

MOS DIGITAL INTEGRATED CIRCUIT

μ PD1706G-011

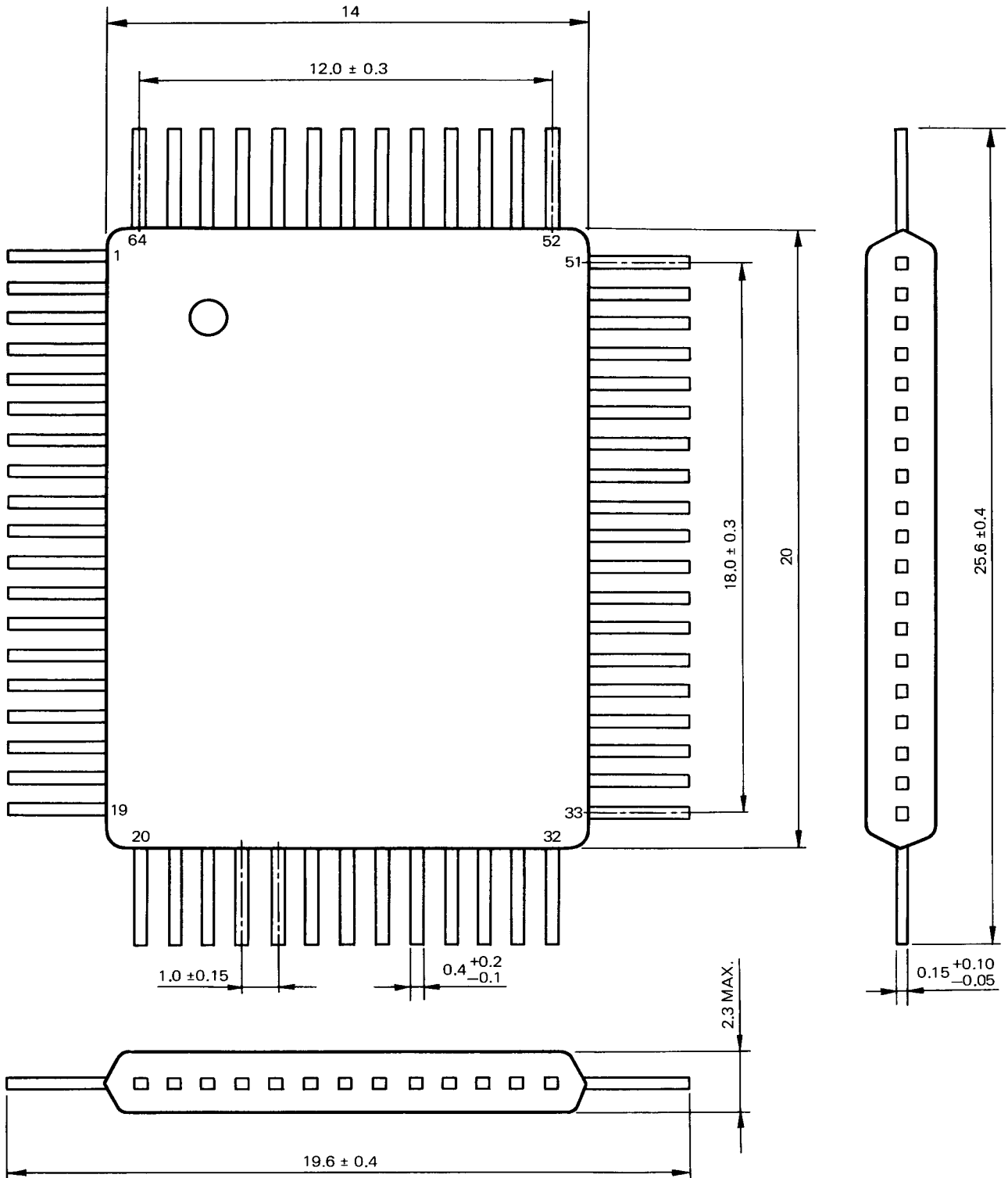
PLL SYNTHESIZER CONTROLLER FOR LW/MW/FM/SW with LCD driver

The μ PD1706G-011 is a 4-band (LW/MW/FM/SW1/SW2/SW3) PLL synthesizer controller with a timer, developed specifically for use in radio cassettes intended for Japan/U.S./Europe. Since it has a built-in LCD driver for display, LCD (Liquid Crystal Display) can be directly driven. By combining it with a low voltage drive prescaler μ PB556C designed for the purpose, therefore, you can build a low-voltage, low-power-consumption LCD drive digital tuning system.

FEATURES

- PLL and controller in a chip
- LCD direct drive (1/3 duty, 1/3 bias)
- Single 3 V $\pm$ 10 % supply
- Low power consumption: due to CMOS
- Capable of receiving six bands (LW/MW/FM/SW1/SW2/SW3)
- Pulse swallowing method (FM/SW2/SW3)
- Capable of controlling radio cassette (with radio/tape switching terminal)
- Main power control terminal provided
- Power on reset circuit self-contained (no external parts required)
- Clock function self-contained (12 hour/24 hour display switching possible)
- Alarm timer self-contained (buzzer modulation signal output possible: 3 kHz + 4 Hz + 0.5 Hz modulation)
- Sleep timer self-contained (60 minutes maximum . . . Time can be set in the unit of five minutes.)
- A variety of tuning modes
 - ★ Manual up/down search (saw-tooth mode): 125 ms/1ch.,
125 ms/10ch.
 - ★ Automatic up/down search (saw-tooth mode): 60 ms/1ch.
 - ★ Preset channel tuning: Random preset system
 - ★ Direct frequency tuning: With error display
- 10 preset channels can be stored in memory. (Random system)
- Last one memory (when power is OFF) and last preset channel memory (when bands are switched over) functions self-contained
- Uses 150 kHz crystal
- Uses 64-pin flat package which allows thinner assembly
- Allows IF offset of FM (four different IFs spaced 25 kHz apart).
- Employs quasi static key scan system (no key scan noise generated).
- All output terminals N-ch open drain (breakdown voltage 8.5 V MIN.)
(except KS₀ through KS₉, E0₁, E0₂, PSC, COM0 through 2, 1a through 9a)

PACKAGE DIMENSIONS (Unit: mm)



ABSOLUTE MAXIMUM RATINGS

Supply Voltage	V_{DD}	-0.3 to +6.0	V
Input Voltage	V_I	-0.3 to $V_{DD} + 0.3$	V
Output Voltage	V_O	+10.5 $\left(\frac{\overline{SW1S}, \overline{SW2S}, \overline{SW3S}, \overline{FMS}, \overline{MWS}, \overline{LWS}, \overline{MUTE}, \overline{PWROUT}}{BUZ \text{ terminals}} \right)$	V
Output Current	I_O	10	mA
Operation Temperature	T_{opt}	-35 to +75	°C
Storage Temperature	T_{stg}	-55 to +125	°C

ELECTRICAL CHARACTERISTICS (Test Condition unless otherwise specified:
 $T_{opt} = -35 \sim +75^\circ\text{C}$, $V_{DD} = 2.55 \sim 3.3\text{ V}$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Supply Voltage	V_{DD1}	2.7	3.0	3.3	V	CPU and PLL operation
Supply Voltage	V_{DD2}	2.55	3.0	3.3	V	CPU operation, PLL stop
Supply Current	I_{DD1}		2.0		mA	FM in = 8.5 MHz ($V_{DD} = 3.0\text{ V}$)
Supply Current	I_{DD2}		85		μA	PLL stop ($V_{DD} = 3.0\text{ V}$)
Supply Voltage Rise Time	t_r			100	ms	
Oscillation Start Voltage	V_{DOS}	2.7			V	$C_L = 20\text{ pF} \times 2$
Output Voltage	V_O			8.5	V	$\overline{SW1S}, \overline{SW2S}, \overline{SW3S}, \overline{FMS}, \overline{MWS}, \overline{LWS}, \overline{MUTE}, \overline{PWROUT}, BUZ$ terminals
Low Level Output Current	I_{OL2}	0.6			mA	" ($V_{OL} = 0.5\text{ V}$)
High Level Output Voltage	V_{OH1}	$V_{DD} - 0.4$			V	KS_8, KS_9 terminals ($I_{OH} = -400\text{ }\mu\text{A}$)
Low Level Output Voltage	V_{OL1}			0.4	V	" ($I_{OL} = 400\text{ }\mu\text{A}$)
High Level Input Voltage	V_{IH1}	$0.7 V_{DD}$			V	" CE terminals
Low Level Input Voltage	V_{IL1}			$0.3 V_{DD}$	V	" "
High Level Output Current	I_{OH2}	-1.0			mA	EO_1, EO_2 terminals ($V_{OH} = 0.6 V_{DD}$)
Low Level Output Current	I_{OL2}	1.0			mA	" ($V_{OL} = 0.4 V_{DD}$)
High Level Output Voltage	V_{OH4}	$V_{DD} - 0.4$			V	$KS_0 \sim KS_7$ ($I_{OH} = -200\text{ }\mu\text{A}$)
Low Level Output Voltage	V_{OL4}			0.5	V	" ($I_{OL} = 8\text{ }\mu\text{A}$)
High Level Input Voltage	V_{IH4}	$0.6 V_{DD}$			V	$K_0 \sim K_3$
Low Level Input Voltage	V_{IL4}			$0.2 V_{DD}$	V	"
High Level Input Current	I_{IL4}	6		40	μA	" ($V_{DD} = 3.3\text{ V}$, $V_{IH} = 0.6 V_{DD}$)
High Level Input Voltage	V_{IH5}	$0.8 V_{DD}$			V	SD terminal
Low Level Input Voltage	V_{IL5}			$0.2 V_{DD}$	V	"
High Level Output Voltage	V_{OH6}	$0.8 V_{DD}$			V	PSC terminal ($I_{OH} = -0.1\text{ mA}$)
Low Level Output Voltage	V_{OL6}			$0.2 V_{DD}$	V	" ($I_{OL} = 0.2\text{ mA}$)
AM Response Frequency	f_{AM}	0.5		6.2	MHz	$V_{IN} = 1\text{ V}_{p-p}$ sine wave (DC cut)
FM Response Frequency	f_{FM}	0.5		8.5	MHz	$V_{IN} = 0.8\text{ V}_{p-p}$ sine wave (DC cut)
Output Off Leak Current	$ I_L $		10^{-3}	1	μA	EO_1, EO_2 terminals
Output Voltage for LCD	V_0	0		0.2	V	$1a \sim 9a, COM0 \sim 2$ terminals ($V_{DD} = 3\text{ V}$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Output Voltage for LCD	V ₁	0.8	1.0	1.2	V	1a~9a, COM0~2 terminal (V _{DD} =3 V)
"	V ₂	1.8	2.0	2.2	V	"
"	V ₃	2.8		3.0	V	"
Pull-down Current	I _{PD1}		400		μ A	AM,FM terminal (V _{DD} =V _{IH} =3.0 V)
"	I _{PD2}		300		μ A	XI terminal (")
High Level Input Current	I _{IH1}		2		μ A	AM, FM terminal (")
Low Level Input Current	I _{IL1}		-2		μ A	"

1. GENERAL DESCRIPTION OF FUNCTIONS

1-1. Receiving frequencies

Band	Receiving Frequency Range	Channel Spacing	Reference Frequency	Intermediate Frequency
LW	153~281 kHz	1 kHz	1 kHz	450 kHz
MW	522~1611 kHz	9 kHz	3 kHz	450 kHz
	530~1610 kHz	10 kHz	5 kHz	
FM	87.5~108.0 MHz	200 kHz	25 kHz	(Note) 10.650, 10.675, 10.700, 10.725 MHz
		50 kHz		(Note) -10.675, -10.700, -10.725, -10.750 MHz
	76.1~108.0 MHz	50 kHz		
SW1	2.300~2.935 MHz	5 kHz	5 kHz	450 kHz
	2.940~3.575 MHz			
	3.580~4.215 MHz			
	4.540~5.175 MHz			
SW2	5.820~6.455 MHz			
	7.100~7.735 MHz			
	9.500~10.135 MHz			
	11.580~12.215 MHz			
SW3	15.100~15.735 MHz			
	17.500~18.135 MHz			
	21.340~21.975 MHz			
	25.500~26.135 MHz			

Note) Selectable by diode matrix
(For details, see P. 11)

1-2. Tuning functions

(1) Automatic tuning (saw-tooth mode)

- Automatic up
 - Automatic down
- Once a station is received, the station is retained.

(2) Manual tuning (saw-tooth mode)

- Manual up
 - Manual down
-Step advance operation by momentary switch.
If key continues to be depressed for more than 0.5 sec., scanning is continued until the key is released. If FAST key is simultaneously depressed, ultra fast scanning is made.

(3) Direct frequency key in Frequency is directly input by 10 keys.

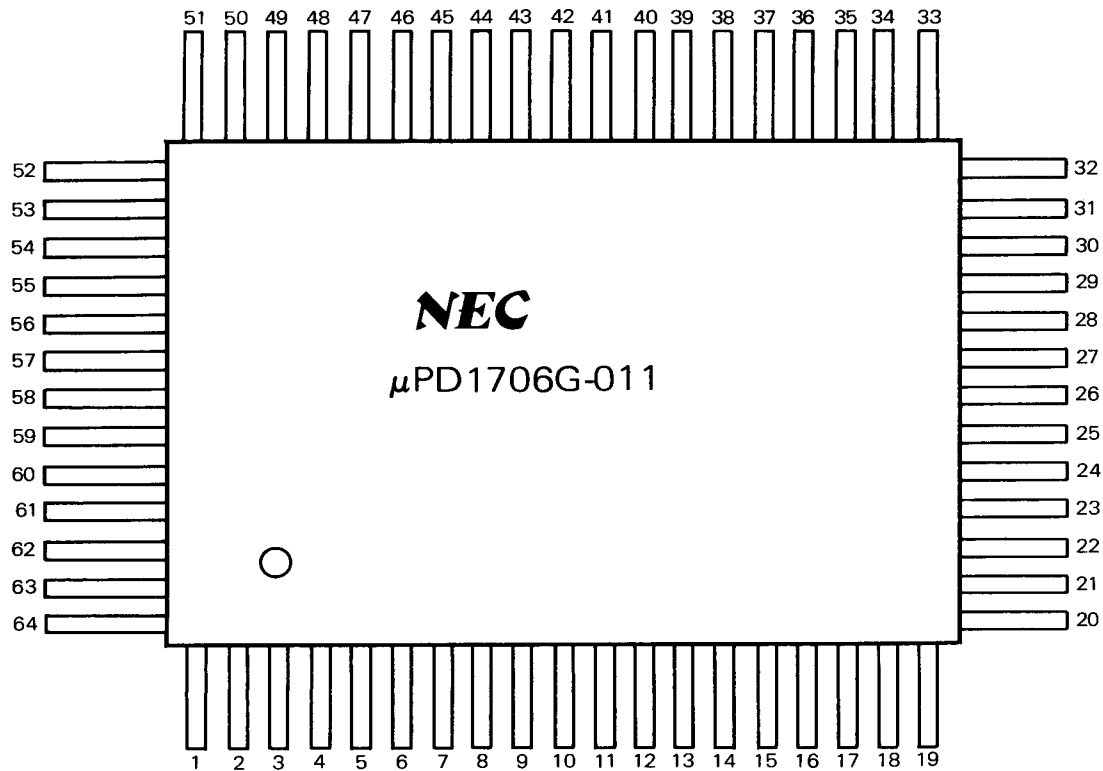
(4) Preset memory call Common to all bands, 10 stations in total

1-3. Timer functions

- (1) Alarm When preset time arrives, buzzer pulse is output. At the same time, power is turned on. The ON state lasts for 120 minutes, and then both are forced to the OFF state. (Daily timer)
- (2) Sleep Can be set to 60 minutes maximum five minutes apart.

2. PIN DESCRIPTION

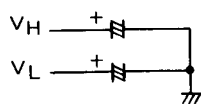
2-1. Pin Configuration (Top View)



Pin. No.	Symbol	Pin. No.	Symbol	Pin. No.	Symbol	Pin. No.	Symbol
1	NC	17	1c	33	SW2S	49	X1
2	8a	18	1b	34	SW3S	50	XO
3	7c	19	1a	35	FMS	51	K3
4	7a	20	7b	36	MWS	52	K2
5	6a	21	9a	37	LWS	53	K1
6	5c	22	V _L	38	MUTE	54	K0
7	5b	23	V _H	39	PWROUT	55	PSC
8	5a	24	COM2	40	BUZ	56	AM
9	3b	25	COM1	41	KS0	57	FM
10	4c	26	V _{DD}	42	KS1	58	V _{DD}
11	4b	27	COM0	43	KS2	59	SD
12	4a	28	KSg	44	KS3	60	PWRIN
13	3a	29	KSg	45	KS4	61	TEST
14	2c	30	T/R	46	KS5	62	EO1
15	2b	31	PWRSW	47	KS6	63	EO2
16	2a	32	SW1S	48	KS7	64	GND

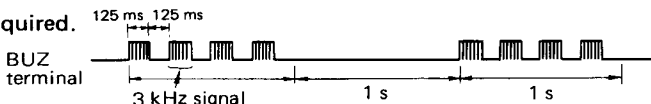
(NC : No Connection)

2-2. Pin Description

Pin No.	Symbol	Pin Name	Description
2~21	1a~9a	LCD SEGMENT SIGNAL	LCD segment signal output terminals (LCD of 1/3 duty and 1/3 bias to be used. See note.)
22 23	V_L V_H	Intermediate voltage output terminals for LCD	Of power voltages for LCD, intermediate ones are output to these pins. If these intermediate potentials do not stabilize when a large-size LCD is to be driven, connect large capacity capacitors between V_H , V_L and GND. Normally opened. 
24,25,27	COM0~2	LCD COMMON SIGNAL	LCD common signal output terminals
26 58	V_{DD}	POWER SUPPLY	Device power terminals 3 V $\pm$ 10 % voltage supplied when device is operated. Power can be supplied to either pin 26 or 58 only. V_{DD} rise time must be less than 100 ms (0 to 2.7 V). Extremely long rise time might result in failure of proper initialization. When V_{DD} does not fall completely to 0 V and rises again to 2.7 V, reset is not assured. In such a case, reset must be made from outside using PWRIN terminal.
28 29 41	KS ₉ KS ₈ KS ₀	KEY RETURN SIGNAL SOURCE FOR ALTERNATE SWITCH	Key return signal source output terminals for initialization diode matrix on key matrix and alternate switch. To input these outputs to terminals K ₀ through K ₃ , make sure that diodes for prevention of counter flow are inserted. (Refer to Key Matrix Configuration on P. 10)
42~48	KS ₁ } KS ₇	KEY RETURN SIGNAL SOURCE FOR MOMENTARY SWITCH	Key return signal source output terminals for momentary switches on key matrix.
51~54	K ₃ } K ₀	KEY RETURN SIGNAL INPUT	Key return signal input pins for key matrix. (For details, refer to Key Matrix Configuration on P. 10)
30	T/ $\bar{R}$	TAPE/RADIO SWITCHING INPUT	TAPE and RADIO switching signal input terminal. To be combined with TAPE/RADIO switch of set. Input as follows: When TAPE is selected: High level (PLL stopped, time displayed) When RADIO is selected: Low level (PLL operated, time or frequency displayed) <u>PWROUT</u> terminal should be directly connected when RADIO is selected. (For details, refer to Application on P. 34)

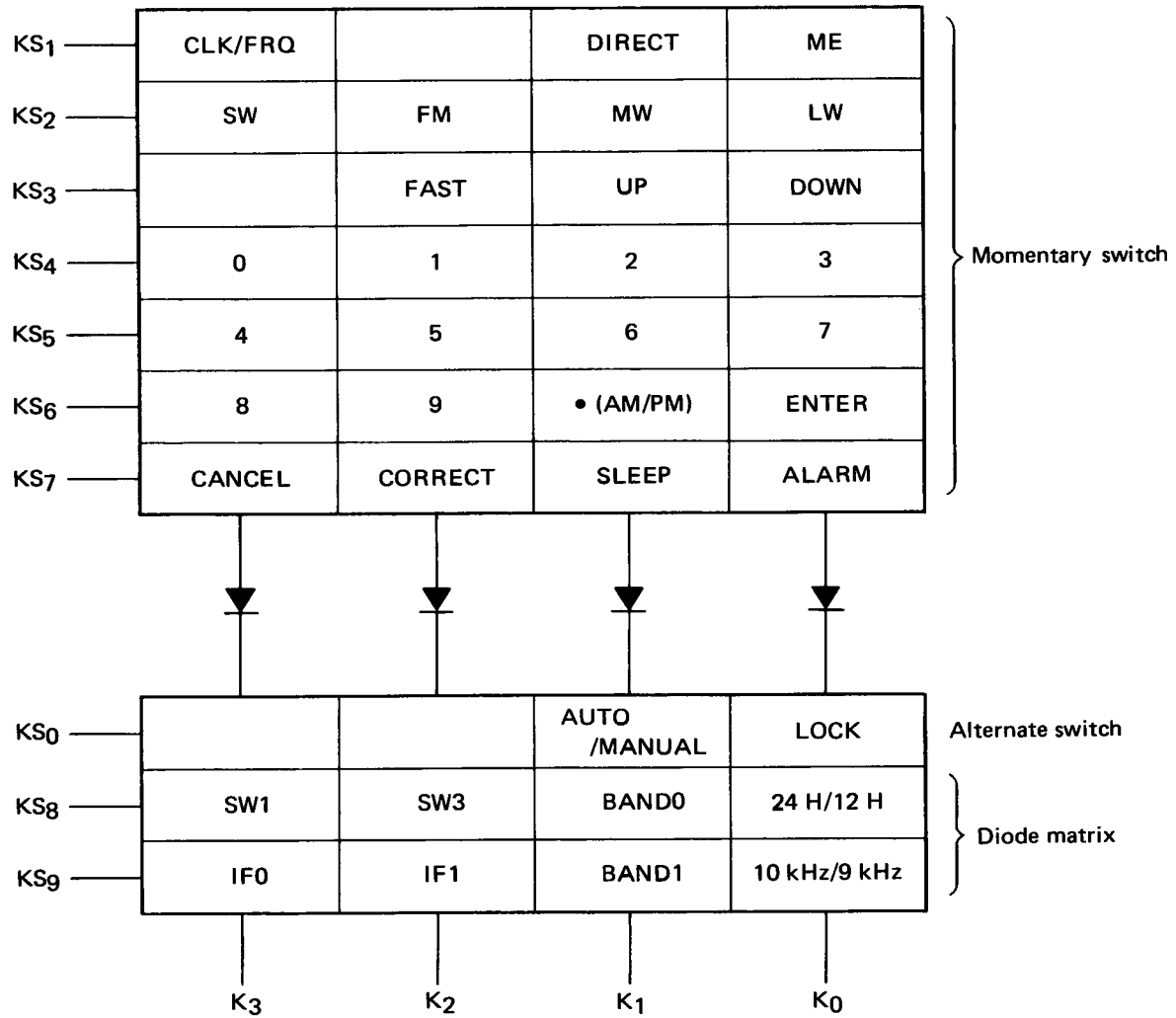
Note) Recommended LCDs:

- EPSON KT-104
- ALPS ELECTRIC CO., LTD. PAD32901
- HITACHI LTD. LP031-C

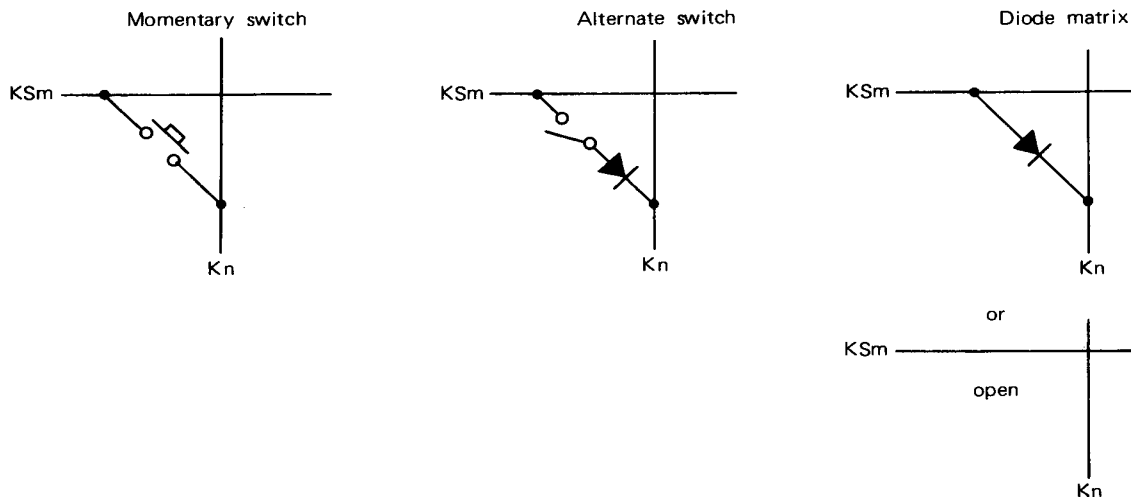
Pin No.	Symbol	Pin Name	Description
31	PWRSW	MAIN SWITCH ON/OFF REQUEST INPUT	Input pin for ON/OFF detection of main switch of set. When main power is to be turned on by $\overline{\text{PWROUT}}$ output, input high level. When it is to be turned off, input low level. When high level is input, low level is output to $\overline{\text{PWROUT}}$ terminal and PLL operates. When low level is input, high level is output to $\overline{\text{PWROUT}}$ terminal, and PLL stops (For details, refer to Application on P. 34.)
32 37	$\overline{\text{SW1S}}$ $\overline{\text{SW2S}}$ $\overline{\text{SW3S}}$ $\overline{\text{FMS}}$ $\overline{\text{MWS}}$ $\overline{\text{LWS}}$	VCO SELECT SIGNAL OUTPUT	VCO select signal output terminal, and active low output. Since it is N-channel open drain output, external pull-up resistor is required. Output breakdown voltage is 8.5 V maximum.
38	MUTE	MUTE OUTPUT	Muting signal output terminal for killing shock noise which may otherwise be produced when PLL is out of lock. Active high. Since it is N-channel open drain output, external pull-up resistor is required. Output breakdown voltage is 8.5 V max. For details of timing, refer to Mute Timing Chart on P. 29.
39	$\overline{\text{PWROUT}}$	MAIN POWER SWITCHING OUTPUT	Output terminal for ON/OFF switching signal of main power of set. Normally this terminal is used so that main power will be turned on when this terminal is low and turned off when this terminal is high. Since it is N-channel open drain output, external pull-up resistor is required. Output breakdown voltage is 8.5 V max. (For details, refer to Application on P. 34.) $\overline{\text{PWROUT}}$ terminal varies with the state of $\overline{\text{PWRIN}}$ terminal and condition of ALARM and SLEEP. When it varies, however, MUTE signal is always output at least 250 ms beforehand to minimize power ON/OFF shock noise.
40	BUZ	BUZZER OUTPUT	Buzzer modulation signal output terminal. Outputs 3 kHz signal modulated by 4 Hz and 0.5 Hz when ALARM is ON. (For details, refer to illustration shown below.) Since it is N-channel open drain output, pull-up resistor is required. 
49 50	XI XO	CRYSTAL	Crystal connection terminals. Connect 150 kHz crystal. Recommended crystals: • TOYO TSUSHINKI TQC-122A-7C • KYOTO CERAMICS KF-38Z

Pin No.	Symbol	Pin Name	Description
55	PSC	PULSE SWALLOW CONTROL	Outputs signal for switching the frequency dividing ratio of prescaler (μPB556C) in modes (FM, SW2 or SW3) where pulse swallowing system is employed for frequency division. Connect this terminal to PSC terminal of the prescaler μPB556C. The dividing ratio of μPB556C is 1/16 and 1/17.
56	AM	VCO INPUT FOR LW, MW and SW1	Terminal for inputting LW, MW or SW1 local oscillation outputs. An AC amplifier is incorporated, and DC should be cut with a capacitor.
57	FM	VCO INPUT FOR SW2, SW3 and FM	Terminal for inputting FM, SW2 or SW3 local oscillation outputs frequency-divided into 1/16 and 1/17 by the prescaler μPB556C. An AC amplifier is incorporated, and DC should be cut with a capacitor.
59	SD	STATION DETECTOR	Terminal for inputting signal for detecting whether broadcast station has been received during automatic tuning (automatic up/down). High level should be input when a station is received. It must be input in less than 30 ms after frequency dividing ratio has changed. (Refer to P. 31)
60	PWRIN	MAIN POWER ON/OFF REQUEST INPUT	Input terminal for detecting main power ON/OFF of the set. Connect this terminal to main power. If this terminal is LOW, no alarm operation is performed. Avoid creating contradictory state where PWRSW terminal is HIGH and PWRPIN terminal is LOW. When reset is to be made using PWRIN terminal, input high level after it has been set LOW. This terminal however, does not accept pulses shorter than 140 μs. When reset is made using this terminal, state of diode switch at initialization is loaded.
61	TEST	DEVICE TEST TERMINAL	Device test terminal. Connect to GND.
62 63	EO1 EO2	ERROR OUT	Charge pump output of phase detector constituting PLL. If divided oscillation frequency is higher than reference frequency, these pins output high level. When it is lower, on the other hand, terminals output low level. If they coincide, the terminals enter floating state. Since EO1 and EO2 output same signal simultaneously, they may be connected to LPF (Low Pass Filter) of any of LW, MW, FM, SW1, SW2 or SW3.
64	GND	GROUND	Connect to GND of the set.

3. KEY MATRIX CONFIGURATION



Switch Connections



4. DESCRIPTION OF KEY MATRIX

4-1. Initialization Diode Matrix

Initialization diode matrices are of the following five kinds. All of them are loaded when power is applied to V_{DD} for the first time (at initialization) or when PWRIN changes from LOW to HIGH.

- (1) Switch for setting IF offset values of FM

IF0 IF1

- (2) Switch for setting FM band areas (the U.S., Europe, Japan)

BAND0 BAND1

- (3) Switch for setting MW band channel spacing and reference frequency

10 kHz/9 kHz

- (4) Switch for selecting SW bands

SW1, SW3

- (5) Switch for selecting 12/24 hour systems of clock

24H/12H

These should be set by shorting or opening intersecting points on the matrix with diodes. (on the following table, "1" means shorting by Diode and "0" means opening.)

SWITCH	FUNCTION DESCRIPTION				
IF1 IF0	Switches for setting IF offset values of FM. Four different IFs spaced 25 kHz apart can be set without changing displayed frequencies.				
	IF1	IF0	U.S. band	European band	Japanese band
	0	0	10.700 MHz	10.700 MHz	-10.700 MHz
	0	1	10.725 MHz	10.725 MHz	-10.675 MHz
	1	0	10.650 MHz	10.650 MHz	-10.750 MHz
	1	1	10.675 MHz	10.675 MHz	-10.725 MHz
BAND1 BAND0	Switches for setting FM band areas. U.S., European or Japanese FM band can be selected.				
	BAND1	BAND0	Band area	Receiving frequency range	Channel spacing
	0	0	Japanese band	76.10~108.00 MHz	50 kHz
	0	1	European band	87.50~108.00 MHz	50 kHz
	1	0	Inhibited*		
	1	1	U.S. band	87.5~107.9 MHz	200 kHz
10 kHz/ 9 kHz	* Do not set switches as shown, as correct band (area) cannot be set.				
	Switch for setting MW band channel spacing, reference frequency and frequency range. Can be set independently regardless of FM band areas (BAND1, BAND0).				
	10 kHz/9 kHz		Receiving frequency range	Channel spacing	Reference frequency
	0		522~1611 kHz	9 kHz	3 kHz
	1		530~1610 kHz	10 kHz	5 kHz

Switch	Function Description		
SW3 SW1	Switches for inhibiting receiving bands of SW bands.		
	SW3	SW1	Receiving band
	0	0	SW1, SW2, SW3
	0	1	SW2, SW3
	1	0	SW1, SW2
	1	1	SW2
24H/12H	Switch for selecting 24/12 hour system.		
	24H/12H	Display	
	0	12-hour display (combined AM/PM display)	
	1	24-hour display	

4-2. Alternate Switches

The alternate switches are of the following two kinds. These are always switchable.

- (1) Switch for switchover between automatic tuning and manual tuning

AUTO/MANUAL

- (2) Switch for locking all switches on key matrix

LOCK

Switch	Function Description
AUTO/ MANUAL	Switch for switchover between automatic tuning and manual tuning. ON . . . Automatic tuning (automatic seek operation) OFF . . . Manual tuning
	Automatic and manual tuning operations are initiated by depressing the UP or DOWN momentary switch after setting AUTO/MANUAL switch. (For details, refer to Description of UP and DOWN keys on P. 13) Even if this switch is changed over to MANUAL during automatic tuning, tuning operation does not stop. To stop operation on switchover to MANUAL, compose the circuit so that high level will be input to SD terminal whenever switchover is made to MANUAL.
LOCK	To prevent accidentally changing receiving frequency or cutting off PWROUT output as during a recording, set this switch to ON, and all switch inputs on the key matrix will be inhibited. ON . . . Switch locked OFF . . . Normal operation

4-3. Momentary Switches

Symbol	Function Description
CLK/FREQ	Present time and frequency display switching key. This key is enabled only during the radio operating mode. When this key is pushed while present time display is ON, switchover is made to frequency display. When this key is pushed while frequency display is ON, switchover is made to current time display.
DIRECT	Key for setting direct frequency input mode. When this key is pushed during the radio operating mode, the direct frequency input mode is created, allowing a frequency to be directly keyed in by 10 keys and the set to be tuned in on the frequency. (For details, refer to Operating Procedures on P. 17)
ME	Use this key to write a new frequency to preset channel memory. This key is enabled only during the radio operating mode. Push any one of the 10 keys in less than five seconds after pushing this key, and the frequency being received at the moment can be preset to the preset channel memory corresponding to the key pushed. (For details, refer to the Operating Procedures on P. 22)
LW MW FM SW	Switches for selecting LW, MW, FM and SW bands. During the radio operating mode, push any one of these keys, and switchover will be made to the selected band. If there is a channel previously written to preset channel memory of the selected band, the set is tuned to the last received preset channel. If the preset channel memory has no written channel for the band, the set is tuned to the lowest channel of the band. (Refer to P. 22)
FAST	Ultra fast key for manual UP/DOWN. After the UP or DOWN key has been depressed during the radio reception, depress this key simultaneously, and ultra-fast operation of 125 ms/10ch will take place.
UP DOWN	Automatic and manual tuning keys. When these keys are pushed, the following operations will be performed. (1) AUTO/MANUAL switch in AUTO position Pushing the UP key will sustain up-tuning operation in sawtooth mode, whereas pushing the DOWN key will sustain down-tuning operation. If high level is input to SD terminal during the period, automatic tuning operation will stop. (2) AUTO/MANUAL switch in MANUAL position Each time the UP or DOWN key is pushed, up or down tuning to another channel a step (channel space) apart will be made. If the UP or DOWN key continues to be pushed for more than 0.5 second, up or down tuning will continue at a speed of 125 ms/1ch until the key is released. (Note) Even if the AUTO/MANUAL switch is changed over to MANUAL during automatic tuning, the automatic tuning operation does not stop. To stop the operation on switchover to MANUAL, compose the circuit so that high level will be input to SD terminal whenever switchover is made to MANUAL.

Symbol	Function Description
0 1 2 3 4 5 6 7 8 9	Numeric keys or preset channel memory write/call keys. (1) As numeric keys (10 keys) When the present time or alarm time is to be corrected, push the CORRECT key and then directly key in a desired time. In the direct frequency input mode, a desired frequency can be keyed in directly by these keys. (2) As preset channel memory keys During the radio operating mode these keys correspond to the preset channel memory on 1:1 basis. ○ To write In less than five seconds after ME key has been pushed, push any one of keys from 0 through 9, and a new channel will be written to memory corresponding to the key pushed. ○ To call When any one of the keys 0 through 9 is pushed during the radio operating mode, the channel corresponding to the key pushed will be called.
• (AM/PM)	Operates as decimal point key or AM/PM switching key. In the direct frequency input mode, this key operates as the decimal point key. When time is corrected during 12-hour display, the key operates as the AM/PM switching key.
ENTER	(1) Direct tuning After a channel has been directly keyed in by 10 keys, push this key, and the set will be tuned to this channel. (2) To correct present time and alarm time After a desired time has been directly keyed in by 10 keys, push this key, and the time will be set. In correcting the present time, correction will begin with 0 second when this key is pushed.
CANCEL	When this key is pushed during the direct tuning, present time correction or alarm time correction mode, the mode is cancelled. When this key is pushed during an alarm or sleep operation, the operation is cancelled.
CORRECT	Present time correction key. When this key is pushed while present time display is ON, the present time correction mode is created. In this case, the LCD presents "CORRECT" display, whereas flashing display of second stops.
SLEEP	Accepted only when PWRSW terminal is LOW and when ALARM is not ON. When this key is pushed while there is no "SLEEP" display on the LCD, the set enters the sleep state, and "SLEEP" display is presented. At this point, the sleep time is set to 60 minutes, and the PWROUT output will be forced to the OFF state 60 minutes later. This key can also be used to check the remaining sleep time. When the key is pushed, the remaining time (in minutes) will be displayed on the LCD. When the SLEEP key is pushed while the sleep time is being displayed on the LCD, the sleep time is reduced by five minutes.
ALARM	When this key is pushed, the alarm time is displayed. Alarm time correction can be made by depressing 10 keys or AM/PM key while the alarm time is on display. The time on display is set when the ENTER key is pushed. When the alarm time arrives while "ALARM" display is ON, the PWROUT and BUZ terminals are caused to be ON. To put out the "ALARM" display, push the ALARM key and then push the CANCEL key.

5. CONTROL TERMINALS

By terminals PWRIN, PWRSW, $\overline{\text{PWROUT}}$ and $\text{T}/\overline{\text{R}}$, modes are set as shown below.

(In the following table, 0 denotes low level, 1 denotes high level, and X denotes low or high level.)

PWRIN	PWRSW	$\overline{\text{PWROUT}}$	$\text{T}/\overline{\text{R}}$	Mode		Display (Note 1)
X	0	0	0	Power ON through alarm or sleep operation	RADIO	FREQ. (Note 2)/TIME
X	0	0	1		TAPE	TIME
X	0	1	0	Inhibited (When PWRSW is LOW, $\text{T}/\overline{\text{R}}$ must always be HIGH.)		
X	0	1	1	Power OFF for both RADIO and TAPE		TIME
1	1	0	0	Normal operation	RADIO	FREQ. (Note 3)/TIME
1	1	0	1		TAPE	TIME
1	1	1	0	Impossible modes (when high level is input to PWRSW pin, $\overline{\text{PWROUT}}$ pin always outputs low level. When PWRIN pin is LOW, do not input high level to PWRSW.)		
1	1	1	1			
0	1	X	X			

(Note 1) FREQ. and TIME displays mean the following displays.

TIME: Display of time (present time, alarm time, sleep time)

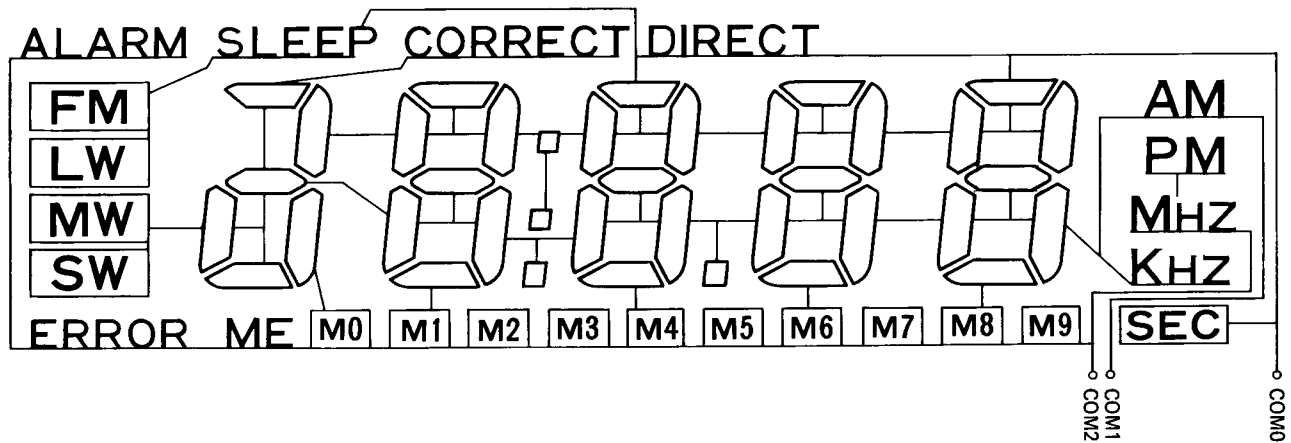
FREQ./TIME: Display of above-mentioned time or receiving frequency

(Note 2) In alarm or sleep mode, time display is given priority. For example, when the radio is turned on in the alarm or sleep mode, the channel will be displayed for the first five seconds only and the time displayed thereafter. When the CLK/FREQ key is pushed while the time display is ON after the radio has been turned on, the channel will be displayed for five seconds only and the time displayed thereafter.

(Note 3) In the normal operating mode where the timer is not used, the channel will be displayed while the radio is ON, and the time displayed during other modes. If the CLK/FREQ key is pushed while the radio is ON, the display will change to time display. The time display will be retained until other keys or switches are operated.

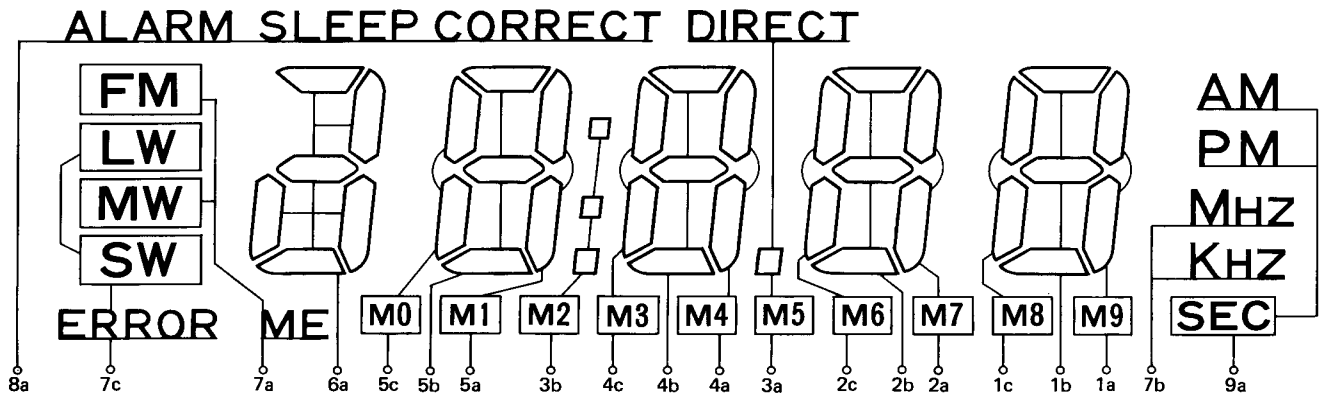
6. LCD PATTERN

COMMON LINES



LCD PATTERN

SEGMENT LINES



7. OPERATING PROCEDURES

7-1. Station selection

1. Manual Up/Down

Set the AUTO/MANUAL switch to MANUAL and depress the UP key or the DOWN key.

Continue the depression for more than 0.5 second, and the UP or DOWN operation occurs at a speed of 125 ms/1ch or so (Fast feed).

At this time, the MUTE of about 60 ms is output by each 1 ch of up or down operation, while no output is given for the remaining 60 ms. (Intermittent MUTE)(See the description on P. 30.)

Depress the UP or DOWN key and the FAST key at the same time, and the up or the down operation is executed at a speed of 125 ms/10ch. (Ultra fast feed)

While the ultra rapid feed is under way, the MUTE is being continually output. Release the FAST key, and the operation of fast feed is restored. If you release the UP or the DOWN key while depressing the FAST key, the UP/DOWN operation stops.

2. Auto Up/Down

Depress the UP or the DOWN key while the AUTO/MANUAL switch is set to AUTO, and the frequency shifts to the UP or the DOWN direction by 1 channel stepwise and whether input (high level) is fed to the SD terminal or not is checked. If there is input, the shift stops at that frequency. If no input is fed, the frequency continues to shift stepwise.

While automatic scanning is under way, the MUTE output continues to be fed. (As to detailed timing, refer to the description on P. 31)

To stop the automatic scanning half-way, depress the UP key, the DOWN key, or the FAST key.

3. Direct station selection

The frequency to be tuned may be directly input by 10 key. Depress the DIRECT key while the radio is on, then "DIRECT" is displayed showing that direct station selection can be accepted. Next, input the desired frequency within the existing band range by the 10 key and the decimal point key. Finally, depress the ENTER key, and the set will be tuned to that frequency.

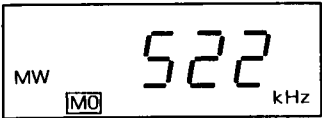
In case the input frequency is outside the existing frequency band, "ERROR" is displayed for 5 seconds. Thereafter the frequency to which the circuit was tuned before the DIRECT key was depressed will be restored. In case, further, the input frequency does not coincide with the channel frequencies within the existing frequency band, then tuning is made to the frequency of a channel just below the desired frequency.

During the time from depression of the direct key till depression of the ENTER key is depressed, and while "ERROR" is being displayed, the radio will continue to be tuned to the frequency received just before the direct key is depressed.

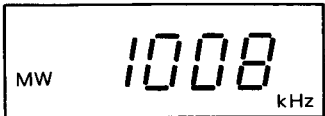
To cancel the direct station selection after depressing the DIRECT key and before depressing the ENTER key, simply depress the CANCEL key.

In case, further, you realized an error in the input frequency before depressing the ENTER key, then depress the DIRECT key for a second time. By doing so, exactly the same state as when you first depressed the direct key is restored. Thereafter, you may repeat the input of the correct frequency.

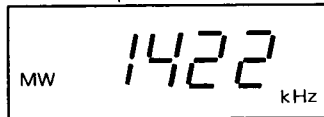
EXAMPLE 1) Correct station selection of MW band (Japan)

Key	Display	Frequency being received	Description
		522 kHz	The preset 0 ch is being received.
		522 kHz	The direct station selection is started. The frequency display goes out and "DIRECT" is displayed instead.
		522 kHz	Optional frequency is input by 10 key. The frequency is displayed at the right-hand end.
		522 kHz	Id.
		522 kHz	Id.
		522 kHz	Id.
		1008 kHz	"DIRECT" display goes out and the circuit is tuned to 1008 kHz. The display is shifted to the right by one unit.

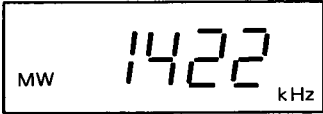
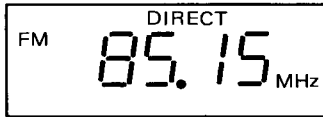
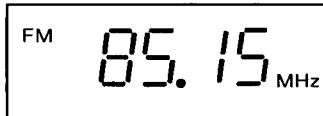
EXAMPLE 2) A frequency outside the MW (Japan) band is input

Key	Display	Frequency being received	Description
		1008 kHz	1008 kHz is being received.
    		1008 kHz	You would like to have the circuit tuned to 2000 kHz by direct station selection.
		1008 kHz	2000 kHz is outside the MW band. So, "ERROR" is displayed.
(5 seconds after)		1008 kHz	The original frequency of 1008 kHz is displayed after 5 seconds.

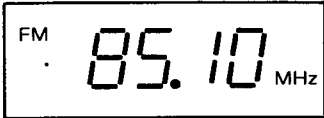
EXAMPLE 3) A frequency other than the channel frequencies in the MW (Japan) band is input

Key	Display	Frequency being received	Description
		1008 kHz	1008 kHz is being received.
    		1008 kHz	You would like to have the circuit tuned to 1425 kHz by direct station selection.
		1008 kHz	1425 kHz does not coincide with the channel frequencies. So, the circuit is tuned to 1422 kHz which is obtained by disregarding the lowest unit.

EXAMPLE 4) Correct station selection within the FM (Japan) band (Fraction of unit are input)

Key	Display	Frequency being received	Description
		1422 kHz	1422 kHz in MW frequency band is being received.
		80 MHz	Band is changed over, ch 5 has been preset on the last preset memory of FM band.
  		80 MHz	You would like to have the circuit tuned to 85.15 MHz by direct station selection.
		80 MHz	Input the decimal point, and the display is shifted to the left.
 		80 MHz	The fractional units are input one after another beginning from the tenth unit. After two fractional units are fed, the 10 Key is rejected.
		85.15 MHz	"DIRECT" display goes out, and the circuit is tuned to 85.15 MHz.

EXAMPLE 5) Correct station selection within FM (Japan) band (in case fractional units are not fed)

Key	Display	Frequency being received	Description
		85.1 MHz	85.1 MHz within the FM band is being received.
  		85.1 MHz	You would like to have the circuit tuned to 80 MHz by direct station selection.
		80 MHz	"DIRECT" display goes out, and the decimal point and "00" are indicated at the fractional units and the tuning is made to 80 MHz.

(Caution) With regard to the FM and SW bands, the fractional units of the frequencies are displayed together with the decimal point in terms of MHz.

In respect of the LW and MW bands, the frequencies are displayed in terms of kHz without the indication of fractional units. So, the decimal point key is rejected when you are selecting a frequency.

4. Preset channel

The preset channel is based upon random preset system, and a total of 10 stations can be preset. Each of the 10 keys 0~9 corresponds to each of the memories.

○ How to preset

Depress the ME key while the frequency is being displayed, and "ME" is shown. After about 5 seconds, the "ME" indication goes out and the original state is restored. Depress one of the keys 0~9 as required while the "ME" indication is on and the frequency under reception is preset on the channel corresponding to the depressed key. Then the "ME" display goes out and the preset channel number is displayed instead.

○ Preset channel calling

Depress the required key while the radio is on, and the corresponding preset channel is selected and the circuit tunes to the frequency of that channel.

In case the frequency band of the required preset channel is different from that of the channel under reception just before the selection is made, then the band is also changed over automatically.

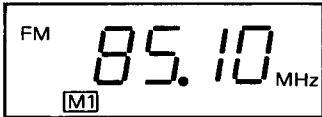
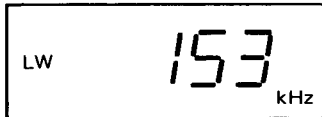
5. Last one memory

This memory is used when the radio power supply is disconnected. When the power supply comes on again, the circuit is tuned to the same frequency as when the power supply was cut off.

6. Last preset channel memory

This memory is used when the bands are changed over. If there exists a frequency already written into the preset memory within the frequency band when the band is selected, the circuit will be tuned to the preset channel within the band being received just before the band is changed over. In case the frequency within the band is not written in the preset memory, the tuning is made to the lowest frequency within the band.

EXAMPLE) Band selection

Key	Display	Description
		1008 kHz of MW band is being received by the preset channel (2 ch).
UP		The frequency is shifted upward by one step and 1017 kHz is received.
FM		The FM band is selected. The preset channel within the FM band received at the last reception (1 ch) is called out.
MW		The MW band is selected. The preset channel received at the last reception (2 ch) is called out. (Note: 1017 kHz which was received at the last reception within the MW band is not called out as it was not preset.)
LW		The LW band is selected. No frequency is preset in LW band. So, the lowest frequency is called out.

7-2. How to adjust the current time

The current time may be changed only when it is being displayed. To change it when the frequency is shown, first depress the CLK/FREQ key so that the time is displayed.

Next, depress the CORRECT key, then the time display goes out and "CORRECT" and ":" (colon) are then displayed, and the flashing of the seconds is interrupted. (In the case of a time display of a 12-hour system, AM or PM is also displayed.)

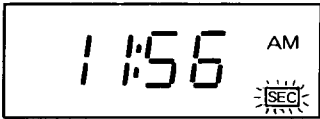
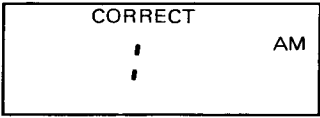
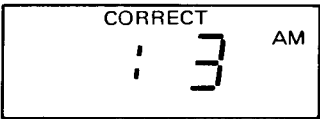
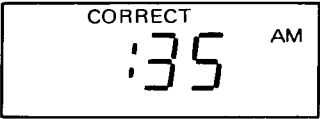
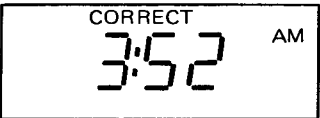
Input the required time by 10 key. In the case of a 12-hour system time display, AM and PM may be included by the AM/PM key.

Depress the ENTER key after the input of the new time has finished and the newly set time is displayed. The flashing of seconds is also restored, starting from zero.

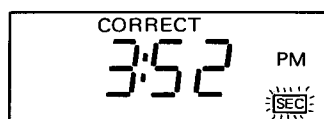
In case the input time is not correct, or in case a wrong key (i.e., any key other than 10 key, AM/PM key and CANCEL key) is depressed, "ERROR" is displayed for 5 seconds and the frequency shows while the radio is on. In other cases, however, the time is displayed. If a mistake is made, there is no need to adjust the time since the mechanism continues as normal.

To cancel the change of the time display after depressing the CORRECT key, you should again depress the CANCEL key. No time adjustment is necessary.

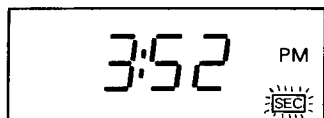
EXAMPLE 1) How to adjust the current time (in the case of a 12-hour display system)

Key	Display	Description
		Radio is under operation (1008 kHz within the MW band is being received)
		Current time is indicated. (by 12-hour system) Second is flashing.
		The correction of current time starts. The time display goes out and "CORRECT" is indicated.
		The time is fed by 10 key. The display is at the right hand end.
		The numerals are shifted by one unit to the left. (Note)
		When the input contains 4 or more digits only 1 or 2 is displayed at the uppermost unit.

Key	Display	Description
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Change AM/PM.

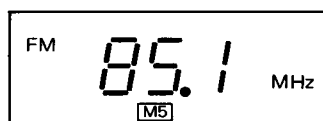


The 0 second starts at the time when the ENTER key is depressed and the second start flashing.

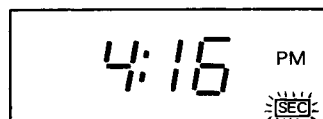
(Note) In the sequence described above, an optional order may be selected between the work of time input and that of the selection between AM/PM.

EXAMPLE 2) In case erroneous time is fed. (in a 12-hour display system)

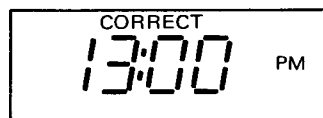
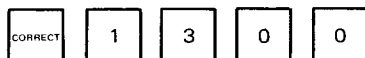
Key	Display	Description
-----	---------	-------------



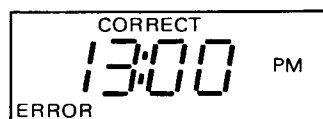
Radio reception is under way. (85.1 MHz is received by the preset 5 ch within FM band)



The current time is being displayed. (12-hour system) . The second is flashing.

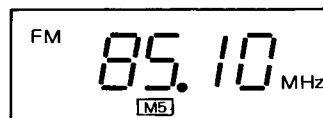


The time is supplied by 10 key.



13:00 in a 12-hour system is an erroneous time. So, "ERROR" is indicated.

(After 5 seconds)



As the radio reception is under way, the frequency display is restored after 5 seconds.

(Note) In doing this, the time before depressing the CORRECT key is maintained in a correct manner.

7-3. Alarm operation

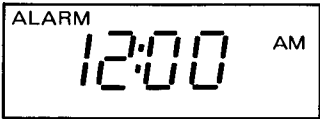
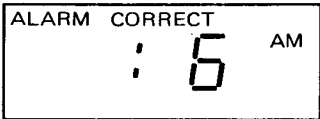
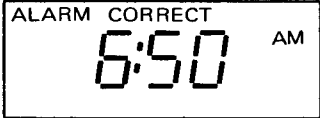
1. How to enter the alarm time

The alarm time may be corrected only when it is being displayed. Depress the **ALARM** key. The alarm time and "ALARM" are then displayed after 5 seconds or so. (The second does not flash.)

Depress the **10** key or the **AM/PM** key while the alarm time is displayed, and the alarm time correction mode is obtained and "CORRECT" is displayed.

Depress the **ENTER** key after finishing the time input. When the radio is on, the frequency is displayed. In other cases, however, the current time is displayed. At the same time "ALARM" is displayed.

EXAMPLE 1) Change of alarm time (12-hour display system)

Key	Display	Description
		1008 kHz within MW band is being received by preset channel 2 ch.
		Alarm time display. "ALARM" is lit. Second does not flash.
		Depress the 10 key (or AM/PM key) within 5 seconds after depressing the ALARM key, and the alarm time can be changed. At the same time, "CORRECT" is displayed.
 		The time is displayed on the right side and shifts to the left stepwise every time you feed one unit.
		Depress the ENTER key, and the alarm time is set to 6:50AM. The frequency is displayed when the radio is on. And the "ALARM" display is left to be lit.

2. Alarm operation

When the alarm time coincides with the existing time during "ALARM" is displayed, the alarm becomes ON. In other words, the $\overline{\text{PWROUT}}$ terminal comes to low level and the BUZ terminal is set on. The pulse of 3 kHz modulated by 4 Hz and 0.5 Hz is output from the BUZ terminal. (Refer to the BUZ terminal output chart on P. 8.) However the alarm operation is not made if the PWRIN terminal is at the low level.

In case the T/R terminal is at the low level when the alarm becomes on the radio is actuated at the same time and the last channel is called out.

In case any key is not operated after actuation of the alarm, the alarm goes off after 120 minutes. In other words, at this time, the $\overline{\text{PWROUT}}$ terminal comes to high level and the BUZ terminal comes to low level. If the radio has been selected, it also stops.

In case you would like to stop the alarm before 120 minutes elapse, invert the input of the PWRSW terminal, and the alarm goes OFF. Also you may stop the alarm by depressing the CANCEL key.

While the alarm is on, the time display has priority. If, therefore, the radio is on in the 120 minutes while the alarm is set (T/R terminal is at low level) and the keys related to the radio (including CLK/FREQ key) are depressed and the frequency is displayed, the time display is restored after 5 seconds or so. If the ME key is depressed while frequency is displayed, "ME" and frequency are displayed for the first 5 seconds, and the frequency is further displayed for 5 seconds after "ME" goes out.

3. Alarm timer set off

While "ALARM" is displayed, the alarm is always set when the alarm time corresponds to the current time. (Provided, however, the PWRIN terminal is at the high level.)

To eliminate the "ALARM" display, depress the CANCEL key within 5 seconds after depressing the ALARM key. In other words, by depressing the CANCEL key while the alarm time is displayed, the "ALARM" display goes out and the alarm operation is not actuated even when the alarm time coincides with the current time.

4. Alarm timer setting

To see the alarm time, depress the ALARM key. In case, you would like to actuate the alarm at that time, depress the ENTER key within 5 seconds after depressing the ALARM key. In other words,, by depressing the ENTER key while the alarm time is displayed, "ALARM" is displayed and the alarm is actuated when the alarm time coincides with the current time. It is necessary, however, that the PWRIN terminal has been at the high level.

7-4. Sleep operation

1. Sleep time setting

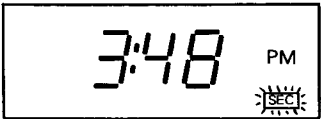
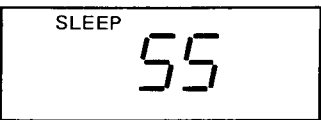
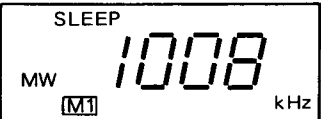
The sleep timer is of such a structure that the power is supplied only during the set time, while the power supply is turned off at other times. The sleep time is divided by 5 minutes intervals and the maximum set time is 60 minutes.

Depress the SLEEP key, and the sleep timer is set and "SLEEP" is displayed. However, this only occurs when the PWRIN terminal accepting the sleep key is at the high level and the PWRSW is at the low level. Further, the alarm timer has priority over the sleep timer. So, the SLEEP key is rejected while the alarm timer is on (PWROUT terminal is at the low level).

"SLEEP" is displayed while the sleep timer is in operation and the radio is operated when the T/R terminal is at the low level.

If the sleep key is depressed while "SLEEP" is displayed, the remaining time of the sleep timer is displayed. If the sleep key is again depressed while the indication of remaining time of the sleep timer is displayed, the sleep time is reduced by 5 minutes.

EXAMPLE) How to set the sleep time

Key	Indication	Description
		PWRIN terminal = High level PWRSW terminal = Low level T/R terminal = Low level Current time is displayed.
		Sleep timer is set on and "SLEEP" is displayed. By doing so, the sleep time is set to 60 minutes and the last channel is called out.
		The remaining time of the sleep time is displayed (in terms of minutes). After 5 seconds, the frequency is displayed if the radio is in operation. In other cases, the time display is restored.
		Depress the SLEEP key within 5 seconds after the operation described above and the sleep time is reduced by 5 minutes.
(After 5 seconds)		5 seconds after depressing the sleep key, the frequency is displayed when the radio is in operation. In other cases, the time display is restored.

2. Suspending sleep operation

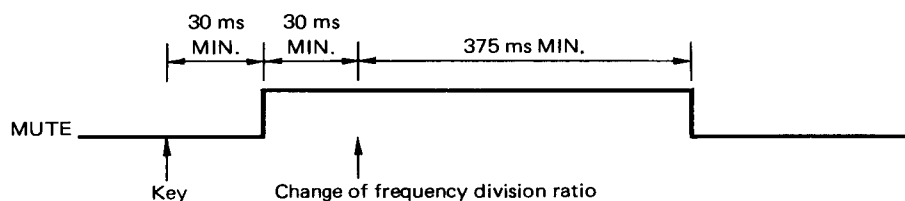
To suspend the sleep operation while the sleep timer is set, either depress the CANCEL key or set either depress the CANCEL key or set the PWRSW terminal to high level.

Note: The alarm timer has priority over the sleep timer. So, when the alarm timer is actuated while the sleep operation is under way, the sleep operation is suspended at that time.

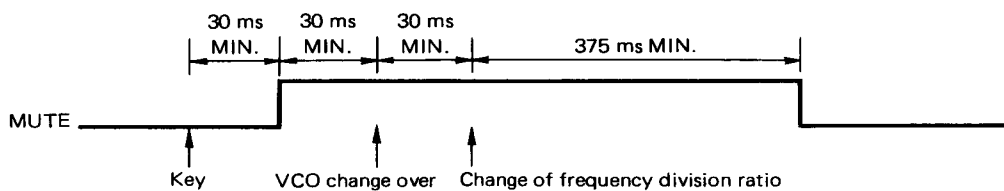
8. MUTE TIMING

8-1. Preset channel calling

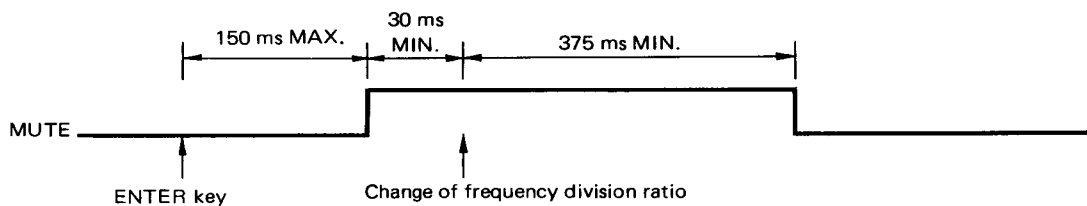
1) In case VCO is not changed over



2) In case VCO is changed over

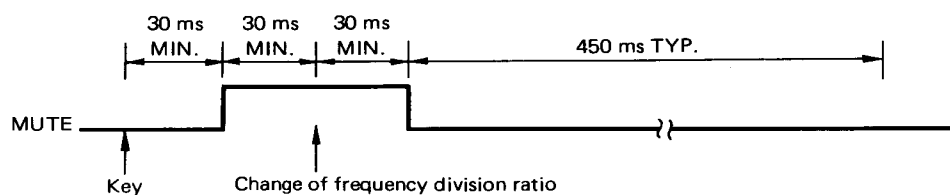


8-2. Direct selection

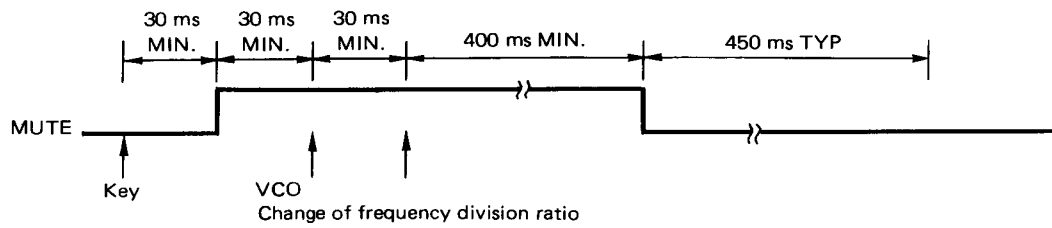


8-3. Manual UP/DOWN

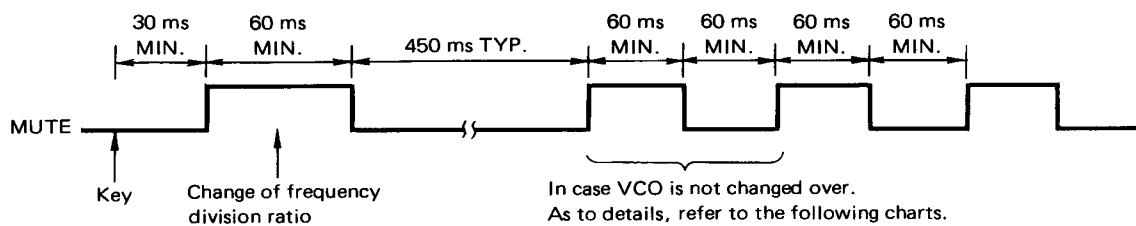
1) 1 channel UP/DOWN (In case VCO is not changed over)



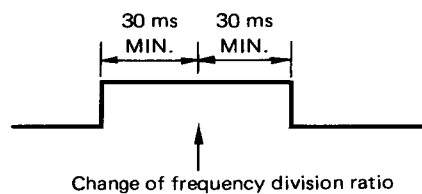
2) 1 channel UP/DOWN (In case VCO is changed over)



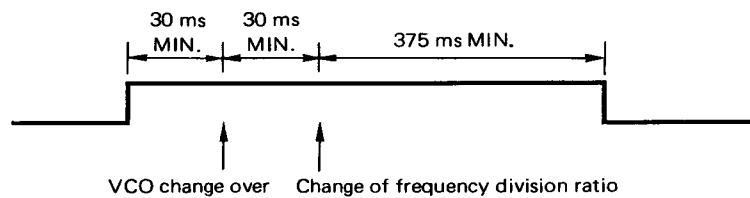
3) Rapid feed UP/DOWN



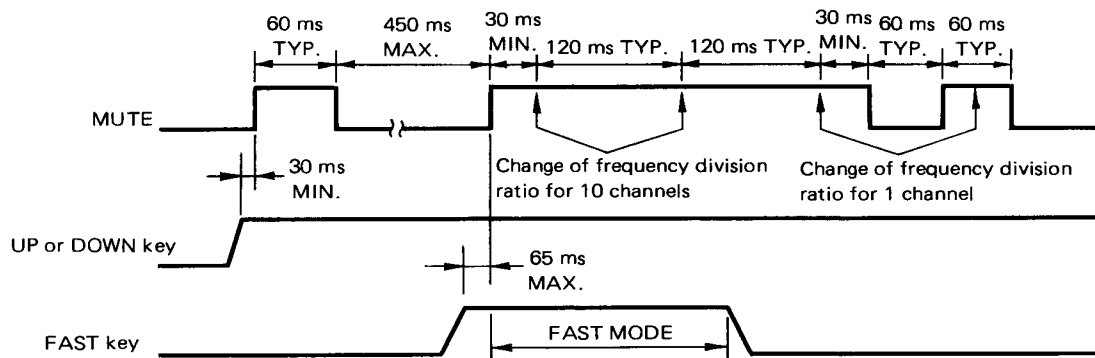
a) In case VCO is not changed over



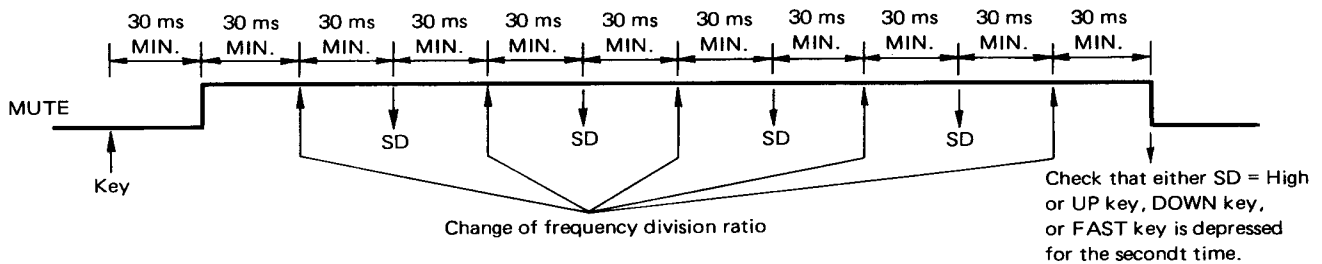
b) In case VCO is changed over



4) Ultra rapid feed UP/DOWN

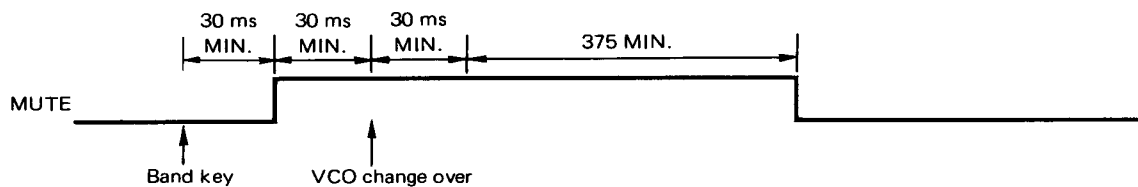


8-4. Auto UP/DOWN

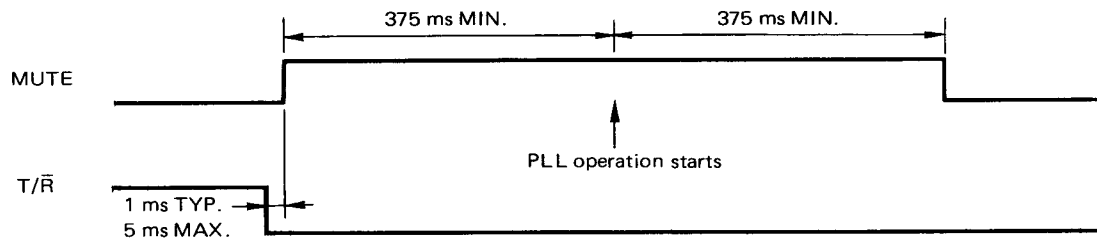


Note) $\downarrow$ SD indicates the timing of SD terminal check.

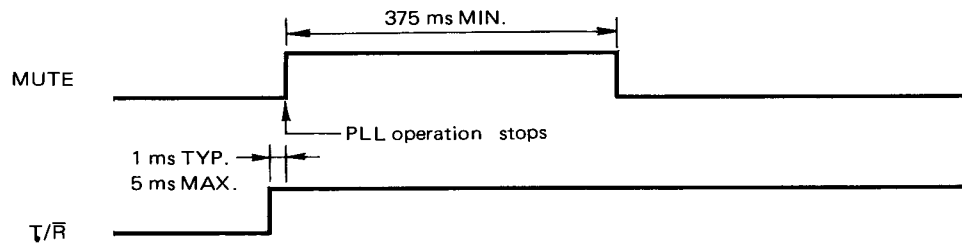
8-5. Frequency band change-over



8-6. Change-over from Tape to Radio

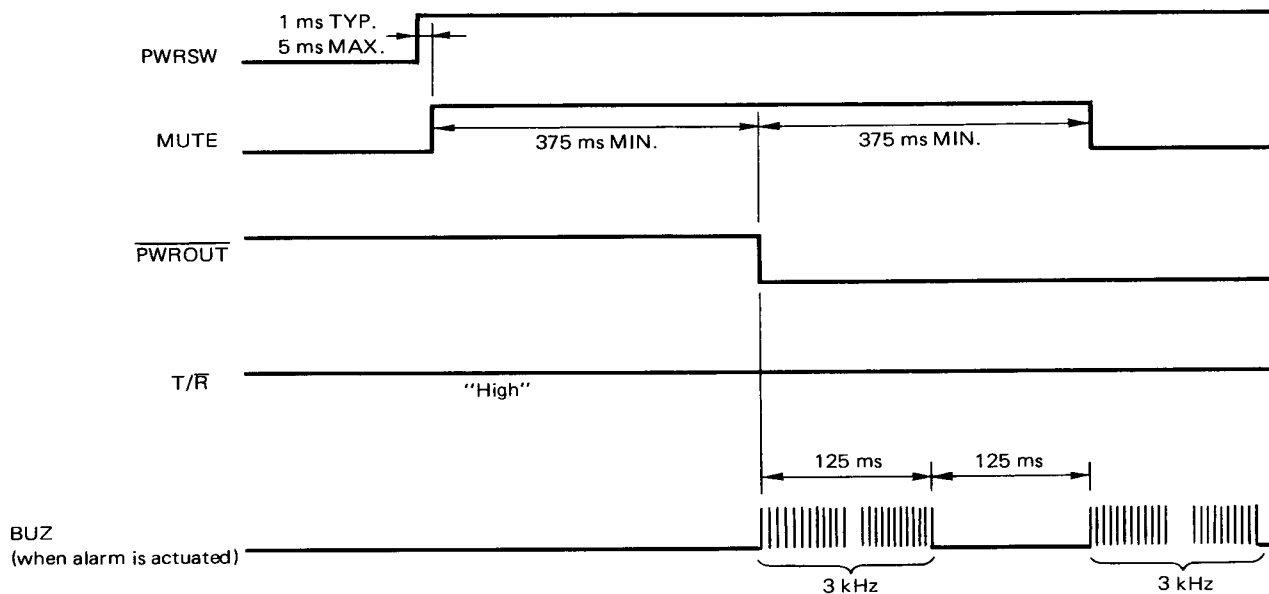


8-7. Change-over from Radio to Tape

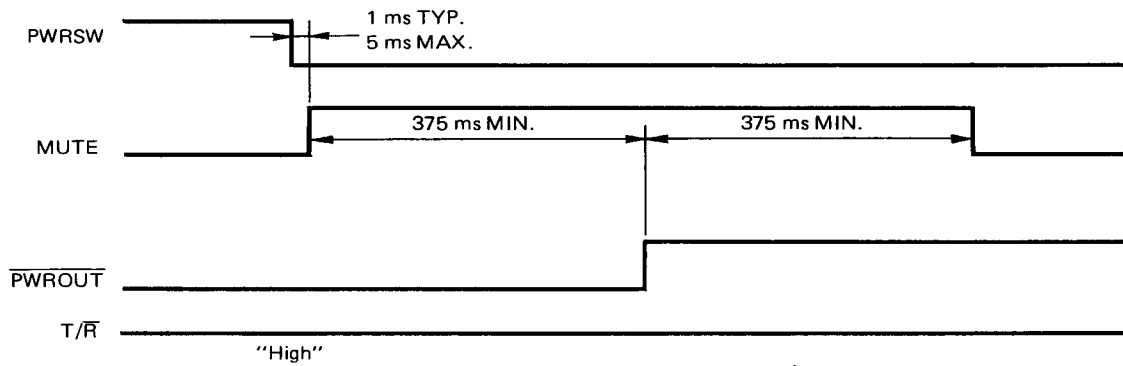


8-8. Power Supply Switch Operation

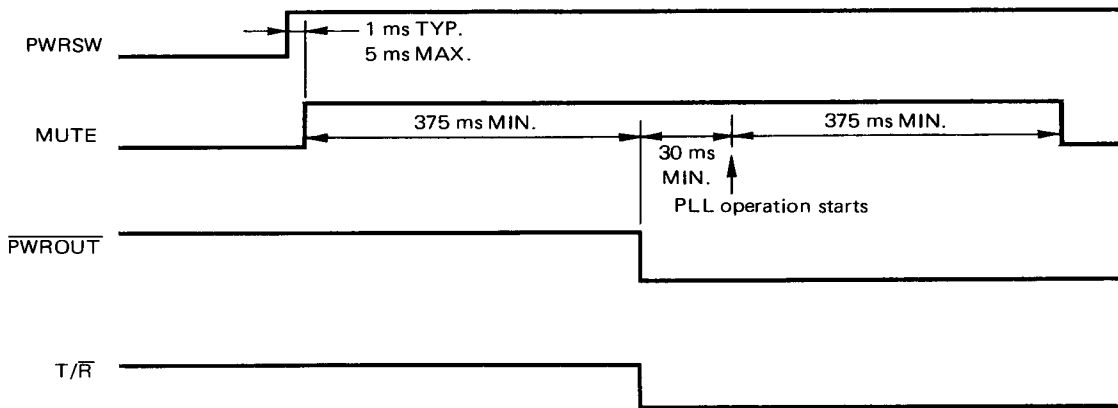
(The Power supply ON/OFF operation by Alarm/Sleep operation is also in the same timing.)

1) PWRSW OFF $\rightarrow$ ON (Low $\rightarrow$ High) (Tape)

2) PWRSW ON → OFF (High → Low) (Tape)

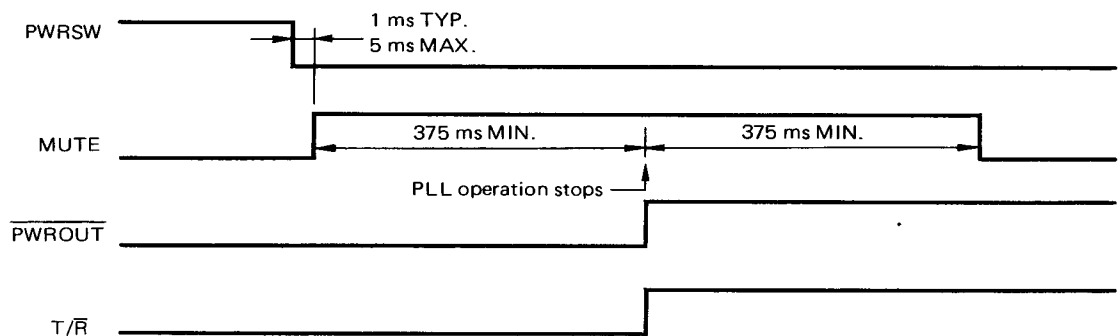


3) PWRSW OFF → ON (Low → High) (For radio)



Note) When the TAPE/RADIO select switch is thrown to the RADIO side, it is interlocked with $\overline{\text{PWR\text{OUT}}}$.

4) PWRSW ON → OFF (High → Low) (For radio)



IN-1404A
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Printed in Japan