MOS DIGITAL INTEGRATED CIRCUIT
μPD1704C-011

PLL FREQUENCY SYNTHESIZER AND CONTROLLER FOR AM/FM TUNER

The μPD1704C-011 is a single chip AM and FM band PLL frequency synthesizer plus controller for the U.S.A., Europe and Japan with a 24-Hour clock and three source-programmable timers. By using μPD1987C (remote control transmitter) and μPD1937C (remote control receiver) as peripherals, the μPD1704C-011 can be remote-controlled through infrared ray.

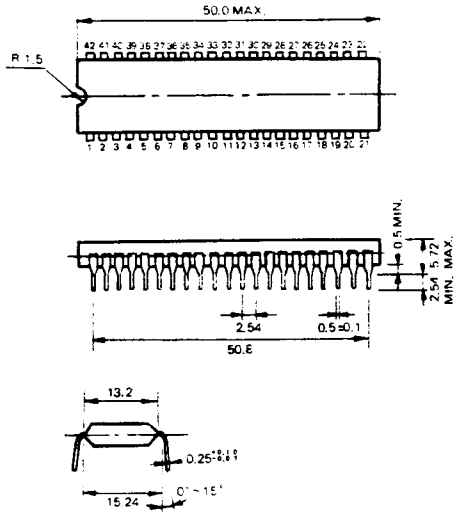
Since the μPD1704C-011 employing pulse-swallowing method in FM band tuning by using μPB553AC prescaler, the reference frequency of FM is as high as 25 kHz. Therefore, the μPD1704C-011 can constitute a multifunctional high performance AM/FM digital tuning system for home stereos and receivers.

The μPD1704C-011 is fablicated with advanced CMOS process and is packaged in 42-pin DIP.

FEATURES

- Single chip PLL + Controller
- Single power supply; +5 V±10 %
- Compatible with AM and FM band receivers for the U.S.A., Europe and Japan
- FM reference frequency is as high as 25 kHz (the pulse swallowing method is employed)
- Built-in 24 hour clock
- Built-in three sets of source programmable timers. (ONCE, EVERYDAY 1 and 2)
- Sixteen preset channel memories (8 for AM and 8 for FM)
- Two last channel memories; AM(1) + FM(1)
- Auto up/down seek tuning (Saw-tooth mode)
- Manual up/down tuning (Saw-tooth mode)
- Auto preset channel scanning (Holding 5 sec for each preset)
- Compatible with remote control system of μPD1986C and μPD1937C
- Source selector function (PHONO, TAPE, AUX)
- FM intermediate frequency compensating capability (4 ways by 25 kHz step)
- Wide variety of function selectability by diode matrix; FM ONLY, NO CLOCK etc.
- FIP (Fluorescent Indicator Panel) direct drive capability. (Segment lines only)
- 5-digit frequency display
- 10-key clock adjusting
- Low-power battery back up capability ($\leq 10\mu A$: only in No CLOCK mode).
- 42-pin DIP package

PACKAGE DIMENSIONS in millimeters



Note. Typical values are shown unless other use specified.

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage	V_{DD}	−0.3 to +6.0	V
Input Voltage	V_I	−0.3 to +V_{DD}	V
Output Voltage	V_O	−0.3 to +V_{DD}	V
Output Absorbing Current	I_O	10	mA
Operation Temperature	Topt	−35 to +75	°C
Storage Temperature	Tstg	−55 to +125	°C
Output Breakdown Voltage	V_{BDS}	−35 across Sa − Sg terminals (drain-source voltage)	V

RECOMMENDED OPERATION CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Power Supply Voltage	V_{DD}	4.5	5.0	5.5	V	
Data (RAM) Retention Voltage	V_{RAM}	2.5		5.5	V	CE=0, CKSTP Instruction Executed
Oscillation Stop Voltage	V_{OSS}		3.2	3.8	V	
Output Breakdown Voltage	V_{BDS}			−30	V	I_{OH}=−5 μA Across Sa−Sg Terminals (Drain-Source Voltage)
Rise Time of Power Supply Voltage	Trise			500	ms	V_{DD}=0→4.5 V

ELECTRICAL CHARACTERISTICS (V_{DD}=4.5 to 5.5 V, Ta=−35 to +75 °C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
High-Level Input Voltage	V_{IH1}	0.8 V_{DD}		V_{DD}	V	SD, $\overline{RMC}$ Terminals
"	V_{IH2}	0.7 V_{DD}		V_{DD}	V	I/O Ports, CE Terminal (Note)
"	V_{IH3}	0.6 V_{DD}		V_{DD}	V	K_0 to K_3 Terminal
Low-Level Input Voltage	V_{IL1}	0		0.3 V_{DD}	V	I/O Ports, CE Terminal
"	V_{IL2}	0		0.2 V_{DD}	V	K_0 to K_3, SD, $\overline{RMC}$ Terminals
High-Level Output Voltage	V_{OH1}	4.0			V	EO_1, EO_2 Terminals I_{OH}=−0.3 mA
"	V_{OH2}	4.0			V	$\overline{D}_1$ to $\overline{D}_6$, MUTE, I/O Ports I_{OH}=−0.2 mA
"	V_{OH3}	4.0			V	PSC Terminal I_{OH}=−0.1 mA
"	V_{OH4}	3.0			V	Sa to Sg Terminals. I_{OH}=−0.5 mA
Low-Level Output Voltage	V_{OL1}			0.5	V	EO_1, EO_2 Terminals, I/O Ports. I_{OL}=0.5 mA
"	V_{OL2}			0.5	V	$\overline{D}_1$ to $\overline{D}_6$, MUTE, PSC Terminals I_{OL}=0.2 mA
High-Level Input Current	$+I_{IH2}$	10	40	100	μA	K_0 to K_3 Terminals $V_{IN}=V_{DD}$=5.5 V
"	$+I_{IH2}$		300		μA	X_1 Terminal (during pull down) $V_{IN}=V_{DD}$=5.0 V
Low-Level Input Current	$-I_{IL1}$		300		μA	AM, FM Terminals (during pull up) V_{IN}=0, V_{DD} =5.0 V
Output Leakage Current	I_L		10^{-3}	1	μA	EO_1, EO_2 Terminals, Ta =25 °C
Response Frequency	f_{AM}	0.5		2.5	MHz	AM Terminal, Vin=1.0 Vp-p (Mim.), Dc Cut
"	f_{FM}		3		mA	FM Terminal, Vin=0.8 V_{p-p} (Mim.), Rectangular wave, Dc Cut
Operation Current	I_{DD1}		3		mA	Input/Output Currents from Input/Output Terminals Excluded
Data (RAM) Retention Current	I_{DD2}		10	10	μA	CE=0, CKSTP instruction executed, Ta=25 °C, V_{DD} =5.0 V
Clock Operation Current	I_{DD3}		600		μA	CE=0 V_{DD}=5.0 V

Note: I/O ports include AC OUT, FM/AM, selection terminals (AUX, TAPE, PHONO, TUNER) A to D, $\overline{DP}$, and $\overline{COLON}$.

FUNCTIONAL OUTLINE

Receiving frequency range, channel spacing, reference frequency, and intermediate frequency.

		Frequency Range	Channel Spacing	Reference Frequency	Intermediate Frequency
U.S.A.	AM	530–1620 kHz	10 kHz	10 kHz	450 kHz
	FM	87.9–107.9 MHz	200 kHz	25 kHz	10.650, 10.675, 10.700, 10.725 MHz
Europe	AM	522–1611 kHz	9 kHz	9 kHz	450 kHz
	FM	87.50–108.00 MHz	50 kHz	25 kHz	10.650, 10.675, 10.700, 10.725 MHz
Japan	AM	522–1611 kHz	9 kHz	9 kHz	450 kHz
	FM	76.1–89.9 MHz	100 kHz	25 kHz	10.675, 10.700, 10.725, 10.750 MHz

Channel Selection

(1) Auto tuning (saw-tooth wave mode)
Auto up-channel tuning
Auto down-channel tuning . . . . . Channel once received is held.

(2) Manual tuning (saw-tooth wave mode)
Manual up-channel tuning
Manual down-channel tuning . . . . . Stepwise action through momentary switch. When held depressed for 0.5 second or more, fast action continued until the switch is released.

(3) Preset scan . . . . . Preset channels from 1CH. to 8CH. are repeatedly scanned with holding for 5 seconds at each channel. To stop scanning at the currently received station, press the preset station key currently selected.

(4) Recall preset memory . . . . . 8 channels each for AM and FM through 8 button switches.

Timer

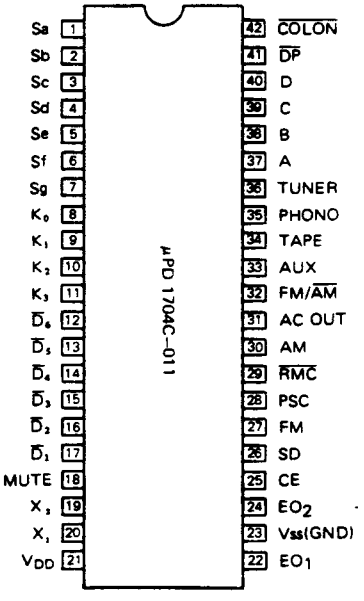
(1) EVERYDAY (for two systems) . . . . . By setting both ON and OFF time with a source, the specified source is switched ON at the ON-time and the whole system is switched OFF at the OFF-time. These action will be repeatedly performed everyday.

(2) ONCE (for one system) . . . . . By setting both ON and OFF-time with a source, the specified source is switched ON at the ON-time, and the whole system is switched OFF at the OFF-time.
In this case, the timer action is performed only once. And after the action, the ONCE-Timer data are cleared.

Remote Control

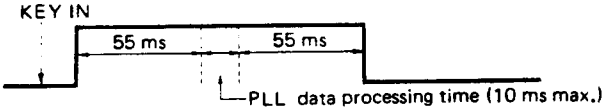
By attaching μPD1986C (transmitter) and μPD1937C (receiver), functions including power ON/OFF, AM/FM switching, preset channel call, and source selection can be remote controlled by infrared ray.

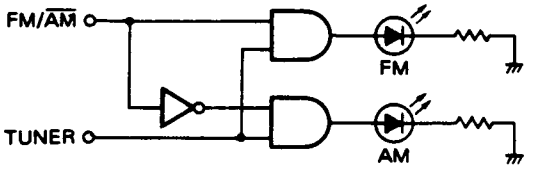
TERMINAL CONFIGURATION (Top View)



DESCRIPTION OF TERMINALS

Terminal Number	Symbol	Terminal Name	Description
1–7	Sa–Sg	Segment Outputs	Terminals for display segment signals and for key return signal source; active high. (For details, see 1. KEY MATRIX CONFIGURATION.) These terminals are open-drain outputs and it is provided with dielectric strength of −30 V max. So it can be directly connected to segment terminals of FIP (fluorescent indicator panel) with pull-down resistances. (For the connections, see 3-1. Display Connection Diagram)
8–11	K_0–K_3	Key Return Signal Inputs	Input terminals for key return signals from externally connected key matrix. As the key return signal sources, segment terminals Sa-Sg and AND signal of TUNER and PHONO terminals are used. (See 1. KEY MATRIX CONFIGURATION.)
12–17	$\overline{D}_1$–$\overline{D}_6$	Digit Outputs	Display digit signal outputs; active low. To interface to a FIP (fluorescent indicator panel), single stage buffers using PNP transistors (2SA733 or equivalent) should be inserted between them. (For details, see 3–1. Display Connection Diagram.)

18	MUTE	mute	Muting signal output to cancel shock noises when PLL is momentarily unlocked; active high. This line goes high before 55 ms to PLL data (content of programmable counter) changes, and it goes low after 55 ms from the completion of the data change. Mute signal is issued while in either of the following cases. ○ AM/FM and selector switchings ○ MANUAL UP/DOWN ○ AUTO UP/DOWN ○ Preset memory call (including preset scan) ○ Switching from CLOCK set to RADIO.  The signal is continuously issued in either of the following cases. ○ OFF key is depressed. (OFF mode) ○ When the following mode is set through MODE SW; TIMER READ, TIMER WRITE, TIMER CANCEL ○ CE terminal is forced low.
19 20	X1 X2	X'tal	Terminal to which crystal oscillator is connected. The oscillation frequency of the crystal should be 4.5 MHz. (Type TQC-231A-8S manufactured by Tōyō Tsūshinki is recommended.)
21	V_{DD}	Power Supply	Terminal for power supply to the device. (5 V±10 %.) The voltage can be lowered to 2.5 V in data retention mode. (When device CLOCK is stopped, i,e, when NONCLOCK is specified through the diode matrix and CE=0). The rise time of V_{DD} should be 500 ms or less (for 0 → 4.5 V). If the rise time is excessively long, the initialization will not operate ploperly.
22 24	EO_1 EO_2	Error Out	Output terminals of charge pump in the phase detector of PLL section (3-state). Comparing the reference frequency with the oscillation frequency divided by the programmable divider, these terminals go high if the divided oscillation frequency is higher than the reference frequency. And go low if it is lower than the reference frequency. If they are the same, these outputs becomes high-impedance. Since EO1 and EO2 output the same signal at the same time, either of them can be connected to the LPF (low pass filter) of either AM or FM.
23	GND	Ground	Terminal to be connected to system ground.
25	CE	Chip Enable	Terminal for input selection signal to device. The terminal voltage has to be high level to operate the device normally and low level to leave the device idle. (1) When NONCLOCK is set through the initial setting diode matrix. CE = High ..... normal operation. CE = Low ..... display OFF, PLL operation stopped, internal clock generator stopped; current consumption 10 μA or less, V_{DD} = 5 V. (2) When NONCLOCK is not set through the initial setting diode matrix. CE = High ..... normal operation CE = Low ..... display OFF, PLL operation stopped; current consumption 500 μA typical, V_{DD} = 5 V.

			High level or low level for 134 μs or shorter cannot be accepted. When NONCLOCK is selected through the initial setting switch, CE terminal should be forced to high level after the rise up of V_{DD}, and forced to low level 200 ms before V_{DD} falls. (See Note 1.)
26	SD	Station Detector	Input terminal of station detection for auto tuning (AUTO UP/DOWN). The auto tuning is stopped on receiving high level. To avoid missing the station, this input should be forced to high level within 50 ms after PLL is locked.
27	FM	FM Local Oscillator Signal Inputs	Input terminal of FM programmable counter. This terminal is normally connected to the output of the two-modulus prescaler μPB553AC. Since an ac amplifier is employed inside, the input signal should be fed through a dc-cut capacitor.
28	PSC	Pulse Swallow Control	Terminal for output signal to switch frequency dividing ratio of prescaler when pulse swallowing method is used in frequency dividing (i.e. for FM signal reception). Connect to PSC terminal of special prescaler μPB553AC. The frequency dividing ratios of μPB553AC are 1/16 and 1/17.
29	$\overline{RCM}$	Remote Control Inputs	Input terminal of remote control signal. Connect to CHU OUT terminal of receiving remote control IC μPD1937C. The remote control action is discriminated by the number or input pulses to this terminal. (For details, see 2–4. Transistor Switch)
30	AM	AM Local Oscillator Signal Inputs	Input terminal of AM programmable counter. It accepts the output signal (VCO) from AM local oscillator. Since an ac amplifier is employed inside, the input signal should be fed through a dc-cut capacitor.
31	ACOUT	AC Outlet Control	Terminal for AC service outlet control. This terminal is used to control the cut-out relay for the main power supply of the receiver set. This goes high level whenever either one of the source selector terminals (TUNER, PHONO, TAPE, and AUX) is to be turned on. When the OFF key is pressed, it becomes low level. Since this terminal becomes high impedance when the CE terminal is shifted to low level under the NONCLOCK conditions, a pull-down resistor should be used if NONCLOCK specification is required. (See Note 3.)
32	FM/$\overline{AM}$	FM/AM Power Supply Control	Terminal for switching power supply to tuner's FM or AM section. High level output is issued to operate FM and low level output to operate AM. This is also used in conjunction with the TUNER terminal to issue an ACKNOWLEDGE signal of AM and FM source selection in TIMER READ and TIMER WRITE modes. The schematic of the ACKNOWLEDGE signal generator is as follows. 

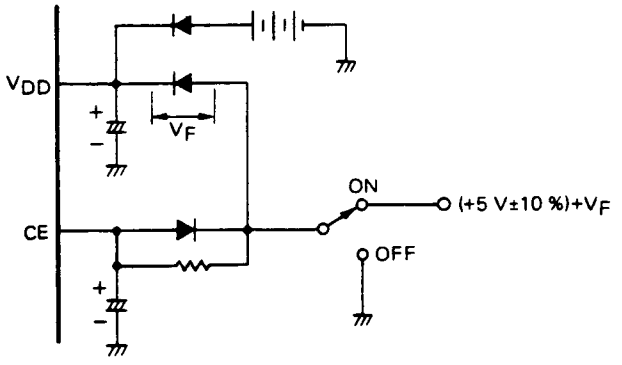
<table>
<tr><td></td><td></td><td></td><td>When FM or AM key is depressed in TIMER WRITE mode with the circuit shown above, the LED corresponding to the specified band will be turned on for 50 ms.
In TIMER READ mode, the LED, corresponding to the band set in WRITE mode, will be turned on for 5 seconds.</td></tr>
<tr><td>33
34
35
36</td><td>AUX
TAPE
PHONO
TUNER</td><td>Source Selector Outputs</td><td>Source selector outputs for TUNER, PHONO, TAPE, and AUX. TUNER terminal goes to high level when FM, AM, or preset key is depressed, and PHONO, TAPE, and AUX terminals goes to high level when PHONO, TAPE, and AUX keys are depressed, respectively.
When OFF key is depressed, all terminals are forced to low level. (See Note 3.)</td></tr>
<tr><td>37–40</td><td>A
B
C
D</td><td>Preset Station Indicator Outputs</td><td>Output terminals of BCD signals to indicate the preset channel memorys. The output combinations for preset stations are shown in the table below.

1: High level Output
0: Low Level Output

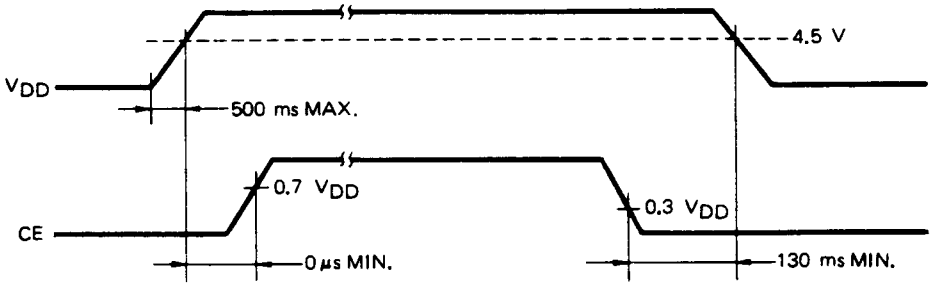
By connecting μPB74LS42 (BCD-to-decimal decoder) to these terminals, the dot pattern display of preset station can be made with LEDs. (See Note 3.)</td></tr>
<tr><td>41</td><td>$\overline{DP}$</td><td>Decimal Point</td><td>Terminal to output a decimal point indication signal to the display for FM frequency; active low.
$\overline{DP}$ as well as $\overline{COLON}$ terminals cannot be directly connected to fluorescent indicator panel. Insert a buffer for the purpose. (See Note 3.)</td></tr>
<tr><td>42</td><td>$\overline{COLON}$</td><td>COLON</td><td>Terminal to output a colon indication signal in CLOCK display mode; active low. (See the discription of DP terminal above.)</td></tr>
</table>

PRESET STATION	D	C	B	A
NON PRESET	0	0	0	0
P1	0	0	0	1
P2	0	0	1	0
P3	0	0	1	1
P4	0	1	0	0
P5	0	1	0	1
P6	0	1	1	0
P7	0	1	1	1
P8	1	0	0	0

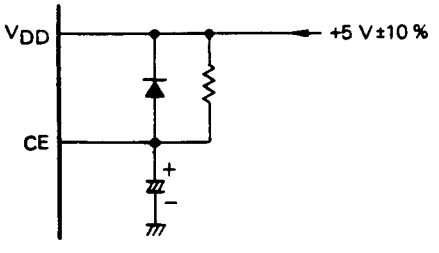
(Note 1) When no clock function is necessary, turn the NONCLOCK switch ON. And if, in this mode of operation, low-power-data-retention is required while radio is off, do not use OFF key, which will be described later, to turn system power supply off, but use CE terminal. The example circuit is shown below.



The value of CR connected to CE terminal should be set so that the following condition is satisfied.



(Note 2) If NONCLOCK is not specified, CE terminal should be connected to V_{DD} as shown below.



(Note 3) AC OUT, A, B, C, D, AUX, TAPE, PHONO, TUNER, and DP terminals are shifted to low level or high impedance status dependent on the internal conditions when CE terminal is changed to low level under the NONCLOCK (refer to 2. Description of Key Matrix) conditions.

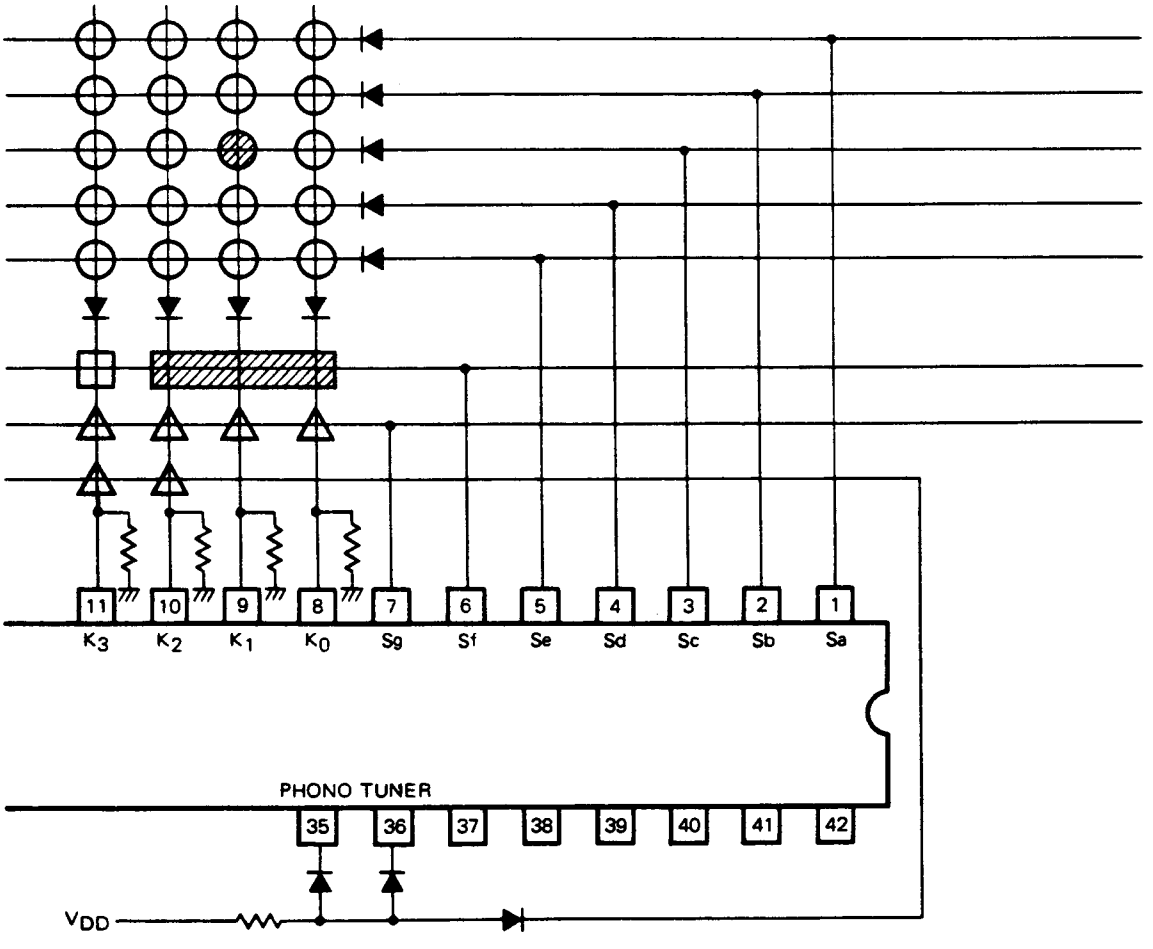
1. KEY MATRIX CONFIGURATION

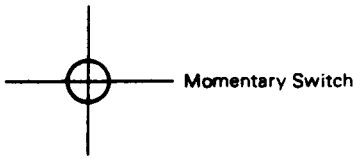
1-1. Key Matrix Configuration

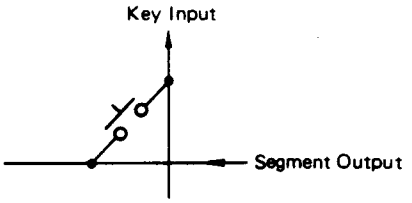
	K_3(11)	K_2(10)	K_1(9)	K_0(8)	Type of Key
Sa(1)	0 (AM)	1 EVERYDAY1 ON	2 EVERYDAY1 OFF	3 EVERYDAY2 ON	Momentary (Normally OFF) * Transistor Switch
Sb(2)	4 EVERYDAY2 OFF	5 ONCE ON	6 ONCE OFF	7	
Sc(3)	8	9 (FM)	REMCON*	OFF	
Sd(4)	CLK CALL	CH SCAN	DOWN	UP	
Se(5)	MEMORY	PHONO	TAPE	AUX	
Sf(6)	AUTO/MANUAL	MODSW2 (note)	MODSW1 (note)	MODSW0 (note)	MODSW . . . Rotary Switch AUTO /MANUAL ... Alternate Switch
Sg(7)	IF0	IF1	BAND1	BAND0	Initially Set Diode Matrix
TUNER & PHONO	NONCLOCK	FM ONLY			

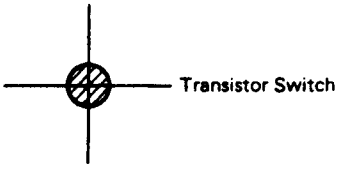
(Note) Rotary switch to be used as mode switch should be of shorting type.

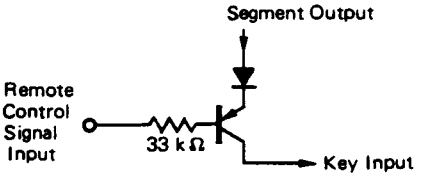
1-2. Connection of Keys and Switch Types on Key Matrix

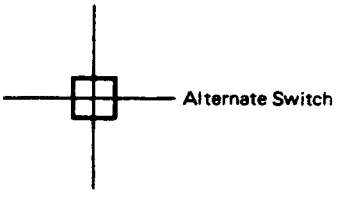


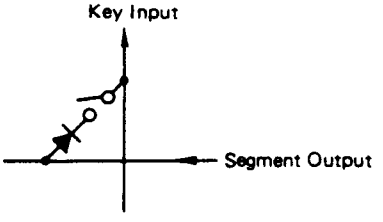


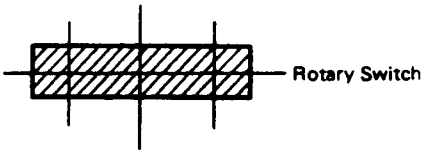


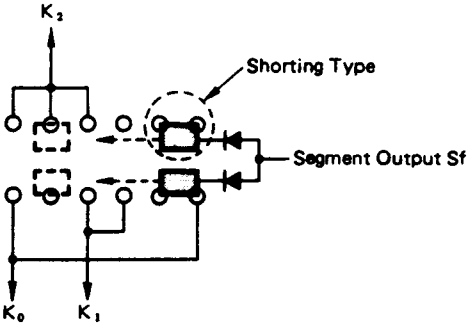


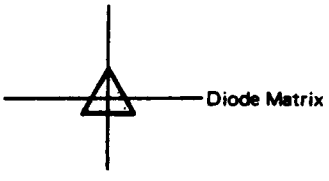


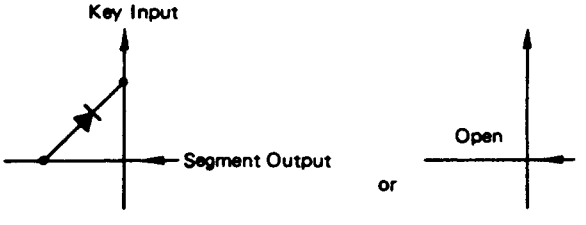












2. DESCRIPTION OF KEY MATRIX

2-1. Initial Setting Diode Matrix

There are four types of initial setting matrices as described below. They are read in when V_{DD} is first fed with power (initializing) or when CE terminal is forced to high level from low level.

(1) Switches for setting IF offset value of FM.
IF1, IF0

(2) Switches to specify the BAND range for the target area. (American, European, or Japanese)
BAND1, BAND0

(3) Switch to kill the clock function.
NONCLOCK

(4) Switch to meet the FM single receiver.
FM ONLY

These settings are done by shorting with a diode or by opening the crosspoint on key matrix. (In the following table, ON means short-circuiting with a diode and OFF means opening.)

<table>
<tr><th>Symbol</th><th>Functional Description</th></tr>
<tr><td>IF1
IF0</td><td>Switches to set IF offset value of FM.
Intermediate frequency can be set in for ways, 25 kHz apart from each other, without changing the frequency displayed.
<table>
<tr><th>IF1</th><th>IF0</th><th>American band</th><th>European band</th><th>Japanese band</th></tr>
<tr><td>OFF</td><td>OFF</td><td>10.700 MHz</td><td>10.700 MHz</td><td>10.700 MHz</td></tr>
<tr><td>OFF</td><td>ON</td><td>10.725</td><td>10.725</td><td>10.675</td></tr>
<tr><td>ON</td><td>OFF</td><td>10.650</td><td>10.650</td><td>10.750</td></tr>
<tr><td>ON</td><td>ON</td><td>10.675</td><td>10.675</td><td>10.725</td></tr>
</table></td></tr>
<tr><td>BAND1
BAND0</td><td>Switches to specify the BAND range for the target area.
Either American, European, or Japanese band can be selected.
<table>
<tr><th>BAND1</th><th>BAND0</th><th>Found Area</th></tr>
<tr><td>OFF</td><td>OFF</td><td>American band</td></tr>
<tr><td>OFF</td><td>ON</td><td>Japanese band</td></tr>
<tr><td>ON</td><td>OFF</td><td>European band</td></tr>
<tr><td>ON</td><td>ON</td><td>Prohibited *</td></tr>
</table>
* Do not turn both BAND1 and BAND0 ON. If both are turned ON, receiving band cannot be set duly.</td></tr>
<tr><td>NONCLOCK</td><td>Switch to kill the clock function.
When no clock function is required, make this switch ON.
Then, data retantion is capable with a low current consumption (10 μA or less).
(Refer to Notes 1 and 2 of Terminal Descriptions.)
ON . . . . . With Clock Function
OFF : . . . . . With Clock Function</td></tr>
<tr><td>FM ONLY</td><td>Switch to set receiving band to FM only.
When this switch is ON, AM band is not received even if '0(AM)' key is pressed. Then band switching keys 'FM' and 'AM' can be accepted only as '9' and '0' for time adjustment.
ON . . . . . FM only
OFF . . . . . FM and AM</td></tr>
</table>

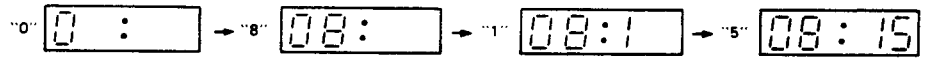
2-2. Alternate Switches

There are two kinds of alternate switches. They can be switched any time.

(1) Switch to select auto tuning or manual tuning.
AUTO/MANUAL

(2) Programmable mode switches to specify operation modes; CLOCK SET, TIMER WRITE, TIMER CANCEL, etc.
MODSW2, MODSW1, MODSW0

<table>
<tr><th>Symbol</th><th>Description of Function</th></tr>
<tr><td>AUTO/
MANUAL</td><td>Switch to select auto tuning or manual tuning.
ON . . . . . Auto Tuning
OFF . . . . . Manual Tuning
Auto or manual tuning starts when the momentary switch of UP or Down is pressed after the setting of this switch.
In the auto tuning operation, the frequency is scanned step by step after confirming that the PLL system is locked. Therefore, in the long lock-up time PLL system, the scanning speed will be slower than the short one. And if the PLL feedback loop is malfunctioned and the PLL is never locked, the scanning will not be started or be stopped.</td></tr>
<tr><td>MODSW2
MODSW1
MODSW0</td><td>Programmable mode switches to specify modes such as CLOCK SET, TIMER WRITE, TIMER CANCEL.
Use shorting-type rotary switch with two circuits and six positions for these switches. (For connections, see 1–2 "Connection of Keys and Switch Types for Key Matrix".)

<table>
<tr><th>MODSW2</th><th>MODSW1</th><th>MODSW0</th><th>Programmable Mode</th></tr>
<tr><td>1</td><td>0</td><td>1</td><td>CLOCK SET</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>RADIO</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>TIMER OPERATION</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>TIMER READ</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>TIMER WRITE</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>TIMER CANCEL</td></tr>
</table>
(Note) 1 and 0 in the table means ON (short) and OFF (open) respectively. Since the mode switch code is modified gray code, the sequence of the codes cannot be changed to others than the above.
1. CLOCK SET mode
Mode to set present time.
μPD1704C-011 is provided with a 24-hour clock system (0:00–23:59). The time can be set by the following procedure.
① Set time in 4-digit input using ten-key 0–9.
(Ex. Setting to 8:15 A.M.)

(Note) If some wrong key was pressed, finish the 4-digit keying and then start keying again from the first digit.

② Turn the programmable mode switch to RADIO coincidentally to time signal. The clock function starts to operate at the moment of switching over to RADIO.
(Note 1) If clock setting is performed while listening to the radio, radio broadcast frequency is indicated when the mode switch is returned to RADIO.
If the similar process is followed in PHONO, TAPE, or AUX mode, the time is indicated, but zero (0) in the most significant digit will be suppressed to blank as shown below.</td></tr>
</table>

2) At the time when V_{DD} (5 V ±10 %) is supplied to the device, "E" is indicated.

3) When the mode switch is in the position of CLOCK SET mode, the internal clock stops functioning. The clock starts functioning when the mode switch is turned to another, and the value of second is set to "0" internally.

2. RADIO mode

In this mode, the tuner functions such as write and call of AM/FM preset memory, UP/DOWN tuning in AUTO/MANUAL, and preset memory scan etc.) and source selection (PHONO, TAPE, or AUX) can be performed.

3. TIMER OPERATION mode

Mode for executing instructions of time and source (AM, FM, PHONO, TAPE, or AUX) specified in TIMER WRITE mode.

Each of three timer systems, EVERYDAY1, EVERYDAY2, and ONCE, is respectively executed (ON or OFF) at the programmed time. Once programmed in ON/OFF-time and source, EVERYDAY1 and EVERYDAY2, repeat the ON and OFF operation to the programmed source everyday at the programmed time, while ONCE is automatically erased after the execution of ON and OFF operation and it will not be executed next day.

MODSW2
MODSW1
MODSW0

Among these three systems, the priority sequence ONCE, EVERYDAY2, EVERYDAY1 is established. (For details, see 4 Description of Programmable Timer Performance)

When timer is executed, one of the following terminals is to be activated corresponding to the programmed source.

Programmed Source	Terminals to be activated
FM	FM/$\overline{AM}$=High, TUNER=High, AC OUT=High
AM	FM/$\overline{AM}$=Low, TUNER=High, AC OUT=High
PHONO	PHONO=High, AC OUT=High
TAPE	TAPE=High, AC OUT=High
AUX	AUX=High, AC OUT=High

If the timer of either one of the systems is ON, all key and remote controlled inputs in this mode cannot be accepted because of protection against wrong operations. Such a manual input operation should be done after switching to RADIO mode if desired.

4. TIMER READ mode

Mode to confirm ON/OFF time and source programmed in TIMER WRITE mode. The procedure is as follows;

① Set the programmable mode switch to TIMER READ mode. Then source selector terminals (TUNER, PHONO, TAPE, and AUX) and AC OUT terminal are forced to low level, and the present time is indicated.

② Press ON key of either of EVERYDAY1, EVERYDAY2, or ONCE, Programmed ON-time, source selector terminal and the preset station are indicated for about 5 seconds. After that, the present time indication is recovered.

③ Press OFF key of EVERYDAY1, EVERYDAY2, or ONCE. Programmed OFF time is indicated for about 5 seconds. After that, the present time indication is recovered.

(Note) If ON or OFF time is not programmed, only colon (:) is indicated for about 5 seconds.

5. TIMER WRITE mode

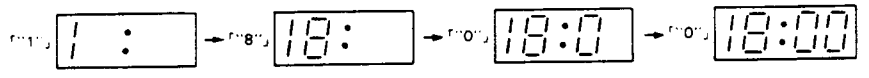
Mode for programming ON and OFF times and source to be operated. Note that OFF-time must be set whenever the ON-time is to be set. If OFF-time is not set, timer-ON action will never be performed and the ON-time which was set alone will be erased. This function is provided to avoid accidents caused by the timer which will never be turned off. Since such a

OFF-time checking is performed when the ON-time is encountered, OFF-time should be set at least before the ON-time.
In otherwise, if only OFF-time is set, the timer-OFF action will function properly. That is, OFF-time has a higher priority than the ON-time.
Five sources, AM, FM, PHONO, TAPE, and AUX, are programmable. The programming procedure is as follows.

① Set programmable mode switch to TIMER WRITE mode. Then the present time is indicated.

② Press the desired ON-key of EVERYDAY1, EVERYDAY2, or ONCE. Then the colon is displayed, and a preset station indicater LED corresponding to the depressed ON-key turns on for about 60 ms.

③ Set time in 4-digit input by using ten-keys 0–9 of momentary switches just similar to the clock set.
(Ex.) Setting 6:00 p.m.



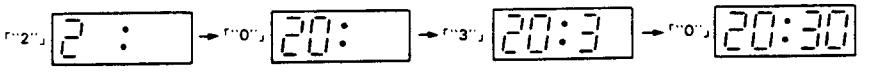
④ Press key corresponding to the desired source (FM, AM, PHONO, TAPE, or AUX). (Even if FM ONLY is specified, you must input FM.)
In cases that PHONO, TAPE, or AUX key is pressed, the corresponding source selector terminal goes High for about 500 ms.
In cases that FM or AM key is pressed, TUNER terminal goes High and FM/AM terminal is activated until a preset station key (1–8) is pressed. By using the statuses of the TUNER and FM/AM terminals, source selection ACKNOWLEGE signal can be generated (refer to description of AM/FM terminal).
When PHONO, TAPE, or AUX key is pressed, present time will be indicated after about 500 ms (the source selector terminal goes High level for that 500 ms), whereas the programmed ON time is indicated until preset station key is pressed when FM or AM key is pressed.

MODSW2
MODSW1
MODSW0

⑤ When FM or AM is selected as a source in ④, the next step to press the desired preset station key (1–8) is required. Then, preset station indicator LED corresponding to the pressed key turns on for about 60 ms. After that, the display will be changed from the programmed ON time to the present time.
(Note) If any wrong time is set or wrong source is selected, switch the programmable mode switch to another mode, and, restart programming from ① or restart programming from ② after finishing ④ or ⑤.

⑥ Press OFF key that corresponds to the ON key pressed in ②.
Then, only colon is indicated. The preset station indicator LED corresponding to the pressed OFF key turns on for about 60 ms.

⑦ Set time in 4-digit number by using ten-keys 0–9 of momentary switch.
(Ex.) Setting 8:30 p.m.



When the input of the fourth digit is over, the above display is changed to the present time indication.
(Note) When any key is wrongly pressed, finish the process up to the fourth digit and then restart the process from ⑥.

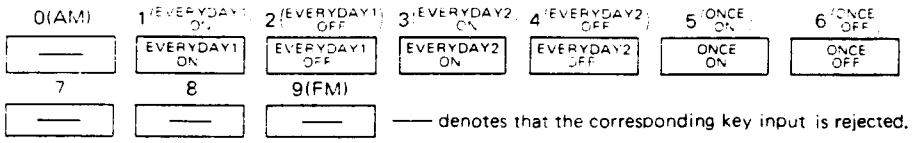
⑧ Set programmable mode switch to TIMER-OPERATION. Then the present time is indicated.
(Note) If timer operation is desired, be sure to set programmable mode switch to TIMER OPERATION. Otherwise timer does not function.

6. TIMER CANCEL mode
Mode for canceling programmed times ON/OFF times and source. Follow the process described below.

MODSW2 MODSW1 MODSW0	① Set programmable mode switch to TIMER CANCEL. Then the present time is indicated. ② Press the ON key of timer to be canceled. (EVERYDAY1, EVERYDAY2, or ONCE). Then colon is indicated momentarily, the programmed ON time and source are canceled, and, immediately, the present time indication is recovered. ③ Press OFF key that corresponds to the ON key pressed in procedure ②. As in ②, colon is indicated momentarily, the programmed OFF time is canceled, and, immediately, the present time indication is recovered.

2-3. Momentary Switches

Symbol	Description of Function
0–9	These keys are multiple function keys. Their functions varies dependent on the positions of programmable mode switches (MODSW0,1,2). (1) In the CLOCK SET mode. 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) 0 1 2 3 4 5 6 7 8 9(FM) 7 8 9 When CLOCK SET mode is selected, the keys are used as ten-keys for setting time. (2) In the RADIO mode 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) AM 1 2 3 4 5 6 7 8 9(FM) 7 8 FM When RADIO mode is selected, the keys are used for AM/FM band switching and as preset station keys. (3) In the TIMER OPERATION mode. 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) AM 1 2 3 4 5 6 7 8 9 (FM) 7 8 FM The functions of the keys are almost the same as those in the RADIO mode. Only difference is that the keys are not accepted during timer operation. (4) In the TIMER READ mode. 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) — EVERYDAY1 ON EVERYDAY1 OFF EVERYDAY2 ON EVERYDAY2 OFF ONCE ON ONCE OFF 7 8 9(FM) — — — — denotes that the corresponding key input is rejected. When TIMER READ mode is selected, only ON/OFF keys of EVERYDAY1, EVERYDAY2, and ONCE are in effect to confirm programmed timer times and source. (5) In the TIMER WRITE mode 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) 0(AM) 1(EVERYDAY1 ON) 2(EVERYDAY1 OFF) 3(EVERYDAY2 ON) 4(EVERYDAY2 OFF) 5(ONCE ON) 6(ONCE OFF) 7 8 9(FM) 7 8 9(FM) When TIMER WRITE mode is selected, the functions of the keys are differently dependent on the sequence of key operation. (For details, see 2-2. Alternate Switches) (6) In the TIMER CANCEL mode.

0 – 9	 When TIMER CANCEL mode is selected, depressing ON/OFF keys of EVERYDAY1, EVERYDAY2, or ONCE cancels the programmed timer times and sources.
OFF	This is the key to cut off power supply relay. By depressing this key, AC OUT terminal and select or terminals (AUX, TAPE, PHONO, and TUNER) are forced to low level and get indication of time on the display. To turn on the power Supply relay, depress one of the AM, FM, preset station keys (1–8) or source selector keys (TAPE, PHONO or AUX) in the RADIO mode.
CLKCAL	Key to call present clock time during frequency display. When this key is pressed, the present clock time is indicated for five seconds and then the frequency display is recovered.
CHSCAN	Key to scan preset channels. When this keys is pressed, the memorized preset stations (1–8) are in turn scanned from "1", holding for 5 sec at each preset station. To stop scanning at the currently received station, press the preset station key currently selected.
UP DOWN	Kyes for auto and manual tunings. When either key is pressed, the following functions are performed. (1) When AUTO/MANUAL switch is set to AUTO. Keying of UP increases frequency in saw-tooth wave mode. If the SD terminal is forced to high level during this process, the automatic upward searching is stopped. Keying of DOWN brings about automatic downward searching. Function of the DOWN key is almost the same as that of the UP key. Only difference is that the DOWN key decreases the frequency. *1 Automatic upward or downward searching is performed at the rate of 60 ms/step (MIN). This rate will varies depending on the lock-up time of the PLL system. *2 If UP or DOWN key is pressed during automatic searching is carried on, the automatic upward/downward searching is kept going on. (2) When AUTO/MANUAL switch is set to MANUAL. When UP or DOWN key is momentarily pressed, frequency is shifted by one step (channel space) upward or downward. When UP or DOWN key is kept pressed for 0.5 second or more, the frequency shift is continued upward or downward at the rate of 60 ms/step (TYP.) until the key is released. (Note) Even if the AUTO/MANUAL switch is turned to MANUAL during auto process, the auto tuning is not intercepted. If the auto-tuning is required to be stopped immediately by switching to MANUAL, formulate the system in such a way that SD terminal is forced to high level whenever the AUTO/MANUAL Switch is turned to MANUAL.
MEMORY	Key used to write currently received frequency into a preset memory. When either of keys 1–8 is depressed within 5 seconds after this key is pressed, the currently received frequency is written into the memory corresponding to the keyed-in switch (1–8). The memory write-enable state lasts 5 sec. from the time when the MEMORY key is pressed. To cancel this state within the 5 sec., press a key other than preset channel keys (1–8) or change the mode switches (MODSW0, 1, 2).
PHONO TAPE AUX	Keys to select a source. When programmable mode switches (MODSW0, 1, 2) are set to RADIO, keying one of these switch will force AC OUT terminal and the source select or terminal corresponding to the pressed key to high level. When programmable mode switches are set to TIMER WRITE, the deying-in of either switch will shift the corresponding select terminal to high level for about 500 ms.

2-4. Transistor Switch

Remote control signal is input to this switch. (For configuration, see 1–2, Connection of Keys and Switch Types on Key Matrix.) The remote control signal should also be input to the $\overline{RMC}$ terminal at the same time.

Fig. 1 shows the wave form of remote control signal. The first 10 ms low level stands for initializing signal. The number of the following pulses determines the type of operation.

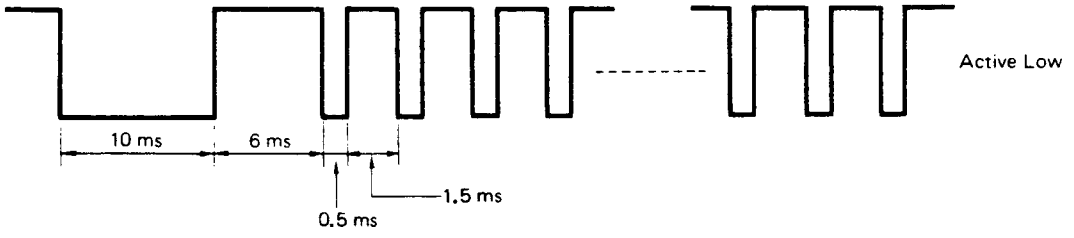


Fig. 1 Timing Waveform of Remote Control Signal

The signal discriminated by key input (K_1 terminal) via the transistor switch is the initializing signal only. The following pulse train is discriminated by $\overline{RMC}$ terminal.

Table 1 shows the correspondence between pulse counts and operations.

Table 1 Number of Pulses and Related Operation

Number of Pulses	Operation
0–7	Preset CH (1–8)
8–10	Don't care
11	AUX
12	PHONO
13	FM
14	TAPE
15	AM

3. DESCRIPTION OF DISPLAY

3-1. Display Connection Diagram

Fig. 2 shows the connection of the display. D1–D6, Sa–Sg, COLON, and DP (decimal point) correspond to digit terminals ($\overline{D1}$–$\overline{D6}$), segment terminals (Sa–Sg), $\overline{COLON}$ terminal, and $\overline{DP}$ terminal of μPD1704C-011, respectively.

Since the segment terminals of μPD1704C-011 have breakdown voltage of 30 V (corresponding to Pch open drain output voltage), they can be directly connected to FIP (fluorescent indicator panel). Digits ($\overline{D1}$–$\overline{D6}$), $\overline{COLON}$, and $\overline{DP}$ are complementary outputs and they are output in active low. Hence one stage of buffer (with PNP transistor 2SA733 or equivalent) is required.

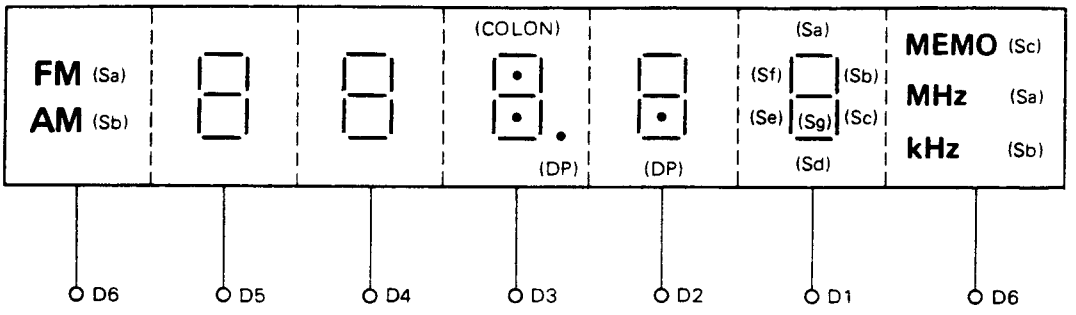


Fig. 2 Example of Indicator Display

3-2. Examples of Displays

The typical displays are as follows.

(1) FM in the U.S.A.

(2) FM in Europe

(3) FM in Japan

(4) AM in the U.S.A.

(5) AM in Europe or in Japan

(6) Clock display

* Display of MEMO is turned on for 5 seconds when the momentary key MEMORY is pressed, i.e. when the key is pressed in order to write the current frequency into the memory. If preset key either of 1–8 is pressed within that 5 seconds, the new frequency is memorized and the indication MEMO goes off.

4. DESCRIPTION OF PROGRAMMABLE TIMER OPERATIONS

There are three sets of programmable timers; EVERYDAY1, EVERYDAY2, and ONCE.

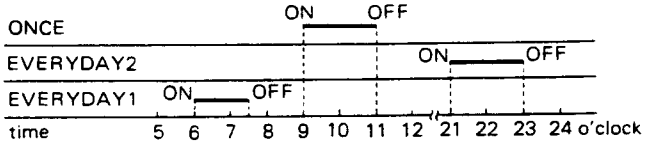
Once programmed with ON/OFF times and source, EVERYDAY1 and EVERYDAY2, execute everyday ON and OFF of the programmed source at the programmed ON/OFF times.

While, in ONCE, programmed source and ON/OFF times are canceled after the source ON/OFF execution is performed.

The priority of these timers is in the sequence of ONCE, EVERYDAY2, and EVERYDAY1. In each timer system, OFF has higher priority than ON. Hence the following performance patterns are realized according to the timing relationship.

① ON and OFF times are not crossed over.

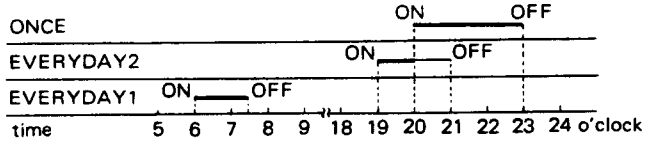
	ON time	OFF time
ONCE	9:00	11:00
EVERYDAY2	21:00	23:00
EVERYDAY1	6:00	7:30



(Note) — Denotes timer in operation.

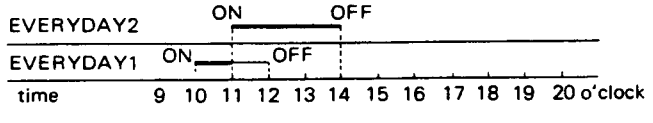
② ONCE goes ON during EVERYDAY2 is in operation.

	ON time	OFF time
ONCE	20:00	23:00
EVERYDAY2	19:00	21:00
EVERYDAY1	6:00	7:30



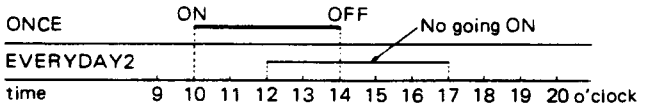
③ EVERYDAY2 goes ON during EVERYDAY1 is in operation.

	ON time	OFF time
EVERYDAY2	11:00	14:00
EVERYDAY1	10:00	12:00



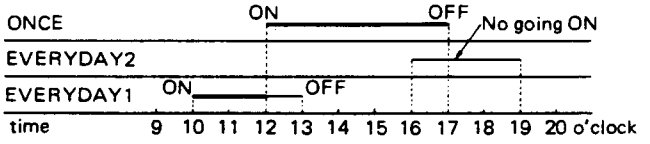
④ EVERYDAY2 goes ON during ONCE is in operation.

	ON time	OFF time
ONCE	10:00	14:00
EVERYDAY2	12:00	17:00



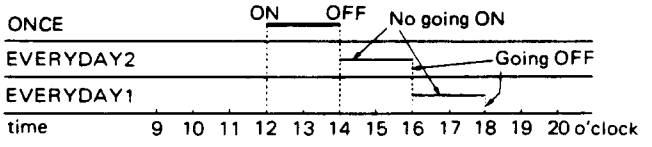
⑤ ONCE goes ON during EVERYDAY1 is in operation, and, EVERYDAY2 goes ON during ONCE is in operation.

	ON time	OFF time
ONCE	12:00	17:00
EVERYDAY2	16:00	19:00
EVERYDAY1	10:00	13:00



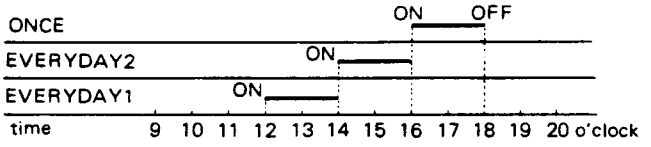
⑥ Continuously programmed in the sequence of ONCE, EVERYDAY2, and EVERYDAY1.

	ON time	OFF time
ONCE	12:00	14:00
EVERYDAY2	14:00	16:00
EVERYDAY1	16:00	18:00



⑦ Reversed sequence of ⑥

	ON time	OFF time
ONCE	16:00	18:00
EVERYDAY2	14:00	16:00
EVERYDAY1	12:00	14:00



5. TYPICAL APPLICATIONS

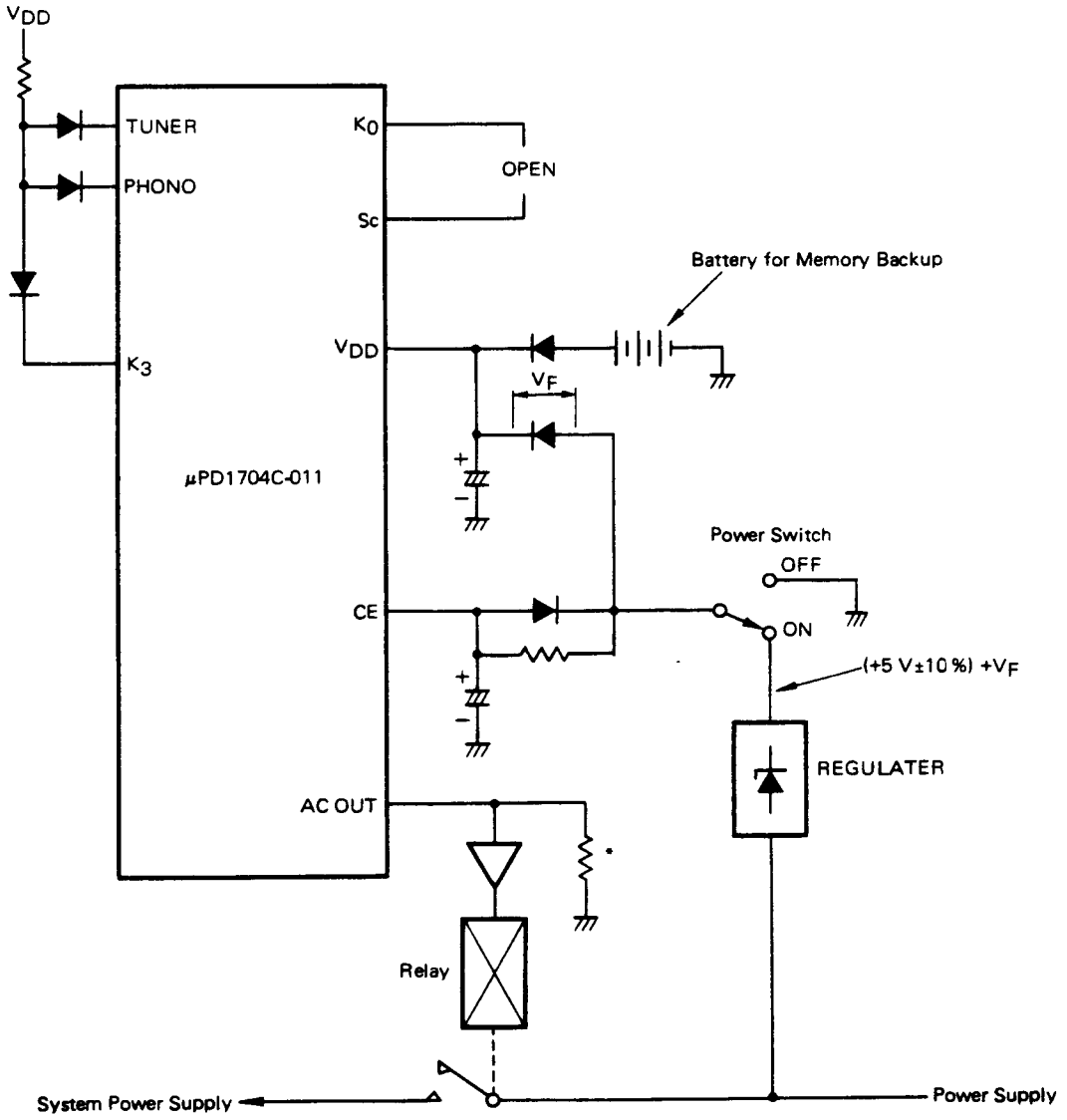
A wide variety of set models can be developed by combining initial setting diode matrix, NONCLOCK and FM ONLY and remote control function. The following table shows some examples of the variations and effective keys on each variation.

LEGEND on symbols

(key) ○ : Function effective　　× : Function ineffective
● : All the key functions diffective　　AM : Only AM effective
FM : Only FM effective　　– : Ineffective (prohibited)

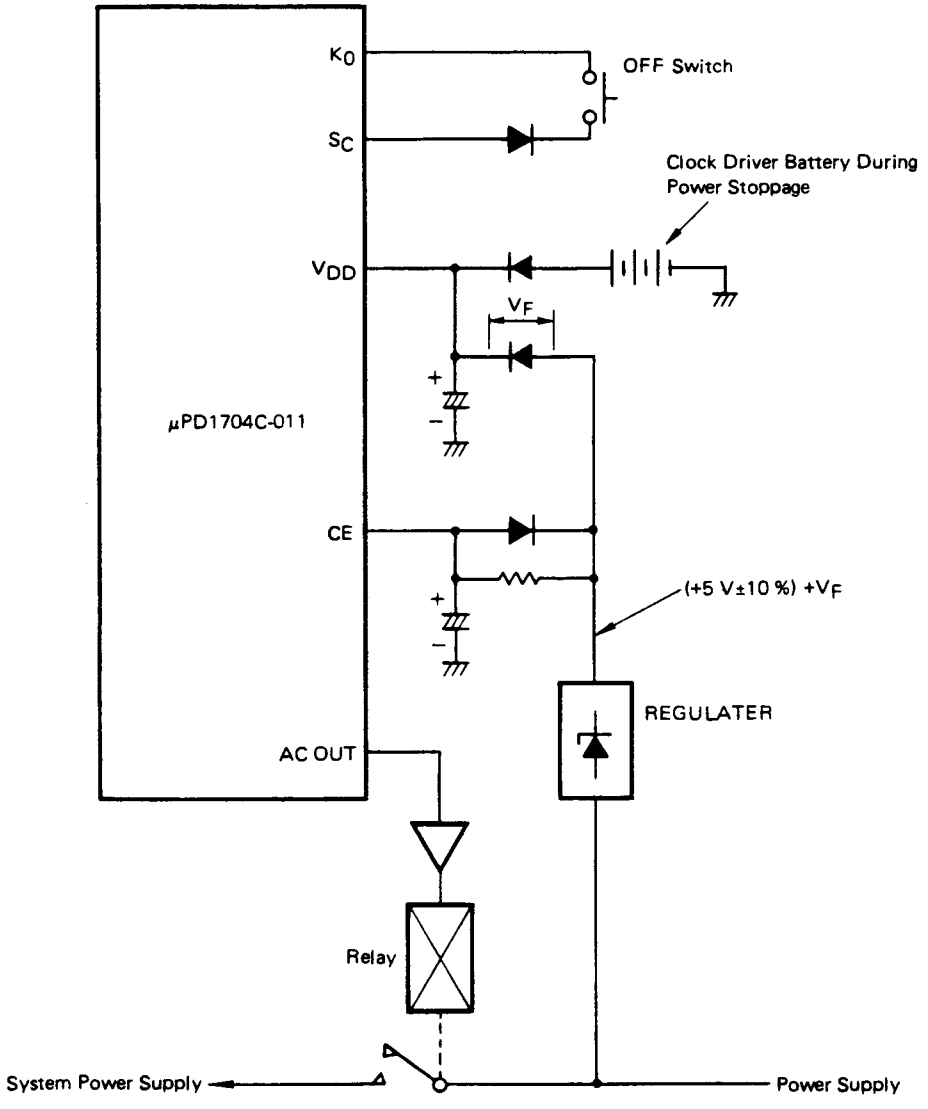
KEY \ Type Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Initial Setting Switch	NONCLOCK	ON	OFF		ON	OFF		ON	OFF		ON	OFF		ON	OFF		ON	OFF		ON	OFF		ON	OFF	
	FM ONLY	OFF												ON											
Function	BAND	Both AM and FM												FM Only											
	Remote Control	×						○						×						○					
	Source Selector	×			○			×			○			×			○			×			○		
	Clock	×		○	×		○	×		○	×		○	×		○	×		○	×		○	×		○
	Timer	×	×	○	×	×	○	×	×	○	×	×	○	×	×	○	×	×	○	×	×	○	×	×	○
Effective Keys or Switches	0 (AM)	AM	●		AM	●		AM	●		AM	●		–	0		–	0		–	0		–	0	
	1 (EVERYDAY1 ON)	1	●		1	●		1	●		1	●		1	●		1	●		1	●		1	●	
	2 (EVERYDAY1 OFF)	2	●		2	●		2	●		2	●		2	●		2	●		2	●		2	●	
	3 (EVERYDAY2 ON)	3	●		3	●		3	●		3	●		3	●		3	●		3	●		3	●	
	4 (EVERYDAY2 OFF)	4	●		4	●		4	●		4	●		4	●		4	●		4	●		4	●	
	5 (ONCE ON)	5	●		5	●		5	●		5	●		5	●		5	●		5	●		5	●	
	6 (ONCE OFF)	6	●		6	●		6	●		6	●		6	●		6	●		6	●		6	●	
	7	7																							
	8	8																							
	9 (FM)	FM	●		FM	●		FM	●		FM	●		–	9	●	–	9	●	–	9	●	–	9	●
	REMCON	–						●						–						●					
	OFF	–	●		–	●		–	●		–	●		–	●		–	●		–	●		–	●	
	CLKCAL																								
	CHSCAN	●																							
	UP																								
	DOWN																								
	MEMORY																								
	PHONO	–			●			–			●			–			●			–			●		
	TAPE																								
	AUX																								
MODE SW	CLOCK SET	–	●		–	●		–	●		–	●		–	●		–	●		–	●		–	●	
	RADIO	●																							
	TIMER OPE	–	●		–	●		–	●		–	●		–	●		–	●		–	●		–	●	
	TIMER READ																								
	TIMER WRITE																								
	TIMER CANCEL																								

5-1. Example of types without remote control nor clock (Corresponding type numbers : 1, 4, 13, and 16)

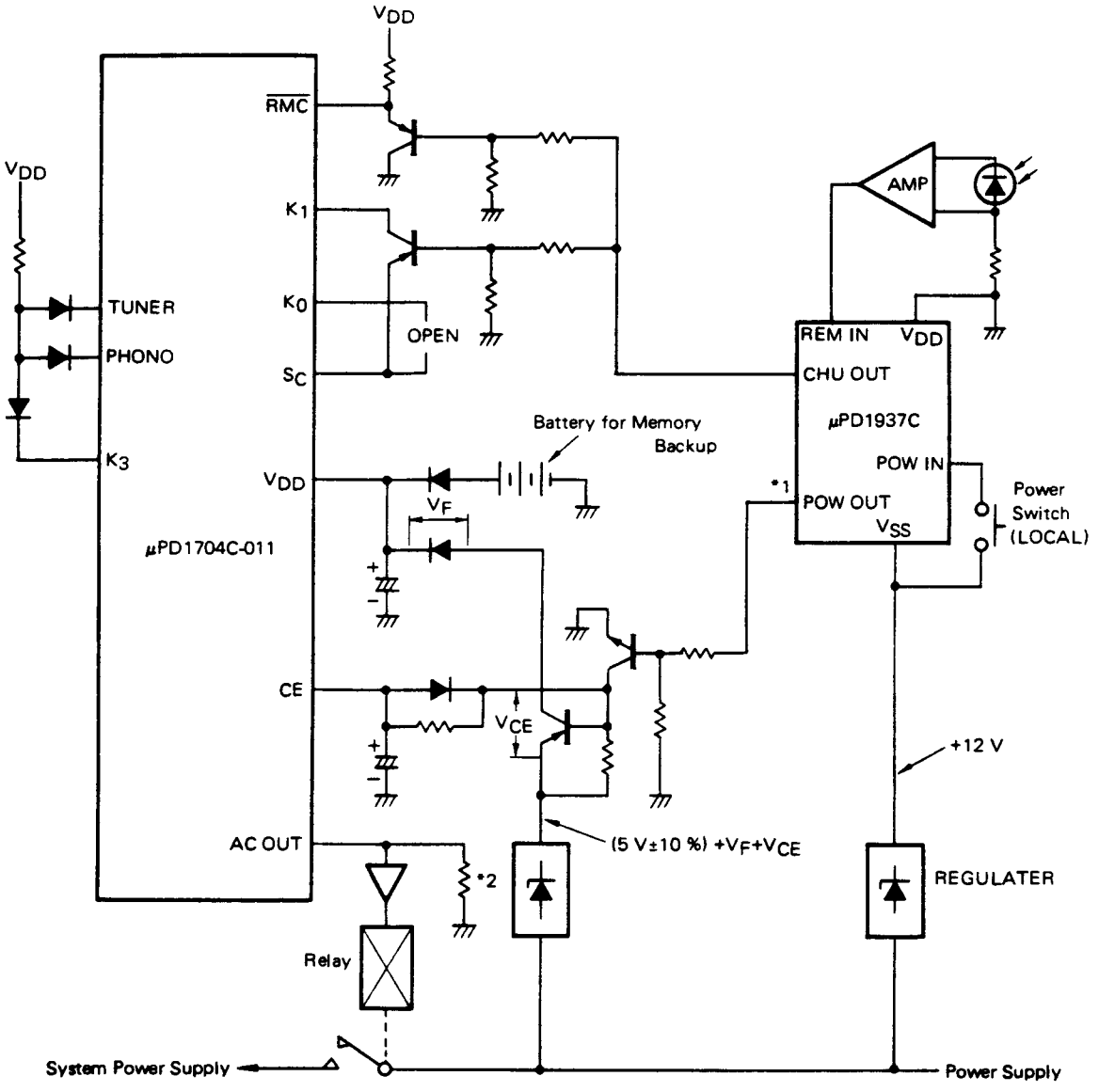


* AC OUT terminal might become high impedance when power switch is OFF. Hence be certain to insert a pull-down resistance.

5-2. Example of types with clock but without remote control (Corresponding type numbers : 2, 3, 5, 6, 14, 15, 17, and 18)

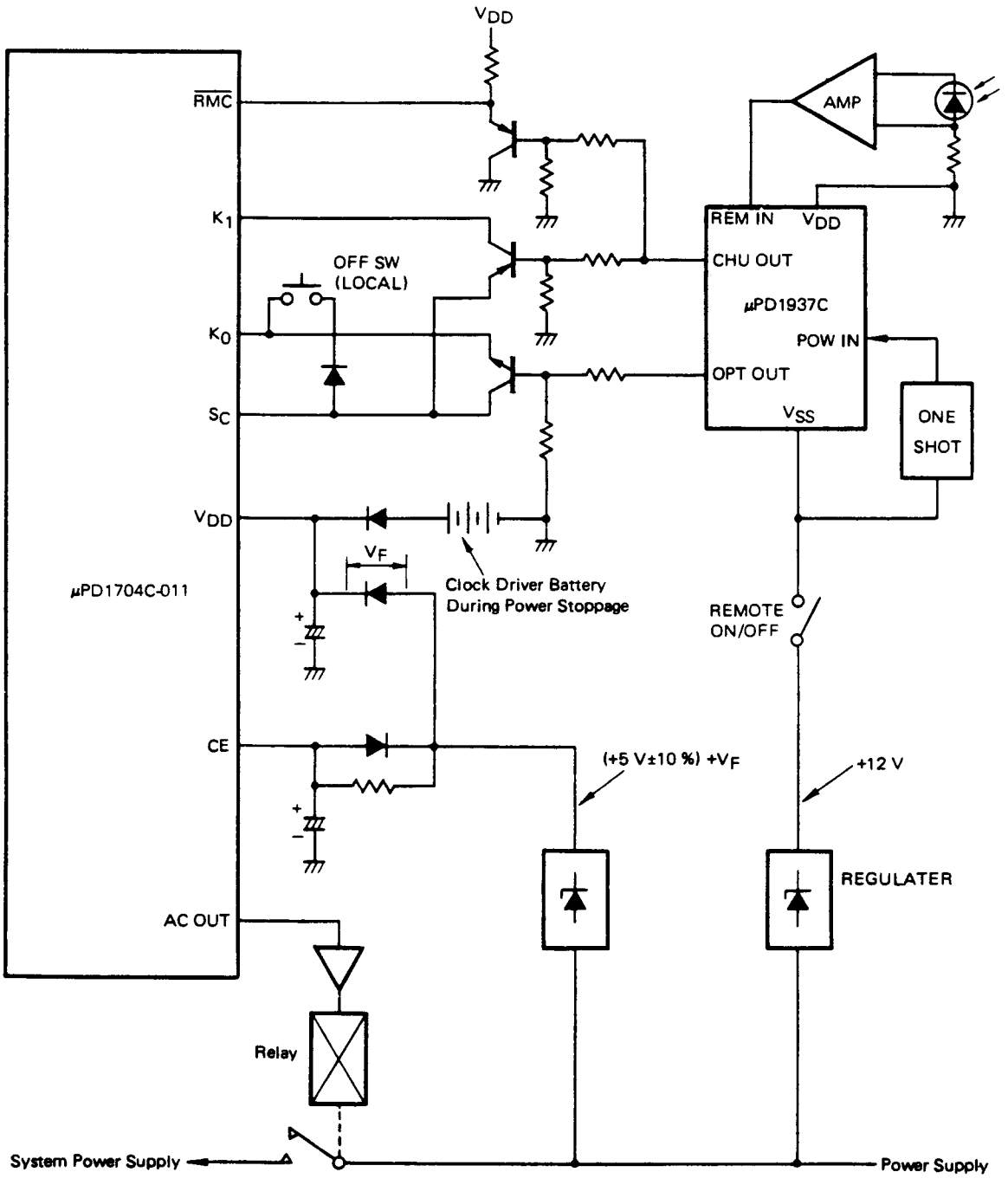


5-3. Example of types with remote control but without clock
(Corresponding type numbers : 7, 10, 19, 22)



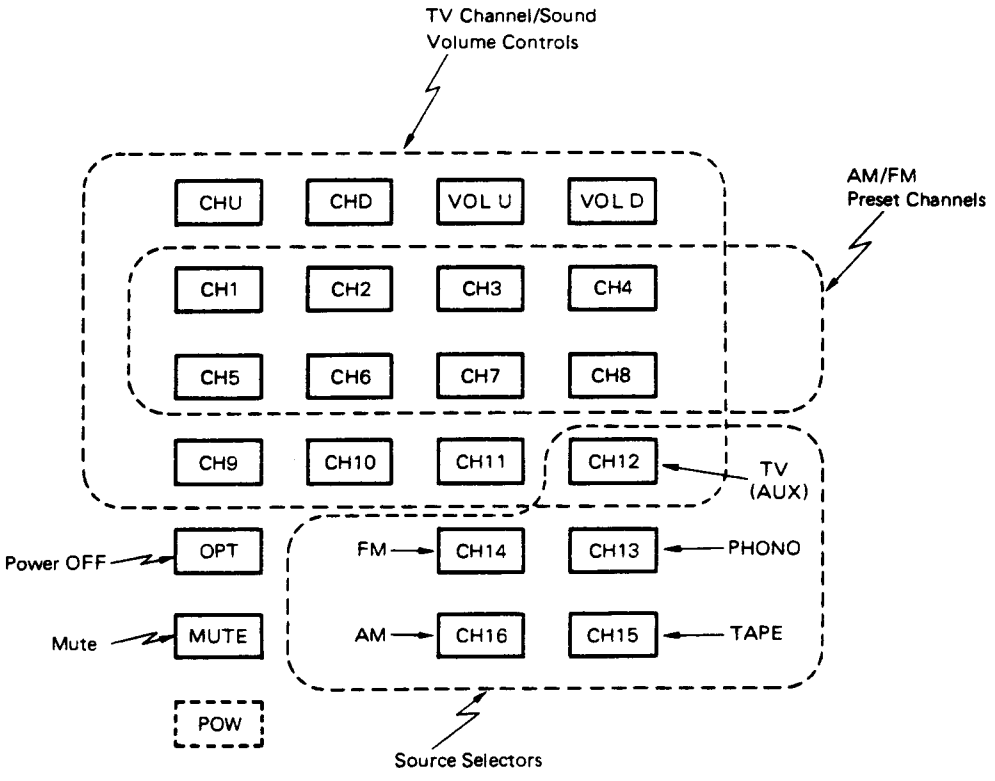
* Note 1.) To turn system ON/OFF by remote control, use POW switch of transmitter (μPD1986C)
2.) AC OUT terminal might become high impedance when power switch is OFF. Hence be certain to insert a pull-down resistance.

5-4. Example of type with both remote control and clock
(Corresponding type numbers : 8, 9, 11, 12, 20, 21, 23, 24)



Note) To turn system OFF by remote control, use OPT switch of transmitter (μPD1986C). Never use POW switch.

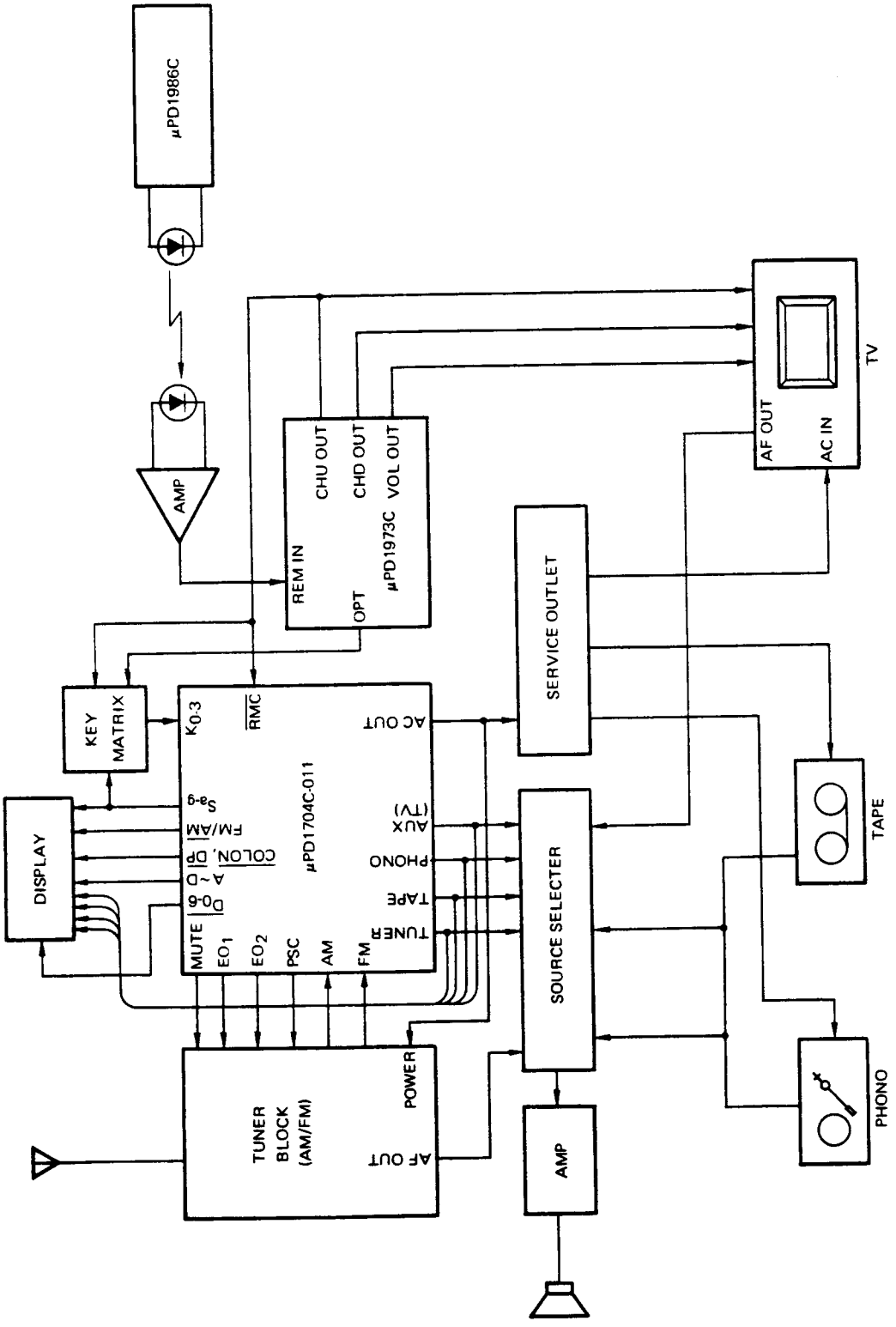
5-5. Key Allocation for Remote Control Transmitter (μPD1986C) (To be used in model types with clock)



Note 1) In models with clock, POW switch of the remote control transmitter is not used. In models without clock, POW switch is used instead of OPT switch shown in the diagram.

Note 2) The symbols inside the square (□) are those used in the specification of μPD1986C.

5-6. Multiplexed Stereo Sound TV Receiver Model with Remote Control/Clock
Example of application to music center



APPLICATION EXAMPLE OF CIRCUIT DIAGRAM