PRELIMINARY DATA SHEET

NEC

MOS INTEGRATED CIRCUIT

μPD17010GF-011

SINGLE-CHIP MICROCONTROLLER WITH ON-CHIP PRESCALER, PLL FREQUENCY SYNTHESIZER, AND IF COUNTER FOR CAR-MOUNTED FM/MW/LW RADIO

DESCRIPTION

μPD17010GF-011 is 4-bit CMOS microcontroller for PLL frequency synthesizer-method digital tuning, which is capable of receiving European FM, MW, and LW.

The external appearance is 80-pin plastic QFP in which the prescaler (150 MHz MAX.), PLL frequency synthesizer, and IF counter are integrated. Also, since it can use various RDS (Radio Data System) functions in the FM band, it is possible for a car-mounted stereo and the high-performance multi-functional FM, MW, and LW tuner to be configured in a single chip.

FEATURES

- Can receive European FW, MW, and LW bands.
- Preset memory of 6 stations in FM1, FM2, and LW, respectively (thus totaling 24 stations)
- One last-channel station memory for each band, FM1, FM2, MW, and LW
- Rich in station-select functions, such as selection of stations through MANUAL or AUTO-SEEK UP/DOWN, preset memory scan, auto store memory (sorting stations with strong SD signals in the order of frequency), etc.
- Traffic information stand-by (TA/DK stand-by) function
- μPD16431A is used for the LCD controller/driver
- Clock function with 12- or 24-hour display (No-clock also possible)
- Program name display function based on RDS-broadcast data
- AF function for 25 stations, handling methods A and B
- 5V ± 10 %: single power supply

ORDERING INFORMATION

Part Number	Pakage	Quality Grade
μPD17010GF-011-3B9	80-pin plastic QFP (14x20 mm)	Standard

Please refer to "Quality grade on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

The information in this document is subject to change without notice.

Document No. ID-3541
(O. D. No. ID-9041)
Date Published November 1994 P
Printed in Japan

FUNCTION OVERVIEW

Receive Frequency, Channel Space, Reference Frequency, Intermediate Frequency

Item / Band	Receive Frequency	Channel Space	Reference Frequency	Intermediate Frequency
FM	87.50 – 108.00 MHz	50 kHz	50 kHz	10.7 MHz
MW	522 – 1620 kHz	9 kHz	9 kHz	450 kHz 459 kHz 10.71 MHz
LW	144 – 281 kHz	1 kHz/9 kHz	1 kHz/9 kHz	450 kHz 459 kHz 10.71 MHz

Channel Selection Function

(1) Manual tuning

Type	Description
Manual up / Manual down	Pressing the key once moves the frequency up/down by a step. Keeping the key pressed for over 0.5 second will result in fast forward.

(2) Auto tuning

Type	Description
Seek up / Seek down	Searches for broadcasting stations in up/down directions. If a station is detected, the frequency of the station is retained. In RDS mode, only RDS broadcasting stations are searched for. In TP/SK and RDS+TP/SK modes, only traffic information stations are searched for.

(3) Preset memory

Data on six broadcasting stations can be stored for each of the bands (FM1, FM2, MW, LW), totaling 24 stations.

(4) Auto store memory

Broadcasting stations are searched for starting from the lowest frequency. Detected stations are written in preset memory starting from the highest SD level. Afterwards, they are sorted in order of the frequency.

(5) Last channel memory

Equipped with last channel memory independently for each of the FM1, FM2, MW, and LW bands.

(6) Auto retuning

If no SD signal can be detected for about 30 seconds or longer during reception of a broadcasting station, auto retuning is started automatically.

(7) TP/SK auto retuning

If no SD or TP/SK signal is detected for 30 seconds or longer in TP/SK mode during reception of a broadcasting station, auto retuning to detect TP/SK stations is started automatically.

RDS Function

(1) Broadcasting station name display
Displays the name of the broadcasting station whose programs are currently being received, by using the PS code.

(2) AF operation
AF list of up to 25 stations can be incorporated to handle METHOD A and METHOD B.

(3) Switchover to a traffic information station
TA or TP data detected during TP/SK stand-by cause a switch to a traffic information station.

(4) PTY alarm
If a PTY code (= 31) alarm is received, the sound is switched to the tuner.

(5) RDS memory
Equipped with RDS memory for 14 stations, namely, preset memory for 6 stations each in FM1 and FM2, and the last channel memory for each of FM1 and FM2. Five PI-code and AF-list stations are stored in the RDS memory.

(6) EON functions
Can incorporate AF lists for other stations or switch to a traffic information station.

Clock Function

(1) Capable of 12-hr (with "AM" and "PM" showing) and 24-hr displays.
(2) Use of a flashing colon (":") (1 Hz) can be selected.
(3) In no-clock mode, backup is possible with low power consumption.

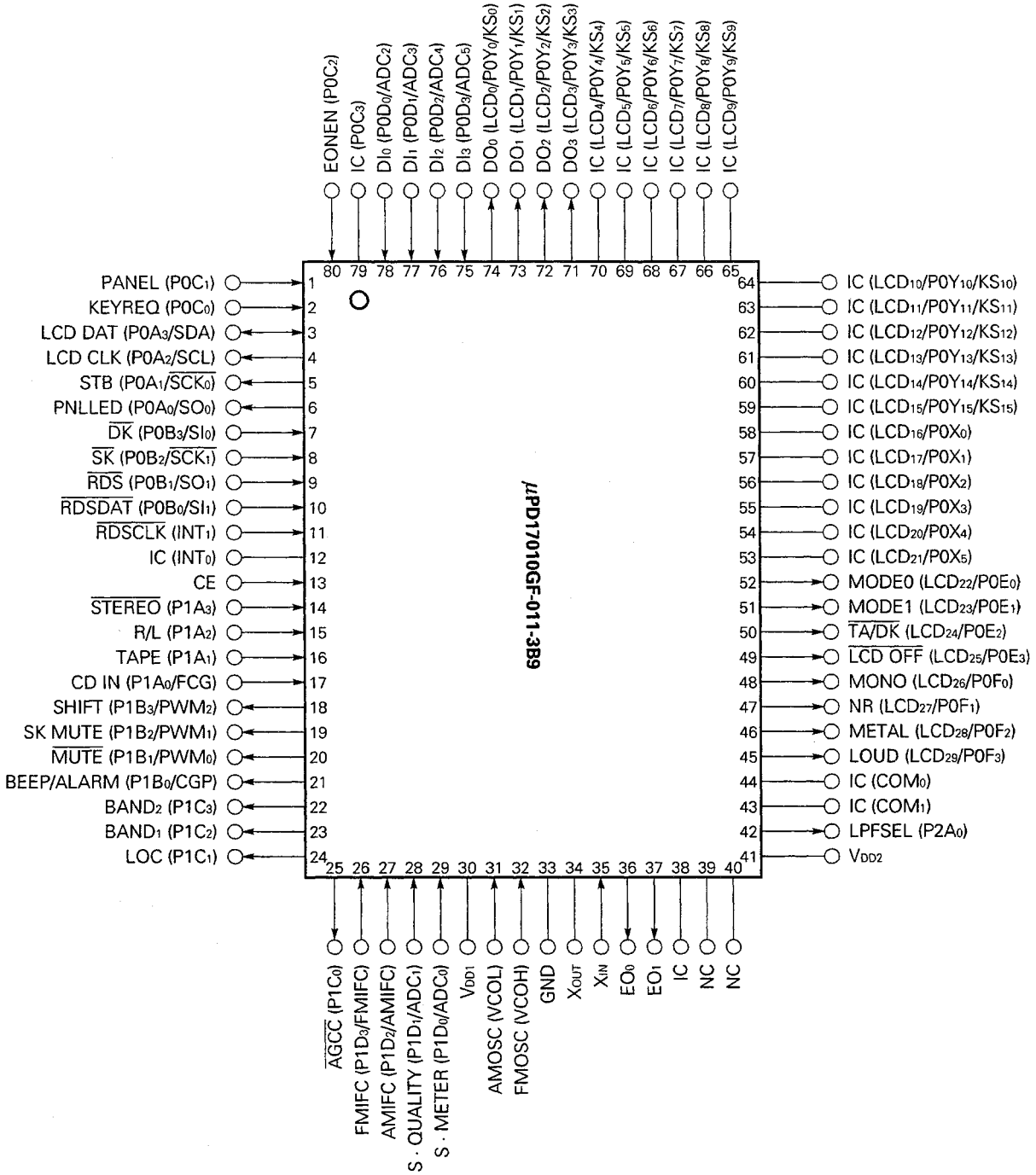
Tape Function

(1) Sound switchover can be made by tape signal input.
(2) The tape run direction can be displayed.
(3) Capable of noise reduction output
(4) Metal tape compatible

CD Function Ooutline

(1) Capable of sound switchover by CD signal input

PIN CONFIGURATION (TOP VIEW)



Remark The values in brackets apply to the μPD17010GF pins.

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1. PIN FUNCTIONS

Pin No.	Symbol	Pin Name	Description	I/O Format
1	PANEL	Panel detach detection signal input	This port detects detachment of the front panel. High level is interpreted as panel in the mounted state; low level is interpreted as panel in the detached state.	Input
2	KEYREQ	Key request signal input	This input pin detects the key request signal of LCD controller/driver μPD16431A. Key detection occurs at high level.	Input
3	LCD DAT	Serial data input/ output	This is the LCD controller/driver (μPD16431A) serial data input/output pin.	N-ch open drain
4	LCD CLK	Clock signal output	This is the LCD controller/driver (μPD16431A) clock signal output pin.	N-ch open drain
5	STB	Strobe signal output	This is the LCD controller/driver (μPD16431A) strobe signal output pin.	CMOS push-pull
6	PNLLED	Panel detach LED signal output	This LED signal output pin indicates detachment of the control panel. If the panel is detached, this pin performs a 1-hertz flash.	CMOS push-pull
7	$\overline{DK}$	DK signal input	This input pin detects the DK signal (traffic information on-air identification) of a VF broadcasting station. If VF broadcasting stations are not in use, pull it up.	Input
8	$\overline{SK}$	SK signal input	This input pin detects the SK signal (traffic information broadcasting station identification) of a VF broadcasting station. If VF broadcasting stations are not in use, please pull it up.	Input
9	$\overline{RDS}$	RDS signal input	This input pin detects the RDS signal of an RDS broadcasting station. It is used to prevent entering into the synchronous state due to a non-RDS broadcasting station. When this pin is at low level, the RDS input data is valid.	Input
10	$\overline{RDSDAT}$	RDS data signal input	This is the RDS data signal input pin. Please input the data signal from the RDS signal detection part. Data is read in on the falling edge of the RDS clock.	Input
11	$\overline{RDSCLK}$	RDS clock input	This is RDS clock input pin. Please enter the clock signal from the RDS signal sensing part. Please input as accurate a clock as possible, because bit synchronization detection by clock signal width is not performed in the μPD17010GF-011.	Input
12	IC	Internal connection	Connect this pin to the GND via the pull-down resistor.	—
13	CE	Chip enable	This is the device selection signal input terminal. To make a device perform usual operations (such as radio, tape, CD, clock), high level is input. At low level, this pin is placed in the backup state, with the radio, tape, and CD turned OFF. It is possible to place this pin in the backup state with low current consumption by eliminating the clock and clock display (initialize diode NOCLK = 1, CLKDSP = 0 (open)).	Input

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin Name</th><th>Description</th><th>I/O Format</th></tr>
<tr><td>14</td><td>$\overline{\text{STEREO}}$</td><td>Stereo signal input</td><td>This is the stereo signal input signal.
Enter data as follows.
<table><tr><th>$\overline{\text{STEREO}}$ Pin</th><th>Description</th></tr><tr><td>Low level</td><td>Stereo broadcasting</td></tr><tr><td>High level</td><td>Monaural broadcasting</td></tr></table>Bands other than FM are invalid.</td><td>Input</td></tr>
<tr><td>15</td><td>R/L</td><td>Tape run signal input</td><td>This is the tape run signal input pin.
It is used for display on the LCD panel.
Enter data as follows.
<table><tr><th>R/L Pin</th><th>Tape Run Direction</th></tr><tr><td>Low level</td><td>Left → right</td></tr><tr><td>High level</td><td>Right → left</td></tr></table></td><td>Input</td></tr>
<tr><td>16</td><td>TAPE</td><td>Tape signal input</td><td>This is the tape signal input pin.
By inputting high level to this pin, the sound source (MODE output) can be switched to tape.</td><td>Input</td></tr>
<tr><td>17</td><td>CD IN</td><td>CD play signal input</td><td>This is the CD play signal input pin.
By inputting high level to this pin, the sound source (MODE output) can be switched to CD.
The CD play signal takes precedence over the tape signal.</td><td>Input</td></tr>
<tr><td>18</td><td>SHIFT</td><td>Shift output</td><td>When the device is placed in the shift state by the SHIFT key, this pin outputs high level.</td><td>N-ch open drain</td></tr>
<tr><td>19</td><td>SK MUTE</td><td>SK MUTE signal output</td><td>This pin outputs SK MUTE when no traffic information identification signal is coming in TP/SK mode.</td><td>N-ch open drain</td></tr>
<tr><td>20</td><td>$\overline{\text{MUTE}}$</td><td>MUTE signal output</td><td>This is the sound MUTE signal output pin.
It is used to remove the shock noise occurring when the PLL lock is not in place in radio mode, or to switchover the MODE pin output.</td><td>N-ch open drain</td></tr>
</table>

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin Name</th><th>Description</th><th>I/O Format</th></tr>
<tr><td>21</td><td>BEEP/
ALARM</td><td>Beep and traffic information alarm signal output</td><td>This is the beep and traffic information alarm output pin.

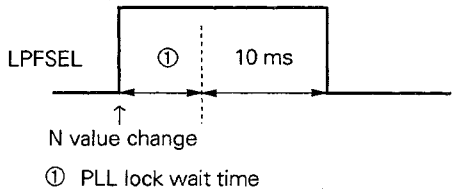
(1) Beeping sound
Outputs about 40 ms of square waves with frequency of 2.25 kHz and duty factor of 50 %.
The beeping sound is issued in the following cases:
① When a valid key is pressed
② When the hold of about 5 seconds during a preset scanning operation is ended
③ When writing is performed in preset memory.
There is no beeping sound when the initialize diode is set to BEEP = 0.

(2) Traffic information alarm
When there is no traffic information station identification signal in the TP/SK mode of the FM band, an alarm sound with a frequency of 2.25 Hz is output on and off about every 0.5 second.</td><td>CMOS
push-pull</td></tr>
<tr><td>22
23</td><td>$BAND_2$
$BAND_1$</td><td>Band switchover signal output</td><td>This is the band switchover signal output pin. If a new receiving band is switched to by means of the band switchover key, depending on the band, the following output.

<table><tr><th>Band/Pin</th><th>$BAND_1$</th><th>$BAND_2$</th></tr><tr><td>MW</td><td>0</td><td>0</td></tr><tr><td>LW</td><td>1</td><td>0</td></tr><tr><td>FM</td><td>×</td><td>1</td></tr></table>
(0 : low level 1 : high level × : don't care)</td><td>CMOS
push-pull</td></tr>
<tr><td>24</td><td>LOC</td><td>LOCAL signal output</td><td>This is the tuner LOCAL/DX switchover output pin.
It is placed in the LOCAL status at high level.</td><td>CMOS
push-pull</td></tr>
<tr><td>25</td><td>$\overline{AGCC}$</td><td>AGCC signal output</td><td>This is the auto-gain control cut signal output pin.
Output during auto tuning.</td><td>CMOS
push-pull</td></tr>
</table>

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin Name</th><th>Description</th><th>I/O Format</th></tr>
<tr><td>26</td><td>FMIFC</td><td>FM intermediate frequency input</td><td>This is the intermediate frequency (IF) input pin for the FM band.
Since the pin connects to a built-in AC amplifier, use a capacitor to cut out the DC portion.
This pin is used to detect the presence/absence of a broadcasting station during auto tuning when the initialize diode is set to "FM SD/IF switch = 1" (short-circuited at the diode).
The input frequency condition for determining that there is a broadcasting station is as follows:
<table><tr><th>Band</th><th>Input Frequency Range</th></tr><tr><td>FM</td><td>10.7 MHz ± 12.5 kHz</td></tr></table>The input frequency range refers to the frequency range in which input must be made within 10 ms after PLL is locked.</td><td>Input</td></tr>
<tr><td>27</td><td>AMIFC</td><td>AM intermediate frequency input</td><td>This is the intermediate frequency (IF) input pin of the AM band.
Since the pin connects to a built-in AC amplifier, please use a capacitor to cut out the DC portion.
This pin is used to detect the presence/absence of a broadcasting station during auto tuning when the initialize diode is set to "AM SD/IF switch = 1" (short-circuited at the diode).
The input frequency condition for determining that there is a broadcasting station is as follows:
<table><tr><th>Band</th><th>Input Frequency Range</th></tr><tr><td rowspan="2">MW</td><td>450 kHz ± 1 kHz</td></tr><tr><td>459 kHz ± 1 kHz</td></tr><tr><td rowspan="2">LW</td><td>450 kHz ± 1 kHz</td></tr><tr><td>459 kHz ± 1 kHz</td></tr></table>The input frequency range refers to the frequency range in which input must be made within 10 ms after PLL is locked.</td><td>Input</td></tr>
<tr><td>28</td><td>S•QUALITY</td><td>Signal quality signal input</td><td>This is the signal quality input pin.
Please input the analog signal in accordance with the receiving quality.
This pin is used for judging conditions for AF switchover.</td><td>Input</td></tr>
<tr><td>29</td><td>S•METER</td><td>Signal meter signal input</td><td>This is the signal meter input pin.
Please input the analog signal in accordance with strength of the received electric field.
This pin is used for judging conditions for AF switchover.</td><td>Input</td></tr>
</table>

Pin No.	Symbol	Pin Name	Description	I/O Format
30 41	V_{DD1} V_{DD2}	Power input	This is the pin for positive power. It supplies the 5V ±10% voltage when running the CPU and peripheral devices. It is possible to retain data at 2.2 V when the clock has stopped. When V_{DD} is started up, the device is reset by the built-in power-ON reset circuit. Avoid applying a voltage higher than V_{DD} to any pins other than V_{DD} (V_{DD1}, V_{DD2}). Be careful about this especially when simultaneously starting up the V_{DD} and CE pins, because application of a higher voltage may cause latch-up. Ensure that the V_{DD1} pin and the V_{DD2} pin are connected to the same voltage.	—
31	AMOSC	AM local call input	This pin is for inputting the local call output (VCO output) of the AM (MW, LW) band. When the MW or LW band is received, the pin becomes active; in other cases, it is internally pulled down. The inputtable frequency range is 0.5 to 30 MHz (0.3 V_{p-p}). Since the pin connects to a built-in AC amplifier, please use a capacitor to cut out the DC portion before inputting.	Input
32	FMOSC	FM local call input	This pin is for inputting the local call output (VCO output) of the FM band. When the FM band is received, the pin becomes active; in other cases, it is internally pulled down. The inputtable frequency range is 9 to 150 MHz (0.3 V_{p-p}). Since the pin connects to a built-in with an AC amplifier, please use a capacitor to cut out the DC portion before inputting.	Input
33	GND	Ground	This is the ground pin.	—
34 35	X_{OUT} X_{IN}	Crystal oscillator	This pin is for connecting the crystal oscillator. A 4.5-MHz crystal oscillator is connected. When using the clock function, the precision of the oscillator frequency affects that of the clock. Adjust the oscillator frequency while observing the PLL local oscillator frequency.	Input
36 37	EO_0 EO_1	Error out	This refers to the output from the charge pump of the PLL frequency synthesizer. If the value which has divided the local oscillator frequency is higher than the reference frequency, high level is output from these pins. If the value is lower, low level is output. If the value is the same as the reference frequency, it results in floating. Since the same waveforms are output from EO_0 and EO_1, either of them can be arbitrarily selected.	CMOS 3 state
38	IC	Internal connection	Connect the pin to the GND via the pull-down resistor.	—
39 40	NC	No connection	Do not connect to anything.	—

Pin No.	Symbol	Pin Name	Description	I/O Format
42	LPFSEL	LPF time-constant switchover signal output	This signal output pin is for switching over the LPF time-constant of the tuner during AF operation. During AF operation, high level is output as shown below.  ① PLL lock wait time	CMOS push-pull
43 44	IC	Internal connection	Don't connect anything.	—
45	LOUD	Loudness output	This is the loudness output pin.	CMOS push-pull
46	METAL	Metal output	This is the metal output pin.	CMOS push-pull
47	NR	Noise reduction output	This is the noise reduction output pin.	CMOS push-pull
48	MONO	Monaural output	This is the monaural output pin.	CMOS push-pull
49	$\overline{\text{LCD OFF}}$	LCD OFF output	This is the LCD OFF output pin of the LCD controller/driver (μPD16431A).	CMOS push-pull
50	$\overline{\text{TA/DK}}$	Traffic information station signal output	This is the traffic information station output pin. Low level is output when SK and DK signals, TP and TA signals, or the PTY alarm is detected in the TP/SK mode of the FM band.	CMOS push-pull
51	$MODE_1$ $MODE_0$	Mode signal output	These output pins show the operation mode of the μPD17010GF-011. The modes are as follows: $MODE_0$ / $MODE_1$ / Mode: 0 / 0 / Tuner; 0 / 1 / CD; 1 / 0 / Tape (0 : low level 1 : high level)	CMOS push-pull
53 | 70	IC	Internal connection	Don't connect this pin to anything.	—
71 | 74	DO_3 | DO_0	Initialize diode source signal output	This is the source signal output pin of the initialize diode matrix.	CMOS push-pull
75 | 78	DI_3 | DI_0	Initialize diode return signal input	This is the return signal input terminal of the initialize diode matrix.	Input

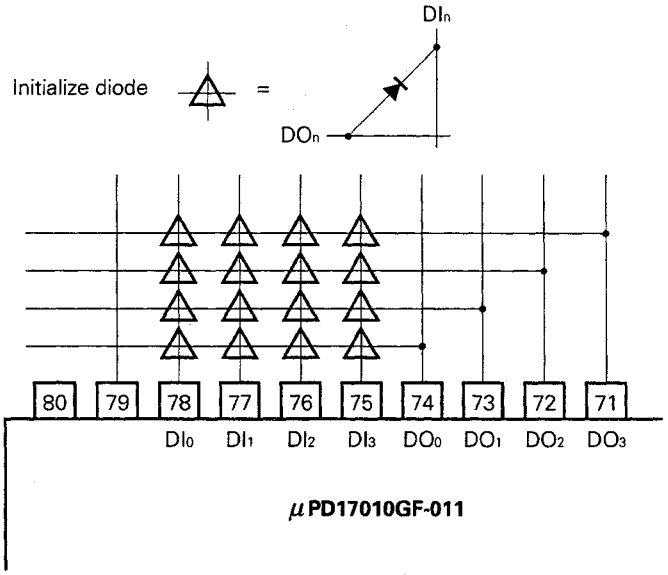
Pin No.	Symbol	Pin Name	Description	I/O Format
79	IC	Internal connection	Connect the pin to V_{DD} via a pull-down resistor.	—
80	EONEN	EON function use signal input	This is the EON data incorporation enable signal input pin for an RDS station. Traffic information switchover by EON is performed by inputting high level to this pin. If this pin is set to low level, each preset AF memory is updated by EON.	Input

2. KEY MATRIX CONFIGURATION

2.1 Allocation of Initialize Diode Matrix

Input Pin / Output Pin	DI_3 (75)	DI_2 (76)	DI_1 (77)	DI_0 (78)
DO_3 (71)	AM SD/IF	FM SD/IF	AMIF1	FMIF1
DO_2 (72)	NOCLK	FLASH	MESEL	CLK24
DO_1 (73)	PRIDISP	RETUNE	ADJTYPE	BEEP
DO_0 (74)	ENMETAL	FUNC	CLKDSP	LW9K

2.2 Connection of Initialize Diode Matrix



2.3 Allocation of Momentary Key Matrix

- **KS1-KS6 : Key source signal output (connected to pins 25-30 of μPD16431A)**
- **KEY1-KEY4 : Key return signal input (connected to pins 2-5 of μPD16431A)**

(1) Momentary key matrix when FUNC = 0

	KS6	KS5	KS4	KS3	KS2	KS1
KEY1	M1	M2	M3	M4	M5	M6
KEY2	PSCAN	RDS	TP/SK	MONO	NR	METAL
KEY3	SEEK UP (MAN UP)	SEEK DWN (MAN DWN)	LOUD	ME	LOC	ASM
KEY4	BAND	DISP	SHIFT	Z ADJ	HR ADJ	MIN ADJ

Remark The values in the brackets are valid only when the mode is set to SHIFT mode by the [SHIFT] key.

(2) Momentary key matrix when FUNC = 1

	KS6	KS5	KS4	KS3	KS2	KS1
KEY1	M1 (PSCAN)	M2 (RDS)	M3 (TP/SK)	M4 (MONO)	M5 (NR)	M6 (METAL)
KEY2	SEEK UP (MAN UP)	SEEK DWN (MAN DWN)	LOUD	ME	LOC	ASM
KEY3	BAND	DISP	SHIFT	Z ADJ	HR ADJ	MIN ADJ

Remark The values in the brackets are valid only when the mode is set to SHIFT mode by the [SHIFT] key.

2.4 Description of Key Matrix

2.4.1 Initialize diode matrix

The initialize diode matrix contains the following ten types (16 items). All these types are read only when the power is initially turned on (power-ON reset) to the V_{DD} pin on when the CE pin is changed from low level to high level. At other times, they are ignored.

(1) Switch for setting the method of detecting broadcasting stations in auto tuning.
AM SD/IF, FM SD/IF

(2) Switch for setting the intermediate frequency of the AM band
AMIF1, AMIF2

(3) Switch for setting clock functions
NOCLK, FLASH, CLK24, ADJTYPE, CLKDSP

(4) Switch for setting the [ME] key
MESEL

(5) Switch for selecting whether a priority display should be made
PRIDISP

(6) Switch for selecting between ON/OFF of auto retune
RETUNE

(7) Switch for selecting between with/without the beeping sound
BEEP

(8) Switch for selecting use of the metal function in tape mode
ENMETAL

(9) Switch for combining the 2nd line with the 1st of the key matrix
UNC

(10) Switch for setting LW's channel space and reference frequency to 9 kHz
LW9K

These switches are set on the matrix after short-circuiting it with diodes.

Functions of the initialize diode matrix are described on the following pages. For the diodes, "1" indicates short-circuited; and "0" indicates open.

<table>
<tr><th>Symbol</th><th>Description of Functions</th></tr>
<tr><td>AM SD/IF</td><td>This switch sets the method of detecting broadcasting stations during auto tuning of the AM band.
It is set as follows:

<table>
<tr><th>AM SD/IF</th><th>Methods of Detecting Broadcasting Stations</th></tr>
<tr><td>0</td><td>SD only used</td></tr>
<tr><td>1</td><td>SD and IF counter</td></tr>
</table>
</td></tr>
<tr><td>FM SD/IF</td><td>This switch sets the method of detecting broadcasting stations during auto tuning of the FM band.
It is set as follows:

<table>
<tr><th>FM SD/IF</th><th>Methods of Detecting Broadcasting Stations</th></tr>
<tr><td>0</td><td>SD only used</td></tr>
<tr><td>1</td><td>SD and IF counter</td></tr>
</table>
</td></tr>
<tr><td>AMIF1
AMIF2</td><td>This switch sets the intermediate frequency of the AM (MW, LW) band.
It is set as follows:

<table>
<tr><th>AMIF1</th><th>AMIF2</th><th>Intermediate Frequency</th></tr>
<tr><td>0</td><td>0</td><td>450 kHz</td></tr>
<tr><td>0</td><td>1</td><td>459 kHz</td></tr>
<tr><td>1</td><td>×</td><td>10.71 MHz</td></tr>
</table>
(× : Don't care)</td></tr>
<tr><td>NOCLK</td><td>This switch sets the clock function.
It is set as follows:

<table>
<tr><th>NOCLK</th><th>Setting of Clock Functions</th></tr>
<tr><td>0</td><td>Clock present</td></tr>
<tr><td>1</td><td>Clock absent.
In this case, the FLASH, CLK24, ADJTYPE, and CLKDSP switches are ignored.</td></tr>
</table>
</td></tr>
<tr><td>FLASH</td><td>This switch sets the colon lighting in the clock display.
It is set as follows:

<table>
<tr><th>FLASH</th><th>Colon (:) Display</th></tr>
<tr><td>0</td><td>Always ON</td></tr>
<tr><td>1</td><td>Flash
Frequency : 1 Hz
Duty factor : 60 %</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description of Functions</th></tr>
<tr><td>CLK24</td><td>This switch selects a 12-hour or 24-hour clock display.
It is set as follows:

<table>
<tr><th>CLK24</th><th>Clock Display</th></tr>
<tr><td>0</td><td>12-hr display</td></tr>
<tr><td>1</td><td>24-hr display (with "AM", "PM" display)</td></tr>
</table></td></tr>
<tr><td>ADJTYPE</td><td>This switch sets the method of making the time adjustment of the clock.
It is set as follows:

<table>
<tr><th>ADJTYPE</th><th>Clock Time Setting Methods</th></tr>
<tr><td>0</td><td>Time adjustment is performed by the Z ADJ, HR ADJ, and MIN ADJ keys.</td></tr>
<tr><td>1</td><td>Time adjustment is performed by pressing the DISP, and SEEK UP / SEEK DWN keys at the same time.</td></tr>
</table></td></tr>
<tr><td>CLKDSP</td><td>This switch selects the clock display in stand-by mode (CE = low level).
It is set as follows:

<table>
<tr><th>CLKDSP</th><th>Clock Display in Stand-by Mode</th></tr>
<tr><td>0</td><td>Not displayed</td></tr>
<tr><td>1</td><td>Displayed</td></tr>
</table></td></tr>
<tr><td>MESEL</td><td>This switch sets whether the ME key is valid or not.
It is set as follows:

<table>
<tr><th>MESEL</th><th>ME key</th></tr>
<tr><td>0</td><td>Invalid</td></tr>
<tr><td>1</td><td>Valid</td></tr>
</table></td></tr>
<tr><td>PRIDISP</td><td>This switch selects whether a priority display should be made or not.
For details of the priority display, please refer to the description of the DISP key.
The PRIDISP switch is set as follows:

<table>
<tr><th>PRIDISP</th><th>Priority Display</th></tr>
<tr><td>0</td><td>Absent</td></tr>
<tr><td>1</td><td>Present</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description of Functions</th></tr>
<tr><td>RETUNE</td><td>This switch selects ON/OFF of the auto retune.
It is set as follows:

<table>
<tr><th>RETUNE</th><th>Auto Retune</th></tr>
<tr><td>0</td><td>ON</td></tr>
<tr><td>1</td><td>OFF</td></tr>
</table>
</td></tr>
<tr><td>BEEP</td><td>This switch selects whether to accept the beeping sound output in key input.
It is set as follows:

<table>
<tr><th>BEEP</th><th>Beeping Sound Output</th></tr>
<tr><td>0</td><td>Absent</td></tr>
<tr><td>1</td><td>Present</td></tr>
</table>
</td></tr>
<tr><td>ENMETAL</td><td>This switch selects whether to use the metal function or not in tape mode.
It is set as follows:

<table>
<tr><th>ENMETAL</th><th>Use of Metal Function</th></tr>
<tr><td>0</td><td>Absent</td></tr>
<tr><td>1</td><td>Present</td></tr>
</table>
</td></tr>
<tr><td>FUNC</td><td>This switch combines the 2nd line with the 1st of the key matrix in SHIFT mode.
It is set as follows:

<table>
<tr><th>FUNC</th><th>Combination of 2nd Line with 1st Line</th></tr>
<tr><td>0</td><td>Absent</td></tr>
<tr><td>1</td><td>Present</td></tr>
</table>
</td></tr>
<tr><td>LW9K</td><td>This switch sets LW's channel space and reference frequency of the AM band to 9 kHz.
It is set as follows:

<table>
<tr><th>LW9K</th><th>Channel Space and Reference Frequency</th></tr>
<tr><td>0</td><td>Channel space : 1 kHz Reference frequency : 1 kHz</td></tr>
<tr><td>1</td><td>Channel space : 9 kHz Reference frequency : 9 kHz</td></tr>
</table>
</td></tr>
</table>

2.4.2 Momentary key

Symbol	Description of Functions
M1 M2 M3 M4 M5 M6	These keys are used for selecting the preset memory mode. There are two modes, that is, NORMAL mode and SHIFT mode. (1) NORMAL mode Performs reading or writing of the preset memory. The read/write procedure differs depending on the MESEL switch of the initialize diode. • If MESEL = 0: If keys [M1] to [M6] are released within 2 seconds, it will result in a memory read operation. If they are kept pressed for 2 seconds or longer, it will result in memory write operation. • If MESEL = 1: If the ME segment of the LCD display is lit, it results in a memory write operation. If the ME segment of the LCD display is unlit, it results in a memory read operation. When reading preset memory, if the called station is an RDS station, the AF list (five stations) stored is used to find the broadcast whose SD is the strongest. When the PI code of the receiving station coincides with that of the preset memory, reception is started. If there is no station whose PI code coincides, or if SD cannot be detected, PI searching is started. PI searching looks for broadcasting stations that satisfy the stop condition in the UP direction from the preset frequency and receives those that are detected as satisfying this condition. If there is no such station, the starting frequency for the PI search is retained. (2) SHIFT mode If functions are allocated by setting the initialize diode FUNC switch, then, when in SHIFT mode, [M1] to [M6] work as FUNCTION keys. The following describes these keys. For details on using these keys, please refer to the description of each key. If the initialize diode FUNC = 0, the functions are invalidated.

<table>
<tr><th>Symbol</th><th>Description of Functions</th></tr>
<tr><td>M1
M2
M3
M4
M5
M6</td><td>
<table>
<tr><th>Key</th><th>Key Allocation in SHIFT Mode</th></tr>
<tr><td>M1</td><td>Functions as preset memory scan operation key PSCAN.
Please refer to the description of the PSCAN key.</td></tr>
<tr><td>M2</td><td>Functions as AF operation mode set key RDS.
Please refer to the description of the RDS key.</td></tr>
<tr><td>M3</td><td>Functions as traffic information interrupt set key TP/SK.
Please refer to the description of the TP/SK key.</td></tr>
<tr><td>M4</td><td>Functions as monaural mode set key MONO.
Please refer to the description of the MONO key.</td></tr>
<tr><td>M5</td><td>Functions as tape noise reduction set key NR.
Please refer to the description of the NR key.</td></tr>
<tr><td>M6</td><td>Functions as tape's metal compatibility selection key
METAL.
Please refer to the description of the METAL key.</td></tr>
</table>
</td></tr>
<tr><td>PSCAN</td><td>This is the preset memory scan operation key. It is valid only in RADIO mode.
If a preset memory is currently being received, reception is made from the next memory (for example, from M4 if M3 is being received).
In other cases, each preset memory is received for five seconds sequentially starting from memory 1.
If the preset station is an RDS broadcasting station, AF operation is performed but not PI searching.
During the 5-second reception period, no RDS operations such as AF judgment are performed.
The operation of each key during a scan operation is shown below.
<table>
<tr><th>Key</th><th>Description of Keys</th></tr>
<tr><td>PSCAN</td><td>The preset scan operation is stopped and the frequency when the key was pressed is retained.</td></tr>
<tr><td>Keys other than PSCAN</td><td>The preset scan operation is stopped and the operation of the pressed key is performed.</td></tr>
</table>
</td></tr>
<tr><td>RDS</td><td>This key selects AF operation mode.
It is valid only when the FM band is been received.
If this key is pressed, the "RDS" display on the LCD panel lights thus placing the device in AF operation enable mode.
While the "RDS" display is on, the signal meter (SD) and the signal quality (SN) are constantly monitored; and when the AF operation start condition is met, AF operations performed.
The AF operation start condition is given a ranking that depends on the signal meter and the signal quality level. If the rank is high (little noise), one station after another is judged; and if the rank is low (with much noise), all AFs are judged.
If AUTO SEEK is performed by the SEEK UP / SEEK DWN key in this mode, it results in operation of RDS broadcasting station detection.
If the key is pressed again while the "RDS" display is lit, the "RDS" display is extinguished, thus placing the device in the AF operation disable mode.
If an RDS broadcasting station is being received, incorporation of RDS data is performed regardless of the ON/OFF state of the "RDS" display.</td></tr>
</table>

Symbol	Description of Functions
TP/SK	This key selects traffic information interrupt operation mode. When this key is pressed, the "TP/SK" display on the LCD panel is lit placing the device in traffic information stand-by status. If both RDS TP and TA bits become 1 at this time, the device is placed in the traffic information interrupt status, thus displaying "T INFO" on the 14 segments of the LCD panel and switching the sound to RADIO mode. If the TP/TA bit becomes other than 1 during the traffic information interrupt, the traffic information stand-by mode is restored and the sound before the traffic information interrupt is returned. If the key is pressed again while the "TP/SK" display is lit, the "TP/SK" display is extinguished and the traffic information stand-by status is canceled. If the device is in the midst of a traffic information interrupt at this time, the traffic information interrupt is canceled and the sound is returned. While "TP/SK" remains unlit, no traffic information interrupt is accepted. The SEEK operation while the "TP/SK" display is lit is for searching traffic information stations only.
MONO	This key sets forced monaural mode when the sound is in RADIO mode. It is valid only when the sound is in RADIO mode and the FM band is selected. If this key is pressed, the "MONO" display on the LCD panel is lit thus placing the device in forced monaural mode. During forced monaural mode, high level is output from the "MONO" pin. If this key is pressed again during forced monaural mode, the "MONO" display is extinguished and the mode is canceled. In the forced monaural mode, the "STEREO" display is unlit even when a stereo signal is input.
NR	This is the ON/OFF key for tape noise reduction. It is invalid unless the sound is in TAPE mode. If this key is pressed, the "NR" display is lit, turning on NR. While the "NR" display is lit, high level is output from the NR pin. If this key is pressed again while the "NR" display is lit, the "NR" display is extinguished, thus turning off NR.
METAL	This is the normal/metal tape switchover key. It is invalid unless the sound is in TAPE mode. If this key is pressed, the "METAL" display is lit. While the "METAL" display is lit, high level is output from the METAL pin. If this key is pressed again while the "METAL" display is lit, the "METAL" display is extinguished.
SEEK UP (MAN UP) SEEK DWN (MAN DWN)	This is used as the receiving frequency AUTO SEEK / MANUAL SEEK operation key while the frequency is being displayed. During the clock display, it is used as a clock adjustment key together with the DISP key. (1) During frequency display Two operation modes are made available by the SHIFT key. • Normal operation mode (AUTO SEEK) If this key is pressed, AUTO SEEK is started in the UP (SEEK UP key) or DOWN (SEEK DWN key) direction one step (FM band: 100 kHz) after another from the receiving frequency at the time the key was pressed, and the "AUTO" display is lit. As a method of detecting broadcasting stations, either SD only or a combination of the SD and IF counters can be selected by means of AM SD/IF and FM SD/IF in the initialize diode. For details of the frequency range of the IF counter, please refer to descriptions of the FMIFC and AMIFC pins. If this key is pressed again during a SEEK operation, the seeking is terminated at the frequency reached when the key was pressed. For details of broadcasting station detection timing, please refer to **6.1.4 Seek up/down**.

Symbol	Description of Functions
SEEK UP (MAN UP) SEEK DWN (MAN DWN)	• Shift mode (MANUAL SEEK) If this key is pressed when in SHIFT mode, the frequency is changed by one step in the UP (SEEK UP key) or DOWN (SEEK DWN key) direction. If the key is kept pressed for 0.5 second or longer, the frequency is changed every 50 ms until the key is released. (2) During clock display The hour digits (SEEK UP key) and the minute digits (SEEK DWN key) are adjusted by pressing this key and the DISP key at the same time while the clock display is on. • Hour digit adjustment The hour digits are incremented by one hour each time the SEEK UP key is pressed. If the key is kept pressed for 0.5 second or longer, the hour digits are incremented every 200 ms until the key is released. • Minute digit adjustment The minute digits are decremented by a minute each time the SEEK DWN key is pressed. If the key is kept pressed for 0.5 second or longer, the minute digits are decremented every 100 ms until the key is released. The operation of each key during AUTO SEEK operation is as follows:

Key	Description of Operation
M1 | M6	The SEEK operation is stopped. The content of the preset memory of the pressed key is called.
SEEK UP SEEK DWN	• When the SEEK UP key during seek up or SEEK DWN key during seek down is pressed, the SEEK operation is stopped retaining the frequency at the time the key was pressed. • When the SEEK DWN key during seek up or SEEK UP key during seek down is pressed, the operation is changed to that of the pressed key (SEEK UP if the SEEK UP key was pressed) from the frequency at the time the key was pressed.
MAN UP MAN DWN (SHIFT mode)	The SEEK operation is stopped. MANUAL UP/DOWN operation is performed from the frequency at the time the key was pressed.
BAND ASM PSCAN	The SEEK operation is stopped, and the operation of the pressed key is performed.

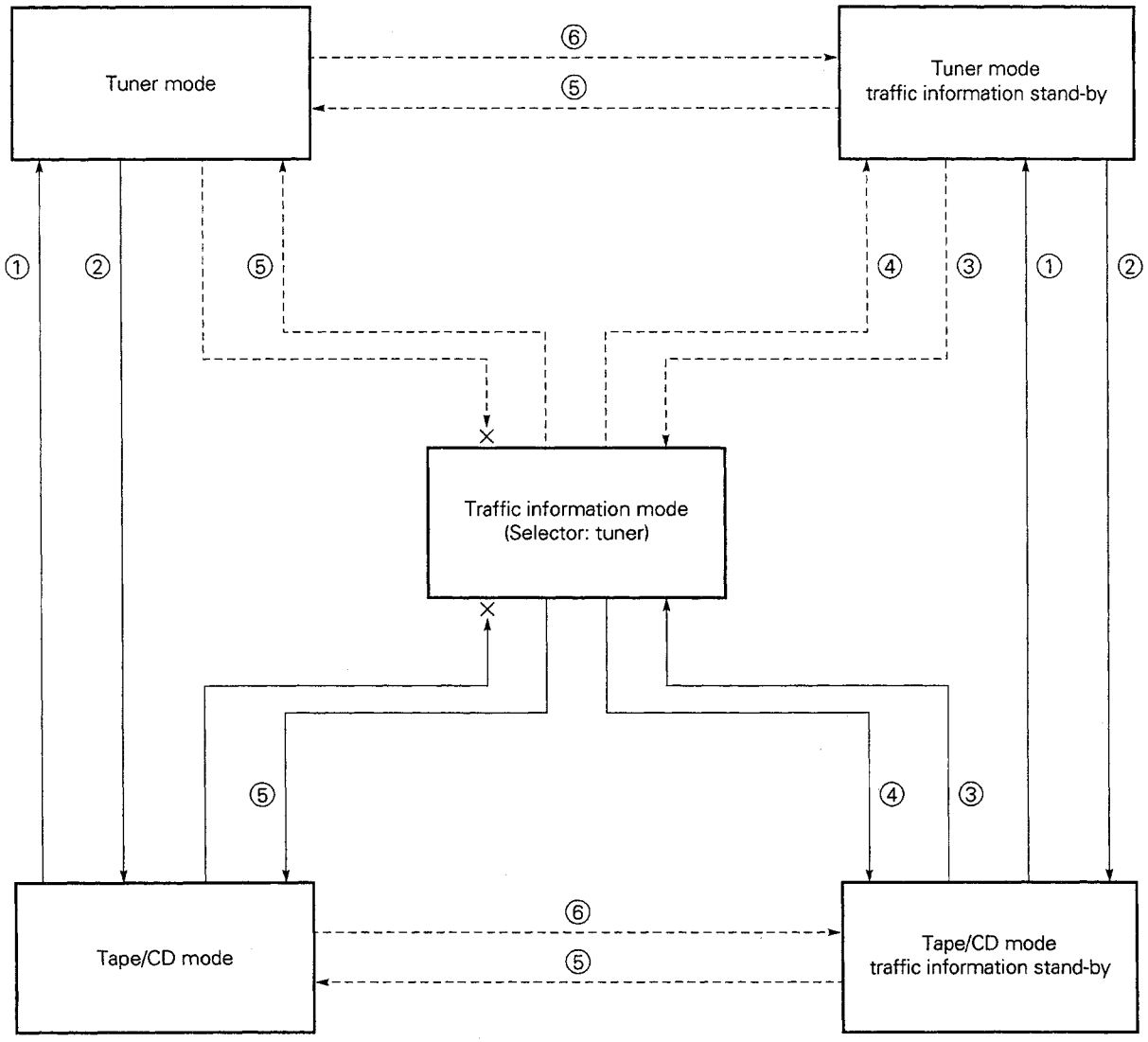
<table>
<tr><th>Symbol</th><th>Description of Functions</th></tr>
<tr><td>SEEK UP
(MAN UP)

SEEK DWN
(MAN DWN)</td><td>
<table>
<tr><th>Key</th><th>Description of Operation</th></tr>
<tr><td>RDS
TP/SK
MONO
LOUD
DISP
SHIFT
Z ADJ
HR ADJ
MINADJ</td><td>The SEEK operation continues.
The function of the pressed key is started.</td></tr>
</table>
Momentary keys other than those listed above are invalid.
</td></tr>
<tr><td>LOUD</td><td>This key sets loudness operation.
If this key is pressed, the "LOUD" display is lit, turning on LOUDNESS. While the "LOUD" display is lit, high level is output from the LOUDNESS pin.
If the key is pressed again while the "LOUD" display is lit, the "LOUD" display is extinguished thus turning off LOUDNESS.</td></tr>
<tr><td>ME</td><td>This key sets preset memory write enable. It is valid when the sound is in RADIO mode (except during clock display). When initialize diode MESEL = 1, this key is used for writing in the preset memory.
If this key is pressed, the "ME" display is lit, placing the device in memory write enable status for five seconds. If one of the preset memory keys (M1 to M6) is pressed during this time, the frequency in current use is written to the corresponding preset memory. If this key is pressed again while the "ME" display remains lit, memory write status is canceled and the "ME" display is extinguished.
The operation of each key relating to ME status is as follows.
<table>
<tr><th>Key</th><th>Description of Operation</th></tr>
<tr><td>M1
|
M6</td><td>The frequency currently being received at the time the key was pressed is written to the preset memory corresponding to the pressed key.
The preset memory write enable status is canceled.</td></tr>
<tr><td>SEEK UP
SEEK DWN
MAN UP
MAN DWN</td><td>The preset memory write enable status is canceled.
The function of the pressed key is started from the current frequency.</td></tr>
<tr><td>ME</td><td>The ME status is canceled.</td></tr>
</table>
Momentary keys other than the above cancel the memory write enable status, thus performing the function of the pressed key.
</td></tr>
<tr><td>LOC</td><td>This is the LOCAL/DX switchover key for the tuner RF part.
If this key is pressed, the "LOC" display is lit placing the device in LOCAL mode. While the "LOC" display is lit, high level is output from the LOCAL pin during a SEEK operation.
If this key is pressed again while the "LOC" display is lit, the "LOC" display is extinguished returning to DX mode.</td></tr>
</table>

Symbol	Description of Functions
ASM	This is the auto store memory operation key. If it is pressed, a search is made from the lowest frequency to the highest frequency of the relevant band to write six stations into preset memory in ascending order of the frequency, starting from the station whose SD is strongest. For details of broadcasting station detection timing, please refer to **6.1.4 Seek up/down.** Data on the detected broadcasting stations are written to one preset memory after another, starting from preset memory 1. If the maximum frequency is reached before the six stations are written, the previous frequencies stay in the remaining preset memories. If this key is pressed again during the auto store memory operation, the operation is suspended. However, the broadcasting stations which have already been detected are written in the preset memory. During the auto store memory operation, operating any momentary key other than the **ASM** key is invalid.
BAND	This is the radio band switchover key. Each time this key is pressed while the sound is in RADIO mode, the band will change as follows: FM 1 → FM 2 → MW → LW
DISP	This is the display switchover key. The display is switched as shown below. (1) Tuner mode (PS) → Frequency → Clock About 5 seconds later (2) Tape/CD mode TAPE display → Clock → (PS) → Frequency About 5 seconds later (3) During traffic information broadcasting in TP/SK mode "T INFO" display → (PS) → Clock (4) PTY alarm Display switchover is not performed when receiving the PTY alarm. When initialize diode NOCLK = 1, the clock display above is skipped. The PS display is made when RDS data has been PS-incorporated. When initialize diode PRIDSP = 1, this display is switched over in five seconds to the one with the highest priority (the ones farther to the left in the diagrams above have higher priority). However, when PRIDISP = 0, the display is switched over to the PS display from the frequency display in 5 seconds.

Symbol	Description of Functions
Z ADJ	This is the clock zero adjustment key. This key is valid when initialize diode ADJTYPE = 0. If this key is pressed during the clock display, the minute and second digits are reset to zero. At this time, if the minute digits are no more than 29, the digits remain the same; if 30 minutes or more, the hour digits are incremented by an hour.
HR ADJ	This is the clock's hour-digit adjustment key. This key is valid when initialize diode ADJTYPE = 0. If it is pressed during the clock display, the hour digits are incremented by an hour. If it is kept pressed for 0.5 second or longer, the hour digits are incremented continuously at the speed of 1 hour per 200 ms.
MIN ADJ	This is the clock's minute-digit adjustment key. This key is valid when initialize diode ADJTYPE = 0. If it is pressed during the clock display, the minute digits are incremented by a minute. If it is kept pressed for 0.5 second or longer, the minute digits are incremented continuously at the speed of 1 minute per 100 ms.
SHIFT	This is the shift mode switchover key. If this key is pressed, high level is output from the shift output pin (pin No.18), thus placing the device in SHIFT mode for 5 seconds. (However, because this pin is an N-ch open drain output pin, ensure that a pull-up resistor is installed externally.) (1) When FUNC = 0 or FUNC = 1 : The AUTO SEEK/MANUAL SEEK operation of the SEEK UP and SEEK DWN keys is toggled (see SEEK UP and SEEK DWN keys). If the SEEK operation is manual, the shift status is delayed by another 5 seconds after the key is released. (2) When FUNC = 1 : • Normal mode (when shift output = 0) Keys M1 to M6 function as preset memory keys. • Shift mode (when shift output = 1) Keys M1 to M6 function as function keys with their respective allocations. SHIFT mode is canceled by pressing the SHIFT key again during SHIFT mode.

3. MODE TRANSITIONS



——— : Actural mode (MODE pin output, MUTE, etc.) changes.

---------- : Actual mode does not change.

× ◄—— : This mode cannot be changed.

① : TAPE pin = low level ; and CD mode is OFF.

② : TAPE pin = high level ; or CD mode is ON.

③ : TA or DK ON

④ : TA or DK OFF

⑤ : TP/SK mode OFF

⑥ : TP/SK mode ON

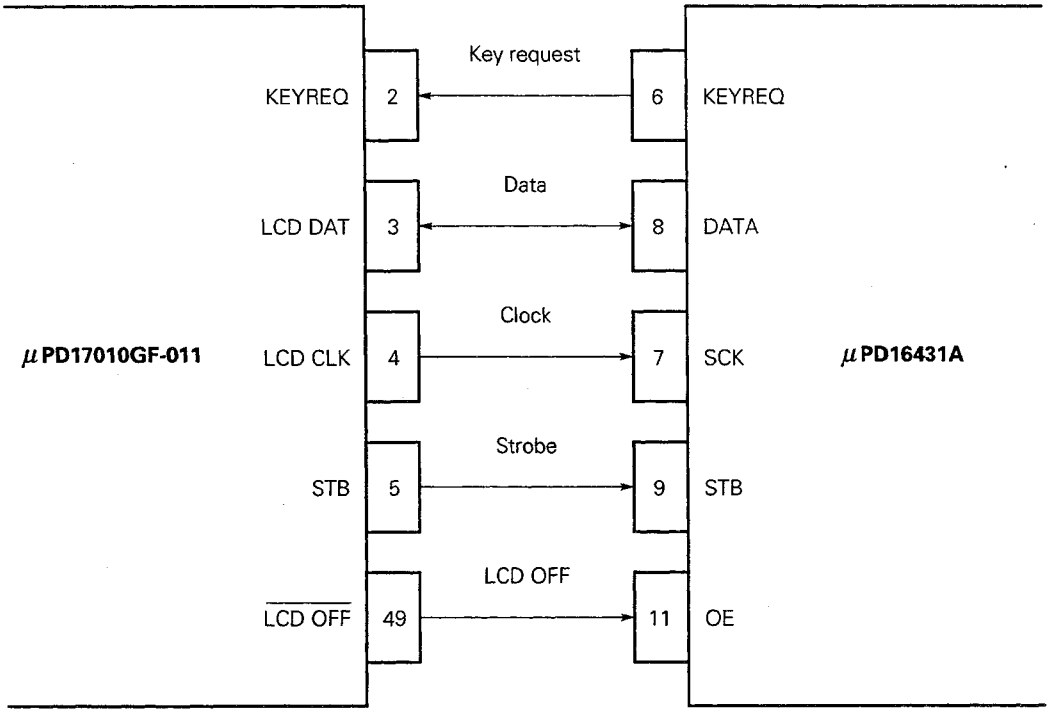
4. DATA OUTPUT TO LCD CONTROLLER/DRIVER (μPD16431A)

The μPD17010GF-011 uses the μPD16431A for LCD display and key sensing.

The μPD17010GF-011 transfers initialization data to the μPD16431A about 400 to 500 ms after the CE pin (pin 13) changes from low level to high level.

The pin configurations of the μPD17010GF-011 and the μPD16431A are shown below.

Fig. 4-1 μPD16431A Pin Configuration

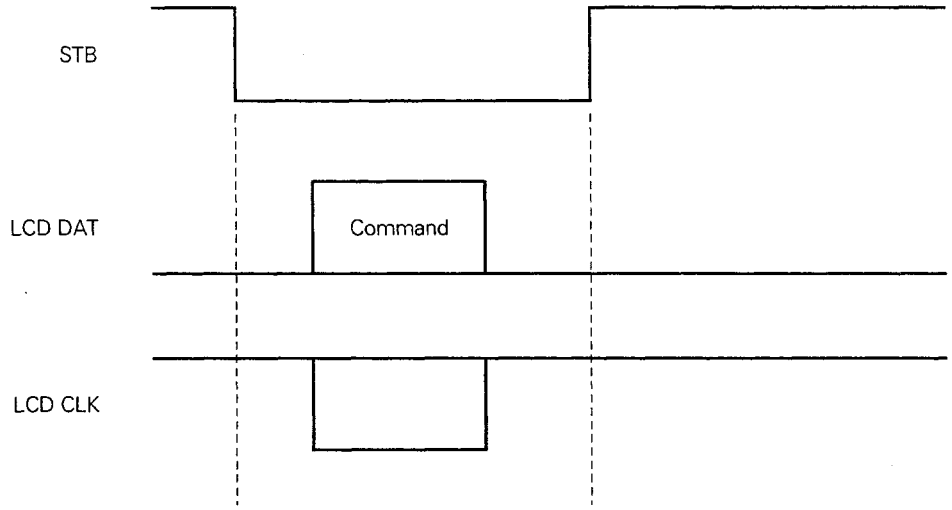


4.1 Data Input/Output Timing

(1) Initialization data output

The initialization data output to the μPD16431A is shown in Fig. 4-2.

Fig. 4-2 Initialization Data Output



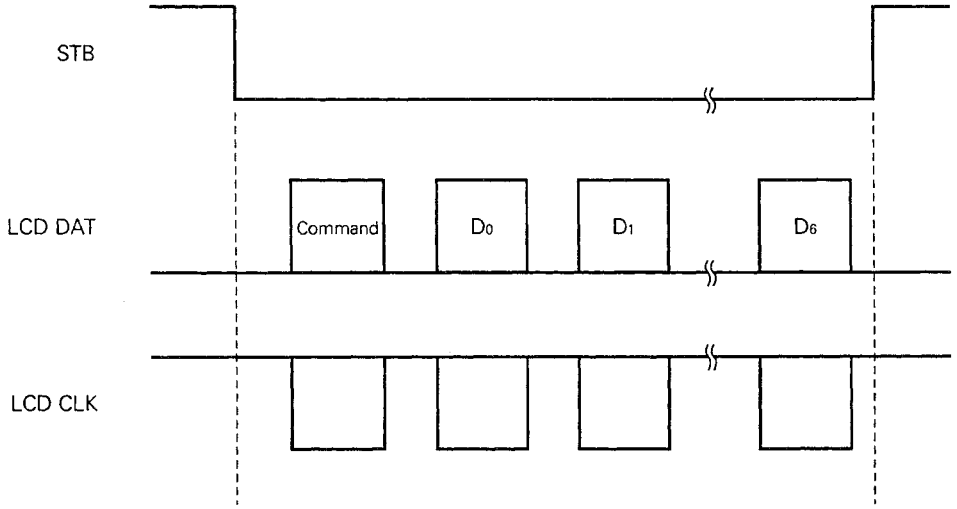
Command: 00000000 (Initialization command)

14 duties, (f osc/128)×n, internal driving voltage, master, and normal operation are initialized.

(2) Display data output

The display data output to the μPD16431A is shown in Fig. 4-3.

Fig. 4-3 Display Data Output



Command : 10000100 (Status command (in COM0 output))
: 10001100 (Status command (in COM1 output))
: 10010100 (Status command (in COM2 output))
: 10011100 (Status command (in COM3 output))

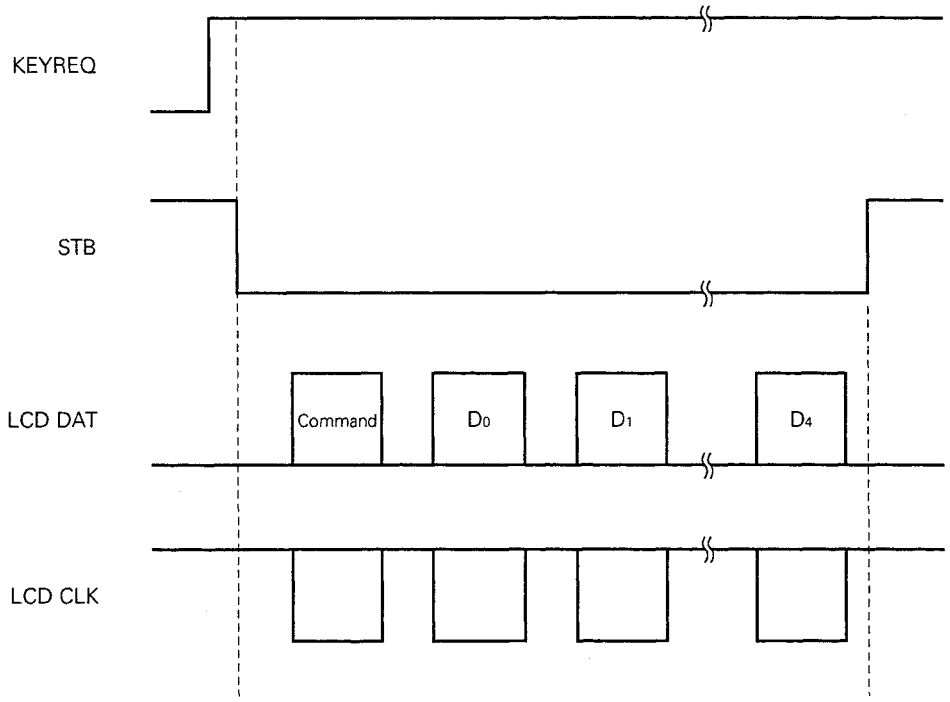
D0-D6 : 00000000 (Display data)
|
11111111

The display output above is repeated four times and the display data is transmitted.

(3) Key data input/output

The key data input/output to μPD16431A are shown in Fig 4-4.

Fig. 4-4 Key Data Input/Output



Command : 10000101 (Status command (Key data read))
D0-D4 : 00000000 (Key data)
|
11111111

After transmission of the status command, the LCD DAT pin is switched to INPUT mode to read the key data.

5. RDS (Radio Data System) FUNCTION

5.1 RDS Data Incorporation

μPD17010GF-011 internally decodes $\overline{\text{RDSDAT}}$ and $\overline{\text{RDSCLK}}$ from the RDS-compound IC. Synchronization detection is limited to block synchronization, and error correction is not performed.

Block synchronization is detected for the following four types of block patterns.

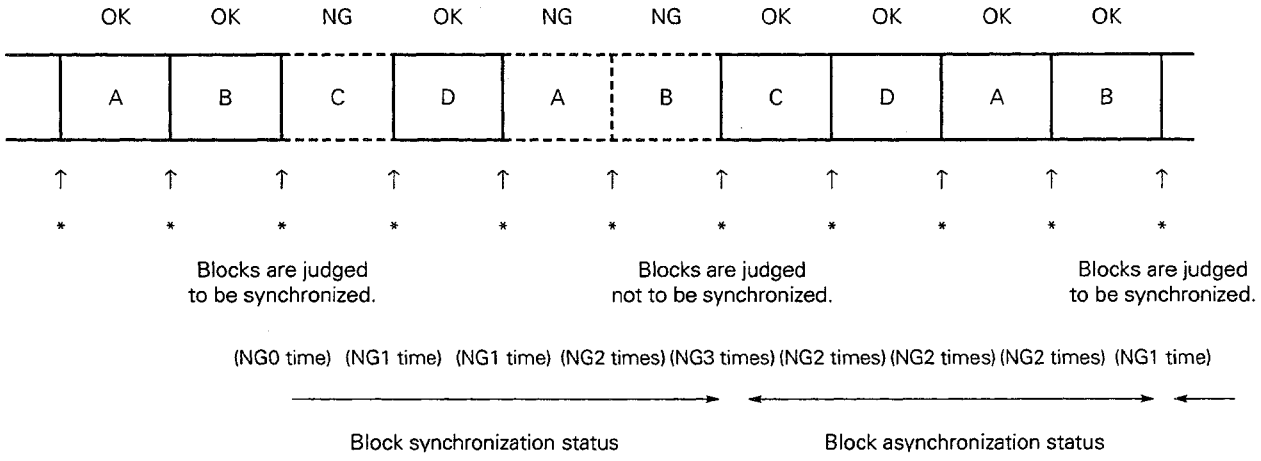
1 : A–B–C–D
2 : A–B–C'–D
3 : A–B–E–E
4 : A–B–F–F

The method of detecting synchronization is as follows: the synchronous status is checked per block from the current point to 5 previous blocks before; if synchronization of three or more blocks out of 5 blocks is detected, it is judged that block synchronization exists.

If block synchronization is not obtained for 1.5 seconds or more, the status of each of TP, TA, and PTY is cleared.

If an error is detected from the incorporated blocks and if block synchronization has taken place, synchronization detection is performed every 26 bits until the block synchronization is removed.

Fig. 5-1 Block Synchronization Detection



* : The synchronization status for the preceding 5 blocks is checked. In this case, if at least 3 blocks are not synchronized out of 5 blocks, the blocks are judged to be asynchronous.

A to D : Indicates offset check words.

5.2 RDS Data Processing

The μPD17010GF-011 contains an RDS data decoder part.

The μPD17010GF-011 uses the following seven types of data:

(1) PI (Program Identification)
(2) PS (Program Service Name)
(3) PTY (Program Type)
(4) AF (Alternative Frequency)
(5) TP (Traffic Program Identification)
(6) TA (Traffic Announcement Identification)
(7) EON (Enhanced Other Network)

5.2.1 PI (Program Identification)

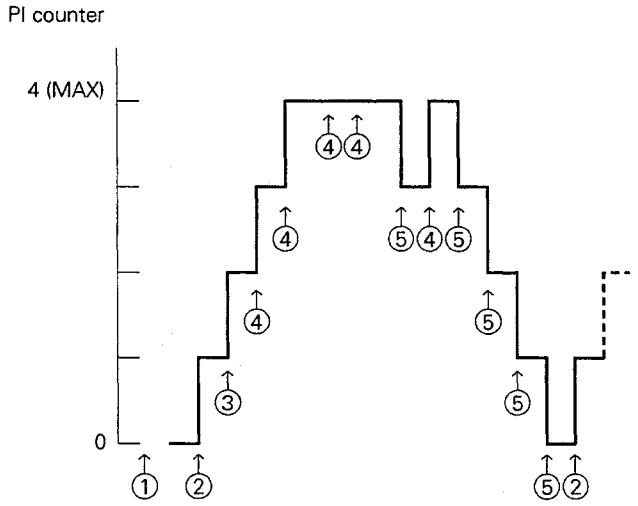
This data is used for program identification.

After a tuning operation is completed, receipt of the same PI code two or more times causes the RDS data that has that PI code to be decoded. The PI counter can be incremented up to four counts.

When RDS data of a different PI code is received, the PI counter is decremented. RDS data other than TP and TA at this time are not decoded.

If the PI counter is decremented to zero, the different PI code is judged to be a new correct PI code, thus incrementing the PI counter; when the maximum count of the PI counter is reached two or more times, the RDS data is decoded.

Fig. 5-2 PI Counter Operation



① : Tuning operation end
② : The PI code is entered in the PI code area for comparison. Counter + 1
③ : The PI code is compared with the PI code. Counter + 1 when the two codes are the same.
④ : The PI code is compared with the PI code. Counter + 1 when the two codes are the same. RDS data is decoded.
⑤ : The PI code is compared with the PI code. Counter – 1 when the two codes are different.

5.2.2 PS (Program Service Name)

This data is used for the PS display.

The PS display is made once when the same PS data is input two or more times.

The PS display appears about 3 seconds after the tuning operation is completed. If the PS data cannot be received during about 3 seconds, the PS display appears when the PS data is eventually received.

Once PS data has been received, if the display is changed by the DISP key or the TP/SK mode ON/OFF change is performed even if no PS data can be received thereafter, the last PS data is stored, and 3 seconds after displaying it, the stored PS data is displayed.

5.2.3 PTY (Program Type)

Used for alarm identification. When the alarm is received, the device is switched over to RADIO mode if in TAPE/CD mode, placing the TA/DK pin at high level.

At this time, the LCD panel displays "ALARM".

5.2.4 AF (Alternative Frequency)

Used as a switchover frequency list.

(1) AF list input

The AF function can be used for both METHOD A and METHOD B. Up to 25 lists can be input. If AF's header block is received, the AF pointer is reset to the front and the lists are stored in the order of their transmission. If more than 25 AF lists are sent, data is overwritten starting from the top of the lists. If, in METHOD B, blocks for the same frequency arrive one after another, they are linked together to form a single AF list. Even when lists are sent in pairs of a descending sequence, all the AF lists are input.

The method of input for AF lists is shown in Fig. 5-3 Flow of AF List Input.

Fig. 5-3 Flow of AF List Input (1/3)

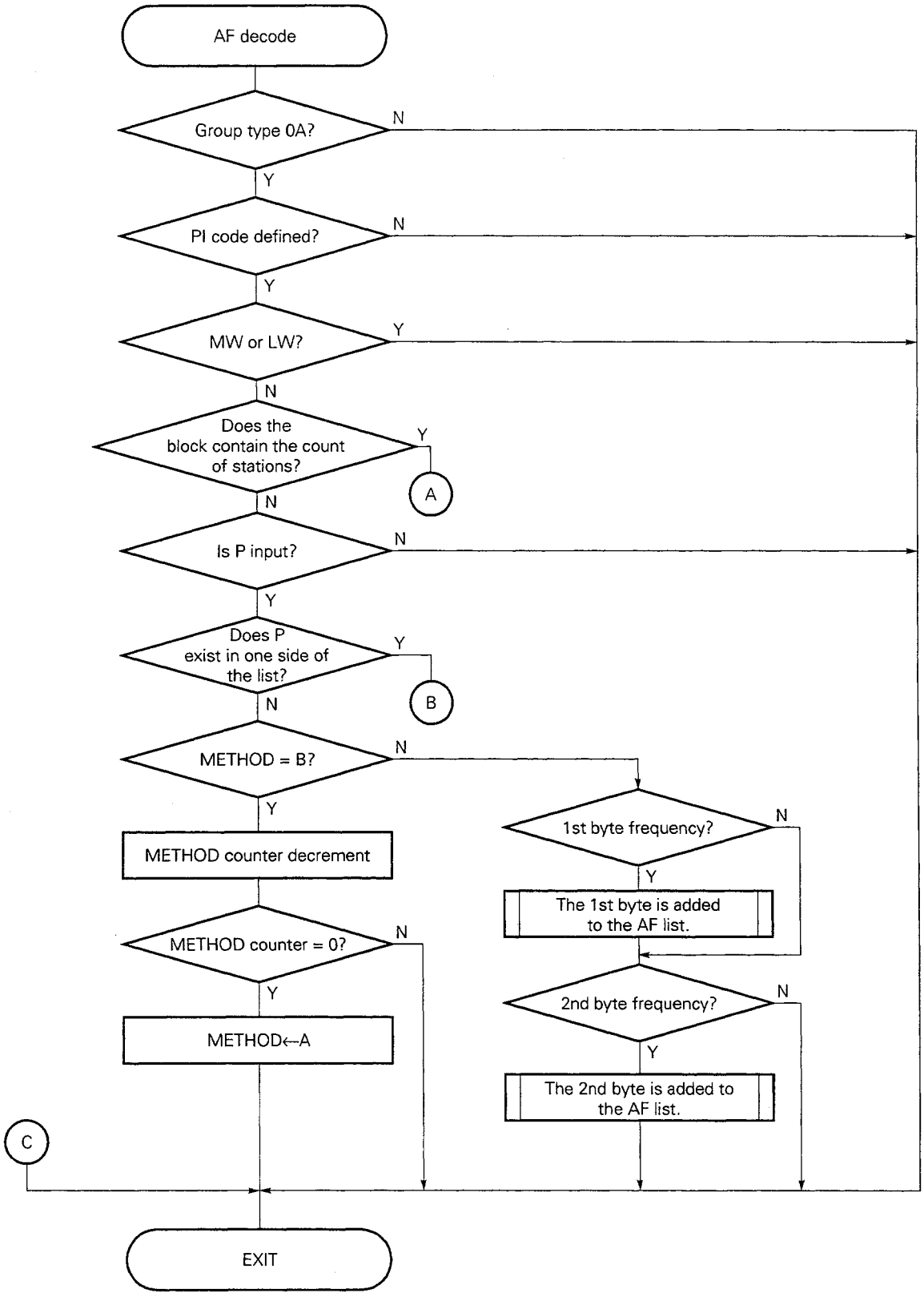


Fig. 5-3 Flow of AF List Input (2/3)

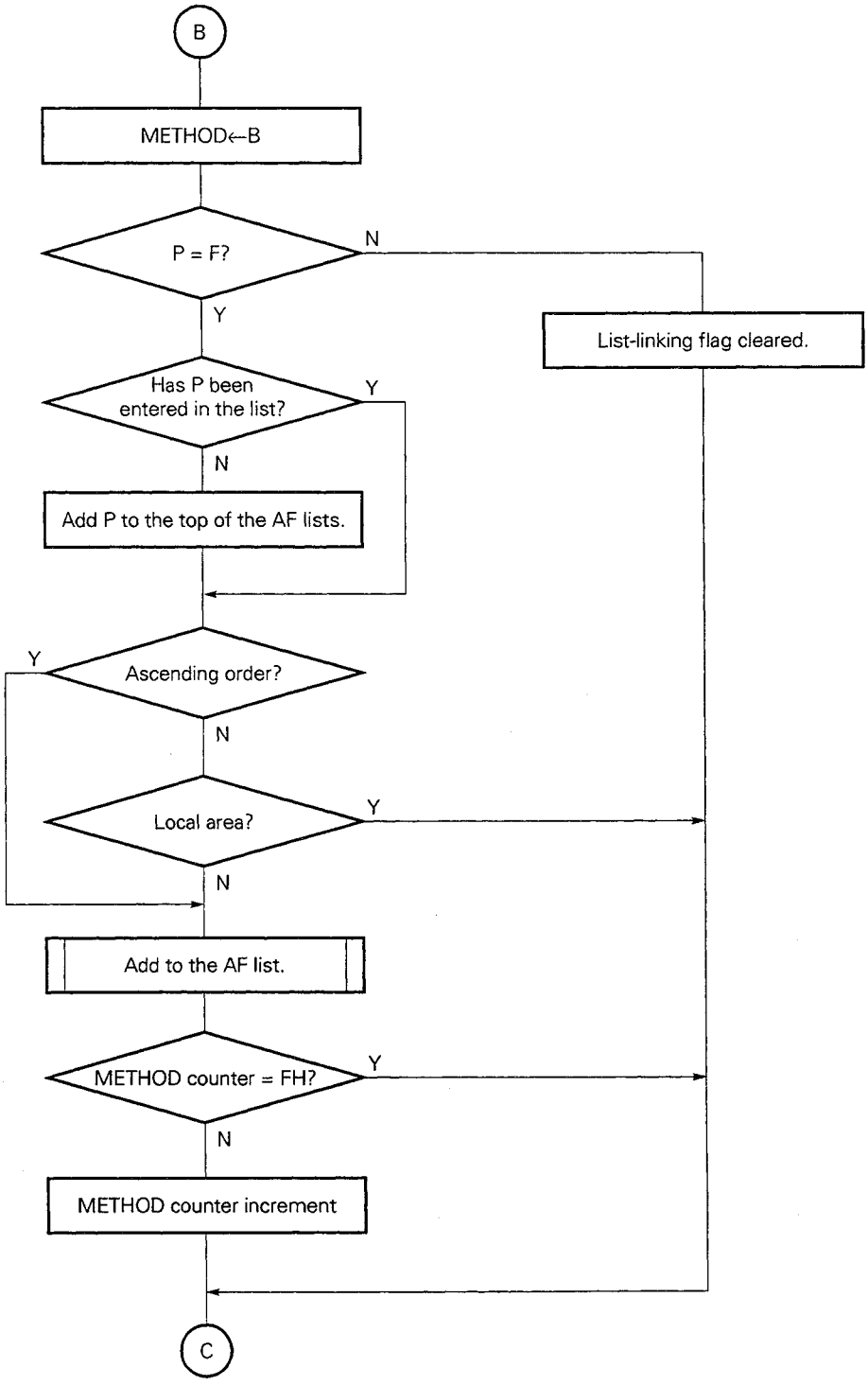
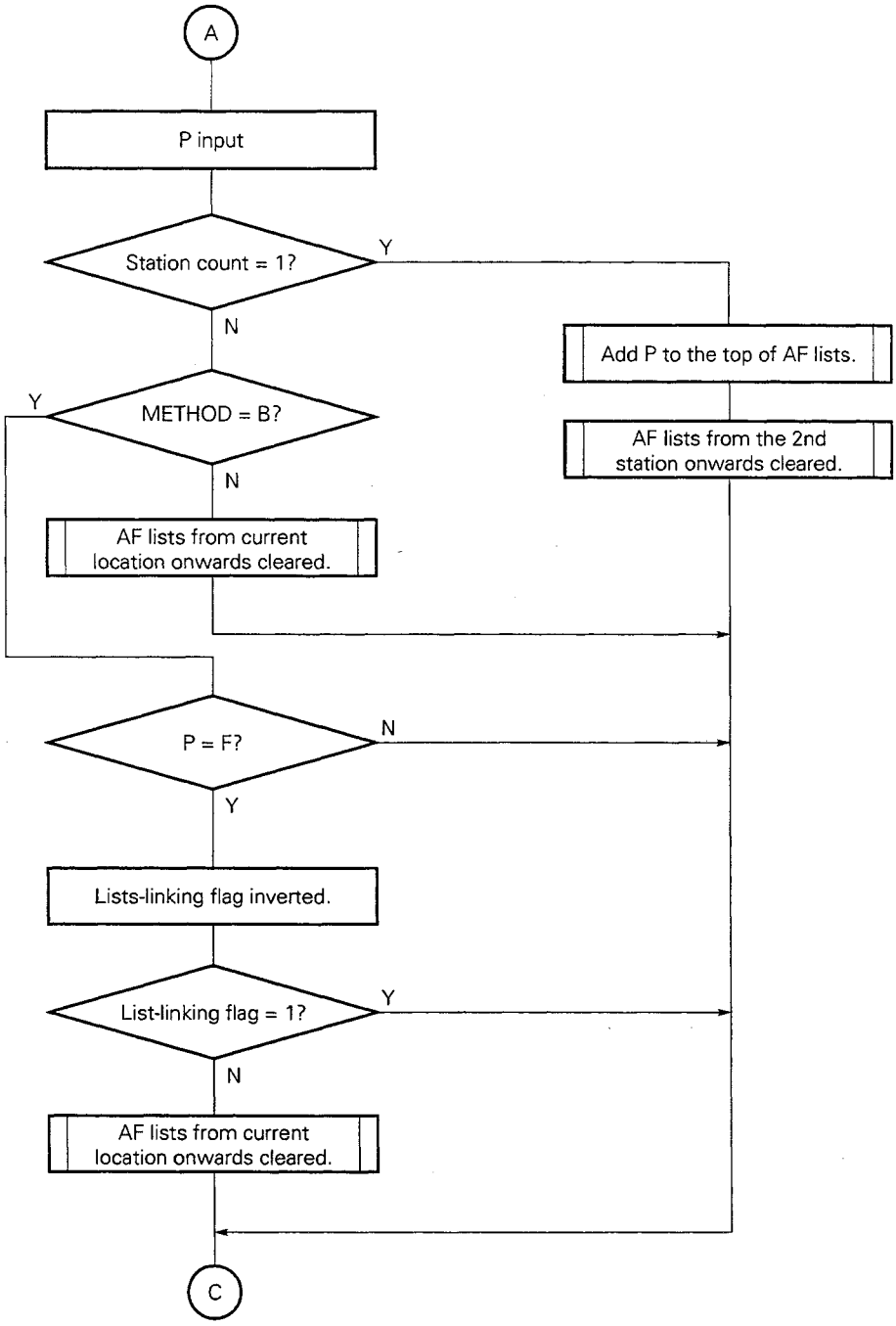


Fig. 5-3 Flow of AF List Input (3/3)



P : Frequency entered in blocks containing the station count

F : Tuning frequency

(2) AF check

Data of the AF operation memory is used for AF checking. One station is checked at a time.

① **AF check start condition:**

The condition for starting the AF check is determined by a combination of the electric field strength and the data error level of the broadcast being received.

First of all, the electric field strength of the broadcast being received is divided into the following three stages (the numeric values are those when the read A/D values are 0-3FH) by the voltage which is input from S•METER (pin No. 29).

$$L \leq 12H < M \leq 20H < H$$

Furthermore, the data error level of the broadcast being received is further divided into the following two stages by the voltage which is input from S•QUALITY (pin No.28).

$$L \leq 14H < H$$

These are listed on the following table.

S•METER \ S•QUALITY	H	L
H	A	A
M	A	B
L	B	C

A : AF check not started.

B : AF check started on a station every 5 seconds

C : All the AFs at the time checked at once.

② **AF check stop condition:**

AF checking is stopped when the signal meter voltage of the AF-checked broadcast is higher than that of the broadcast originally being listened to, and the PI of the broadcast at the check destination has satisfied the STOP condition.

Conditions for broadcast (PI) capable of AF switchover are as follows:

- Broadcast whose 16 bits are completely identical, including the PI code and the area cover code of the broadcast being currently received.
- Broadcast whose area cover code is '4' to 'F' when the PI code and the area cover code of the broadcast being currently received is '1' to '3', and whose remaining 12 bits are identical.
- Broadcast whose area cover code is '1' to '3' when the PI code and the area cover code of the broadcast being currently received is '4' to 'F', and whose remaining 12 bits are identical.

③ **AF check when calling the preset memory:**

When calling the preset memory, the AF data (within 4 stations) of the preset memory is moved to the AF operation memory, and immediately all the AFs are checked.

The broadcasting station whose PI stored in the preset memory has satisfied the STOP condition, and whose signal meter voltage is the highest, is selected for reception. This AF checking is performed during MUTE output of the preset memory calling.

If no station satisfies the STOP condition as a result of checking the broadcast stations of the preset frequency and all their AF, the SEEK operation is performed from the preset frequency to detect the broadcasting station which satisfies the STOP condition.

If a broadcasting station which satisfies the STOP condition appears, the SEEK operation is halted to receive the relevant broadcasting station (PI search). Even if the SEEK operation is carried out across the entire width of reception band, if a broadcasting station which satisfies the STOP condition cannot be found, the SEEK operation is halted to receive the originally set frequency.

④ **AF check for calling when CE low level has been switched over to high level or when the last station is an FM RDS station:**

AF checking is performed for calling when the CE low level has been switched over to low level or when the last station is an FM RDS station.

At this time, the AF data of the last channel memory is moved to the AF operation memory, and immediately all the AFs are checked. The broadcasting station whose PI stored in the preset memory has satisfied the STOP condition and whose signal meter voltage is the highest is selected for reception. This AF checking is performed during MUTE output. As in ③ above, the PI search is performed.

(3) EON (Enhanced Other Network) information mapped AF

Incorporation of the frequency is performed.

The other-station network AF list and the mapped FM frequency of the EON information sent in group type 14A and block 3 are input to update the AF list of the preset memory station.

If USAGE CODE of group 3 is as follows when group type 14A has been input, the preset memory is updated as the PI station AF list indicated in block 4.

USAGE CODE = 4 (AF list)
USAGE CODE = 5 - 8 (Mapped FM frequency)

(4) Traffic information switchover by EON information

When the EONEN pin (pin No.80) is high level, the traffic information switchover is performed by the EON information. The TP (ON) TA (ON) of other stations in the EON information sent in group type 14B is used to perform the traffic information switchover.

If the TP (TN) of the currently received station is 1 or is not TP/SK stand-by, the traffic information switchover is not performed.

5.2.5 TP (Traffic Program Identification), TA (Traffic Announcement Identification)

These are used for traffic information station identification and traffic information announcement identification. Depending on the TP and TA statuses of the current receiving station, the methods of identifying a traffic information station are as follows:

- When TP = 1,
  Recognized as the traffic information station.
- When TP = 0 and TA = 1,
  Recognized as EON's traffic information.

TP and TA are decoded by inputting the same data at least twice after the tuning operation is ended. If 1 is input as the TP or TA data, the TP or TA counter is incremented up to 4 counts. If 0 is input, the counter is decremented; and when the counter becomes 0, it is determined that there is no TP or TA.

The method of identifying the traffic information announcement is as follows.

- If it results that TA=1 when TP=1, the traffic information is recognized as being broadcast.

The methods of switching over to the traffic information are as follows:

- When TA = 1,
  High level is output from TA/DK. At this time, if the device is in TAPE/CD mode, it is switched over to RADIO mode.
- If TA = 0,
  Low level is output from TA/DK, returning to the original mode.

5.2.6 EON (Enhanced Other Network)

(1) Input of EON information mapped AF frequency

The EON information which is sent in group type 14A and block 3 uses the other-station network AF list and the mapped FM frequency.

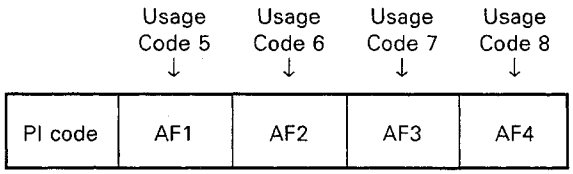
The procedure for input of the group type 14A data is:

① The PI code which is the same as the one stored in block 4 of the data sent in 14A is searched from the preset memory.

② If a coinciding PI code is detected, the following frequency of block 3 of the data sent in 14A is registered in the AF list that comes with the relevant PI code.

- AF list sent with usage code 4
- Mapped FM frequency sent with usage codes 5-8

③ If there is already a coinciding PI code in the preset memory in connection with incorporation of usage codes 5-8, updating is performed directly on the AF list of the preset memory (see the diagram below).



As shown in the diagram above, the storage locations corresponding to usage codes 5 to 8 are specified.

AF1 is given the highest priority in AF switchover.

In this case, even when the AF list of the pool memory has already been registered, it is overwritten by incorporating usage codes 5 to 8.

(2) Traffic information switchover by EON information

(a) Determining the traffic information broadcasting start of EON station

If the station being currently received is RDS and is in the traffic information stand-by state when TP = 0 and TA = 1, the traffic information switchover is performed with data input of valid group 14B.

The conditions for valid group 14B are:

- TP (TN) of group 14B is "0" and both TP(ON) and TA(ON) are "1".
- The above data is decoded at least twice in 2 seconds.

(b) Input operation into the EON station

When the EONEN pin (pin No.80) is high level, the traffic information switchover operation to the EON station is accepted.

If a request for switchover to the EON station occurs when the FM band is in TP/SK mode, the following operations are performed.

① Whether or not the preset memory contains a PI code which is the same as that of the EON station is determined. If the same PI code is detected, the AF switchover operation is performed in the AF list of the preset memory. If not, the PI search based on PI by 14B data is performed.

② When the EON switchover has been successful, the TA wait timer is set for 3 seconds. The device is placed in the traffic information interrupt status at the point of TA ON within 3 seconds.

If the TA signal cannot be input within 3 seconds, if the traffic information broadcasting is ended, or if reception is impossible due to deterioration of the SD level, the device is returned to the station before EON station switchover.

③ If the switchover to the EON station has failed due to the AF operation in ① above, the PI search is performed with the PI code of the EON station. An entire rotation is made on the band in the up direction from the frequency before EON station switchover. When stations of the same PI are detected, the same operation as in ② above is performed. If stations of the same PI are not detected throughout the entire width of the band, the frequency before starting the PI search is received.

6. MUTE TIMING

6.1 Tuner Operation

The operation of the tuner function and the output of the $\overline{\text{MUTE}}$ pin are explained in the following order.

(1) Preset memory reading (see **6.1.1 Preset memory reading**)
(2) Preset scan (see **6.1.2 Preset scan**)
(3) Preset memory writing (see **6.1.3 Preset memory writing**)
(4) Seek up/down (see **6.1.4 Seek up/down**)
(5) Manual up/down (see **6.1.5 Manual up/down**)
(6) Auto store memory (see **6.1.6 Auto store memory**)
(7) AF switchover (see **6.1.7 AF switchover**)
(8) EON switchover (see **6.1.8 EON switchover**)

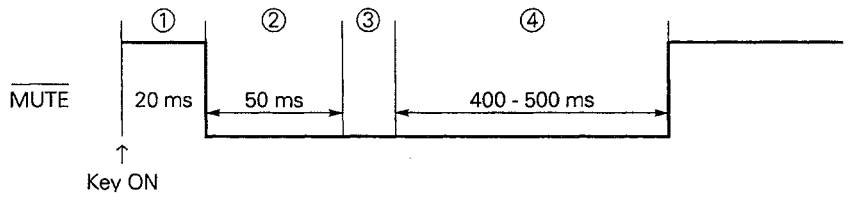
6.1.1 Preset memory reading

Reading in the preset memory is performed by pressing key [M1] to [M6] for less than 2 seconds when initialize diode MESEL = 0 in TUNER mode, or by pressing these keys in modes other than preset memory write enable mode when MESEL = 1.

The timing chart showing the preset memory reading operation is shown below.

AF operation is performed if the broadcasting station being read is an FM RDS station (see **5.2.4 AF (Alternative Frequency)**).

Fig. 6-1 Timing Chart in Preset Memory Read



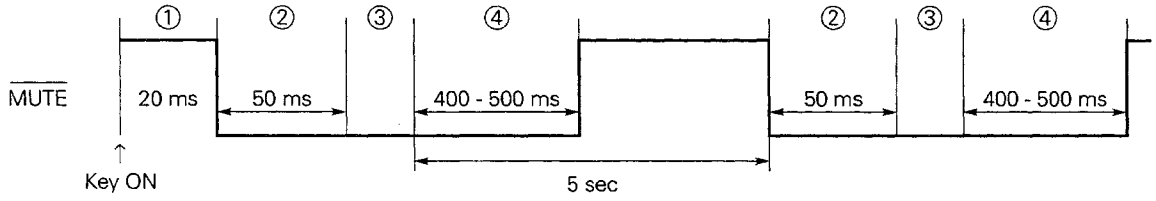
① Key-ON chattering prevention
(When MESEL = 0, this becomes the time of 20 ms from key-OFF.)
② MUTE first-out and beep output
③ Frequency division ratio setting
④ MUTE last-out output

6.1.2 Preset scan

The preset scan operation is started by pressing the [PSCAN] key in TUNER mode. The timing chart showing the preset scan operation is shown below.

AF operation is performed if the broadcasting station being preset-scanned is an FM RDS station (see **5.2.4 AF (Alternative Frequency)**).

Fig. 6-2 Timing Chart in Preset Scanning



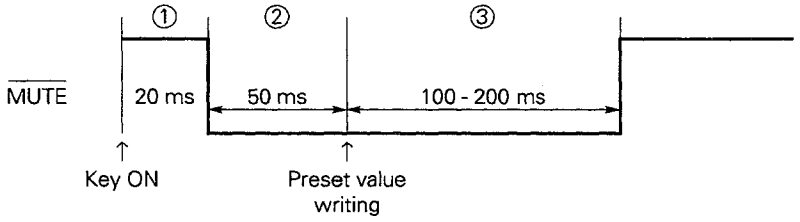
① Key-ON chattering prevention
① MUTE first-out and beep output
① Frequency division ratio setting
① MUTE last-out output

6.1.3 Preset memory writing

Writing in the preset memory is performed by pressing key [M1] to [M6] for 2 seconds or longer when initialize diode MESEL = 0 in TUNER mode, or by pressing these keys in the preset memory write enable mode when MESEL = 1.

The timing chart showing the preset memory writing operation is shown below.

Fig. 6-3 Timing Chart in Preset Memory Write



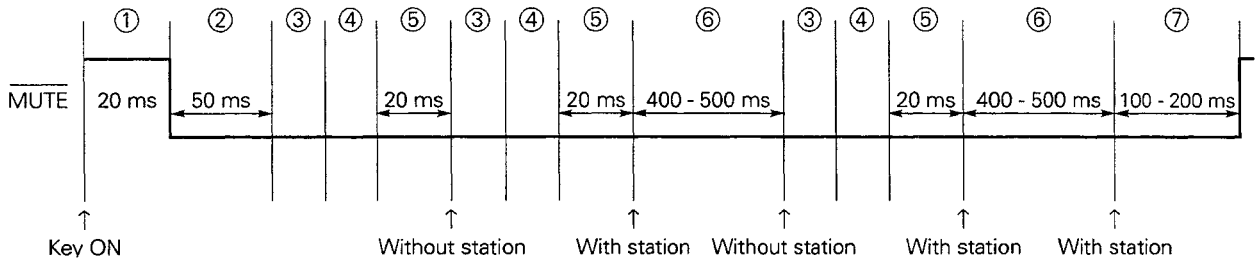
① Key-ON chattering prevention
② MUTE first-out and beep output
③ MUTE last-out output

6.1.4 Seek up/down

The operation is started by pressing SEEK UP / SEEK DWN when the device is in TUNER mode but other than in SHIFT mode.

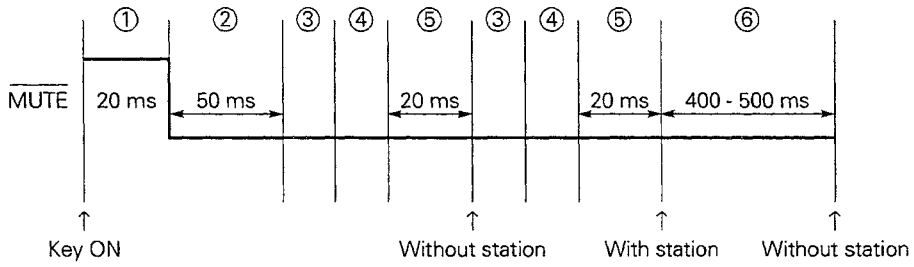
The broadcasting station detection operation judges the IF count if the SD level and initialize diodes (AM SD/IF, FM SD/IF) are ON and terminates the SEEK operation if the condition for "with broadcasting station" is satisfied twice at the interval of 500 ms. In RDS mode and TP/SK mode, after the condition above has been satisfied, the operations of detecting the RDS broadcasting station and the traffic information station are performed according to the timing chart below.

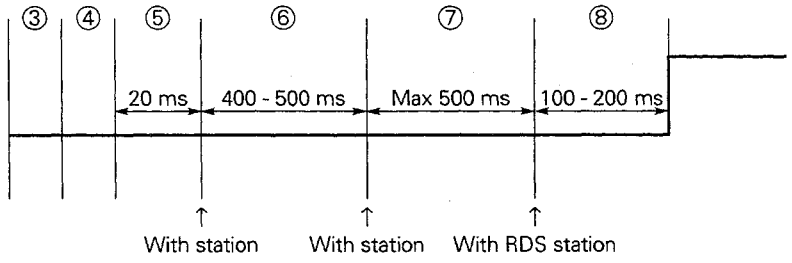
Fig. 6-4 Timing Chart in Seek Up/Down (Normal Mode)



① Key-ON chattering prevention
② MUTE first-out and beep output
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait (1)
⑥ SD stability wait (2)
⑦ MUTE last-out output (400-500 ms in band edge detection)

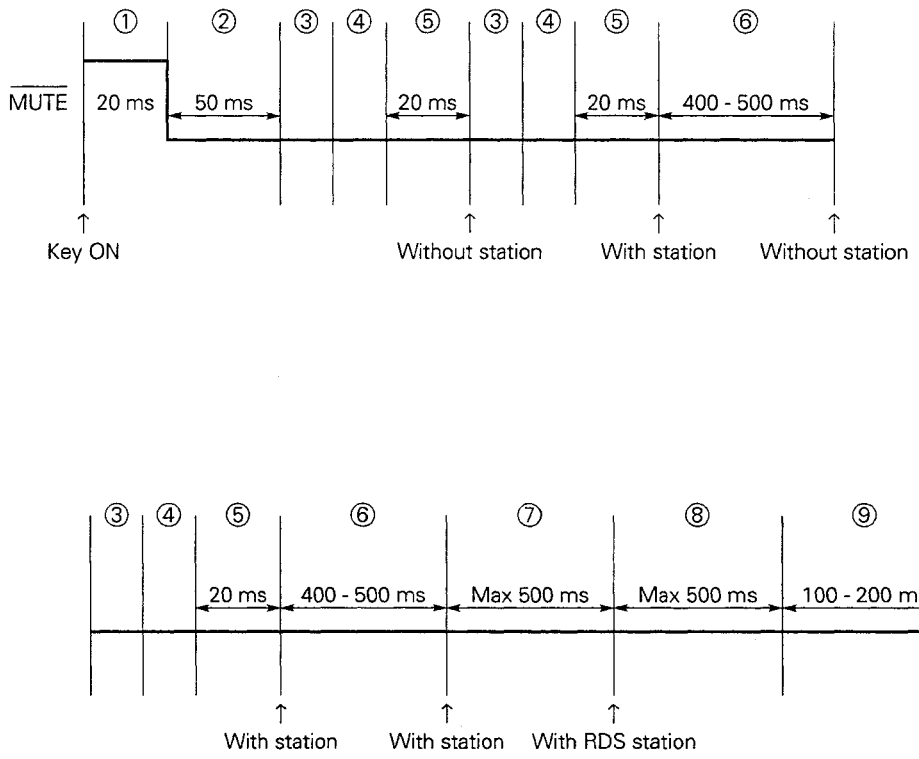
Fig. 6-5 Timing Chart in Seek Up/Down (RDS Mode)





① Key-ON chattering prevention
② MUTE first-out and beep output
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait (1)
⑥ SD stability wait (2)
⑦ RDS station detection wait
⑧ MUTE last-out output (400-500 ms in band edge detection)

Fig. 6-6 Timing Chart in Seek Up/Down (TP/SK Mode)



① Key-ON chattering prevention
② MUTE first-out and beep output
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait (1)
⑥ SD stability wait (2)
⑦ RDS station detection wait
⑧ Traffic information station identification (TP/SK) wait
⑨ MUTE last-out output (400-500 ms in band edge detection)

6.1.5 Manual up/down

The operation is started by pressing [SEEK UP] / [SEEK DWN] when the device is in TUNER mode and in SHIFT mode.

The timing chart below shows the manual operation.

Fig. 6-7 Timing Chart in Manual Operation (with key released within 0.5 second)

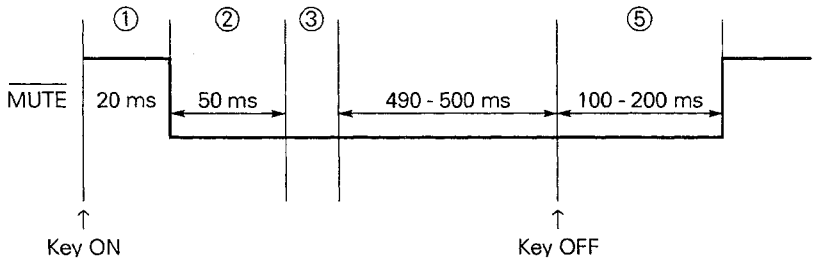
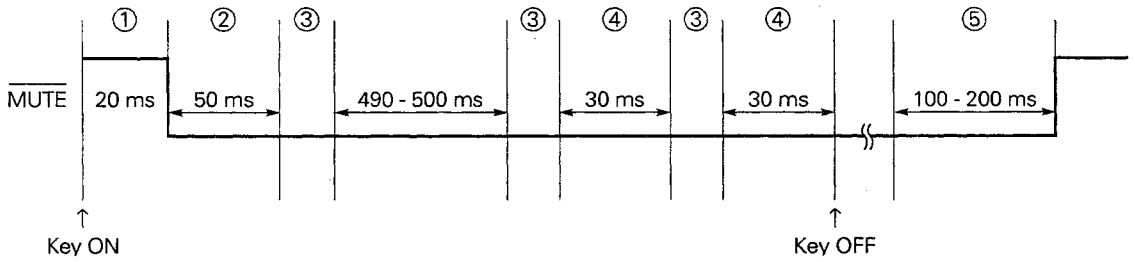


Fig. 6-8 Timing Chart in Manual Operation (with key kept pressed for 0.5 second or longer)

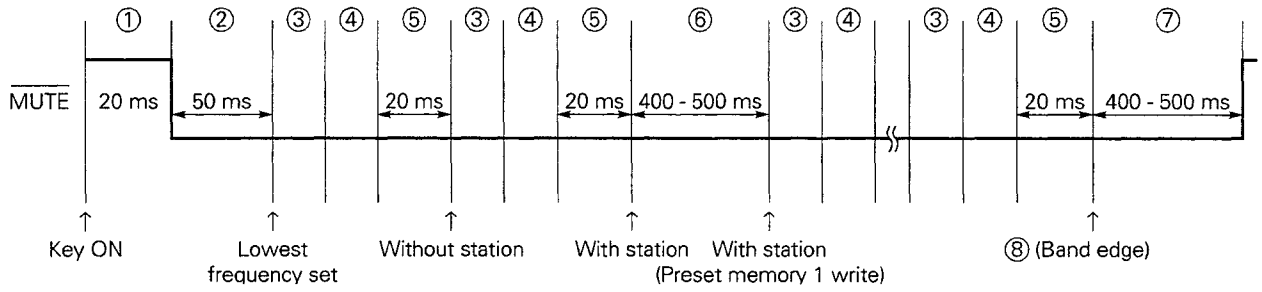


① Key-ON chattering prevention
② MUTE first-out and beep output
③ Frequency division ratio setting
④ Key repeat time (This refers to the time when the band is FM. It is 50 ms when the band is AM; and 200 ms for both AM and FM when the band edge has been detected.)
⑤ MUTE last-out output (400-500 ms in band edge detection)

6.1.6 Auto store memory

The operation is started by pressing the [ASM] key when the device is in TUNER mode.
The timing chart below shows the AUTO STORE operation.

Fig. 6-9 Timing Chart in Auto Store Memory



① Key-ON chattering prevention
② MUTE first-out and beep output
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait (1)
⑥ SD stability wait (2)
⑦ MUTE last-out output
⑧ ASM end. Sorted in the ascending order of the frequency to call preset memory M1. If no station is detected, the frequency before pressing the key is retained. If the relevant station is detected after writing the preset memories up to M6, it is compared with the SD levels of the written preset memories to be sorted in the order of higher SD levels.

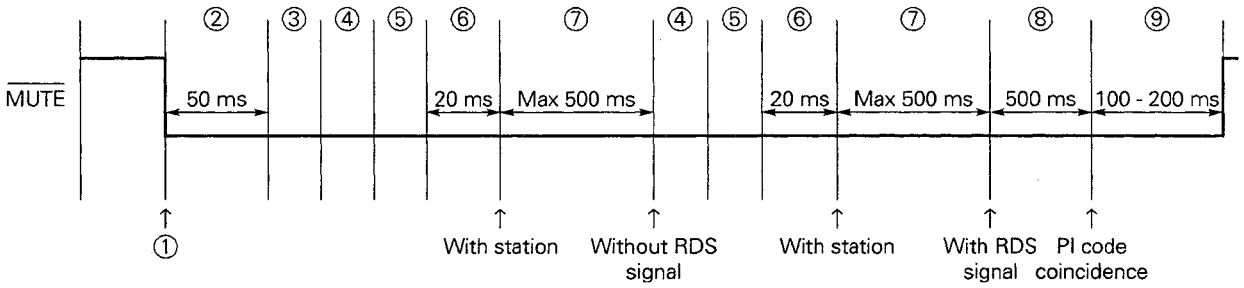
6.1.7 AF switchover

There are two types of AF switchover operations.

(1) AF switchover of all stations at once (see **Fig. 6-10**)
(2) AF switchover of a station at a time (Interval 5 seconds (see **Fig. 6-11**))

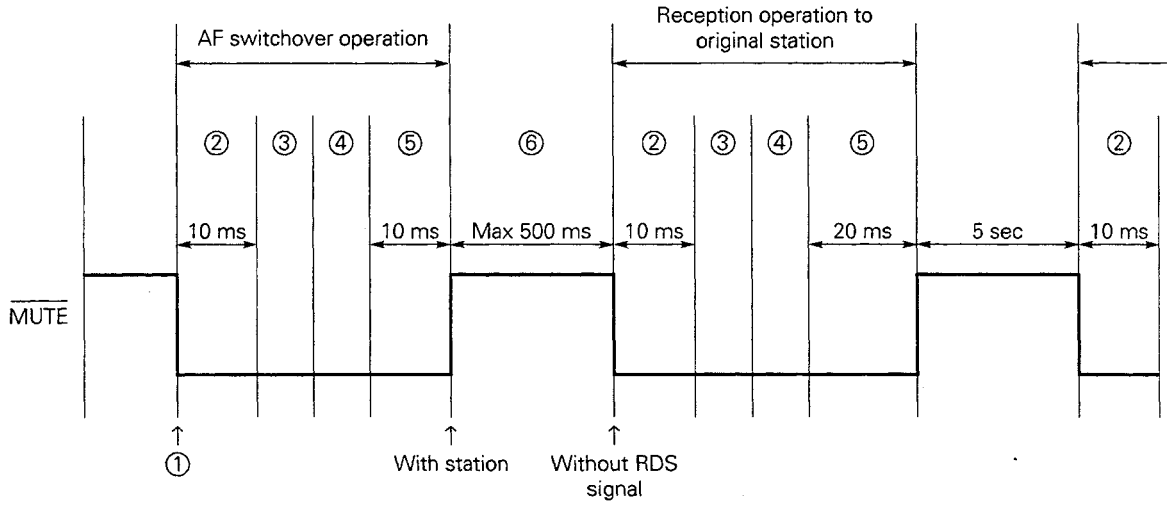
The timing charts of the respective operations are shown below and on the following page.
For conditions for occurrence of the AF operations, please refer to **5.2.4 AF (Alternative Frequency)**.

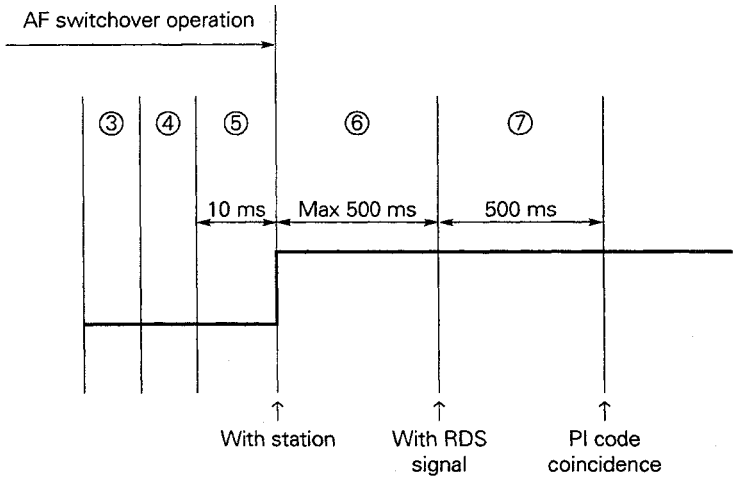
Fig. 6-10 Timing Chart for All-Station AF Switchover



① Occurrence of AF switchover condition
② MUTE first-out wait
③ SD sort (Stations with SD are determined beforehand on the AF list and sorted in the order of the stronger SD first.)
④ Frequency division ratio setting
⑤ PLL lock wait
⑥ SD stability wait
⑦ RDS station detection wait
⑧ PI code input wait
⑨ MUTE last-out output

Fig. 6-11 Timing Chart for One-Station AF Switchover





① Occurrence of AF switchover condition
② MUTE first-out wait
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait
⑥ RDS station detection wait
⑦ PI code input wait

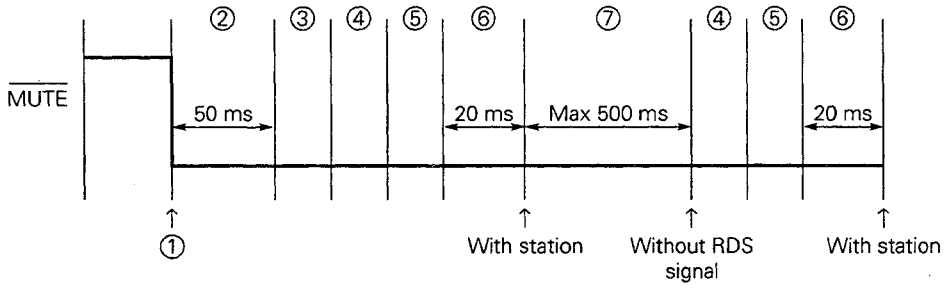
6.1.8 EON switchover

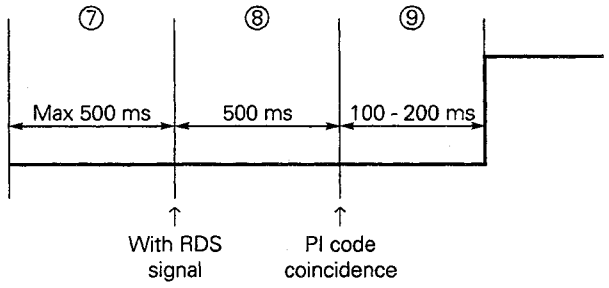
There are two types of EON switchover operations.

(1) Receiving-to-EON-station switchover operation (see **Figs. 6-12 & 13**)
(2) EON-to-receiving station switchover operation (see **Fig. 6-14**)

For conditions for occurrence of the EON switchover operations, please refer to **5.2.6 EON (Enhanced Other Network)**.

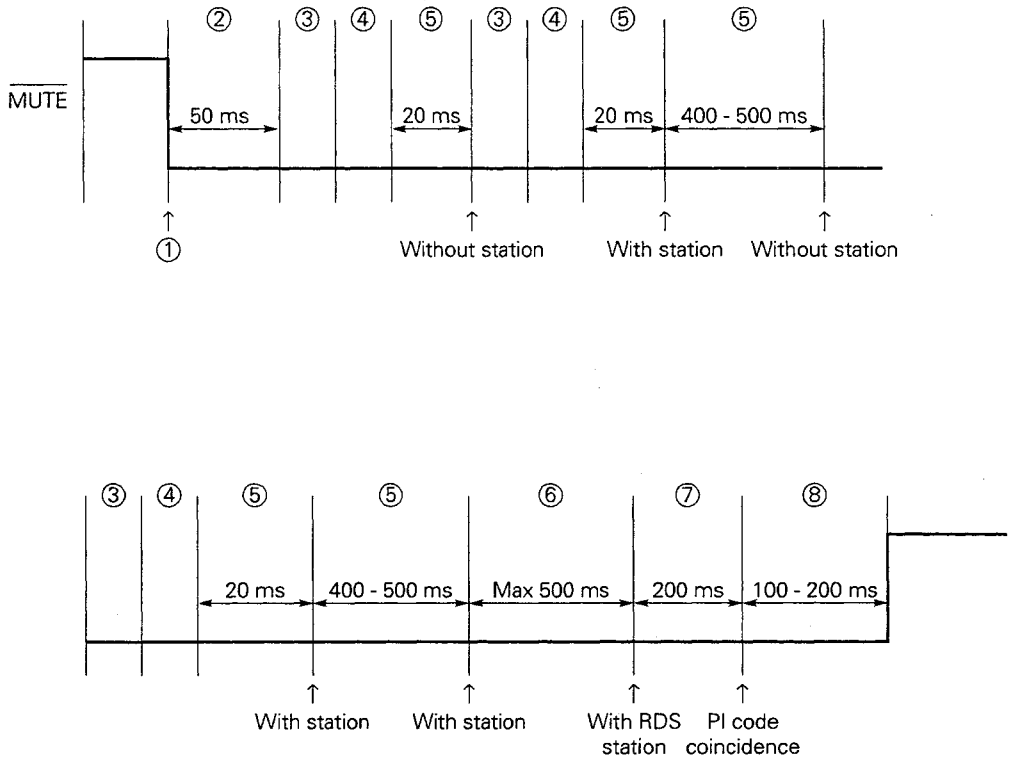
Fig. 6-12 Timing Chart of Switchover to EON Station
(if the preset memory contains the same PI code as the EON station)





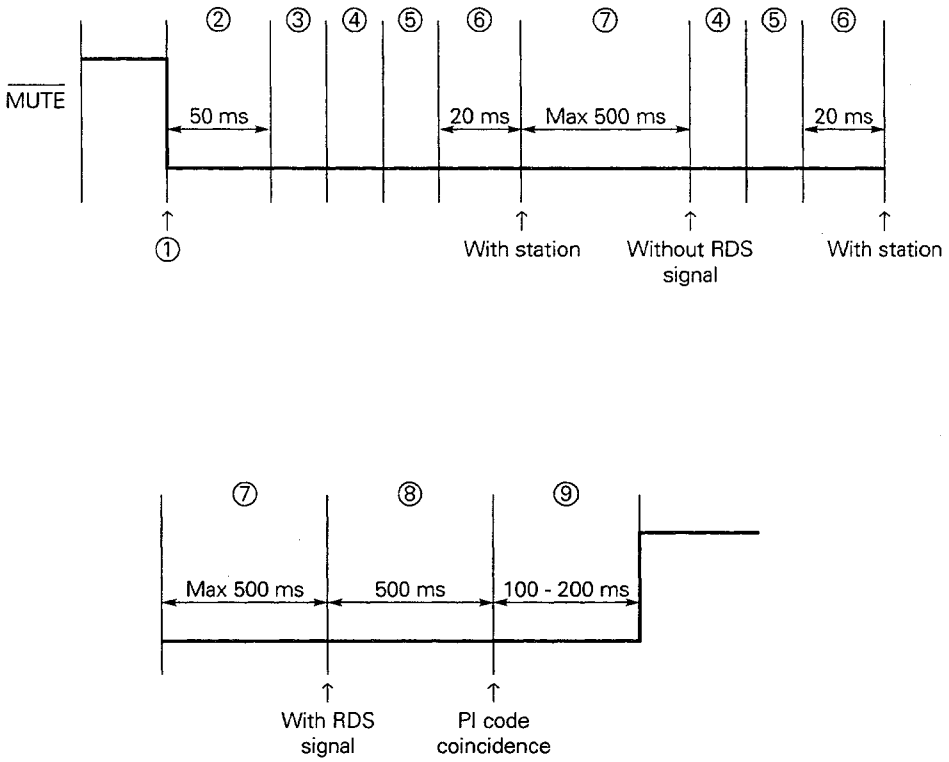
① Occurrence of condition for switchover to EON station
② MUTE first-out wait
③ SD sort (Stations with SD are determined beforehand on the AF list and sorted in the order of the frequency.)
④ Frequency division ratio setting
⑤ PLL lock wait
⑥ SD stability wait
⑦ RDS station detection wait
⑧ PI code input wait
⑨ MUTE last-out output

Fig. 6-13 Timing Chart of Switchover to EON Station
(if the preset memory does not contain the same PI code as the EON station)



① Occurrence of condition for switchover to EON station
② MUTE first-out wait
③ Frequency division ratio setting
④ PLL lock wait
⑤ SD stability wait
⑥ RDS station detection wait
⑦ PI code input wait
⑧ MUTE last-out output

Fig. 6-14 Timing Chart of Switchover to Original Receiving Station

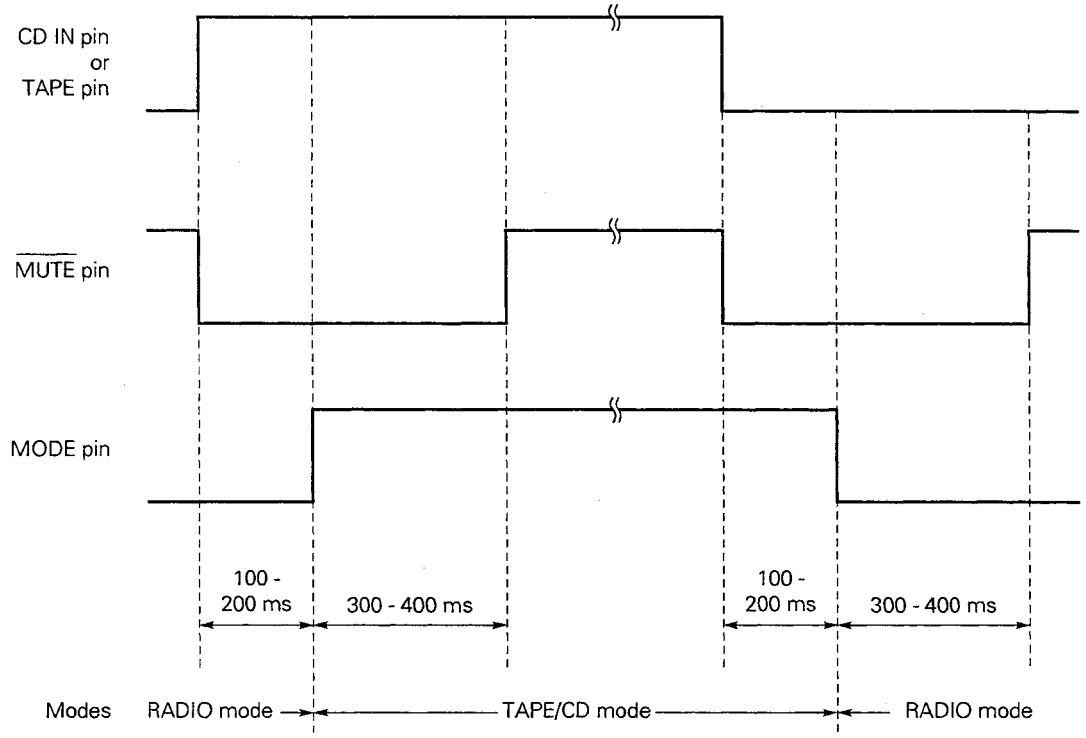


① Occurrence of condition for switchover to original receiving station
② MUTE first-out wait
③ SD sort (Stations with SD are determined beforehand on the AF list and sorted in the order of the frequency.)
④ Frequency division ratio setting
⑤ PLL lock wait
⑥ SD stability wait
⑦ RDS station detection wait
⑧ PI code input wait
⑨ MUTE last-out output

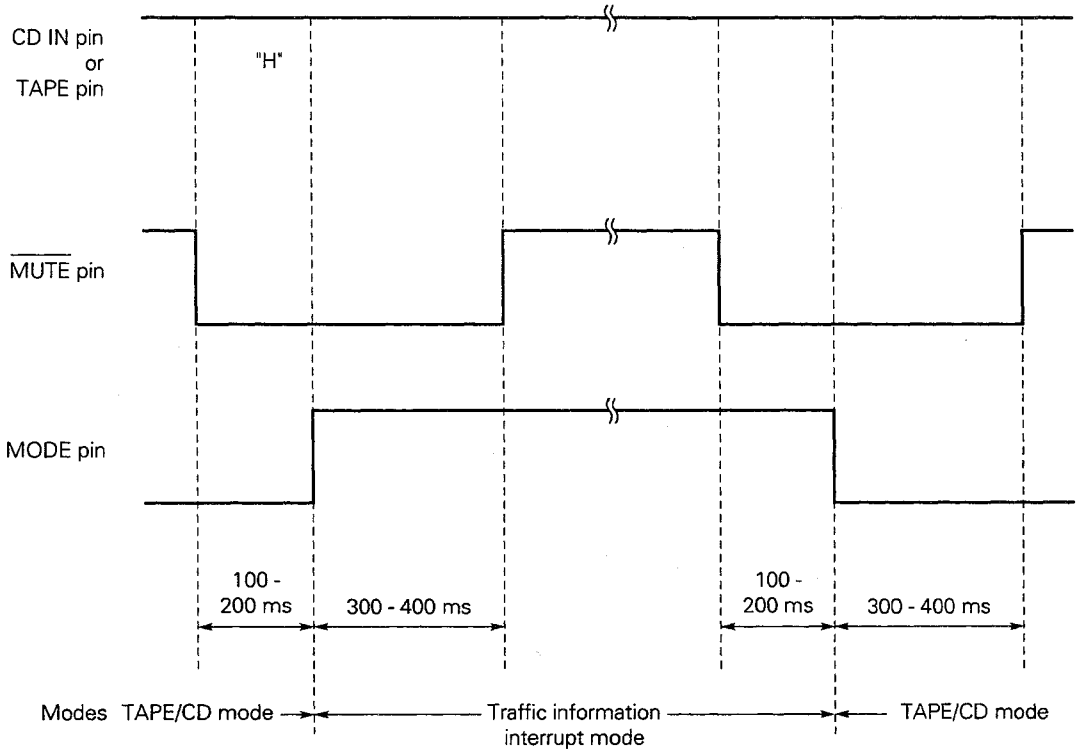
6.2 Mode Switchover

The mode pin switchover and the MUTE output timing chart are shown below.

6.2.1 Radio mode ↔ tape/CD mode



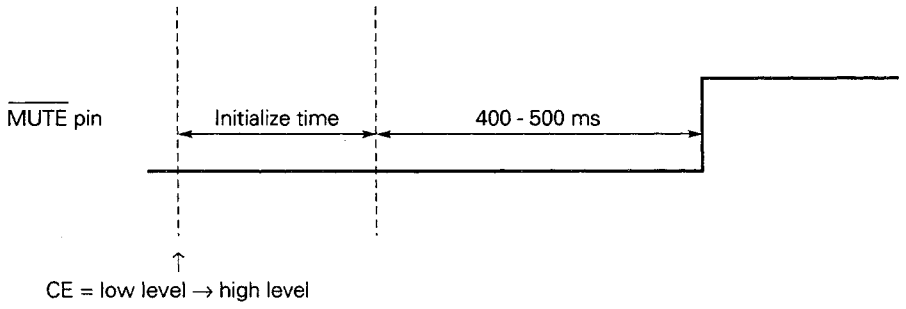
6.2.2 Traffic information broadcasting/PTY alarm ↔ tape/CD mode (TP/SK mode)



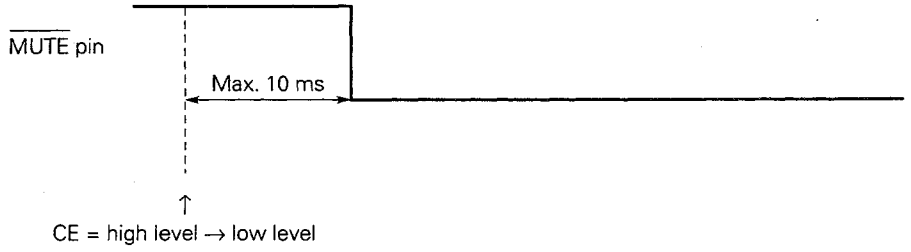
6.3 CE Pin

The MUTE output timing charts in level change of the CE pin are shown below.

6.3.1 Low level → high level



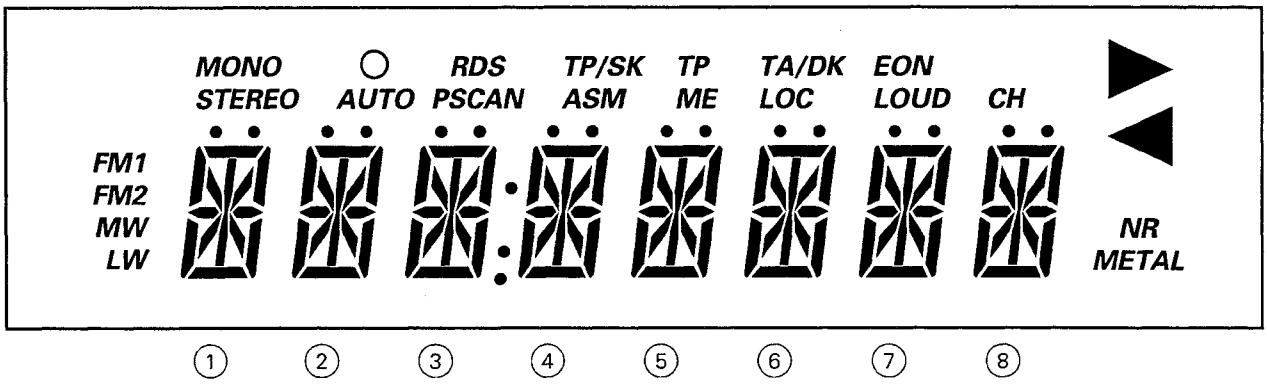
6.3.2 High level → low level



7. LCD PANEL

7.1 LCD Panel Configuration

An example of the LCD panel configuration is shown below.



For inquiries on the LCD panel, please contact the following address or phone.

Address : 1-4-33 Kitakyuhoji, Yao-shi, Osaka 581
Administration Section of Displayer Product Division, Hoshiden, Ltd.

Tel : 0729-93-1010 (key number)

7.2 LCD Pin Assignment

The LCD pin assignment table of μPD16431A is shown in Table 7-1.

① to ⑧ indicate the column locations of the 14 segments. "a" to "n" show the following 14 segments respectively.

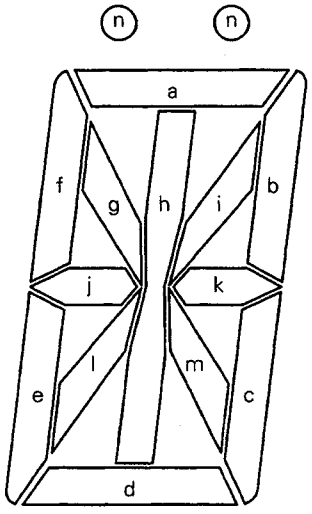


Table 7-1 LCD Pin Assignment Table of μPD16431A (1/2)

Common / Segment	COM_1 (21)	COM_2 (22)	COM_3 (23)	COM_4 (24)
SEG_1 (25)	⑧ n	⑧ b	⑧ c	CH
SEG_2 (26)	⑧ i	⑧ k	⑧ m	—
SEG_3 (27)	⑧ a	⑧ h	⑧ d	—
SEG_4 (28)	⑧ g	⑧ j	⑧ l	—
SEG_5 (29)	—	⑧ f	⑧ e	EON
SEG_6 (30)	—	—	—	—
SEG_7 (31)	⑦ n	⑦ b	⑦ c	—
SEG_8 (32)	⑦ i	⑦ k	⑦ m	—
SEG_9 (33)	⑦ a	⑦ h	⑦ d	—
SEG_{10} (34)	⑦ g	⑦ j	⑦ l	—
SEG_{11} (35)	LOC	⑦ f	⑦ e	▶
SEG_{12} (36)	—	—	—	—
SEG_{13} (37)	⑥ n	⑥ b	⑥ c	TA/DK
SEG_{14} (38)	⑥ i	⑥ k	⑥ m	—
SEG_{15} (39)	⑥ a	⑥ h	⑥ d	—
SEG_{16} (40)	⑥ g	⑥ j	⑥ l	—
SEG_{17} (41)	ME	⑥ f	⑥ e	◀
SEG_{18} (42)	—	—	—	—
SEG_{19} (43)	⑤ n	⑤ b	⑤ c	TP
SEG_{20} (44)	⑤ i	⑤ k	⑤ m	—
SEG_{21} (45)	⑤ a	⑤ h	⑤ d	—
SEG_{22} (46)	⑤ g	⑤ j	⑤ l	—
SEG_{23} (47)	ASM	⑤ f	⑤ e	TP/SK
SEG_{24} (48)	—	NR	METAL	—
SEG_{25} (49)	④ n	④ b	④ c	—
SEG_{26} (50)	④ i	④ k	④ m	—
SEG_{27} (51)	④ a	④ h	④ d	—
SEG_{28} (52)	④ g	④ j	④ l	—
SEG_{29} (53)	PSCAN	④ f	④ e	:
SEG_{30} (54)	—	—	—	—
SEG_{31} (55)	③ n	③ b	③ c	.
SEG_{32} (56)	③ i	③ k	③ m	—
SEG_{33} (57)	③ a	③ h	③ d	—
SEG_{34} (58)	③ g	③ j	③ l	—
SEG_{35} (59)	AUTO	③ f	③ e	RDS
SEG_{36} (60)	—	—	—	—

— : Unused

Remark The value in parenthesese indicates the pin number of μPD16431A.

Table 7-1 LCD Pin Assignment Table of μPD16431A (2/2)

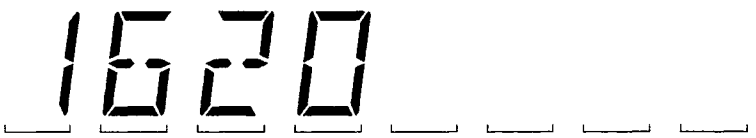
Common / Segment	COM_1 (21)	COM_2 (22)	COM_3 (23)	COM_4 (24)
SEG_{37} (61)	② n	② b	② c	○
SEG_{38} (62)	② i	② k	② m	—
SEG_{39} (63)	② a	② h	② d	—
SEG_{40} (64)	② g	② j	② l	—
SEG_{41} (65)	STEREO	② f	② e	MONO
SEG_{42} (66)	—	—	—	—
SEG_{43} (67)	① n	① b	① c	—
SEG_{44} (68)	① i	① k	① m	—
SEG_{45} (69)	① a	① h	① d	LOUD
SEG_{46} (70)	① g	① j	① l	—
SEG_{47} (71)	FM2	① f	① e	FM1
SEG_{48} (72)	—	MW	LW	—

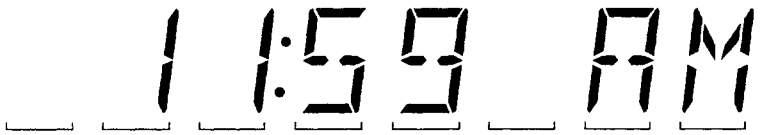
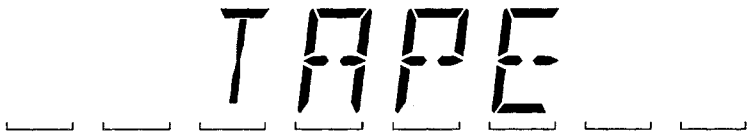
— : Unused

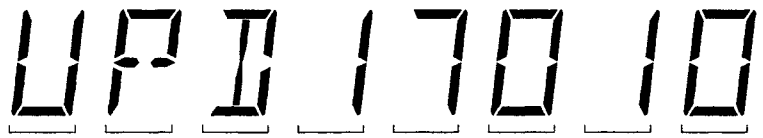
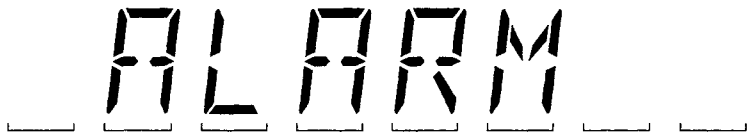
Remark The value in parentheses indicates the pin number of μPD16431A.

7.3 Description of LCD Panel Display

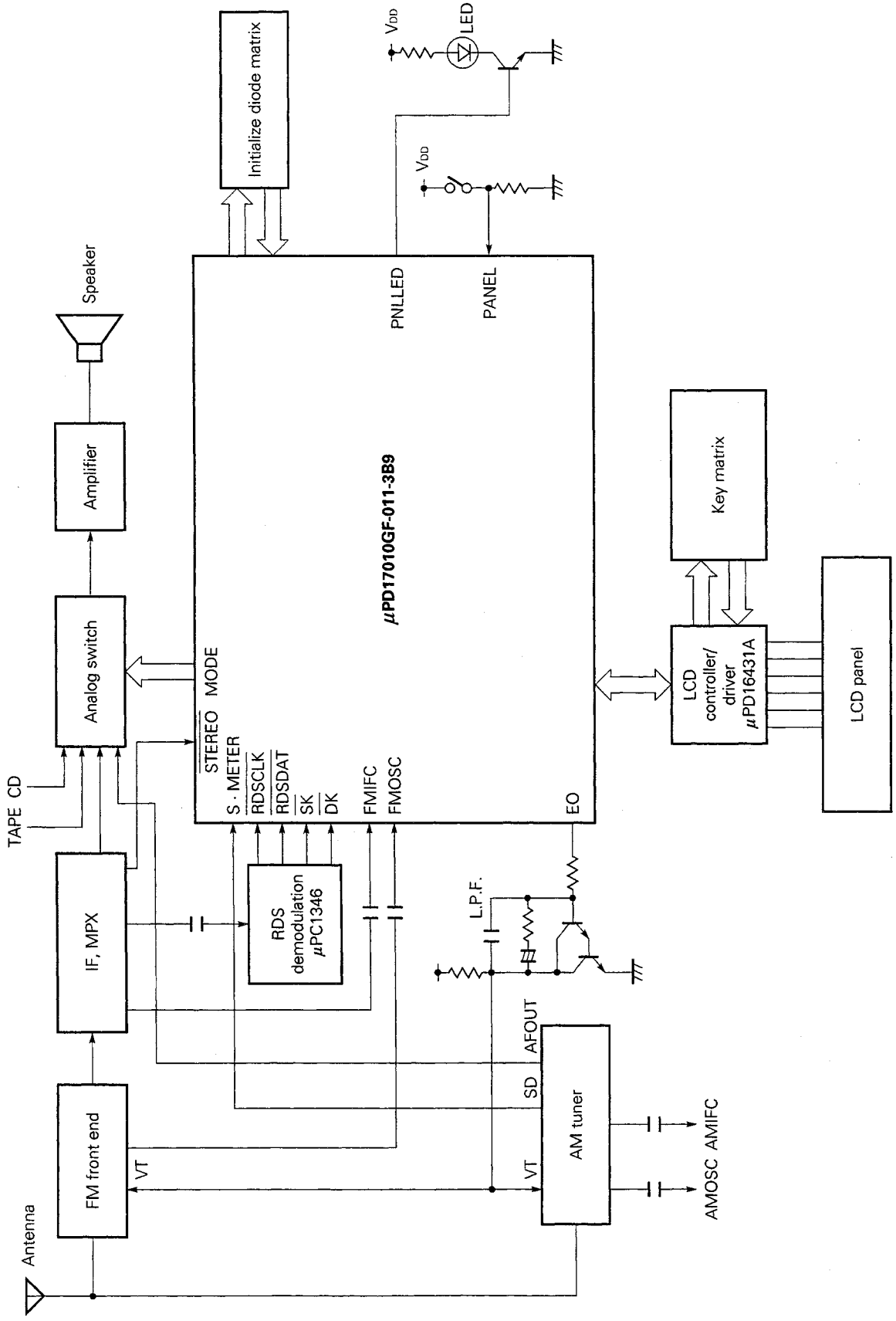
Display	Description
MONO	Indicates that the device is in forced monaural voice output mode. Inverted by pressing the [MONO] key while receiving the FM band in RADIO mode.
○	Indicates that the broadcasting station being currently received is an RDS station. Lit when an RDS station is received on the FM band.
RDS	Indicates that the device is in RDS mode. Lit when the band is FM and the mode is RDS.
TP/SK	Indicates that the device is in TP/SK mode. Lit when the band is FM and the mode is TP/SK.
TP	Indicates that the broadcasting station currently being received is broadcasting the traffic information. Lit when the TP signal of an RDS broadcasting station or the SK signal of a VF broadcasting station is detected.
TA/DK	Indicates that the broadcasting station currently being received is broadcasting the traffic information. Lit when the TA signal of an RDS broadcasting station or the DK signal of a VF broadcasting station is detected.
EON	Indicates that the broadcasting station currently being received is the EON station of a RDS broadcasting station. Lit when the traffic information station of a EON station is received in TP/SK mode.
STEREO	Indicates that the STEREO signal is being input. Lit when the $\overline{\text{STEREO}}$ pin is at a low level in the FM band. Always unlit in MONO mode.
AUTO	Indicates that the tuning mode of the radio is AUTO (SEEK). Unlit (MANUAL) when SHIFT mode is selected with the [SHIFT] key during RADIO mode.
PSCAN	Indicates that the device is in preset memory scan operation. Lit if the device is placed in preset memory scan operation by the [PSCAN] key.
ASM	Indicates that the device is in auto store memory operation. Lit if the device is placed in auto store memory operation by the [ASM] key.
ME	Indicates that the device is in the preset memory write status. Lit if the device is placed in preset memory write status by the [ME] key.
LOC	Indicates that LOCAL/DX is set to LOCAL. Inverted by pressing the [LOC] key during RADIO mode.
LOUD	Indicates the output status of the LOUD pin. Inverted by pressing the [LOUD] key.
CH	Indicates the channel of the preset memory number. Lit while the channel number is being displayed in 14 segments.
FM1 FM2 MW LW	Indicates the receiving band of the radio.
NR	Indicates that the device is in noise reduction mode. Inverted by pressing the [NR] key during TAPE mode.
METAL	Indicates that the device is in metal tape compatible mode. Inverted by pressing the [METAL] key during TAPE mode.

Display	Description
▶ ◀	Indicates the running direction of the tape. In TAPE mode, "▶" is lit when the R/L pin is low level; and "◀" when high level.
14-segment display area	Displays the following: (1) Receiving frequency (2) Clock (3) Tape (4) CD (5) PS (Program Service Name) (6) PTY alarm (7) Traffic information being broadcast in TP/SK mode (1) Receiving frequency display ① FM band (108.00 MHz)  ② MW band (1620 kHz)  ③ LW band (281 kHz) 

Display	Description
14-segment display area	(2) Clock display The 12- or 24-hr time display can be selected by the CLK24 switch of the initialize diode. The ":(colon)" display can be flashed at 1 Hz by the FLASH switch of the initialize diode. ① When CLK24 = 1 (9:00 p.m.)  ② When CLK24 = 0 (9:00 p.m.)  ③ When CLK24 = 0 (11:59 a.m.)  (3) Tape display When in TAPE mode, the display is as follows.  (4) CD display When in CD mode, the display is as follows. 

Display	Description
14-segment display area	(5) PS display If PS data is input, 8-digit PS is displayed.  (6) PTY alarm display If PTY alarm is input, the display is as follows.  (7) Traffic information broadcasting display in TP/SK mode If the traffic information is being broadcast in TP/SK mode, the display is as follows. 

8. SYSTEM CONFIGURATION EXAMPLE



9. ELECTRICAL SPECIFICATIONS (PRELIMINARY)

Absolute Maximum Ratings (T_a = 25 ± 2°C)

Item	Symbol	Condition	Rating	Unit
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	Other than $P1B_1$–$B1B_3$, $P0A_2$, $P0A_3$	−0.3 to V_{DD} +0.3	V
Output pressure proof	V_{BDS1}	$P1B_1$–$P1B_3$	18.0	V
	V_{BDS2}	$P0A_2$, $P0A_3$	V_{DD} +0.3	V
High-level output current	I_{OH}	One pin	−12	mA
		Total of $P2A_0$, LOD_0–LCD_{29} pins	−25	mA
		Total of pins other than those above	−40	mA
Low-level output current	I_{OL}	Any one of $P0A_0$–$P0A_3$, $P1A_1$–$P1A_3$, $P2A_0$ pins	15	mA
		One pin other than those above	10	mA
		Total of $P0A_0$–$P0A_3$, $P1A_1$–$P1A_3$, $P2A_0$ pins	50	mA
		Total of all pins other than those above	20	mA
Total loss	P_I		450	mW
Operating temperature	T_{opt}		−40 to +85	°C
Storage temperature	T_{stg}		−55 to +125	°C

Caution If the absolute maximum rating of even one of the items above is exceeded, product quality may deteriorate. In other words, the absolute maximum rating is the rating value which if exceeded, may result in damage to the product. Be certain not to exceed the absolute maximum rating.

Recommended Operation Conditions

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply voltatge	V_{DD1}	PLL and CPU operation	4.5	5.0	5.5	V
	V_{DD2}	PLL stop, CPU operation	3.5	5.0	5.5	V
Data retention voltage	V_{DDR}	Crystal oscillation stop	2.2		5.5	V
Supply voltage rise time	t_{rise}	V_{DD} = 0 → 4.5 V			500	ms
Input amplitude	V_{IN1}	VCOL, VCOH	0.5		V_{DD}	V_{p-p}
	V_{IN2}	AMIFC, FMIFC	0.5		V_{DD}	V_{p-p}
Output pressure proof	V_{BDS}	$P1B_1$–$P1B_3$			16.0	V
Operating temperature	T_{opt}		−40		+85	°C

DC Characteristics (T_a = −40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{DD1}	CPU and PLL operation	4.5	5.0	5.5	V
	V_{DD2}	CPU operation, PLL stop	3.5	5.0	5.5	V
Supply current	I_{DD1}	CPU and PLL operation; X_{IN} pin sine-wage input (f_{IN} = 4.5 MHz, V_{IN} = V_{DD}), T_a = 25 °C		1.2	2.4	mA
	I_{DD2}	CPU operation, PLL stop; HALT command used (20 commands executed per 1 ms); X_{IN} pin sine-wave input (f_{IN} = 4.5 MHz, V_{IN} = V_{DD}), T_a = 25 °C		0.45	0.90	mA
Data retention voltage	V_{DDR1}	Uses the power failure detection method by timer FF; in crystal oscillation	3.5		5.5	V
	V_{DDR2}	Uses the power failure detection method by timer FF; in crystal oscillation stop	2.2		5.5	V
	V_{DDR3}	Retention of data memory (RAM)	2.0		5.5	V
Data retnetion current	I_{DDR1}	In crystal oscillation stop T_a = 25 °C		3	5	μA
	I_{DDR2}	In crystal oscillation stop V_{DD} = 5.0 V, T_a = 25 °C		2	3	μA
Intermediate level output voltage	V_{OM1}	COM_0, COM_1 V_{DD} = 5 V	2.3	2.5	2.7	V
High-level input voltage	V_{IH1}	$P0A_0$–$P0A_3$, $P0B_0$–$P0B_3$, $P0C_0$–$P0C_3$, $P1A_0$–$P1A_3$, $P1D_0$–$P1D_3$, CE, INT_0, INT_1	0.8 V_{DD}		V_{DD}	V
	V_{IH2}	$P0D_0$–$P0D_3$	0.6 V_{DD}		V_{DD}	V
Low-level input voltage	V_{IL}	$P0A_0$–$P0A_3$, $P0B_0$–$P0B_3$, $P0C_0$–$P0C_3$, $P0D_0$–$P0D_3$, $P1A_0$–$P1A_3$, $P1D_0$–$P1D_3$, CE, INT_0, INT_1	0		0.2 V_{DD}	V
High-level output current	I_{OH1}	$P0A_0$, $P0A_1$, $P1A_1$–$P1A_3$, $P2A_0$ V_{OH} = V_{DD} −2 V, V_{DD} = 5 V, T_a = 25 °C	−2.0	−10.0		mA
	I_{OH2}	$P0B_0$–$P0B_3$, $P0C_0$–$P0C_3$, $P1A_0$, $P1B_0$, $P1C_0$–$P1C_3$ V_{OH} = V_{DD} −1 V	−1.0	−5.0		mA
	I_{OH3}	LCD_0–LCD_{29}, EO_0, EO_1, V_{OH} = V_{DD} −1 V	−1.0	−4.0		mA
Low-level output current	I_{OL1}	$P0A_0$–$P0A_3$, $P1A_1$–$P1A_3$, $P2A_0$ V_{OL} = 2 V, V_{DD} = 5 V, T_a = 25 °C	5.0	15.0		mA
	I_{OL2}	$P0B_0$–$P0B_3$, $P0C_0$–$P0C_3$, $P1B_0$, $P1C_0$–$P1C_3$ V_{OL} = 1 V	1.0	7.0		mA
	I_{OL3}	LCD_0–LCD_{29}, EO_0, EO_1, V_{OL} = 1 V	1.0	3.5		mA
	I_{OL4}	$P1B_1$–$P1B_3$ V_{OL} = 1 V	1.0	2.0		mA
High-level input current	I_{IH1}	VCOH pull-down V_{IH} = V_{DD}	0.1	0.8		mA
	I_{IH2}	VCOL pull-down V_{IH} = V_{DD}	0.1	0.8		mA
	I_{IH3}	X_{IN} pull-down V_{IH} = V_{DD}	0.1	1.3		mA
	I_{IH4}	$P0D_0$–$P0D_3$ pull-down V_{IH} = V_{DD}	0.05	0.13	0.30	mA
Output off leakage current	I_{L1}	$P0A_2$, $P0A_3$ V_{OH} = V_{DD}			500	nA
	I_{L2}	$P1B_1$–$P1B_3$ V_{OH} = 16 V			500	nA
	I_{L3}	EO_0, EO_1 V_{OH} = V_{DD}, V_{OL} = 0 V			±100	nA

AC Characteristics (T_a = −40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Operating frequencies	f_{IN1}	VCOL MF mode sine wave input V_{IN} = 0.3 V_{p-p}	0.5		30	MHz
	f_{IN2}	VCOL HF mode sine wave input V_{IN} = 0.3 V_{p-p}	5		40	MHz
	f_{IN3}	VCOH sine wave input V_{IN} = 0.3 V_{p-p}	9		150	MHz
	f_{IN4}	AMIFC sine wave input V_{IN} = 0.5 V_{p-p}	0.1		1	MHz
	f_{IN5}	AMIFC sine wave input V_{IN} = 0.05 V_{p-p}	0.44		0.46	MHz
	f_{IN6}	FMIFC sine wave input V_{IN} = 0.5 V_{p-p}	5		15	MHz
	f_{IN7}	FMIFC sine wave input V_{IN} = 0.06 V_{p-p}	10.5		10.9	MHz

A/D Converter Characteristics (T_a = −40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

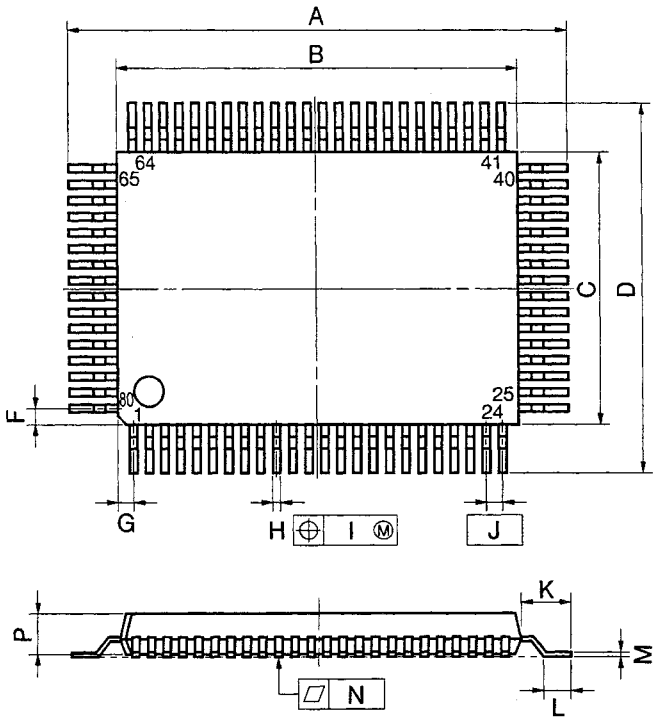
Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
A/D conversion resolution					6	bit
A/D conversion overall error		T_a = −10 to +50 °C		±1	±1.5	LSB

Reference Characteristics

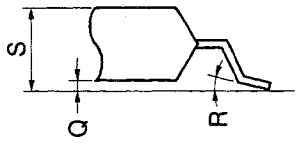
Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply current	I_{DD3}	CPU and PLL operation VCOH sine wave input f_{IN} = 150 MHz, V_{IN} = 0.3 V_{p-p} V_{DD} = 5 V, T_a = 25 °C		15		mA
High-level output current	I_{OH4}	COM_0, COM_1 V_{OH} = V_{DD} −1 V		−0.2		mA
Intermediate-level output current	I_{OM1}	COM_0, COM_1 V_{OM} = V_{DD} −1 V		−20		μA
	I_{OM2}	COM_0, COM_1 V_{OM} = 1 V		20		μA
Low-level output current	I_{OL5}	COM_0, COM_1 V_{OL} = 1 V		0.2		mA

10. PACKAGE DRAWING

80 PIN PLASTIC QFP (14×20)



detail of lead end



NOTE

Each lead centerline is located within 0.15 mm (0.006 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	23.2±0.2	$0.913^{+0.009}_{-0.008}$
B	20.0±0.2	$0.787^{+0.009}_{-0.008}$
C	14.0±0.2	$0.551^{+0.009}_{-0.008}$
D	17.2±0.2	0.677±0.008
F	1.0	0.039
G	1.8	0.031
H	0.35±0.10	$0.014^{+0.004}_{-0.005}$
I	0.15	0.006
J	0.8 (T.P.)	0.031 (T.P.)
K	1.6±0.2	0.063±0.008
L	0.8±0.2	$0.031^{+0.009}_{-0.008}$
M	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.003}$
N	0.12	0.005
P	2.7	0.106
Q	0.125±0.075	0.005±0.003
R	5°±5°	5°±5°
S	3.0 MAX.	0.119 MAX.

S80GF-80-3B9-2

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

[MEMO]

The application circuits and their parameters are for references only and are not intended for use in actual design-in's.

M4 92.6