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April 1st, 2010
Renesas Electronics Corporation

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RENESAS

MOS INTEGRATED CIRCUIT

μPD17006AGF-052

4-BIT SINGLE-CHIP MICROCONTROLLER WITH BUILT-IN PRESCALER, PLL FREQUENCY SYNTHESIZER, AND IF COUNTER FOR AUTOMOTIVE FM/MW/LW RADIO APPLICATIONS

The μPD17006AGF-052 is a 4-bit CMOS microcontroller for use in digital tuners designed to receive the European FM, MW, and LW bands. It incorporates a prescaler (150 MHz max.), PLL frequency synthesizer, and IF counter.

The device supports the European RDS (Radio Data System), offering a variety of RDS functions. Thus, it provides a means of configuring a high-performance, multi-function FM/MW/LW tuner, such as a high-quality automative stereo system, using a single chip.

Because the device implements an RDS decoder as a software library, the number of required ICs can be reduced by one, relative to a conventional system.

FEATURES

- Preset memory
  Stores six stations in each of the FM1, FM2, and AM (MW and LW) bands, or a total of 18 stations.
- Last channel memory
  One station per band
- Tuning functions
  - Manual seek/auto-seek
  - Auto-storage
  - Preset scan
  - Auto-retuning
- A μPD16431A is used as the LCD controller/driver
- Single power supply (5 V ±10%)
- RDS functions
  - Station name display (PS)
  - AF operation
    - Stores an AF list of up to 25 stations.
    - Supports METHODs A/B.
  - Traffic information standby function (TP and TA)
  - Alarm function (PTY=31)
  - PTY seek function (program identification information)
  - CT function (automatic time adjustment)
  - Built-in RDS decode function

ORDERING INFORMATION

Part number	Package
μPD17006AGF-052-3B9	80-pin plastic QFP (14 × 20 mm, 0.65-mm pitch)

Document No. U11106EJ1V0DS00 (1st edition)
Date Published July 1996 P
Printed in Japan

FUNCTION OVERVIEW

TUNABLE FREQUENCIES, CHANNEL SEPARATION, REFERENCE FREQUENCY, AND INTERMEDIATE FREQUENCY

Band	Tunable frequency	Channel separation	Reference frequency	Intermediate frequency
FM	87.50 to 108.00 MHz	50 kHz	50 kHz	10.71 MHz
MW	522 to 1620 kHz	9 kHz	9 kHz	450 kHz 459 kHz 10.71 MHz
LW	144 to 279 kHz	9 kHz	9 kHz	450 kHz 459 kHz 10.71 MHz

TUNING FUNCTIONS

(1) Manual tuning (in shift mode)

Function	Description
Manual up Manual down	Each time these keys are pressed, the frequency is increased or reduced by one step, respectively. If the keys are pressed and held down for about 0.5 second or longer, the frequency is adjusted in fast-forward mode until the key is released.

(2) Auto-tuning

Function	Description
Seek up Seek down	Search for a station, moving either up or down through the frequency range, respectively. When a station is detected, the corresponding frequency is retained. In RDS mode, the device searches for RDS stations only. In TP/SK mode, the device searches for only those stations broadcasting traffic information.

(3) Preset memory

Stores six stations in each band (FM1/FM2/AM), or a total of 18 stations.
The AM band covers both MW and LW.

(4) Preset memory scanning

Tunes to the stations stored in the preset memory, holding each station for about five seconds, in each of the FM1, FM2, and AM bands.

(5) Auto-storage

Searches for stations starting from the lowest frequency, stores the detected stations into preset memory starting from that having the strongest signal level, and finally sorts them into order by frequency.

(6) Last channel memory

The device provides a last channel memory for one station in each of the FM1, FM2, and AM bands.

(7) Auto-retuning

Automatically starts auto-tuning if the SD signal is not detected for about 20 seconds during broadcast reception.

RDS FUNCTIONS

(1) Station name display

Uses a PS code to display the name of the station currently being received.

(2) AF operation

Supports METHOD A and METHOD B. The device stores an AF list of up to 25 stations. Using EON, it can also store an AF list of other stations.

(3) Traffic information station switching

Switches to a traffic information station by monitoring the TP and TA bits during TP/SK standby. This function supports EON.

(4) Time correction

Uses a CT code to correct the built-in clock.

(5) Alarm

Switches the audio source to radio if a PTY code 31 alarm is received.

(6) Program identification information

Displays the name of the program currently being received by using a PTY code between 0 and 15. The device is also capable of performing search based on the displayed program name.

CLOCK FUNCTIONS

(1) 12-hour clock display (with "AM" and "PM" indication) or 24-hour clock display
(2) Selectable colon (":") flashing (1 Hz)

TAPE FUNCTIONS

(1) The audio source can be switched with tape signal input.
(2) The tape running direction can be displayed.
(3) Noise reduction
(4) Metal tape support
(5) Auto music search

CD CHANGER CONTROL FUNCTIONS

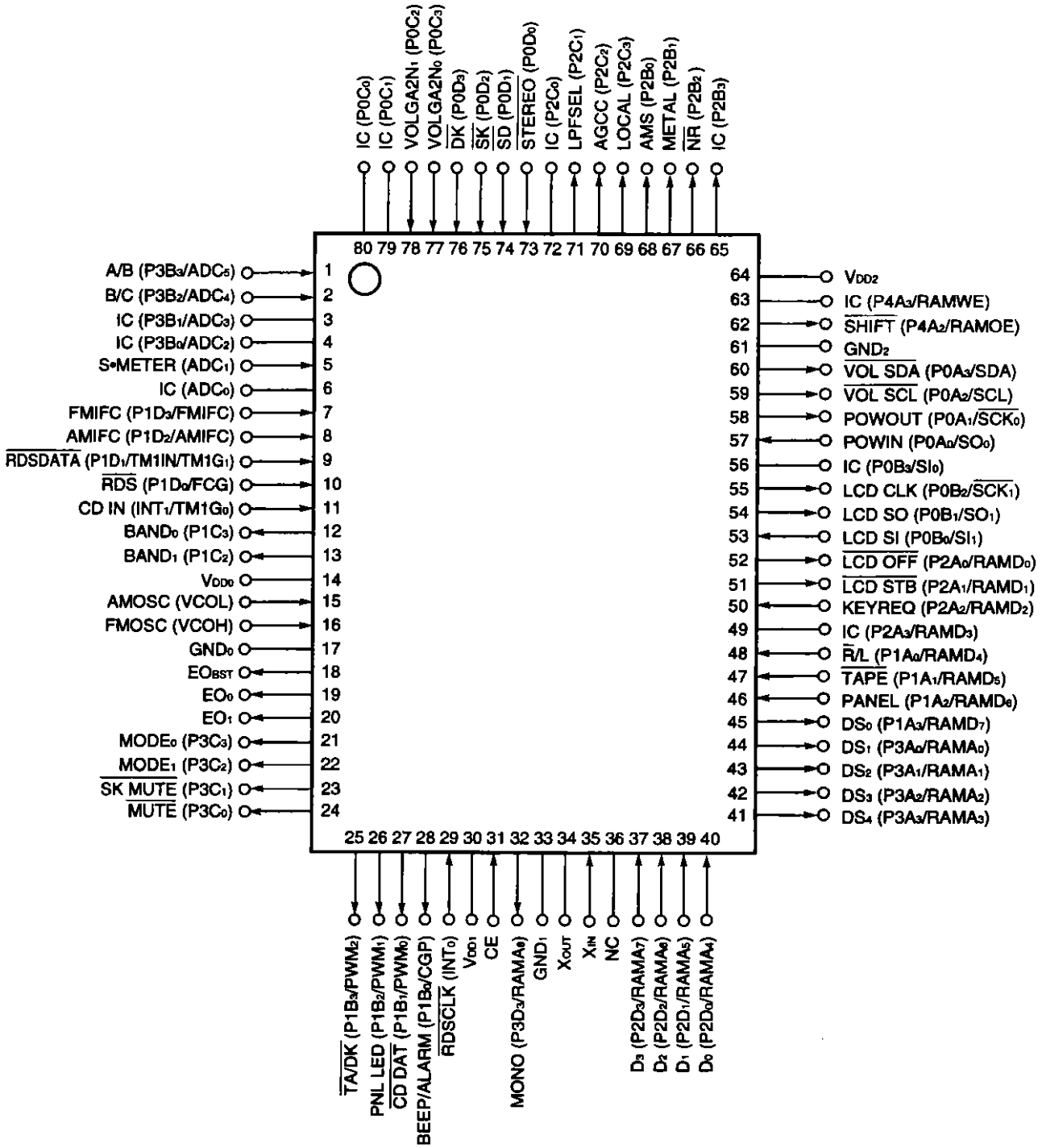
Supports the CD changer control functions.

ELECTRONIC VOLUME CONTROL FUNCTIONS

(1) The volume/bass/treble/balance/fader are adjustable.
(2) The attenuator/loudness functions are settable.

PIN CONFIGURATION (TOP VIEW)

μPD17006AGF-052-3B9



Remarks 1. Pin symbols enclosed in parentheses are those for the μPD17006AGF-×××-3B9.

2. IC indicates that the pin is internally connected.

CONTENTS

1. PIN FUNCTIONS

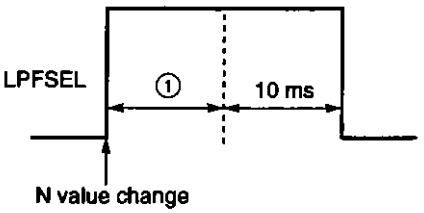
<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin name</th><th>Description</th><th>I/O type</th></tr>
<tr><td>1</td><td>A/B</td><td rowspan="2">Signal meter reading range input</td><td rowspan="2">Pin for setting the signal meter ranges used as an AF operation start condition. (See (2) in Section 3.2.4.)</td><td rowspan="2">Analog input</td></tr>
<tr><td>2</td><td>B/C</td></tr>
<tr><td>3, 4</td><td>IC</td><td>Internally connected</td><td>Connect these pins to GND via a pulldown resistors.</td><td>—</td></tr>
<tr><td>5</td><td>S•METER</td><td>Signal meter signal input</td><td>Input pin for signal meter signal.
Input an analog signal in accordance with the received electric field strength.
This pin is used to monitor the conditions controlling AF switching.</td><td>Analog input</td></tr>
<tr><td>6</td><td>IC</td><td>Internally connected</td><td>Connect this pin to GND via a pulldown resistor.</td><td>—</td></tr>
<tr><td>7</td><td>FMIFC</td><td>FM intermediate frequency input</td><td>Input pin for intermediate frequency (IF) in FM band.
A frequency of between 5 and 15 MHz (0.3 $V_{p\text{-}p}$) can be input.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current.
When the FM IF/SD switch of the initial setting diode matrix is set to 1 (the diode is shorted), this pin is used to detect a station during auto-tuning.
When the input frequency range and conditions listed below are satisfied, the device judges that a station has been detected.
<table><tr><th>Band</th><th>Input frequency range</th></tr><tr><td>FM</td><td>10.7 MHz ±20.0 kHz</td></tr></table>
A frequency within the input frequency range must be input within 10 ms of the PLL being locked.</td><td>Input</td></tr>
<tr><td>8</td><td>AMIFC</td><td>AM intermediate frequency input</td><td>Input pin for intermediate frequency (IF) in the AM (MW, LW) band.
A frequency of between 0.1 and 1.0 MHz (0.3 $V_{p\text{-}p}$) can be input.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current.
When the AM IF/SD switch of the initial setting diode matrix is set to 1 (the diode is shorted), this pin is used to detect a station during auto-tuning.
When the input frequency range and conditions listed below are satisfied, the device judges that a station has been detected.
<table><tr><th>Band</th><th>Input frequency range</th></tr><tr><td rowspan="2">MW</td><td>450 kHz ±3 kHz</td></tr><tr><td>459 kHz ±3 kHz</td></tr><tr><td rowspan="2">LW</td><td>450 kHz ±3 kHz</td></tr><tr><td>459 kHz ±3 kHz</td></tr></table>
A frequency within the input frequency range must be input within 20 ms of the PLL being locked.</td><td>Input</td></tr>
<tr><td>9</td><td>$\overline{\text{RDSDATA}}$</td><td>RDS data input</td><td>Input pin for RDS data. To this pin, input the data signal from the RDS signal detector section.
Data is read at the falling edge of an RDS clock pulse.</td><td>Input</td></tr>
</table>

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin name</th><th>Description</th><th>I/O type</th></tr>
<tr><td>10</td><td>$\overline{RDS}$</td><td>RDS signal input</td><td>Input pin used to detect the RDS signal of an RDS station.
Prevents the device from being erroneously synchronized with a non-RDS station.
The RDS data, read when the pin is at the low level, is valid.
Pull down this pin if synchronization is to be performed using only $\overline{RDSDATA}$ and $\overline{RDSCLK}$ during auto-tuning.</td><td>Input</td></tr>
<tr><td>11</td><td>CD IN</td><td>CD changer data signal input</td><td>Input pin for CD changer data signals.</td><td>Input</td></tr>
<tr><td>12
13</td><td>$BAND_0$
$BAND_1$</td><td>Band switching signal output</td><td>Band switching signal output pins.
If the band is switched by pressing the band switch key, the outputs will vary with the band, as listed below:
<table><tr><th>Pin / Band</th><th>$BAND_0$</th><th>$BAND_1$</th></tr><tr><td>MW</td><td>0</td><td>0</td></tr><tr><td>LW</td><td>0</td><td>1</td></tr><tr><td>FM</td><td>1</td><td>×</td></tr></table>0 : Low
1 : High
× : Don't care</td><td>CMOS push-pull output</td></tr>
<tr><td>14
30
64</td><td>V_{DD0}
V_{DD1}
V_{DD2}</td><td>Power input</td><td>Power supply pins for the device.
To these pins, supply 5V ±10% while the device is operating.
When the clock is not available (the NOCLK switch of the initial setting diode matrix is set to 0 (open)), setting the CE pin (pin 31) to low level enables data to be retained even if the voltage at the pin falls to 2.2 V.
When a voltage that changes from 0 to 4.5 V is supplied to these pins, all data is initialized to the initial values. The time required for the voltage to change from 0 to 4.5 V must be about 500 ms or shorter.
Pins V_{DD0} to V_{DD2} must always be of the same potential.</td><td>—</td></tr>
<tr><td>15</td><td>AMOSC</td><td>AM local oscillator input</td><td>Input pin for the local oscillator output (VCO output) in the AM (MW, LW) band.
Tuning to MW or LW band broadcasts causes this pin to become active. Otherwise, the pin is internally pulled down. A frequency of between 0.5 and 30 MHz (0.3 V_{P-P}) can be input.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current before inputting the output.</td><td>Input</td></tr>
<tr><td>16</td><td>FMOSC</td><td>FM local oscillator input</td><td>Input pin for the FM band local oscillator output (VCO output).
Tuning to FM band broadcasts causes this pin to become active. Otherwise, the pin is internally pulled down. A frequency of between 9 and 150 MHz (0.3 V_{P-P}) can be input.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current before inputting the output.</td><td>Input</td></tr>
<tr><td>17
33
61</td><td>GND_0
GND_1
GND_2</td><td>Ground</td><td>Ground pins.
GND_0 is the ground pin for the PLL. GND_1 and GND_2 are the ground pins for the digital system.</td><td>—</td></tr>
</table>

Pin No.	Symbol	Pin name	Description	I/O type
18 19 20	EO_{BST} EO_0 EO_1	Error boost output Error output	• **EO_{BST}** Error boost output pin. If a high or low level is continuously output from EO_0 and EO_1 for 4 clock cycles after the PLL data has been rewritten, the EO_{BST} pin holds that level until EO_0 and EO_1 output the opposite level, causing EO_{BST} to become floating. • **EO_0, EO_1** Output pins for the PLL (Phase Locked Loop) charge pump. If a divided local oscillator frequency (VCO output) is greater than the reference frequency, the outputs of these pins will go high. If the divided local oscillator frequency is less than the reference frequency, the outputs go low. If the divided local oscillator frequency is equal to the reference frequency, the outputs enter the floating state. Input either of the outputs to a varactor diode via an external LPF (Low Pass Filter). Because EO_0 and EO_1 output identical waveforms, the user can use either pin.	CMOS tristate output
21 22	$MODE_0$ $MODE_1$	Mode signal output	Output pins indicating the operating mode of the μPD17006AGF-052. See the table below. ($MODE_0$: $MODE_1$: Mode) 0: 0: Radio 1: 0: Tape 0: 1: CD (0: Low, 1: High)	CMOS push-pull output
23	$\overline{SK\ MUTE}$	SK mute signal output	Traffic information mute output pin. The SK mute output pin is used when no traffic information station identification signal is being received in TP/SK mode.	CMOS push-pull output
24	$\overline{MUTE}$	Mute signal output	Audio mute signal output pin. The output of this pin is active low. This pin is used to eliminate the shock noise generated when the PLL is out of lock in radio mode, and to switch the mode pin output.	CMOS push-pull output
25	$\overline{TA/DK}$	Traffic information station signal output	Traffic information station identification signal output pin. The output of this pin is low when: • The SK and DK signals, TP and TA signals, or PTY alarm is detected in TP/SK mode in the FM band, or • Traffic information alarm is output.	N-ch open drain output
26	PNL LED	Panel detachment detection LED signal output	Output pin of the LED signal indicating that the front panel has been detached. In this state, the pin outputs a signal of 1 Hz (1/2 duty cycle).	N-ch open drain output
27	$\overline{CD\ DAT}$	CD changer data signal output	Output pin for CD changer data signal.	CMOS open-drain output

Pin No.	Symbol	Pin name	Description	I/O type
28	BEEP/ ALARM	Beep and traffic information alarm signal output	Beep and alarm information alarm output. • **Beep sound** Square waves with a frequency of 2.25 kHz and a duty cycle of 50% are output for about 40 ms. This period is equal to the period of the preceding mute. A beep is output when: • Writing is performed to preset memory, or • Auto-storage is started. No beep is output in no-beep mode (the BEEP switch of the initial setting diode matrix is set to 0 (open)). • **Traffic information alarm** An alarm sound with a frequency of 900 kHz is output with a cycle of about 0.5 seconds ON and about 0.5 seconds OFF if no traffic information station identification signal is detected for about three seconds after SK mute is output in TP/SK or RDS+TP/SK mode in the FM band. Leave this pin open if no beep or traffic information alarm is to be used.	CMOS push-pull output
29	$\overline{\text{RDSCLK}}$	RDS clock input	Input pin for RDS clock. Supply the clock pulse output from the RDS signal detection circuit to this pin. The clock pulse supplied to the μPD17006AGF-052 must be as accurate as possible because the device does not use bit synchronization detection based on the clock pulse width.	Input
31	CE	Chip enable	Input pin for the device selection signal. To enable normal operation of the device (radio, tape, CD, clock display, etc.), set the input high. When this pin goes high, the radio, tape, CD changer, and display are all set to off and the device enters the backup state. A low level signal not exceeding 80-100 μs is not accepted. If no-clock mode is selected (the NOCLK switch of the initial setting diode matrix is set to 0 (open)), the current consumption in the backup state can be reduced.	Input
32	MONO	MONO signal output	Output pin for the tuner MONO signal.	CMOS push-pull output
34 35	X_{OUT} X_{IN}	Crystal	Pins for connecting a crystal oscillator. A 4.5-MHz crystal oscillator is connected. When the clock functions are used, the precision of the clock is entirely dependent on the precision of the clock. Adjust the oscillator frequency while observing the PLL local oscillator frequency.	—
36	NC	No connection	Do not connect anything to this pin.	—
37-40	D_3-D_0	Initial setting diode return signal input	Input pins for the return signals of the initial setting diode matrix. These pins, together with DS_0 (pin 45) to DS_4 (pin 41), constitute a matrix.	Input
41-45	DS_4-DS_0	Initial setting diode source signal output	Output pins of the source signals of the initial setting diode matrix.	CMOS push-pull output
46	PANEL	Panel detachment detection input	Input pin used to detect whether the front panel is detached. The input of a high-level signal indicates that the front panel is detached.	Input

Pin No.	Symbol	Pin name	Description	I/O type
47	$\overline{\text{TAPE}}$	Tape signal input	Tape signal input pin. When a low-level signal is input to this pin, the audio source (mode output) is switched to a tape.	Input
48	$\overline{\text{R/L}}$	Tape running signal input	Tape running signal input pin. This pin is used to display the tape running direction on the LCD panel. Input a signal according to the table below. $\overline{\text{R/L}}$ pin: 0 — Tape running direction: Left to right $\overline{\text{R/L}}$ pin: 1 — Tape running direction: Right to left (0: Low, 1: High)	Input
49	IC	Internally connected	Connect this pin to GND via a pulldown resistor.	—
50	KEYREQ	LCD driver key request signal input	Input pin for the key request signal output by the LCD controller/driver (μPD16431A). When a high level signal is input, key data is read.	Input
51	$\overline{\text{LCD STB}}$	LCD driver strobe signal output	Output pin for the strobe signal to the LCD controller/driver (μPD16431A).	CMOS push-pull output
52	$\overline{\text{LCD OFF}}$	LCD driver display OFF signal output	Output pin for the strobe signal to the LCD controller/driver (μPD16431A).	CMOS push-pull output
53	LCD SI	LCD driver data signal input	Input pin for the data signal output by the LCD controller/driver (μPD16431A).	Input
54	LCD SO	LCD driver data signal output	Output pin for the data signal to the LCD controller/driver (μPD16431A).	CMOS push-pull output
55	LCD CLK	LCD driver clock signal output	Output pin for the clock signal to the LCD controller/driver (μPD16431A).	CMOS push-pull output
56	IC	Internally connected	Do not connect anything to this pin.	—
57	POWIN	Power key input	Signal input pin used to detect power key input.	Input
58	POWOUT	Power state output	Output pin indicating the power state of the system.	CMOS push-pull output
59	$\overline{\text{VOL SCL}}$	Electronic volume control clock signal output	Output pin for the serial clock signal that is fed to the electronic volume control.	N-ch open drain output
60	$\overline{\text{VOL SDA}}$	Electronic volume control data signal output	Output pin for the serial data signal that is fed to the electronic volume control.	N-ch open drain output
62	$\overline{\text{SHIFT}}$	Shift output	Output pin for the shift signal.	CMOS push-pull output
63 65	IC	Internally connected	Do not connect anything to these pins.	—
66	$\overline{\text{NR}}$	Noise reduction signal output	Output pin for the noise reduction signal. While "NR" is displayed on the LCD panel in tape mode, the output of this pin is low.	CMOS push-pull output

Pin No.	Symbol	Pin name	Description	I/O type
67	METAL	Metal signal output	Output pin for the metal signal. While "METAL" is displayed on the LCD panel in tape mode, the output of this pin is high.	CMOS push-pull output
68	AMS	Auto music search signal output	Output pin for the auto music search signal. While "AMS" is displayed on the LCD panel in tape mode, the output of this pin is high.	CMOS push-pull output
69	LOCAL	LOCAL output	Output pin for the tuner LOCAL/DX switching output. The output is high in LOCAL mode.	CMOS push-pull output
70	AGCC	AGCC output	Output pin for the auto gain control cut signal. The signal is output during auto-tuning.	CMOS push-pull output
71	LPFSEL	LPF time constant switching signal output	Output pin for the signal for switching the time constant of the LPF of the tuner during AF operation. The output is high during AF operation, as shown below.  ① : PLL lock wait time	CMOS push-pull output
72	IC	Internally connected	Do not connect anything to this pin.	—
73	$\overline{\text{STEREO}}$	Stereo signal input	Input pin for the stereo broadcast signal. Input the signal as indicated in the table below. $\overline{\text{STEREO}}$ pin: 0 — Description: Stereo broadcast $\overline{\text{STEREO}}$ pin: 1 — Description: Mono broadcast (0: Low, 1: High) The pin is valid for the FM band only.	Input
74	$\overline{\text{SD}}$	SD signal input	Input pin for the station detection signal.	Input
75	$\overline{\text{SK}}$	SK signal input	Input pin used to detect the SK signal of a VF station. The input is used as the auto-tuning stop signal. When a station is detected, if the input goes low within about 500 ms, the device judges that a traffic information station has been detected, and auto-tuning is stopped. Pull up this pin when ARI is not used.	Input
76	$\overline{\text{DK}}$	DK signal input	Input pin used to detect the DK signal of a VF station. If both the SK pin (pin 75) and the DK pin go low in standby mode, the device judges that traffic information is being broadcast and the device changes to standby radio mode. If the DK pin goes from low to high, the device returns to standby mode. Pull up this pin when ARI is not used.	Input

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Pin namex</th><th>Description</th><th>I/O type</th></tr>
<tr><td>77
78</td><td>VOLGA2N0
VOLGA2N1</td><td>Electronic volume control gain select input</td><td>These input pins are valid when the TDA7313 electronic volume control IC is being used.
Set the gain of the volume control by setting the pins as indicated in the table below.
Leave the pins open if an electronic volume control IC other than the TDA7313 is used.

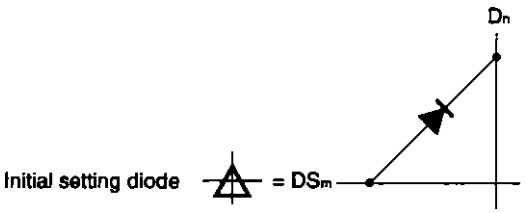
<table><tr><th>VOLGA2N0</th><th>VOLGA2N1</th><th>Volume control gain</th></tr><tr><td>0</td><td>0</td><td>+11.25 dB</td></tr><tr><td>0</td><td>1</td><td>+7.5 dB</td></tr><tr><td>1</td><td>0</td><td>+3.5 dB</td></tr><tr><td>1</td><td>1</td><td>0 dB</td></tr></table>(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>79
80</td><td>IC</td><td>Internally connected</td><td>Connect these pins to GND via a pulldown resistors.</td><td>—</td></tr>
</table>

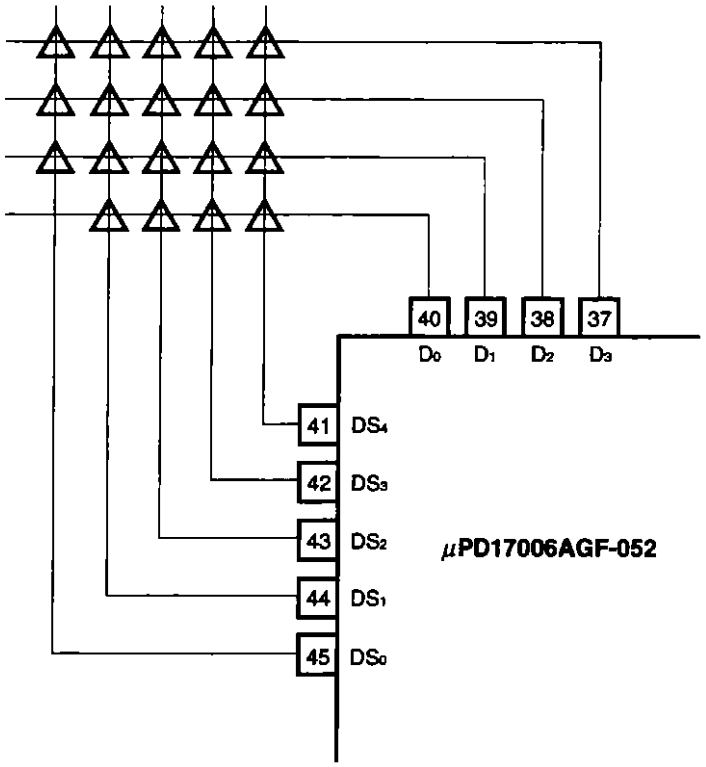
2. KEY MATRIX STRUCTURE

2.1 CONFIGURATION OF THE INITIAL SETTING DIODE MATRIX

Input pin (pin number) / Output pin (pin number)	D_3 (37)	D_2 (38)	D_1 (39)	D_0 (40)
DS_4 (41)	FM SD/IF	AM SD/IF	AMIF1	AMIF2
DS_3 (42)	NOCLK	CLK24	CTADJ	FLASH
DS_2 (43)	RETUNE	FUNC	BEEP	VOLSEL
DS_1 (44)	MESEL	ENMTL	ENNR	ENAMS
DS_0 (45)	REGEN	USASEL	CLKDSP	

2.2 INITIAL SETTING DIODE MATRIX CONNECTION





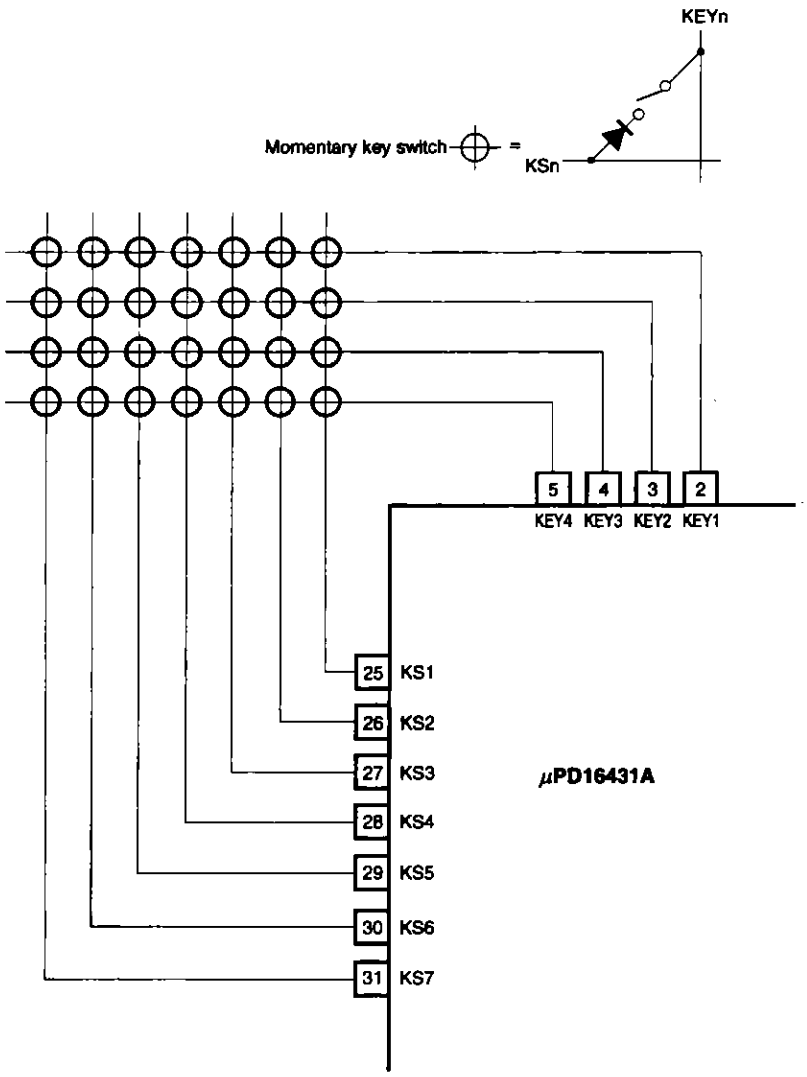
2.3 MOMENTARY KEY MATRIX CONFIGURATION

Output pin (pin number) / Input pin (pin number)	KS1 (25)	KS2 (26)	KS3 (27)	KS4 (28)	KS5 (29)	KS6 (30)	KS7 (31)
KEY1 (2)	M1 [DISC1]	M2 [DISC2]	M3 [DISC3]	M4 [DISC4]	M5 [DISC5]	M6 [DISC6]	RDS/REGION
KEY2 (3)	SEEK DWN (MAN DWN)Note 1	SEEK UP (MAN UP)Note 2	ME	MODE	PSCAN/ASM	SHIFT	POWER
KEY3 (4)	VOL DWN	VOL UP	BAND/ AREA CH	DISP	VOL SEL	PTY	TP/SK
KEY4 (5)	CT	MONO/LOCAL	LOUD/ATT	AMS [INTRO]	METAL [REPEAT]	NR [SHUFF]	PI

Notes 1. REVIEW/TRACK DOWN for CD changer mode
2. CUE/TRACK UP for CD changer mode

Remarks 1. The signals indicated in [ ] are valid only in CD changer mode.
2. The signals indicated in ( ) are valid only when shift mode is selected by pressing the SHIFT key.

2.4 MOMENTARY KEY MATRIX CONNECTION



2.5 DESCRIPTION OF THE KEY MATRIXES

2.5.1 Initial Setting Diode Matrix

The initial setting diode matrix includes 19 switches of 11 types. When power is first supplied to the V_{DD} pin (at a power-on reset) or when the CE pin goes from the low level to the high level (at a CE reset), the states of the matrix switches are read in. Otherwise, they are ignored.

(1) Switches used to specify the method for detecting a station during auto-tuning
FM SD/IF and AM SD/IF

(2) Switches used to specify the intermediate frequency for the AM band
AMIF1 and AMIF2

(3) Switches related to the clock functions
CLK24, NOCLK, CTADJ, CLKDSP, and FLASH

(4) Switch used to specify whether to turn auto-retuning on or off
RETUNE

(5) Switch used to specify whether the double function key function is used
FUNC

(6) Switch used to specify whether a beep sound is output
BEEP

(7) Switch used to specify which type of electronic volume control IC is being used
VOLSEL

(8) Switch used to select the method of writing to the preset memory
MESEL

(9) Switches used to specify whether to use the tape mode functions
ENMTL, ENNR, and ENAMS

(10) Switch used to specify whether to use the region key function
REGEN

(11) Switch used to select the destination market (Europe/USA)
USASEL

To set these switches, short-circuit the respective diodes in the matrix.

The functions of the switches in the initial setting diode matrix are summarized below. "1" indicates that the diode must be short-circuited, while "0" indicates that it must be left open.

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>FM SD/IF</td><td>This switch is used to specify the method used to detect a station during auto-tuning in the FM band.
Set the switch as indicated in the following table.
<table>
<tr><th>FM SD/IF</th><th>Method used to detect a station</th></tr>
<tr><td>0</td><td>Only SD is used.</td></tr>
<tr><td>1</td><td>SD and the IF counter are used.</td></tr>
</table></td></tr>
<tr><td>AM SD/IF</td><td>This switch is used to specify the method used to detect a station during auto-tuning in the AM band.
Set the switch as indicated in the following table.
<table>
<tr><th>AM SD/IF</th><th>Method used to detect a station</th></tr>
<tr><td>0</td><td>Only SD is used.</td></tr>
<tr><td>1</td><td>SD and the IF counter are used.</td></tr>
</table></td></tr>
<tr><td>AMIF1
AMIF2</td><td>These switches are used to specify the intermediate frequency in the MW and LW bands.
Set the switches as indicated in the following table.
<table>
<tr><th>AMIF1</th><th>AMIF2</th><th>Intermediate frequency</th><th>IF count range</th></tr>
<tr><td>0</td><td>0</td><td>450 kHz</td><td>450 ±3 kHz</td></tr>
<tr><td>0</td><td>1</td><td>459 kHz</td><td>459 ±3 kHz</td></tr>
<tr><td>1</td><td>×</td><td>10.71 MHz</td><td>450 ±3 kHz</td></tr>
</table>
(×: Don't care)</td></tr>
<tr><td>CLK24</td><td>This switch is used to select 12-hour or 24-hour clock display.
Set this switch as indicated in the following table.
<table>
<tr><th>CLK24</th><th>Hour display</th></tr>
<tr><td>0</td><td>12-hour clock display (with "AM" or "PM" displayed)</td></tr>
<tr><td>1</td><td>24-hour clock display</td></tr>
</table>
(1 = closed with a diode, 0 = open)</td></tr>
<tr><td>NOCLK</td><td>This switch is used to specify whether the clock is to be provided.
Set this switch as indicated in the following table.
<table>
<tr><th>NOCLK</th><th>Availability of the clock</th></tr>
<tr><td>0</td><td>The clock is available.</td></tr>
<tr><td>1</td><td>The clock is unavailable.
With this setting, the settings of switches CLK24, FLASH, and CTADJ are ignored.</td></tr>
</table></td></tr>
<tr><td>CTADJ</td><td>This switch is valid only when the clock is available (when the NOCLK switch is set to 0).
Set this switch as indicated in the following table.
<table>
<tr><th>CTADJ</th><th>Clock correction</th></tr>
<tr><td>0</td><td>The clock is not corrected using the data supplied by an RDS broadcast.
The device operates according to its internal clock.</td></tr>
<tr><td>1</td><td>While the clock is operating, if an RDS broadcast is received, the clock is corrected according to the time information provided by the RDS signal.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>CLKDSP</td><td>This switch is used to specify whether to continue to display the clock when the device is turned off with the [POWER] key.
Set the switch as indicated in the following table.

<table><tr><th>CLKDSP</th><th>Clock display</th></tr><tr><td>0</td><td>The clock is not displayed while the device is turned off.</td></tr><tr><td>1</td><td>The clock is displayed while the device is turned off.</td></tr></table>
When initial setting diode NOCLK is set to 1, the clock is not displayed, even if CLKDSP is set to 1.
Initial setting diode CLKDSP is linked to the control of the supply of power to the LCD controller/driver (μPD16431A) in the power-off state ($\overline{\text{LCDOFF}}$ or pin 52). Power is not supplied irrespective of the setting of initial setting diode NOCLK.
See the table below for details.

<table><tr><th>CLKDSP</th><th>Description</th></tr><tr><td>0</td><td>Power is not supplied to the LCD controller/driver (μPD16431A) in the power-off state (if the $\overline{\text{LCDOFF}}$ pin is low).</td></tr><tr><td>1</td><td>Power is supplied to the LCD controller/driver (μPD16431A) in the power-off state (if the $\overline{\text{LCDOFF}}$ pin is high).</td></tr></table></td></tr>
<tr><td>FLASH</td><td>This switch is valid only when the clock is available (the NOCLK switch is set to 0).
Set this switch as indicated in the following table.

<table><tr><th>FLASH</th><th>Colon (:) display</th></tr><tr><td>0</td><td>Constantly displayed</td></tr><tr><td>1</td><td>Flashing
Frequency: 1 Hz
Duty cycle: 60%</td></tr></table></td></tr>
<tr><td>RETUNE</td><td>This switch is used to specify whether to turn auto-retuning on or off.
Set this switch as indicated in the following table.

<table><tr><th>RETUNE</th><th>Auto-retuning on/off</th></tr><tr><td>0</td><td>Off</td></tr><tr><td>1</td><td>On</td></tr></table>
When auto-retuning is turned on, if the SD signal is not detected for about 20 seconds during station reception (or about three seconds in a mode other than a tuner mode), ascending for auto seek is automatically performed.
In TP/SK mode, the same operation as that described above is performed if the station is other than a traffic information station.</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>FUNC</td><td>This switch is used to specify whether to use the double function key function.
Set this switch as indicated in the following table.
<table>
<tr><th>FUNC</th><th>Use of the double function key function</th></tr>
<tr><td>0</td><td>The double function key function is not used.</td></tr>
<tr><td>1</td><td>The double function key function is used.</td></tr>
</table></td></tr>
<tr><td>BEEP</td><td>This switch is used to specify whether to output a beep whenever a key entry is accepted.
Set this switch as indicated in the following table.
<table>
<tr><th>BEEP</th><th>Beep</th></tr>
<tr><td>0</td><td>Not output</td></tr>
<tr><td>1</td><td>Output</td></tr>
</table></td></tr>
<tr><td>VOLSEL</td><td>This product supports two types of electronic volume control IC.
Set this switch as indicated in the following table.
<table>
<tr><th>VOLSEL</th><th>Description</th></tr>
<tr><td>0</td><td>SGS-TDA7313 electronic volume control IC</td></tr>
<tr><td>1</td><td>PHILIPS TEA6300/6320T electronic volume control IC</td></tr>
</table></td></tr>
<tr><td>MESEL</td><td>This switch is used to select the method of writing data into the preset memory.
Set this switch as indicated in the following table.
<table>
<tr><th>MESEL</th><th>Method of writing to preset memory</th></tr>
<tr><td>0</td><td>Press and hold down one of keys [M1] to [M6] for at least two seconds.
The [ME] key is invalid.</td></tr>
<tr><td>1</td><td>Press the [ME] key then, within five seconds, press any of keys [M1] to [M6].</td></tr>
</table></td></tr>
<tr><td>ENMTL</td><td>This switch is used to specify whether use of the [METAL] key is to be enabled in tape mode.
Set this switch as indicated in the following table.
<table>
<tr><th>ENMTL</th><th>[METAL] key</th></tr>
<tr><td>0</td><td>The [METAL] key is not used.</td></tr>
<tr><td>1</td><td>The [METAL] key is used.</td></tr>
</table></td></tr>
<tr><td>ENNR</td><td>This switch is used to specify whether use of the [NR] key is to be enabled in tape mode.
Set the switch as indicated in the following table.
<table>
<tr><th>ENNR</th><th>[NR] key</th></tr>
<tr><td>0</td><td>The [NR] key is not used.</td></tr>
<tr><td>1</td><td>The [NR] key is used.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>ENAMS</td><td>This switch is used to specify whether use of the [AMS] key is to be enabled in tape mode.
Set the switch as indicated in the following table.
<table>
<tr><th>ENAMS</th><th>[AMS] key</th></tr>
<tr><td>0</td><td>The [AMS] key is not used.</td></tr>
<tr><td>1</td><td>The [AMS] key is used.</td></tr>
</table></td></tr>
<tr><td>REGEN</td><td>This switch is used to specify whether use of the region key is to be enabled.
Set the switch as indicated in the following table.
<table>
<tr><th>REGEN</th><th>Region key function</th></tr>
<tr><td>0</td><td>The region key function is not used.</td></tr>
<tr><td>1</td><td>The region key function is used.</td></tr>
</table></td></tr>
<tr><td>USASEL</td><td>This switch is used to select the destination market (Europe/USA).
Set the switch as indicated in the following table.
<table>
<tr><th>USASEL</th><th>Europe/USA</th></tr>
<tr><td>0</td><td>Europe</td></tr>
<tr><td>1</td><td>USA</td></tr>
</table></td></tr>
</table>

2.5.2 Momentary Keys

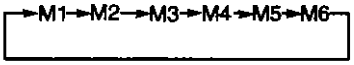
<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>RDS/REGION</td><td>
(1) RDS key
This key is used to set or release RDS mode.
While the device is tuned to the FM band, this key is valid even in CD changer/tape mode.
While RDS mode is selected, it is indicated by "RDS" appearing in the LCD indicator.
The following processing is performed in RDS mode.
• While on-air mode is set, the signal meter level is monitored. If the level falls below a preset value, AF switching occurs.
• In auto-seek mode, only RDS broadcasting stations are detected.
If TP/SK mode is also selected, however, TP/SK seek takes precedence. RDS data reading and PS display are performed regardless of whether RDS mode is selected.
(2) REGION key
This key is used to select the method used to judge the PI code of the RDS station to which the device is switched when AF switching to an RDS station in the FM band and PI seek occur.
This key is valid in the FM band in tuner mode.
When region mode is set, LCD indicator "REGION" appears to indicate the mode setting.
The following table explains the methods used to judge the PI code of the station to which the device switches against the PI code of the previous station.
<table>
<tr><th></th><th>REGION mode is on</th><th>REGION mode is off</th></tr>
<tr><td>AF switching</td><td>The 12 bits other than the area cover code are judged against the PI code of the previous station to determine whether they match.</td><td>The entire PI code (16 bits) is judged against the PI code of the previous station.</td></tr>
<tr><td>PI seek</td><td>The area cover code is judged against the PI code of the previous station as follows:
If the area cover code changes from "1"-"3" to "4"-"F" or vice versa, the PI codes are assumed to match.
If the area cover code changes within the ranges "1"-"3" or "4"-"F", the PI codes are assumed to be different.</td><td>The 12 bits other than the area cover code are judged against the PI code of the previous station to determine whether they match.</td></tr>
</table>
The key is invalid when initial setting diode REGEN is set to 0. At this time, the methods used to judge the PI code are the same as those used when region mode is not set.
</td></tr>
<tr><td>LOUD/ATT</td><td>
(1) Attenuator
This key is used to set or release attenuator mode.
Pressing the LOUD/ATT key for up to 0.5 seconds sets or releases attenuator mode.
While attenuator mode is set, the LCD indicator "ATT" appears to indicate the mode setting.
(2) Loudness function
This key is used to set and release loudness mode. Pressing the LOUD/ATT key for 0.5 seconds or longer sets or releases loudness mode.
When loudness mode is on, LCD indicator "LOUD" appears to indicate the mode setting.
</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>ME</td><td>
This key is used to enable or disable writing to the preset memory.
The key is enabled when initial setting diode MESEL is set to 1 (the diode is shorted).
Writing to the preset memory is enabled for five seconds after this key is pressed. Pressing one of keys M1 to M6 causes the frequency of the station to which the device is tuned to be written into the preset memory location corresponding to the pressed key. If the ME key is held down, however, writing cannot be performed.
This key is disabled except while tuning and in tuner mode.
The table below lists the functions assumed by the keys when writing to memory is enabled.
<table>
<tr><th>Key</th><th>Description</th></tr>
<tr><td>M1 to M6</td><td>The memory write-enabled state is canceled.
When the key is pressed, the frequency of the station to which the device is tuned is written into the preset memory location corresponding to the pressed key. No mute is output.</td></tr>
<tr><td>ME</td><td>The memory write-enabled state is canceled.</td></tr>
<tr><td>RDS/REGION
TP/SK
PI
PTY
CT</td><td>• For the FM band
The memory write enabled state is canceled.
The function assigned to the pressed key is performed.
• For a band other than the FM band
These keys are disabled.</td></tr>
<tr><td>SEEK UP
(MAN UP)
SEEK DWN
(MAN DWN)</td><td>The memory write-enabled state is canceled.
The function assigned to the pressed key is performed, starting from the frequency to which the device is tuned.</td></tr>
<tr><td>MODE
PSCAN/ASM
SHIFT
VOL UP
VOL DWN
VOL SEL
BAND/AREA CH
DISP
MONO/LOCAL
LOUD/ATT</td><td>The memory write-enabled state is canceled.
The function assigned to the pressed key is performed.</td></tr>
</table>
Momentary-contact keys other than those listed above are disabled.
</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>M1
M2
M3
M4
M5
M6</td><td>These keys are used to call and write to the preset memory in tuner mode.
The procedures for calling and writing to the preset memory are described below.
<table>
<tr><th>Operation</th><th>Description</th></tr>
<tr><td>Call</td><td>• When initial setting diode MESEL is set to 0 (open)
Pressing any one of keys M1 to M6, then releasing it within two seconds, calls the contents of the preset memory location corresponding to the pressed key.
When one of these keys is pressed, the LCD panel switches to display of the frequency.
• When initial setting diode MESEL is set to 1 (the diode is shorted)
Pressing any of keys M1 to M6 while the preset memory is not in the write-enabled state calls the contents of the preset memory location corresponding to the pressed key.</td></tr>
<tr><td>Write</td><td>• When initial setting diode MESEL is set to 0 (open)
Pressing any one of keys M1 to M6 and holding it down for at least two seconds causes the frequency to which the device is tuned to be written to the preset memory location corresponding to the pressed key.
When one of these keys is pressed, the LCD panel switches to display of the frequency or to band/preset display when the frequency is written.
• When initial setting diode MESEL is set to 1 (the diode is shorted)
Pressing the ME key enables writing to the preset memory for five seconds after the key is pressed. Pressing any one of keys M1 to M6 within this five-second period causes the frequency to which the device is tuned to be written to the preset memory location corresponding to the pressed key.
The preset memory write enabled state is canceled once the frequency has been written.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>PSCAN/ASM</td><td>
Auto-storage is performed when this key is pressed and held down for at least two seconds; preset memory scan is performed when the key is pressed and released within two seconds.

• For preset memory scan
Preset stations are sequentially called from the preset memory locations in the order listed below, starting from M1 if the device is tuned to a station other than a preset station or, when tuned to a preset station, from the subsequent station (for example, when the device is tuned to M3, scanning starts from M4). During scanning, each preset station is held for five seconds.



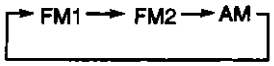
During preset memory scan, PSCAN appears in the LCD indicator.
The function assigned to each key during preset memory scan is described below.

<table>
<tr><th>Key</th><th>Description</th></tr>
<tr><td>PSCAN/ASM</td><td>Preset memory scan is stopped.</td></tr>
<tr><td>SEEK UP (MAN UP)
SEEK DWN (MAN DWN)</td><td>Preset memory scan is stopped.
The function assigned to the pressed key is performed, starting from the frequency to which the device is tuned when the key is pressed.</td></tr>
<tr><td>SHIFT
VOL UP
VOL DWN
VOL SEL
MONO/LOCAL
LOUD/ATT</td><td>Preset memory scan continues.
The function assigned to the pressed key is performed.</td></tr>
<tr><td>M1 to M6
MODE
BAND/AREA CH
DISP
ME</td><td>Preset memory scan is stopped.
The function assigned to the pressed key is performed.</td></tr>
<tr><td>PTY
RDS/REGION
TP/SK
PI
CT</td><td>• In the FM band
Preset memory scan is stopped.
The function assigned to the pressed key is performed.
• In a band other than the FM band
The keys are disabled.</td></tr>
</table>

All momentary-contact keys other than those described above are disabled.
</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>PSCAN/ASM</td><td>• For auto-storage operation
During auto-storage operation, "ASM" appears in the LCD indicator.
The function assigned to each key during auto-storage is described below.

<table><tr><th>Key</th><th>Description</th></tr><tr><td>PSCAN/ASM</td><td>Auto-storage is stopped.
M1 is retained if a station is detected during auto-storage; the frequency to which the device was tuned before the start of auto-storage is retained if no station is detected.</td></tr><tr><td>MODE</td><td>Auto-storage is stopped.
The function assigned to the pressed key is performed.</td></tr></table>
All momentary-contact keys other than those described above are disabled.</td></tr>
<tr><td>TP/SK</td><td>This key is used to switch the traffic information interrupt enable mode (TP/SK mode) on or off.
The key is valid even in CD changer/tape modes if the device is tuned to an FM band station.
When TP/SK mode is selected, "TP/SK" appears in the LCD indicator.
In TP/SK mode, auto-seek detects traffic information stations only.</td></tr>
<tr><td>PI</td><td>• This is a mode selection key, used to specify whether to perform seek based on the PI code of the current RDS station if AF switching occurs during CE reset, band switching, or reading from the preset memory thus causing AF switching to fail.
• This key is valid in tuner mode when the device is tuned to an FM band station.
• PI seek is performed throughout the band, starting from the frequency at which seek is selected.
• When PI seek mode is selected, "PI" appears in the LCD indicator.</td></tr>
</table>

Symbol	Description
BAND/AREA CH	**(1) When initial setting diode USASEL is set to 0** This key is used to switch the band in tuner mode. Pressing this key switches the band in the following order.  In the initial state, the FM1 band is selected. According to the selected band, the outputs of pins $BAND_0$ and $BAND_1$ are switched as listed below.

Band	$BAND_0$	$BAND_1$
FM	1	×
MW	0	0
LW	0	1

(1: High, 0: Low, ×: Don't care)

(2) When initial setting diode USASEL is set to 1

This key switches the band if pressed and released within two seconds.
The function of the key in this case is the same as that when initial setting diode USASEL is set to 0.
The key changes the area if it is pressed and held down for two seconds or longer.
This function enables switching between the frequency bands for Europe and those for the USA.
The frequency bands for each destination market and the initial values are listed below.

- **Frequency bands for each destination market**

Destination market	Band	Reception frequency band	Channel separation		Reference frequency
			Auto tuning	Manual tuning	
Europe	FM	87.50 to 108.00 MHz	100 kHz	50 kHz	50 kHz
	MW	522 to 1620 kHz	9 kHz	9 kHz	9 kHz
	LW	144 to 279 kHz	9 kHz	9 kHz	9 kHz
USA	FM	87.50 to 107.90 MHz	200 kHz	200 kHz	50 kHz
	MW	530 to 1710 kHz	10 kHz	10 kHz	10 kHz

- **Initial preset values**

Destination	Band	M1	M2	M3	M4	M5	M6	Last
Europe	FM	87.5	89.9	97.9	105.9	107.9	87.5	87.5
	AM	144	216	603	999	1620	522	522
USA	FM	87.5	89.9	97.9	105.9	107.9	87.5	87.5
	AM	530	600	1000	1500	1710	530	530

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>SHIFT</td><td>
• This key is used to set shift mode.
Pressing this key once places the device in shift mode for about five seconds.
Pressing this key again while the device is in shift mode releases shift mode.
• When both tuner mode and shift mode are set, pressing the SEEK UP or SEEK DWN key performs manual tuning. (See the descriptions of the SEEK UP and SEEK DWN keys for details.)
• When initial setting diode FUNC is set to 1, keys are assigned as follows in shift mode.

M1 → CT
M2 → MONO/LOCAL
M3 → LOUD/ATT
M4 → AMS
M5 → METAL
M6 → NR
RDS/REGION → PI

The functions of the keys are the same as those in the normal case (when initial setting diode FUNC is set to 0).
</td></tr>
<tr><td>MONO/LOCAL</td><td>
(1) For forced MONO
• When the FM band is selected in tuner mode, pressing the key within about 0.5 seconds switches forced MONO mode on or off.
• In forced MONO mode, "MONO" appears in the LCD indicator. The "STEREO" indicator is forcibly turned off.
(2) For LOCAL control
• In tuner mode, pressing and holding down the key for about 0.5 seconds, or longer reverses the setting of LOCAL/DX.
• In LOCAL mode, the LOCAL pin outputs a high level signal, and "LOCAL" appears in the LCD indicator.
</td></tr>
<tr><td>METAL</td><td>
This key is used for METAL control.
It is effective in radio mode, tape DK standby mode, tape DK on mode, and tape and radio monitor mode.
Pressing the key turns METAL on or off.
The following table lists the relationships between the on/off state of METAL, "METAL" display, and the output state of the METAL pin.

<table>
<tr><th>METAL state</th><th>"METAL" display</th><th>METAL pin</th></tr>
<tr><td>ON</td><td>Lit</td><td>High level</td></tr>
<tr><td>OFF</td><td>Not lit</td><td>Low level</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>NR</td><td>This key is used to select noise reduction (NR) control.
It is effective in tape mode, tape DK standby mode, tape DK on mode, and tape and radio monitor mode.
Pressing the key turns NR on or off.
The following table lists the relationships between the on/off state of NR, "NR" display, and the output state of the NR/MONO pin.

<table>
<tr><th>NR state</th><th>"NR" display</th><th>NR/MONO pin</th></tr>
<tr><td>ON</td><td>Lit</td><td>High level[Note]</td></tr>
<tr><td>OFF</td><td>Not lit</td><td>Low level[Note]</td></tr>
</table>

Note In tape DK on mode and tape radio monitor mode, the NR/MONO pin functions as the MONO/STEREO state output pin. So, its output level corresponds to the MONO/STEREO state.</td></tr>
<tr><td>ASM</td><td>This key is used to select Auto Music Search (AMS) control.
It is effective in tape mode, tape DK standby mode, tape DK on mode, and tape and radio monitor mode.
Pressing the key turns AMS on or off.
The following table lists the relationships between the on/off state of AMS, "AMS" display, and the output state of the AMS pin.

<table>
<tr><th>AMS state</th><th>"AMS" display</th><th>AMS pin</th></tr>
<tr><td>ON</td><td>Lit</td><td>High level</td></tr>
<tr><td>OFF</td><td>Not lit</td><td>Low level</td></tr>
</table></td></tr>
<tr><td>MODE</td><td>This key is used to switch audio source mode.
In the power-on state, the key is always enabled.
Pressing the key switches the audio source in the following order.

→Tuner→CD changer[Note 1]→Tape[Note 2]

Notes 1. If the CD changer controller cannot recognize the CD changer, switching to CD change mode is skipped.
2. When a tape pack-in signal is not detected, switching to tape mode is skipped.</td></tr>
</table>

Symbol	Description
PTY	• This key is used to display and search for a program using a PTY (program type) among the RDS data. • This key is valid when an FM band station is received in tuner mode. • Pressing this key once, while the device is tuned to an RDS station, causes the current program type to be displayed. If the station currently being received is other than an RDS station, a symbol appears in the LCD indicator, indicating that the program does not have a program type. (See **Section 5.3** for details.) • The procedure for performing PTY search using a PTY (program type) is described below: When the key is pressed, the program type is displayed for five seconds. Within those five seconds, each time the key is pressed, the program type is switched. When the desired program type is displayed, pressing the SEEK UP or SEEK DWN key during the five seconds the program type is displayed instigates a search of the entire band for an RDS station broadcasting a program of that program type. (For this to be possible, however, the "AUTO" indicator indicating the auto-seek state must be displayed.) • When a program type is displayed, or when a search is made for a program based on a program type, "PTY" appears in the LCD indicator.
CT	This key is used to set the mode in which the clock is corrected according to the CT data (clock data) contained in the RDS data. This key is valid when the device is tuned to an FM band station in tuner mode. When clock correction mode is selected, "CT" appears in the LCD indicator. The key is disabled when initial setting diode NOCLK is set to 1.
VOL SEL	This key is used to select the electronic volume control function. Pressing the key switches the mode in the order below. BASS adjustment mode[Note] → TREBLE adjustment mode → BALANCE adjustment mode → FADER adjustment mode → VOLUME adjustment mode → (back to BASS adjustment mode) **Note** The first time the VOL SEL key is pressed causes the device to enter BASS adjustment mode. Each time the key is pressed, the device enters one of the electronic volume control adjustment modes. In each mode, the VOL UP and VOL DWN keys are used to adjust the corresponding level. (For details, see the description of the VOL UP and VOL DWN keys.)

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>VOL UP
VOL DWN</td><td>
These keys are used to adjust each electronic volume control in the corresponding electronic volume control adjustment mode. In a mode other than an electronic volume control adjustment mode, these keys are used to adjust the volume.
Each time either key is pressed, the electronic volume control is adjusted as explained below.

<table>
<tr><th>Function</th><th>Step</th></tr>
<tr><td>VOLUME</td><td>0 to 40</td></tr>
<tr><td>BASS</td><td>–6 to +6</td></tr>
<tr><td>TREBLE</td><td>–6 to +6</td></tr>
<tr><td>BALANCE</td><td>L6 to R6</td></tr>
<tr><td>FADER</td><td>F6 to R6</td></tr>
</table>

Pressing and holding down either key causes the device to enter key repeat mode.
In key repeat mode, the key is repeated as follows.

During VOLUME adjustment: First key repeat wait: 500 ms
Key repeat: 100 ms
In all other adjustment modes: First key repeat wait: 500 ms
Key repeat: 300 ms

When BASS, TREBLE, BALANCE, or FADER is adjusted in key repeat mode, the repeat mode stops upon reaching the center setting ("0" is indicated).
</td></tr>
<tr><td>DISP</td><td>
This key is used to switch the LCD panel display.
Pressing and releasing the key causes the LCD panel display to be switched.
Each time the key is pressed, the display is switched in the following order.

(In tuner mode)

PS display → Frequency display → Clock display
(Within five seconds)

(In tape mode)

Tape display → Clock display

(In CD changer mode)

CD changer display → Clock display

The clock display is skipped when initial setting diode NOCLK is set to 1.
PS display is performed when PS data within the RDS data is read. (See Section 5.3 for details.)
By pressing a combination of the DISP and SEEK UP/SEEK DWN keys, the clock can be adjusted.
(See the description of the SEEK UP/SEEK DWN keys for details.)
</td></tr>
</table>

Symbol	Description
SEEK UP SEEK DWN	These keys are used to perform auto-seek/manual seek for a reception frequency during frequency display; and to adjust the clock in combination with the DISP key during clock display. **(1) When used for auto-seek** When the "AUTO" indicator is lit in tuner mode, these keys are used to perform auto-seek. During auto-seek, the channel separations are as follows: FM band : 100 kHz[Note] AM band (MW) : 9 kHz AM band (LW) : 9 kHz **Note** For example, when the device is tuned to 87.55 MHz, pressing the SEEK UP key instigates seek from 87.60 MHz to 87.70 MHz. During ascending seek with the SEEK UP key held down, seek continues even if the SEEK DWN key is pressed. In this state, if the SEEK UP key is released while the SEEK DWN key is held down, descending seek is performed from the point where the SEEK UP key is released. (This is also true in the opposite case.) The function of each key during auto seek is described below.

Key	Description
M1 to M6	Auto seek is interrupted. The contents of the preset memory location corresponding to the pressed key are called.
RDS/REGION TP/SK PI PTY CT	In the FM band, the function assigned to the pressed key is performed. The keys are invalid other than the FM band.
SEEK UP (MAN UP) SEEK DWN (MAN DWN)	• **When the "AUTO" indicator is lit** Pressing SEEK UP during ascending seek or pressing SEEK DWN during descending seek stops auto seek and calls the frequency to which the device was tuned before auto seek was started. Pressing SEEK DWN during ascending seek or pressing SEEK UP during descending seek reverses the direction of the seek. • **When the "AUTO" indicator is not lit** Manual seek starts, beginning from the frequency to which the device was tuned when the key is pressed.

Symbol	Description
SEEK UP SEEK DWN	

Key	Description
SHIFT VOL UP VOL DWN VOL SEL MONO/LOCAL LOUD/ATT	Auto seek continues. The function assigned to the pressed key is performed.
PSCAN/ASM MODE BAND/AREA CH DISP	Auto seek is stopped. The function assigned to the pressed key is performed.

Momentary-contact keys other than those above are disabled.

(2) When used for manual seek

In tuner mode, while the "AUTO" indicator is not lit (the device is in shift mode), these keys are used for manual seek.

During manual seek, the channel separations are as follows:

FM band : 50 kHz
AM band (MW) : 9 kHz
AM band (LW) : 9 kHz

During manual ascending seek with the SEEK UP held down, ascending seek continues even if the SEEK DWN key is pressed.

In this state, if the SEEK UP key is released while the SEEK DWN key is held down, descending seek is performed from the point where the SEEK UP key is released. (This is also true in the opposite case.)

During manual seek, each time the keys are pressed, the frequency is increased or decreased by one step (one channel separation), respectively.

When the keys are pressed and held down for about 0.5 seconds or longer, the frequency is continuously increased/decreased at a about 40 ms per step, respectively. When the keys are held down for manual tuning, all other keys are disabled.

(3) When used to adjust the clock

During clock display, while the DISP key is held down, pressing the SEEK UP and SEEK DWN keys adjusts the hour and minute digits of the clock, respectively.

- **Adjustment of the hour digits**
  Each time the SEEK UP key is pressed, the hour digits of the clock are incremented by one.
  When the key is pressed for about 0.5 seconds or longer, the digits increment continuously every 200 ms until the key is released.
  While the hour digits are being adjusted, the minute digits and the second count are not affected.
- **Adjustment of the minute digits**
  Each time the SEEK DWN key is pressed, the minute digits of the clock are incremented by one.
  When the key is pressed for about 0.5 seconds or longer, the digits increment continuously every 100 ms until the key is released. There is no carry-over to the hour digits.
  Whenever the minute digits are adjusted, the second count is reset to zero.

Symbol	Description
DISC1 DISC2 DISC3 DISC4 DISC5 DISC6	In CD changer mode, these keys function as disc direct selection keys. The key assignment is shown below: M1 → DISC1 M2 → DISC2 M3 → DISC3 M4 → DISC4 M5 → DISC5 M6 → DISC6 The assignment of each key in CD changer mode is shown below: SEEK UP → CUE/TRACK UP SEEK DWN → REVIEW/TRACK DOWN AMS → INTRO METAL → REPEAT NR → SHUFF
CUE/TRACK UP REVIEW/TRACK DOWN	This key is effective in CD changer mode. (1) **When used as CUE/REVIEW** Pressing and holding down the key for at least 0.5 seconds causes it to function as the CUE/REVIEW operation key for the CD changer. This state continues until the key is released. (2) **When used as TRACK UP/TRACK DOWN** When the key is pressed and released within 0.5 seconds, the track selection of the disc being played back is shifted up or down.
INTRO	In CD changer mode, this key functions as the intro scan mode on/off key. In intro scan mode, the operation currently being performed is indicated as "SCAN" or "ALL" in the LCD indicator. Each time the key is pressed, intro scan is set as shown below. SCAN → SCAN ALL → Intro scan released SCAN : Intro scan only for the disc currently being played back. SCAN ALL : Intro scan for all discs in the CD changer magazine. The intro scan operation is automatically released after one cycle.
REPEAT	In CD changer mode, this key functions as the repeat mode on/off key. In repeat mode, the operation currently being performed is indicated as "REPEAT" or "ALL" in the LCD indicator. Each time the key is pressed, repeat operation is set as shown below. REPEAT → REPEAT ALL → Repeat mode released REPEAT : Only the track currently being played is repeated. REPEAT ALL : All tracks on the current disc are repeated.
SHUFF	In CD changer mode, this key functions as the shuffle mode on/off key. Each time the SHUFF key is pressed, shuffle mode is turned on or off. When shuffle mode is set, "SHUFF" appears in the LCD indicator.

3. RDS (RADIO DATA SYSTEM) FUNCTIONS

3.1 READING RDS DATA

The μPD17006AGF-052 internally decodes the $\overline{\text{RDSDATA}}$ and $\overline{\text{RDSCLK}}$ signals output by the RDS composite IC. Synchronization detection concerns block synchronization only; no error correction is performed.

Block synchronization is detected using the five block patterns below:

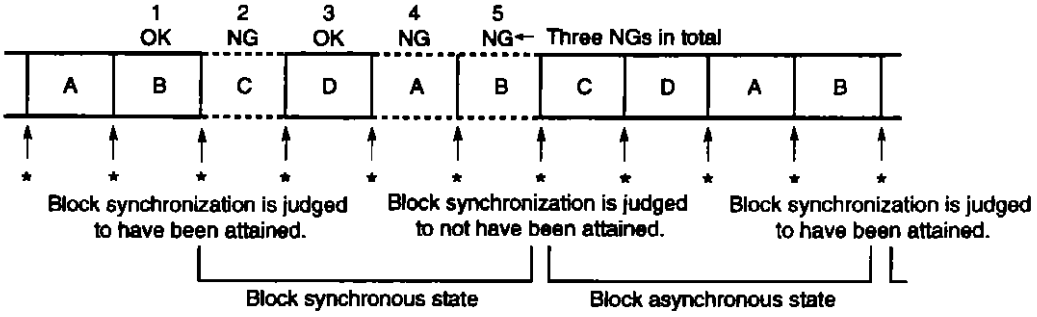
1: A-B-C-D
2: A-B-C'-D
3: A-B-E-E
4: A-B-F-F
5: E-E-E-E[Note]

Note Used to read RDS data in the United States. This block pattern is valid when initial setting diode USASEL is set to 1, the device is tuned to a US frequency, and after block pattern A-B-E-E has been detected.

Synchronization detection is performed is as follows: For each block, the five preceding blocks are checked for synchronization. If three or more of the five blocks, are detected as being synchronized block synchronization is judged to have been attained.

If block synchronization is not attained within 1.5 seconds, the statuses of TP, TA, and PTY are all cleared. If an error is detected in those blocks that have been read, synchronization detection is performed every 26 bits if block synchronization has been attained until block synchronization is no longer attained.

Fig. 3-1 Detecting Block Synchronization



* : The preceding five blocks are checked for synchronization.
Unless three or more of the five blocks are synchronized, block asynchronous state is assumed.

A to D: Represent offset check words.

3.2 PROCESSING OF RDS DATA

The μPD17006AGF-052 incorporates an RDS data decoder section.

The μPD17006AGF-052 uses the following eight types of data:

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

3.2.1 PI (Program Identification)

PI is used to identify the program being received.

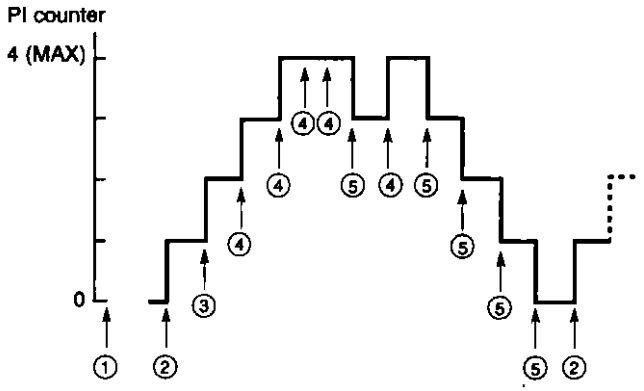
Upon the completion of tuning, if the same PI code is read two or more times, the RDS data having that PI code is decoded.

The PI counter can be incremented up to four.

When RDS data having a different PI code is read, the PI counter is decremented. At this time, only TP and TA in the RDS data are decoded.

Once the PI counter has been decremented to zero, a different PI code is assumed to be a correct PI code, causing the PI counter to be incremented. When the value of the PI counter reaches two, RDS date is decoded.

Fig. 3-2 PI Counter Operation



①: Completion of tuning
②: A PI code is placed in the PI code area for comparison. The counter is incremented by 1.
③: A PI code is compared with the stored PI code. If the codes are the same, the counter is incremented by 1.
④: A PI code is compared with the stored PI code. If the codes are the same, the counter is incremented by 1. The RDS data is decoded.
⑤: A PI code is compared with the stored PI code. If the codes are different, the counter is decremented by 1.

3.2.2 PS (Program Service Name)

PS is used for PS display on the LCD panel.

When identical PS data is read two or more times, the PS data is confirmed and displayed on the LCD panel.

About three seconds after the completion of tuning, the LCD panel changes to the PS display.

If PS data cannot be read within about three seconds, the LCD panel changes to the PS display at the point where PS data is read.

Once PS data has been read, if display switching is performed with the DISP key and TP/SK mode is turned on or off, the most resently read PS data will be displayed about three seconds later, even if no other PS data is subsequently read.

3.2.3 PTY (Program Type)

PTY is used to identify an alarm and display a program type.

If an alarm is read while the device is tuned to an RDS station, the device is switched to radio mode (if in tape/CD mode) and the $\overline{\text{TA/DK}}$ pin (pin 25) goes low.

By pressing the PTY key, the program type can be displayed or a search can be performed for a given program type. (**See Section 2.5.2.**)

Program types are allocated as follows.

The character string enclosed in parentheses in the program type column is displayed on the 14-segment display area of the LCD panel when the corresponding program type is selected.

No.	Program type	
1	No program type	(NONE)
2	News	(NEWS)
3	Current affairs	(AFFAIRES)
4	Information	(INFO)
5	Sports	(SPORT)
6	Education	(EDUCATE)
7	Drama	(DRAMA)
8	Culture	(CULTURE)
9	Science	(SCIENCE)
10	Variety	(VARIED)
11	Pop music	(POP M)
12	Rock music	(ROCK M)
13	M.O.R music	(M.O.R. M)
14	Light classic music	(LIGHT M)
15	Serious classic	(CLASSICS)
16	Other music	(OTHER M)

3.2.4 AF (Alternative Frequency)

AF is used as a list of alternative frequencies.

(1) Reading an AF list

The AF function supports both METHOD A and METHOD B.

An AF list of up to 25 frequencies can be stored.

When the top block of an AF list is read, the AF pointer is returned to the top, and the blocks are stored in the order in which they are transmitted.

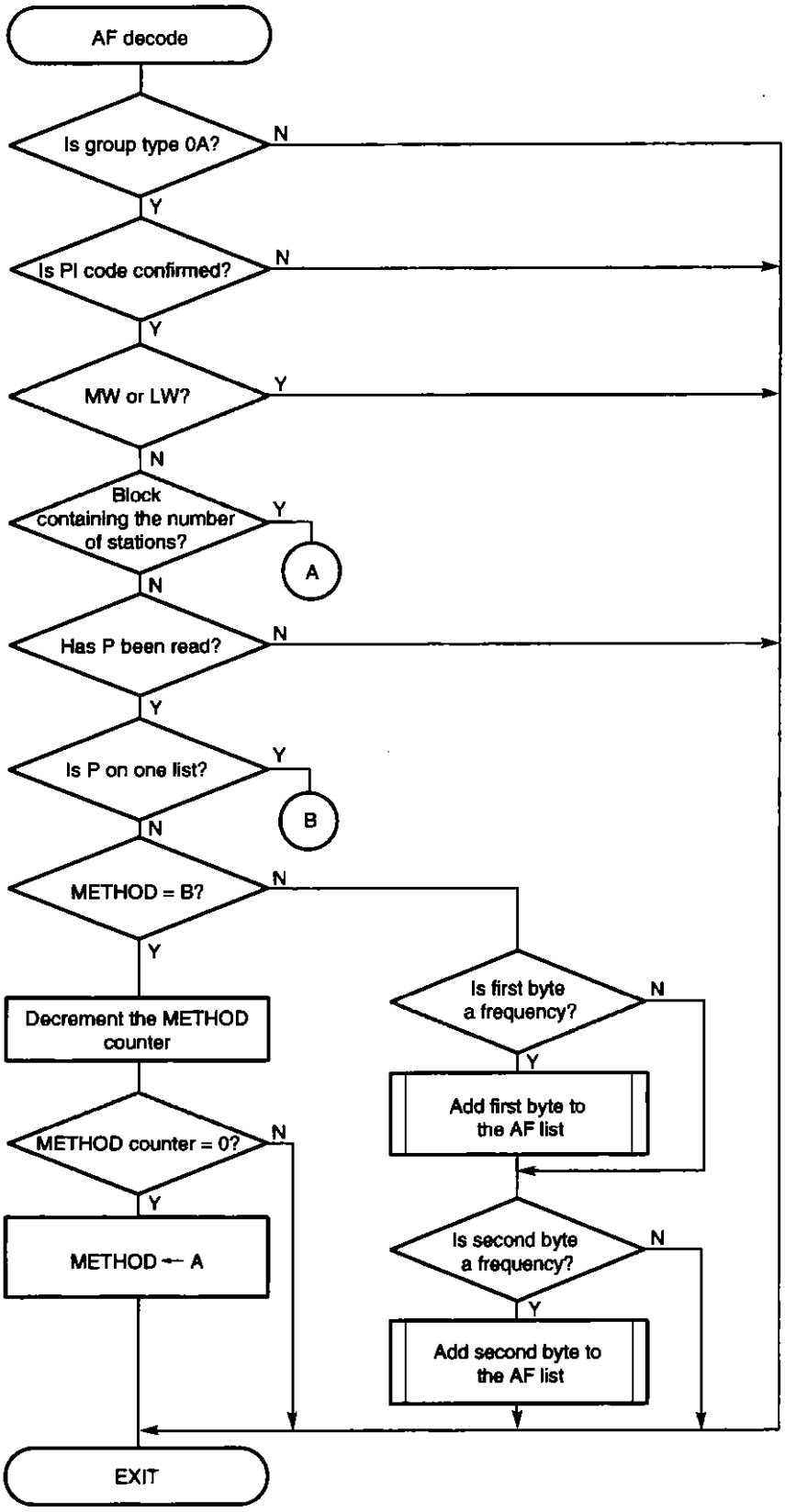
If an AF list of more than 25 frequencies is issued, the list will be overwritten, starting from the top.

In METHOD B, if consecutive blocks having the same frequency are issued, they are joined together into a single block.

In METHOD B, even if pairs of lists in ascending order are issued, all AF lists are stored.

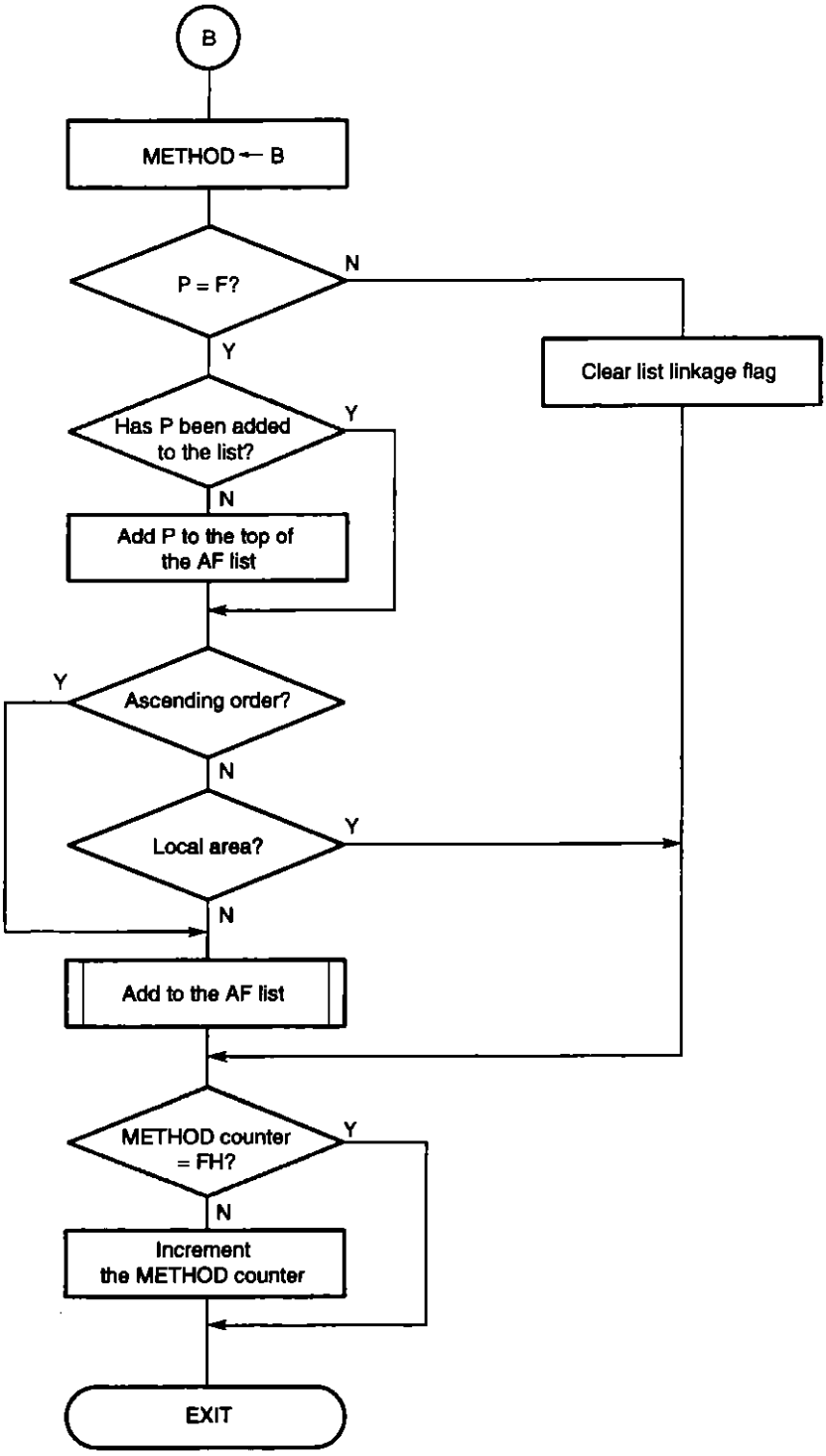
Fig. 3-3 illustrates how to the method read an AF list.

Fig. 3-3 Reading an AF List (1/3)



P: Frequency in the block containing the number of stations

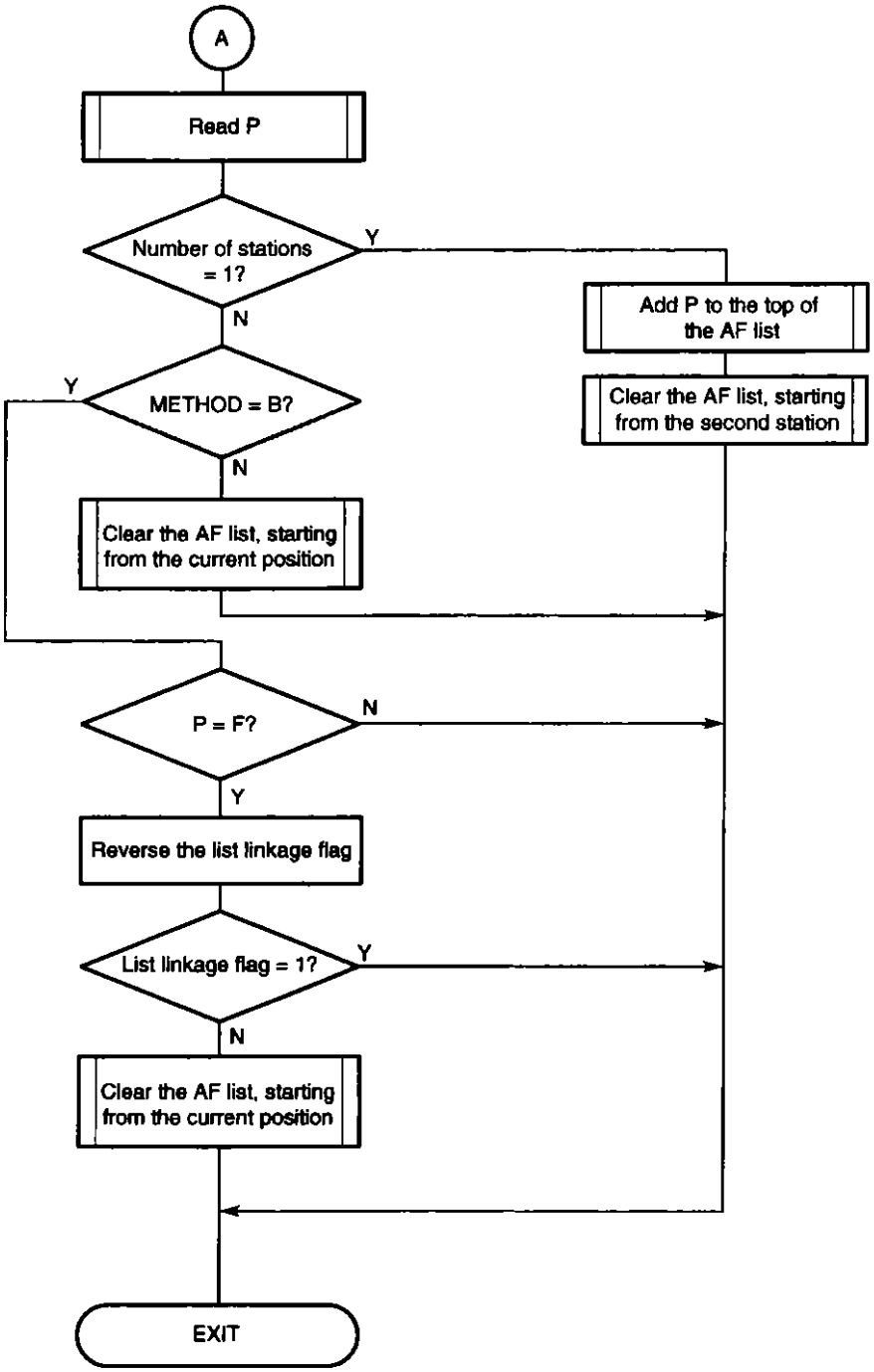
Fig. 3-3 Reading an AF List (2/3)



P: Frequency in the block containing the number of stations

F: Tuned frequency

Fig. 3-3 Reading an AF List (3/3)



P: Frequency in the block containing the number of stations

F: Tuned frequency

(2) AF operation

AF operation features two operating procedures, AF operation 1 and AF operation 2.
AF operations 1 and 2 are performed in the following cases.

- **AF operation 1**
  When an RDS station is called in the FM band, AF operation 1 occurs under the following conditions:
  - CE reset
  - Band switching
  - Preset read
  - The tuner is selected with audio selector switching (provided the tuner is not performing seek).

- **AF operation 2**
  While the RDS key is effective, and RDS mode is selected with the device tuned to an RDS station, AF operation 2 occurs as described below:
  - AF switching when the signal meter reading (broadcasting station signal intensity) for the broadcasting station currently being received drops below a certain level.
  - AF switching when RDS data synchronization cannot be detected for a preset period.

AF operation is described below.

(a) AF operation 1

AF switching is performed, according to the following procedure, at CE reset, band switching, preset read, and when the tuner is selected with audio selector switching (provided the tuner is not performing seek), and provided that the FM band is currently selected and that the recalled station is an RDS station.

① The data items (up to eight stations) in AF memory corresponding to the recalled RDS station are sorted according to their frequency.
② The SD pin is judged, starting from the station having the highest frequency. If a stations is detected,the level of the signal meter is stored.
③ From the results of detection described in ②, AF switching is performed starting from the station for which the signal meter level is highest.
④ For AF switching, if the station is an RDS station, its PI code is judged.
The PI code is judjed as follows:

(When initial setting diode REGEN is set to 1 and the region mode is set to ON with the RDS/REGION key, the 12 bits of the PI code other than the area cover code are examined for matching. Otherwise, the 16-bit PI code is examined for matching.)

At the point where a PI code match is detected, AF operation ends and the station is received as an RDS station.
⑤ If the AF switching described in step ④ fails, PI search mode is assumed.
If PI search mode is set, PI search is performed. (See the description in **"(3) PI search"** for details of PI search).
If PI search mode is not set, the station to which the device was tuned before the start of AF switching is retained. At this time, the preset memory number is cleared (if originally displayed).

(b) AF operation 2

This operation is valid when RDS mode is selected.

This AF operation is performed when the signal strength of the broadcast currently being received fulls below a certain level while the device is tuned to an RDS station.

While the device is tuned to an RDS station, AF operation 2 starts under the following conditions:

- When the signal meter reading (broadcasting station signal intensity) changes.
- When an RDS decode error is detected.

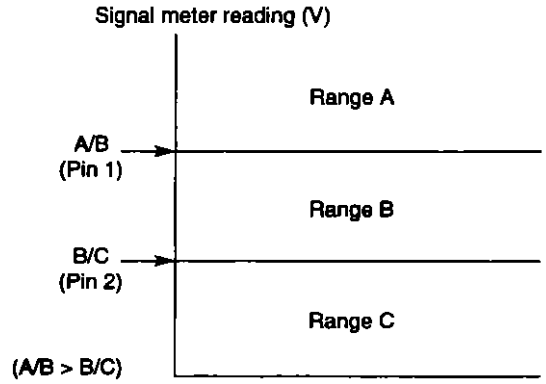
Each start condition is explained below.

- **Change in the signal meter reading (broadcasting station signal intensity)**

① Signal meter reading ranges

The signal meter is graded in three ranges, A, B, and C, as shown in Figure 3-4. AF operation 2 is performed according to the range.

Fig. 3-4 Signal Meter Reading Ranges



A boundary voltage between ranges A and B and between ranges B and C should be supplied to pins 1 and 2, respectively, according to the characteristics of the tuner being used. The boundary voltage must not exceed the supply voltage for the device.

- When A/B boundary voltage = B/C boundary voltage, two signal meter ranges, A and C, are used.
- When A/B boundary voltage < B/C boundary voltage, the input voltage at pin 1 is used as the B/C range boundary voltage, and the input voltage at pin 2 is used as the A/C range boundary voltage.

② Changes in AF operation 2 with transition through signal meter ranges

Table 3-1 lists the changes in AF operation 2 and the related transitions through signal meter ranges. There are two types of AF operation 2, single-station AF operation and all-station AF operation. (See **(2) (C) in Section 3.2.4.**)

Table 3-1 Changes in AF Operation 2 and Related Transitions Through Signal Meter Ranges

Current signal meter range	Previous signal meter range		
	Range A	Range B	Range C
Range A	Single-station AF operation is performed upon the detection of an RDS decode error.	AF inhibited period (25 seconds) begins.	
Range B	Once the AF inhibited period ends, single-station AF operation is performed.		
Range C	Once the AF inhibited period ends, all-station AF operation is performed.	All-station operation is performed even during the AF inhibited period.	After the end of the AF inhibited period, all-station AF operation is performed.

- **RDS operation upon the detection of an RDS error**

  If the signal meter reading is within range A, single-station AF operation is performed if seven out of ten checks, made at one-second intervals, detect the inactive state (high level) of the $\overline{RDS}$ pin or the internal RDS data being out of synchronization.

  AF operation is disabled for 25 seconds between two consecutive single-station AF operations.

(c) AF switching in AF operation 2

Once an AF operation 2 start condition is satisfied, AF switching is performed in either of the following two modes.

- Single-station AF operation
- All-station AF operation

Each AF operation mode is explained below.

- **Single-station AF operation**

  Each broadcasting station is detected starting from the beginning of the current AF list, according to the following procedure.

  ① Premute is output for about 20ms.
  ② The N value is changed.
  ③ PLL lock is awaited.
  ④ The signal meter level is allowed to settle (about 20 ms).
  ⑤ The signal meter reading is checked.
  When the level meter reading is detected as being in range A, the following operation is started.
  ⑥ A check is made for an RDS station.
  The active state (low level) of the $\overline{RDS}$ pin and RDS synchronization are checked.
  At least 500 ms are allowed to elapse.
  If the $\overline{RDS}$ pin is not used, it should be pulled down externally.
  ⑦ The detection of a PI code is awaited (at least 500 ms).

  An AF station is detected when all of the above conditions are satisfied. If an attempt to detect a single station fails, the AF inhibited period begins.

- **All-station AF operation**

  AF operation is performed for all stations in the current AF list (up to 25) at one time, according to the following procedure.

  ① The AF list is sorted into descending order of frequency.
  ② The signal meter reading is checked for all frequencies, starting from the highest (to determine those stations in range A).
  ③ The eight highest signal meter readings, identified in the above step, are selected and the corresponding stations are held.
  ④ The signal meter readings and RDS data are checked, starting from the highest frequency. The rest of this procedure is the same as that for single-station AF operation. If AF operation fails, the AF inhibited period (25 seconds) begins.

Cautions 1. AF switching does not occur if RDS mode has not been selected using the RDS/REGION key, or if AF data is not stored in the AF list.
2. During AF switching, station detection based on the IF (intermediate frequency) counter is not performed, regardless of the initial state.

(3) PI search

When PI search mode is set, PI search is performed according to the following procedure if AF operation 1 fails while performing AF operation:

① Ascending station search is performed throughout the band in 100 kHz steps, starting with the frequency to which the device was tuned before the start of AF switching.
② When a station is detected, the device proceeds to the next step if the station is other than an RDS station; otherwise, its PI code is judged.
③ The method of judging a PI code is as follows: When initial setting diode REGEN is set to 1 and the region mode is set with the RDS/REGION key, the 12 bits of the PI code, except the area cover code, are judged for matching. Otherwise, the 16-bit PI code is judged for matching.
④ If the station is determined as being OK as a result of judging its PI code in step ③, the device assumes PI search to have been successful, ends the search, and retains the station.
⑤ If the station is determined as being NG as a result of step ③ and station search has been performed throughout the band, the frequency to which the device was tuned before the start of PI search is retained and the search ends.

3.2.5 EON (Enhanced Other Network)

EON information, which is transmitted with block 3 of group type 14A, uses the AF list of the network of another station and mapped FM frequencies.

The following describes the procedure for reading data of group type 14A :

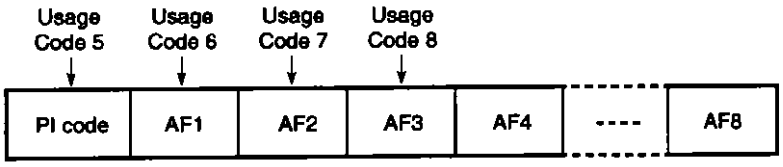
① The same PI code as that stored in block 4 of the data transmitted with 14A is retrieved from pool memory.
② If a matching PI code is found, the following frequencies in block 3 of the data transmitted with 14A are registered in the AF list associated with the PI code:
- AF list transmitted with Usage Code 4
- Mapped FM frequencies transmitted with Usage Codes 5 to 8.

③ Frequencies are registered in step ② as follows:

- **Registering the AF list transmitted with Usage Code 4**
  The frequencies of up to eight stations are read into the work area.
  When the PI code transmitted with block 4 of 14A is changed, together with and the received frequency, the data in the work area is updated as the AF list associated with the matching PI code.
  If no matching PI code is found, the PI code is newly registered in the pool memory.
  If the pool memory does not have sufficient free space, the oldest item in pool memory, that is not registered in the preset memory, is overwritten.

- **Registering the AF list sent with Usage Codes 5 to 8**

  (a) If a matching PI code already exists in the pool memory
  The AF list in the pool memory is updated directly (see the figure below).



  As shown in the figure, there are predetermined storage locations for Usage Codes 5 to 8. In AF switching, AF1 takes the highest priority. Even if the AF list is already registered in the pool memory, the list is overwritten by reading Usage Codes 5 to 8.

  (b) If a matching PI code is not found in the pool memory
  The operation performed is the same as that performed if the PI code matching that in Usage Code 4 is not found.

3.2.6 TP (Traffic Program Identification) and TA (Traffic Announcement Identification)

TP and TA are used to identify traffic information station and to identify a traffic information announcement.
The method of identifying a traffic information station is as follows:

- TP = 1
- TP = 0 and TA = 1

The method of identifying a traffic information announcement is as follows:

- **For a broadcast with TP = 1**
  When TA is set to 1, it is judged that traffic information is being broadcast.

- **TP = 0 and TA = 1**
  If group type 14B is sent, the station having the PI is judged as broadcasting traffic information.

The method of switching to traffic information is as follows:

- **For a broadcast with TP = 1**
  When TA is set to 1, the $\overline{\text{TA/DK}}$ pin (pin 25) goes low. The device is switched to radio mode if it is currently in tape/CD mode.
  When TA returns to 0, the $\overline{\text{TA/DK}}$ pin (pin 25) goes high and the device returns to the previous mode.

- **For a broadcast with TP = 0 and TA = 1**

  When group type 14B is sent and the TA of the network of another station is set to 1, if the station of the PI indicated by block 4 is stored in the preset or pool memory, all the AF lists are checked and the station having the highest signal meter level is selected from among all those stations having matching PIs.

  If no station having a matching PI can be found, PI search is performed if the device is in PI search mode. (See **(3) in Section 3.2.4.**)

In radio mode, at the point where the device is switched to a new broadcast, mute is canceled and the broadcast is received. Then, the TP and TA of the broadcast are checked and, if they are not set to 1 within four seconds, the device retunes to the previous frequency. In this case, switching with 14B within the PI is not performed within four seconds of that point.

When both TP and TA are set to 1, the $\overline{TA/DK}$ pin (pin 25) goes low.

In tape/CD changer mode, at the point where the device switches to a new broadcast, the TP and TA of the broadcast are checked and, if they are not set to 1 within four seconds, the device retunes to the previous frequency. When both TP and TA are set to 1, the $\overline{TA/DK}$ pin (pin 25) goes low, and the device is switched to radio mode.

In both radio and tape/CD changer modes, if TP is set to 1 after which TA is set to 0 , the $\overline{TA/DK}$ pin (pin 25) goes high and the device retunes to the previous frequency. Even if 14B is received at this time, the device remains in reception mode if the TA of the network of another station is set to 0.

After the device has switched to a new broadcast, it retunes to the previous frequency if no RDS signal is received.

- **Alarm generated upon loss of the signal of a traffic information station**

(1) When the traffic information station to which the device is tuned is no longer judged as being a traffic information station, and this state continues for 20 seconds (except in the case where traffic information from another station is received using EON)

In radio mode: SK mute is output. Three seconds later, an alarm is output.

In a mode other than radio mode: The entire band is searched for a traffic information station.

(2) When the frequency is changed while an alarm is being output (and the new frequency is not that of a traffic information station)

The alarm stops temporarily. When mute is canceled, the alarm overlaps the mute to output SK mute. Three seconds later, the alarm is output.

(3) If the station is judged as not being a traffic information station when CE changes from low to high, and cannot be judged as a traffic information station within three seconds of mute being canceled

The same operation as that described in (1) above is performed.

(4) If the device is switched to another mode while an alarm is being output

The same operation as that performed in a mode other than radio mode, described in (1) above, is performed.

(5) If the device is switched to radio mode while ascending seek is being performed in a mode other than radio mode

The ascending seek continues and the same operation as that performed in a mode other than radio mode, described in (1) above, is performed.

(6) If traffic information mode is canceled while ascending seek is being performed in a mode other than radio mode

Ascending seek continues and normal auto-tuning is performed. (If RDS is on, only RDS stations are received.)

- **Search for a traffic information station**

  When auto-tuning is performed in traffic information mode, stations are judged to determine whether they are traffic information stations 400 to 500 ms after SD pauses, and only traffic information stations are received.

The above traffic information operation is based on RDS data, even if RDS mode is not set.

3.2.7 CT (Clock Time and Data)

CT is used to adjust the clock.

The time transmitted by a broadcast is the universal time of convention (UTC) as specified in the CCIR recommendations. It is converted to the local time before being used as clock data.

By inputting time announcement information, the internal clock of the μPD17006AGF-052 is corrected using the broadcast time information.

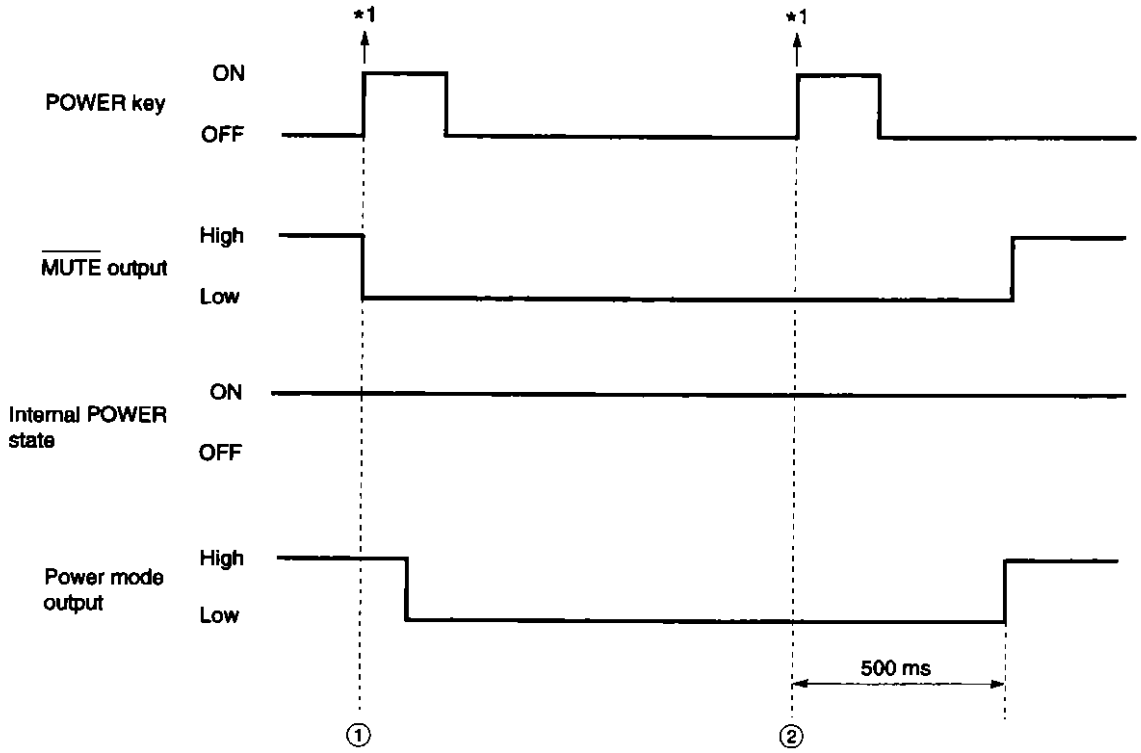
When initial setting diode CTADJ is set to 1, the clock is constantly corrected by inputting broadcast time information. Whenever the clock is corrected, the seconds are reset to zero.

Note that correction is made based on the broadcast time information, even when the clock is being adjusted using the time adjustment keys.

Whether to enable adjustment of the clock using the time adjustment keys is specified using initial setting diodes NOCLK and CTADJ.

4. SELECTOR CONTROL

4.1 TIMING OF TRANSITION FROM POWER ON TO OFF, AND VICE VERSA, WITH THE POWER KEY

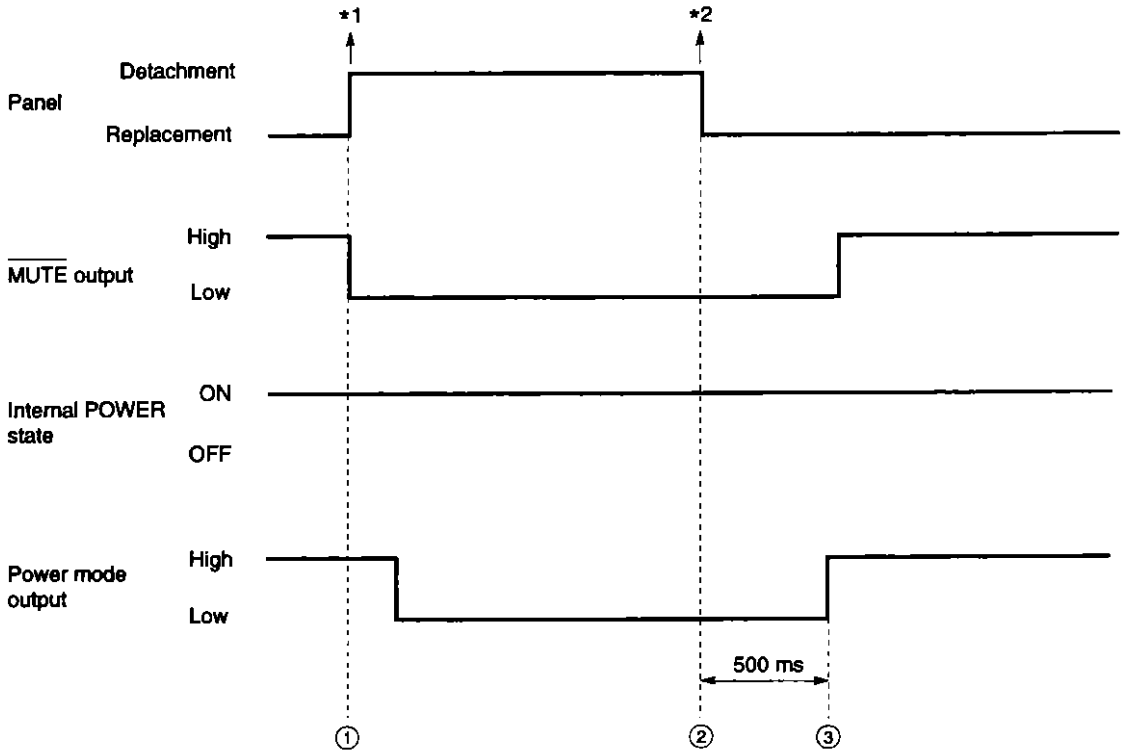


① Port setting, tuner OFF, and serial communication interruption at POWER OFF

② Tuner ON

*1 Time at which a change in key entry is detected (not including chattering removal time)

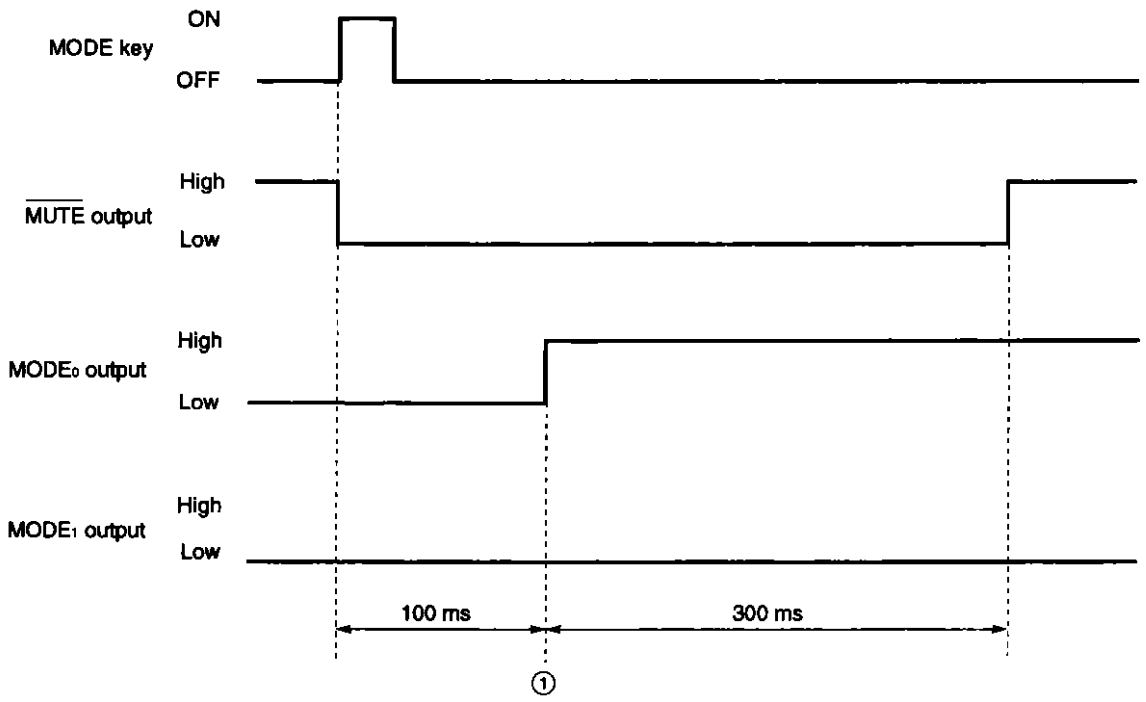
4.2 TIMING OF TRANSITION FROM POWER ON TO OFF, AND VICE VERSA, WITH THE DETACHABLE PANEL



① Port setting, tuner OFF, and serial communication interruption at POWER OFF
② Tuner ON
③ Start of audio source mode and start of serial communication
*1 Timing at which panel detachment is detected (not including chattering removal time)
*2 Timing at which panel mounting is detected (not including chattering removal time)

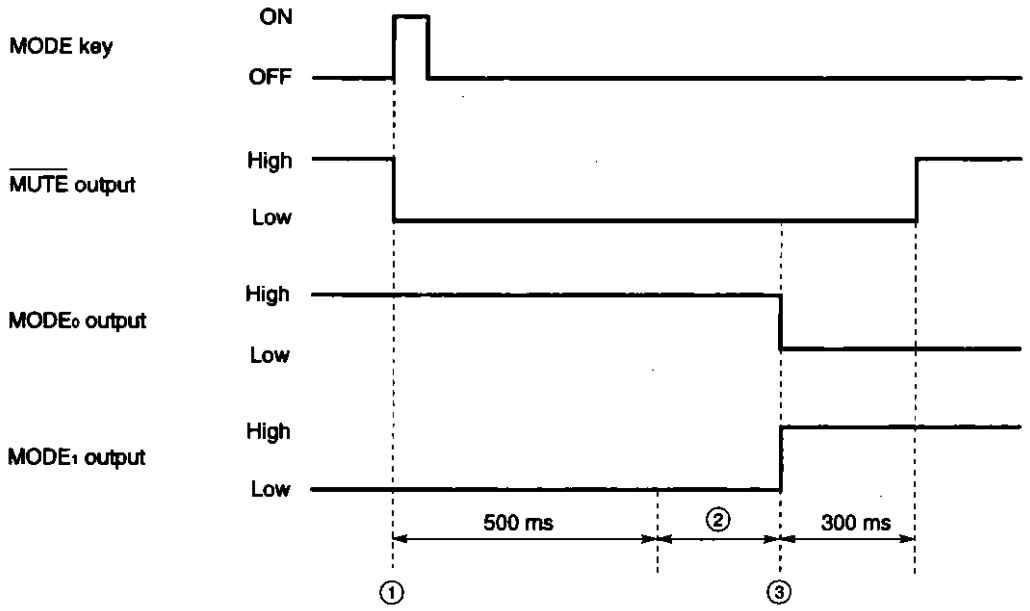
4.3 TIMING OF AUDIO MODE SWITCHING

Example: Tuner to TAPE



① Display switching

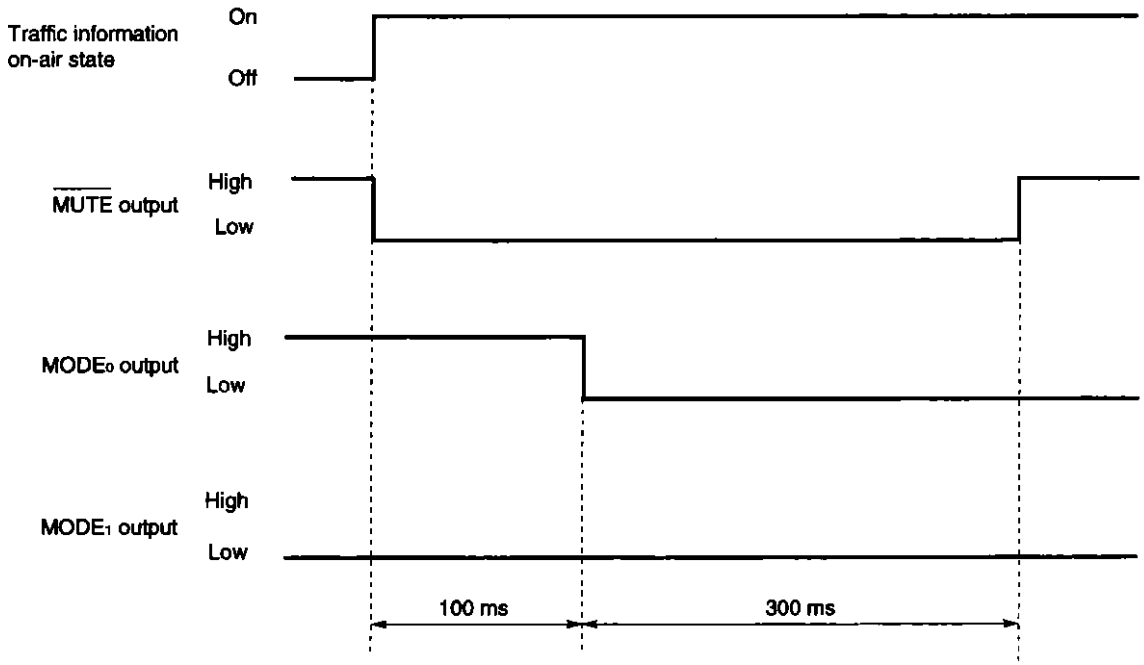
Example: TAPE to CD changer



① CD changer ON
② One second to confirm that the CD changer is connected (the tuner will be connected when no CD changer is present).
③ Display switching

4.4 TIMING OF AUDIO MODE SWITCHING WHILE TRAFFIC INFORMATION IS BEING BROADCAST (IN TP/SK MODE)

Example: TAPE to traffic information

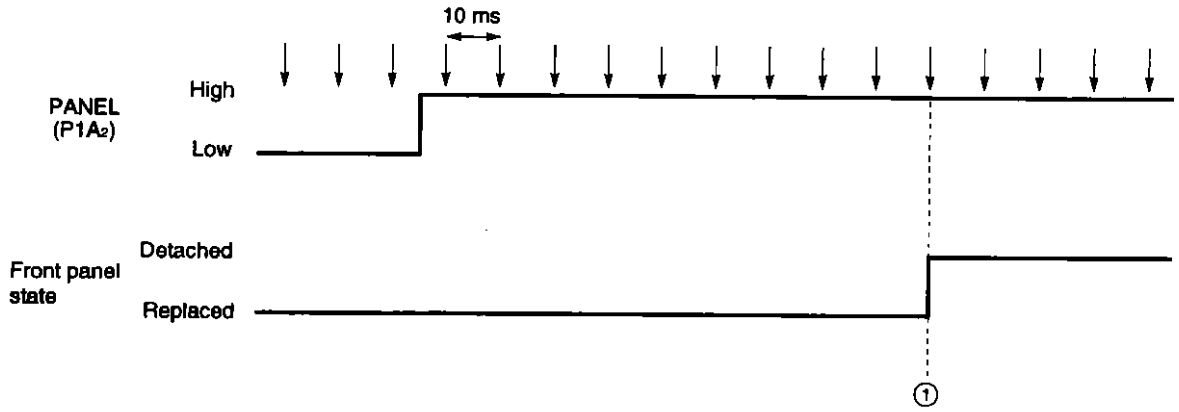


Caution If traffic information is being broadcast in tuner mode, $\overline{\text{MUTE}}$ output is not performed (because audio mode does not change).

4.5 DETECTION OF FRONT PANEL DETACHMENT

(1) Panel state detection timing

When the high level state of the panel input signal is detected ten times in a row, the panel is assumed to have been detached. (See ①.) The time required to assume that the panel is detached is
10 ms × 10 + Time required for sensing = 100 ms or longer but less than 110 ms.
The timing at which the replacement of the front panel is detected is the same as above.



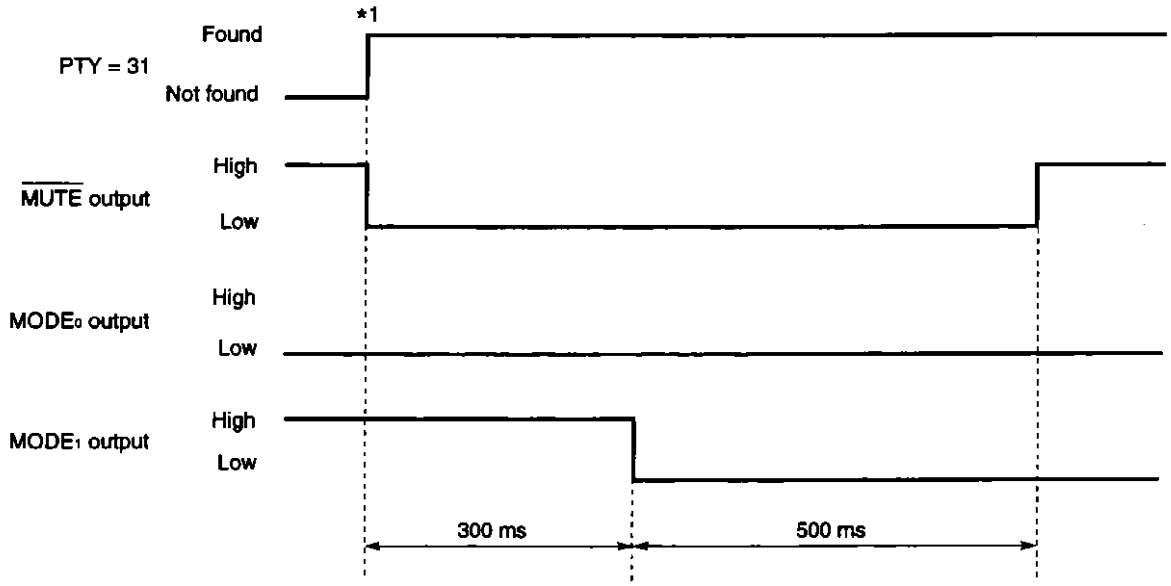
↓: Timing at which the panel input signal is sensed

(2) Operations performed when front panel detachment and replacement are detected

When the front panel is judged to have been detached, the power is turned off irrespective of the setting of the POWER key.
When the panel is judged as being installed, the setting of the POWER key is checked and, if it is judged to be OK, the power is turned on.
(See **Sections 4.1 and 4.2** for details on power state transitions.)

4.6 TIMING OF AUDIO MODE SWITCHING TIMING WITH PTY ALARM (PTY=31)

Example: CD changer to PTY alarm



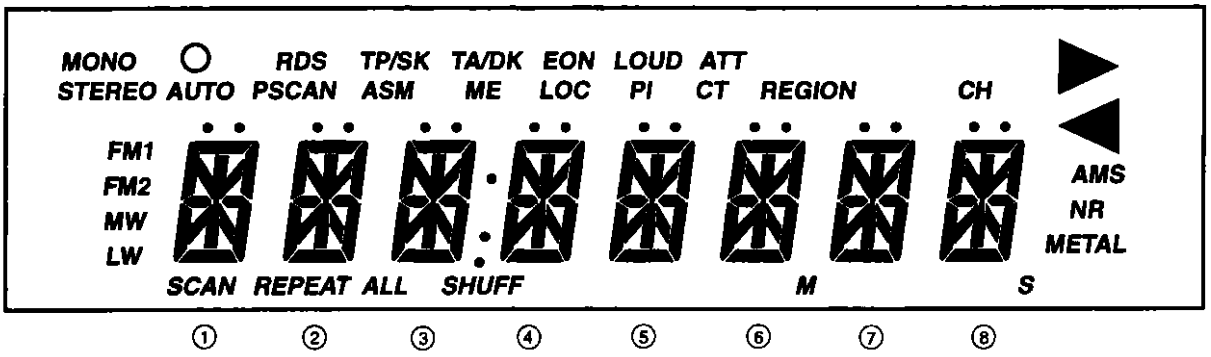
*1 Timing at which PTY=31 is detected (not including the time required to confirm two matches)

Caution If a PTY alarm is generated in tuner mode, $\overline{\text{MUTE}}$ output is not performed because audio mode does not change.

5. LCD PANEL

5.1 CONFIGURATION OF THE LCD PANEL

An example of the configuration of the LCD panel is shown below.



5.2 ASSIGNMENT OF LCD PINS

Table 5-1 lists the assignments of the LCD pins of the μPD16431A.

① to ⑧ indicate column positions in the 14-segment display area. "a" through "n" indicate the following 14 segments.

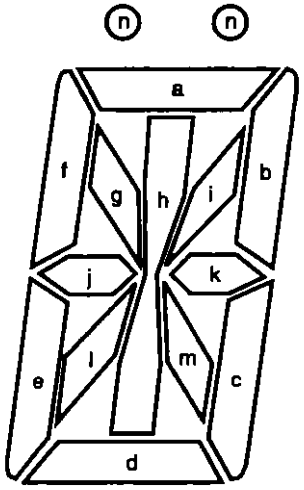


Table 5-1 Assignment of LCD Pins of μPD16431A (1/2)

Segment \ Common	COM_1 (21)	COM_2 (22)	COM_3 (23)	COM_4 (24)
SEG_1 (25)	⑧n	⑧b	⑧c	CH
SEG_2 (26)	⑧i	⑧k	⑧m	—
SEG_3 (27)	⑧a	⑧h	⑧d	—
SEG_4 (28)	⑧g	⑧j	⑧l	—
SEG_5 (29)	PI	⑧f	⑧e	EON
SEG_6 (30)	—	—	—	—
SEG_7 (31)	⑦n	⑦b	⑦c	CT
SEG_8 (32)	⑦i	⑦k	⑦m	—
SEG_9 (33)	⑦a	⑦h	⑦d	M, S
SEG_{10} (34)	⑦g	⑦j	⑦l	—
SEG_{11} (35)	LOC	⑦f	⑦e	ATT
SEG_{12} (36)	—	—	—	—
SEG_{13} (37)	⑥n	⑥b	⑥c	TA/DK
SEG_{14} (38)	⑥i	⑥k	⑥m	—
SEG_{15} (39)	⑥a	⑥h	⑥d	—
SEG_{16} (40)	⑥g	⑥j	⑥l	—
SEG_{17} (41)	ME	⑥f	⑥e	LOUD
SEG_{18} (42)	—	—	—	—
SEG_{19} (43)	⑤n	⑤b	⑤c	TP
SEG_{20} (44)	⑤i	⑤k	⑤m	—
SEG_{21} (45)	⑤a	⑤h	⑤d	—
SEG_{22} (46)	⑤g	⑤j	⑤l	—
SEG_{23} (47)	ASM	⑤f	⑤e	TP/SK
SEG_{24} (48)	—	—	—	—

Remarks 1. —: Not used.

2. The digit in parentheses indicates a pin number of the μPD16431A.

Table 5-1 Assignment of LCD Pins of μPD16431A (2/2)

Segment \ Common	COM_1 (21)	COM_2 (22)	COM_3 (23)	COM_4 (24)
SEG_{25} (49)	④n	④b	④c	—
SEG_{26} (50)	④i	④k	④m	—
SEG_{27} (51)	④a	④h	④d	SHUFF
SEG_{28} (52)	④g	④j	④l	—
SEG_{29} (53)	PSCAN	④f	④e	:
SEG_{30} (54)	—	NR	METAL	AMS
SEG_{31} (55)	③n	③b	③c	.
SEG_{32} (56)	③i	③k	③m	—
SEG_{33} (57)	③a	③h	ALL	—
SEG_{34} (58)	③g	③j	③l	—
SEG_{35} (59)	AUTO	③f	③e	RDS
SEG_{36} (60)	—	—	—	—
SEG_{37} (61)	②n	②b	②c	○
SEG_{38} (62)	②i	②k	②m	—
SEG_{39} (63)	②a	②h	②d	REPEAT
SEG_{40} (64)	②g	②j	②l	—
SEG_{41} (65)	STEREO	②f	②e	MONO
SEG_{42} (66)	—	—	—	—
SEG_{43} (67)	①n	①b	①c	—
SEG_{44} (68)	①i	①k	①m	—
SEG_{45} (69)	①a	①h	①d	SCAN
SEG_{46} (70)	①g	①j	①l	—
SEG_{47} (71)	FM2	①f	①e	FM1
SEG_{48} (72)	REGION	MW	LW	—

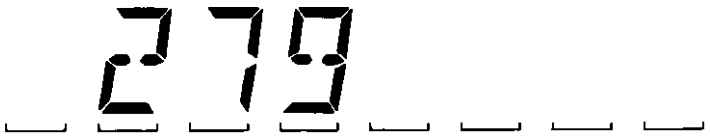
Remarks 1. —: Not used.

2. The digit in parentheses indicates a pin number of the μPD16431A.

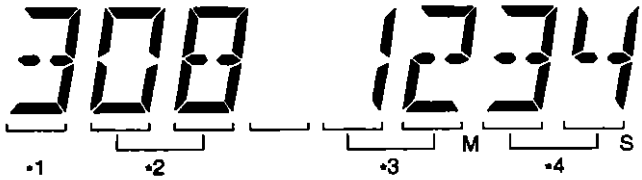
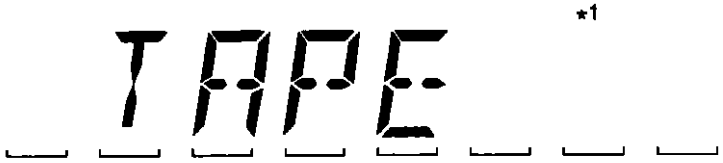
5.3 THE LCD PANEL DISPLAYS

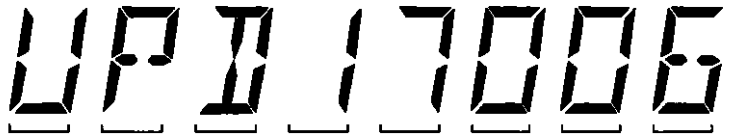
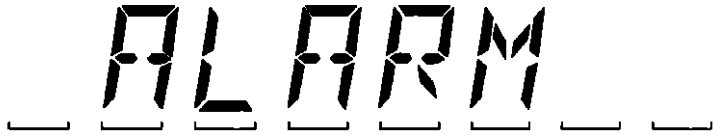
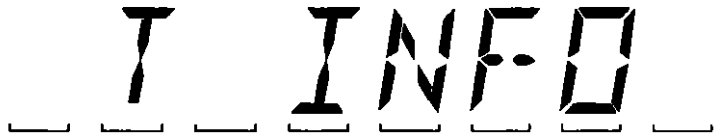
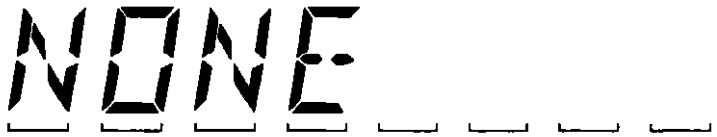
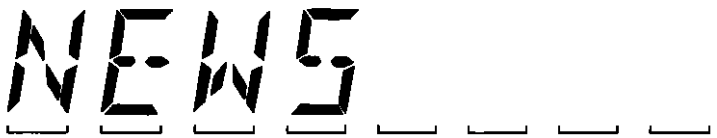
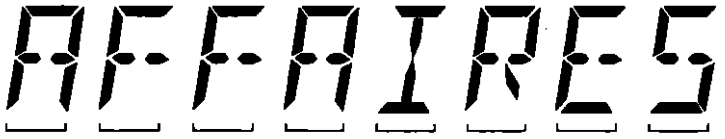
Display	Description
MONO	Indicates that the system is in forced MONO audio output mode. Pressing the [MONO] key while the FM band is selected in radio mode reverses the display.
○	Indicates that the device is tuned to an RDS station. The display turns on when an RDS station in the FM band is received.
RDS	Indicates that the system is in RDS mode. The display turns on when the FM band is selected and RDS mode is set.
TP/SK	Indicates that the system is in TP/SK mode. The display turns on when the FM band is selected and TP/SK mode is set.
TP	Indicates that the device is tuned to a traffic information station. The display turns on when the TP signal of an RDS station or the SK signal of a VF station is detected.
TA/DK	Indicates that the station to which the device is tuned is broadcasting traffic information. The display turns on when the TA signal of an RDS station or the DK signal of a VF station is detected.
EON	Indicates that the station to which the device is tuned is an RDS station and also an EON station. The display turns on when a traffic information station which is also an EON station is received in TP/SK mode.
STEREO	Indicates that a STEREO signal is being input. The display turns on when the FM band is selected and the $\overline{\text{STEREO}}$ pin goes low. This is always off in MONO mode.
PSCAN	Indicates that preset memory scan is being performed. The display turns on when preset memory scan is performed by pressing the [PSCAN] key.
ASM	Indicates that auto-storage is being performed. The display turns on when auto-storage operation is performed by pressing the [ASM] key.
ME	Indicates that writing to preset memory is enabled. The display turns on when writing to the preset memory is enabled by pressing the [ME] key.
LOC	Indicates the LOCAL/DX setting is LOCAL. Pressing the [LOC] key in radio mode reverses the display.
CH	Indicates the channel of a preset memory number. The display turns on when a channel number is displayed in the 14-segment display area.
FM1 FM2 MW LW	Indicate the radio bands.
NR	Indicates that the system is in noise reduction mode. Pressing the [NR] key in tape mode reverses the display.
METAL	Indicates that the system is in metal tape mode. Pressing the [METAL] key in tape mode reverses the display.
AMS	Indicates that the system is in auto music search mode. Pressing the [ASM] key in tape mode reverses the display.
AUTO	Indicates that the tuner is in auto seek mode. This turns off (manual seek mode) when the system is placed in shift mode by pressing the [SHIFT] key in radio mode.

Display	Description
LOUD	Indicates that the loudness function is enabled. Pressing the [LOUD] key reverses the display.
ATT	Indicates that the attenuator is on. Pressing the [ATT] key reverses the display.
PI	Indicates that the system is in PI search mode. The display turns on when the FM band is selected and PI search mode is set.
CT	Indicates that the system is in clock correction mode, where the clock is corrected based on RDS data. The display turns on when the FM band Is selected and clock correction mode is set.
REGION	Indicates that the system is in region mode. The display turns on when the FM band is selected and region mode is set.
SCAN	Indicates that the system is performing scanning in CD changer mode. This indication appears while a scan operation is being performed in CD changer mode.
REPEAT	Indicates that the system is performing a repeat operation in CD changer mode. This Indication appears while a repeat operation is being performed in CD changer mode.
ALL	This indication appears at the same time as "SCAN" and "REPEAT."
SHUFF	Indicates that the system is set to shuffle operation in CD changer mode. This indication appears while shuffle operation is set in CD changer mode.

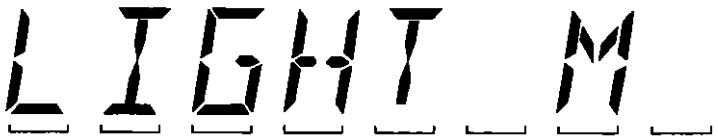
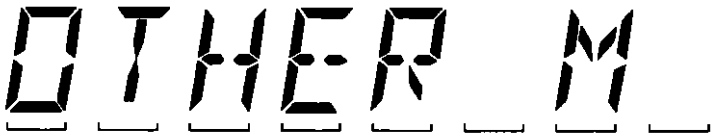
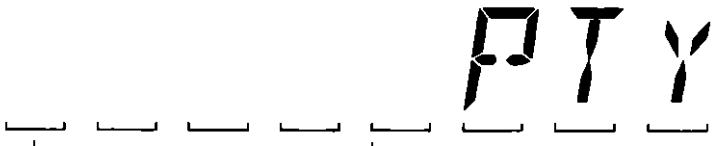
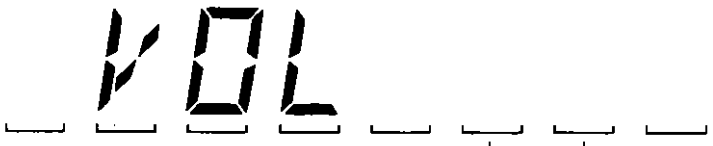
Display	Description
▶ ◀	Indicates the tape running direction. In tape mode, "▶" turns on when the $\overline{R}$/L pin goes low and "◀" turns on when it goes high.
14-segment display area	Displays the following: (1) Received frequency (2) Clock (3) CD changer (4) Tape (5) PS (Program Service Name) (6) PTY alarm (7) Indication that traffic information is being broadcast in TP/SK mode (8) PTY code (9) Electronic volume control **(1) Received frequency display** **① In the FM band (108.00 MHz)**  **② In the MW band (1620 kHz)**  **③ LW band (279 kHz)** 

Display	Description
14-segment display area	**(2) Clock display** Initial setting diode CLK24 switch is used to select 12-hour or 24-hour clock display. The colon ":" can be flashed at 1 Hz by setting initial setting diode FLASH switch. **① When CLK24 is set to 1 (9:00 p.m.)**  **② When CLK24 is set to 0 (9:00 p.m.)**  **③ When CLK24 is set to 0 (11:59 a.m.)** 

Display	Description
14-segment display area	(3) **CD changer display** When the system enters CD changer mode, the following is displayed: Also, the "M" and "S" indicators appear during playback. ① **For disc check**  ② **For no disc**  ③ **For playback (disc 3, track 8, 12 minutes 34 seconds)**  *1 Number of disc being played back. *2 Number of track being played back. *3 Minutes played back. *4 Seconds played back. (4) **Tape display** When the system enters tape mode, the following is displayed:  *1 The tape running direction is displayed in this position. When the direction is from left to right, "▶" is displayed. When the direction is from right to left, "◀" is displayed.

Display	Description
14-segment display area	**(5) PS display** PS data is displayed as follows: **Example:** If PS data is "μPD17006"  **(6) PTY alarm display** When a PTY alarm is read, the following is displayed:  **(7) Display of indication that traffic information is being broadcast in TP/SK mode** The indication of traffic information broadcast in TP/SK mode is displayed as follows:  **(8) PTY code display** A program type (PTY) is displayed as follows: PTY number Displayed PTY 0  1  2 

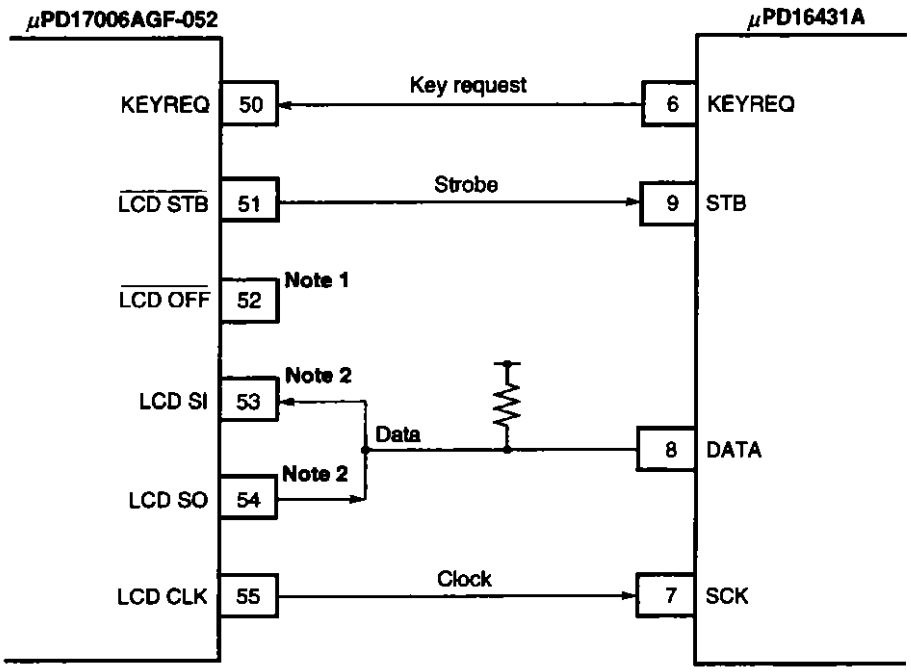
Display	Description
14-segment display area	3 INFO 4 SPORT 5 DRAMA 6 EDUCATE 7 CULTURE 8 SCIENCE 9 VARIED 10 POP M 11 ROCK M

Display	Description
14-segment display area	12  13  14  15  Search for a program based on a program type (PTY search) is displayed as follows:  The frequency is displayed. **(9) Electronic volume control display** **(a) During VOLUME adjustment**  The VOLUME setting is displayed.

Display	Description
14-segment display area	**(b) During BASS adjustment**  *1 "+" or "–" is displayed during BASS adjustment. *2 The BASS setting is displayed. **(c) During TREBLE adjustment**  *1 "+" or "–" is displayed during TREBLE adjustment. *2 The TREBLE setting is displayed. **(d) During BALANCE adjustment**  *1 "L" or "R" is displayed during BALANCE adjustment. *2 The BALANCE setting is displayed. **(e) During FADER adjustment**  *1 "F" or "R" is displayed during FADER adjustment. *2 The FADER setting is displayed.

6. DESCRIPTION OF μPD16431A CONTROL

The μPD17006AGF-052 uses the μPD16431A to control the key scan and the LCD display.
The connection of the μPD17006AGF-052 to the μPD16431A is illustrated below.



Notes 1. The LCD OFF pin (pin 52) is used as the power control pin for the μPD16431A. The setting of initial setting diode CLKDSP changes the state of the output.
See **Section 2.5.1** for details.

2. The controller (μPD17006AGF-052) uses a 3-wire serial line for transmitting and receiving serial data. Connect the controller to the μPD16431A so that 3-to-2 and 2-to-3 wire serial conversion is made.

Caution Connect the OE pin (pin 11) of the μPD16431A to the V_{DD} pin (pin 15).

6.1 KEY SCAN

Key scan using the μPD16431A is performed as follows.

(1) Detecting a pressed key

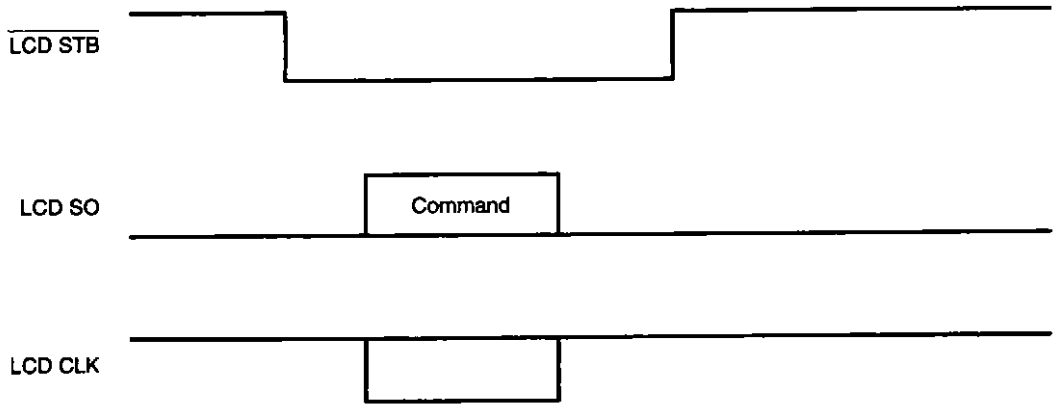
The controller judges the state of the KEYREQ pin (pin 6) of the μPD16431A every 20 ms.
When the KEYREQ pin is high, it is assumed that a key is pressed. Noise elimination (chattering elimination) based on three consecutive matches is applied.
When noise elimination is performed correctly, the key code is read with serial reception.
Key data is received within 20 ms while a key is held down (the KEYREQ pin is high).

(2) Detecting the release of a key

When a key is released, the level of the KEYREQ pin of the μPD16431A goes from high to low. The pin is scanned every 20 ms, and if the low level is detected three times in a row, it is judged that the key has been released.

6.2 INITIALIZATION DATA OUTPUT

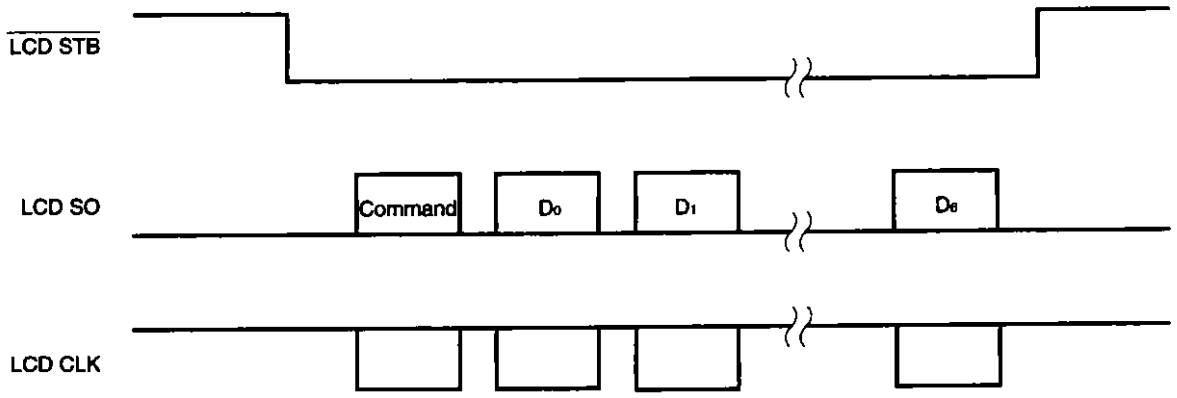
The μPD17006AGF-052 transfers the next initialization data to the μPD16431A about 500 ms after the level of $\overline{\text{LCD OFF}}$ (pin 52) changes from low to high.



Command: 00000000 (initialization command)
1/4 duty cycle, (fosc/128) × n, internal drive voltage, master, and normal operation are initialized.

6.3 DISPLAY DATA OUTPUT

The output of display data to the μPD16431A is shown below.

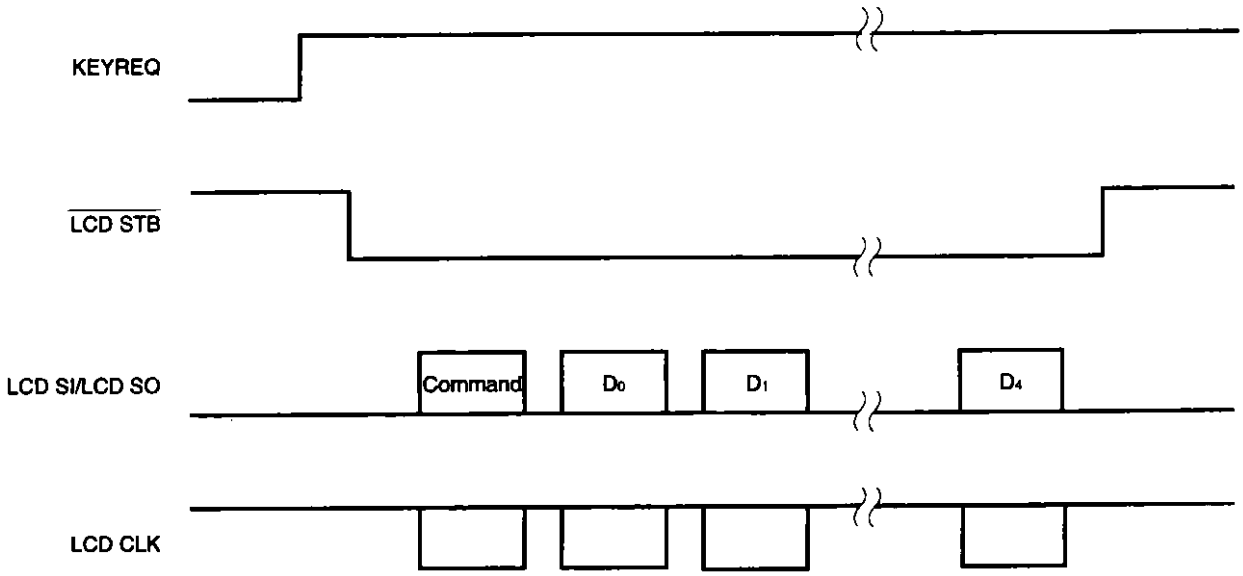


Command : 10000100 (status command (at COM0 output))
: 10001100 (status command (at COM1 output))
: 10010100 (status command (at COM2 output))
: 11001100 (status command (at COM3 output))
D_0 to D_6 : 00000000 (display data)
|
11111111

The above display output is repeated four times when sending display data.

6.4 KEY DATA INPUT/OUTPUT

The input and output of key data to and from the μPD16431A are shown below.



Command : 10000101 (status command (key data readout))

D_0 to D_4 : 00000000 (display data)

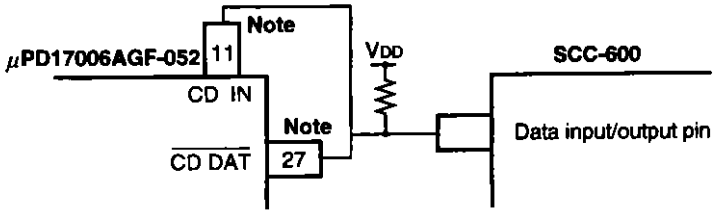
|

11111111

After the status command is sent, key data is read from the LCD SI pin.

7. DESCRIPTION OF CD CHANGER CONTROL

The μPD17006AGF-052 is provided with a CD changer control function.
The pin connection between the μPD17006AGF-052 and SCC-600 (CD changer) is illustrated below.



Note The μPD17006AGF-052 uses a three-wire serial interface for serial data transmission. To connect it to the SCC-600, 3-wire to 2-wire serial conversion is necessary.

8. ELECTRONIC VOLUME CONTROLS

8.1 ELECTRONIC VOLUME CONTROLS

The μPD17006AGF-052 uses an electronic volume control IC for audio control and selection. It supports two types of electronic volume control ICs, the TDA7313 and TEA6300/TEA6320T. Initial setting diode VOL SEL is set depending on which electronic volume control IC is being used.

The following electronic volume controls are supported:

(1) VOLUME (0 to 40)
(2) BASS (–6 to +6)
(3) TREBLE (–6 to +6)
(4) BALANCE (L6 to R6)
(5) FADER (F6 to R6)
(6) LOUDNESS on/off
(7) Attenuator on/off
(8) Audio selector

See the descriptions of the [VOL SEL] key and the [VOL UP] and [VOL DWN] keys for information on how each is adjusted.

8.2 INITIAL VALUES OF ELECTRONIC VOLUME CONTROLS

When the μPD17006AGF-052 is turned on, the initial values of the electronic volume controls are as listed below.

Control	Initial value
VOLUME	20
BASS	0
TREBLE	0
BALANCE	0
FADER	0
LOUDNESS	Off
Attenuator	Off

At CE reset, the same values as those before CE reset are retained.

9. TUNER FUNCTIONS

(1) The four European FM1/FM2/MW/LW bands are selectable by band switching.
(2) Six FM1 stations, six FM2 stations, and six AM stations, or a total of 18 stations, can be stored in the preset memory.
(3) The device supports last station preset memory for one station in each of the FM1, FM2, and AM bands.
(4) The seek UP/DOWN keys can be used to perform auto seek or manual seek by setting or clearing SHIFT mode.
(5) Auto-seek (SEEK) function
(6) Auto-storage (ASM) function
(7) Preset scan (PSCAN) function
(8) Auto-retuning function
(9) Reception of RDS information of an FM broadcast
(10) Reception of VF (ARI) of an FM broadcast
(11) Traffic information standby function

9.1 TUNING FUNCTIONS

9.1.1 Manual Tuning UP/DOWN

- Manual tuning is performed with the SEEK UP / SEEK DWN keys when SHIFT mode is set.
- Pressing the keys for a short time (less than 0.5 seconds) causes the frequency to go up or down by one channel separation.
- Pressing the keys for 0.5 seconds or longer causes the frequency to go up or down continuously, one channel separation every 30 ms in the FM band, or every 50 ms in the AM band, until the keys are released.
- When the maximum frequency is reached when pressing the SEEK UP key, scanning continues from the minimum frequency. When the minimum frequency is exceeded by pressing the SEEK DWN key, scanning continues from the maximum frequency.
- When scanning jumps from the maximum frequency to the minimum frequency, or vice versa, the frequency is retained for about 200 ms after the transition.
- Whichever key is pressed first takes precedence; pressing the SEEK DWN key while the SEEK UP key is being held down does not stop ascending seek. Only after the SEEK UP key is released does descending seek begin.

9.1.2 Auto-Seek (SEEK) UP/DOWN

- Pressing the SEEK UP or SEEK DWN key in a mode other than SHIFT mode starts seek tuning.
- During seek tuning, it is judged that a station has been detected in the following cases.

FM (AM) SD/IF	Description
0	SD is detected twice, and each time it is judged that a station is detected.
1	An SD and IF count are both detected, and it is judged that a station is detected for both.

FM (AM) SD/IF: Initial setting diodes FM SD/IF and AM SD/IF

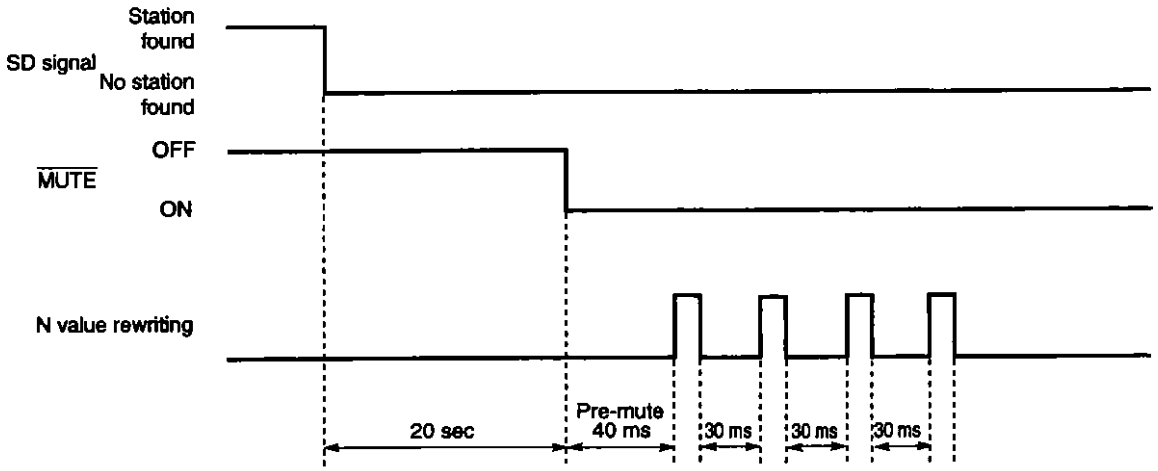
- In the same way as for manual tuning, when the frequency jumps from the maximum frequency to the minimum frequency, or vice versa, the frequency is retained for about 200 ms after the transition.
- Mute is output during seek.
- Pressing the SEEK UP or SEEK DWN key again during seek abandons the seek and recalls the station received before the seek was started.

9.1.3 Preset Scan (PSCAN)

- Pressing the [PSCAN/ASM] key starts preset scan.
- If the device is tuned to a preset station, preset scan starts from the next preset station. Otherwise, preset scan starts from the preset station corresponding to M1.
- Preset scan recalls a station from preset memory and tunes to that station for five seconds. If the recalled station is an RDS station but cannot be received, AF switching is performed (PI operation is not performed).
- Pressing the [PSCAN/ASM] key during preset scan stops the preset scan and retains the current preset station.

9.1.4 Auto-Retuning

- Auto-retuning is performed only when initial setting diode RETUNE is set to 1.
  If the signal of the station to which the device is tuned becomes weak, auto-retuning is performed automatically to search for another station.
- Auto retuning entails performing the same operation as that of seek up if the SD signal remains in the no-station state for 20 seconds.



9.1.5 Writing to and Reading from Preset Memory

- Writing to and reading from preset memory are performed by pressing keys [M1] to [M6].
- **When initial setting diode MESEL is set to 0**
  Pressing one of keys [M1] to [M6] and releasing it within two seconds recalls the stored frequency. Pressing the key and holding it down for two seconds or longer writes the displayed frequency to the corresponding preset memory location.
- **When initial setting diode MESEL is set to 1**
  In the ME state, pressing one of keys [M1] to [M6] writes the displayed frequency to the corresponding preset memory location.
  In other than the ME state, pressing one of keys [M1] to [M6] recalls the stored frequency.

9.1.6 Auto-Storage (ASM) Operation

- Pressing the [PSCAN/ASM] key and holding it down for two seconds or longer starts auto-storage.
- Auto-storage operation searches for stations throughout the selected band, from the minimum frequency to the highest frequency, writes as many stations as the maximum number of preset stations, starting with that having the highest SD level, and finally sorts them according to frequency.
- After the operation, the device tunes to the station corresponding to M1. If no station is detected, the device again tunes to the frequency being received when the above operation was started.

- If another station is found after stations have been assigned to all at M1 to M6, ASM operation continues if the SD level of the station is lower than that of the stations assigned to M1 to M6.
  If the SD level is higher than that of at least one of the assigned stations, SD sort is performed, the memory location storing the station with the lowest SD level is overwritten with the newly found station, the stations are reordered starting with that having the highest SD level, and ASM operation continues.
  If stations having an identical SD level are found, the one found later is assumed to have the higher SD level.
- If the detected stations are fewer than the maximum number of preset stations, the stations are written sequentially into the preset memory and sorted by frequency. The remaining preset memory locations retain the same data as was set before auto-storage was started.
- If auto-storage is stopped before being completed, the operation will be the same as that performed when fewer stations than the maximum number of preset stations are found.

9.2 TUNER MUTE

The operations of the tuner functions and the output of the $\overline{\text{MUTE}}$ pin are explained in the following order:

(1) Preset read (Section 9.2.1)
(2) Preset scan (Section 9.2.2)
(3) Preset write (Section 9.2.3)
(4) Seek up/down (Section 9.2.4)
(5) Manual up/down (Section 9.2.5)
(6) Auto-storage (Section 9.2.6)
(7) AF switching (Section 9.2.7)
(8) EON switching (Section 9.2.8)

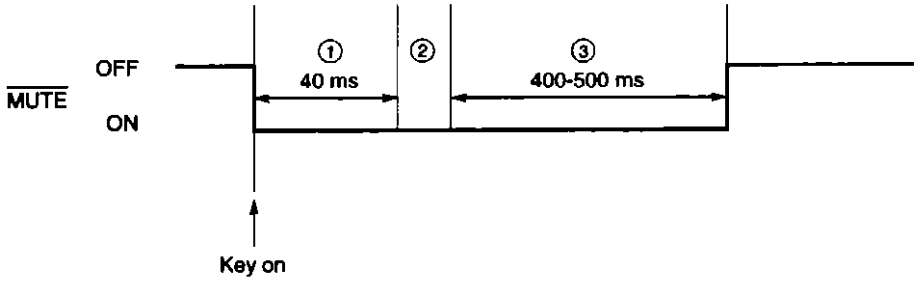
9.2.1 Preset Read

In tuner mode, pressing one of keys M1 to M6 for less than two seconds when initial setting diode MESEL has been set to 0, or pressing the key when MESEL is set to 1 and in a state other than the preset memory write enabled state, reading from preset memory is performed.

The figure below shows the timing chart for preset read.

If the station read by means of preset read is an RDS station, AF operation is performed. (See **Section 3.2.4.**)

Fig. 9-1 Preset Read Timing Chart



① Preceding mute and beep output
② Division ratio setting
③ Following mute

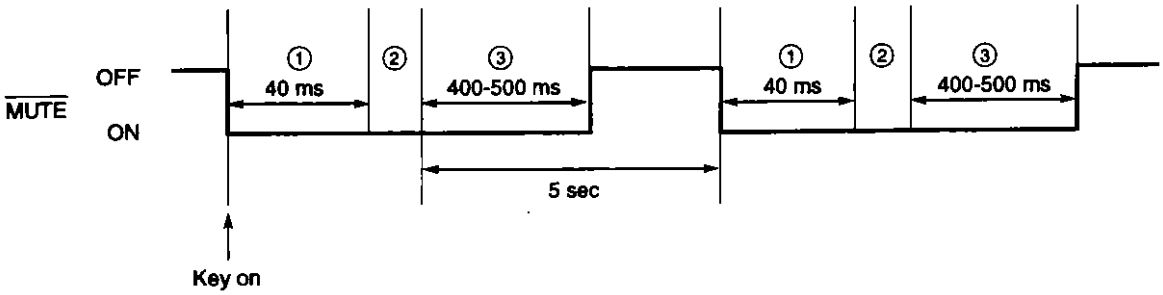
9.2.2 Preset Scan

Pressing the PSCAN/ASM key tuner mode starts preset scan.

The figure below shows the timing chart for preset scan.

If a station scanned by preset scan is an RDS station, AF operation is performed. (See **Section 3.2.4.**)

Fig. 9-2 Preset Scan Timing Chart



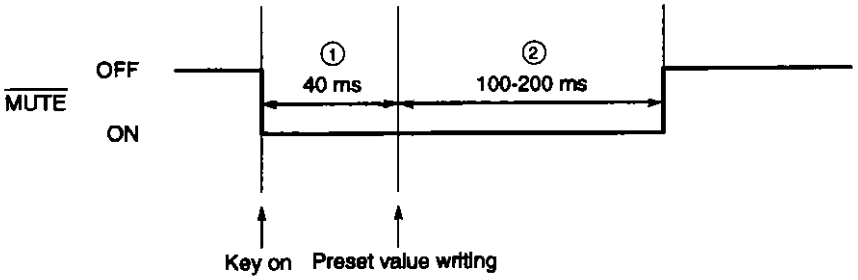
① Preceding mute and beep output
② Division ratio setting
③ Following mute

9.2.3 Preset Write

In tuner mode, pressing one of keys M1 to M6 for less than two seconds when initial setting diode MESEL is set to 0, or by pressing the key when MESEL is set to 1 and in a state other than the preset memory write enabled state, writing to preset memory is performed.

The figure below shows the timing chart for preset write.

Fig. 9-3 Preset Write Timing Chart



① Preceding mute and beep output
② Following mute

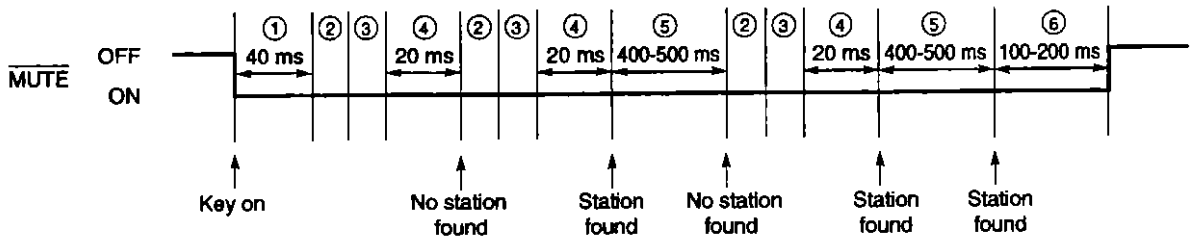
9.2.4 Seek Up/Down

In tuner mode, pressing the SEEK UP and SEEK DWN keys in other than shift mode starts ascending or descending seek, respectively.

If the following conditions are judged and satisfied two times at 500 ms intervals, it is assumed that a station has been detected, and seek ends.

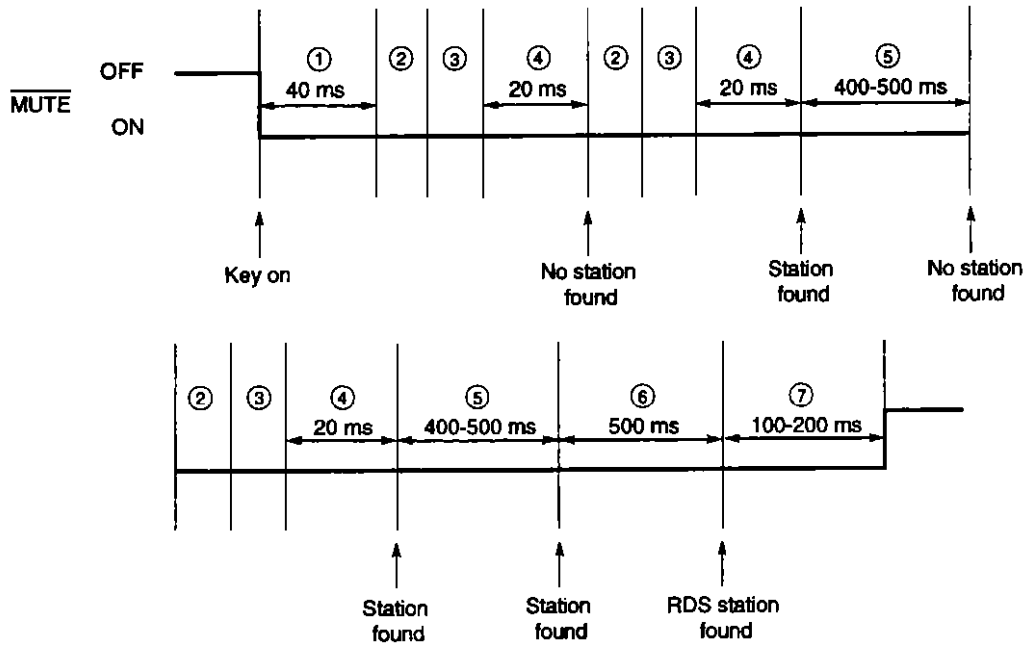
- The $\overline{SD}$ pin (pin 74) is at the low level.
- IF count judgment (only when initial setting diode AM SD/IF or FM SD/IF is set to 1)
  In RDS and TP/SK modes, once the above conditions have been satisfied, RDS station detection and traffic station detection are performed according to the following timings.

Fig. 9-4 Seek Up/Down Timing Chart (Normal Mode)



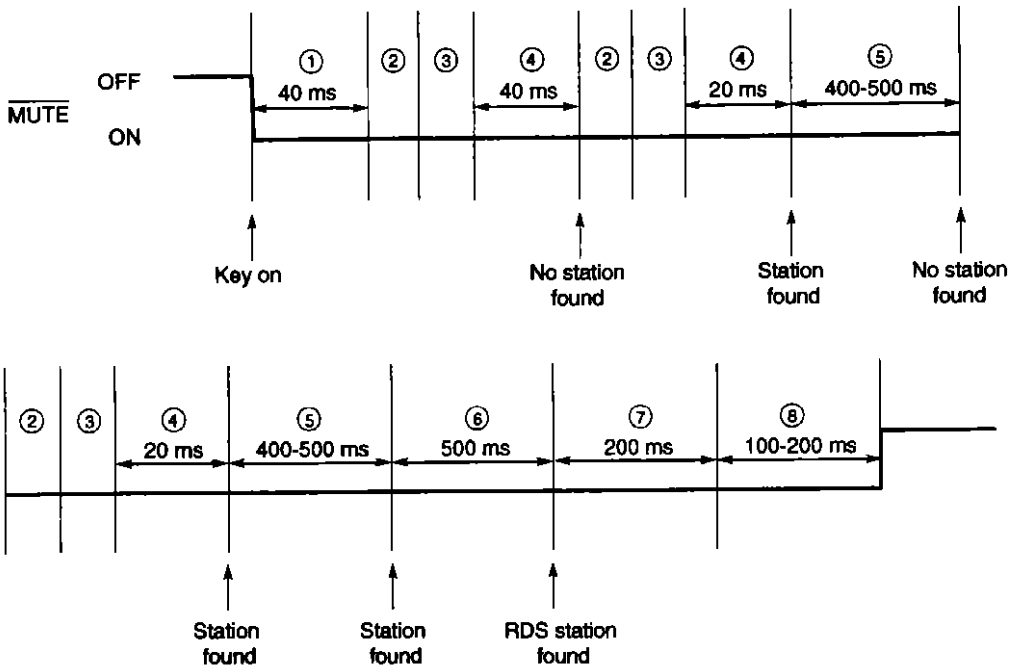
① Preceding mute and beep output
② Division ratio setting
③ PLL wait
④ SD stabilization wait (1)
⑤ SD stabilization wait (2)
⑥ Following mute (400 to 500 ms when a band edge is detected)

Fig. 9-5 Seek Up/Down Timing Chart (RDS Mode)



① Preceding mute and beep output
② Division ratio setting
③ PLL wait
④ SD stabilization wait (1)
⑤ SD stabilization wait (2)
⑥ RDS station detection wait
⑦ Following mute (400 to 500 ms when a band edge is detected)

Fig. 9-6 Timing Chart of Seek Up/Down (TP/SK Mode)



① Preceding mute and beep output
② Division ratio setting
③ PLL wait
④ SD stabilization wait (1)
⑤ SD stabilization wait (2)
⑥ RDS station detection wait
⑦ Traffic information station identification (TP/SK) wait
⑧ Following mute (400 to 500 ms when a band edge is detected)

9.2.5 Manual Up/Down

In tuner mode, pressing the SEEK UP and SEEK DWN keys in shift mode starts manual ascending or descending seek, respectively.

The figures below show the timing charts for manual seek.

Fig. 9-7 Manual Seek Timing Chart (When the Key is Pressed and Released Within 0.5 Seconds)

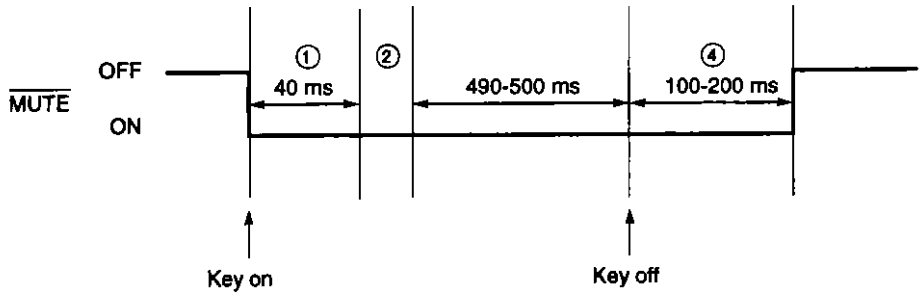
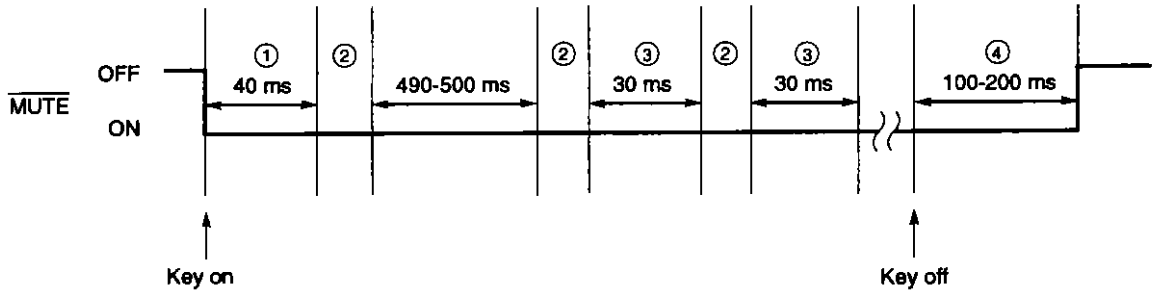


Fig. 9-8 Manual Seek Timing Chart (When the Key is Pressed and Held Down for 0.5 Seconds or Longer)



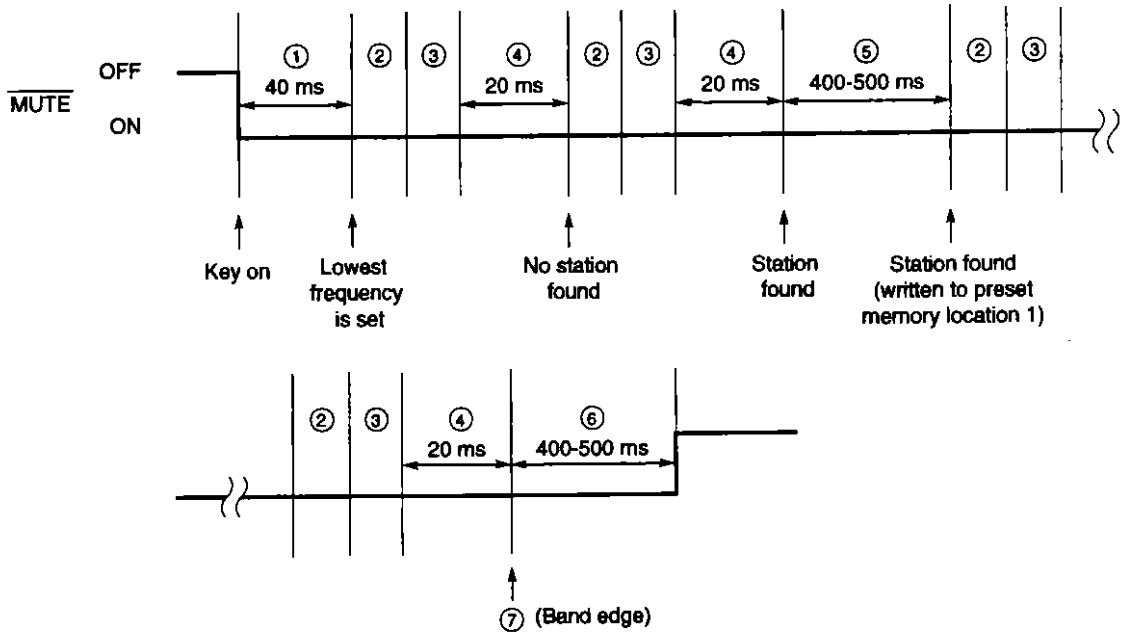
① Preceding mute and beep output
② Division ratio setting
③ Key repeat time (when the FM band is selected. 50 ms in the AM band; and 200 ms in both the AM and FM bands when a band edge is detected)
④ Following mute (400 to 500 ms when a band edge is detected)

9.2.6 Auto-Storage

Pressing the PSCAN/ASM key in tuner mode starts auto-storage.

The figure below shows the timing chart for auto-storage.

Fig. 9-9 Auto-Storage Operation Timing Chart



① Preceding mute and beep output
② Division ratio setting
③ PLL wait
④ SD stabilization wait (1)
⑤ SD stabilization wait (2)
⑥ Following mute
⑦ End of ASM. The stations are sorted into ascending order by frequency and the station corresponding to preset memory location M1 is recalled.
If no station is detected, the same frequencies as those before the key was pressed will be retained.
If a station is detected after the stations have been written to the preset memory locations corresponding to M1 to M6, the SD level of the detected station is compared with those of the preset stations, the station replaces the preset station having the lowest SD level, and the preset stations are sorted into order, starting with that having the highest SD level.

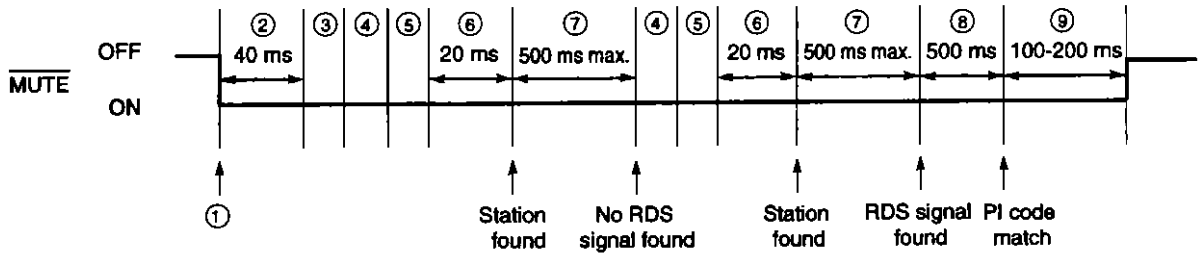
9.2.7 AF Switching

AF switching can be performed in either of two ways:

(1) AF switching of all stations at one time (see **Fig. 9-10**)
(2) AF switching of one station at a time (interval: 5 seconds, see **Fig. 9-11**)

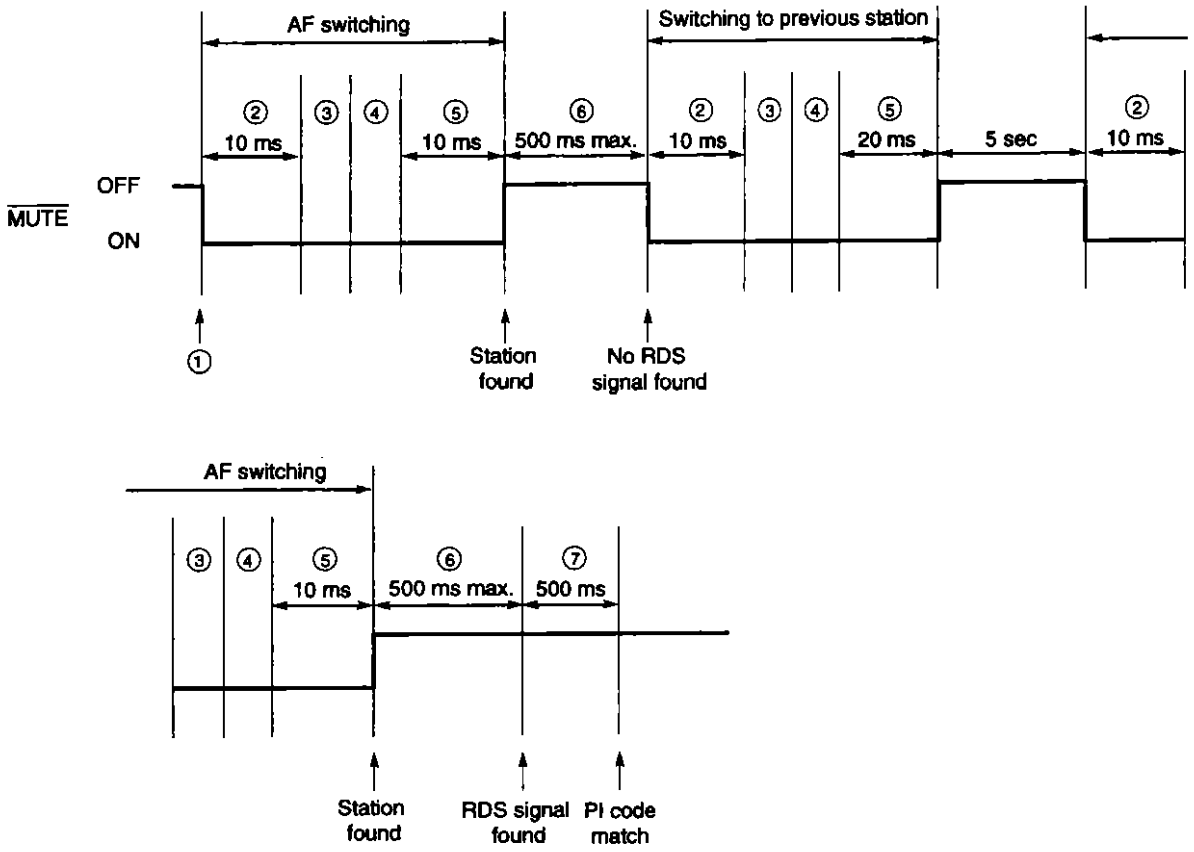
The figures below show the timing charts for the above operations.
See **Section 3.2.4** for details of the conditions that must be satisfied to enable AF operation.

Fig. 9-10 Timing Chart for AF Switching of All Stations at One Time



① Occurrence of conditions for AF switching
② Preceding mute wait
③ SD sort (The stations in the AF list that have SD are judged and sorted in to order according to frequency beforehand.)
④ Division ratio setting
⑤ PLL wait
⑥ SD stabilization wait
⑦ RDS station detection wait
⑧ PI code read wait
⑨ Following mute

Fig. 9-11 Timing Chart for AF Switching One Station at a Time



① Occurrence of conditions for AF switching
② Preceding mute wait
③ Division ratio setting
④ PLL wait
⑤ SD stabilization wait
⑥ RDS station detection wait
⑦ PI code read wait

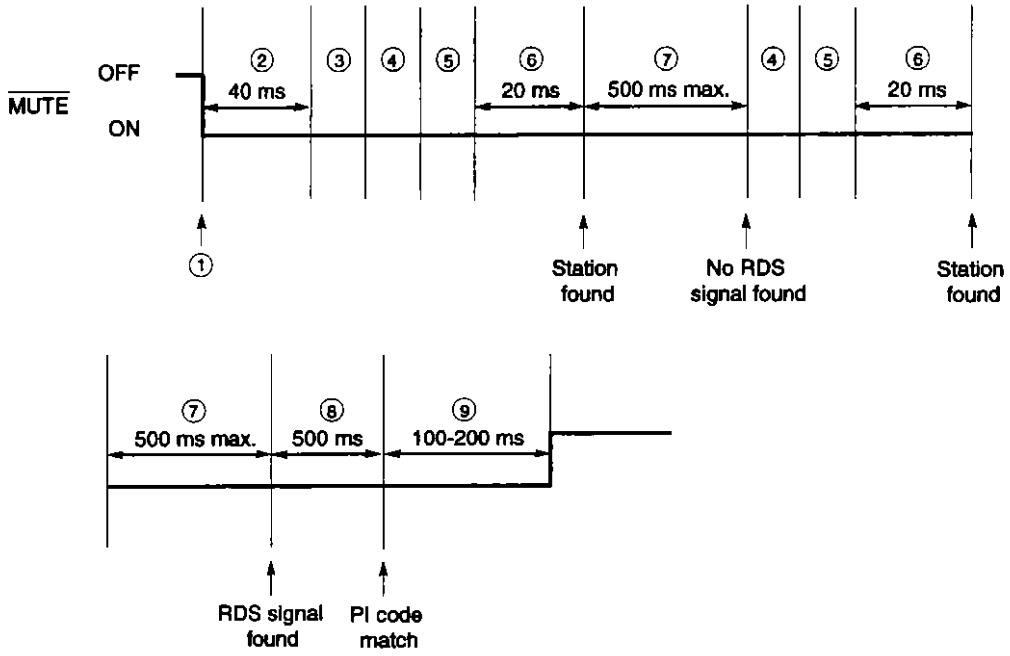
9.2.8 EON Switching

EON switching can be performed in either of two ways:

(1) Switching from a received station to an EON station (see **Figs. 9-12 and 9-13**)
(2) Switching from an EON station to a received station (see **Fig. 9-14**)

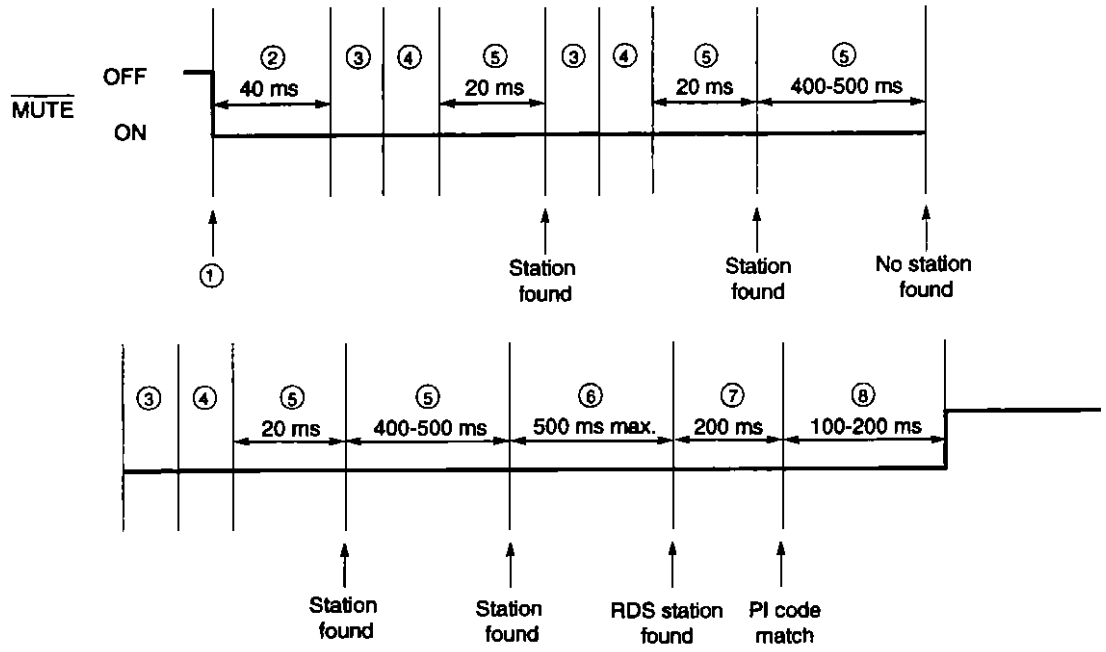
See **Section 3.2.6** for details of the conditions that must be satisfied to enable EON operation.

Fig. 9-12 Timing Chart for Switching to an EON Station (When the Preset Memory Has the Same PI Code as That of the EON Station)



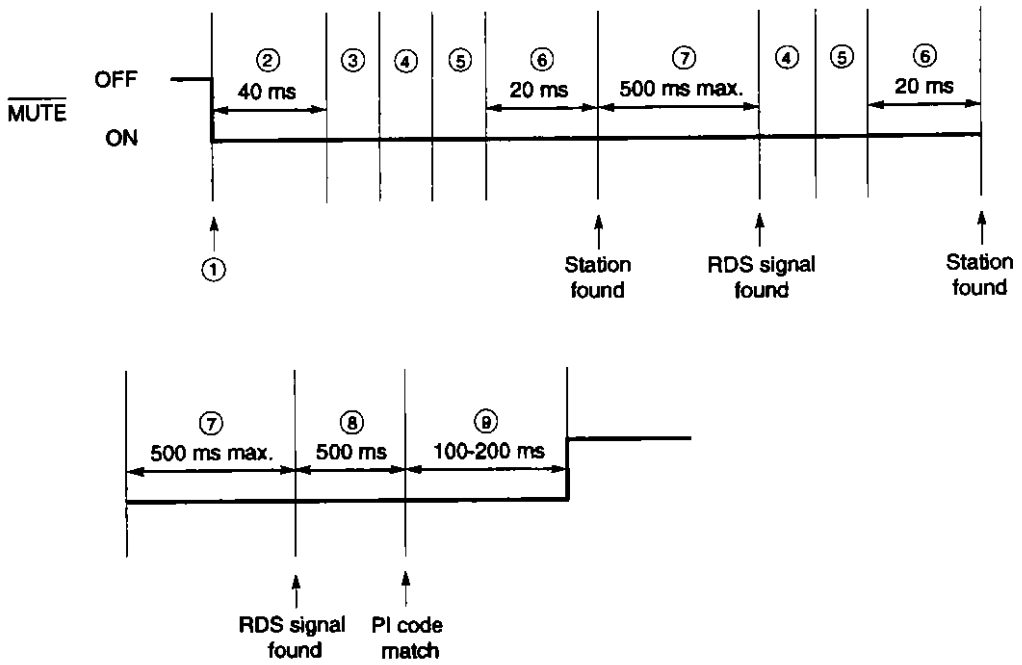
① Occurrence of conditions for switching to an EON station
② Preceding mute
③ SD sort (The stations in the AF list that have SD are judged and sorted into order according to frequency beforehand.)
④ Division ratio setting
⑤ PLL wait
⑥ SD stabilization wait
⑦ RDS station detection wait
⑧ PI code read wait
⑨ Following mute

Fig. 9-13 Timing Chart for Switching to an EON Station (When the Preset Memory Does Not Have the Same PI Code as That of the EON Station)



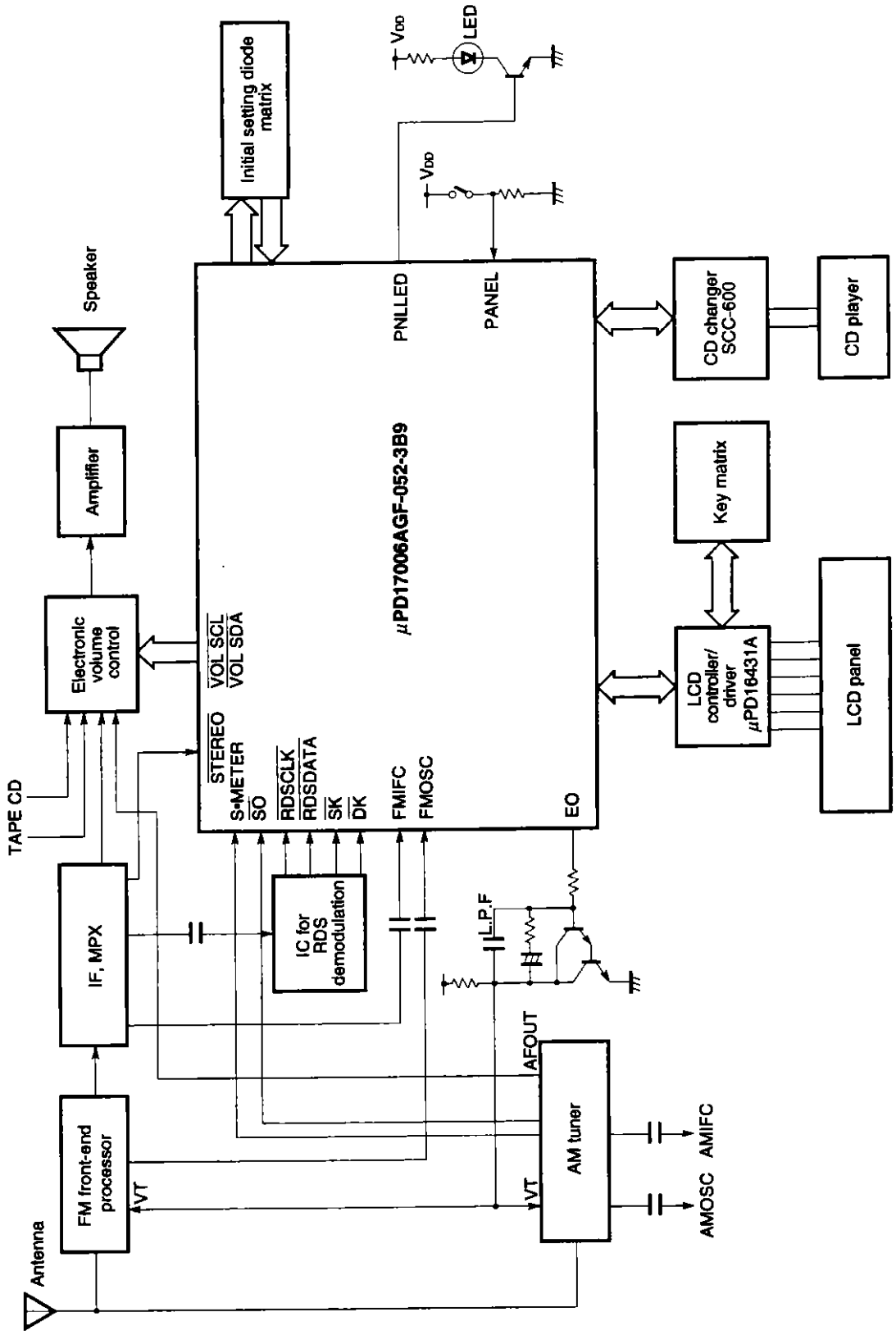
① Occurrence of conditions for switching to an EON station
② Preceding mute
③ Division ratio setting
④ PLL wait
⑤ SD stabilization wait
⑥ RDS station detection wait
⑦ PI code read wait
⑧ Following mute

Fig. 9-14 Timing Chart for Switching to the Previously Received Station



① Occurrence of conditions enabling switching to the previous station
② Preceding mute
③ SD sort (The stations in the AF list that have SD are judged and sorted into order according to frequency beforehand.)
④ Division ratio setting
⑤ PLL wait
⑥ SD stabilization wait
⑦ RDS station detection wait
⑧ PI code read wait
⑨ Following mute

10. SAMPLE APPLICATION CIRCUIT



11. ELECTRICAL CHARACTERISTICS (PRELIMINARY)

ABSOLUTE MAXIMUM RATINGS (T_A = 25 ±2°C)

Parameter	Symbol	Conditions	Rated value	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 $P0A_2$, $P0A_3$, $P1B_1$, $P1B_2$, and $P1B_3$	−0.3 to V_{DD} + 0.3	V
Output high current	I_{OH}	Each pin	−10.0	mA
		Total for all pins	−20.0	mA
Output low current	I_{OL}	Each pin	10.0	mA
		Total for all pins	20.0	mA
Output withstand voltage	V_{BDS1}	$P1B_1$-$P1B_3$	−0.3 to +13.0	V
	V_{BDS2}	$P0A_2$, $P0A_3$	−0.3 to V_{DD} + 0.3	V
Total loss	P_I		450	mW
Operating ambient temperature	T_A		−40 to +85	°C
Storage temperature	T_{stg}		−55 to +125	°C

Caution Absolute maximum ratings are rated values beyond which some physical damages may be caused to the product; if any of the parameters in the table above exceeds its rated value even for a moment, the quality of the product may deteriorate. Be sure to use the product within the rated values.

RECOMMENDED OPERATING RANGES (T_A = −40 to +85°C)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage	V_{DD1}	While the CPU and PLL are operating	4.5	5.0	5.5	V
	V_{DD2}	While the CPU is operating but the PLL is halted	4.1	5.0	5.5	V
Data hold voltage	V_{DDR}	While the crystal oscillator is halted	2.3		5.5	V
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 withstand voltage	V_{BDS}	$P1B_1$-$P1B_3$			12.0	V
Rise time of supply voltage	t_{RISE}	V_{DD}: 0 → 4.1V			500	ms

DC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 5 V ±10%) (1/2)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply current	I_{DD1}	While the CPU and PLL are operating, with 0.3 V_{P-P} applied to the VCOH pin (at 150 MHz) and a sinusoidal wave applied to the X_{IN} pin (f_{IN} = 4.5 MHz, V_{IN} = V_{DD})		15.0	22.0	mA
	I_{DD2}	While the CPU are operating but the PLL is halted, with a sinusoidal wave applied to the X_{IN} pin (f_{IN} = 4.5 MHz, V_{IN} = V_{DD})		3.5	9.0	mA
	I_{DD3}	While the CPU and PLL are operating, in HALT mode, with 0.3 V_{P-P} applied to the VCOH pin (at 150 MHz) and a sinusoidal wave applied to the X_{IN} pin (f_{IN} = 4.5 MHz, V_{IN} = V_{DD}) (without HALT release conditions)			17.0	mA
	I_{DD4}	While the CPU are operating but the PLL is halted, in HALT mode, with a sinusoidal wave applied to the X_{IN} pin (f_{IN} = 4.5 MHz, V_{IN} = V_{DD}) (20 instructions are executed every 1 ms.)		0.5	1.2	mA
Data hold voltage	V_{DDR1}	While the crystal oscillator is operating, with the timer flip-flop used for detecting power interruption	4.1		5.5	V
	V_{DDR2}	While the crystal oscillator is halted, with the timer flip-flop used for detecting power interruption	2.3		5.5	V
	V_{DDR3}	When data memory contents are held	2.0		5.5	V
Data hold current	I_{DDR1}	While the crystal oscillator is halted; V_{DD} = 5 V, T_A = 25°C		2	5	μA
	I_{DDR2}			2	20	μA
Input high voltage	V_{IH1}	$P0A_0$, $P0A_3$, $P0B_0$, $P0B_1$, $P0B_3$, $P0C_0$-$P0C_3$, $P2A_0$-$P2A_3$, $P2B_0$-$P2B_3$, $P2C_0$-$P2C_3$, $P2D_0$-$P2D_3$, $P3A_0$-$P3A_3$, $P3B_0$-$P3B_3$	0.7V_{DD}			V
	V_{IH2}	CE, INT_0, INT_1, $P0A_2$/SCL, $P0A_1$/SCK_0, $P0B_2$/SCK_1	0.8V_{DD}			V
	V_{IH3}	$P0D_0$-$P0D_3$	0.6V_{DD}			V
Input low voltage	V_{IL}	$P0A_0$-$P0A_3$, $P0B_0$-$P0B_3$, $P0C_0$-$P0C_3$, $P0D_0$-$P0D_3$, $P2A_0$-$P2A_3$, $P2B_0$-$P2B_3$, $P2C_0$-$P2C_3$, $P2D_0$-$P2D_3$, $P3A_0$-$P3A_3$, $P3B_0$-$P3B_3$, CE, INT_0, INT_1			0.2V_{DD}	V
Output high current	I_{OH1}	$P0A_0$, $P0A_1$, $P0B_0$-$P0B_3$, $P0C_0$-$P0C_3$, $P1A_0$-$P1A_3$, $P1B_0$, $P1C_2$, $P2A_0$-$P2A_3$, $P2B_0$-$P2B_3$, $P2C_0$-$P2C_3$, $P2D_0$-$P2D_3$, $P3A_0$-$P3A_3$, $P3B_0$-$P3B_3$, $P3C_0$-$P3C_3$, $P3D_3$, $P4A_2$, $P4A_3$ V_{OH} = V_{DD} – 1 V	–1.0	–2.0		mA
	I_{OH2}	EO_0, EO_1 V_{OH} = V_{DD} – 1 V	–1.0	–3.0		mA
Output low current	I_{OL1}	$P0A_0$, $P0A_1$, $P0B_0$-$P0B_3$, $P0C_0$-$P0C_3$, $P1A_0$-$P1A_3$, $P1B_0$, $P1C_2$, $P2A_0$-$P2A_3$, $P2B_0$-$P2B_3$, $P2C_0$-$P2C_3$, $P2D_0$-$P2D_3$, $P3A_0$-$P3A_3$, $P3B_0$-$P3B_3$, $P3C_0$-$P3C_3$, $P3D_3$, $P4A_2$, $P4A_3$ V_{OL} = 1 V	1.0	2.0		mA
	I_{OL2}	EO_0, EO_1 V_{OL} = 1 V	1.0	3.0		mA
	I_{OL3}	$P1B_1$-$P1B_3$ V_{OL} = 1 V	1.0	2.0		mA
	I_{OL4}	$P0A_2$, $P0A_3$ V_{OL} = 1 V	1.0	10.0		mA

DC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 5 V ±10%) (2/2)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input high current	I_{IH1}	When the VCOH pin is pulled down $V_{IH} = V_{DD}$	0.1	0.8		mA
	I_{IH2}	When the VCOL pin is pulled down $V_{IH} = V_{DD}$	0.1	0.8		mA
	I_{IH3}	When the X_{IN} pin is pulled down $V_{IH} = V_{DD}$	0.1	1.3		mA
Output-off leakage current	I_{L1}	$P0A_2$, $P0A_3$ $V_{OH} = V_{DD}$			1	μA
	I_{L2}	$P1B_1$-$P1B_3$ V_{OH} = 12 V			1	μA
	I_{L3}	EO_0, EO_1 $V_{OH} = V_{DD}$, V_{OL} = 0 V			±1	μA

AC CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 5 V ±10%)

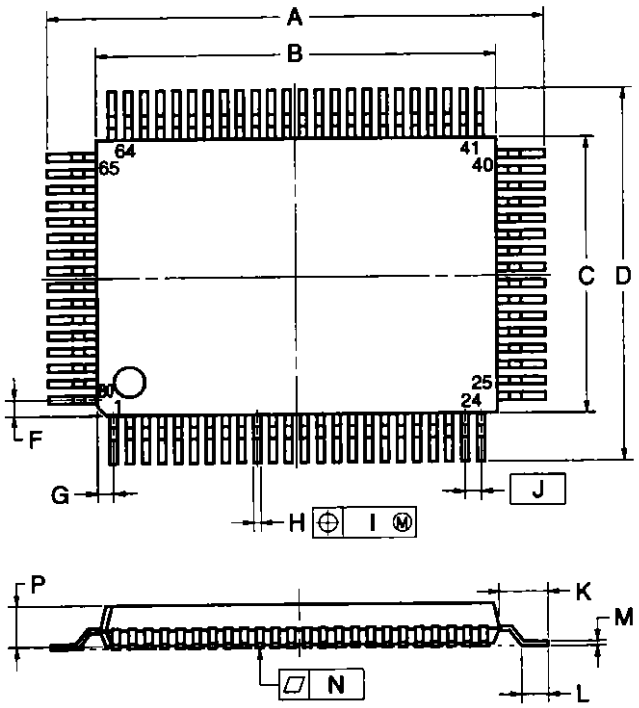
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating frequency	f_{IN1}	VCOL pin in MF mode, with a sinusoidal wave applied at $V_{IN} = 0.3V_{p-p}$	0.5		25	MHz
	f_{IN2}	VCOH pin, with a sinusoidal wave applied at $V_{IN} = 0.3V_{p-p}$	15		150	MHz
	f_{IN3}	AMIFC pin, with a sinusoidal wave applied at $V_{IN} = 0.3V_{p-p}$	0.1		1	MHz
	f_{IN4}	AMIFC pin, with a sinusoidal wave applied at $V_{IN} = 0.15V_{p-p}$	0.4		0.5	MHz
	f_{IN5}	FMIFC pin, with a sinusoidal wave applied at $V_{IN} = 0.3V_{p-p}$	5		13	MHz
	f_{IN6}	FMIFC pin, with a sinusoidal wave applied at $V_{IN} = 0.15V_{p-p}$	10		11	MHz

A/D CONVERTER CHARACTERISTICS (T_A = –40 to +85°C, V_{DD} = 5 V ±10%)

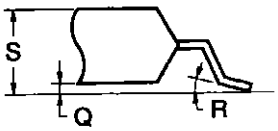
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
A/D conversion resolution					8	bit
Total error in A/D conversion		T_A = –10 to +50°C		±1.5		LSB

12. 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	0.10	0.004
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-80-3B9-3

Cautions on CMOS Devices

① **Countermeasures against static electricity for all MOSs**

Caution When handling MOS devices, take care so that they are not electrostatically charged.

Strong static electricity may cause dielectric breakdown in gates. When transporting or storing MOS devices, use conductive trays, magazine cases, shock absorbers, or metal cases that NEC uses for packaging and shipping. Be sure to ground MOS devices during assembling. Do not allow MOS devices to stand on plastic plates or do not touch pins.

Also handle boards on which MOS devices are mounted in the same way.

② **CMOS-specific handling of unused input pins**

Caution Hold CMOS devices at a fixed input level.

Unlike bipolar or NMOS devices, if a CMOS device is operated with no input, an intermediate-level input may be caused by noise. This allows current to flow in the CMOS device, resulting in a malfunction. Use a pull-up or pull-down resistor to hold a fixed input level. Since unused pins may function as output pins at unexpected times, each unused pin should be separately connected to the V_{DD} or GND pin through a resistor.

If handling of unused pins is documented, follow the instructions in the document.

③ **Statuses of all MOS devices at initialization**

Caution The initial status of a MOS device is unpredictable when power is turned on.

Since characteristics of a MOS device are determined by the amount of ions implanted in molecules, the initial status cannot be determined in the manufacture process. NEC has no responsibility for the output statuses of pins, input and output settings, and the contents of registers at power on. However, NEC assures operation after reset and items for mode setting if they are defined.

When you turn on a device having a reset function, be sure to reset the device first.

Caution This product contains an I^2C bus interface circuit.

When using the I^2C bus interface, notify its use to NEC when ordering custom code. NEC can guarantee the following only when the customer informs NEC of the use of the interface:

Purchase of NEC I^2C components conveys a license under the Philips I^2C Patent Rights to use these components in an I^2C system, provided that the system conforms to the I^2C Standard Specification as defined by Philips.

Regional Information

Some information contained in this document may vary from country to country. Before using any NEC product in your application, please contact the NEC office in your country to obtain a list of authorized representatives and distributors. They will verify:

- Device availability
- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

In addition, trademarks, registered trademarks, export restrictions, and other legal issues may also vary from country to country.

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J96. 3

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

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