome mode setting
- 1 = 16-color mode setting (standard)

BIT1 ......... Setting of use of EL display; Yes, or No

0 = Yes

1 = No (standard)

BIT0 ......... Setting of use of TFT LC display; Yes, or No

0 = Yes

1 = No (standard)

112 : Pallet bank control (output), RS232C control

BIT7 ......... Permission of use of RS232C control; Yes, or No

0 = Yes

1 = No (standard)

BIT6 ......... Switching of RS232C port

0 = Port for EL display is used.

1 = Port for TFT LC display is used.

BIT5 ......... RTS signal output

BIT4 ......... DTS signal output

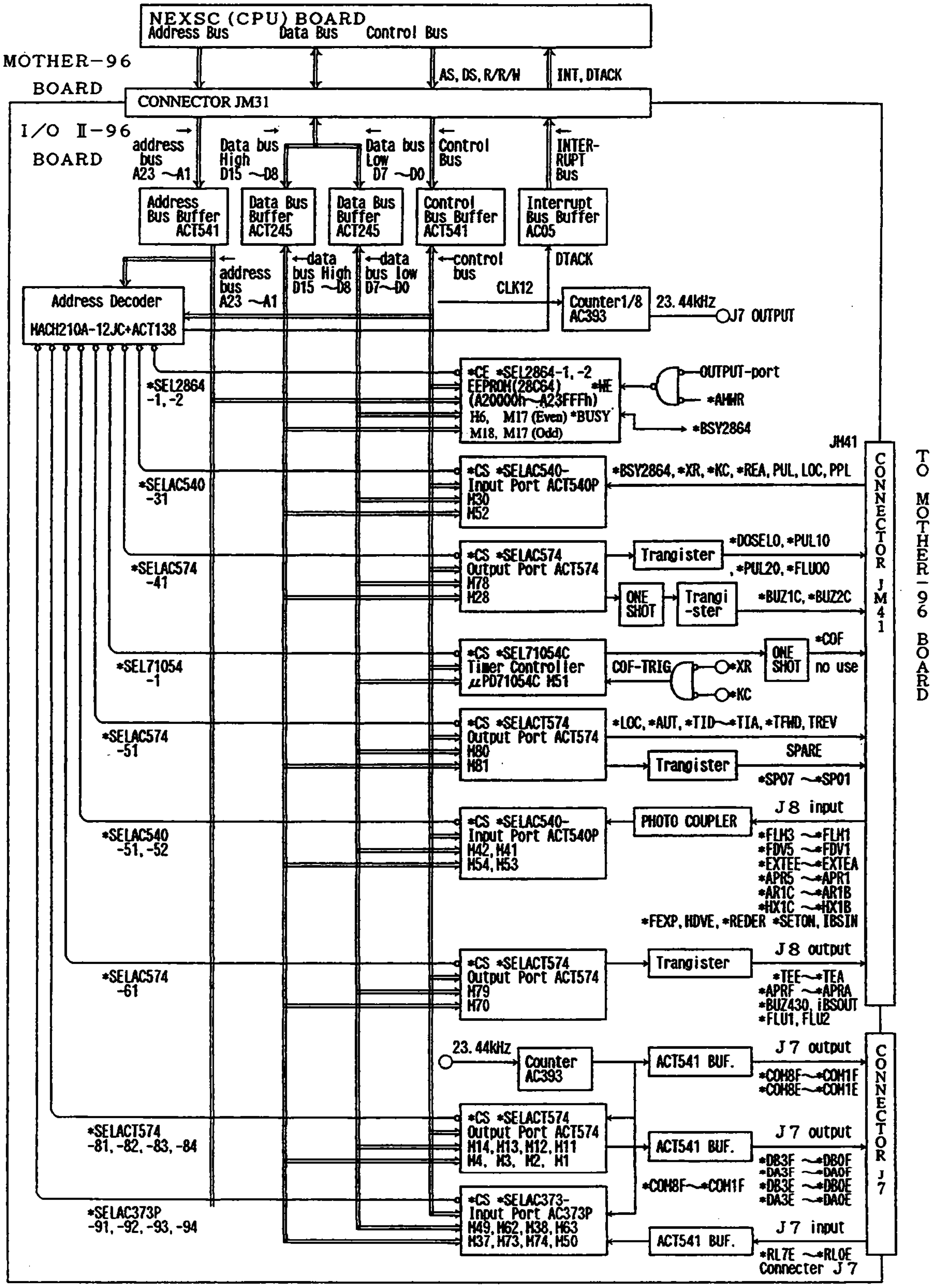
BIT3-0 ...... Selection of pallet bank

| 3 | 2 | 1 | 0 | Setting |
|---|---|---|---|---|
| OFF | OFF | OFF | OFF | Pallet bank 0 is used. (standard) |
| OFF | OFF | OFF | ON | Pallet bank 1 is used. |
| OFF | OFF | ON | OFF | Pallet bank 2 is used. |
| OFF | OFF | ON | ON | Pallet bank 3 is used. |
| OFF | ON | OFF | OFF | Pallet bank 4 is used. |
| OFF | ON | OFF | ON | Pallet bank 5 is used. |
| OFF | ON | ON | OFF | Pallet bank 6 is used. |
| OFF | ON | ON | ON | Pallet bank 7 is used. |
| ON | OFF | OFF | OFF | Pallet bank 8 is used. |
| ON | OFF | OFF | ON | Pallet bank 9 is used. |
| ON | OFF | ON | OFF | Pallet bank 10 is used. |
| ON | OFF | ON | ON | Pallet bank 11 is used. |
| ON | ON | OFF | OFF | Pallet bank 12 is used. |
| ON | ON | OFF | ON | Pallet bank 13 is used. |
| ON | ON | ON | OFF | Pallet bank 14 is used. |
| ON | ON | ON | ON | Pallet bank 15 is used. |

# 10. I/O Ⅱ-96 board

## 10.1 Schematic diagram of I/O Ⅱ-96 board

This board comprises NEXSC(CPU) board, EEPROM(28C64), Timer IC (μPD71054C), Input IC (ACT540, 373), Output IC (ACT574), connectors, buses, etc.



## 10.2 Input/output signals on I/O Ⅱ-96 board

[1] Input/output signals on I/O Ⅱ-96 board are as follows.

For circuit mark r ~ w, refer to 6.2 "Input/output signals on I/O CONT-96 board" [2] "Input/output circuit", for k ~ p, refer to 13.3 "EXT CONT-96 board" [2] "Input/output circuit", and for a ~ j, refer to 7.31 "Input/output signals on EMC-96 board" [2] "Input/output circuit".

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM31 | 13/13 | A-1<br>B-1<br>C-1<br>A-2<br>B-2<br>C-2 | +5V | In | | DC power supply<br>+5 V | Mother-96 |
| | | A-3<br>B-3<br>C-3 | +15V | In | | +15 V input | |
| | | A-4<br>B-4<br>C-4 | -15V | In | | -15 V input | |
| JM31 | 4/13 | A-5 | *AR1I | Out | | READY operation output signal | →EMC-96 |
| | | B-5 | *HX1I | Out | | X-RAY operation output | |
| | | C-5 | (no use) | — | — | | |
| | | A-6 | 〃 | 〃 | 〃 | | |
| | | B-6 | 〃 | 〃 | 〃 | | |
| | | C-6 | 〃 | 〃 | 〃 | | |
| | | A-7 | 〃 | 〃 | 〃 | | |
| | | B-7 | 〃 | 〃 | 〃 | | |
| | | C-7 | 〃 | 〃 | 〃 | | |
| | | A-8 | 〃 | 〃 | 〃 | | |
| | | B-8 | 〃 | 〃 | 〃 | | |
| | | C-8 | 〃 | 〃 | 〃 | | |
| | | A-9 | 〃 | 〃 | 〃 | | |
| | | B-9 | 〃 | 〃 | 〃 | | |
| | | C-9 | 〃 | 〃 | 〃 | | |
| | | A-10 | 〃 | 〃 | 〃 | | |
| | | B-10 | 〃 | 〃 | 〃 | | |
| | | C-10 | 〃 | 〃 | 〃 | | |
| | | A-11 | 〃 | 〃 | 〃 | | |
| | | B-11 | 〃 | 〃 | 〃 | | |
| | | C-11 | 〃 | 〃 | 〃 | | |
| | | A-12 | 〃 | 〃 | 〃 | | |
| | | B-12 | 〃 | 〃 | 〃 | | |
| | | C-12 | 〃 | 〃 | 〃 | | |
| | | A-13 | 〃 | 〃 | 〃 | | |
| | 1/13 | B-13 | O-GATE | In | a | Control Signals | NEXSC (BASE) |
| | | C-13 | OUT-FC2 | 〃 | 〃 | | |
| | | A-14 | OUT-FC1 | 〃 | 〃 | | |
| | | B-14 | OUT-FC0 | 〃 | 〃 | | |
| | | C-14 | *OUT-AS | 〃 | 〃 | | |
| | | A-15 | *OUT-LDS | 〃 | 〃 | | |
| | | B-15 | *OUT-UDS | 〃 | 〃 | | |
| | | C-15 | OUT-R/*W | 〃 | 〃 | | |
| | | A-16 | O-DTACK | Out | g | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM31 | 1/13 | B-16 | 0D [15] | In | a | | NEXSC (BASE) |
| | | C-16 | 〃 [14] | 〃 | 〃 | | |
| | | A-17 | 〃 [13] | 〃 | 〃 | | |
| | | B-17 | 〃 [12] | 〃 | 〃 | | |
| | | C-17 | 〃 [11] | 〃 | 〃 | | |
| | | A-18 | 〃 [10] | 〃 | 〃 | | |
| | | B-18 | 〃 [ 9] | 〃 | 〃 | | |
| | | C-18 | 〃 [ 8] | 〃 | 〃 | | |
| | | A-19 | 〃 [ 7] | 〃 | 〃 | Data Bus | |
| | | B-19 | 〃 [ 6] | 〃 | 〃 | | |
| | | C-19 | 〃 [ 5] | 〃 | 〃 | | |
| | | A-20 | 〃 [ 4] | 〃 | 〃 | | |
| | | B-20 | 〃 [ 3] | 〃 | 〃 | | |
| | | C-20 | 〃 [ 2] | 〃 | 〃 | | |
| | | A-21 | 〃 [ 1] | 〃 | 〃 | | |
| | | B-21 | 〃 [ 0] | 〃 | 〃 | | |
| JM31 | 1/13 | C-21 | 0A [23] | In | a | | NEXSC (BASE) |
| | | A-22 | 〃 [22] | 〃 | 〃 | | |
| | | B-22 | 〃 [21] | 〃 | 〃 | | |
| | | C-22 | 〃 [20] | 〃 | 〃 | | |
| | | A-23 | 〃 [19] | 〃 | 〃 | | |
| | | B-23 | 〃 [18] | 〃 | 〃 | | |
| | | C-23 | 〃 [17] | 〃 | 〃 | | |
| | | A-24 | 〃 [16] | 〃 | 〃 | | |
| | | B-24 | 〃 [15] | 〃 | 〃 | | |
| | | C-24 | 〃 [14] | 〃 | 〃 | | |
| | | A-25 | 〃 [13] | 〃 | 〃 | | |
| | | B-25 | 〃 [12] | 〃 | 〃 | | |
| | | C-25 | 〃 [11] | 〃 | 〃 | Adress Bus | |
| | | A-26 | 〃 [10] | 〃 | 〃 | | |
| | | B-26 | 〃 [ 9] | 〃 | 〃 | | |
| | | C-26 | 〃 [ 8] | 〃 | 〃 | | |
| | | A-27 | 〃 [ 7] | 〃 | 〃 | | |
| | | B-27 | 〃 [ 6] | 〃 | 〃 | | |
| | | C-27 | 〃 [ 5] | 〃 | 〃 | | |
| | | A-28 | 〃 [ 4] | 〃 | 〃 | | |
| | | B-28 | 〃 [ 3] | 〃 | 〃 | | |
| | | C-28 | 〃 [ 2] | 〃 | 〃 | | |
| | | A-29 | 〃 [ 1] | 〃 | 〃 | | |
| JM31 | 1/13 | B-29 | *O-RESET | In | a | RESET INPUT SIGNAL | |
| | | C-29 | O-CLK12 | 〃 | 〃 | CLOCK [12MHz] INPUT SIGNL | |
| | 5/12 | A-30 | *SP01 | Out | g | Spare output signal | |
| | | B-30 | *SP02 | 〃 | 〃 | [+15 V current-loop] | |
| | | C-30 | *SP03 | 〃 | 〃 | | |
| | 5/12 | A-30 | GND | In | | | Mother-96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | GND input | |
| | | A-32 | GND | In | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM41 | 6/13 | A-1 | *APR1 | In | t | APR key selection input signal | Mother-96 |
| | | B-1 | EXPWC | In | 〃 | Common power input from external devices (C) | J8→JM41 |
| | | C-1 | (N.C.) | — | | | |
| | | A-2 | *APR3 | In | t | APR key selection input signal | Mother-96 |
| | | B-2 | *APR2 | 〃 | 〃 | 〃 | J8→JM41 |
| | 4/13 | C-2 | *PPL | In | a | Signal to move top panel of examination bed [TTL level] | EMC-96→ |
| | 6/13 | A-3 | *APR5 | In | t | APR key selection input signal | Mother-96 |
| | | B-3 | *APR4 | 〃 | 〃 | 〃 | J8→JM41 |
| | 4/13 | C-3 | *PUL | In | a | Pulse radiography selection signal (unused) | EMC-96→ |
| | 6/13 | A-4 | *HX1C | In | t | Radiographic operation input signal (C) | Mother-96 |
| | | B-4 | *APR6 | In | t | APR key selection input signal | J8→JM41 |
| | 4/13 | C-4 | *SPI2 | In | a | Spare input signal | Mother-96 |
| | 6/13 | A-5 | EXPWB | In | t | Common power input from external devices (B) | Mother-96 |
| | | B-5 | *AR1C | In | 〃 | Radiographic preparation start input signal (C) | J8→JM41 |
| | 4/13 | C-5 | *SPI3 | In | a | Spare input signal | Mother-96 |
| | 6/13 | A-6 | *EXTEB | In | t | Operation method selection input signal from external devices | Mother-96 J8→JM41 |
| | | B-6 | *EXTEA | 〃 | 〃 | 〃 | |
| | 4/13 | C-6 | *SPI4 | In | a | Spare input signal | Mother-96 |
| | 6/13 | A-7 | *EXTED | In | t | Operation method selection input signal from external devices | Mother-96 J8→JM41 |
| | | B-7 | *EXTEC | 〃 | 〃 | 〃 | |
| | 4/13 | C-7 | *SPI5 | In | a | Spare input signal | Mother-96 |
| | 6/13 | A-8 | *RDER | In | t | Leader radiography selection signal | Mother-96 |
| | | B-8 | *EXTEE | 〃 | 〃 | Operation method selection input signal from external devices | J8→JM41 |
| | 4/13 | C-8 | *KC | In | a | Radiographic preparation start input signal | EMC-96→ |
| | 6/13 | A-9 | *FEXP | In | t | First X-ray input signal from fluoroscopic operation bed to film | Mother-96 J8→JM41 |
| | | B-9 | *HDEV | 〃 | 〃 | Input signal for film division direction | |
| | 4/13 | C-9 | *REA | In | a | Radiographic preparation finish input signal | EMC-96→ |
| | 6/13 | A-10 | EXPWA | In | t | Common power input from external devices | Mother-96 |
| | | B-10 | 〃 | 〃 | 〃 | 〃 | J8→JM41 |
| | 4/13 | C-10 | *SPI1 | In | a | Spare input signal | |
| | 6/13 | A-11 | *FDV2 | In | t | Signal to select film division size (6 divisions) | Mother-96 |
| | | B-11 | *FDV1 | 〃 | 〃 | Signal to select film division size (9 divisions) | J8→JM41 |
| | 4/13 | C-11 | *XR | In | a | Measured X-RAY signal [TTL level] | EMC-96→ |
| | 6/13 | A-12 | *FDV4 | In | t | Signal to select film division size (3 divisions) | Mother-96 |
| | | B-12 | *FDV3 | 〃 | 〃 | Signal to select film division size (4 divisions) | J8→JM41 |
| | 4/13 | C-12 | (N.C.) | — | | | |
| | 6/13 | A-13 | *FLM1 | In | t | Signal to select film size (quarter size) | Mother-96 |
| | | B-13 | *FDV5 | In | 〃 | Signal to select film division size (2 divisions) | |
| | 4/13 | C-13 | *BZ2C | Out | i | Buzzer output signal [for FLUO.PANEL] | JM41→MOTHER-96 J10 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM41 | | A-14 | *FLM3 | In | t | Signal to select film size (continent size) | Mother-96 |
| | | B-14 | *FLM2 | 〃 | 〃 | Signal to select film size (large size) | J8→JM41 |
| | 4/13 | C-14 | *BZ1C | Out | i | Buzzer output signal [for FLUO.PANEL] | JM41→MOTH -ER-96 J10 |
| | 6/13 | A-15 | *SETON | In | t | Input signal to reset 5-minute timer for fluoroscopy | Mother-96 |
| | | B-15 | *IBSIN | 〃 | 〃 | IBS selection input signal | J8→JM41 |
| | 4/13 | C-15 | *LOCK | In | a | DSA selection signal (for IDR 700) | TERMINAL→ J127 |
| | 6/13 | A-16 | *AR1B | In | t | READY operation input signal (B) | Mother-96 |
| | | B-16 | *HX1B | In | 〃 | Radiographic operation input signal (B) | J8→JM41 |
| | | C-16 | (N.C.) | — | | | |
| | 12/13 | A-17 | GND | Out | — | GND output | JM41→MOTH |
| | | B-17 | 〃 | 〃 | 〃 | | -ER-96 J10 |
| | 4/13 | C-17 | *DOSELOO | Out | i | (Unused) [for FLUO.PANEL] | JM41→MOTH -ER-96 J10 |
| | 12/13 | A-18 | GND | Out | — | GND output | JM41→MOTH |
| | | B-18 | 〃 | 〃 | 〃 | | -ER-96 J10 |
| | 4/13 | C-18 | *PUL10 | Out | i | Pulse-rate selection output signal [for FLUO.PANEL] | JM41→MOTH -ER-96 J10 |
| | | A-19 | (N.C.) | — | | | |
| | 6/13 | B-19 | *IBSOUT | Out 〃 | i 〃 | IBS selection intermediate output signal | JM41→MOTH -ER-96 J10 |
| | 4/13 | C-19 | *PUL20 | Out | i | Pulse-rate selection intermediate output signal [for FLUO.PANEL] | JM41→MOTH -ER-96 J10 |
| | 6/13 | A-20 | *SPJ801 | Out | i | Spare output signal [for J8] | JM41 |
| | | B-20 | (N.C.) | — | | | |
| | 4/13 | C-20 | *PFLUOO | Out | i | Pulse fluoroscopy selection output signal [for FLUO.PANEL] | JM41→MOTH -ER-96 J10 |
| | 6/13 | A-21 | *APRB | Out | i | APR key selection output signal | JM41→MOTH |
| | | B-21 | *APRA | 〃 | 〃 | 〃 | -ER-96 J8 |
| | 4/13 | C-21 | *PLFUOTTL | Out | g | Pulsed fluoroscopy selection output signal [TTL level] | →EMC-96 |
| | 6/13 | A-22 | *APRD | Out | i | APR key selection output signal | JM41→MOTH |
| | | B-22 | *APRC | 〃 | 〃 | 〃 | -ER-96 J8 |
| | 5/13 | C-22 | *COF | Out | g | X-ray cutoff signal from CINE 1 exposure timer (unused) | →EMC-96 |
| | 6/13 | A-23 | *APRF | Out | i | APR key selection output signal | JM41→MOTH |
| | | B-23 | *APRE | 〃 | 〃 | 〃 | -ER-96 J8 |
| | 5/13 | C-23 | *LOC | Out | g | Signal to fix radiographic conditions (for CINE AUTO) (unused) | →EMC-96 |
| | 6/13 | A-24 | *FLU2 | Out | i | APR key selection output signal | JM41→MOTH |
| | | B-24 | *FLU1 | 〃 | 〃 | 〃 | -ER-96 J8 |
| | 5/13 | C-24 | *AUT | Out | g | CINE AUTO selection signal [TTL level] (unused) | →EMC-96 |
| | | A-25 | (N.C.) | — | | | |
| | | B-25 | *BZ430 | Out | i | Signal output when 4 min. and 30 sec. has passed with 5-minute fluoroscopic timer | JM41→MOTH -ER-96 J8 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM41 | 5/13 | C-25 | (*TIA)<br>*CUT | Out | g | X-ray cutoff signal from CINE 1 exposure timer (unused) | → EMC-96 |
| | 6/13 | A-26<br>B-26 | *TEA<br>*AR1 | Out<br>〃 | i<br>〃 | Operation method selection output signal<br>〃 | JM41→MOTH -ER-96 J8 |
| | 5/13 | C-26 | *TIB<br>(no use) | Out | g | Time selection signal for radiographic backup timer (unused) | → EMC-96 |
| | 6/13 | A-27<br>B-27 | *TEC<br>*TEB | Out<br>〃 | i<br>〃 | Operation method selection output signal<br>〃 | JM41→MOTH -ER-96 J8 |
| | 5/13 | C-27 | *TIC<br>(no use) | Out | g | Time selection signal for radiographic backup timer (unused) | → EMC-96 |
| | 6/13 | A-28<br>B-28 | *TEE<br>*TED | Out<br>〃 | i<br>〃 | Operation method selection output signal<br>〃 | JM41→MOTH -ER-96 J8 |
| | 5/13 | C-28 | *TID<br>(no use) | Out | g | X-ray cutoff signal from CINE 1 exposure timer (unused) | → EMC-96 |
| | 5/13 | A-29<br>B-29 | *SP04<br>*SP06 | Out<br>〃 | i<br>〃 | Spare output signal<br>〃 | Mother-96 |
| | 5/13 | C-29 | *TFWD | Out | g | Signal to move top-panel of examination bed forward | → EMC-96 |
| | 5/13 | A-30<br>B-30 | *SP05<br>*SP07 | Out<br>〃 | i<br>〃 | Spare output signal<br>〃 | Mother-96 |
| | 5/13 | C-30 | *TREV | Out | g | Signal to move top-panel of examination bed backward | → EMC-96 |
| | | A-31<br>B-31<br>C-31<br>A-32<br>B-32<br>C-32 | GND<br>〃<br>〃<br>GND<br>〃<br>〃 | In<br>〃<br>〃<br>In<br>〃<br>〃 | | GND input | Mother-96 |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J7 | 13/13 | A-1 | +5V | Out | — | +5 V output | |
| | | B-1 | 〃 | 〃 | 〃 | | |
| | | A-2 | 〃 | 〃 | 〃 | | |
| | | B-2 | 〃 | 〃 | 〃 | | |
| | 10/13 | A-3 | (LOF) | — | — | Power-off switch input signal | |
| | | B-3 | (PGND) | 〃 | 〃 | Power-on switch GND output signal | |
| | | A-4 | (LN12) | 〃 | 〃 | Power-on switch power output signal | |
| | | B-4 | (LON) | 〃 | 〃 | Power-on switch input signal | |
| | 10/13 | A-5 | (*RL1F)*RL1E | In | a | Input signal to read keyboard keys | J7 EXTENSION → |
| | | B-5 | (*RL0F)*RL0E | 〃 | 〃 | | |
| | | A-6 | (*RL3F)*RL3E | 〃 | 〃 | | |
| | | B-6 | (*RL2F)*RL2E | 〃 | 〃 | | |
| | | A-7 | (*RL5F)*RL5E | 〃 | 〃 | | |
| | | B-7 | (*RL4F)*RL4E | 〃 | 〃 | | |
| J7 | | A-8 | (*RL7F)*RL7E | 〃 | 〃 | | |
| | | B-8 | (*RL6F)*RL6E | 〃 | 〃 | | |
| | 7/13 | A-9 | *COM7F | Out | g | Common output signal to read keyboard keys | → J7 EXTENSION |
| | | B-9 | *COM8F | 〃 | 〃 | | |
| | | A-10 | *COM5F | 〃 | 〃 | | |
| | | B-10 | *COM6F | 〃 | 〃 | | |
| | | A-11 | *COM3F | 〃 | 〃 | | |
| | | B-11 | *COM4F | 〃 | 〃 | | |
| | | A-12 | *COM1F | 〃 | 〃 | | |
| | | B-12 | *COM2F | 〃 | 〃 | | |
| J7 | 7/13 | A-13 | *DB1F | Out | g | Data output for keyboard LED dynamic display | → J7 EXTENSION |
| | | B-13 | *DB0F | 〃 | 〃 | | |
| | | A-14 | *DB3F | 〃 | 〃 | | |
| | | B-14 | *DB2F | 〃 | 〃 | | |
| | | A-15 | *DA1F | 〃 | 〃 | | |
| | | B-15 | *DA0F | 〃 | 〃 | | |
| | | A-16 | *DA3F | 〃 | 〃 | | |
| | | B-16 | *DA2F | 〃 | 〃 | | |
| | 10/13 | A-17 | *RL1E | In | a | Input signal to read keyboard keys | J7 EXTENSION → |
| | | B-17 | *RL0E | 〃 | 〃 | | |
| | | A-18 | *RL3E | 〃 | 〃 | | |
| | | B-18 | *RL2E | 〃 | 〃 | | |
| | | A-19 | *RL5E | 〃 | 〃 | | |
| | | B-19 | *RL4E | 〃 | 〃 | | |
| J7 | | A-20 | *RL7E | 〃 | v | | |
| | | B-20 | *RL6E | 〃 | 〃 | | |
| | 7/13 | A-21 | *COM7E | Out | g | Common output signal to read keyboard keys | → J7 EXTENSION |
| | | B-21 | *COM8E | 〃 | 〃 | | |
| | | A-22 | *COM5E | 〃 | 〃 | | |
| | | B-22 | *COM6E | 〃 | 〃 | | |
| | | A-23 | *COM3E | 〃 | 〃 | | |
| | | B-23 | *COM4E | 〃 | 〃 | | |
| | | A-24 | *COM1E | 〃 | v | | |
| | | B-24 | *COM2E | 〃 | 〃 | | |



88

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| J7 | 9/13 | A-25 | *DB1E | Out | g | Data output for keyboard LED dynamic display | → J7 EXTENSION |
| | | B-25 | *DB0E | 〃 | 〃 | | |
| | | A-26 | *DB3E | 〃 | 〃 | | |
| | | B-26 | *DB2E | 〃 | 〃 | | |
| | | A-27 | *DA1E | 〃 | 〃 | | |
| | | B-27 | *DA0E | 〃 | 〃 | | |
| | | A-28 | *DA3E | 〃 | 〃 | | |
| | | B-28 | *DA2E | 〃 | 〃 | | |
| | | A-29 | GND | In | | GND input | |
| | | B-29 | 〃 | 〃 | | | |
| | | A-30 | 〃 | 〃 | | | |
| | | B-30 | 〃 | 〃 | | | |

# 11. PH POWER-96 board

## 11.1 Outline of functions of PH POWER-96 board

(1) Photo-timer control in direct spot filming

(2) High voltage output for photomultiplier in direct spot filming

(3) Correction of long-time characteristics in direct spot filming

(4) Correction of short-time characteristics in direct spot filming

(5) Photo-timer control in I.I. in direct spot filming

(6) High voltage output for photomultiplier in I.I. indirect spot filming

(7) IBS control circuit of pulsed fluoroscopy for UD series

(8) Circuit to correct covering ratio of contrast medium

(9) Input circuit for the external set value of photomultiplier voltage when an optional I/O CONT-96 board is added.

(10) High voltage output for photomultiplier for direct radiographic photo-timer (VR is used to adjust the voltage.)

This board controls the high voltage for photo-timer of I.I. light-receiving type and the high voltage for photomultiplier for direct photo-timer.

When an optional I/O CONT-96 board is added, the high voltage for photomultiplier for photo-timer of I.I. light-receiving type can be set from the control console panel.

## 11.2 Photomultiplier high-voltage setting circuit

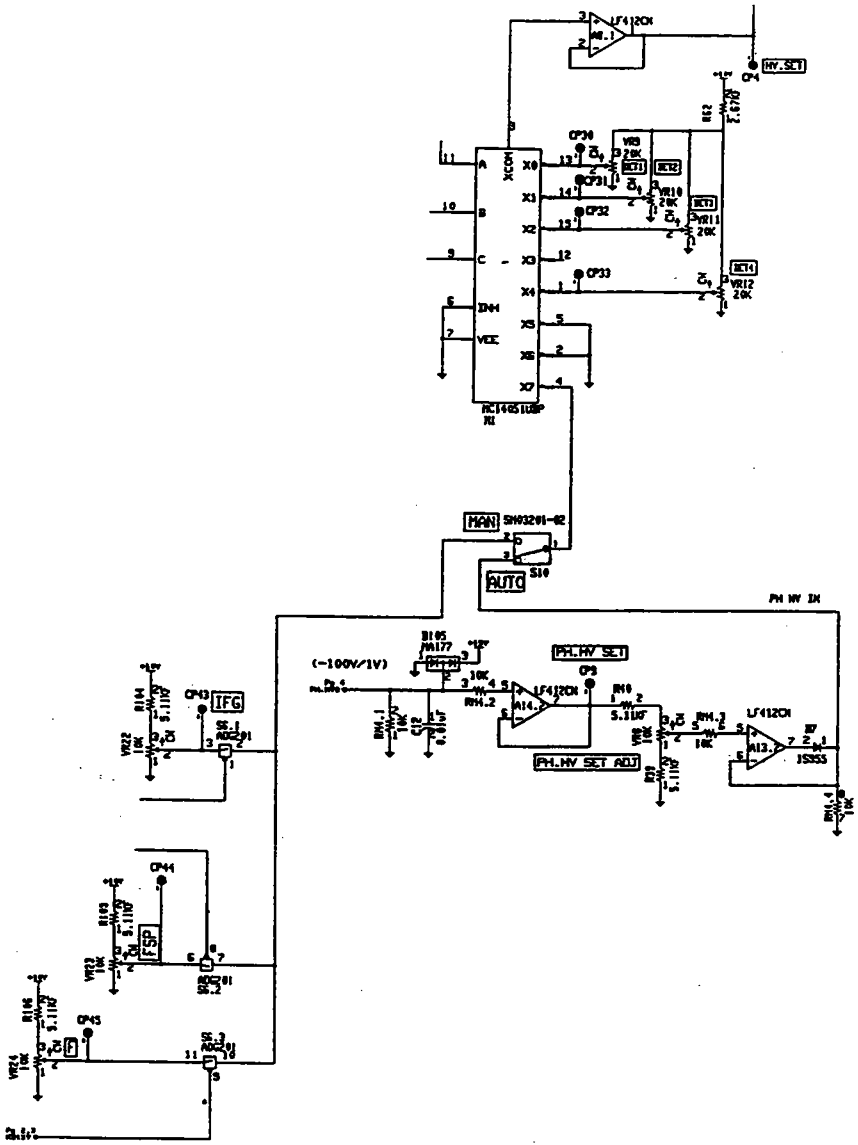



**Fig. 11.1**

This circuit sets the high-voltage for the photomultiplier of the photo-timer of I.I. light-receiving type.

When S10 is set to AUTO side, the value (PHOTO-S) at the console panel set by the added I/O CONT board is input from pin C5 of edge connector JM 46. This value is output to CP9 PH.HV SET. VR6 PH.HV SET ADJ adjusts the voltage at CP9 PH.HV SET ADJ so that it is related to the high-voltage output (CP17- HV) with a ratio 1 V : -100 V.

Without the optional I/O CONT-96 board, the high-voltage for the photomultiplier of the photo-timer of I.I. light receiving type is adjusted by VR22 [FSP], VR23 [IFG], and VR24 [F] with setting switch S10 to MAN side.

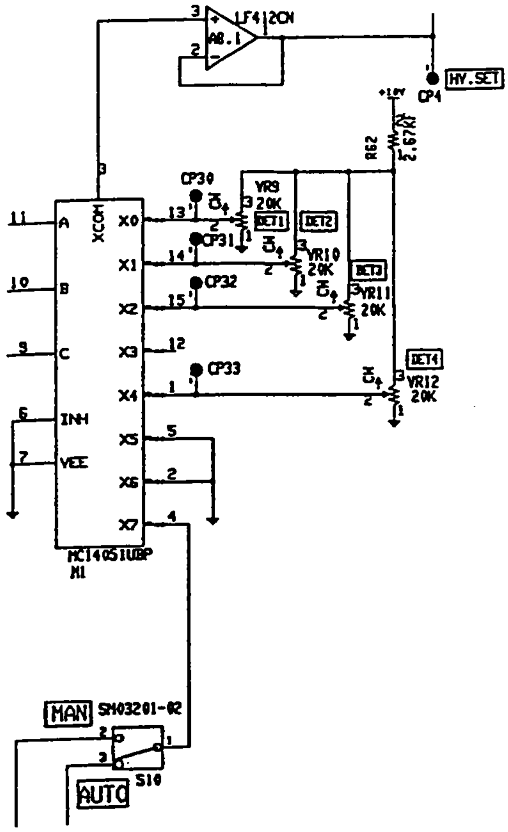



**Fig. 11.2**

This circuit sets the high voltage for the photomultiplier and adjusts the high voltage for the direct photo-timer.

The outputs of multiplexer M11 are supplied to the high-voltage power supply HV1 through a voltage follower A8-1, and the high voltage for the photomultiplier is output in accordance with the supplied voltage.

The high-voltage of the photomultiplier for each photocell is adjusted by VR9 [DET1], VR10 [DET2], VR11 [DET3], and VR12 [DET4] respectively.

## 11.3 Photomultiplier high-voltage switching circuit

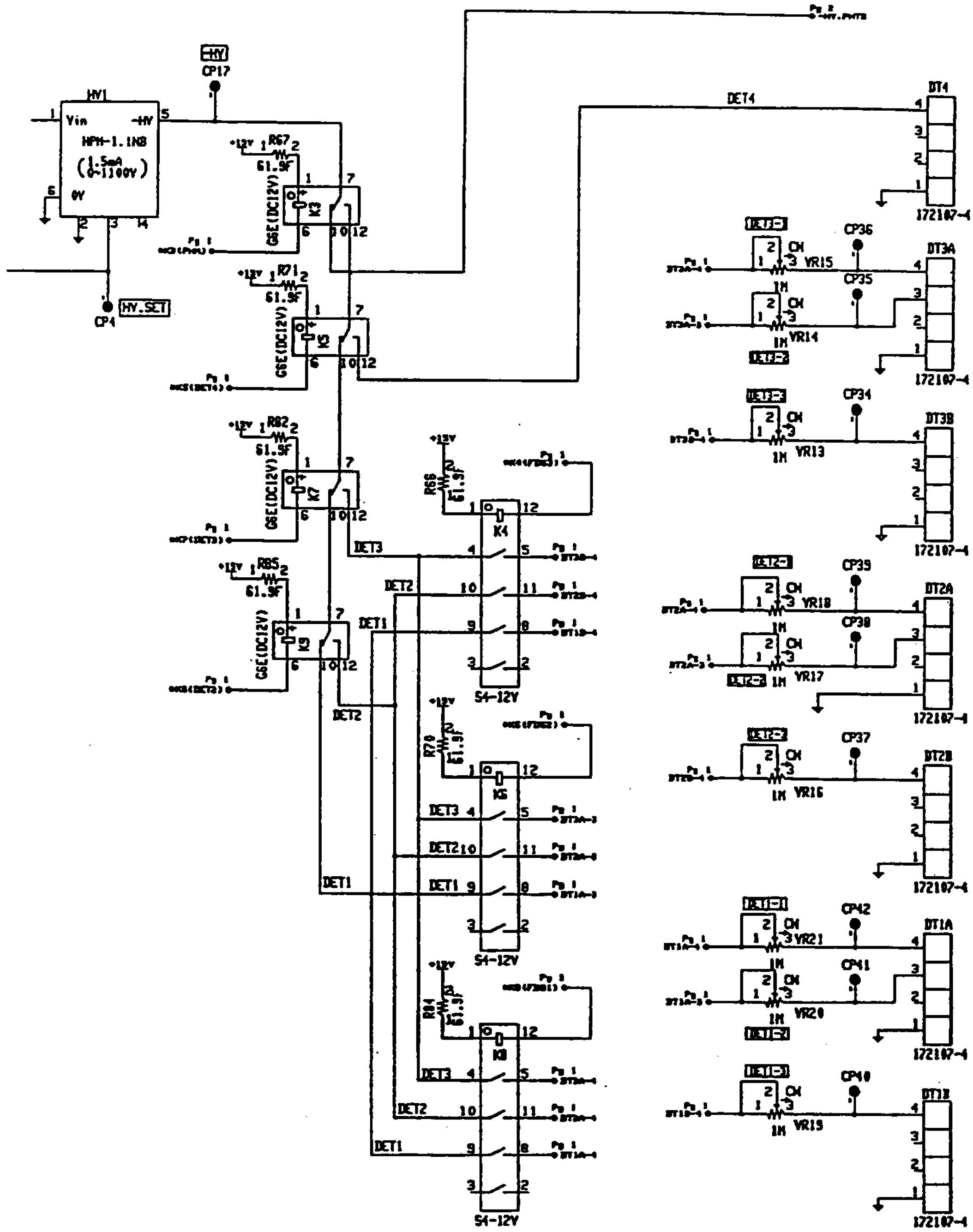



**Fig. 11.3**

This circuit switches the high-voltages of the photomultipliers for the direct phototimer.

The photomultiplier high-voltage for each photocell DET1, DET2, and DET3 is finely adjusted respectively by

VR13 DET3-1, VR14 DET3-2, VR15 DET3-3,

VR18 DET2-1, VR17 DET2-2, VR16 DET2-2,

VR21 DET1-1, VR20 DET1-2, VR19 DET2-3.

## 11.4 Photomultiplier high-voltage generating circuit

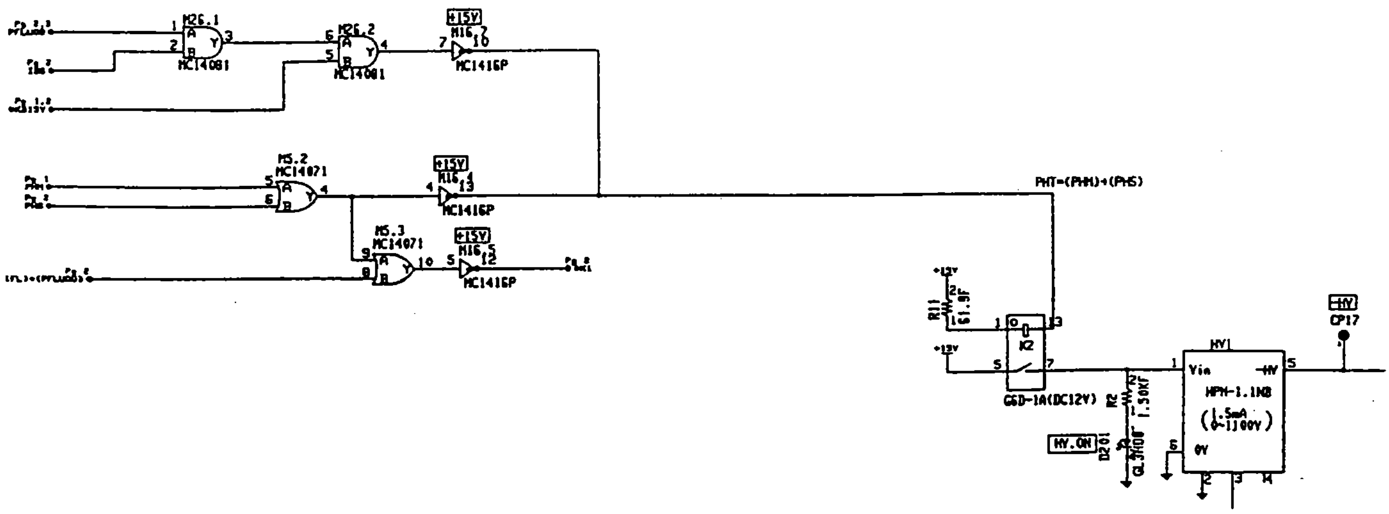



**Fig. 11.4**

This circuit switches on/off power to the high-voltage supply. When PHOTOMULTI, PHOTO SINGLE, PULSE FLUO., or FLUO. is selected, a relay K2 is turned ON and power is supplied to the high-voltage power supply HV1.

## 11.5 I.I. photo-input circuit

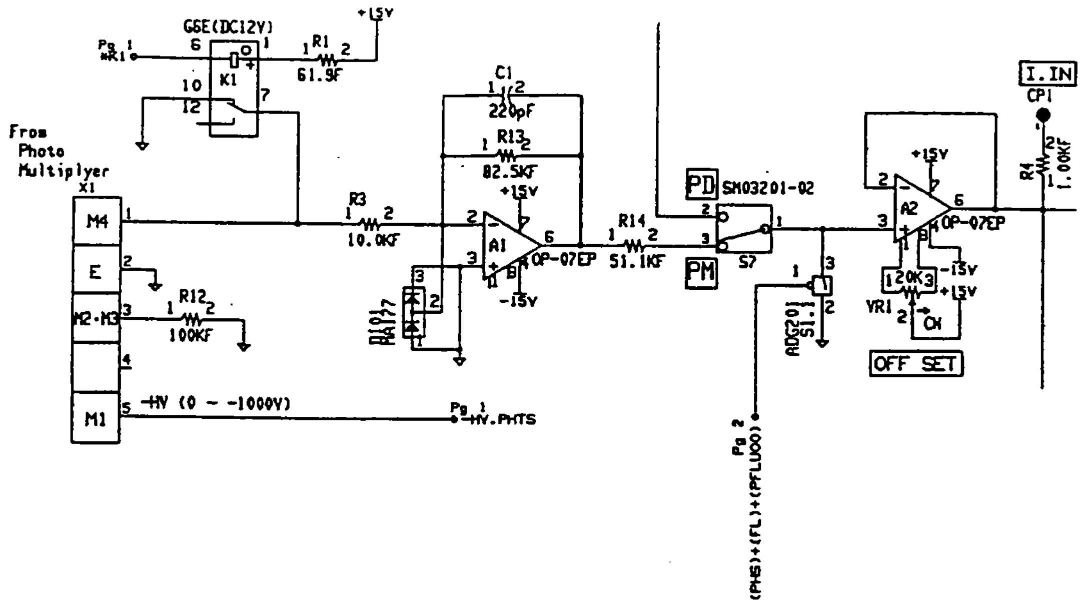



**Fig. 11.5**

Terminal stage X1 is used to input photo-currents from the photomultipliers. The current input to terminal M4 is subjected to a current-to-voltage conversion.

Switch S7 selects the input signal to PH POWER board from the photomultipliers or from the photocells. Usually the switch is set to PM side.

A2 is a buffer circuit for the input voltage from a differential amplifier or the voltage from the current-to-voltage conversion circuit. VR1 of the amplifier A2 adjust the off-set voltage of the input signal.

The output from this circuit I. IN is input to an integrating circuit to control the phototimer, and to a correction circuit of covering ratios and an automatic control circuit for pulsed fluoroscopy, as well.

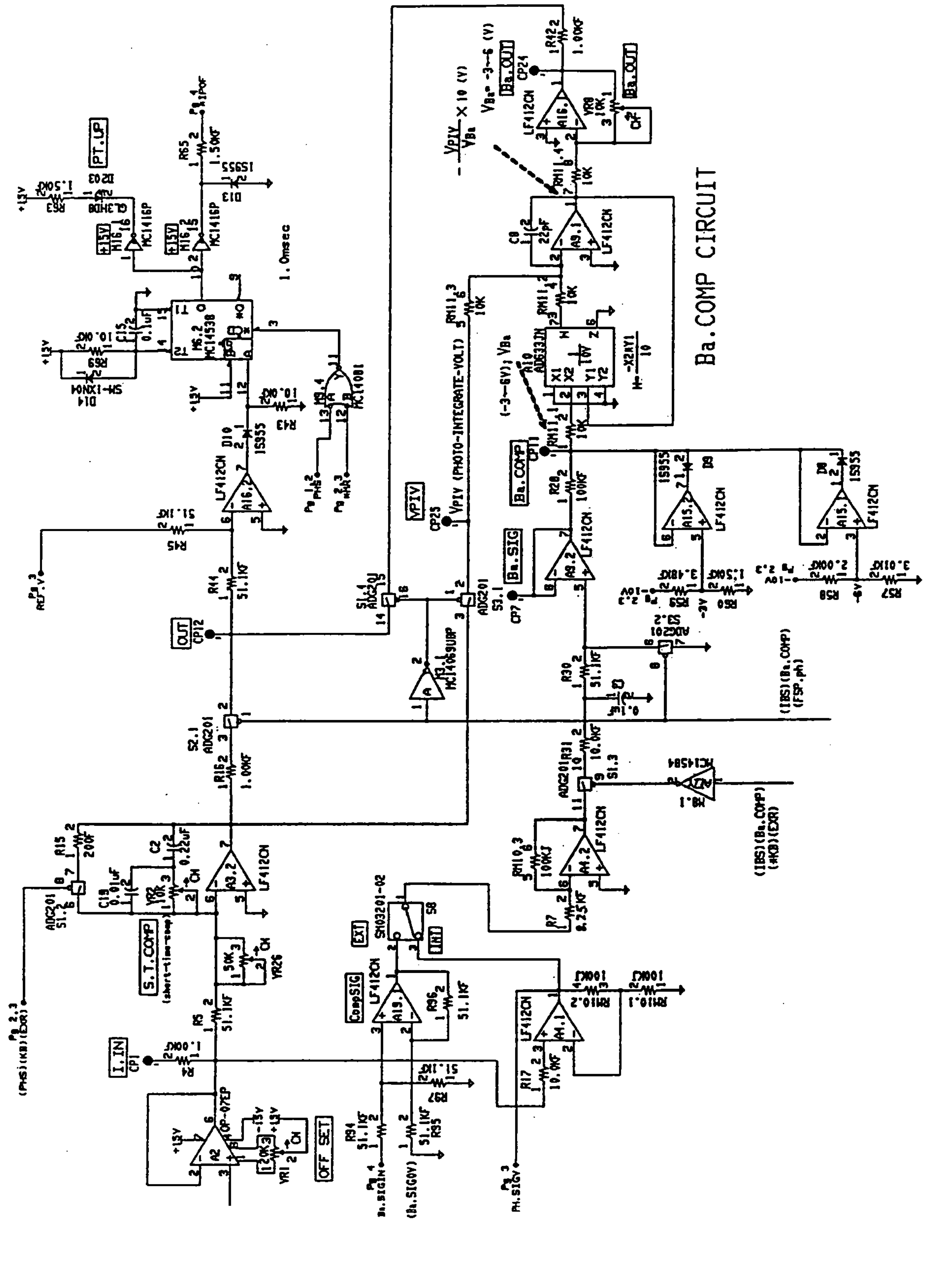

Ba.COMP CIRCUIT
S.T.COMP
OFF SET
I.IN
OUT
VPIV
Ba.SIG
Ba.COMP
Ba.OUT
PT.UP
CompSIG
EXT
INT

Fig. 11.6

## 11.6 Photo-timer of I.I. light receiving type circuit

The circuit including A3-2, VR2, C19, and C2 is an integrating circuit of the photo-current for the photo-timer control. VR2 is a VR for correcting the short-time characteristics.

An operational amplifier A16-2 compares the integrated value of the photo-current and the reference voltage REF.V. When the integrated value is larger than REF.V, the output of A16-2 becomes H. .

A one-shot multivibrator M16-2 outputs the cutoff signal of the photo-timer. At the same time the output of A16-2 is turned to H, a signal IPOF is output and stops inverter operation. This circuit works only when PHS is selected.

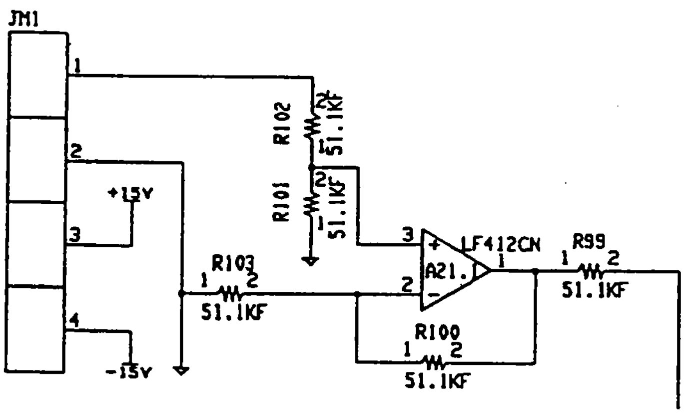



**Fig. 11.7**

When the photo-timer is controlled by the signal from photocell, the signal is input to JM1 and amplified by a differential amplifier A21-1. This circuit is not used now.

## 11.7 Circuit to correct covering ratio of contrast medium

When the photo-timer is used in fluoroscopic high-speed operation and the light detection field of the photo-timer is covered by a contrast medium such as Barium, the input current to the photo-timer is decreased to a smaller value than that when the field is not covered.

Then, the operation time is extended in accordance with the covering ratio, and the film density is increased.

The circuit corrects the effect of this phenomenon.

The signal to correct the covering ratio is input from [I. IN] through a non-converting amplifier A4-1 (①②③). The signal can be input from external devices through a differential amplifier A19-1.

Switch S8 can switch from internal signals to external signals and vice versa. However, S8 is set to INT side because external signals are not used now.

In fluoroscopic operation, when IBS has reached a stable state, the photomultiplier detects an output light from I.I., and the detected signal is sampled and held at C9. The voltage at C9 is output to CP7 Ba SIG.

The high-voltage of the photomultiplier is adjusted so that the voltage at CP7 is -6.0 V in a stable state of IBS when the covering ratio of contrast medium is 0%. Analog switch S1-3 is ON only when fluoroscopy is ON.

Ideally, the voltage at CP7 should be 0 V when the covering ratio is 100%. However, the operating range is limited to a covering ratio of 0 ~ 50% in this circuit, because the larger the covering ratio, the larger the error of correction. The circuit comprising amplifiers A15-1 and A15-2 limits the signal of the covering ratio inputted to a divider to a range of -6V ~ -3V. Therefore, the voltage at CP11 is controlled in a range of -6V ~ -3V.

The circuit comprising IC's A10 and A9 is a divider. For correction of the covering ratio, the divider adjusts the voltage at pin 1 of A9 through the integrated signal at CP25 VPIV so that the voltage has a relation given by

$$-\frac{VPIV}{Vba} \times 10$$

Finally, with the covering ratio of 100%, VR8 [Ba OUT] is adjusted so that the film density when the correction circuit is operated becomes same as that when it is not operated.

## 11.8 Reference voltage circuit and long-time characteristic correction circuit

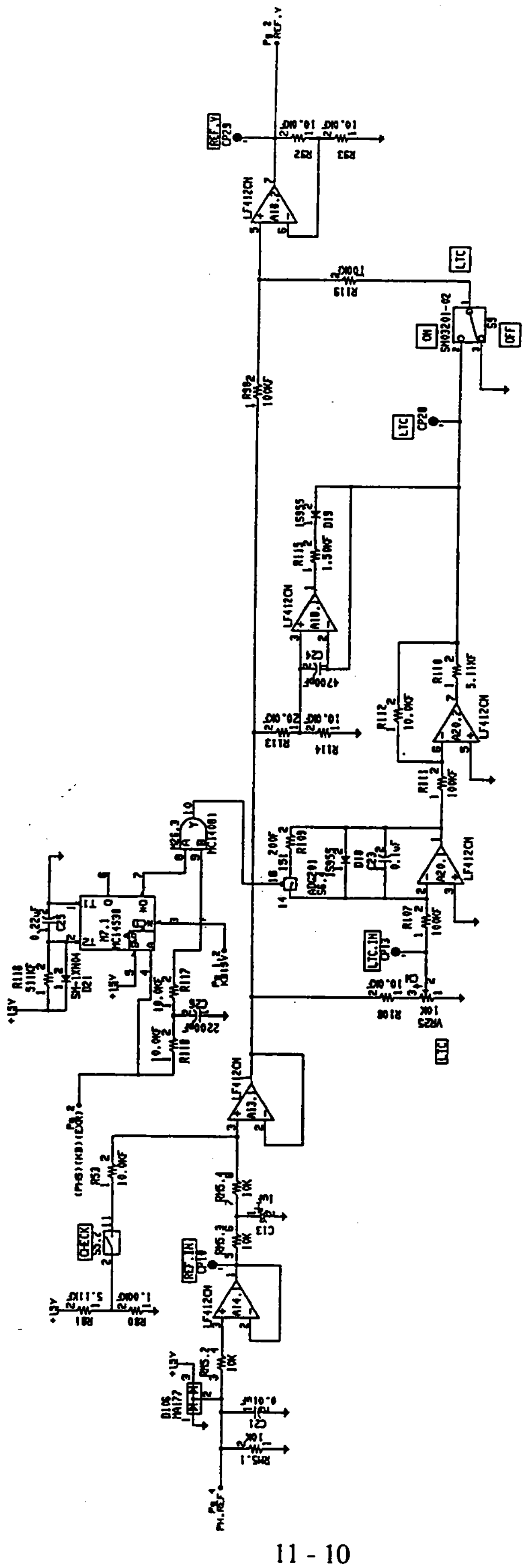


Fig. 11.8

Reference voltage circuit

PH. REF signal is the comparison reference signal set by CPU for the photo-timer. The signal is input as an analog value from I/O CONT-96 board to edge-connector pin JM46-A5 and output to CP16 [REF IN].

Change of the reference voltage, correction of tube voltage, and division correction in accordance with sensitivity of a sensitized film are controlled by CPU.

The voltage at CP10 [REF IN] is output to CP29 [REF V] through A13-1 (①②③) and A18-2 (⑤⑥⑦).

The voltage [REF V] is the reference which is to be compared to the integrated voltage of the photo-current of the photo-timer.

Circuit to correct the long-time characteristics (to correct reciprocity law failure of film)

This circuit corrects a characteristic that film density is not proportional to the amount of X-ray exposure in long-time radiography.

To compensate a reduced signal due to a lower density of the exposed film, an integrated current proportional to the reference voltage is added to the reference voltage later than 100 msec after the start of X-ray exposure. It corrects the signal so as to be exactly proportional to the amount of X-ray exposure.

ON and OFF of LTC switch S3 determine whether the correction is done or not.

VR25 [LTC] adjusts the degree of correction of the long-time characteristic. The amount of correction is limited up to one third of an initially set density.

## 11.9 Pulsed fluoroscopy IBS circuit

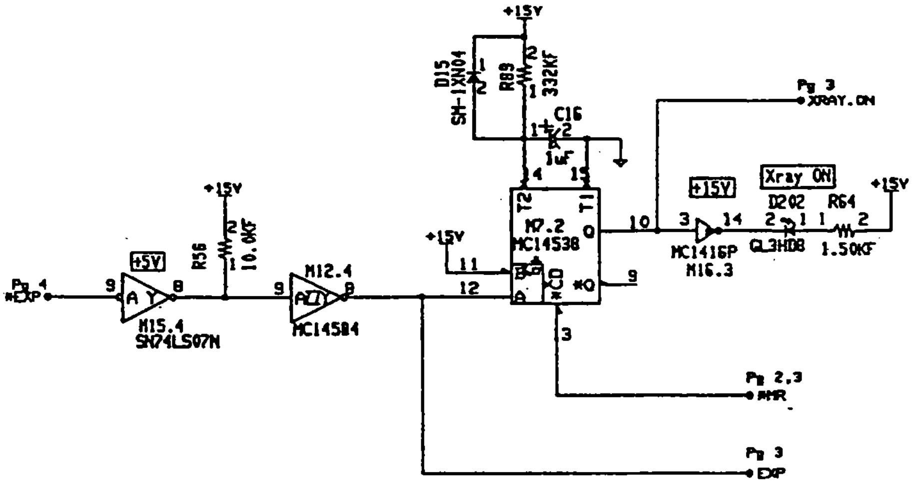



Fig. 11.9

The circuit comprising M7-2 generates a continuous X-RAY ON signal from a real exposure signal EXP of pulsed fluoroscopy. The EXP signal is a pulse signal, which is converted to a continuous signal necessary for continuous controls. The EXP signal with a pulse rate up to 3.75 FPS is converted to a continuous signal by triggering a one-shot multivibrator. (the pulse rate in pulse fluoroscopy is 3.75 FPS ~ 30 FPS.)

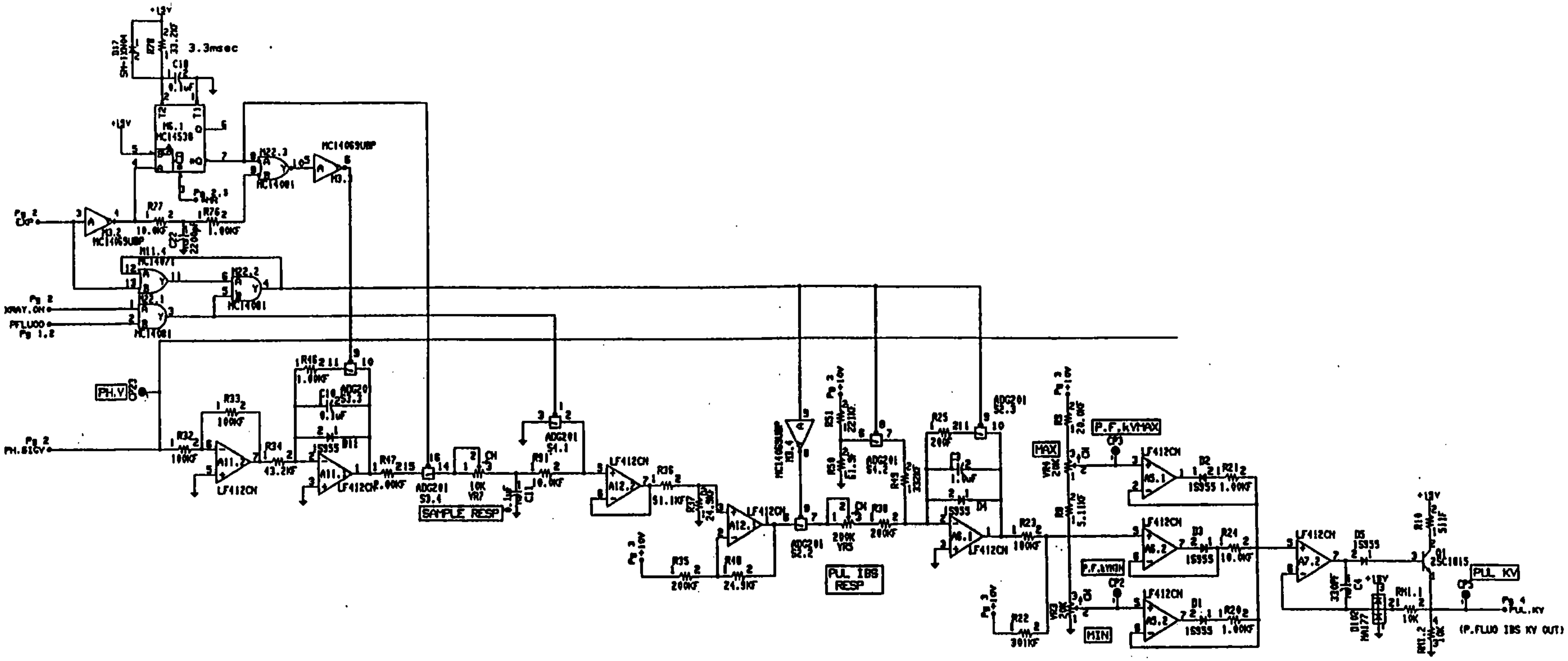

3.3msec
SAMPLE RESP
PUL IBS RESP
MAX
MIN
P.F.kVMAX
PUL KV
(P.FLUO IBS KV OUT)

Fig. 11.10

Pulsed fluoroscopy IBS control circuit

This circuit automatically controls (IBS) a tube voltage in pulsed fluoroscopy.

Light generated by I.I. is detected by photomultiplier. The detected photo-current is subjected to a current-to-voltage conversion, and the converted voltage signal PH.V is input to the pulsed fluoroscopy IBS control circuit.

The circuit comprising M6-1, M22-3, and M3-2 generates a timing pulse to peak-hold the signal for 3 msec after an exposure time.

The signal [PH. V] at CP23 is inverted by A11-2 (①②③) and integrated for a real exposure time + 3 msec by A11-1 (①②③).

The integrated value is peak-held for 3 msec after the end of a real exposure pulse by the circuit comprising S3-4 (⑭⑮⑯), VR7, and C11.

The peak-held voltage is compared to a reference voltage in A12-1 (①②③) and the derived difference signal controls IBS by a circuit of VR5, R38, and A6-1 (①②③).

VR4 [MAX] and VR3 [MIN] set a maximum and minimum tube voltage in pulse fluoroscopic IBS, respectively.

The IBS-controlled output voltage at CP5 [PUL KV] is input to ANOLOG-96 board through an edge connector.

The relation between the voltage [PUL KV] and the pulsed fluoroscopic tube output voltage is given by 1 V = 20 KV.

# 12. PH CONT-96 board

## 12.1 Outline of PH CONT-96 board

(1) Signal input circuit for direct photo-timer

Number of connectable photo-receptors

3 pickups × 3 photo-receptors

1 pickup × 1 photo-receptors

(2) Photomultipliers and semiconductor photo-receptors (Tweem, Comet, etc.) are connectable.

(3) AND circuit and average value circuit (for semiconductor photo-receptors) are switchable.

(4) Short-time characteristic correction circuit (by CR circuit)

(5) Long-time characteristic correction circuit (adjusted by VR in accordance with set value of REF. V)

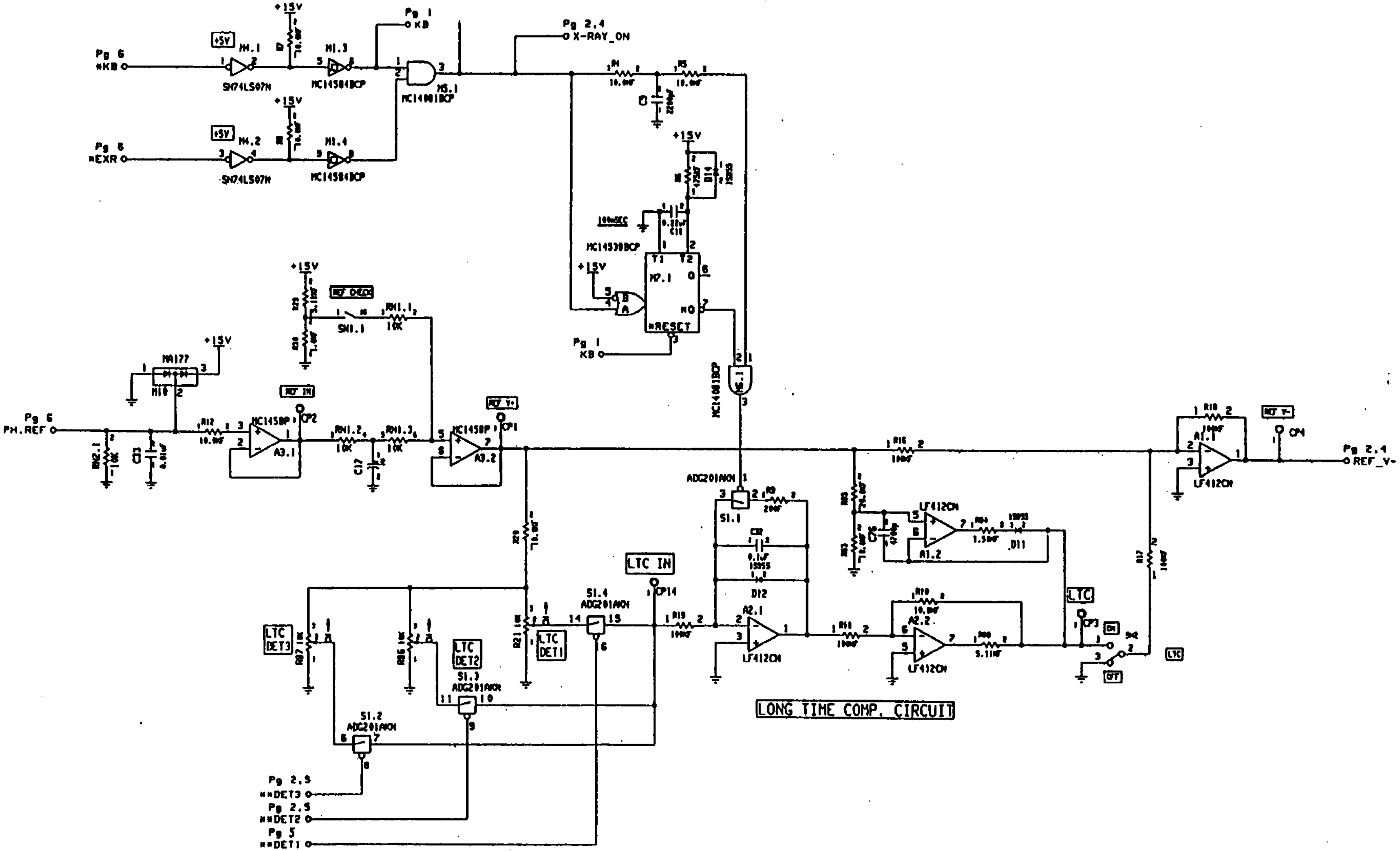

Pg 6
*KB
Pg 6
*EXR
SN74LS07N
MC14584BCP
MC14081BCP
Pg 1
KB
Pg 2,4
X-RAY_ON
+15V
+5V
MC14538BCP
*RESET
REF CHECK
SW1.1
MA177
Pg 6
PH.REF
REF IN
REF V+
MC1458P
ADG201AKN
LTC IN
LTC DET3
LTC DET2
LTC DET1
LF412CN
REF V-
Pg 2,4
REF_V-
LTC
ON
OFF
LONG TIME COMP. CIRCUIT
Pg 2,5
**DET3
Pg 2,5
**DET2
Pg 5
**DET1

Fig. 12.1

## 12.2 Reference voltage circuit

PH. REF signal is the comparison reference signal set by CPU for the photo-timer. The signal is output as an analog value from I/O CONT-96 board to edge-connector pin JM45-A5 and output to CP [REF IN].

Change of the reference voltage, correction of tube voltage, and division correction in accordance with sensitivity of a sensitized film are controlled by CPU.

The voltage at CP2 [REF IN] is output to CP4 [REF V-] through A3-2 (①②③) and A1-1 (①②③).

The voltage [REF V-] is the reference which is to be compared to the integrated voltage of the photo-current of the photo-timer.

## 12.3 Circuit to correct the long-time characteristics (to correct reciprocity law failure of film)

This circuit corrects a characteristic that film density is not proportional to the amount of X-ray exposure in long-time radiography.

To compensate a reduced signal due to a lower density of the exposed film, an integrated current proportional to the reference voltage is added to the reference voltage later than 100 msec after the start of X-ray exposure. It corrects the signal so as to be exactly proportional to the amount of X-ray exposure.

ON and OFF of LTC switch S2 determine whether the correction is done or not.

R21 [LTC DET 1], R86 [LTC DET 2], and R87 [LTC DET 3] adjust the degree of correction of the long-time characteristic of each photo-receptor. The degree of correction is limited up to one third of an initially set density.

## 12.4 IP. OFF circuit

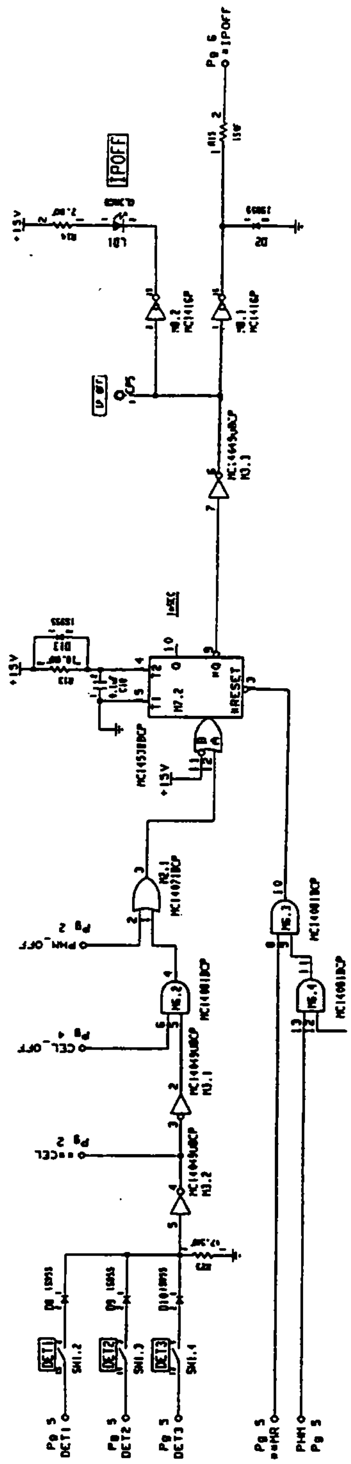



Fig. 12.2

This circuit receives signals from the comparison circuits and outputs X-ray cutoff signal IP. OFF.

SW1.2 [DET 1], SW1.3 [DET 2], and SW1.4 [DET 3] select to control each photoreceptor signal by an average value circuit or by an OR circuit.

Usually, the switches are OFF because the OR circuit is used.

## 12.5 Average value control circuit

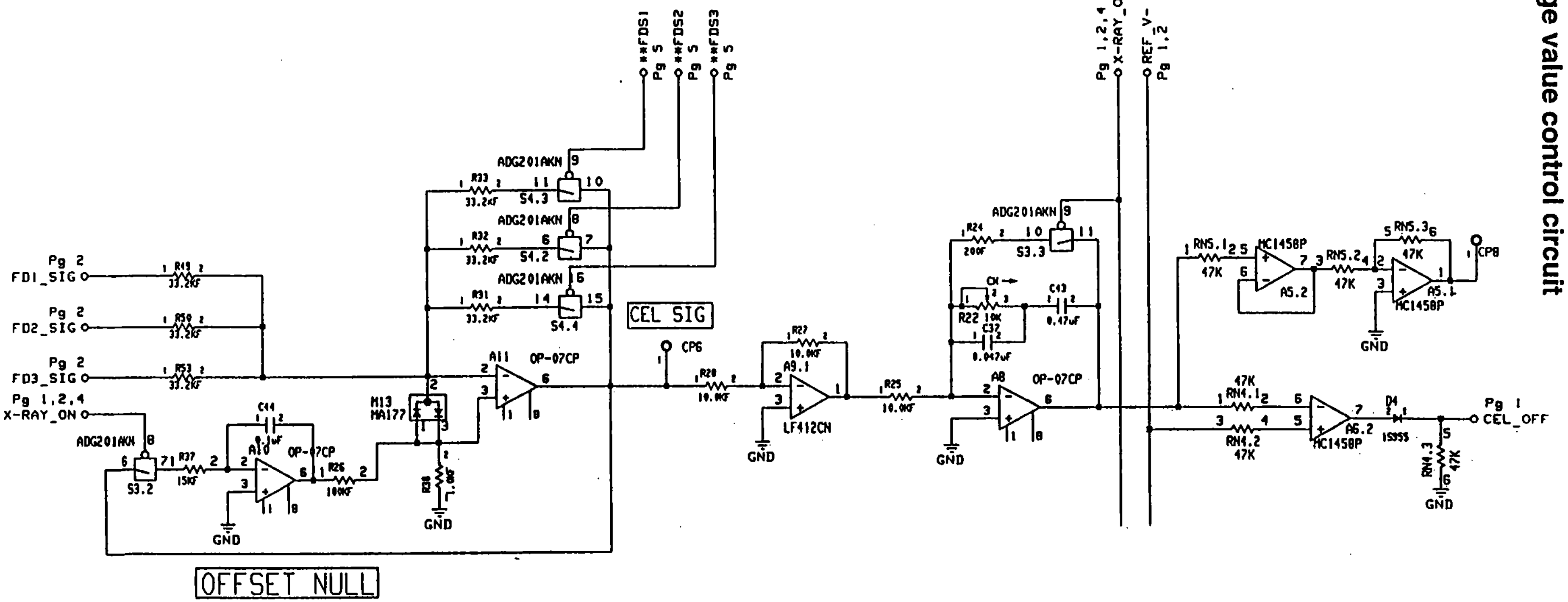



Fig. 12.3





98

Average value control circuit

The outputs from light-receiving fields are converted from currents to voltages and input to this circuit as signals FC1_SIG, FD2_SIG, and FD3_SIG.

The gain of an amplifier A11 is switched in accordance with a selected light-receiving field, and the output of A11 is reduced to an average value of the three signals at CP6 [CEL SIG].

An integrating circuit of A8 integrates the average output voltage, and the integrated value is compared to [REF V-] by A6-2 (⑤⑥⑦) and outputs OFF signals.

A circuit comprising A10, C44, and S3-2 (⑥⑦⑧) is OFFSET NULL circuit and automatically cancels the offset voltage of A11.

## 12.6 Direct photo-timer control circuit (OR circuit)

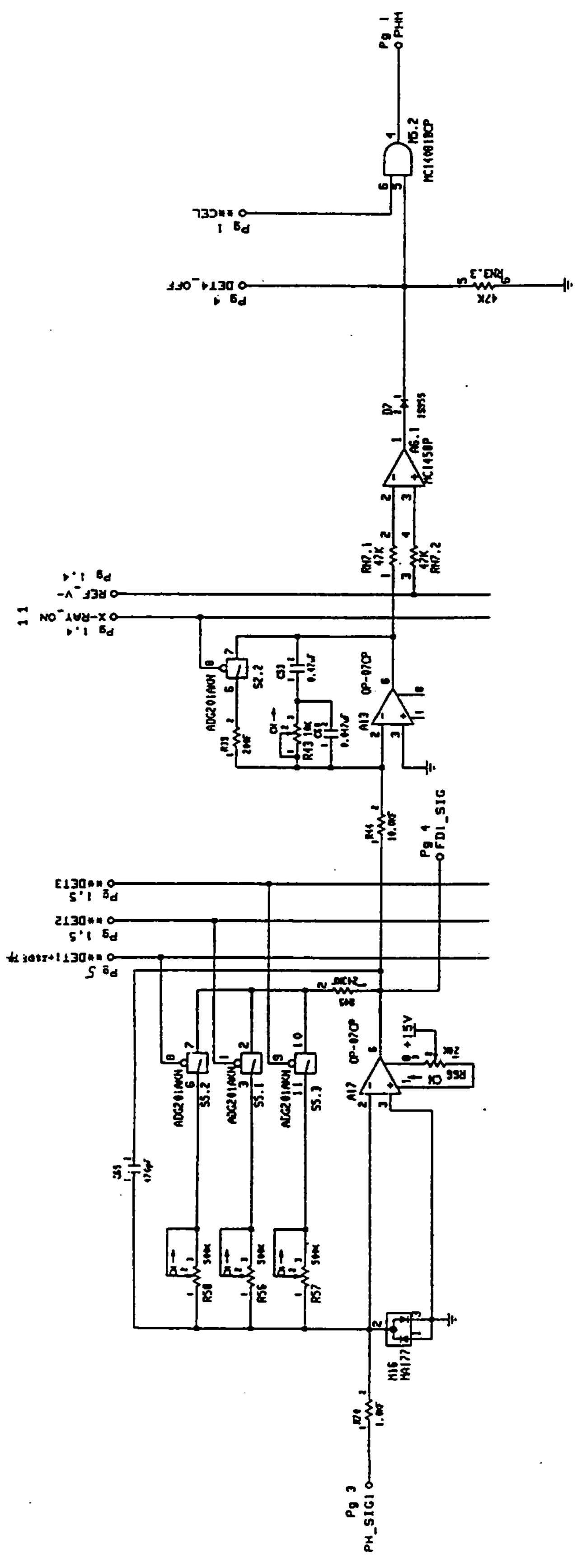



Fig. 12.4

PH_SIG1 is a photo-current input from the first light-receiving field of the photo-timer.

A circuit comprising R45, R56, R57, R58, and A17 is a current-to-voltage conversion circuit. R56, R57, and R58 are variable resistors to adjust gains for each light-receiving field when photo-receptors of foreign manufacturers are assembled.

When a photo-timer of photomultiplier type is used, the variable resistors are extremely turned counterclockwise, because the photomultiplier high-voltage generating circuit adjusts the GAIN of each light-receiving field.

A13 is an integrating circuit which integrates the signal converted from current to voltage by A17.

R43 is a variable resistor to correct a short-time characteristic. Turning it clockwise reduces the cutoff time, correcting a delay in cutoff of the system.

The output voltage integrated by A13 is compared to the reference voltage by A6-1 (①②③) and outputs OFF signal.

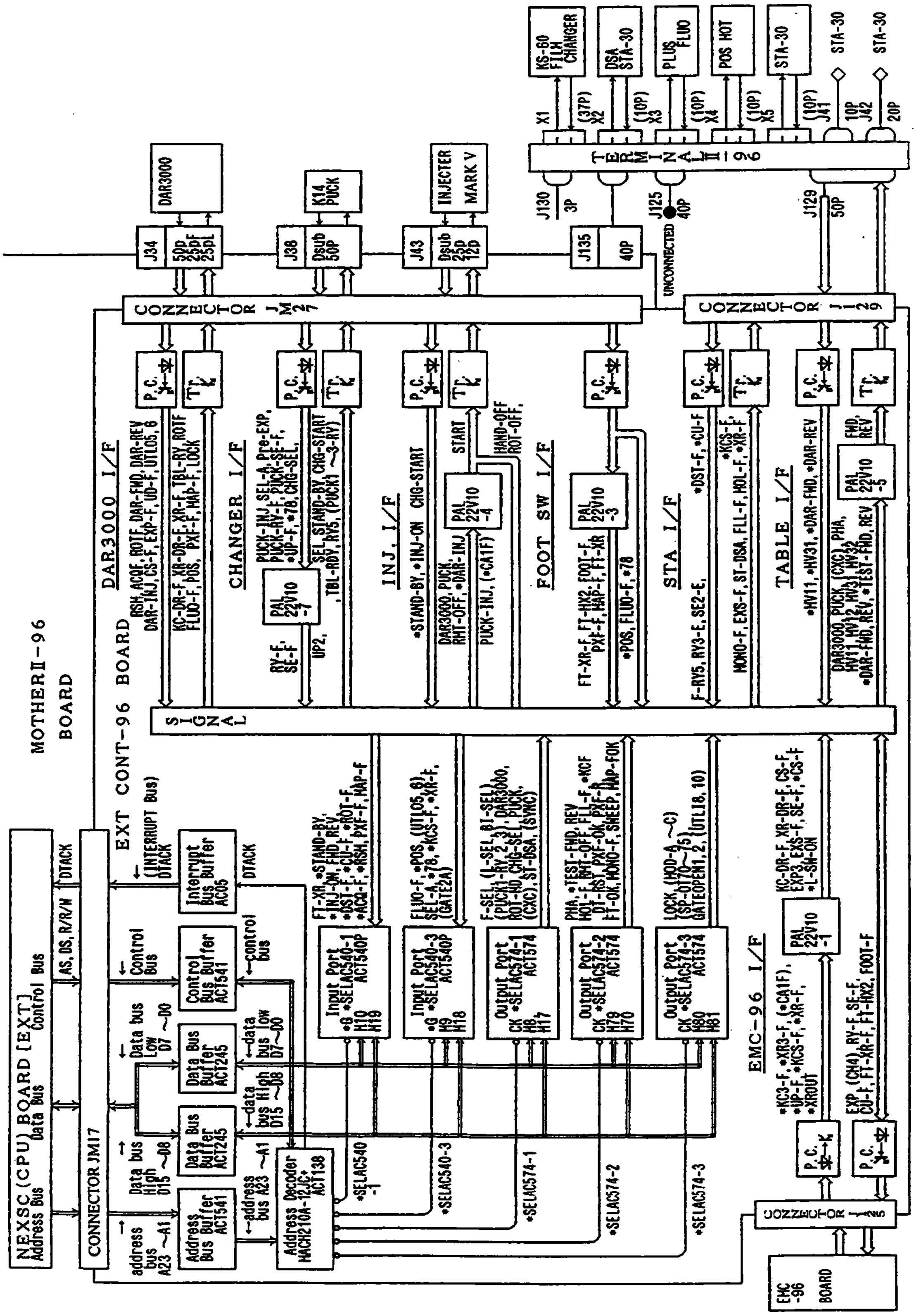
This OFF signal is invalid when the average value control is set.

The second to fourth light-receiving fields work in the same way as the first one.

# 13. EXT CONT-96 board

## 13.1 Schematic block diagram of EXT CONT-96 board

The block diagram includes NEXSC (CPU) BOARD [EXT], PAL (22V10), INPUT-IC (ACT540), OUTPUT-IC (ACT574), and connectors and data buses, etc.



## 13.2 EXT CONT-96 board LED display

[1] List of LED displays

LED displays of EXT CONT-96 board are listed below.

| LED No. | Color | Connection diagram Page | Connector Pin No | Signal | Significance | Destination |
|---|---|---|---|---|---|---|
| LD1 | RED | 3/5 | J125 B- 9 | *XRIN | X-RAY real exposure input signal | |
| LD2 | 〃 | 3/5 | 〃 B-11 | *KCS2 | Radiography preparation signal input to STA-30 device (KC input signal) | →STA-30 |
| LD3 | 〃 | 3/5 | 〃 B-13 | *EPS2 | X-ray radiation signal input to STA-30 device (EXR input signal) | →STA-30 |
| LD4 | 〃 | 3/5 | — | *SMALL | Small focus selection signal input to STA-30 device (SM input signal) (unused) | →STA-30 |
| LD5 | GREEN | 3/5 | 〃 B- 4<br>〃 A- 5 | *EXP1<br>*EXP2 | X-RAY OK signal output from DSA device | |
| LD6 | 〃 | 3/5 | 〃 A-17<br>〃 B-17 | *CM4<br>0V | CINE camera exposure signal (unused)<br>0 V for CM4 (unused) | |
| LD7 | 〃 | 3/5 | 〃 A-11 | *RY3 | READY operation signal output from film-changer device | PUCK→ |
| LD8 | 〃 | 3/5 | 〃 A-13 | *SE2 | X-RAY operation signal output from film-changer device | PUCK→ |
| LD9 | RED | 3/5 | 〃 B-12 | *UP2 | READY UP signal input to film-changer device | →PUCK |
| LD10 | 〃 | 3/5 | 〃 B-15 | *CA2 | X-RAY ON signal input to CINE camera device | →CINE |
| LD11 | 〃 | 3/5 | 〃 A- 9 | *XROB | X-RAY ON input signal | |
| LD12 | 〃 | 3/5 | 〃 A-15 | *KCB | Radiography preparation input signal (KC input signal) | TERMINAL Ⅱ |
| LD13 | GREEN | 5/5 | J129 A-22 | *FLL | Sub-focus fluoroscopy selection signal output to STA-30 device | →STA-30 |
| LD14 | 〃 | 5/5 | 〃 B-22 | *MOL | Sub-focus selection signal output to STA-30 device (in adjustment) | →STA-30 |
| LD15 | 〃 | 5/5 | 〃 B-20 | EXS-1F | X-RAY ON signal output to STA-30 device | →STA-30 |
| LD16 | 〃 | 5/5 | 〃 B-18 | *EIN | Stereo DSA selection signal output to STA-30 device (ST-DSA output signal) | →STA-30 |
| LD17 | 〃 | 3/5 | J125 A-12 | ·CU2 | Acknowledge signal of heating from STA-30 device | →EMC-96 |
| LD18 | 〃 | 3/5 | 〃 B- 5 | *AR2I | READY operation second output signal | →EMC-96 |
| LD19 | 〃 | 3/5 | 〃 A- 6 | *HX2I | X-RAY operation second output signal | →EMC-96 |
| LD20 | 〃 | 3/5 | 〃 A-18 | FOOT2 | Foot-switch output signal | EMC-96 |
| LD21 | 〃 | 3/5 | JM27 A- 5 | *KCF | Hand-switch ON status | →DAR3000 |
| LD22 | 〃 | 〃 | 〃 B- 5 | *XRF | X-RAY switch ON status | →DAR3000 |
| LD23 | 〃 | 〃 | 〃 B- 8 | *CKTB | Bed move finish status | →DAR3000 |

| LED No. | Color | Connection diagram Page | Connector Pin No | Signal | Significance | Destination |
|---|---|---|---|---|---|---|
| LD24 | GREEN | 3/5 | JM27 C- 5 | *SOKF | CINE camera synchronization OK status [OFF] | |
| LD25 | RED | 3/5 | JM27 C- 1 | *EXPF | X-ray exposure command | DAR3000 → |
| LD26 | 〃 | 3/5 | 〃 A- 2 | *VDF | VD command for CINE camera | 〃 |
| LD27 | 〃 | 3/5 | 〃 B- 4 | *UTL052F | Spare input signal | 〃 |
| LD28 | 〃 | 3/5 | 〃 C- 4 | *UTL062F | Spare input signal | 〃 |
| LD29 | GREEN | 5/5 | J129 B-19 | *MON | Monaural radiography selection signal output to STA-30 device | →STA-30 |
| LD30 | 〃 | 3/5 | 〃 A-18 | *ROT | Mechanism rotation command output from DSA device | →MH |
| LD32 | 〃 | 〃 | JM27 A- 6 | *FLUOF | Fluoroscopy ON status | →DAR3000 |
| LD31 | 〃 | 〃 | JM27 C- 7 | *PREEXPF | Television blanking command before exposure | →DAR3000 |
| LD33 | 〃 | 〃 | 〃 A- 8 | *FOOTSWONF | Foot-switch ON status for fluoroscopy | 〃 |
| LD34 | 〃 | 〃 | 〃 B- 6 | *LOCK | X-ray radiographic condition lock OK status | 〃 |
| LD35 | 〃 | 〃 | 〃 B- 7 | *MAPF | Foot-switch ON status for MAP | 〃 |
| LD36 | RED | 3/5 | 〃 C- 3 | *FWD | Bed forward-move command | DAR3000 → |
| LD37 | 〃 | 〃 | 〃 A- 4 | *BWD | Bed backward-move command | 〃 |
| LD38 | 〃 | 3/5 | 〃 A- 1 | *INJ | INJECTER start command | DAR3000→ |
| LD39 | 〃 | 〃 | 〃 B- 1 | *CSF | CINE camera start command | 〃 |
| LD40 | GREEN | 5/5 | J129 B-13 | EPS02-F | X-ray radiation signal output to STA-30 device (XR output signal) | →STA-30 |
| LD41 | 〃 | 5/5 | 〃 B-11 | *KCS | Radiographic preparation signal output to STA-30 device (KC output signal) | →STA-30 |
| LD42 | 〃 | 〃 | 〃 B- 8 | M34-E | Top-panel forward-move signal to drive TERMINAL2-96 board relay | →TERMINAL II -96 |
| LD43 | 〃 | 〃 | 〃 A- 8 | M36-E | Top-panel backward-move signal to drive TERMINAL2-96 board relay | →TERMINAL II -96 |
| LD44 | 〃 | 3/5 | 〃 B- 3 | *KC14 | Radiographic preparation output signal [DSA device] (KC output signal) | →TERMINAL II -96 |
| LD45 | 〃 | 3/5 | 〃 A- 4 | *KC14 | Radiographic X-RAY output signal [DSA device] (KC output signal) | →TERMINAL II -96 |
| LD46 | 〃 | 5/5 | 〃 B-23<br>A-23 | *UNSHI2<br>*UNSHI1 | RSM-DSA selection output signal<br>〃 | →TERMINAL II -96 |
| LD47 | 〃 | 3/5 | JM27 C- 6 | *PUL-FLUOF | Pulse fluoroscopy ON status | →DAR3000 |
| LD48 | 〃 | 3/5 | — | *UTLI8 | Spare output signal | |
| LD49 | 〃 | 3/5 | JM27 A- 7 | *ROT-POS | Mechanism position confirmation status in rotary DSA | →DAR3000 |
| LD50 | 〃 | 3/5 | — | *UTLI10 | Spare output signal | |
| LD51 | RED | 3/5 | JM27 C- 2 | *RSMR | I.I. defocus command in RSM-DSA | DAR3000→ |

| LED No. | Color | Connection diagram Page | Connector Pin No | Signal | Significance | Destination |
|---|---|---|---|---|---|---|
| LD52 | RED | 3/5 | JM27 B- 3 | *ACQF | Active in assembly (for VTR remote operation) | DAR3000→ |
| LD53 | 〃 | 〃 | 〃 B- 2 | *ROTATEF | Mechanism rotation command (F side) | 〃 |
| LD54 | 〃 | 〃 | — | *ROTATEL | Mechanism rotation command (L side) (unused) | 〃 |
| LD55 | GREEN | 4/5 | JM27 C-23 | TBL-RY2 | Table READY signal output to PUCK | →PUCK |
| LD56 | 〃 | 〃 | 〃 C-21 | UP2 | READY UP signal output to PUCK device | →PUCK |
| LD57 | 〃 | 〃 | 〃 A-24 | PUCK1-RY2 | (Unused) | 〃 |
| LD58 | 〃 | 〃 | 〃 B-22 | SEL-OKA2 | X-ray controller selection acknowledge signal to PUCK device | 〃 |
| LD59 | 〃 | 〃 | 〃 B-24 | PUCK2-RY2 | (Unused) | 〃 |
| LD60 | 〃 | 〃 | 〃 A-23 | INJ-RY2 | Injector READY signal to PUCK | →PUCK |
| LD61 | 〃 | 〃 | 〃 C-24 | PUCK3-RY2 | (Unused) | 〃 |
| LD62 | 〃 | 〃 | 〃 B-23 | START2 | START signal from injector to PUCK | →J38 →PUCK |
| LD63 | RED | 4/5 | J129 A-13 | SE2-E | X-ray operation signal input from film changer device | PUCK等→ |
| LD64 | RED | 4/5 | J129 A-11 | RY3-E | READY operation signal input from film changer device | 〃 |
| LD65 | RED | 4/5 | J129 B-10 | F-RY5 | READY operation signal input from film changer device | TERMINAL Ⅱ -96→ |
| LD66 | RED | 5/5 | JM27 B-11 | POS2 | Mechanism position confirmation status | TERMINAL Ⅱ -96→ |
| LD67 | RED | 4/5 | J129 B- 9 | MAP-F2 | Foot-switch for MAP ON input signal | 〃 |
| LD68 | 〃 | 〃 | 〃 A- 9 | PXF-F2 | Pulse radiography ON input signal | 〃 |
| LD69 | RED | 5/5 | JM27 A-10 | FT-XR2 | Foot-switch for radiography ON status | 〃 |
| LD70 | 〃 | 4/5 | J129 A-12 | CU2-E | Acknowledge signal of heating from STA-30 device | STA-30→ |
| LD71 | 〃 | 〃 | J129 A-21 | DST2-F | Stereo acknowledge signal input from STA-30 device | STA-30→ |
| LD72 | 〃 | 〃 | JM27 C-20 | CH-EXP2 | X-ray exposure request signal input to X-ray controller from PUCK device | PUCK→ |
| LD73 | 〃 | 4/5 | JM27 B-20 | START-2 | READY request signal input to X-ray controller from PUCK device | PUCK→ |
| LD74 | GREEN | 5/5 | JM27 A-28<br>B-28 | HAND-OFF2<br>HAND-OFF1 | Output signal to select invalid injector hand-switch (unused) | |
| LD75 | 〃 | 5/5 | JM27 C-28 | RMT-OFF2 | Output signal to select invalid injector remote control (unused) | |
| LD76 | RED | 〃 | J129 B- 7 | MV3-E | Signal to move top-panel of examination bed backward (output from film-changer device) | |
| LD77 | 〃 | 〃 | J129 A- 7 | MV1-E | Signal to move top-panel of examination bed forward (output from film-changer device) | |

| LED No. | Color | Connection diagram Page | Connector Pin No | Signal | Significance | Destination |
|---|---|---|---|---|---|---|
| LD78 | RED | 5/5 | JM27 B-25 | MV3-P | Signal to move top-panel of examination bed backward (output from PUCK device) | PUCK→ |
| LD79 | RED | 〃 | JM27 A-25 | MV1-P | Signal to move top-panel of examination bed forward (output from PUCK device) | PUCK→ |
| LD80 | RED | 5/5 | JM27 C-29 | XR-ST2 | Changer start signal from injector | INJ→ |
| LD81 | RED | 5/5 | JM27 B-27 | INJ-CN2 | Signal during injection from injector | INJ→ |
| LD82 | RED | 5/5 | JM27 C-27 | STAND-BY2 | Standby signal from injector | INJ→ |
| LD83 | RED | 4/5 | JM27 C-25 | PRE-F2 | Advanced X-ray exposure request signal input from PUCK device | PUCK→ |
| LD84 | 〃 | 〃 | JM27 C-19 | SELA2 | X-ray controller selection signal from PUCK device (F) | PUCK→ |
| LD85 | 〃 | 〃 | JM27 B-19 | INJ2 | Injector start signal from PUCK device | PUCK→ |
| LD86 | GREEN | 5/5 | JM27 A-29<br>B-29 | INJ-ST2<br>INJ-ST1 | Start signal to injector | →INJ |

## 13.3 Input/output signals of EXT CONT-96 board

[1] Table of input/output signals

Input/output signals of EXT CONT-96 board are as follows.

Refer to "[2] Input/output circuit" for circuit mark k ~ p, and refer to "7.31 Input/output signals of EMC-96 board, [2] Input/output circuit" for mark a ~ j.

't' indicates that connectors J125 and J129 are only connected and there is no circuit between them.

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM17 | 1/5 | A- 1 | +5VM | In | | +5 V input | Mother Ⅱ -96 |
| | | B- 1 | 〃 | 〃 | | | |
| | | C- 1 | 〃 | 〃 | | | |
| | | A- 2 | +5VM | In | | | |
| | | B- 2 | 〃 | 〃 | | | |
| | | C- 2 | 〃 | 〃 | | | |
| | 1/5 | A- 3 | +15VM | In | | +15 V input | |
| | | B- 3 | 〃 | 〃 | | | |
| | | C- 3 | 〃 | 〃 | | | |
| | 1/5 | A- 4 | +12Vin | In | | +12 V input | |
| | | B- 4 | 〃 | 〃 | | | |
| | | C- 4 | 〃 | 〃 | | | |
| | 1/5 | A- 5 | +24Vin | In | | +24 V input | |
| | | B- 5 | 〃 | 〃 | | | |
| | | C- 5 | 〃 | 〃 | | | |
| | | A- 6 | (no use) | — | | | |
| | | B- 6 | 〃 | 〃 | | | |
| | | C- 6 | 〃 | 〃 | | | |
| | 1/5 | A- 7 | OUT0B | — | | (no use) | |
| | | B- 7 | OUT1B | 〃 | | 〃 | |
| | | C- 7 | OUT2B | 〃 | | 〃 | |
| | | A- 8 | OUT3B | 〃 | | 〃 | |
| | | B- 8 | IN0A | 〃 | | 〃 | |
| | | C- 8 | IN1A | 〃 | | 〃 | |
| | | A- 9 | IN2A | 〃 | | 〃 | |
| | | B- 9 | IN3A | 〃 | | 〃 | |
| | | C- 9 | IN4A | 〃 | | 〃 | |
| | | A-10 | IN5A | 〃 | | 〃 | |
| | | B-10 | IN6A | 〃 | | 〃 | |
| | | C-10 | IN7A | 〃 | | 〃 | |
| | | A-11 | (no use) | — | | | |
| | | B-11 | 〃 | 〃 | | | |
| | | C-11 | 〃 | 〃 | | | |
| | | A-12 | 〃 | 〃 | | | |
| | | B-12 | 〃 | 〃 | | | |
| | | C-12 | 〃 | 〃 | | | |
| | | A-13 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| JM17 | 2/5 | B-13 | O-GATE | In | a | Control Signal | NEXSC (EXT) |
| | | C-13 | OUT-FC2 | 〃 | 〃 | | |
| | | A-14 | OUT-FC1 | 〃 | 〃 | | |
| | | B-14 | OUT-FC0 | 〃 | 〃 | | |
| | | C-14 | OUT-*AS | 〃 | 〃 | | |
| | | A-15 | OUT-*LDS | 〃 | 〃 | | |
| | | B-15 | OUT-*UDS | 〃 | 〃 | | |
| | | C-15 | OUT-R/*W | 〃 | 〃 | | |
| | | A-16 | *O-DTACK | Out | g | | |
| | 2/5 | B-16 | OD [15] | In | a | Data Bus | NEXSC (EXT) |
| | | C-16 | 〃 [14] | 〃 | 〃 | | |
| | | A-17 | 〃 [13] | 〃 | 〃 | | |
| | | B-17 | 〃 [12] | 〃 | 〃 | | |
| | | C-17 | 〃 [11] | 〃 | 〃 | | |
| | | A-18 | 〃 [10] | 〃 | 〃 | | |
| | | B-18 | 〃 [9] | 〃 | 〃 | | |
| | | C-18 | 〃 [8] | 〃 | 〃 | | |
| | | A-19 | 〃 [7] | 〃 | 〃 | | |
| | | B-19 | 〃 [6] | 〃 | 〃 | | |
| | | C-19 | 〃 [5] | 〃 | 〃 | | |
| | | A-20 | 〃 [4] | 〃 | 〃 | | |
| | | B-20 | 〃 [3] | 〃 | 〃 | | |
| | | C-20 | 〃 [2] | 〃 | 〃 | | |
| | | A-21 | 〃 [1] | 〃 | 〃 | | |
| | | B-21 | 〃 [0] | 〃 | 〃 | | |
| | 2/5 | C-21 | OA [23] | In | a | AdressBus | NEXSC (EXT) |
| | | A-22 | 〃 [22] | 〃 | 〃 | | |
| | | B-22 | 〃 [21] | 〃 | 〃 | | |
| | | C-22 | 〃 [20] | 〃 | 〃 | | |
| | | A-23 | 〃 [19] | 〃 | 〃 | | |
| | | B-23 | 〃 [18] | 〃 | 〃 | | |
| | | C-23 | 〃 [17] | 〃 | 〃 | | |
| | | A-24 | 〃 [16] | 〃 | 〃 | | |
| | | B-24 | 〃 [15] | 〃 | 〃 | | |
| | | C-24 | 〃 [14] | 〃 | 〃 | | |
| | | A-25 | 〃 [13] | 〃 | 〃 | | |
| | | B-25 | 〃 [12] | 〃 | 〃 | | |
| | | C-25 | 〃 [11] | 〃 | 〃 | | |
| | | A-26 | 〃 [10] | 〃 | 〃 | | |
| | | B-26 | 〃 [9] | 〃 | 〃 | | |
| | | C-26 | 〃 [8] | 〃 | 〃 | | |
| | | A-27 | 〃 [7] | 〃 | 〃 | | |
| | | B-27 | 〃 [6] | 〃 | 〃 | | |
| | | C-27 | 〃 [5] | 〃 | 〃 | | |
| | | A-28 | 〃 [4] | 〃 | 〃 | | |
| | | B-28 | 〃 [3] | 〃 | 〃 | | |
| | | C-28 | 〃 [2] | 〃 | 〃 | | |
| | | A-29 | 〃 [1] | 〃 | 〃 | | |

| Connector No | Connection diagram Page | Pin No | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|
| | 2/5 | B-29 | *O-RESET | In | a | | NEXSC (EXT) |
| | | C-29 | O-CLK12 | 〃 | 〃 | | |
| | | A-30 | (no use) | — | | | |
| | | B-30 | 〃 | 〃 | | | |
| | | C-30 | 〃 | 〃 | | | |
| | 1/5 | A-31 | GND | In | | GND input | Mother Ⅱ -96 |
| | | B-31 | 〃 | 〃 | | | |
| | | C-31 | 〃 | 〃 | | | |
| | | A-32 | GND | In | | | |
| | | B-32 | 〃 | 〃 | | | |
| | | C-32 | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | LED No. | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|---|
| JM27 | 3/5 | A- 1 | LD38 | *INJ | In | k | Injector START command | DAR3000 |
| | | B- 1 | LD39 | *CSF | 〃 | 〃 | CINE camera START command | →Cable |
| | | C- 1 | LD25 | *EXPF | 〃 | 〃 | X-ray exposure command | →Mother |
| | | A- 2 | LD26 | *VDF | 〃 | 〃 | VD command for CINE camera | Ⅱ -96 |
| | | B- 2 | LD53 | *ROTATEF | 〃 | 〃 | Mechanism rotation command | J34 |
| | | C- 2 | LD51 | *RSMR | 〃 | 〃 | I.I. defocus command in RSM-DSA | →JM27 |
| | | A- 3 | — | —— | — | — | | |
| | | B- 3 | LD52 | *ACQF | In | k | Active in assembly (for VTR remote control) | |
| | | C- 3 | LD36 | *FWD | 〃 | 〃 | Bed forward-move command | |
| | | A- 4 | LD37 | *BWD | 〃 | 〃 | Bed backward-move command | |
| | | B- 4 | LD27 | *UTL052F | 〃 | 〃 | Spare input signal | |
| | | C- 4 | LD28 | *UTL062F | 〃 | 〃 | 〃 | |
| | 3/5 | A- 5 | LD21 | *KC-F | Out | m | Hand-switch ON status | →JM27 |
| | | B- 5 | LD22 | *XRF | 〃 | 〃 | X-RAY switch ON status | →Mother |
| | | C- 5 | LD24 | *SOKF | 〃 | 〃 | CINE camera synchronization OK status | Ⅱ -96 |
| | | A- 6 | LD32 | *FLUOF | 〃 | 〃 | Fluoroscopy ON status | J34 |
| | | B- 6 | LD34 | *LOCK | 〃 | 〃 | X-ray radiographic condition lock OK status | →Cable |
| | | C- 6 | LD47 | *PUL-FLUOF | 〃 | 〃 | Pulsed fluoroscopy ON status | → |
| | | A- 7 | LD49 | *ROT-POS | 〃 | 〃 | Mechanism position confirmation status in rotary DSA | DAR3000 |
| | | B- 7 | LD35 | *MAPF | 〃 | 〃 | Foot-switch for MAP ON status | |
| | | C- 7 | LD31 | *PREEXPF | 〃 | 〃 | Television blanking command before exposure | |
| | | A- 8 | LD33 | *FOOTSWONF | 〃 | 〃 | Foot-switch for fluoroscopy ON status | |
| | | B- 8 | LD23 | *CKTB | 〃 | 〃 | Bed move finish status | |
| | | C- 8 | — | (no use) | — | — | | |
| | | A- 9 | 〃 | 〃 | 〃 | 〃 | | |
| | | B- 9 | 〃 | 〃 | 〃 | 〃 | | |
| | | C- 9 | 〃 | 〃 | 〃 | 〃 | | |
| | 5/5 | A-10 | LD69 | FT-XR2 | In | l | Foot-switch for radiography ON status | |
| | | B-10 | — | (no use) | — | — | | |
| | | C-10 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-11 | 〃 | 〃 | 〃 | 〃 | | |
| | 5/5 | B-11 | LD66 | POS2 | In | l | Mechanism position confirmation status | TERMINAL Ⅱ -96→ |
| | | C-11 | — | TRY-I | | | | |
| | | A-12 | — | (no use) | — | — | | |
| | | B-12 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-12 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-13 | 〃 | 〃 | 〃 | 〃 | | |
| | | B-13 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-13 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-14 | 〃 | 〃 | 〃 | 〃 | | |
| | | B-14 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-14 | 〃 | 〃 | 〃 | 〃 | | |

| Connector No | Connection diagram Page | Pin No | LED No. | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|---|
| JM27 | | A-26 | — | (no use) | — | — | | |
| | | B-26 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-26 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-27 | — | 〃 | — | — | | |
| | 5/5 | B-27 | LD81 | INJ-CN2 | In | b | Signal during injection from injector | INJ→ |
| | | C-27 | LD82 | STAND-BY2 | 〃 | 〃 | Standby signal from injector | |
| | 5/5 | A-28 | LD74 | HAND-OFF2 | Out | p | Output signal to select invalid | →INJ |
| | | B-28 | — | HAND-OFF1 | 〃 | 〃 | injector hand-switch (unused) | |
| | | C-28 | LD75 | RMT-OFF2 | Out | 〃 | Output signal to select invalid injector remote control (unused) | →INJ |
| | | A-29 | LD86 | INJ-ST2 | Out | p | Start signal to injector | →INJ |
| | | B-29 | — | INJ-ST1 | 〃 | 〃 | | |
| | | C-29 | LD80 | XR-ST2 | In | b | Changer start signal from injector | INJ→ |
| | | A-30 | — | (no use) | — | — | | |
| | | B-30 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-30 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-31 | — | GND | In | — | GND input | |
| | | B-31 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-31 | 〃 | 〃 | 〃 | 〃 | | |
| | | A-32 | 〃 | 〃 | 〃 | 〃 | | |
| | | B-32 | 〃 | 〃 | 〃 | 〃 | | |
| | | C-32 | 〃 | 〃 | 〃 | 〃 | | |

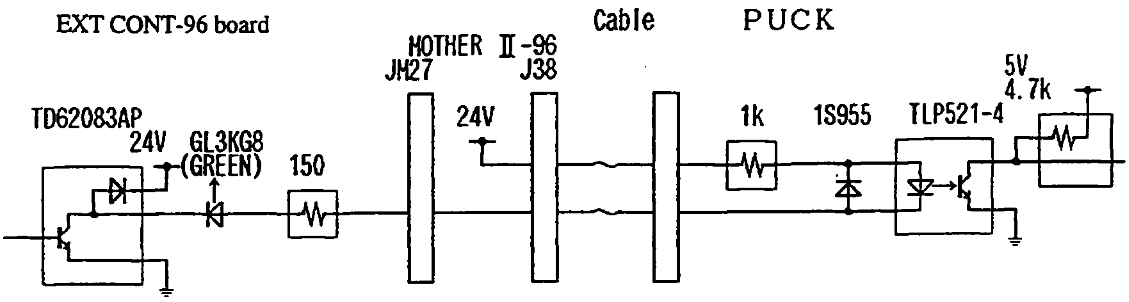
| Connector No | Connection diagram Page | Pin No | LED No. | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|---|
| J125 | 3/5 | B-15 | LD10 | *CA2 | In | l | X-RAY ON input signal to CINE camera device | →CINE |
| | 1/5 | A-16 | — | *XR8 | 〃 | t | 〃 | 〃 |
| | | B-16 | | (no use) | — | | | |
| | 3/5 | A-17 | LD6 | *CM4 | Out | n | CINE camera exposure signal (unused) | |
| | | B-17 | | 0V | 〃 | 〃 | 0 V for CM4 (unused) | |
| | | A-18 | LD20 | FOOT2 | Out | n | Foot-switch output signal | EMC-96 |
| | | B-18 | | (no use) | | | | |
| | | A-19 | | GND | In | | GND input | |
| | | B-19 | | 〃 | 〃 | | | |
| | | A-20 | | 〃 | 〃 | | | |
| | | B-20 | | 〃 | 〃 | | | |

| Connector No | Connection diagram Page | Pin No | LED No. | Designation | In / Out | Circuit | Significance | Destination |
|---|---|---|---|---|---|---|---|---|
| J129 | 1/5 | A-16 | — | *XR8 | Out | t | X-RAY ON output signal to CINE camera device | →CINE |
| | | B-16 | 〃 | *XR10 | — | 〃 | 〃 | |
| | | A-17 | — | (no use) | — | | | |
| | | B-17 | 〃 | 〃 | 〃 | | | |
| | 3/5 | A-18 | LD30 | *ROT | Out | m | Mechanism rotation command output from DSA device | →MH |
| | 5/5 | B-18 | LD16 | *EIN | Out | m | Stereo DSA selection signal output to STA-30 device (ST-DSA output signal) | →STA-30 |
| | 1/5 | A-19 | — | (*RMT) | — | | (Unused) | →STA-30 |
| | 5/5 | B-19 | LD29 | *MON | Out | m | Monaural radiography selection signal output to STA-30 device | →STA-30 |
| | | A-20 | — | EXS-2F | Out | m | X-RAY ON signal output to STA-30 device | →STA-30 |
| | | B-20 | LD15 | EXS-1F | 〃 | 〃 | 〃 | |
| | 4/5 | A-21 | LD71 | DST2-F | In | l | Stereo acknowledge signal input from STA-30 device | STA-30→ |
| | | B-21 | — | (CU2F) | — | | (Unused) | STA-30→ |
| | 5/5 | A-22 | LD13 | *FLL | Out | m | Sub-focus fluoroscopy selection signal output to STA-30 device | →STA-30 |
| | | B-22 | LD14 | *MOL | 〃 | 〃 | Sub-focus fluoroscopy selection signal output to STA-30 device (in adjustment) | →STA-30 |
| | | A-23 | — | UNSH1 | Out | m | RSM-DSA selection output signal | |
| | | B-23 | LD46 | UNSH2 | 〃 | 〃 | 〃 | |
| | | A-24 | | GND | Out | | GND output | → TERMINAL Ⅱ-96 |
| | | B-24 | | 〃 | 〃 | | | |
| | | A-25 | | 〃 | 〃 | | | |
| | | B-25 | | 〃 | 〃 | | | |

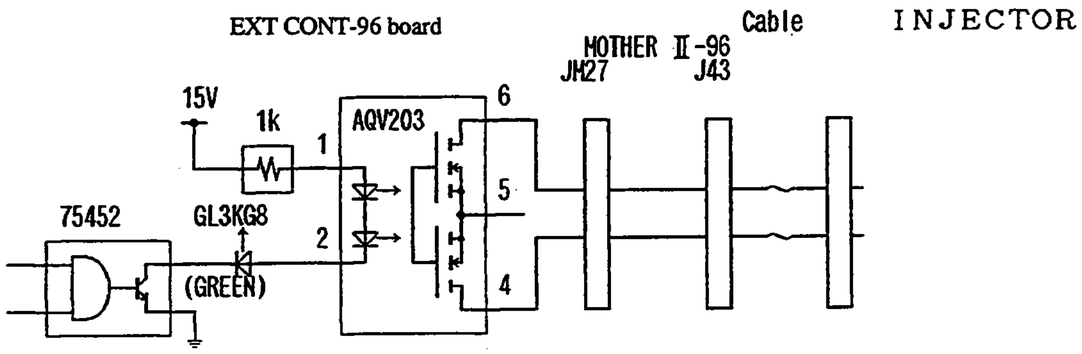


107

(o) Output circuit [No. 7] {transistor to current-loop (24 V) drive output circuit}




(p) Output circuit [No. 8] {PHOTO-MOS relay drive output circuit}






108