AUTOMATION EQUIPMENT FOR TRANSMITTING STATIONS

EDITED

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1. Automation Systems

1.1 Definition and Adaptability of Automation

The definition of automation in a narrow sense is automatic control of operation in compliance with preset schedules or set values. But here, we shall treat this as reduction of control and monitoring work or centralization of operation work for operation of facilities.

When automating transmitter facilities, prevention of deterioration of service due to automation is of utmost necessity. As unmanned operation is a general practice particularly for automation of transmitting stations, it will be necessary to provide substitute equipment and spare equipment against breakdowns and ease of maintenance work.

1.2 Automation Systems

(1) Control and Supervision Systems

Automation systems can be divided into the following.

- Control system
  - Remote control system
  - Automatic control system
- Supervision system
  - Remote supervision system
  - Automatic supervision system

In addition, they may be further subdivided into various systems as follows. The combination of automatic systems to use may be decided by the scale of the facility, the condition of operation and economic factors. It will also be necessary to pay attention to legal restrictions.

As service to a great number of unspecified listeners is the objective of broadcasting, it is necessary for the broadcast-int station itself to obtain necessary information to secure its operation. For instance, a feedback loop in Fig. 1.1 is effective.

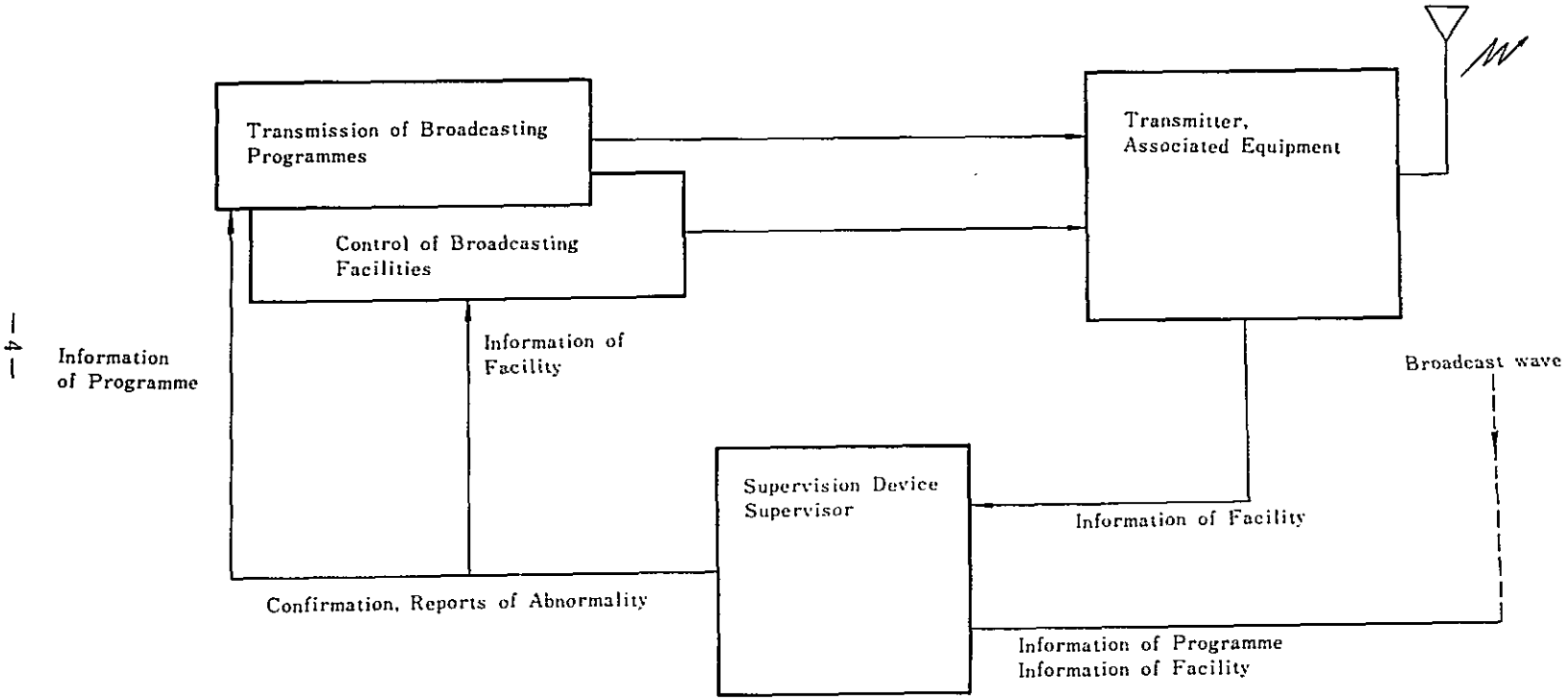


Fig. 1.1 Flow chart of Broodcasting Stations

If we merely consider a control and supervision system for facilities, it may be roughly divided into (1) a remote control loop (e.g. radio rebroadcasting station) involving remote operation by an attendant and (2) an automatic control loop utilizing an automatic detector circuit (e.g. TV rebroadcasting station). Fig. 1.2 shows an example of these two systems combined.

(2) Control Systems

(a) Remote control system

This is a system controlled by operators at the master station or at the studio site. There are various remote control systems according to the method of transmission of control signals and the number of control items.

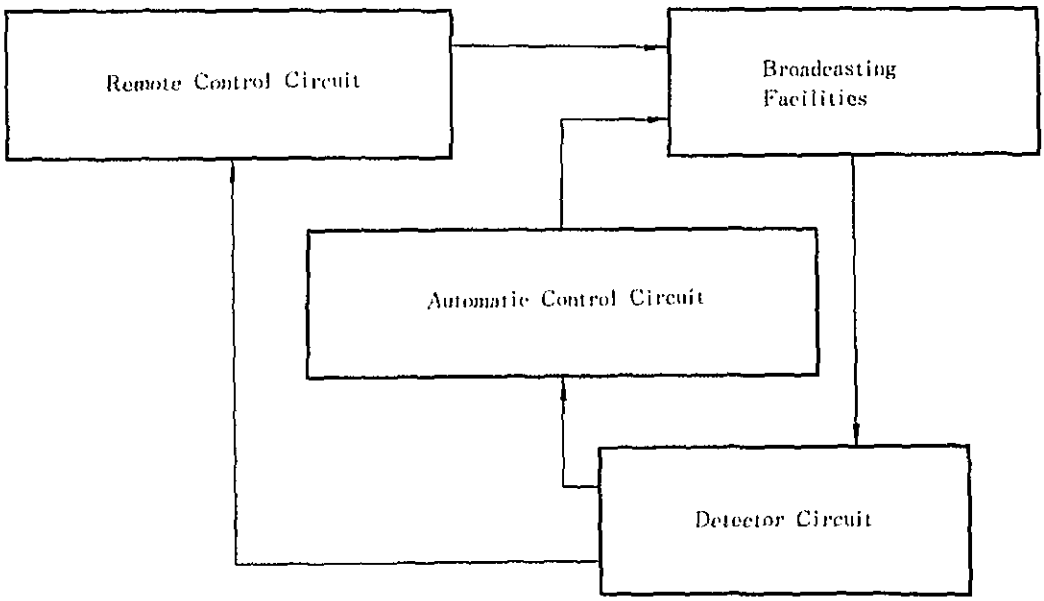


Fig. 1.2 Flow chart of Control Systems

(b) Automatic control system

This system is generally referred to automatic control at transmitting stations but there is a method of automatically controlling the transmitter station from the studio site by detecting the information sent to the studio

site from the transmitter station. A practical example of items controlled is shown in table 1.1.

Table 1.1 Control System

Items Controlled	System	Device of Detector Circuit	Practical Examples
Start, Stop	Clock Control	Relay Clock	Radio Transmitter Station
	Carrier Reception Control	Input Detector Relay	TV Translater Station
	Carrier Failure, Detection of Power Reduction	Carrier Failure, Power Reduction Detector Relay	TV Transmitter Station
Changeover of Trans-mitters	Comparison of Programme Input and Output Signal	Automatic Monitor	Radio Transmitter Station
	Comparison of Input and Output of Synchronous Signal	Synchronous Signal Automatic Monitor	TV Transmitter Station
	Non-modulation Detection	Non-modulation Alarm Device	
	Comparison of Input and output Detection	Input and Output Detector Relay	TV Translater Station
Changeover of Programmes	Comparison of Programme Input	Automatic Monitor	
	Detection of Programme Input	Non-modulation Alarm Device	
	Comparison of Input of Synchronous Signal	Synchronous Signal Automatic Monitor	
	Detection of Input of Synchro-nous Signal	Synchronous Signal Detector Relay	
	Detection of Radio Circuit Squelch	Squelch Relay	Stations using Radio Relay Circuits
Switchover of Power Sources	Detection of Voltage of City Power	Low Voltage Relay	Each Station

(3) Supervision Systems

(a) Radio-wave reception system

This is a supervision system which receives the radio-wave directly. The items shown in Table 1.2 can be supervised.

Table 1.2 Supervision System of Reception of Radio Wave

Items Supervised	Device of Detector Circuit
Antenna Power	Carrier Wave Strength Indicator
Condition of Modulation	Detector Output Monitor of Carrier (Audio, Video) CRT Oscilloscope
Sound Quality, Picture Quality	Detector Output Monitor of Carrier
Troubles	Non-modulation Alarm Devices related to the above Devices, Automatic Monitor Devices

(b) Remote supervision system

A radio-wave reception supervision system is to check whether the broadcast-wave is normal or abnormal, but this remote supervision system is to indicate the normalty or abnormalty in operation of the facilities.

The following items are indicated and certain ones of them are alarmed.

1) Indication of usage of transmitter, indication of trouble.
2) Indication of usage of relay-route, indication of trouble.
3) Indicat on of usage of commercial power or engine generator, indication of trouble.

4) Indication of mode of control (manual, remote, automatic)
5) Confirmation of remote control
6) Fire alarms
7) Station-door open, alarm

2. Examples of Automation of Transmitting Stations.

2.1 For 1 to 10 kW Radio Transmitter Stations (Unmanned)

When separating the transmitters from the studio site, an automatic unmanned transmitting station is usually built, and a subsitute transmitter is provided in common use for the two network transmitters.

The number of programme transmission lines for 1 to 5 kW class stations is 4 lines (2 for programmes, 2 for control and supervision), and for 10 kW class stations; 2 lines of UHF triplex FM-STL, respectively for programmes, control and telephone and as a spare programme line. A VHF STL is used for communication of supervision.

As for the control of facilities, automatic control and remote control is combined. Items of automatic control are such as changeover of transmitters by means of automatic monitor; start and stop of transmitter by means of relay clock; start and stop of engine generator and switchover of power-lines and changeover of STL by means of squelch relay. The remote control system is used only on a supplementary basis.

Supervision is carried out at the studio site by a supervision receiver device, and items such as antenna power, audio qualit degree of modulation and failure of carrier are supervised. The condition of transmitters, occurance of abnormalities in equipment are indicated through the remote supervision and control device.

2.2 Television Transmitting Stations (Unmanned)

This is an example of conversion of manned television transmitting station built apart from the studio site into unmanned automatic operation. A substitute transmitter is provided for each General and Educational network transmitters, and a combination of remote control from studio site and automatic control of transmitting facilities are both being used.

(1) Control System

When trouble occurs in automatic control of transmitter station from studio site, the automatic control system at transmitter station will be automatically applied.

(a) Items of remote control

1) Start, stop of No. 1 transmitter (video, audio)
2) Start, stop of No. 2 transmitter (video, audio)
3) Selection of video input programme.
4) Start, stop of engine generator.
5) Switchover between incoming power and generator power.
6) Switchover of control mode, retransmission of indication of restoration of automatic monitor, stop of alarm.

(b) Items of automatic control at transmitter stations

1) Start, stop of transmitter
   Carried out by detection of 15 kHz synchronous signal in output of microwave STL and output of radio relay receiver.
2) Changeover of No. 1 and No. 2 transmitter.
   According to detection of automatic monitor output.
3) Switchover of video input
   Carried out by detection of 15 kHz synchronous output signal of No. 1 and No. 2 microwave STL.

4) Start, stop of engine generator
5) Switchover between incoming power and engine generator power.
6) Start of automatic fire extinguisher

(2) Supervision System

Supervision is provided at studio site by reception of radio-wave, and remote supervision device. The former is to supervise the broadcast-wave and programme contents while the latter is to supervise the operational condition of each equipment, as in the case of radio transmitting stations.

3. Remote Supervision and Control Systems

Various remote control and supervision systems are considered; according to the way of application, items to control, items to supervise and condition of the transmission path. In the following, the composition and principles of typical examples of remote control and supervision systems currently used at NHK is explained in brief.

3.1 RSC (Remote Supervision and Control) Type

The remote control device and remote supervision device is combined in one unit and employs an exclusive transmission line. The items of control and supervision are comparatively large in number and are used for operation of NHK's unmanned radio and television transmitting stations constructed since 1960.

It is provided with control switches, indication lamps and alarm buzzers, respectively for each item of remote control and supervision. They are all contained in a graphic panel indicating the networks, for ease of operation and supervision work.

(1) Control System

A parity check pulse-code which is a kind of self-check code is adopted.

The parity check pulse code system uses 2 frequencies f_1 and f_2, as shown in Fig. 3.1, and in addition to the pulse code for selection of items, a self check pulse is added. In other words, it if there are 5 pulses for selection of items, it will be possible to create 32 codes ($2^5 = 32$), by combination of f_1 and f_2. If f_2 of these 5 pulses is an odd number, and if it is an even number, f_1 and f_2 will be respectively added as the 6th pulse of self-check. Therefore, the total number of f_2 of these 6 pulses will always be an odd number.

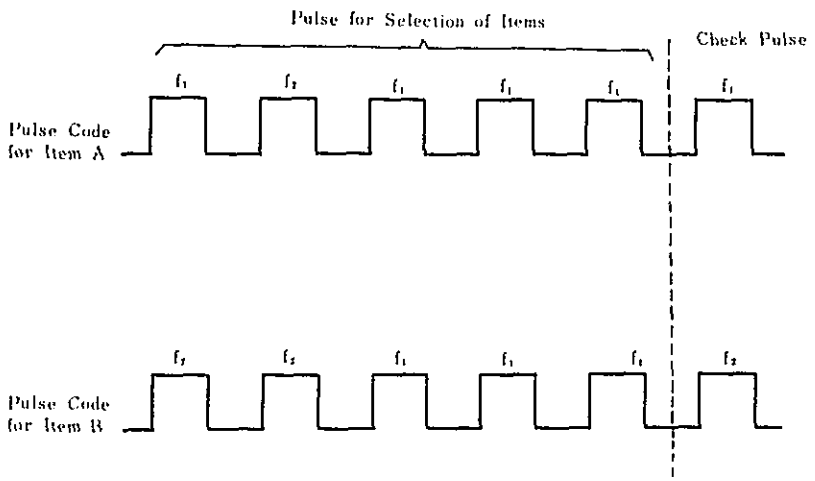


Fig. 3.1 Composition of Pulse of Control Signal

At the receiving side, the total pulses sent will be calculated, and further, the number of f_2 pulses in it will be counted to see that it is always an odd number. This is to detect errors and the 'even and odd number' check is called the "parity check".

The logical circuit is divided into a matrix panel; a control transmission panel and a control receiver panel as shown in Fig. 3.2.

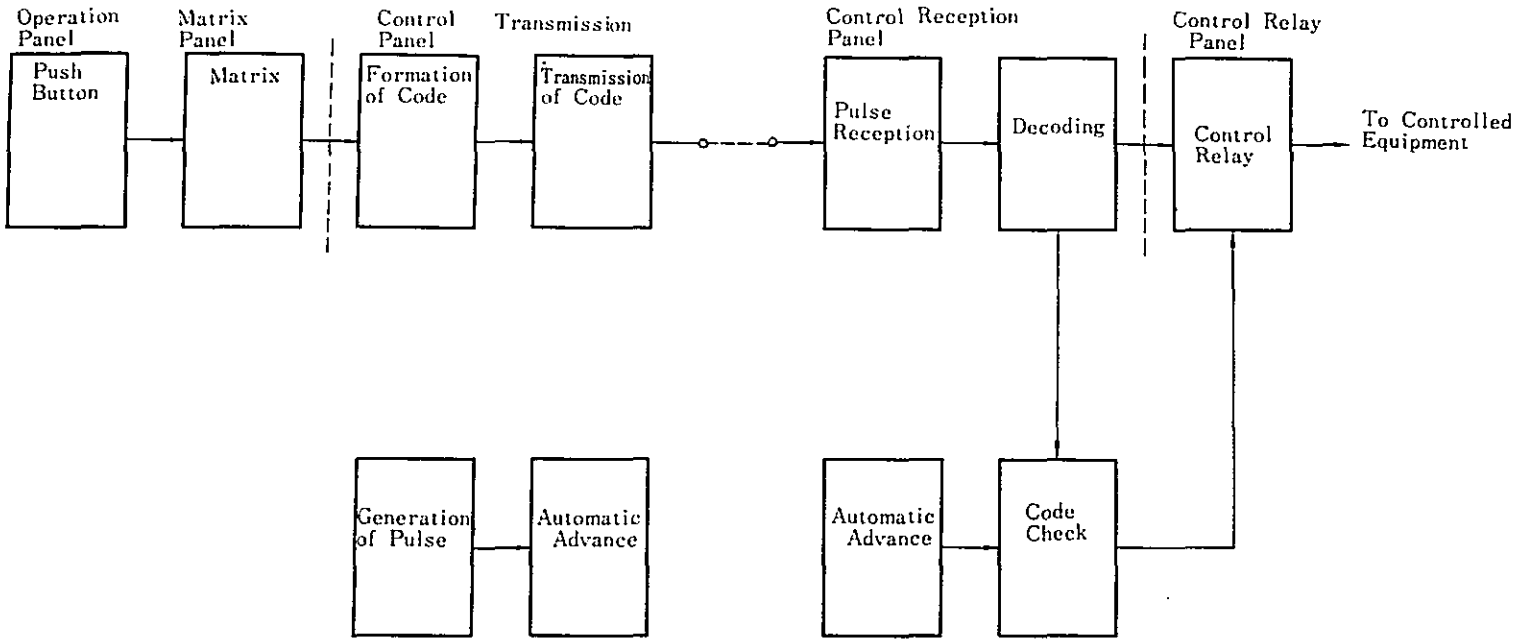


Fig. 3.2 Logic Circuit Flow of Remote Control

(a) Matrix Panel

As shown in Fig. 3.3, silicon diodes are arranged in form of matrix, and a code corresponding to the control item is made by depressing the operation button. That is, of the relays X_1 to X_6, the relay connected by the diode will become signal f_2 according to the pulse transmission circuit and the relay not connected to the diode will become signal f_1.

(b) Control Transmission Panel

With the formation of codes by the matrix panel, pulses will be developed in the pulse generator circuit simultaneously, and become 6 pulses by the automatic stepper circuit and it will apply f_1 and f_2 FS (Frequency Sghift) modulation to the oscillator of the signal transmission circuit. In the operation of the FS system, the oscillator will oscillate at f_o - 35 Hz when the relay contact of the transmission side is in OFF position, and when it is in the ON position, that is, when either relay of D_1 or D_2 functions, a frequency shift of 70 Hz will develop and the oscillation will become f_o + 35 Hz.

A spare channel is also provided which will be used when trouble occurs in one of the operation channels. The channel will be automatically switched over to it at the reception side.

(c) Control Reception Panel

At the reception side, after separation of telephone communication signal from the FS transmission signal by use of reception band-pass filter, each f_1, f_2, f_3, channels is limitation-amplified and frequency discriminated, and converted into each F_1 and F_2 control signals and then decoded by means of just about the same logic circuit as for the control side.

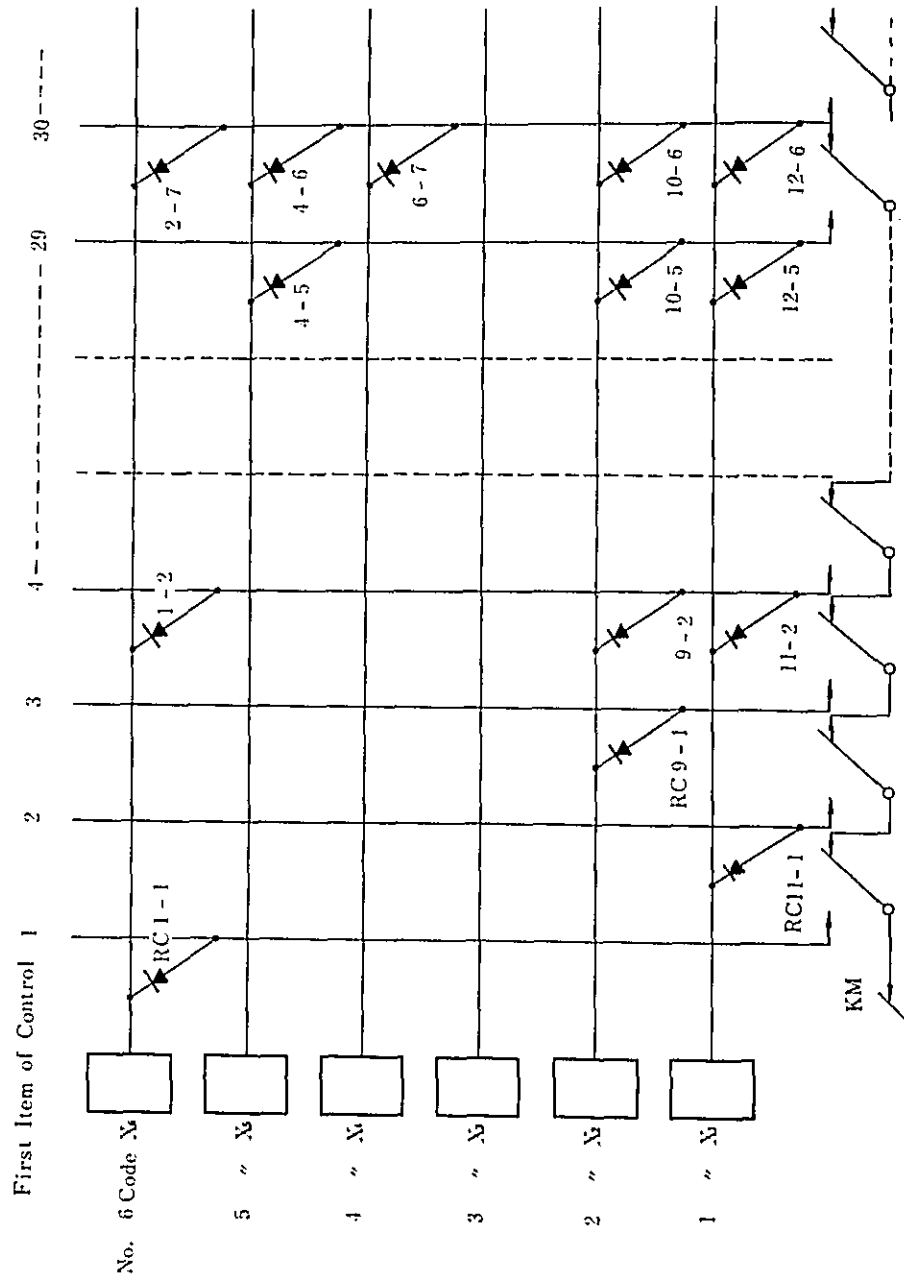


Fig. 3.3 Diode Matrix Circuit

(2) Display System

A synchronized stepper system using 2 frequencies is employed for the following reasons.

(a) It is slightly lower in accuracy as compared to the control system, but can be compensated by supervision of radio waves. It can be displayed for a number of times.

(b) As the number of items to display is great, it is preferable to simplify the circuit construction by reducing the number of logic elements from the standpoint of ease of maintenance and economy.

(c) The time requested for display is rather long, but this is not a serious drawback as in the case of control. A logic circuit flow chart of the display system is shown in Fig. 3.4 and the pulse composition of the display signal is shown in Fig. 3.5.

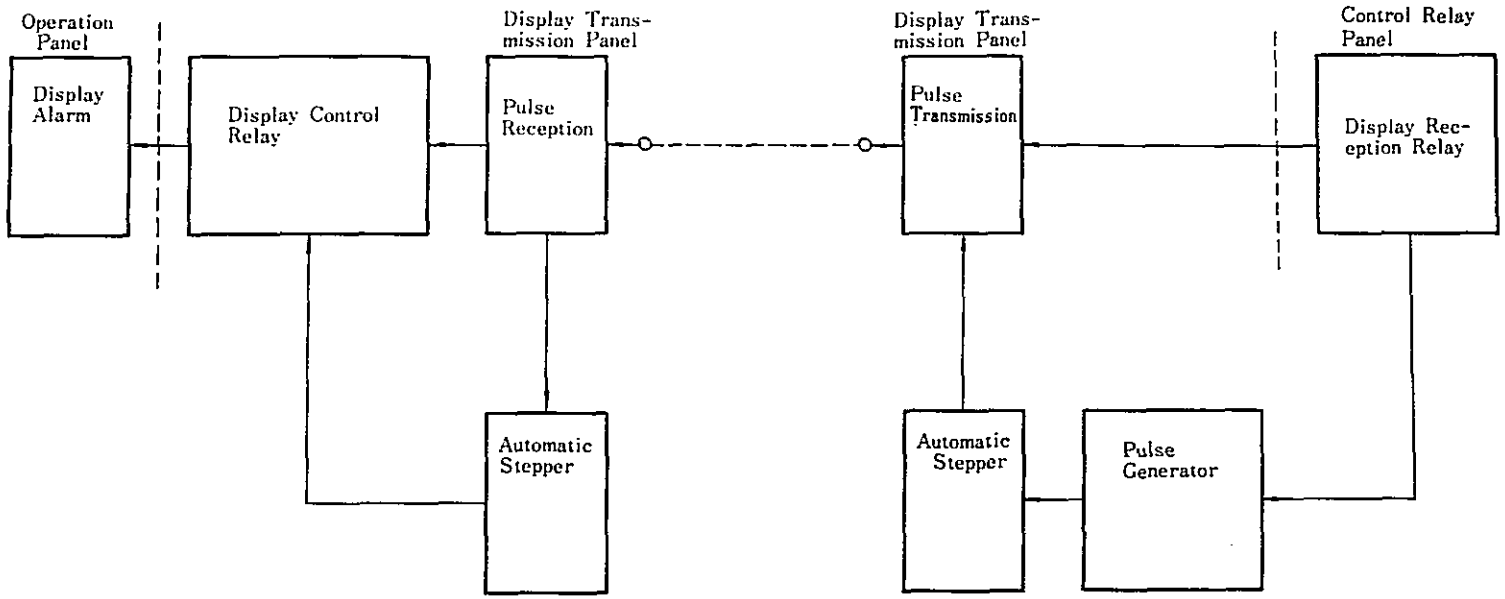


Fig. 3.4 Logic Circuit Flow Chart of Remote Display

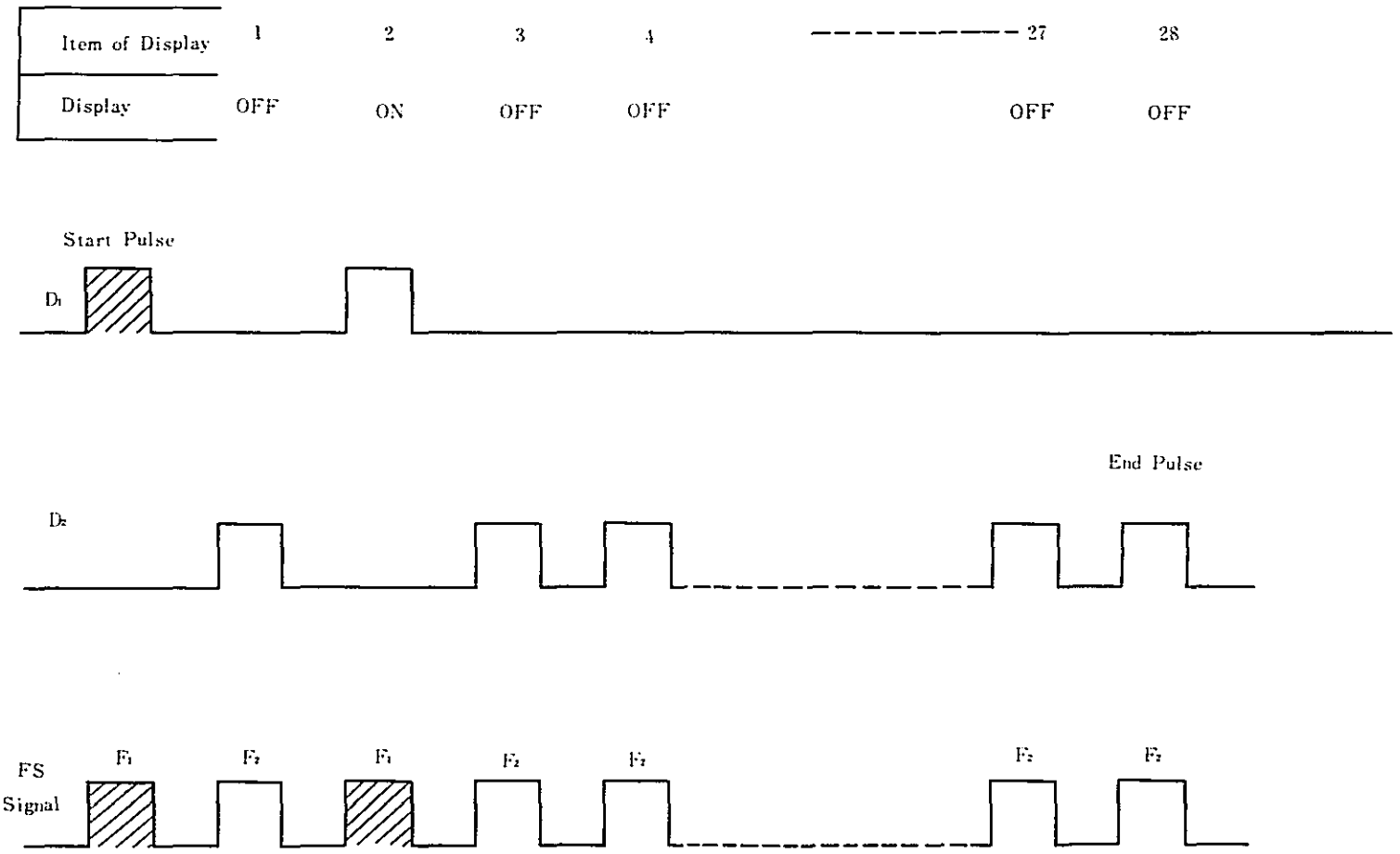


Fig. 3.5 Composition of Pulse of Display Signal

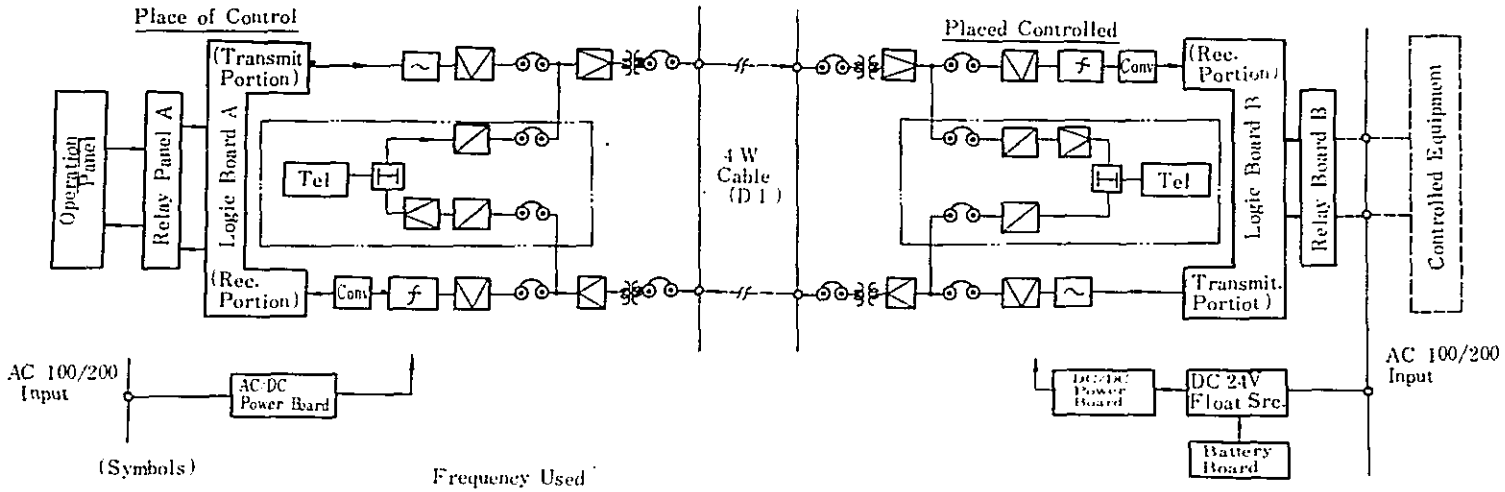
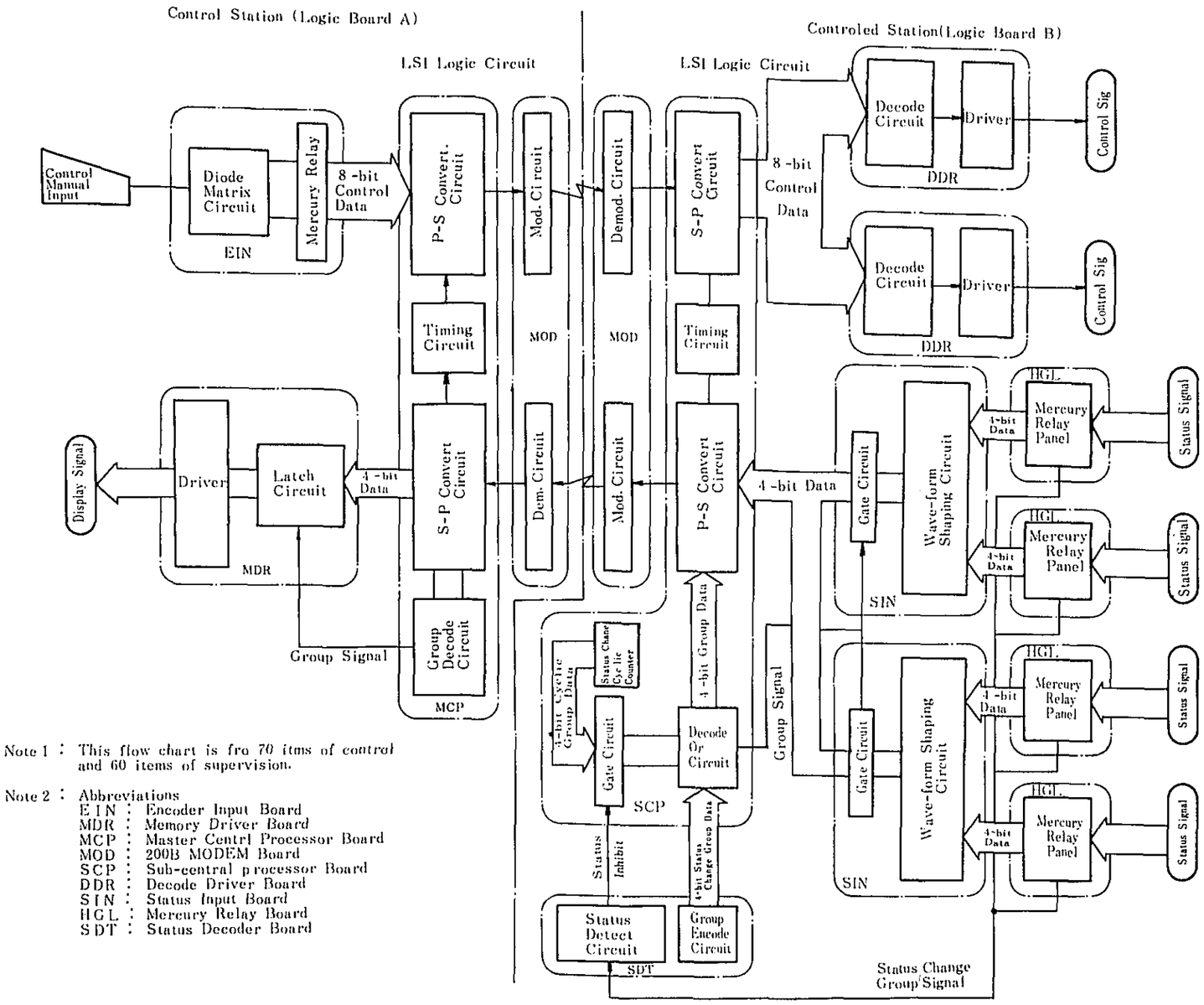


Fig. 3.6 Block Diagram of Type WR-72 Remote Supervision and Control System



Note 1 : This flow chart is fro 70 itms of control and 60 items of supervision.

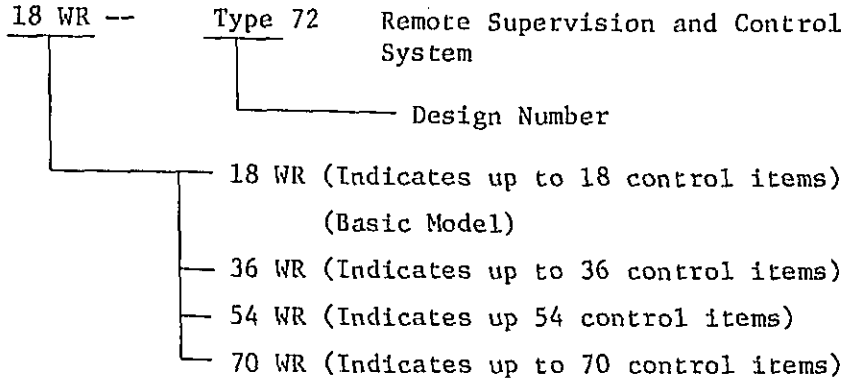
Note 2 : Abbreviations
EIN : Encoder Input Board
MDR : Memory Driver Board
MCP : Master Centrl Processor Board
MOD : 200B MODEM Board
SCP : Sub-central processor Board
DDR : Decode Driver Board
SIN : Status Input Board
HGL : Mercury Relay Board
SDT : Status Decoder Board

Fig. 3.7 Logic Flow chart of Type WR-72 Remote Supervision and Control System

3.2 WR Type

As the newly produced remote supervision control systems are of the type WR, we shall explain this system a little bit more in detail.

3.2.1 Nomenclature of the Systems



3.2.2 Explanation of System

Refer to Fig. 3.6 for the system flow chart and to Fig. 3.7 for the logic flow chart. For controlling, the contact signals from the key on the "operation panel" at the place of control are applied to the "diode matrix" (incorporated in logic board A) through "relay panel ".

At the matrix, it is converted into 8C4 codes (4 of the 8 bits to be mark bits) by means of the matrix and form control codes for maximum of 70 control items.

After applying this control code to the "LSI logic circuit" of the "logic board A"; for P-S conversion (convert parallel signals into series signals), and create a series of pulse tones of "1" for mark bits and "0" for space bits corresponding to the input information, it is fed to the "signal transmission circuit section" (modulation circuit).

The carrier signal is modulated with the pulse codes by the modulation circuit and sent to the place controlled in the form of FM (FS) signals.

of FM (FS) signals.

Upon demodulating the FM signal by the "signal transmission circuit" (demodulation circuit) at the place controlled, error-check is carried out at the "LSI type logic circuit" and, if found normal, will send codes to "relay board B" corresponding to the push buttons on the "operating panel". These codes are converted to relay contact signals in "relay board B" and sent as control output to the controlled devices.

The contact information sent to the controlled devices may be either in the form of pulse control (approx. 100ms) or continuous control.

In connection with supervision, the display acceptor relay of "relay board B" receives status change information of the monitored devices in the form of contact signals. (receives when ON contacts closes)

This display acceptor relay is provided with relays equal in number to the items of supervision and when the relay is ON, it will be mark bit "1" and when OFF it will be space bit "0".

Contact signals corresponding to the operation of the display acceptor relay are fed in a parallel form to the "LSI type logic circuit". After carrying out P - S conversion here, same as that in control, it is fed to the "signal transmission circuit" and sent to the place of control in the form of FM signals. At the place of control, these signals are restored to pulse codes in the demodulation circuit and then fed to the logic circuit. S - P conversion (conversion from series to parallel) is carried out by the logic circuit and, after making error checks, these pulses operate the display relays concerned on "relay board A". The display lamp is then lit by means of the display relay contact. Alarms may be provided when necessary. Next, the power supply for the equipment at both control and controlled places will have an AC input. At the place controlled, however, a 24V DC floated power supply will be

provided after the AC input to ensure uninterrupted operation in the event of power failures.

3.2.3 Construction

The construction of this system is as shown in Fig. 3.8.

1. Controlling Side

   (1) Control Terminal Panel
   - (a) No.4 Rack (BTS)
   - (b) Logic Board A
   - (c) Relay Board A
   - (d) AC-DC Power Supply Board
   - (e) Operating Panel
   - (f) Telephone Board

2. Controlled Side

   (2) Controlled Terminal Panel
   - (a) No.4 Rack (BTS)
   - (b) Logic Board B
   - (c) Relay Board B
   - (d) DC-DC Power Supply Board
   - (e) 24V DC Floating Power Supply
   - (f) Telephone Board

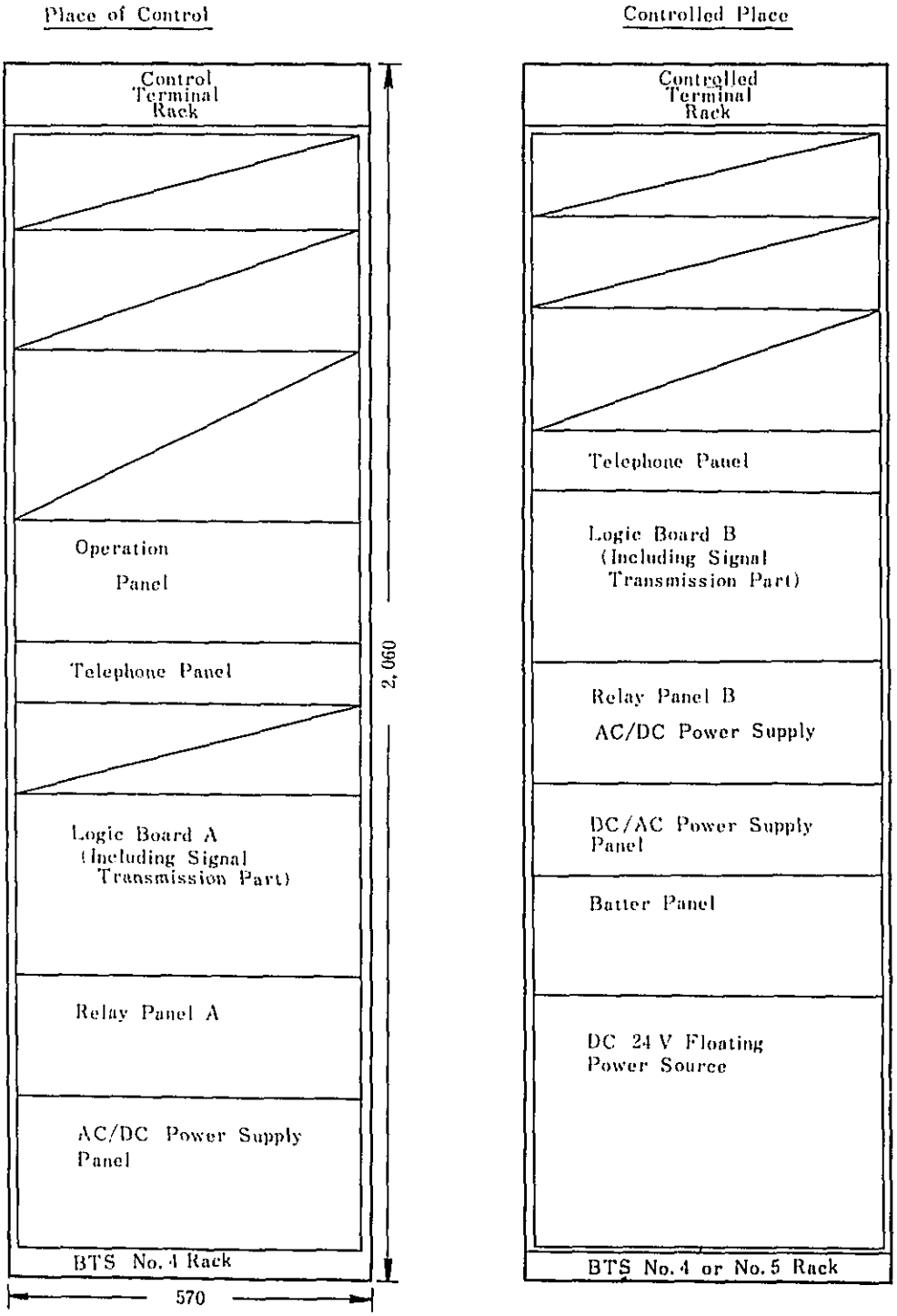


Fig. 3.8 Structure of Type WR-72 Remote Supervision and Control Device

3.2.4 Rating and Stability

1. Rating

(1) System: Code system by means of long codes such as NRZ

(2) Check System: Dual transmission check. Parity check and fixed mark check (8C4)

(3) Transmission System: Modulation System - FM (FS) System
Transmission Speed - 200BPS
Transmission Frequency

Control	2800 ± 100 Hz
Supervision	2400 ± 100 Hz
Telephone	300 to 2000 Hz

(4) Communication Circuit: 1 Circuit cable 4-wire system (D-1) or a radio circuit

(5) Circuit Impedance: 600Ω balanced

(6) Unused Outgoing Level

If P (dBm) is the outgoing level in the prescribed band, the unused outgoing level outside the prescribed frequency band (300 - 3400 Hz) shall be as follows.

(a) Under P-20dB from 4 kHz to 8 kHz

(b) Under P-40dB from 8 kHz to 12 kHz

(c) Under P-60dB for each 4 kHz band above 12 kHz.

(7) Number of Control Items: 18 (Basic form)

(8) Number of Supervisory Items: 16 (Basic form)

(9) Telemeter Items: None

(10) Outgoing Signal Level

0 to -30dBm (adjustable in 1dB steps)

(11) Receiving Signal Level

0 to -30dBm (Adjustable in 1dB steps)

(12) Level Margin ± 10 dBm

(13) Operating Time

Control: Final control relay in the controlled device to operate within 0.3 seconds after depressing the push button on the operating panel.

Supervision: Display lamp at the place of control to lie within 0.3 seconds after the display acceptor relay goes on due to change in status of the controlled device.

(14) Power Supply

Controlling Side: 100V AC ±10%, 1ϕ 50/60 Hz

Controlled Side : 100V AC ±10%, 1ϕ 50/60 Hz

(24V DC floating power supply provided in the equipment)

(15) Surrounding Conditions

Temperature: -10°C to 40°C

Humidity : 40% to 90%

(16) Use Continuous

2. Stability

(1) Power Supply Fluctuations: 100V AC ±10%

(2) Circuit Noise: S/N Over 30dB

(3) Frequency Drifting: Within ±5 Hz

(4) Surrounding Conditions: Surroundings indicated in the ratings

3.2.5 Functions

Control and supervisory items for a high power radio broadcasting station and an example of an operating panel are shown in Table 3.1 and Fig. 3.9 respectively, and those for a television broadcasting station are shown in Table 3.2 and Fig. 3.10.

Table 3.1 Items of Control and Supervision at High Power Radio Transmitting Stations (500 kW)

(1) Items of Control

No.	Contents	Indication of Switch	Remarks
1	Start of transmitter	Transmitter ON at non-broadcast hours	Continous make output
2	Stop of transmitter	Transmitter OFF	"
3	Independent operation of No.1 transmitter	No.1 transmitter independent	Pulse make output
4	Independent operation of No.2 transmitter	No.2 transmitter independent	"
5	Parallel operation of transmitters	Parallel operation	"
6	Use of STL No.1	STL-1	"
7	Use of STL No.2	STL-2	"
8	Start of emergency engine generator	Generator start	By response signals
9	Stop of emergency engine generator	Generator stop	Pulse make output
10	Use of emergency engine generator	Generator operation	By response signals
11	Use of incoming power	Incoming power	"
12	Reset of display	Display reset	
13	Stop of alarm	Alarm stop	
14	Test of lamp	Lamp test	
15	ON, OFF of lamp	Lamp OFF	

(2) Items of Supervision

No.	Contents	Indication of Display	Buzzer	Lamp Colour
1	Abnormality in control	Control abnormal	o	R
2	Open of control circuit	Control circuit	o	R
3	Abnormality in No.1 STL	Abnormal	o	R
4	Abnormality in No.2 STL	Abnormal	o	R
5	Trouble in No.1 transmitter	Trouble	o	R
6	Independent operation of No.1 transmitter	No.1 transmitter independent operation		G
7	Trouble in No.2 transmitter	Trouble	o	R
8	Independent operation of No.2 transmitter	No.2 transmitter independent operation		G
9	Trouble of associated equipment	Associated equipment trouble	o	R
10	Trouble in cooling system of transmitter	Cooling system trouble	o	R
11	Abnormality in transmitter output power	Abnormal output	o	R
12	Abnormality in paralle operation	Abnormal parallel operation	o	R
13	Stop of emergency power generator	Generator Start/ Stop		G/W
14	Use of engine generator/use of incoming power	Generator/Incoming power		G/W
15	Serious trouble in engine generator	Serious trouble	o	R
16	Simple trouble in generator	Simple trouble	o	R

No.	Contents	Indication of Display	Buzzer	Lamp Colour
17	Abnormality in incoming power/normal	Abnormal/normal, incoming power	o	R/W
18	Failure of power	Failure	o	R
19	Abnormality in power plant	Abnormal power plant	o	R
20	Use of STL No.1/No.2	STL-1/STL-2		W/W
21	Start of transmitter No.1	ON		W
22	HT of No.1 transmitter ON	HT		W
23	Start of transmitter No.2	ON		W
24	HT of No.2 transmitter ON	HT		W
25	Parallel operation of transmitters	Parallel operation		W
26	Manual control of transmitting station	Transmitting station manual		R
27	Abnormality of control response	Response abnormal	o	R
28	Open of station building door	Door open	o	R
29	Fire	Fire	o	R
30	Transmitter operating at non-broadcast hours	Transmitter ON at non-broadcast hours		G
31	OLR of No.1 transmitter	1 - OLR	o	R
32	OLR of No.2 transmitter	2 - OLR	o	R
33	Abnormality in No.1 Osc.	OSC - 1	o	R
34	Abnormality in No.2 Osc.	OSC - 2	o	R
35	Abnormality in display circuit	Display circuit	o	R
36	Rest of display	Display reset		W

No.	Contents	Indication of Display	Buzzer	Lamp Colour
37	Test of lamps	Lamp test		W
38	Abnormality in displa	Display abnormal	o	R

Table 3.2 Items of Control and Supervision at General TV Transmitting Station (The same for Educational TV)

(1) Items of Control

No.	Contents	Indication of Switch	Remarks
1	Control, Remote/ Automatic	Remote/Automatic	Ratchet operates
2	Changeover of Terminal Device No.3/No.1.2	No.3 Terminal Device	"
3	Start of No.1 Transmitter	No.1 Transmitter ON	Pulse make output
4	Stop of No.1 Transmitter	No.1 Transmitter OFF	"
5	Start of No.2 Transmitter	No.2 Transmitter ON	"
6	Stop of No.2 Transmitter	No.2 Transmitter OFF	"
7	Start/Stop at non-broadcast hours	ON/OFF at non-broadcast hours	Continous make out put
8	Clamp of AC/DC	Clamp AC/ Clamp DC	"
9	Start of Engine Generator	Engine Generator ON	
10	Stop of Engine Generator	Engine Generator OFF	
11	Use of Incoming Power	Incoming Power	
12	Use of Engine Generator	Engine Generator	
13	Retransmission of Response	Re-response	Ratchet operates
14	Restoration	Restoration	

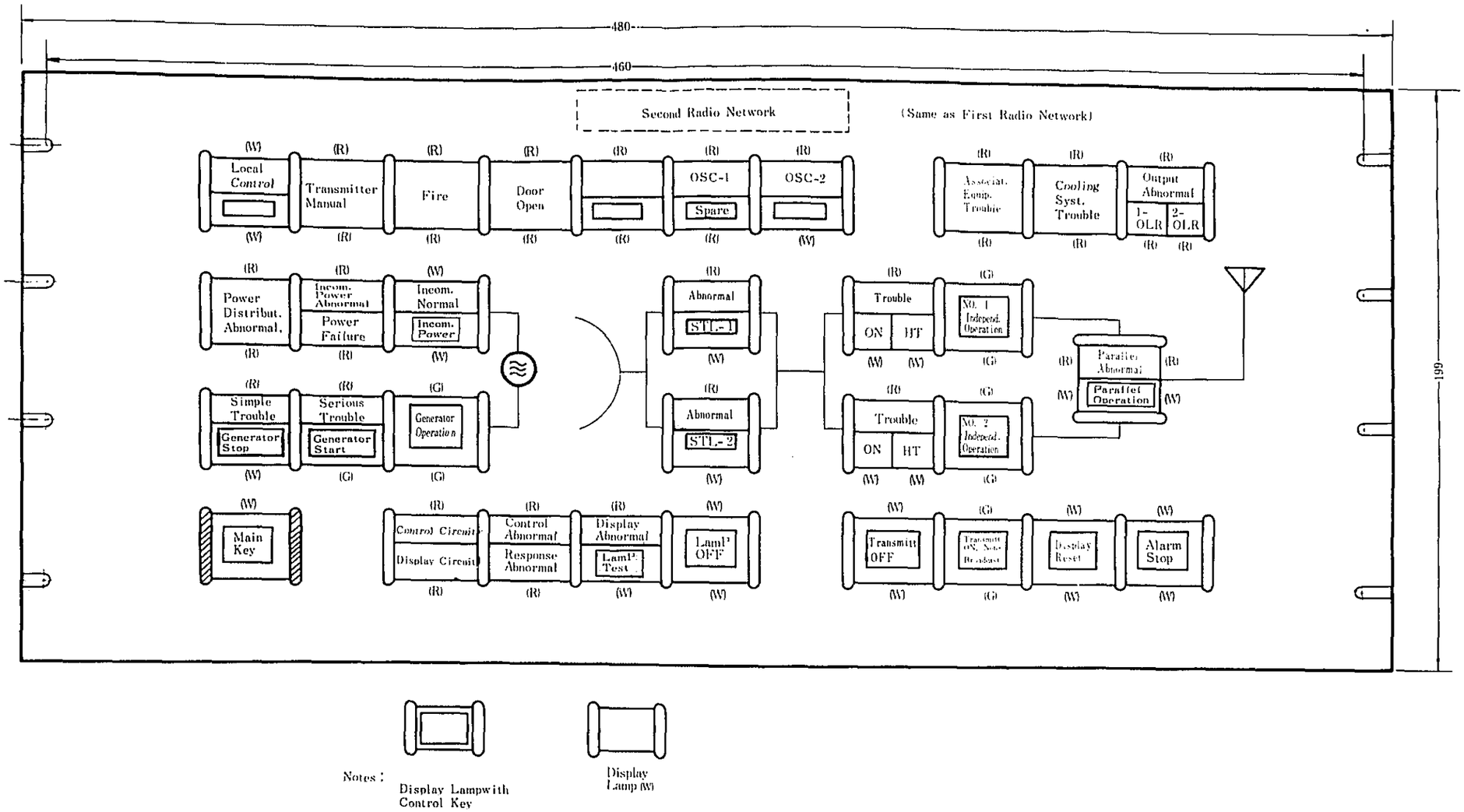
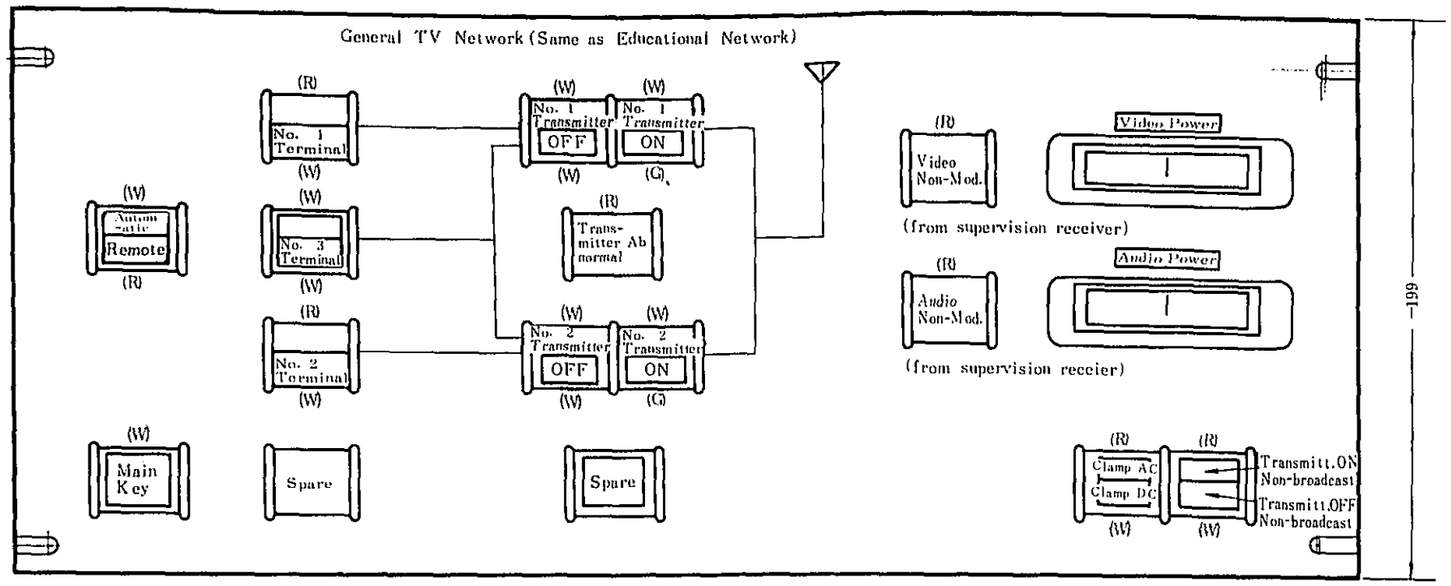
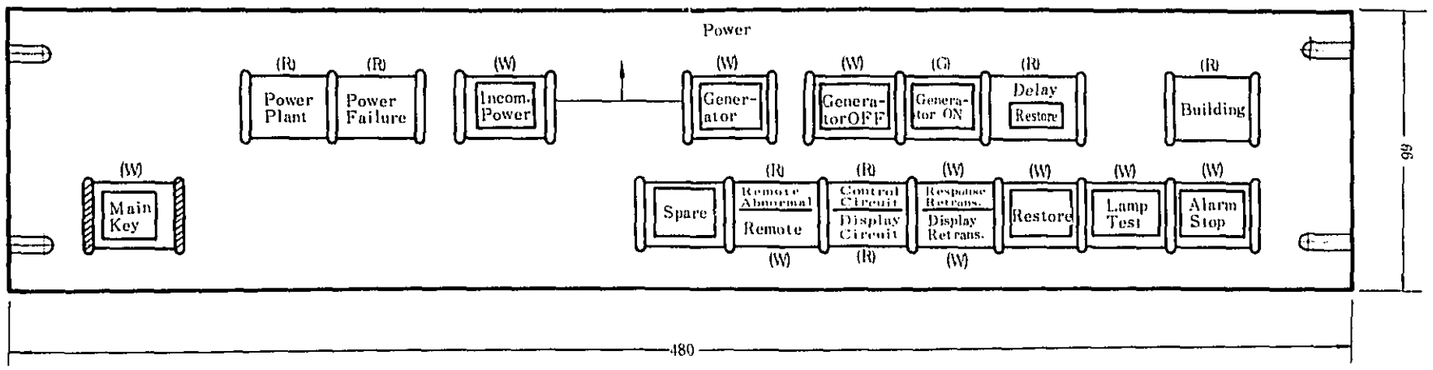


Fig. 3.9 Operation Panel of High Power Radio Transmitting Station





Notes : Display Lamp with Control Key

Display Lamp(W)

Fig. 3.10 Operation Panel of Television Transmitting Station

(2) Items of Supervision

No.	Contents	Indication of Displays	Buzzer	Lamp Colour
1	Open of Building door	Station Building	o	R
2	Control, Remote/Automatic	Manual/Remote		R/W
3	Abnormality in No.1 Terminal Device	No.1 Terminal Device	o	R
4	Abnormality in No.2 Terminal Device	No.2 Terminal Device	o	R
5	Abnormality in Video and Audio Power	Transmitter Abnormal	o	R
6	Abnormality in Modulation of Video and Audio		o	R
7	Clamp AC/DC	Clamp AC/Clamp DC		R/W
8	Stop of No.1 Transmitter (Standby)	No.1 Transmitter OFF		W
9	Stop of No.2 Transmitter (Standby)	No.2 Transmitter OFF		W
10	Start of No.1 Transmitter (HT/Standby)	No.1 Transmitter ON		W/G
11	Start of No.2 Transmitter (HT/Standby)	No.2 Transmitter ON		W/G
12	Use of No.3 Terminal Device	No.3 Terminal Device		W
13	Start/Stop at non-broadcast hours	ON/OFF at non-broadcast hours		R/W
14	Abnormality in Power Supply	Power Supply	o	R
15	Start of Engine Generator	Engine Generator ON		G
16	Stop of Engine Generator	Engine Generator OFF		W
17	Use of Engine Generator	Engine Generator		W
18	Use of Incoming Power	Incoming Power		W
19	Re-transmission of Response	Response		R
20	Abnormality in Control Circuit	Control Circuit	o	R
21	Abnormality in Control Circuit	Control Abnormal	o	R
22	Abnormality in Display Circuit	Display Abnormal	o	R
23	Reset of Display	Restore		W
24	Test of Lamp	Lamp Test		W

Note: For stations where radio wave supervision is impossible, item No.5 and 6 are used.
For stations where radio wave supervision is available, these two items are integrated into one item.

1. Control

When controlling devices installed at the place to be controlled, the forms of control employed are manual, remote and automatic.

The order of priority for these control forms is (1) manual, (2) automatic and (3) remote.

2. Supervision (Display)

The operational status of the controlled devices installed at the place to be controlled is continually monitored and the details are indicated by lamps on the operating panels at the studio. Red lamps will lit and alarm buzzers may also sound for abnormal conditions monitored.

3.2.6 System

1. Code Transmission System

All control and supervisory signals between the place of control and the place controlled will use code systems. NRZ (Nonreturn Zero) codes will also be used for code transmission.

The control code and display code will be composed of a start bit, group bit (display), data bit, parity bit, and stop bit for a total of 12 bits forming 1 character. The start bit will be logic "0" and the stop bit will be "1". The number of stop bits (2 in this unit) and the parity bit will be initially selected in the control circuit.

A duplex system of code transmission will also be used with the first code sent in successive order.

The following checks will be made at the receiving side.

(1) Detection of the start bit

Detection of the start bit is accomplished by detecting the point at which logic "1" becomes logic "0". Also, as long as "0" is continuing, it will be considered an accurate

start bit although it may be in the center of the start bit.

(2) Detection of the stop bit

Detect and confirm that the stop bit is "1". If it is not "1", consider this a frame error and an abnormal condition.

(3) Parity check

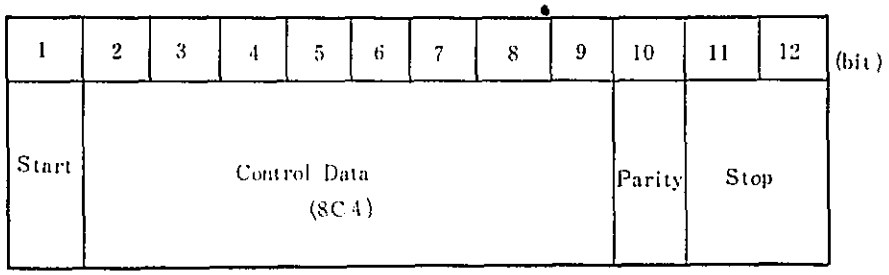
"1" will appear in the output if an error is detected during the parity check. This will be maintained until the next character is shifted to the register.

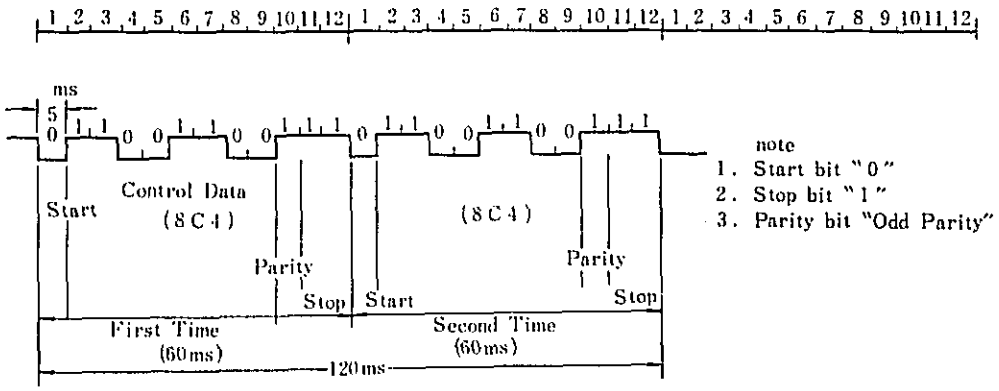
(4) Continuous transmission check

This is a check to determine whether the code received the second time matches the first code.

2. Control Codes

The sending format for control codes is as follows.

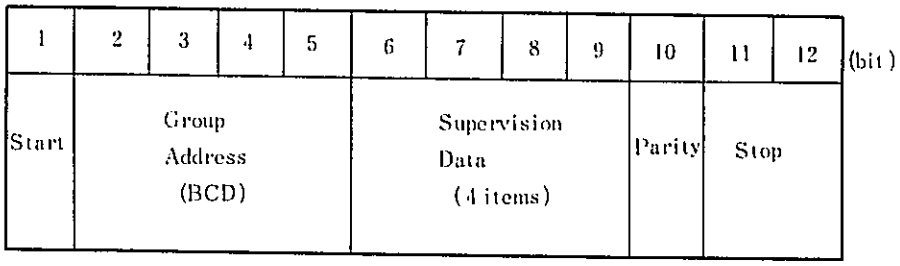




Following the start bit, the control code will be arranged in 8 bits (8C4 code) as data bits with the 10th bit as the parity bit and the following 11th and 12th bit as the stop bits.

3. Supervision Code

The format of sending supervision codes is as follows.

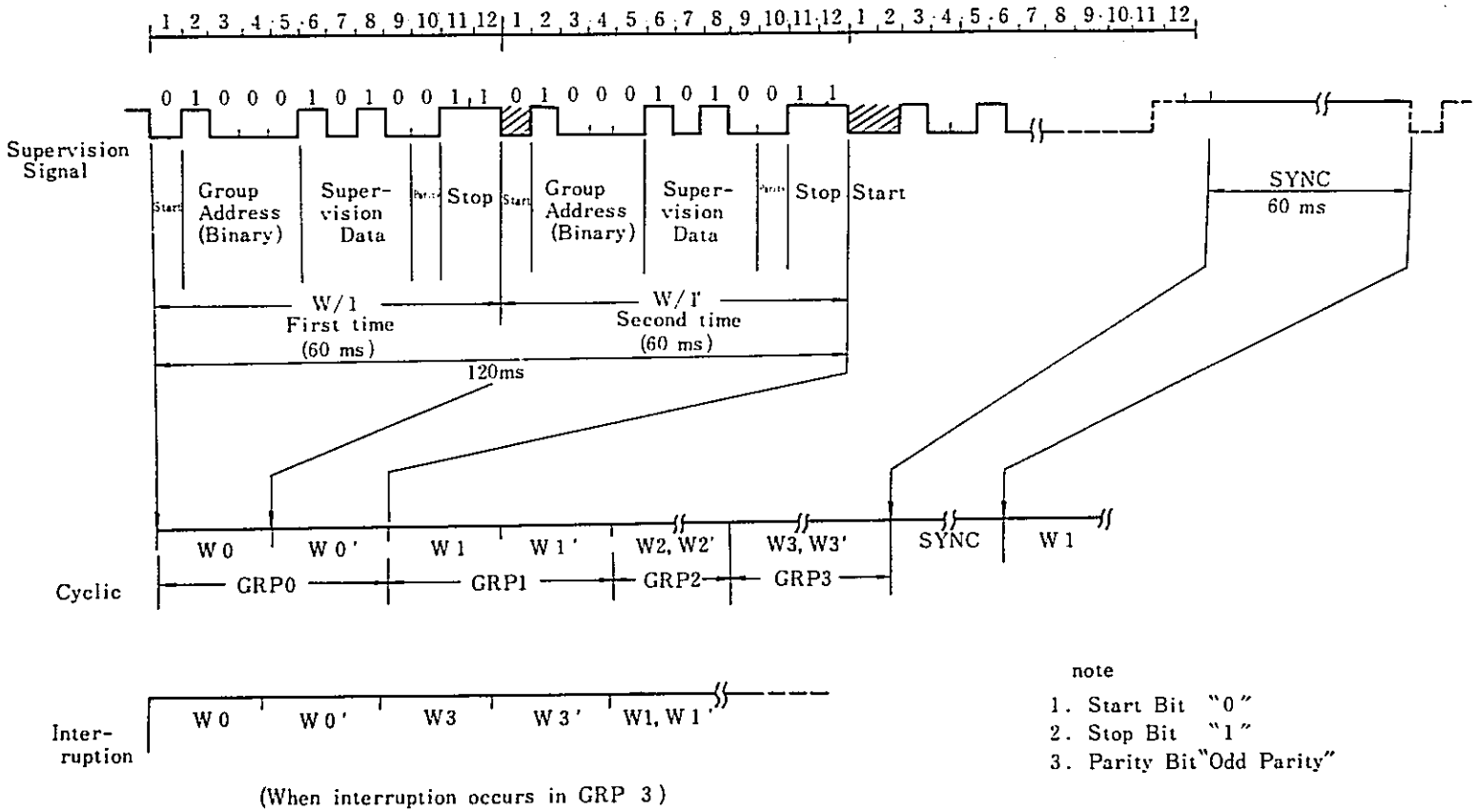


The group address of the monitoring code will be considered as a binary code. Also, the 4 bits in the data section will be employed in an allocation system to the respective monitoring items.

Monitoring codes are sent on a continuous cyclic basis regardless of the presence of any status changes.

System-wise, the monitoring items will be classified as follows.

Classification	Number of Items	Group Allocation
A	16 (Basic Form)	1 - 4 Group
B	32	1 - 8 "
C	48	1 - 12 "
D	60	1 - 15 "



(When interruption occurs in GRP 3)

note

1. Start Bit "0"
2. Stop Bit "1"
3. Parity Bit "Odd Parity"

4. Signal Transmission System

Signal transmission is to transmit control signals from the controlling side to the controlled side, and to transmit monitoring signals from the controlled side to the controlling side through communications lines.

This transmission system uses FM signals for code transmission as it is resistant to noise, is only slightly affected by fluctuations in reception level and is moreover, stable in operation.

To speed up operations, 200BPS MODEM of $f_o \pm 100$Hz is used as the control signal and the monitoring signal.

Also, these FM signals are used as carriers in the circuit to carry out supervision of the transmission line at all times.

Telephone functions may also be added to this unit on an optional basis by using bands below 2kHz.

3.2.7 Connection with External Devices

1. Control Output

(1) All control outputs from this unit will be relay contacts.

(2) Output contacts will be wire spring relay contacts (24V DC, 0.5A)

(3) The control output pulse time will be approximately 100ms.

2. Supervision Input

(1) Connections to the monitored devices will be made by means of independent relay contacts with contact capacities exceeding 24V DC, 0.1A. (Contacts that close when in operation)

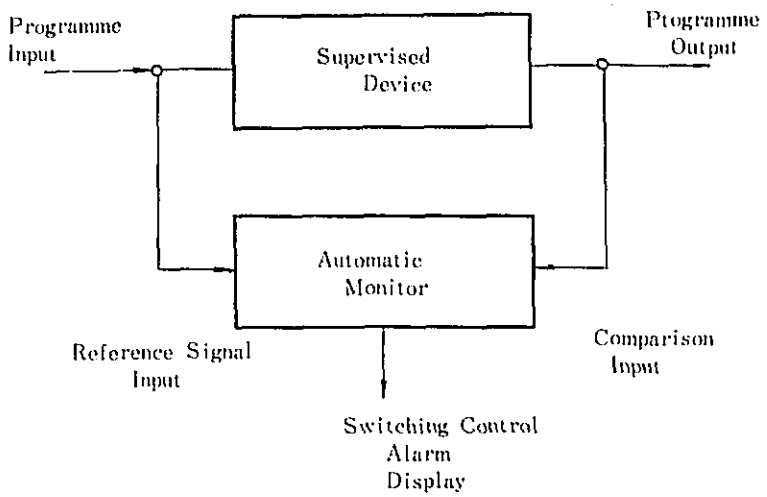
4. Automatic Audio Monitor

We shall now explain about the AU-71 audio monitor, mainly use used for newly built transmitting stations for automatic control and alarm.

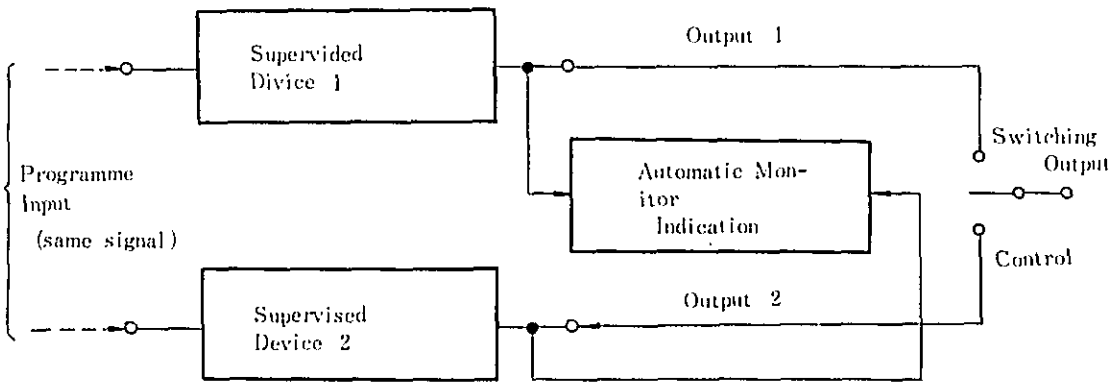
The monitor is built into a 4H width F type unit and is mounted on a P type shelf together with a power supply unit. It is incorporated with an AR-72 type or FM lineaner detector. Besides this type, there are many A-5 type vacuum type and transistorized A-6 type aut matic monitors in use.

4.1 Basic Composit on and Operation of Automatic Monitors

The automatic monitor for audio programmes signals consists of a block diagram given in Fig. 4.1. The amplifiers for the reference signal and comparison signal are about the same and the signals are rectified and compared at the detector section. When the comparison signal level becomes lower than the reference level, relative to the preset level, it will be detected and operate the control circuit. The block diagram is shown in Fig. 4.2.



(a) Supervison of Input and Out put



(b) Automatic Monitor

(Automatic Selection Circuit for 2 Signals)

Fig. 4.1 Example of Usage of Automatic Monitor

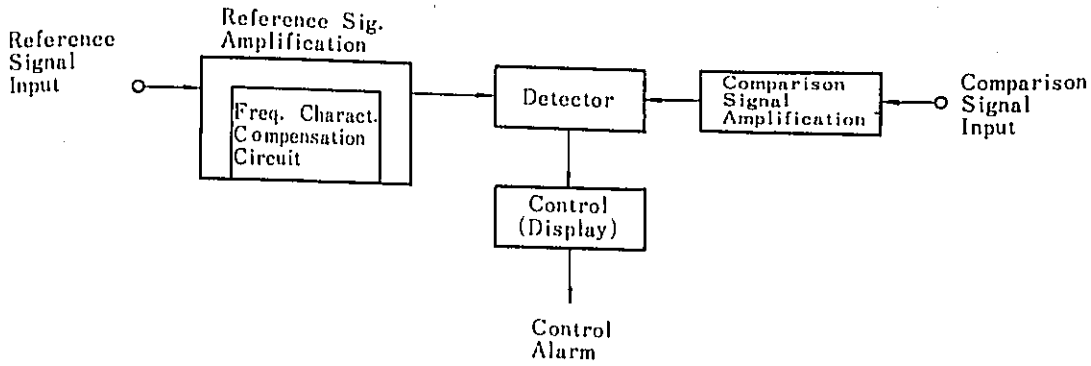


Fig. 4.2 Composition Diagram of AU-71 Automatic Monitor

4.2 Explanation of Automatic Monitors

(1) Compensation circuit for Frequency Response

As the frequency response of the supervision device usually drops at the low and high frequency ranges, the reference input signal range and the comparison signal range is matched, and in order to prevent maloperation due to the frequency characteristic of the supervision device, this device is inserted into the reference signal side circuit.

(2) Signal Amplification Section

The amplifiers for the reference signal and comparison signal are about the same, and they are for obtaining the necessary amount of rectified voltage.
The reference circuit is able to be switched so that it can accept an input level of -20 dBm and + 10 dBm. It is also possible to adjust the gain of the comparison signal, so that the detective sensitivity can be continuously varied between ranges of 3 dB to 8 dB.

(3) Detector and Control Section

The detector and control sect on rectifier and compares the output signal of the comparison amplifier, and when the

relative level difference exceeds the preset value, and continues this state for a certain time (variable between 0 to 6 seconds), the external control relay will operate and control or display action will be provided.

This section was formerly compared and detected by a polarized relay, but in the new AU-71 type, it is compared by a Schmidt circuit electronically.

This device also incorporates a malfunction preventive circuit to prevent the occurance of malfunctions which will enevitably occur due to the non-linearity (for instance, when modulation exceeds 100 % at amplitude modulation) of the supervision device. This circuit is available to be connected or disconnected by operating the limiter switch.

5. Automatic Video Monitor

At present, a synchronous detector type is used for the input and the output. The SU-71 type automatic monitor will be explained in the following.

5.1 Operation

The block diagram is shown in Fig. 5.1. When a video signal of 1 $V_{(p-p)}$ is applied to the input (input impedance : high), the synchronous component will be mainly extracted at the sensitivity

Fig. 5.1 Composition of SU-71 Automatic Monitor

adjustment section, to minimize the variation of sensitivity caused by the video component.

At the 15 kHz filter section, the synchronized component of 15.75 kHz is selected and then full-wave rectified and direct-current amplified at the rectification amplifier. Then it will operate the final relay, after switching of quick and delay motion and adjustment of delay-time at the delay section.

The operation is stable in comparison to the conventional type because the operational principle is simple. It is normally set to operate at -6 to -9 dB, in relation to the synchronous signal of 0.3 $V_{(p-p)}$.

5.2 Performance

Input impedance : over 100 kilo-ohms at 3 MHz.

Operation level : When a special signal wave form of APL 50 % is applied to the input, the operation level of the relay is to be under o.1 $V_{(p-p)}$.

Selectivity : As compared with 15.75 kHz, it is to be less than -6dB at 15.75 $\pm$ 1 kHz.

Operat on time : quick, 0.3 - 0.5 seconds
slow, 2 - 5 seconds.

6. Other Automatic Monitors

Besides the audio and video monitors, a output detector unit (V/U F-71 type) is in use. This unit is used for output of audio transmitters of VHF television, output of audio exciters, and output of audio and video power amplifiers of UHF television and also for output of FM transmitters.

The FET in the input circuit raises the load impedance of the detector, to reduce the variation of sensitivity due to the modulation degree of the modulation wave. This is the main difference from other automatic monitors, but the use of direct-

current amplification to operate the relay is the same.

The main performances are such as,

Input SWR : less than 1.2

Operation level : adjustable within -3 to -9 dB against the rated input (120 dBμ) and the level difference in operation and non-operat on is within 2 dB.

7. Relay Clock

The control by clocks are applicable for repeat of controls at certain durations. The accuracy of the relay clock differs according to the purpose of usage and, recently, a crystal controlled relay clock is used. This type is advantageous because it will not stop during earthquakes and other vibrations. The external view is shown in Fig. 7.1, measuring 470 x 304 x 132 mm.

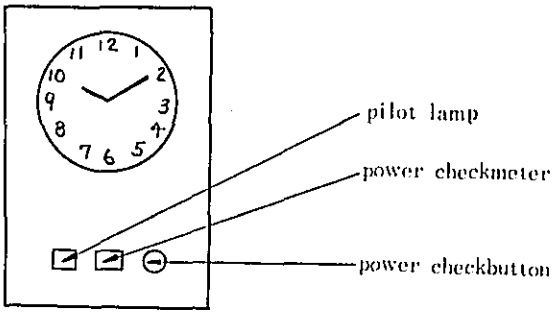


Fig. 7.1 QC-5N type Crystal Oscillation Clock

7.1 Operation

A 30 second pulse is obtained by frequency deviation of the 99kHz crystal oscillator output, to rotate the 24 hour disc. It is possible to set the pins in the disc at intervals of 15 minutes.

There is a separate disc which generates accurate pulse at 15 minute intervals, and the pulse of the 24 hour disc gates this 15 minute pulse to raise the accuracy of the setting time. The

contact point of the mechanic is provided by a keep relay (lock relay) operated by these pulses.

Therefore, in setting the 24 hour disc, it is only necessary to insert 2 pins in the places where broadcast will start and end. As two 24 hour discs are equipped, and the opposite side can also be used, control of 4 separate equipment is possible.

Precise adjustment of clock can be made by adjusting the parallel capacitance of the crystal qualtz. In Fig. 7.2, the relation of pulses are shown.

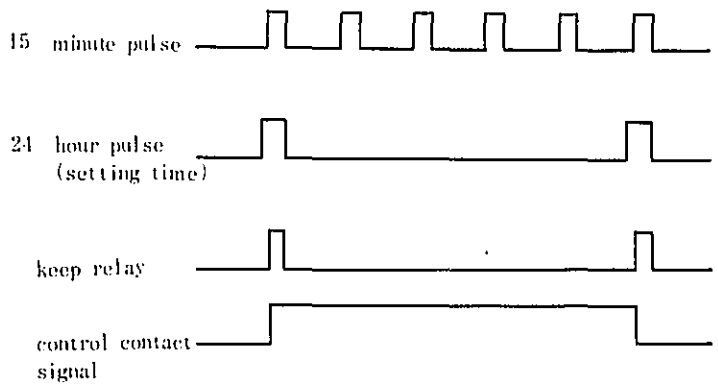


Fig. 7.2 Pulse for Relay Clock

7.2 Precision and Accuracy

An accuracy of 3 sec/week is guranteed under ambient temperature of 0 to - +40°C. The precision of setting is zero.

8. Automatic Carbon Dioxide Fire Extinguisher

8.1 Characteristics of Carbon Dioxide

In general, there is a volumetric ratio of 21 % of oxygen in the air, but if this ratio is reduced to 15 % by releasing carbon dioxide, ordinary substances will not burn nor explode any more. To dilute the volume of oxygen in the air to 15 %, it is necessary to release carbon dioxide until its volumetric ratio in

the air becomes 25 %.

The characteristics of carbon dioxide as fire extinguish agent are as follows.

(1) Since water is not used, the surrounding objects will not be drenched.
(2) Non-toxic.
(3) As its specific gravity is high, it is suitable for covering the surface of objects, especially of that of fluid.
(4) As it can be stored in the state of fluid, it requires only a little storage space.
(5) It can be discharged in minimum of time.
(6) It has no chemical reaction with metals and other substances.
(7) It is an excellent insulator against electricity.
(8) It has cooling action when released to gas.
(9) It diffuses well and penetrates in cracks.
(10) It can easily be released by means of remote control or automation.

From the foregoing reasons, the carbon dioxide is extremely an effective agent, as far as it is used in a closed room. It is advantageous for extinguishing fire caused by electric equipment and semi-dangerous substances.

8.2 Outline of Automatic Carbon dioxide Fire Extinguisher

This system consists of an automatic fire alarm device and a carbon dioxide fire extinguisher device and employs carbon dioxide as agent. It detects the rise in temperature by a sensor and releases gas out from the container by means of the signal received at the receiver panel. The gas released into the fire area reduces the necessary amount of oxygen in the air for combustion.

The device installed at unmanned transmitting stations are provided with both automatic and manual control and those of studio

centers are of manual control. Each of them are in compliance with the fire prevention laws.

The composition of the extinguishers is shown in Table 8.1.

Table 8.1 Carbon Dioxide Automatic Fire Extinguisher

Automatic Fire Alarm Device	Carbon Dioxide Fire Extinguisher Device
(1) CO_2 Interlocked Receiver Panel	(1) CO_2 Cylindric Valve and Mounting Frame
(2) Fire Alarm or Thermostat	(2) CO_2 Starting Device
(3) Alarm Device and Associated Device	(3) CO_2 Piping and Release Horn, Nozzle

8.3 Operation of Fire Extinguisher

A block diagram of an extinguisher for unmanned transmitting Stations is given in Fig. 8.1.

(1) Automatic (Fundamental Operation)

When the sensor operates and closes its contact, the relay in the receiver panel corresponding to the sensor will operate and indicate abnormal sign, and at the same time, it will excite the magnet of the container-valve solenoid (CVS) of the starting container.

The magnet removes the mechanical hook off from the break-open needle and punctures the copper retaining film of the gas container. The gas in the starting container operates the puncture needle of the opening device of the discharge container by the pressure of the gas, and punctures the sealing and opens the branch valve for the area to be released. Then, the gas passes through the lead-in piping and is discharged to the area concerned from the discharge horn.

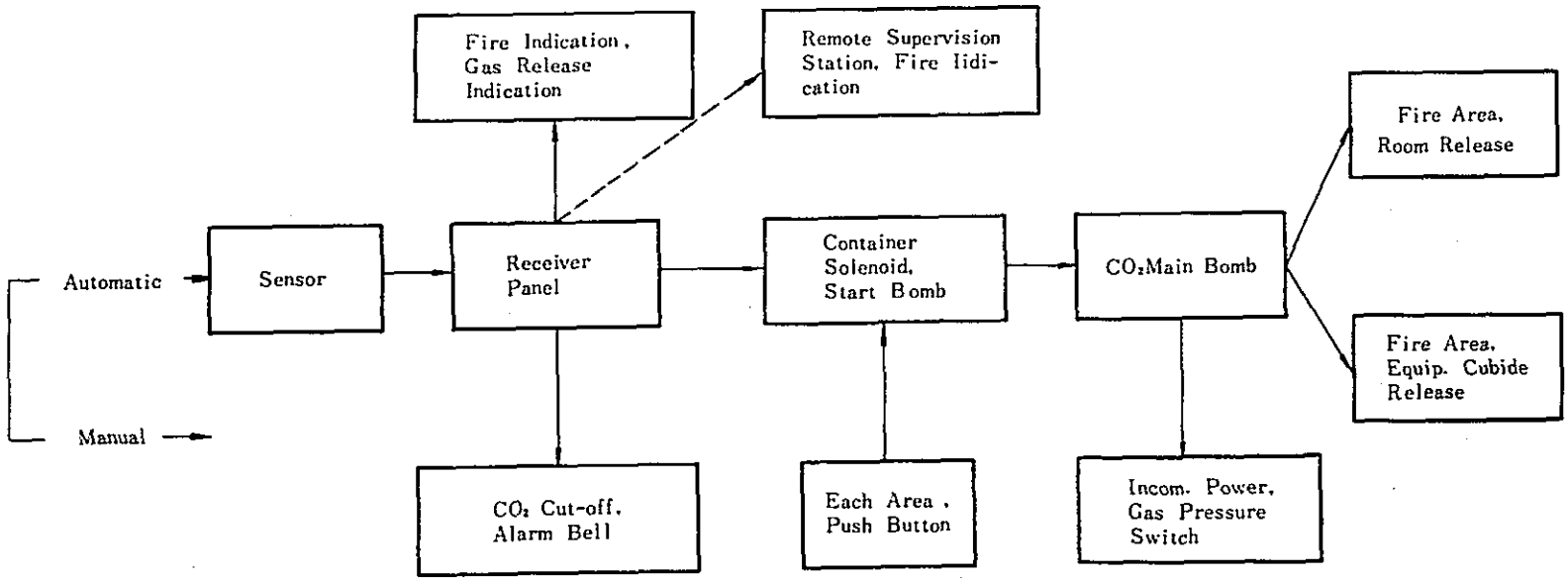


Fig. 8.1 Control System of Fire Extinguisher for Unmanned Transmitting Station

(2) Manual

When the cut-off switch for CO_2 of the receiver panel is set to the "OFF" position, the excitation circuit of the container valve solenoid will open. In case the sensor operates at this time, the bell will alarm and if the push button of the area concerned is depressed, after confirming that nobody is left in the room, the container valve solenoid will operate and gas will release.

(3) Cut-off of Incoming and Engine Generator Power

To prevent occurance of secondary fires, the incoming power line and engine generator line will be cut-off by means of the action of gas pressure switch by the gas released.

The incoming power is connected to the main power-switch trip-contact, and the engine generator is connected to the mechanical stop circuit of the engine.

Restoration is available by operating the pressure switch to its original position, manually.

(4) Indication

Release of gas and area of sensor operating will be indicated on the receiver panel. At remote supervision studio sites, occurance of fire will be indicated.

8.4 Sensors

There are many types of sensors according to the nature of fires and objectives of usage, and the ones shown in Table 8.2 are being used.

Table 8.2 Fire Sensors

Type	Description
Constant Temperature	Uses the expansion of bimetals due to rise of ambient temperature. Activating temperature is 80°C and operating time is from 20 to 140 seconds. This type is used in conjunction with CO_2.
Temperature Switch (Thermostat)	Mounted inside a cubicle and uses heat expansion of fluid due to rise of ambient temperature. Activating temperature is 90°C and operation time is within 30 seconds. This type is used in conjunction with CO_2.
Differential	Utilizes pressure developed by sudden expansion of air pressure. This type is used for alarming purpose.
Ion	Detects smoke of incomplete combustion. Used in conjunction with CO_2.

8.5 Gas

The gas is charged in a container in a liquified form, and will be gasified when released into the air. The weight of liquid gas is 755 g/ℓ at 21°C, and the gasified gas is 0.56 m^3/kg. The ordinary discharge container is charged up to 45 kg and the starting container is filled up to 1 kg.

The handling of the liquid carbon dioxide gas is governed by the 'High Pressure Gas Control Law (Law No. 204,1951)' and the containers must have cirtificates proving that they have passed the regulation examinations.

The necessary amount of gas carbon dioxide can be calculated by Table 8.3, which is determined from the maximum value of the room concerned. The opening portion of the protection section is provided with a device to seal the opening surface by the gas released, but in case this sealing device is not provided, the

Table 8.3 Necessary Amount of Carbon Dioxide Gas

Areas	Required Amount of CO_2 (kg/m^3)	Discharge Time
Transmitter Room, Power Distribution Room	1.14	within 7 minutes
Engine Generator Room, Automobile Garage, Storage for Quasi-dangerous Substances	1.14 - 0.73	within 2 minutes

Volume of Protective Area	Required Amount of CO_2 (kg/m^3)	Minimum Amount of CO_2 (kg)
less than 5 m^3	1.14	
more than 5 m^3, less than 15 m^3	1.07	6
more than 15 m^3, less than 50 m^3	1.09	16
more than 50 m^3, less than 150 m^3	0.89	50
more than 150 m^3, less than 500 m^3	0.80	134
more than 1,500 m^3	0.73	1,200

volume of gas must include an additional amount of gas compensating the loss caused by the opening surface.
The additional gas should be calculated so that it will exceed 5 kg per 1 m^2 opening and 6.5 kg per 1 m^2 opening for transmitter and power distribution rooms.

When the transmitter equipment is an open type, the gas is to be released in the transmitter room, and when it is a cubicle type, it is to be released in the cubicle and also in the transmitter room.

8.6 Maintenance

The system is usually in a static state but is required to operate positively at emergency. Tests shall be carried out on function of sensor, circuit operation, displays, cut-off of incoming power, solenoid container valve, and the amount of gas should be checked.

The piping route of gas should be checked by releasing gas at the time of initial installation, and after that, external appearance check will only be necessary.

Periodic inspection for facilities installed in accordance with legal requirements are to be undertaken yearly, and for others, in intervals of 2 to 3 years. In general, the inspection should be entrusted to commercial agents.

8.7 Precautionary Items

Carbon dioxide itself is not toxic, but precaution must be taken on the following, because it is harmful to health, if a large amount of it is inhaled.

(1) When entering an unmanned transmitting station, cut off the CO_2 switch of the receiver panel and return it to the former position when leaving the station.

(2) When releasing gas manually, close the door after confirming that nobody is in the area concerned. When gas is released in the room, leave the room as quickly as possible.

(3) When entering the room where gas was released, open the door and leave it open for about 10 minutes and confirm that there is no residual gas.

(4) When it is necessary to make inspections, remove the container valve solenoid connecter and tighten the safety nut, to prevent discharge of gas.

Be sure to put the safety pin in before starting work on the discharge container.

(5) The solenoid valve is connected to the discharger by a nut. In mounting the solenoid valve, be sure that the manual operation button will come to the top position.

(6) Do not lose the pressure certificate attached to the gas container, because it is necessary for inspection and refilling. The certificate for unmanned stations is kept at the Headquarters.